HYBRID SYSTEM
FOR
INNOVATIVE DESIGN

A Thesis submitted for the degree
of Doctor of Philosophy

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Abstract

The thesis focuses on in two vital and interrelated aspects of *modelling design support systems*, they are: how innovative solutions may arise, and the knowledge-base's extension and maintenance.

The dilemma *'reproduction versus creativity'* is identified as one of the main deadlocks that the design methods' debate, research in Computer Aided Architectural Design, CAAD, and Artificial Intelligence, AI, have faced in the last thirty years.

A hybrid approach is then proposed as a means of overcoming these difficulties, where a rudimentary evolving design support environment is developed. It draws inspiration from three areas of Artificial Intelligence: knowledge-base systems, connectionist models, and case-based reasoning (CBR). However, it differs fundamentally from conventional knowledge-base systems, connectionist models and CBR tools, in its architecture, although strongly inspired by these underlying theories.

The main benefits and contributions of this hybrid system are an incremental self-extending feature able to minimise substantially the dependency on knowledge engineer intervention, and an interactive support to innovation by augmenting the designer's creativity.

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Chapter 1

Introduction

The notions of 'creative', 'innovative' and 'routine' have generated inconclusive debate along the years, particularly in design theory research. The very formal definitions of these words expose the difficulties in establishing precise boundaries between these ideas. The 'Longman Dictionary of Contemporary English' defines the words 'creative', 'innovative' and 'routine' as follow:

> *"**Creative** 1: producing new and original ideas and things; 2: resulting from newness of thought or expression..." (Longman, 1987:241)*

> *"**Innovative** 1: newly invented or introduced; different from, especially better or cleverer than previous ones... 2: tending or liking to introduce new ideas or methods..." (Longman, 1987: 541)*

> *"**Routine** 1: regular; according to what is always habitually done; not special... 2: not unusual or exciting..." (Longman, 1987: 912)*

In spite of not being difficult to distinguish intuitively between 'creative' and 'routine' it is very difficult to establish precise boundaries between 'creative' and 'innovative'. The description of 'innovative' might suggested something more incremental and perhaps lesser than 'creative', through the notion of "especially better or cleverer than previous ones". However, it is still difficult to suppose that a clear distinction can be established in practice from these definitions. The attempt to clarifying the meaning of some of the used words such as 'new', ‘original’, ‘different’, ‘better’, ‘cleverer’ or ‘regular’ unveils how those descriptions are prone to produce continuous regression of context.

1.1 Creativity in design:

Attempts have been made to define expressions such as 'creative design', 'innovative design' and 'routine design' in the recent history of research in design theory. Gero and Maher (Gero et al, 1993) suggest two basic categories of design: routine and nonroutine designs. Nonroutine design would have two subcategories: innovative and creative.

> *"Routine designs may be defined as the ones that are recognised as not being different from previously produced designs in their class in any substantive way... What makes these designs similar, it can be argued, is that they all exhibit the same properties with different magnitudes. More formally, we state that these designers all chose to use the same design variables to work with and produce different values for those variables dependent on their perception of the situation".(Gero et al, 1993: 2)*

> *"Nonroutine design may be defined as ones that are recognised as being different from previously produced designs in their class in some substantive sense... It is convenient to draw a further distinction within nonroutine design. We label these two subcategories as innovative and creative design". (Gero et al, 1993: 2)*

> *"In innovative design we recognise that the substantive difference has come about from a particular set of values for the design variables that are outside the commonly used range. For example, in designing a camera with a zoom lens, the focal length of such lenses is normally 35 mm to 105 mm, however a designer may wish to use a range of 28 mm to 135 mm. This is likely to result in a longer, heavier lens but*

may well not produce any other changes. The camera would still look, feel, and work like any other similar zoom lens camera. This design could be considered innovative". (Gero et al, 1993: 2)

"In creative designs we recognise that the substantive difference has come about from the introduction of new design variables. For example, in designing telephones, the normal way of allowing the user to move away from the location of a telephone cradle has been to provide a long, extensible cord connecting the handset to the cradle. The introduction of an alternative means of connection of the handset to the cradle based on radio waves produces a design that is seen as being creative". (Gero et al, 1993: 3)

Regardless of how abstract these assertions may be, this kind of formalisation is as prone to generate continuous regress of context as are the Longman definitions. The expression 'substantive difference' is one evidence of this.

The notion of 'difference' also raises another problem that is not mentioned in the definition above: 'different' is always a notion relative to the known referential domain. A designer or a design team will always have as reference a particular known sample of precedents to distinguish between 'routine', 'innovative' and 'creative' design. This sample rarely matches the entire population due to the known and obvious limitations of memory, regional contexts and historical data sharing and conservation. Also, it will always vary from one designer or design team to another.

The sample of architectural precedents used in the experimentation described in Chapter 8 of this thesis uses a fixed set of descriptors or variables. The creation of new solutions, as it will be explained in detail in Chapters 5 to 8, does not imply the introduction of new variables, but configurations or combinations of features different from those known in the original case-base. In this sense what is referred to as 'new' in this research would be closer to what Gero calls innovative rather than creative.

However, these new configurations can present, in a significant number of times, features that were not present in the closest existing cases. Although their variable labels were pre-existing somewhere else in the case-base those 'new configurations' do not match any particular case in the sample and represent useful solutions for present problems. It is not just the situation of having the same variables with different values, but having cases with different defining variables. In this sense the definitions above turn out to be of difficult application because those 'new configurations' could also be taken as creative.

It is not my purpose to propose a new and conclusive definition of 'routine', 'innovative' and 'creative' design. My main objective here is to show that things are not as 'black and white' in the real world as it may be suggested in the last citations.

I would prefer to accept these categorisations as simple 'guide marks in a continuous scale' rather than as self-contained and distinct 'boxes'. This scale would range from a hypothetical full 'routine' design to an also hypothetical full 'creative' design. The word 'hypothetical' is employed here because it seems that a design is very rarely either completely 'routine', in the sense of having absolutely nothing that distinguishes it from others, or completely 'creative', in the sense of having no inspiration drawn from previous experiences.

Therefore, the word 'innovative' in this thesis will be employed from a relative point of view: I will be referring to the design that differs from all other designs previously known in a particular sample. This 'innovative' quality will be relative and variable as well: some designs will be more or less 'innovative' than others if they are closer to or further away from the hypothetical full creative status. A simple method will be described and employed in Chapter 8 of this thesis just to provide some analytical criteria for assessing levels of innovation.

1.2 Creativity and previous knowledge:

The relationship between creativity or innovation and the use of previous knowledge in design has also generated controversial debate along the years. The modern movement assumed that the act of designing was largely independent from the thing being designed. The focus shifted from the emphasis on tradition that prevailed during the 19th century, to the emphasis on procedure, almost to the point of denigrating any kind of recourse to past experience.

However, with the uncertainty that emerged in the post-modern era, and due to research undertaken in design theory and cognitive science, these assumptions have been deeply questioned.

The notion of design, as a form of knowledge, not relying only on methods but also on a process of adaptation and transformation of previous design experiences, has found increasing acceptance among theoreticians. Oxman (1990) suggests that the experience of the designer, expressed as design knowledge is dependent on how knowledge is structured and organised in memory. She suggests that the design process would start by recalling either relevant typifications or cases from memory.

Several models and systems have been developed or are under development with the aim of formalising and making precedent design experience accessible and useful (Koutamanis, 1993; Kuhn et al, 1993; Oxman 1990; Oxman et al, 1993a, 1993b, Schmitt, 1993).

Those attempts have been often referred to as Case-based Design, or CBD for short. CBD is a specialised application of the broader technology Case-based Reasoning, or CBR for short. It is not the only approach that may prove useful in the problem of modelling experience in the design process. It may provide an important framework for the analysis of the topic.

However, other approaches such as knowledge-base systems and connectionist models also find relevance in modelling prior knowledge or experience in design. All of these approaches rely, in greater or lesser degree, on some sort of previous knowledge representation. Therefore, I shall examine, in more detail, the relevance and efficacy of all those techniques in the next chapters.

1.3 Objectives:

The design activity is an evolving process: while relying in previous knowledge, this domain knowledge is changeable, that is, what is known about the design objects changes as more knowledge is acquired, new techniques and paradigms are introduced or as the design context changes. Therefore, the modelling of the design practice claims some sort of precedent-based, self-extending, innovation-supportive model.

However, research in design theory and artificial intelligence, AI for short, has produce models and systems that provide either interactive interfaces, but with static knowledge-bases, hard to be extended, or knowledge-acquisition tools with awkward interfaces leading to little usability. Moreover, they have failed to deliver integrated models capable of handling previous knowledge and supporting innovation. This will be discussed in more detail in Chapter 3 of this thesis.

Therefore, this thesis concentrates in two vital and interrelated aspects of *modelling design support systems*, that are: how innovative solutions may arise, and the knowledge-base's extension and maintenance.

The necessary conditions to implement that precedent-based, self-extending, innovation-supportive model, are the ability to support the emergence of reliable new solutions in a knowledge-representation scheme that allows the continuous extension of the knowledge-base while at the same time preserving its original consistency. The testing of these conditions and the prototyping of a hybrid model that complys with those requirements are the goals of this thesis.

The proposed model draws inspiration from three approaches from artificial intelligence: knowledge-base systems, case-based reasoning and connectionist models. It is important to emphasise that a hybrid approach does not necessarily mean the acceptance of failure and the impossibility of moving forward with the techniques from which it draws inspiration. In fact, it can also bring innovation to those paradigms.

What is going to be proposed here is not simply the gathering of three well-known processes, but a hybrid approach that also makes contributions to knowledge in the three original techniques. In its architecture, it differs fundamentally from conventional knowledge-base systems, connectionist models and CBRs, although strongly inspired in their underlying theories.

Firstly, the knowledge-base system module is not a rule-based one. It is a unique implementation hosted on an innovative pattern-recognition-based shell developed at the University of Strathclyde (Mustoe, 1990, 1993).

Secondly, the connectionist model works in the background receiving input controlled by the knowledge-base system, which acts as a front end. It does not aim the classification of cases it has not seen before. It aims the learning of general trends to produce suggestions of new cases.

The third, and the most important contribution to knowledge, are its results. Although the connectionist sub-system uses a standard learning algorithm while training, it adopts an innovative hybrid procedure in the running mode. This architecture provides important user's interface gains. Moreover, this integrated model offers an incremental self-extending feature that minimises substantially the dependency on knowledge engineer intervention, and provides interactive support to innovation by augmenting the designer's creativity.

1.4 Thesis structure:

This thesis is divided in four parts. The first one is composed of Chapters 1, this *'Introduction'*, Chapter 2, *'Design Theory and Design Practice'*, Chapter 3, *'Design Computing, Previous Knowledge and Innovation'*, and Chapter 4, *'Neural network paradigms'*. It sets the theoretical framework with the critical analysis of design theory and research in CAAD and AI. It leads to the definition of the problem and to the explanation of why existing research has failed to provide a solution.

The second part is composed of Chapter 5, *'Cortex and neural networks: stand-alone performance and integrated operation'*, Chapter 6, *'The plan of a precedent-based, self-extending, innovation-supportive environment'*, and Chapter 7, *'Prototyping'*. Chapters 5 and 6 develop the main thesis, goals and describe an algorithm for the problem. Chapter 7 describes prototyping objectives, strategies and a loose coupling scheme.

The third part, composed of Chapter 8, *'Experimentation and data analysis'*, describes all the methodology and procedures developed with the objective of verifying the main thesis and the algorithm reliability. It also assesses the results of this experimentation.

At last, the fourth part, composed of Chapter 9, *'Contribution, Applications and Further Research'*, identifies the implications of the proposed model and its contributions. It also establishes a critique of the model and prospective further research.

Chapter 2

Design Theory and Design Practice

The design methods debate and Computer Aided Architectural Design, CAAD, are inherently related and this relationship has steadily grown in importance in the last three decades. Therefore, a historic framework of design theory is necessary to properly understand research and development in CAAD.

2.1 The design methods debate:

Accounts on design theory developments often refer to 'generations' of design methods (Logan, 1987). Alternative categorisations prefer an approach based on 'paradigm shifts' instead (Levy, 1981). Whatever is the categorisation adopted, both group researchers and their ideas according to some time-based trends and preoccupations.

Logan (1987) identified four generations of design methods named as: *A Systematic Methodology, Participation in Design, The Nature of Design Activity* and *The Failure of Method.*

The first generation of design methods searched for *a systematic methodology.* According to Logan (1987), two basic assumptions underlie this generation's literature:

> *"1. Designers were, by and large, not equipped with adequate methods.*

2. Designers could be helped by the introduction of more self-conscious and systematic procedures from disciplines such as science and systems engineering". (Logan, 1987: 25)

The early days of research in design theory were driven by the search for what design methods should be, rather then an in depth attempt to verify and understand what design is as a phenomenon and process.

Several models resulted from this approach. Markus (1969) and Maver (1970) devised models where the design activity was seen as a sequence of defined steps involving *analysis*, *synthesis*, *appraisal* and *decision* that is repeated at an increasing level of detail. This sequential view of the design process can be found in the work of other researchers (Asimov, 1962; Jones, 1970).

Alexander (1964) adopted a Cartesian view of design, in which the problem is broken down into fragments and each of which is solved separately before being synthesised into an overall solution.

Logan (1987) maintains that all these models were based in the assumption that the design process is *systematic*, that is, it follows a linear sequence. However, this kind of model turned out to be unmanageable in practical design problems.

On the other hand, if those models were inadequate as descriptions of design, they were successful in revealing some of the complexities of the design activity and in setting the foundations of the research in the domain.

The cycles of *analysis*, *synthesis*, *appraisal* and *decision* formalised by Markus (1969) and Maver (1970) would echo, in some ways, in the work of later generations as far as early 80's. Lawson (1980) adopts similar repeated sequences of *analysis*, *synthesis*, *appraisal* and *decision*. However, he introduces feedback loops between each stage and all preceding stages. Logan (1987) argues that Lawson's model (Lawson, 1980) does not show any clear route through the design process, but at least becomes a more realistic representation of the design activity, since the attempt to represent it as a logical sequence has been abandoned.

The first generation of design methods did not find significant acceptance in practice. In fact, some of their authors later revised their positions, abandoning the idea of decomposition as a means of improving the quality of design solutions. Alexander (1966, 1971) is one example.

Logan (1987) argues that the problems faced by those methods or models have their origin in the assumptions made by the first generation. Page (1963) argued against the idea of design process as a linear sequence of well-defined steps, as follows:

> *"...in the majority of practical design situations, by the time you have produced this and found out that and made a synthesis, you realise you have forgotten to analyse something else here, and you have to go around the cycle and produce a modified synthesis, and so on. In practice you go around several times". (Page, 1963)*

This endless sequence of feedback loops led to Rittel's (1972) argumentation of design problems as 'wicked'. He argues that the relevant criteria will change along the life of the designed artefact. Wicked problems have no definitive formulation, that is, at any time a formulation is made, additional questions can be asked and more information requested. This feature has come to be known in the context of artificial intelligence as non-monotonicity:

"Non-monotonic logical systems are logics in which the introduction of new axioms can invalidate old theorems. Such logics are very important in modelling the beliefs of active processes which, acting in the presence of incomplete information, must make and subsequently reverse assumptions in the light of new knowledge". (McDermott and Doyle, 1980)

Rittel (1972) also argues that one cannot simply first define the problem and then the solution, because solutions are continuously generated as the problems are formulated. Every formulation of the wicked problem corresponds to the formulation of the solution and vice versa.

According to Rittel (1972) any design solution is appraised on a large number of ill-defined and conflicting criteria. Wicked problems have no terminating condition. Any time a solution is formulated, it can be improved or worked on more. For this reason there are no definitive tests for the evaluation of solutions, since proposing a solution modifies the definition of the problem. A design solution is never 'the right solution' but only 'a good enough solution'. Therefore, the number of alternative solutions is so large that it is impossible to define a solution set that is not effectively infinite.

Therefore, the most remarkable contribution of the second generation of design methods is the conclusion that, while existing as ways of approaching objects in other fields, analysis cannot be separated from synthesis in the design practice domain. For this reason the first generation design models did not provide a proper description of the design process.

However, if the second generation of design methods was able to provide a better description of the design process, on the other hand it failed in the formulation of proposals that could find lasting acceptance and application in practice.

The problems of those models were generally related to the idea of *participation in design*. With this generation the objective shifted to externalising the design activity so that other people could contribute to it with insights that were outside the designer's experience. For this reason, argumentation as a process that could be procedurally improved in order to improve the products, was taken as playing a major role in design methods. This approach resulted in several methodologies in which the underlying paradigm is that of *participation in design*.

Rittel (1972) developed a structure of argumentation with the objective of removing the 'artificial separation' between the expert who does the work and the client whose problem the work is supposed to solve.

Another example is the later work of Alexander (1974) in which he abandoned the idea of decomposition and embraced the idea of patterns. Logan (1987) argues that Alexander's model was based on the following assumption:

> *"...everyone is a designer with a considerable set of their own patterns, and that everyone makes design decisions no matter how incorrect or ill-formed their patterns are. The role of patterns designed by specialists is to correct existing patterns that might lead to failure, or to add new and better patterns". (Logan, 1987: 32)*

'Participation in design' with its underlying assumptions was translated into the formulation of several models within this generation, such as *'citizen participation'*, *'advocacy planning'* and *'charette'*. However, the experiments

with participation in design have achieved a very limited success. Broadbent (1979) suggests the reasons for the failure of the design participation's methodologies:

> *"At best they may identify a 'highest common factor' of user needs, but compounded by the existentialist designer's needs to become himself, they may mislead him into thinking other people want the same things... It is quite impossible for either of them to avoid feeding their own preconceptions and values into the solution of design problems". (Broadbent, 1979)*

As an evidence of failure, Broadbent (1979) also mentions the work of Kroll at the University of Louvain where the architect's insistence on total participation resulted in severe environmental problems.

The third generation of design methods, as described by Logan (1987) emerged in a rather different context of ideas. The main concern became *the nature of design activity* and design problems. As a consequence, research methodology shifted from the solely theoretical arguments to an increasing search for empirical evidence. The work of Lawson (1979) attempting to determine if in fact designers do adopt a consistent approach to design problems is one example. In this work, the strategies of final year architectural and science students at a similar stage in their education were compared. He found that the scientists focused their attention on discovering a rule governing the acceptability of a solution by studying the problem specifically. On the other hand, the architects concentrated on learning about the nature of the problem by trying out solutions to achieve a 'good' one.

Logan (1987) argues that the models that emerged from this empirical approach characterise design as driven by interests, approaches and strategies of individual designers. Therefore, they legitimise the role of the designer's intuition as an essential part of the design activity, rather than propose any prescriptive methodology. Several other studies have been developed giving support to this tendency of exploring the problem through the creation of solutions (Foz, 1972; Lera, 1982; Willey et al, 1974).

In spite of having different theoretical bases, Logan (1987) argues that these so called 'third generation models' show a high level of functional or procedural similarity and draw heavily inspiration from earlier work in cognitive psychology and artificial intelligence:

> *"They may be broadly characterised as 'rule-based', in viewing design as a series of problem transformations governed by 'rules' or 'codes' linking design solutions and abstract requirements". (Logan, 1987: 47)*

Hillier et al (1972) have attempted to formalise the designer's contribution to the design activity as a system of informal 'codes' or 'rules' acquired through education and experience. They have drawn parallels between the design activity and the methodology of science developed by Popper (1959). They rejected the view that solutions should be derived from an analysis of the requirements of users and suggested a paradigm based on conjecture-analysis. Darke (1979), drawing inspiration from Hillier et al (1972) and using empirical evidence, proposed a model of the design process based on generator-conjecture-analysis.

However, it has been argued that design models cannot be based on scientific methodology. March argues:

"A scientific hypothesis is not the same thing as a design hypothesis. A logical proposition is not to be mistaken for a design proposal. There has been much confusion over these matters, hence the illusions about scientifically testable hypotheses and value-free proposals". (March, 1976)

The objective of science is the study of existing phenomena, whereas the design method is a pattern of behaviour employed in inventing things that do not yet exist. Mustoe (1990) argues that the assumptions that Popper (1959) formalised a methodology of science, and analogous methodology of architecture can therefore be formulated, are misguided. He provides the reasons for this:

"A wicked problem cannot be definitively formulated, and it will be found that in consequence it cannot be empirically falsified". (Mustoe, 1990: 8)

Mustoe (1990) also stresses that the lack of agreement about the meaning of the expression 'scientific method' and raises doubts if improved clarity in design can be achieved by reference to a notion that is itself 'cloudy'.

Logan's (1987) fourth generation is one of disillusion and uncertainty. The failure to arrive at a generalised description of 'science' has undermined the validity of the third generation models. Cross et al argue that:

"any attempt to equate 'design' with 'science' must logically be predicated on a concept of science that is epistemologically coherent and historically valid". (Cross et al, 1981)

However, Logan (1987) stresses that the history of the twentieth century debate on the philosophy of science shows that such a concept does not yet exist. Therefore, any attempt at analogy between design and science cannot succeed.

2.2 The critique of design methods generations:

The first generation models were essentially procedural. Perhaps because of a still strong modernist paradigm. As mentioned in Chapter 1, the modern movement assumed that the act of designing was largely independent from the thing being designed. Therefore, it placed a strong emphasis on procedure, disregarding almost any kind of recourse to past experience. The early design methods debate followed a similar trend: the role played by previous knowledge, its representation and manipulation are by large and large ignored as an important topic of research.

The second generation of design methods made progress particularly in the formulation of a more realistic description of the design process through the notion of 'wicked' problem, but it was as procedural as the first generation. It advocated the controversial importance of popular knowledge in designing. However, it still placed heavy emphasis on procedures related to participation and argumentation rather than on a deeper investigation of the role played by specialised previous knowledge in the design process.

The third generation of design methods is different from the previous two for having adopted the search for empirical evidence to support its hypothesis. It also differs in the sense of bringing the role of previous knowledge into the scenario of the design models. However, as the first two generations, it still persisted in the use of otherwise well established models as analogies for design, in this case the popperian model.

If the first two generations models were essentially prescriptive in their proposals, the third generation models legitimise the designer's intuition as far as to become essentially descriptive. Therefore, models such as those proposed by Hillier and Leaman (1974) may provide explanations for how things may be reproduced, but offer no explanation for how new ideas may arise (Bridges, 1986). This dilemma 'reproduction versus creation' is central to this thesis as it has strong implications in the performance and maintenance of design support systems, particularly in those models drawing inspiration from research in artificial intelligence and cognitive science.

The next chapter will focus on the present generation, particularly on research developed in the domain of CAAD from the late 80s onwards. It will focus on models related to computer vision, knowledge-base systems, case-based reasoning, learning and connectionist models, and hybrid systems. This may seem a very broad variety of techniques or approaches.

However, all those models have in common the use of some sort of previous knowledge representation. Moreover, they all have in common the fact of facing, in one way or another, the dilemma of 'reproduction versus creation'. Next I will discuss the specific implications of this dilemma in each approach, and some of the reasons why research in CAAD has so far failed to overcome it.

Chapter 3

Design Computing, Previous Knowledge and Innovation

In the earlier stages of research in artificial intelligence, AI, it was assumed that mundane human tasks such as vision, speech, language understanding and common-sense reasoning should be tackled first. It may be that the basic assumption was that those tasks should be easier to model because every normal human being was supposed to execute them without much difficulty.

Other human tasks that required expertise in specialised areas, i.e., engineering, scientific analysis, medical diagnosis, financial analysis, were perhaps naturally regarded as more difficult to tackle.

However, as research on AI progressed, it became evident that, paradoxically, the so called mundane tasks were more difficult to model because they required a greater amount of knowledge than the specialised tasks. The modelling of those tasks required the representation of a large amount of facts, objects and ideas. The things that are normally taken for granted on the human minds, for instance notions such as gravity, space and time, need to be modeled precisely in a computer system, and are much more difficult to be isolated from a wider net of external conceptual dependencies. The problem faced in the development of computer vision models and techniques is one example.

In more specialised tasks it became evident that it was easier to reduce external dependencies and the continual regress of context. The development of knowledge-base systems, which is driven by the concern with the use and representation of previous knowledge in specific domains, fits in this context.

Research in CAAD has thus seen in recent years a growing interest in the role played by previous knowledge in the design process. The design methods debate has shifted from a solely 'procedural' approach to a 'previous-knowledge-based' one, as it was shown in Chapter 2. Several models have been developed in CAAD, particularly by specialising paradigms of artificial intelligence and cognitive science.

This process of specialisation was firstly focused on the representation and use of generalised knowledge in design, as seen in the work carried out in CAAD research with shape grammars and knowledge-base systems in the 80s and early 90s (Stiny, 1980; Flemming, 1987; Schmitt, 1987; Oxman and Gero, 1988; Oxman, 1990a; Oxman, 1990b; Mitchell, 1990; Coyne et al, 1990).

From the late 80's onwards another shift seems to have happened. The main preoccupation still seems to be with the representation and use of previous knowledge in design. However, a growing number of researchers place their emphasis on the use of precedents as a means of designing rather than on generalised knowledge representation (Coyne et al, 1989; Coyne and Newton, 1990; Coyne and Postmus, 1990; Coyne, 1991; Rosenman, 1991; Oxman, 1991; Coyne and Yokozawa, 1992; Kuhn et al, 1993; Oxman et al, 1993a, 1993b; Schmitt, 1993; Coyne et al, 1993; Maher et al, 1995).

A series of those models is analysed in the coming sections with the objective of assessing their contributions and failures. They have been grouped according to the general techniques they inherited from from AI and cognitive science. Particular emphasis will be given to the dilemma 'reproduction versus creativity' as mentioned in the previous chapter.

3.1 Computer Vision:

Computer vision has been suggested by some authors as the natural way of capturing and manipulating architectural knowledge (see Koutamanis, 1993). However, it has shown to be one of the hardest tasks to be fully achieved. The reasons are those mentioned above and because the techniques developed so far turned out to be extremely computationally intensive.

Rich and Knight (1991) raise some particular problems in the process of converting a bit-mapped image into useful information about the world. First, they argue that some information is necessarily lost when an image is created. This happens because an image is two-dimensional, while the world is three-dimensional.

Second, some objects may be partially obstructed by others in an image. Also, there are several effects over each pixel that are hard to be disentangled such as colour, source of light, the angle and distance of the camera, pollution in the air, etc.

Nevertheless, there has been some progress in the area of computer vision that is worth mentioning. The most known positive outcome may be optical character recognition (OCR) tools that are useful at the syntactical level of recognition.

In the area of architectural design, Koutamanis (1993) suggests that automated recognition may play a crucial rule in transforming the computer into an efficient, knowledgeable design assistant. The author argues that the relevance of traditional visual representations, specially orthographic projections, have been long neglected.

Koutamanis (1993) argues that this is due to long-standing prejudices such as the idea that the visual representations are a means of communicating decisions rather than an essential part of the design thinking itself. Another prejudice would be the subordination of orthographic projections to perspective and a "quite uneducated preference" for three-dimensional representations from which the conventional two-dimensional drawings could be produced.

Koutamanis (1993) suggests that automated recognition of digitised architectural drawings can occur at three levels: geometric elements, building elements and spatial articulation. At the first level, recognition normally makes use of chain coding and edge following techniques to identify line segments in the bit-mapped image. Afterwards these segments are grouped into two-dimensional shapes.

The author seems to recognise that the use of a CAD document is always dependent upon semantic structure and that this first level of recognition does not solve this problem.

Koutamanis suggests that the weaknesses of this first level of recognition can be compensated by the other two higher levels. The recognition of building elements transforms the pixel array of bit-mapped image into an array of building element symbols.

The recognition of spatial articulation, as opposed to the recognition of building elements, which deals with what bounds the space, concentrates on the space itself. This task is performed with skeletonized versions of the bit-mapped image.

Koutamanis (1993) suggests, as an alternative to the present tendency in architectural research of giving precedence to three-dimensional representations, the use of several parallel design representations, as it happens on traditional design practice. According to the author, this allows a single problem to be tackled at a time and subsequently the consideration of indirectly related aspects.

Koutamanis (1993) argues that the consequent difficulty of design decisions' propagation taken regarding one partial representation to the others can be overcome by automated recognition itself. This would transform the computer into an intelligent design assistant able to interpret, structure and comprehend all the consequences of design decisions. He gives an example:

> *"When, for example, the architect alters the spatial arrangement of a design in a floor plan, a CAD system equipped with recognition capabilities would recognise the changes and modify accordingly other visual representations of the design, such as elevations and sections. (In fact, by means of the so-called reconstruction algorithms the computer would also be able to produce automatically a three-dimensional representation of the design on the basis of floor plans, sections and/or elevations.) Moreover, it would be able to correlate these changes with aspects other than spatial articulation, such as the proposed load bearing structure, and warn the architect if and where the changes cause any conflicts" (Koutamanis, 1993, p. 55).*

Koutamanis argues for the necessity of visual representations in design. Certain approaches in design research tend to assume that drawings are only a means of communicating decisions taken at other levels and this can lead to the idea that thinking can exist in design completely apart from the act of making visual representations. This is not true because in design several problems can only be identified and solved during the act of drawing.

The tools proposed by Koutamanis (1993) may be useful for capturing and interpreting structured design descriptions. However, computer vision is still a very rudimentary technology in capturing unstructured information such as photographs and video, and these sources of information can not be regarded as secondary as Koutamanis suggests.

Koutamanis (1993) also emphasises the orthographic projections' prevalence over three-dimensional representations. However, one thing is to argue that there is no thinking in design without the act of building a visual representation. Another one is to argue that if two-dimensional representations have prevailed in traditional design practice they should necessarily continue to prevail over three-dimensional representations under new technologies. Even in traditional design practice it is well known the resource of making extensive use of three-dimensional sketches to elucidate and solve problems in all different stages of the design process and then transforming the solutions in two-dimensional representations.

Koutamanis rises the well known problem of maintaining consistency among the different representations along the design process when he proposes the use of several parallel design representations under new technologies. He suggests that this problem can be overcome by automated recognition itself, as if the capability of recognising the changes in one visual representation and updating the others were naturally inherent to visual recognition. If even the human designer's visual perception is not able to automatically guarantee the perfect consistency among several different representations, why should computer vision be? The solution for consistency maintenance is dependent upon other techniques outside the scope of computer vision itself.

3.2 Knowledge-based systems:

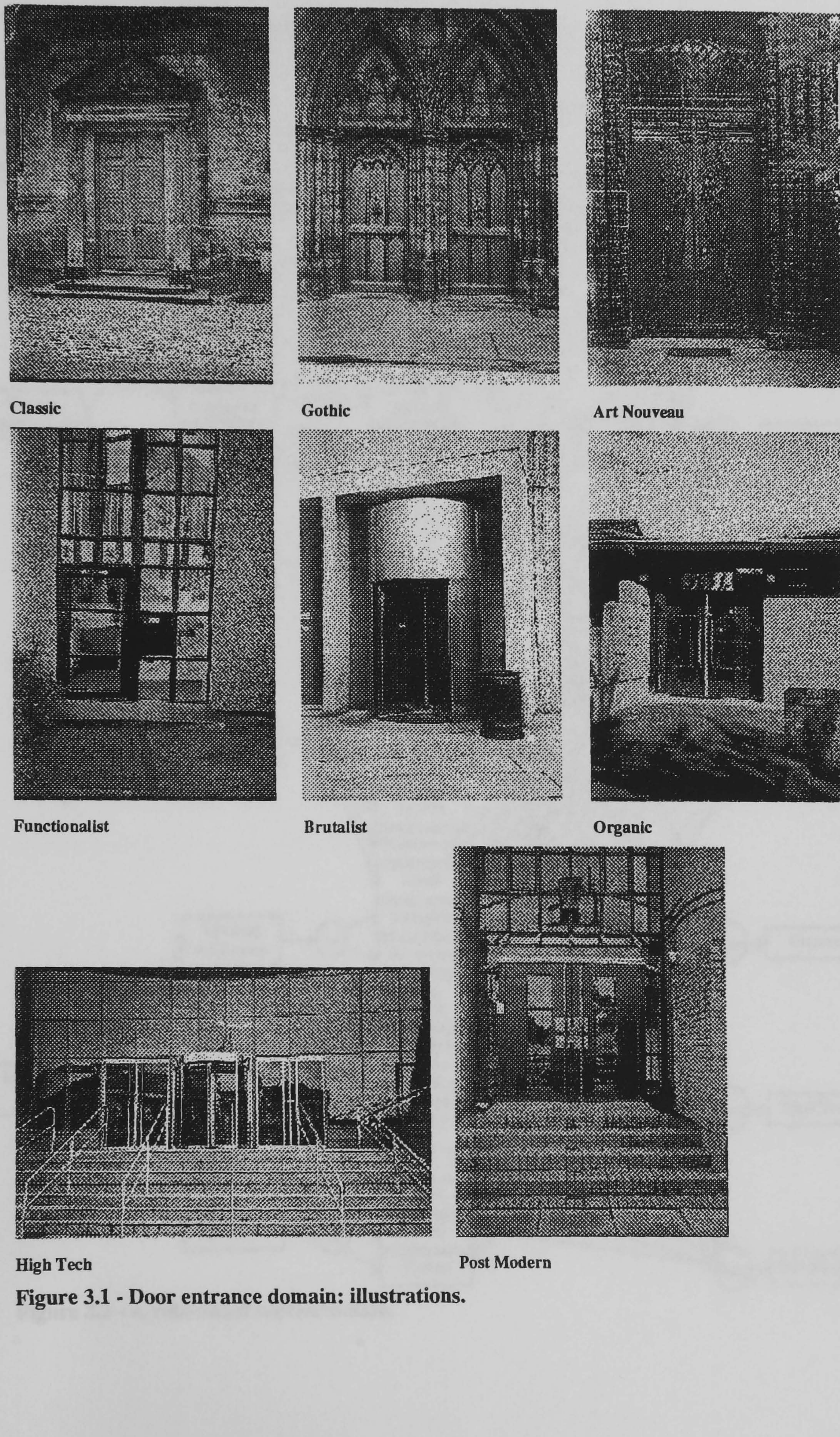
A knowledge-based system, KBS, is an application that can store, retrieve and analyse vast stores of knowledge. In the past they used to be called expert systems since they were extensions of the early AI notion of building an application to simulate the role and behaviour of an expert on a particular domain.

3.2.1 Conventional knowledge-base systems:

Knowledge-base systems have been used to support and solve a broad variety of tasks such as medical diagnosis, stock trends forecasting, equipment fault diagnosis, engineering design, etc. In spite of dealing with such highly diverse problems, there are some general issues that arise across these domains.

The first of these issues is related to the representation and use of domain knowledge. Although almost all techniques from AI have been employed on at least one KBS, the most widely used way of representing domain knowledge is as a set of production rules. This kind of representation has become almost a *'de facto'* standard for KBS's.

An example of this knowledge representation can be built from a door entrance classification domain composed of eight styles that are illustrated by the instances in figure 3.1:



Classic
Gothic
Art Nouveau
Functionalist
Brutalist
Organic
High Tech
Post Modern

Figure 3.1 - Door entrance domain: illustrations.

The knowledge of this domain can be represented as a set of rules as shown in figure 3.2:

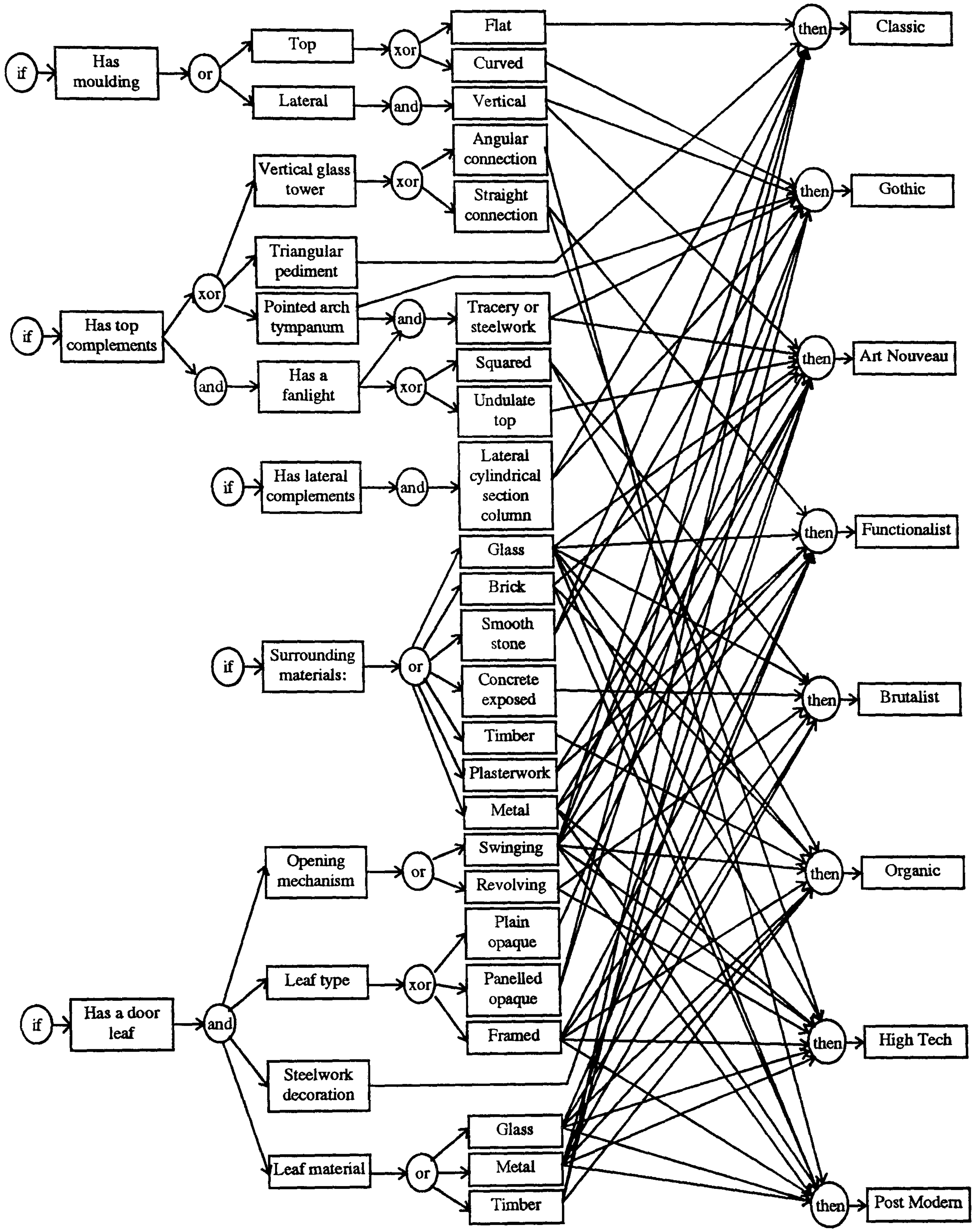


Figure 3.2 - A rule-based representation.

In the graph above, the boxes represent conditions and conclusions, while the circles represent the logical nature of these statements. For instance, *if* the entrance *has a moulding* that may be present either on top *or* in the lateral part of the entrance, *and* the lateral moulding is vertical, while the moulding on top is curved but not (*xor*) flat, *then* it follows that the entrance is a *Gothic* one.

The control of a rule-base system will typically search for a solution by verifying the truthfulness or falsehood of each statement in the production rules. Therefore, if the statement *'has moulding'* is falsified by a user's answer, the related statements *'top'*, *'lateral'*, *'flat'*, *'curved'* and *'vertical'* are also falsified and removed from the reasoning process. Because these statements are essential conditions for the solutions *'Classic'*, *'Gothic'* and *'Art Nouveau'*, these three possible conclusions are also removed from the reasoning process. Moreover, the statements *'triangular pediment'*, *'pointed arch tympanum'*, *'tracery or steelwork'*, *'undulate top'*, *'lateral cylindrical section column'*, *'smooth stone'*, *'plain opaque'*, *'panelled opaque'* and *'steelwork decoration'* are also removed because they became irrelevant for the reasoning process. The resulting graph representing the reasoning state would be as in figure 3.3 bellow.

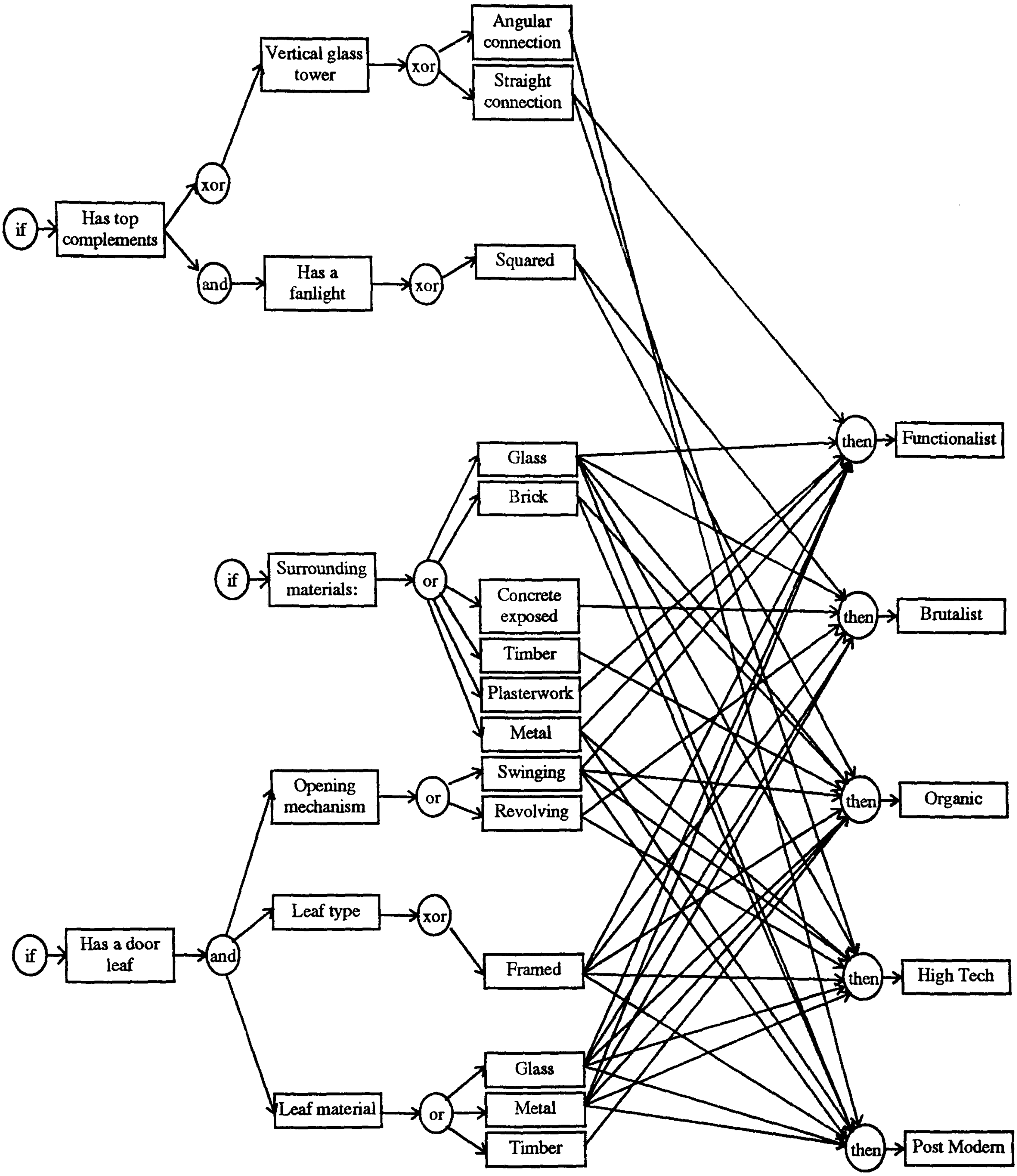


Figure 3.3 - The network of rules pruned.

If in a later stage the statements *'has a door leaf'*, and *'opening mechanism'* is *'revolving'* are found to be true, then the solutions *'Functionalist'*, *'Organic'* and *'Post Modern'* turn out to be false. Their removal from the network of rules causes the statements *'angular connection'* with vertical glass tower, surrounding material: *'brick'*, surrounding material: *'timber'*, surrounding material: *'plasterwork'*, and leaf material: *'timber'* to become irrelevant to the reasoning process. Figure 3.4 shows the network of rules after the latest pruning.

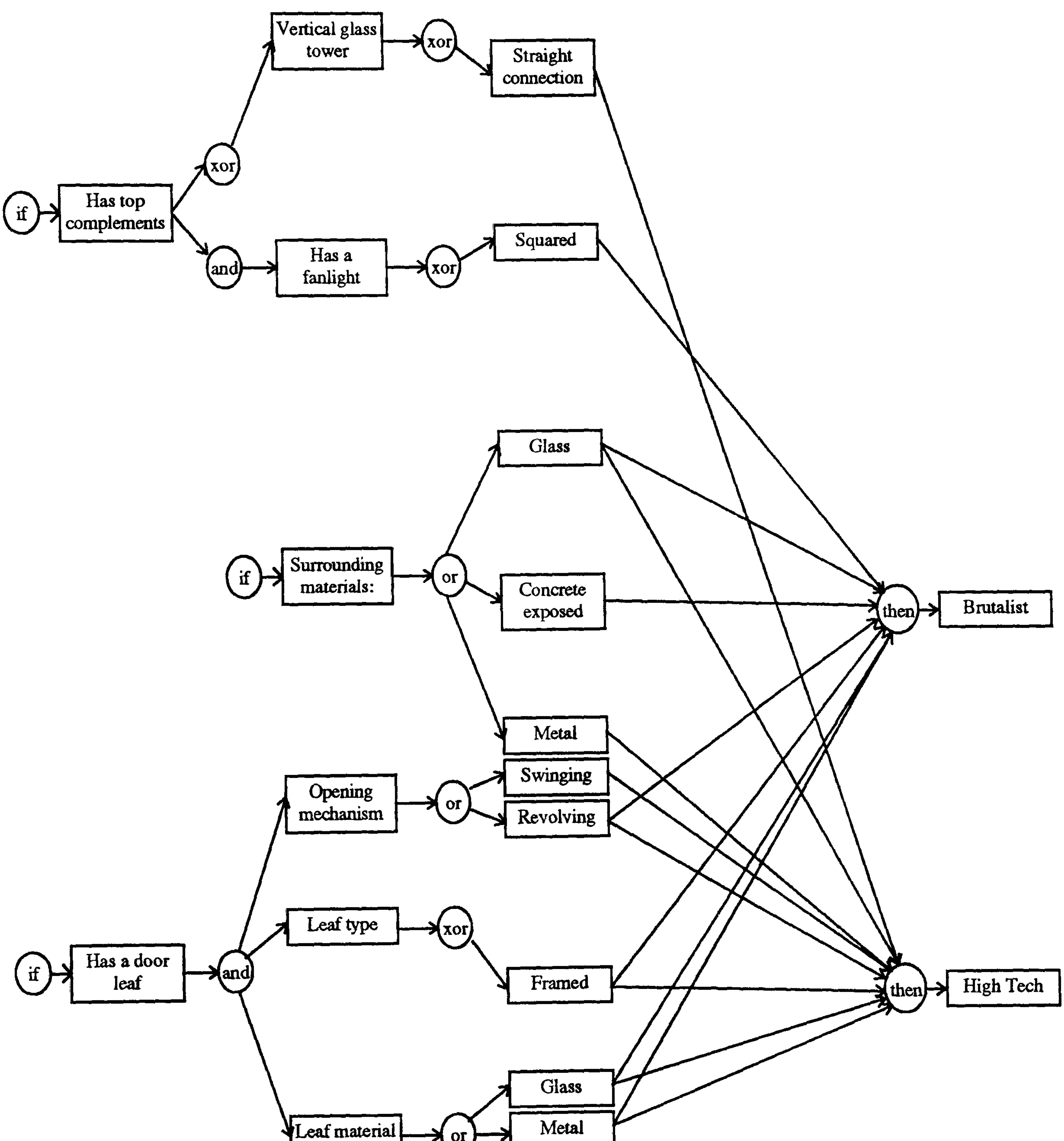
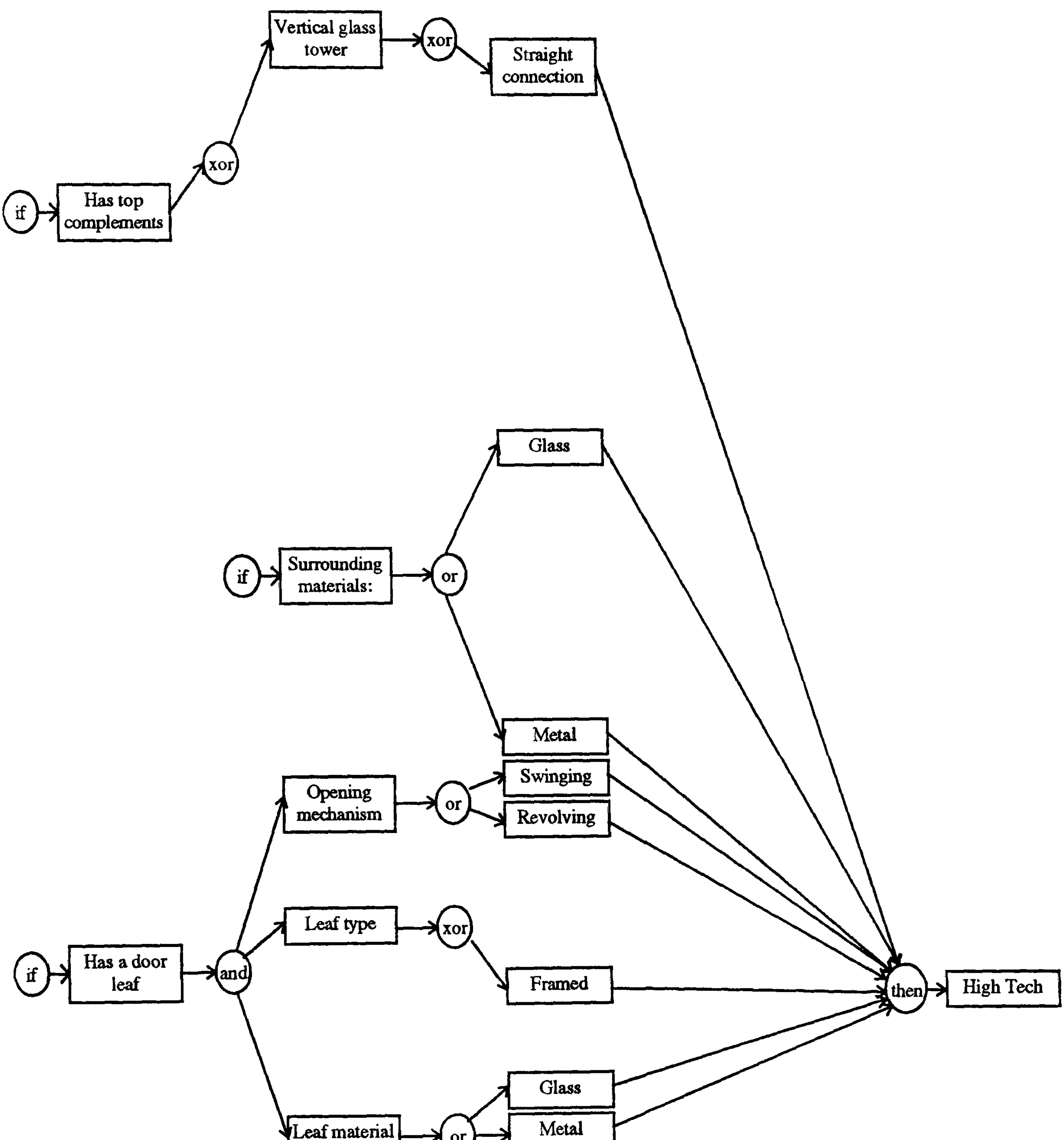


Figure 3.4 - Further pruning in the network of rules.

At last, if the statement surrounding material: *'concrete exposed'* is falsified by a user's answer, then the solution *'Brutalist'* is also false and should be removed from the reasoning process. This will cause the statement *'has a fanlight'* and *'squared'* to become irrelevant to the reasoning process. Therefore, the solution *'High Tech'* turns out to be the only possible conclusion, provided that the remaining statements are also true. Figure 3.5 shows the network of rules final state.



3.5 - The final state of the network of production rules.

The second important issue is related to the explanatory mechanisms KBS's must provide. Their results will not be reliable unless their users have been convinced of the accuracy of the reasoning process that produced those results (Rich and Knight, 1991). Therefore, it is important that the reasoning process used in such systems proceed in understandable steps and that enough knowledge about the reasoning process be available so that the explanations of these steps can be generated.

The third issue is related to the development of KBS' shells. In their earlier stage of research and development, each KBS was created from scratch. However, as the number of systems built grew substantially, it became clear that they often had many similarities (Rich and Knight, 1991). Those systems were constructed as a set of declarative representations, generally rules, combined with an inference engine operating on those representations. Therefore, it was possible to isolate the inference engine from the domain-specific knowledge to create true system shells that could be used to construct new expert systems by adding new knowledge corresponding to the new problem domain.

This leads to the fourth issue: the knowledge acquisition methods. The process of creating and developing a KBS usually starts with a knowledge engineer interviewing a domain expert to elucidate expert knowledge, which is then translated into rules. After a prototype is built, it is refined until it reaches a satisfactory expert-level performance. This process is expensive and time-consuming. For this reason a number of more automatic ways of constructing knowledge-bases have been object of research.

However, no totally automatic knowledge acquisition systems yet exist. Rich and Knight (1991) mention several programs that interact with domain experts to extract expert knowledge efficiently. These programs provide support for entering knowledge, maintaining knowledge base consistency, ensuring knowledge base completeness. Rich and Knight (1991) describe some of the characteristics of useful knowledge acquisition tools, and anticipate some limitations:

> *"The most useful knowledge acquisition programs are those restricted to a particular problem-solving paradigm, e.g., diagnosis or design. It is important to be able to enumerate the roles that knowledge can play in the problem-solving process. For example, if the paradigm is diagnosis, then the program can structure its knowledge-base around symptoms, hypotheses and causes. It can identify symptoms for which the expert has not yet provided causes. Since one symptom may have multiple causes, the program can ask for knowledge about how to decide when one hypothesis is better than another. If we move to another type of problem solving, say designing artefacts, then these acquisition strategies no longer apply, and we must look for other ways of profitably interacting with an expert". (Rich and Knight, 1991: 553)*

It is thus evident that while those programs may improve the communication between knowledge engineer and expert, they do not eliminate or even reduce the dependence on knowledge engineer intervention. Rich and Knight (1991) themselves acknowledged the difficulties related to knowledge acquisition:

> *"Despite the development of the tools that we described... acquisition still remains a major bottleneck in applying expert system technology to new domains". (Rich and Knight, 1991: 557)*

Therefore, in the context of wicked problems like design, where knowledge is incomplete and ever changing, the knowledge acquisition issue becomes even more vital in determining the performance and life span of the KBSs.

A problem that has stigmatised rule-based systems and is central to this thesis is related to their knowledge-bases' extension and maintenance. The addition of new knowledge in a conventional rule-based system can make its knowledge-base inconsistent, requiring a complete review of the knowledge already in the system, particularly if it is a solution that represents an exception to a more general rule in the system. A simple example can be taken from the same door entrance classification domain described earlier. Suppose we are about to extend that domain by adding a hybrid style to it. This style is illustrated by the instance in figure 3.6 bellow.

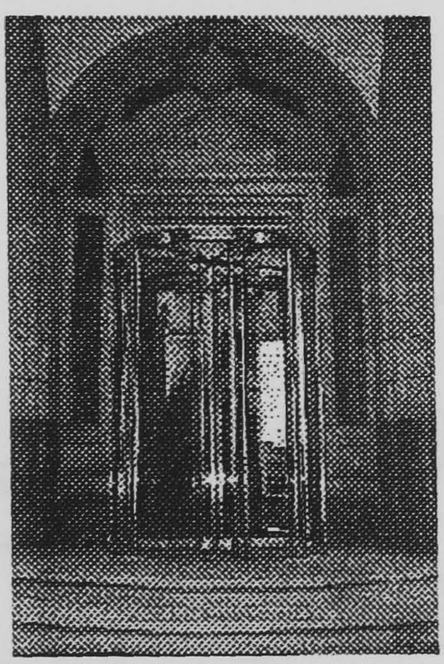


Figure 3.6 - Hybrid style: Classic + High Tech.

The addition of such solution has two major consequences for the knowledge-base maintenance, which are shown in figure 3.7 in a graph representing an updated version of the one in figure 3.2.

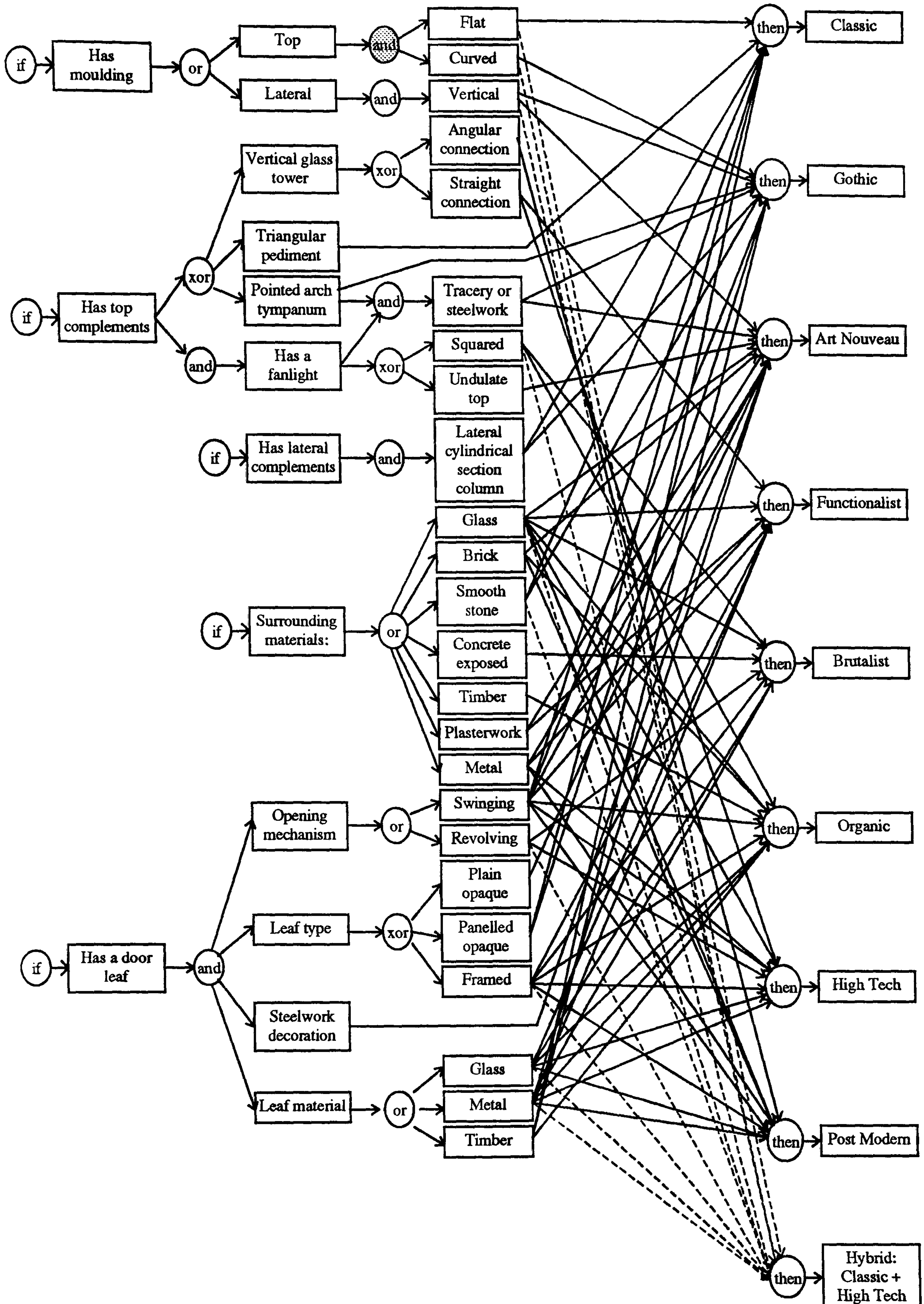


Figure 3.7 - Network of rules updated.

The first consequence was the need to change the logical nature of the statements *'flat'* top moulding and *'curved'* top moulding. Those statements were mutually exclusive (*'xor'*) in the initial knowledge-base. However, the added solution contradicts this rule because since it has *'flat'* and *'curved'* top moulding simultaneously. Therefore, the present logical statement *'xor'* needs to be replaced be an *'and'*. This update is shown in figure 3.7 through the greyed circle *'and'* in the top of the graph.

The second consequence is a series of additional statements linking the new conclusion, that is, the added solution, with the conditional statements of network of rules. This update is shown in figure 3.7 through the segmented lines.

Therefore, a complete updating of its declarations is necessary. Because the domain used as example is very small, this updating may seem also a small task. However, real life knowledge-bases are much larger and more complex than that. This makes conventional knowledge-base systems extremely dependent of the knowledge engineer intervention.

3.2.2 Alternative Knowledge-based Systems:

Alternative knowledge-base systems, based on pattern-recognition rather than on rules, have been devised (Frey, 1986; Mustoe, 1990, 1993). Mustoe (1990) argues that evidently the function of the network of rules in conventional knowledge-base systems is to place a set of individual productions into a correct relationship with a particular solution. In other words, solutions are classified according to their question set, while questions are classified by reference to the solutions they verify. His claims can be illustrated with a different representation of the same entrance classification domain described in the previous section. In this representation the multilayered network of rules has been replaced by a network of only two layers: a set of conditions and a set of conclusions. This is shown in Figure 3.8 bellow.

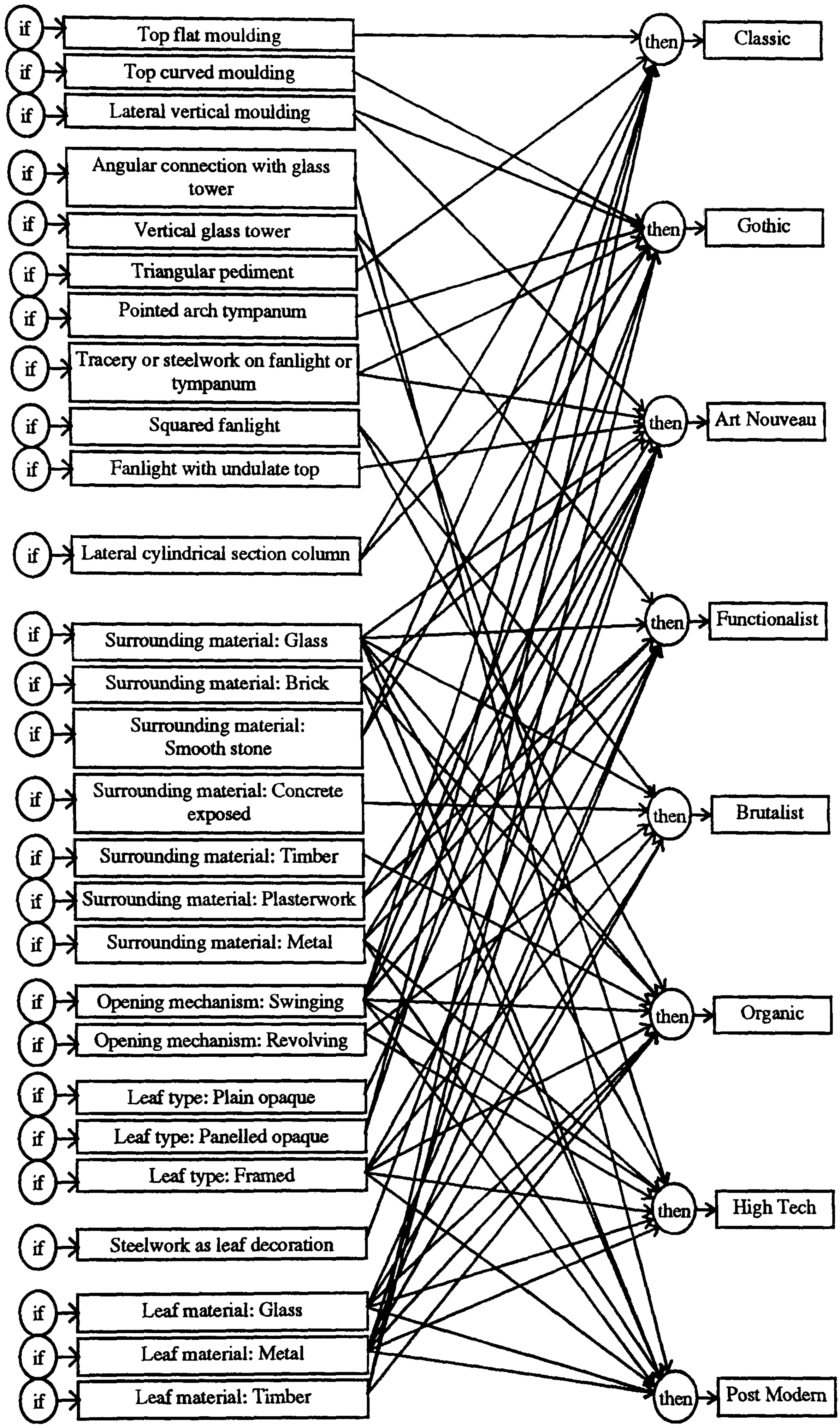


Figure 3.8 - Dual-layer network of rules

The graph above is used only as a means of demonstrating that it is possible to represent the same knowledge of the earlier entrance door classification domain by directly relating a questions' set (*the conditions*) with a solutions' set (*the conclusions*). If this knowledge were represented as rules the system would be less prone to inconsistencies, but would still require the updating of '*if... then*' statements to link new conclusions with existing conditions. Drawing from these facts, Mustoe (1990, 1993) proposes that the same domain knowledge would be better represented through a Boolean classification structure, instead of encoding that relationship through a dual-layer rule-based representation. Figure 3.9 shows the same door entrance classification domain in this kind of representation, where a feature present is encoded as a bit of value '1' while a feature not present is encoded as a bit of value '0'.

		1	2	3	4	5	6	7	8
		Classic	*Gothic*	*Art Nouveau*	*Functionalist*	*Brutalist*	*Organic*	*High Tech*	*Post Modern*
1	**top flat moulding**	1	0	0	0	0	0	0	0
2	**top curved moulding**	0	1	0	0	0	0	0	0
3	**lateral vertical moulding**	0	1	1	0	0	0	0	0
4	**angular connection with glass tower**	0	0	0	0	0	0	0	1
5	**vertical glass tower**	0	0	0	1	0	0	1	1
6	**triangular pediment**	1	0	0	0	0	0	0	0
7	**pointed arch tympanum**	0	1	0	0	0	0	0	0
8	**tracery or steelwork on fanlight or tympanum**	0	1	1	0	0	0	0	0
9	**squared fanlight**	0	0	0	0	1	1	0	0
10	**fanlight with undulate top**	0	0	1	0	0	0	0	0
11	**lateral cylindrical section column**	1	1	0	0	0	0	0	0
12	**Surrounding material: glass**	0	0	1	1	1	1	1	1
13	**Surrounding material: brick**	0	0	1	0	0	1	0	1
14	**surrounding material: smooth stone**	1	1	0	0	0	0	0	0
15	**surrounding material: concrete exposed**	0	0	0	0	1	0	0	0
16	**surrounding material: timber**	0	0	0	0	0	1	0	0
17	**surrounding material: plasterwork**	0	0	1	1	0	0	0	0
18	**surrounding material: metal**	0	0	1	1	0	0	1	1
19	**opening mechanism: swinging door**	1	1	1	1	0	1	1	1
20	**opening mechanism: revolving door**	0	0	0	0	1	0	1	0
21	**leaf type: plain opaque**	0	0	1	0	0	0	0	0
22	**leaf type: paneled opaque**	1	1	0	0	0	0	0	0
23	**leaf type: framed**	0	0	0	1	1	1	1	1
24	**steelwork as leaf decoration**	0	0	1	0	0	0	0	0
25	**leaf material: glass**	0	0	0	1	1	1	1	1
26	**leaf material: metal**	0	0	1	1	1	1	1	1
27	**leaf material: timber**	1	1	0	0	0	1	0	0

Figure 3.9 - The door entrance domain in Mustoe's knowledge representation.

At a first glance, this kind of representation may suggest that we actually went back to a relational database. However, there are substantial differences. The table above just illustrates how Mustoe's system, 'Cortex', maps questions (which verify *conditions*) into solutions (which describe *conclusions*). The solutions are classified independently from each other in a set of binary relationships with the questions that verify them. These relationships are actually encoded in the system as true bit-strings and not as rules. Moreover, the control system will not operate on them through *'if-then'* statements or a query language, but through a direct bit-string manipulation. Mustoe (1990) explains the reasons for this kind of representation and inference engine:

> *"Bit-strings are a very compact way of representing information. By manipulating individual bits in the string, the presence or absence of 8 facts, or the truth or falsehood of 8 assertions, can be stored in memory within a single byte. Furthermore, bit-strings lend themselves to rapid processing, since an alteration to the state of a variable is only a matter of changing a single bit." (Mustoe, 1990:154)*

Cortex (Mustoe, 1990, 1993) uses a Popperian (Popper, 1959) control algorithm that functions by rejecting falsified solutions. It will keep on presenting to the user the currently most frequent question among those still relevant. It will finish either with one or more unfalsified solutions, or with a confession that it cannot find a solution within that particular domain. It operates in a process of zeroing-in upon a successively shortened list of still-possible solutions. For instance, consider the domain knowledge in figure 3.9. The system verifies each of the conditions through a series of questions, which are listed bellow:

1 **Does it have a top flat moulding?**
2 **Does it have a top curved moulding?**
3 **Is there lateral vertical moulding?**
4 **Is the entrance door connected to a vertical glass tower through a plan in an 45 degrees angle?**
5 **Is the entrance door under or within a vertical glass tower?**
6 **Does it have a triangular pediment?**
7 **Does it have a pointed arch tympanum?**
8 **Is there tracery or steelwork on fanlight or tympanum?**

9 Does it have a squared fanlight?
10 Does it have fanlight with an undulate top?
11 Are there lateral cylindrical section columns?
12 Is there glass among the surrounding materials?
13 Is there brick among the surrounding materials?
14 Is there smooth stone among the surrounding materials?
15 Is there concrete exposed among the surrounding materials?
16 Is there timber among the surrounding materials?
17 Is there plasterwork among the surrounding materials?
18 Is there metal among the surrounding materials?
19 Does it have a swinging door?
20 Does it have a revolving door with four leaves?
21 Is the leaf plain opaque?
22 Is the leaf paneled opaque?
23 Is the leaf framed with one or more light cross panels?
24 Is there steelwork as leaf decoration?
25 Is there non-stained glass among the leaf materials?
26 Is there metal among the leaf materials?
27 Is there timber among the leaf materials?

The most frequent question is the number 19: 'Does it have a swinging door?'. Cortex will accept the following answers: *yes*, *no* and *don't know.* If the user answers yes, then the solution number 5, Brutalist, is falsified and thus removed for the set of possible solutions. As a consequence, the question number 15 becomes irrelevant and it is removed from the set of relevant questions. The resulting state is shown in figure 3.10 bellow:

		1	2	3	4	6	7	8
		Classic	*Gothic*	*Art Nouveau*	*Functionalist*	*Organic*	*High Tech*	*Post Modern*
1	top flat moulding	1	0	0	0	0	0	0
2	top curved moulding	0	1	0	0	0	0	0
3	lateral vertical moulding	0	1	1	0	0	0	0
4	angular connection with glass tower	0	0	0	0	0	0	1
5	vertical glass tower	0	0	0	1	0	1	1
6	triangular pediment	1	0	0	0	0	0	0
7	pointed arch tympanum	0	1	0	0	0	0	0
8	tracery or steelwork on fanlight or tympanum	0	1	1	0	0	0	0
9	squared fanlight	0	0	0	0	1	0	0
10	fanlight with undulate top	0	0	1	0	0	0	0
11	lateral cylindrical section column	1	1	0	0	0	0	0
12	Surrounding material: glass	0	0	1	1	1	1	1
13	Surrounding material: brick	0	0	1	0	1	0	1
14	surrounding material: smooth stone	1	1	0	0	0	0	0
16	surrounding material: timber	0	0	0	0	1	0	0
17	surrounding material: plasterwork	0	0	1	1	0	0	0
18	surrounding material: metal	0	0	1	1	0	1	1
20	opening mechanism: revolving door	0	0	0	0	0	1	0
21	leaf type: plain opaque	0	0	1	0	0	0	0
22	leaf type: paneled opaque	1	1	0	0	0	0	0
23	leaf type: framed	0	0	0	1	1	1	1
24	steelwork as leaf decoration	0	0	1	0	0	0	0
25	leaf material: glass	0	0	0	1	1	1	1
26	leaf material: metal	0	0	1	1	1	1	1
27	leaf material: timber	1	1	0	0	1	0	0

Figure 3.10 - Knowledge-base state after first question.

The question number 12: 'Is there glass among the surrounding materials?' is now the first most frequent one in the list and it is presented to the user. If he or she answers yes, solutions 1, Classic, and 2, Gothic, are falsified and thus removed from the set of possible solutions. This will cause questions number 1, 2, 6, 7, 11, 14, and 22 to become irrelevant and to be removed from the set of questions. Question number 26 became non-discriminating and it is also remove from the set of questions. The resulting state of the knowledge-base is shown in figure 3.11 bellow.

		3	4	6	7	8
		Art Nouveau	*Functionalist*	*Organic*	*High Tech*	*Post Modern*
3	lateral vertical moulding	1	0	0	0	0
4	angular connection with glass tower	0	0	0	0	1
5	vertical glass tower	0	1	0	1	1
8	tracery or steelwork on fanlight or tympanum	1	0	0	0	0
9	squared fanlight	0	0	1	0	0
10	fanlight with undulate top	1	0	0	0	0
13	Surrounding material: brick	1	0	1	0	1
16	surrounding material: timber	0	0	1	0	0
17	surrounding material: plasterwork	1	1	0	0	0
18	surrounding material: metal	1	1	0	1	1
20	opening mechanism: revolving door	0	0	0	1	0
21	leaf type: plain opaque	1	0	0	0	0
23	leaf type: framed	0	1	1	1	1
24	steelwork as leaf decoration	1	0	0	0	0
25	leaf material: glass	0	1	1	1	1
27	leaf material: timber	0	0	1	0	0

Figure 3.11 - Knowledge-base state after second question.

The first most frequent question in the list is now number 18: 'Is there metal among the surrounding materials?'. If the user answers 'don't know' then the system moves to the next most frequent question in the set, which is number 23: 'Is the leaf framed with one or more light cross panels?'. If now the user answers yes to this question, the solution number 3: Art Nouveau is falsified and removed from the solutions set. This will cause the questions number 3, 8, 10, 21, and 24 to become irrelevant and to be removed from the questions set. Question number 25 became non-discriminating and is also removed from the set. Figure 3.12 shows the state of the knowledge-base after the third and fourth questions.

		4	6	7	8
		Functionalist	*Organic*	*High Tech*	*Post Modern*
4	angular connection with glass tower	0	0	0	1
5	vertical glass tower	1	0	1	1
9	squared fanlight	0	1	0	0
13	Surrounding material: brick	0	1	0	1
16	surrounding material: timber	0	1	0	0
17	surrounding material: plasterwork	1	0	0	0
20	opening mechanism: revolving door	0	0	1	0
27	leaf material: timber	0	1	0	0

Figure 3.12 - Knowledge-base state after the third and fourth questions.

The first most frequent question in the list is now number 5: 'Is the entrance door under or within a vertical glass tower?'. If the user answers yes, the solution number 6: Organic is falsified and removed from the solutions set. Consequently, questions number 9, 16 and 27 become irrelevant and are removed from the set of questions. The resulting knowledge-base state is shown in figure 3.13 bellow.

		4	7	8
		Functionalist	*High Tech*	*Post Modern*
4	angular connection with glass tower	0	0	1
13	Surrounding material: brick	0	0	1
17	surrounding material: plasterwork	1	0	0
20	opening mechanism: revolving door	0	1	0

Figure 3.13 - Knowledge-base state after fifth question.

There are now four questions left and there is no most frequent one. In this case the system will bring the first one in the list, that is, question number 4: 'Is the entrance door connected to a vertical glass tower through a plan in an 45 degrees angle?'. If the user answers 'no', then solution number 8: Post Modern is falsified and removed from the solution's set. This will cause question 13 to become irrelevant and be removed from the questions set. The resulting knowledge-base state is shown bellow in figure 3.14.

		4	7
		Functionalist	*High Tech*
17	**surrounding material: plasterwork**	1	0
20	**opening mechanism: revolving door**	0	1

3.14 - Knowledge-base state after sixth question.

Without a most frequent question the system will again present to the user the first one on the list, which is question number 17: 'Is there plasterwork among the surrounding materials?'. If the user answers no, the solution number 4 is falsified and removed from the set of possible solutions. The resulting knowledge-base state is shown bellow in figure 3.15.

		7
		High Tech
20	**opening mechanism: revolving door**	1

3.15 - Knowledge-base state after seventh question.

If the user answers 'yes' to the last question, 'Does it have a revolving door with four leaves?', then the solution number 7 is the right answer to the problem of identifying an entrance door style.

It might be argued that this procedure does not actually model thought. However, it does simulate the behaviour of a human expert, who will begin by overviewing the scope of the problem before concentrating his or her attention upon the most promising of the remaining solutions.

The advantages of this kind of knowledge representation are two: firstly, the system will run faster than a rule-based one due to the direct bit-string manipulation. Secondly, the addition of new solutions will not require the re-writing of '*if... then*' statements in this kind of representation. The addition of a the hybrid: classic+high tech solution will imply only the incorporation of another bit-string as shown in figure 3.16 bellow.

		1	2	3	4	5	6	7	8	9
		Classic	*Gothic*	*Art Nouveau*	*Functionalist*	*Brutalist*	*Organic*	*High Tech*	*Post Modern*	*Hybrid: Classic + High tech*
1	top flat moulding	1	0	0	0	0	0	0	0	1
2	top curved moulding	0	1	0	0	0	0	0	0	1
3	lateral vertical moulding	0	1	1	0	0	0	0	0	1
4	angular connection with glass tower	0	0	0	0	0	0	0	1	0
5	vertical glass tower	0	0	0	1	0	0	1	1	0
6	triangular pediment	1	0	0	0	0	0	0	0	1
7	pointed arch tympanum	0	1	0	0	0	0	0	0	0
8	tracery or steelwork on fanlight or tympanum	0	1	1	0	0	0	0	0	0
9	squared fanlight	0	0	0	0	1	1	0	0	1
10	fanlight with undulate top	0	0	1	0	0	0	0	0	0
11	lateral cylindrical section column	1	1	0	0	0	0	0	0	0
12	Surrounding material: glass	0	0	1	1	1	1	1	1	1
13	Surrounding material: brick	0	0	1	0	0	1	0	1	0
14	surrounding material: smooth stone	1	1	0	0	0	0	0	0	1
15	surrounding material: concrete exposed	0	0	0	0	1	0	0	0	0
16	surrounding material: timber	0	0	0	0	0	1	0	0	0
17	surrounding material: plasterwork	0	0	1	1	0	0	0	0	0
18	surrounding material: metal	0	0	1	1	0	0	1	1	0
19	opening mechanism: swinging door	1	1	1	1	0	1	1	1	0
20	opening mechanism: revolving door	0	0	0	0	1	0	1	0	1
21	leaf type: plain opaque	0	0	1	0	0	0	0	0	0
22	leaf type: paneled opaque	1	1	0	0	0	0	0	0	0
23	leaf type: framed	0	0	0	1	1	1	1	1	1
24	steelwork as leaf decoration	0	0	1	0	0	0	0	0	0
25	leaf material: glass	0	0	0	1	1	1	1	1	1
26	leaf material: metal	0	0	1	1	1	1	1	1	1
27	leaf material: timber	1	1	0	0	0	1	0	0	0

Figure 3.16 - Knowledge-base extended with the addition of a new solution.

A drawback of this kind of knowledge representation is that, in complex domains, a huge number of conditions, or questions, can be generated by this approach. However, this is largely compensated by the control system, as described above.

If no inconsistency is necessarily introduced on the knowledge-base already in the system with the addition of new solutions, new horizons are open for building systems in which the knowledge-bases can be consistently expanded. However, as the options must be manually set before hand, Cortex (Mustoe, 1990, 1993) has no inherent knowledge acquisition mechanism as any other knowledge-base system.

Since generalised knowledge is not explicitly represented in Cortex (Mustoe, 1990, 1993) it has some similarities with case-based reasoning tools, which will be described in the next section.

3.3 Case-based reasoning:

Most of knowledge-base systems adopt first principles as a reasoning mechanism for solving problems. They usually explain their conclusions by referring to the set of rules that led to them. However, in the real world we normally observe a very different type of explanation. An expert facing a new problem will often be reminded of similar cases of his experience. New problems will be solved considering old ones and explanations will be given referring to them.

Computer systems that try to model this strategy of solving new problems by analogy with old ones are called case-based reasoning (CBR) systems. They rely on a very large set of cases rather than a set of first principles, as argued by Kolodner (1993):

> *"Case-based reasoning emphasises the use of concrete instances over abstract operators. It regards large chunks of composed knowledge as the starting point for reasoning. Though there may be smaller and more abstract chunks of knowledge in memory, they derive from cases and are thus secondary to them". (Kolodner, 1993: 14)*

Rich and Knight (1991) suggest that CBR systems must respond to four problems in order to be successful. First, how the cases are organised in memory. The most obvious idea is to index past cases by their features, in a scheme that allows the distinction of important indices from unimportant ones.

Second, how relevant cases are retrieved from memory. Kolodner (1993) argues that remembering is a process of retrieving a case or a set of cases from memory and that this consists of two sub-steps: recall previous cases and select the best subset.

Third, how the previous cases can be adapted to new cases. In CBR problem solving, old solutions are used as inspiration for solving new problems. However, new situations rarely match old ones exactly and, therefore, old solutions must be fixed to fit new situations.

Fourth, how the cases are originally acquired. Actually, most CBR systems are based on a small library of cases that are entered by hand. Another approach to this last problem would be to start solving problems with rule-based search. Every time a problem is solved, it is automatically stored in a case library. As the library grows, it is possible to solve new problems by analogy with old ones.

Kolodner (1993) argues that CBR offers several advantages:

> *"Case-based reasoning allows the reasoner to propose solutions to problems quickly, avoiding the time necessary to derive those answers from scratch... Case-based reasoning allows the reasoner to propose solutions in domains that are not completely understood by the reasoner... Case-based reasoning gives a reasoner a means of evaluating solutions when no algorithmic method is available for evaluation... Cases are useful in interpreting open-ended and ill-defined concepts... Remembering previous experiences is particularly useful in warning of the potential for problems that have occurred in the past, alerting a reasoner to take actions to avoid repeating past mistakes... Cases help a reasoner to focus its reasoning on important parts of a problem by pointing out what features of a problem are the important ones". (Kolodner, 1993: 25-26)*

Kolodner (1993) also acknowledges some of the CBR disadvantages:

"A case-based reasoner might be tempted to use old cases blindly, relying on previous experience without validating it in the new situation. A case-base reasoner might allow cases to bias him or her or it too much in solving a new problem. Often people, especially novices, are not reminded of the most appropriate sets of cases when they are reasoning". (Kolodner, 1993: 26)

I would go further and say that CBR, like KBS, provide the basis for the reproduction of things, but not for the creation of new things. It may even have a higher potential than KBS's to prevent innovative actions by biasing users with cases. In the design domain this limitation does become a major problem.

In the field of architectural research there has been a growing interest in the use of CBR techniques for building tools that might support the design process in a better way than the rule-based systems. Several models are currently in development and are worthy of mention. Each of them often places more emphasis on one of the four problems that Rich and Knight (1991) have suggested as the key features of a successful CBR.

For Kuhn and Herzog (1993) and the Oxmans (1993a, 1993b) the main problem is domain knowledge structuring for memory organisation. For Schmitt (1993) the emphasis is on the case adaptation to the current problem, while Guena and Zreik (1993) try to tackle several of the main problems at the same time.

Unlike what happened in the field of knowledge-base systems where a particular technique became the 'de facto' standard, that is, the rule-based one, there are no clear standards for CBR tools yet, especially regarding the issues of retrieval and adaptation (Hedberg, 1993a). For this reason, I have tried to summarise and assess the most relevant research on the area in the next sections on a basis of specific works rather than on general issues.

3.3.1 Kuhn and Herzog and the Language-game Abstraction:

Kuhn and Herzog (1993) argue that the language we use for describing objects cannot be separated from the described entities. Words are used to describe objects, but at the same time there is the need for using objects to indicate the meaning of a word. They suggest a metaphor called language-game abstraction (LGA) based on the later work of Ludwig Wittgenstein's theory for the representation and exploration of a space of possible design.

An LGA would comprise the following elements:

- Information items that are containers of text, plans, pictures and video-sequences.

- Descriptors that represent the vocabulary available for reasoning and communicating about the domain of interest. Descriptors may share a common generalisation. Some descriptors, called 'concepts,' are used to classify other descriptors.

- The relations within the set of descriptors and information items: there are two kinds of links: those between items that are accomplished through hypertext techniques, and those between items and descriptors. At least one information item of a case has to be linked to a descriptor. It may be that one information item is addressed by several descriptors, and there may be items that are only accessible by way of item-item links.

The system could comprise several different LGAs representing different view points or particular preferences or interpretations.

In a conventional database the retrieval of a case must match exactly the specifications given a query. In contrast Kuhn and Herzog argue that in an LGA the objective is to additionally explore similarities between cases and the relevance of cases regarding a query, respectively. A query would result in a list of cases ordered by their relevance.

The model they propose would result in a system where the designer might start by searching for items that are described by a certain word within certain concept. By browsing through the retrieved items he or she will find one example explicitly linked to the word used in the initial query but also implicitly linked to a descriptor and a concept that are different from the initial ones. He or she may now ask for the consequences of the new descriptor and concept relating them to other contexts through other queries.

Kuhn and Herzog's model focus on domain knowledge structure. It has a potential of facilitating the structuring of memory in the architectural area and of capturing more than one designer's view. Their model is a browsing system that allows for the exploration of not only explicit but also of implicit links. However, for being based on the exploration of the relation between the words and the objects described by them, it is a passive system in the sense that the user must always take the initiative of defining the problem exactly. I would regard its searching and retrieval procedures as a small improvement over conventional databases.

3.3.2 Rivka and Robert Oxman and the Design Stories:

The Oxmans (1993a, 1993b) research places special emphasis on memory organisation. Therefore, they also concentrate on domain knowledge structure, leaving the utilisation of the knowledge derived for the human designer. The authors argue that precedent representation and indexing are key issues in enhancing the search and browsing capabilities of a case library system.

The Oxmans (1993a, 1993b) argue that the main problems concerning design aid systems in precedent-based libraries are related with representing knowledge of past designs and making it 'searchable' and 'browsable'. Their research is an attempt at modelling conceptual reminding in the design process. They argue that the labeling of designs should be according to the unique design ideas and concepts that justifies its storing in memory, rather than according archival categories, such as name, historical period, style and location that do not reflect cognitive content of reminding.

They suggest that the representation of design descriptions should comprise three separate chunks of knowledge: structural illustration; design stories, which annotate a holistic aspect, or part of a precedent description; and a vocabulary of high-level design concepts.

The structural illustration provides for a complete graphical representation of the design solution. However, they do not provide explicit information about the concepts behind that graphical representation.

The Oxmans (1993a, 1993b) argue that the holistic design is presented by graphical illustrations, while concepts are generally presented in textual descriptions. These annotations may be regarded as 'design stories', or chunks of conceptual knowledge that reveal the uniqueness of a design. 'Design stories' is a specialisation derived from the concept 'story' currently prominent in CBR.

Through the analysis of the contents of writings on relevant designs, these stories begin to form key concepts' cluster connected with the conceptual design, and building type design. The stories are indexed by key words within the texts, which become the concept vocabulary. These vocabularies are domain independent. The concepts may be common to stories of other design precedents in which the same concept occurs.

The Oxmans (1993a, 1993b) argue that the phenomenon of reminding in CBR is connected with search and browsing. In searching, an explicit goal is known beforehand. In browsing, information is sought without the establishment of an a prior goal. They suggest that designers appear to be able to browse freely and associatively to make relevant connections in the course of design ideas' exploration within precedents. Therefore, the purpose of their proposed linkage system is to support cross-contextual browsing within the precedent library.

The authors built a prototype of the precedent library named Memorabilia, which has the proposed memory structure built-in and operates in the following way:

> *"In our approach, the user presents his design issues to the system by filling the indexing formalisms presented above. The system searches for relevant stories in the related design precedents. If the user wishes to investigate other related conceptual solutions, or to explore various concepts in a particular precedent, he may browse through the library by employing the 'indexing system' as a search mechanism. This will enable the exploration of new concepts and design principles from other building types" .(Oxman, Rivka and Robert Oxman, 1993a: 28)*

As in Kuhn's approach, the Oxmans emphasise domain knowledge structure rather than other aspects of case-based reasoning. However, the main difference between them is that Kuhn is concerned with the mutual dependencies between the words used as descriptors and the objects they describe. His approach could be applied in any area that relates graphical representations to textual descriptors. The search in Kuhn's model is intrinsically dependent on key words because it relies on the relation between words and the objects described by them.

In the Oxmans' (1993a, 1993b) research a more domain specific approach to architectural design is intended, where the acquisition of high-level design concept vocabularies is based upon knowledge acquisition through the content analysis of written descriptions of designs in the literature.

One thing that rises from Oxmans' prototype is that it is still a passive system in the sense that the user must always take the initiative of either defining the problem exactly through key words, or browsing freely through the case structure. The authors argue that browsing seems to be the mechanism through which designers are able to make relevant connections and make the discovery of new, often unanticipated, concepts in precedents.

However, I think that this computerised browsing is also only a partial improvement over either the manual one based on delving through magazines and catalogues or electronic databases.

3.3.3 Case adaptation in Gerhard Schmitt's model:

Schmitt (1993) places much more emphasis on case adaptation and case combination than on memory organisation and retrieval. He implemented a system's prototype called 'Architectural CAse BAsed design System', ACABAS, to demonstrate the validity of this approach.

This system performs the following tasks:

- Appraisal of the selected case to identify topological and dimensional inconsistencies between the original context and the present design task.

- In the case of dimensional inconsistency, the system identifies the discrepancies and defines a set of constraints on the local generalisation of the design.

- In the case of topological inconsistency, the system calls transformation rules to adapt the topological graph of the selected case to the needs of the new context while preserving the functions.

- The system defines all the variables in the local constraint network using constraints that are not satisfied in the new context and constraints in the local generalisation of the design.

- The system varies the parameters of adaptation to ensure that no constraints are violated.

- The system checks the validity of adaptation. If no constraints are contradicted, the process is terminated.

- Or, the system fires topological transformation rules that relax constraints in the related constraint set.

The system proposed by Schmitt differs from the majority of those mentioned because it places emphasis on the adaptation process rather than on other aspects of case-based reasoning such as memory organisation, retrieval and knowledge acquisition.

Schmitt (1993) argues that architectural design based on CBR places more emphasis on the adaptation and modification process rather than on storage and retrieval problems. This assertion is not proven. It seems that the retrieval and matching process are taken for grant. How the best set of cases is selected is as important as the adaptation process. Moreover, important research on the area places strong emphasis on memory structure rather then on adaptation. Memory and retrieval may be the most important issues considering the present stage of development on architectural design CBR tools.

One thing that also rises from the Schmitt's description of ACABAS is that it is not clear how the sets of constraints are established and how the transformation rules are acquired. Are those constraints and rules only syntactic or also semantic? It is also not clear how the system deals with different designer preferences, if it does, and how the knowledge-base is updated and maintained.

3.3.4 Analogy, Exploration and Generalisation in Francois Guena's model:

Guena and Zreik (1993) propose a system that, starting with a project and a sketch provided by the user, locates analogous situations in the past and uses these to improve a problem's description. When a sufficiently improved description is reached a constraint-satisfaction mechanism is activated. Precedents are stored in a case-base where the descriptions of past problems are matched to the generic description of past solutions.

The system would comprise three mechanisms:

- An analogy mechanism that has two stages: the first searches in the case-base for the solution schema that best satisfies the requirement of the current design problem in terms of a user's order of preference. The second stage adapts this precedent by combining it with certain aspects of other situations, producing a new constraint satisfaction problem.

- An exploratory mechanism that searches over the solution space. This comprises a complete set of variables and hypothetical constraints.

- A generalising mechanism memorises only what is needed to collect hypotheses from experiences. The objective here would be to improve on the explicit knowledge and to clarify the implicit knowledge present in the solutions.

It must be noticed that, differently from other CBR approaches described earlier, there is no emphasis on a particular aspect of case-based reasoning process. The preoccupation of the authors seems to be the construction of a more holistic system by deploying several existing AI and computing techniques.

Although Guena and Zreik (1993) state that the system would work by starting with a project and a sketch provided by the user and then would locate analogous precedents, it is not clear what this means and how it would be achieved.

3.4 Learning and connectionist models:

3.4.1 Human learning and machine learning:

The notion of human learning is perhaps not as difficult to define as creativity. Learning according to The Concise Oxford Dictionary could be defined as follows:

> *"Get knowledge of (subject) or skill (art, etc.) or ability to do, by study, experience, or being taught (from study or of teacher)... commit to memory... 3. become aware by information or from observation... be informed of, ascertain... receive instruction..." (The Concise Oxford Dictionary, 1988: 571).*

Therefore, learning consists of a broad range of phenomena that goes from skill refinement to knowledge acquisition. People improve their skills at many tasks by simple practicing. The more you play a particular game the better you get. On the other hand, we acquire knowledge through several means.

The simplest way is through memorisation of experience. We also acquire knowledge by taking advice from others. Another way we learn is through our own problem-solving experience. After solving a problem, we remember the structure of the problem and the methods we used to solve it. We then generalise from our experience to provide better solutions to related problems.

On the other hand, we also learn from examples. We often classify things in the world without being given explicit rules or generalisations. This sort of learning usually involves a teacher who helps us to classify things by correcting us when we are wrong.

What lies behind all these ways of learning is that something new is introduced in our operational capabilities (skills) or in our minds (knowledge) which changes our behaviour or way of thinking to provide a better performance in our future actions.

Having said that, the notion of learning can be applied to computing in certain ways. However, if it is not difficult to understand human learning, at least from the view point of the results it brings to our behaviour and minds, machine learning is more controversial.

Firstly, it is a major bottleneck and challenge in the area of artificial intelligence (Rich and Knight, 1991: 557) with not so many successful models. Secondly, a great controversy does exist regarding the few models that have been so far able to exhibit some learning capabilities. Do these systems really learn? Some people thing they do (Rich and Knight, 1991). Other people thing it is just a manipulation of symbols (Searle, 1980). However, this controversy is not so relevant for those primarily concerned with applications.

It is also suggested that learning and creativity may have some relationship and this relationship is particularly relevant in Artificial Intelligence. Rich and Knight (1991) argue that:

> *"One of the most often criticisms of AI is that machines cannot be called intelligent until they are able to learn to do new things and adapt to new situations, rather than simply doing as they are told to do". (Rich and Knight, 1991: 447)*

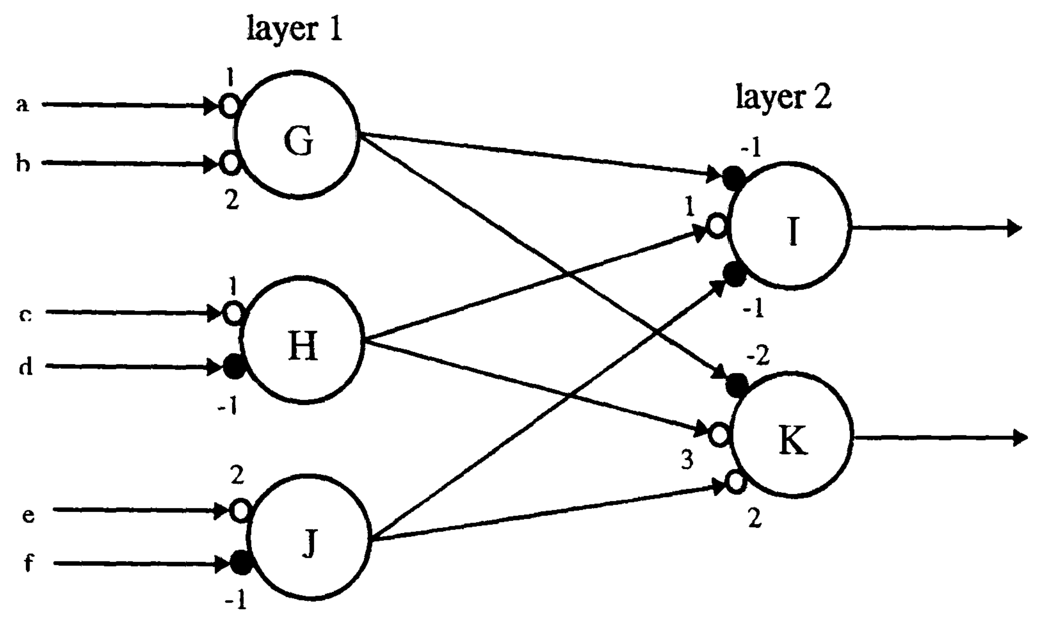
3.4.2 Connectionist models:

Connectionist models are successful learning systems in specific domains. They have found use in several areas such as pattern recognition, language translation, process control and financial and credit analysis. They are based on some of the organisational and operating features of the human brain. For this reason they are also called neural networks.

The main characteristics of connectionist models can be summarised as follows: they consist of one or more layers of neurons, also called nodes, units or cells, that are connected to each other. There are three kinds of layers in multi-layered networks: the input, the hidden and the output layers. The input layer receives information from the user. The hidden layer consists of all neurons in between the input and output layers. The output layer sends information to the user (Lawrence, 1993). The knowledge of a connectionist system is represented and distributed in the interconnections between neurons. The point where two neurons communicate is called a connection. The strength of the connection between two neurons is called a weight. The collection of weights arranged in rows and columns is called the weight matrix (Lawrence, 1993).

The are many types of connectionist models, which I shall try to describe briefly in the next chapter. However, a basic network can be illustrated as in figure 3.17 that shows, in two forms of representation, some of its features as described by Lawrence (1993). Signals '*a*' through '*f*' are coming from the user. The actual neuron values are not indicated since they are dependent on the data presented. The values shown are the weights, or connection strengths, between neurons of each layer. These weight values are established by training. They perform the function of controlling the strength of the signal coming into the neuron. The graphic representation shows the weights, or connections' strength, from the receiving neurons to the sending neurons as small circles with their values, on the larger ones, the receiving neurons. A weight that is a solid circle has a negative or inhibitory effect on the incoming signal. A hollow circle indicates a positive weight or excitatory effect.

Graphic representation



Matrix representation

Layer 1

	a	b	c	d	e	f
G	+1	+2				
H			+1	-1		
J					+2	-1

Layer 2

	G	H	J
i	-1	+1	-1
k	-2	+3	+2

Figure 3.17 Two network representations (Lawrence, 1993)

The matrix representation of the same network requires one matrix for each layer. The columns represent the sending neurons and the rows the receiving neurons.

The neurons process input and produce output. Each neuron takes in the output from many other neurons. These incoming signals are summed to a net value. In most models they are simply added together. Figure 3.18, bellow, illustrates the functioning of a simple neuron, as described by Lawrence (1993).

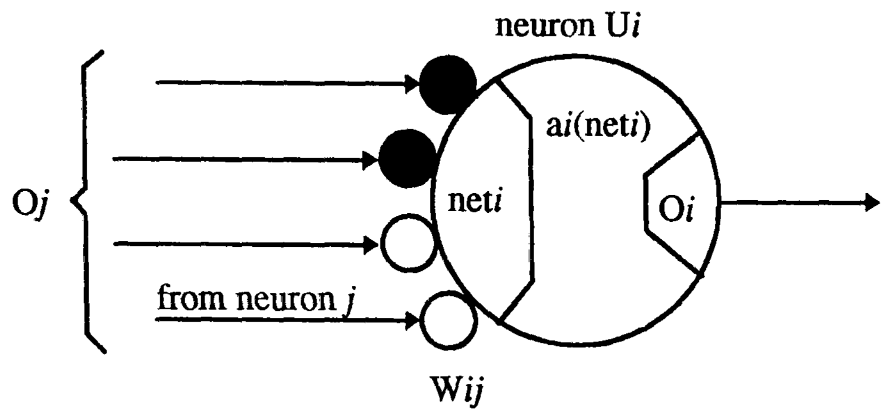


Figure 3.18 Neuron functions (Lawrence, 1993)

In this figure, W*ij* represents the connections, where '*i*' is the receiving neuron and '*j*' is the sending neuron. The neuron U*i* calculates its output by finding the weighted sum of its inputs (net*i*) and then applying an activation function that produces an activation level (a*i*) 'inside' the neuron. The activation is passed through an output, or transfer function, that produces the actual output O*i* for that neuron for that time (Lawrence, 1993). There are several kinds of transfer functions, among them, the step function that provides the basis for binary output networks, and the sigmoid function for continuous output.

The most appealing characteristic of connectionist models is their supervised or unsupervised learning capability. A supervised learning is that one in which a teacher is required. The act of teaching is represented in the training process by patterns pre-set by a domain expert that will be used by the network to achieve the desirable outputs.

An unsupervised learning is the other way round. There is no teacher involved, that is, there are no patterns pre-set by a domain expert for the training process (see Kohonen, 1988, as an example). The self organizing behaviour of unsupervised neural networks may involve competition, cooperation, or both. (Lawrence, 1993: 103).

I shall provide a more detailed description of both supervised and unsupervised models in the next chapter. I will then explain why a particular neural network paradigm has been chosen for use in the experimentation described later in this thesis.

However, these general descriptions of the internal mathematical models and training process of connectionist systems are intended as a framework for a basic understanding of their functioning and use. It is not the objective of this thesis to probe deep into the analysis of their inner procedures. The objective is to access experimentally the reliability and relevance of results provided by connectionist systems within a wider application framework as it will be described in Chapters 5 to 8. Whatever is the inner mathematical procedure of these models, most of the supervised learning systems can be taken as the simulation of a process of behavioural conditioning. From this point of view the final assessment of their validity relies on experimental evaluation of results rather than by proving their inner procedures.

3.4.3 Connectionism in architectural design:

Connectionist models, as demonstrated by Coyne and Newton (1990), Coyne and Postmus (1990), Coyne (1991), Coyne and Yokozawa (1992), and Coyne et al (1993), can provide support for the exploration of implicit, therefore, unexpected connections among information. Moreover, it is also argued that they can provide the basis for creative design by providing the means of extracting information from implicit knowledge representation that can be translated as new explicit solutions (Coyne et al, 1993).

In one of these experiments (Coyne and Yokozawa, 1992), it is argued that combinations of features are the primary interest in considering design precedents, rather than combinations of examples into categories as it is common in conventional databases:

> *"So the main concern is with connections between features rather than between examples. It is possible to construct a database with the features as the records instead of the examples. The fields would then be the examples in which the features occurs". (Coyne and Yokozawa, 1992)*

This provided the basis, not only for the statistical analysis described in their paper, but also, and more important, for a connectionist experiment where an auto-associative network design was adopted (Coyne and Yokozawa, 1992). In this kind of design the inputs map into themselves, as opposed to a hetero-associative design where the input-output pairs are arbitrary. Masters (1993) defines an auto-associative connectionist model as follows:

> *"When a neural network has exactly as many output neurons as input neurons and is trained so that its outputs attempt to match its inputs for every member of a training set, it is said to be an auto-associative network". (Masters, 1993)*

Figure 3.19 provides a graphic representation of one of the ways in which an auto-associative network may be designed:

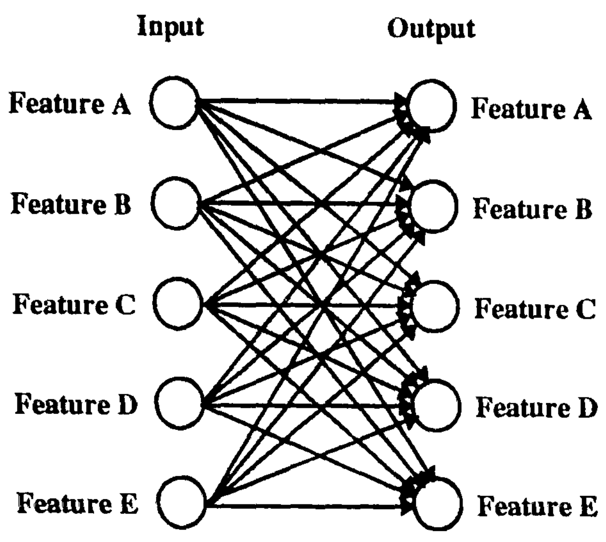


Figure 3.19 An auto-associative network

The use of this design, with features mapping into features, may not be obvious at a first glance. However, after being trained through the exposure to a certain number of examples, represented by different sets of combinations of features, this network becomes 'aware' of what features are mutually excitatory or inhibitory. Coyne and Yokozawa (1992) suggested that if a designer used such trained network by selecting and manipulating features (neurons) on its input layer, the outcome would be not only combinations of features matching examples from the training set, but eventually the emergence of new combinations of features.

For instance, a neural network could be trained with the same set of instances described in figure 3.16. If after training, the user chooses to make active the input units *'surrounding material: metal'* and *'leaf material: metal'*, the output will be a binary string which represents the solution number 3, *'Art Nouveau'*, of the training set. This is illustrated in figure 3.20, bellow.

		Input layer	Output layer
1	top flat moulding	○	○
2	top curved moulding	○	○
3	lateral vertical moulding	○	●
4	angular connection with glass tower	○	○
5	vertical glass tower	○	○
6	triangular pediment	○	○
7	pointed arch tympanum	○	○
8	tracery or steelwork on fanlight or tympanum	○	●
9	squared fanlight	○	○
10	fanlight with undulate top	○	●
11	lateral cylindrical section column	○	○
12	Surrounding material: glass	○	●
13	Surrounding material: brick	○	●
14	Surrounding material: smooth stone	○	○
15	Surrounding material: concrete exposed	○	○
16	Surrounding material: timber	○	○
17	Surrounding material: plasterwork	○	●
18	Surrounding material: metal	●	●
19	opening mechanism: swinging door	○	●
20	opening mechanism: revolving door	○	○
21	leaf type: plain opaque	○	●
22	leaf type: paneled opaque	○	○
23	leaf type: framed	○	○
24	steelwork as leaf decoration	○	●
25	leaf material: glass	○	○
26	leaf material: metal	●	●
27	leaf material: timber	○	○

Figure 3.20 - The *'Art Nouveau'* entrance description built by the trained neural network.

However, if the user chooses to make active the input units *'triangular pediment'*, *'opening mechanism: revolving door'*, and *'leaf material: glass'*, then the output will be the one shown in figure 3.21, which is a new combination of features, but still represents a sensible solution from the architectural point of view.

		Input layer	*Output layer*
1	top flat moulding	○	●
2	top curved moulding	○	●
3	lateral vertical moulding	○	○
4	angular connection with glass tower	○	○
5	vertical glass tower	○	○
6	triangular pediment	●	●
7	pointed arch tympanum	○	○
8	tracery or steelwork on fanlight or tympanum	○	○
9	squared fanlight	○	●
10	fanlight with undulate top	○	○
11	lateral cylindrical section column	○	○
12	Surrounding material: glass	○	●
13	Surrounding material: brick	○	○
14	Surrounding material: smooth stone	○	●
15	Surrounding material: concrete exposed	○	●
16	Surrounding material: timber	○	○
17	Surrounding material: plasterwork	○	○
18	Surrounding material: metal	○	○
19	opening mechanism: swinging door	○	●
20	opening mechanism: revolving door	●	●
21	leaf type: plain opaque	○	○
22	leaf type: paneled opaque	○	○
23	leaf type: framed	○	●
24	steelwork as leaf decoration	○	○
25	leaf material: glass	●	●
26	leaf material: metal	○	●
27	leaf material: timber	○	●

3.21 - New solution emerged from the trained neural network.

Connectionist models have two main drawbacks: they may take a long time to be trained, and they do not provide explanations for their decisions. However, as it will be argued later in this chapter, these problems may be overcome or minimised if these models are integrated to other paradigms in a wider framework.

3.5 Hybrid systems:

There has been a growing interest on researching the potential of merging two or more approaches to exploit their strength and compensate for their deficiencies. As an example, Hedberg (1993a, 1993b) suggests that if KBSs are combined with multimedia and virtual reality the results are powerful interfaces for the KBSs:

> *"Programmers can use KBS technology to manage and retrieve multimedia data sources and to create intelligent agents and objects in virtual reality. As a result, the computer interfaces come alive" (Hedberg, 1993a: 107)*

Hedberg (1993a) argues that when a system combines two techniques it can intelligently process a wider variety of information than could be handled by either of the techniques it comprises. She suggests that a hybrid system can, starting from a general front end, select a subsystem to handle each problem through the front end, while the back end formats and consolidates partial answers from each subsystem.

The computer technologies developed so far have tended to prove useful on restricted domains or circumstances and have shown a common inability to provide a holistic representation. Liebowitz (1993) argues that KBSs are powerful in well-defined domains. However, their reasoning is not adaptive and their performance does not increase with experience. Moreover, they require too much human input in their construction and maintenance. CBR systems are able to store, analyse and process previous experiences and decisions allowing the interpretation of open-ended and ill-defined domains. However, there is no standard yet for how cases are prioritised and how the system adapts them to new situations. Connectionist models learn and train themselves and provide high-response accuracy in certain domains. However, they often require prolonged training and do not provide explanations for their results, as already said in the previous section.

Liebowitz (1993) suggests that hybrid systems can take advantage of each technology's best features. For instance, a CBR technology can add to a KBS the ability to reason from past experiences and intelligent system to store and analyse data. A connectionist system can add learning capabilities to a KBS, while this last may explain the connectionist system results. I would add the fact the KBSs can provide a better user interface to connectionist systems by providing an interactive and intelligent front end.

3.6 Conclusion:

Knowledge-base systems, particularly those rule-based, and Case-based reasoning tools have found relatively successful applications in very specific domains. Once these systems are built they are able to provide useful support in particular domains. However, both models face three major difficulties already mentioned: firstly, the extension of knowledge-bases or case-bases is extremely labour intensive. Secondly, the consistency maintenance involved in their extension makes their updating extremely complex in that they require constant intervention of a specialist. Thirdly, and more important, there is the dilemma 'reproduction versus creation', mentioned in the previous chapter. Those models may provide algorithms for how things may be reproduced, but offer no support for the emergence of new solutions.

A knowledge-base system based on pattern-recognition such as Cortex (Mustoe, 1990, 1993) is not as prone as the rule-based systems to consistency problems, as already shown earlier in this chapter. Yet its knowledge-base extension is still labour intensive since the model does not have any inherent knowledge acquisition mechanism. As it happens with all other models, it does not provide an answer for how new designs may arise. However, I will explain in chapter 5, its integration with a particular design of connectionist model may provide the answers for this problem.

Connectionist models are best known for their knowledge acquisition capabilities. As mentioned earlier in this chapter, they may also provide support to innovation. Their main drawbacks are their training time, and their user interfaces regarding two aspects: the lack of explanations and their passive character.

I believe that the training time is not a major problem, first because once trained the network responds in real time. Second, it is a circumstantial problem that may be overcome as more powerful hardware is developed.

Regarding to the interface problems, the lack of explanations can be solved by integration of other techniques, particularly with knowledge-base systems (Liebowitz, 1993: 115). However, this is not the main interface problem of connectionist systems tackled by this thesis. The main interface problem dealt with is related to their passive character. A proposed solution, that is, using a network in the background, and a KBS as the front end, acting as an intelligent filter, will be described later in this thesis.

Therefore, Chapter 5 describes an algorithm built upon the integration of a knowledge-base system, based on pattern-recognition (Mustoe, 1990, 1993), with a connectionist system inspired on the work of Coyne and Newton (1990), Coyne and Postmus (1990), Coyne (1991), Coyne and Yokozawa (1992), and Coyne et al (1993). This algorithm aims to provide the basis of an environment able to support innovation by augmenting the designer's creativity.

However, it is necessary to provide a more detailed background of neural network paradigms before proceeding with the algorithm's description. Therefore, Chapter 4 describes the main neural network models. It provides an explanation of why a particular architecture has been chosen for use in the proposed system.

Chapter 4

Neural network paradigms

4.1 Introduction

The history of neural networks' research goes back to the origins of Artificial Intelligence in the early 1940s. The first relevant results were achieved with the work carried out by McCulloch and Pitts (1943). They demonstrated that networks composed of binary valued neurons were capable of performing simple threshold logic computations.

In the late 1940s Hebb (1949) proposed a learning mechanism in which whenever two neurons are excited at the same time, the connection between the two neurons should be strengthened. This rule was the basis of most network learning rules.

The research in the field would be dominated in the 1950s by Rosenblatt's work (1958). He proposed a model of networks, called *Perceptrons*, which he claimed was sufficient for pattern recognition, associative learning, selective attention and recall, and temporal pattern recognition. The Perceptrons were designed to resemble a biological sensory model, with neurons of binary state ('on' or 'off'), and used a variation of Hebb's learning rule (Hebb, 1949). However, the *Perceptron* was more limited than initially suggested by Rosenblatt, although later models did exhibit some of those capabilities.

By the end of the 1960s, Bryson and Ho (1969) developed new learning algorithms for multilayer networks based on back-propagation, which would be ignored for almost two decades. The main reason for this was an in depth study of the capabilities and limitations of the Perceptrons undertook by Marvin Minsky and Seymour Papert during the 1960s. They argued that although the Perceptrons could be shown to learn anything they were able to represent, yet they could represent very little. Therefore, several problems could never bee solved by the Perceptrons. The results, published in the book *'Perceptrons'* (Minsky and Papert, 1969) led to a virtual halt in neural network research in the field of computer science from early 1970s to early 1980s, while rule-based systems research flourished.

Few researchers continued working with neural networks during the 1970s and early 1980s. Among them were Anderson (1972) and Kohonen (1972) that simultaneously developed the linear associator. In this model, neurons could fire in varying frequency in response to incoming signals, rather than by simply turning 'on' or 'off' as in the Perceptrons.

Although neural networks were neglected in computer science after Minsky and Papert's *'Perceptrons'* book (1969), research continued in other fields, particularly physics and psychology.

Research in neural networks saw a resurgence from mid 1980s for several reasons. Among them are: the appearance of faster digital computers on which the simulation of larger networks became possible, research in parallel computers, and the development of new neural network models and learning algorithms. The work of the physicist Hopfield (1982) was of particular importance in that resurgence. He demonstrated that neural networks were capable of some interesting behaviour, such as pattern recognition despite garbled input.

The psychologists David Rumelhart and Geoff Hinton studied the neural network models of memory and reinvented the back-propagation learning algorithm first developed by Bryson and Ho (1969). The algorithm was applied to several learning problems in computer science and psychology and the broad variety of results, published in the collection *'Parallel Distributed Processing'* (Rumelhart and McClelland, 1986) caused a significant resurgence in neural network's research.

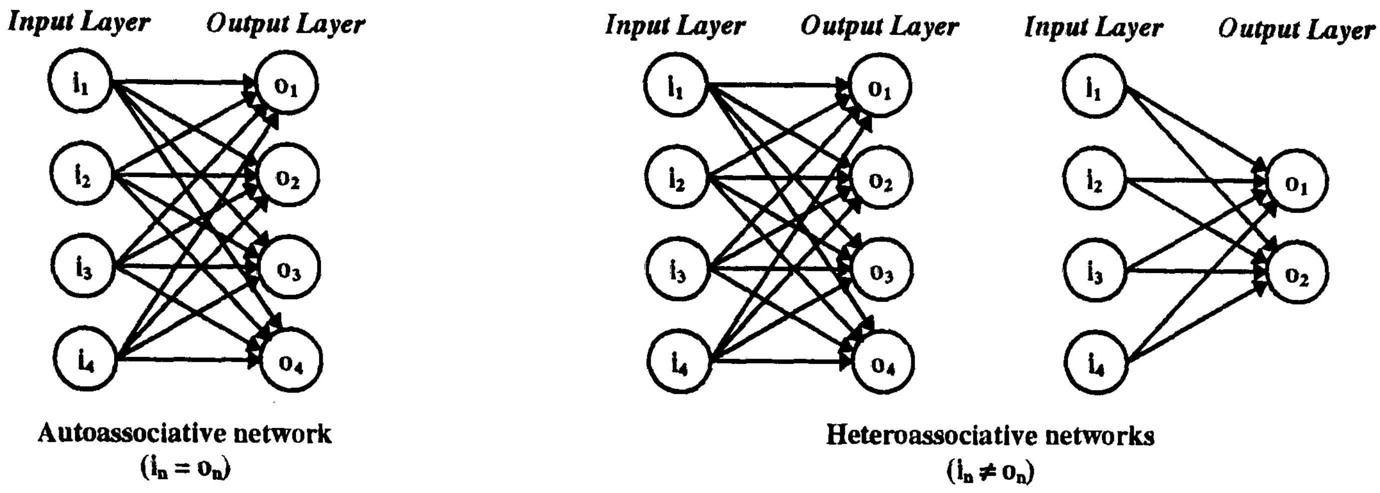
During a long time neural networks and traditional AI, that is, rule-based systems, were seen as rival fields, rather than as mutually supporting approaches to the same problem. However, the limitations of the expert systems technology, particularly in relation to knowledge acquisition and maintenance, coupled with the resurgence of neural networks has led to more co-operative research and to the proposition of hybrid approaches such as advocated by Clark (1989).

4.2 Classes of neural networks:

Attempting to classify neural network models into neat categories is a difficult task since many combinations of characteristics exist between the several models. Yet I shall try to describe and classify the most common neural network models in the coming sections of this chapter in order to provide a better background against which the decision to adopt a particular model will be explained.

Neural networks can be arbitrarily classified by their association paradigm, processing flow, neuron behaviour, and learning method. The classifications shown later in this chapter are an attempt to provide some understanding of similarities and differences among some of the most important models. They are not intended as an exhaustive and complete list.

Neural networks can be classified according to their association paradigm: they can support either autoassociation, heteroassociation or both. These categorisations have already been introduced in Chapter 3, section 3.4.3. Associative networks map pairs of inputs (i) and outputs (o), where $i = o$. Therefore, they have the same number of input and output units. Heteroassociative networks map inputs (i) and outputs (o) arbitrarily, that is, $i \neq o$. They may or may not have the same number of input and output units. Figure 4.1 illustrates these association paradigms.



4.1 - Association paradigms.

Most of the network models support heteroassociation as shown in figure 4.2 bellow. Hopfield (1982) and Bidirectional Associative Memory (Kosko, 1988) networks are inherently autoassociative. All the others may accommodate both paradigms.

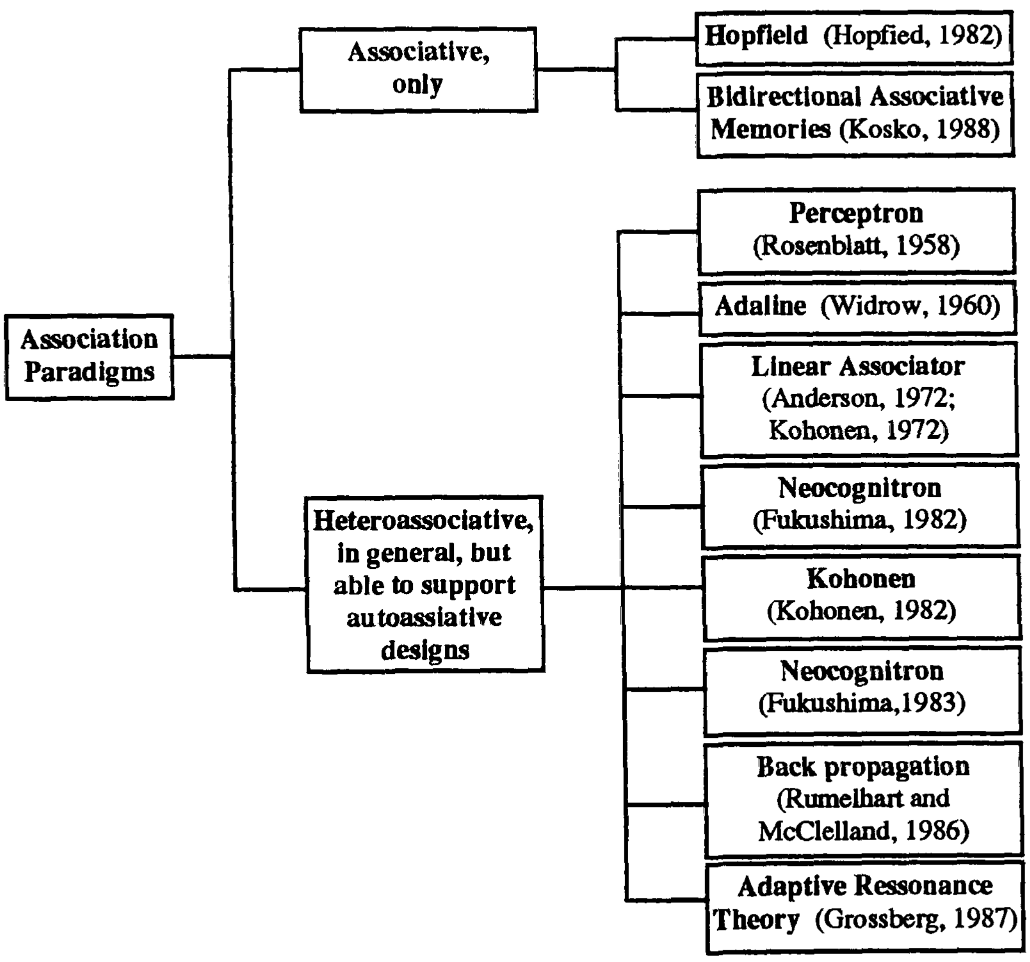


Figure 4.2 - Neural network's classification according to association paradigms.

The processing flow can contain feedback loops or not. If a neuron's output is never dependent on the output of subsequent neurons, that is, signals go only one way, the network is said to be feed forward. Otherwise is a feedback or recurrent network. This distinction will become clearer, later in this chapter, particularly through the differences between Hopfield networks, and Perceptrons and back propagation. Figure 4.3 shows a classification of the same models above according their processing flow.

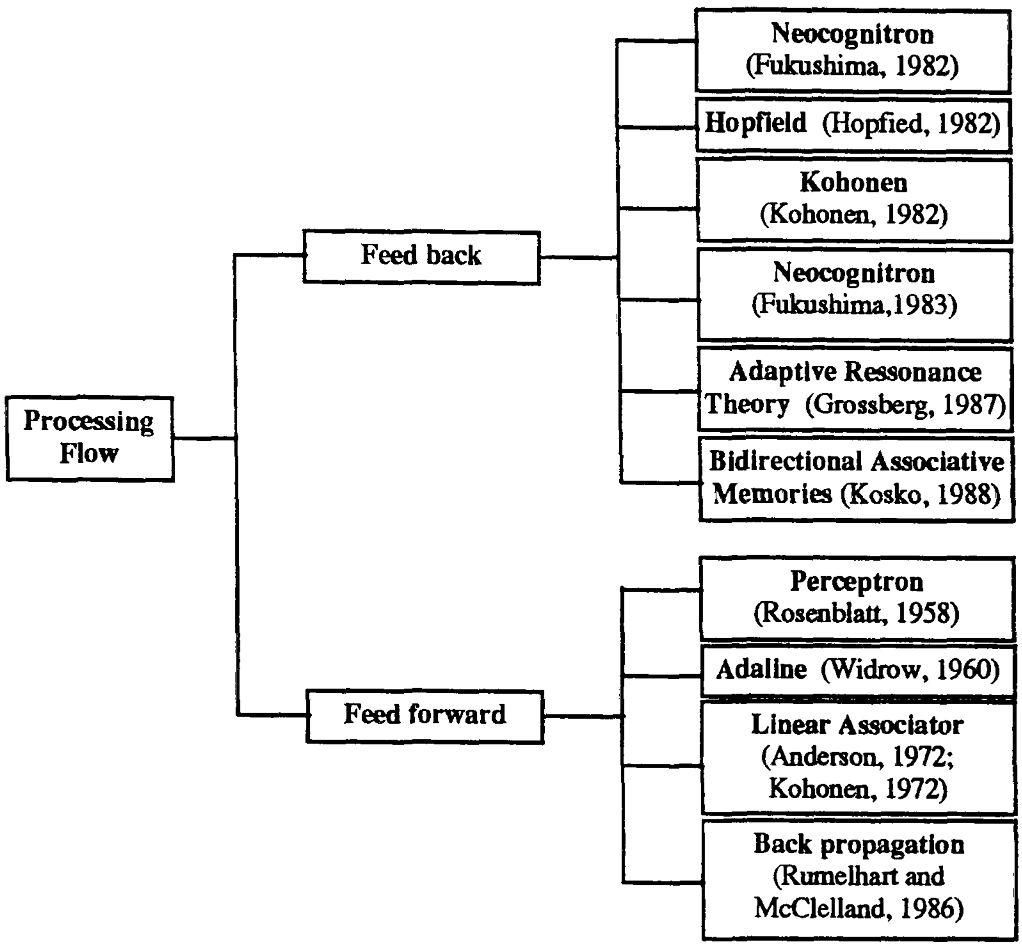


Figure 4.3 Network classification according to the processing flow.

Another general feature is the transfer function, which is applied to each neuron's activation value to generate each neuron's output. This function is based either on linear or nonlinear models. As stated in the previous chapter, section 3.4.2, there are several kinds of transfer functions. The simplest of them is the linear transfer function in which the output is a constant slope, such as shown in figure 4.4 bellow:

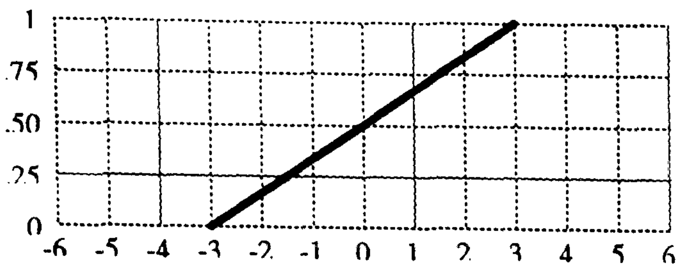


Figure 4.4 - Linear transfer function.

Another kind of transfer function is the linear threshold, in which the output is a constant multiple of the input over some range, possibly shifted left or right by a constant, such as shown in figure 4.5, bellow:

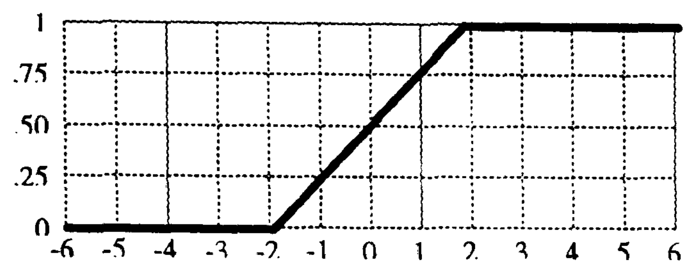
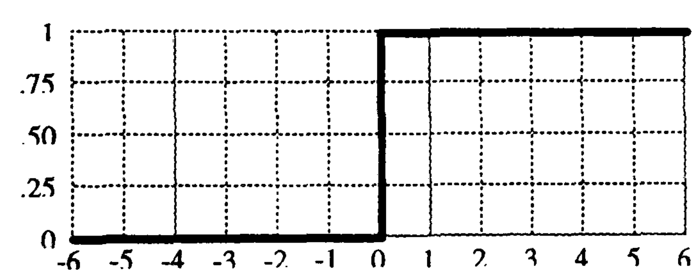


Figure 4.5 - Linear threshold transfer function.

Linear transfer functions are reported not very useful for most applications (Minsky and Papert, 1969; Rich and Knigh, 1991), while linear threshold transfer functions can show a slightly more interesting behaviour (Lawrence, 1993). However, they also have been shown to possess severe limitations on what they can represent and thus learn (Minsky and Papert, 1969).

The step transfer function, shown in figure 4.6, is the one in which the output is binary. Below threshold, the output is always low, and at or above threshold it is always high. This kind of function is used in neural networks designed to simulate digital circuits or to process binary symbolic knowledge.



4.6 - Step transfer function.

Because the discontinuity in the function, step functions are quite nonlinear. Therefore, networks built with this kind of functions can present much more interesting behaviour than networks with partially or entirely linear neurons (Lawrence, 1993).

Finally, the sigmoid function, also known as an S-shaped, semi-linear, or squashing function, is the one in which the output is a continuous function of the input, as shown in figure 4.7 bellow:

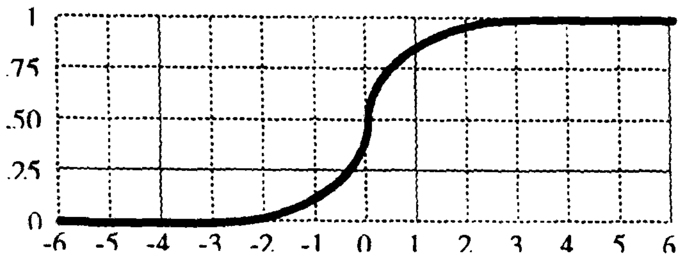


Figure 4.7 - Sigmoid transfer function.

Since sigmoid functions are both nonlinear and continuously differentiable, they exhibit many advantages when used to build neural networks. I shall try explain it better later on this chapter, particularly in the section describing the Perceptron and its limitations.

Figure 4.8 shows a network's classification according to their neuron transfer function. The models have been grouped in two clusters, linear and non-linear, according to the type of transfer function usually adopted by each paradigm.

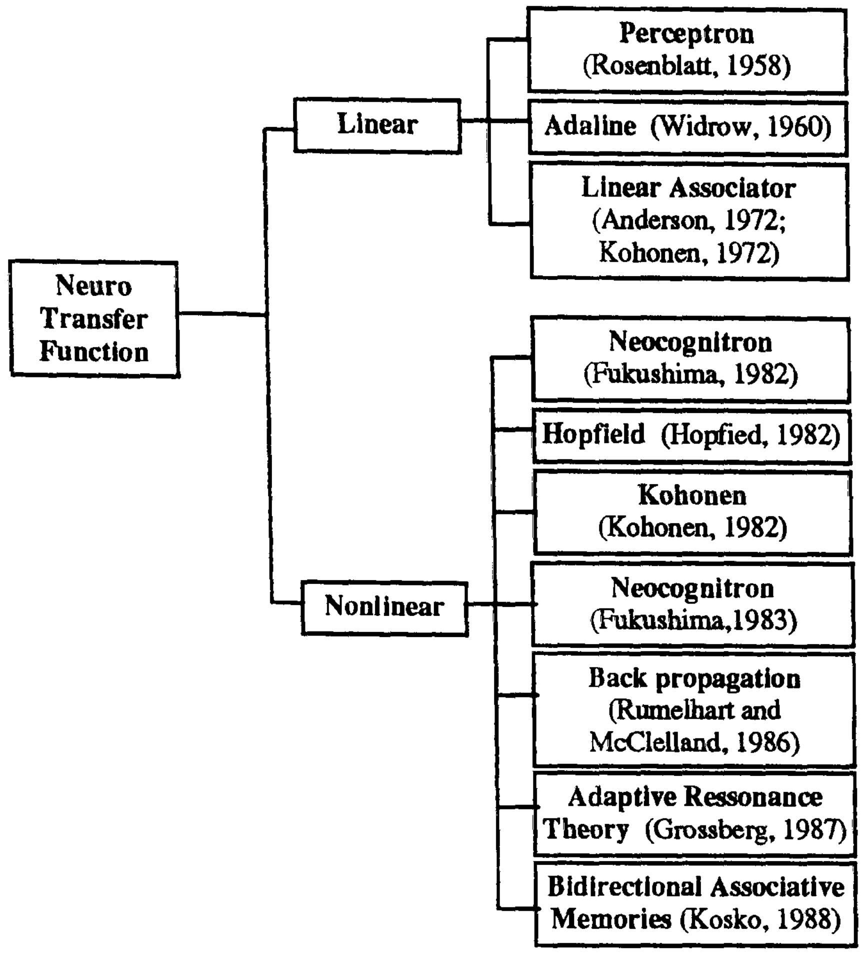
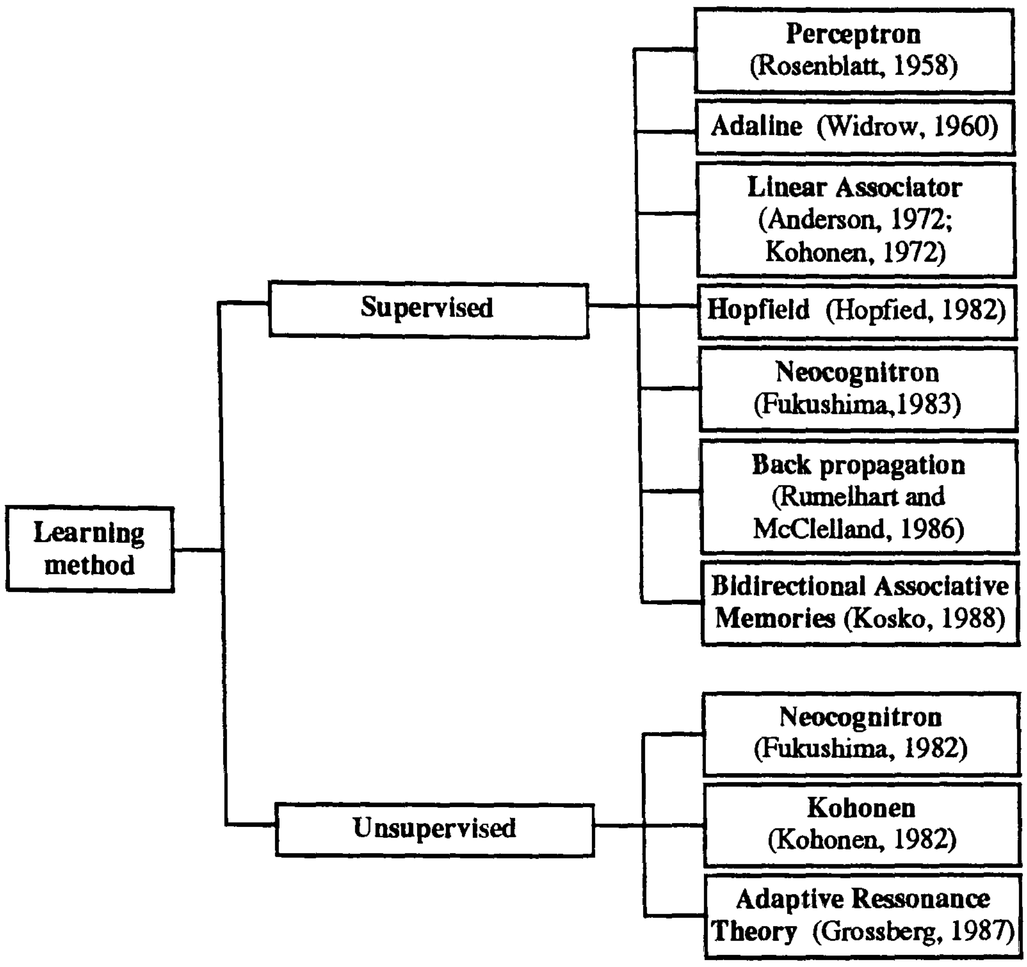


Figure 4.8 - Network's classification according to their transfer functions.

Neural networks can also be classified by their learning algorithm, which is usually either supervised or unsupervised. They adopt a supervised learning algorithm when they are trained by presentation of cases for which the desired outputs are known. They majority of applications require this kind of training in which the desired outputs are known for each input contained in the training set. The pairs of inputs and outputs are presented to the network which will learn to associate them.

However, there are some applications where a 'correct' association between inputs and outputs is not known. Moreover, an unsupervised model may be sometimes adopted because we may want to verify if the network can learn the 'correct' outputs on its own, without the guidance of known associations. Also, it may be of interest to know the patterns a network can discover in data.

Figure 4.9 shows the network's classification according to their learning method.



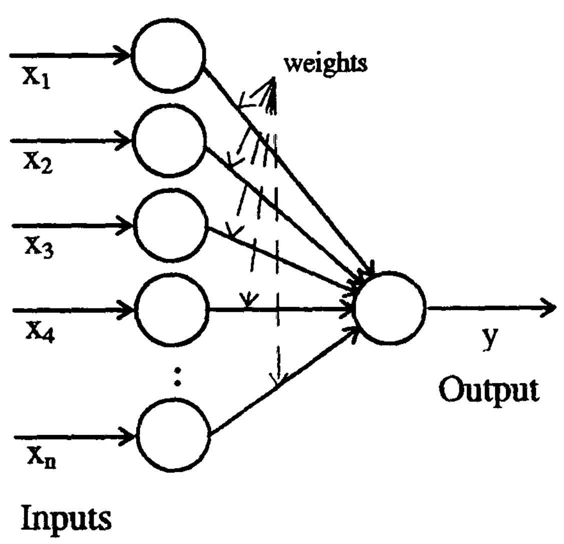
4.9 - Network's classification according to their learning method.

I will not describe all the above paradigms. However, I shall describe in more detail four of the models mentioned in the classification above in the coming sections. These models are: the *Perceptron* (Rosenblatt, 1958), the *Hopfield* (1982), the *Kohonen* (1982) and the *Back Propagation* (Rumelhart and McClelland, 1986). The description of these paradigms will provide a basic understanding of the main neural network's paradigms.

4.3 The Perceptron:

The Perceptron (Rosenblatt, 1958) was one of the earliest models of neural networks. It has been characterised basically as a two-layered feed-forward network (input and output layers, with no hidden layers) built out of neurons of binary output. Although networks of all sizes and topologies have been considered and described in the late 1950s by Rosenblatt and others, most of the research efforts were devoted to two-layer perceptrons. The main reason for this was the difficulty of finding a sensible way to update the weights between the inputs and hidden units (Russel and Norvig, 1995).

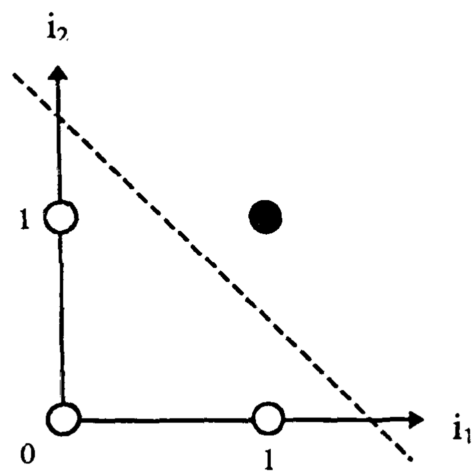
The perceptron models a neuron by taking a weighted sum of its inputs and sending the input *1* if the sum is greater than some adjustable threshold value, otherwise it sends *0*. Since each output unit is independent of the others, that is, each weight only affects one of the outputs, they can be analysed separately. Figure 4.10 shows a Perceptron with many inputs and one output:



4.10 - Single output perceptron network.

Learning is a process of modifying the values of the weights and the threshold. The *perceptron convergence theorem* (Rosenblatt, 1962), guarantees that the perceptron will learn. However, due to its linear model, this is true only for linearly separable set of inputs as demonstrated by Minsky and Papert (1969). They also argued that most problems do not provide such nice data, and the perceptron is thus incapable of learning to solve some very simple problems. For instance, a perceptron can represent and learn *'and'* and *'or'* functions but not *'xor'*.

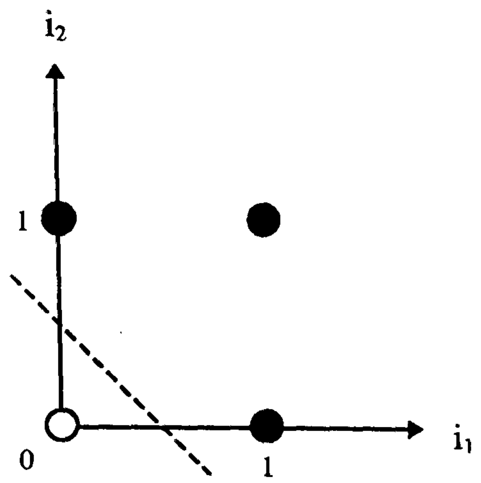
This limitation was graphically illustrated as follows. Firstly, the *'and'* function: given two binary inputs, output *1* if *both* of the inputs are 'on' and output *0* otherwise. The *'and'* can be seen as a pattern classification problem in which there are four patterns and two possible outputs as illustrated in figure 4.11 bellow. The white circles represent *0* outputs, while the black circle a *1* input.



i_1	i_2	i_1 *and* i_2
0	0	0
0	1	0
1	0	0
1	1	1

4.11 - 'And', a linearly separable problem.

Secondly, the *'or'* function: given two binary inputs, output *1* if *at least* one of the inputs is 'on' and output *0* otherwise. The *'or'* is also a pattern classification problem with four patterns and two possible outputs as illustrated in figure 4.12 bellow.

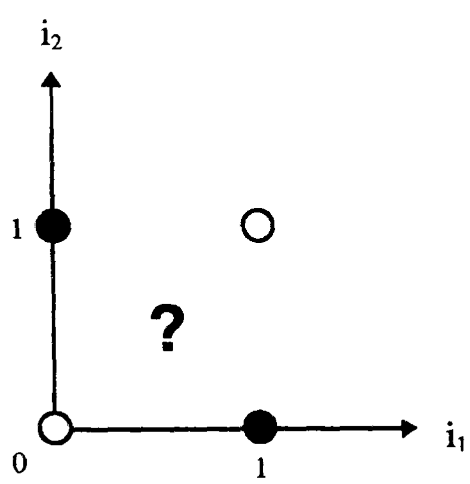


i_1	i_2	i_1 *or* i_2
0	0	0
0	1	1
1	0	1
1	1	1

4.12 - 'Or', another linearly separable problem.

In both cases above, that is, the *'and'* and the *'or'* functions, it is possible to separate the different outputs in the graphs above by drawing a straight line between the two kinds of outputs.

Finally, the exclusive-or (*xor*) problem: given two binary inputs, output *1* if *exactly* one of the inputs is 'on' and output *0* otherwise. The *'xor'* is also a pattern classification problem with four patterns and two possible outputs as illustrated in figure 4.13 bellow.



i_1	i_2	i_1 *xor* i_2
0	0	0
0	1	1
1	0	1
1	1	0

4.13 - The *xor*, a non linearly separable problem.

It is impossible to separate the different outputs in the graph above by drawing a straight line between the two kinds of outputs. Therefore, the perceptron cannot learn a linear decision surface to separate these different outputs since no such decision surface exists. It is important to stress that the this is not a deficiency of the perceptron learning algorithm, but of the way it represents knowledge. A perceptron algorithm will learn any linearly separable function, given enough training examples. Unfortunately, very few problems can be modelled as linearly separable functions.

An example may be provided by the door entrance domain, mentioned earlier in this thesis. If a perceptron is designed for and trained with that domain, and the user makes active the input units '*triangular pediment*', '*opening mechanism: revolving door*', and '*leaf material: glass*', the resulting output will be as shown in figure 4.14 bellow.

		Input layer	*Output layer*
1	top flat moulding	○	○
2	top curved moulding	○	●
3	lateral vertical moulding	○	○
4	angular connection with glass tower	○	●
5	vertical glass tower	○	○
6	triangular pediment	●	●
7	pointed arch tympanum	○	○
8	tracery or steelwork on fanlight or tympanum	○	○
9	squared fanlight	○	○
10	fanlight with undulate top	○	○
11	lateral cylindrical section column	○	○
12	Surrounding material: glass	○	●
13	Surrounding material: brick	○	○
14	Surrounding material: smooth stone	○	●
15	Surrounding material: concrete exposed	○	○
16	Surrounding material: timber	○	●
17	Surrounding material: plasterwork	○	○
18	Surrounding material: metal	○	○
19	opening mechanism: swinging door	○	●
20	opening mechanism: revolving door	●	○
21	leaf type: plain opaque	○	○
22	leaf type: paneled opaque	○	●
23	leaf type: framed	○	●
24	steelwork as leaf decoration	○	○
25	leaf material: glass	●	●
26	leaf material: metal	○	○
27	leaf material: timber	○	○

4.14 - Output of a Perceptron network trained with the door entrance domain.

As it can be seen the perceptron was unable to learn that the features *'leaf type: panelled opaque'* and *'leaf type: framed'* are mutually exclusive (*'xor'*) in the training set (see figure 3.16 in the previous chapter).

It was argued that the construction of multilayer perceptrons would solve this problem. However, it introduced a serious learning problem: the perceptron learning algorithm could correctly adjust weights between inputs and outputs, but not between perceptrons. At the time of the *Perceptrons* (Minsky and Papert, 1969) publication, it was not known how multilayer perceptrons could be made to learn, that is, how the weights between inputs and hidden units could be sensibly updated. It would be only with the invention of the back propagation learning algorithm (Bryson and Ho, 1969; Rumelhart and McClelland, 1986) that multi-layered feed forward networks became feasible.

4.4 Hopfield Networks:

Hopfield networks (Hopfield, 1982) are probably one of the best examples of feed-back networks. The connections among their neurons are bidirectional and the weights are symmetric. All the neurons of Hopfield networks are simultaneously input and output units, thus they are single-layer networks. The processing units are always in one of two states, active or inactive. Each of the units may be either connected to all other units or just to few of them. Figure 4.15 bellow illustrates a Hopfield network architecture with four neurons, each one connected to all other neurons.

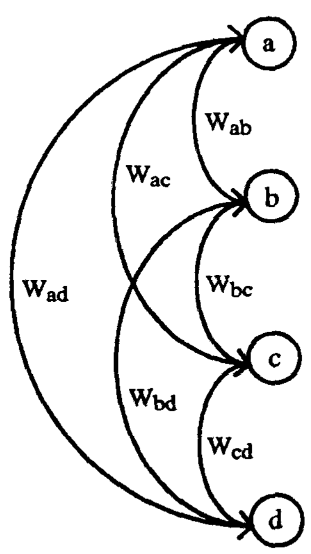


Figure 4.15 - A simple Hopfield network

A Hopfield network functions as an associative memory network. After being trained with a set of examples a new stimulus, or input, will cause the network to settle into an activation pattern generally corresponding to the example in the training set that most closely resembles the new stimulus.

The network processes this response as follows: all the units are initially inactive. Once the input has been entered, a random unit is chosen. If any of its neighbours is active, the unit computes the sum of the weights on the connections to those active neighbours. If the sum is positive, the unit becomes active, otherwise it remains inactive. Another random unit is chosen, and the process repeated until the network reaches a stable state. This process is called *parallel relaxation.*

For instance, suppose that a Hopfield network is design for and trained with the door entrance domain described in the previous chapter. A stimulus, or input, containing few active units, such as *'triangular pediment'* and *'lateral cylindrical section column'*, may cause the network to settle in a complete activation pattern. In this case the pattern represents the closest example in the training set, that is, the *'Classic'* one. Figure 4.16 bellow illustrates this process.

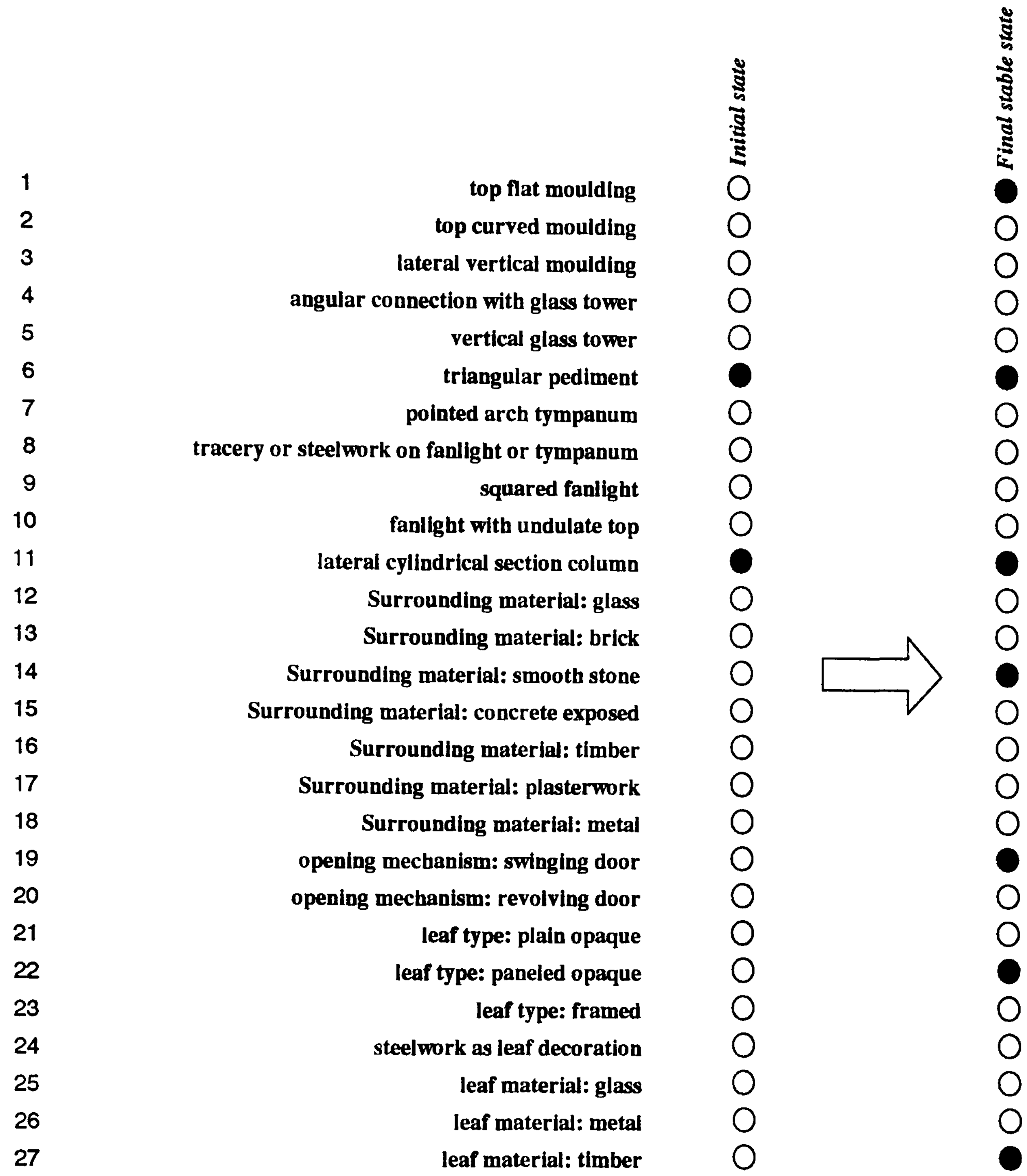


Figure 4.16 - Running a Hopfield network that was trained with the door entrance domain.

Recurrent networks, such as Hopfield's, may take a long time to compute a stable state or end up in a oscillatory state. On the other hand, Hopfield networks deliver two of the most interesting theoretical results among feed-back networks, which are pattern completion and fault tolerance.

The first benefit is the retrieval of a complete pattern by only specifying a portion of it, as it was shown above. The second benefit, fault tolerance, means that if a unit fails, for instance by becoming active or inactive when it should not, the surrounding units will quickly set it straight again (Rich and Knight, 1991).

4.5 Kohonen Networks:

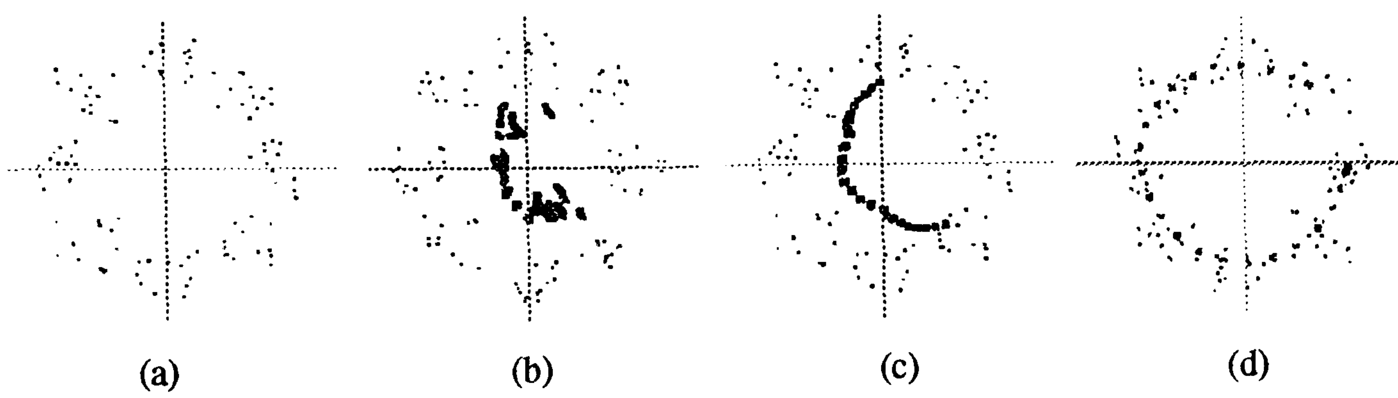
The most popular neural network paradigm based on unsupervised learning is probably that developed by Kohonen (1982, 1984, 1988). In supervised learning all neurons adjust their weights in response to an input-output pattern presentation. However, unsupervised learning takes places without the supervision of a teacher, as mentioned earlier in this thesis.

During the process of unsupervised learning, a sequence of input patterns x is presented to the network. Those patterns are generated by some usually unknown probability distribution $\rho(x)$ (Patterson, 1996). The network responds by computing output activations, but there is no direct feedback given to the network about the correctness of the response to the input. The network must somehow learn by discovering and exploiting any structure found among the input examples.

The nature of structures that a network may discover among a set of pattern inputs depends on the source $\rho(x)$ and the learning method adopted by the network. Patterson (1996) suggests that the following types of structure might be found through unsupervised learning methods: clusters of closely related patterns, frequencies of clusters of patterns, relative ordering (for instance, length) among vector inputs, correlations among patterns, mappings which transform input patterns into structured coding of the inputs, and feature mapping which transforms the input manifold to one of different dimension through a topological preserving process.

The Kohonen network adopts a particular method of learning called *competitive learning*. In this kind of learning, units may be organised into one or more layers with the units in a single layer grouped into disjoint clusters. Each unit in a cluster inhibits all other units within the cluster to compete for the winning position. The unit receiving the largest input achieves its maximum output while the others are driven to zero. Learning is thus achieved by shifting quantities of weights from the inactive to the active connections of the winning unit. No learning takes place among the loosers. Usually, weight values of the winner are shifted toward the input pattern vector. In practice, this kind of learning can produce results such as those shown in figure 4.17 bellow.

The first graph (*a*) shows a scatter plot of an input that may have been generated by monitoring a physical phenomenon or may be simply statistical data. What is important here, is that the all the other inputs will follow similar pattern: a series of points distributed around the centre of the co-ordinates (x=0, y=0), all of them at a roughly similar distance from that centre.



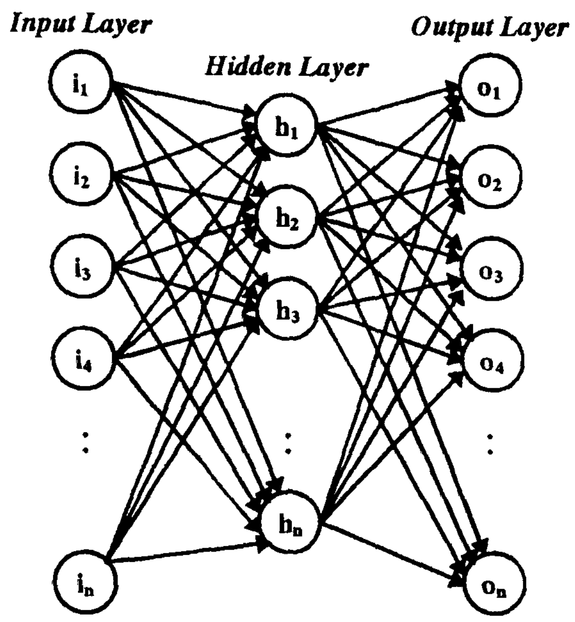
4.17 - An application of Kohonen's competitive learning.

The second graph (*b*) represents the beginning of the training process. The darker dots represent outputs from the network. The third graph (*c*) represents the process of learning after some training. At last, the fourth graph (*d*) represents the final state of the training process. Most of the weight vectors have been shifted toward the centres of the small clusters that form the unstructured dotted ring. The network mapped input patterns to output patterns in to a topologically coherent way, by discovering the circle shown in graph (*d*) above.

Kohonen's networks have found a number of applications such as vector quantization (the process of transforming an analogue or continuous valued variable into a discrete variable), data compression, robotics control, and speech and pattern recognition. However, it is reported that one of the most serious obstacles to a widespread use of the Kohonen networks is that its inputs are subject to several restrictions (see Masters, 1993, for a description of these restrictions).

4.6 The back propagation model:

One of the most popular connectionist models based on supervised learning are presently those adopting feed-forward back propagation algorithms (Rumelhart et al, 1985, 1986; Sejnowski et al, 1988). In this scheme, a multi-layered network, generally with continuously valued neurons, is trained to become a pattern matching machine. Figure 4.18 illustrates the basic architecture of such networks.



4.18 - Back propagation network architecture.

The central aspect of multi-layered feed-forward is the learning algorithm. The learning takes place in the same way as for the Perceptrons: a training set is presented to the network, and if the network computes and output matching the pattern, the process is terminated. If there is an error, that is, a difference between the output and the pattern, then the weights are adjusted to reduce the error. In the Perceptrons this was simple because there is only one weight between each input and the outputs.

However, there are many weights connecting each input to an output and each of them contributes to more than one output. The proposed solution is them to assess the blame for an error and divide it among the contributing weights.

Therefore, the back propagation network learns by making corrections to the connections, based on the error at the output. Correction signals propagate back through the network during training, thus the name. As training progresses, the amount of error is minimised. This learning algorithm was developed as response to the weaknesses of the Perceptron, as already mentioned.

Indeed, a variation of back propagation network, with binary outputs, could be designed for and trained with the 'entrance door domain'. This network would provide the outputs shown in figure 4.19, if the user made active the input units *'triangular pediment'*, *'opening mechanism: revolving door'*, and *'leaf material: glass'*. These are the same input units made active in figure 4.14 earlier, which illustrates the outputs of a perceptron's network.

		Input layer	Output layer
1	top flat moulding	○	●
2	top curved moulding	○	●
3	lateral vertical moulding	○	○
4	angular connection with glass tower	○	○
5	vertical glass tower	○	○
6	triangular pediment	●	●
7	pointed arch tympanum	○	○
8	tracery or steelwork on fanlight or tympanum	○	○
9	squared fanlight	○	●
10	fanlight with undulate top	○	○
11	lateral cylindrical section column	○	○
12	Surrounding material: glass	○	●
13	Surrounding material: brick	○	○
14	Surrounding material: smooth stone	○	●
15	Surrounding material: concrete exposed	○	●
16	Surrounding material: timber	○	○
17	Surrounding material: plasterwork	○	○
18	Surrounding material: metal	○	○
19	opening mechanism: swinging door	○	●
20	opening mechanism: revolving door	●	●
21	leaf type: plain opaque	○	○
22	leaf type: paneled opaque	○	○
23	leaf type: framed	○	●
24	steelwork as leaf decoration	○	○
25	leaf material: glass	●	●
26	leaf material: metal	○	●
27	leaf material: timber	○	●

4.19 - Output of a feed forward multi-layered network trained with the door entrance domain.

The last example was already shown in the previous chapter, in figure 3.19. It is shown again here to highlight the capability of this kind of network to learn non-linearly separable functions. Given the same inputs, the back propagation network produced outputs without contradictions, while the Perceptron was unable to distinguish mutually exclusive features (see figure 4.14).

4.7 The model adopted in this research:

The neural network architecture adopted in this research is itself a hybrid model. It is a consequence of four choices: the first one was related to the association paradigm. An autoassociative design was essential once the training set was described by a number of features that also described the outputs.

The second choice was related to the neuron transfer function, that is, binary or continuous values. The need for a binary output network was driven by the nature of the knowledge represented: instance features that may be either present or not.

The third choice was related to the learning algorithm: supervised or unsupervised. A supervised algorithm was adopted because of the objective of the application proposed. It was not the purpose to test either the network's capability to learn the 'correct' outputs without the guidance of known associations or to know what patterns it could discover in data. The objective was to build new combinations of features out of *knowledge implicit in precedents.*

Another important reason for a supervised learning was that most architects acquired their skills through supervised learning. Even those self-educated acquired their skills referring to previous knowledge, that is, through books, magazines, precedent designs and the contact with other professionals.

Human beings certainly may learn to perform certain tasks, such as basic visual perception, without supervision, that is, without recurring to either previous knowledge or who holds it. However, the role of previous knowledge and the skills developed by previous generations are central in a designer's training. Therefore, the primary choice was an algorithm supporting supervised learning.

The choice of a back propagation algorithm is important, but secondary, for the purposes of this research, and it is driven by its established success as a supervised learning method.

The fourth choice was related to the processing flow: feedback or feed forward network. The main reason for the choice of a feed forward network was the need of an architecture that provided a clear distinction between input and output. The distinction was necessary for two reasons: firstly, the experimentation undertaken called for an architecture that could allow the precise monitoring of inputs and outputs. Secondly, the proposed neural network running procedure, which will be described in chapter 5, 6 and 7, called for a processing flow that could allow external control while running. The proposed architecture allows the computation of a stable state to be externally checked, step by step, against the initial user's input. It also allows the termination of processes in which the network reaches unstable deadlocks. These would not be possible with fully recurrent networks, where it is not possible to interact with the system between entering the initial input and achieving the final and stable output.

In the next chapter I will initially describe the stand-alone operations of Cortex (Mustoe, 1990, 1993) and the adopted neural network architecture. I will then describe a proposed integrated model. I shall provide practical illustrations of both their stand-alone and integrated operations.

Chapter 5

Cortex and neural networks: stand-alone performance and integrated operation

5.1 Introduction:

Each section using Cortex (Mustoe, 1990, 1993) has two major consequences: firstly, the definition of a problem's partial description by the user's input, and secondly, the retrieval of a solution based on the closest match. The use of this last one has been already focus of extensive research carried out by Mustoe (1990) himself. I shall concentrate on the first outcome, that is, the partial description presented by the user, because an innovative hybrid may be built upon it.

The problem's partial description can then be run into a trained neural network providing three possible outcomes: the output matches with Cortex's, the output is a new solution, or the network cannot find a solution that is consistent with the partial description.

I shall demonstrate these facts in the coming sections, particularly the generation of partial descriptions and their use by a particular architecture of neural network, which also will be described. Moreover, I shall explain how a hybrid system may be built out of the integration of those two models and what benefits it can deliver.

A domain knowledge, the door entrance domain, which I will call 'small domain' from now on, was used in Chapters 3 and 4 to explain the knowledge representation and inference engine adopted in Cortex (Mustoe, 1990, 1993) as well as to illustrate the performance of neural network paradigms. Although that domain is very small and thus unlikely to produce advice of use in a real design task, it will be used here again because it can make the application logic easily understandable.

Therefore, the objective here is to demonstrate how problem's partial descriptions are generated at each section using Cortex, how they can be properly input into a particular design of neural network, and what are the possible outcomes.

The results may not be rich enough to represent a real design task because the domain is very small. Nine cases are far to few to provide a neural network with the opportunity to learn and generalise properly. However, the focus of this chapter is on procedure rather than on the relevance of results. The illustrations that follow will show that the proposed integrated model is workable and is able to produce consistent results. The capability of producing results that are not only consistent but also relevant in real design tasks will be demonstrated in Chapter 8 through the experimentation with a much larger domain, which I will call 'extended domain'.

5.2 Cortex stand-alone operation and the generation of problem's partial descriptions:

The small domain is composed of 9 door entrances styles, or solutions, classified according to 27 features, as described earlier in this thesis (figure 3.16 in Chapter 3), and shown again in figure 5.1 bellow:

		1	2	3	4	5	6	7	8	9
		Classic	*Gothic*	*Art Nouveau*	*Functionalist*	*Brutalist*	*Organic*	*High Tech*	*Post Modern*	*Hybrid: Classic + High tech*
1	top flat moulding	1	0	0	0	0	0	0	0	1
2	top curved moulding	0	1	0	0	0	0	0	0	1
3	lateral vertical moulding	0	1	1	0	0	0	0	0	1
4	angular connection with glass tower	0	0	0	0	0	0	0	1	0
5	vertical glass tower	0	0	0	1	0	0	1	1	0
6	triangular pediment	1	0	0	0	0	0	0	0	1
7	pointed arch tympanum	0	1	0	0	0	0	0	0	0
8	tracery or steelwork on fanlight or tympanum	0	1	1	0	0	0	0	0	0
9	squared fanlight	0	0	0	0	1	1	0	0	1
10	fanlight with undulate top	0	0	1	0	0	0	0	0	0
11	lateral cylindrical section column	1	1	0	0	0	0	0	0	0
12	Surrounding material: glass	0	0	1	1	1	1	1	1	1
13	Surrounding material: brick	0	0	1	0	0	1	0	1	0
14	surrounding material: smooth stone	1	1	0	0	0	0	0	0	1
15	surrounding material: concrete exposed	0	0	0	0	1	0	0	0	0
16	surrounding material: timber	0	0	0	0	0	1	0	0	0
17	surrounding material: plasterwork	0	0	1	1	0	0	0	0	0
18	surrounding material: metal	0	0	1	1	0	0	1	1	0
19	opening mechanism: swinging door	1	1	1	1	0	1	1	1	0
20	opening mechanism: revolving door	0	0	0	0	1	0	1	0	1
21	leaf type: plain opaque	0	0	1	0	0	0	0	0	0
22	leaf type: paneled opaque	1	1	0	0	0	0	0	0	0
23	leaf type: framed	0	0	0	1	1	1	1	1	1
24	steelwork as leaf decoration	0	0	1	0	0	0	0	0	0
25	leaf material: glass	0	0	0	1	1	1	1	1	1
26	leaf material: metal	0	0	1	1	1	1	1	1	1
27	leaf material: timber	1	1	0	0	0	1	0	0	0

Figure 5.1 - The 'small domain'.

I shall now describe three examples of sections using Cortex. Three different problem's partial descriptions will be produced. These partial descriptions will lead to the three possible neural network's output mentioned at the outset of this chapter.

5.2.1 An example of a section consulting Cortex:

Suppose that I am designing an entrance door. I do not have, from the start, a 'complete picture' of a possible solution and my search is driven by some basic constraints: I have to use glass as a surrounding material to match with the overall building, I need to use a revolving door to provide environmental control to a high flow entrance, and the door leaf must be framed for safety reasons, that is, it should have one or more light cross panels. I have also some preferences: I do not want to use either mouldings or exposed concrete.

The system verifies each of the features through the same questions mentioned in Chapter 3, at pages 43 and 44. Therefore, Cortex control (Mustoe, 1990, 1993) brings to the screen question number 12, which verifies the most common feature:

Is there glass among the surrounding materials?

The user will have always three options of answers: *'yes'*, *'no'*, and *'don't know'*. Suppose that my answer is *'yes'* due to the constraints and preferences mentioned above. This causes the solutions *'Classic'* and *'Gothic'* to be falsified and removed from the solutions set as it is shown in figure 5.2 bellow.

		3	4	5	6	7	8	9
		Art Nouveau	*Functionalist*	*Brutalist*	*Organic*	*High Tech*	*Post Modern*	*Hybrid: Classic + High tech*
1	top flat moulding	0	0	0	0	0	0	1
2	top curved moulding	0	0	0	0	0	0	1
3	lateral vertical moulding	1	0	0	0	0	0	1
4	angular connection with glass tower	0	0	0	0	0	1	0
5	vertical glass tower	0	1	0	0	1	1	0
6	triangular pediment	0	0	0	0	0	0	1
7	pointed arch tympanum	0	0	0	0	0	0	0
8	tracery or steelwork on fanlight or tympanum	1	0	0	0	0	0	0
9	squared fanlight	0	0	1	1	0	0	1
10	fanlight with undulate top	1	0	0	0	0	0	0
11	lateral cylindrical section column	0	0	0	0	0	0	0
13	Surrounding material: brick	1	0	0	1	0	1	0
14	surrounding material: smooth stone	0	0	0	0	0	0	1
15	surrounding material: concrete exposed	0	0	1	0	0	0	0
16	surrounding material: timber	0	0	0	1	0	0	0
17	surrounding material: plasterwork	1	1	0	0	0	0	0
18	surrounding material: metal	1	1	0	0	1	1	0
19	opening mechanism: swinging door	1	1	0	1	1	1	0
20	opening mechanism: revolving door	0	0	1	0	1	0	1
21	leaf type: plain opaque	1	0	0	0	0	0	0
22	leaf type: paneled opaque	0	0	0	0	0	0	0
23	leaf type: framed	0	1	1	1	1	1	1
24	steelwork as leaf decoration	1	0	0	0	0	0	0
25	leaf material: glass	0	1	1	1	1	1	1
26	leaf material: metal	1	1	1	1	1	1	1
27	leaf material: timber	0	0	0	1	0	0	0

Figure 5.2 - The 'Classic' and 'Gothic' solutions are removed from the solutions set.

However, this also causes questions number 7, 11 and 22 to become irrelevant and be removed from the reasoning process since they verify features not present in any of the remaining solutions. Moreover, question number 26 is also removed because it became non-discriminating once it verifies a feature that is present in all the remaining solutions. The resulting knowledge-base state is shown in figure 5.3 bellow.

		3	4	5	6	7	8	9
		Art Nouveau	*Functionalist*	*Brutalist*	*Organic*	*High Tech*	*Post Modern*	*Hybrid: Classic + High tech*
1	top flat moulding	0	0	0	0	0	0	1
2	top curved moulding	0	0	0	0	0	0	1
3	lateral vertical moulding	1	0	0	0	0	0	1
4	angular connection with glass tower	0	0	0	0	0	1	0
5	vertical glass tower	0	1	0	0	1	1	0
6	triangular pediment	0	0	0	0	0	0	1
8	tracery or steelwork on fanlight or tympanum	1	0	0	0	0	0	0
9	squared fanlight	0	0	1	1	0	0	1
10	fanlight with undulate top	1	0	0	0	0	0	0
13	Surrounding material: brick	1	0	0	1	0	1	0
14	surrounding material: smooth stone	0	0	0	0	0	0	1
15	surrounding material: concrete exposed	0	0	1	0	0	0	0
16	surrounding material: timber	0	0	0	1	0	0	0
17	surrounding material: plasterwork	1	1	0	0	0	0	0
18	surrounding material: metal	1	1	0	0	1	1	0
19	opening mechanism: swinging door	1	1	0	1	1	1	0
20	opening mechanism: revolving door	0	0	1	0	1	0	1
21	leaf type: plain opaque	1	0	0	0	0	0	0
23	leaf type: framed	0	1	1	1	1	1	1
24	steelwork as leaf decoration	1	0	0	0	0	0	0
25	leaf material: glass	0	1	1	1	1	1	1
27	leaf material: timber	0	0	0	1	0	0	0

Figure 5.3 - The knowledge-base state after the first question.

The first question on the list verifying the most common feature is now the one of number 23:

Is the leaf framed with one or more light cross panels?

Considering the constraints mentioned earlier, suppose that I answer 'yes' to this question. This will cause the solution number 3 '*Art Nouveau*' to be falsified and removed from the set of solutions as it is shown in figure 5.4 bellow.

		4	5	6	7	8	9
		Funcionalist	*Brutalist*	*Organic*	*High Tech*	*Post Modern*	*Hybrid: Classic + High tech*
1	top flat moulding	0	0	0	0	0	1
2	top curved moulding	0	0	0	0	0	1
3	lateral vertical moulding	0	0	0	0	0	1
4	angular connection with glass tower	0	0	0	0	1	0
5	vertical glass tower	1	0	0	1	1	0
6	triangular pediment	0	0	0	0	0	1
8	tracery or steelwork on fanlight or tympanum	0	0	0	0	0	0
9	squared fanlight	0	1	1	0	0	1
10	fanlight with undulate top	0	0	0	0	0	0
13	Surrounding material: brick	0	0	1	0	1	0
14	surrounding material: smooth stone	0	0	0	0	0	1
15	surrounding material: concrete exposed	0	1	0	0	0	0
16	surrounding material: timber	0	0	1	0	0	0
17	surrounding material: plasterwork	1	0	0	0	0	0
18	surrounding material: metal	1	0	0	1	1	0
19	opening mechanism: swinging door	1	0	1	1	1	0
20	opening mechanism: revolving door	0	1	0	1	0	1
21	leaf type: plain opaque	0	0	0	0	0	0
24	steelwork as leaf decoration	0	0	0	0	0	0
25	leaf material: glass	1	1	1	1	1	1
27	leaf material: timber	0	0	1	0	0	0

5.4 - The 'Art Nouveau' solution removed.

The removal of 'Art Nouveau' from the solution's set causes the questions number 8, 10, 21 and 24 to become irrelevant, that is, they verify features not present in any of the remaining solutions. They are thus removed from the reasoning process. The question number 25 is also removed because it became non-discriminating, that is, it verifies a feature that is present in all the remaining solutions. The resulting knowledge-base state is shown in figure 5.5.

		4	5	6	7	8	9
		Funcionalist	*Brutalist*	*Organic*	*High Tech*	*Post Modern*	*Hybrid: Classic + High tech*
1	top flat moulding	0	0	0	0	0	1
2	top curved moulding	0	0	0	0	0	1
3	lateral vertical moulding	0	0	0	0	0	1
4	angular connection with glass tower	0	0	0	0	1	0
5	vertical glass tower	1	0	0	1	1	0
6	triangular pediment	0	0	0	0	0	1
9	squared fanlight	0	1	1	0	0	1
13	Surrounding material: brick	0	0	1	0	1	0
14	surrounding material: smooth stone	0	0	0	0	0	1
15	surrounding material: concrete exposed	0	1	0	0	0	0
16	surrounding material: timber	0	0	1	0	0	0
17	surrounding material: plasterwork	1	0	0	0	0	0
18	surrounding material: metal	1	0	0	1	1	0
19	opening mechanism: swinging door	1	0	1	1	1	0
20	opening mechanism: revolving door	0	1	0	1	0	1
27	leaf material: timber	0	0	1	0	0	0

5.5 The knowledge-base state after the second question.

The first question on the list verifying the most common feature is now the one of number 19:

Does it have a swinging door?

The entrance door I am designing is a high flow one, that is, it will be in constant use by a large amount of people. It will also require an environmental control able to minimise heat loss under that high flow of people. A revolving door is a good solution for this problem and it can be accompanied or not by a lateral swing door. However, I am not sure about this yet. Therefore, my answer to the question above is 'don't know'. This answer does not cause any solution to be falsified and removed from the set of solutions. Only question number 19 itself is removed from the question's set. The resulting knowledge-base state is shown in figure 5.6 bellow.

		4	5	6	7	8	9
		Funcionalist	*Brutalist*	*Organic*	*High Tech*	*Post Modern*	*Hybrid: Classic + High tech*
1	top flat moulding	0	0	0	0	0	1
2	top curved moulding	0	0	0	0	0	1
3	lateral vertical moulding	0	0	0	0	0	1
4	angular connection with glass tower	0	0	0	0	1	0
5	vertical glass tower	1	0	0	1	1	0
6	triangular pediment	0	0	0	0	0	1
9	squared fanlight	0	1	1	0	0	1
13	Surrounding material: brick	0	0	1	0	1	0
14	surrounding material: smooth stone	0	0	0	0	0	1
15	surrounding material: concrete exposed	0	1	0	0	0	0
16	surrounding material: timber	0	0	1	0	0	0
17	surrounding material: plasterwork	1	0	0	0	0	0
18	surrounding material: metal	1	0	0	1	1	0
20	opening mechanism: revolving door	0	1	0	1	0	1
27	leaf material: timber	0	0	1	0	0	0

Figure 5.6 - The knowledge-base state after the third question.

The first question on the list verifying the most common feature is now the one of number 5:

Is the entrance door under or within a vertical glass tower?

Although glass is going to be a dominant material in the building's facade, I am not sure yet if this will imply in a vertical glass tower or not, since there are still other components to define in the rest of the building. Therefore, my answer to this question is 'don't know'. The resulting knowledge-base state, after the removal of question 5, is shown in figure 5.7 bellow.

		4	5	6	7	8	9
		Funcionalist	*Brutalist*	*Organic*	*High Tech*	*Post Modern*	*Hybrid: Classic + High tech*
1	top flat moulding	0	0	0	0	0	1
2	top curved moulding	0	0	0	0	0	1
3	lateral vertical moulding	0	0	0	0	0	1
4	angular connection with glass tower	0	0	0	0	1	0
6	triangular pediment	0	0	0	0	0	1
9	squared fanlight	0	1	1	0	0	1
13	Surrounding material: brick	0	0	1	0	1	0
14	surrounding material: smooth stone	0	0	0	0	0	1
15	surrounding material: concrete exposed	0	1	0	0	0	0
16	surrounding material: timber	0	0	1	0	0	0
17	surrounding material: plasterwork	1	0	0	0	0	0
18	surrounding material: metal	1	0	0	1	1	0
20	opening mechanism: revolving door	0	1	0	1	0	1
27	leaf material: timber	0	0	1	0	0	0

5.7 - The knowledge-base state after the fourth question.

The first question on the list verifying the most common feature is now the one of number 9:

Does it have a squared fanlight?

Suppose that I am not sure about the presence of such component yet. Thus my answer will be 'don't know'. The resulting knowledge-base state, after the removal of question 9, is shown in figure 5.8 bellow.

		4	5	6	7	8	9
		Funcionalist	*Brutalist*	*Organic*	*High Tech*	*Post Modern*	*Hybrid: Classic + High tech*
1	top flat moulding	0	0	0	0	0	1
2	top curved moulding	0	0	0	0	0	1
3	lateral vertical moulding	0	0	0	0	0	1
4	angular connection with glass tower	0	0	0	0	1	0
6	triangular pediment	0	0	0	0	0	1
13	Surrounding material: brick	0	0	1	0	1	0
14	surrounding material: smooth stone	0	0	0	0	0	1
15	surrounding material: concrete exposed	0	1	0	0	0	0
16	surrounding material: timber	0	0	1	0	0	0
17	surrounding material: plasterwork	1	0	0	0	0	0
18	surrounding material: metal	1	0	0	1	1	0
20	opening mechanism: revolving door	0	1	0	1	0	1
27	leaf material: timber	0	0	1	0	0	0

Figure 5.8 - The knowledge-base state after the fifth question.

The first question on the list verifying the most common feature is now the one of number 18:

Is there metal among the surrounding materials?

Although I know that some metal components may be present in the facade, I am not sure yet how visible they will be to an outsider observer. Therefore, I answer 'don't know' to this question. The resulting knowledge-base state, after the removal of question 18, is shown in figure 5.9 bellow.

		4	5	6	7	8	9
		Functionalist	*Brutalist*	*Organic*	*High Tech*	*Post Modern*	*Hybrid: Classic + High tech*
1	top flat moulding	0	0	0	0	0	1
2	top curved moulding	0	0	0	0	0	1
3	lateral vertical moulding	0	0	0	0	0	1
4	angular connection with glass tower	0	0	0	0	1	0
6	triangular pediment	0	0	0	0	0	1
13	Surrounding material: brick	0	0	1	0	1	0
14	surrounding material: smooth stone	0	0	0	0	0	1
15	surrounding material: concrete exposed	0	1	0	0	0	0
16	surrounding material: timber	0	0	1	0	0	0
17	surrounding material: plasterwork	1	0	0	0	0	0
20	opening mechanism: revolving door	0	1	0	1	0	1
27	leaf material: timber	0	0	1	0	0	0

Figure 5.9 - The knowledge-base state after the sixth question.

The first question on the list verifying the most common feature is now the one of number 20:

Does it have a revolving door with four leaves?

As mentioned earlier, the environmental control to avoid heat loss is an essential requirement. Therefore, my answer to the question above is 'yes'. This causes the solutions 'Functionalist', 'Organic' and 'Post Modern' to be falsified and removed from the solution's set, as shown in figure 5.10 bellow.

			5	7	9
			Brutalist	*High Tech*	*Hybrid: Classic + High tech*
1	top flat moulding		0	0	1
2	top curved moulding		0	0	1
3	lateral vertical moulding		0	0	1
4	angular connection with glass tower		0	0	0
6	triangular pediment		0	0	1
13	Surrounding material: brick		0	0	0
14	surrounding material: smooth stone		0	0	1
15	surrounding material: concrete exposed		1	0	0
16	surrounding material: timber		0	0	0
17	surrounding material: plasterwork		0	0	0
27	leaf material: timber		0	0	0

5.10 - The 'Functionalist', 'Organic' and 'Post Modern' solutions are removed.

The removal of these solutions from the solution's set causes the questions number 4, 13, 16, 17 and 27 to become irrelevant, that is, they verify features not present in any of the remaining solutions. They are thus removed from the reasoning process. The resulting knowledge-base state is shown in figure 5.11 bellow.

		5	7	9
		Brutalist	*High Tech*	*Hybrid: Classic + High tech*
1	**top flat moulding**	0	0	1
2	**top curved moulding**	0	0	1
3	**lateral vertical moulding**	0	0	1
6	**triangular pediment**	0	0	1
14	**surrounding material: smooth stone**	0	0	1
15	**surrounding material: concrete exposed**	1	0	0

Figure 5.11 - The knowledge-base state after the seventh question.

The first question on the list verifying the most common feature is now the one of number 1:

Does it have a top flat moulding?

Since mouldings are not among my particular preferences, my answer to this question is 'no'. This causes the solution 'Hybrid: Classic + High Tech' to be falsified and removed from the solution's set as shown in figure 5.12 bellow.

		5	7
		Brutalist	*High Tech*
2	**top curved moulding**	0	0
3	**lateral vertical moulding**	0	0
6	**triangular pediment**	0	0
14	**surrounding material: smooth stone**	0	0
15	**surrounding material: concrete exposed**	1	0

Figure 5.12 - The 'Hybrid: Classic + High Tech' solution is removed.

However, the removal of this solution from the solution's set causes the questions number 2, 3, 6 and 14 to become irrelevant since they verify features not present in any of the remaining solutions. Therefore, they are removed from the reasoning process and the resulting knowledge-base state is shown in figure 5.13 bellow.

		5	7
		Brutalist	*High Tech*
15	surrounding material: concrete exposed	1	0

Figure 5.13 - The knowledge-base state after the eighth question.

Cortex thus brings the only remaining question, number 15, to the screen:

Is there concrete exposed among the surrounding materials?

Since 'exposed concrete' is not among my preferences to this particular design task, my answer is 'no'. This causes the solution 'Brutalist' to be falsified and removed from the solution's set while the 'High Tech' solution is confirmed as the closest match. Therefore, Cortex brings to the screen the textual description of the only solution that has not been falsified, that is, the 'High Tech' solution. This textual description is written before hand and contains the features that are present in the matching solution from all the 27 feature's descriptors:

'The most likely solution in the Small domain is:
The solution may be a high tech door entrance, with the following features:
-vertical glass tower
-surrounding materials: glass, metal
-swinging door
-revolving door (with four leaves)
-leaf type: framed with one or more light cross panels
-leaf materials: non-stained glass, metal'

It is important to notice that Cortex had, at the beginning of this section, 27 questions available for testing the presence or absence of 27 features. However, it used only nine because its control algorithm progressively removes from the question's set any question that becomes irrelevant or non-discriminating.

The search for the closest match is guided by a partial description of the problem for the reason above and also because the user is allowed to answer 'don't know' to the questions.

The process of defining this problem's partial description can be demonstrated as follows. Considering the user's answers, there are three possible states for each feature: definitely present, if the answer is 'yes', definitely absent, if the answer is 'no', and neutral, if the answer is 'don't know'. The initial state is illustrated in figure 5.14, where the grey circles represent all the features initially in a neutral state.

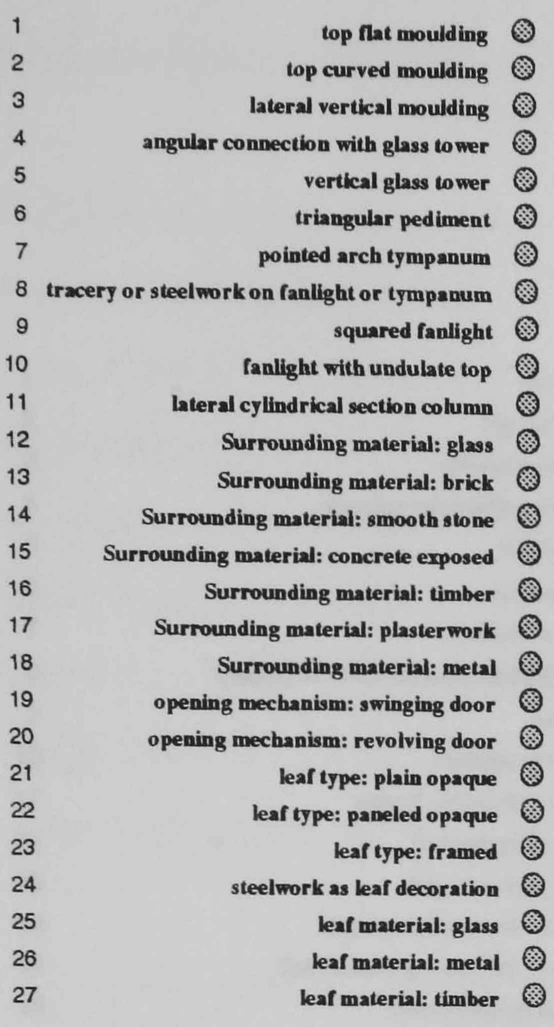


Figure 5.14 - The problem description's initial state.

While consulting the 'small domain', as described earlier, the user answered 'yes' to the questions verifying features number 12 and 23. Then the user answered 'don't know' to the questions verifying features number 19, 5, 9 and 18. Next, the user answered 'yes' to the question verifying feature number 20. At last, the user answered 'no' to the question verifying features number 1 and 15. If we assigned a black circle to the features receiving an answer 'yes', a white circle to the features receiving an answer 'no', and a grey circle to the features receiving an answer 'don't know' and to those verified by questions not used, we would have the partial description of the problem shown in figure 5.15. This figure also shows, in binary representation, the solution retrieved by Cortex as a result of that partial description.

		Problem's partial description	*High Tech solution*
1	**top flat moulding**	○	0
2	**top curved moulding**	◍	0
3	**lateral vertical moulding**	◍	0
4	**angular connection with glass tower**	◍	0
5	**vertical glass tower**	◍	1
6	**triangular pediment**	◍	0
7	**pointed arch tympanum**	◍	0
8	**tracery or steelwork on fanlight or tympanum**	◍	0
9	**squared fanlight**	◍	0
10	**fanlight with undulate top**	◍	0
11	**lateral cylindrical section column**	◍	0
12	**Surrounding material: glass**	●	1
13	**Surrounding material: brick**	◍	0
14	**Surrounding material: smooth stone**	◍	0
15	**Surrounding material: concrete exposed**	○	0
16	**Surrounding material: timber**	◍	0
17	**Surrounding material: plasterwork**	◍	0
18	**Surrounding material: metal**	◍	1
19	**opening mechanism: swinging door**	◍	1
20	**opening mechanism: revolving door**	●	1
21	**leaf type: plain opaque**	◍	0
22	**leaf type: paneled opaque**	◍	0
23	**leaf type: framed**	●	1
24	**steelwork as leaf decoration**	◍	0
25	**leaf material: glass**	◍	1
26	**leaf material: metal**	◍	1
27	**leaf material: timber**	◍	0

5.15 - The problem description final state and the solution retrieved by Cortex.

Therefore, this illustrates how a partial description of the problem is defined by the user at each section of Cortex. However, I would like to describe more two possible sections using the 'small domain' in Cortex, before going further into the use of these partial descriptions.

5.2.2 Another example of a section consulting Cortex:

Suppose that I now approach the same design task of designing an entrance door, but from a slightly different point of view. As in the previous example, I do not have a complete description of the problem, but just some basic constraints and preferences: I know that 'metal' has to be among the surrounding materials because it is being used in other components of the building's facade, I have to use a framed door leaf with one or more light cross panels for safety reasons, I know that metal is among the door materials since it has been specified by the client, and I am not going to use brick because it has been ruled out as an option at earlier stages of the overall building design.

As in the previous section, Cortex control (Mustoe, 1990, 1993) starts by bringing to the screen question number 12, which verifies the most common feature:

Is there glass among the surrounding materials?

Suppose that I am not sure yet to which extent glass is to be used around the entrance. Therefore, I answer 'don't know' to this question. This does not cause any solution to be falsified and removed from the set of solutions. Only question number 12 itself is removed from the question's set. The resulting knowledge-base state is shown in figure 5.16 bellow.

		1	2	3	4	5	6	7	8	9
		Classic	*Gothic*	*Art Nouveau*	*Functionalist*	*Brutalist*	*Organic*	*High Tech*	*Post Modern*	*Hybrid: Classic + High tech*
1	**top flat moulding**	1	0	0	0	0	0	0	0	1
2	**top curved moulding**	0	1	0	0	0	0	0	0	1
3	**lateral vertical moulding**	0	1	1	0	0	0	0	0	1
4	**angular connection with glass tower**	0	0	0	0	0	0	0	1	0
5	**vertical glass tower**	0	0	0	1	0	0	1	1	0
6	**triangular pediment**	1	0	0	0	0	0	0	0	1
7	**pointed arch tympanum**	0	1	0	0	0	0	0	0	0
8	**tracery or steelwork on fanlight or tympanum**	0	1	1	0	0	0	0	0	0
9	**squared fanlight**	0	0	0	0	1	1	0	0	1
10	**fanlight with undulate top**	0	0	1	0	0	0	0	0	0
11	**lateral cylindrical section column**	1	1	0	0	0	0	0	0	0
13	**Surrounding material: brick**	0	0	1	0	0	1	0	1	0
14	**surrounding material: smooth stone**	1	1	0	0	0	0	0	0	1
15	**surrounding material: concrete exposed**	0	0	0	0	1	0	0	0	0
16	**surrounding material: timber**	0	0	0	0	0	1	0	0	0
17	**surrounding material: plasterwork**	0	0	1	1	0	0	0	0	0
18	**surrounding material: metal**	0	0	1	1	0	0	1	1	0
19	**opening mechanism: swinging door**	1	1	1	1	0	1	1	1	0
20	**opening mechanism: revolving door**	0	0	0	0	1	0	1	0	1
21	**leaf type: plain opaque**	0	0	1	0	0	0	0	0	0
22	**leaf type: paneled opaque**	1	1	0	0	0	0	0	0	0
23	**leaf type: framed**	0	0	0	1	1	1	1	1	1
24	**steelwork as leaf decoration**	0	0	1	0	0	0	0	0	0
25	**leaf material: glass**	0	0	0	1	1	1	1	1	1
26	**leaf material: metal**	0	0	1	1	1	1	1	1	1
27	**leaf material: timber**	1	1	0	0	0	1	0	0	0

Figure 5.16 - The knowledge-base state after the first question.

The first question on the list verifying the most common feature is now the one of number 19:

Does it have a swinging door?

Suppose it is not clear yet if the frequency in which the proposed entrance is going to be used. I do not know if a tight environmental control will be necessary, and I am unable to decide about the opening mechanism just now. Therefore, I answer ‘don’t know’ to this question. Once again no solution is falsified and removed from the set of solutions, and only question number 19 itself is removed from the question's set. The resulting knowledge-base state is shown in figure 5.17 bellow.

		1	2	3	4	5	6	7	8	9
		Classic	*Gothic*	*Art Nouveau*	*Functionalist*	*Brutalist*	*Organic*	*High Tech*	*Post Modern*	*Hybrid: Classic + High tech*
1	top flat moulding	1	0	0	0	0	0	0	0	1
2	top curved moulding	0	1	0	0	0	0	0	0	1
3	lateral vertical moulding	0	1	1	0	0	0	0	0	1
4	angular connection with glass tower	0	0	0	0	0	0	0	1	0
5	vertical glass tower	0	0	0	1	0	0	1	1	0
6	triangular pediment	1	0	0	0	0	0	0	0	1
7	pointed arch tympanum	0	1	0	0	0	0	0	0	0
8	tracery or steelwork on fanlight or tympanum	0	1	1	0	0	0	0	0	0
9	squared fanlight	0	0	0	0	1	1	0	0	1
10	fanlight with undulate top	0	0	1	0	0	0	0	0	0
11	lateral cylindrical section column	1	1	0	0	0	0	0	0	0
13	Surrounding material: brick	0	0	1	0	0	1	0	1	0
14	surrounding material: smooth stone	1	1	0	0	0	0	0	0	1
15	surrounding material: concrete exposed	0	0	0	0	1	0	0	0	0
16	surrounding material: timber	0	0	0	0	0	1	0	0	0
17	surrounding material: plasterwork	0	0	1	1	0	0	0	0	0
18	surrounding material: metal	0	0	1	1	0	0	1	1	0
20	opening mechanism: revolving door	0	0	0	0	1	0	1	0	1
21	leaf type: plain opaque	0	0	1	0	0	0	0	0	0
22	leaf type: paneled opaque	1	1	0	0	0	0	0	0	0
23	leaf type: framed	0	0	0	1	1	1	1	1	1
24	steelwork as leaf decoration	0	0	1	0	0	0	0	0	0
25	leaf material: glass	0	0	0	1	1	1	1	1	1
26	leaf material: metal	0	0	1	1	1	1	1	1	1
27	leaf material: timber	1	1	0	0	0	1	0	0	0

Figure 5.17 - The knowledge-base state after the second question.

The first question on the list verifying the most common feature is now the one of number 26:

Is there metal among the leaf materials?

Considering that metal has been specified by the client as one of the door materials, my answer to this question is 'yes'. This causes the solutions 'Classic' and 'Gothic' to be falsified and removed from the solution's set as shown in figure 5.18 bellow.

		3	4	5	6	7	8	9
		Art Nouveau	*Functionalist*	*Brutalist*	*Organic*	*High Tech*	*Post Modern*	*Hybrid: Classic + High tech*
1	top flat moulding	0	0	0	0	0	0	1
2	top curved moulding	0	0	0	0	0	0	1
3	lateral vertical moulding	1	0	0	0	0	0	1
4	angular connection with glass tower	0	0	0	0	0	1	0
5	vertical glass tower	0	1	0	0	1	1	0
6	triangular pediment	0	0	0	0	0	0	1
7	pointed arch tympanum	0	0	0	0	0	0	0
8	tracery or steelwork on fanlight or tympanum	1	0	0	0	0	0	0
9	squared fanlight	0	0	1	1	0	0	1
10	fanlight with undulate top	1	0	0	0	0	0	0
11	lateral cylindrical section column	0	0	0	0	0	0	0
13	Surrounding material: brick	1	0	0	1	0	1	0
14	surrounding material: smooth stone	0	0	0	0	0	0	1
15	surrounding material: concrete exposed	0	0	1	0	0	0	0
16	surrounding material: timber	0	0	0	1	0	0	0
17	surrounding material: plasterwork	1	1	0	0	0	0	0
18	surrounding material: metal	1	1	0	0	1	1	0
20	opening mechanism: revolving door	0	0	1	0	1	0	1
21	leaf type: plain opaque	1	0	0	0	0	0	0
22	leaf type: paneled opaque	0	0	0	0	0	0	0
23	leaf type: framed	0	1	1	1	1	1	1
24	steelwork as leaf decoration	1	0	0	0	0	0	0
25	leaf material: glass	0	1	1	1	1	1	1
27	leaf material: timber	0	0	0	1	0	0	0

Figure 5.18 - The solutions 'Classic' and 'Gothic' are removed.

However, the removal of those solutions also causes the questions number 7, 11 and 22 to become irrelevant and be removed from the question's set since they now verify features that are not present in any of the remaining solutions. The resulting knowledge-base state is shown in figure 5.19.

		3	4	5	6	7	8	9
		Art Nouveau	*Functionalist*	*Brutalist*	*Organic*	*High Tech*	*Post Modern*	*Hybrid: Classic + High tech*
1	top flat moulding	0	0	0	0	0	0	1
2	top curved moulding	0	0	0	0	0	0	1
3	lateral vertical moulding	1	0	0	0	0	0	1
4	angular connection with glass tower	0	0	0	0	0	1	0
5	vertical glass tower	0	1	0	0	1	1	0
6	triangular pediment	0	0	0	0	0	0	1
8	tracery or steelwork on fanlight or tympanum	1	0	0	0	0	0	0
9	squared fanlight	0	0	1	1	0	0	1
10	fanlight with undulate top	1	0	0	0	0	0	0
13	Surrounding material: brick	1	0	0	1	0	1	0
14	surrounding material: smooth stone	0	0	0	0	0	0	1
15	surrounding material: concrete exposed	0	0	1	0	0	0	0
16	surrounding material: timber	0	0	0	1	0	0	0
17	surrounding material: plasterwork	1	1	0	0	0	0	0
18	surrounding material: metal	1	1	0	0	1	1	0
20	opening mechanism: revolving door	0	0	1	0	1	0	1
21	leaf type: plain opaque	1	0	0	0	0	0	0
23	leaf type: framed	0	1	1	1	1	1	1
24	steelwork as leaf decoration	1	0	0	0	0	0	0
25	leaf material: glass	0	1	1	1	1	1	1
27	leaf material: timber	0	0	0	1	0	0	0

5.19 - The knowledge-base state after the third question.

The first question on the list verifying the most common feature is now the one of number 23:

Is the leaf framed with one or more light cross panels?

The need of a framed door leaf has been defined as a client's request, as mentioned earlier. Therefore, my answer to the question is 'yes', and this causes the solution 'Art Nouveau' to be falsified and removed from the solution's set, as shown in figure 5.20.

		4 *Functionalist*	5 *Brutalist*	6 *Organic*	7 *High Tech*	8 *Post Modern*	9 *Hybrid: Classic + High tech*
1	top flat moulding	0	0	0	0	0	1
2	top curved moulding	0	0	0	0	0	1
3	lateral vertical moulding	0	0	0	0	0	1
4	angular connection with glass tower	0	0	0	0	1	0
5	vertical glass tower	1	0	0	1	1	0
6	triangular pediment	0	0	0	0	0	1
8	tracery or steelwork on fanlight or tympanum	0	0	0	0	0	0
9	squared fanlight	0	1	1	0	0	1
10	fanlight with undulate top	0	0	0	0	0	0
13	Surrounding material: brick	0	0	1	0	1	0
14	surrounding material: smooth stone	0	0	0	0	0	1
15	surrounding material: concrete exposed	0	1	0	0	0	0
16	surrounding material: timber	0	0	1	0	0	0
17	surrounding material: plasterwork	1	0	0	0	0	0
18	surrounding material: metal	1	0	0	1	1	0
20	opening mechanism: revolving door	0	1	0	1	0	1
21	leaf type: plain opaque	0	0	0	0	0	0
24	steelwork as leaf decoration	0	0	0	0	0	0
25	leaf material: glass	1	1	1	1	1	1
27	leaf material: timber	0	0	1	0	0	0

Figure 5.20 - The solution 'Art Nouveau' is removed.

The removal of the 'Art Nouveau' solution causes the questions number 8, 10, 21 and 24 to become irrelevant and be removed from the question's set because they now verify features that are not present in any of the remaining solutions. The question number 25 is also removed since it became non-discriminating, that is, it verifies a feature that is present in all the remaining solutions. The resulting knowledge-base state is shown in figure 5.21 bellow.

		Funcionalist	Brutalist	Organic	High Tech	Post Modern	Hybrid: Classic + High tech
		4	5	6	7	8	9
1	top flat moulding	0	0	0	0	0	1
2	top curved moulding	0	0	0	0	0	1
3	lateral vertical moulding	0	0	0	0	0	1
4	angular connection with glass tower	0	0	0	0	1	0
5	vertical glass tower	1	0	0	1	1	0
6	triangular pediment	0	0	0	0	0	1
9	squared fanlight	0	1	1	0	0	1
13	Surrounding material: brick	0	0	1	0	1	0
14	surrounding material: smooth stone	0	0	0	0	0	1
15	surrounding material: concrete exposed	0	1	0	0	0	0
16	surrounding material: timber	0	0	1	0	0	0
17	surrounding material: plasterwork	1	0	0	0	0	0
18	surrounding material: metal	1	0	0	1	1	0
20	opening mechanism: revolving door	0	1	0	1	0	1
27	leaf material: timber	0	0	1	0	0	0

5.21 - The knowledge-base state after the fourth question.

The first question on the list verifying the most common feature is now the one of number 5:

Is the entrance door under or within a vertical glass tower?

Suppose I know that glass is an important component in the building facade, but I do not know yet if the door entrance is going to be integrated in it under a tower glass. My answer to this question is thus a 'don't know'. This answer does not cause any solution to become falsified. The only consequence is the removal of question number 5 itself from the question's set. The resulting knowledge-base state is shown in figure 5.22 bellow.

		4	5	6	7	8	9
		Functionalist	*Brutalist*	*Organic*	*High Tech*	*Post Modern*	*Hybrid: Classic + High tech*
1	top flat moulding	0	0	0	0	0	1
2	top curved moulding	0	0	0	0	0	1
3	lateral vertical moulding	0	0	0	0	0	1
4	angular connection with glass tower	0	0	0	0	1	0
6	triangular pediment	0	0	0	0	0	1
9	squared fanlight	0	1	1	0	0	1
13	Surrounding material: brick	0	0	1	0	1	0
14	surrounding material: smooth stone	0	0	0	0	0	1
15	surrounding material: concrete exposed	0	1	0	0	0	0
16	surrounding material: timber	0	0	1	0	0	0
17	surrounding material: plasterwork	1	0	0	0	0	0
18	surrounding material: metal	1	0	0	1	1	0
20	opening mechanism: revolving door	0	1	0	1	0	1
27	leaf material: timber	0	0	1	0	0	0

Figure 5.22 - The knowledge-base state after the fifth question.

The first question on the list verifying the most common feature is now the one of number 9:

Does it have a squared fanlight?

Since I do not know yet if this kind of component is to be used, my answer to this question is a 'don't know'. The only consequence of this is the removal of question number 9 from the question's set because no solution has been falsified by the answer. The resulting knowledge-base state is shown in figure 5.23.

		4	5	6	7	8	9
		Functionalist	*Brutalist*	*Organic*	*High Tech*	*Post Modern*	*Hybrid: Classic + High tech*
1	top flat moulding	0	0	0	0	0	1
2	top curved moulding	0	0	0	0	0	1
3	lateral vertical moulding	0	0	0	0	0	1
4	angular connection with glass tower	0	0	0	0	1	0
6	triangular pediment	0	0	0	0	0	1
13	Surrounding material: brick	0	0	1	0	1	0
14	surrounding material: smooth stone	0	0	0	0	0	1
15	surrounding material: concrete exposed	0	1	0	0	0	0
16	surrounding material: timber	0	0	1	0	0	0
17	surrounding material: plasterwork	1	0	0	0	0	0
18	surrounding material: metal	1	0	0	1	1	0
20	opening mechanism: revolving door	0	1	0	1	0	1
27	leaf material: timber	0	0	1	0	0	0

Figure 5.23 - The knowledge-base state after the sixth question.

The first question on the list verifying the most common feature is now the one of number 18:

Is there metal among the surrounding materials?

Considering my initial constraints, I answer 'yes' to this question. The consequence of the answer is that the solutions 'Brutalist', 'Organic' and 'Hybrid: Classic + High Tech' have been falsified and are removed from the solution's set, as shown in figure 5.24 bellow.

		4	7	8
		Functionalist	*High Tech*	*Post Modern*
1	top flat moulding	0	0	0
2	top curved moulding	0	0	0
3	lateral vertical moulding	0	0	0
4	angular connection with glass tower	0	0	1
6	triangular pediment	0	0	0
13	Surrounding material: brick	0	0	1
14	surrounding material: smooth stone	0	0	0
15	surrounding material: concrete exposed	0	0	0
16	surrounding material: timber	0	0	0
17	surrounding material: plasterwork	1	0	0
20	opening mechanism: revolving door	0	1	0
27	leaf material: timber	0	0	0

Figure 5.24 - The solutions 'Brutalist', 'Organic' and 'Hybrid: Classic + High Tech' are removed.

However, the removal of the solutions above causes the questions number 1, 2, 3, 6, 14, 15, 16 and 27 to become irrelevant since they now verify features not present in any of the remaining solutions. They are all removed from the question's set as shown in figure 5.25.

		4	7	8
		Functionalist	*High Tech*	*Post Modern*
4	angular connection with glass tower	0	0	1
13	Surrounding material: brick	0	0	1
17	surrounding material: plasterwork	1	0	0
20	opening mechanism: revolving door	0	1	0

5.25 - The knowledge-base state after the seventh question.

The first question on the list verifying the most common feature is now the one of number 4:

Is the entrance door connected to a vertical glass tower through a plan in an 45 degree's angle?

Since I do not even know yet if the door entrance is going to be integrated in a glass tower, my answer to this question is a 'don't know'. The only consequence of this is the removal of question number 4 itself from the question's set. Figure 5.26 shows the resulting knowledge-base state.

		4	7	8
		Functionalist	*High Tech*	*Post Modern*
13	**Surrounding material: brick**	0	0	1
17	**surrounding material: plasterwork**	1	0	0
20	**opening mechanism: revolving door**	0	1	0

Figure 5.26 - The knowledge-base state after the eighth question.

The first question on the list verifying the most common feature is now the one of number 13:

Is there brick among the surrounding materials?

The use of brick has been ruled out as an option at earlier stages of the overall building design. Therefore, my answer to this question is a 'no'. This answer causes the solution 'Post Modern' to be falsified and removed from the solution's set. The resulting knowledge-base state is shown in figure 5.27 bellow.

		4	7
		Functionalist	*High Tech*
17	**surrounding material: plasterwork**	1	0
20	**opening mechanism: revolving door**	0	1

Figure 5.27 - The knowledge-base state after the ninth question.

Cortex then brings to the screen the current first question verifying the most common feature, that is, question number 17:

Is there plasterwork among the surrounding materials?

Since it is not clear yet if this kind of material is going to be in immediate neighbourhood of the entrance, my answer to this question is a 'don't know'. The consequence of this answer is just the removal of question number 17 from the question's set once no solution has been falsified. Figure 5.28 shows the resulting knowledge-base state.

		4	7
		Functionalist	*High Tech*
20	**opening mechanism: revolving door**	0	1

Figure 5.28 - The knowledge-base state after the tenth question.

Cortex then brings to the screen the only remaining question, that is, question number 20:

Does it have a revolving door with four leaves?

As mentioned before, it is not clear yet the frequency in which the proposed entrance is going to be used and I do not know if a tight environmental control will be necessary. Therefore, I am still unable to decide about the opening mechanism. My answer to this question is thus a 'don't know'. As a result, none of the remaining solutions has been falsified, and they are both possible solutions for the current design problem.

Cortex will bring to the screen the textual description of the first solution in the set, that is, the 'Functionalist':

The most likely solution in the Small domain is:
The solution may be a funcionalist door entrance, with the following features:
-vertical glass tower
-surrounding materials: glass, plasterwork and metal
-swinging door
-leaf type: framed with one or more light cross panels
-leaf materials: non-stained glass, metal

The solution's description if followed by the notice:

> *There is an additional possible solution available. To display it press Y, for 'yes'.*

Cortex then brings to the screen the textual description of the second possible solution in the set, that is, the 'High Tech' one:

> *The remaining possible solution in the Small domain is:*
> *The solution may be a high tech door entrance, with the following features:*
> *-vertical glass tower*
> *-surrounding materials: glass, metal*
> *-swinging door*
> *-revolving door (with four leaves)*
> *-leaf type: framed with one or more light cross panels*
> *-leaf materials: non-stained glass, metal*

Again, it is important to notice that Cortex used only eleven of the 27 questions available because the questions that became irrelevant or non-discriminating were successively removed from the question's set.

As mentioned before, the user's interaction with the system results in a partial description of the problem. This problem's partial description can be illustrated in the same way as in the previous section. There are three possible states for each feature: definitely present, if the answer is 'yes', definitely absent, if the answer is 'no', and neutral, if the answer is 'don't know'.

While consulting the 'small domain', in the last example, the user answered 'don't know' to the questions verifying features number 12 and 19. Then the user answered 'yes' to the questions verifying features number 26 and 23. Next, the user answered 'don't know' to the questions verifying features number 5 and 9. The user then answered 'yes' to the question verifying feature 18, 'don't know' to the question verifying feature number 4, and 'no' to the question verifying feature number 13. At last, the user answered 'don't know' to the questions verifying features number 17 and 20.

If we then assigned a black circle to the features receiving an answer 'yes', a white circle to the features receiving an answer 'no', and a grey circle to the features either receiving an answer 'don't know' or verified by questions not used, we would have the problem's partial description shown in figure 5.29. This figure also shows, in binary representation, the solutions retrieved by Cortex as a result of that partial description.

		Problem's partial description	*Functionalist solution*	*High Tech solution*
1	top flat moulding	◍	0	0
2	top curved moulding	◍	0	0
3	lateral vertical moulding	◍	0	0
4	angular connection with glass tower	◍	0	0
5	vertical glass tower	◍	1	1
6	triangular pediment	◍	0	0
7	pointed arch tympanum	◍	0	0
8	tracery or steelwork on fanlight or tympanum	◍	0	0
9	squared fanlight	◍	0	0
10	fanlight with undulate top	◍	0	0
11	lateral cylindrical section column	◍	0	0
12	Surrounding material: glass	◍	1	1
13	Surrounding material: brick	○	0	0
14	Surrounding material: smooth stone	◍	0	0
15	Surrounding material: concrete exposed	◍	0	0
16	Surrounding material: timber	◍	0	0
17	Surrounding material: plasterwork	◍	1	0
18	Surrounding material: metal	●	1	1
19	opening mechanism: swinging door	◍	1	1
20	opening mechanism: revolving door	◍	0	1
21	leaf type: plain opaque	◍	0	0
22	leaf type: paneled opaque	◍	0	0
23	leaf type: framed	●	1	1
24	steelwork as leaf decoration	◍	0	0
25	leaf material: glass	◍	1	1
26	leaf material: metal	●	1	1
27	leaf material: timber	◍	0	0

Figure 5.29 - A second example of a problem's partial description and solutions retrieved by Cortex.

Therefore, this is a second illustration of how a problem's partial description is defined by the user at each section of Cortex. I would like to describe one more possible section using the 'small domain' in Cortex, before going further into the use of these partial descriptions.

5.2.3 A third example of a section consulting Cortex:

Now suppose that I have the same initial constraints and preferences I had in the previous example of consulting the 'small domain': I know that 'metal' has to be among the surrounding materials because it is being used in other components of the building's facade, I have to use a framed door leaf with one or more light cross panels for safety reasons, I know that metal is among the door materials since it has been specified by the client, and I am not going to use brick because it has been ruled out as an option at earlier stages of the overall building design.

However, an additional constraint is added to those mentioned above: it is clear that the frequency in which the proposed entrance is going to be used is high. I do know that a tight environmental control will be necessary, and it is thus ideal to use a revolving door.

In the previous section, Cortex used 11 questions, which verify the following features, in this order: 12, 19, 26, 23, 5, 9, 18, 4, 13, 17, and 20. The addition of the new constraint affects only the answer to the last question. This is because I approach the small domain with the same preoccupation of the previous section, except by the additional constraint mentioned above, and because the last condition was verified by the last question.

Therefore, suppose that I have just answered the tenth question, the one verifying the feature number 17, in the last section. The current knowledge-base state after my answer is as follows:

		4	7
		Functionalist	High Tech
20	opening mechanism: revolving door	0	1

Figure 5.30 - The knowledge-base state after the tenth question.

Cortex then brings to the screen the only remaining question, that is, question number 20:

> *Does it have a revolving door with four leaves?*

As mentioned above, in the present section it is clear to me that the frequency in which the proposed entrance is going to be used is high and I know that a tight environmental control is necessary. Therefore, a revolving door is an ideal solution, and my answer is a 'yes'. As a result, the solution 'Functionalist' is falsified and removed from the solution's set, and the solution 'High Tech' turned out to be the only possible one within the small domain.

Cortex then brings to the screen the textual description of the 'High Tech' solution:

> *The most likely solution in the Small domain is:*
> *The solution may be a high tech door entrance, with the following features:*
> *-vertical glass tower*
> *-surrounding materials: glass, metal*
> *-swinging door*
> *-revolving door (with four leaves)*
> *-leaf type: framed with one or more light cross panels*
> *-leaf materials: non-stained glass, metal*

The problem's partial description in this section then can be illustrated in the same way as in the previous sections, that is, there are the three possible states for each feature: definitely present, if the answer is 'yes', definitely absent, if the answer is 'no', and neutral, if the answer is 'don't know'.

In this third example of consulting the 'small domain', the user answered 'don't know' to the questions verifying features number 12 and 19. Then the user answered 'yes' to the questions verifying features number 26 and 23. Next, the user answered 'don't know' to the questions verifying features number 5 and 9. The user then answered 'yes' to the question verifying feature 18, 'don't know' to the question verifying feature number 4, and 'no' to the question verifying feature number 13. Then the user answered 'don't know' to the question verifying feature number 17. At last, the user answered 'yes' to the question verifying feature number 20.

By assigning a black circle to the features receiving an answer 'yes', a white circle to the features receiving an answer 'no', and a grey circle to the features either receiving an answer 'don't know' or verified by questions not used, we have the problem's partial description shown in figure 5.31. This figure also shows, in binary representation, the solution retrieved by Cortex as a result of that partial description.

		Problem's partial description	*High Tech solution*
1	**top flat moulding**	◍	0
2	**top curved moulding**	◍	0
3	**lateral vertical moulding**	◍	0
4	**angular connection with glass tower**	◍	0
5	**vertical glass tower**	◍	1
6	**triangular pediment**	◍	0
7	**pointed arch tympanum**	◍	0
8	**tracery or steelwork on fanlight or tympanum**	◍	0
9	**squared fanlight**	◍	0
10	**fanlight with undulate top**	◍	0
11	**lateral cylindrical section column**	◍	0
12	**Surrounding material: glass**	◍	1
13	**Surrounding material: brick**	○	0
14	**Surrounding material: smooth stone**	◍	0
15	**Surrounding material: concrete exposed**	◍	0
16	**Surrounding material: timber**	◍	0
17	**Surrounding material: plasterwork**	◍	0
18	**Surrounding material: metal**	●	1
19	**opening mechanism: swinging door**	◍	1
20	**opening mechanism: revolving door**	●	1
21	**leaf type: plain opaque**	◍	0
22	**leaf type: paneled opaque**	◍	0
23	**leaf type: framed**	●	1
24	**steelwork as leaf decoration**	◍	0
25	**leaf material: glass**	◍	1
26	**leaf material: metal**	●	1
27	**leaf material: timber**	◍	0

Figure 5.31 - The third example of a problem's partial description and the solution retrieved by Cortex.

I shall demonstrate in the coming sections the use of those three problem's partial descriptions and how a possible integration with a particular neural network can yield a system able to support innovative design.

5.3 A stand-alone neural network implementation of the 'small domain':

As mentioned in Chapter 3, neural networks can provide support for the exploration of implicit, therefore, unexpected connections among information (Coyne and Newton, 1990; Coyne and Postmus, 1990; Coyne, 1991; Coyne and Yokozawa, 1992; and Coyne et al, 1993). It was also argued that they can provide the basis for creative design by providing the means of extracting information from implicit knowledge representation that can be translated as new explicit solutions (Coyne et al, 1993).

For instance, an auto-associative, feed forward, binary network, and with one hidden layer of 6 neurons, designed for the 'small domain' may have the following architecture, as shown in figure 5.32. Since the limitations of no hidden layer networks (the Perceptron) have been already raised in Chapter 4, a multi-layered network is adopted here.

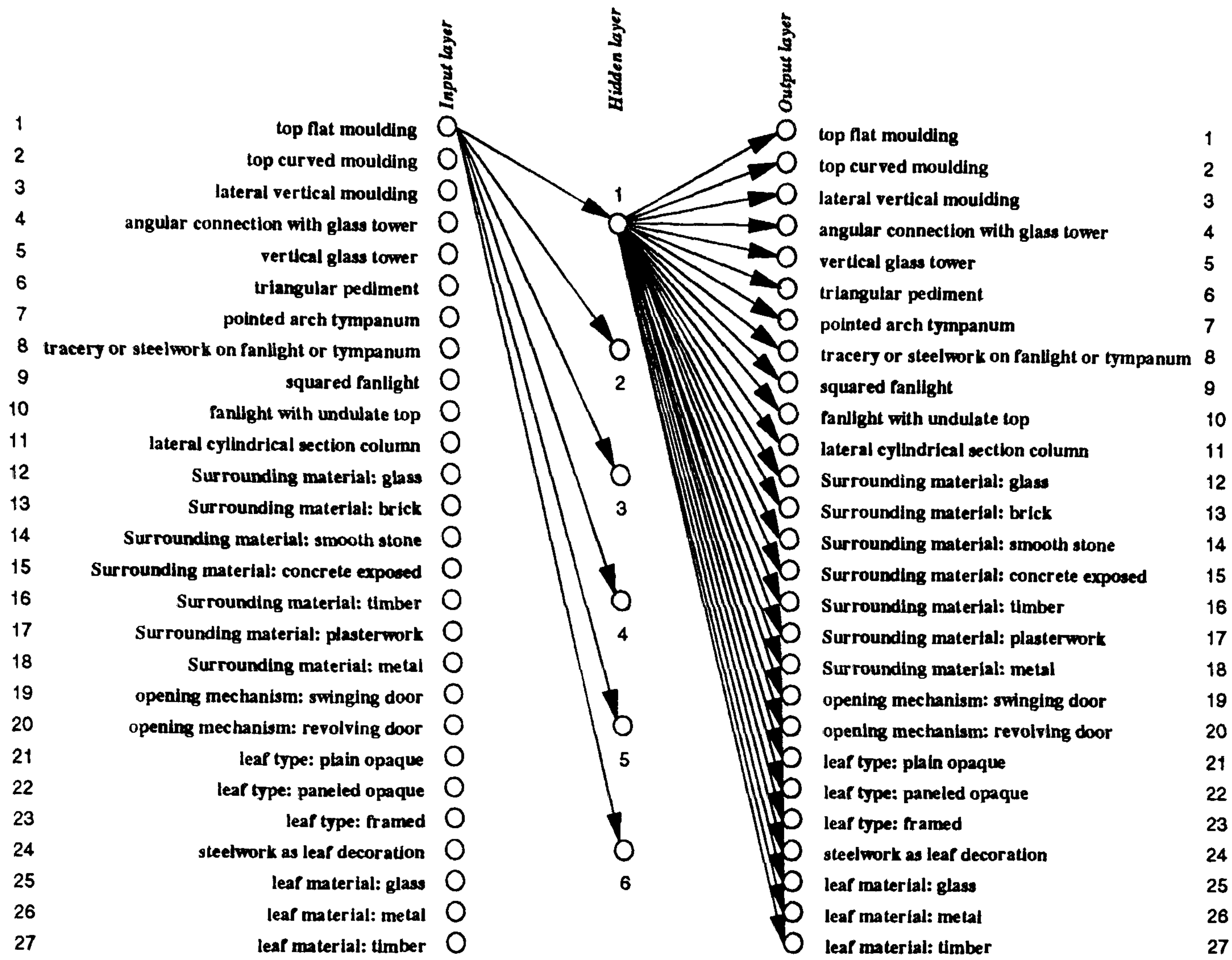


Figure 5.32 - The 'small domain' neural network design.

Only those connections between the input neuron number 1 and all the hidden neurons, and those between the hidden neuron number 1 and all the output neurons are represented, to avoid a cluttered graph. Therefore, each input neuron has 6 connections with the hidden layer, what leads to a total of 162 connections (6 times 27 input neurons), and each hidden neuron has 27 connections with the output layer, what leads to a total of 162 connections (27 times 6 hidden neurons).

After being trained through the exposure to a certain number of examples, represented by different sets of combinations of features, this network becomes 'aware' of what features are mutually excitatory or inhibitory. Its knowledge is stored in the weights between each unit of one layer and all the units of the subsequent layer.

These weights would allow us to identify which pairs of neurons were either mutually excitatory or inhibitory. However, it is possible to identify those relationships only between input neurons and hidden neurons, and between hidden neurons and output neurons. Since this is a multi-layered network it becomes difficult to understand the connection's strength between input and output neurons by simply reading these weights. This is because there are many weights connecting each input to an output, through each hidden neuron, and each of them contributes to more than one output. For instance, the input neuron number 1 contributes with only one weight to the hidden neuron number 1. Nevertheless, it contributes to the output neuron number 1 in six different ways, as shown in figure 5.33 bellow.

Figure 5.33 - The connections between an input neuron and an output neuron.

However, each input neuron has also connections with each hidden neuron. For instance, all the other 26 input neurons have connections with the hidden neuron number 1, as shown in figure 5.34 bellow.

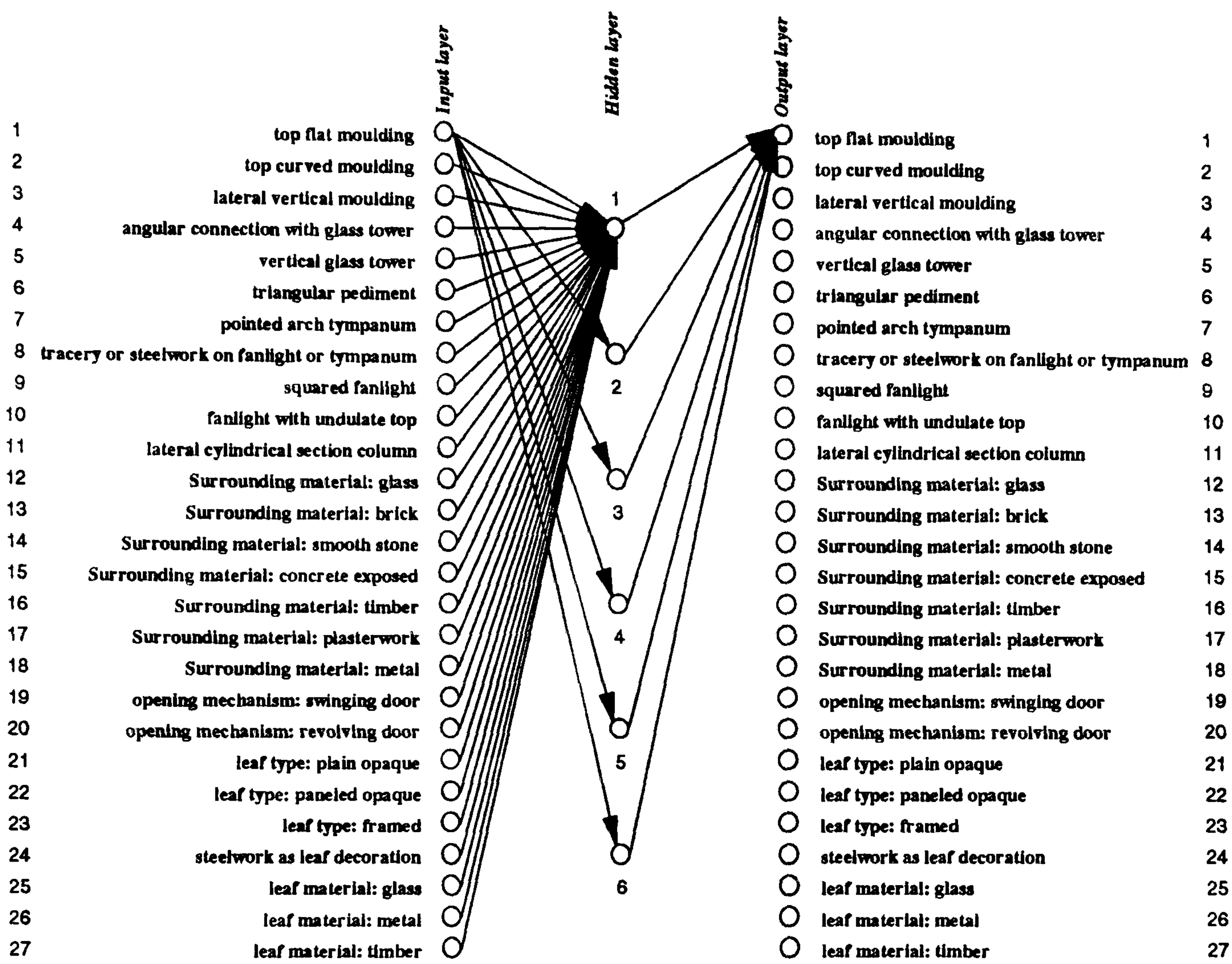


Figure 5.34 - The connections between all the input neurons and a hidden neuron.

The connection between the hidden neuron number 1 and the output neuron number 1 is thus influenced by 27 connections with input neurons and not only with the input neuron number 1. The same is true for each connection between hidden and output neurons. Therefore, it is impossible to identify which pairs of input and output neurons are either mutually excitatory or inhibitory by simply reading these weights.

In the Perceptrons this was simple because there was only one weight between each input and the outputs, that is, each input neuron contributed to each output neuron with just one weight. Therefore, the consistency and relevance of results of a multi-layered can only be verified through experimentation rather than by proof.

I shall try to demonstrate experimentally the consistency and relevance of network's results in Chapter 8. I will now focus on the application logic of a stand-alone neural network inspired in earlier work led by Coyne (Coyne and Newton, 1990; Coyne and Postmus, 1990; Coyne, 1991; Coyne and Yokozawa, 1992; and Coyne et al, 1993).

Coyne and Yokozawa (1992) suggested that if a designer used a trained network by selecting and manipulating features (neurons) on its input layer, the outcome would be not only combinations of features matching examples from the training set, but eventually the emergence of new combinations of features.

For instance, the 'small domain' network could be used in the following way: all input and output neurons are inactive as I approach the system. Suppose that I have the same preoccupation of the second example of using Cortex, mentioned earlier in this Chapter, at section 5.2.2: I know that 'metal' has to be among the surrounding materials because it is being used in other components of the building's facade, I have to use a framed door leaf with one or more light cross panels for safety reasons, I know that metal is among the door leaf materials since it has been specified by the client, and I am not going to use brick because it has been ruled out as an option at earlier stages of the overall building design.

Therefore, I start by making active the input neurons number 18, 23 and 26, which are the features I definitely want to be present. The input neuron number 13 refers to the feature I definitely do not want present, but I leave it as it is since its initial state is already inactive. Figure 5.35 shows the input mentioned above and the network's output.

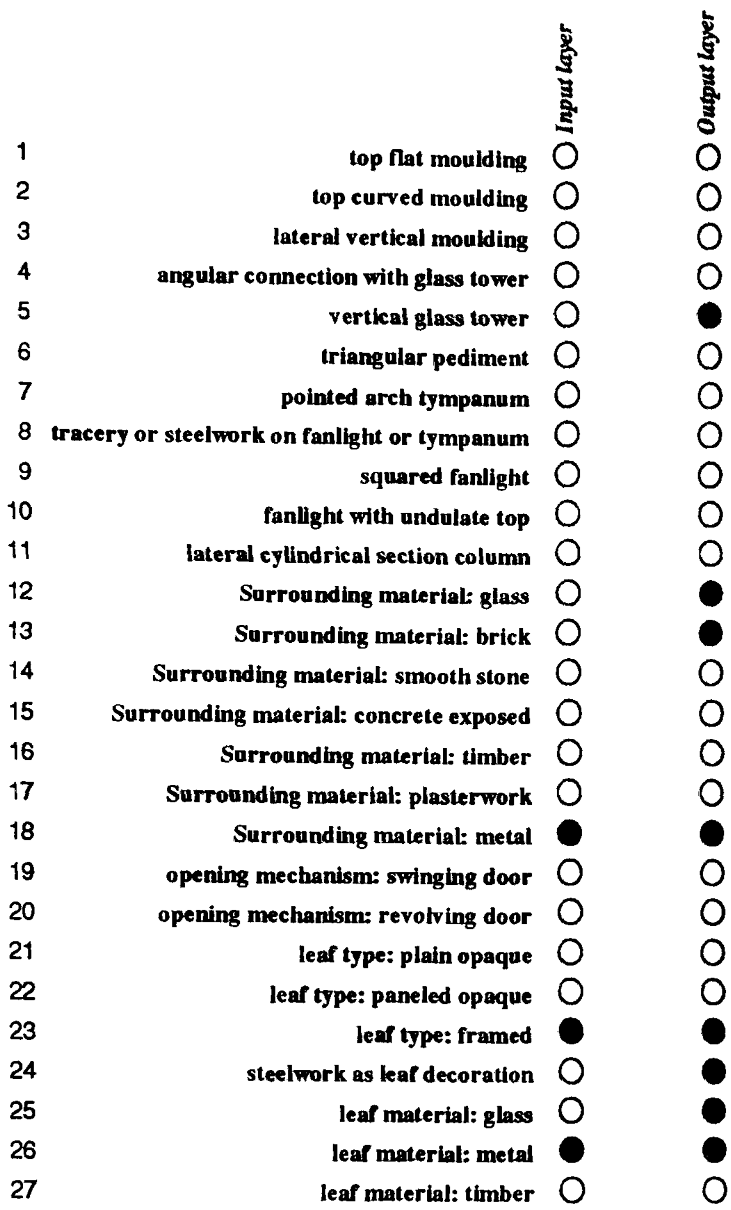


Figure 5.35 - The first set of inputs to the 'small domain' network and its outputs.

The network replied by making active the output units number 5, 12, 13, 18, 23, 24, 25 and 26. The act of making active the output units 18, 23 and 26 comes as a confirmation of my initial choices in the input layer. The added features, 5, 12, 24 and 25, are neutral in relation to my initial preoccupation. However, the presence of feature number 13, 'surrounding material: brick', contradicts my initial constraints, as stated above.

Now, suppose that I accept features 5, 12, 24 and 25 by making them active in the input layer. Suppose also that I reject the presence o feature number 13 by keeping its neuron inactive in the input layer. The neural network output should be as shown in the figure 5.36 bellow.

		Input layer	*Output layer*
1	top flat moulding	○	●
2	top curved moulding	○	●
3	lateral vertical moulding	○	○
4	angular connection with glass tower	○	○
5	vertical glass tower	●	●
6	triangular pediment	○	○
7	pointed arch tympanum	○	○
8	tracery or steelwork on fanlight or tympanum	○	○
9	squared fanlight	○	○
10	fanlight with undulate top	○	○
11	lateral cylindrical section column	○	○
12	Surrounding material: glass	●	●
13	Surrounding material: brick	○	○
14	Surrounding material: smooth stone	○	○
15	Surrounding material: concrete exposed	○	○
16	Surrounding material: timber	○	○
17	Surrounding material: plasterwork	○	○
18	Surrounding material: metal	●	●
19	opening mechanism: swinging door	○	●
20	opening mechanism: revolving door	○	○
21	leaf type: plain opaque	○	●
22	leaf type: paneled opaque	○	○
23	leaf type: framed	●	●
24	steelwork as leaf decoration	●	●
25	leaf material: glass	●	●
26	leaf material: metal	●	●
27	leaf material: timber	○	○

Figure 5.36 - The second set of inputs to the 'small domain' network and its outputs.

The network replied to the above changes in the input layer by making active the output neurons number 1, 2, 19 and 21, and by making inactive the neuron number 13. All the other units remained in their previous state. Therefore, the present state of the output layer has the following neurons active: 1, 2, 5, 12, 18, 19, 21, 23, 24, 25 and 26.

Suppose that I accept feature number 19 by making it active in the input layer. Suppose also that I reject the presence of features number 1 and 2, because I do not want any kind of mouldings, by keeping their neurons inactive in the input layer. I also reject the presence of feature 21, 'leaf type: plain opaque', because it contradicts feature 23, 'leaf type: framed'. The neural network output should be as shown in the figure 5.37 bellow.

		Input layer	*Output layer*
1	top flat moulding	○	○
2	top curved moulding	○	○
3	lateral vertical moulding	○	○
4	angular connection with glass tower	○	○
5	vertical glass tower	●	●
6	triangular pediment	○	○
7	pointed arch tympanum	○	○
8	tracery or steelwork on fanlight or tympanum	○	○
9	squared fanlight	○	○
10	fanlight with undulate top	○	○
11	lateral cylindrical section column	○	●
12	Surrounding material: glass	●	●
13	Surrounding material: brick	○	○
14	Surrounding material: smooth stone	○	○
15	Surrounding material: concrete exposed	○	○
16	Surrounding material: timber	○	○
17	Surrounding material: plasterwork	○	○
18	Surrounding material: metal	●	●
19	opening mechanism: swinging door	●	●
20	opening mechanism: revolving door	○	○
21	leaf type: plain opaque	○	○
22	leaf type: paneled opaque	○	○
23	leaf type: framed	●	●
24	steelwork as leaf decoration	●	●
25	leaf material: glass	●	●
26	leaf material: metal	●	●
27	leaf material: timber	●	●

Figure 5.37 - The third set of inputs to the 'small domain' network and its outputs.

The network replied to the above changes in the input layer by making active the output neuron number 12, and by making inactive the output neurons number 1, 2 and 21. Therefore, the present state of the output layer has the following neurons active: 5, 11, 12, 18, 19, 23, 24, 25, 26 and 27.

Now, suppose that I accept the added feature number 11 by making its neuron active in the input layer. The network outputs will be as shown in figure 5.38.

		Input layer	*Output layer*
1	top flat moulding	○	○
2	top curved moulding	○	○
3	lateral vertical moulding	○	○
4	angular connection with glass tower	○	○
5	vertical glass tower	●	●
6	triangular pediment	○	○
7	pointed arch tympanum	○	○
8	tracery or steelwork on fanlight or tympanum	○	○
9	squared fanlight	○	○
10	fanlight with undulate top	○	○
11	lateral cylindrical section column	●	●
12	Surrounding material: glass	●	●
13	Surrounding material: brick	○	○
14	Surrounding material: smooth stone	○	○
15	Surrounding material: concrete exposed	○	○
16	Surrounding material: timber	○	○
17	Surrounding material: plasterwork	○	○
18	Surrounding material: metal	●	●
19	opening mechanism: swinging door	●	●
20	opening mechanism: revolving door	○	○
21	leaf type: plain opaque	○	○
22	leaf type: paneled opaque	○	○
23	leaf type: framed	●	●
24	steelwork as leaf decoration	●	●
25	leaf material: glass	●	●
26	leaf material: metal	●	●
27	leaf material: timber	●	●

Figure 5.38 - The final set of inputs to the 'small domain' network and its outputs.

This result represents a stable output set because it reproduces the input set exactly, that is, considering that no further changes are introduced in the input layer, no changes are observed in the output layer. It is also a new combination of features because it does not match with any of the original examples used for training the neural network.

The above method, that is, using such networks in a direct input layer manipulation, has as main advantage the freedom of testing and of possibly 'forcing' hybrid solutions by picking up pairs of input neurons otherwise considered unusual in the training set. Another advantage is that such model can be implemented through simple multi-layered feed-forward networks, as demonstrated earlier in this chapter.

However, there are disadvantages. For instance, the user may get an output that is actually not a stable state, since the process can be terminated arbitrarily. The user may also have to undertake a trial process in which he or she may get lost, once there is no inherent trace facility. Moreover, the user may end up in a dead lock in which the network cannot compute a stable state because the units made active are highly incompatible. At last, the method does not provide a plain English interface.

Therefore, better interfaces and procedures must be sought for and I shall try to demonstrated in the next section how such problem may be overcome through the integration of a particular neural network architecture with Cortex (Mustoe, 1990, 1993).

5.5 - Cortex and neural network's integration: an automated and 'semi-recurrent' model.

As mentioned in Chapter 3, Cortex (Mustoe, 1990, 1993) opens new horizons for building systems in which the knowledge-bases can be consistently expanded. However, as the options must be manually set before hand, Cortex has no inherent knowledge acquisition mechanism as any other knowledge-base system.

Neural networks have become known as one of the most promising learning mechanisms. Nevertheless, their limitations are know, and some of them have just been described in the previous section.

A solution to the limitations of both models might be the use of a neural network in the background, and Cortex as the front end, acting as an intelligent filter by providing, as network's input, the problem's partial descriptions. It would supplement Cortex with learning capabilities while the neural network interface limitations mentioned above would be removed by providing an interactive plain English interface.

However, there are two main obstacles to the direct use of the problem's partial descriptions mentioned earlier in this Chapter in the input layer of neural networks. The first is related to some differences in knowledge representation. In the examples of using Cortex, three possible states for each feature were identified: definitely present, if the answer is 'yes', definitely absent, if the answer is 'no', and neutral, if the answer is 'don't know'. However, a binary neural network input unit has obviously only two states: active and inactive.

The second obstacle is related to the way in which the neural network is trained and the amount of information provide by the problem's partial descriptions. For instance, the 'small domain' neural network was trained with complete patterns, that is, it learnt to auto-associate 27 pairs of features. However, since Cortex usually finds a solution using few of the questions in the question's set, its problem's partial descriptions provide, by definition, limited information, which is rarely enough to produce a stable solution.

Yet, we could overcome both obstacles if we used a plain feed-forward multi-layered network at training time and a semi-recurrent network, with limited feed-back, at running time. The question may then be raised: why do not use one of this architectures at both training and running time? Firstly, a plain feed-forward multi-layered network is a sufficiently effective architecture to train the kind of knowledge representation that has been described in this thesis.

Secondly, the recurrent element that is added at running time, and will be described shortly, is used with the purpose of providing external control to a process of automating the search for a stable state that would otherwise be undertaken manually as in Coyne and Yokozawa's (1992) experiment. It is not a standard neural network component based in fuzzy logic, but an element that aims to emulate the role played by the user such as seen in Coyne and Yokozawa (1992).

If we considered a network design in which each input unit had two attributes, the first specifying if it is active or inactive, and the second specifying if it is 'clamped' or 'unclamped', the problem's partial description could then be used as input. In other words, each input unit would have, besides two possible states (active or inactive), and extra attribute that could have a constant value, if the unit's status is clamped, or a variable value, if the unit's status is unclamped. Therefore, the problem's partial description could be input to the network using the following conversion rules:

1- For each question answered 'yes' set its correspondent network input unit to the states 'active' and 'clamped'.

2 - For each question answered 'no' set its correspondent network input unit to the states 'inactive' and 'clamped'.

3 - For each question answered 'don't know' set its correspondent network input unit to the states 'inactive' and 'unclamped'.

Now, suppose that we add a recurrent element between each output unit and its correspondent input unit at running time in which each output is checked against the clamping criteria described above. Figure 5.39 illustrates this feed-back process.

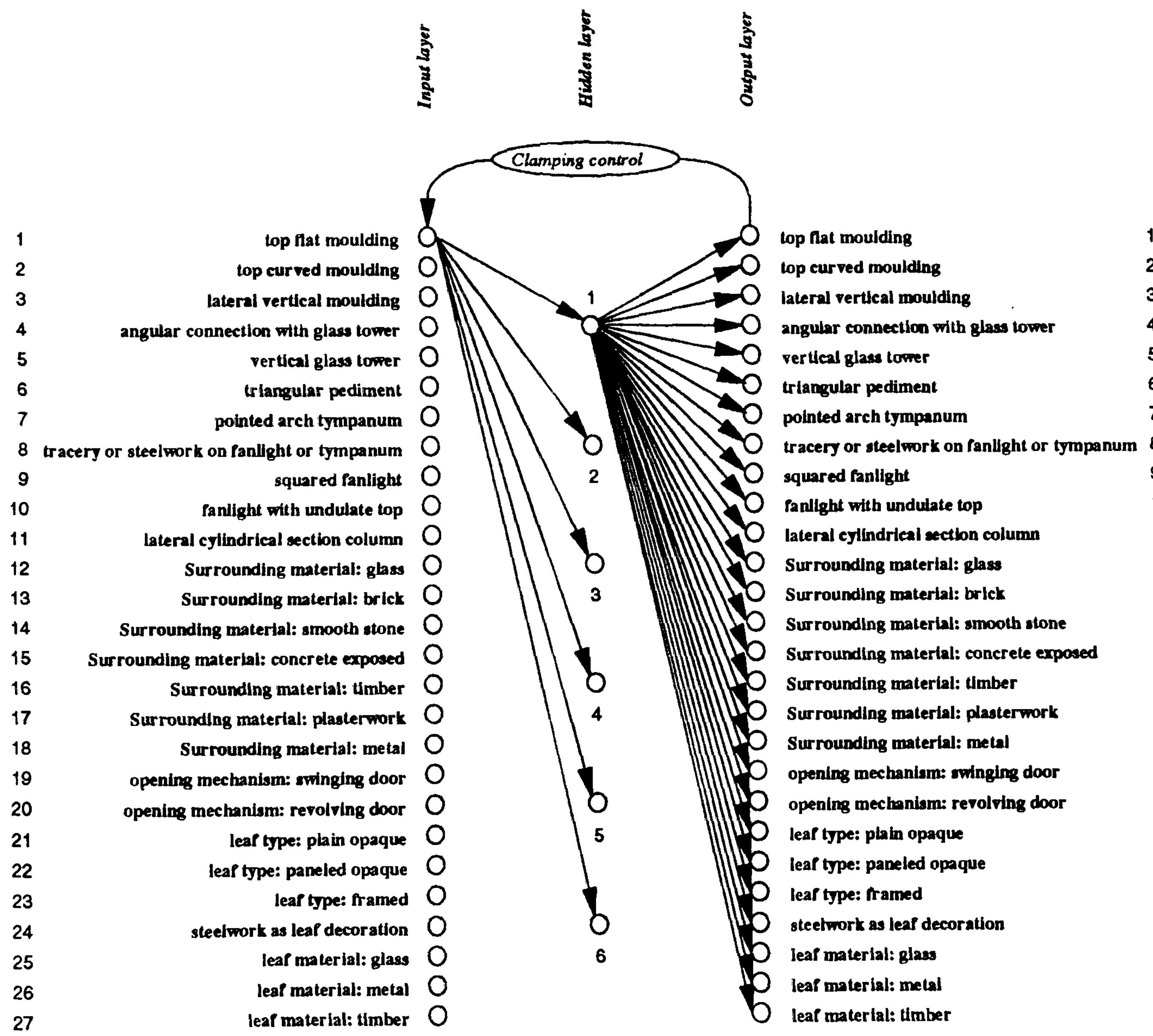


Figure 5.39 - A semi-recurrent network.

In other words, all the output values of 'unclamped' units are accepted and successively re-entered as input. Also, all the output values of 'clamped' units are checked and reset to their initial state (if it has been changed), and successively re-entered as input.

The network could then search for stable states in which reliable solutions could be produced. The process would be terminated in two situations: firstly, when no further changes or mismatches are observed between the input layer and the output layer. Secondly, when the network reaches an infinite loop, that is, the last output equals an output of a previous of stage in the same running process.

As mentioned earlier in this Chapter, this process could lead to three outcomes. Firstly, it could lead to a solution that matches with the solution presented by Cortex. For instance, the entering of the first problem's partial description defined in section 5.2.1 of this Chapter, would lead to a neural network solution that matches with the solution 'High Tech' from the original set of examples. This process is illustrated in figure 5.40 bellow. The first column represents the problem's partial description. Each pair of input and output columns represents one running cycle of the process.

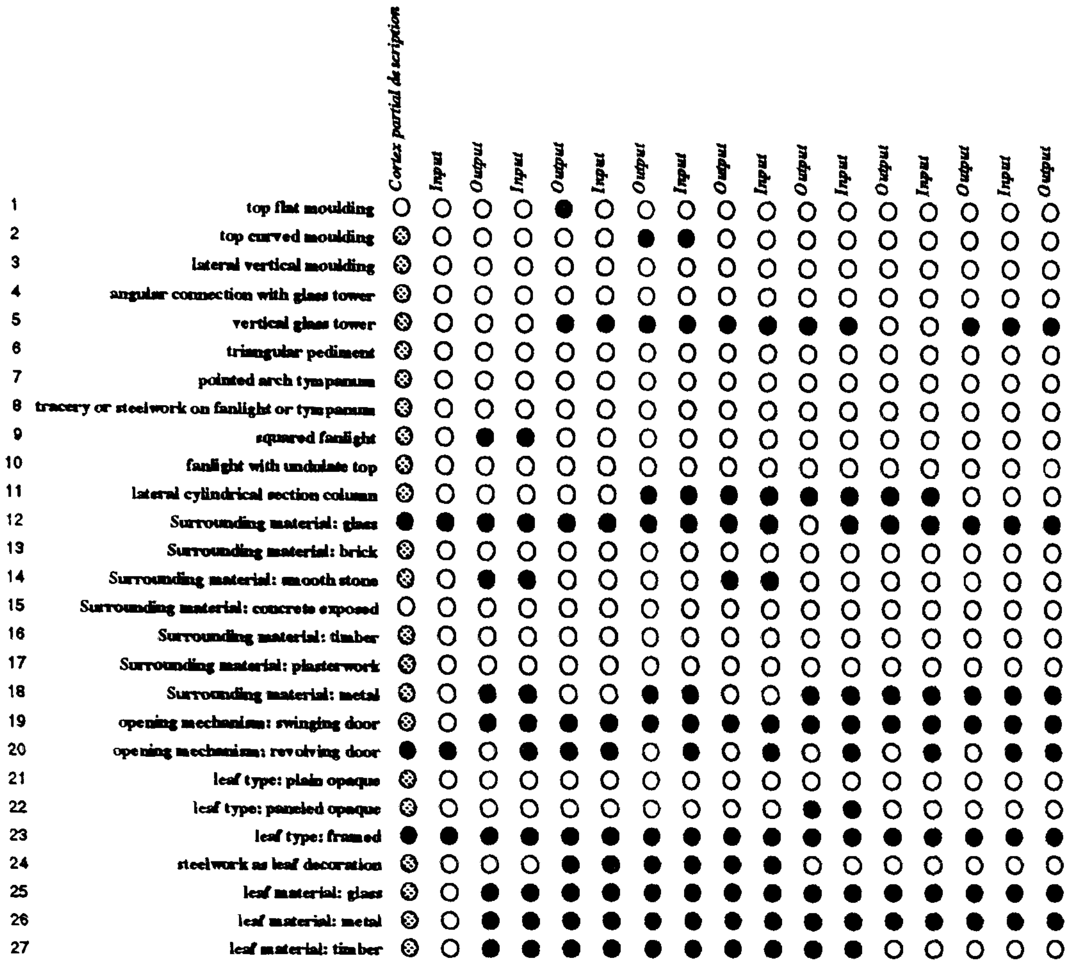


Figure 5.40 - The network computes a stable solution out of the first problem's partial description that matches with the 'High Tech' Cortex solution.

Secondly, it could lead to a solution that does not match with of the solution present by Cortex. Since the solution found by Cortex is the only one in the knowledge-base able to satisfy the user's input, the network's solution will not match with any of the solutions in the original set of examples either. It is thus a new solution.

For instance, the entering of the second problem's partial description defined in section 5.2.2 of this Chapter, would lead to a neural network solution that does not match with either of the two solutions found by Cortex, 'Functionalist' or 'High Tech'. This process is illustrated in figure 5.41 bellow. Again, the first column represents the problem's partial description, while each pair of input and output columns represents one running cycle of the process.

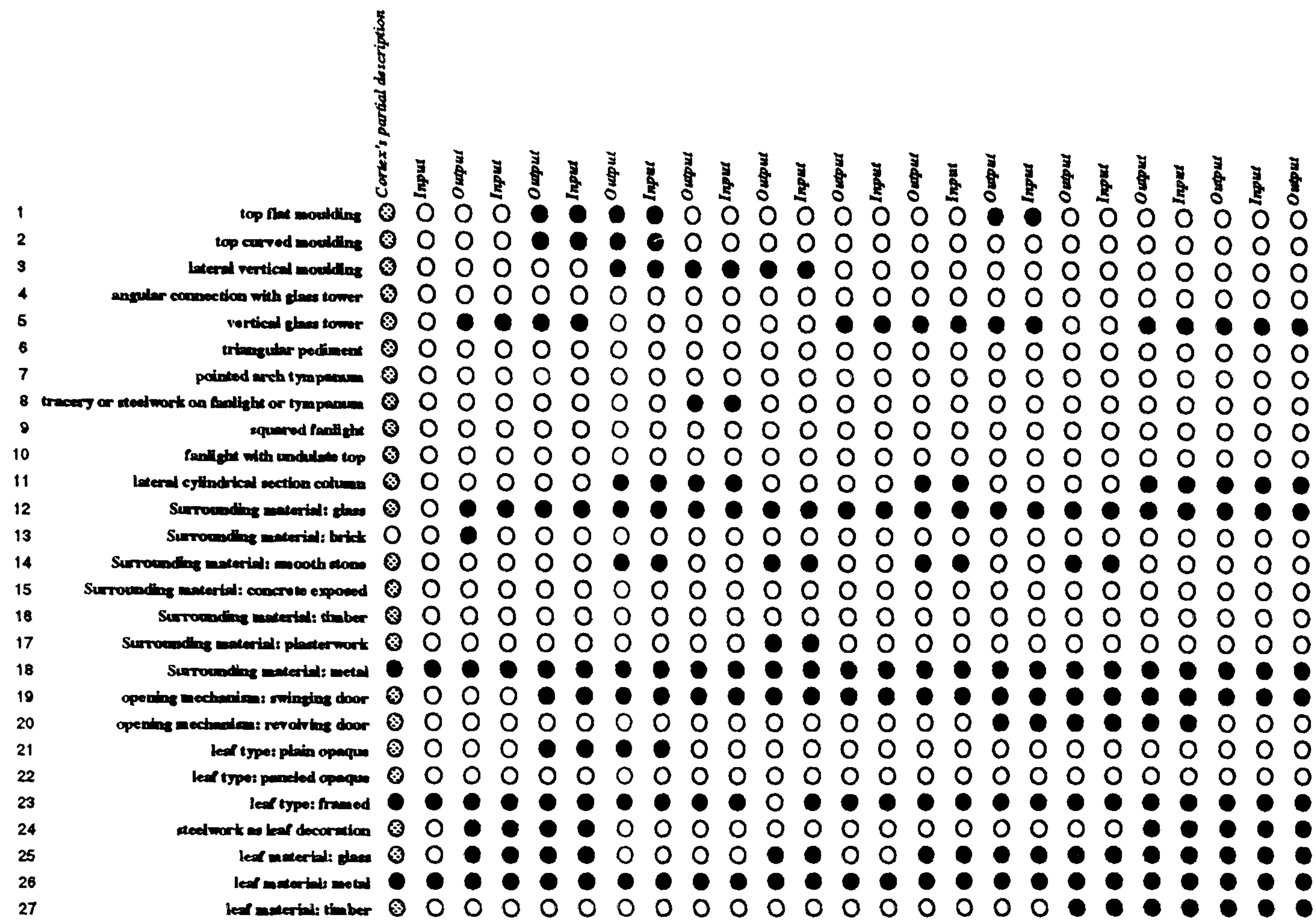


Figure 5.41 - The network computes a stable solution out of the second problem's partial description that represents a new combination of features.

The binary string of such new solutions' can be converted into plain English textual descriptions composed of a list of the features present in the new combinations. For instance, the above solution could be presented to the user as the following textual description:

A new solution may be possible with the following features:
- vertical glass tower.
- lateral cylindrical section column.
- surrounding materials: glass, metal.
- opening mechanism: swinging door, revolving door.
- leaf type: framed.
- steework as leaf decoration.
- leaf materials: glass, metal, timber.

The third possible outcome of the process of searching for a stable state would be the case in which the network is unable to find a stable state satisfying the problem's partial description.

For instance, the entering of the third problem's partial description defined in section 5.2.3 of this Chapter, would lead to a situation in which the network could not find a stable state consistent with all the user's input. Figure 5.42 illustrates this process. Again, the first column represents the problem's partial description, while each pair of input and output columns represents one running cycle of the process.

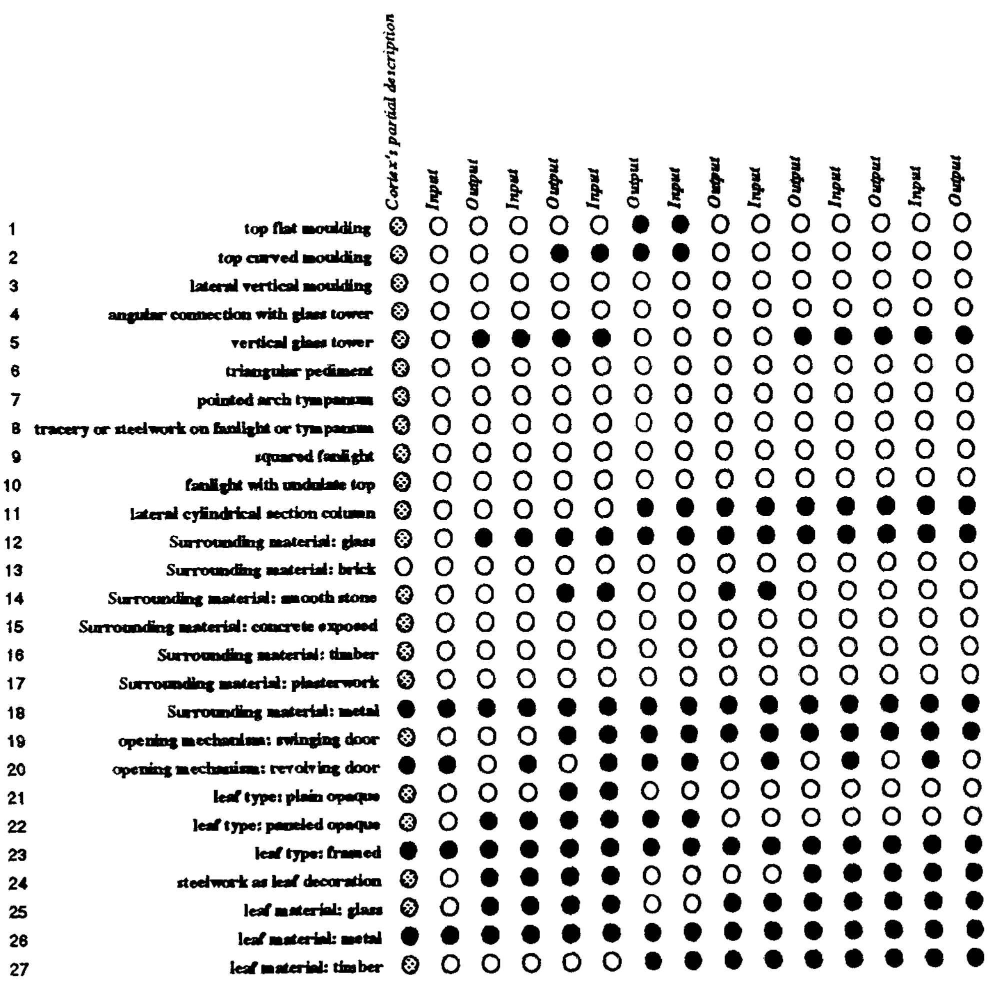


Figure 5.42 - The network is not able to compute a fully stable solution out of the third problem's partial description.

The network's oscillatory behaviour is noticeable in feature number 20, that is, 'opening mechanism: revolving door'. This feature needs to be present in order to satisfy the problem's partial description. However, the network keeps computing an output with the correspondent neuron inactive. Making it active in the next input by the campling control only leads to the network repeating the previous output. Obviously, there may be some situations in which the selection of pairs or set of features contains incompatibilities difficult to be overcome. In these cases the system will terminate the process and inform the user's that, considering what is known, it is difficult to think of a new solution.

Although such solutions have no use, if the only criterion is to satisfy the user's input, it is important to notice that the solution of the last example does not contain internal inconsistencies. In other words, the solution does not contain mutually exclusive features in active state. Also, the process did reach 'a most possibly stable solution', because only one feature at the end of the running process was oscillating and did not comply with the user's input. These will be demonstrate to be very common in the 'extended domain' used in Chapter 8, where about 80% of the solutions not complying with the user's input were still 'architecturally' sensible. For this reason, those solutions are suggested as one of the possible objects of further research in Chapter 9.

5.6 - Cortex and 'semi-recurrent' network integration: a user's point of view.

Now, suppose that an integrated model is built upon the methods and procedures described in the previous sections. Suppose that a user approaches this system with the same preoccupation we had in the section 5.2.2 of this Chapter: he or she knows that 'metal' has to be among the surrounding materials because it is being used in other components of the building's facade, he or she has to use a framed door leaf with one or more light cross panels for safety reasons, he or she knows that metal is among the door materials since it has been specified by the client, and he or she is not going to use brick because it has been ruled out as an option at earlier stages of the overall building design.

What this user will see on the screen and interact with will be as follows. The system starts by bringing to the first question to the screen:

Is there glass among the surrounding materials?

As the user is not sure yet to which extent glass is to be used around the entrance, he or she answers 'don't know' to this question. The system then brings to screen the next question:

Does it have a swinging door?

Suppose the user does not know if a tight environmental control will be necessary, and he or she is unable to decide about the opening mechanism just now. Therefore, he or she answers 'don't know' to this question. The system then asks the next question:

Is there metal among the leaf materials?

Considering that metal has been specified by the client as one of the door materials, the user's answer to this question is 'yes'. The system will then bring the next question to the screen, which is:

Is the leaf framed with one or more light cross panels?

The need of a framed door leaf has been defined as a client's request. Therefore, the user's answer to the question is 'yes'. It follows then the next question:

Is the entrance door under or within a vertical glass tower?

Suppose the user knows that glass is an important component in the building facade, but he or she does not know yet if the door entrance is going to be integrated in it under a tower glass. The answer to this question is thus a 'don't know'. The next question from the system is:

Does it have a squared fanlight?

Since the user does not know yet if this kind of component is to be used, his or her answer to this question is a 'don't know'. The system then moves to the next question:

Is there metal among the surrounding materials?

'Metal' has to be among the surrounding materials because it is being used in other components of the building's facade. Therefore, the user answers 'yes' to this question. The system then asks:

Is the entrance door connected to a vertical glass tower through a plan in an 45 degree's angle?

The user does not even know yet if the door entrance is going to be integrated in a glass tower, and thus answers 'don't know'. Next, the system asks:

Is there brick among the surrounding materials?

The use of brick has been ruled out as an option at earlier stages of the overall building design. Therefore, the user's answer to this question is a 'no'. The system then brings to the screen the following question:

Is there plasterwork among the surrounding materials?

Since it is not clear yet if this kind of material is going to be in immediate neighbourhood of the entrance, the user's answer to this question is a 'don't know'. The next question from the system will be:

Does it have a revolving door with four leaves?

It is not clear yet if a tight environmental control will be necessary. Therefore, the user is still unable to decide about the opening mechanism. The answer to this question is thus a 'don't know'.

The system then brings to the screen the textual description of a first possible solution:

The most likely solution in the Small domain is:
The solution may be a funcionalist door entrance, with the following features:
-vertical glass tower
-surrounding materials: glass, plasterwork and metal
-swinging door
-leaf type: framed with one or more light cross panels
-leaf materials: non-stained glass, metal

The solution's description if followed by the notice:

There is an additional possible solution available. To display it press Y, for 'yes'.

The system then brings to the screen the textual description of a second possible solution:

The remaining possible solution in the Small domain is:
The solution may be a high tech door entrance, with the following features:
-vertical glass tower
-surrounding materials: glass, metal
-swinging door
-revolving door (with four leaves)
-leaf type: framed with one or more light cross panels
-leaf materials: non-stained glass, metal

The text of the remaining solution is followed by a another notice:

Double click the icon More.xls in the Project's folder to see if a suggestion of new solution is available.

The system will then bring to the screen the textual description of a new possible solution, as follows:

A new solution may be possible with the following features:
- vertical glass tower.
- lateral cylindrical section column.
- surrounding materials: glass, metal.
- opening mechanism: swinging door, revolving door.
- leaf type: framed.
- steelwork as leaf decoration.
- leaf materials: glass, metal, timber.

This proposed model can thus support innovative design by augmenting the designer's creativity. In other words, the system provides the user not only with precedent solutions, but also with new possible combinations of features that may lead to new solutions. It can potentially provide the user with ideas that he or she has not though of before. It builds upon the earlier works of Mustoe (1990, 1993) and Coyne (Coyne and Newton, 1990; Coyne and Postmus, 1990; Coyne, 1991; Coyne and Yokozawa, 1992; and Coyne et al, 1993).

The main benefits of this hybrid model are: firstly, the system always reaches a stable solution or the most possible stable solution. There is no risk that a search will be terminated at an unstable state. Secondly, there is no risk of the user getting lost in the search for a stable solution, because all the basic choices are made prior to their entering in the neural network, the search is automated and the system itself keeps track of previous actions. Thirdly, there is no risk of getting into an infinite loop since the system filters features by guiding the user through the most promising path and controlling and terminating deadlock situations. At last, the system offers a plain English interactive interface throughout the process of solution search.

The main technical contribution to knowledge is the integration between Cortex and a network inspired in the earlier work of Coyne. This coupling automates the process of searching for stable solution by emulating the user's actions through the semi-recurrent network described earlier.

The methods and procedures described in this Chapter will be generalised into an algorithm outline in Chapter 6 and an implementation strategy will be described in Chapter 7.

Chapter 6

The plan of a precedent-based, self-extending, innovation-supportive environment

6.1 Introduction:

As mentioned earlier, the dilemma 'reproduction versus creativity' is central in this thesis. One of the main failures or weaknesses of research in design theory and CAAD is related to the deadlock represented by paradigms, either based on pure procedure or previous knowledge, expressing the inability to provide explanations and models of how new solutions may arise and be incorporated into their memory representations.

As mentioned in Chapter 1, the necessary conditions to implement models in which some of this difficulties may be overcome, are the ability to support the emergence of reliable new solutions in a knowledge-representation scheme that allows the continuous extension of the knowledge-base, while at the same time preserving its original consistency.

Therefore, the objective of this thesis is the development of an incremental self-extending environment, thus minimising substantially the dependency on knowledge engineer intervention, and supporting innovation by augmenting the designer's creativity.

As demonstrated in Chapter 3, the addition of new knowledge in a conventional rule-based system can make its knowledge-base inconsistent. However, it was also shown that the addition of new knowledge does not necessarily introduce inconsistency in the original knowledge-base, if within an alternative algorithm such as Cortex's model is adopted (Mustoe, 1990, 1993).

It was also argued that connectionist models, as demonstrated by Coyne and Yokozawa (1992) and Coyne et al (1993), can provide the basis for creative design by extracting information from implicit knowledge that can be translated as new explicit solutions.

In spite of their very different underlying theories and control algorithms, there are evident similarities among Cortex's model (Mustoe, 1990, 1993) and an auto-associative connectionist system such as that described by Coyne and Yokozawa (1992) and Coyne et al (1993). These similarities refer to the domain knowledge representation in Cortex's model and to the knowledge representation of the training set in Coyne and Yokozawa's (1992) and Coyne et al (1993), experiments. Both adopt representations that result in matrices where design precedents map into features. Their input and output structures are thus quite similar: they are both one-dimensional arrays of binary values representing solution's descriptions.

The similarities of these input-output structures raise the possibility of co-operation between the two approaches, as shown in Chapter 5. Moreover, it facilitates the information exchange and the development of a hybrid environment through their integration.

An assumption of this thesis is that if an initial knowledge-base domain is consistently set by knowledge-engineers and experts, and provided that the conditions described in the next section are fulfilled, an integrated environment inspired on the works of Mustoe (1990, 1993), Coyne and Yokozawa (1992) and

Coyne et al (1993), will consistently self-extend through the emergence of consistent new solutions.

As already mentioned, Cortex's algorithm (Mustoe, 1990), which interacts with the user through a dialogue, very often finds a solution with few questions, either without having to ask all questions in the question's set or without requiring the user to answer all the questions that were brought to the screen. However, what happens in both cases is that the user makes some basic, but definite selections among those features represented by the questions the system brings to the screen.

For instance, the system may behave in the following way: for a set of cases described by the features A, B, C, D, E, F, G, H, I, J, K, L, M, and given that the user answers by saying he or she thinks B and G are definitely necessary conditions, A and D are definitely not, and he or she does not know if F is important, at least for the time being, the system may reply by informing that the most likely solution is a case retrieved from the knowledge-base in which the features B, E, F, G, K, L, are present.

Therefore, Cortex (Mustoe, 1993) would be able to find a complete pattern of six features present with two positive answers, two negative and one undefined. It thus works with what is known in its knowledge-base.

If the same set of the user's answers given to the knowledge-based system is run on a trained network with a design such as that described in the previous chapter, new combinations of features may emerge and may be added to both systems providing the basis of a self-expanding environment.

Following the example above, with B and G definitely activated, A and D definitely inactivated, such an environment may answer that the most likely combination of features is either that retrieved from memory, B, E, F, G, K, L, or a combination of B, C, E, G, J, L. Both satisfy the user's selections. The outcome depends on two factors, basically: the strength of the connections established by the network after training and on which features the user selected.

Therefore, this integration may yield a precedent-based, incrementally self-extending, innovation-supportive environment, provided the fulfilment of some conditions that will be described in the next section.

5.2 Conditions:

The feasibility of the proposed environment is dependent on some conditions. One of those conditions is related to the description of solutions in that initial knowledge-base domain. The knowledge representation of domains in Mustoe's model (1990, 1993) and the connectionist training set (Coyne and Yokozawa, 1992, and Coyne et al, 1993) implies the breaking down of the solutions' descriptions into descriptors of binary range value.

However, connectionist systems do have limitations, in spite of having their learning capabilities as their most attractive feature. A binary connectionist system knows nothing about the contextual meaning of those precedent features, except the values 'zero' or 'one'. Therefore, they cannot distinguish between features in different levels of abstraction, such as things like 'internal flat layout' and the 'building overall style', if they are introduced as descriptors in the same training set. They will try to find some correlation between those features, even when they are not related in the real world.

Coyne et al (1993) explores this problem and suggests it can prevent the emergence of new schemes. I would go further and say that it can also lead to the establishment of undesirable connections.

Therefore, when a correlation between two descriptors, representing different levels of abstraction, does exist in the real world, a solution is the extension of the number of descriptors through the breaking down of features into lower levels of abstraction, so that proper connections can be established. Then the descriptors that became simply labels of sub-sets of others in the set are removed (see Coyne et al, 1993: 191, for a similar procedure). Their meanings are still represented there implicitly and can be used if necessary without generating undesirable connections.

The third condition refers to the necessity of having only unique cases or solutions' set. They should be represented in such a way that every solution is distinguishable from all the others. They may obviously have and will have several features' settings in common, but they need to have at least one feature distinguishing every solution from all the others. This is necessary because Cortex's model (Mustoe, 1990, 1993) works with a CBR-like knowledge representation that it needs to be able to discriminate among all the solutions. Its system (Mustoe, 1993) may either come to a unique solution or to a prioritised list of several unique solutions. Therefore, if two solutions have identical settings, they were either improperly described or they are actually the same solution, and one is thus redundant.

5.3 Algorithm outline:

Coyne and Yokozawa (1992) suggest the use of the input layer of those connectionist systems as the user interface:

> *"...For example, the situation may be that I am designing an entrance for a brick wall. The 'brick' wall or any other features may be the starting point for the 'dialogue' with a trained connectionist system. The designer registers this interest by 'clamping' the 'brick wall' feature. In the manner outlined above, the system could respond to the clamping of 'brick wall' with a set of features that constitute a typical brick-wall entrance. The way in which the designer responds to this description could be to accept some of the descriptors as being of interest and to reject others. This is based on the designer's current understanding of the design task, which of course will change in the course of the dialogue with the system. So the designer may clamp certain features on or off, and the system throws back a new description in response to these changes. In response the designer may favour new combinations of features". (Coyne and Yokozawa, 1992: 169).*

However, this raises a major interface problem that is related to the passive character of the direct manipulation of connectionist systems input layer. Mustoe (1990) suggests that passive systems require the user to know with a degree of certainty what he or she is looking for, prior to the start of searching, and to take all the initiative in defining those parameters.

Yet the design activity, as a wicked problem, has no definitive formulation, that is, one cannot simply first define the problem and then the solution, as shown in Chapter 2 (Rittel, 1972). Therefore, a more active interface needs to be found.

The connectionist system described by Coyne and Yokozawa (1992) does provide some rudimentary inter-activity by replying to changes in the input layer, but the initiative of defining the problem-solution is always from the designer.

An alternative way of implementing an auto-associative connectionist system in design would be to keep it in the interface's background where it would act to support Cortex's algorithm (1990, 1993). The KBS would thus act as an intelligent front end, by providing an interactive interface where the initiative would not be taken only by the user.

This architecture will also result in the filtering of the user's input by guiding him or her through the most promising relationships, based on the knowledge of previous cases. This will not necessarily pre-empt or inhibit the emergence of new schemes, as it will be shown in the experimentation described in Chapter 8. Since Mustoe's algorithm usually finds solutions with few questions, this provides enough flexibility for new combinations of features, given the small set of user selections in relation to the total set of descriptors.

The architecture proposed here would also provide a more automatic procedure for the emergence of new solutions, for their incorporation into existing knowledge-bases and for the reuse of previous knowledge.

Therefore, an outline algorithm can be established as follow:

1 - The user's input is controlled by the knowledge-base system and formatted as a binary one-dimensional array in the following way: for each question answered 'yes' set it to 'one' and to the status 'clamped'. For each question answered 'no' set it to 'zero' and to the status 'clamped'. For each question answered 'don't know' set it to 'zero' and to the status 'unclamped'.

2 - Run the the user's input one-dimensional array as many times as necessary in the network to reach a stable state, that is to say, a state in which additional runs do not bring any further changes. This process in Coyne and Yokozawa's (1992) experiment was undertaken manually by the user's manipulation of the network input layer.
In the present case an alternative procedure is adopted in which this process is automated. As already mentioned, the Cortex (Mustoe, 1990, 1993) will find a solution using only few of the questions in the set in most situations. This amount of initial settings will represent very often an insufficient input for the network to perform pattern completion.
Therefore, the running of the user's input on the network only once, rarely produces interesting results. However, if the output of the first or previous run is again entered as input, and this process repeated several times, the network will progressively settle down on a more complete and interesting pattern. As shown in the previous chapter, this process is stopped when it reaches a state where no more changes are verified from one run to the next.
Clamping is achieved by checking the status of each clamped unit, after each run, and by resetting it to its initial state if there was any change. This has the objective of preserving the user's initial selections. All the other unclamped units' status are accepted. This experimental procedure has produced promising results and they will be shown in Chapter 8.

3 - If the output matches with the knowledge-base system's solution, and if the user's initial selections are preserved, then it must also match with a classifier already in the knowledge-base. In this case quit the connectionist system and return to the knowledge-base system. Show the solution available in knowledge-base.

If the output does not match with the knowledge-base system's solution, and if the user's initial selections are preserved, then it also does not match with any of the classifiers already in the knowledge-base. Bring the new instance one-dimensional array description to the screen.

The conceptual consistency of the new solutions will be verified in Chapter 8. If those solutions are consistent and reliable, and I think it will be experimentally demonstrated so, then the foundations of a precedent-based, self-extending, innovation-supportive environment will have been laid.

This algorithm outline will be described in more detail in Chapters 7 and 8 through a prototype implementation, where a loose coupling strategy will be adopted for the purposes of this thesis verification.

Chapter 7

Prototyping

7.1 Introduction:

The proposed environment may have several implications and benefits for the design process. For instance, it inherently minimises the dependency on knowledge engineer intervention. This was demonstrated in Chapter 6. It also supports innovative design by augmenting the designer's creative thinking. In the long term, it may also yield an incremental evolving model in which the system's behaviour changes over time adapting to new situations.

The integration of different paradigms may also raise several expectations about the issues that may be addressed. For instance, the integration of a knowledge-base system, such as Cortex (Mustoe, 1990, 1993), with an auto-associative connectionist system may raise expectations about the reliability of the new solutions. The provision of explanations for the network's reasoning and decisions, and the process of building representations for the new solutions (one-dimensional arrays of binary values, textual descriptions or even graphical representations) may also be taken as relevant issues to be addressed.

However, due to the time constraints related to the development of the research described in this thesis, the main issue tackled, by experimentation, was the support to innovative design. Therefore, the focus was placed in the consistency and reliability of those so called new solutions. This issue was chosen because the relevance of anything else mentioned above is dependent on the successful emergence of reliable new solutions from the environment described in chapters 5 and 6. If this fails everything else becomes unworkable.

7.2 Prototyping strategies:

The development of new computer models and systems faces the difficulty of assessing their impact in the environment they are to fit in before they are actually built and put into use.

Sommerville (1989) suggests the existence of two possible approaches: first, an exploratory system development where an executable system is presented to the user knowing that it is incomplete. The system is then modified and refined so that the user's real requirements become apparent and may be met.

A second approach is a widely used one. It is based on building a 'through-away' prototype. In this case a prototype is built to identify initial problems and, after experimentation, an improved specification is formulated. The prototype is then discarded and a production-quality system built (Sommerville, 1989).

The second approach has been adopted in this thesis. A prototype, that is described in the next section, was built for the specific needs and objectives of the experimentation that will be reported in Chapter 8. Some of the conclusions found in Chapter 9 may contribute to the future development of improved specifications for building a stand-alone executable system.

Another important aspect of the prototyping described in this Chapter is the character of the hybrid system involved. Liebowitz (1993: 114) suggests a hierarchy of hybrid approaches in which four possible levels of integration can be distinguished: first, at the bottom of the hierarchy, would be the stand-alone models with no communication passing between them. At a higher level in the hierarchy would be the loose coupling architecture where communication is achieved through data files being transferred between the two applications. At the next level above, would be the tight coupling architecture in which the straight communication between the modules is achieved through parameter passing. At last, at the top would be the fully integrated model that is so unified that the distinction between the modules is blurred.

The loose coupling model satisfies the needs of this thesis since it provides the means of data exchange between KBS and connectionist system and because the prototyping does not aim at a production-quality system.

7.3 A loose coupling prototyping schema:

The prototype scheme described in this section was developed primarily with the objective of providing an environment for experimental thesis verification. Therefore, it is not yet intended for the end users and it does not have a complete graphical interface. It does not produce graphical representations of new solutions, but one-dimensional arrays of binary values, since those arrays provide enough information to assess the consistency and reliability of the new solutions.

The prototype is not built on a stand-alone executable code, but is based on the loose coupling between two existing shells, *Cortex 1.5* (Mustoe, 1993) and the neural network development tool *BrainMaker 3.0* (California Scientific Software, 1993), which were linked through *Excel 5.0* macros (Microsoft Corporation, 1993).

Cortex 1.5 (Mustoe, 1993) is a knowledge-based system shell developed by Mustoe as an outcome of his research (Mustoe, 1990), as already mentioned. It was written in Pascal for DOS operating system.

BrainMaker 3.0 (California Scientific Software, 1993), is a *Windows 3.1* (Microsoft Corporation, 1992) based neural network shell, which allows the design of connectionist systems without conventional programming. The default system operates as a feed-forward back propagation network in which a sigmoid transfer function is adopted producing a continuous output.

However, *BrainMaker's* shell offers several types of customisation resources, with different types of transfer functions, that are, Linear Threshold, Step, Sigmoid and Gaussian. This allows the design of either binary networks resembling single layer perceptrons (Rosenblatt's,1962), standard back propagation networks with continuous output, recurrent networks and hybrid models.

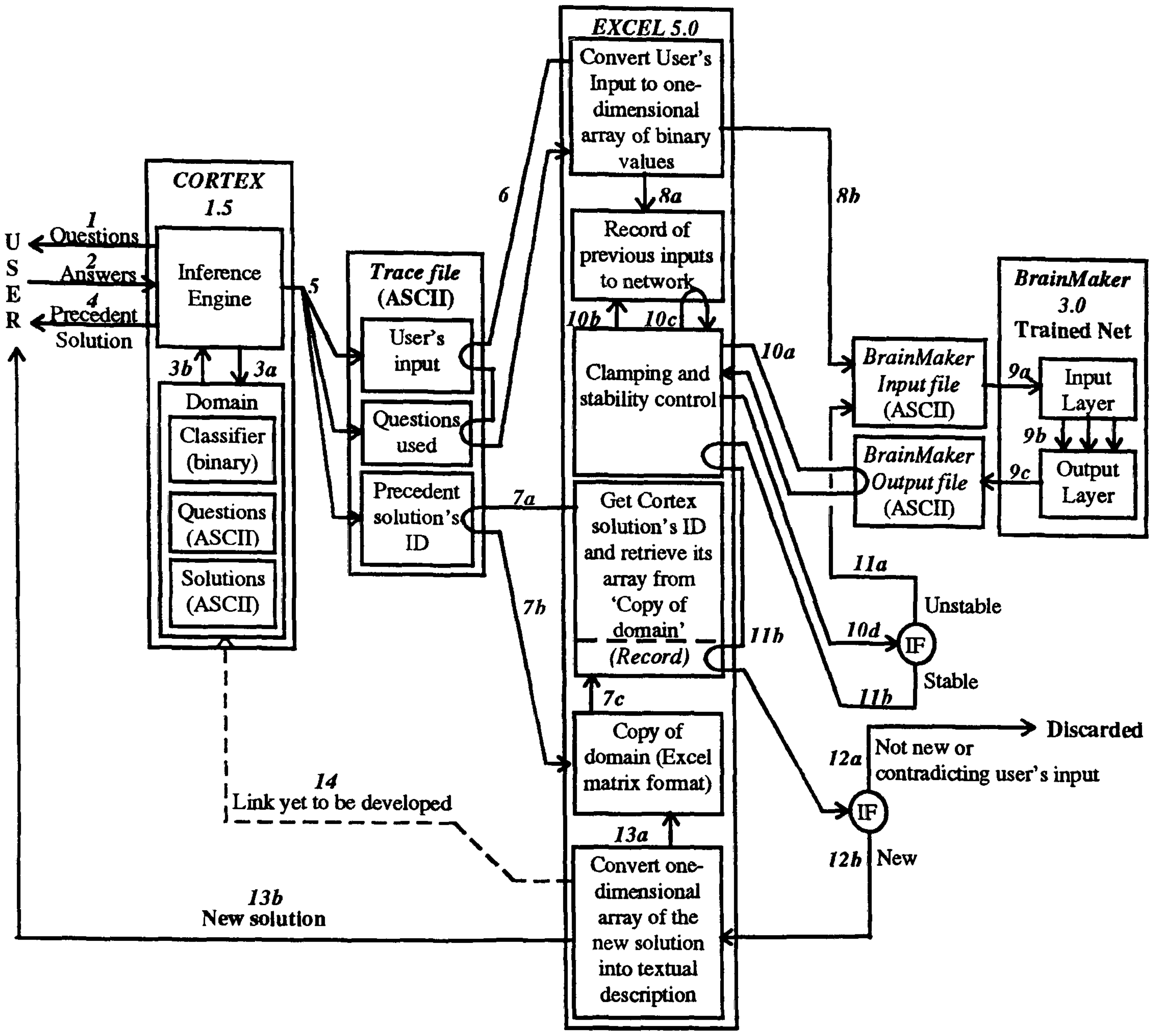
The main task was thus to link the two shells so that the main procedures of the outline algorithm described in the previous chapters could be implemented and tested. The *Excel 5.0* macro language (Microsoft Corporation, 1993) was used for three reasons: firstly, the previous knowledge I had about the language, which would allow some sort of workable implementation without the need of mastering another development tool.

Secondly, it would allow fast verification of application logic and algorithms' reliability, without too much concern either in building a complete and elegant interface or in writing code from scratch.

Thirdly, it would produce one-dimensional arrays of binary values as outputs and, as already mentioned, those arrays provide enough information to assess the consistency and reliability of the algorithm's results.

Cortex 1.5 (Mustoe, 1993) was built as a DOS application, while *BrainMaker 3.0* (California Scientific Software, 1993) and *Excel 5.0* (Microsoft Corporation, 1993) are *Windows 3.1* (Microsoft Corporation, 1992) based applications. The solution was then to set up and run *Cortex 1.5* as a DOS window in a multitasking environment. *OS/2 3.0* (IBM Corporation, 1994) was the chosen operating system because it provides a more reliable support to DOS multitasking then *Windows 3.1* (Microsoft Corporation, 1992), while also running native Windows applicactions.

Figure 7.1 shows an overall structure of this loose coupling prototyping scheme. The boxes in it represent components, while the arrows represent the basic actions in the program flow.



7.1 A loose coupling prototyping schema.

Actions '1' to '5' are *Cortex* proprietary built-in procedures. '1' and '2' represent the basic interaction with the user. '3a' and '3b' represent the inference engine searching for a solution using the algorithm described in the Chapter 3, section 3.2.2. As an outcome it offers a precedent solution represented in the flow-chart by the action '4'. *Cortex* then writes an ASCII trace file, through the procedure

‘5’, reporting what questions of the question set were used, what were the user’s answers, and the ID of the solution presented.

An *Excel* macro, represented in the flow-chart by action ‘6’, then reads that ASCII trace file and converts the user’s input into a one-dimensional array of binary values. Another macro, represented by actions ‘7a’, ‘7b’ and ‘7c’, gets the *Cortex* solution ID from the trace file, retrieves its correspondent one-dimensional array from the ‘Copy of domain’ and stores it in a separate ‘record’.

A copy of the domain stored in *Cortex*, with a matrix representation, was necessary because the knowledge-base in that system is stored in a proprietary binary file. It was thus faster to duplicate the domain rather than write a procedure to overcome file format incompatibilities.

The user’s input converted to a one-dimensional array of binary values is then stored in a ‘Record’ of previous inputs to the network, and sent to *BrainMaker’s* input ASCII file through the macro represented in Figure 5.1 by actions ‘8a’ and ‘8b’.

Actions ‘9a’, ‘9b’ and ‘9c’ represent *BrainMaker’s* built-in procedures. ‘9a’ is a procedure that gets the input from *BrainMaker’s* input file and enters it to the input layer of the trained network. ‘9b’ represents the trained network running process. ‘9c’ is a procedure that gets the output from the trained network output layer and writes it to *BrainMaker’s* output file.

Actions ‘10a’, ‘10b’, ‘10c’ and ‘10d’ are performed by an *Excel* macro. ‘10a’ gets the output from *BrainMaker* by reading in its output file. It then checks if any of the clamped units, that is, those representing the user’s basic choices, have had its status changed. It then re-sets the changed clamped units, if any, to its original state. '10b' sends a copy of that corrected array to the 'Record of previous input to BrainMaker'. The macro then checks if the solution presented is stable through action '10c'. This is achieved by comparing the last result with the inputs in the 'Record of previous inputs to the network'.

'10d' is an 'if... then...' statement. If the solution is unstable, action '11a' is performed, that is, the corrected array is sent to the *BrainMaker's* input file for another running cycle. If the solution has reached stable state, action '11b' is performed, that is, the macro checks again if the solution does not contradict any of the user's basic choices. Then it checks whether it matches with the one found by *Cortex*, by comparing with the separate record created by actions '7a', '7b' and '7c'.

Cortex presents only the solution not falsified by the user's input. The acceptable network solution is that one in which the user's input is not contradicted. Thus these solutions must have in common at least the same settings regarding the units related to the user's basic choices. If the acceptable network's solution is in one or more other units different from *Cortex* solution, it will also not match with any other solution in the existing knowledge-base. Therefore, it will represent a new solution.

If the network's solution is not new or contradicts any of the user's input, action '12a' is performed, that is, the network solution is discarded. If the network solution is new and does not contradict any user's basic choices, then action '12b' is performed, that is, its one-dimensional array of binary values is converted into textual description.

This description is recorded in the 'Copy of domain' through action '13a', and presented to the user through action '13b'. Action '14' represents a hypothetical link, not written yet, in which the new solution would be converted to the proprietary *Cortex* format and added to its knowledge-base domain.

The algorithm and prototyping scheme describe in this chapter has no inherent mechanism of checking for the conceptual consistency of the new solutions. As mentioned in Chapter 6, it is a basic assumption in this research that if an initial knowledge-base domain is consistently set by knowledge-engineers and experts, and provided that the conditions described in Chapter 6 are fulfilled, the integrated environment proposed here will consistently self-extend through the emergence of also consistent new solutions. However, this consistency can be experimentally verified, as it will be described in the next chapter.

Chapter 8

Experimentation and Data Analysis

8.1 Methodology:

The verification in this thesis was developed by experimentally inspecting the consistency and relevance of the new solutions, regarding architectural knowledge, and also by verifying how often they occur. It was necessary to build a knowledge-base into the loose coupling prototyping scheme that could test the logic and potential of the hybrid approach.

It was not the objective in this experimentation to include a representative sample of all possible user's answers to the knowledge-base system built on a combinatory basis. The input sample shown in this experimentation was not built by combining 'yes' and 'no' at random, but through a conceptual analysis of the architectural meaning of each question presented by the system in the context of a particular design task.

The same approach was adopted in verifying the consistency of the new combinations of features emerging from the neural network. The checking of the absence of mutually exclusive features is part of this methodology. However, it is the architectural meaning of each of those new combinations that is actually taken into final consideration.

There were no pre-set conditions of what might be architecturally acceptable or not. I have tried to use, on a case by case analysis, my designer's knowledge, which is a result of my own previous experience in architectural design practices. Only afterwards some generalisations were drawn from this case by case analysis.

The efficacy of the procedures stated in the algorithm outline and prototyping scheme, as described in Chapters 5 to 7, were verified by executing its actions into the loosely integrated modules and by keeping track of its results.

The 'small domain' used in Chapter 3 and 5 was concise enough to provide easier understanding of application logic. The focus in those chapters was on procedure rather than on the relevance of results. The objective was to show that the proposed integrated model was workable and able to produce consistent results.

However, the design problem description in the 'small domain' and its results is not rich enough to represent a real design task. The capability of producing results that are not only consistent but also relevant needs to be demonstrated through the experimentation with a much larger domain.

Therefore, it was necessary to set up data, create a new knowledge domain in the *Cortex* shell, identify general trends in this domain for analysis purposes, train and validate a connectionist system in *BrainMaker*, explore *Cortex's* inputs-outputs, collect network output and analyse the results.

8.2 Data preparation:

A new domain, which I will call 'extended domain', was built from a set of 122 instances of entrance doors collected from buildings in the University of Strathclyde, Glasgow city centre, Glasgow University and architectural magazines (see Appendix 1 for their photographs). No pre-set conditions were established in this task. The only constraints were the technical and legal possibilities of photographing them. Apart from this, the selection of instances was undertaken at random. Despite the similarities, the resulting sample has only the theme in common with the one used by Coyne and Yokozawa (1992). Besides the obviously distinct instances, the description of the problem was intended to be more extensive than the one used by Coyne and Yokozawa.

The resulting sample of 122 instances was described in binary according to 80 features. Figure 8.1 bellow shows a partial view of the resulting knowledge matrix, which has a knowledge representation scheme similar to the 'small domain' used in earlier chapters of this thesis. The complete matrix can be found in Appendix 2.

	Instance Number >>	1	2	3	4	5	...	118	119	120	121	122
1	*main entrance*	1	0	1	1	1	...	1	1	1	1	1
2	*secondary entrance*	0	0	0	0	0	...	0	0	0	0	0
3	public access	0	0	0	1	0	...	1	0	0	1	1
4	restricted access	1	0	1	0	1	...	0	1	1	0	0
5	exit only	0	1	0	0	0	...	0	0	0	0	0
6	*gives access to: air lock, vestibule or foyer*	1	1	1	1	1	...	1	1	1	1	1
	...	...	...	...	...	...		...	...	...	...	...
75	*retangular, squared or trapezoid handle*	0	0	0	0	0	...	0	0	0	0	0
76	*lever handle*	0	0	0	0	0	...	0	0	0	1	0
77	*long horizontal static handle*	0	0	0	0	0	...	0	0	0	0	0
78	*long vertical static handle*	1	1	1	1	1	...	0	0	0	0	0
79	*short vertical static handle*	0	0	0	0	0	...	0	0	0	0	1
80	*curved static handle*	0	0	0	0	0	...	0	0	0	0	0

Figure 8.1 - Partial view of the 'extend domain' knowledge matrix.

Features can represent either abstract concepts, such as 'flow function' (main or secondary entrance), or geometric characteristics such as 'top flat moulding'. It may be argued that the majority of the descriptors in this sample are geometric features. However, I believe that this is appropriate. Firstly, this is appropriate to the design task at hand and its level of abstraction. It is a well-known trend that design moves away from a high level of abstraction to a low level as the process moves from conceptual design to detailed design. Therefore, an entrance door generally represents a task closer to detailed design than conceptual design.

Secondly, sub-sets of geometrical descriptors in this set can represent implicit non-geometrical concepts. For instance, the sub-set of descriptors consisting of *'flat door top'*, *'top flat moulding'*, *'triangular pediment'*, *'lateral cylindrical section column'*, *'lateral vertical moulding'* and *'leaf: panelled opaque'*, represents the non-geometrical implicit concept of *'classical entrance'*. The following is the list of the 80 descriptors used to classify the sample. It was designed with the concerns described in Chapter 6, section 6.2.

Flow function:
1 main entrance
2 secondary entrance

Flow control:
3 public access
4 restricted access
5 exit only

Flow connection:
6 gives access to air lock, vestibule or foyer
7 gives access to corridor or aisle
8 gives access to shop or working room

Formal insertion:
9 aligned to the facade
10 pulled out from the facade
11 pulled in from the facade

Door top shape:
12 flat door top
13 semi-circular door top arch
14 segmental door top arch
15 pointed door top arch
16 round trefoil door top arch

Top complements:
17 top flat moulding
18 top curved moulding
19 triangular pediment
20 semi-circular or segmental pediment
21 squared fanlight
22 fanlight with undulate top
23 pointed arch fanlight
24 semi-circular or segmental arch fanlight
25 pointed arch tympanum
26 semi-circular arch tympanum
27 tracery or steelworks on fanlight or tympanum
28 stained glass on fanlight
29 flat rectangular porch
30 flat semi-circular porch
31 pediment porch
32 segmental (concave) porch
33 convex porch

Lateral complements:
34 columns supporting porch
35 walls supporting porch
36 cables supporting porch
37 lateral squared section column
38 lateral cylindrical section column
39 lateral vertical moulding
40 window in one side
41 windows in both sides

Other complements:
42 vertical glass tower
43 angular connection with glass tower
44 decorative sculptures

Surrounding materials:
45 glass
46 brick
47 smooth stone
48 rough stone
49 concrete blocks
50 concrete exposed
51 timber
52 smooth plasterwork
53 rusticated plasterwork
54 tiles or small tiles
55 metal

Door operation type:
56 swinging door: one single
57 swinging door: two singles
58 swinging door: one double
59 swinging door: triple, two doubles or more
60 revolving door (with four leaves)
61 sliding door (one or more leaves)

Door leaf type:
62 plain opaque
63 plain transparent
64 semi-opaque plain with one or more light cross panels
65 panelled opaque
66 panelled semi-opaque with one or more light cross panels
67 framed with one or two light cross panels
68 framed with three or more light cross panels

(continued)

(continued)

Door leaf materials:
69 steelworks leaf decoration
70 non-stained glass
71 stained glass
72 metal
73 timber

Door handle, if any:
74 round knob or ring handle
75 rectangular, squared or trapezoid handle
76 lever handle
77 long horizontal static handle
78 long vertical static handle
79 short vertical static handle
80 curved static handle

8.2.1 General trends in the chosen sample:

Before going further in reporting the process of data preparation and experimentation it is important to provide some means of visualising the general trends in this particular sample. This will help to understand the sample itself and it will provide some criteria for validating the number of hidden units in the neural network design.

A frequency table reporting the presence of feature 'y' given that 'x' is present can be found in Appendix 3. A partial view of this table is shown in figure 8.2 bellow.

<< Input (x)	(y) Output >>	1	2	3	4	5	6	...	75	76	77	78	79	80
		main entrance	*secondary entrance*	public access	restricted access	exit only	*gives access to: air lock, vestibule or foyer*	...	*retangular, squared or trapezoid handle*	*lever handle*	*long horizontal static handle*	*long vertical static handle*	*short vertical static handle*	*curved static handle*
1	***main entrance***		0.0000	0.6078	0.3922	0.0000	0.9706	...	0.1569	0.1078	0.0392	0.1863	0.1176	0.0294
2	secondary entrance	0.0000		0.4000	0.5333	0.0667	0.3333	...	0.0000	0.0000	0.0000	0.0667	0.1333	0.0667
3	***public access***	0.9118	0.0882		0.0000	0.0000	0.9118	...	0.1176	0.0147	0.0588	0.2206	0.1324	0.0441
4	***restricted access***	0.8333	0.1667	0.0000		0.0000	0.8750	...	0.1667	0.2083	0.0000	0.1042	0.1042	0.0208
5	exit only	0.0000	0.1667	0.0000	0.0000		0.1667	...	0.0000	0.0000	0.3333	0.1667	0.0000	0.0000
6	***gives access to: air lock, vestibule or foyer***	0.9429	0.0476	0.5905	0.4000	0.0095		...	0.1524	0.0952	0.0381	0.1905	0.1238	0.0286
...	...	...	...	...	...	...	...		...	...	...	...	...	...
75	retangular, squared or trapezoid handle	1.0000	0.0000	0.5000	0.5000	0.0000	1.0000	...		0.1875	0.0000	0.0000	0.0000	0.0000
76	lever handle	1.0000	0.0000	0.0909	0.9091	0.0000	0.9091	...	0.2727		0.0000	0.0000	0.0000	0.0000
77	long horizontal static handle	0.6667	0.0000	0.6667	0.0000	0.3333	0.6667	...	0.0000	0.0000		0.1667	0.1667	0.0000
78	long vertical static handle	0.9048	0.0476	0.7143	0.2381	0.0476	0.9524	...	0.0000	0.0000	0.0476		0.0000	0.0000
79	short vertical static handle	0.8571	0.1429	0.6429	0.3571	0.0000	0.9286	...	0.0000	0.0000	0.0714	0.0000		0.0000
80	curved static handle	0.7500	0.2500	0.7500	0.2500	0.0000	0.7500	...	0.0000	0.0000	0.0000	0.0000	0.0000	

Figure 8.2 - Partial view of 'extended domain' frequency table.

This is a matrix of 80 columns and 80 rows. Each row represents the frequencies of each column's feature given that the row's feature is present. The probability values in that table were normalised to values between 0 and 1 to facilitate the comparison with the network settings later. For instance, if the feature *'Flow function: main entrance'* is present, the features *'Flow function: secondary entrance'*, *'Flow control: public access'* and *'Flow control: restricted access'* have a probability of 0.0%, 60.78% and 39.22%, respectively, of being present.

Another instrument that could be used in the understanding of the sample's general trends was the clustering of cases into categories. However, the hierarchical clustering that leads inevitably to a knowledge structure where upper classes' descriptions act as labels of descriptors in lower levels was not used here. This knowledge representation resembles conventional rule-base systems and that is exactly one of the things avoided in this thesis, for the reasons already explained in Chapter 3.

The important relationship tested was not the association of case labels with features' descriptors, but features with features. Figure 8.3 shows a graph with the percentage of occurrence of each feature in the sample. Its sole purpose is to inform the richness and diversity of the sample.

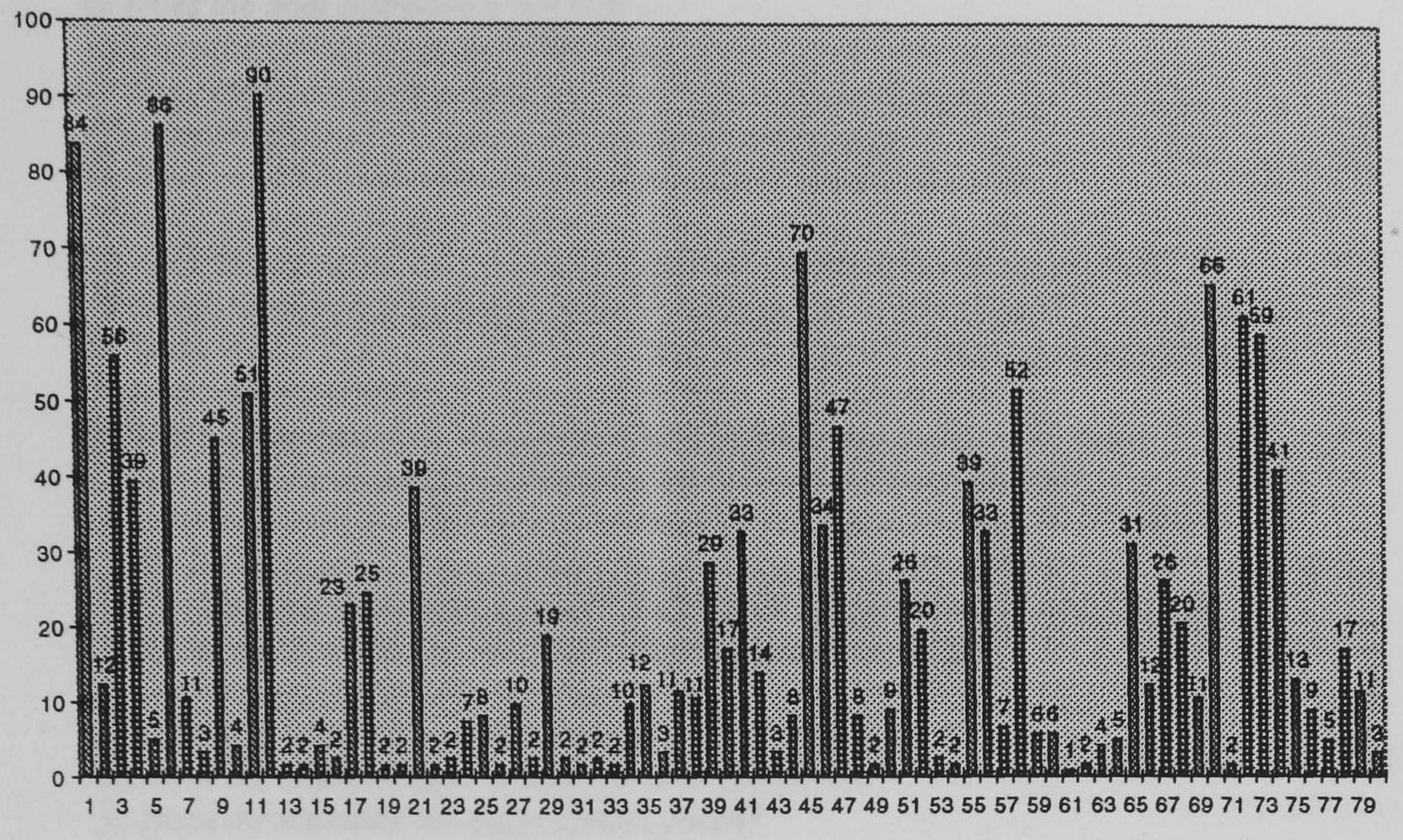


Figure 8.3 - Percentage of features' occurrences.

However, the most important instrument of analysis is the frequency table contained in Appendix 3, since it is the association of features with features, rather than cases with cases or cases with features, that are important.

8.2.2 Domain knowledge set-up and data collection:

The feature's descriptors were converted into questions in the setting up of the 'extended knowledge-base domain' in Cortex. These questions are listed bellow.

1 Is it supposed to be the main entrance?
2 Is it supposed to be a secondary entrance?
3 Is it supposed to allow public access?
4 Is it supposed to allow restricted access only?
5 Is it an exit only entrance?
6 Does it give access to an air lock, vestibule or foyer?
7 Does it give access to a corridor or aisle?
8 Does it give access to a shop or working room?
9 Is it aligned to the facade?
10 Is it pulled out from the facade?
11 Is it pulled in from the facade?

12 Does the door leaf have a flat top?
13 Does the door leaf top have the shape of a semi-circular arch?
14 Does the door leaf top have the shape of a segmental arch?
15 Does the door leaf top have the shape of a pointed arch?
16 Does the door leaf top have the shape of a round trefoil arch?
17 Does the entrance have any kind of flat moulding on its upper part?
18 Does the entrance have any kind of curved moulding on its upper part?
19 Does the entrance have a triangular pediment on its upper part?
20 Does the entrance have a semi-circular or segmental pediment on its upper part?
21 Does the entrance have a squared fanlight on its upper part?
22 Does the entrance have a fanlight with undulate top on its upper part?
23 Does the entrance have a pointed arch fanlight on its upper part?
24 Does the entrance have a semi-circular or segmental fanlight on its upper part?
25 Does the entrance have a pointed arch tympanum on its upper part?
26 Does the entrance have a semi-circular arch tympanum on its upper part?
27 Is there any tracery or steelwork on fanlight or tympanum?
28 Is there stained glass in the fanlight?
29 Does the entrance have a rectangular flat porch?
30 Does the entrance have a semi-circular flat porch?
31 Does the entrance have a pediment porch?
32 Does the entrance have a segmental (concave) porch?
33 Does the entrance have a convex porch?
34 Is there a porch supported by columns?
35 Is there a porch supported by walls?
36 Is there a porch supported by cables?
37 Is there any lateral squared section column?
38 Is there any lateral cylindrical section column?
39 Is there any lateral vertical moulding?
40 Is there a window in only one side?
41 Are there windows in both sides?
42 Is there a vertical glass tower above the entrance?
43 Is there an angular connection between the entrance and a vertical glass tower?
44 Is there any decorative sculpture?
45 Is there glass in the surroundings of the entrance?
46 Are there bricks in the surroundings of the entrance?
47 Is there smooth stone in the surroundings of the entrance?
48 Is there rough stone in the surroundings of the entrance?
49 Are there concrete blocks in the surroundings of the entrance?
50 Is there concrete exposed in the surroundings of the entrance?
51 Is there timber in the surroundings of the entrance?
52 Is there smooth plasterwork in the surroundings of the entrance?
53 Is there rusticated plasterwork in the surroundings of the entrance?
54 Are there tiles or small tiles in the surroundings of the entrance?
55 Is there metal in the surroundings of the entrance?
56 Does the entrance have one single swinging door?
57 Does the entrance have two single swinging doors?
58 Does the entrance have one double swinging door?
59 Does the entrance have a triple, two doubles or more swinging doors?
60 Does the entrance have a revolving door?
61 Does the entrance have a sliding door (with one or more leaves)?
62 Is the leaf plain opaque?
63 Is the leaf plain transparent?

64 Is the leaf plain semi-opaque with one or more light-cross panels?
65 Is the leaf panelled opaque?
66 Is the leaf panelled semi-opaque with one or more light-cross panels?
67 Is the leaf framed with one or two light-cross panels?
68 Is the leaf framed with three or more light-cross panels?
69 Is there steelwork decoration in the leaf?
70 Is there non-stained glass in the leaf?
71 Is there stained glass in the leaf?
72 Is there metal in the leaf?
73 Is there timber in the leaf?
74 Does the door have a round knob or ring handle?
75 Does the door have a rectangular, squared or trapezoid handle?
76 Does the door have a lever handle?
77 Does the door have a long horizontal static handle?
78 Does the door have a long vertical static handle?
79 Does the door have a short vertical static handle?
80 Does the door have a curved static handle?

The knowledge-base matrix, as shown in figure 8.1 and Appendix 2, was the basis of the domain knowledge-base settings. A '1' setting was interpreted as a 'yes' answer while a '0' is a 'no' answer.

As explained in Chapters 5 to 7, the user's inputs to the knowledge-base system are sent to the neural network and the solutions of both sub-systems compared. Therefore, it was necessary to generate a representative sample of users' inputs and Cortex output. A set of 46 *'user types'* was built covering a wide variety of different concerns and contexts. Figure 8.4 shows a partial view of those user types. The complete sample can be found in Appendix 4.

	1	2	3	4		77	78	79	80
User's type	*main entrance*	*secondary entrance*	public access	restricted access	...	***long horizontal static handle***	***long vertical static handle***	***short vertical static handle***	***curved static handle***
Classic 1	y		y		...				
Classic 2		y		y	...				
Classic 3	*y*		*d*	*d*	...	*d*	*d*	*d*	*d*
...	...	...	...	...		...	...	...	...
Modern (high tech 3)	y		y		...		*y*		
Modern (high tech 4)	*d*	*d*	*d*	*d*	...		*d*		
Post-Modern (neo-classic 1)	*d*	*d*	*d*	*d*	...		*d*		
...	...	...	...	...		...	...	...	...
Materials 2 (Industrialised)		*y*	*y*		...	*d*	*d*	*d*	
Materials 3 (Hand-crafted)		*y*	*y*		...	*d*	*d*	*d*	
Materials 4 (Hand-crafted)		*y*	*y*		...	*d*	*d*	*d*	

Figure 8.4 - Partial view of the user types table.

Each row in this table represents how a user of a particular type may answer the questions from the system. If a feature has a setting 'y' the answer should be 'yes', while having a 'd' setting would require an answer 'don't know'. A blank cell would require an answer 'no'.

As mentioned earlier in this Chapter, this sample of user's concerns or expectations was not built at random, but on the basis of the architectural meaning of each question presented by the system in the context of a particular design task.

A second aim of this set of *'user types'* is to demonstrate the richness of the knowledge represented in the domain. The *'user types'* show that, with the set of descriptors used in the sample, it is possible to construct a wide variety of prototypes representing different concerns.

Is also important to emphasise that it is possible to build combinations of features mapping into categories and concepts not explicitly represented in the sample, such as *'modern high-tech'*, *'tight environmental control'* or *'high flow function'*. It may be argued that it is difficult to distinguish a *'modern high-tech'* entrance from a *'modern functionalist'* one.

However, the 'user types' were not built with the intention of providing a complete description of what *'modern high-tech'* architecture or *'modern functionalist'* architecture may be. They were built with the intention of providing a description of how a designer, of any of those 'types', would answer those questions constrained to the boundaries of the specific design problem *'entrance door'*.

8.2.3 Neural network design, training and validation of hidden units configuration:

A series of experimental methods of designing and validating the neural network sub-system was developed. The objective was not the classification of unknown cases in the light of known ones, as it is common in other applications such as computer vision. In most domains, a series of cases, that is, a 'testing set', is presented to the trained neural network, which have seen only a 'training set', to verify if it is able to associate a particular existing pattern with the correct concept or label.

However, a performance phenomenon, called 'memorisation', is often mentioned in neural network's literature (Lawrence, 1993; Rich and Knight, 1991). This phenomenon may be associate with the training time, the levels of noise in the input, or with the number of hidden neurons.

Noise is not considered here since is more relevant in applications in which the input is composed of non-structured information, such as the recognition of photographic information. Controlling the training time is more relevant in networks of continuous output where the network reaches a trained state when it surpasses a pre-set error tolerance, which is by definition a variable. In the present case the trained state is not dependent on a error tolerance, since the output is binary: all the pairs of input-pattern should match at the end of training, otherwise the network is considered untrained.

Therefore, the number of hidden neurons is the most important factor in controlling the network performance in the present case. Figure 8.5 shows graphic illustration of the relation between the number of hidden neurons and the networks performance.

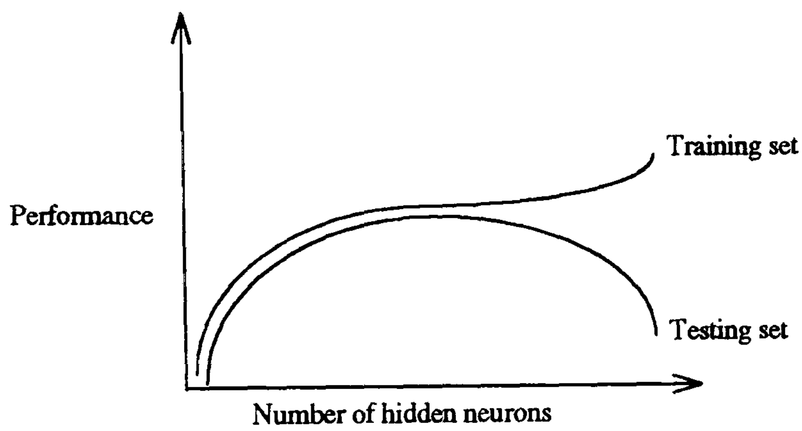


Figure 8.5 - Relation between performance and the number of hidden neurons.

As the number of hidden units increases, the performance on the training set improves, while performance on the testing set also improves. After the addition of a number of hidden units, the training performance may reach a plateau before finding a path of further improvement. However, the performance on the testing set gets constantly worse. This happens because the network has begun to memorise the individual input-output pairs rather than settling for weights that generally describe the mapping for all cases. With enough hidden units, the network could store entire training sets.

In this thesis the objective was to train the neural network to 'create' the new or unknown cases themselves. Therefore, there is no testing set. Yet, the memorisation phenomenon must still be avoided. An unconventional validation method, not based on testing unknown cases, should be found to determine the optimum number of hidden neurons.

A total of 19 neural networks were created and tested. All of them had in common the auto-associative design of 80 feature's descriptors mapping into themselves, that is, 80 input nodes and 80 output nodes, as shown in figure 8.6.

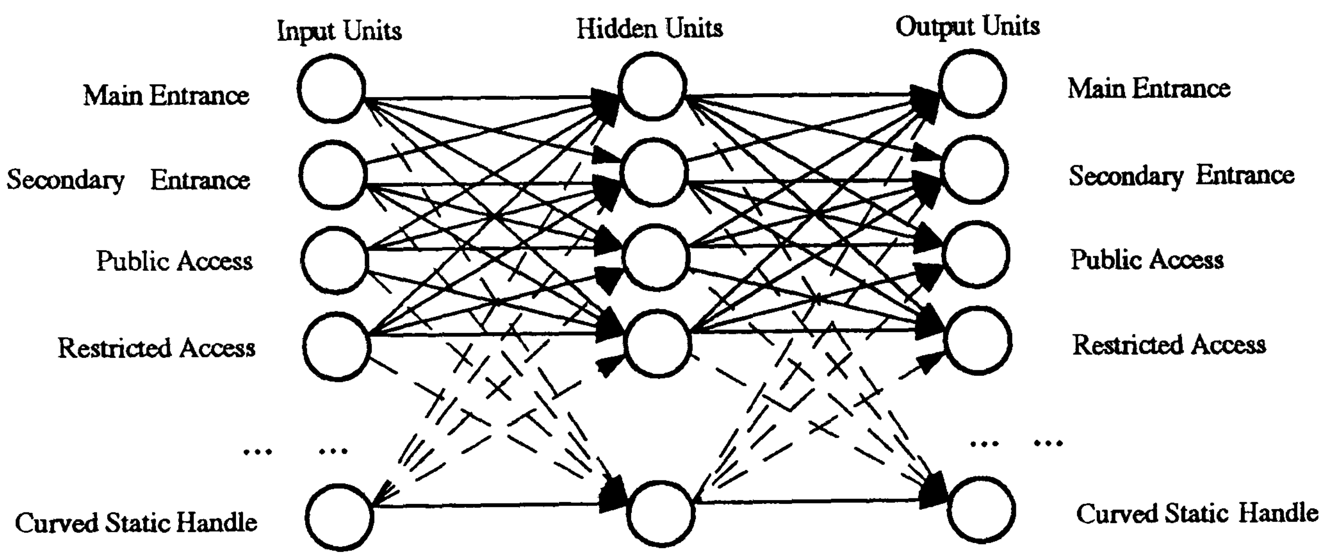


Figure 8.6 The training time network for the 'extended domain'.

The variation in their design resided on the amount of hidden neurons or units. The training started with 10 hidden neurons. In the next stages the number of hidden neurons was progressively increased, from 10 units to 130.

The neural networks unable to reach the learning rate were discarded. This was the case with two of them: those with 10 and 20 hidden nodes. Therefore, 17 remained to be tested, with the following configurations:

Network number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Number of hidden neurons	30	40	50	55	60	65	70	75	80	85	90	95	100	105	110	120	130

Figure 8.7 Configuration of trained networks.

The knowledge of each network is stored in matrixes of connection's weights. Networks with one hidden layer have two matrixes. For instance, figure 8.8 shows a partial view of the matrix of weights between the input and hidden layers of the trained network with 50 hidden nodes (see Appendix 5.1 for a complete matrix).

Input # >>	1	2	3	4	5	...	76	77	78	79	80	Threshold
<< Hidden neuron number	*main entrance*	*secondary entrance*	public access	restricted access	exit only	...	*lever handle*	*long horizontal static handle*	*long vertical static handle*	*short vertical static handle*	*curved static handle*	
1	-1.0172	-1.8774	0.3908	-1.1546	-2.9380	...	-2.1916	2.8382	2.0650	0.1784	2.5712	-0.4236
2	1.0376	-1.3230	-1.8870	0.3630	-2.0586	...	3.2486	1.8952	-2.1972	4.2240	-3.1242	-0.7234
3	0.8414	-4.1994	0.9084	-0.7450	-2.3112	...	-4.4662	-0.9076	2.2600	-0.1604	-2.9230	0.6946
4	-0.8312	0.6962	0.0006	1.0710	1.5452	...	0.9650	-1.1820	0.4464	0.0600	-0.0904	-1.0014
5	1.2582	-3.1008	0.0510	-0.2852	-2.1652	...	3.1434	-0.2322	-0.8312	-1.4000	0.0980	-0.2030
6	-0.2494	1.1282	-0.3272	-0.9546	3.7620	...	-5.7966	0.8726	0.2076	-1.2976	3.3356	0.4054
7	-0.3746	0.0904	-0.6336	-0.4480	-3.1812	...	-6.3766	1.6614	1.0424	0.4236	2.9024	0.6284
...	...	...	...	...	...		...	...	...	...	...	...
44	0.5004	-3.6886	-0.2706	-0.0772	-0.9922	...	0.3600	0.5692	-1.2844	-0.8466	0.9330	-1.0450
45	1.0354	-2.1402	0.0362	-1.0622	5.5784	...	1.1050	2.7016	0.4350	1.0514	-3.1056	-0.6366
46	0.4216	-2.9576	1.2596	-1.8116	3.3814	...	0.6776	2.1356	-0.0440	-1.6508	1.0244	0.3394
47	-0.3730	-0.1884	1.8442	-3.9310	2.9834	...	1.4744	2.9444	2.8376	0.2072	1.0706	0.5642
48	-1.3340	-2.2006	-0.1994	0.4940	1.3940	...	2.3864	2.6760	-3.6796	1.5002	4.5670	0.2166
49	1.6370	-3.6340	0.1874	-1.1126	-4.5110	...	-1.8286	-2.4276	1.0230	-1.3672	-2.6166	-1.0980
50	-0.3934	2.0510	-2.0332	2.1704	-0.1774	...	5.6322	2.0760	0.7002	-2.3196	3.1490	0.3694

Figure 8.8 - Partial view of the matrix of weights between the input and hidden layers of the trained network with 50 hidden nodes.

The matrix has 81 columns and 50 rows. Each row represents the 80 connection's weights between a hidden node and every node in the input layer. The 81st value in each row represents the threshold of each hidden node.

The second matrix has 51 columns and 80 rows. Each row represents the connection's weight between an output node and every node in the hidden layer. The 51st value in each row represents the threshold of each output node. Figure 8.9 shows a partial view of the matrix of weights between the hidden and output layers of the trained network with 50 hidden nodes (see Appendix 5.2 for a complete matrix).

<< Output #	Hidden neuron number >>	1	2	3	4	5	...	46	47	48	49	50	Threshold
1	*main entrance*	3.4826	0.7642	3.7852	-1.2554	3.4920	...	0.2036	-0.4716	-3.5042	5.0184	0.2350	0.2724
2	*secondary entrance*	-0.9574	-3.6062	-7.9998	-1.8436	-1.6302	...	-5.1776	-1.7992	-0.2536	-6.8616	0.5586	-0.2616
3	public access	1.5960	-2.0806	0.2800	-3.3236	0.6672	...	1.4586	2.7256	-2.6272	0.5544	-2.2390	0.2112
4	restricted access	-1.3434	1.5934	-1.2836	0.4180	1.0630	...	-1.7190	-2.6642	-0.2044	-0.7382	1.7184	0.8264
5	exit only	-3.7262	-7.9998	2.9850	-1.7544	0.1464	...	5.1808	4.1342	5.5682	-3.5850	-1.8710	-0.5412
6	*gives access to: air lock, vestibule or foyer*	0.7314	7.0644	1.1232	0.1066	2.6192	...	-1.1382	-2.8022	-1.3756	3.4732	1.1344	0.7156
7	*gives access to: corridor or aisle*	-1.7030	-5.3602	-7.9998	1.9194	-1.3504	...	-0.1266	2.1254	1.2512	-7.9998	-1.8696	-1.9470
...	...	...	...	...	...	...	...	...	...	...	...	...	...
74	*round knob or ring handle*	-1.8410	-0.5536	0.6254	0.7706	-0.1674	...	-1.5056	-0.0564	-1.8304	0.1732	-1.8596	-0.6184
75	*retangular, squared or trapezoid handle*	0.2456	-3.6362	-6.0486	1.2062	-1.3416	...	1.0312	-7.6174	3.4824	2.5254	0.2034	-2.5212
76	*lever handle*	-2.3102	1.5550	-7.9998	2.0560	1.0140	...	0.2086	0.6760	2.2946	-1.4896	2.7200	-1.5642
77	*long horizontal static handle*	3.2326	0.8150	-2.2702	3.4606	-1.0572	...	0.3530	1.1108	1.9306	-7.9670	-1.7352	-1.8352
78	*long vertical static handle*	-0.0532	-3.3392	3.6840	-0.7160	-0.3920	...	0.1972	3.1282	-6.8430	0.8144	-0.5816	-1.0726
79	*short vertical static handle*	0.7732	2.6340	0.5144	-1.9386	-1.2630	...	-0.8016	0.3854	-0.1184	-0.3616	-1.3144	-0.7660
80	*curved static handle*	-0.3602	-5.6880	1.8774	-1.5342	0.2808	...	0.1344	1.1844	-2.4926	-5.1026	4.6256	-0.5524

Figure 8.9 - Partial view of the matrix of weights between the hidden and output layers of the trained network with 50 hidden nodes.

As already explained in Chapters 4 and 5, the connection's weight matrix of a network with no hidden layer provides a good idea of what features might be mutually excitatory or inhibitory. This is due to the fact that there is only one way through which each input unit can influence each output unit. The higher the weight the more mutually supportive are the units connected. The lower the weight the more mutually excluding are the units connected.

However, the interpretation of the weight matrixes for the networks with one hidden layer becomes much more complex and less straightforward. An input unit can influence the status of an output unit in as many ways as the number of hidden units. Besides, each hidden unit is influenced by not only one but all the units in the previous layer. The meaning of the weights thus becomes blurred. It is not possible to verify which input-output pairs are either mutually supportive or exclusive.

Therefore, it is difficult to verify if a one hidden layer network has generalised well by simply reading from its weight's matrixes. It is then clear that a better method of validation of hidden units configuration is necessary, either to determine which network is the more reliable or at least to provide some criteria for distinguishing the differences in the networks' behaviours.

This phenomenon of memorisation could be translated in the case of this thesis by the networks with fewer hidden units being prone to activate a greater number of output units for each input unit made active. The networks with a number of hidden nodes closer to the number of patterns in the training set, that is, 122, will tend solely to reproduce the existing cases and thus to make fewer units active in the output layer.

For this reason, a test was undertaken with each of the trained networks that consisted of making active one input unit at a time and counting the number of resulting active output units. The procedure was repeated for each unit in the input layer and the number of activated output units added altogether.

In this experiment a table of active units was generated for each of the 17 networks indicating what output units would be made active for each one of the 80 features made active at a time. The overall results of this experimentation are show in Figure 8.10, below:

Number of hidden neurons	30	40	50	55	60	65	70	75	80	85	90	95	100	105	110	120	130
Overall number of output neurons activ	889	906	820	889	830	796	721	770	698	799	679	738	669	748	642	613	537

Figure 8.10 The relation between number of hidden nodes and the number of output units made active.

The chart in Figure 8.11 shows the relationship mentioned above more clearly.

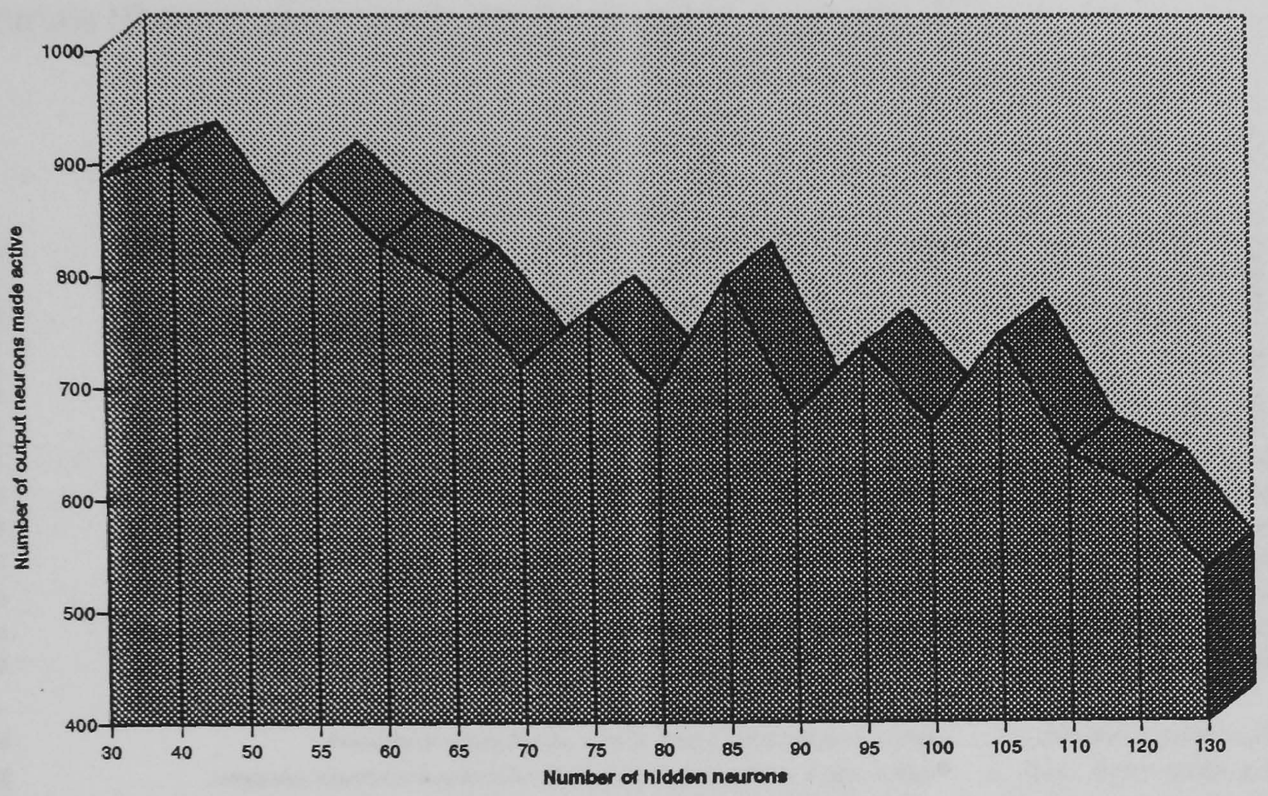


Figure 8.11 A graphic representation of the relationship 'hidden nodes and number of output units made active'.

This is evidence that the different networks do have various behaviours. However, in spite of confirming the relation between the number of hidden nodes and the memorisation phenomenon, these results do not provide any criteria for choosing the more reliable network.

Another method was then applied to verify the similarities and differences among the networks by measuring the distance of each one of them from the frequency matrix found in Appendix 3. The validity and use of this method will be discussed later in the section.

In this approach, tables with values of support varying between '0' and '1' were produced, for each trained network, by using a sigmoid transfer function instead of the step function, and by making each input feature active at a time. The result were matrixes with 80 rows and 80 columns for each of the 17 trained networks. Figure 8.12 shows a partial view of the matrix for the network with 50 hidden neurons (the complete matrix can be found in Appendix 6).

<< Active input unit	Levels of support of each output unit >>	1	2	3	4	5	...	76	77	78	79	80
		main entrance	*secondary entrance*	public access	restricted access	exit only	...	*lever handle*	*long horizontal static handle*	*long vertical static handle*	*short vertical static handle*	*curved static handle*
1	*main entrance*	0.9998	0.0003	0.1683	0.1055	0.0003	...	0.0003	0.0003	0.0003	0.0003	0.0003
2	*secondary entrance*	0.0003	0.9993	0.1204	0.9478	0.0003	...	0.0003	0.0003	0.0003	0.0003	0.0003
3	public access	0.9993	0.0003	0.9998	0.0003	0.0003	...	0.0003	0.0003	0.0003	0.0003	0.0003
4	restricted access	0.9861	0.0003	0.0003	0.9998	0.0003	...	0.0003	0.0003	0.0003	0.0003	0.0003
5	exit only	0.0005	0.0003	0.0003	0.0018	0.9998	...	0.0003	0.9986	0.0003	0.0003	0.0003
6	*gives access to: air lock, vestibule or foyer*	0.9998	0.0003	0.0916	0.6768	0.0003	...	0.0003	0.0003	0.0003	0.0003	0.0003
7	*gives access to: corridor or aisle*	0.0042	0.0101	0.3118	0.0274	0.0003	...	0.0003	0.0003	0.0003	0.0003	0.0003
...	...	...	...	...	...	...	...	...	...	...	...	...
74	*round knob or ring handle*	0.9808	0.0003	0.2613	0.2278	0.0003	...	0.0003	0.0003	0.0003	0.0003	0.0003
75	*retangular, squared or trapezoid handle*	0.9998	0.0003	0.0184	0.1460	0.0003	...	0.0003	0.0003	0.0003	0.0003	0.0003
76	*lever handle*	0.9944	0.0003	0.0008	0.8235	0.0003	...	0.9998	0.0003	0.0003	0.0003	0.0003
77	*long horizontal static handle*	0.9864	0.0003	0.0013	0.0184	0.0003	...	0.0003	0.9998	0.0003	0.0003	0.0003
78	*long vertical static handle*	0.9998	0.0003	0.8016	0.0039	0.0003	...	0.0003	0.0003	0.9998	0.0003	0.0003
79	*short vertical static handle*	0.8072	0.0003	0.0020	0.7088	0.0003	...	0.0003	0.0003	0.0003	0.9998	0.0003
80	*curved static handle*	0.9869	0.0003	0.1629	0.0359	0.0003	...	0.0003	0.0003	0.0003	0.0003	0.9998

Figure 8.12 - Partial view of the levels of support for the 50 hidden neurons network.

With such transfer function configuration the network will present a continuously valued output, which represents a the levels of support between each feature and all the others. If the input neuron number 3 is made active the network will respond by making active, in different varying levels, the output units. For instance, output number 3 will be almost fully active (0.9993) and output number 4 will be almost fully inactive (0.0003). The closer the output is to 1 the more is the input-output pair mutually excitatory. The closer the output is to 0 the more is the input-output pair mutually inhibitory.

A proximity rate was then calculated, for each network, by subtracting from each value of level of support found in the previous tables, the correspondent frequency show in figure 8.2 and Appendix 3. The sum of all the absolute values of those subtractions was then divided by the total number of operations (that is, the number of cells in the matrixes) in order to find an average. A network that tends to activate a unit with low frequency will receive a higher rate then another that does not. A network that tends to inactivate a unit with high frequency will also receive a higher rate than another that does not. Therefore, the lower the rate the closer is the network to the statistical trends in the sample. The results are shown in Figure 8.13, bellow.

Number of Hidden Nodes	30	40	50	55	60	65	70	75	80	85	90	95	100	105	110	120	130
Proximity rate	0.1340	0.1160	0.1155	0.1162	0.1195	0.1193	0.1258	0.1267	0.1265	0.1236	0.1312	0.1260	0.1347	0.1243	0.1382	0.1353	0.1494

Figure 8.13 The relation between the number of hidden nodes and the proximity rate when using the sigmoid transfer function.

Figure 8.14 shows the relation between the number of hidden nodes and the proximity rate, when using the sigmoid transfer function, more clearly.

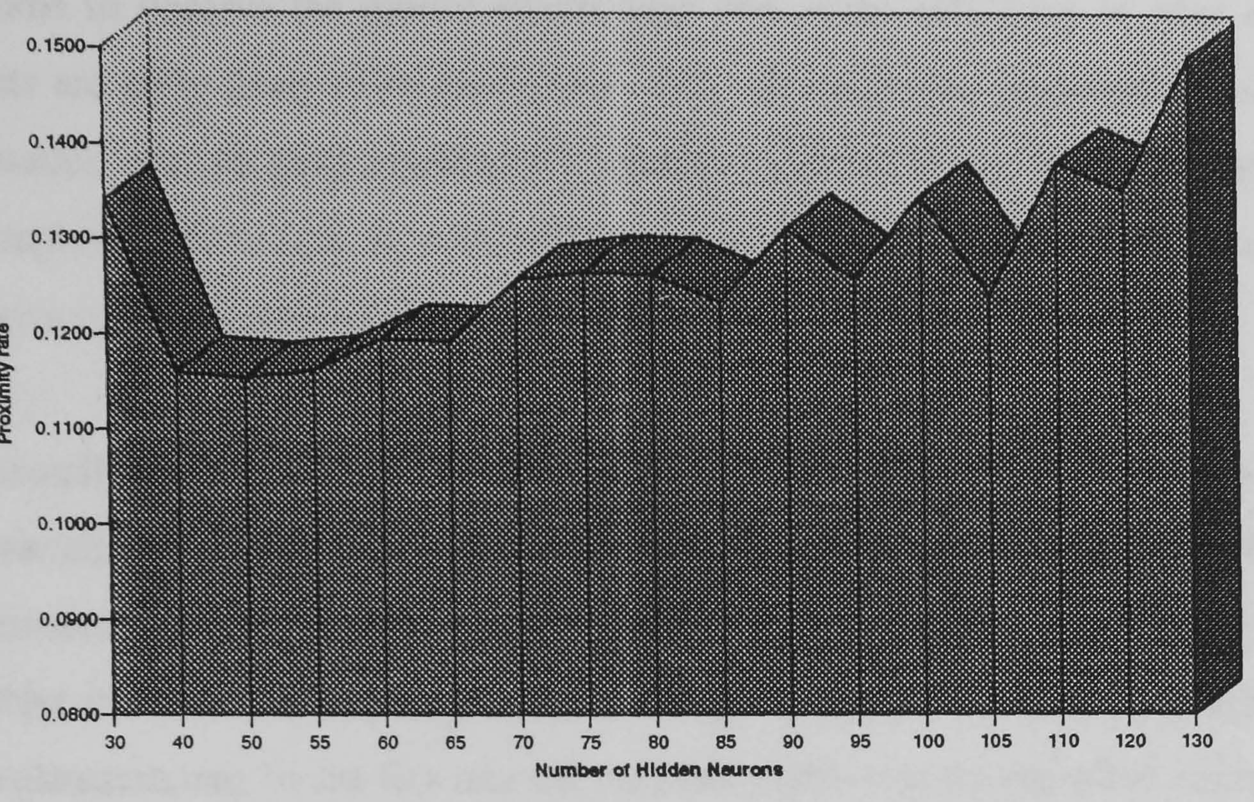


Figure 8.14 A graphic representation of the relation 'number of hidden nodes and proximity rate', when using the sigmoid transfer function.

This test may give a more precise idea of the similarities and dissimilarities among the trained networks. However, this method suggests that a clear correlation between output tables of levels of support and the frequency table will never be strong. At best, it will be moderate. This may be illustrated by the chart in Figure 8.14, in which the curve never got really closer to the axe X after a certain gradient.

Therefore, an underlying assumption of those tests is that the most reliable network, or at least the one less prone to contradictions, should be the one with likely results closer to the frequency table of 'y' feature given that 'x' is present (Appendix 3).

However, this assumption is difficult to sustain or to be verified for some reasons. Firstly, it is difficult to establish precisely the probabilities of results for each network, as shown in the tests above. Secondly, the activation of an input unit at a time to observe the output results may give some indication of what output units are more likely to be supportive. Yet, this technique represents an unusual situation for an auto-associative network, because it has been trained with complete patterns, that is, with multiple input units made active, while in the tests above only one input unit was active at a time.

Secondly, although the tables produced in the last experiment may show some resemblance to that frequency table, there is at least one significant difference between them: the gradient among levels of support seems to be sharper in the tables from the networks than those values found in the frequency table. An explanation may be the fact that the frequency table reports statistical occurrences as they are, while the tables of levels of support report attempts from the networks to discriminate among features during training. This phenomenon has been described by Coyne and Yokozawa (1992: 164) in their experiments.

Nevertheless, the method is useful in certain respects: it provide means of testing similarities and dissimilarities among networks' behaviours. It thus show that some networks in the range tested have very close output behaviour, particularly those ranging from 40 to 65 hidden units. It also provides an approximate selectivity criterion for choosing the best network. It permits at least the monitoring of the memorisation process. The downwards slope between the networks with 30 and 50 hidden neurons may be interpreted as an increase in performance, while the relatively constant upwards slope between the networks with 50 and 130 hidden neurons may be interpreted as a memorisation process. Therefore, the network with 50 hidden nodes was selected for experimentation for two reasons: firstly, because it was within that middle ground range, with several networks with similar behaviour. Secondly, because it has the lowest proximity rate in the set of trained networks.

8.3 Experimentation and result analysis:

As explained in Chapter 5, two main obstacles to the integration of Cortex and auto-associative neural networks were identified: the first was related to some differences in knowledge representation and clamping control. The second obstacle was related to the way in which the neural network is trained and the amount of information provide by Cortex.

It was also argued that we could overcome both obstacles if we used a plain feed-forward multi-layered network at training time and a semi-recurrent network, with limited feed-back, at running time. A recurrent element between each output unit and its correspondent input unit is added at running time causing each output to be checked against a clamping criteria and to be sent back to its correspondent input unit. The running time neural network for the 'extended domain' could then be described as in figure 8.15 bellow.

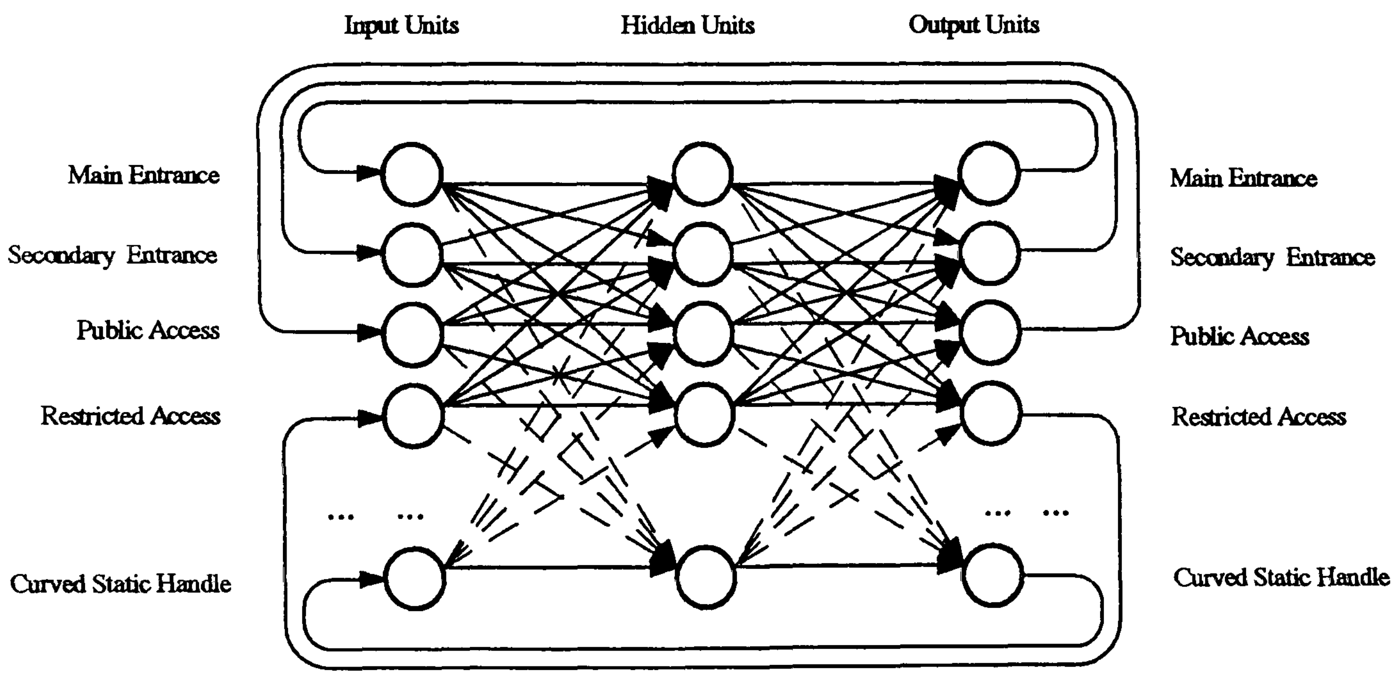


Figure 8.15 The running time network for the 'extended domain'.

The user types found in the Appendix 4 were used for collecting data from the system's prototype. Those data is composed of the questions' traces, the user's answers, as well as the solutions offered by the system.

The network was tested by reproducing the procedures described in the algorithm found in Chapters 5 to 7. The overall experimentation results are shown in Appendix 7. It includes the user types, the respective traces of questions and answers (which corresponds to the problem's partial descriptions), the knowledge-base system solutions, and the neural network solutions for the 46 tests undertaken. Figure 8.16 shows a summary of these results.

Summary of neural network results																	
Unable to reach a stable solution		Able to reach a stable solution															
		Solution matches KBS's (1)		Solution does not match with KBS's													
				Total		Not complying with user's input (2)						Complying with user's input (3)					
						Total		Consistent		Inconsistent		Total		Consistent		Inconsistent	
#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
0	0	0	0	46	100	37	80.4	32	69.5	5	10.8	9	19.6	9	19.6	0	0

(Percentages are in relation to the total number of tests: 46)

Figure 8.16 Summary of network results.

As mentioned in Chapter 5, the problem's partial description run into the trained neural network can provide three possible outcomes: the output matches with Cortex's (which corresponds to the data under the label (1) in the table above), the network cannot find a solution that is consistent with the partial description (the area under the label (2) in the table above), or the output is a new solution (the data in the area under the label (3) in that table).

It is important to notice that the network always reached a stable solution. This demonstrates the validity of the procedure described in Chapters 5 and 7, through which the last output is re-entered in as input as many times as necessary to reach a stable solution.

Another important thing is how often new solutions emerged. At the outset of this research the possibility of new schemes emergence was thought to be something likely to happen rarely. It was believed that the neural network outcome would generally match with a solution already in memory, and only exceptionally would produce a new case. However, this did not happen to be the case. As seen in the table above, in all the 46 tests none of them resulted in a neural network's solution matching the knowledge-based system's. An inspection of Appendix 7 allows the conclusion that in several of these cases the neural network solution was very similar to the KBS's one, but never having exactly the same settings.

It is also true that several of those cases were unusable for the user's because the network was unable to reach a solution without contradicting at least one of the user's inputs. Yet, this does not mean that those solutions were also mostly inconsistent from the point of view of architectural knowledge. As it can be seen from figure 8.16, for each inconsistent case there were more than six consistent ones among those discarded by the proposed algorithm.

However, what is more important to notice is that the rate of new acceptable solution's emergence in the present sample was almost 20%, and this does not suggest that the occurrence is just exceptional. Besides, the rate of inconsistency was zero. The reason for this may be that these acceptable solutions are produced with a more rigorous criterion than the rejected ones, which makes this sub-sample more selective than the total sample.

I think there are two main reasons for the high incidence of new solutions, and moreover for the consistency of the acceptable new solutions: first, the solution found by the knowledge-base module is based on the closest match of existing unique cases with the user's request, which may have features that represent exceptions. Second, the solution presented by the connectionist module is based on generalisation, which takes into consideration the strongest trends in the sample that are compatible with the user's request.

Appendix 8 shows a table similar to Appendix 7, but with information related only to the 9 situations in which new solutions emerged. These situations are those satisfying all the conditions controlled by the proposed algorithm, that are: first, the solution provided by the neural network should be different from the one retrieved from the knowledge-base; second, the solution provided by the neural network should not contradict, at the end of the running process, any of the initial user's choices. The third criteria of evaluation, not explicitly controlled by the algorithm, was the architectural consistency of the new solutions. But this is exactly one of the main aims of this research: to experimentally verify the ability of the proposed system to implicitly control those inconsistencies.

The table in Figure 8.17 shows the occurrence of new solutions in the whole testing sample and among those user types with and without uncertainty. A type with uncertainty is that one in which the user answered at least one question with a 'don't know'. A type without uncertainty is the other way round.

Category	Whole Sample (1)		Among cases with no uncertainty (2)		Among cases with uncertainty (3)	
	#	%	#	%	#	%
Total of new solutions	9	19.6	6	28.6	3	12.0
Solutions inconsistent	0	0.0	0	0.0	0	0.0

(1) New solutions in the whole sample of 46 user types.
(2) New solutions among the 21 cases in which the user did not answer any questions with a 'don't know'.
(3) New solutions among the 25 cases in which the user answered at least one question with a 'don't know".

Figure 8.17 New solutions and uncertainty.

These results do not provide conclusive evidence about the relationship between the occurrence of new solutions and the presence of uncertainty in the user's answers. However, there seems to exist some sort of relation between the user's uncertainty and levels of innovation in the new solutions, as shown in Figure 8.18.

User Type Generator	New Solution Number	Questions from KBS: Total Number of Questions	Number of Don't Knows	Percentage of Uncertainty	Level of Innovation: Number of Active Nodes in union set: (a U b)=c*	Number of differences from KBS solution (d)	Innovation Percentage of (d) out of (c)
Gothic	1	11	0	0.0	17	6	35.3
Art Nouveau 2	2	11	3	27.2	19	4	21.1
Modern (functionalist 1)	3	13	0	0.0	15	3	20.0
Modern (brutalist 2)	4	15	0	0.0	14	1	7.1
Modern (high tech 1)	5	10	0	0.0	23	12	52.2
Modern (high tech 2)	6	13	2	15.4	22	11	50.0
Modern (high tech 3)	7	13	0	0.0	16	3	18.8
Post-Modern (eclectic 2)	8	13	0	0.0	17	4	23.5
Environmental control 4 (loose)	9	31	24	77.4	22	15	68.2

(*) Where 'a' is the set of present features in KBS solution and 'b' is the set of present features in new solution.

Figure 8.18 Uncertainty and levels of innovation.

The levels of innovation in the table of Figure 8.18 are the results of a measurement formula to assess different levels of newness. It is not intended as a definition of innovation, but as a tool for visualisation of its different degrees. It is based on the number of different descriptors found between the KBS's solution and the neural network solution. Evidently, it is a crude analysis tool, since there may be situations when only one different descriptor can have more significance in terms of innovation then two or more, depending on their architectural meaning. However, it is used here just as a means of establishing analytical distinctions.

The chart in Figure 8.19 confirms more clearly that there is at least a moderate relationship between the level of uncertainty in the user's answers and the level of innovation in the new solutions.

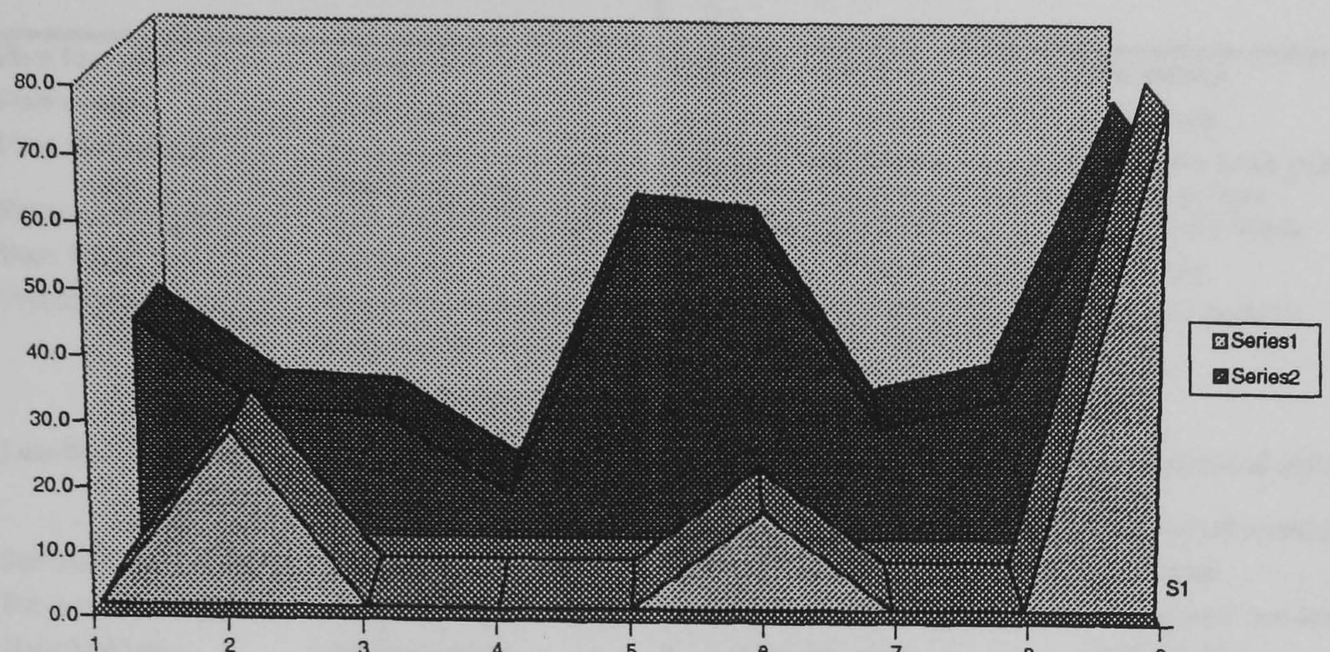


Figure 8.19 Uncertainty and levels of innovation as a chart.

However, rather than being a problem this may be taken as another parallel with the real world of design, where certainty can lead to very conservative solutions, while uncertainty or, let us say, openness can lead to more innovative behaviour.

The descriptions of the 9 new solutions suggested by the connectionist module, together with their knowledge-base system counterparts, are show in Figures 8.20 to 8.24, bellow.

Gothic 1 (case 14)	
Flow function:	main entrance
Flow control:	public access
Flow connection:	gives access to: air lock, vestibule or foyer
Formal insertion:	pulled in from the facade
Door top shape:	flat door top
Top complements:	top curved moulding pointed arch tympanum tracery or steelworks on fanlight or tympanum
Lateral complements:	lateral cylindrical section column lateral vertical moulding
Surrounding materials:	smooth stone
Door operation type:	swinging door: two singles
Door leaf type:	panelled opaque
Door leaf materials:	timber
Door handle, if any:	round knob or ring handle

New solution 1	
Flow function:	main entrance
Flow control:	public access
Flow connection:	gives access to: air lock, vestibule or foyer
Formal insertion:	aligned to the facade
Door top shape:	flat door top
Top complements:	top curved moulding
Lateral complements:	lateral cylindrical section column lateral vertical moulding
Surrounding materials:	smooth stone
Door operation type:	swinging door: one double
Door leaf type:	panelled opaque
Door leaf materials:	timber
Door handle, if any:	round knob or ring handle

Art Nouveau 2 (case 103)	
Flow function:	main entrance
Flow control:	restricted access
Flow connection:	gives access to: air lock, vestibule or foyer
Formal insertion:	aligned to the facade
Door top shape:	flat door top
Top complements:	top flat moulding squared fanlight stained glass on fanlight
Lateral complements:	lateral vertical moulding
Surrounding materials:	glass timber smooth plasterwork
Door operation type:	swinging door: one single
Door leaf type:	panelled semi-opaque with one or more light cross panels
Door leaf materials:	stained glass metal timber
Door handle, if any:	round knob or ring handle

New solution 2	
Flow function:	main entrance
Flow control:	restricted access
Flow connection:	gives access to: air lock, vestibule or foyer
Door top shape:	flat door top
Top complements:	top flat moulding squared fanlight stained glass on fanlight
Lateral complements:	lateral vertical moulding window in one side
Surrounding materials:	glass timber smooth plasterwork
Door operation type:	swinging door: one single
Door leaf materials:	stained glass metal timber

Figure 8.20 KBS's solutions and new solution 1 and 2.

Modern (Funcionalist 1) (case 3)	
Flow function:	main entrance
Flow control:	restricted access
Flow connection:	gives access to: air lock, vestibule or foyer
Formal insertion:	aligned to the facade
Door top shape:	flat door top
Lateral complements:	window in one side
Other complements:	vertical glass tower
Surrounding materials:	glass
	rusticated plasterwork
	metal
Door operation type:	swinging door: one single
Door leaf type:	framed with three or more light cross panels
Door leaf materials:	non-stained glass
	metal
Door handle, if any:	long vertical static handle

New solution 3	
Flow function:	main entrance
Flow control:	restricted access
Flow connection:	gives access to: air lock, vestibule or foyer
Formal insertion:	aligned to the facade
Door top shape:	flat door top
Lateral complements:	window in one side
Other complements:	vertical glass tower
Surrounding materials:	glass
	metal
Door operation type:	swinging door: one single
Door leaf type:	framed with three or more light cross panels
Door leaf materials:	non-stained glass
	metal

Modern (Brutalist 2) (case 52)	
Flow function:	main entrance
Flow control:	public access
Flow connection:	gives access to: air lock, vestibule or foyer
Formal insertion:	pulled in from the facade
Door top shape:	flat door top
Top complements:	squared fanlight
Lateral complements:	windows in both sides
Surrounding materials:	glass
	concrete exposed
Door operation type:	revolving door (with four leaves)
Door leaf type:	framed with one or two light cross panels
Door leaf materials:	non-stained glass
	metal
Door handle, if any:	long vertical static handle

New solution 4	
Flow function:	main entrance
Flow control:	public access
Flow connection:	gives access to: air lock, vestibule or foyer
Formal insertion:	pulled in from the facade
Door top shape:	flat door top
Top complements:	squared fanlight
Lateral complements:	windows in both sides
Surrounding materials:	glass
Door operation type:	revolving door (with four leaves)
Door leaf type:	framed with one or two light cross panels
Door leaf materials:	non-stained glass
	metal
Door handle, if any:	long vertical static handle

Figure 8.21 KBS's solutions and new solution 3 and 4.

Modern (high tech 1) (case 48)	
Flow function:	main entrance
Flow control:	public access
Flow connection:	gives access to: air lock, vestibule or foyer
Formal insertion:	pulled in from the facade
Door top shape:	flat door top
Top complements:	squared fanlight
	flat rectangular porch
Other complements:	columns supporting porch
Surrounding materials:	glass
	smooth stone
	metal
Door operation type:	swinging door: two singles
	revolving door (with four leaves)
Door leaf type:	framed with one or two light cross panels
Door leaf materials:	non-stained glass
	metal
Door handle, if any:	long horizontal static handle

New solution 5	
Flow function:	main entrance
Flow control:	public access
Flow connection:	gives access to: air lock, vestibule or foyer
Formal insertion:	aligned to the facade
Door top shape:	flat door top
Top complements:	squared fanlight
	convex porch
Other complements:	cables supporting porch
	vertical glass tower
Surrounding materials:	glass
	smooth stone
	tiles or small tiles
	metal
Door leaf type:	framed with one or two light cross panels
Door leaf materials:	non-stained glass
	metal
Door handle, if any:	long vertical static handle

Modern (high tech 2) (case 63)	
Flow function:	main entrance
Flow control:	restrict access
Flow connection:	gives access to: air lock, vestibule or foyer
Formal insertion:	pulled in from the facade
Door top shape:	flat door top
Top complements:	squared fanlight
	flat semi-circular porch
Other complements:	walls supporting porch
Lateral complements:	windows in both sides
Surrounding materials:	glass
	smooth stone
	metal
Door operation type:	swinging door, one single
Door leaf type:	framed with three or more light cross panels
Door leaf materials:	non-stained glass
	metal
Door handle, if any:	round knob or ring handle

New solution 6	
Flow function:	main entrance
Flow control:	public access
Flow connection:	gives access to: air lock, vestibule or foyer
Formal insertion:	pulled in from the facade
Door top shape:	flat door top
Top complements:	squared fanlight
Other complements:	vertical glass tower
Lateral complements:	windows in both sides
Surrounding materials:	glass
	metal
Door operation type:	swinging door, one single
	revolving door (with four leaves)
Door leaf type:	framed with one or two light cross panels
Door leaf materials:	non-stained glass
	metal
Door handle, if any:	long vertical static handle

Figure 8.22 KBS's solutions and new solution 5 and 6.

Modern (high tech 3) (case 73)	
Flow function:	main entrance
Flow control:	public access
Flow connection:	gives access to: air lock, vestibule or foyer
Formal insertion:	pulled in from the facade
Door top shape:	flat door top
Lateral complements:	windows in both sides
Surrounding materials:	glass
	metal
Door operation type:	swinging door: triple, two doubles or more
	revolving door (with four leaves)
Door leaf type:	framed with one or two light cross panels
Door leaf materials:	non-stained glass
	metal
Door handle, if any:	long vertical static handle

New solution 7	
Flow function:	main entrance
Flow control:	public access
Flow connection:	gives access to: air lock, vestibule or foyer
Formal insertion:	pulled in from the facade
Door top shape:	flat door top
Top complements:	squared fanlight
Lateral complements:	windows in both sides
Surrounding materials:	glass
	metal
Door operation type:	swinging door: one single
	revolving door (with four leaves)
Door leaf type:	framed with one or two light cross panels
Door leaf materials:	non-stained glass
	metal
Door handle, if any:	long vertical static handle

Post-Modern (Eclectic 2) (case 1)	
Flow function:	main entrance
Flow control:	restricted access
Flow connection:	gives access to: air lock, vestibule or foyer
Formal insertion:	pulled out from the facade
Door top shape:	flat door top
Lateral complements:	windows in both sides
Other complements:	vertical glass tower
	angular connection with glass tower
Surrounding materials:	glass
	brick
	metal
Door operation type:	swinging door: one double
Door leaf type:	framed with three or more light cross panels
Door leaf materials:	non-stained glass
	metal
Door handle, if any:	long vertical static handle

New solution 8	
Flow function:	main entrance
Flow control:	restricted access
Flow connection:	gives access to: air lock, vestibule or foyer
Door top shape:	flat door top
Lateral complements:	windows in both sides
Other complements:	vertical glass tower
Surrounding materials:	glass
	brick
	metal
Door operation type:	swinging door: one single
Door leaf type:	framed with three or more light cross panels
Door leaf materials:	non-stained glass
	metal
Door handle, if any:	long vertical static handle

Figure 8.23 KBS's solutions and new solution 7 and 8.

Environmental Control 4 (loose) (case 13)	
Flow function:	secondary entrance
Flow control:	public access
Flow connection:	gives access to: corridor or aisle
Formal insertion:	pulled in from the facade
Door top shape:	flat door top
Top complements:	top curved moulding pointed arch tympanum tracery or steelworks on fanlight or tympanum
Lateral complements:	lateral cylindrical section column lateral vertical moulding
Surrounding materials:	smooth stone
Door operation type:	swinging door: one double
Door leaf type:	panelled opaque
Door leaf materials:	timber
Door handle, if any:	round knob or ring handle

New solution 9	
Flow function:	secondary entrance
Flow control:	public access
Flow connection:	gives access to: corridor or aisle
Formal insertion:	pulled in from the facade
Door top shape:	flat door top
Other complements:	vertical glass tower
Surrounding materials:	glass smooth stone metal
Door operation type:	swinging door: one double
Door leaf type:	framed with one or two light cross panels
Door leaf materials:	non-stained glass metal

Environmental Control 4 (loose) (case 61)	
Flow function:	secondary entrance
Flow control:	public access
Flow connection:	gives access to: corridor or aisle
Formal insertion:	aligned to the facade
Door top shape:	flat door top
Top complements:	top curved moulding pointed arch tympanum
Lateral complements:	lateral vertical moulding
Surrounding materials:	smooth stone
Door operation type:	swinging door: one double
Door leaf type:	panelled semi-opaque with one or more light cross panels
Door leaf materials:	steelworks leaf decoration non-stained glass metal timber
Door handle, if any:	round knob or ring handle

Figure 8.24 KBS's solutions and new solution 9.

Firstly, it is important to notice the absence of architecturally absurd combinations of features. It is clear that some of the new solutions have an incremental difference in relation to its KBS's counterparts. The new solution 3 is an example of this, with very small differences.

However, whatever is the level of innovation the important thing is that the system will be able very frequently to suggest solutions without being limited to those precedents in memory as it happens with conventional knowledge-base systems.

Secondly, all the new solutions are eligible to be added to the existing knowledge-base because their Boolean knowledge representation does not impose risk of inconsistency addition. This was demonstrated in Chapter 3.

Thirdly, if there are solutions with just an incremental difference, there are solutions with significant innovation such as new solutions 5 and 6, which provide some interesting suggestions. *'New solution 5'*, for instance, suggests the presence of some features such as *'cables supporting porch'* and *'vertical glass tower'* that make it closer to the user's type generating it than the solution suggested by the knowledge-base system.

It is evident that the neural network does not know this. However, the importance of this kind of suggestion is an ability to augment the designer's creativity that is beyond conventional systems.

The same happens with *'New solution 6'*, with the proposed absence of *'smooth stone'* in the surrounding materials, the replacement of *'round knob'* by *'long vertical static handle'* and the suggested presence of *'vertical glass tower'* and *'revolving door'*.

It is interesting to notice that the network did not simply replace *'swinging door: one single'* by *'revolving door'* but it kept them both. This is important evidence that the network captured in its connection's weights the knowledge that a *'revolving door'* generally is accompanied by at least a conventional *'swinging door: one single'*, even if those schemes happened a few times in the training set.

6.4 Conclusions:

It was not a goal in this thesis to provide an algorithm for radical changes, but for a rudimentary incremental self-extending model, to minimise substantially the knowledge engineer intervention dependency, and to provide interactive support to innovative design thinking.

Therefore, I believe that the experimentation described in this chapter strongly suggests that the necessary conditions to implement such model have been achieved: the ability to generate reliable new solutions in a knowledge representation scheme that allows the continuous extension of the knowledge-base while at the same time preserving its consistency.

In the next chapter I will summarise the contributions and potential of the described hybrid environment. I shall describe different scenarios of how one could potentially interact with the system in realistic design situations. I will also develop a series of recommendations of what may be relevant regarding further research.

Chapter 9

Contribution, Applications and Further Research

9.1 Contribution to knowledge:

The relevance of the proposed environment resides in its potential as a framework for innovative thinking and designing. It can support the designer's creativity by suggesting solutions he or she has not thought of at the outset of the design task. Its contributions are thus evident through its results.

This integrated environment offers an incremental self-extending feature, as shown by the empirical evidence reported in the previous chapter. The self-extendibility can potentially minimise substantially the dependency on knowledge engineer intervention, as demonstrated in chapters 3, 5, 6 and 7. Moreover, it provides support to innovation by augmenting the designer's creativity.

The results are an important evidence of the hybrid model's contribution. However, they cannot be separated from the system's architecture adopted. The unconventional knowledge-based system shell (Mustoe, 1990, 1993) with its ability to accept new knowledge, without becoming inconsistent, whatever are the acquisition procedures, was a vital part of the system's architecture. Yet, contribution was built upon that system by adding learning capabilities it does not inherently have.

The connectionist model operating in the background of the environment and receiving input controlled by the knowledge-base system, provides an important tool not only for knowledge-acquisition, but also for the discovering of innovative solutions. It does draw inspiration from the work of Coyne and Yokozawa (1992) and Coyne et al (1993). Yet, emergence in their experiment was undertaken manually by the user's manipulation of the network input layer.

The stand-alone model and its direct manipulation provide freedom that may allow the user to 'force' solutions out of unusual combinations of input units. It can also be implemented through a simple multi-layered feed forward network.

The environment proposed here builds upon Coyne and Yokozawa (1992) and Coyne et al (1993) research by providing a better interface and an automated procedure for the emergence of new solutions.

Firstly, within the proposed model, the user does not have to undertake a trial process in which he or she may become lost due to the lack of inherent trace facility. The choices are made prior to their entering into the neural network, through Cortex, and the system itself keeps track of the previous actions, as demonstrated in Chapters 5 to 7. Secondly, there is no risk of getting into a dead lock since Cortex filters features of high incompatibility. Infinite loop situations are controlled and terminated by the integrated model. Thirdly, the system always reaches the most possibly stable solution because the process cannot be terminated arbitrarily before all viable possibilities have been tested. At last, the system offers active and plain English interfaces at both input and output operations, which are obvious advantages.

The procedure for automating emergence, as implied above, has as its main drawback the impossibility of direct network input layer manipulation. It also requires a neural network architecture more complex than a simple feed forward model, as explained and described in earlier chapters. However, the benefits for automation and interface are worth the price.

9.2 Applications:

The proposed integrated environment may find several applications. For instance, it may be used with educational purposes in architectural schools. It would lead the design students towards 'repertoire' acquisition through the exploration of precedents and encourage re-thinking and re-invention through the suggestion of new combinations of features.

The system may also find application as a design support system in architectural practices. In such context, the system may favour the emergence of solutions the designer has not thought of at the outset of the design task. I shall soon provide some illustrations for this potential.

The 'small domain' described in Chapters 3 and 5 provided a good illustration of the internal procedures of the proposed integrated model. However, its reduced number of precedents (9 cases described by 27 features) did not represent a sample large enough for a neural network learning process. Also, the fewer the number of precedents in the knowledge-base the greater the possibility of retrieving unsatisfactory solutions because a case-based reasoning representation is adopted in Cortex and this system operates by searching for the closest match.

However, the 'extended domain', as described in Chapter 8, has a much larger number of precedents (122 cases), described in much more detail than in the small domain (80 features), which provides an environment much closer to a realistic design situation.

For instance, suppose that I am given the task of designing an entrance door in an existing historical building, which is being partially restored, but needs some upgrading to accommodate new functions. The original door entrance has been destroyed and information about it is not available as a source of design inspiration.

I approach the 'extend domain' with the following basic constraints: it is a 19th century stone building with mixed features. For instance, some of its windows have gothic characteristics such as pointed arch and stained glass.

However, all the remaining existing doors have classic features such as a flat top with a semi-circular moulded arch on its upper part and lateral cylindrical section column. The building is going to be used as an antiques showroom. The entrance being designed gives access to a small vestibule in which a check out desk will be fitted.

The system starts by bringing to the first question to the screen:

Does the door leaf have a flat top?

For a matter of consistency with the rest of the building I answer 'yes' to the above question. The system will then ask me the next question:

Does it give access to an air lock, vestibule or foyer?

Considering my initial constraints, my answer to this question is 'yes'. The next question is then brought to the screen:

Is it supposed to be the main entrance?

Since a check out desk is going to be placed in the vestibule just beyond the entrance I imply that this is the main entrance to the building. Therefore, my answer is 'yes'. The system then brings the next question:

Is there glass in the surroundings of the entrance?

This is a 19th century stone building. All its existing doors have only stone in its surroundings and I have not been given freedom to intervene in the whole building. My answer to the above questions is 'no'. The next question is:

Is there timber in the leaf?

The client has asked me to provide, as much as possible, a solution consistent with the whole building. Since all the remaining doors are made of timber my answer is 'yes'. This causes the system to bring the next question to the screen:

Does the door have a round knob or ring handle?

For the same reason of the previous question, my answer is 'yes'. The system then asks me the following question:

Is there smooth stone in the surroundings of the entrance?

Considering the whole building features I answer 'yes' to the above question. The system then brings the next question to the screen:

Is it supposed to allow public access?

The building is going to be used as an antique showroom. The entrance is also the main access to the building. Therefore, my answer to this question is 'yes'. The next question will be:

Is the leaf panelled opaque?

All the remaining doors have a panelled opaque leaf. My answer to the above question is thus 'yes'. The next question is:

Does the entrance have any kind of flat moulding on its upper part?

This kind of element is not present in the existing doors, which have some sort of curved moulding, but not flat. Therefore, my answer is 'no'. The system then brings to the screen the following question:

Is there any lateral cylindrical section column?

Considering my initial constraints, my answer to the above question is 'yes'. The system will then bring a solution to the screen:

The most likely solution in the Extended domain is:
The closest match is Case 14, which has the following features:

Flow function:	*main entrance*
Flow control:	*public access*
Flow connection:	*gives access to: air lock, vestibule or foyer*
Formal insertion:	*pulled in from the facade*
Door top shape:	*flat door top*
Top complements:	*top curved moulding*
	pointed arch tympanum
	tracery or steelworks on fanlight or tympanum
Lateral complements:	*lateral cylindrical section column*
	lateral vertical moulding
Surrounding materials:	*smooth stone*
Door operation type:	*swinging door: two singles*

Door leaf type:	*panelled opaque*
Door leaf materials:	*timber*
Door handle, if any:	*round knob or ring handle*

The solution's description is followed by the notice:

Retrieve illustration number Case14.pcx in the Illustration's folder. Double click the icon More.xls in the Project's folder to see if a suggestion of new solution is available.

The following illustration will come up on the screen:

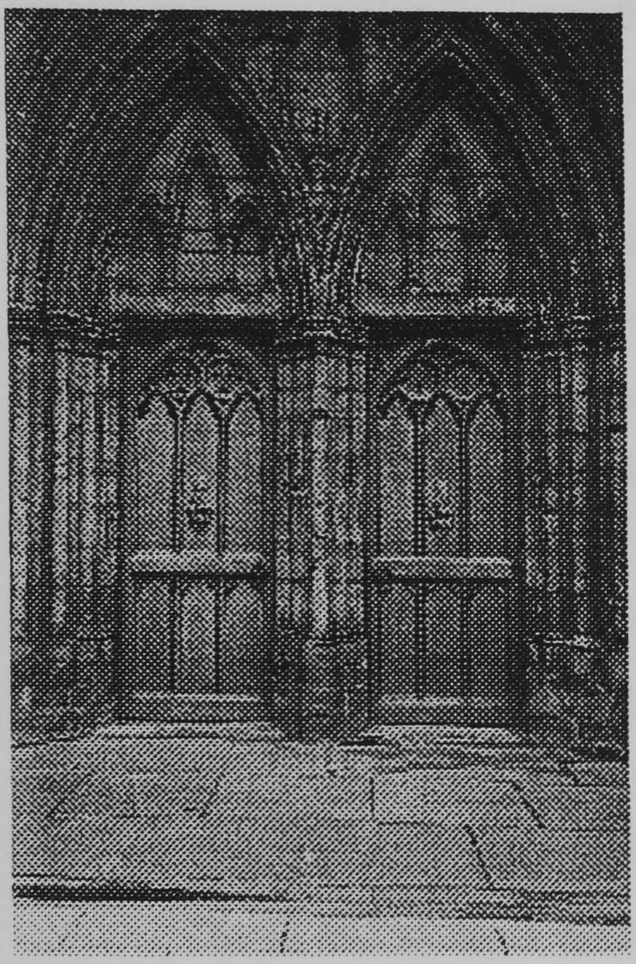


Figure 9.1 - Case 14.

The system will then propose the following new combination of features:

A new solution may be possible with the following features:

Flow function:	*main entrance*
Flow control:	*public access*
Flow connection:	*gives access to: air lock, vestibule or foyer*

Formal insertion:	*aligned to the facade*
Door top shape:	*flat door top*
Top complements:	*top curved moulding*
Lateral complements:	*lateral cylindrical section column*
	lateral vertical moulding
Surrounding materials:	*smooth stone*
Door operation type:	*swinging door: one double*
Door leaf type:	*panelled opaque*
Door leaf materials:	*timber*
Door handle, if any:	*round knob or ring handle*

The first solution is retrieved because it is the closest match in the case-base. It satisfies all the conditions verified by the questions presented to the user. The second solution, which is a result of the neural network computation, also satisfies all the conditions verified by the questions above.

However, it provides more interesting features regarding the initial constraints, than the solution retrieved from the case-base, such as: the absence of 'pointed arch tympanum' and 'tracery or steelworks on fanlight or tympanum'. This makes the second solution a more classic-like solution rather than gothic one.

However, more interesting applications of the proposed model can be found in situations were the whole building is being designed. For instance, suppose that I am now given the task of designing an entrance door in a non-existing building. I approach the 'extend domain' with the following basic constraints: firstly, the materials should be, as much as possible, industrialised and non hand-crafted. Secondly, it is supposed to be a single door and to give access to a reception desk. Thirdly, an emphasis should be placed on natural heat conservation in the winter.

The system starts by bringing to the first question to the screen:

Does the door leaf have a flat top?

Since the presence of a flat door top favours industrialisation, I answer 'yes' to the question above. The system then brings to the screen the next question:

Does it give access to an air lock, vestibule or foyer?

This entrance door is supposed to give access to a reception desk, as mentioned above. In these situations it is usual to have a foyer where people can make enquires and meet other people. Therefore, I answer 'yes'. The system then brings the next question to the screen:

Is it supposed to be the main entrance?

I know that the entrance being designed is an important one. However, as I am not aware yet of the situation in the remaining of the building, the answer is 'don't know'. The system then asks me:

Is there glass in the surroundings of the entrance?

I interpret the presence of glass, as a dominant surrounding material, as a means of favouring natural heat conservation in the winter. Therefore the answer is 'yes'. The next question is:

Is there non-stained glass in the leaf?

Since the presence of non-stained glass in the leaf can also be interpreted as favouring natural heat conservation in the winter, the answer is also 'yes'. The system then brings to the screen the following question:

Is there metal in the leaf?

Since metal favours industrialisation, the answer is once again 'yes'. The system then asks me:

Is there metal in the surroundings of the entrance?

Once more, the industrialisation factor drives me to answer 'yes'. The next question is:

Are there windows in both sides?

Since I have decided at an earlier stage that glass was going to be one of the dominant materials in the surrounding of the entrance to provide natural heat conservation, I decide to use windows in both sides of the door. The answer is therefore 'yes'. The system then asks the next question:

Is it supposed to allow public access?

Although I am aware of the importance of the door, I do not know yet about the type of flow control for this entrance. The answer is thus a 'don't know'. The system then brings to the screen the following questions:

Is it pulled in from the facade?

I did not have a prior opinion on this matter, but I am now inclined to think that the feature above may give some protection from the flow of people in the street and from bed weather. Therefore, the answer to the question above is 'yes'. The next question is:

Does the entrance have a squared fanlight on its upper part?

Since glass is going to be one of the dominant materials in the surroundings of the door entrance, I think of a squared fanlight as a means of increasing heat loss in the summer. Therefore, the answer is 'yes'. The system then brings the next question to the screen:

Does the entrance have one double swinging door?

Considering the initial constraints, which call for a single door, I answer 'no' to this question. The system then brings the next question to the screen:

Are there bricks in the surroundings of the entrance?

Bricks are nowadays industrialised construction materials. However, they do not favour a mechanised construction process to the same extend of their own manufacturing, particularly due to their dimensions and to the need of manual and careful bricklaying. Therefore, I answer 'no' to this question. The system will then bring a solution to the screen:

The most likely solution in the Extended domain is:
The closest match is Case 63, which has the following features:

Flow function:	*main entrance*
Flow control:	*restrict access*
Flow connection:	*gives access to: air lock, vestibule or foyer*
Formal insertion:	*pulled in from the facade*
Door top shape:	*flat door top*
Top complements:	*squared fanlight*
	flat semi-circular porch

Other complements:	*walls supporting porch*
Lateral complements:	*windows in both sides*
Surrounding materials:	*glass*
	smooth stone
	metal
Door operation type:	*swinging door, one single*
Door leaf type:	*framed with three or more light cross panels*
Door leaf materials:	*non-stained glass*
	metal
Door handle, if any:	*round knob or ring handle*

The solution's description is followed by the notice:

Retrieve illustration number Case63.pcx in the Illustration's folder. Double click the icon More.xls in the Project's folder to see if a suggestion of new solution is available.

The following illustration will come up on the screen:

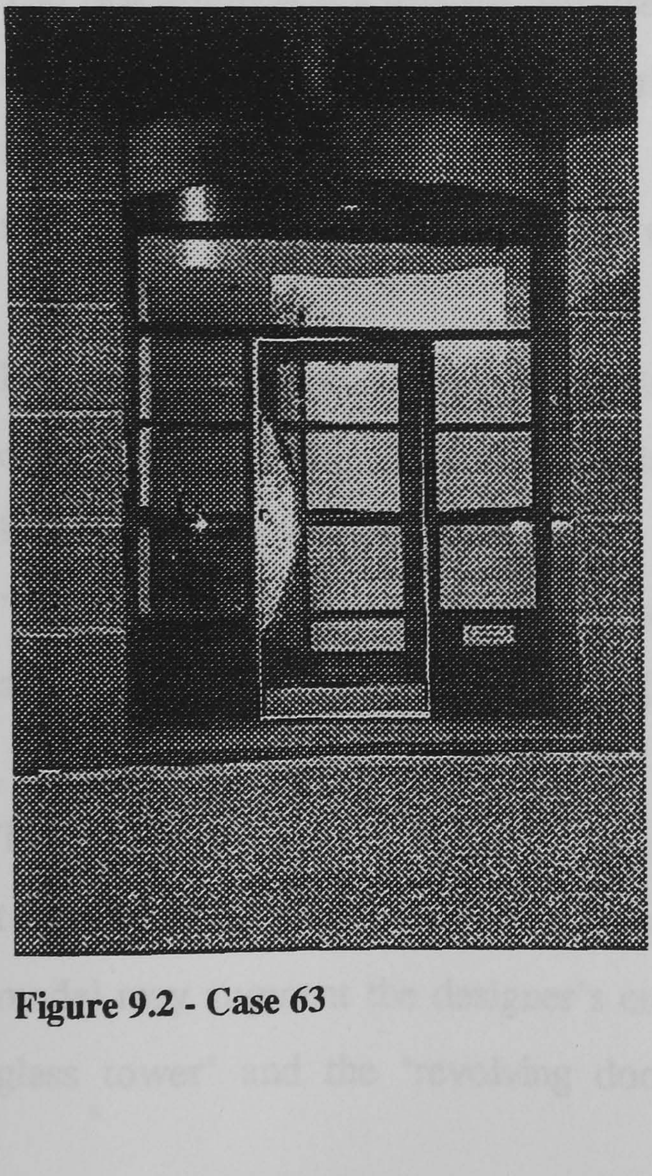


Figure 9.2 - Case 63

The system will then propose the following new combination of features:

A new solution may be possible with the following features:	
Flow function:	*main entrance*
Flow control:	*public access*
Flow connection:	*gives access to: air lock, vestibule or foyer*
Formal insertion:	*pulled in from the facade*
Door top shape:	*flat door top*
Top complements:	*squared fanlight*
Other complements:	*vertical glass tower*
Lateral complements:	*windows in both sides*
Surrounding materials:	*glass* *metal*
Door operation type:	*swinging door, one single* *revolving door (with four leaves)*
Door leaf type:	*framed with one or two light cross panels*
Door leaf materials:	*non-stained glass* *metal*
Door handle, if any:	*long vertical static handle*

The first solution is retrieved because it is the closest match in the case-base. It thus satisfies all the conditions verified by the questions presented to the user. The second solution, which is a result of the neural network computation, also satisfies all the conditions verified by the questions above.

However, it provides some more interesting features regarding natural heat conservation in winter, than the solution retrieved from the case-base. These features are: 'a vertical glass tower' (instead of 'walls supporting porch'), only 'glass' and 'metal' among the surrounding materials (no 'smooth stone'), and the addition of a 'revolving door' (instead of just a 'swinging door: one single').

There may be several possible graphic interpretations of the new solution, but the textual description above already provides some illustration of how the proposed model may augment the designer's creativity. In the example above the 'vertical glass tower' and the 'revolving door' represent features not thought by the designer at the outset of the design task. Yet, they comply with the initial set of constraints, which were that the materials should be, as much as possible, industrialised and non hand-crafted, and an emphasis should be placed on natural heat conservation in the winter.

Several domains could be implemented in the proposed model representing different levels of abstraction for a particular design task. At the end of each section I may accept the proposed solution and move towards its detailing, or decide to go back to the beginning and start another section at the same level of abstraction.

9.3 Further research:

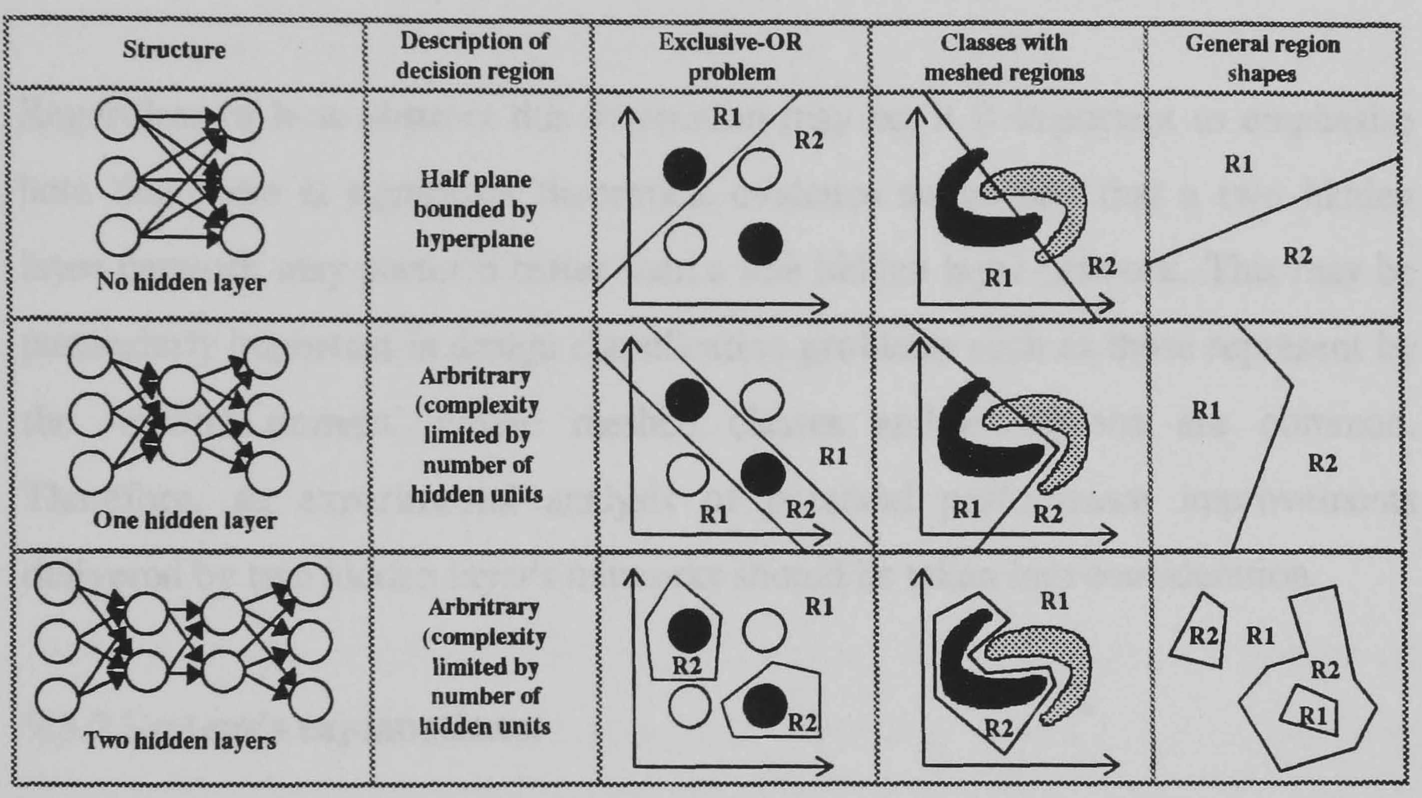
The proposed model represents a significant improvement in relation to the interfaces of conventional stand-alone neural networks. It also delivers learning capabilities to a knowledge-base system. However, there is a series of issues related to learning performance, interface and implementation that need to be addressed. I shall try to point out some of these issues in the coming sections.

9.3.1 Learning performance:

As observed in the experimentation described in Chapter 8, 100% of the solutions compatible with the user's input (see in figure 8.16, the data under the label 3) did not present architectural inconsistencies. However, as the sample of new solutions was relatively small (9 cases), the reliability might decrease in larger samples. An additional underlying problem may suggest the need for searching improved performance: the architecturally consistent new solutions that are compatible with the user's input show different levels of completeness. A careful examination of those new solutions (figures 8.20 to 8.24) shows that not all sets of features were present in all examples. This may be an indication of neural network's inability to handle class exceptions. Therefore, the search for improved performance should proceed.

Among the new solutions not entirely complying with the user's input (see in figure 8.16, the data under the label 2) 32 out of 37, that is 86%, were architecturally consistent. Although they did not fulfil all the requirements in relation to the user's input, they may become useful knowledge. They may be interpreted as if the network were trying to 'say' that the output should be a certain one, that does not entirely satisfy the user's input, but it provides a new solution that raises important issues the user had not thought of at the design task's outset. However, 14% is still a too high rate of unreliability. Therefore, if improved learning performance could somehow be reached and those solutions incorporated to the set of acceptable ones, then the system would see a dramatic expansion in the number of useful new suggestions.

An unexplored territory, which may provide the performance improvement mentioned above is related to the number of hidden layers. A geometric interpretation of this (adopted and modified from Lippmann, 1987; and Jain et al., 1996) is presented in figure 9.3 bellow.



(R1 = region 1; R2 = region 2)

Figure 9.3 - A geometric interpretation of the role of hidden layers in binary networks (Lippmann, 1987; Jain et al., 1996).

The networks without hidden layer, or perceptrons, make the learning problem much simpler, but are very limited in what they can represent, as already mentioned in Chapter 4. They can only learn linearly separable problems, that is, those classes that can be separated by a decision region comprising a half plane bounded by a hyperplane such as in the first row of figure 9.3.

Networks with one hidden layer can represent continuos' functions, that is, they can solve all problems where the argument space is divided into convex open or closed regions of arbitrary shape, as seen in the second row of figure 9.3. The complexity of those decision regions is limited by the number of hidden units.

Networks with two hidden layers can represent even discontinuous functions, that is, they can solve problems in which the argument space need not even to be continuos or simply connected. This is shown in the third row of figure 9.3. The complexities of those regions are also determined by the number of hidden units.

Regardless of how abstract this illustration may be, it is important to emphasise here that there is significant theoretical evidence suggesting that a two hidden layer network may perform better than a one hidden layer network. This may be particularly important in design classification problems such as those represent by the 'extend domain' where meshed classes and exceptions are common. Therefore, an experimental analysis of potential performance improvements delivered by two hidden layer's networks should be taken into consideration.

9.3.2 System's explanations:

No emphasis was placed in this research on the aspect of providing reliable explanations to the connectionist system's reasoning and decision processes, due to the time constraints. Therefore, this issue remains as a major research field in AI and CAAD. *Cortex* has a modular scheme for representing and storing explanations that is worth while investigating, since it may facilitate the provision of explanations for neural network's behaviour.

9.3.3 Controlling architectural libraries, multimedia and virtual reality resources:

The solutions presented by the system, either those retrieved from the case-base or those computed by the neural network, have no graphic representation that may ease the user's understanding and the transition between a textual representation and a graphically designed one.

Two lines of further research are foreseeable on this matter: firstly, the intelligent management of improved representations of design components and design solutions. The use of the proposed model to control libraries of unstructured representations of architectural components is perhaps the most obvious one. However, other sources of unstructured information are worth mentioning, such as multimedia. Hedberg (1993a, 1993b) has insisted on the integration of conventional knowledge-base systems and multimedia resources as a means of providing 'alive interfaces' to first ones and intelligent management over the second ones.

The second line of further research is related to the intelligent management of structured representations. The control of libraries of architectural components represented as parametrised types, is one of the possible leads towards the transition between a mere textual description and a graphically designed one. Hedberg (1993a, 1993b) has also insisted on the intelligent management of virtual reality by knowledge-base systems as a means of providing improved interfaces to intelligent systems. The same should be considered in relation to the model proposed in this thesis.

9.3.4 Implementation models: from a loose coupling prototyping to a stand-alone executable.

As mentioned in Chapter 7, the adopted loose coupling model of prototyping satisfied the needs of this thesis since it provided the basic means of data exchange between KBS and connectionist system. It was developed primarily with the objective of providing an environment for experimental thesis verification. It was not intended for the end users and it did not have a complete graphical interface.

The prototype was not built on a stand-alone executable code, but is based on the loose coupling between two existing shells, *Cortex 1.5* (Mustoe, 1993) and the neural network development tool *BrainMaker 3.0* (California Scientific Software, 1993). However, it provided enough information to assess the consistency and reliability of the new solutions, which was one of the main objectives of this thesis.

Nevertheless, regardless of the short term research benefits of that prototyping scheme, serious problems may arise if considered for widespread and medium term research or end use. For instance, the incomplete interface may result in confusion to the user. Also, for being based on a macro, the present scheme is highly insecure because it allows the user to either accidentally or intentionally tamper with the application code. For the same reason, the system performs much slower than it would a stand-alone application because all actions, otherwise invisible to the user, are performed visually on the screen.

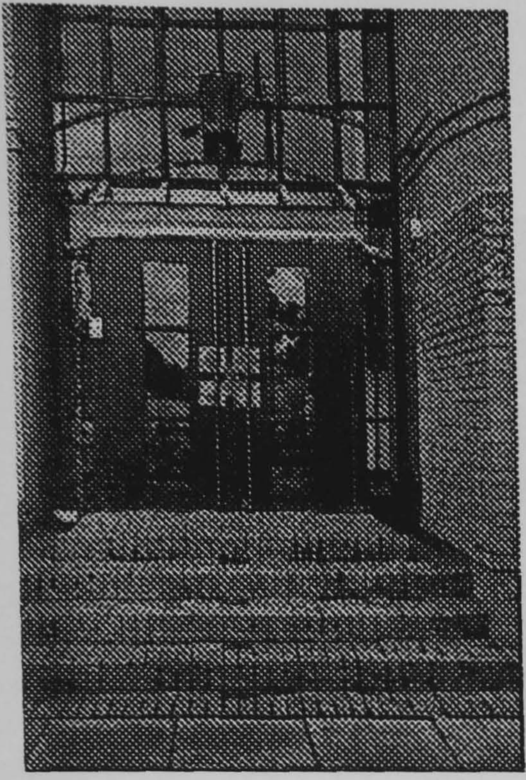
Therefore, the prototyping of a tight coupling scheme, through a stand-alone executable code, perhaps in Pascal or C++, seems to be a necessary condition for proper further research development.

Appendix 1

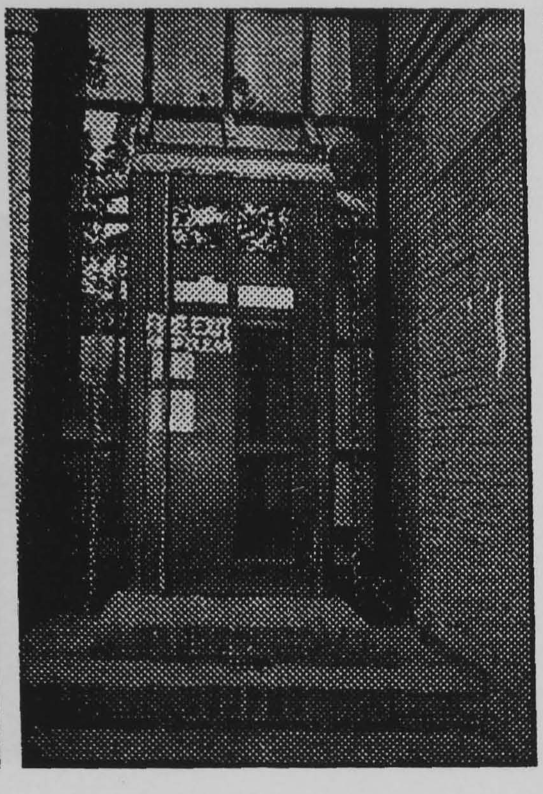
The 122 instances of the 'extended domain':

This appendix contains the photografies of the instances of the so called 'extended domain', which was built from a set of 122 entrance doors collected from buildings in the University of Strathclyde, Glasgow city centre, Glasgow University and architectural magazines. No pre-set conditions were established except the technical and legal possibilities of photographing them. Apart from this, the selection of instances was undertaken at random.

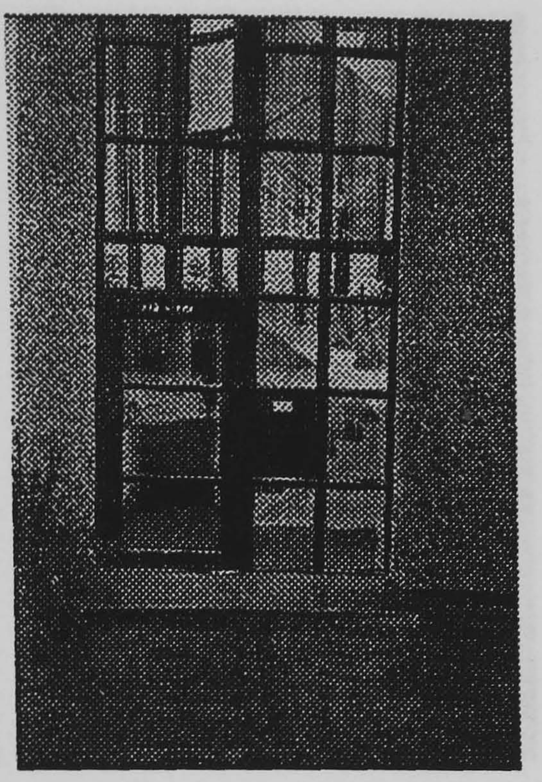
The resulting sample was described in binary according to 80 features, producing a knowledge matrix, which is shown in Appendix 2.



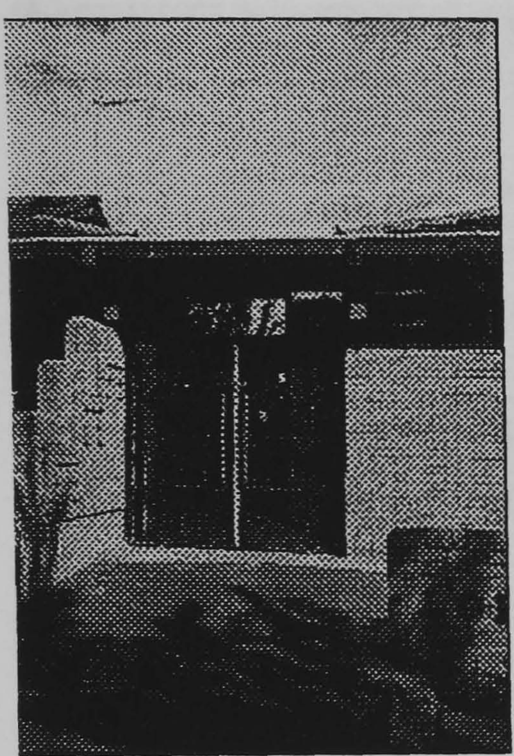
Case 1



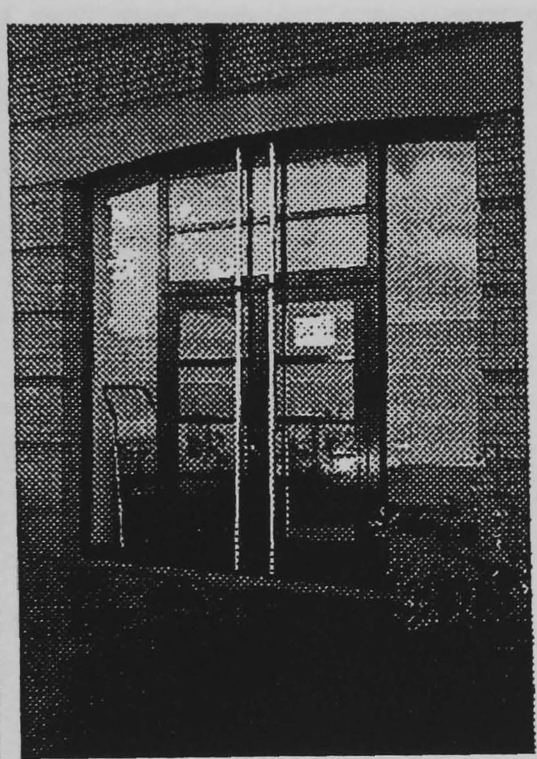
Case 2



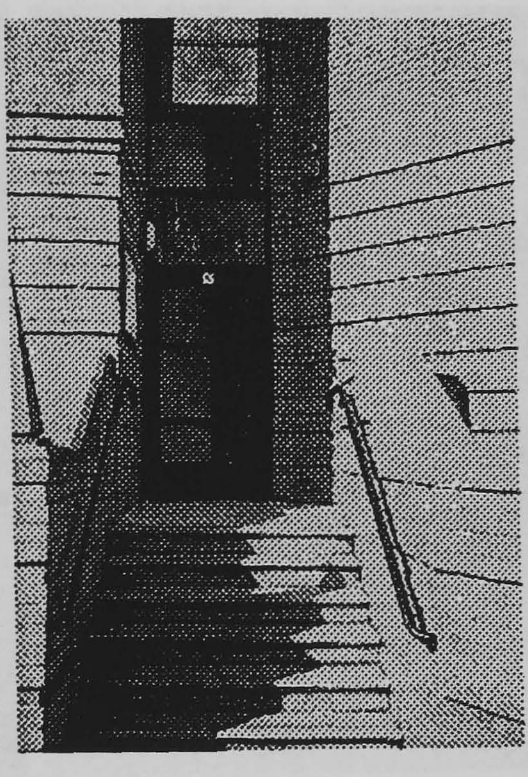
Case 3



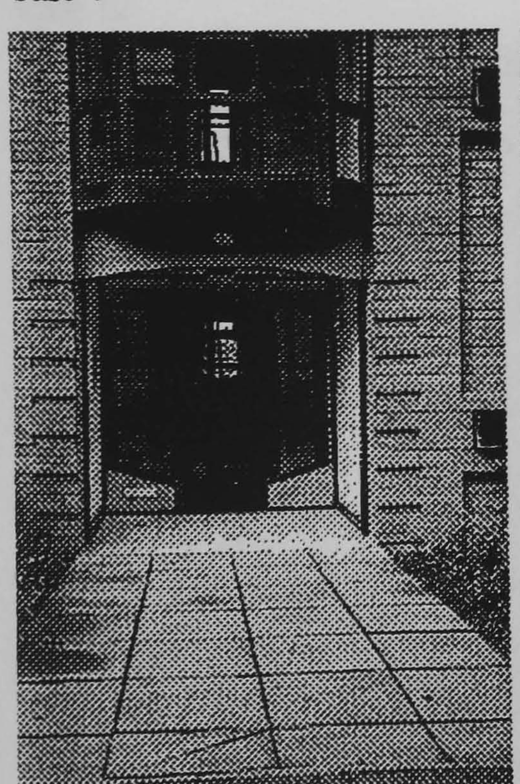
Case 4



Case 5



Case 6



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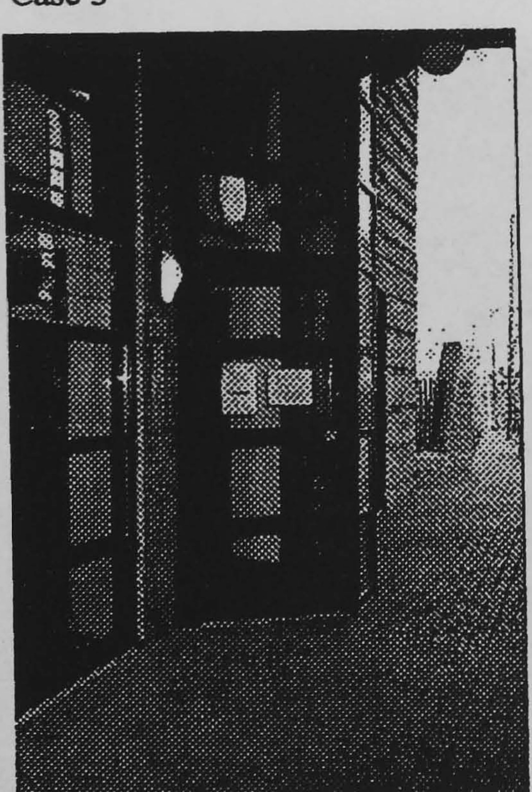
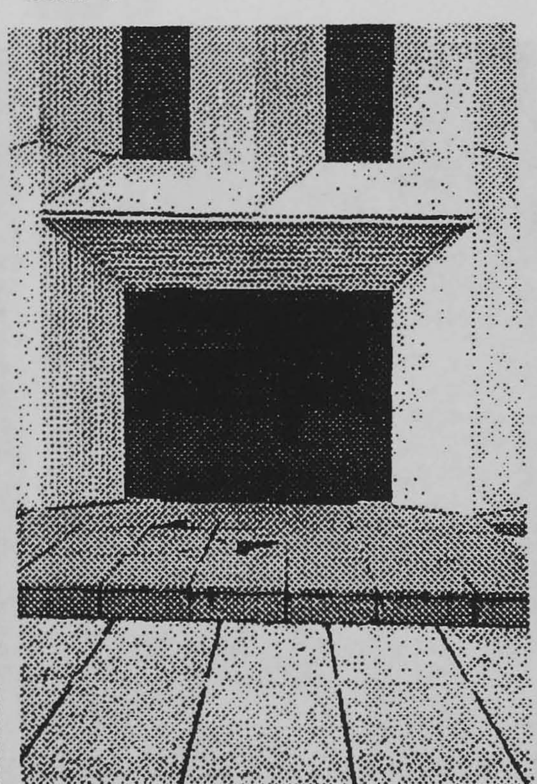
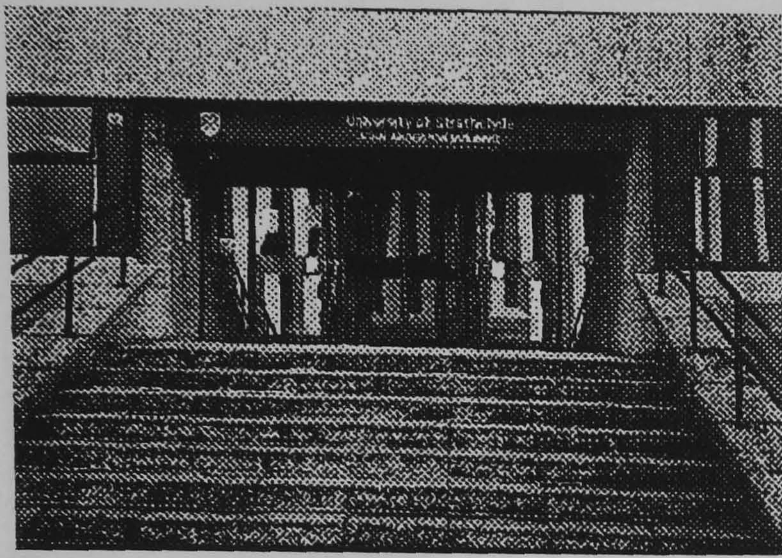


Case 8

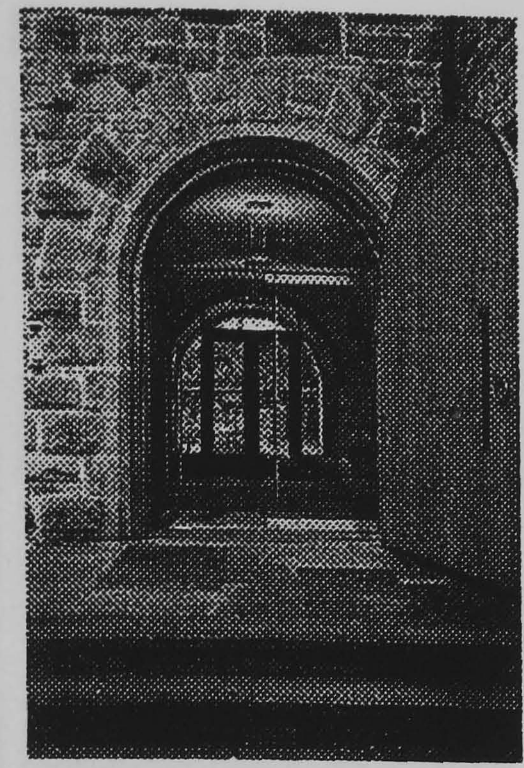


Case 9

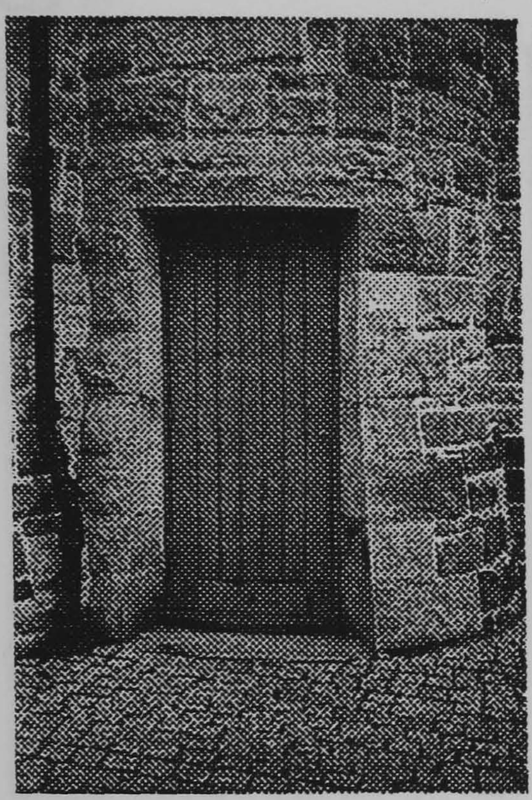
Appendix 1. The instances of the 'extended domain'



Case 10



Case 11



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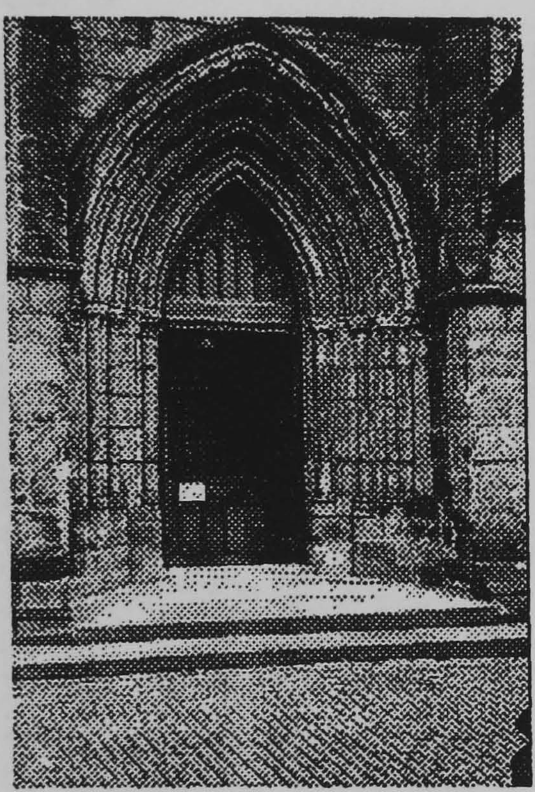
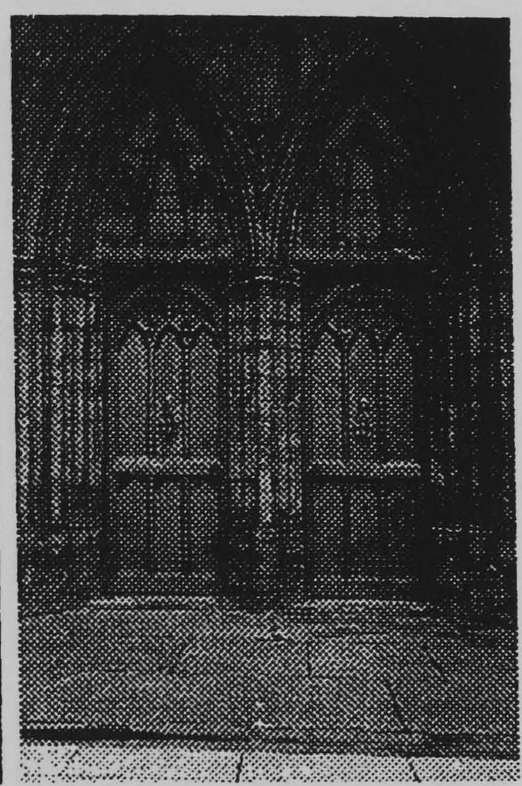
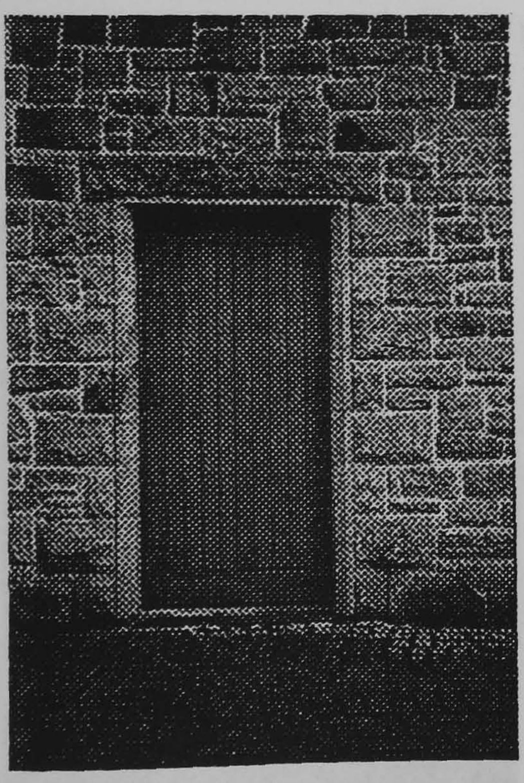


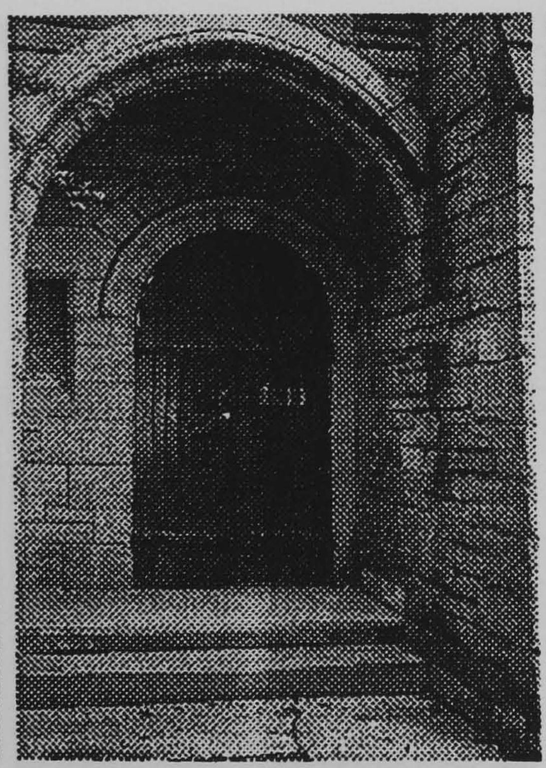
Case 13



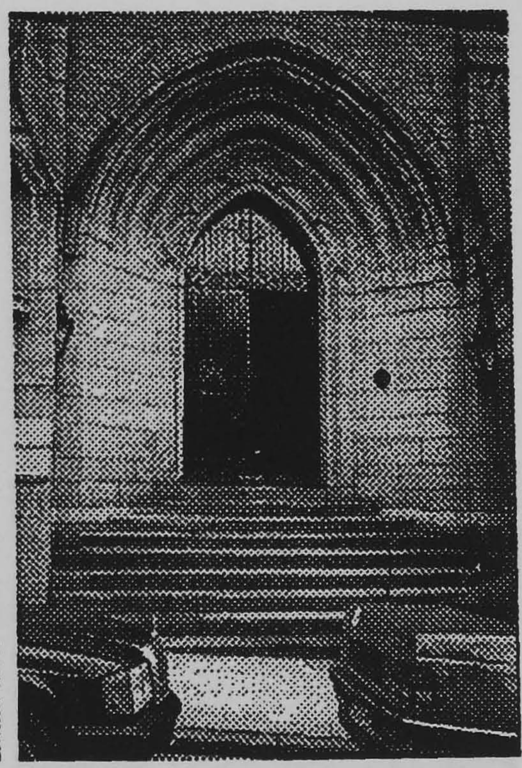
Case 14



Case 15

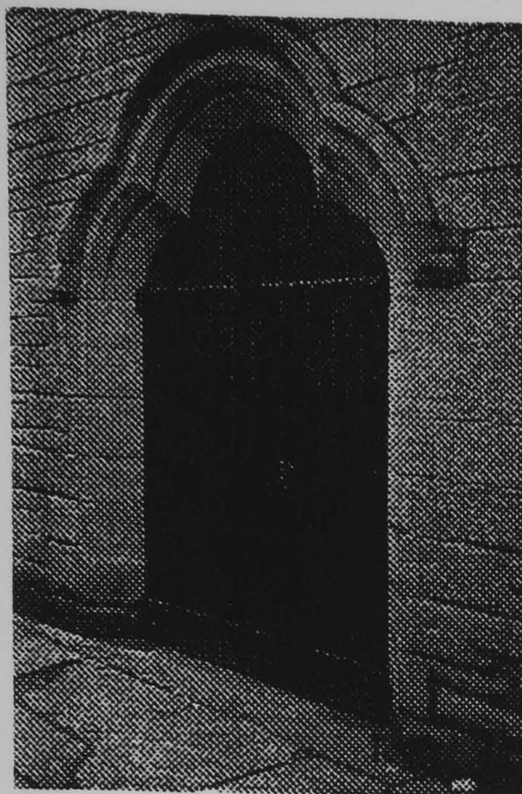


Case 16



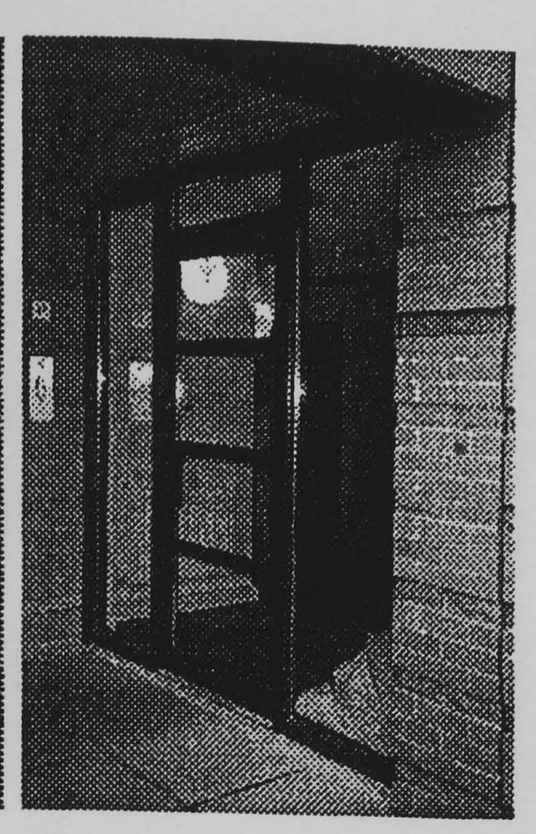
Case 17

Appendix 1. The instances of the 'extended domain'

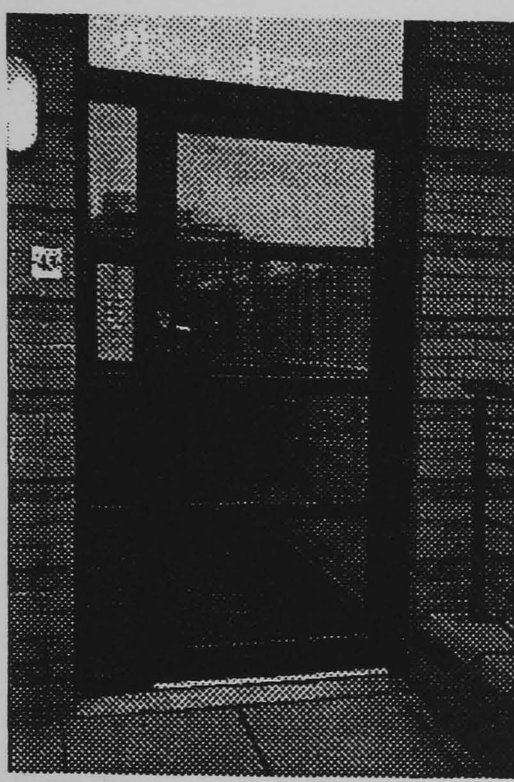


Case 18

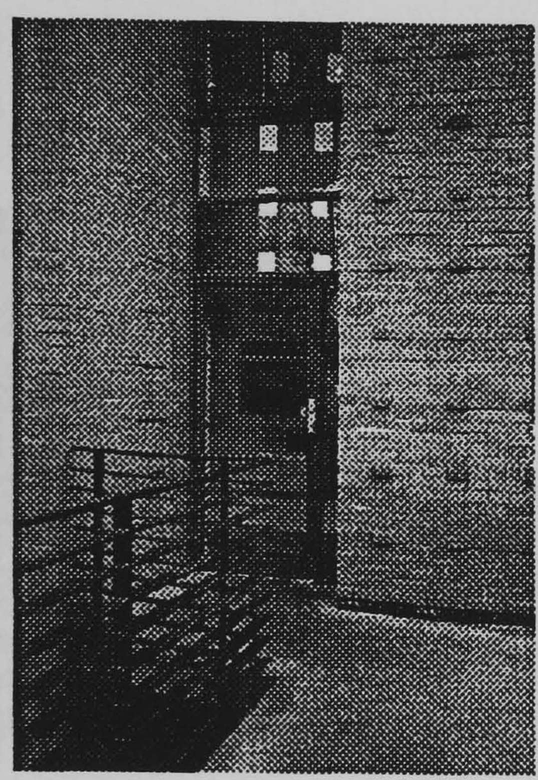
Case 19



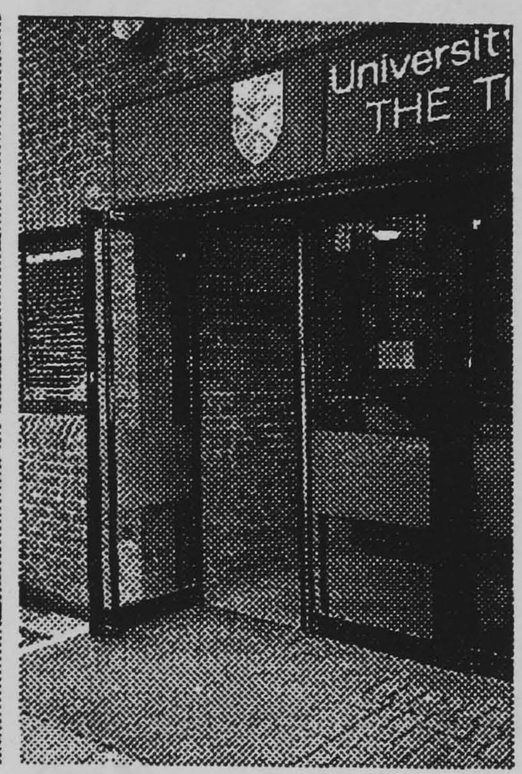
Case 20



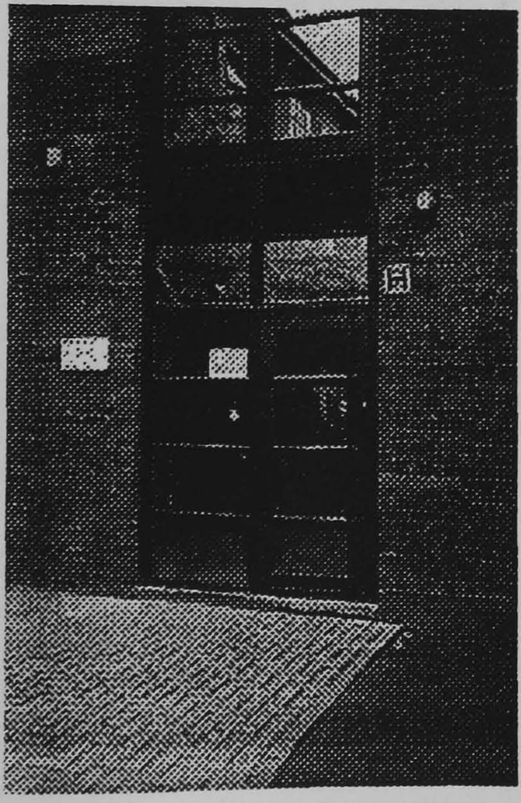
Case 21



Case 22



Case 23



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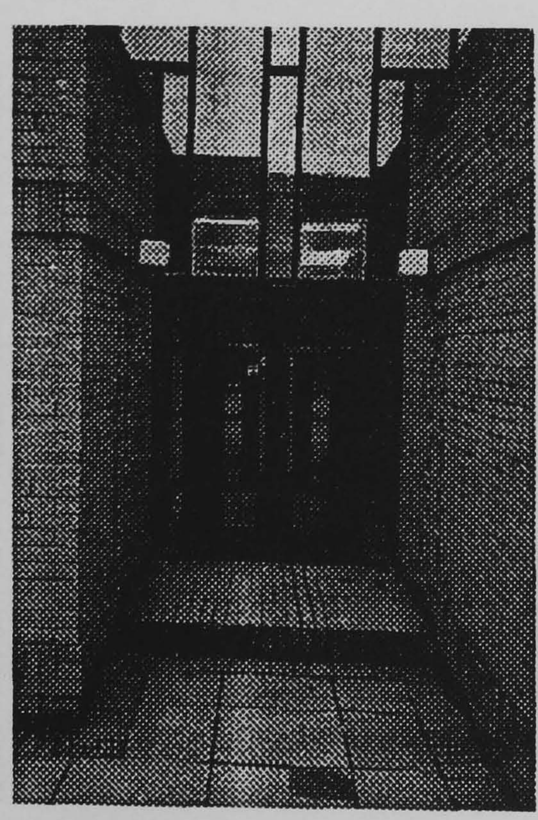

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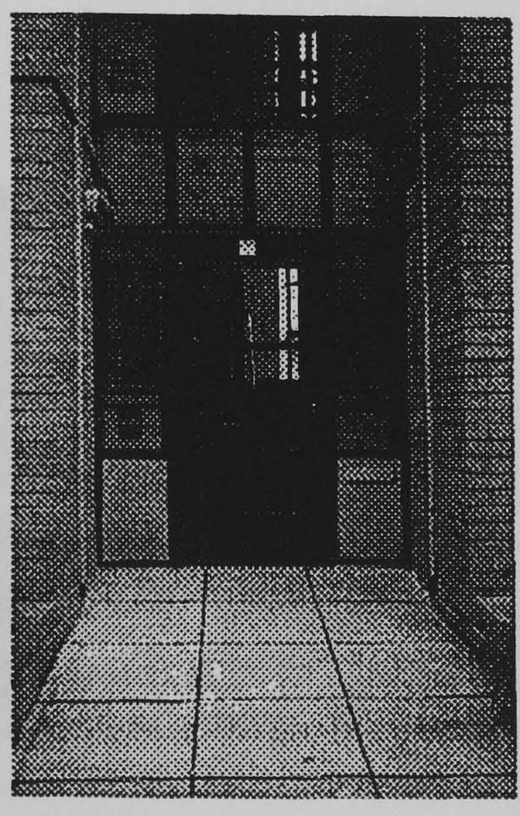

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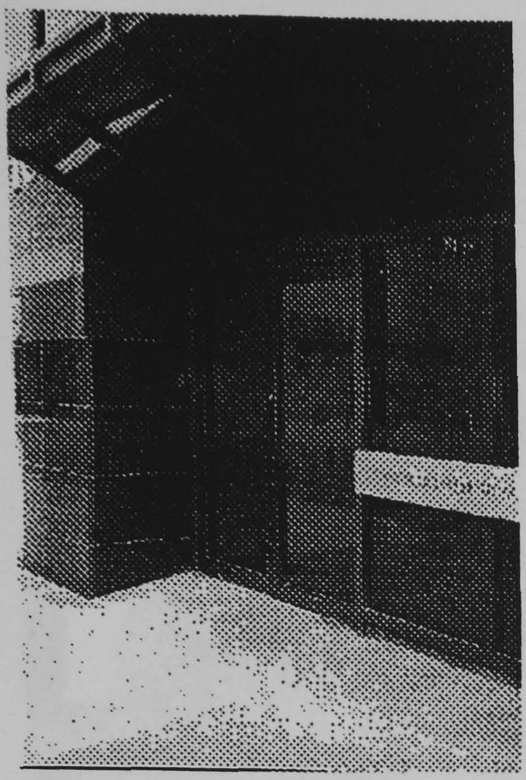

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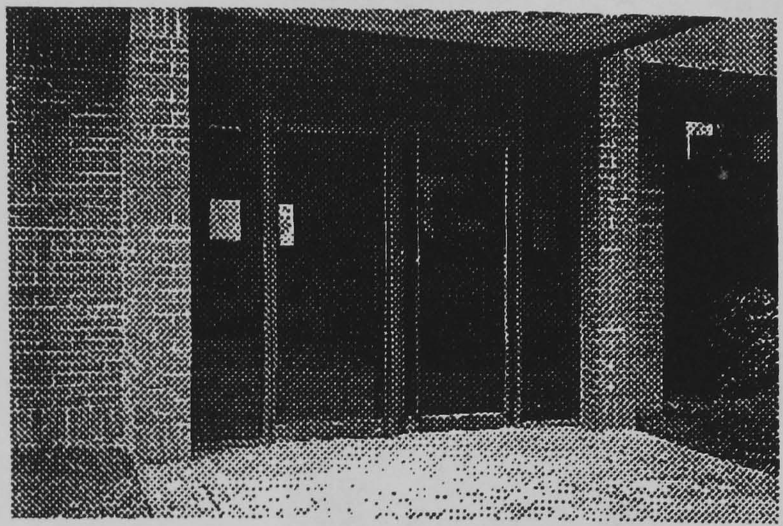

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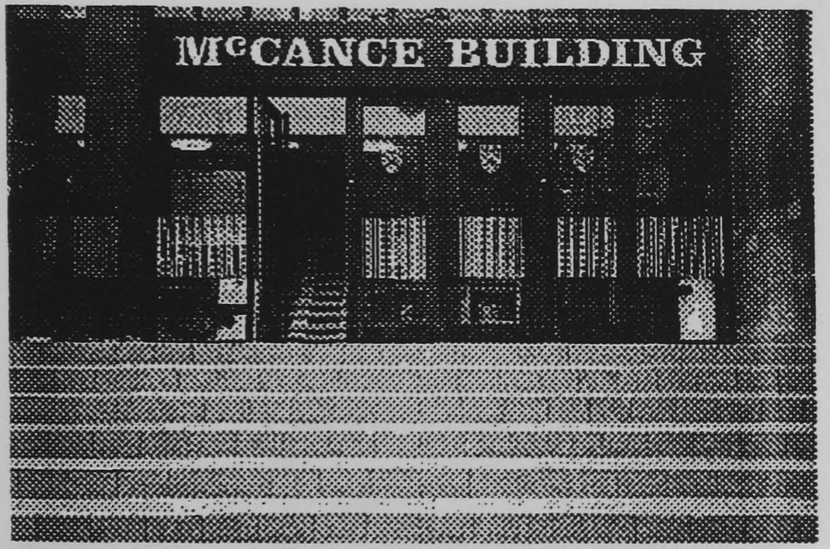

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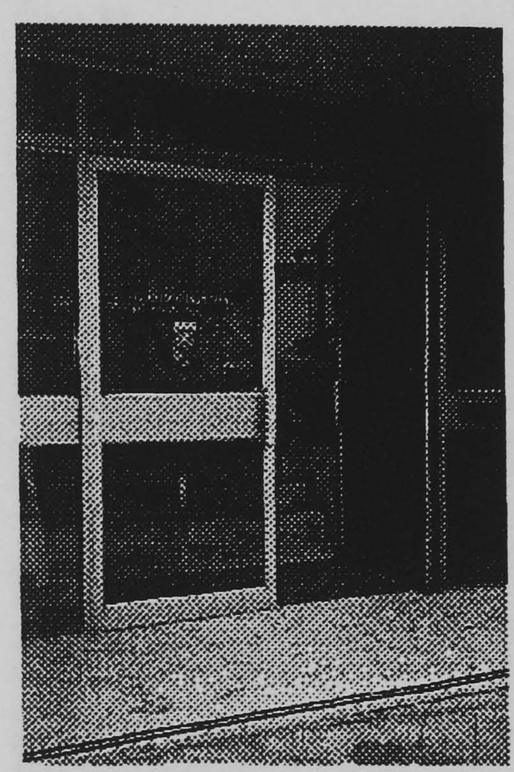
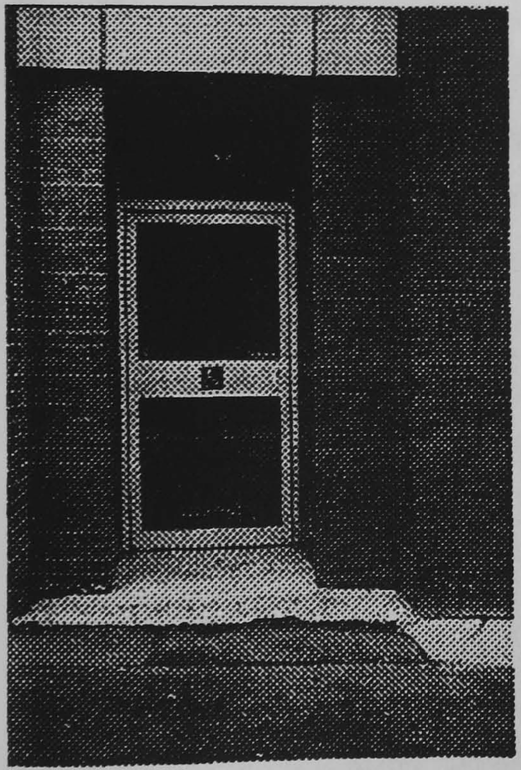


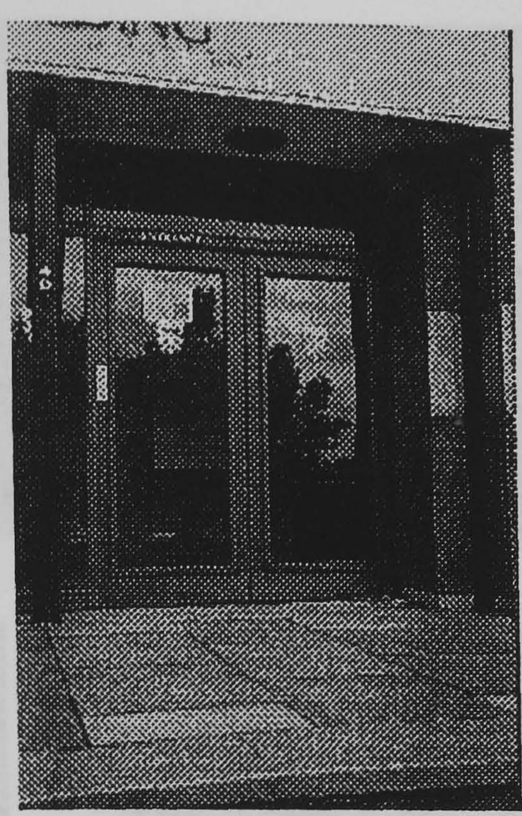
Case 30



Case 31

Case 32

Case 33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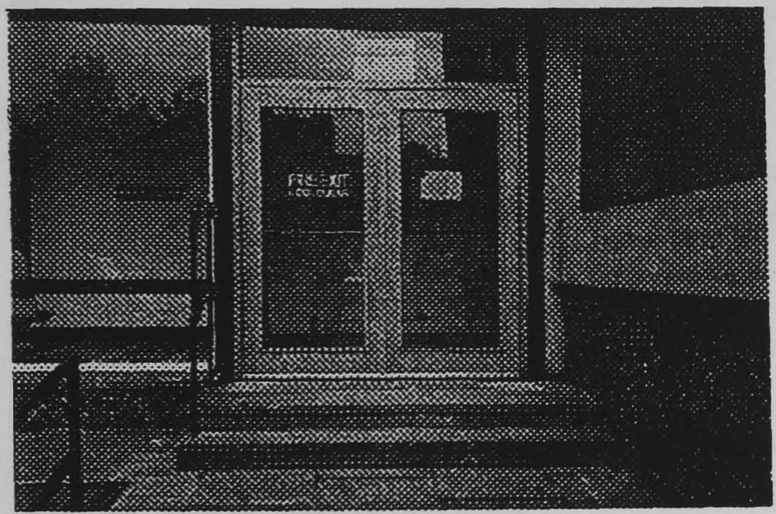
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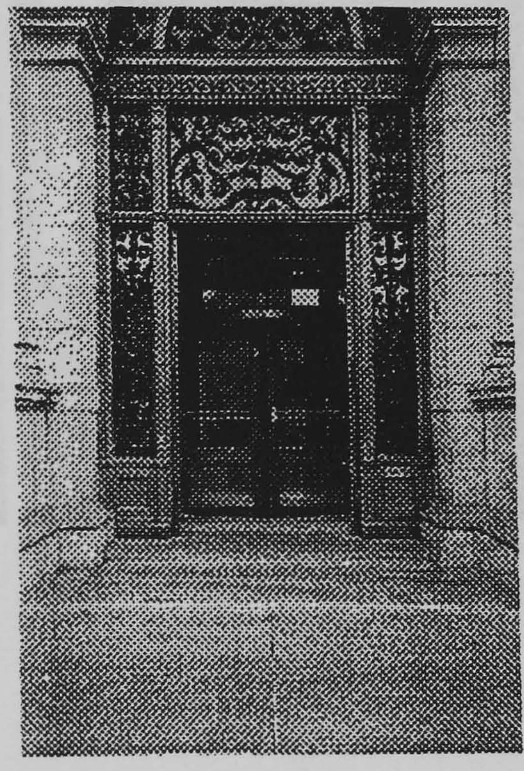
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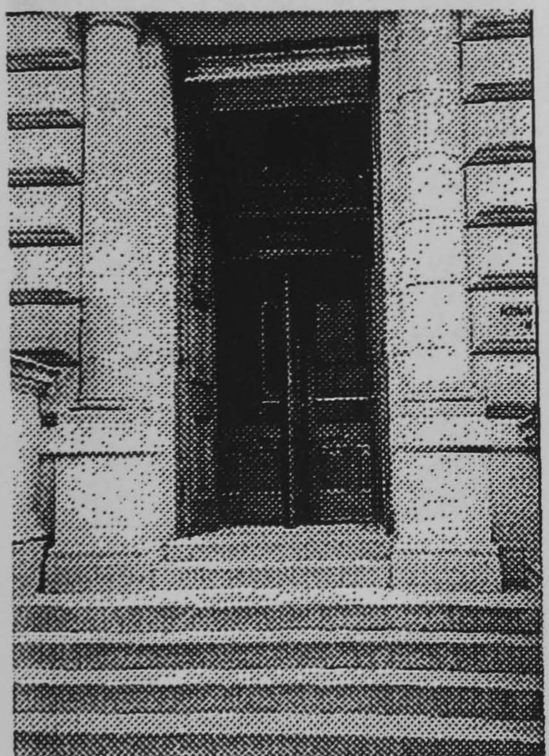
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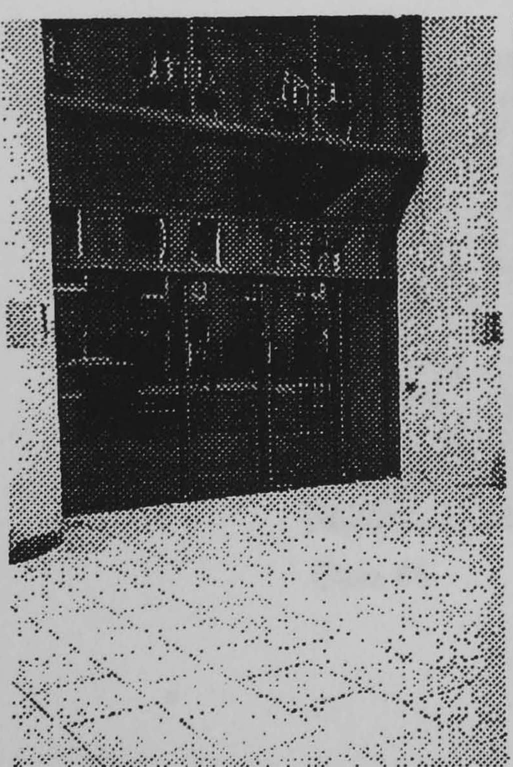
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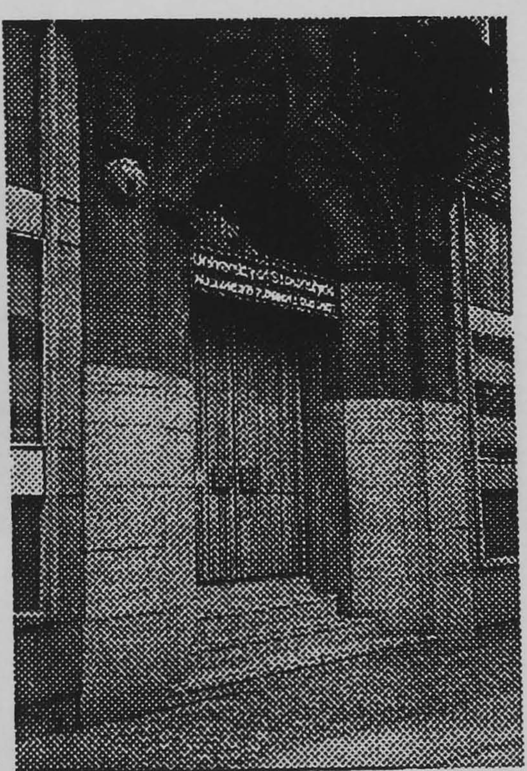
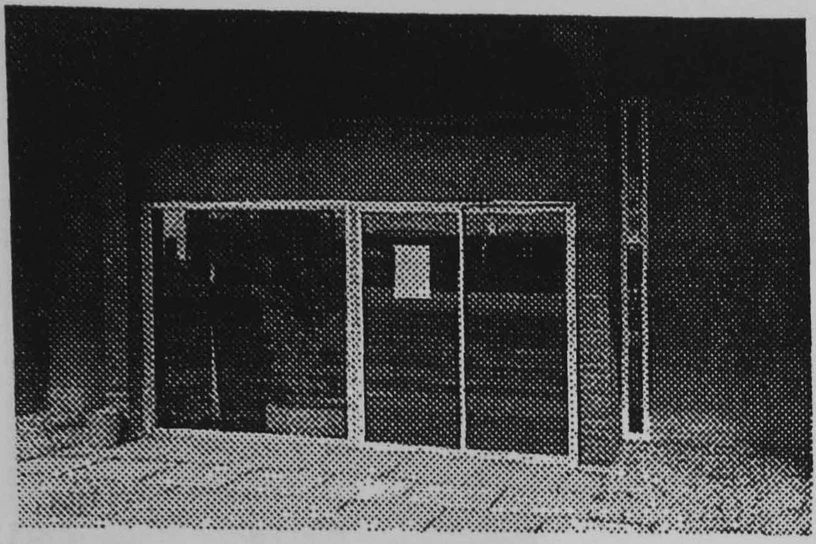

Case 39

Appendix 1. The instances of the 'extended domain'



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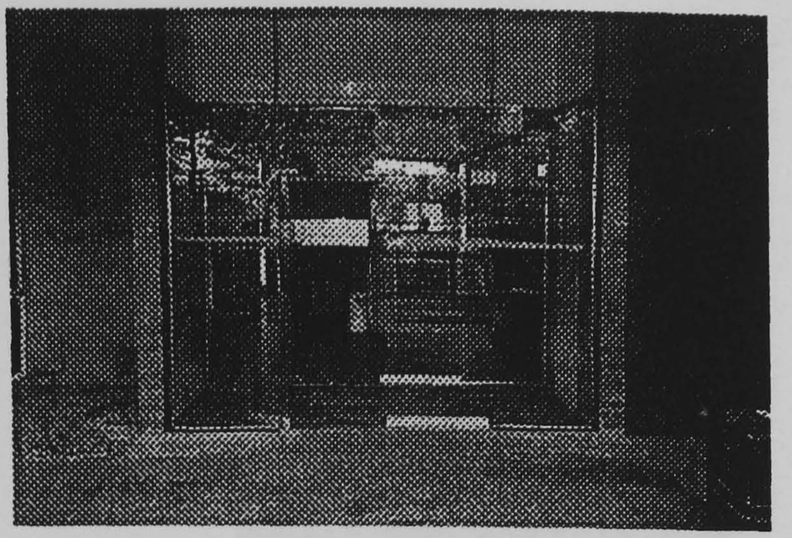

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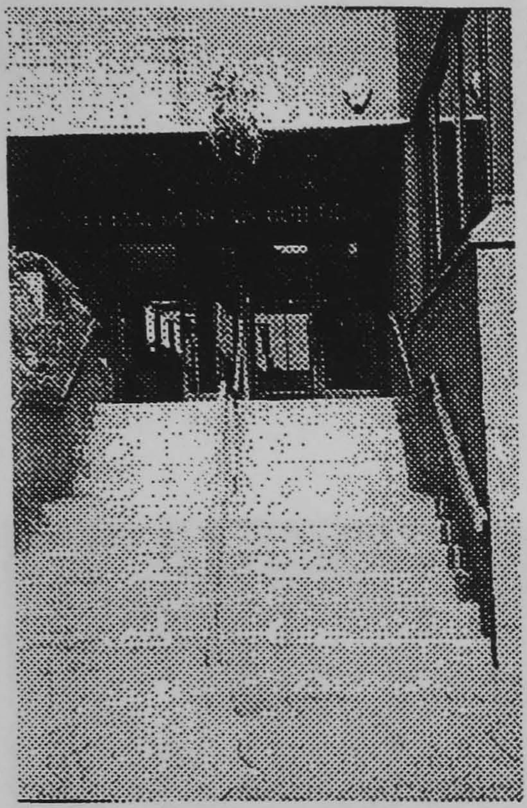

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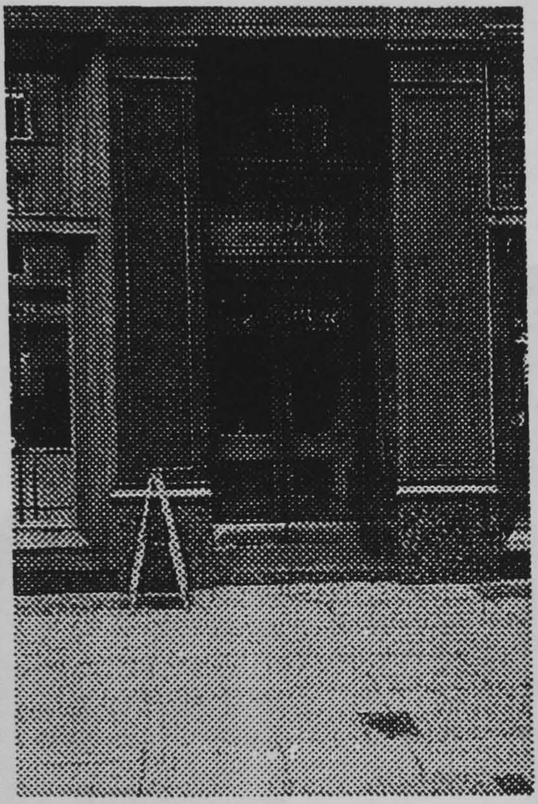

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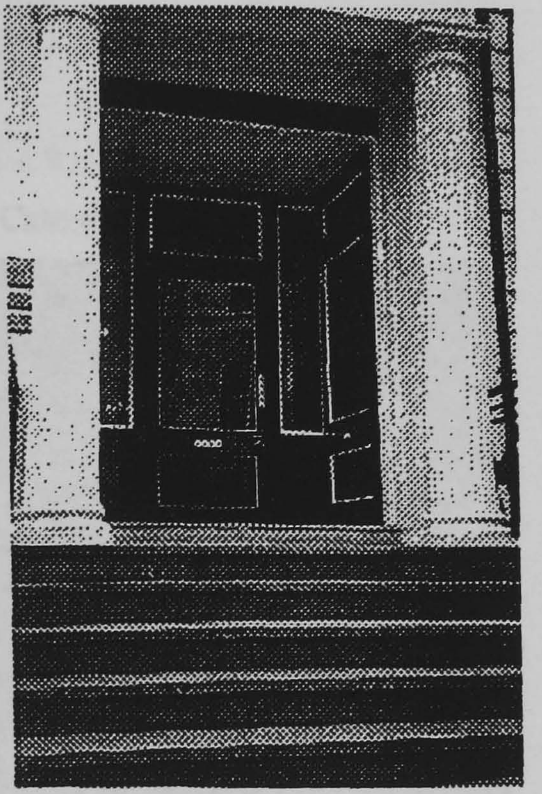

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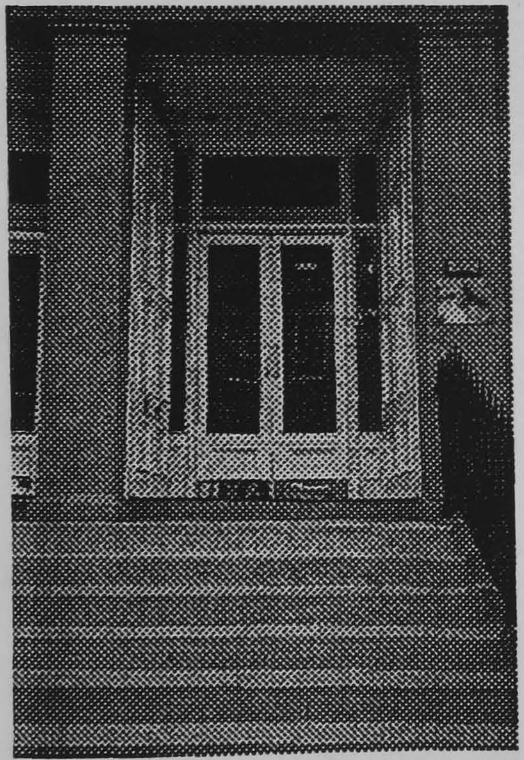

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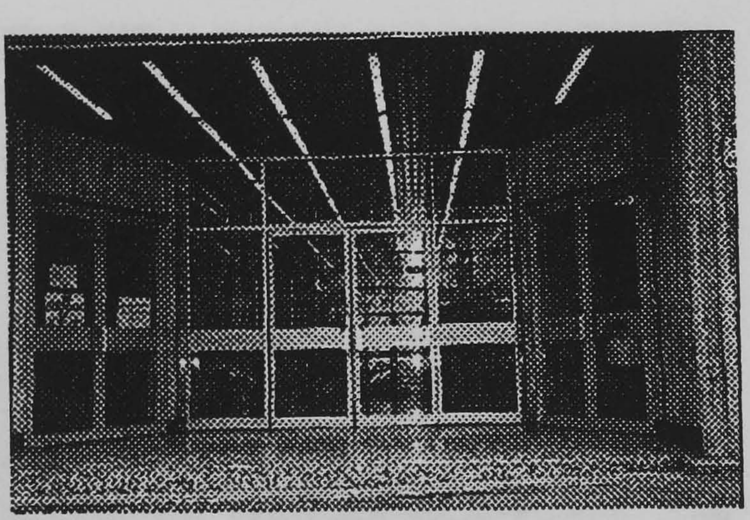
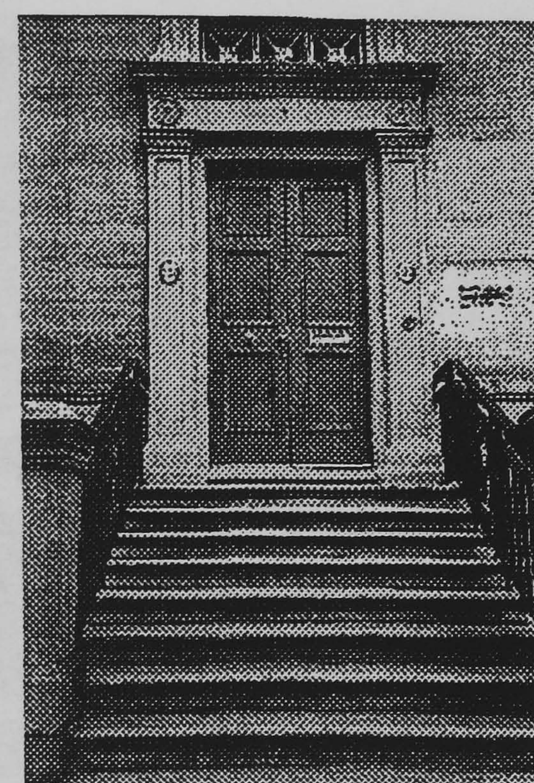


Case 46

Case 47

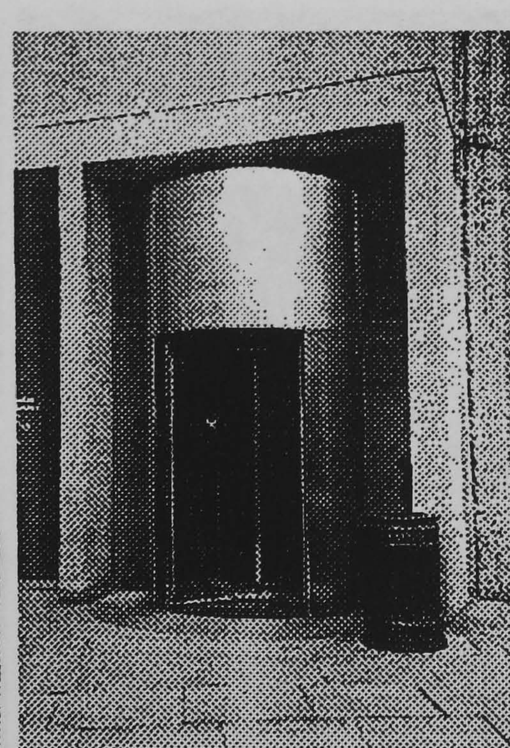
Case 48

Case 49



Case 50

Case 51



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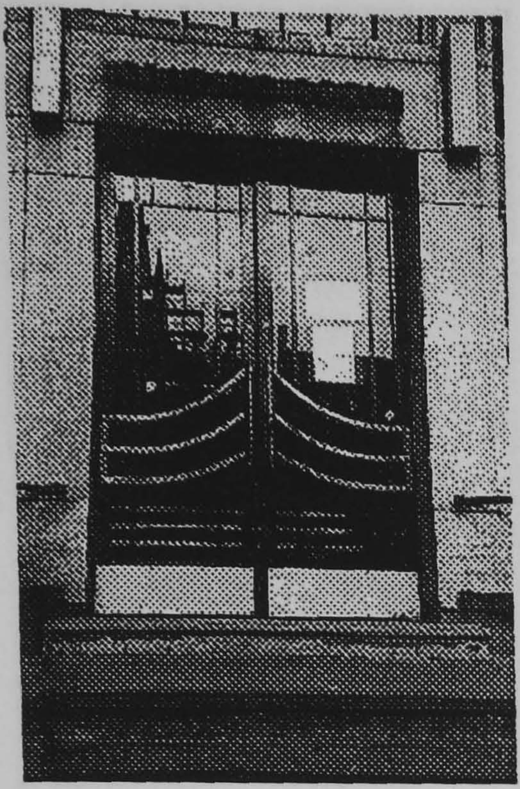
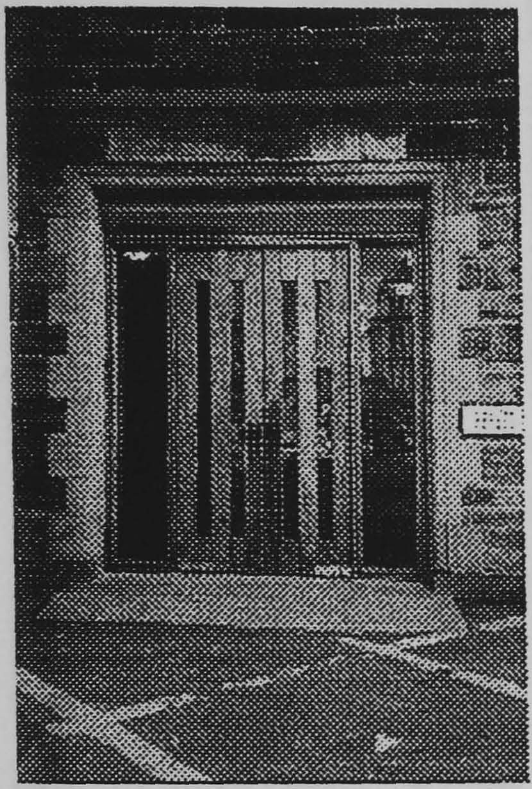
Case 53


Case 54


Case 55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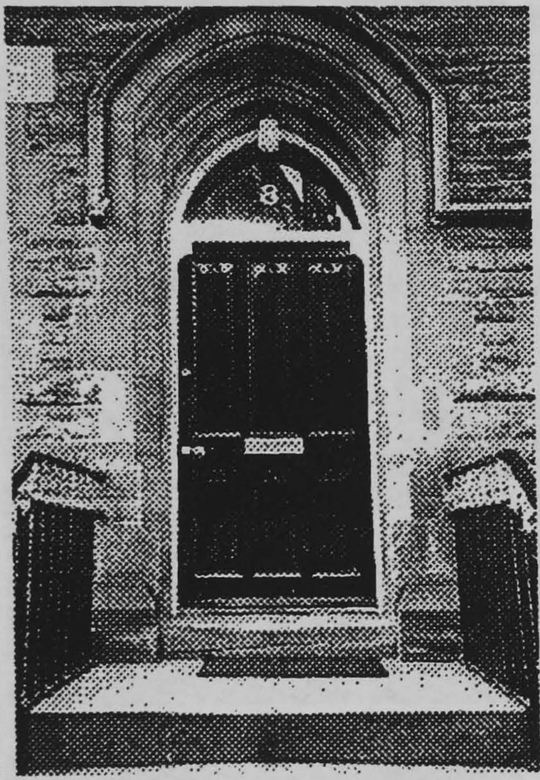
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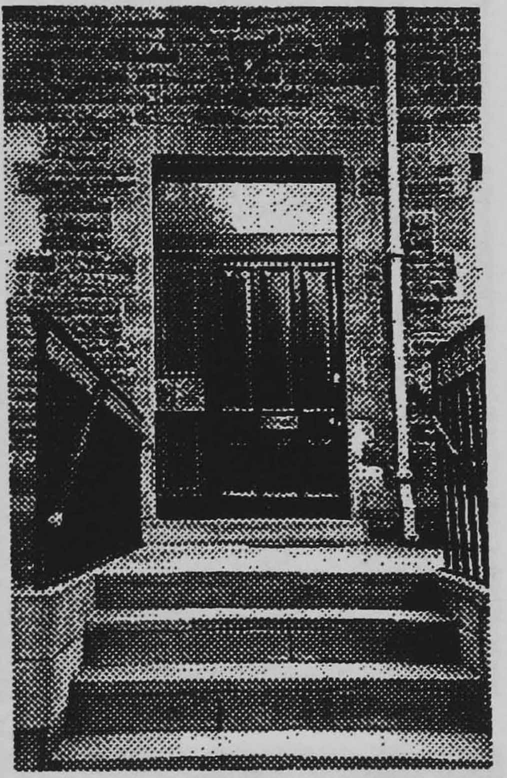
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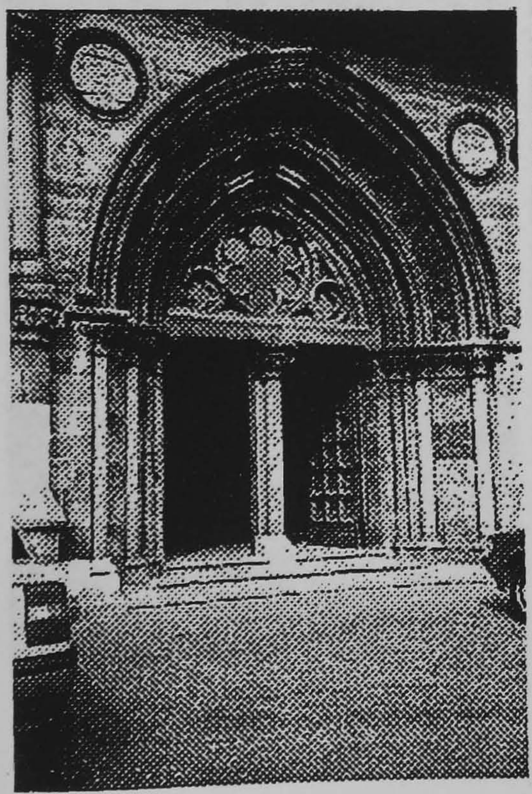
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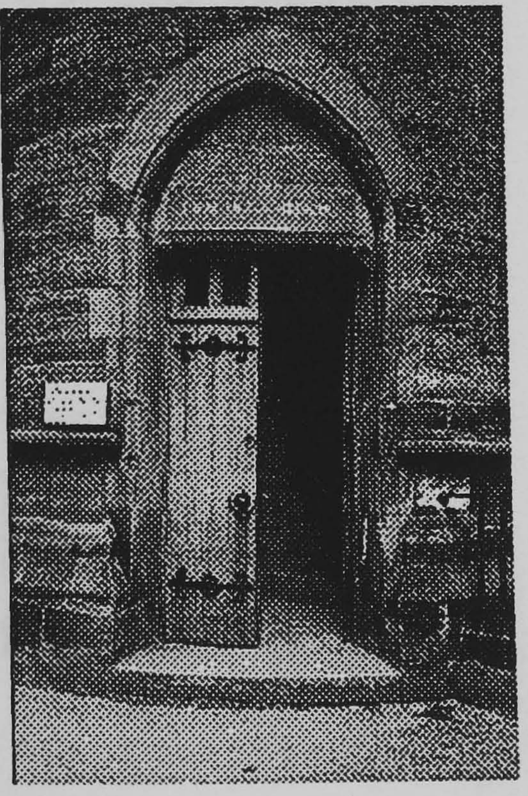
Case 60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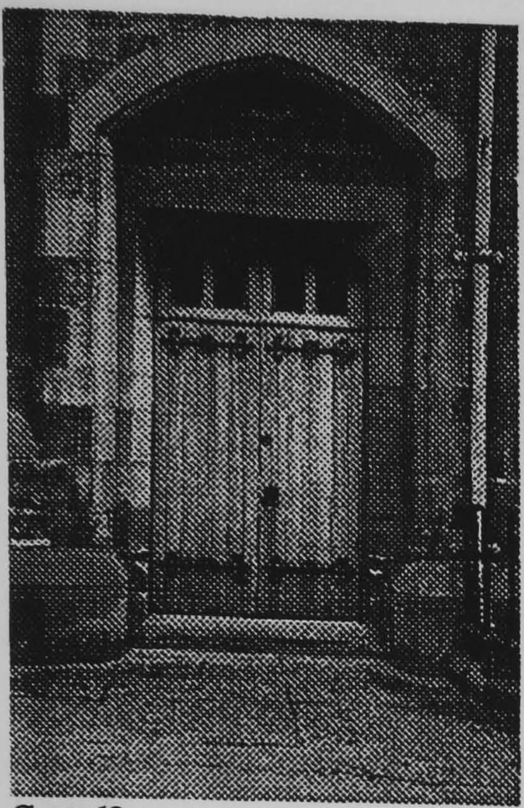
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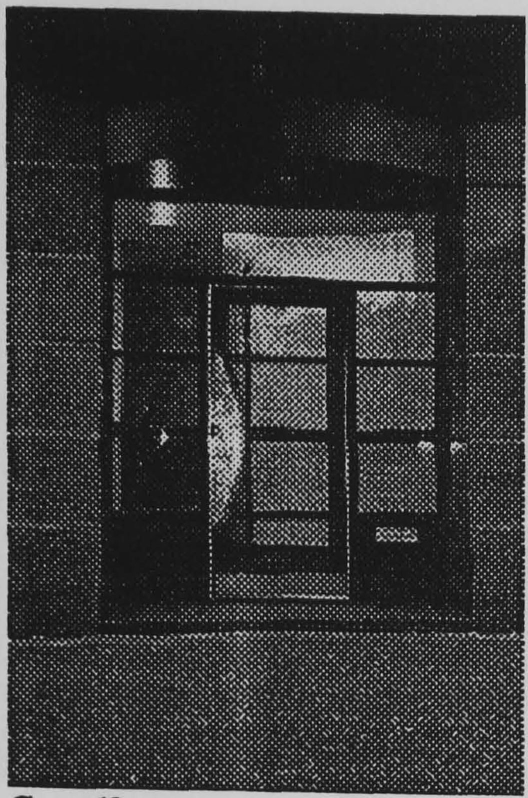
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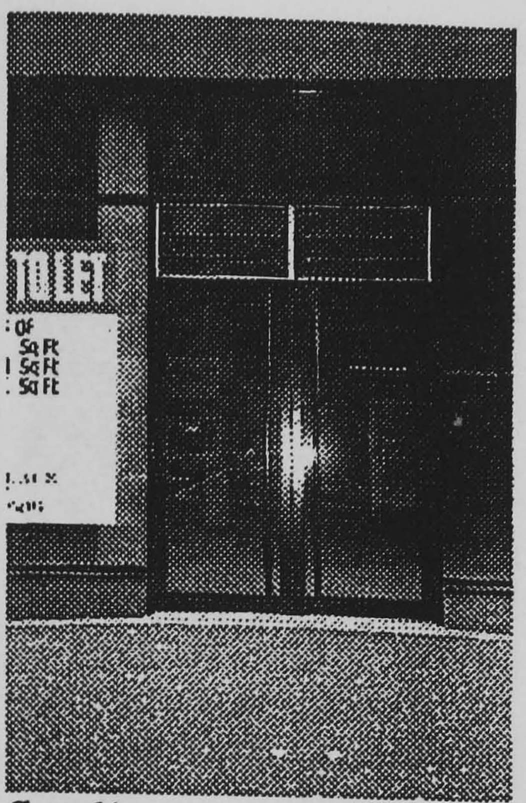

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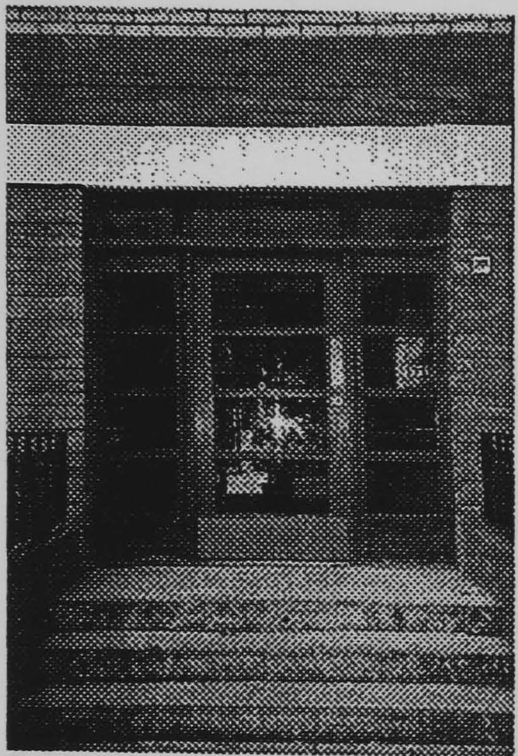
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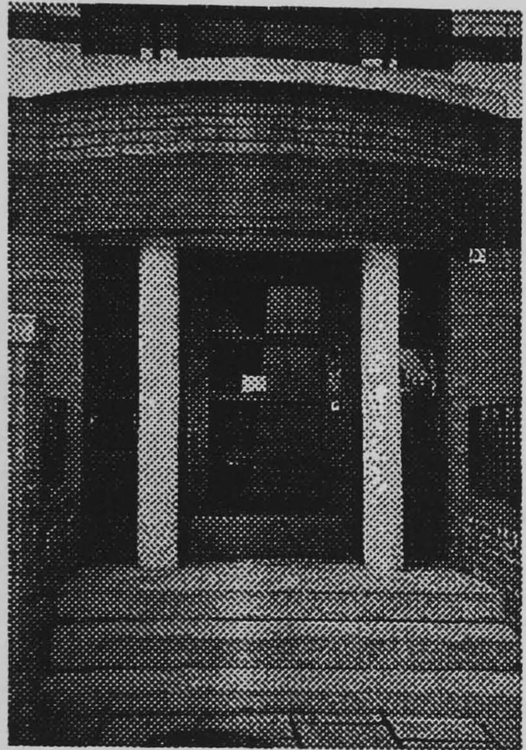
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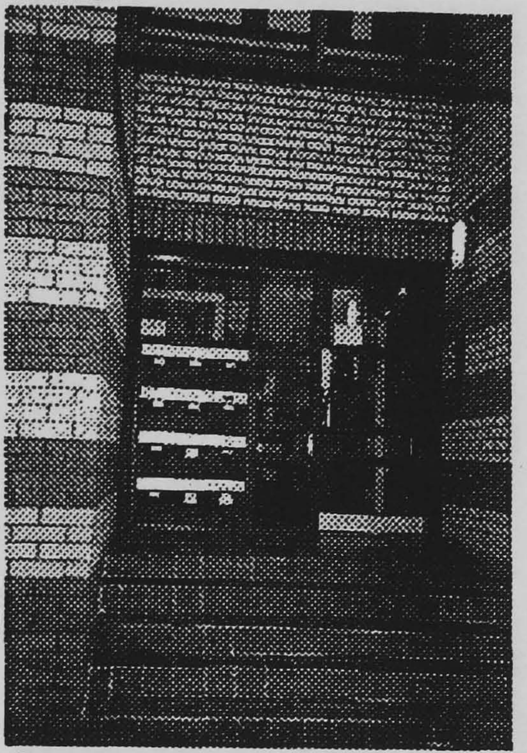
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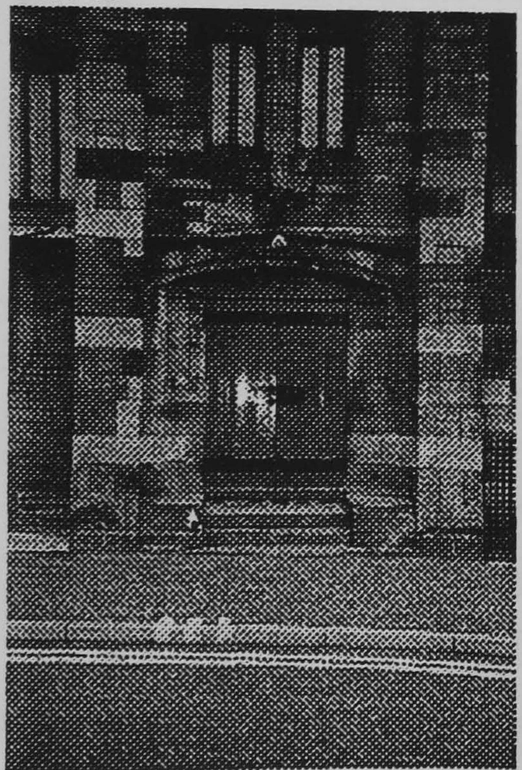
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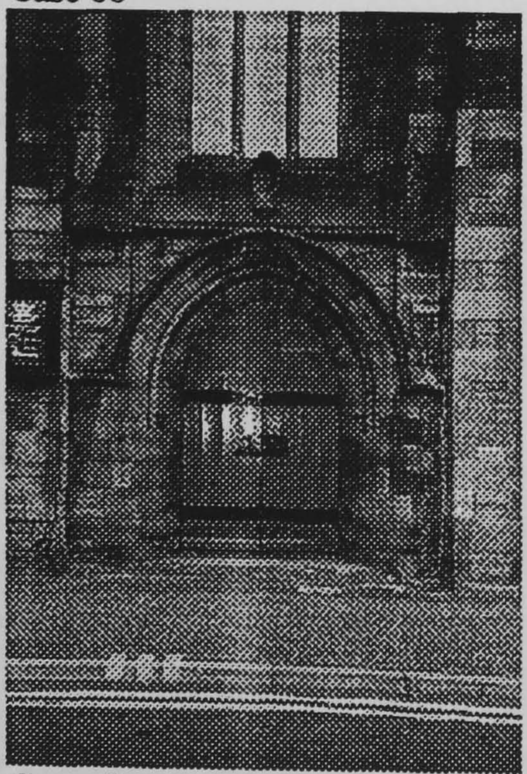
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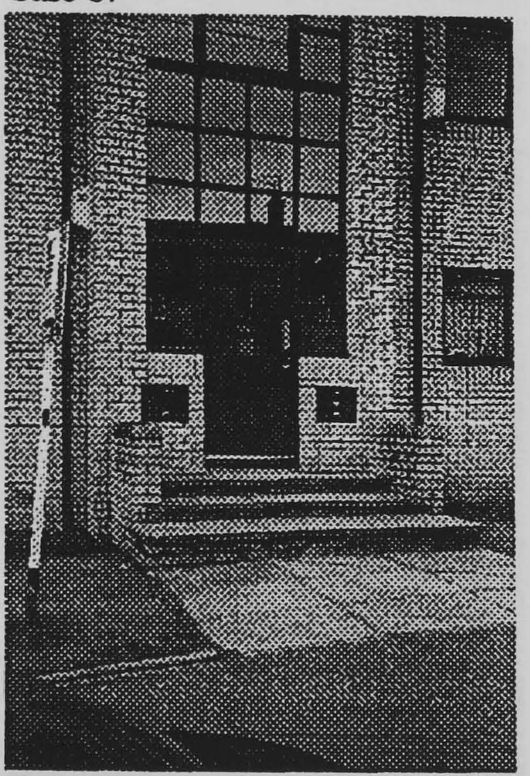
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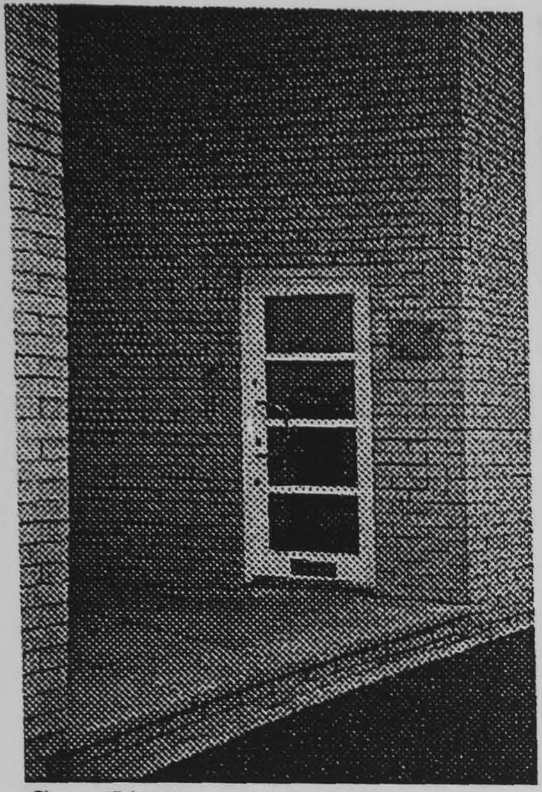
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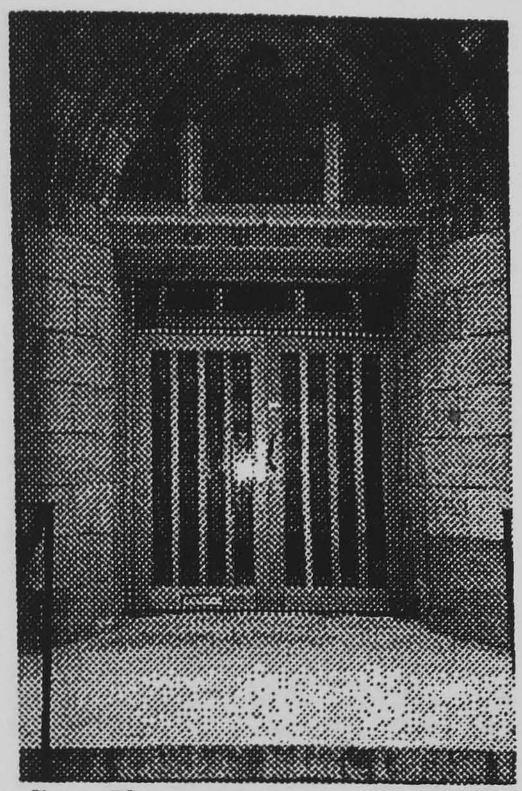
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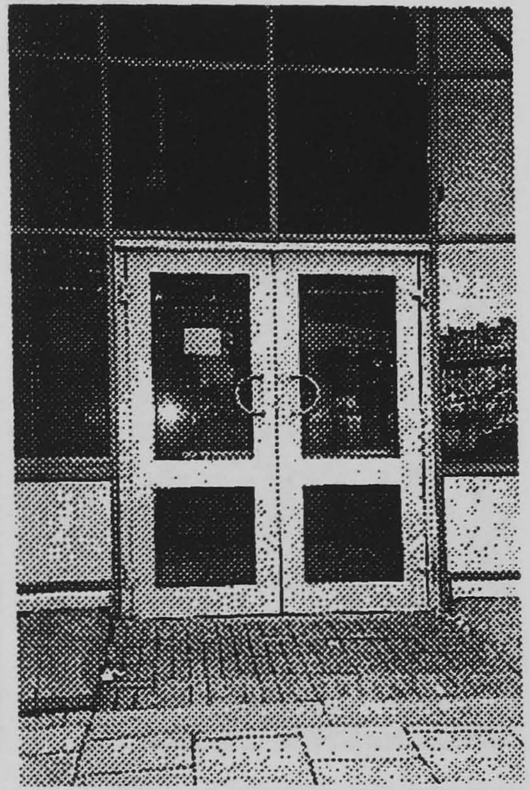
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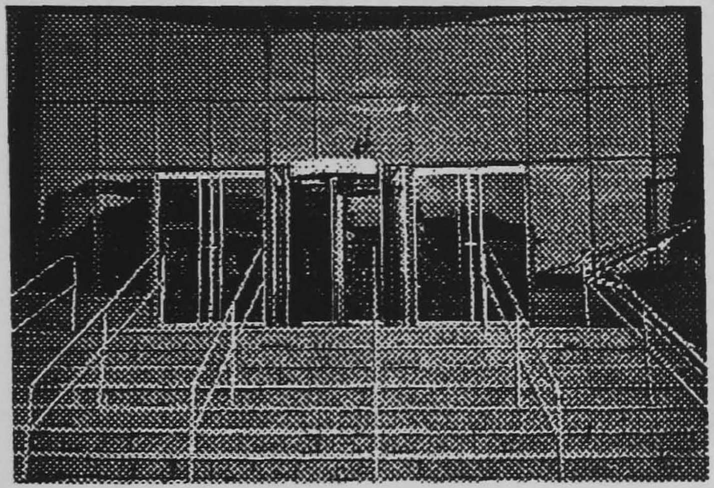
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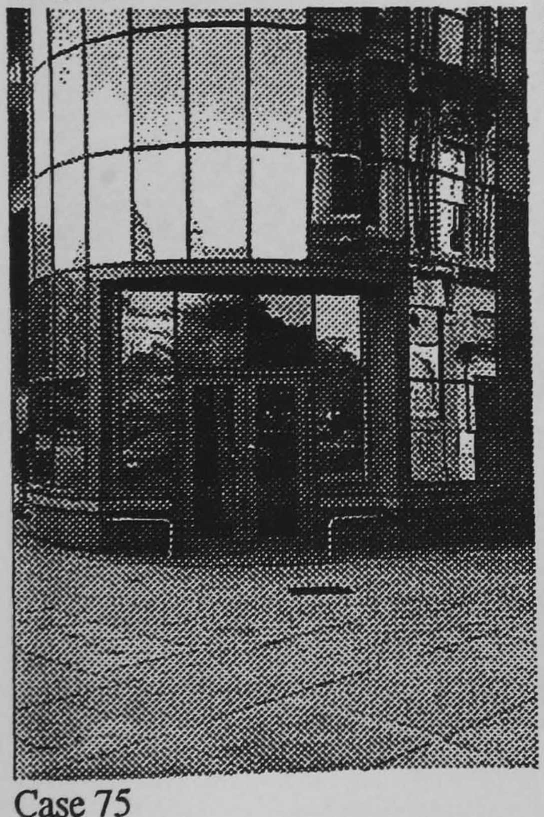
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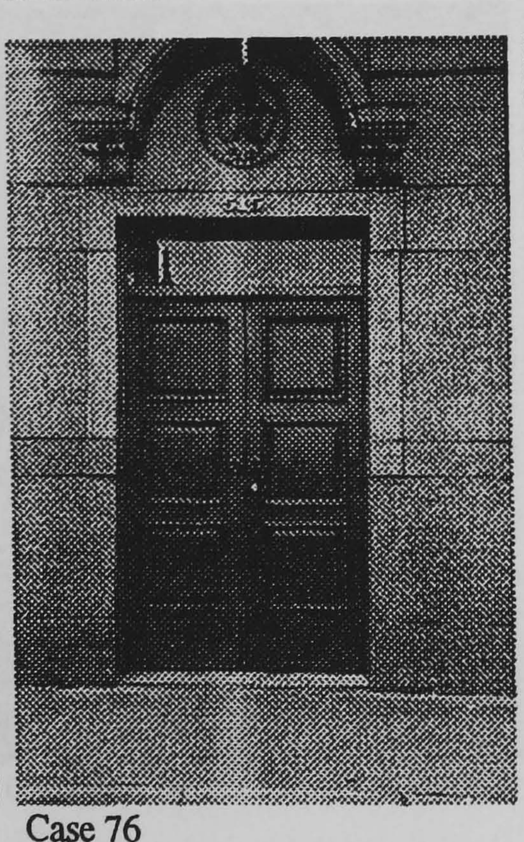
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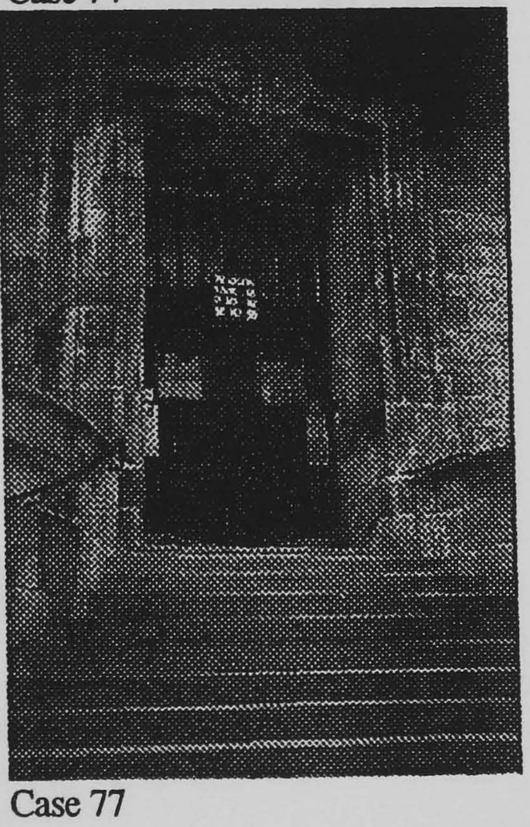
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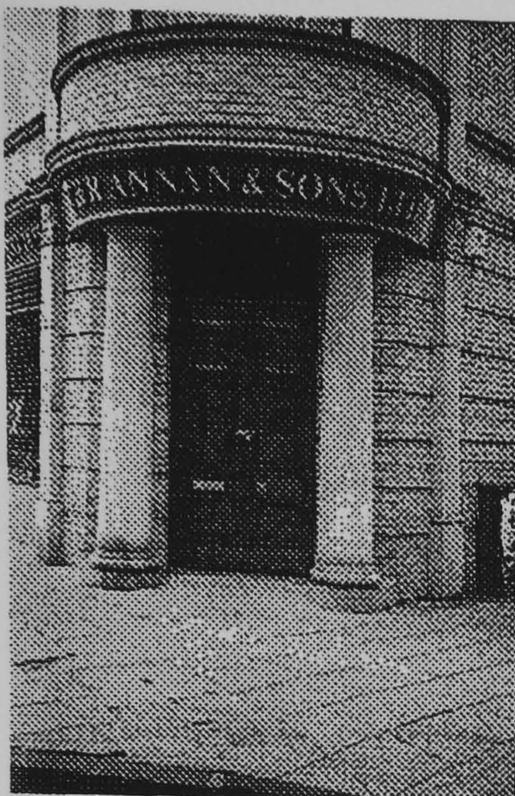
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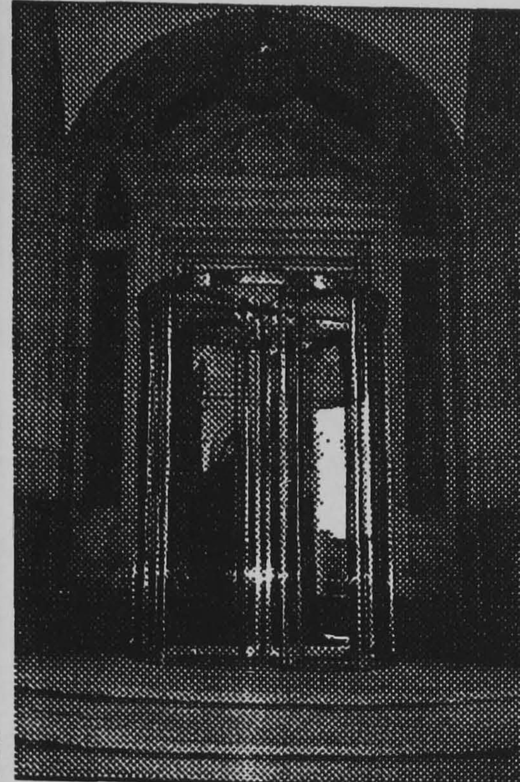
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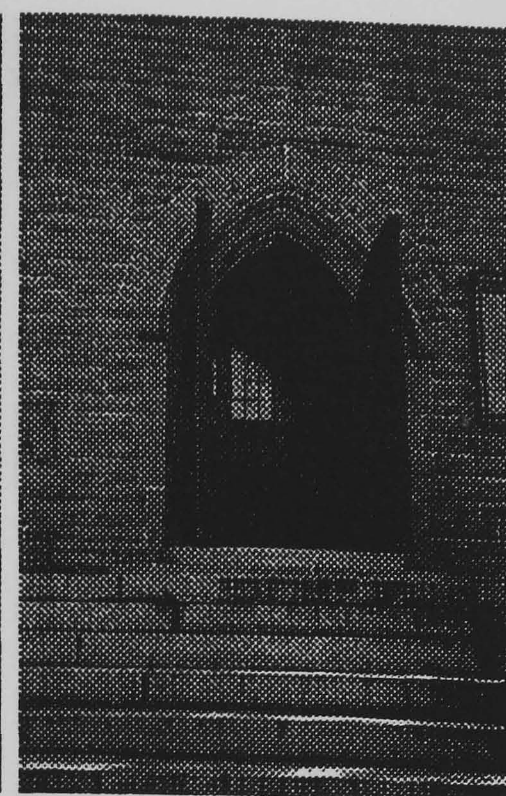
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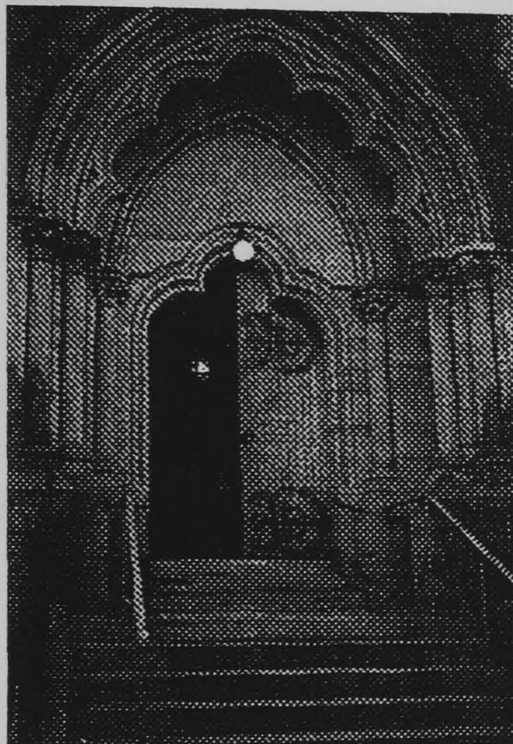
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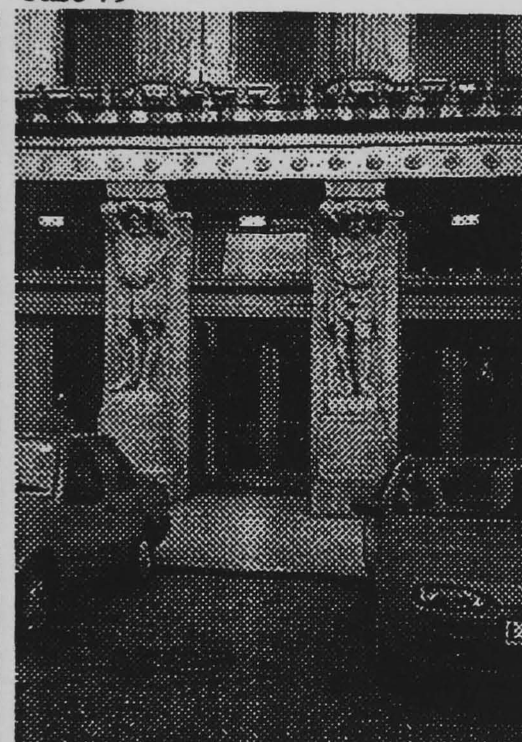
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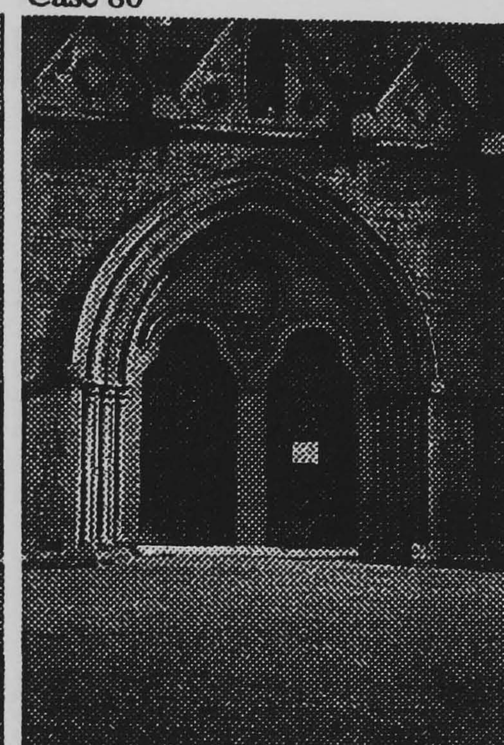
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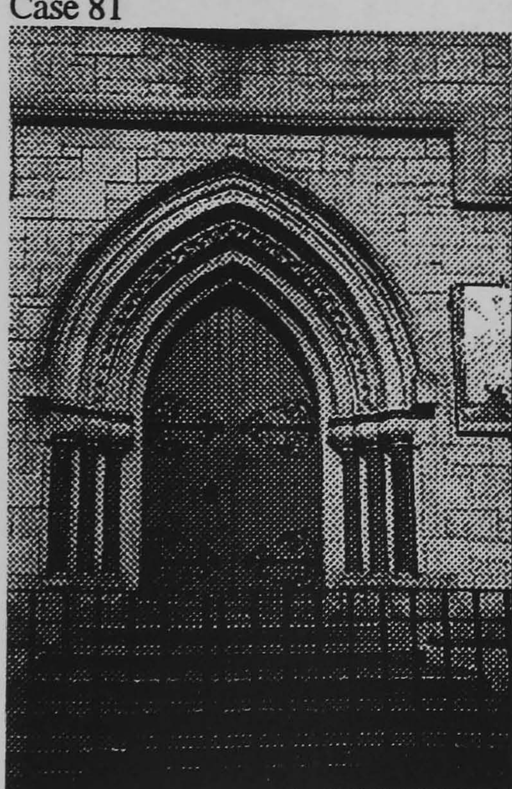
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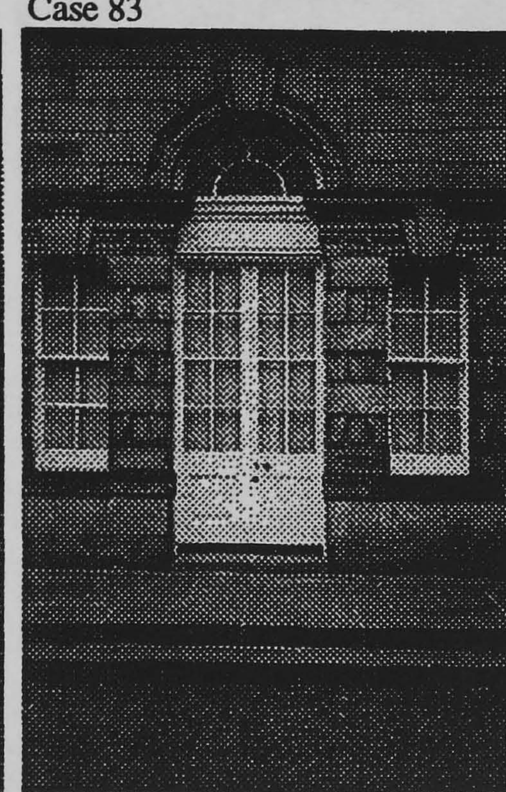
Case 85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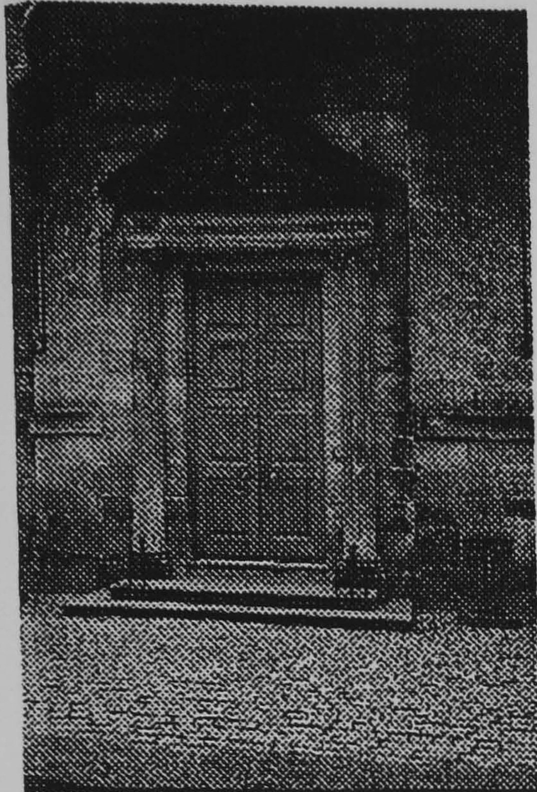
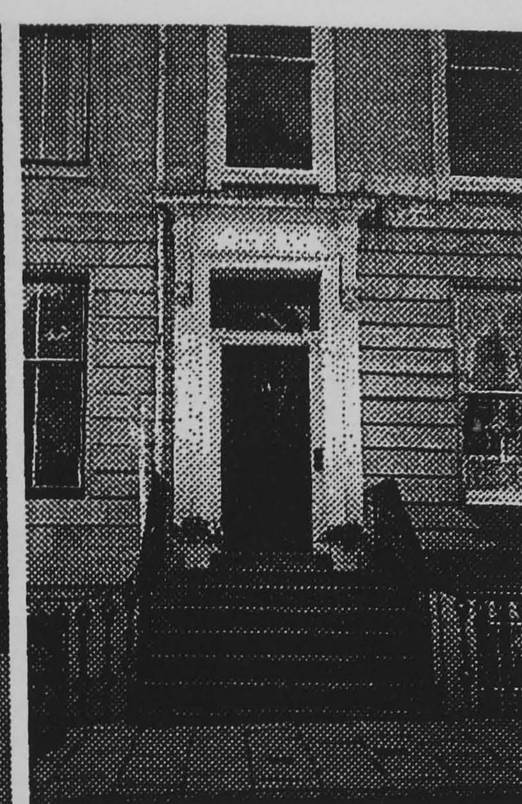


Case 87

Case 88



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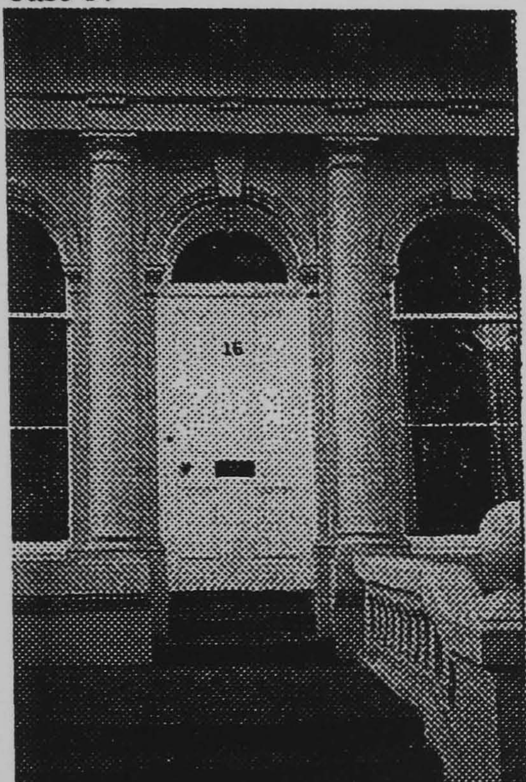
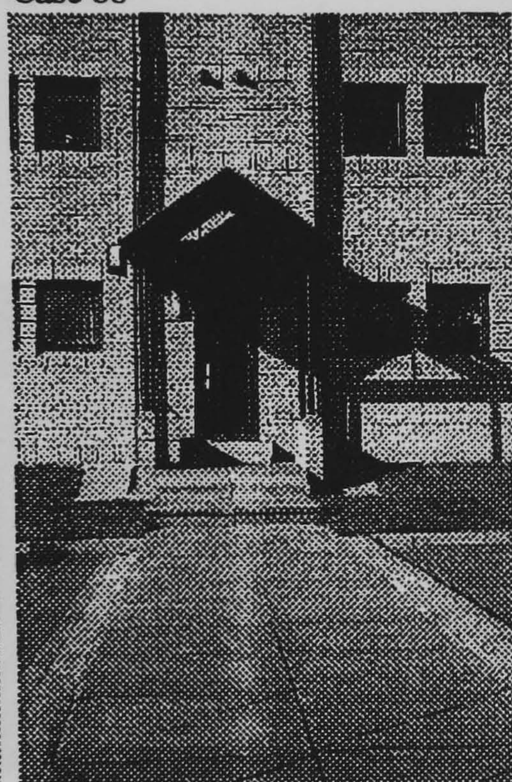
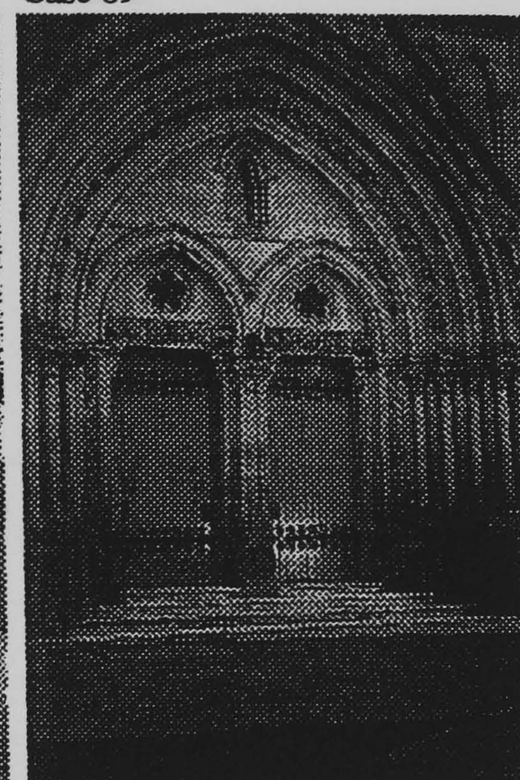


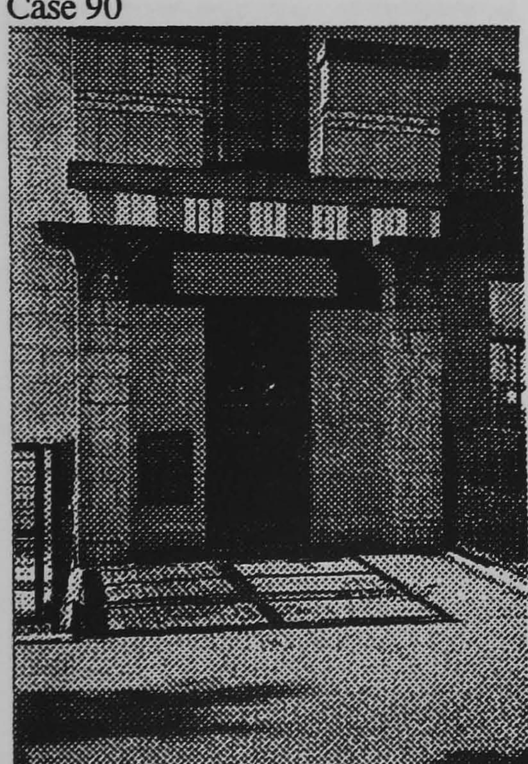
Case 90



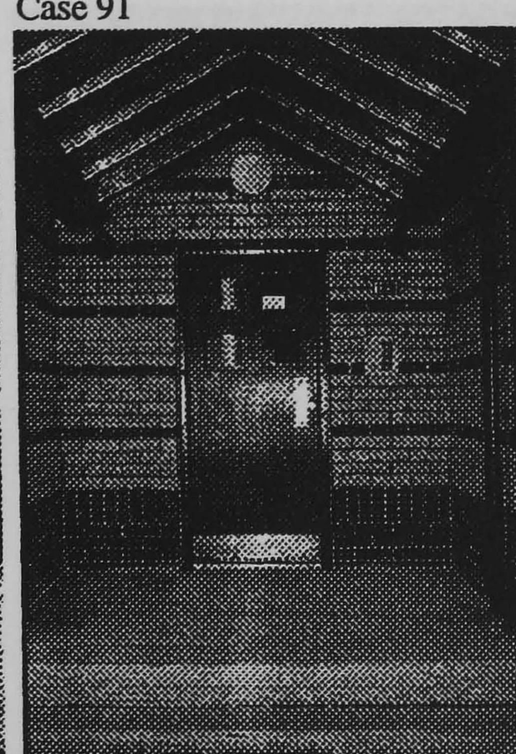
Case 91



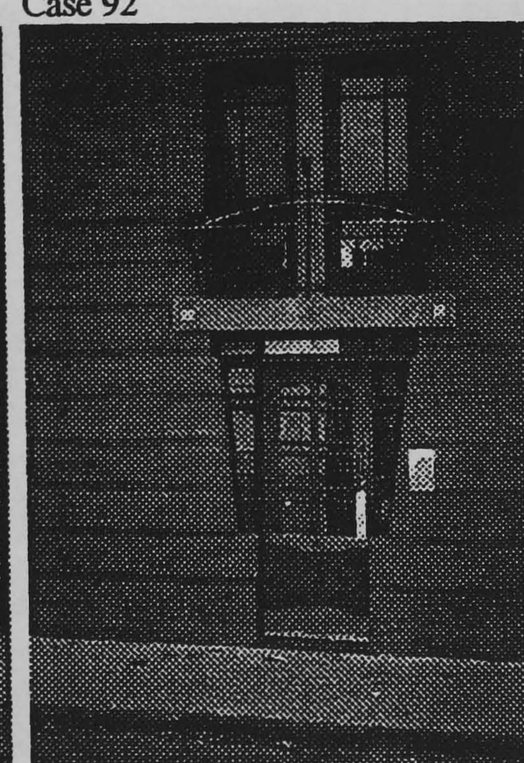
Case 92



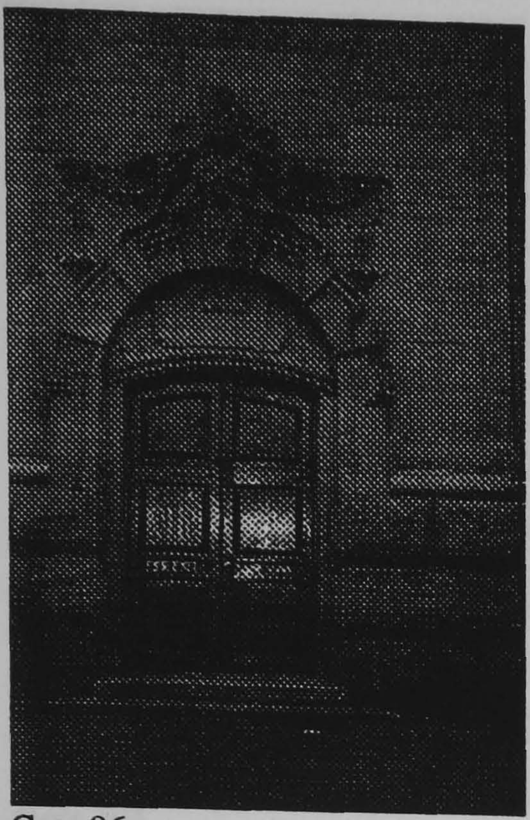
Case 93

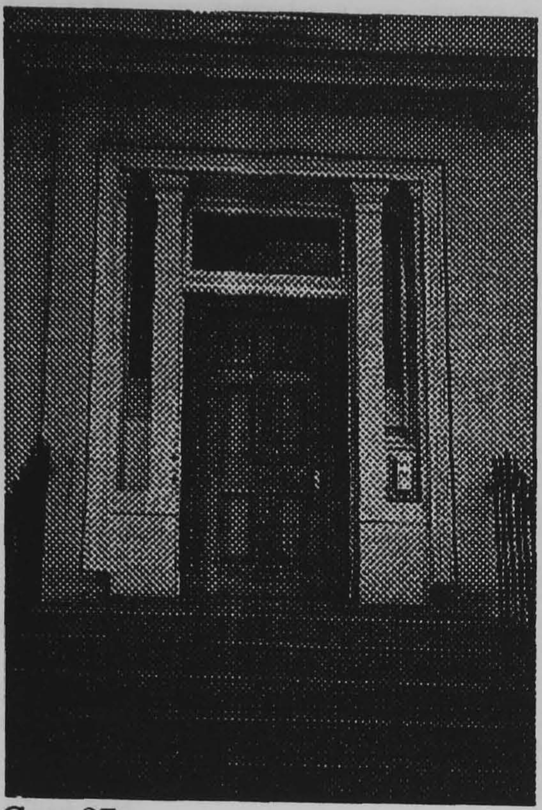


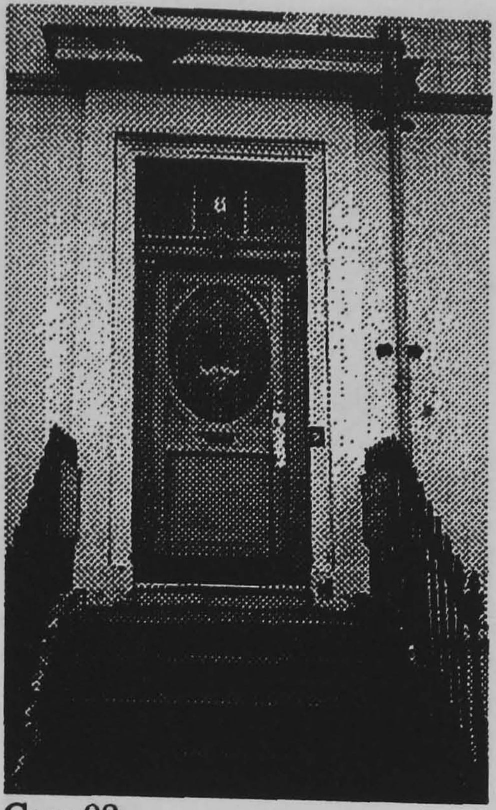
Case 94



Case 95


Case 96


Case 97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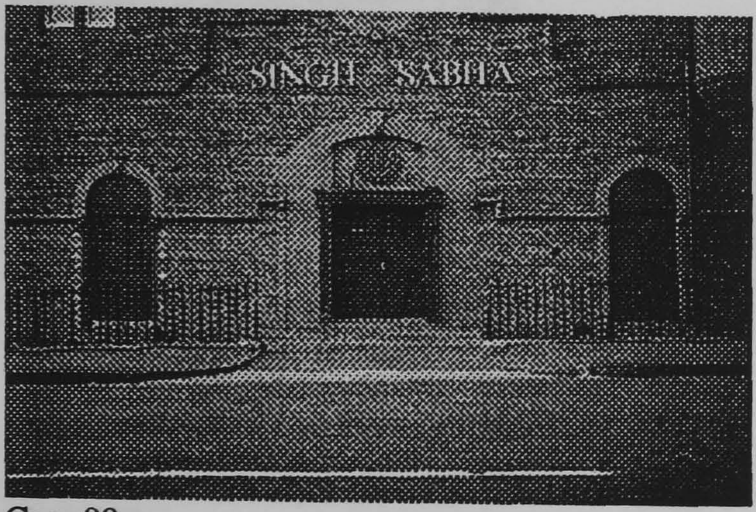
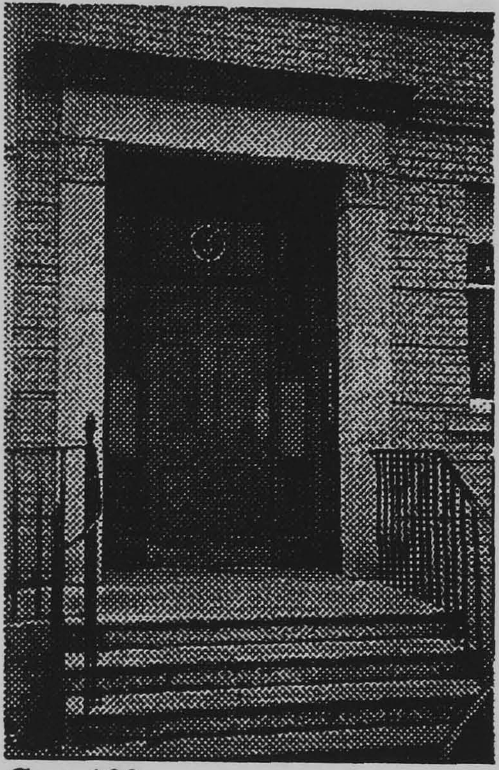


Case 99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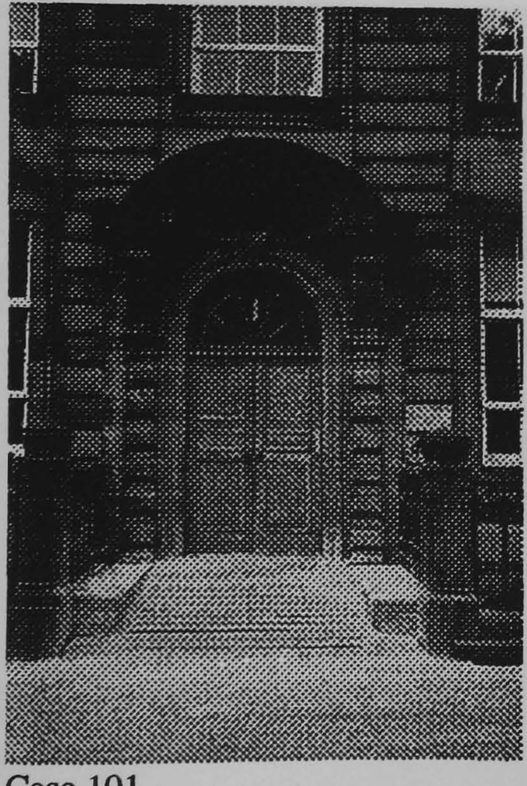
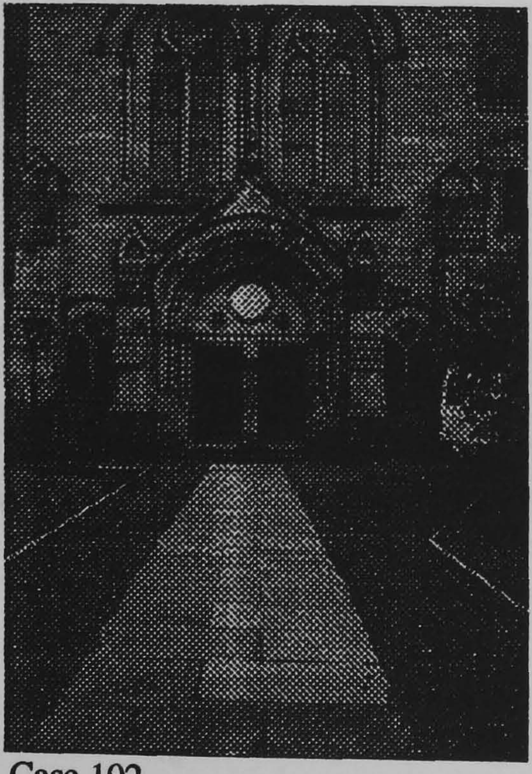
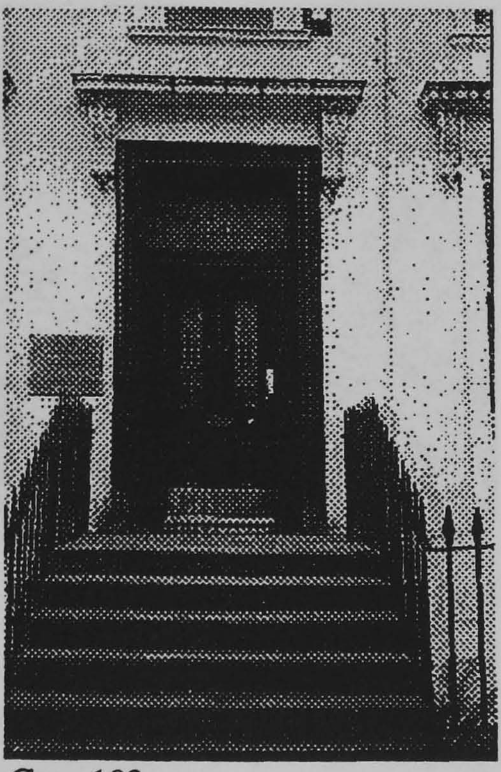
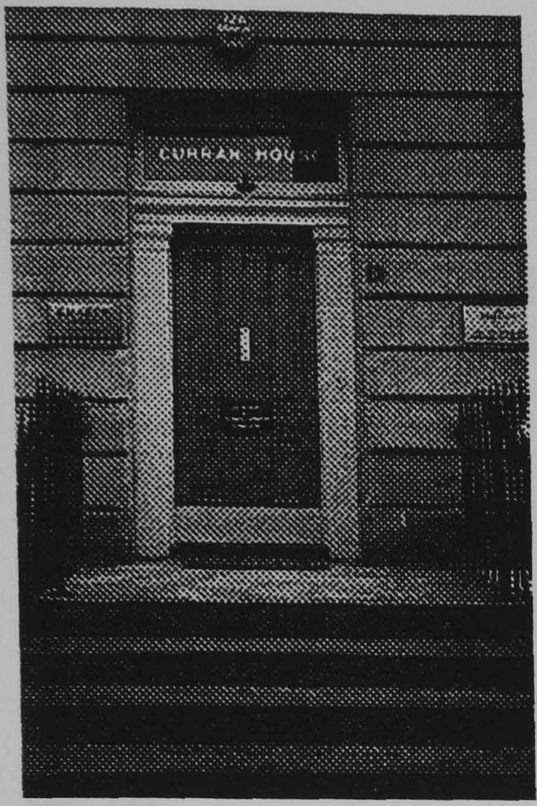
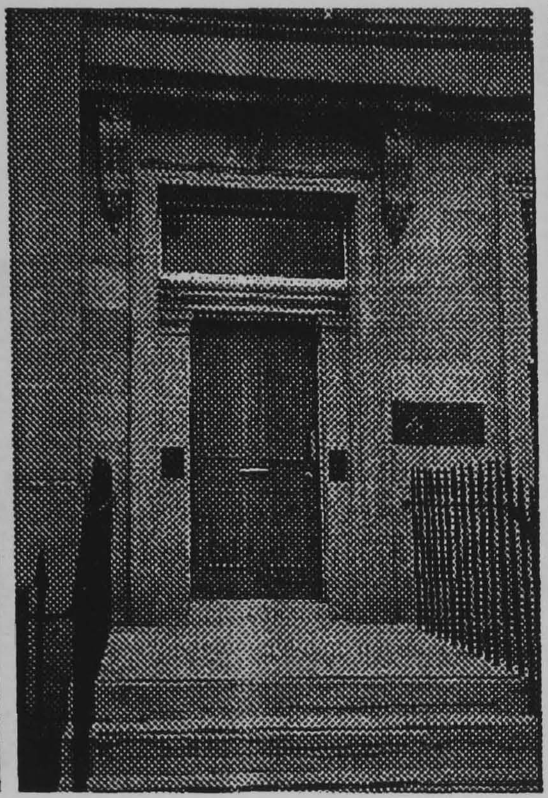
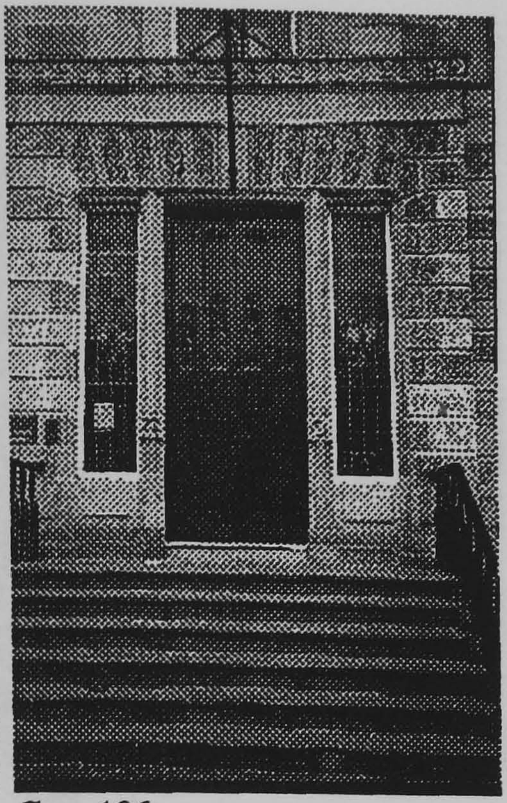

Case 101

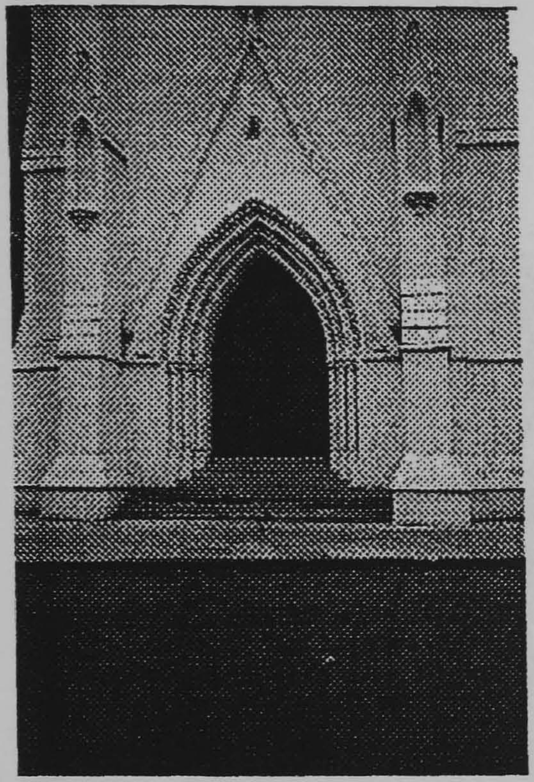

Case 102

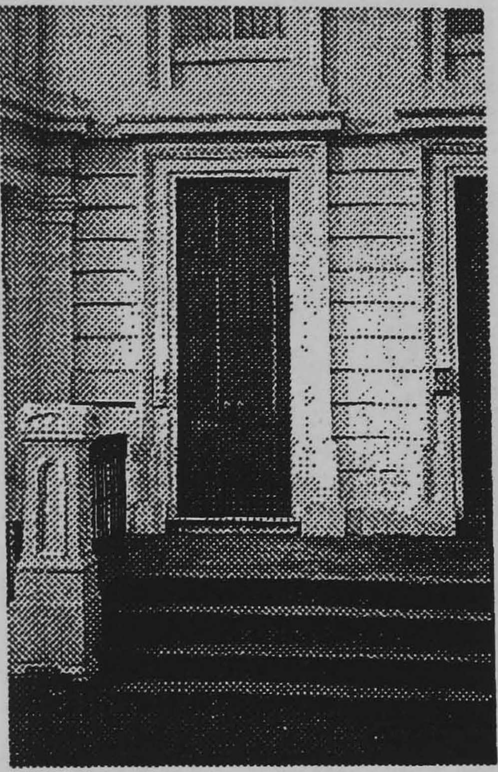

Case 103

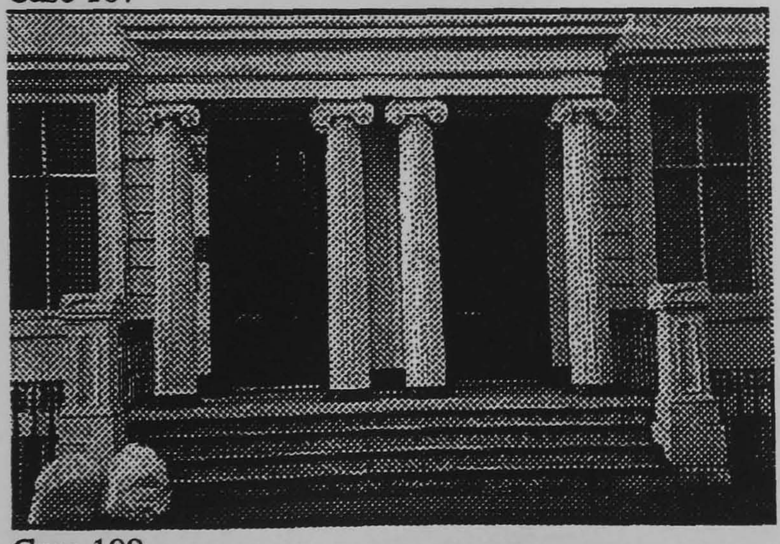

Case 104

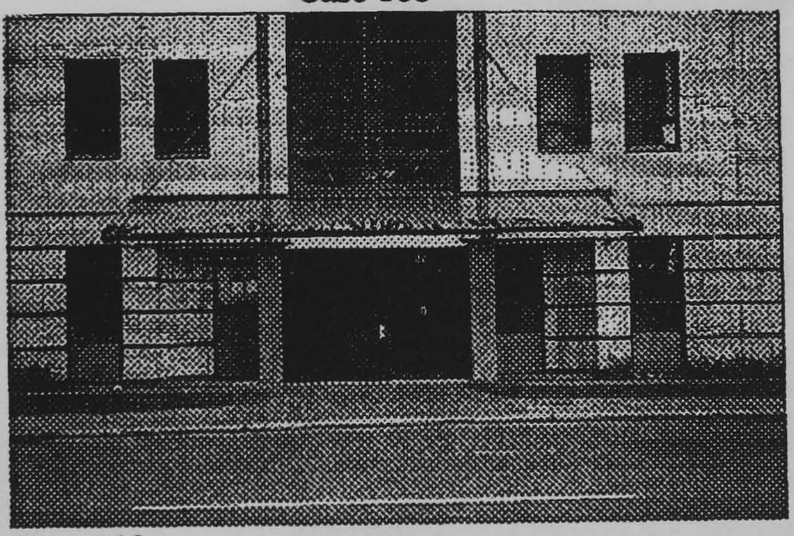

Case 105

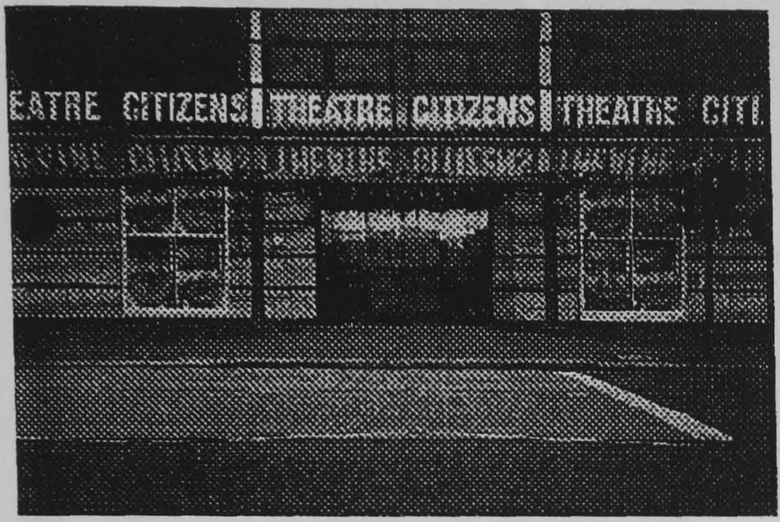

Case 106


Case 107

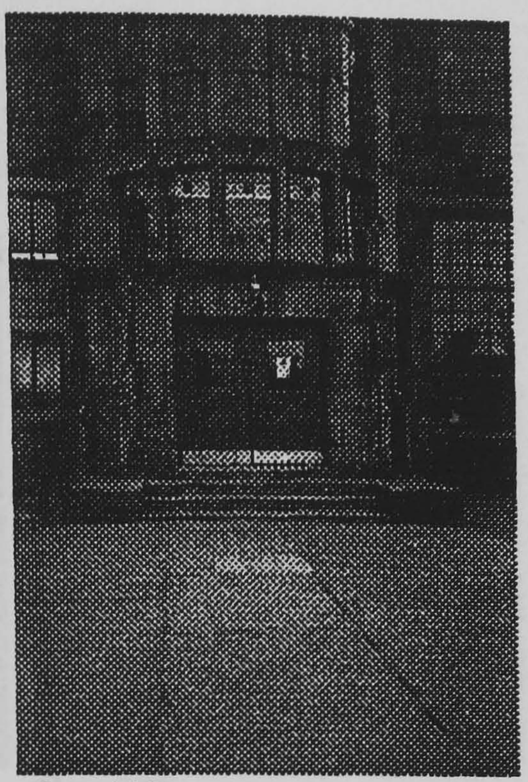

Case 108

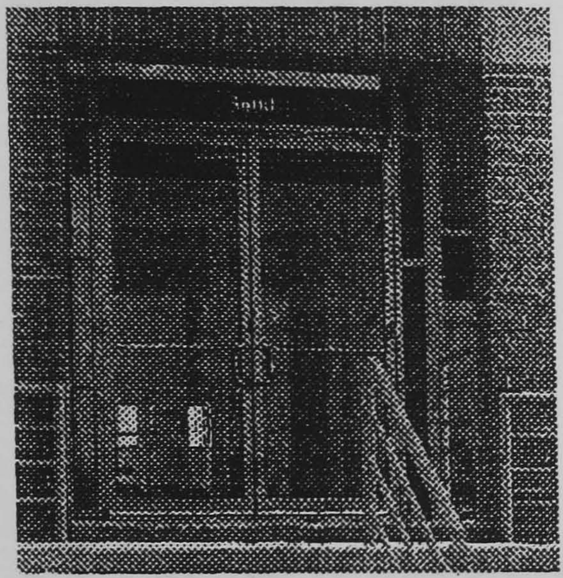

Case 109

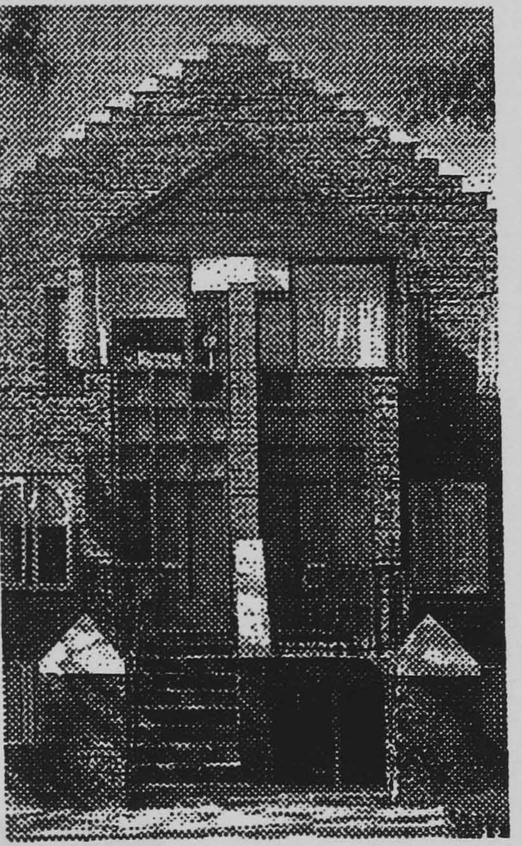

Case 110

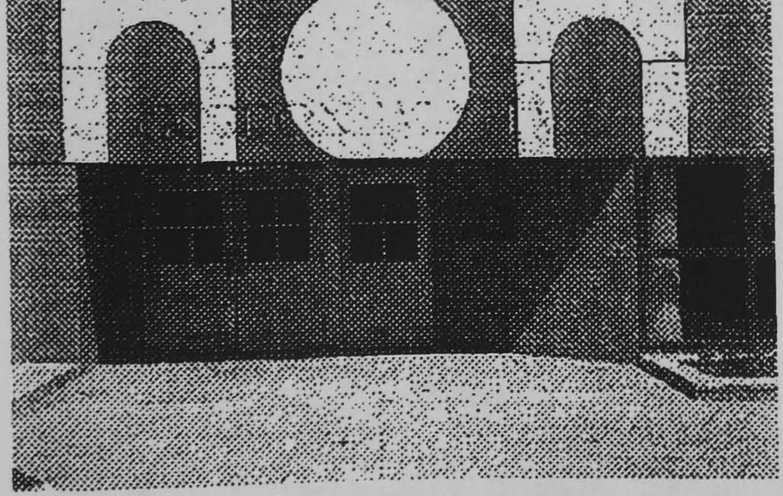


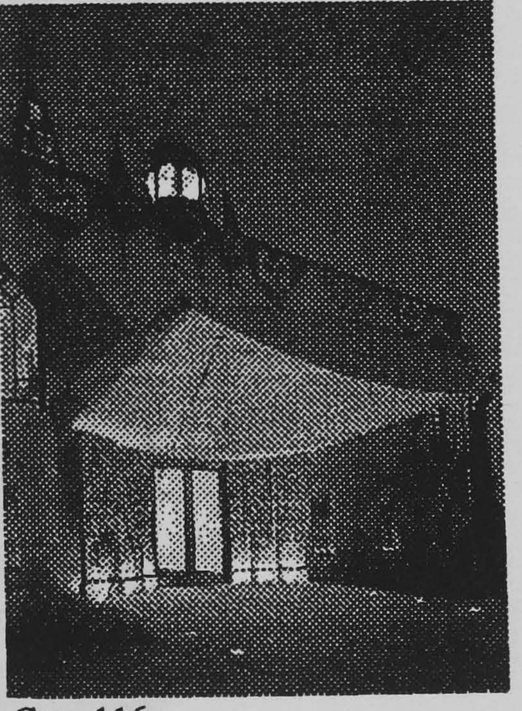
Case 111

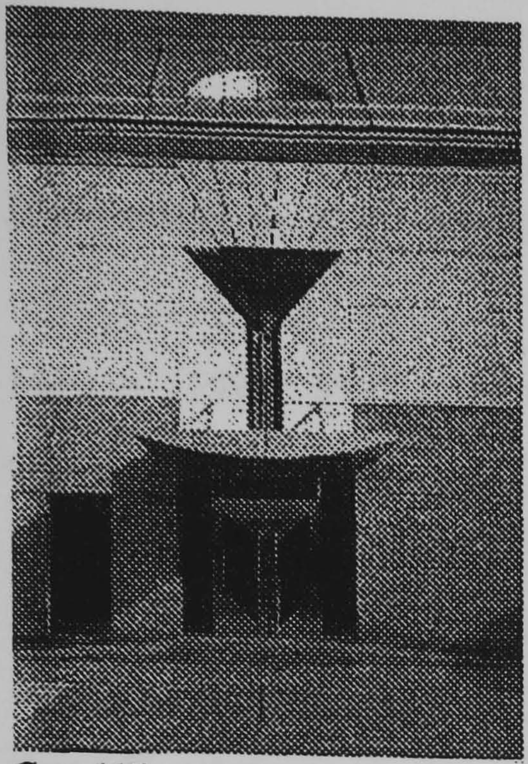

Case 112

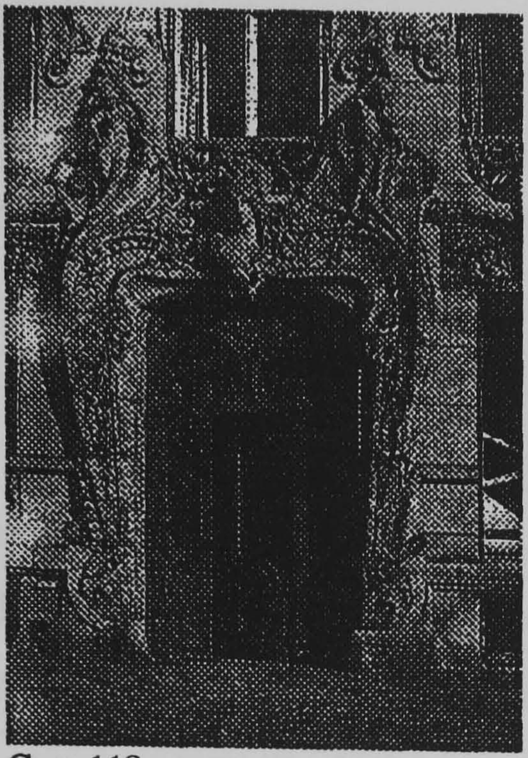

Case 113

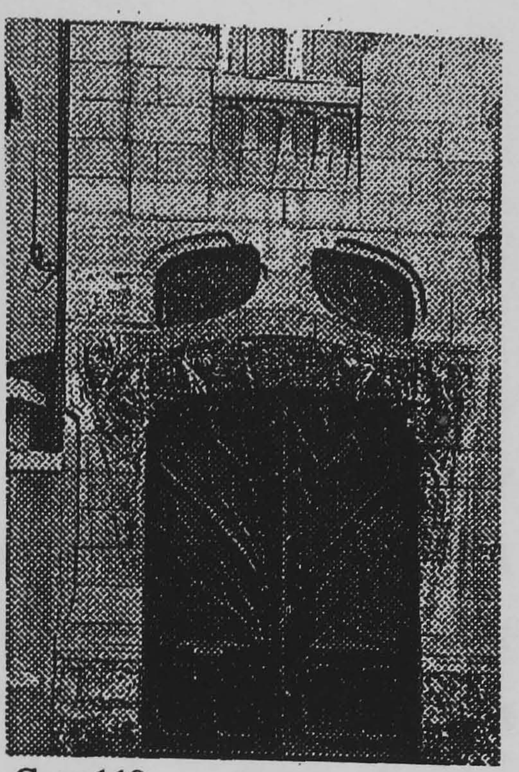

Case 114

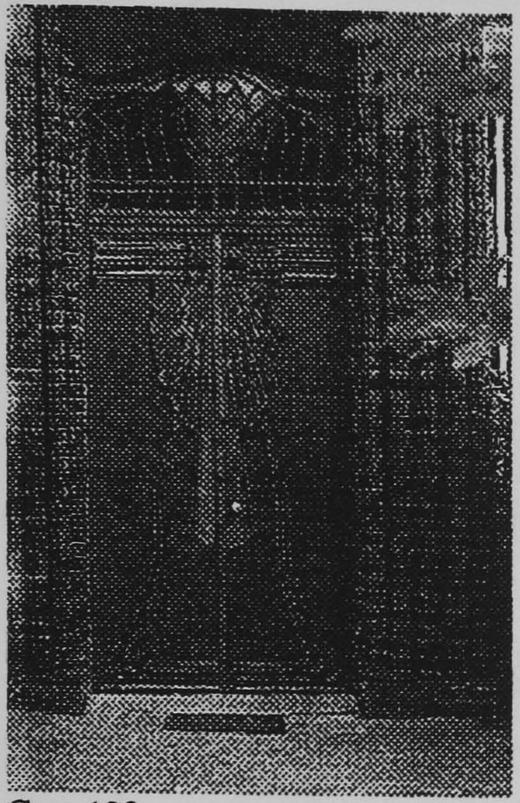

Case 115

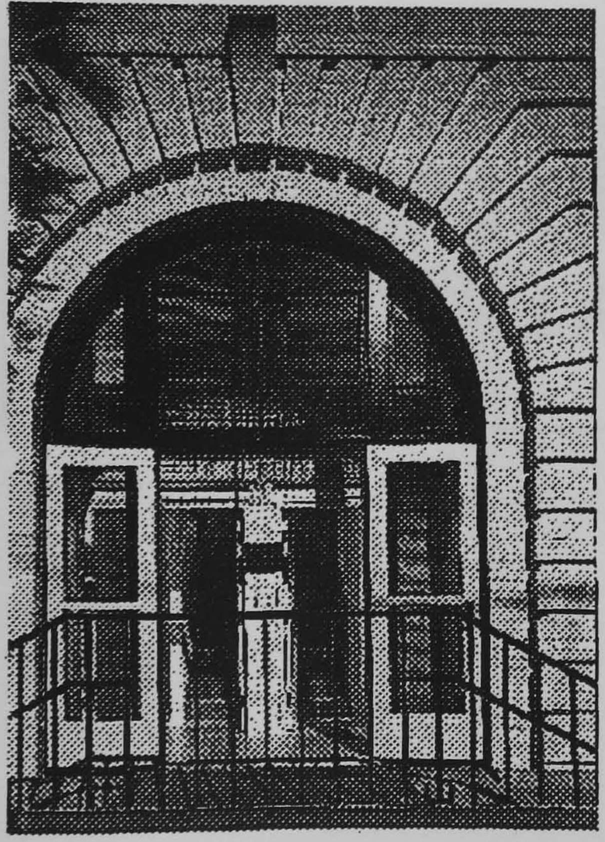

Case 116

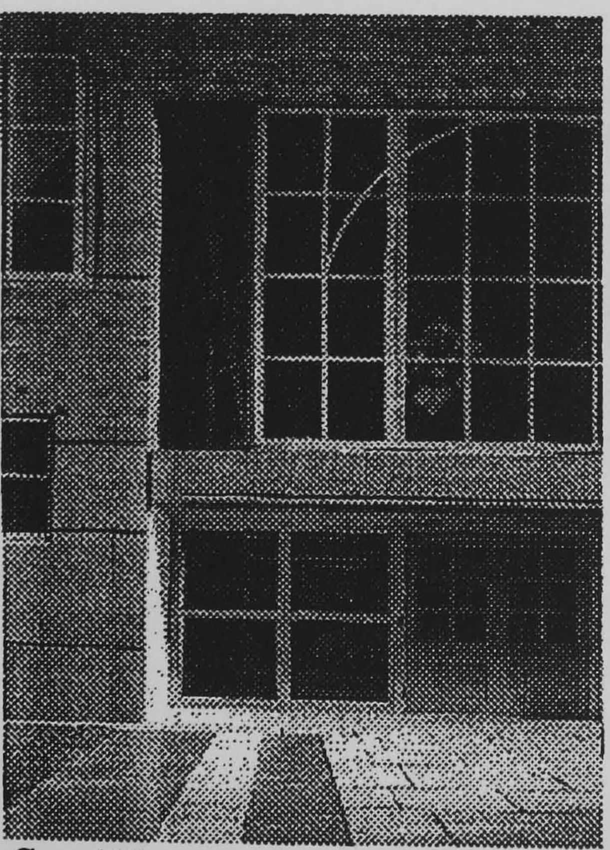

Case 117


Case 118


Case 119


Case 120


Case 121


Case 122

Appendix 2

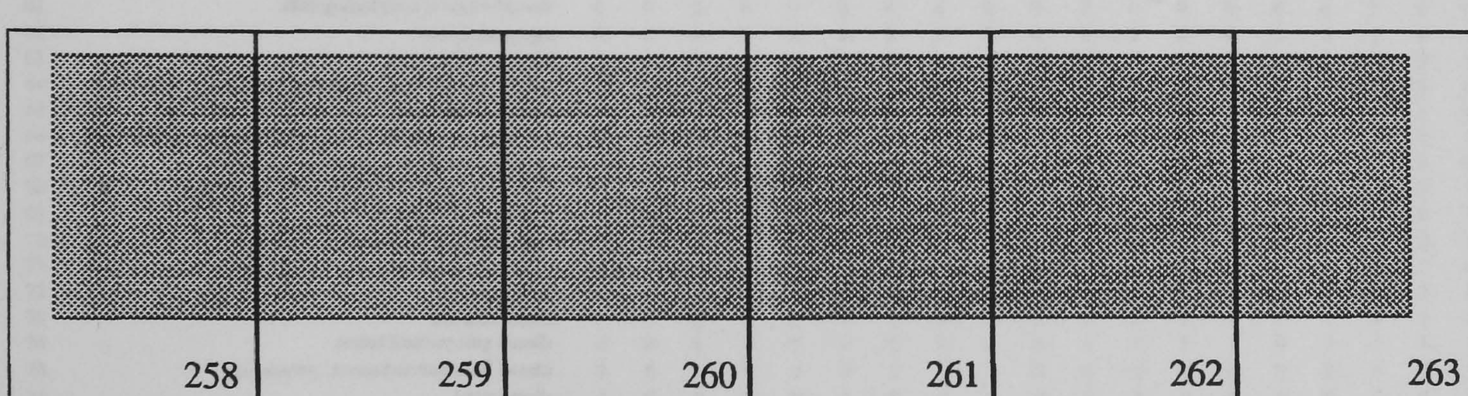
Knowledge-base matrix of the 'extended domain'

Mustoe (1990, 1993) proposes a knowledge representation that adopts a Boolean classification structure. This appendix shows the 'extended domain' in this kind of representation. This representation may suggest a relational database. However, there are substantial differences. The relationships represented are actually encoded in the system as true bit-strings and not as rules. Moreover, the control system will not operate on them through *'if-then'* statements or a query language, but through a direct bit-string manipulation, as explained in Chapter 3.

Each column represents the description of an instance where a feature present is encoded as a bit of value '1' while a feature not present is encoded as a bit of value '0'.

Once the matrix is too large to fit in a single page, it has been broken down into 6 small tables, each with its own labels of columns and rows.

The key map bellow indicates the relationship between tables. The numbers indicate the page in which each table can be found.



	Instance Number >>	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	*main entrance*	1	0	1	1	1	1	1	1	1	1	1	0	0	1	0	0	1	0	0	1	1
2	*secondary entrance*	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0
3	public access	0	0	0	1	0	0	0	0	1	1	1	0	1	1	0	0	1	0	0	0	0
4	restricted access	1	0	1	0	1	1	1	1	0	0	0	0	0	0	0	1	0	1	0	1	1
5	exit only	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0
6	*gives access to: air lock, vestibule or foyer*	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	0	1	0	0	1	1
7	*gives access to: corridor or aisle*	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	1	1	0	0
8	*gives access to: shop or working room*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
9	aligned to the facade	0	0	1	1	1	0	0	0	0	0	1	1	0	0	1	0	0	1	0	0	1
10	pulled out from the facade	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
11	pulled in from the facade	0	0	0	0	0	1	1	0	1	1	0	0	1	1	0	1	1	0	1	1	0
12	*flat door top*	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	0	1	1	1
13	*semi-circular door top arch*	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0
14	*segmental door top arch*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	*pointed door top arch*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	*round trefoil door top arch*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
17	top flat moulding	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	top curved moulding	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	1	0	0	0
19	triangular pediment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	semi-circular or segmental pediment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	*squared fanlight*	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
22	*fanlight with undulate top*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	*pointed arch fanlight*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	*semi-circular or segmental arch fanlight*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	pointed arch tympanum	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0
26	semi-circular arch tympanum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	*tracery or steelwork on fanlight or tympanum*	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0
28	*stained glass on fanlight*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	flat retangular porch	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
30	flat semi-circular porch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	pediment porch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	segmental (concave) porch	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0
33	convex porch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	*columns supporting porch*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	*walls supporting porch*	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	1	0
36	*cables supporting porch*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	lateral squared section column	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	lateral cylindrical section column	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
39	lateral vertical moulding	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0
40	window in one side	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1
41	windows in both sides	1	1	0	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0
42	*vertical glass tower*	1	1	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1
43	*angular connection with glass tower*	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44	*decorative sculptures*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45	Surroundings material: glass	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1
46	Surroundings material: brick	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1
47	Surroundings material: smooth stone	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	0
48	Surroundings material: rough stone	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	1	0	0	0
49	Surroundings material: concrete blocks	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
50	Surroundings material: concrete exposed	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
51	Surroundings material: timber	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52	Surroundings material: smooth plasterwork	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53	Surroundings material: rusticated plasterwork	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
54	Surroundings materials: tiles or small tiles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55	Surroundings material: metal	1	1	1	0	1	1	1	1	0	1	0	0	0	0	0	0	0	0	1	1	1
56	*swinging door: one single*	0	1	1	0	0	1	1	1	0	0	1	1	0	0	1	0	0	0	1	1	1
57	*swinging door: two singles*	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
58	*swinging door: one double*	1	0	0	1	1	0	0	0	1	0	0	0	1	0	0	1	1	1	0	0	0
59	*swinging door: triple, two doubles or more*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60	*revolving door (with four leaves)*	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
61	*sliding door (one or more leaves)*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	leaf: plain opaque	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63	leaf: plain transparent	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
64	leaf: semi-opaque plain with one or more light cross panels	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
65	leaf: paneled opaque	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0
66	leaf: paneled semi-opaque with one or more light cross panels	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
67	leaf: framed with one or two light cross panels	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
68	leaf: framed with three or more light cross panels	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1
69	*steelwork leaf decoration*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
70	leaf mat.: non-stained glass	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	1	1	1
71	leaf mat.: stained glass	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	leaf mat.: metal	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1
73	leaf mat.: timber	0	0	0	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0
74	*round knob or ring handle*	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	1	1	0	0	0
75	*retangular, squared or trapezoid handle*	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1
76	*lever handle*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
77	*long horizontal static handle*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
78	*long vertical static handle*	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
79	*short vertical static handle*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
80	*curved static handle*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Instance Number >>	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
1	*main entrance*	1	1	0	1	1	1	1	1	1	0	1	1	0	0	1	0	1	1	0	1	1
2	*secondary entrance*	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	1	0	0
3	public access	0	1	0	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1
4	restricted access	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
5	exit only	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
6	*gives access to: air lock, vestibule or foyer*	1	1	1	1	1	1	1	1	1	0	1	1	0	0	1	1	1	1	1	1	1
7	*gives access to: corridor or aisle*	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0
8	*gives access to: shop or working room*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	aligned to the facade	0	1	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
10	pulled out from the facade	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	pulled in from the facade	1	0	0	1	1	1	0	1	0	1	1	1	1	0	1	1	1	1	1	1	1
12	*flat door top*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
13	*semi-circular door top arch*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	*segmental door top arch*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	*pointed door top arch*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	*round trefoil door top arch*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	top flat moulding	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
18	top curved moulding	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0
19	triangular pediment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	semi-circular or segmental pediment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	*squared fanlight*	0	0	1	1	0	0	1	0	1	1	1	1	1	1	1	0	0	0	0	1	0
22	*fanlight with undulate top*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	*pointed arch fanlight*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	*semi-circular or segmental arch fanlight*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0
25	pointed arch tympanum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	semi-circular arch tympanum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	*tracery or steelwork on fanlight or tympanum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
28	*stained glass on fanlight*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	flat retangular porch	0	0	0	0	0	1	1	0	0	0	1	1	1	0	0	0	0	0	1	1	1
30	flat semi-circular porch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	pediment porch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	segmental (concave) porch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	convex porch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	*columns supporting porch*	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
35	*walls supporting porch*	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	1
36	*cables supporting porch*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	lateral squared section column	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
38	lateral cylindrical section column	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
39	lateral vertical moulding	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
40	window in one side	1	1	1	0	0	1	0	0	0	0	0	1	1	1	0	0	0	0	1	0	1
41	windows in both sides	0	0	0	1	1	0	1	1	1	0	1	0	0	0	1	0	1	0	0	1	0
42	*vertical glass tower*	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
43	*angular connection with glass tower*	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
44	*decorative sculptures*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
45	Surroundings material: glass	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
46	Surroundings material: brick	1	1	1	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	1	1	1
47	Surroundings material: smooth stone	0	0	0	0	0	1	0	1	0	0	0	0	1	0	1	1	1	1	0	0	0
48	Surroundings material: rough stone	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49	Surroundings material: concrete blocks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	Surroundings material: concrete exposed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
51	Surroundings material: timber	0	0	0	1	0	0	0	0	0	0	1	0	1	1	1	0	0	0	0	0	1
52	Surroundings material: smooth plasterwork	0	0	0	0	0	1	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0
53	Surroundings material: rusticated plasterwork	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
54	Surroundings materials: tiles or small tiles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55	Surroundings material: metal	1	1	1	1	1	1	1	1	1	1	0	1	0	0	1	0	1	0	1	0	1
56	*swinging door: one single*	1	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
57	*swinging door: two singles*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58	*swinging door: one double*	0	1	0	1	0	1	1	0	1	0	1	0	1	1	1	1	0	1	0	1	0
59	*swinging door: triple, two doubles or more*	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	1
60	*revolving door (with four leaves)*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61	*sliding door (one or more leaves)*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
62	leaf: plain opaque	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63	leaf: plain transparent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0
64	leaf: semi-opaque plain with one or more light cross panels	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
65	leaf: paneled opaque	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
66	leaf: paneled semi-opaque with one or more light cross panels	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
67	leaf: framed with one or two light cross panels	0	1	0	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	1	0	1
68	leaf: framed with three or more light cross panels	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
69	*steelwork leaf decoration*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
70	leaf mat.: non-stained glass	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1
71	leaf mat.: stained glass	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	leaf mat.: metal	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	1	0	1	1	1
73	leaf mat.: timber	0	0	0	1	0	0	0	0	0	0	1	0	1	1	1	1	0	1	0	0	0
74	*round knob or ring handle*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
75	*retangular, squared or trapezoid handle*	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0	1
76	*lever handle*	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
77	*long horizontal static handle*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0
78	*long vertical static handle*	0	1	1	1	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	1	0
79	*short vertical static handle*	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0
80	*curved static handle*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Instance Number >>	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
1	*main entrance*	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	0	1
2	*secondary entrance*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0
3	public access	1	1	1	1	1	1	1	0	0	1	1	1	1	0	1	0	1	1	1	0	0
4	restricted access	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	1	0	0	0	1	1
5	exit only	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	*gives access to: air lock, vestibule or foyer*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1
7	*gives access to: corridor or aisle*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
8	*gives access to: shop or working room*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
9	aligned to the facade	0	0	1	0	0	0	0	1	0	0	0	1	1	1	1	1	0	1	1	1	0
10	pulled out from the facade	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	pulled in from the facade	1	1	0	1	1	1	1	0	1	1	1	0	0	0	0	0	1	0	0	0	1
12	*flat door top*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
13	*semi-circular door top arch*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	*segmental door top arch*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	*pointed door top arch*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	*round trefoil door top arch*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	top flat moulding	1	1	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0
18	top curved moulding	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	0
19	triangular pediment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	semi-circular or segmental pediment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	*squared fanlight*	1	0	0	1	1	1	0	0	0	1	1	0	0	0	0	1	0	0	0	0	1
22	*fanlight with undulate top*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	*pointed arch fanlight*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
24	*semi-circular or segmental arch fanlight*	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
25	pointed arch tympanum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0
26	semi-circular arch tympanum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	*tracery or steelwork on fanlight or tympanum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
28	*stained glass on fanlight*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	flat retangular porch	0	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	flat semi-circular porch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
31	pediment porch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	segmental (concave) porch	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
33	convex porch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	*columns supporting porch*	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	*walls supporting porch*	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
36	*cables supporting porch*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	lateral squared section column	1	0	1	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0
38	lateral cylindrical section column	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
39	lateral vertical moulding	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0
40	window in one side	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0
41	windows in both sides	0	0	0	1	0	0	1	0	0	1	0	0	1	1	0	0	0	0	0	0	1
42	*vertical glass tower*	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
43	*angular connection with glass tower*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44	*decorative sculptures*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45	Surroundings material: glass	1	0	0	1	1	1	1	0	1	1	1	0	1	1	1	1	1	0	0	0	1
46	Surroundings material: brick	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47	Surroundings material: smooth stone	0	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1
48	Surroundings material: rough stone	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
49	Surroundings material: concrete blocks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	Surroundings material: concrete exposed	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0
51	Surroundings material: timber	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0
52	Surroundings material: smooth plasterwork	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
53	Surroundings material: rusticated plasterwork	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54	Surroundings materials: tiles or small tiles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55	Surroundings material: metal	0	0	0	1	0	1	1	0	1	0	0	0	1	0	0	0	0	0	0	0	1
56	*swinging door: one single*	0	0	0	0	0	0	1	0	1	0	1	0	0	0	1	1	0	0	0	0	1
57	*swinging door: two singles*	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
58	*swinging door: one double*	1	1	1	1	0	0	0	1	0	0	0	1	1	1	0	0	0	1	1	1	0
59	*swinging door: triple, two doubles or more*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60	*revolving door (with four leaves)*	0	0	0	0	1	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
61	*sliding door (one or more leaves)*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	leaf: plain opaque	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63	leaf: plain transparent	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
64	leaf: semi-opaque plain with one or more light cross panels	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
65	leaf: paneled opaque	0	1	1	0	0	0	0	1	0	0	0	0	0	0	1	1	1	0	0	0	0
66	leaf: paneled semi-opaque with one or more light cross panels	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0
67	leaf: framed with one or two light cross panels	1	0	0	1	1	1	1	0	1	1	1	0	1	0	0	0	0	0	0	0	0
68	leaf: framed with three or more light cross panels	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1
69	*steelwork leaf decoration*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
70	leaf mat.: non-stained glass	1	0	0	1	1	1	1	0	1	1	1	1	1	1	0	0	0	1	1	1	1
71	leaf mat.: stained glass	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	leaf mat.: metal	0	0	0	1	1	1	1	0	1	1	1	1	1	0	0	0	0	1	1	1	1
73	leaf mat.: timber	1	1	1	0	1	0	0	1	0	0	0	0	0	1	1	1	1	1	1	1	0
74	*round knob or ring handle*	0	1	1	0	0	0	0	1	0	0	0	0	0	1	1	1	1	1	1	1	1
75	*retangular, squared or trapezoid handle*	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
76	*lever handle*	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
77	*long horizontal static handle*	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
78	*long vertical static handle*	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
79	*short vertical static handle*	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
80	*curved static handle*	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0

	Instance Number >>	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84
1	*main entrance*	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1
2	*secondary entrance*	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
3	public access	1	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1
4	restricted access	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
5	exit only	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	*gives access to: air lock, vestibule or foyer*	0	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1
7	*gives access to: corridor or aisle*	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	*gives access to: shop or working room*	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
9	aligned to the facade	1	1	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0
10	pulled out from the facade	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	pulled in from the facade	0	0	1	1	1	1	0	1	1	1	0	1	0	1	1	1	1	1	1	1	1
12	*flat door top*	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	0	1	0	0
13	*semi-circular door top arch*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	*segmental door top arch*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	*pointed door top arch*	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
16	*round trefoil door top arch*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
17	top flat moulding	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	1	0	0
18	top curved moulding	0	0	0	0	1	1	0	0	1	0	0	0	1	1	0	0	1	1	0	1	1
19	triangular pediment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
20	semi-circular or segmental pediment	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
21	*squared fanlight*	1	1	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	1	0	0
22	*fanlight with undulate top*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	*pointed arch fanlight*	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
24	*semi-circular or segmental arch fanlight*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	pointed arch tympanum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
26	semi-circular arch tympanum	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	*tracery or steelwork on fanlight or tympanum*	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
28	*stained glass on fanlight*	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
29	flat retangular porch	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
30	flat semi-circular porch	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
31	pediment porch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	segmental (concave) porch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	convex porch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	*columns supporting porch*	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
35	*walls supporting porch*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
36	*cables supporting porch*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	lateral squared section column	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
38	lateral cylindrical section column	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
39	lateral vertical moulding	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	1	1	1	0	1	1
40	window in one side	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	windows in both sides	1	1	1	0	0	0	1	0	0	1	1	1	0	0	0	1	0	0	0	0	0
42	*vertical glass tower*	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
43	*angular connection with glass tower*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44	*decorative sculptures*	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0
45	Surroundings material: glass	1	1	1	1	0	0	1	0	1	1	1	1	1	1	0	1	0	0	1	0	0
46	Surroundings material: brick	0	1	1	1	0	0	1	1	0	0	0	1	0	0	1	0	0	0	0	0	0
47	Surroundings material: smooth stone	1	0	0	0	1	1	0	0	1	0	0	0	1	1	0	1	0	1	1	1	1
48	Surroundings material: rough stone	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
49	Surroundings material: concrete blocks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	Surroundings material: concrete exposed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51	Surroundings material: timber	0	1	1	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0
52	Surroundings material: smooth plasterwork	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
53	Surroundings material: rusticated plasterwork	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54	Surroundings materials: tiles or small tiles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55	Surroundings material: metal	1	0	0	0	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0
56	*swinging door: one single*	0	1	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
57	*swinging door: two singles*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
58	*swinging door: one double*	1	0	0	0	1	1	0	0	1	0	1	1	1	1	1	0	1	1	0	0	1
59	*swinging door: triple, two doubles or more*	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0
60	*revolving door (with four leaves)*	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
61	*sliding door (one or more leaves)*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	leaf: plain opaque	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
63	leaf: plain transparent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
64	leaf: semi-opaque plain with one or more light cross panels	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
65	leaf: paneled opaque	0	0	0	0	1	1	0	0	0	0	0	0	1	0	1	0	1	1	0	1	1
66	leaf: paneled semi-opaque with one or more light cross panels	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67	leaf: framed with one or two light cross panels	1	0	0	0	0	0	0	0	0	1	1	1	0	0	0	1	0	0	0	0	0
68	leaf: framed with three or more light cross panels	0	1	1	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
69	*steelwork leaf decoration*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
70	leaf mat.: non-stained glass	1	1	1	1	0	0	1	1	1	1	1	1	0	1	0	1	0	0	0	0	0
71	leaf mat.: stained glass	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	leaf mat.: metal	1	0	0	1	1	1	0	1	0	1	1	1	0	0	0	1	0	1	0	1	1
73	leaf mat.: timber	0	1	1	1	1	1	1	0	1	0	0	0	1	1	1	0	1	1	1	1	1
74	*round knob or ring handle*	0	0	0	0	1	1	1	0	0	0	0	0	1	0	1	0	1	1	1	1	1
75	*retangular, squared or trapezoid handle*	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
76	*lever handle*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
77	*long horizontal static handle*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
78	*long vertical static handle*	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
79	*short vertical static handle*	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
80	*curved static handle*	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0

	Instance Number >>	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
1	*main entrance*	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1
2	*secondary entrance*	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
3	public access	1	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0
4	restricted access	0	1	0	0	1	1	1	0	1	1	1	0	1	1	1	1	1	0	1	1	1
5	exit only	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
6	*gives access to: air lock, vestibule or foyer*	1	0	1	1	1	1	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1
7	*gives access to: corridor or aisle*	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
8	*gives access to: shop or working room*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	aligned to the facade	0	1	1	0	1	1	1	0	1	0	1	1	1	1	1	0	1	1	1	1	1
10	pulled out from the facade	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	pulled in from the facade	1	0	0	1	0	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0
12	*flat door top*	0	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1
13	*semi-circular door top arch*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	*segmental door top arch*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	*pointed door top arch*	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
16	*round trefoil door top arch*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	top flat moulding	0	1	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
18	top curved moulding	1	0	0	0	0	1	0	1	0	0	0	0	1	1	1	1	0	1	1	1	1
19	triangular pediment	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0
20	semi-circular or segmental pediment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
21	*squared fanlight*	0	0	0	1	1	0	0	0	1	0	1	0	1	1	0	1	0	0	1	1	1
22	*fanlight with undulate top*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	*pointed arch fanlight*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	*semi-circular or segmental arch fanlight*	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
25	pointed arch tympanum	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0
26	semi-circular arch tympanum	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
27	*tracery or steelwork on fanlight or tympanum*	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0
28	*stained glass on fanlight*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0
29	flat retangular porch	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	flat semi-circular porch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	pediment porch	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
32	segmental (concave) porch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	convex porch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	*columns supporting porch*	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0
35	*walls supporting porch*	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
36	*cables supporting porch*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	lateral squared section column	1	0	0	0	0	0	0	0	1	0	0	0	1	0	1	1	1	0	0	0	0
38	lateral cylindrical section column	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0
39	lateral vertical moulding	1	0	0	0	1	0	0	1	0	0	0	1	1	1	0	0	1	1	1	0	1
40	window in one side	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	windows in both sides	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0
42	*vertical glass tower*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43	*angular connection with glass tower*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44	*decorative sculptures*	1	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
45	Surroundings material: glass	0	1	0	1	1	1	0	0	1	0	1	0	1	1	0	1	1	0	1	1	1
46	Surroundings material: brick	0	0	0	0	0	0	1	0	0	1	1	0	0	0	1	1	0	0	0	0	0
47	Surroundings material: smooth stone	1	1	1	0	1	0	0	1	0	0	0	1	0	0	1	0	1	1	0	1	1
48	Surroundings material: rough stone	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
49	Surroundings material: concrete blocks	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
50	Surroundings material: concrete exposed	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
51	Surroundings material: timber	0	1	0	1	0	0	1	0	1	0	0	0	1	1	1	1	0	0	1	1	0
52	Surroundings material: smooth plasterwork	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	0	0	0	1	0	1
53	Surroundings material: rusticated plasterwork	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54	Surroundings materials: tiles or small tiles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55	Surroundings material: metal	0	0	0	1	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0
56	*swinging door: one single*	0	0	0	0	1	1	1	0	1	1	1	0	1	1	0	1	0	0	1	1	1
57	*swinging door: two singles*	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0
58	*swinging door: one double*	1	1	1	1	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0
59	*swinging door: triple, two doubles or more*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60	*revolving door (with four leaves)*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61	*sliding door (one or more leaves)*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	leaf: plain opaque	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63	leaf: plain transparent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
64	leaf: semi-opaque plain with one or more light cross panels	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
65	leaf: paneled opaque	1	0	1	0	0	1	0	1	0	0	0	1	1	0	1	1	1	1	0	1	1
66	leaf: paneled semi-opaque with one or more light cross panels	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0
67	leaf: framed with one or two light cross panels	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68	leaf: framed with three or more light cross panels	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
69	*steelwork leaf decoration*	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0
70	leaf mat.: non-stained glass	0	1	0	1	1	0	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0
71	leaf mat.: stained glass	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0
72	leaf mat.: metal	0	0	0	1	0	0	0	1	1	1	1	0	0	1	0	0	0	1	1	0	0
73	leaf mat.: timber	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1
74	*round knob or ring handle*	1	1	1	0	0	1	0	1	0	0	0	1	0	0	0	1	1	1	1	1	1
75	*retangular, squared or trapezoid handle*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
76	*lever handle*	0	0	0	0	1	0	1	0	0	1	0	0	1	0	1	0	0	0	0	0	0
77	*long horizontal static handle*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
78	*long vertical static handle*	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
79	*short vertical static handle*	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0
80	*curved static handle*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Instance Number >>	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122
1	*main entrance*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	*secondary entrance*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	public access	0	1	0	0	1	1	1	1	0	1	1	1	1	0	0	1	1
4	restricted access	1	0	1	1	0	0	0	0	1	0	0	0	0	1	1	0	0
5	exit only	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	*gives access to: air lock, vestibule or foyer*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
7	*gives access to: corridor or aisle*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	*gives access to: shop or working room*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	aligned to the facade	1	0	1	1	1	1	0	0	1	0	1	1	1	1	1	1	0
10	pulled out from the facade	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
11	pulled in from the facade	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1
12	*flat door top*	1	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1
13	*semi-circular door top arch*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	*segmental door top arch*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
15	*pointed door top arch*	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	*round trefoil door top arch*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	top flat moulding	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0
18	top curved moulding	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	triangular pediment	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
20	semi-circular or segmental pediment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	*squared fanlight*	0	0	0	0	1	1	0	1	0	1	0	1	0	0	0	0	0
22	*fanlight with undulate top*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
23	*pointed arch fanlight*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	*semi-circular or segmental arch fanlight*	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0
25	pointed arch tympanum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	semi-circular arch tympanum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	*tracery or steelwork on fanlight or tympanum*	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0
28	*stained glass on fanlight*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	flat retangular porch	0	0	0	1	1	1	0	1	0	1	0	0	0	0	0	0	1
30	flat semi-circular porch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	pediment porch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	segmental (concave) porch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	convex porch	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
34	*columns supporting porch*	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0
35	*walls supporting porch*	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
36	*cables supporting porch*	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0	0
37	lateral squared section column	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
38	lateral cylindrical section column	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	lateral vertical moulding	1	1	1	0	0	0	1	0	0	0	0	0	1	1	1	0	0
40	window in one side	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	1
41	windows in both sides	1	0	0	0	0	1	0	1	0	0	0	1	1	0	0	1	0
42	*vertical glass tower*	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
43	*angular connection with glass tower*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44	*decorative sculptures*	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
45	Surroundings material: glass	1	0	0	0	1	1	0	1	1	1	0	1	1	1	1	1	1
46	Surroundings material: brick	0	0	0	0	1	1	0	1	1	1	0	0	0	0	1	1	1
47	Surroundings material: smooth stone	1	0	0	1	0	0	1	0	0	1	0	1	1	1	0	0	1
48	Surroundings material: rough stone	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49	Surroundings material: concrete blocks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	Surroundings material: concrete exposed	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
51	Surroundings material: timber	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1
52	Surroundings material: smooth plasterwork	1	1	1	1	0	0	0	0	0	0	1	0	0	0	1	0	0
53	Surroundings material: rusticated plasterwork	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54	Surroundings materials: tiles or small tiles	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
55	Surroundings material: metal	0	0	0	0	1	0	0	1	0	0	1	1	1	1	1	0	0
56	*swinging door: one single*	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
57	*swinging door: two singles*	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
58	*swinging door: one double*	1	1	1	0	1	0	1	1	0	1	1	1	0	1	1	1	1
59	*swinging door: triple, two doubles or more*	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
60	*revolving door (with four leaves)*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61	*sliding door (one or more leaves)*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	leaf: plain opaque	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
63	leaf: plain transparent	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
64	leaf: semi-opaque plain with one or more light cross panels	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
65	leaf: paneled opaque	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
66	leaf: paneled semi-opaque with one or more light cross panels	0	0	0	0	0	0	1	0	0	1	0	0	1	1	0	0	1
67	leaf: framed with one or two light cross panels	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	1	0
68	leaf: framed with three or more light cross panels	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
69	*steelwork leaf decoration*	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0
70	leaf mat.: non-stained glass	0	0	0	0	1	1	1	1	1	1	1	1	1	1	0	1	1
71	leaf mat.: stained glass	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	leaf mat.: metal	1	0	0	0	1	0	0	1	0	0	1	1	1	1	1	0	0
73	leaf mat.: timber	1	1	1	1	0	0	1	0	1	1	0	0	0	0	0	1	1
74	*round knob or ring handle*	1	1	1	1	0	0	1	0	0	0	1	0	1	1	1	0	0
75	*retangular, squared or trapezoid handle*	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
76	*lever handle*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
77	*long horizontal static handle*	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
78	*long vertical static handle*	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
79	*short vertical static handle*	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	1
80	*curved static handle*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

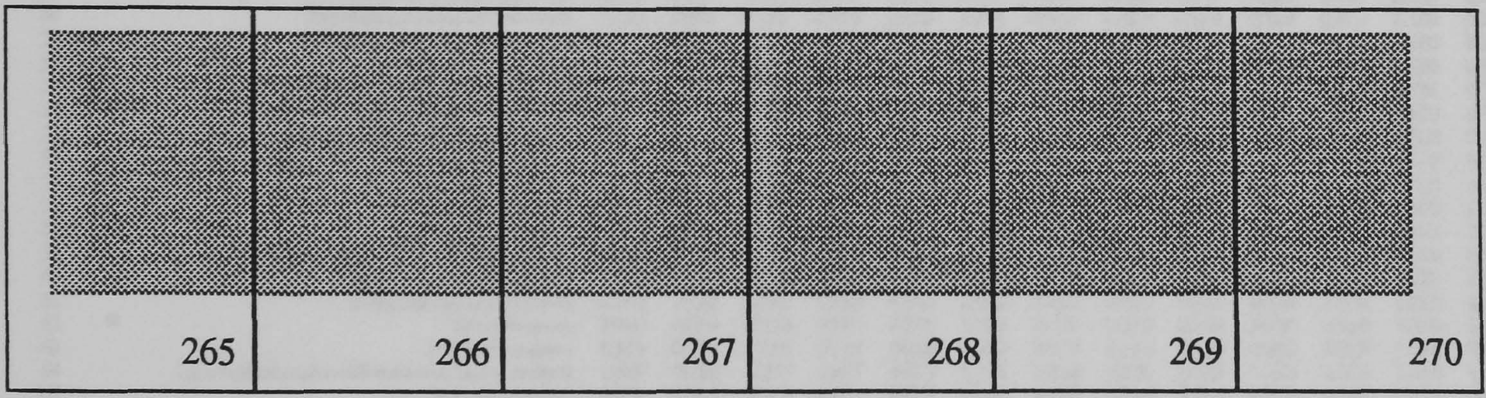
Appendix 3

Frequency table

This appendix shows a frequency table, for the 'extended domain', reporting the presence of feature 'y' given that 'x' is present. It is a matrix of 80 columns and 80 rows. Each row represents the frequencies of each column's feature given that the row's feature is present. The probability values were normalised to values between 0 and 1 to facilitate the comparison with the network behaviour. For instance, if the feature *'Flow function: main entrance'* is present, the features *'Flow function: secondary entrance'*, *'Flow control: public access'* and *'Flow control: restricted access'* have a probability of 0.0%, 60.78% and 39.22%, respectively, of being present.

Once the matrix is too large to fit in a single page, it has been broken down into 6 smaller tables, each with its own labels of columns and rows.

The key map bellow indicates the relationship between tables. The numbers indicate the page in which each table can be found.



<< Input (x)	(y) Output >>	1	2	3	4	5	6	7	8	9	10	11	12	13	14
		main entrance	***secondary entrance***	public access	restricted access	exit only	***gives access to: air lock, vestibule or foyer***	***gives access to: corridor or aisle***	***gives access to: shop or working room***	aligned to the facade	pulled out from the facade	pulled in from the facade	***flat door top***	***semi-circular door top arch***	***segmental door top arch***
1	***main entrance***		0.0000	0.6078	0.3922	0.0000	0.9706	0.0098	0.0196	0.4412	0.0392	0.5196	0.9118	0.0098	0.0098
2	secondary entrance	0.0000		0.4000	0.5333	0.0667	0.3333	0.6000	0.0667	0.4667	0.0000	0.5333	0.8000	0.0667	0.0667
3	***public access***	0.9118	0.0882		0.0000	0.0000	0.9118	0.0588	0.0294	0.3088	0.0294	0.6618	0.8971	0.0147	0.0000
4	***restricted access***	0.8333	0.1667	0.0000		0.0000	0.8750	0.1042	0.0208	0.6250	0.0417	0.3333	0.9167	0.0208	0.0208
5	exit only	0.0000	0.1667	0.0000	0.0000		0.1667	0.6667	0.1667	0.6667	0.1667	0.1667	0.8333	0.0000	0.1667
6	***gives access to: air lock, vestibule or foyer***	0.9429	0.0476	0.5905	0.4000	0.0095		0.0000	0.0000	0.4190	0.0476	0.5333	0.9143	0.0095	0.0095
7	***gives access to: corridor or aisle***	0.0769	0.6923	0.3077	0.3846	0.3077	0.0000		0.0000	0.5385	0.0000	0.4615	0.7692	0.0769	0.0769
8	***gives access to: shop or working room***	0.5000	0.2500	0.5000	0.2500	0.2500	0.0000	0.0000		1.0000	0.0000	0.0000	1.0000	0.0000	0.0000
9	aligned to the facade	0.8182	0.1273	0.3818	0.5455	0.0727	0.8000	0.1273	0.0727		0.0000	0.0000	0.9273	0.0182	0.0364
10	pulled out from the facade	0.8000	0.0000	0.4000	0.4000	0.2000	1.0000	0.0000	0.0000	0.0000		0.0000	1.0000	0.0000	0.0000
11	***pulled in from the facade***	0.8548	0.1290	0.7258	0.2581	0.0161	0.9032	0.0968	0.0000	0.0000	0.0000		0.8710	0.0161	0.0000
12	***flat door top***	0.8455	0.1091	0.5545	0.4000	0.0455	0.8727	0.0909	0.0364	0.4636	0.0455	0.4909		0.0000	0.0000
13	semi-circular door top arch	0.5000	0.5000	0.5000	0.5000	0.0000	0.5000	0.5000	0.0000	0.5000	0.0000	0.5000	0.0000		0.0000
14	***segmental door top arch***	0.5000	0.5000	0.0000	0.5000	0.5000	0.5000	0.5000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	
15	pointed door top arch	1.0000	0.0000	0.8000	0.2000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000
16	round trefoil door top arch	0.6667	0.3333	0.6667	0.3333	0.0000	0.6667	0.3333	0.0000	0.3333	0.0000	0.6667	0.0000	0.0000	0.0000
17	***top flat moulding***	0.8929	0.1071	0.4643	0.5357	0.0000	0.9643	0.0357	0.0000	0.6071	0.0357	0.3571	1.0000	0.0000	0.0000
18	***top curved moulding***	0.7667	0.2333	0.7000	0.2667	0.0333	0.7667	0.2000	0.0333	0.4000	0.0000	0.6000	0.6333	0.0333	0.0667
19	triangular pediment	1.0000	0.0000	1.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.5000	0.0000	0.5000	1.0000	0.0000	0.0000
20	semi-circular or segmental pediment	1.0000	0.0000	0.5000	0.5000	0.0000	1.0000	0.0000	0.0000	1.0000	0.0000	0.0000	1.0000	0.0000	0.0000
21	***squared fanlight***	0.8936	0.0851	0.6170	0.3617	0.0213	0.9149	0.0638	0.0213	0.4255	0.0213	0.5532	1.0000	0.0000	0.0000
22	***fanlight with undulate top***	1.0000	0.0000	0.0000	1.0000	0.0000	1.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.5000	0.0000	0.5000
23	pointed arch fanlight	1.0000	0.0000	1.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.3333	0.0000	0.6667	1.0000	0.0000	0.0000
24	semi-circular or segmental arch fanlight	0.8889	0.1111	0.6667	0.3333	0.0000	0.8889	0.1111	0.0000	0.6667	0.0000	0.3333	1.0000	0.0000	0.0000
25	pointed arch tympanum	0.7000	0.3000	0.9000	0.1000	0.0000	0.7000	0.2000	0.1000	0.4000	0.0000	0.6000	0.8000	0.0000	0.0000
26	semi-circular arch tympanum	0.0000	1.0000	0.0000	0.5000	0.5000	0.0000	1.0000	0.0000	0.5000	0.0000	0.5000	0.5000	0.0000	0.5000
27	tracery or steelwork on fanlight or tympanum	0.9167	0.0833	0.8333	0.1667	0.0000	0.9167	0.0833	0.0000	0.3333	0.0000	0.6667	0.8333	0.0000	0.0833
28	***stained glass on fanlight***	1.0000	0.0000	0.3333	0.6667	0.0000	1.0000	0.0000	0.0000	0.6667	0.0000	0.3333	1.0000	0.0000	0.0000
29	***flat retangular porch***	0.9130	0.0870	0.8696	0.1304	0.0000	0.9565	0.0435	0.0000	0.1304	0.0435	0.8261	1.0000	0.0000	0.0000
30	***flat semi-circular porch***	1.0000	0.0000	0.3333	0.6667	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	0.0000	0.0000
31	pediment porch	1.0000	0.0000	0.0000	1.0000	0.0000	0.5000	0.5000	0.0000	0.5000	0.0000	0.5000	1.0000	0.0000	0.0000
32	segmental (concave) porch	0.6667	0.3333	0.3333	0.6667	0.0000	0.6667	0.3333	0.0000	0.3333	0.0000	0.6667	0.6667	0.3333	0.0000
33	convex porch	1.0000	0.0000	1.0000	0.0000	0.0000	1.0000	0.0000	0.0000	1.0000	0.0000	0.0000	1.0000	0.0000	0.0000
34	columns supporting porch	0.9167	0.0833	0.5833	0.4167	0.0000	0.8333	0.1667	0.0000	0.1667	0.0000	0.8333	1.0000	0.0000	0.0000
35	walls supporting porch	0.8667	0.1333	0.6667	0.3333	0.0000	0.8667	0.1333	0.0000	0.0000	0.0000	1.0000	0.9333	0.0667	0.0000
36	cables supporting porch	1.0000	0.0000	1.0000	0.0000	0.0000	1.0000	0.0000	0.0000	1.0000	0.0000	0.0000	1.0000	0.0000	0.0000
37	***lateral squared section column***	1.0000	0.0000	0.5714	0.4286	0.0000	1.0000	0.0000	0.0000	0.6429	0.0000	0.3571	0.9286	0.0000	0.0000
38	***lateral cylindrical section column***	0.8462	0.1538	0.9231	0.0769	0.0000	0.9231	0.0769	0.0000	0.2308	0.0000	0.7692	0.6923	0.0000	0.0000
39	***lateral vertical moulding***	0.8286	0.1714	0.5714	0.4000	0.0286	0.8571	0.1143	0.0286	0.5143	0.0286	0.4571	0.7429	0.0000	0.0571
40	***window in one side***	0.8095	0.1429	0.4762	0.4762	0.0476	0.9048	0.0952	0.0000	0.3810	0.0476	0.5714	1.0000	0.0000	0.0000
41	***window in both sides***	0.9250	0.0500	0.6250	0.3500	0.0250	0.9500	0.0000	0.0500	0.4000	0.0750	0.5250	1.0000	0.0000	0.0000
42	vertical glass tower	0.7647	0.1176	0.2941	0.5882	0.1176	0.9412	0.0588	0.0000	0.2941	0.1765	0.5294	1.0000	0.0000	0.0000
43	angular connection with glass tower	0.7500	0.0000	0.5000	0.2500	0.2500	1.0000	0.0000	0.0000	0.0000	0.5000	0.5000	1.0000	0.0000	0.0000
44	decorative sculptures	0.9000	0.1000	0.7000	0.2000	0.1000	0.9000	0.1000	0.0000	0.6000	0.0000	0.4000	0.7000	0.0000	0.2000
45	Surroundings material: glass	0.8824	0.0824	0.5412	0.4235	0.0353	0.9176	0.0588	0.0235	0.4353	0.0471	0.5176	0.9882	0.0000	0.0118
46	Surroundings material: brick	0.8537	0.0976	0.3902	0.5610	0.0488	0.9268	0.0732	0.0000	0.3659	0.0976	0.5366	1.0000	0.0000	0.0000
47	Surroundings material: smooth stone	0.8246	0.1754	0.6667	0.3158	0.0175	0.8421	0.1228	0.0351	0.4386	0.0175	0.5439	0.8596	0.0000	0.0351
48	Surroundings material: rough stone	0.5000	0.3000	0.3000	0.4000	0.3000	0.5000	0.4000	0.1000	0.8000	0.0000	0.2000	0.5000	0.2000	0.1000
49	Surroundings material: concrete blocks	1.0000	0.0000	0.5000	0.5000	0.0000	1.0000	0.0000	0.0000	0.5000	0.0000	0.5000	1.0000	0.0000	0.0000
50	Surroundings material: concrete exposed	0.9091	0.0909	0.7273	0.2727	0.0000	1.0000	0.0000	0.0000	0.3636	0.0000	0.6364	1.0000	0.0000	0.0000
51	Surroundings material: timber	0.8750	0.0938	0.5000	0.4688	0.0313	0.8750	0.1250	0.0000	0.5000	0.0000	0.5000	1.0000	0.0000	0.0000
52	Surroundings material: smooth plasterwork	0.9167	0.0417	0.3750	0.5833	0.0417	0.8750	0.0833	0.0417	0.6667	0.0000	0.3333	0.9583	0.0000	0.0000
53	Surroundings material: rusticated plasterwork	0.6667	0.0000	0.3333	0.3333	0.3333	0.6667	0.3333	0.0000	0.6667	0.0000	0.3333	1.0000	0.0000	0.0000
54	Surroundings materials: tiles or small tiles	1.0000	0.0000	1.0000	0.0000	0.0000	1.0000	0.0000	0.0000	1.0000	0.0000	0.0000	1.0000	0.0000	0.0000
55	Surroundings material: metal	0.8750	0.0833	0.5417	0.4167	0.0417	0.8958	0.0625	0.0417	0.3750	0.0833	0.5417	0.9792	0.0000	0.0208
56	swinging door: one single	0.8500	0.0500	0.1500	0.7500	0.1000	0.8750	0.1000	0.0250	0.5500	0.0500	0.4000	0.9750	0.0250	0.0000
57	swinging door: two singles	1.0000	0.0000	0.8750	0.1250	0.0000	1.0000	0.0000	0.0000	0.2500	0.0000	0.7500	0.8750	0.0000	0.0000
58	swinging door: one double	0.7937	0.1905	0.7143	0.2540	0.0317	0.8095	0.1429	0.0476	0.4762	0.0476	0.4762	0.8413	0.0159	0.0317
59	swinging door: triple, two doubles or more	1.0000	0.0000	1.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.1429	0.0000	0.8571	1.0000	0.0000	0.0000
60	revolving door (with four leaves)	1.0000	0.0000	1.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	0.0000	0.0000
61	sliding door (one or more leaves)	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	0.0000	0.0000
62	leaf: plain opaque	1.0000	0.0000	0.5000	0.5000	0.0000	1.0000	0.0000	0.0000	0.5000	0.0000	0.5000	1.0000	0.0000	0.0000
63	leaf: plain transparent	1.0000	0.0000	1.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.2000	0.0000	0.8000	1.0000	0.0000	0.0000
64	leaf: semi-opaque plain with one or more light cross panels	1.0000	0.0000	0.3333	0.6667	0.0000	1.0000	0.0000	0.0000	0.6667	0.0000	0.3333	1.0000	0.0000	0.0000
65	leaf: paneled opaque	0.8158	0.1316	0.5000	0.4211	0.0789	0.8158	0.1579	0.0263	0.5263	0.0000	0.4737	0.7368	0.0263	0.0263
66	leaf: paneled semi-opaque with one or more light cross panels	0.7333	0.2667	0.6000	0.4000	0.0000	0.8000	0.1333	0.0667	0.6667	0.0667	0.2667	0.8667	0.0667	0.0667
67	leaf: framed with one or two light cross panels	0.8438	0.1250	0.9063	0.0625	0.0313	0.8438	0.0938	0.0625	0.2813	0.0313	0.6875	1.0000	0.0000	0.0000
68	leaf: framed with three or more light cross panels	0.8400	0.0800	0.1600	0.7600	0.0800	0.9200	0.0800	0.0000	0.4000	0.1200	0.4800	1.0000	0.0000	0.0000
69	steelwork leaf decoration	0.8462	0.1538	0.6923	0.3077	0.0000	0.8462	0.0769	0.0769	0.5385	0.0000	0.4615	0.6923	0.0000	0.0769
70	leaf mat.: non-stained glass	0.8375	0.1250	0.6000	0.3625	0.0375	0.8750	0.0875	0.0375	0.4000	0.0625	0.5375	0.9750	0.0125	0.0125
71	leaf mat.: stained glass	1.0000	0.0000	0.0000	1.0000	0.0000	1.0000	0.0000	0.0000	1.0000	0.0000	0.0000	1.0000	0.0000	0.0000
72	leaf mat.: metal	0.8533	0.1200	0.5867	0.3867	0.0267	0.8800	0.0800	0.0400	0.3733	0.0533	0.5733	0.8933	0.0267	0.0133
73	leaf mat.: timber	0.8056	0.1528	0.5278	0.4167	0.0556	0.8194	0.1528	0.0278	0.5139	0.0139	0.4722	0.8472	0.0278	0.0139
74	round knob or ring handle	0.8000	0.2000	0.5400	0.4400	0.0200	0.8400	0.1400	0.0200	0.5600	0.0200	0.4200	0.7600	0.0400	0.0400
75	retangular, squared or trapezoid handle	1.0000	0.0000	0.5000	0.5000	0.0000	1.0000	0.0000	0.0000	0.3125	0.0625	0.6250	1.0000	0.0000	0.0000
76	lever handle	1.0000	0.0000	0.0909	0.9091	0.0000	0.9091	0.0909	0.0000	0.5455	0.0000	0.4545	1.0000	0.0000	0.0000
77	long horizontal static handle	0.6667	0.0000	0.6667	0.0000	0.3333	0.6667	0.3333	0.0000	0.1667	0.0000	0.8333	1.0000	0.0000	0.0000
78	long vertical static handle	0.9048	0.0476	0.7143	0.2381	0.0476	0.9524	0.0000	0.0476	0.3333	0.1429	0.5238	1.0000	0.0000	0.0000
79	short vertical static handle	0.8571	0.1429	0.6429	0.3571	0.0000	0.9286	0.0714	0.0000	0.3571	0.0000	0.6429	1.0000	0.0000	0.0000
80	curved static handle	0.7500	0.2500	0.7500	0.2500	0.0000	0.7500	0.0000	0.2500	0.5000	0.0000	0.5000	1.0000	0.0000	0.0000

<< Input (x)	(y) Output >>	15	16	17	18	19	20	21	22	23	24	25	26	27	28
		pointed door top arch	*round trefoil door top arch*	top flat moulding	top curved moulding	triangular pediment	semi-circular or segmental pediment	*squared fanlight*	*fanlight with undulate top*	*pointed arch fanlight*	*semi-circular or segmental arch fanlight*	pointed arch tympanum	semi-circular arch tympanum	*tracery or steelwork on fanlight or tympanum*	*stained glass on fanlight*
1	*main entrance*	0.0490	0.0196	0.2451	0.2255	0.0196	0.0196	0.4118	0.0196	0.0294	0.0784	0.0686	0.0000	0.1078	0.0294
2	secondary entrance	0.0000	0.0667	0.2000	0.4667	0.0000	0.0000	0.2667	0.0000	0.0000	0.0667	0.2000	0.1333	0.0667	0.0000
3	*public access*	0.0588	0.0294	0.1912	0.3088	0.0294	0.0147	0.4265	0.0000	0.0441	0.0882	0.1324	0.0000	0.1471	0.0147
4	*restricted access*	0.0208	0.0208	0.3125	0.1667	0.0000	0.0208	0.3542	0.0417	0.0000	0.0625	0.0208	0.0208	0.0417	0.0417
5	exit only	0.0000	0.0000	0.0000	0.1667	0.0000	0.0000	0.1667	0.0000	0.0000	0.0000	0.0000	0.1667	0.0000	0.0000
6	*gives access to: air lock, vestibule or foyer*	0.0476	0.0190	0.2571	0.2190	0.0190	0.0190	0.4095	0.0190	0.0286	0.0762	0.0667	0.0000	0.1048	0.0286
7	*gives access to: corridor or aisle*	0.0000	0.0769	0.0769	0.4615	0.0000	0.0000	0.2308	0.0000	0.0000	0.0769	0.1538	0.1538	0.0769	0.0000
8	*gives access to: shop or working room*	0.0000	0.0000	0.0000	0.2500	0.0000	0.0000	0.2500	0.0000	0.0000	0.0000	0.2500	0.0000	0.0000	0.0000
9	aligned to the facade	0.0000	0.0182	0.3091	0.2182	0.0182	0.0364	0.3636	0.0364	0.0182	0.1091	0.0727	0.0182	0.0727	0.0364
10	pulled out from the facade	0.0000	0.0000	0.2000	0.0000	0.0000	0.0000	0.2000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
11	*pulled in from the facade*	0.0806	0.0323	0.1613	0.2903	0.0161	0.0000	0.4194	0.0000	0.0323	0.0484	0.0968	0.0161	0.1290	0.0161
12	*flat door top*	0.0000	0.0000	0.2545	0.1727	0.0182	0.0182	0.4273	0.0091	0.0273	0.0818	0.0727	0.0091	0.0909	0.0273
13	semi-circular door top arch	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
14	*segmental door top arch*	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000	0.0000	0.5000	0.5000	0.0000
15	pointed door top arch		0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
16	round trefoil door top arch	0.0000		0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.6667	0.0000	0.3333	0.0000
17	*top flat moulding*	0.0000	0.0000		0.1786	0.0714	0.0000	0.4286	0.0000	0.0357	0.1429	0.0714	0.0000	0.1429	0.1071
18	*top curved moulding*	0.1667	0.1000	0.1667		0.0000	0.0667	0.1000	0.0333	0.1000	0.1667	0.3333	0.0667	0.3667	0.0333
19	triangular pediment	0.0000	0.0000	1.0000	0.0000		0.0000	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
20	semi-circular or segmental pediment	0.0000	0.0000	0.0000	1.0000	0.0000		0.5000	0.0000	0.0000	0.5000	0.0000	0.0000	0.0000	0.0000
21	*squared fanlight*	0.0000	0.0000	0.2553	0.0638	0.0213	0.0213		0.0000	0.0000	0.0426	0.0000	0.0000	0.0213	0.0426
22	*fanlight with undulate top*	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	1.0000	0.0000
23	pointed arch fanlight	0.0000	0.0000	0.3333	1.0000	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000	0.0000	0.6667	0.3333
24	semi-circular or segmental arch fanlight	0.0000	0.0000	0.4444	0.5556	0.0000	0.1111	0.2222	0.0000	0.0000		0.0000	0.0000	0.2222	0.0000
25	pointed arch tympanum	0.0000	0.2000	0.2000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		0.0000	0.6000	0.0000
26	semi-circular arch tympanum	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000
27	tracery or steelwork on fanlight or tympanum	0.0000	0.0833	0.3333	0.9167	0.0000	0.0000	0.0833	0.1667	0.1667	0.1667	0.5000	0.0000		0.0833
28	*stained glass on fanlight*	0.0000	0.0000	1.0000	0.3333	0.0000	0.0000	0.6667	0.0000	0.3333	0.0000	0.0000	0.0000	0.3333	
29	*flat rectangular porch*	0.0000	0.0000	0.0870	0.0435	0.0000	0.0000	0.6522	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	*flat semi-circular porch*	0.0000	0.0000	0.3333	0.0000	0.0000	0.0000	0.6667	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
31	pediment porch	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
32	segmental (concave) porch	0.0000	0.0000	0.0000	0.3333	0.0000	0.0000	0.3333	0.0000	0.0000	0.3333	0.0000	0.0000	0.0000	0.0000
33	convex porch	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
34	columns supporting porch	0.0000	0.0000	0.3333	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
35	walls supporting porch	0.0000	0.0000	0.0667	0.1333	0.0000	0.0000	0.7333	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
36	cables supporting porch	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.7500	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
37	*lateral squared section column*	0.0714	0.0000	0.5714	0.2143	0.0000	0.0714	0.5000	0.0000	0.0000	0.2857	0.0000	0.0000	0.0714	0.0000
38	*lateral cylindrical section column*	0.1538	0.1538	0.4615	0.7692	0.0769	0.0000	0.0000	0.0000	0.0769	0.0769	0.4615	0.0000	0.4615	0.0000
39	*lateral vertical moulding*	0.1429	0.0571	0.3429	0.6857	0.0286	0.0286	0.2000	0.0571	0.0571	0.0857	0.2857	0.0571	0.2857	0.0571
40	*window in one side*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3810	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
41	*windows in both sides*	0.0000	0.0000	0.1500	0.0500	0.0250	0.0000	0.6000	0.0000	0.0000	0.1000	0.0000	0.0000	0.0500	0.0000
42	vertical glass tower	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2941	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
43	angular connection with glass tower	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
44	decorative sculptures	0.1000	0.0000	0.3000	0.7000	0.1000	0.1000	0.4000	0.1000	0.0000	0.2000	0.0000	0.1000	0.2000	0.1000
45	Surroundings material: glass	0.0000	0.0000	0.1882	0.1294	0.0118	0.0235	0.5412	0.0235	0.0353	0.1059	0.0000	0.0000	0.0706	0.0353
46	Surroundings material: brick	0.0000	0.0000	0.0732	0.0000	0.0000	0.0000	0.4634	0.0244	0.0000	0.0244	0.0000	0.0000	0.0244	0.0000
47	Surroundings material: smooth stone	0.0526	0.0526	0.3509	0.4561	0.0351	0.0351	0.2982	0.0175	0.0526	0.0877	0.1754	0.0351	0.1930	0.0175
48	Surroundings material: rough stone	0.1000	0.1000	0.1000	0.5000	0.0000	0.0000	0.1000	0.0000	0.1000	0.0000	0.0000	0.1000	0.0000	0.0000
49	Surroundings material: concrete blocks	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
50	Surroundings material: concrete exposed	0.0000	0.0000	0.0909	0.0000	0.0000	0.0000	0.6364	0.0000	0.0000	0.0909	0.0000	0.0000	0.0000	0.0000
51	Surroundings material: timber	0.0000	0.0000	0.4063	0.0938	0.0000	0.0000	0.6250	0.0000	0.0313	0.1563	0.0000	0.0000	0.0625	0.0938
52	Surroundings material: smooth plasterwork	0.0417	0.0000	0.5000	0.0833	0.0000	0.0000	0.4583	0.0417	0.0000	0.0417	0.0000	0.0000	0.0417	0.0833
53	Surroundings material: rusticated plasterwork	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3333	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
54	Surroundings materials: tiles or small tiles	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
55	Surroundings material: metal	0.0000	0.0000	0.0208	0.0625	0.0000	0.0000	0.4375	0.0417	0.0000	0.0625	0.0000	0.0000	0.0833	0.0000
56	swinging door: one single	0.0000	0.0000	0.2000	0.0750	0.0000	0.0000	0.4500	0.0000	0.0250	0.0500	0.0000	0.0000	0.0250	0.0500
57	swinging door: two singles	0.0000	0.1250	0.3750	0.6250	0.0000	0.0000	0.1250	0.0000	0.1250	0.0000	0.5000	0.0000	0.6250	0.0000
58	swinging door: one double	0.0794	0.0317	0.2381	0.3492	0.0159	0.0317	0.3492	0.0317	0.0159	0.1111	0.0952	0.0317	0.0952	0.0159
59	swinging door: triple, two doubles or more	0.0000	0.0000	0.1429	0.0000	0.0000	0.0000	0.4286	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
60	revolving door (with four leaves)	0.0000	0.0000	0.1429	0.0000	0.1429	0.0000	0.7143	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
61	sliding door (one or more leaves)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
62	leaf: plain opaque	0.0000	0.0000	0.5000	0.0000	0.0000	0.0000	0.5000	0.5000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000
63	leaf: plain transparent	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.6000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
64	leaf: semi-opaque plain with one or more light cross panels	0.0000	0.0000	0.0000	0.1667	0.0000	0.0000	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
65	leaf: paneled opaque	0.1316	0.0789	0.4211	0.5789	0.0263	0.0526	0.1842	0.0000	0.0526	0.0789	0.1842	0.0526	0.1842	0.0000
66	leaf: paneled semi-opaque with one or more light cross panels	0.0000	0.0000	0.4000	0.4000	0.0000	0.0000	0.3333	0.0667	0.0000	0.2000	0.2000	0.0000	0.2000	0.1333
67	leaf: framed with one or two light cross panels	0.0000	0.0000	0.0625	0.0000	0.0313	0.0000	0.5938	0.0000	0.0000	0.0938	0.0000	0.0000	0.0000	0.0000
68	leaf: framed with three or more light cross panels	0.0000	0.0000	0.1200	0.0400	0.0000	0.0000	0.4000	0.0000	0.0400	0.0000	0.0000	0.0000	0.0400	0.0400
69	steelwork leaf decoration	0.0769	0.1538	0.3077	0.8462	0.0000	0.0000	0.0769	0.1538	0.0000	0.1538	0.5385	0.0000	0.6154	0.0000
70	leaf mat.: non-stained glass	0.0000	0.0000	0.1125	0.1000	0.0125	0.0000	0.4625	0.0125	0.0125	0.0750	0.0375	0.0000	0.0500	0.0125
71	leaf mat.: stained glass	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
72	leaf mat.: metal	0.0267	0.0400	0.0933	0.2133	0.0133	0.0000	0.4133	0.0267	0.0000	0.0400	0.1067	0.0133	0.1067	0.0267
73	leaf mat.: timber	0.0694	0.0417	0.3750	0.3889	0.0139	0.0278	0.3333	0.0000	0.0417	0.0972	0.1389	0.0278	0.1250	0.0417
74	round knob or ring handle	0.1000	0.0600	0.4200	0.5400	0.0200	0.0400	0.2000	0.0400	0.0400	0.1000	0.2000	0.0400	0.2200	0.0200
75	retangular, squared or trapezoid handle	0.0000	0.0000	0.0000	0.1250	0.0000	0.0000	0.5000	0.0000	0.0000	0.0625	0.0000	0.0000	0.0000	0.0000
76	lever handle	0.0000	0.0000	0.2727	0.0000	0.0000	0.0000	0.2727	0.0000	0.0000	0.0909	0.0000	0.0000	0.0000	0.0000
77	long horizontal static handle	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.8333	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
78	long vertical static handle	0.0000	0.0000	0.0476	0.0000	0.0476	0.0000	0.6667	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
79	short vertical static handle	0.0000	0.0000	0.2143	0.0714	0.0000	0.0000	0.5714	0.0000	0.0714	0.1429	0.0000	0.0000	0.0714	0.1429
80	curved static handle	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2500	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

<< Input (x)	(y) Output >>	29 flat retangular porch	30 flat semi-circular porch	31 pediment porch	32 segmental (concave) porch	33 convex porch	34 *columns supporting porch*	35 *walls supporting porch*	36 *cables supporting porch*	37 lateral squared section column	38 lateral cylindrical section column	39 lateral vertical moulding	40 window in one side	41 windows in both sides	42 *vertical glass tower*
1	*main entrance*	0.2059	0.0294	0.0196	0.0196	0.0196	0.1078	0.1275	0.0392	0.1373	0.1078	0.2843	0.1667	0.3627	0.1275
2	secondary entrance	0.1333	0.0000	0.0000	0.0667	0.0000	0.0667	0.1333	0.0000	0.0000	0.1333	0.4000	0.2000	0.1333	0.1333
3	*public access*	0.2941	0.0147	0.0000	0.0147	0.0294	0.1029	0.1471	0.0588	0.1176	0.1765	0.2941	0.1471	0.3676	0.0735
4	*restricted access*	0.0625	0.0417	0.0417	0.0417	0.0000	0.1042	0.1042	0.0000	0.1250	0.0208	0.2917	0.2083	0.2917	0.2083
5	exit only	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1667	0.1667	0.1667	0.3333
6	*gives access to: air lock, vestibule or foyer*	0.2095	0.0286	0.0095	0.0190	0.0190	0.0952	0.1238	0.0381	0.1333	0.1143	0.2857	0.1810	0.3619	0.1524
7	*gives access to: corridor or aisle*	0.0769	0.0000	0.0769	0.0769	0.0000	0.1538	0.1538	0.0000	0.0000	0.0769	0.3077	0.1538	0.0000	0.0769
8	*gives access to: shop or working room*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2500	0.0000	0.5000	0.0000
9	aligned to the facade	0.0545	0.0000	0.0182	0.0182	0.0364	0.0364	0.0000	0.0727	0.1636	0.0545	0.3273	0.1455	0.2909	0.0909
10	pulled out from the facade	0.2000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2000	0.2000	0.6000	0.6000
11	*pulled in from the facade*	0.3065	0.0484	0.0161	0.0323	0.0000	0.1613	0.2419	0.0000	0.0806	0.1613	0.2581	0.1935	0.3387	0.1452
12	*flat door top*	0.2091	0.0273	0.0182	0.0182	0.0182	0.1091	0.1273	0.0364	0.1182	0.0818	0.2364	0.1909	0.3636	0.1545
13	semi-circular door top arch	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
14	*segmental door top arch*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000
15	pointed door top arch	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2000	0.4000	1.0000	0.0000	0.0000	0.0000
16	round trefoil door top arch	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.6667	0.6667	0.0000	0.0000	0.0000
17	*top flat moulding*	0.0714	0.0357	0.0000	0.0000	0.0000	0.1429	0.0357	0.0000	0.2857	0.2143	0.4286	0.0000	0.2143	0.0000
18	*top curved moulding*	0.0333	0.0000	0.0000	0.0333	0.0000	0.0000	0.0667	0.0000	0.1000	0.3333	0.8000	0.0000	0.0667	0.0000
19	triangular pediment	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.5000	0.0000	0.5000	0.0000
20	semi-circular or segmental pediment	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.5000	0.0000	0.0000	0.0000
21	*squared fanlight*	0.3191	0.0426	0.0000	0.0213	0.0213	0.1277	0.2340	0.0638	0.1489	0.0000	0.1489	0.1702	0.5106	0.1064
22	*fanlight with undulate top*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000
23	pointed arch fanlight	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3333	0.6667	0.0000	0.0000	0.0000
24	semi-circular or segmental arch fanlight	0.0000	0.0000	0.0000	0.1111	0.0000	0.0000	0.0000	0.0000	0.4444	0.1111	0.3333	0.0000	0.4444	0.0000
25	pointed arch tympanum	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.6000	1.0000	0.0000	0.0000	0.0000
26	semi-circular arch tympanum	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000
27	tracery or steelwork on fanlight or tympanum	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0833	0.5000	0.8333	0.0000	0.1667	0.0000
28	*stained glass on fanlight*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.6667	0.0000	0.0000	0.0000
29	*flat retangular porch*		0.0000	0.0000	0.0000	0.0000	0.3043	0.4783	0.0870	0.0435	0.0435	0.0435	0.3478	0.4348	0.0870
30	*flat semi-circular porch*	0.0000		0.0000	0.0000	0.0000	0.6667	0.3333	0.0000	0.0000	0.0000	0.0000	0.0000	0.6667	0.0000
31	pediment porch	0.0000	0.0000		0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.6667	0.0000
32	segmental (concave) porch	0.0000	0.0000	0.0000		0.0000	0.0000	0.6667	0.0000	0.3333	0.0000	0.0000	0.0000	0.6667	0.0000
33	convex porch	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000
34	columns supporting porch	0.5833	0.1667	0.1667	0.0000	0.0000		0.1667	0.0000	0.0833	0.0833	0.0000	0.0833	0.3333	0.0000
35	walls supporting porch	0.7333	0.0667	0.0000	0.1333	0.0000	0.1333		0.0000	0.0667	0.0000	0.0667	0.3333	0.5333	0.0000
36	cables supporting porch	0.5000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000		0.2500	0.0000	0.0000	0.2500	0.5000	0.2500
37	*lateral squared section column*	0.0714	0.0000	0.0000	0.0714	0.0000	0.0714	0.0714	0.0714		0.0000	0.2143	0.0714	0.2857	0.0714
38	*lateral cylindrical section column*	0.0769	0.0000	0.0000	0.0000	0.0000	0.0769	0.0000	0.0000	0.0000		0.6923	0.0000	0.0000	0.0000
39	*lateral vertical moulding*	0.0286	0.0000	0.0000	0.0000	0.0000	0.0000	0.0286	0.0000	0.0857	0.2571		0.0000	0.1429	0.0000
40	*window in one side*	0.3810	0.0000	0.0000	0.0000	0.0000	0.0476	0.2381	0.0476	0.0476	0.0000	0.0000		0.0000	0.3810
41	*windows in both sides*	0.2500	0.0500	0.0000	0.0500	0.0250	0.1000	0.2000	0.0500	0.1000	0.0000	0.1250	0.0000		0.1750
42	vertical glass tower	0.1176	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0588	0.0588	0.0000	0.0000	0.4706	0.4118	
43	angular connection with glass tower	0.2500	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2500	0.7500	1.0000
44	decorative sculptures	0.1000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1000	0.0000	0.2000	0.1000	0.7000	0.0000	0.1000	0.0000
45	Surroundings material: glass	0.2471	0.0235	0.0000	0.0235	0.0118	0.0824	0.1647	0.0353	0.1059	0.0235	0.1882	0.2471	0.4706	0.2000
46	Surroundings material: brick	0.2683	0.0488	0.0488	0.0244	0.0000	0.1463	0.1463	0.0488	0.0732	0.0000	0.0244	0.3171	0.4634	0.3415
47	Surroundings material: smooth stone	0.1930	0.0175	0.0000	0.0000	0.0175	0.1053	0.1053	0.0175	0.1228	0.1930	0.4912	0.1053	0.2105	0.0526
48	Surroundings material: rough stone	0.0000	0.0000	0.0000	0.1000	0.0000	0.0000	0.1000	0.0000	0.0000	0.0000	0.4000	0.1000	0.1000	0.0000
49	Surroundings material: concrete blocks	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.5000	0.0000	0.0000	0.0000	0.5000	0.0000
50	Surroundings material: concrete exposed	0.3636	0.0000	0.0000	0.0909	0.0000	0.0909	0.1818	0.0909	0.3636	0.0000	0.0000	0.3636	0.5455	0.0909
51	Surroundings material: timber	0.2188	0.0625	0.0313	0.0313	0.0000	0.1563	0.2500	0.0000	0.2500	0.0000	0.1563	0.2500	0.3750	0.0313
52	Surroundings material: smooth plasterwork	0.2500	0.0417	0.0000	0.0417	0.0417	0.1667	0.1667	0.0417	0.1250	0.1250	0.3750	0.1667	0.2917	0.0417
53	Surroundings material: rusticated plasterwork	0.3333	0.0000	0.0000	0.0000	0.0000	0.0000	0.3333	0.0000	0.0000	0.0000	0.0000	0.6667	0.3333	0.3333
54	Surroundings materials: tiles or small tiles	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000
55	Surroundings material: metal	0.2708	0.0208	0.0417	0.0417	0.0417	0.1042	0.1667	0.0625	0.0625	0.0000	0.0625	0.2500	0.5625	0.3542
56	swinging door: one single	0.0500	0.0500	0.0500	0.0250	0.0000	0.1250	0.1000	0.0000	0.0750	0.0250	0.1750	0.2500	0.3250	0.2750
57	swinging door: two singles	0.3750	0.0000	0.0000	0.0000	0.0000	0.2500	0.1250	0.0000	0.0000	0.6250	0.6250	0.0000	0.1250	0.0000
58	swinging door: one double	0.2063	0.0159	0.0000	0.0317	0.0317	0.0635	0.1270	0.0476	0.1587	0.1111	0.3492	0.1270	0.3175	0.0794
59	swinging door: triple, two doubles or more	0.4286	0.0000	0.0000	0.0000	0.0000	0.0000	0.2857	0.1429	0.1429	0.0000	0.0000	0.2857	0.5714	0.1429
60	revolving door (with four leaves)	0.4286	0.0000	0.0000	0.0000	0.0000	0.2857	0.1429	0.0000	0.0000	0.0000	0.1429	0.1429	0.5714	0.0000
61	sliding door (one or more leaves)	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000
62	leaf: plain opaque	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.5000	0.0000	0.0000	0.0000
63	leaf: plain transparent	0.4000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2000	0.0000	0.0000	0.0000	0.4000	0.6000	0.2000
64	leaf: semi-opaque plain with one or more light cross panels	0.1667	0.0000	0.1667	0.0000	0.1667	0.1667	0.1667	0.1667	0.0000	0.0000	0.1667	0.1667	0.5000	0.1667
65	leaf: paneled opaque	0.0526	0.0263	0.0000	0.0263	0.0000	0.1053	0.0526	0.0000	0.1842	0.3158	0.5789	0.0263	0.0789	0.0000
66	leaf: paneled semi-opaque with one or more light cross panels	0.1333	0.0000	0.0000	0.0000	0.0000	0.0000	0.1333	0.0000	0.1333	0.0667	0.5333	0.1333	0.1333	0.0000
67	leaf: framed with one or two light cross panels	0.4688	0.0000	0.0000	0.0313	0.0313	0.1563	0.2188	0.0625	0.0938	0.0000	0.0313	0.3125	0.5313	0.1250
68	leaf: framed with three or more light cross panels	0.0400	0.0800	0.0400	0.0400	0.0000	0.0800	0.1200	0.0000	0.0400	0.0000	0.0800	0.2400	0.4800	0.4400
69	steelwork leaf decoration	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0769	0.3846	0.9231	0.0000	0.2308	0.0000
70	leaf mat.: non-stained glass	0.2625	0.0250	0.0250	0.0250	0.0250	0.1000	0.1625	0.0500	0.0750	0.0125	0.1250	0.2500	0.4625	0.2125
71	leaf mat.: stained glass	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000
72	leaf mat.: metal	0.2133	0.0133	0.0133	0.0400	0.0267	0.0667	0.1333	0.0400	0.0667	0.0667	0.2400	0.2000	0.4267	0.2133
73	leaf mat.: timber	0.1250	0.0278	0.0278	0.0139	0.0000	0.1250	0.1111	0.0000	0.1528	0.1806	0.4306	0.0972	0.1806	0.0278
74	round knob or ring handle	0.0400	0.0400	0.0000	0.0200	0.0200	0.0800	0.0600	0.0200	0.1400	0.2600	0.5800	0.0200	0.1400	0.0200
75	retangular, squared or trapezoid handle	0.3750	0.0625	0.0000	0.0625	0.0000	0.0625	0.3750	0.0625	0.0625	0.0000	0.1250	0.4375	0.4375	0.2500
76	lever handle	0.0909	0.0000	0.1818	0.0000	0.0000	0.1818	0.0909	0.0000	0.1818	0.0000	0.1818	0.2727	0.3636	0.3636
77	long horizontal static handle	0.6667	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1667	0.3333	0.1667
78	long vertical static handle	0.1905	0.0000	0.0000	0.0000	0.0476	0.0000	0.0952	0.0476	0.0000	0.0000	0.0476	0.2381	0.7143	0.3333
79	short vertical static handle	0.4286	0.0000	0.0000	0.0714	0.0000	0.1429	0.1429	0.0714	0.2143	0.0000	0.0714	0.2857	0.3571	0.0000
80	curved static handle	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2500	0.0000	0.0000	0.0000	0.5000	0.2500

<< Input (x)	(y) Output >>	43	44	45	46	47	48	49	50	51	52	53	54	55	56
		angular connection with glass tower	*decorative sculptures*	Surroundings material: glass	Surroundings material: brick	Surroundings material: smooth stone	Surroundings material: rough stone	Surroundings material: concrete blocks	Surroundings material: concrete exposed	Surroundings material: timber	Surroundings material: smooth plasterwork	Surroundings material: rusticated plasterwork	Surroundings materials: tiles or small tiles	Surroundings material: metal	*swinging door: one single*
1	*main entrance*	0.0294	0.0882	0.7353	0.3431	0.4608	0.0490	0.0196	0.0980	0.2745	0.2157	0.0196	0.0196	0.4118	0.3333
2	secondary entrance	0.0000	0.0667	0.4667	0.2667	0.6667	0.2000	0.0000	0.0667	0.2000	0.0667	0.0000	0.0000	0.2667	0.1333
3	*public access*	0.0294	0.1029	0.6765	0.2353	0.5588	0.0441	0.0147	0.1176	0.2353	0.1324	0.0147	0.0294	0.3824	0.0882
4	*restricted access*	0.0208	0.0417	0.7500	0.4792	0.3750	0.0833	0.0208	0.0625	0.3125	0.2917	0.0208	0.0000	0.4167	0.6250
5	exit only	0.1667	0.1667	0.5000	0.3333	0.1667	0.5000	0.0000	0.0000	0.1667	0.1667	0.1667	0.0000	0.3333	0.6667
6	*gives access to: air lock, vestibule or foyer*	0.0381	0.0857	0.7429	0.3619	0.4571	0.0476	0.0190	0.1048	0.2667	0.2000	0.0190	0.0190	0.4095	0.3333
7	*gives access to: corridor or aisle*	0.0000	0.0769	0.3846	0.2308	0.5385	0.3077	0.0000	0.0000	0.3077	0.1538	0.0769	0.0000	0.2308	0.3077
8	*gives access to: shop or working room*	0.0000	0.0000	0.5000	0.0000	0.5000	0.2500	0.0000	0.0000	0.0000	0.2500	0.0000	0.0000	0.5000	0.2500
9	aligned to the facade	0.0000	0.1091	0.6727	0.2727	0.4545	0.1455	0.0182	0.0727	0.2909	0.2909	0.0364	0.0364	0.3273	0.4000
10	pulled out from the facade	0.4000	0.0000	0.8000	0.8000	0.2000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.8000	0.4000
11	*pulled in from the facade*	0.0323	0.0645	0.7097	0.3548	0.5000	0.0323	0.0161	0.1129	0.2581	0.1290	0.0161	0.0000	0.4194	0.2581
12	*flat door top*	0.0364	0.0636	0.7636	0.3727	0.4455	0.0455	0.0182	0.1000	0.2909	0.2091	0.0273	0.0182	0.4273	0.3545
13	semi-circular door top arch	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000
14	*segmental door top arch*	0.0000	1.0000	0.5000	0.0000	1.0000	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000
15	pointed door top arch	0.0000	0.2000	0.0000	0.0000	0.6000	0.2000	0.0000	0.0000	0.0000	0.2000	0.0000	0.0000	0.0000	0.0000
16	round trefoil door top arch	0.0000	0.0000	0.0000	0.0000	1.0000	0.3333	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
17	*top flat moulding*	0.0000	0.1071	0.5714	0.1071	0.7143	0.0357	0.0000	0.0357	0.4643	0.4286	0.0000	0.0000	0.0357	0.2857
18	*top curved moulding*	0.0000	0.2333	0.3667	0.0000	0.8667	0.1667	0.0000	0.0000	0.1000	0.0667	0.0000	0.0000	0.1000	0.1000
19	triangular pediment	0.0000	0.5000	0.5000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
20	semi-circular or segmental pediment	0.0000	0.5000	1.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21	*squared fanlight*	0.0000	0.0851	0.9787	0.4043	0.3617	0.0213	0.0213	0.1489	0.4255	0.2340	0.0213	0.0213	0.4468	0.3830
22	*fanlight with undulate top*	0.0000	0.5000	1.0000	0.5000	0.5000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000	1.0000	0.0000
23	pointed arch fanlight	0.0000	0.0000	1.0000	0.0000	1.0000	0.3333	0.0000	0.0000	0.3333	0.0000	0.0000	0.0000	0.0000	0.3333
24	semi-circular or segmental arch fanlight	0.0000	0.2222	1.0000	0.1111	0.5556	0.0000	0.0000	0.1111	0.5556	0.1111	0.0000	0.0000	0.3333	0.2222
25	pointed arch tympanum	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
26	semi-circular arch tympanum	0.0000	0.5000	0.0000	0.0000	1.0000	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
27	tracery or steelwork on fanlight or tympanum	0.0000	0.1667	0.5000	0.0833	0.9167	0.0000	0.0000	0.0000	0.1667	0.0833	0.0000	0.0000	0.3333	0.0833
28	*stained glass on fanlight*	0.0000	0.3333	1.0000	0.0000	0.3333	0.0000	0.0000	0.0000	1.0000	0.6667	0.0000	0.0000	0.0000	0.6667
29	*flat retangular porch*	0.0435	0.0435	0.9130	0.4783	0.4783	0.0000	0.0435	0.1739	0.3043	0.2609	0.0435	0.0000	0.5652	0.0870
30	*flat semi-circular porch*	0.0000	0.0000	0.6667	0.6667	0.3333	0.0000	0.0000	0.0000	0.6667	0.3333	0.0000	0.0000	0.3333	0.6667
31	pediment porch	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000	0.0000	1.0000	1.0000
32	segmental (concave) porch	0.0000	0.0000	0.6667	0.3333	0.0000	0.3333	0.0000	0.3333	0.3333	0.3333	0.0000	0.0000	0.6667	0.3333
33	convex porch	0.0000	0.0000	0.5000	0.0000	0.5000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	1.0000	1.0000	0.0000
34	columns supporting porch	0.0000	0.0000	0.5833	0.5000	0.5000	0.0000	0.0000	0.0833	0.4167	0.3333	0.0000	0.0000	0.4167	0.4167
35	walls supporting porch	0.0000	0.0667	0.9333	0.4000	0.4000	0.0667	0.0667	0.1333	0.5333	0.2667	0.0667	0.0000	0.5333	0.2667
36	cables supporting porch	0.0000	0.0000	0.7500	0.5000	0.2500	0.0000	0.0000	0.2500	0.0000	0.2500	0.0000	0.5000	0.7500	0.0000
37	*lateral squared section column*	0.0000	0.1429	0.6429	0.2143	0.5000	0.0000	0.0714	0.2857	0.5714	0.2143	0.0000	0.0000	0.2143	0.2143
38	*lateral cylindrical section column*	0.0000	0.0769	0.1538	0.0000	0.8462	0.0000	0.0000	0.0000	0.0000	0.2308	0.0000	0.0000	0.0000	0.0769
39	*lateral vertical moulding*	0.0000	0.2000	0.4571	0.0286	0.8000	0.1143	0.0000	0.0000	0.1429	0.2571	0.0000	0.0000	0.0857	0.2000
40	*window in one side*	0.0476	0.0000	1.0000	0.6190	0.2857	0.0476	0.0000	0.1905	0.3810	0.1905	0.0952	0.0000	0.5714	0.4762
41	*windows in both sides*	0.0750	0.0250	1.0000	0.4750	0.3000	0.0250	0.0250	0.1500	0.3000	0.1750	0.0250	0.0250	0.6750	0.3250
42	vertical glass tower	0.2353	0.0000	1.0000	0.8235	0.1765	0.0000	0.0000	0.0588	0.0588	0.0588	0.0588	0.0000	1.0000	0.6471
43	angular connection with glass tower		0.0000	1.0000	0.7500	0.5000	0.0000	0.0000	0.0000	0.0000	0.2500	0.0000	0.0000	1.0000	0.2500
44	decorative sculptures	0.0000		0.7000	0.0000	0.9000	0.1000	0.0000	0.0000	0.3000	0.1000	0.0000	0.0000	0.2000	0.2000
45	Surroundings material: glass	0.0471	0.0824		0.4235	0.3882	0.0353	0.0235	0.1176	0.3412	0.2000	0.0353	0.0118	0.5294	0.4000
46	Surroundings material: brick	0.0732	0.0000	0.8780		0.0976	0.0000	0.0000	0.1220	0.3415	0.1220	0.0000	0.0000	0.6585	0.5122
47	Surroundings material: smooth stone	0.0351	0.1579	0.5789	0.0702		0.0877	0.0000	0.0000	0.2105	0.1579	0.0000	0.0175	0.2281	0.1579
48	Surroundings material: rough stone	0.0000	0.1000	0.3000	0.0000	0.5000		0.0000	0.0000	0.1000	0.1000	0.0000	0.0000	0.0000	0.5000
49	Surroundings material: concrete blocks	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000		0.0000	0.5000	0.0000	0.5000	0.0000	0.5000	0.5000
50	Surroundings material: concrete exposed	0.0000	0.0000	0.9091	0.4545	0.0000	0.0000	0.0000		0.2727	0.0000	0.0000	0.0000	0.4545	0.1818
51	Surroundings material: timber	0.0000	0.0938	0.9063	0.4375	0.3750	0.0313	0.0313	0.0938		0.2500	0.0313	0.0000	0.1875	0.3750
52	Surroundings material: smooth plasterwork	0.0417	0.0417	0.7083	0.2083	0.3750	0.0417	0.0000	0.0000	0.3333		0.0417	0.0417	0.2500	0.3750
53	Surroundings material: rusticated plasterwork	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.3333	0.0000	0.3333	0.3333		0.0000	0.6667	0.3333
54	Surroundings materials: tiles or small tiles	0.0000	0.0000	0.5000	0.0000	0.5000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000		1.0000	0.0000
55	Surroundings material: metal	0.0833	0.0417	0.9375	0.5625	0.2708	0.0000	0.0208	0.1042	0.1250	0.1250	0.0417	0.0417		0.4167
56	swinging door: one single	0.0250	0.0500	0.8500	0.5250	0.2250	0.1250	0.0250	0.0500	0.3000	0.2250	0.0250	0.0000	0.5000	
57	swinging door: two singles	0.0000	0.0000	0.3750	0.0000	0.8750	0.0000	0.1250	0.0000	0.0000	0.1250	0.1250	0.0000	0.2500	0.0000
58	swinging door: one double	0.0317	0.1111	0.5873	0.2698	0.5714	0.0794	0.0000	0.1111	0.2857	0.2063	0.0159	0.0317	0.3175	0.0000
59	swinging door: triple, two doubles or more	0.1429	0.1429	1.0000	0.2857	0.4286	0.0000	0.0000	0.0000	0.2857	0.1429	0.0000	0.0000	0.7143	0.0000
60	revolving door (with four leaves)	0.0000	0.0000	1.0000	0.0000	0.4286	0.0000	0.1429	0.2857	0.0000	0.0000	0.1429	0.0000	0.4286	0.1429
61	sliding door (one or more leaves)	0.0000	0.0000	1.0000	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000
62	leaf: plain opaque	0.0000	0.5000	1.0000	0.5000	0.5000	0.0000	0.0000	0.0000	0.5000	0.5000	0.0000	0.0000	0.5000	0.0000
63	leaf: plain transparent	0.2000	0.0000	1.0000	0.4000	0.2000	0.0000	0.0000	0.6000	0.0000	0.0000	0.0000	0.0000	0.2000	0.2000
64	leaf: semi-opaque plain with one or more light cross panels	0.0000	0.1667	0.8333	0.6667	0.3333	0.0000	0.0000	0.0000	0.3333	0.0000	0.0000	0.1667	0.6667	0.6667
65	leaf: paneled opaque	0.0000	0.1316	0.3158	0.0789	0.7368	0.2368	0.0000	0.0263	0.1579	0.2632	0.0000	0.0000	0.0000	0.2368
66	leaf: paneled semi-opaque with one or more light cross panels	0.0000	0.2000	0.6000	0.1333	0.7333	0.0667	0.0667	0.0000	0.4667	0.1333	0.0000	0.0000	0.2000	0.3333
67	leaf: framed with one or two light cross panels	0.0313	0.0000	0.9688	0.3125	0.3125	0.0000	0.0313	0.1875	0.2500	0.2188	0.0625	0.0313	0.7188	0.1250
68	leaf: framed with three or more light cross panels	0.0800	0.0000	0.8800	0.7600	0.1600	0.0000	0.0000	0.0800	0.3200	0.1600	0.0400	0.0000	0.6400	0.7200
69	steelwork leaf decoration	0.0000	0.1538	0.3846	0.0769	0.9231	0.0769	0.0000	0.0000	0.0769	0.1538	0.0000	0.0000	0.3077	0.0769
70	leaf mat.: non-stained glass	0.0500	0.0375	0.8625	0.4625	0.3500	0.0125	0.0250	0.1250	0.2875	0.1375	0.0375	0.0250	0.5875	0.3625
71	leaf mat.: stained glass	0.0000	0.5000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	0.0000	0.0000	0.0000	1.0000
72	leaf mat.: metal	0.0533	0.0400	0.7600	0.3867	0.3733	0.0533	0.0267	0.1333	0.1467	0.1333	0.0267	0.0267	0.6133	0.3333
73	leaf mat.: timber	0.0000	0.1111	0.5278	0.2083	0.6111	0.1389	0.0139	0.0278	0.4167	0.2500	0.0139	0.0000	0.0833	0.2917
74	round knob or ring handle	0.0000	0.1400	0.4000	0.0800	0.7600	0.1600	0.0000	0.0200	0.1800	0.2400	0.0000	0.0200	0.1400	0.2200
75	retangular, squared or trapezoid handle	0.0000	0.1250	1.0000	0.6250	0.1875	0.0000	0.0000	0.1250	0.3750	0.2500	0.0000	0.0000	0.5625	0.5000
76	lever handle	0.0000	0.0000	0.7273	0.7273	0.2727	0.0000	0.0000	0.0000	0.3636	0.1818	0.0000	0.0000	0.6364	0.8182
77	long horizontal static handle	0.0000	0.0000	1.0000	0.5000	0.3333	0.0000	0.0000	0.1667	0.1667	0.1667	0.1667	0.0000	0.5000	0.1667
78	long vertical static handle	0.1429	0.0000	1.0000	0.4762	0.2381	0.0000	0.0000	0.2381	0.1429	0.0476	0.0476	0.0476	0.7619	0.2381
79	short vertical static handle	0.0000	0.0714	1.0000	0.5714	0.2857	0.0000	0.0714	0.1429	0.5714	0.0714	0.0000	0.0000	0.4286	0.4286
80	curved static handle	0.0000	0.0000	0.5000	0.5000	0.0000	0.0000	0.0000	0.2500	0.0000	0.2500	0.0000	0.0000	0.5000	0.2500

<< Input (x)	(y) Output >>	57 *swinging door: two singles*	58 *swinging door: one double*	59 *swinging door: triple, two doubles or more*	60 *revolving door (with four leaves)*	61 *sliding door (one or more leaves)*	62 leaf: plain opaque	63 leaf: plain transparent	64 leaf: semi-opaque plain with one or more light cross panels	65 leaf: paneled opaque	66 leaf: paneled semi-opaque with one or more light cross panels	67 leaf: framed with one or two light cross panels	68 leaf: framed with three or more light cross panels	69 *steelwork leaf decoration*	70 leaf mat: non-stained glass
1	*main entrance*	0.0784	0.4902	0.0686	0.0686	0.0000	0.0196	0.0490	0.0588	0.3039	0.1078	0.2647	0.2059	0.1078	0.6569
2	secondary entrance	0.0000	0.8000	0.0000	0.0000	0.0667	0.0000	0.0000	0.0000	0.3333	0.2667	0.2667	0.1333	0.1333	0.6667
3	*public access*	0.1029	0.6618	0.1029	0.1029	0.0000	0.0147	0.0735	0.0294	0.2794	0.1324	0.4265	0.0588	0.1324	0.7059
4	*restricted access*	0.0208	0.3333	0.0000	0.0000	0.0208	0.0208	0.0000	0.0833	0.3333	0.1250	0.0417	0.3958	0.0833	0.6042
5	exit only	0.0000	0.3333	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.1667	0.3333	0.0000	0.5000
6	*gives access to: air lock, vestibule or foyer*	0.0762	0.4857	0.0667	0.0667	0.0095	0.0190	0.0476	0.0571	0.2952	0.1143	0.2571	0.2190	0.1048	0.6667
7	*gives access to: corridor or aisle*	0.0000	0.6923	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4615	0.1538	0.2308	0.1538	0.0769	0.5385
8	*gives access to: shop or working room*	0.0000	0.7500	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2500	0.2500	0.5000	0.0000	0.2500	0.7500
9	aligned to the facade	0.0364	0.5455	0.0182	0.0000	0.0000	0.0182	0.0182	0.0727	0.3636	0.1818	0.1636	0.1818	0.1273	0.5818
10	pulled out from the facade	0.0000	0.6000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2000	0.2000	0.6000	0.0000	1.0000
11	*pulled in from the facade*	0.0968	0.4839	0.0968	0.1129	0.0161	0.0161	0.0645	0.0323	0.2903	0.0645	0.3548	0.1935	0.0968	0.6935
12	*flat door top*	0.0636	0.4818	0.0636	0.0636	0.0091	0.0182	0.0455	0.0545	0.2545	0.1182	0.2909	0.2273	0.0818	0.7091
13	semi-circular door top arch	0.0000	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.5000	0.0000	0.0000	0.0000	0.5000
14	*segmental door top arch*	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.5000	0.0000	0.0000	0.5000	0.5000
15	pointed door top arch	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.2000	0.0000
16	round trefoil door top arch	0.3333	0.6667	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.6667	0.0000
17	*top flat moulding*	0.1071	0.5357	0.0357	0.0357	0.0000	0.0357	0.0000	0.0000	0.5714	0.2143	0.0714	0.1071	0.1429	0.3214
18	*top curved moulding*	0.1667	0.7333	0.0000	0.0000	0.0000	0.0000	0.0000	0.0333	0.7333	0.2000	0.0000	0.0333	0.3667	0.2667
19	triangular pediment	0.0000	0.5000	0.0000	0.5000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.5000	0.0000	0.0000	0.5000
20	semi-circular or segmental pediment	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21	*squared fanlight*	0.0213	0.4681	0.0638	0.1064	0.0000	0.0213	0.0638	0.0638	0.1489	0.1064	0.4043	0.2128	0.0213	0.7872
22	*fanlight with undulate top*	0.0000	1.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000	1.0000	0.5000
23	pointed arch fanlight	0.3333	0.3333	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.6667	0.0000	0.0000	0.3333	0.0000	0.3333
24	semi-circular or segmental arch fanlight	0.0000	0.7778	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3333	0.3333	0.3333	0.0000	0.2222	0.6667
25	pointed arch tympanum	0.4000	0.6000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.7000	0.3000	0.0000	0.0000	0.7000	0.3000
26	semi-circular arch tympanum	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
27	tracery or steelwork on fanlight or tympanum	0.4167	0.5000	0.0000	0.0000	0.0000	0.0833	0.0000	0.0000	0.5833	0.2500	0.0000	0.0833	0.6667	0.3333
28	*stained glass on fanlight*	0.0000	0.3333	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.6667	0.0000	0.3333	0.0000	0.3333
29	*flat retangular porch*	0.1304	0.5652	0.1304	0.1304	0.0435	0.0000	0.0870	0.0435	0.0870	0.0870	0.6522	0.0435	0.0000	0.9130
30	*flat semi-circular porch*	0.0000	0.3333	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3333	0.0000	0.0000	0.6667	0.0000	0.6667
31	pediment porch	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000	0.0000	0.5000	0.0000	1.0000
32	segmental (concave) porch	0.0000	0.6667	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3333	0.0000	0.3333	0.3333	0.0000	0.6667
33	convex porch	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000	0.5000	0.0000	0.0000	1.0000
34	columns supporting porch	0.1667	0.3333	0.0000	0.1667	0.0000	0.0000	0.0000	0.0833	0.3333	0.0000	0.4167	0.1667	0.0000	0.6667
35	walls supporting porch	0.0667	0.5333	0.1333	0.0667	0.0000	0.0000	0.0000	0.0667	0.1333	0.1333	0.4667	0.2000	0.0000	0.8667
36	cables supporting porch	0.0000	0.7500	0.2500	0.0000	0.0000	0.0000	0.2500	0.2500	0.0000	0.0000	0.5000	0.0000	0.0000	1.0000
37	*lateral squared section column*	0.0000	0.7143	0.0714	0.0000	0.0000	0.0714	0.0000	0.0000	0.5000	0.1429	0.2143	0.0714	0.0714	0.4286
38	*lateral cylindrical section column*	0.3846	0.5385	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.9231	0.0769	0.0000	0.0000	0.3846	0.0769
39	*lateral vertical moulding*	0.1429	0.6286	0.0000	0.0286	0.0000	0.0286	0.0000	0.0286	0.6286	0.2286	0.0286	0.0571	0.3429	0.2857
40	*window in one side*	0.0000	0.3810	0.0952	0.0476	0.0476	0.0000	0.0952	0.0476	0.0476	0.0952	0.4762	0.2857	0.0000	0.9524
41	*windows in both sides*	0.0250	0.5000	0.1000	0.1000	0.0000	0.0000	0.0750	0.0750	0.0750	0.0500	0.4250	0.3000	0.0750	0.9250
42	vertical glass tower	0.0000	0.2941	0.0588	0.0000	0.0000	0.0000	0.0588	0.0588	0.0000	0.0000	0.2353	0.6471	0.0000	1.0000
43	angular connection with glass tower	0.0000	0.5000	0.2500	0.0000	0.0000	0.0000	0.2500	0.0000	0.0000	0.0000	0.2500	0.5000	0.0000	1.0000
44	decorative sculptures	0.0000	0.7000	0.1000	0.0000	0.0000	0.1000	0.0000	0.1000	0.5000	0.3000	0.0000	0.0000	0.2000	0.3000
45	Surroundings material: glass	0.0353	0.4353	0.0824	0.0824	0.0118	0.0235	0.0588	0.0588	0.1412	0.1059	0.3647	0.2588	0.0588	0.8118
46	Surroundings material: brick	0.0000	0.4146	0.0488	0.0000	0.0244	0.0244	0.0488	0.0976	0.0732	0.0488	0.2439	0.4634	0.0244	0.9024
47	Surroundings material: smooth stone	0.1228	0.6316	0.0526	0.0526	0.0000	0.0175	0.0175	0.0351	0.4912	0.1930	0.1754	0.0702	0.2105	0.4912
48	Surroundings material: rough stone	0.0000	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.9000	0.1000	0.0000	0.0000	0.1000	0.1000
49	Surroundings material: concrete blocks	0.5000	0.0000	0.0000	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.5000	0.0000	0.0000	1.0000
50	Surroundings material: concrete exposed	0.0000	0.6364	0.0000	0.1818	0.0909	0.0000	0.2727	0.0000	0.0909	0.0000	0.5455	0.1818	0.0000	0.9091
51	Surroundings material: timber	0.0000	0.5625	0.0625	0.0000	0.0000	0.0313	0.0000	0.0625	0.1875	0.2188	0.2500	0.2500	0.0313	0.7188
52	Surroundings material: smooth plasterwork	0.0417	0.5417	0.0417	0.0000	0.0000	0.0417	0.0000	0.0000	0.4167	0.0833	0.2917	0.1667	0.0833	0.4583
53	Surroundings material: rusticated plasterwork	0.3333	0.3333	0.0000	0.3333	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.6667	0.3333	0.0000	1.0000
54	Surroundings materials: tiles or small tiles	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000	0.5000	0.0000	0.0000	1.0000
55	Surroundings material: metal	0.0417	0.4167	0.1042	0.0625	0.0208	0.0208	0.0208	0.0833	0.0000	0.0625	0.4792	0.3333	0.0833	0.9792
56	swinging door: one single	0.0000	0.0000	0.0000	0.0250	0.0000	0.0000	0.0250	0.1000	0.2250	0.1250	0.1000	0.4500	0.0250	0.7250
57	swinging door: two singles		0.0000	0.0000	0.2500	0.0000	0.0000	0.0000	0.0000	0.7500	0.0000	0.2500	0.0000	0.3750	0.2500
58	swinging door: one double	0.0000		0.0000	0.0000	0.0000	0.0159	0.0317	0.0317	0.3651	0.1587	0.2857	0.1111	0.1429	0.6190
59	swinging door: triple, two doubles or more	0.0000	0.0000		0.1429	0.0000	0.1429	0.2857	0.0000	0.0000	0.0000	0.5714	0.0000	0.0000	0.8571
60	revolving door (with four leaves)	0.2857	0.0000	0.1429		0.0000	0.0000	0.1429	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	1.0000
61	sliding door (one or more leaves)	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	1.0000
62	leaf: plain opaque	0.0000	0.5000	0.5000	0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000
63	leaf: plain transparent	0.0000	0.4000	0.4000	0.2000	0.0000	0.0000		0.0000	0.0000	0.0000	0.2000	0.0000	0.0000	1.0000
64	leaf: semi-opaque plain with one or more light cross panels	0.0000	0.3333	0.0000	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
65	leaf: paneled opaque	0.1579	0.6053	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000	0.0000	0.1842	0.0000
66	leaf: paneled semi-opaque with one or more light cross panels	0.0000	0.6667	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000	0.3333	0.8667
67	leaf: framed with one or two light cross panels	0.0625	0.5625	0.1250	0.2188	0.0313	0.0000	0.0313	0.0000	0.0000	0.0000		0.0000	0.0000	1.0000
68	leaf: framed with three or more light cross panels	0.0000	0.2800	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		0.0000	1.0000
69	steelwork leaf decoration	0.2308	0.6923	0.0000	0.0000	0.0000	0.0769	0.0000	0.0000	0.5385	0.3846	0.0000	0.0000		0.3846
70	leaf mat.: non-stained glass	0.0250	0.4875	0.0750	0.0875	0.0125	0.0000	0.0625	0.0750	0.0000	0.1625	0.4000	0.3125	0.0625	
71	leaf mat.: stained glass	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000
72	leaf mat.: metal	0.0667	0.4800	0.0667	0.0933	0.0133	0.0133	0.0533	0.0400	0.1467	0.1333	0.3733	0.2533	0.1733	0.8133
73	leaf mat.: timber	0.0833	0.5972	0.0139	0.0139	0.0000	0.0139	0.0000	0.0556	0.5278	0.1806	0.0972	0.1250	0.1389	0.4306
74	round knob or ring handle	0.1200	0.6400	0.0200	0.0000	0.0000	0.0400	0.0000	0.0200	0.6600	0.2200	0.0200	0.0400	0.2600	0.2800
75	retangular, squared or trapezoid handle	0.0000	0.4375	0.0625	0.0000	0.0000	0.0000	0.0625	0.1250	0.0625	0.0000	0.3125	0.4375	0.0000	0.9375
76	lever handle	0.0000	0.1818	0.0000	0.0000	0.0000	0.0000	0.0000	0.0909	0.1818	0.0000	0.1818	0.5455	0.0000	0.8182
77	long horizontal static handle	0.1667	0.5000	0.0000	0.3333	0.0000	0.0000	0.1667	0.0000	0.0000	0.0000	0.6667	0.1667	0.0000	1.0000
78	long vertical static handle	0.0000	0.4762	0.1905	0.1905	0.0000	0.0000	0.1429	0.0476	0.0000	0.0000	0.4762	0.3810	0.0000	1.0000
79	short vertical static handle	0.0000	0.4286	0.0714	0.0000	0.0714	0.0000	0.0714	0.0714	0.0000	0.2857	0.4286	0.1429	0.0000	0.9286
80	curved static handle	0.0000	0.7500	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.5000	0.0000	1.0000

<< Input (x)	(y) Output >>	71 leaf mat.: stained glass	72 leaf mat.: metal	73 leaf mat.: timber	74 round knob or ring handle	75 retangular, squared or trapezoid handle	76 lever handle	77 long horizontal static handle	78 long vertical static handle	79 short vertical static handle	80 curved static handle
1	main entrance	0.0196	0.6275	0.5686	0.3922	0.1569	0.1078	0.0392	0.1863	0.1176	0.0294
2	secondary entrance	0.0000	0.6000	0.7333	0.6667	0.0000	0.0000	0.0000	0.0667	0.1333	0.0667
3	public access	0.0000	0.6471	0.5588	0.3971	0.1176	0.0147	0.0588	0.2206	0.1324	0.0441
4	restricted access	0.0417	0.6042	0.6250	0.4583	0.1667	0.2083	0.0000	0.1042	0.1042	0.0208
5	exit only	0.0000	0.3333	0.6667	0.1667	0.0000	0.0000	0.3333	0.1667	0.0000	0.0000
6	gives access to: air lock, vestibule or foyer	0.0190	0.6286	0.5619	0.4000	0.1524	0.0952	0.0381	0.1905	0.1238	0.0286
7	gives access to: corridor or aisle	0.0000	0.4615	0.8462	0.5385	0.0000	0.0769	0.1538	0.0000	0.0769	0.0000
8	gives access to: shop or working room	0.0000	0.7500	0.5000	0.2500	0.0000	0.0000	0.0000	0.2500	0.0000	0.2500
9	aligned to the facade	0.0364	0.5091	0.6727	0.5091	0.0909	0.1091	0.0182	0.1273	0.0909	0.0364
10	pulled out from the facade	0.0000	0.8000	0.2000	0.2000	0.2000	0.0000	0.0000	0.6000	0.0000	0.0000
11	pulled in from the facade	0.0000	0.6935	0.5484	0.3387	0.1613	0.0806	0.0806	0.1774	0.1452	0.0323
12	flat door top	0.0182	0.6091	0.5545	0.3455	0.1455	0.1000	0.0545	0.1909	0.1273	0.0364
13	semi-circular door top arch	0.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
14	segmental door top arch	0.0000	0.5000	0.5000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15	pointed door top arch	0.0000	0.4000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
16	round trefoil door top arch	0.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
17	top flat moulding	0.0714	0.2500	0.9643	0.7500	0.0000	0.1071	0.0000	0.0357	0.1071	0.0000
18	top curved moulding	0.0000	0.5333	0.9333	0.9000	0.0667	0.0000	0.0000	0.0000	0.0333	0.0000
19	triangular pediment	0.0000	0.5000	0.5000	0.5000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000
20	semi-circular or segmental pediment	0.0000	0.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21	squared fanlight	0.0426	0.6596	0.5106	0.2128	0.1702	0.0638	0.1064	0.2979	0.1702	0.0213
22	fanlight with undulate top	0.0000	1.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
23	pointed arch fanlight	0.0000	0.0000	1.0000	0.6667	0.0000	0.0000	0.0000	0.0000	0.3333	0.0000
24	semi-circular or segmental arch fanlight	0.0000	0.3333	0.7778	0.5556	0.1111	0.1111	0.0000	0.0000	0.2222	0.0000
25	pointed arch tympanum	0.0000	0.8000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
26	semi-circular arch tympanum	0.0000	0.5000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
27	tracery or steelwork on fanlight or tympanum	0.0000	0.6667	0.7500	0.9167	0.0000	0.0000	0.0000	0.0000	0.0833	0.0000
28	stained glass on fanlight	0.6667	0.6667	1.0000	0.3333	0.0000	0.0000	0.0000	0.0000	0.6667	0.0000
29	flat retangular porch	0.0000	0.6957	0.3913	0.0870	0.2609	0.0435	0.1739	0.1739	0.2609	0.0000
30	flat semi-circular porch	0.0000	0.3333	0.6667	0.6667	0.3333	0.0000	0.0000	0.0000	0.0000	0.0000
31	pediment porch	0.0000	0.5000	1.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000
32	segmental (concave) porch	0.0000	1.0000	0.3333	0.3333	0.3333	0.0000	0.0000	0.0000	0.3333	0.0000
33	convex porch	0.0000	1.0000	0.0000	0.5000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000
34	columns supporting porch	0.0000	0.4167	0.7500	0.3333	0.0833	0.1667	0.2500	0.0000	0.1667	0.0000
35	walls supporting porch	0.0000	0.6667	0.5333	0.2000	0.4000	0.0667	0.0000	0.1333	0.1333	0.0000
36	cables supporting porch	0.0000	0.7500	0.0000	0.2500	0.2500	0.0000	0.0000	0.2500	0.2500	0.0000
37	lateral squared section column	0.0000	0.3571	0.7857	0.5000	0.0714	0.1429	0.0000	0.0000	0.2143	0.0714
38	lateral cylindrical section column	0.0000	0.3846	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
39	lateral vertical moulding	0.0571	0.5143	0.8857	0.8286	0.0571	0.0571	0.0000	0.0286	0.0286	0.0000
40	window in one side	0.0000	0.7143	0.3333	0.0476	0.3333	0.1429	0.0476	0.2381	0.1905	0.0000
41	windows in both sides	0.0000	0.8000	0.3250	0.1750	0.1750	0.1000	0.0500	0.3750	0.1250	0.0500
42	vertical glass tower	0.0000	0.9412	0.1176	0.0588	0.2353	0.2353	0.0588	0.4118	0.0000	0.0588
43	angular connection with glass tower	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.7500	0.0000	0.0000
44	decorative sculptures	0.1000	0.3000	0.8000	0.7000	0.2000	0.0000	0.0000	0.0000	0.1000	0.0000
45	Surroundings material: glass	0.0235	0.6706	0.4471	0.2353	0.1882	0.0941	0.0706	0.2471	0.1647	0.0235
46	Surroundings material: brick	0.0000	0.7073	0.3659	0.0976	0.2439	0.1951	0.0732	0.2439	0.1951	0.0488
47	Surroundings material: smooth stone	0.0000	0.4912	0.7719	0.6667	0.0526	0.0526	0.0351	0.0877	0.0702	0.0000
48	Surroundings material: rough stone	0.0000	0.4000	1.0000	0.8000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
49	Surroundings material: concrete blocks	0.0000	1.0000	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000
50	Surroundings material: concrete exposed	0.0000	0.9091	0.1818	0.0909	0.1818	0.0000	0.0909	0.4545	0.1818	0.0909
51	Surroundings material: timber	0.0625	0.3438	0.9375	0.2813	0.1875	0.1250	0.0313	0.0938	0.2500	0.0000
52	Surroundings material: smooth plasterwork	0.0833	0.4167	0.7500	0.5000	0.1667	0.0833	0.0417	0.0417	0.0417	0.0417
53	Surroundings material: rusticated plasterwork	0.0000	0.6667	0.3333	0.0000	0.0000	0.0000	0.3333	0.3333	0.0000	0.0000
54	Surroundings materials: tiles or small tiles	0.0000	1.0000	0.0000	0.5000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000
55	Surroundings material: metal	0.0000	0.9583	0.1250	0.1458	0.1875	0.1458	0.0625	0.3333	0.1250	0.0417
56	swinging door: one single	0.0500	0.6250	0.5250	0.2750	0.2000	0.2250	0.0250	0.1250	0.1500	0.0250
57	swinging door: two singles	0.0000	0.6250	0.7500	0.7500	0.0000	0.0000	0.1250	0.0000	0.0000	0.0000
58	swinging door: one double	0.0000	0.5714	0.6825	0.5079	0.1111	0.0317	0.0476	0.1587	0.0952	0.0476
59	swinging door: triple, two doubles or more	0.0000	0.7143	0.1429	0.1429	0.1429	0.0000	0.0000	0.5714	0.1429	0.0000
60	revolving door (with four leaves)	0.0000	1.0000	0.1429	0.0000	0.0000	0.0000	0.2857	0.5714	0.0000	0.0000
61	sliding door (one or more leaves)	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000
62	leaf: plain opaque	0.0000	0.5000	0.5000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
63	leaf: plain transparent	0.0000	0.8000	0.0000	0.0000	0.2000	0.0000	0.2000	0.6000	0.2000	0.0000
64	leaf: semi-opaque plain with one or more light cross panels	0.0000	0.5000	0.6667	0.1667	0.3333	0.1667	0.0000	0.1667	0.1667	0.0000
65	leaf: paneled opaque	0.0000	0.2895	1.0000	0.8684	0.0263	0.0526	0.0000	0.0000	0.0000	0.0000
66	leaf: paneled semi-opaque with one or more light cross panels	0.1333	0.6667	0.8667	0.7333	0.0000	0.0000	0.0000	0.0000	0.2667	0.0000
67	leaf: framed with one or two light cross panels	0.0000	0.8750	0.2188	0.0313	0.1563	0.0625	0.1250	0.3125	0.1875	0.0625
68	leaf: framed with three or more light cross panels	0.0000	0.7600	0.3600	0.0800	0.2800	0.2400	0.0400	0.3200	0.0800	0.0800
69	steelwork leaf decoration	0.0000	1.0000	0.7692	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
70	leaf mat.: non-stained glass	0.0000	0.7625	0.3875	0.1750	0.1875	0.1125	0.0750	0.2625	0.1625	0.0500
71	leaf mat.: stained glass		1.0000	1.0000	0.5000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000
72	leaf mat.: metal	0.0267		0.3467	0.2933	0.1467	0.0800	0.0667	0.2800	0.1200	0.0533
73	leaf mat.: timber	0.0278	0.3611		0.6250	0.0833	0.0833	0.0278	0.0417	0.0972	0.0000
74	round knob or ring handle	0.0200	0.4400	0.9000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
75	retangular, squared or trapezoid handle	0.0000	0.6875	0.3750	0.0000		0.1875	0.0000	0.0000	0.0000	0.0000
76	lever handle	0.0000	0.5455	0.5455	0.0000	0.2727		0.0000	0.0000	0.0000	0.0000
77	long horizontal static handle	0.0000	0.8333	0.3333	0.0000	0.0000	0.0000		0.1667	0.1667	0.0000
78	long vertical static handle	0.0000	1.0000	0.1429	0.0000	0.0000	0.0000	0.0476		0.0000	0.0000
79	short vertical static handle	0.0714	0.6429	0.5000	0.0000	0.0000	0.0000	0.0714	0.0000		0.0000
80	curved static handle	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	

Appendix 4

User types

It was necessary to generate a representative sample of users' inputs and Cortex output. Therefore, a set of 46 *'user types'* was built covering a wide variety of different concerns and contexts.

This appendix shows a table with the description of those user types. Each row in this table represents how a user of a particular type may answer each of the questions from the system. If a feature has a setting 'y' the answer should be 'yes', while having a 'd' setting would require an answer 'don't know'. A blank cell would require an answer 'no'.

Once the table is too large to fit in a single page, it has been broken down into 5 small tables, each with its own labels of columns and rows.

The key map bellow indicates the relationship between tables. The numbers indicate the page in which each table can be found.

272	273	274	275	276

Type	1 main entrance	2 secondary entrance	3 public access	4 restricted access	5 exit only	6 gives access to: air lock, vestibule or foyer	7 gives access to: corridor or aisle	8 gives access to: shop or working room	9 aligned to the facade	10 pulled out from the facade	11 pulled in from the facade	12 flat door top	13 semi-circular door top arch	14 segmental door top arch	15 pointed door top arch	16 round trefoil door top arch
Classic 1	y		y			y			y			y				
Classic 2		y		y			y		y			y				
Classic 3	y		d	d	d	d	d	d	y			y				
Classic 4	y			y		y			y			y				
Classic 5	y		y			y			y			y				
Classic 6	y			y		y			y			y				
Classic 7		y		y		d	d	d	y			y				
Gothic 1	y		y			y					y	y				
Gothic 2	d	d	d	d			y				y	y				
Art Nouveau 1	y			y		y			y			y				
Art Nouveau 2	y		d	d	d	y			d	d	d	d		d		
Modern (functionalist 1)	y			y		y			y			y				
Modern (functionalist 2)	y			y		y			y			y				
Modern (functionalist 3)		y	y				y		d	d	d	y				
Modern (brutalist 1)	y		y			y					y	y				
Modern (brutalist 2)	y		y			y					y	y				
Modern (brutalist 3)	y		y			y					y	y				
Modern (organic 1)	y		y			y			y			y				
Modern (organic 2)	y		y			y					y	y				
Modern (organic3)	d	d	d	d		y					y	y				
Modern (high tech 1)	y		y			y					y	y				
Modern (high tech 2)	d	d	d	d		y					y	y				
Modern (high tech 3)	y		y			y					y	y				
Modern (high tech 4)	d	d	d	d		y					y	y				
Post-Modern (neo-classic 1)	d	d	d	d		d					y	y				
Post-Modern (neo-classic 2)	y		y			y					y	y				
Post-Modern (neo-classic 3)	y		y			y					y	y				
Post-Modern (neo-classic 4)	d	d	d	d		y			y			y				
Post-Modern (ecletic 1)	d	d	d	d		d	d	d	y			y				
Post-Modern (ecletic 2)	y			y		y				y		y				
Post-Modern (ecletic 3)	y			y		y					y	y				
Post-Modern (ecletic 4)	d	d	d	d		d	d				y	y				
Environmental control 1 (Tight)	y		d	d	d	y					y	y				
Environmental control 2 (Tight)	d	d	d	d		y					y	y				
Environmental control 3 (loose)	y		y				y		d		d	y				
Environmental control 4 (loose)		y	y				y		d		d	y				
Environmental control 5 (no control)	d	d	y					y			y	d	d		d	d
Environmental control 6 (no control)		y	d	d				y	d	d	d	d	d		d	d
Function 1 (High flow)	y		y			y					y	y				
Function 2 (High flow)	y		y			d	d	d	y			d	d	d	d	d
Function 3 (Medium flow)		y	d	d		d	d		d		d	y				
Function 4 (Medium flow)		y		y		y			d		d	d				
Materials 1 (Industrialised)	y			y		d	d		d	d	d	y				
Materials 2 (Industrialised)		y	y			d	d				y	y				
Materials 3 (Hand-crafted)		y	y			d	d		d	d	d	y				
Materials 4 (Hand-crafted)		y	y			d	d		d	d	d	y				

Type	17 top flat moulding	18 top curved moulding	19 triangular pediment	20 semi-circular or segmental pediment	21 squared fanlight	22 fanlight with undulate top	23 pointed arch fanlight	24 semi-circular or segmental arch fanlight	25 pointed arch tympanum	26 semi-circular arch tympanum	27 tracery or steelwork on fanlight or tympanum	28 stained glass on fanlight	29 flat retangular porch	30 flat semi-circular porch	31 pediment porch	32 segmental (concave) porch
Classic 1	y		y													
Classic 3	y		y													
Classic 4	y		y										y			
Classic 5	y		y										y			
Classic 6	y	y						y					y			
Classic 7	y	y						y								
Classic 8	y	y						y			d	d				
Gothic 1		y							y		y					
Gothic 2		y					y				d	d				
Art Nouveau 1						y						y				
Art Nouveau 2						y						y				
Modern (functionalist 1)																
Modern (functionalist 3)					y								y			
Modern (functionalist 5)					y								y			
Modern (brutalist 1)					y								y			
Modern (brutalist 2)					y											
Modern (brutalist 3)					y											
Modern (organic 1)					y											
Modern (organic 2)													y			
Modern (organic3)													y			
Modern (high tech 1)					y								y			
Modern (high tech 2)					y											
Modern (high tech 3)																
Modern (high tech 4)					y											
Post-Modern (neo-classic 1)	y				y											
Post-Modern (neo-classic 2)	y				y									y		
Post-Modern (neo-classic 3)	y		y		y											
Post-Modern (neo-classic 4)	y	y						y								
Post-Modern (ecletic 2)															y	
Post-Modern (ecletic 3)																
Post-Modern (ecletic 4)															y	
Post-Modern (ecletic 5)																
Environmental control 1 (Tight)	d	d			y											
Environmental control 2 (Tight)	d	d			y			d	d		d		y			
Environmental control 3 (loose)	d	d			y				d		d		d			
Environmental control 4 (loose)	d	d			d			d	d		d		d			
Environmental control 5 (no control)	d	d			y				d		d	d	d	d		d
Environmental control 6 (no control)	d	d			y				d		d	d	d	d		d
Function 1 (High flow)	d	d	d	d	d	d	d	d	d	d	d	d	d	d	d	d
Function 2 (High flow)	d	d	d	d	d	d	d	d	d	d	d	d	d	d	d	d
Function 3 (Medium flow)	d	d			d				d		d		d			
Function 4 (Medium flow)	d	d			d				d		d		d			
Materials 1 (Industrialised)					d								d			
Materials 2 (Industrialised)	d				d								d			
Materials 3 (Hand-crafted)	d	d			d			d	d		d		d			
Materials 4 (Hand-crafted)	d	d			d			d	d		d		d			

	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
Type	convex porch	***columns supporting porch***	***walls supporting porch***	***cables supporting porch***	lateral squared section column	lateral cylindrical section column	lateral vertical moulding	window in one side	windows in both sides	***vertical glass tower***	***angular connection with glass tower***	***decorative sculptures***	Surroundings material: glass	Surroundings material: brick	Surroundings material: smooth stone	Surroundings material: rough stone
Classic 1						y	y					y			y	
Classic 3		y			y		y					y			y	
Classic 4		y				y	d					d			y	d
Classic 5		y			y							y		y	y	
Classic 6					y										y	
Classic 7					y										y	
Classic 8					y		d	d	d			d			y	d
Gothic 1						y	y								y	
Gothic 2						y	y								y	d
Art Nouveau 1													y		y	
Art Nouveau 2													y		y	
Modern (functionalist 1)								y		y			y			
Modern (functionalist 3)									y				y			
Modern (functionalist 5)								d	d				y			
Modern (brutalist 1)			y													
Modern (brutalist 2)									y				y			
Modern (brutalist 3)								y					y			
Modern (organic 1)									y				y	y		
Modern (organic 2)			y					y					y	y	y	
Modern (organic3)			y					y					y	y	y	
Modern (high tech 1)		y											y		y	
Modern (high tech 2)									y	y	d		y			
Modern (high tech 3)									y				y			
Modern (high tech 4)									y	y			y	d		
Post-Modern (neo-classic 1)														y		
Post-Modern (neo-classic 2)		y												y		
Post-Modern (neo-classic 3)							y		y				y		y	
Post-Modern (neo-classic 4)					y		d	d	d			d	y			
Post-Modern (ecletic 2)		y						d	d	d		d	y	y		
Post-Modern (ecletic 3)									y	y	y		y	y		
Post-Modern (ecletic 4)		y												y		
Post-Modern (ecletic 5)														y		
Environmental control 1 (Tight)								y				d	d	d	d	d
Environmental control 2 (Tight)		y											y		y	
Environmental control 3 (loose)		d	d		d	d	d	d	d	d		d	d	d	d	d
Environmental control 4 (loose)		d	d		d	d	d		y	d		d	d	d	d	d
Environmental control 5 (no control)		d	d	d	d	d	d	d	d	d	d	d	d	d	d	d
Environmental control 6 (no control)		d	d	d	d	d	d	d	d	d	d	d	d	d	d	d
Function 1 (High flow)	d	d	d	d	d	d	d	d	d	d	d	d	d	d	d	d
Function 2 (High flow)	d	d	d	d	d	d	d		y	d	d	d	d	d	d	d
Function 3 (Medium flow)		d	d		d	d	d	d	d	d			d	d	d	
Function 4 (Medium flow)		d	d		d	d	d	d	d	d			d	d	d	
Materials 1 (Industrialised)		d	d						y	y		d	y			
Materials 2 (Industrialised)		d	d		d	d	d	d	d			d	y	y		
Materials 3 (Hand-crafted)		d	d		d	d	d	d	d			d				y
Materials 4 (Hand-crafted)		d	d		d	d	d	d	d			d				y

Type	49 Surroundings material: concrete blocks	50 Surroundings material: concrete exposed	51 Surroundings material: timber	52 Surroundings material: smooth plasterwork	53 Surroundings material: rusticated plasterwork	54 Surroundings materials: tiles or small tiles	55 Surroundings material: metal	56 *swinging door: one single*	57 *swinging door: two singles*	58 *swinging door: one double*	59 *swinging door: triple, two doubles or more*	60 *revolving door (with four leaves)*	61 *sliding door (one or more leaves)*	62 Leaf: plain opaque	63 Leaf: plain transparent	64 Leaf: semi-opaque plain with one or more light cross panels
Classic 1										y						
Classic 3										y						
Classic 4				y				d		d						
Classic 5										y						y
Classic 6			y							y						
Classic 7			y					y								y
Classic 8			d					d		d						
Gothic 1									y							
Gothic 2								d	d	d						y
Art Nouveau 1				y				y								
Art Nouveau 2				y				y								
Modern (functionalist 1)					y		y	y								
Modern (functionalist 3)	y						y	y								
Modern (functionalist 5)		y					y	d	d	d	d					
Modern (brutalist 1)		y								y					y	
Modern (brutalist 2)		y										y				
Modern (brutalist 3)		y						y				y			y	
Modern (organic 1)			y							y						
Modern (organic 2)			y							y						
Modern (organic3)			y				y			y						
Modern (high tech 1)							y		y			y				
Modern (high tech 2)							y		d			d			y	
Modern (high tech 3)							y				y	y				
Modern (high tech 4)							y			y						
Post-Modern (neo-classic 1)			y							y						
Post-Modern (neo-classic 2)			y							y						
Post-Modern (neo-classic 3)												y				
Post-Modern (neo-classic 4)				y				y								
Post-Modern (ecletic 2)		y	y	y						y						
Post-Modern (ecletic 3)							y			y						
Post-Modern (ecletic 4)							y	y								y
Post-Modern (ecletic 5)							y	y								
Environmental control 1 (Tight)		d	d	d			d	y				y			y	
Environmental control 2 (Tight)		d	d	d			y					y				
Environmental control 3 (loose)		d	d	d			d			y						
Environmental control 4 (loose)		d	d	d			d			d						
Environmental control 5 (no control)		d	d	d	d		d	d	d	d	d	d			d	d
Environmental control 6 (no control)		d	d	d	d		d	d	d	d	d	d			d	d
Function 1 (High flow)	d	d	d	d	d	d	d				y					
Function 2 (High flow)	d	d	d	d	d	d	d				y				y	
Function 3 (Medium flow)		d	d	d			d			y						
Function 4 (Medium flow)		d	d	d			d			y						
Materials 1 (Industrialised)							y			y						
Materials 2 (Industrialised)							y	d	d	d	d	d			y	
Materials 3 (Hand-crafted)								d	d	d	d	d				
Materials 4 (Hand-crafted)			y					d	d	d	d	d				

Type	65 leaf: paneled opaque	66 leaf: paneled semi-opaque with one or more light cross panels	67 leaf: framed with one or two light cross panels	68 leaf: framed with three or more light cross panels	69 *steelwork leaf decoration*	70 leaf mat.: non-stained glass	71 leaf mat.: stained glass	72 leaf mat.: metal	73 leaf mat.: timber	74 *round knob or ring handle*	75 *rectangular, squared or trapezoid handle*	76 *lever handle*	77 *long horizontal static handle*	78 *long vertical static handle*	79 *short vertical static handle*	80 *curved static handle*
Classic 1	y								y	y						
Classic 3	y								y	y						
Classic 4	y								y	d	d	d	d	d	d	d
Classic 5							y		y	y						
Classic 6	y								y	y						
Classic 7						y			y	y						
Classic 8	y								y	d	d	d	d	d	d	d
Gothic 1	y								y	y						
Gothic 2					d		y		y	d	d	d	d	d	d	d
Art Nouveau 1			y				y	y	y							y
Art Nouveau 2			y				y	y	y	d	d	d	d	d	d	d
Modern (functionalist 1)				y		y		y						y		
Modern (functionalist 3)			y			y		y				y				
Modern (functionalist 5)			y			y		y		d	d	d	d	d	d	d
Modern (brutalist 1)						y		y						y		
Modern (brutalist 2)			y			y		y						y		
Modern (brutalist 3)			y			y		y						y		
Modern (organic 1)				y		y		y	y					y		
Modern (organic 2)		y				y			y						y	
Modern (organic3)		y				y			y	d	d	d		d	d	
Modern (high tech 1)			y			y		y					y			
Modern (high tech 2)						y		y					d	d	d	
Modern (high tech 3)			y			y		y						y		
Modern (high tech 4)			y			y		y		d	d			d		
Post-Modern (neo-classic 1)	y								y	d	d			d		
Post-Modern (neo-classic 2)	y								y	y						
Post-Modern (neo-classic 3)			y			y		y						y		
Post-Modern (neo-classic 4)			y			y		y		d	d	d	d	d	d	d
Post-Modern (ecletic 2)			y			y		y	y	d	d	d	d	d	d	d
Post-Modern (ecletic 3)				y		y		y						y		
Post-Modern (ecletic 4)						y		y	y			y				
Post-Modern (ecletic 5)						y		y	y	d	d			d	d	
Environmental control 1 (Tight)			y			y		y		d	d	d	d	d	d	d
Environmental control 2 (Tight)			y			y		y	y	d	d	d	d	d	d	d
Environmental control 3 (loose)	d	d	d	d	d	d		d	d	d	d	d		d	d	
Environmental control 4 (loose)	d	d	d	d	d	d		d	d	d	d	d		d	d	
Environmental control 5 (no control)	d	d	d	d	d	d		d	d	d	d	d	d	d	d	d
Environmental control 6 (no control)	d	d	d	d	d	d		d	d	d	d	d	d	d	d	d
Function 1 (High flow)			y		d	d	d	d	d	d	d	d	d	d	d	d
Function 2 (High flow)					d	d	d	d	d	d	d	d	d	d	d	d
Function 3 (Medium flow)		y			d	y		d	d	d	d	d		d	d	
Function 4 (Medium flow)		y			d	d		d	d	d	d	d		d	d	
Materials 1 (Industrialised)			y			y		y		d	d	d	d	d	d	
Materials 2 (Industrialised)						y		y		d	d	d	d	d	d	
Materials 3 (Hand-crafted)	y				d				y	d	d	d	d	d	d	
Materials 4 (Hand-crafted)		y			d	y			y	d	d	d	d	d	d	

Appendix 5

Weight matrices examples

The knowledge of each neural network is stored in matrixes of connection weights. Networks with one hidden layers have two matrixes. The first contains the weights between each input neuron and each hidden neuron. The second contains the weights between each hidden neuron and each output neuron. This appendix shows those matrixes of weights of the trained network with 50 hidden neurons.

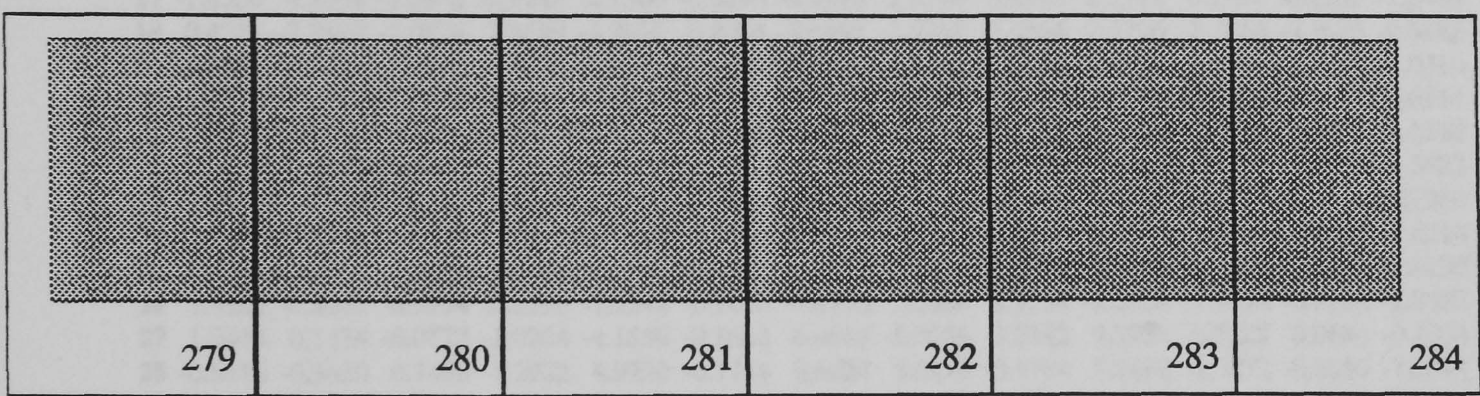
Appendix 5.1

Weight matrix of 50 hidden neurons network: input to hidden layer connections

This appendix shows the matrix of weights between the input and hidden layers of the trained network with 50 hidden neurons. The matrix has 81 columns and 50 rows. Each row represents the 80 connection's weights between a hidden neuron and every neuron in the input layer. The 81st value in each row represents the threshold of each hidden node.

Once the matrix is too large to fit in a single page, it has been broken down into smaller tables, each with its own labels of columns and rows.

The key map bellow indicates the relationship between tables. The numbers indicate the page in which each table can be found.



Input # >> / << Hidden neuron number	1 *main entrance*	2 *secondary entrance*	3 public access	4 restricted access	5 exit only	6 *gives access to: air lock, vestibule or foyer*	7 *gives access to: corridor or aisle*	8 *gives access to: shop or working room*	9 aligned to the facade	10 pulled out from the facade	11 pulled in from the facade	12 *flat door top*	13 *semi-circular door top arch*	14 *segmental door top arch*
1	-1.0172	-1.8774	0.3908	-1.1546	-2.9380	-0.1120	0.5010	-1.2626	2.0972	-4.6820	-1.1406	-0.2606	1.4280	-6.8390
2	1.0376	-1.3230	-1.8870	0.3630	-2.0586	0.2942	-4.0312	-3.2624	0.0382	-3.0512	0.9350	-1.1696	-2.5812	-1.4132
3	0.8414	-4.1994	0.9084	-0.7450	-2.3112	0.2552	-5.4210	0.2490	-0.3422	0.7272	-1.2614	-1.2246	1.0276	-1.6044
4	-0.8312	0.6962	0.0006	1.0710	1.5452	-0.0350	1.0460	-1.7570	0.1846	0.7070	-0.4464	-0.6970	0.5870	-5.6874
5	1.2582	-3.1008	0.0510	-0.2852	-2.1652	1.4510	-2.4474	-0.0870	-0.8008	-3.4126	1.0176	-0.2214	4.0966	-4.0964
6	-0.2494	1.1282	-0.3272	-0.9546	3.7620	0.4184	-0.4082	2.6324	1.3200	-3.2280	-1.2292	-0.1882	-0.7744	-3.1296
7	-0.3746	0.0904	-0.6336	-0.4480	-3.1812	0.5842	-1.6100	5.8612	-0.9804	5.3574	0.5516	-0.2714	5.3270	-1.9100
8	-0.1346	1.7102	0.8908	-1.2216	-3.9582	0.3014	-2.3070	-0.0304	2.4646	-2.2212	-2.3146	0.0206	-1.7560	-5.1860
9	-1.0344	3.2804	0.0496	0.2304	-5.1890	-0.8556	-0.1426	4.6416	-0.9554	-1.6846	-0.6884	-1.4444	-3.4724	0.1160
10	-0.1262	-0.8408	1.7544	-2.4906	-1.2222	0.7926	-3.2046	-0.6356	0.3066	0.7362	-0.2910	-0.7970	-4.7194	-4.4650
11	-0.9102	-1.0082	-0.2830	-1.1450	-1.2454	-0.8002	0.5884	2.1696	-1.0522	-4.6850	1.3922	-0.7644	2.8314	2.9680
12	-0.1036	-0.9332	1.9944	-3.1536	-4.6374	0.2174	-2.7656	-3.8014	-0.3066	-1.5002	0.1574	-0.1444	1.3214	-4.6716
13	-1.4070	1.9364	2.8772	-3.4414	-1.5010	-0.6382	-0.2012	-1.6702	-0.8932	-6.9282	1.5990	-1.3804	3.2172	-0.1412
14	0.4960	-1.8566	-0.0446	-1.6092	-1.9856	-0.5840	0.1974	-5.4144	-1.7610	0.2804	0.8684	-0.3914	5.0676	-6.7370
15	-0.9934	-0.3008	0.5994	0.7530	-2.8336	-0.0006	-0.4790	-4.6250	-0.2324	-4.9222	0.2880	-0.5452	-5.2422	-5.2108
16	-0.5060	-0.5290	0.2986	0.3836	-4.4750	-0.7744	-3.9146	4.6722	1.0822	-2.8546	-1.1476	0.6494	-0.6800	-3.4396
17	-1.4300	4.1004	-1.0862	-0.3546	5.1500	-0.8846	-0.2276	2.6146	0.2940	0.5712	0.2794	-0.2962	-1.5406	4.6386
18	0.4784	-2.0892	-2.0626	2.0530	-3.9516	0.8054	-3.4496	3.9708	3.0264	-2.1796	-2.7010	-0.1626	-2.6882	-6.1274
19	-1.1222	0.2784	-0.9032	-0.7926	3.4212	0.3024	-0.3010	-1.5656	1.2052	2.0002	-1.7324	0.2884	-3.0210	-5.8280
20	0.2726	1.4686	-1.4682	1.6646	-2.9396	0.7370	-1.2506	-6.8514	-0.5108	5.9890	-0.7904	0.6372	-2.6314	-6.1604
21	-0.7636	1.0356	-1.3394	0.6554	-3.2356	-0.0560	1.3946	-3.9006	-1.2324	-3.1926	0.6634	1.0344	-0.1526	-3.9934
22	-0.0022	0.0822	-0.9762	1.2172	-4.4900	0.9300	-3.1644	-5.0124	-3.2094	-0.6266	2.6524	-1.0730	-4.5822	-2.1950
23	-0.3464	-0.9194	-2.4570	3.0374	-1.7790	0.7100	-1.4552	-4.7736	-0.7950	-0.4964	-0.3394	-0.4616	3.7380	1.4780
24	1.1630	-2.8112	1.6074	-1.4356	-1.9180	1.4566	-0.9560	-3.6374	-4.3046	-3.4084	2.5890	-1.1220	-7.4214	-6.8372
25	0.5384	-2.2346	-2.3726	0.4136	3.0182	-0.7806	-0.3154	2.1406	-1.8908	2.7774	0.7000	-1.3532	-3.9130	1.0520
26	1.9184	-3.8052	0.9964	0.5690	-1.5344	0.1040	-4.8990	2.2836	3.9534	-2.0234	-1.9550	-0.9140	-1.8362	2.0640
27	1.3444	0.1134	-0.0772	-1.0264	-4.1656	-0.1622	-0.4664	-5.3036	-1.2342	5.7952	0.5222	0.0684	-0.1054	-3.2554
28	-0.6416	-0.3650	0.1490	-1.2922	4.9220	-0.7744	0.6024	5.0270	-0.4784	5.1692	-1.3072	-0.1050	-7.2644	-1.0284
29	0.4008	-0.7444	0.9464	0.1804	-1.6942	-0.0304	0.4404	-3.3772	-0.4980	-5.3704	1.1370	-1.4002	0.2560	2.8104
30	-1.7004	1.3066	-1.7562	0.6962	0.2912	-0.0656	1.0150	-1.9744	-2.0626	-5.9112	0.3612	-0.5692	1.8454	0.4172
31	-0.3612	-1.3666	-0.3090	-1.4310	1.5720	-0.5432	0.9800	-4.2054	-0.0644	2.2562	-1.4792	0.4900	4.0180	-4.6184
32	0.8166	-2.5156	-0.1864	0.2962	-2.5266	-0.2000	-2.5276	0.2064	1.5622	3.4834	-1.7366	1.2990	-6.1134	-3.5292
33	-1.5534	5.1704	0.5426	1.3126	-4.6770	0.2654	2.4516	-0.0552	-0.7002	-0.9510	-0.0976	0.9002	-0.0800	-6.9108
34	-1.3860	3.6344	1.0256	-0.2870	-1.0504	-1.2860	3.9474	0.9870	1.2320	-6.9912	-0.2214	-0.3752	3.7052	-3.5976
35	-0.9366	1.8014	-1.4154	1.5152	-0.8432	-0.7012	-0.6206	2.8026	-0.5716	5.4806	-1.2922	-0.5802	2.3462	5.0832
36	-1.6820	1.1422	-0.0014	0.0508	-3.8630	0.1766	-0.8066	1.0156	-1.5770	3.9760	1.0432	0.3740	1.6026	-6.2402
37	-0.3904	0.7116	-1.6426	0.4832	-3.4986	-0.3410	0.2140	-5.4936	0.1736	1.5470	-1.1926	-0.0292	-4.8024	-2.2416
38	-1.5090	1.2890	0.3926	0.7692	0.4006	-0.7234	2.9292	-2.1550	1.7842	-6.2554	0.3666	-1.0394	-2.2314	-4.8214
39	0.2246	-0.2394	-1.0442	1.6340	-1.5320	-0.8510	0.6064	2.3590	0.1662	-0.0154	-1.5036	0.4130	3.7004	-7.9998
40	0.1360	-0.8854	1.4220	-0.9922	-1.2446	0.9440	-1.7006	-3.7910	-0.4830	-4.7694	1.1814	-0.1166	2.3152	-6.9962
41	0.8522	-1.2536	0.2794	-1.9170	-2.5166	0.5894	-2.6250	1.4406	1.1082	-0.9326	-1.3924	0.1872	3.9300	1.7046
42	-0.4730	2.2282	0.3702	-1.3022	-1.3960	0.0192	2.3576	-1.7282	2.4982	-0.6412	-2.4824	-0.9882	-3.0680	0.3756
43	0.9566	-1.7570	-1.3020	1.0144	-4.3372	0.7042	-0.8308	-5.0136	-0.2872	-6.0572	0.5616	0.8770	-2.2982	-6.6732
44	0.5004	-3.6886	-0.2706	-0.0772	-0.9922	0.0382	-0.8600	2.3332	-0.5352	2.4782	-0.0636	-0.6520	-5.9110	-5.1672
45	1.0354	-2.1402	0.0362	-1.0622	5.5784	-0.9680	-0.5422	-0.3342	1.1502	-2.6662	-0.9640	-0.7608	-3.4504	1.0536
46	0.4216	-2.9576	1.2596	-1.8116	3.3814	-0.0024	0.5426	-3.6460	-1.9440	-0.1094	1.4374	0.3708	3.8702	-1.9126
47	-0.3730	-0.1884	1.8442	-3.9310	2.9834	-1.6304	3.8342	1.1912	-1.5634	-3.1872	0.6214	0.5264	-4.2370	-6.0822
48	-1.3340	-2.2006	-0.1994	0.4940	1.3940	-0.3352	0.6460	-0.2222	2.5254	-3.1820	-1.2862	0.3636	-1.3886	-1.6874
49	1.6370	-3.6340	0.1874	-1.1126	-4.5110	0.7070	-3.7356	-3.1624	-1.1914	2.2780	-0.4310	-0.7654	-3.9526	-1.4820
50	-0.3934	2.0510	-2.0332	2.1704	-0.1774	-0.7876	-1.6106	3.6574	-0.6590	5.7130	-1.3572	-0.9106	-4.2566	4.0754

Appendix 5.1. Weight matrix of 50 hidden neurons network: input to hidden layer connections

Input # >>	15	16	17	18	19	20	21	22	23	24	25	26	27	28
<< Hidden neuron number	*pointed door top arch*	*round trefoil door top arch*	top flat moulding	top curved moulding	triangular pediment	semi-circular or segmental pediment	*squared fanlight*	*fanlight with undulate top*	*pointed arch fanlight*	*semi-circular or segmental arch fanlight*	pointed arch tympanum	semi-circular arch tympanum	*tracery or steelwork on fanlight or tympanum*	*stained glass on fanlight*
1	-3.2396	-7.9998	0.7844	-0.4270	2.0256	4.7052	5.2508	-1.6522	0.9794	-3.9324	-1.7692	2.5114	-0.5664	1.9970
2	-1.0246	4.4186	0.4982	-0.1474	-1.3314	-4.5872	-1.5734	5.4274	5.8330	-0.7380	0.5734	-2.6834	2.2850	4.0910
3	2.4802	0.0162	2.0604	-1.4570	-0.7642	-3.0890	0.0560	2.1690	-3.0526	-0.9942	0.1516	-6.4410	1.2320	-2.4614
4	1.1586	4.1690	-1.5890	-0.5614	-5.8960	-3.2842	-2.3114	-2.3472	-3.4396	2.6876	-0.5734	-1.0702	-1.6876	-2.8274
5	-3.6252	4.9012	-1.3000	-0.9354	-2.3008	-0.0902	-0.6652	1.4846	-1.0350	-6.5340	2.6506	-2.0784	-2.3312	-0.9146
6	0.6750	-1.6826	0.2800	-0.7614	2.4810	6.6564	-0.7022	-3.4426	-1.6892	-2.6006	0.9414	1.3752	-3.0324	1.7310
7	0.1184	0.5250	0.8734	-2.0430	1.7092	-5.8164	-0.9084	0.3762	-4.0572	-2.7908	1.7008	3.2512	-4.7166	-0.0990
8	-1.0912	-6.5734	4.3450	-0.7064	4.5066	-3.8622	-2.4400	-5.0462	-0.6082	4.5252	1.5440	-0.9960	0.9714	-0.3356
9	3.9394	-5.6374	0.1008	1.9952	4.8514	-2.6108	-0.1960	-1.1204	0.3856	2.2754	2.7704	1.7902	-1.6546	0.0890
10	1.0912	-0.1864	0.7160	-0.7580	2.2456	-4.0380	-0.9808	-1.3662	-2.2742	-3.6776	3.5496	0.9064	-2.5180	-4.5962
11	3.0312	-0.8800	-1.2706	1.1930	-5.2008	-0.5890	0.0176	-1.4842	-2.2764	-1.8690	1.0944	2.8466	1.5950	-0.3306
12	-3.9492	-7.4532	-1.2400	0.5814	1.5804	-2.1572	-1.2502	-2.7264	5.3212	1.8784	1.1352	-3.8994	1.4334	0.0194
13	4.5644	-4.9514	-1.4872	1.4830	-2.3220	2.0200	-0.8582	-3.9904	4.0682	2.5216	-1.0460	-0.6262	-2.0036	-2.8950
14	3.0274	1.9580	0.8208	-0.9770	0.2596	-4.8704	-0.6182	-4.5606	-1.8626	2.7606	0.6802	-5.3772	-1.2354	-1.0994
15	1.5940	5.3682	-0.6486	-0.5442	-4.7932	-0.5752	0.4590	-1.8714	-1.3264	-2.6422	5.1140	1.3176	-1.2052	0.4274
16	0.4530	-6.3570	0.3400	-0.9302	-4.1106	1.3302	-0.7592	2.2382	0.8810	2.5526	-3.8852	0.4482	0.2172	0.8012
17	0.1306	-2.5092	-1.3110	2.1264	-0.4908	-1.5074	-0.4672	-4.3706	1.3234	-0.0996	0.6956	3.6556	-0.2480	4.6020
18	-4.0632	-4.5596	-0.1760	-0.4286	2.0304	2.1984	2.2830	5.3570	-0.0122	0.0020	0.3332	-4.0624	-0.6734	-1.1880
19	-3.0508	-5.6812	0.1940	-2.9612	-3.1394	-1.1010	2.9790	-2.6042	-0.1794	-4.6242	-1.9710	2.9520	-3.8414	-0.6102
20	-2.0394	-5.8104	1.7430	-1.2704	-2.7526	-4.9650	0.0942	-2.8346	3.4046	1.9750	-2.3700	2.8650	-0.1300	2.6712
21	-4.2682	-5.2556	-0.5808	-2.9896	-3.2900	-3.3700	-0.6814	1.9982	2.0310	0.4292	-2.5060	0.6846	-1.7582	-1.9786
22	4.8382	0.5884	1.8146	-1.7036	4.8360	1.5732	3.1452	-0.4826	-1.6612	-4.6250	-2.5660	3.0164	-3.0670	-2.5782
23	0.1476	3.9536	-0.9396	0.1172	-7.2350	3.5480	0.4840	3.6756	2.0332	-5.7734	-1.0432	0.1094	0.5486	-1.4670
24	2.8620	-2.8752	2.5312	-0.0872	-3.0334	3.6350	3.8594	-5.3056	6.8012	-0.8240	-3.3486	0.7120	2.7990	-0.9436
25	2.5514	-0.0162	-1.2482	-0.5454	-3.9932	-0.4956	0.7720	4.1064	-3.2292	-0.7292	-1.0484	0.1756	0.7510	-1.8266
26	0.4404	3.9474	-1.7454	-0.4980	-1.5632	2.0162	-2.7144	2.1330	-3.0060	0.8264	1.0994	-5.1308	-1.7102	-3.2912
27	-1.8304	-5.4560	1.8770	-2.4132	3.5634	-0.6214	0.1864	3.1990	-0.0142	-1.2064	-3.5806	2.8412	-1.8172	-0.1130
28	-3.6122	4.1234	1.8136	0.6534	6.6042	-1.8442	0.4120	-1.1316	0.8296	1.3932	2.1684	-1.0244	1.2374	-2.6384
29	5.7520	6.0122	-1.8894	1.8196	-4.4512	2.1596	-2.8064	-2.2456	-0.8474	-0.6256	0.9472	4.8914	0.5020	-2.1592
30	6.0926	-1.0922	-1.4670	1.1408	-4.4336	-0.8916	-2.2294	2.7362	-1.5262	1.5074	1.0580	5.0094	0.5090	-2.6210
31	3.5772	-3.9506	-1.0508	0.8756	-7.4962	-2.0056	-0.4046	-7.3206	2.8390	1.8946	-1.7686	1.7292	-1.2890	-1.2354
32	-4.5400	-3.9742	-0.4972	0.8194	-7.2446	2.7470	-0.7334	-0.2144	-1.8796	1.2144	0.7116	1.7140	0.4172	-5.1026
33	-6.3584	-1.9194	2.2820	-1.4344	-7.2316	1.7554	0.8006	-4.5076	-1.5266	4.5386	1.0364	-3.0100	0.3316	-5.5080
34	-1.7942	-4.0496	-0.9262	-1.5944	-4.5804	-0.9304	-0.2900	-4.6976	-3.0290	-3.6744	1.8884	-0.5526	-2.2652	-1.5734
35	1.6632	2.5614	0.8692	-0.0780	2.7972	3.2974	-2.5162	4.8108	-2.7554	-0.4582	0.7808	5.7164	-1.3332	-0.5124
36	-1.0234	-6.3984	-3.2166	-2.2426	-5.6084	-3.6014	-1.0470	3.6322	-3.1872	-1.0960	-1.0108	-1.0342	-1.6020	-2.4166
37	-1.7150	-6.2490	-0.0782	-0.8524	-5.4210	4.5792	-0.4408	3.3602	2.7194	2.7066	-0.3040	0.3544	-1.9920	-2.4470
38	-1.0372	4.3722	0.2382	0.1256	4.2504	2.4486	-0.3740	-6.4164	-0.8596	2.5180	-1.3176	2.9104	-1.9574	-2.1846
39	-0.1824	-2.2500	0.9006	0.2430	-5.3430	-2.9710	-3.3842	-4.7466	2.5282	-0.5376	3.4220	0.1650	0.5994	1.4390
40	-3.4554	5.8304	0.6866	0.0202	1.5794	0.9950	-3.9116	-5.6250	6.4210	0.9592	3.1014	-0.5682	3.0662	1.6916
41	3.4422	0.0066	-0.6126	-0.9854	-6.1972	-2.1546	-0.0054	-0.2322	0.0170	-3.4120	-1.1674	-2.0144	-2.7874	-4.7982
42	0.2152	0.6790	-2.6332	0.0052	-7.1496	-1.2870	-2.4402	2.0920	-4.6052	-0.0852	1.2252	0.5942	-1.2082	0.8550
43	-1.8908	-6.7184	1.9060	-0.2162	3.5662	4.5022	-0.3872	-1.4234	-1.1016	2.6394	-0.8592	-0.6402	-2.0360	0.9530
44	-1.4992	-0.8090	0.7842	-0.2572	-3.2994	-3.7766	-2.7790	2.3416	2.9400	1.1974	-0.2254	2.1144	1.8706	-0.9550
45	0.9834	-3.3256	-0.5716	-0.4312	-0.5774	5.1252	0.3466	-5.0602	1.4460	-2.5886	-2.4986	3.3610	-2.9926	-1.3140
46	4.5060	3.9434	-3.6190	-0.2094	-4.2026	-4.5652	-0.6134	-0.3674	2.4750	-1.7902	1.2440	-2.6360	1.2414	-1.6506
47	-6.3806	3.1526	-1.0890	-1.0580	-4.3972	2.8324	0.0454	-5.4226	4.4646	2.0784	-0.2372	1.8746	1.5016	-0.4750
48	0.6456	-6.4150	0.6812	-0.6772	-5.2206	-2.5884	-2.3846	6.2976	-2.1354	1.3472	-3.7334	-0.7514	-0.4102	-1.6344
49	2.0770	-5.3780	-0.1932	0.5092	2.7246	3.4220	1.5736	1.8954	0.1552	2.3486	-1.9544	-2.0914	2.5590	0.0480
50	-3.0966	-4.7592	1.6460	-1.8232	0.2210	-4.0336	-0.4704	0.8608	-0.8506	-1.5102	-1.6894	3.0836	-3.0546	-3.3740

Input # >>	29	30	31	32	33	34	35	36	37	38	39	40	41	42
<< Hidden neuron number	flat retangular porch	flat semi-circular porch	pediment porch	segmental (concave) porch	convex porch	***columns supporting porch***	***walls supporting porch***	***cables supporting porch***	lateral squared section column	lateral cylindrical section column	lateral vertical moulding	window in one side	windows in both sides	***vertical glass tower***
1	-0.9144	-4.5570	-7.0008	0.2224	2.5242	-1.2244	0.7194	2.6400	1.8304	-3.6664	-0.6924	-3.3346	0.8936	-3.7444
2	1.2202	1.1210	-0.3646	-4.6676	-1.7932	-1.2810	-1.2274	-4.4824	-2.8646	1.0642	0.7204	1.2550	-1.6420	-1.2132
3	-0.7994	-1.7694	-0.8150	-1.0290	3.7124	0.0076	0.3970	2.1134	2.9464	0.5294	-1.8064	-2.3206	0.2832	-0.8462
4	-2.4014	-2.1406	3.9924	2.6186	4.3886	0.4722	-1.7994	-4.1372	-5.3114	2.1116	-2.6882	2.1564	-1.8446	-0.1816
5	-0.5440	-2.6276	5.0010	-5.8690	2.2720	-1.5502	-0.5544	0.4690	-0.0962	-2.5586	0.3356	0.6524	-4.6472	0.1892
6	-1.0652	-2.0182	-5.9664	-4.5282	-2.2464	-1.6456	-2.6214	-4.8996	-2.3262	-1.3716	-0.1250	0.7250	-1.6534	-3.4370
7	0.0976	3.9712	-2.2504	1.5210	1.5002	1.1114	-1.8622	-4.4896	-4.0194	-0.3782	0.8074	0.6732	-2.4916	-6.2004
8	-2.4508	-1.4624	-2.5408	-3.3246	-6.1274	0.4880	-4.1576	0.2660	2.1616	1.5974	1.8336	-5.5174	2.1850	-2.5766
9	-1.0726	-0.4164	-5.9116	-3.5250	-1.5054	-3.9266	1.3646	-4.4382	-3.7496	-0.9300	-0.5844	3.1060	-0.1532	-2.1410
10	1.6984	-3.0180	-6.2036	-3.4214	4.5804	-2.4256	0.2142	2.3252	2.5776	3.0514	-0.3430	0.9580	-0.7516	2.2196
11	0.7866	1.9056	-1.2900	2.1092	0.1250	1.3052	0.5032	-0.4282	0.0792	-2.6726	0.3290	-1.7612	-0.1370	-0.3216
12	0.7330	-0.6920	-4.0296	-4.9464	-3.4382	-1.7780	-0.6524	-1.2810	0.1822	-2.1162	-1.6686	-0.9710	1.2634	-3.5566
13	-1.7356	-3.5454	-1.7584	-1.3364	-1.1006	0.6066	-1.8122	-0.8032	0.2864	0.6454	-1.1040	0.4852	0.1632	-3.0044
14	-1.5012	-0.1746	-2.8264	0.9712	1.1010	1.8022	2.8884	-0.4504	-1.9066	0.5156	-1.6864	-1.7882	2.1166	-1.3102
15	-2.1152	-0.4874	4.2952	0.0896	-3.5054	-1.8342	-0.4722	-1.3250	1.6356	0.2660	1.7344	0.2712	-1.1406	0.0472
16	-0.0056	-5.3890	-3.1230	1.0944	0.6546	-4.4454	0.5534	-1.5440	0.4632	0.1020	-1.2154	2.9556	0.5154	1.5374
17	-3.4182	-1.2894	-3.7766	0.2000	-4.1134	-4.3926	-2.5616	-5.6536	-4.0090	-0.9344	1.5522	-1.8510	-0.6342	0.9394
18	-0.5244	-1.0740	-3.4530	3.8160	-0.5774	-1.4772	0.4122	-1.3552	-2.0730	-0.7746	2.6092	-0.0420	2.7552	-0.9760
19	2.1390	1.7196	-6.5412	-3.7574	-0.9152	0.6562	-2.4122	2.8212	-4.6654	-1.8990	-1.1622	2.5412	-1.9746	-1.8866
20	-2.5176	0.9422	-1.6664	-2.6454	-4.3876	-2.1260	-2.5280	-1.0142	-2.0408	0.1506	-1.1070	-1.1992	-0.0870	1.9394
21	1.1182	2.3810	1.1722	0.3144	-5.7852	2.4160	2.0536	-3.0640	-3.0066	-3.2904	-1.4330	1.8834	2.4186	-1.9310
22	0.6774	-3.1154	0.3408	-5.5220	-5.8730	-0.2260	-1.1802	-4.4620	-2.6086	1.1206	-0.1826	-1.0000	-1.0806	2.8830
23	0.7006	3.9930	-1.3594	1.7406	-0.1152	-0.6254	-0.1182	3.2612	2.5482	-3.7782	-2.2360	1.0302	-3.0616	-0.4734
24	-0.3116	2.8200	-4.4542	-5.7650	6.2332	-0.6764	-0.8364	-1.4050	-1.0704	0.9482	0.6124	-1.3644	1.3466	0.6936
25	1.5254	0.1520	0.5090	-1.0492	-0.6860	-0.0364	2.1764	0.6826	-4.2056	-2.9480	-1.7490	-1.4984	0.5008	-1.6824
26	-2.7956	-3.4820	-2.2606	-0.5190	6.5004	-2.6564	-3.6894	-0.8646	-3.8794	0.0602	0.7624	0.2926	-0.4492	-1.5014
27	1.6734	-2.6622	-6.6306	-3.7972	0.6750	-1.2490	-1.6430	1.8508	-3.1314	-1.3856	-1.7016	2.4800	-2.9404	-0.3842
28	-2.6952	-0.0530	-3.7304	-7.6106	-2.1212	-2.3310	-3.1660	-0.8276	-4.5856	1.9472	0.7082	0.3170	-0.0124	0.9800
29	-0.8886	-1.3230	-1.9208	-4.6694	-0.5314	-3.6670	-0.6784	-1.9064	-3.3896	3.1496	2.7256	-0.8404	-1.5794	-2.3864
30	-3.1160	-2.3396	0.3442	2.2992	-4.5140	-1.5354	-3.4210	-2.0542	-0.8954	-0.3780	3.3442	-3.3276	-0.4214	0.2720
31	-0.7480	-0.8674	-2.5176	2.7542	0.4730	-1.1554	1.1064	-0.4206	-0.1344	-0.6074	-0.2400	-2.2362	0.7254	0.0012
32	1.2360	-3.7050	-4.6234	-5.6364	3.4800	-1.3780	-3.1626	-0.4532	-2.1302	-2.6664	-1.0286	-1.0612	0.6234	2.2908
33	0.4336	6.0166	-4.3870	-0.4580	-4.6054	-1.5930	4.5114	-3.0172	-1.9320	-1.9586	-1.4654	0.0250	-0.5084	-2.9712
34	1.0246	-3.3876	4.9560	2.6456	2.2960	3.6940	1.7706	-2.1696	0.9192	-0.9422	-3.6346	0.7712	-2.2730	0.2270
35	-2.9104	3.5024	-1.6592	4.9630	-0.5916	-0.4794	-1.7664	-2.6716	1.8136	0.0480	-0.9246	-2.0680	0.5896	1.2162
36	1.0616	1.4108	-1.1384	3.3892	-2.3066	-0.6554	-1.0894	-2.3360	-1.9592	-2.0290	-2.8432	-0.0766	1.1970	-1.4124
37	0.2296	-5.2180	-4.8972	2.5084	1.4946	-1.6384	-2.8576	3.0362	0.7536	-3.4054	-1.1394	4.0216	-1.6000	4.0400
38	-0.1510	1.3396	2.7162	-1.5704	1.2162	1.9442	0.0060	-1.8334	-0.6642	0.7350	-1.8384	-0.9084	-0.4574	-2.3676
39	-0.3572	-1.0984	5.2820	0.6764	-3.2116	1.2676	-0.9382	-1.5652	-1.9970	0.7584	0.7432	0.3744	-0.5334	-0.6714
40	-1.4980	5.0950	-6.9008	1.9464	-1.9864	-2.0540	-1.2064	-1.6402	-1.0302	3.9770	-0.3340	-0.4706	0.2970	-0.4608
41	1.3922	-0.2344	-6.9602	0.4166	0.6730	-0.8690	1.8876	1.1354	-0.8634	0.2642	0.6974	-1.9396	0.1020	-5.2476
42	-3.4960	-1.0012	5.4326	0.0602	3.9656	-0.1810	-5.5244	-1.7102	-4.9650	-1.8056	-0.3664	-1.6414	0.3736	-0.6322
43	-0.2790	-4.5542	3.5222	-2.7654	-5.2090	-0.5066	2.0860	-3.9040	3.2576	-0.9482	-0.2226	2.6574	-3.3202	-2.0864
44	0.1722	3.0030	0.2194	-1.6580	5.6434	3.5396	-2.3124	1.0254	1.9394	-0.0590	0.1244	-2.8836	1.5210	-3.8260
45	-0.8292	1.0356	-1.3544	-6.0494	-1.3040	2.5426	-2.0276	5.0954	2.6940	-1.4322	-0.3222	-2.7932	2.1352	-1.6580
46	-2.2992	1.0536	1.1260	-0.6592	-7.8802	0.7142	-0.8234	-2.1844	-0.7696	-0.1860	-0.7732	-3.3294	1.7326	-1.4206
47	1.1902	4.6856	2.8542	-4.8320	2.4196	2.5752	-3.0092	-3.3026	-2.3216	-0.6354	-3.3956	-1.7136	-1.1156	2.2292
48	-1.8442	-3.7086	-3.6314	-0.0966	-4.2620	-0.6596	-3.5540	-2.5422	3.1500	-3.2362	-0.2774	0.0926	0.5440	-0.1762
49	-1.3724	2.8114	-4.9592	2.1582	4.5834	-3.5694	0.2390	0.7862	2.4276	-1.1086	1.1602	-0.9286	0.8136	0.9856
50	-0.4276	0.1746	-1.7010	-3.9642	0.3312	0.7374	-1.6956	1.0924	-4.3444	-3.7384	0.2562	-3.8666	5.5584	0.7960

Appendix 5.1. Weight matrix of 50 hidden neurons network: input to hidden layer connections

<< Hidden neuron number / Input # >>	43 *angular connection with glass tower*	44 *decorative sculptures*	45 Surroundings material: glass	46 Surroundings material: brick	47 Surroundings material: smooth stone	48 Surroundings material: rough stone	49 Surroundings material: concrete blocks	50 Surroundings material: concrete exposed	51 Surroundings material: timber	52 Surroundings material: smooth plasterwork	53 Surroundings material: rusticated plasterwork	54 Surroundings materials: tiles or small tiles	55 Surroundings material: metal	56 *swinging door: one single*
1	-6.4384	-0.0980	0.0034	-1.4808	-1.5108	-0.1276	2.3406	-1.2436	0.5990	0.0102	-0.6594	2.9260	-1.1444	-0.6404
2	-0.0140	-0.4414	0.4066	-1.0436	0.3720	-1.4932	-0.8490	-2.0284	-1.3590	-0.3904	0.8266	-1.6222	0.8210	0.2706
3	1.5366	-3.7492	-1.4760	-2.3410	-2.2010	-0.3300	2.2294	0.0184	-1.4270	-0.1794	3.4510	3.3614	1.0782	-0.2952
4	-0.7016	-3.9824	-0.5108	-0.5016	-1.9440	0.8940	-4.9208	-2.7420	-0.6886	1.6762	5.4312	2.6560	1.9230	0.8542
5	-1.7616	-1.9130	-0.7104	-1.3140	1.8556	2.8516	0.5882	-5.5554	-0.3060	-3.6032	-3.9210	1.9762	-0.9796	2.2656
6	0.3124	-1.5790	-1.6056	-1.9390	2.3346	-0.7844	2.5232	0.0386	1.1202	2.0880	1.3116	-1.0232	-2.2252	-0.3312
7	-0.4822	-2.9074	-1.6986	-0.9944	-1.0676	1.3602	0.1142	1.5582	-0.5672	3.0550	-1.1640	1.7402	-2.6946	-1.2716
8	-5.2562	0.8126	-0.3076	-1.9526	-0.3002	-3.4320	-1.1172	-2.2722	-2.6682	-3.4840	-6.7144	-6.3560	-1.6614	0.5314
9	-2.1676	-2.1284	-0.2526	-0.7314	2.2960	-1.2008	-3.1700	1.6706	1.6366	-3.6624	2.6024	-1.5092	-2.7530	-3.4040
10	1.8694	-2.5664	-1.6608	0.2322	-0.7108	-5.2790	-0.9242	0.0470	-1.7012	0.5880	2.4352	3.8462	-1.0600	-2.5196
11	0.0670	0.3586	-0.0708	0.1740	1.7156	-2.7586	-1.6084	-4.3340	0.5786	1.3274	-2.4542	1.3434	-0.2002	-2.3042
12	-2.8632	-2.4204	-0.2070	1.2110	-1.1070	0.0164	3.2712	5.5704	0.1566	-7.9584	-4.3392	-2.6504	-1.5486	-1.4764
13	-3.5912	0.4000	-0.1246	-2.5670	-1.0092	0.8682	-4.1160	1.6222	-2.1276	-1.8152	-0.2156	-0.8886	-1.5812	-2.8196
14	-3.7244	-3.8954	-0.3736	-1.3432	-2.4506	0.4294	-4.7530	0.9030	0.5916	-2.0916	2.2662	0.0272	0.9108	-0.2242
15	-3.7154	-0.9114	-1.0806	1.9594	-1.3144	1.2762	-1.6432	2.0146	1.3082	0.2674	-4.1396	-3.3792	-1.5732	-0.6700
16	2.7230	0.9512	1.1052	-0.9962	-1.5490	-3.9932	1.9810	0.6166	0.0176	1.6980	0.9096	1.8760	2.0762	-0.6026
17	-3.0020	-0.2646	0.1712	-1.2410	-1.9374	2.3226	-4.9834	0.2882	-3.0224	-1.5280	-5.6332	-4.2760	-0.1134	2.0942
18	0.4114	-5.4064	2.4176	-0.8126	-1.0394	-1.0222	-2.9882	1.1226	-0.6444	4.0752	-3.6996	-1.3026	-0.8666	1.2742
19	-4.5962	-4.8636	0.4190	1.9182	-1.4146	1.5326	-2.0354	0.4476	0.1666	1.7042	-1.8512	-1.4072	-2.1214	0.4840
20	1.3752	-3.1816	0.2500	0.3782	-1.3084	-1.8956	1.0292	-0.9752	1.0834	-1.5820	0.2530	-3.4122	-1.1284	2.0330
21	1.5250	-0.5790	1.0760	-0.9872	-0.3460	-2.2246	3.5536	-0.1554	0.2730	-0.4816	6.5052	-5.7570	2.6964	1.9864
22	0.6094	0.4934	-0.0504	2.9034	-1.6266	-4.9114	-5.5706	-1.4470	-1.8546	-1.1820	-4.7696	-7.0456	1.9156	-0.5964
23	-1.3552	-4.0542	-1.3130	1.5966	0.0942	0.8214	3.8108	2.9602	-2.7886	-4.0862	-0.0904	0.1244	-0.8894	0.2484
24	1.6134	-1.1344	1.2264	-3.3972	2.4740	-1.3902	-4.4892	-2.8066	-1.7554	1.2320	-2.9094	5.6334	-0.9842	1.8960
25	1.3406	-0.0408	-0.5276	0.1914	-2.5166	-1.5806	1.5126	-3.4274	-2.4072	1.7330	1.8710	-0.9700	1.3062	1.0802
26	-1.3296	-2.3724	-0.6236	-1.1772	0.8436	3.0444	-4.6532	-1.6200	-2.2472	0.1810	-3.3836	6.4900	0.1474	0.1850
27	-3.3966	2.3232	0.3010	1.7946	-1.7934	-2.2856	-4.4724	-4.4514	1.9224	-0.0406	-5.5174	1.6532	-2.4036	-0.9696
28	3.7414	0.2602	-0.1084	-1.5052	2.8090	-2.7574	-4.4950	-3.5906	-3.4830	-2.9724	-0.0074	-1.8324	0.2076	0.4086
29	-2.9006	-0.3100	0.4906	-2.1314	0.4084	0.7646	5.1024	-5.3126	-1.2870	0.1016	1.1470	-1.5872	-0.7662	-0.9356
30	-3.7472	-0.1322	-0.5206	0.8006	-1.2676	-0.8600	-3.7686	-1.5326	-4.1226	-0.5754	-5.4186	-4.3494	-0.4506	0.0502
31	-5.0040	0.3552	0.3154	-1.4562	-2.4366	3.4186	0.2300	0.1966	3.4796	-0.1446	3.1584	-0.8184	-2.1020	0.7634
32	-1.5206	-3.5708	-1.1086	1.4608	-0.6772	-1.9124	-5.7566	3.2046	-2.3270	-2.8770	-5.1232	2.5808	0.5882	0.5886
33	-2.8566	-2.9400	1.6810	-0.3660	2.3370	-3.2190	-1.5764	-2.2480	1.2312	-2.1830	-5.8066	-4.6266	-1.4394	-1.2122
34	-5.4990	-1.9342	-0.3986	-1.9392	0.6222	2.0972	4.1552	1.9608	-1.4222	0.3474	-0.7532	3.4982	1.6166	-0.9250
35	2.7980	-0.5944	-1.2246	-0.4036	0.4900	-0.4332	-2.7490	-0.4946	-1.3214	-1.0394	-5.6124	0.3820	0.5852	-1.8462
36	2.3114	-2.5550	-0.7386	4.5932	-1.6222	-3.1400	1.2694	-0.7684	-0.2706	-0.4206	-3.4540	-2.1200	3.0092	-1.0050
37	2.6880	-4.8316	0.5434	0.4416	0.0740	0.6066	-5.4446	3.5492	0.0808	-0.4142	-2.9900	0.4690	-0.1766	-1.2272
38	-2.4636	-3.5974	-1.9452	-0.1964	0.0334	0.7760	-6.8676	-0.3486	0.9290	0.5864	-5.0614	1.7220	-0.4962	-0.6624
39	1.4274	-3.8384	-1.4694	0.6552	-0.0380	-0.8526	-5.0930	-1.3166	0.3136	1.9460	-4.1012	-3.4464	-0.7010	1.0732
40	1.0524	-3.2936	0.5550	-1.2662	0.9066	-1.5006	-4.1734	0.6008	-1.7540	-0.9472	-5.3134	-2.4264	-3.8156	-0.5024
41	-2.6480	-1.8114	-0.8174	-0.0504	1.8234	1.6244	-1.2250	-2.5956	-2.4322	1.6700	-6.1580	-0.5754	-1.6526	-1.3208
42	-4.4944	-0.2780	-0.5360	0.3520	0.4360	2.3452	-2.2100	-3.9070	-0.3216	0.0350	-2.8194	3.8914	1.8892	1.6496
43	-4.0260	-0.4896	0.0256	-0.9770	-0.8602	-4.6840	2.1434	0.5442	1.8660	1.6092	1.4174	-5.3634	-1.8370	1.4364
44	-0.7986	-5.4622	-1.0204	1.6660	-1.6304	-3.5832	-3.5354	2.2014	-0.1904	0.9084	-3.9966	6.1040	0.0194	-1.5232
45	-3.1202	3.0250	-0.0650	1.7232	1.5184	1.0330	-1.1490	-1.2282	1.2414	-5.5540	-4.9860	-0.8384	-1.9100	-0.3962
46	0.7984	-3.5286	-0.2382	1.2046	-4.3632	2.1812	3.6220	2.8408	1.2984	-2.0182	-0.0280	-7.6814	-2.8502	1.6502
47	2.4146	-3.0842	-0.3640	1.3010	1.8812	-2.1644	-3.9356	-1.8908	0.9332	-1.3736	-3.4486	1.7340	2.2876	-2.1182
48	-3.3810	0.9242	-0.2844	0.9002	-1.0544	0.6880	-2.6242	1.4674	1.5204	1.4076	-0.1524	-3.1372	-0.5624	-1.2914
49	2.1070	2.2232	0.2552	-0.6206	0.4790	-2.8256	-0.3862	-2.9412	-0.0142	-0.8110	-4.5682	3.7422	0.7360	-0.8142
50	2.3492	-3.2672	0.7808	-0.4390	-0.2280	-0.5240	0.6632	-3.7254	-1.1246	-0.0360	0.1512	1.2836	0.0176	-2.1636

Input # >>	57	58	59	60	61	62	63	64	65	66	67	68	69	70
<< Hidden neuron number	*swinging door: two singles*	*swinging door: one double*	*swinging door: triple, two doubles or more*	*revolving door (with four leaves)*	*sliding door (one or more leaves)*	leaf: plain opaque	leaf: plain transparent	leaf: semi-opaque plain with one or more light cross panels	leaf: paneled opaque	leaf: paneled semi-opaque with one or more light cross panels	leaf: framed with one or two light cross panels	leaf: framed with three or more light cross panels	***steelwork leaf decoration***	leaf mat.: non-stained glass
1	-0.4220	1.0556	-4.2196	-0.3836	-7.9998	-3.4772	-0.4812	-0.9316	-0.9262	0.4708	0.4044	0.6210	-2.7220	-0.7326
2	5.0276	-1.7236	-2.7476	2.5506	2.9656	-1.3192	-2.1708	-2.6008	-1.1752	1.8672	0.8940	0.0294	2.6100	-0.3460
3	3.7562	-1.4646	2.6790	1.2824	-4.7880	5.1784	-1.4622	-1.2816	-0.2770	1.4502	1.4750	-0.1220	1.7022	-0.5400
4	-1.0124	0.2824	-0.8940	-2.7194	-4.9466	-4.8680	-2.5808	0.8700	-0.6372	-1.9912	1.3724	1.7284	-1.0804	0.2512
5	-0.6642	-0.8462	2.2412	3.4784	-7.3772	3.6716	1.0460	3.6064	-1.5620	3.0686	-0.1440	-0.9060	-1.2966	0.4980
6	0.3734	-0.2434	2.9624	1.5702	-3.5326	1.2620	-1.9100	-2.7644	1.9944	-0.9302	1.3308	-1.6608	-3.6650	0.2180
7	-0.6760	2.0244	-4.0850	0.6154	6.1594	-2.7432	-1.5736	-2.7892	-0.3716	0.8172	1.3746	-1.2590	-2.9086	-0.6394
8	-1.7426	-1.5892	-1.0926	0.0770	-5.5096	1.5474	-0.5390	-3.2102	0.2986	2.0304	-0.1996	-1.7354	0.0104	-1.1014
9	-5.2440	4.0266	-1.1164	-0.4826	-4.4006	-3.1222	-1.5434	-0.9956	-3.3722	2.0510	0.7424	1.5810	2.3674	1.2142
10	0.6516	1.6666	1.0874	-2.1674	-5.5306	-0.4936	-0.2772	-1.0834	0.0042	0.0040	-1.8462	-0.5962	1.2146	0.6230
11	2.6134	1.5712	-2.0180	-2.6020	-5.3272	1.5172	-4.1876	3.4814	-1.2190	0.9726	0.7902	1.0920	1.1772	-0.0274
12	-1.1756	1.3072	-1.0250	3.0036	-2.4964	-5.1208	2.4084	4.8362	-0.9560	0.8234	-1.1186	-2.4564	-0.7414	0.9908
13	-2.0332	-0.1954	1.9596	2.1412	0.5634	-1.0544	0.9710	-3.3520	-1.1912	-2.4444	3.3412	-2.6404	-3.4222	1.4770
14	-0.9766	0.5390	1.8930	0.9986	-5.2452	-1.9302	-1.1322	-3.3656	1.0280	-1.9050	0.0406	0.2710	3.4756	-0.8016
15	-4.2644	0.8704	-0.6942	-2.6860	-5.3950	4.9950	-1.6504	-2.1730	3.0174	-0.8520	-1.9056	2.0962	0.9162	-0.5400
16	-0.2514	-0.2304	3.9392	-0.8234	0.0862	2.3036	-1.3266	-1.4762	-2.2594	2.8556	1.6954	-3.4412	-0.2730	-0.4336
17	-4.3672	-1.5634	-2.4086	1.4136	-0.0594	-7.4600	0.3462	-3.8962	-0.6746	1.7706	0.7440	3.2012	-0.7160	0.4664
18	-1.5816	-1.8860	-2.8616	0.1144	-6.8996	-2.1246	0.4116	-0.9030	0.6604	-1.8034	-1.3680	-1.0172	1.1714	-2.0606
19	1.4216	-1.5216	2.5790	-0.3482	-2.1424	4.6562	4.6602	-2.8324	-0.8452	1.6326	-0.4334	-0.4666	-2.3066	-0.3434
20	-3.0942	-0.6632	-2.7254	-3.1780	-4.9652	1.8166	-0.0546	-1.5202	-0.5772	3.3186	-3.8126	2.5876	-0.8264	0.2594
21	-0.4314	-1.4122	5.2746	4.4050	5.3232	-1.3882	1.6840	-0.2484	-1.6156	-0.7294	1.5662	1.9206	-2.0910	1.7534
22	-0.5340	-0.0276	-0.5856	0.7624	6.0152	1.0096	-4.7444	0.8936	-0.1090	-3.0562	1.3070	-2.3436	-0.0166	-2.3782
23	1.3402	-0.2546	-3.3214	-1.6070	5.6080	-2.5596	1.5134	1.5780	0.0020	-1.0350	-2.5886	1.7144	-1.3470	-0.1180
24	0.0434	-0.0066	0.4530	2.1562	-7.6132	3.5942	1.4946	2.0126	0.2856	-1.1196	-0.4026	-1.8024	-1.3430	-0.3996
25	-1.2154	-2.0354	0.0820	-2.1342	-2.3736	2.8766	-0.4832	1.0414	-1.4876	-0.3924	-1.0272	1.9064	1.0426	-1.3190
26	-2.0704	0.5294	0.3190	-0.3370	-7.3054	0.2032	-1.5116	2.2882	0.6094	-0.6640	0.0882	-1.9824	1.9572	0.4006
27	-4.5024	1.0200	4.6604	-0.1170	-1.4672	7.2310	-0.7794	1.2184	-1.6294	0.0220	-0.0284	-1.2054	-4.9432	0.1340
28	3.5982	-1.9530	2.1274	3.3696	-4.9120	-4.9762	3.5552	1.5334	0.3932	-1.3804	0.1024	-0.1096	0.3972	1.3264
29	4.0854	-1.2980	3.5140	1.2340	-3.5082	-0.2114	-1.7724	2.6542	1.6026	-1.2570	1.1730	-2.3484	0.6146	-1.0008
30	0.2426	-0.4502	-0.6274	-1.4500	4.1420	2.3980	-0.6230	-1.9786	2.9926	-2.5994	-0.3342	-0.9574	-1.2890	-2.1904
31	-3.8522	1.2512	-5.0854	-2.7644	-5.4360	-1.6476	-4.0006	1.9472	0.0942	1.2386	0.0062	-2.2146	-3.5946	-0.6054
32	-2.1162	2.2762	-0.5556	-2.6496	0.4666	-3.7874	-1.2774	-3.3896	1.4334	-3.1222	0.3186	2.9856	-0.7530	0.4152
33	-1.7974	0.0476	-1.1862	-3.3376	1.6310	-1.6342	-2.8834	-0.6960	-2.2608	3.1730	-0.5990	-0.5704	2.7224	0.4692
34	-0.4990	0.8594	-2.8092	3.4636	6.2564	-1.9136	-3.8654	-3.1246	-0.6904	-0.7854	3.1372	-0.9604	-4.7880	0.3774
35	-2.7770	2.4182	0.2432	-5.1292	-0.3122	2.7872	-1.6336	-3.8470	0.8366	0.8840	-1.9624	-0.3646	3.9232	-1.7970
36	-4.7254	0.1782	0.2056	-3.5854	7.8394	1.6512	-2.0416	-2.5446	-3.3624	1.6346	0.6216	2.1760	-2.7704	2.4854
37	-5.8010	1.2114	-1.6180	0.0276	4.4142	-4.3740	2.7020	-3.4410	0.9704	-3.7994	1.9900	1.7034	-2.2356	0.2560
38	-2.0908	1.3844	-2.8512	-3.4322	-2.9856	-1.5834	-3.5742	2.2850	2.3744	-1.1436	-0.2512	-2.0092	-2.9012	-1.5720
39	-0.8696	-1.7660	-3.2574	-3.2902	0.3050	-1.8840	-2.0060	3.4656	0.9264	-1.4990	-1.8842	0.6090	-0.2450	-0.4082
40	2.0754	-1.4986	3.8182	-2.2514	-1.3912	4.8246	3.3366	-3.7632	1.1382	-2.5470	-3.1472	1.4156	-0.7254	-0.2530
41	0.2308	-0.0886	1.2302	-4.1484	-5.2220	-1.0464	-1.2174	0.0476	1.4382	-0.7482	-0.8436	0.0360	-3.2500	0.1482
42	-3.6780	-1.1076	-0.3104	-2.1550	-3.7256	-1.5652	-0.2046	2.8992	-1.9020	2.0190	-0.1516	0.0600	1.1446	0.9954
43	0.6756	-1.9742	3.9022	3.2784	-1.6590	-3.0282	1.6722	-3.3294	-1.2220	-0.8362	2.2004	-0.8850	-3.8040	0.7832
44	1.8344	1.9866	-5.4260	-0.3396	-1.5534	2.0404	-3.9314	1.3834	2.5820	-4.8404	0.6450	2.4450	-0.6732	-1.2012
45	-0.8326	-1.0170	3.9494	-1.8224	-7.2532	-4.1614	4.3896	2.4870	2.2532	-3.7342	-1.0026	-1.5826	-3.2442	-0.7654
46	0.1964	-2.8926	1.3462	1.2550	-4.3776	0.5346	2.1996	-5.4312	-0.2900	-1.4586	-0.2010	1.7200	-1.5750	0.1592
47	-1.8262	0.0974	1.7902	-0.8554	-2.6132	0.6702	-0.9282	-3.8382	-0.2620	-1.6610	0.3652	1.9630	-5.0564	0.4320
48	-2.9540	1.3892	-2.5426	-4.9050	-0.3390	4.0080	-2.4294	-1.5996	-0.5594	0.6200	-0.4380	-0.9322	1.2524	-0.8482
49	-2.7664	0.9844	-1.0196	-0.6154	-7.1652	1.2956	-2.8014	0.0954	-0.1652	0.6254	-0.2484	2.1044	-0.2780	0.0146
50	-0.6212	0.5372	0.0476	1.4304	-2.3442	-4.3884	-0.4016	1.9296	-1.0346	-3.4496	0.3046	1.4930	-0.7042	0.4792

<< Hidden neuron number	Input # >> 71: leaf mat.: stained glass	72: leaf mat.: metal	73: leaf mat.: timber	74: *round knob or ring handle*	75: *retangular, squared or trapezoid handle*	76: *lever handle*	77: *long horizontal static handle*	78: *long vertical static handle*	79: *short vertical static handle*	80: *curved static handle*	**Threshold**
1	4.7122	1.2510	-0.3260	-2.0120	0.1634	-2.1916	2.8382	2.0650	0.1784	2.5712	-0.4236
2	4.4902	0.8224	-0.3432	-0.0546	-2.3374	3.2486	1.8952	-2.1972	4.2240	-3.1242	-0.7234
3	-0.9642	0.9870	-2.5894	-0.2720	-4.4442	-4.4662	-0.9076	2.2600	-0.1604	-2.9230	0.6946
4	-4.0686	0.5680	-0.6666	-1.3226	1.0982	0.9650	-1.1820	0.4464	0.0600	-0.0904	-1.0014
5	0.9052	1.0282	0.4874	-0.9012	-0.6536	3.1434	-0.2322	-0.8312	-1.4000	0.0980	-0.2030
6	2.5252	-0.1092	1.1496	0.1472	-1.3070	-5.7966	0.8726	0.2076	-1.2976	3.3356	0.4054
7	2.2630	1.2334	-0.7262	-0.9508	-0.9344	-6.3766	1.6614	1.0424	0.4236	2.9024	0.6284
8	1.3724	-0.6910	-1.5120	1.7664	-5.0290	0.2176	-2.9382	-3.0730	5.3212	5.3436	-0.4136
9	-2.3542	0.5612	1.3706	-0.1754	1.1530	-3.4420	-0.9382	4.4506	-1.6740	-1.1286	-0.6652
10	-4.1282	-0.3892	0.0456	-0.2400	1.3140	-5.5100	-1.9362	0.5354	-4.6820	4.5386	-0.9394
11	-0.8608	-0.2284	0.0142	0.0294	1.1376	-3.6814	4.7422	-3.4134	0.5080	0.9142	-0.9320
12	-3.1320	1.0450	-0.6180	-1.5762	1.4832	-1.3154	0.4776	1.3236	2.6034	3.7344	-1.2440
13	-6.3010	-0.8706	0.4566	-1.6094	-1.7408	-0.3724	0.8130	0.0850	2.1592	3.2934	-0.1974
14	0.1706	1.4030	0.5182	1.6010	0.2204	-2.5194	3.0386	1.7252	-1.9600	-4.9912	-0.3952
15	3.5906	-1.8622	3.3464	-1.1964	-2.7756	-0.4940	-3.1954	0.8706	2.5986	-1.1624	-0.9152
16	5.6734	0.6122	-1.7150	-0.4486	1.0064	2.2350	-5.1774	1.8766	0.0614	-2.5566	-0.6154
17	4.7646	1.3592	-2.1556	-1.2226	-0.5100	-0.1010	-0.4784	0.1290	1.4712	6.4944	0.3974
18	6.1066	1.0808	-0.7760	-0.3344	0.5632	-0.0774	-3.0526	1.5290	-2.7560	-0.6652	-1.3750
19	1.0804	-0.6764	0.5956	0.4826	-2.1096	-2.7730	1.7624	3.7774	0.8716	-6.5502	-0.3612
20	4.5426	-1.1762	1.0426	0.8852	0.9960	-2.8966	-1.1094	-1.3054	-0.8194	2.6672	-0.1762
21	-6.8862	-0.3412	-0.8122	-1.8344	2.2016	-1.0672	-1.3572	0.9596	1.2780	-2.4312	-0.1190
22	3.8436	0.5434	-0.6064	-0.1180	-0.3520	0.9386	1.3400	0.2890	1.0526	2.0144	-0.5624
23	-6.1192	0.7042	-1.5010	0.8396	-0.3408	-2.7290	3.3444	0.1784	3.6916	-1.1732	0.2112
24	-0.7560	-1.2106	0.2950	-0.4406	-0.2194	-0.2220	0.8040	0.8736	-2.8550	-5.4534	-0.7552
25	-0.4604	-0.3684	-1.9710	-2.2344	0.4270	3.3612	0.3374	-0.9224	0.9154	1.7204	-0.0046
26	0.3732	1.2222	-1.4316	1.0042	-0.2130	-0.4344	-3.6336	0.8670	-4.2924	2.8752	-0.7632
27	0.7272	-2.1864	-0.0182	-0.3064	4.8808	-0.1052	-0.9002	-2.2710	3.9162	-1.5106	0.7066
28	-3.2026	0.6506	-1.8480	-0.3830	0.7592	-0.2244	0.2314	2.2932	-2.4732	-4.0108	0.1906
29	-2.8684	-0.0916	0.5500	0.4842	1.0322	-1.5126	0.1906	-0.9316	-0.4250	-0.7140	0.8064
30	-2.2030	0.3474	-0.8542	1.4900	-0.6942	-1.9194	0.4776	-4.2812	0.2650	4.7386	-0.7076
31	1.0496	-3.4020	4.2110	0.9704	-0.5434	-2.1970	-2.3312	-2.0630	2.2892	1.7246	-1.2100
32	-5.0000	0.5864	-0.8086	-0.3746	2.5686	4.9554	-0.8446	-0.7560	-3.3534	2.9316	-0.1530
33	-4.0172	0.2326	0.4042	1.4670	-1.3436	-1.1882	-4.1060	-1.7880	-1.1700	-0.7076	0.0344
34	-0.1296	-0.5162	0.1450	1.0350	-0.1344	-0.9022	3.0108	-2.4804	-3.6550	0.1222	-0.3044
35	1.7282	0.7492	-0.7936	2.4136	-4.3044	-2.6792	-1.5130	1.5908	0.5422	-1.5300	-1.6736
36	-3.6666	0.2042	-0.7700	-1.8714	0.8042	0.5936	0.4660	-1.8284	3.1844	3.7392	-0.1956
37	-4.8364	0.5106	-1.0154	-0.8776	1.3480	1.5900	2.1656	1.0486	1.0192	0.3430	-0.4410
38	-2.2364	-1.4506	2.1866	0.6682	0.9402	1.2192	-0.8126	-1.8656	-0.4074	-0.0652	-0.1164
39	0.7946	-1.2814	1.5232	0.1202	3.2982	4.5536	-3.0190	-3.4896	1.5434	-1.2780	-1.2824
40	-2.4110	-1.1580	0.7982	2.3820	-1.6996	-5.2416	-1.0264	-2.3452	-1.0550	0.8654	-1.4754
41	-4.5182	-0.6736	-1.3332	-0.2804	0.8310	1.6608	-2.9230	-2.4832	0.9392	-0.0274	0.3292
42	2.6804	-0.4602	-1.6644	0.2532	-1.1280	-0.2410	-2.2256	-1.2132	1.8304	-3.3790	-0.3516
43	-0.5862	-0.8740	0.4324	-1.5074	2.2780	2.0626	-2.4406	0.0470	-0.3174	0.1224	-1.0594
44	-4.1174	-0.2562	-0.8560	-0.5656	-1.3692	0.3600	0.5692	-1.2844	-0.8466	0.9330	-1.0450
45	-3.9210	-2.0134	0.2340	-0.5260	0.8304	1.1050	2.7016	0.4350	1.0514	-3.1056	-0.6366
46	-2.5962	0.2502	0.3352	-0.5320	1.8840	0.6776	2.1356	-0.0440	-1.6508	1.0244	0.3394
47	-5.7092	-1.4846	0.1562	-0.1340	-4.6804	1.4744	2.9444	2.8376	0.2072	1.0706	0.5642
48	-1.9750	-0.7040	0.4730	-1.3694	2.4136	2.3864	2.6760	-3.6796	1.5002	4.5670	0.2166
49	1.9830	1.4192	-0.8874	-0.6250	4.8246	-1.8286	-2.4276	1.0230	-1.3672	-2.6166	-1.0980
50	-2.2850	-0.4684	-0.4882	-1.8012	2.3520	5.6322	2.0760	0.7002	-2.3196	3.1490	0.3694

Appendix 5.1. Weight matrix of 50 hidden neurons network: input to hidden layer connections

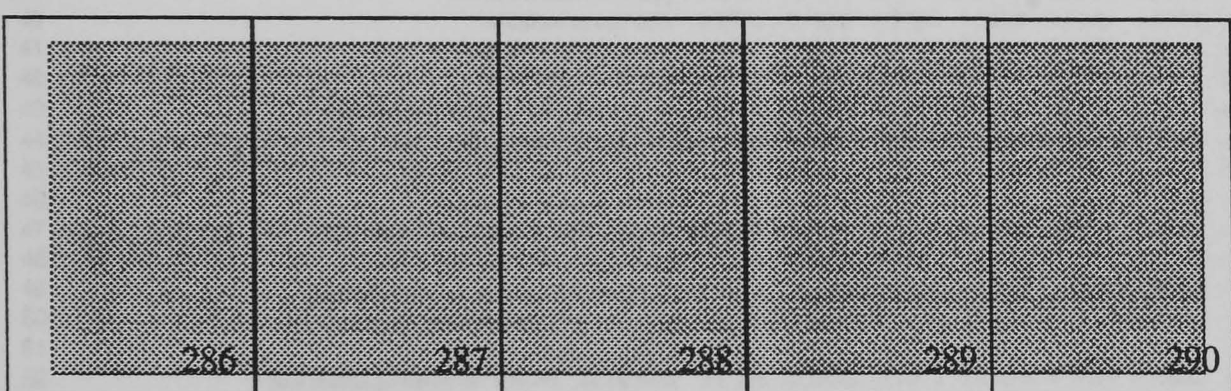
Appendix 5.2

Weight matrix of 50 hidden neurons network: hidden to output layer connections

This appendix shows the matrix of weights between the hidden and output layers of the trained network with 50 hidden neurons. The matrix has 51 columns and 80 rows. Each row represents the 80 connection's weights between an output neuron and every neuron in the hidden layer. The 51st value in each row represents the threshold of each output neuron.

Once the matrix is too large to fit in a single page, it has been broken down into smaller tables, each with its own labels of columns and rows.

The key map bellow indicates the relationship between tables. The numbers indicate the page in which each table can be found.



Output #	Hidden neuron number >>	1	2	3	4	5	6	7	8	9	10
1	*main entrance*	3.4826	0.7642	3.7852	-1.2554	3.4920	-0.7760	-0.9526	0.4366	-1.8200	0.7986
2	*secondary entrance*	-0.9574	-3.6062	-7.9998	-1.8436	-1.6302	0.8114	0.6036	0.1892	1.2592	-0.2342
3	public access	1.5960	-2.0806	0.2800	-3.3236	0.6672	-0.8086	-1.2284	1.0120	1.1904	2.6246
4	restricted access	-1.3434	1.5934	-1.2836	0.4180	1.0630	0.2006	1.1008	-0.3612	0.1816	-2.7796
5	exit only	-3.7262	-7.9998	2.9850	-1.7544	0.1464	5.2484	-5.4324	-7.9998	-4.6836	-0.1276
6	*gives access to: air lock, vestibule or foyer*	0.7314	7.0644	1.1232	0.1066	2.6192	-2.0970	0.2864	0.4700	-1.3444	4.9612
7	*gives access to: corridor or aisle*	-1.7030	-5.3602	-7.9998	1.9194	-1.3504	-0.5672	-3.6580	-4.0190	-2.2976	-4.1794
8	*gives access to: shop or working room*	-1.1676	-7.4240	2.9214	-1.8364	-3.0762	2.0270	6.4516	-2.1936	-1.4596	-5.7692
9	aligned to the facade	0.9766	0.3372	0.1104	-0.1194	-0.5236	0.2544	-2.1472	1.6430	0.5156	0.0220
10	pulled out from the facade	-0.5030	-7.3660	0.1176	-0.9794	1.9056	-0.7232	2.5512	0.6646	-0.5684	0.2574
11	pulled in from the facade	-2.0676	0.3632	-0.6654	-0.4674	1.4842	-1.5220	0.0408	-1.1162	0.8190	0.4286
12	*flat door top*	1.7876	-1.5208	-1.4104	-0.7970	-1.5734	2.2354	-2.3386	1.6508	0.2056	-0.7100
13	*semi-circular door top arch*	5.3104	-7.0654	3.0440	3.8122	-1.2906	-6.7732	4.2314	-3.2584	-3.4576	-7.9998
14	*segmental door top arch*	-7.4142	4.7724	-7.4792	-7.9998	-5.2980	1.4810	-6.7930	-7.3302	-2.9940	-7.9998
15	*pointed door top arch*	-7.9998	-1.6824	-3.0742	-6.3704	-3.5692	0.2692	-4.5716	0.0160	1.6326	0.1084
16	*round trefoil door top arch*	-7.9998	1.5756	-1.1216	-0.3556	3.5092	-3.0692	1.7832	-7.8636	-0.7976	1.3894
17	top flat moulding	-1.7746	0.5208	1.7662	-1.8550	-2.1732	-0.1340	-0.2216	2.1016	0.6590	-0.4420
18	top curved moulding	-3.8984	0.2224	-2.3660	1.4712	-0.2236	-1.7816	-3.0352	-1.0182	2.2252	-1.2884
19	triangular pediment	3.3852	-4.8182	0.9400	-7.9998	1.8126	2.0724	-2.6636	3.4200	2.8274	-1.1584
20	semi-circular or segmental pediment	2.2076	-7.9998	-7.9998	-7.7960	-7.9998	5.6282	-7.9998	-5.2490	-7.9998	-7.7222
21	*squared fanlight*	3.1694	-1.5174	0.0822	-1.5400	-0.0308	0.3194	-0.6792	-0.7276	-0.2856	-0.6210
22	*fanlight with undulate top*	-7.2820	1.8580	5.9508	-6.9220	2.1514	-7.3640	1.7308	-6.7936	0.9464	-7.9998
23	*pointed arch fanlight*	-3.5410	5.2166	-7.9998	-7.9998	-1.1694	-3.4894	-6.5986	1.7530	2.1956	-7.5340
24	*semi-circular or segmental arch fanlight*	-5.0154	-1.3292	-3.5024	2.0306	-7.9998	-1.1634	-3.2514	4.0822	1.5570	-7.8540
25	pointed arch tympanum	-7.9998	-0.4484	1.5304	-7.9998	3.4796	0.5954	-2.8596	2.3954	0.3754	3.6186
26	semi-circular arch tympanum	-7.9998	-7.9998	-7.9998	-7.9998	-7.6794	1.4664	2.8070	-5.5226	0.3700	-7.4734
27	*tracery or steelwork on fanlight or tympanum*	1.6706	2.6208	3.2332	-5.7160	-3.0974	-1.0996	-4.6840	0.4320	-1.5696	-1.0970
28	*stained glass on fanlight*	2.1794	1.6706	-7.5072	-7.9998	-0.4184	-2.8592	-1.0886	-0.8790	-2.3474	-7.9998
29	flat retangular porch	-0.5074	2.6604	0.0754	-5.8394	1.4292	1.2032	-0.4462	-2.3740	-1.0692	0.5912
30	flat semi-circular porch	-7.9998	-1.4932	-1.1914	-7.5870	-7.9998	-7.9998	1.9936	-7.9998	-7.9998	-7.9998
31	pediment porch	-7.9998	2.8756	-7.9998	5.7380	0.0064	-7.9998	-7.9998	-7.9998	-7.9998	-7.9998
32	segmental (concave) porch	1.9570	-5.0912	0.1962	5.2450	-7.1646	-7.6074	2.7894	0.4724	-6.0076	-7.9998
33	convex porch	1.3746	-7.6992	0.4080	2.9370	-3.0720	-7.9998	4.2044	-7.9514	-7.9998	2.0530
34	*columns supporting porch*	-0.6310	0.9026	0.4902	-0.8394	-0.7994	-2.2682	3.7960	-1.9784	-4.4944	-1.9566
35	*walls supporting porch*	0.1474	-0.9822	0.3610	-0.2930	0.2164	-3.8260	-2.8942	-7.9998	0.6066	1.2660
36	*cables supporting porch*	2.2916	-7.9998	4.6600	2.2750	2.5356	-7.9998	1.8894	4.6422	-7.9998	3.3162
37	lateral squared section column	1.0654	-2.0776	1.9660	-7.9998	0.8180	-1.4084	-3.8460	1.2256	-2.5192	0.9984
38	lateral cylindrical section column	-7.8816	1.9152	-0.7972	7.6282	-3.2142	0.6986	-0.3570	1.4294	-2.0666	3.5480
39	lateral vertical moulding	-0.8442	1.3780	-0.3594	-6.3200	-0.0544	-0.8700	0.6760	1.3830	0.5982	-1.0652
40	window in one side	-2.3366	-0.5892	-1.3500	1.3024	2.9160	1.3876	-0.3756	-7.9998	1.6916	2.0584
41	windows in both sides	0.7306	0.2810	-0.3506	-2.0800	-2.3026	-1.3246	-0.6532	1.3392	0.0330	-0.4616
42	*vertical glass tower*	-1.3242	0.1556	-0.9076	-0.3480	0.2536	-7.9998	-7.9998	-5.0974	-1.8342	1.6662
43	*angular connection with glass tower*	-7.0696	-3.6730	3.5632	-2.1830	-2.6056	-7.5646	-6.8140	-7.7746	-7.4100	5.7432
44	*decorative sculptures*	1.7062	0.8252	-0.9774	-7.9998	-1.3682	0.8996	-1.3450	-0.5970	-2.6344	-1.4380
45	Surroundings material: glass	1.2784	2.0096	-1.1790	-0.9406	-1.4214	-0.1672	-2.6282	0.5304	-0.9186	-3.4134
46	Surroundings material: brick	-0.8970	-0.4516	-2.1936	-0.8400	0.7890	-5.9840	-1.2622	-3.0606	-1.0660	-0.6812
47	Surroundings material: smooth stone	-1.6980	1.6860	-1.0490	-3.4384	1.6524	1.4022	-0.6592	0.5990	0.8350	0.0650
48	Surroundings material: rough stone	-6.7116	-5.8492	-3.8712	1.4186	-0.4844	-2.2146	-1.4456	-2.8162	-3.6100	-7.9998
49	Surroundings material: concrete blocks	3.1764	5.4104	5.2464	-7.9998	3.1452	-0.8834	-7.1912	2.7886	-7.9998	-4.9500
50	Surroundings material: concrete exposed	1.3100	-0.4164	-0.4690	-7.9998	-2.1680	-1.0532	1.7260	-3.0256	1.6676	0.4796
51	Surroundings material: timber	0.4520	-2.1712	-0.5416	-0.7154	2.5506	-0.0864	1.6340	-0.5604	2.4724	-2.1084
52	Surroundings material: smooth plasterwork	2.0392	-0.8066	-0.4072	0.4908	-0.7190	-0.2580	0.4380	-0.6792	-2.6680	1.8176
53	Surroundings material: rusticated plasterwork	2.4186	6.5322	3.4052	2.0912	-7.7152	4.4422	-3.1896	-7.9998	2.5976	-3.9402
54	Surroundings materials: tiles or small tiles	2.9624	-7.9998	2.0510	-2.9306	4.3236	-7.6862	-6.6790	-7.3872	-7.8192	3.2656
55	Surroundings material: metal	-0.9160	2.3022	-0.0946	1.3084	-1.3750	-2.6852	-2.1674	-1.1862	-1.7594	0.7310
56	*swinging door: one single*	-0.8334	0.9284	-0.4860	3.6042	0.5930	-2.3060	-0.5240	0.8526	-3.6726	-3.6608
57	*swinging door: two singles*	0.2404	2.3766	4.6136	-7.3202	-0.9352	0.4286	-1.2902	1.2008	-7.6214	-1.9574
58	*swinging door: one double*	0.3472	-1.4186	-1.1070	-0.5100	-1.8962	-0.3230	1.8344	-1.3106	3.9846	1.2844
59	*swinging door: triple, two doubles or more*	-1.2016	-7.9998	2.4784	-1.2660	4.8336	3.2330	-7.1916	1.3822	-3.7408	1.4870
60	*revolving door (with four leaves)*	0.5730	-1.2582	1.8342	-7.9998	1.7902	-0.3990	1.1720	0.0744	-1.0472	0.7706
61	*sliding door (one or more leaves)*	-7.7508	5.9324	-7.9998	-7.2290	-7.9998	-7.5680	3.1212	-7.9998	-7.9998	-7.6894
62	leaf: plain opaque	-5.2774	-3.2934	2.0602	0.4676	2.1022	-0.5484	-7.0194	0.3156	-7.9998	-7.9998
63	leaf: plain transparent	1.7240	-7.7262	-3.8286	-7.9998	5.5708	-7.9998	3.1674	5.4496	0.3792	-1.0806
64	leaf: semi-opaque plain with one or more light cross panels	1.3250	-1.7130	2.4950	3.8910	2.4822	-6.7810	-6.7830	-5.7102	-0.2826	0.5464
65	leaf: paneled opaque	-3.3630	-1.8064	-4.9422	-0.9540	-2.8066	0.3442	1.8416	-1.6594	-2.8584	-2.3260
66	leaf: paneled semi-opaque with one or more light cross panels	-2.2952	0.6714	0.7754	-4.5902	3.5102	-0.3192	0.7764	3.1322	1.5962	3.1440
67	leaf: framed with one or two light cross panels	0.6974	-0.2886	1.3606	-0.1754	-0.8444	-1.9326	-0.9346	-1.1826	-0.4164	-1.3604
68	leaf: framed with three or more light cross panels	-1.5752	0.1070	-0.5464	2.6952	-1.2940	-0.1472	-0.0008	-0.8702	0.6570	-1.3432
69	*steelwork leaf decoration*	-7.4510	3.1460	4.8856	-6.1786	-2.5154	-1.3982	-1.9670	-0.8180	1.4762	0.5040
70	leaf mat.: non-stained glass	0.8006	-0.1554	-2.0676	1.8062	1.4592	-1.8970	-0.5300	0.1172	2.1202	1.2808
71	leaf mat.: stained glass	6.4704	0.2814	-7.9998	-6.3102	5.1910	4.0264	2.0408	-2.1736	-7.9998	-7.7010
72	leaf mat.: metal	1.0586	1.9150	0.4192	1.2892	0.7590	-0.3512	0.6826	-0.3284	0.1570	0.7576
73	leaf mat.: timber	1.1126	-2.3552	-2.3172	-2.2976	0.7532	0.4124	0.9272	0.3592	2.5166	-0.9720
74	*round knob or ring handle*	-1.8410	-0.5536	0.6254	0.7706	-0.1674	1.8074	0.7216	1.3954	-0.9282	-0.0534
75	*retangular, squared or trapezoid handle*	0.2456	-3.6362	-6.0486	1.2062	-1.3416	-4.7942	-0.5060	-6.9676	0.1892	0.0120
76	*lever handle*	-2.3102	1.5550	-7.9998	2.0560	1.0140	-5.3734	-7.9998	1.0810	-1.5982	-7.9998
77	*long horizontal static handle*	3.2326	0.8150	-2.2702	3.4606	-1.0572	1.5486	-0.7272	-7.9998	-0.0470	1.1210
78	*long vertical static handle*	-0.0532	-3.3392	3.6840	-0.7160	-0.3920	-0.0636	1.2220	-3.3756	3.3282	-1.1262
79	*short vertical static handle*	0.7732	2.6340	0.5144	-1.9386	-1.2630	-3.1708	-2.2420	1.4792	-1.8202	-5.1016
80	*curved static handle*	-0.3602	-5.6880	1.8774	-1.5342	0.2808	0.4612	1.6162	2.4014	-4.0860	4.6000

Output #	Hidden neuron number >>	11	12	13	14	15	16	17	18	19	20
1	***main entrance***	0.4834	-0.6842	-1.6876	2.1262	0.5544	1.7920	-2.4642	1.2962	-1.6974	0.3466
2	***secondary entrance***	0.7296	0.5686	2.6056	-3.7766	-0.1266	1.1784	1.2550	-0.9232	-1.1196	-2.2060
3	public access	-1.7080	3.2836	1.9380	1.9702	-0.3582	0.7362	0.5284	-2.2456	-1.7330	-2.1324
4	restricted access	-0.6040	-1.9726	-1.8482	-1.9902	0.5272	-0.0910	-1.2464	2.5392	-0.5352	2.1000
5	exit only	0.6672	0.9480	-6.6546	-1.3446	-7.9998	-2.9408	1.2752	-5.4692	4.5384	-3.2202
6	***gives access to: air lock, vestibule or foyer***	-2.8596	5.6566	0.4314	0.6046	-0.3108	0.3110	-1.9082	1.4546	1.5700	3.2442
7	***gives access to: corridor or aisle***	2.0572	-3.5180	1.4912	-1.7930	1.7626	-7.9564	1.2702	-7.9998	-0.6296	0.5966
8	***gives access to: shop or working room***	-1.7094	-5.4874	2.3042	-7.9998	-6.9414	-1.2346	1.7622	5.0276	-0.6604	-7.9998
9	aligned to the facade	-2.2440	0.1126	-2.6824	-1.0726	-0.1308	1.1294	-0.0734	2.4186	0.7764	0.7734
10	pulled out from the facade	-7.9998	-0.4154	-7.9998	-0.7752	-7.9998	-1.4714	-0.2690	-4.7724	-0.1916	-1.7940
11	pulled in from the facade	2.9844	-0.6060	1.8900	2.1000	-0.6892	-1.4192	0.0354	-2.4882	-0.4644	-0.8284
12	***flat door top***	-1.3020	0.8596	-1.6214	-4.4184	-0.2656	3.5572	0.8164	7.9994	4.3812	-0.5640
13	***semi-circular door top arch***	-1.1986	1.0208	-7.2434	3.4172	-7.8814	-7.9998	-3.4006	-7.9998	1.2362	0.7386
14	***segmental door top arch***	1.5266	-7.9356	-7.5402	-7.9998	4.5082	-0.4354	-0.2220	-7.9998	-7.1954	-7.9998
15	***pointed door top arch***	1.8120	-7.9998	3.8600	0.8514	-1.4280	-7.1372	-6.5512	-7.9412	-7.9998	-7.9998
16	***round trefoil door top arch***	-1.3480	-6.4032	-7.6324	0.4386	1.8204	-7.9998	-3.3074	-7.8270	-7.5736	-7.9998
17	top flat moulding	-1.5250	-0.7356	-2.0702	3.1824	0.4394	-0.8556	-1.0266	0.1650	-0.2736	1.6082
18	top curved moulding	4.9514	1.6310	0.1508	0.1744	-0.6024	-1.5044	3.3684	0.0546	-6.7384	-2.4922
19	triangular pediment	-7.7336	-0.4406	-1.6806	-3.2150	-7.9998	-7.6536	-0.8480	4.5882	-7.7224	-7.5990
20	semi-circular or segmental pediment	-7.1294	-6.7360	-7.9998	-7.3706	-3.7600	-6.9610	-7.9998	-1.9132	-7.9998	-7.9998
21	***squared fanlight***	0.2612	0.2570	-0.2976	0.4086	0.8724	-0.4234	0.2586	1.6230	1.6294	0.5324
22	***fanlight with undulate top***	-0.9840	-5.9192	-7.5282	-7.4316	-6.8092	4.0356	2.0114	1.6064	-7.9998	-0.0584
23	***pointed arch fanlight***	-2.8484	3.5040	-6.3754	-7.8206	2.6166	-7.9998	3.8202	1.3132	-7.9942	3.2634
24	***semi-circular or segmental arch fanlight***	-2.8734	0.6394	3.4602	1.9292	-1.9842	1.8842	-0.5380	-1.4666	-7.9998	-0.2150
25	pointed arch tympanum	2.4724	-3.3166	-1.8222	0.0908	2.5900	-7.5810	1.5172	1.1460	-7.9998	-7.9998
26	semi-circular arch tympanum	1.1302	-7.9998	2.0154	-7.9998	-4.6584	-7.9998	4.4334	-7.8154	-7.9998	-7.2614
27	***tracery or steelwork on fanlight or tympanum***	2.0014	1.4336	1.2096	-1.0986	0.0372	1.8074	0.5356	2.5042	-7.9998	-0.6162
28	***stained glass on fanlight***	0.0412	-4.6566	-6.0126	-7.9998	-1.5672	3.1680	-0.1320	-1.9254	-1.7952	3.5464
29	flat retangular porch	2.1756	0.7394	-2.4004	0.2794	-4.1386	0.4430	-6.9204	-1.2346	1.8050	-7.5256
30	flat semi-circular porch	2.1312	-7.9998	-7.7976	-0.1080	-1.6142	-7.9998	-7.9998	0.6434	3.7742	2.8386
31	pediment porch	-6.9342	-1.7552	-7.5286	-7.4074	1.7362	-7.8742	-7.9564	-7.9998	-7.9998	-0.1974
32	segmental (concave) porch	-5.2012	0.0270	4.0914	1.1982	-7.4396	2.3800	0.1336	1.1444	-7.9998	-2.5810
33	convex porch	4.8092	-3.6830	-5.4062	-2.0100	-7.9998	-0.9614	-7.8262	-7.2102	-2.4600	-7.9998
34	***columns supporting porch***	2.5934	-2.9074	0.5214	0.7450	-2.2606	-7.9998	-7.9998	-1.1796	-0.7508	-1.6602
35	***walls supporting porch***	2.3784	-0.8484	-2.8442	2.2196	-3.2802	1.2484	-3.3472	1.2914	0.3562	0.1026
36	***cables supporting porch***	-6.8560	-3.3544	-2.2014	-2.6614	-7.5180	1.0244	-7.9998	-7.3742	3.5520	-7.8202
37	lateral squared section column	1.0146	-0.8094	0.7896	-1.1414	2.1994	0.8726	-1.6706	-2.1604	-4.3334	1.0470
38	lateral cylindrical section column	-0.8606	-4.9912	0.5380	-0.0224	-0.9340	-0.8270	-5.1396	-2.5074	-6.9156	-2.6614
39	lateral vertical moulding	1.3890	-2.3020	0.1894	-2.9406	1.6244	-1.3772	-0.1532	2.0772	-1.4086	-1.0264
40	window in one side	0.3002	0.2614	-0.4790	-0.6734	0.4908	1.7154	-1.6280	-0.7604	1.1242	0.7292
41	windows in both sides	-1.5284	0.6792	0.7214	1.4254	-0.4304	0.5752	0.1732	0.8260	-1.7196	-0.2100
42	***vertical glass tower***	0.5508	-2.3074	-3.0182	1.0232	0.4854	0.4472	3.3794	-0.3286	-3.7476	2.2276
43	***angular connection with glass tower***	0.0190	-5.7930	2.0142	-7.9998	-7.4572	4.0534	-5.6802	-5.7034	-4.8350	-1.3464
44	***decorative sculptures***	0.4480	-2.7776	-2.1574	-6.9732	-1.2340	1.5872	0.4810	-3.9570	-1.8364	-2.8054
45	Surroundings material: glass	0.3422	1.8342	-1.1806	-0.9622	-1.5570	3.2706	-1.8660	2.5026	-0.8626	0.7894
46	Surroundings material: brick	0.3302	0.7012	-1.7984	-0.9032	0.9080	-0.3212	-0.2022	0.2852	1.6692	0.0702
47	Surroundings material: smooth stone	1.3840	-0.3396	-0.5830	-1.3186	-0.0794	-1.2090	-1.4240	-0.6236	-1.2504	-1.5504
48	Surroundings material: rough stone	-3.5292	0.4146	3.4880	2.7594	1.2884	-7.9998	1.7760	0.6744	-1.7076	-1.7416
49	Surroundings material: concrete blocks	-7.9998	-3.6536	-7.9998	-0.8286	-1.4446	1.4320	-7.9998	-3.5742	-7.9998	3.4564
50	Surroundings material: concrete exposed	-7.9998	1.6690	-0.8504	0.9040	-0.6432	0.2620	0.1826	0.4034	0.4536	-1.3408
51	Surroundings material: timber	1.4336	0.8832	-2.3626	-0.5636	2.8012	0.7574	-2.0234	-1.1274	-1.3632	1.4214
52	Surroundings material: smooth plasterwork	0.9262	-7.4200	1.3030	-0.3562	0.1632	1.2830	-2.9260	1.7894	1.7582	0.1526
53	Surroundings material: rusticated plasterwork	0.3306	1.9790	0.6284	-0.9320	-7.5074	1.7192	-4.5102	1.4004	0.3406	1.4254
54	Surroundings materials: tiles or small tiles	-7.9998	1.6716	-6.6274	-6.0236	-7.9998	3.0892	-7.7672	-3.8520	0.6886	-7.8174
55	Surroundings material: metal	0.4620	-0.3424	-0.7636	0.7232	-1.4680	2.7082	-0.1384	-0.2242	-1.0406	-0.6680
56	***swinging door: one single***	-3.2236	-0.5108	-0.1974	-0.8786	-0.3776	-1.2440	2.5410	1.4892	0.3790	2.1706
57	***swinging door: two singles***	2.0672	1.8030	-2.2232	-1.2046	-1.9022	1.0696	-7.9998	1.1516	-0.0704	-7.4524
58	***swinging door: one double***	2.2584	1.1908	0.4792	0.1516	1.3976	-0.8412	-1.3036	-0.7630	-1.0470	-2.0434
59	***swinging door: triple, two doubles or more***	-6.1664	-0.1760	0.3708	1.1692	0.1972	-0.1450	-7.9998	-7.0140	0.9462	-7.9998
60	***revolving door (with four leaves)***	1.3404	0.3874	0.1542	0.9134	-7.9998	-0.4596	6.1470	2.8084	0.5124	-7.4846
61	***sliding door (one or more leaves)***	-7.9998	3.4104	-4.5084	-7.9998	-7.9998	1.6524	1.7360	-7.9998	-0.2476	-7.9998
62	leaf: plain opaque	-5.3342	-7.9998	-6.1104	-7.9998	-0.2902	1.7544	-7.9998	2.1934	-0.6384	-5.2840
63	leaf: plain transparent	-7.9998	2.3720	3.9642	-3.9402	-7.9998	-1.5094	1.4776	-1.5420	1.0204	-7.9912
64	leaf: semi-opaque plain with one or more light cross panels	2.5744	-0.0544	-6.3674	-4.3792	-7.9998	-1.3808	-7.9998	0.2644	0.7742	0.5682
65	leaf: paneled opaque	-0.3306	-2.1144	-2.9194	3.9344	1.5740	-6.2440	-0.6740	0.4262	0.1030	-1.4104
66	leaf: paneled semi-opaque with one or more light cross panels	0.8796	0.9122	-2.3466	-0.8386	-0.8490	0.4112	2.2016	-1.7246	2.0370	3.0272
67	leaf: framed with one or two light cross panels	-0.7708	0.3894	1.4344	0.7326	-3.1950	1.6760	0.3364	0.6400	-0.6082	-5.6796
68	leaf: framed with three or more light cross panels	-0.8052	-1.2900	-2.7982	-1.4622	1.2816	-4.1864	2.8506	0.8902	-1.2212	2.5862
69	***steelwork leaf decoration***	-0.9016	-2.3902	-6.2660	5.6264	-0.3664	2.8564	1.6622	3.0270	-5.1792	-5.7114
70	leaf mat.: non-stained glass	1.6836	3.4402	2.3126	-1.9036	-2.5726	0.7762	-0.6900	-1.7376	-0.4624	0.9334
71	leaf mat.: stained glass	-7.8710	-7.9998	-7.9860	-7.8004	5.1584	-0.3046	-0.1296	-2.1292	2.1396	3.2400
72	leaf mat.: metal	0.0226	0.4164	-0.9390	2.3204	-0.2922	1.7814	2.2082	0.0012	0.2136	-1.0736
73	leaf mat.: timber	-1.1684	-0.7532	-2.6050	0.7320	5.2426	-1.4980	-2.6460	-1.9152	1.4874	2.0024
74	***round knob or ring handle***	-1.1606	-2.0716	-3.0662	1.6792	-0.4204	0.4800	-1.6022	1.5604	-1.1732	1.6264
75	***retangular, squared or trapezoid handle***	2.8702	1.3792	-0.8906	0.2992	-6.1622	0.0794	-1.5830	-0.1394	-4.4622	-0.6862
76	***lever handle***	-7.9998	-2.5160	1.7924	-2.2464	-2.6646	1.6232	-1.8904	-1.0514	-3.2502	-2.3032
77	***long horizontal static handle***	4.2514	-1.3608	1.1826	0.6076	-7.9998	-7.9998	-1.6262	-2.9976	3.5504	2.3684
78	***long vertical static handle***	-6.2392	-0.9044	-0.9286	-0.3202	-1.6210	1.6814	-0.0396	1.0216	1.5590	-0.9476
79	***short vertical static handle***	-0.4064	1.1024	2.5584	-1.9546	2.5556	-0.9370	0.8616	-1.0902	0.7624	-0.6260
80	***curved static handle***	1.1040	-0.3542	0.3060	-7.9998	-5.7710	-3.9482	5.1280	-3.3066	-7.9998	-1.6226

Output #	Hidden neuron number >>	21	22	23	24	25	26	27	28	29	30
1	***main entrance***	1.5454	0.5692	0.1002	2.8508	-0.7210	3.1704	-0.0456	-2.4200	2.2970	2.2116
2	***secondary entrance***	-1.0170	1.5902	2.4882	-1.4908	-7.9998	-3.1340	-1.3560	-1.3444	-0.8876	2.1922
3	public access	0.2520	-0.9476	-4.5046	2.1740	-6.8090	0.0086	1.2480	1.3904	0.7702	-1.2234
4	restricted access	0.4056	1.9408	3.5374	-1.9864	1.4720	-0.5970	-1.0934	-2.4124	-0.3182	1.6136
5	exit only	-0.2970	-2.2084	-3.0982	-3.3350	0.0372	-3.1766	-7.9998	3.2408	-5.7562	-5.7510
6	***gives access to: air lock, vestibule or foyer***	-0.4580	5.2592	0.5032	3.9584	-1.1920	0.9592	0.6614	-1.0746	0.5660	0.0462
7	***gives access to: corridor or aisle***	1.8350	-3.0696	0.7400	-3.6494	-0.8064	-7.9998	0.3960	0.2596	0.5060	4.6816
8	***gives access to: shop or working room***	-3.9342	-7.9998	-7.9998	-7.5884	-0.3842	4.6842	-7.9998	2.6454	-7.9998	-5.0836
9	aligned to the facade	-0.9310	-2.1110	0.0192	-3.5708	-3.5550	6.0380	-1.2006	-0.4890	-0.1702	-1.8686
10	pulled out from the facade	0.1870	1.7306	-2.1404	-0.3808	-0.4644	-5.5156	4.4162	4.0106	-7.9998	-7.7536
11	pulled in from the facade	1.2680	2.2074	-0.0046	3.6590	2.1800	-4.8374	0.4582	-1.6914	2.6340	2.2812
12	***flat door top***	7.9994	0.7456	-3.8302	1.9790	-2.5140	-0.2540	2.9216	1.3906	-1.7224	-2.1164
13	***semi-circular door top arch***	-7.9998	-7.9998	2.8134	-7.9998	-0.7300	-1.5902	-5.4094	-7.9998	1.0350	3.6464
14	***segmental door top arch***	-7.9998	-7.8620	-5.2760	-7.3480	0.0024	2.2908	-7.8010	-3.2192	-0.7222	-3.4380
15	***pointed door top arch***	-7.9998	3.3992	4.0794	1.6590	0.5874	0.5502	-7.9998	-4.1962	1.2876	2.5334
16	***round trefoil door top arch***	-7.9998	0.2852	-1.5172	-0.5956	1.7192	3.1246	-7.3804	2.2272	0.7508	-0.5720
17	top flat moulding	-3.5934	0.8460	-1.6232	1.0206	-6.0550	-2.0096	2.3274	-0.8324	-2.5780	-3.0016
18	top curved moulding	-7.1674	-0.6502	-2.9746	1.7808	-6.2794	0.2496	-4.8260	-0.1612	4.5796	2.3054
19	triangular pediment	-1.7064	2.9380	-7.9998	-0.5590	-7.0490	-2.1510	-0.0032	3.3020	0.5076	-7.8756
20	semi-circular or segmental pediment	-7.9998	-7.0922	3.5496	-1.5476	0.2172	5.7326	-5.7286	-7.9998	1.5926	-4.2630
21	***squared fanlight***	-0.7012	0.2682	0.8932	1.2940	0.7696	-1.6420	0.0024	-0.1912	-1.9784	-3.1392
22	***fanlight with undulate top***	-7.2512	-7.5914	-7.0570	-7.8060	-7.2732	0.0066	6.9826	-7.9998	-1.3206	3.9224
23	***pointed arch fanlight***	-7.9998	-7.1126	-5.0354	-2.9372	-1.5474	-1.2856	2.4012	-1.6924	-1.5072	-5.6640
24	***semi-circular or segmental arch fanlight***	-2.8154	-7.9024	-6.5844	-0.7016	-4.0842	-0.2830	-0.6092	0.1176	-0.4870	-0.8550
25	pointed arch tympanum	-7.9998	-7.3326	-6.8796	-0.5856	-7.2936	1.7070	-7.9998	3.1554	-0.5244	-2.3940
26	semi-circular arch tympanum	-7.9998	0.0692	-7.9998	-2.8962	0.0364	-7.9998	-7.9998	-1.7320	3.3194	4.2630
27	***tracery or steelwork on fanlight or tympanum***	-7.9998	-3.5824	-2.6912	0.2860	0.9908	-1.8910	-2.9696	-0.3910	-1.3424	2.0146
28	***stained glass on fanlight***	-7.9998	-3.3484	-7.9998	0.2710	-0.6516	-7.9998	2.2372	-7.9998	-7.5072	-7.9998
29	flat retangular porch	0.4316	1.3770	1.6286	0.0282	1.5332	-7.9998	0.8890	-3.3734	-0.8770	-5.2552
30	flat semi-circular porch	-0.2586	-2.2292	0.9374	1.7172	-2.0044	-7.9998	0.4980	-7.9880	-7.9998	-7.9998
31	pediment porch	1.1586	1.0910	1.4922	-7.9998	1.7314	-6.8664	-7.8242	-7.9998	-7.9998	-7.4994
32	segmental (concave) porch	-1.3984	-7.4622	2.3650	-7.9998	1.2826	-7.7508	-7.7276	-7.9998	-6.5616	3.8584
33	convex porch	-7.9998	-7.9998	0.2032	4.4636	0.6900	4.2656	-4.0332	3.3272	-7.1980	-7.9998
34	***columns supporting porch***	1.7220	0.8786	-4.1800	1.6154	-1.6376	-7.7832	-0.2174	-5.6154	-5.3056	-7.9998
35	***walls supporting porch***	0.9072	-0.9526	2.0960	-1.5646	5.0576	-7.9998	-0.2582	-7.9998	2.3534	-4.5604
36	***cables supporting porch***	-4.6790	-7.9998	5.1142	1.0796	0.1704	1.3624	4.5862	-5.1536	-0.4222	-5.1316
37	lateral squared section column	-1.1786	0.3992	0.5104	-0.0540	-7.9998	-3.2486	-2.1546	-7.9998	-1.2194	0.6474
38	lateral cylindrical section column	-7.9998	0.0586	-7.9998	0.6132	-7.9998	1.5506	0.7444	0.8630	1.0386	-0.3200
39	lateral vertical moulding	-0.4096	0.8932	-3.0550	0.3424	-0.0554	-0.5714	-0.5850	2.3146	3.5594	5.6490
40	window in one side	0.9524	-0.3200	0.2572	-0.8882	-0.7856	1.0730	2.5710	-0.1022	-3.4124	-6.3872
41	windows in both sides	1.2180	-0.1056	-1.8580	-0.3756	0.2224	0.2782	-1.2532	-0.0814	-0.7092	-3.0160
42	***vertical glass tower***	-0.8850	1.1804	0.7092	-0.1276	-3.7496	-2.3704	-1.9632	3.2236	-7.9998	2.7090
43	***angular connection with glass tower***	0.0080	0.6316	-5.1714	0.9042	-2.4080	-7.7782	-4.1090	0.1690	-7.9998	-7.9998
44	***decorative sculptures***	-2.0050	1.8204	-7.9912	0.5794	-4.9094	-0.1036	3.3002	0.9006	0.7960	1.2846
45	Surroundings material: glass	2.7404	0.4626	-0.6140	1.4450	-1.6072	0.3002	-0.4674	0.0430	0.1680	-1.6516
46	Surroundings material: brick	0.1036	1.4294	-0.7732	-3.0642	2.3120	-0.6634	1.4502	-1.4070	-0.6840	1.3226
47	Surroundings material: smooth stone	0.0264	-1.1940	0.0204	2.1936	-1.1640	-0.3336	-1.2110	2.6300	-1.0806	-1.6774
48	Surroundings material: rough stone	-7.7970	-5.4852	-1.1400	0.4296	0.6316	2.3802	-5.2364	-1.2290	0.0522	1.3656
49	Surroundings material: concrete blocks	-2.3790	-5.8370	4.4450	-7.2760	0.1774	-7.9998	-6.3360	-7.9998	0.9246	-7.8162
50	Surroundings material: concrete exposed	0.4502	0.6026	2.6900	-0.9710	-7.9998	1.1596	-4.7826	-2.0140	-7.9998	-5.6262
51	Surroundings material: timber	-0.3172	-1.2706	-3.1246	-1.5264	-3.2286	-4.0856	0.9602	-7.8820	-0.9164	-7.9998
52	Surroundings material: smooth plasterwork	-0.3680	-1.4016	-1.3506	1.6072	-0.3324	-0.1842	0.8070	-4.8696	-0.7050	-1.0362
53	Surroundings material: rusticated plasterwork	0.4504	-6.8716	-1.0492	-6.1442	-2.1986	-4.8872	-7.9998	-1.2666	7.9994	-7.2236
54	Surroundings materials: tiles or small tiles	-7.9998	-7.9998	-2.5480	3.3160	0.3014	7.2220	-3.5676	-0.9214	-7.3104	-7.2354
55	Surroundings material: metal	0.7412	1.2232	-1.1310	-0.0596	1.2746	0.8516	-1.5472	-0.5542	0.1830	-2.2816
56	***swinging door: one single***	1.8526	-0.3916	-0.1616	1.7540	1.7894	0.8520	-2.0050	-0.1000	-1.9140	-1.3974
57	***swinging door: two singles***	1.1040	-3.1272	-1.5102	-0.0204	-0.1608	-2.9562	-7.9998	3.6326	1.0010	1.6950
58	***swinging door: one double***	-1.4176	-0.9840	-0.7924	-0.8966	-1.3070	1.0506	0.3676	-2.3150	-1.5308	0.3406
59	***swinging door: triple, two doubles or more***	2.5742	-0.9540	0.8330	-2.3876	-7.9144	-2.0614	0.5816	0.7524	1.8602	-7.1286
60	***revolving door (with four leaves)***	-0.4322	1.8154	-6.1314	0.1364	-2.6000	-4.8574	-3.7644	0.8930	1.5108	-7.9998
61	***sliding door (one or more leaves)***	-2.3296	-2.4716	4.3242	-7.9998	-5.8408	-7.9998	-1.9822	-7.6682	-7.9998	3.3422
62	leaf: plain opaque	-7.9998	4.3964	-7.9826	-3.8224	1.0520	-1.6720	0.4226	-5.9982	-7.3910	3.0146
63	leaf: plain transparent	-3.3144	-5.0764	3.7152	-1.3656	-1.5580	-7.8726	-3.3004	4.3512	-7.9998	-7.9998
64	leaf: semi-opaque plain with one or more light cross panels	-0.5552	0.8872	2.6370	-1.1006	-2.3870	1.1236	-1.4754	-1.0280	-0.1846	-3.9842
65	leaf: paneled opaque	-5.4246	0.6420	0.0400	1.2290	-7.5332	1.2222	-1.2134	0.3714	3.0290	6.3882
66	leaf: paneled semi-opaque with one or more light cross panels	-2.3662	-4.3040	-0.7134	-1.0434	-1.2440	-1.4876	-0.3444	1.4090	-0.2056	-5.1722
67	leaf: framed with one or two light cross panels	0.1456	0.5716	-4.1384	0.1366	-7.9998	0.4696	-0.1894	-1.3240	-0.5960	-1.0094
68	leaf: framed with three or more light cross panels	0.4776	-1.8144	0.7064	-0.6416	0.7764	-3.6006	-0.8180	0.8910	-7.9998	-0.4740
69	***steelwork leaf decoration***	-7.2544	0.5346	-7.3806	1.0046	0.5808	2.3030	-0.0826	2.1172	-1.1480	-1.5814
70	leaf mat.: non-stained glass	5.5240	-0.0356	1.0880	-0.7008	-1.2356	-0.8696	-0.2792	-0.6862	-2.4710	-5.4394
71	leaf mat.: stained glass	-7.9998	3.8764	-7.9086	-4.2320	-0.6072	-7.9998	5.7696	-7.9998	-7.9998	-5.2536
72	leaf mat.: metal	0.0894	0.5086	0.8772	-0.5102	0.1444	0.5690	-1.9470	0.4372	0.7086	-0.4884
73	leaf mat.: timber	-0.5660	0.5042	-2.6056	1.5664	-1.1702	-0.9334	-1.4376	-2.7074	0.2252	1.9852
74	***round knob or ring handle***	-1.3672	0.5636	1.0956	1.3500	-0.6110	2.0796	-1.3186	-1.3074	0.8912	0.8390
75	***retangular, squared or trapezoid handle***	-0.4412	-0.7476	-0.2046	-1.1594	1.1422	1.5760	3.1786	-1.2426	1.9674	-1.0172
76	***lever handle***	-3.2410	1.0744	-2.4026	-0.3716	3.3900	-2.1040	-1.2580	-4.6150	-7.9998	-7.6966
77	***long horizontal static handle***	-1.2642	-1.7402	0.5392	-0.8856	-1.0710	-7.9998	-0.7784	2.2654	-0.9280	1.7882
78	***long vertical static handle***	0.1742	-0.3146	-0.2030	0.5506	-1.4650	0.1602	-3.2482	2.5146	-1.7270	-7.9998
79	***short vertical static handle***	0.1630	0.5636	2.5422	-1.5004	-1.1270	-7.9998	1.8296	-5.2502	-1.4730	-0.0774
80	***curved static handle***	-1.5412	3.3312	2.7906	-7.9998	-0.4256	2.3774	-7.7682	-7.9998	-7.9998	5.3250

Appendix 5.2.Weight matrix of 50 hidden neurons network: hidden to output layer connections

Output #	Hidden neuron number >>	31	32	33	34	35	36	37	38	39	40
1	main entrance	-0.6922	0.3720	-2.8166	-2.9820	-3.1342	0.1846	-0.8022	-0.4850	1.1832	0.8184
2	secondary entrance	0.1080	-0.4932	3.3092	3.1726	1.3514	-1.2266	-0.6666	3.4200	0.3114	-1.3072
3	public access	0.5216	0.2306	-0.2876	0.6554	-2.7320	1.5976	-1.0172	-0.0226	-1.1836	1.9764
4	restricted access	-0.8890	0.1142	0.6102	-0.9410	1.3540	-0.3984	0.7342	0.4550	0.5620	-1.9516
5	exit only	5.3324	-2.3946	-7.2500	4.8636	3.7184	-3.4080	-1.2884	-3.4640	1.4810	4.2506
6	gives access to: air lock, vestibule or foyer	0.0726	0.6800	-0.6594	-4.0672	1.0046	-1.1584	2.0620	-2.1924	-0.5754	2.9674
7	gives access to: corridor or aisle	-0.1852	-1.3226	1.4172	4.4632	3.3112	0.5452	0.7250	1.7166	-1.9100	-3.4252
8	gives access to: shop or working room	-3.2086	0.2076	-2.5560	0.5612	-0.3806	-1.4086	-7.1630	-2.7722	3.7766	-7.0730
9	aligned to the facade	1.0850	2.1736	-0.2160	1.3174	-0.7024	-0.8362	0.0604	1.0684	1.2200	-0.4722
10	pulled out from the facade	0.3708	0.5774	-0.3486	-7.7146	5.0840	0.0980	-0.2860	-7.9998	-1.0662	-7.6152
11	pulled in from the facade	-1.9484	-2.1362	0.6734	-0.2274	-1.8264	1.2542	-1.1290	0.1908	-2.2230	1.7624
12	flat door top	-0.9414	6.7760	2.6182	-0.8300	-2.5110	3.9626	5.1484	0.2276	4.5044	-0.7290
13	semi-circular door top arch	1.9776	-7.9108	0.8526	2.4500	-2.7440	-7.9998	-7.6096	-2.1710	1.5774	3.0046
14	segmental door top arch	4.4666	-7.0272	-7.9998	2.1800	-1.8244	-7.3496	-7.9246	0.1166	-7.9998	-7.9998
15	pointed door top arch	-3.1490	-6.9032	-7.8124	-7.1252	-1.1094	-7.2856	-7.9998	0.2330	-7.0306	-0.9304
16	round trefoil door top arch	-7.9998	-3.9770	1.2030	-3.3870	1.7704	-7.9714	-7.8306	1.7146	-4.4990	0.4808
17	top flat moulding	0.2636	-1.4804	0.5272	-1.2154	-0.4392	-5.1450	-0.8960	1.2272	1.1152	1.9412
18	top curved moulding	-0.3376	2.4892	0.3304	-3.2470	-0.5322	-7.9998	-0.9246	-0.2392	2.0720	0.8436
19	triangular pediment	-7.9998	-7.9998	-7.9998	-6.4142	-1.4276	-7.9998	-6.4724	-0.2486	-7.9998	-1.3030
20	semi-circular or segmental pediment	1.3776	4.3792	-2.9752	-7.9998	3.7744	-0.5654	6.5866	5.4826	-7.1086	-3.2860
21	squared fanlight	-0.8972	0.0694	0.7490	0.2426	-1.8964	-0.4230	-0.9420	0.0806	-1.6590	-0.9842
22	fanlight with undulate top	-7.9998	-6.3012	-7.9998	-7.9998	1.0626	5.2092	-7.9998	-7.9998	-7.2522	-7.9842
23	pointed arch fanlight	1.5780	-5.0394	-3.1456	-7.9346	-7.7280	-7.9998	-5.7530	1.7894	0.2036	3.7756
24	semi-circular or segmental arch fanlight	2.0162	0.8984	1.0416	-0.4152	-1.7544	-4.1752	3.2424	1.9260	-1.8810	-0.2396
25	pointed arch tympanum	-4.6892	-0.6544	1.3200	-2.0956	1.4542	-7.9604	-7.3346	-3.0980	-0.4786	1.7030
26	semi-circular arch tympanum	0.0270	4.9934	-3.4524	1.4684	3.4272	-7.9998	0.7244	2.6076	-0.2736	-7.9998
27	tracery or steelwork on fanlight or tympanum	-2.5276	-2.1706	-0.3354	-0.2770	-0.5460	-3.4030	-7.9998	-0.9826	2.1656	1.9120
28	stained glass on fanlight	0.7530	-7.9998	-6.1184	-7.3150	-4.3570	-7.9998	-7.9998	-7.9998	5.0292	2.9540
29	flat retangular porch	0.9936	0.6720	1.0006	1.9244	-7.9998	0.4134	-0.3650	-0.2056	0.9810	-3.3924
30	flat semi-circular porch	-0.7082	-7.4180	0.1270	-7.9998	0.5346	3.1132	-7.9998	0.9396	4.2714	1.4326
31	pediment porch	-7.9998	-5.8162	-7.9998	6.0542	-7.7112	0.7044	-1.6082	4.2852	0.9166	-7.9998
32	segmental (concave) porch	0.6732	-6.8130	0.0224	1.6242	2.0700	-0.3704	3.9632	3.8164	-4.2084	-6.0396
33	convex porch	5.9732	-5.9136	-7.9998	5.3394	-7.9998	-7.9998	1.0094	-7.9998	-7.9998	-7.9998
34	columns supporting porch	-0.5434	-1.8174	-1.3872	2.7410	0.9656	-0.3270	-3.7866	3.0490	1.2046	-1.3090
35	walls supporting porch	2.8332	-1.6312	1.9844	1.7676	-2.1110	-0.3116	-5.9560	3.5860	-3.1402	-0.0766
36	cables supporting porch	-7.5772	2.9994	-7.0542	3.9166	-7.9998	-3.4122	2.7576	-7.9042	-7.5562	-7.7140
37	lateral squared section column	-0.6744	-0.1590	0.0310	0.0516	0.6342	-2.4190	0.1572	-0.5094	-0.2812	-0.5934
38	lateral cylindrical section column	-2.5222	-5.3212	-1.7472	-2.2580	-0.4014	-2.0782	-7.9046	1.5944	1.1936	3.2782
39	lateral vertical moulding	0.7556	-1.0092	-1.0174	-3.9284	-1.0682	-3.6866	-1.1502	-1.9606	0.6202	-1.0454
40	window in one side	-0.4890	-1.0536	0.3522	-2.2620	-2.8302	-0.4632	2.0394	-0.4876	0.9036	-4.9032
41	windows in both sides	0.0802	-0.1160	-0.6782	-0.6774	-0.5852	1.0674	-1.1808	-1.0946	-1.2286	-0.8102
42	vertical glass tower	1.4042	1.5884	-3.9922	1.8086	-1.7922	-0.3750	3.6276	-7.9998	0.6510	-2.0966
43	angular connection with glass tower	-7.9998	0.8992	-5.3774	0.1212	7.4746	1.4256	2.9080	-7.9998	-4.0024	2.5676
44	decorative sculptures	0.9184	0.1142	-0.3844	-1.8366	0.1174	-7.9998	-7.9998	-2.3342	-4.3300	-1.8092
45	Surroundings material: glass	0.9254	-0.0602	0.7400	-0.7572	-0.6512	0.9756	1.7082	-1.2246	-2.4546	-0.0900
46	Surroundings material: brick	-0.8022	0.0992	-0.0342	-1.0480	1.0556	1.6084	1.5652	-0.6194	0.1626	-1.6430
47	Surroundings material: smooth stone	-1.6308	-0.2532	1.2056	0.8776	1.0312	-1.1440	-0.7310	0.2400	0.1342	1.0580
48	Surroundings material: rough stone	2.6992	-5.5782	-1.5126	1.5140	-1.3686	-7.9998	2.8402	0.7754	0.3350	2.1784
49	Surroundings material: concrete blocks	5.3232	-7.9998	-1.8814	5.2466	-6.4252	-2.6080	-7.9998	-7.9998	-7.9998	-7.8746
50	Surroundings material: concrete exposed	1.8424	0.5990	-0.4132	1.3856	-1.3120	-0.5052	1.6256	-1.4262	-7.7108	2.2374
51	Surroundings material: timber	3.2176	-1.9450	0.9726	-1.3874	-1.1540	-0.2966	-0.8122	0.9640	0.7496	-3.1280
52	Surroundings material: smooth plasterwork	-0.4546	-0.4326	-0.5386	-0.6416	0.4364	-0.1000	-0.0770	-0.7756	0.6280	-0.7090
53	Surroundings material: rusticated plasterwork	5.7720	-0.6236	-7.3254	3.6544	-6.7592	-4.6166	2.9332	2.2790	-7.5282	-7.9998
54	Surroundings materials: tiles or small tiles	-7.3544	-2.8724	-7.9998	-5.6646	-7.9998	-7.9998	-4.2566	6.2356	-7.7342	-7.7860
55	Surroundings material: metal	-1.9760	0.4756	-0.3486	0.2076	-0.3340	2.6454	-0.0460	0.2500	-0.8690	-3.0074
56	swinging door: one single	2.2020	-1.1166	-0.6472	-2.2008	-5.6808	0.5730	-1.2196	1.3896	1.7662	-2.4040
57	swinging door: two singles	-7.5180	-2.2462	-0.6022	0.7714	-3.5860	-7.9998	-7.9998	-2.9372	0.9272	2.1164
58	swinging door: one double	1.1076	1.6112	0.0554	-0.5910	3.7414	0.4612	0.9602	1.0212	-1.8806	-0.2014
59	swinging door: triple, two doubles or more	-5.6892	-6.6762	-2.9452	-3.5590	-6.0482	1.5506	-1.0392	-7.9998	-7.9998	2.6284
60	revolving door (with four leaves)	-7.9998	-7.5626	-7.9998	4.6594	-7.9998	-4.8006	-0.6944	-7.6026	-7.9998	-7.7446
61	sliding door (one or more leaves)	-7.9800	3.0008	-2.1914	-0.7456	-1.6574	-1.1808	3.1340	-7.9998	-7.0682	-7.9820
62	leaf: plain opaque	-6.8436	-6.9570	-3.4886	-7.3206	0.8800	4.5606	-7.9998	-7.9998	-1.8904	3.6364
63	leaf: plain transparent	-7.9998	1.8872	-7.8456	-7.9998	-7.5104	-1.1740	4.8274	-7.9998	-7.7052	7.9994
64	leaf: semi-opaque plain with one or more light cross panels	1.1256	-5.0354	-0.6922	-6.8800	-7.9998	-1.4102	-5.5444	0.7176	3.5056	-7.9998
65	leaf: paneled opaque	1.4260	1.8620	-0.6934	-3.8744	0.5040	-7.9998	-0.6414	4.4156	1.8910	0.7286
66	leaf: paneled semi-opaque with one or more light cross panels	0.6836	-1.9340	0.7416	0.2754	0.2330	0.8022	-4.7344	-1.5362	-2.4316	-0.6110
67	leaf: framed with one or two light cross panels	-0.4780	-0.6722	-0.4934	5.5114	-4.6216	-0.0172	-0.5984	-0.9374	-4.9492	-7.9998
68	leaf: framed with three or more light cross panels	-2.6952	2.1054	0.9512	0.3502	-2.7050	0.6766	0.1822	-4.8652	-0.0906	1.4570
69	steelwork leaf decoration	-3.9170	-3.3672	0.2722	-1.2866	3.9570	-0.2814	-4.6194	-4.1274	-0.2724	-0.2922
70	leaf mat.: non-stained glass	-0.2960	-0.2866	1.4466	1.0034	-0.5916	0.8016	0.0936	-2.7014	0.1012	-1.4710
71	leaf mat.: stained glass	4.1844	-7.9998	-7.6496	-7.7592	1.5564	-7.9998	-7.9998	-7.9998	4.4474	-7.2420
72	leaf mat.: metal	-2.8406	-0.6296	-0.0276	1.5632	1.6024	1.2636	0.0470	-2.7754	-0.8974	-0.8106
73	leaf mat.: timber	6.8954	-0.9800	0.9474	1.4230	-0.8040	-1.2976	-3.6014	5.1322	7.9994	3.6030
74	round knob or ring handle	0.9524	-1.2092	0.6244	0.6922	2.7992	-1.6862	-1.1750	-0.9226	0.2934	2.5030
75	retangular, squared or trapezoid handle	-0.0644	-0.6174	-0.9140	1.4512	-7.9998	0.1690	-0.6584	-2.8880	3.8456	1.8872
76	lever handle	-1.3312	3.0410	-1.0682	-0.3176	-2.7796	-1.6456	0.9172	1.8174	2.8730	-7.6772
77	long horizontal static handle	0.8270	-0.7834	-7.9998	2.8470	-7.9998	-1.7110	1.1270	-0.4106	-7.9998	-6.4140
78	long vertical static handle	-2.4544	-0.1762	-0.2414	-3.7204	1.2136	-0.8486	-0.3414	-7.8264	-7.9998	-3.7250
79	short vertical static handle	1.0162	-2.7344	-0.8282	-1.1404	0.4022	1.4824	0.5620	-4.8636	-1.9394	-1.6876
80	curved static handle	-1.0622	1.3636	-4.8434	0.9004	-7.9998	2.5206	1.7622	-7.9998	-7.2384	-3.2334

Output #	Hidden neuron number >>	41	42	43	44	45	46	47	48	49	50	Threshold
1	*main entrance*	-0.2144	0.2504	0.8490	7.2342	1.3854	0.2036	-0.4716	-3.5042	5.0184	0.2350	0.2724
2	*secondary entrance*	-3.7452	0.1316	-3.3450	-5.1272	-1.3042	-5.1776	-1.7992	-0.2536	-6.8616	0.5586	-0.2616
3	public access	1.8180	0.4316	-1.0660	-0.9086	0.1126	1.4586	2.7256	-2.6272	0.5544	-2.2390	0.2112
4	restricted access	-1.3400	1.8570	1.3702	1.0612	-1.5352	-1.7190	-2.6642	-0.2044	-0.7382	1.7184	0.8264
5	exit only	-4.0294	-5.2064	-7.9998	-7.1684	3.7640	5.1808	4.1342	5.5682	-3.5850	-1.8710	-0.5412
6	*gives access to: air lock, vestibule or foyer*	-0.0460	-3.2440	0.1380	1.1870	-1.1002	-1.1382	-2.8022	-1.3756	3.4732	1.1344	0.7156
7	*gives access to: corridor or aisle*	-5.6456	2.6740	-1.6630	-2.6122	0.5374	-0.1266	2.1254	1.2512	-7.9998	-1.8696	-1.9470
8	*gives access to: shop or working room*	-1.2840	-4.2994	-7.8510	5.9832	-0.5566	-3.9136	2.0020	-2.9946	-2.6494	-0.7574	-0.1102
9	aligned to the facade	1.9382	3.8696	0.1730	-0.0642	1.3846	-0.6790	-1.2006	1.6926	-1.6242	-0.6106	0.1456
10	pulled out from the facade	0.3576	-6.7402	-7.6346	2.6492	-7.9998	-1.2620	-0.5606	-7.6084	1.7376	1.7312	-1.8010
11	pulled in from the facade	-3.1206	-2.7942	1.6720	-1.8156	-1.2524	0.9734	0.5314	-1.5042	0.3302	-0.3562	1.1734
12	*flat door top*	-1.1146	-2.0866	7.9994	2.6970	0.3672	-3.0286	0.2122	-1.8402	-0.8906	-2.2132	2.6040
13	*semi-circular door top arch*	5.2336	-4.6776	-7.9998	-6.7576	-7.9230	7.6894	-7.9998	-7.8880	-7.9998	-7.9998	0.1554
14	*segmental door top arch*	-6.1070	4.4890	-7.3308	-7.9998	4.2814	-7.0950	-7.0710	4.8246	2.0350	4.0142	-2.8954
15	*pointed door top arch*	5.1506	-7.6844	-7.9998	0.5290	-3.9254	6.6122	-7.9998	-3.6708	4.7734	-7.9998	-1.7466
16	*round trefoil door top arch*	-4.7876	4.9042	-7.9998	0.0440	-7.9998	3.3260	-0.7494	-7.9998	-7.9826	-7.9998	-2.1852
17	top flat moulding	0.3256	-2.1302	2.2306	1.4636	-1.1190	-2.2476	-0.9814	0.7556	-1.0140	1.6552	-0.6316
18	top curved moulding	-2.3322	0.3980	-0.4100	1.3208	0.6582	-1.6144	-1.4210	-2.7116	0.5474	-2.9060	-0.6482
19	triangular pediment	-7.9866	-4.6660	0.7308	-7.7480	3.9984	-6.8446	-7.9998	-6.9752	2.7746	0.5572	0.6606
20	semi-circular or segmental pediment	-4.6804	-7.2590	4.6674	-4.9212	4.7736	-7.9998	-0.5474	-6.4174	1.4852	-6.6536	-1.1502
21	*squared fanlight*	0.1236	0.0792	0.1132	-2.1896	0.8980	-0.7392	0.2744	0.1602	0.8690	0.2210	-0.5644
22	*fanlight with undulate top*	-7.1654	5.3246	-7.6644	2.0990	-7.9998	-7.9998	-7.9998	3.6256	-0.4600	-7.9998	-2.3142
23	*pointed arch fanlight*	0.6244	-7.2640	-5.6112	2.8632	0.1766	6.4704	3.6030	-7.9998	-4.4360	-7.9998	-2.9810
24	*semi-circular or segmental arch fanlight*	-7.2566	-0.5136	1.6444	1.9208	-1.8620	-2.8610	-0.9044	2.1286	1.8670	-4.6892	-0.6460
25	pointed arch tympanum	-2.0342	1.7554	-7.9998	-1.5676	-7.9998	1.1408	-1.9282	-4.6562	-5.7306	-7.6520	-0.8006
26	semi-circular arch tympanum	-5.0122	0.2166	-7.9636	-1.9532	2.5966	-6.0184	-0.2732	-1.5484	-7.9998	5.7908	1.1352
27	*tracery or steelwork on fanlight or tympanum*	-5.2944	0.1214	-6.0522	4.9516	-7.2152	-0.6266	2.3086	1.5572	3.0234	-7.9998	-0.9676
28	*stained glass on fanlight*	-7.9998	-0.6582	-1.7974	-0.3662	-7.9998	-7.9998	0.2554	-0.2334	3.2174	-7.9276	-3.0026
29	flat retangular porch	3.1762	-7.9998	-0.3716	-0.5744	1.4824	-2.0344	0.3408	-1.7172	0.9526	-0.9334	-0.3504
30	flat semi-circular porch	-1.7780	-0.9514	-4.8410	1.1614	-0.8000	-3.8090	2.8120	0.2634	3.2224	4.4054	-1.5782
31	pediment porch	-7.9998	3.3974	1.0560	2.5280	1.9416	2.1882	5.9192	-5.5100	-7.9998	2.1416	-3.1480
32	segmental (concave) porch	2.2916	-7.3800	-1.2376	-1.1670	-7.9998	0.4544	-7.8760	-2.2212	1.8370	-2.3840	-0.6914
33	convex porch	2.7206	7.1514	-7.9998	4.4186	-4.5204	-7.9998	-7.7724	-7.9998	3.2434	2.9990	-1.3236
34	*columns supporting porch*	-2.9446	2.1624	0.2936	3.6366	1.5076	4.2810	2.1796	-1.7692	-2.7746	-1.0292	-0.0280
35	*walls supporting porch*	0.0008	-7.9998	2.1790	-3.6266	-4.5104	0.3012	-1.0354	-7.9998	0.7502	-2.8184	0.0222
36	*cables supporting porch*	1.9272	6.3814	-5.6390	5.0530	5.8186	-4.6616	-5.3862	-5.9150	-1.2116	-4.7072	-0.6842
37	lateral squared section column	-0.4252	-7.9998	1.7280	1.9284	1.5332	-0.1252	-0.9884	3.7662	1.7670	-4.3330	-0.6262
38	lateral cylindrical section column	-2.0374	-7.9998	-4.4540	-0.1246	-3.4436	-0.1414	0.6734	-3.4820	-0.6362	-7.9998	-0.6132
39	lateral vertical moulding	0.5306	-0.3314	0.6372	-0.7492	-1.5222	-2.5214	-4.0406	0.6396	0.5612	1.2608	0.1246
40	window in one side	-4.1794	-2.1624	1.3966	-6.6108	-2.5356	-1.9636	-1.9102	-0.6364	-0.4806	-1.8000	0.1308
41	windows in both sides	-0.3994	0.0580	-1.5506	0.2992	2.0362	1.4160	-0.1944	-0.9276	0.1334	2.9784	0.1212
42	*vertical glass tower*	-7.9998	0.5006	-2.0452	-3.0330	-2.4236	-0.6890	0.5806	-0.2912	-0.6636	1.2074	-1.4522
43	*angular connection with glass tower*	-0.6236	-7.8512	-7.9998	-4.5616	2.1502	-0.7980	2.1230	-7.7700	3.4594	-0.8714	0.3722
44	*decorative sculptures*	-2.8462	2.0320	0.5510	-7.0604	2.9314	-7.1322	-1.2130	0.4652	2.0374	-3.1890	1.0102
45	Surroundings material: glass	-0.0010	-1.1216	0.2050	-2.0040	-0.1232	0.1896	1.8960	0.9962	0.6414	0.2956	0.8064
46	Surroundings material: brick	-0.8366	-0.2584	-0.1008	1.5362	1.9506	1.3090	-0.0202	-0.4660	0.0552	0.3194	-1.0420
47	Surroundings material: smooth stone	-0.2120	1.3044	0.0372	-1.6120	0.6096	-2.8008	0.7994	-1.3156	0.6408	0.9432	0.8366
48	Surroundings material: rough stone	-0.0462	-0.1222	-7.9998	-2.1962	3.6482	6.0154	-3.9520	-0.3308	-6.1112	0.0536	0.8850
49	Surroundings material: concrete blocks	-7.9998	-5.5826	1.6070	-6.3764	-3.5774	0.1946	-7.9998	4.8706	-2.8114	-4.2136	-2.2022
50	Surroundings material: concrete exposed	-4.7204	-7.9998	-0.0220	1.8396	-0.4910	1.5124	-3.1204	0.1540	-0.4126	-3.9884	-1.5130
51	Surroundings material: timber	-4.4540	-0.3116	0.6532	0.8508	1.3994	1.1224	1.0564	2.0304	0.0972	-0.7920	-0.6480
52	Surroundings material: smooth plasterwork	0.9666	-1.6756	0.2576	1.8240	-5.6552	-0.6192	0.5816	1.5230	-0.2056	-0.5546	-0.6802
53	Surroundings material: rusticated plasterwork	-7.9180	-7.4452	3.0942	-5.4512	-7.3690	-5.1506	-7.8356	0.5314	-7.9998	2.1440	-4.1654
54	Surroundings materials: tiles or small tiles	3.0782	7.9994	-7.9998	6.1556	-0.6056	-7.9998	-7.9998	-7.9998	3.7334	4.0924	1.4954
55	Surroundings material: metal	-1.1746	3.0966	-1.6094	-0.6136	-1.8504	-2.7366	1.2344	0.5826	1.7852	0.8542	-0.0206
56	*swinging door: one single*	-1.0674	3.4706	0.2046	-1.7036	-1.2092	1.7416	-0.9030	-1.1900	-1.4616	-2.1852	0.8872
57	*swinging door: two singles*	1.8070	-7.9998	0.1452	1.9962	0.4072	-0.7616	-1.0354	-5.5908	-5.5120	-0.4630	-0.2606
58	*swinging door: one double*	1.1830	-0.3166	-1.4852	1.8434	0.3964	-2.1900	0.9302	0.9932	0.9260	0.2532	-0.3726
59	*swinging door: triple, two doubles or more*	2.5462	-4.9386	2.0812	-7.9998	3.4264	-1.2786	0.0576	-3.5108	-1.5694	0.5166	-0.1742
60	*revolving door (with four leaves)*	-7.9998	-7.7642	3.4242	-5.6026	-4.0330	4.2084	-3.6704	-7.9998	-0.1426	0.5882	-1.5012
61	*sliding door (one or more leaves)*	-7.3750	-7.9998	-3.9400	-5.5520	-7.9998	-7.9998	-6.7734	-7.8980	-7.9998	-6.8824	-2.2904
62	leaf: plain opaque	-7.8614	4.3292	-1.6972	0.9824	4.1200	-5.8520	-5.4560	2.8584	2.4134	-7.9998	-2.0052
63	leaf: plain transparent	3.0782	-7.4894	-1.7710	-7.0134	4.1634	3.9896	-1.5874	-5.8836	-6.0604	2.1934	-2.4746
64	leaf: semi-opaque plain with one or more light cross panels	-0.9574	6.4484	-0.5390	2.9442	4.0972	-6.1134	-1.2644	-1.7844	-0.8206	-1.1790	-0.4256
65	leaf: paneled opaque	-1.6904	-4.3284	0.7334	3.6400	4.7094	0.4352	-0.2880	-0.2484	-1.4910	-0.5734	-0.3212
66	leaf: paneled semi-opaque with one or more light cross panels	0.1102	3.9240	-1.1376	-7.9998	-7.1880	-1.0002	-3.1984	0.6160	-1.0204	-4.0576	-0.5752
67	leaf: framed with one or two light cross panels	-1.1576	-3.5084	2.3234	1.3012	-2.5716	-1.3130	2.1850	-0.0490	0.8556	0.8366	-0.6270
68	leaf: framed with three or more light cross panels	-1.5232	-2.4590	-0.4660	2.4602	-3.5194	2.0880	-0.0960	-0.4806	1.6208	0.0744	-0.8582
69	*steelwork leaf decoration*	-2.3002	1.1956	-7.9998	-1.4036	-7.9998	-7.0380	-7.6094	0.9154	0.9122	1.9924	-0.0014
70	leaf mat.: non-stained glass	0.0684	3.8756	-0.4520	-1.3808	-3.3892	-0.6936	1.2102	-0.5644	0.8092	1.2392	1.5002
71	leaf mat.: stained glass	-7.9998	-2.6906	-3.7554	-7.9998	-7.9998	-7.9998	-7.9998	-2.2696	0.1216	-7.8050	-4.5836
72	leaf mat.: metal	-1.4950	0.8912	0.4326	-0.1822	-1.8372	-0.2192	-1.4684	-0.5602	1.6064	0.4974	-0.9676
73	leaf mat.: timber	-1.0760	-0.1026	1.1860	-0.5702	0.3776	0.1282	1.0802	0.2220	-0.9972	-0.5890	-0.7216
74	*round knob or ring handle*	-0.0046	1.4112	-1.7602	-0.6604	-1.5944	-1.5056	-0.0564	-1.8304	0.1732	-1.8596	-0.6184
75	*retangular, squared or trapezoid handle*	0.4830	-3.3556	3.1322	-1.3910	0.0796	1.0312	-7.6174	3.4824	2.5254	0.2034	-2.5212
76	*lever handle*	3.2674	-1.4620	2.0990	-0.9554	2.3752	0.2086	0.6760	2.2946	-1.4896	2.7200	-1.5642
77	*long horizontal static handle*	-7.9998	-7.6656	-4.7402	-0.9990	2.5790	0.3530	1.1108	1.9306	-7.9670	-1.7352	-1.8352
78	*long vertical static handle*	-2.2670	-0.2308	0.3160	1.5610	0.3856	0.1972	3.1282	-6.8430	0.8144	-0.5816	-1.0726
79	*short vertical static handle*	0.3690	1.7432	-0.6966	0.6120	0.2316	-0.8016	0.3854	-0.1184	-0.3616	-1.3144	-0.7660
80	*curved static handle*	-2.7352	-7.9998	4.1570	0.9364	-7.7052	0.1344	1.1844	-2.4926	-5.1026	4.6256	-0.5524

Appendix 5.2.Weight matrix of 50 hidden neurons network: hidden to output layer connections

Appendix 6

Example of levels of support matrix: 50 hidden neurons network

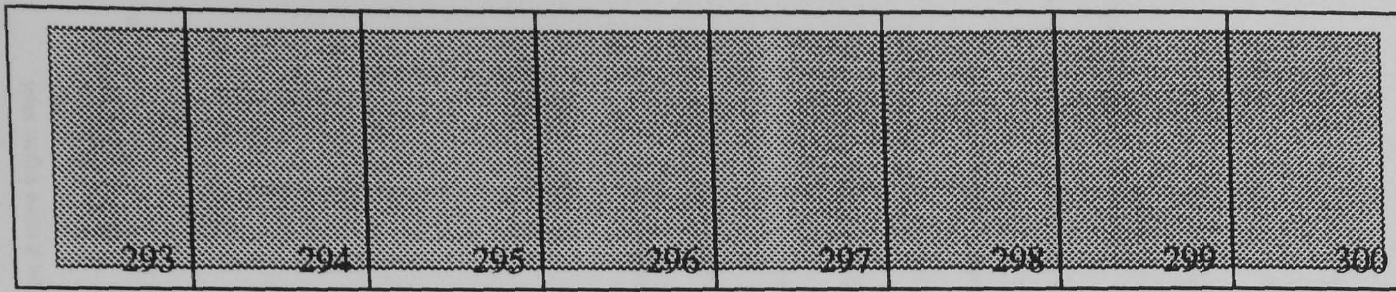
The matrix shown in this appendix is an example of a method applied to verify the similarities and differences among the networks by measuring the distance of each one of them from the frequency matrix found in Appendix 3.

In this approach, tables with values of support varying between '0' and '1' were produced, for each trained network, by using a sigmoid transfer function instead of the step function, and by making each input feature active at a time. The results were matrixes with 80 rows and 80 columns for each of the 17 trained networks. This appendix shows one of those matrixes, that is, the matrix of the network with 50 hidden neurons.

With a sigmoid transfer function configuration the network presents a continuously valued output, which represents the levels of support between each feature and all the others. If the input neuron number 3 is made active, the network will respond by making active, in different varying levels, the output units. For instance, output number 3 will be almost fully active (0.9993) and output number 4 will be almost fully inactive (0.0003). The closer the output is to 1 the more is the input-output pair mutually excitatory. The closer the output is to 0 the more is the input-output pair mutually inhibitory.

Because the matrix is too large to fit in a single page, it has been broken down into smaller tables, each with its own labels of columns and rows.

The key map bellow indicates the relationship between tables. The numbers indicate the page in which each table can be found.



Appendix 6. Example of levels of support matrix: 50 hidden neurons network

<< Active input unit		1 main entrance	2 secondary entrance	3 public access	4 restricted access	5 exit only	6 gives access to: air lock, vestibule or foyer	7 gives access to: corridor or aisle	8 gives access to: shop or working room	9 aligned to the facade	10 pulled out from the facade	11 pulled in from the facade	12 flat door top	13 semi-circular door top arch	14 segmental door top arch
1	*main entrance*	0.9998	0.0003	0.1683	0.1055	0.0003	0.9998	0.0003	0.0003	0.7720	0.0003	0.1394	0.9998	0.0003	0.0003
2	*secondary entrance*	0.0003	0.9993	0.1204	0.9478	0.0003	0.0101	0.9280	0.0003	0.3345	0.0003	0.6490	0.9998	0.0003	0.0003
3	public access	0.9993	0.0003	0.9998	0.0003	0.0003	0.9988	0.0003	0.0003	0.7413	0.0003	0.5076	0.9991	0.0003	0.0003
4	restricted access	0.9861	0.0003	0.0003	0.9998	0.0003	0.9998	0.0003	0.0003	0.9107	0.0003	0.1001	0.9998	0.0003	0.0003
5	exit only	0.0005	0.0003	0.0003	0.0018	0.9998	0.0003	0.8067	0.0003	0.2286	0.0003	0.1285	0.5621	0.0003	0.0003
6	*gives access to: air lock, vestibule or foyer*	0.9998	0.0003	0.0916	0.6768	0.0003	0.9998	0.0003	0.0003	0.2476	0.0003	0.7559	0.9998	0.0003	0.0003
7	*gives access to: corridor or aisle*	0.0042	0.0101	0.3118	0.0274	0.0003	0.0003	0.9998	0.0003	0.3509	0.0003	0.9173	0.9998	0.0003	0.0003
8	*gives access to: shop or working room*	0.8521	0.0003	0.0005	0.3807	0.0003	0.0005	0.0003	0.9998	0.9944	0.0003	0.0003	0.9998	0.0003	0.0003
9	aligned to the facade	0.9895	0.0003	0.0591	0.2679	0.0003	0.7884	0.0003	0.0003	0.9998	0.0003	0.0003	0.9998	0.0003	0.0003
10	pulled out from the facade	0.9666	0.0003	0.0003	0.8179	0.0003	0.9998	0.0003	0.0003	0.0071	0.9998	0.0013	0.9998	0.0003	0.0003
11	pulled in from the facade	0.9998	0.0003	0.7012	0.0318	0.0003	0.9998	0.0003	0.0003	0.0003	0.0003	0.9998	0.9949	0.0003	0.0003
12	*flat door top*	0.8536	0.0003	0.4441	0.1121	0.0003	0.9380	0.0003	0.0003	0.8558	0.0003	0.0435	0.9998	0.0003	0.0003
13	*semi-circular door top arch*	0.9983	0.0003	0.9480	0.0061	0.0003	0.9163	0.0003	0.0003	0.0049	0.0003	0.9886	0.0013	0.9998	0.0003
14	*segmental door top arch*	0.5098	0.0003	0.0003	0.9600	0.0003	0.0794	0.0003	0.0003	0.7273	0.0003	0.1736	0.0003	0.0003	0.0003
15	*pointed door top arch*	0.9998	0.0003	0.0076	0.0147	0.0003	0.9996	0.0003	0.0003	0.0003	0.0003	0.9996	0.0003	0.0003	0.0003
16	*round trefoil door top arch*	0.9998	0.0003	0.0101	0.4070	0.0003	0.9998	0.0003	0.0003	0.6607	0.0003	0.6670	0.0003	0.0003	0.0003
17	top flat moulding	0.9993	0.0003	0.0542	0.2876	0.0003	0.9998	0.0003	0.0003	0.0740	0.0003	0.2908	0.9998	0.0003	0.0003
18	top curved moulding	0.9717	0.0003	0.5359	0.0464	0.0003	0.8894	0.0003	0.0003	0.3365	0.0003	0.8604	0.9776	0.0003	0.0003
19	triangular pediment	0.9917	0.0003	0.9844	0.0611	0.0003	0.9998	0.0003	0.0003	0.1202	0.0003	0.2286	0.9998	0.0003	0.0003
20	semi-circular or segmental pediment	0.9998	0.0003	0.0538	0.5940	0.0003	0.9998	0.0003	0.0003	0.6468	0.0003	0.3404	0.9998	0.0003	0.0003
21	*squared fanlight*	0.9996	0.0003	0.0293	0.1314	0.0003	0.9998	0.0003	0.0003	0.0020	0.0003	0.9034	0.9998	0.0003	0.0003
22	*fanlight with undulate top*	0.9998	0.0003	0.0003	0.9998	0.0003	0.9998	0.0003	0.0003	0.9192	0.0003	0.0005	0.9998	0.0003	0.0003
23	*pointed arch fanlight*	0.9998	0.0003	0.9991	0.0005	0.0003	0.9998	0.0003	0.0003	0.0374	0.0003	0.3587	0.9998	0.0003	0.0003
24	*semi-circular or segmental arch fanlight*	0.9954	0.0003	0.8870	0.0162	0.0003	0.9996	0.0003	0.0003	0.9324	0.0003	0.1668	0.9998	0.0003	0.0003
25	pointed arch tympanum	0.9952	0.0003	0.9920	0.0066	0.0003	0.9932	0.0003	0.0003	0.9749	0.0003	0.1517	0.9903	0.0003	0.0003
26	semi-circular arch tympanum	0.9969	0.0022	0.0003	0.9595	0.0003	0.9888	0.0044	0.0003	0.0079	0.0003	0.6097	0.9998	0.0003	0.0003
27	*tracery or steelwork on fanlight or tympanum*	0.9998	0.0003	0.4087	0.0044	0.0003	0.9998	0.0003	0.0003	0.0022	0.0003	0.9966	0.9969	0.0003	0.0003
28	*stained glass on fanlight*	0.9964	0.0003	0.2061	0.7183	0.0003	0.9998	0.0003	0.0003	0.8765	0.0003	0.0935	0.9998	0.0003	0.0003
29	flat retangular porch	0.9793	0.0003	0.0159	0.3335	0.0003	0.9998	0.0003	0.0003	0.0149	0.0003	0.9637	0.9998	0.0003	0.0003
30	flat semi-circular porch	0.9998	0.0003	0.0022	0.3809	0.0003	0.9998	0.0003	0.0003	0.0003	0.0003	0.9988	0.9971	0.0003	0.0003
31	pediment porch	0.9998	0.0003	0.0010	0.9966	0.0003	0.0030	0.8985	0.0003	0.5264	0.0003	0.9695	0.9998	0.0003	0.0003
32	segmental (concave) porch	0.9178	0.0003	0.0003	0.9685	0.0003	0.4707	0.0003	0.0003	0.5474	0.0003	0.0181	0.9993	0.0003	0.0003
33	convex porch	0.9998	0.0003	0.9627	0.0035	0.0003	0.9998	0.0003	0.0003	0.9891	0.0003	0.0008	0.9974	0.0003	0.0003
34	*columns supporting porch*	0.9996	0.0003	0.0198	0.0643	0.0003	0.0074	0.0003	0.0003	0.0318	0.0003	0.8462	0.9996	0.0003	0.0003
35	*walls supporting porch*	0.9991	0.0003	0.1707	0.2278	0.0003	0.8057	0.0003	0.0003	0.0599	0.0003	0.9974	0.9998	0.0003	0.0003
36	*cables supporting porch*	0.9998	0.0003	0.0149	0.0525	0.0003	0.9998	0.0003	0.0003	0.7986	0.0003	0.0047	0.9998	0.0003	0.0003
37	lateral squared section column	0.9998	0.0003	0.2515	0.0562	0.0003	0.9998	0.0003	0.0003	0.9412	0.0003	0.0140	0.9996	0.0003	0.0003
38	lateral cylindrical section column	0.9998	0.0003	0.9988	0.0003	0.0003	0.9998	0.0003	0.0003	0.1394	0.0003	0.9461	0.7657	0.0003	0.0003
39	lateral vertical moulding	0.9998	0.0003	0.0586	0.8035	0.0003	0.9998	0.0003	0.0003	0.8528	0.0003	0.0645	0.9998	0.0003	0.0003
40	window in one side	0.0809	0.0003	0.0025	0.9085	0.0003	0.9998	0.0003	0.0003	0.7278	0.0003	0.5166	0.9998	0.0003	0.0003
41	windows in both sides	0.9998	0.0003	0.8748	0.0052	0.0003	0.9993	0.0003	0.0003	0.8194	0.0003	0.0220	0.9998	0.0003	0.0003
42	*vertical glass tower*	0.9681	0.0003	0.1531	0.2522	0.0003	0.9998	0.0003	0.0003	0.0818	0.0003	0.4358	0.9998	0.0003	0.0003
43	*angular connection with glass tower*	0.9998	0.0003	0.0066	0.1961	0.0008	0.9998	0.0003	0.0003	0.0003	0.0018	0.8255	0.9998	0.0003	0.0003
44	*decorative sculptures*	0.9886	0.0003	0.4068	0.0223	0.0003	0.9559	0.0003	0.0003	0.0884	0.0003	0.8106	0.9996	0.0003	0.0003
45	Surroundings material: glass	0.9937	0.0003	0.1946	0.1905	0.0003	0.9998	0.0003	0.0003	0.1949	0.0003	0.8760	0.9998	0.0003	0.0003
46	Surroundings material: brick	0.9903	0.0003	0.0013	0.8890	0.0003	0.9993	0.0003	0.0003	0.3565	0.0003	0.1499	0.9998	0.0003	0.0003
47	Surroundings material: smooth stone	0.9664	0.0003	0.9314	0.0313	0.0003	0.8619	0.0003	0.0003	0.8448	0.0003	0.3995	0.9998	0.0003	0.0003
48	Surroundings material: rough stone	0.8570	0.0003	0.0979	0.0874	0.0003	0.1883	0.0003	0.0003	0.9998	0.0003	0.0003	0.0003	0.0003	0.0003
49	Surroundings material: concrete blocks	0.9998	0.0003	0.0069	0.9373	0.0003	0.9981	0.0003	0.0003	0.1329	0.0003	0.9275	0.9998	0.0003	0.0003
50	Surroundings material: concrete exposed	0.6783	0.0003	0.3699	0.1722	0.0003	0.9988	0.0003	0.0003	0.9134	0.0003	0.0149	0.9998	0.0003	0.0003
51	Surroundings material: timber	0.9649	0.0003	0.6170	0.0745	0.0003	0.3013	0.0003	0.0003	0.8045	0.0003	0.3216	0.9998	0.0003	0.0003
52	Surroundings material: smooth plasterwork	0.9996	0.0003	0.0003	0.8665	0.0003	0.9581	0.0003	0.0003	0.8384	0.0003	0.0142	0.9998	0.0003	0.0003
53	Surroundings material: rusticated plasterwork	0.9776	0.0003	0.0003	0.2864	0.0003	0.9988	0.0003	0.0003	0.0347	0.0003	0.9842	0.7942	0.0003	0.0003
54	Surroundings materials: tiles or small tiles	0.9998	0.0003	0.8536	0.0096	0.0003	0.9998	0.0003	0.0003	0.9751	0.0003	0.0008	0.9983	0.0003	0.0003
55	Surroundings material: metal	0.9996	0.0003	0.0064	0.6233	0.0003	0.9463	0.0003	0.0003	0.3628	0.0003	0.6089	0.9998	0.0003	0.0003
56	*swinging door: one single*	0.9998	0.0003	0.0010	0.9380	0.0003	0.9996	0.0003	0.0003	0.8899	0.0003	0.3389	0.9998	0.0003	0.0003
57	*swinging door: two singles*	0.9998	0.0003	0.0144	0.1253	0.0003	0.9998	0.0003	0.0003	0.0184	0.0003	0.9891	0.9764	0.0003	0.0003
58	*swinging door: one double*	0.9903	0.0003	0.4576	0.0743	0.0003	0.9996	0.0003	0.0003	0.5845	0.0003	0.0147	0.9998	0.0003	0.0003
59	*swinging door: triple, two doubles or more*	0.9998	0.0003	0.9998	0.0003	0.0003	0.9998	0.0003	0.0003	0.0279	0.0003	0.9959	0.9998	0.0003	0.0003
60	*revolving door (with four leaves)*	0.9998	0.0003	0.9983	0.0032	0.0003	0.9998	0.0003	0.0003	0.0005	0.0003	0.9998	0.9998	0.0003	0.0003
61	*sliding door (one or more leaves)*	0.0130	0.9988	0.0003	0.9998	0.0003	0.9998	0.1509	0.0003	0.0030	0.0003	0.9974	0.9998	0.0003	0.0003
62	leaf: plain opaque	0.9998	0.0003	0.0066	0.0755	0.0003	0.9998	0.0003	0.0003	0.0003	0.0003	0.9993	0.9991	0.0003	0.0003
63	leaf: plain transparent	0.9883	0.0003	0.8914	0.0037	0.0003	0.9998	0.0003	0.0003	0.0357	0.0003	0.9537	0.9998	0.0003	0.0003
64	leaf: semi-opaque plain with one or more light cross panels	0.9998	0.0003	0.0039	0.7754	0.0003	0.9998	0.0003	0.0003	0.9139	0.0003	0.0708	0.9917	0.0003	0.0003
65	leaf: paneled opaque	0.9998	0.0003	0.1407	0.0914	0.0003	0.9978	0.0003	0.0003	0.9468	0.0003	0.0037	0.9998	0.0003	0.0003
66	leaf: paneled semi-opaque with one or more light cross panels	0.9292	0.0003	0.1446	0.5957	0.0003	0.9998	0.0003	0.0003	0.9783	0.0003	0.0633	0.9998	0.0003	0.0003
67	leaf: framed with one or two light cross panels	0.9969	0.0003	0.6739	0.0279	0.0003	0.9471	0.0003	0.0003	0.0564	0.0003	0.9234	0.9998	0.0003	0.0003
68	leaf: framed with three or more light cross panels	0.9998	0.0003	0.0003	0.6961	0.0003	0.9886	0.0003	0.0003	0.0318	0.0003	0.2493	0.9998	0.0003	0.0003
69	*steelwork leaf decoration*	0.9837	0.0003	0.0003	0.8909	0.0003	0.9998	0.0003	0.0003	0.9839	0.0003	0.1414	0.0376	0.0003	0.0003
70	leaf mat.: non-stained glass	0.7654	0.0003	0.9842	0.0088	0.0003	0.9590	0.0003	0.0003	0.6265	0.0003	0.2664	0.9998	0.0003	0.0003
71	leaf mat.: stained glass	0.9998	0.0003	0.0003	0.9991	0.0003	0.9998	0.0003	0.0003	0.9954	0.0003	0.0003	0.9998	0.0003	0.0003
72	leaf mat.: metal	0.9998	0.0003	0.0396	0.4983	0.0003	0.9998	0.0003	0.0003	0.6282	0.0003	0.1050	0.9998	0.0003	0.0003
73	leaf mat.: timber	0.8819	0.0003	0.7164	0.0430	0.0003	0.9776	0.0003	0.0003	0.3665	0.0003	0.9002	0.9998	0.0003	0.0003
74	*round knob or ring handle*	0.9808	0.0003	0.2613	0.2278	0.0003	0.9974	0.0003	0.0003	0.9817	0.0003	0.1519	0.9248	0.0003	0.0003
75	*retangular, squared or trapezoid handle*	0.9998	0.0003	0.0184	0.1460	0.0003	0.9998	0.0003	0.0003	0.6641	0.0003	0.2464	0.9998	0.0003	0.0003
76	*lever handle*	0.9944	0.0003	0.0008	0.8235	0.0003	0.9993	0.0003	0.0003	0.9380	0.0003	0.0271	0.9998	0.0003	0.0003
77	*long horizontal static handle*	0.9864	0.0003	0.0013	0.0184	0.0003	0.9969	0.0003	0.0003	0.0003	0.0003	0.9996	0.3899	0.0003	0.0003
78	*long vertical static handle*	0.9998	0.0003	0.8016	0.0039	0.0003	0.9998	0.0003	0.0003	0.1114	0.0003	0.0679	0.9998	0.0003	0.0003
79	*short vertical static handle*	0.8072	0.0003	0.0020	0.7088	0.0003	0.9998	0.0003	0.0003	0.2386	0.0003	0.1206	0.9998	0.0003	0.0003
80	*curved static handle*	0.9869	0.0003	0.1629	0.0359	0.0003	0.9998	0.0003	0.0003	0.4776	0.0003	0.0938	0.9998	0.0003	0.0003

Levels of support of each output unit >>

<< Active Input unit	Levels of support of each output unit >>	15 *pointed door top arch*	16 *round trefoil door top arch*	17 top flat moulding	18 top curved moulding	19 triangular pediment	20 semi-circular or segmental pediment	21 *squared fanlight*	22 *fanlight with undulate top*	23 *pointed arch fanlight*	24 *semi-circular or segmental arch fanlight*	25 pointed arch tympanum	26 semi-circular arch tympanum	27 *tracery or steelwork on fanlight or tympanum*	28 *stained glass on fanlight*
1	*main entrance*	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0686	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
2	*secondary entrance*	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0091	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
3	public access	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.1014	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
4	restricted access	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0159	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
5	exit only	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.2830	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
6	*gives access to: air lock, vestibule or foyer*	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.1744	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
7	*gives access to: corridor or aisle*	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0581	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
8	*gives access to: shop or working room*	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0201	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
9	aligned to the facade	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.5579	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
10	pulled out from the facade	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0201	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
11	pulled in from the facade	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0384	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
12	*flat door top*	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.1936	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
13	*semi-circular door top arch*	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0010	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
14	*segmental door top arch*	0.0003	0.0003	0.0003	0.2190	0.0003	0.0003	0.0076	0.0003	0.0003	0.0003	0.0003	0.5249	0.0003	0.0003
15	*pointed door top arch*	0.0027	0.0003	0.0003	0.0008	0.0003	0.0003	0.0020	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
16	*round trefoil door top arch*	0.0003	0.9998	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
17	top flat moulding	0.0003	0.0003	0.9986	0.0003	0.0003	0.0003	0.5252	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
18	top curved moulding	0.0003	0.0003	0.0003	0.8777	0.0003	0.0003	0.0130	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
19	triangular pediment	0.0003	0.0003	0.9991	0.0003	0.9998	0.0003	0.7049	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
20	semi-circular or segmental pediment	0.0003	0.0003	0.0003	0.0003	0.0003	0.7952	0.9427	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
21	*squared fanlight*	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.9998	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
22	*fanlight with undulate top*	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
23	*pointed arch fanlight*	0.0003	0.0003	0.0010	0.0003	0.0003	0.0003	0.0225	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
24	*semi-circular or segmental arch fanlight*	0.0003	0.0003	0.0022	0.0005	0.0003	0.0003	0.0005	0.0003	0.0003	0.9998	0.0003	0.0003	0.0003	0.0003
25	pointed arch tympanum	0.0003	0.0003	0.0003	0.0254	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0086	0.0003	0.0003	0.0003
26	semi-circular arch tympanum	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0291	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
27	*tracery or steelwork on fanlight or tympanum*	0.0003	0.0003	0.0003	0.0267	0.0003	0.0003	0.0198	0.0003	0.0003	0.0003	0.0003	0.0003	0.9998	0.0003
28	*stained glass on fanlight*	0.0003	0.0003	0.1341	0.0003	0.0003	0.0003	0.5074	0.0003	0.0003	0.0003	0.0003	0.0003	0.0025	0.0003
29	flat retangular porch	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.4378	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
30	flat semi-circular porch	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.1021	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
31	pediment porch	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0049	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
32	segmental (concave) porch	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0047	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
33	convex porch	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.1043	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
34	*columns supporting porch*	0.0003	0.0003	0.0005	0.0003	0.0003	0.0003	0.0852	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
35	*walls supporting porch*	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.8328	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
36	*cables supporting porch*	0.0003	0.0003	0.0008	0.0003	0.0003	0.0003	0.9573	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
37	lateral squared section column	0.0003	0.0003	0.0223	0.0003	0.0003	0.0003	0.5247	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
38	lateral cylindrical section column	0.0003	0.0003	0.2552	0.0035	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
39	lateral vertical moulding	0.0003	0.0003	0.0003	0.0137	0.0003	0.0003	0.0059	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
40	window in one side	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0188	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
41	windows in both sides	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.4258	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
42	*vertical glass tower*	0.0003	0.0003	0.0005	0.0003	0.0003	0.0003	0.0889	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
43	*angular connection with glass tower*	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0157	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
44	*decorative sculptures*	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.2918	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
45	Surroundings material: glass	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.4458	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
46	Surroundings material: brick	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.1795	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
47	Surroundings material: smooth stone	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.1692	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
48	Surroundings material: rough stone	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0752	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
49	Surroundings material: concrete blocks	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.6390	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
50	Surroundings material: concrete exposed	0.0003	0.0003	0.0005	0.0003	0.0003	0.0003	0.1543	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
51	Surroundings material: timber	0.0003	0.0003	0.0284	0.0003	0.0003	0.0003	0.6077	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
52	Surroundings material: smooth plasterwork	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.1497	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
53	Surroundings material: rusticated plasterwork	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0101	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
54	Surroundings materials: tiles or small tiles	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.1912	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
55	Surroundings material: metal	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0186	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
56	*swinging door: one single*	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.1809	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
57	*swinging door: two singles*	0.0003	0.0003	0.0008	0.0003	0.0003	0.0003	0.0098	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
58	*swinging door: one double*	0.0003	0.0003	0.0008	0.0003	0.0003	0.0003	0.0452	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
59	*swinging door: triple, two doubles or more*	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0464	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
60	*revolving door (with four leaves)*	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0601	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
61	*sliding door (one or more leaves)*	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0015	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
62	leaf: plain opaque	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0088	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
63	leaf: plain transparent	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.6963	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
64	leaf: semi-opaque plain with one or more light cross panels	0.0003	0.0003	0.0003	0.0008	0.0003	0.0003	0.0393	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
65	leaf: paneled opaque	0.0003	0.0003	0.0022	0.0003	0.0003	0.0003	0.0020	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
66	leaf: paneled semi-opaque with one or more light cross panels	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.3977	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
67	leaf: framed with one or two light cross panels	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0064	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
68	leaf: framed with three or more light cross panels	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.1585	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
69	*steelwork leaf decoration*	0.0003	0.0003	0.0022	0.0115	0.0003	0.0003	0.0088	0.0003	0.0003	0.0003	0.0003	0.0003	0.0066	0.0003
70	leaf mat.: non-stained glass	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.1018	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
71	leaf mat.: stained glass	0.0003	0.0003	0.0413	0.0003	0.0003	0.0003	0.9424	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
72	leaf mat.: metal	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0704	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
73	leaf mat.: timber	0.0003	0.0003	0.0181	0.0003	0.0003	0.0003	0.1563	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
74	*round knob or ring handle*	0.0003	0.0003	0.0208	0.0003	0.0003	0.0003	0.0032	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
75	*retangular, squared or trapezoid handle*	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0538	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
76	*lever handle*	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0079	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
77	*long horizontal static handle*	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.6763	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
78	*long vertical static handle*	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.8836	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
79	*short vertical static handle*	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0245	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
80	*curved static handle*	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0035	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003

<< Active input unit	Levels of support of each output unit >>	29	30	31	32	33	34	35	36	37	38	39	40	41	42
		flat retangular porch	flat semi-circular porch	pediment porch	segmental (concave) porch	convex porch	***columns supporting porch***	***walls supporting porch***	***cables supporting porch***	lateral squared section column	lateral cylindrical section column	lateral vertical moulding	window in one side	windows in both sides	***vertical glass tower***
1	***main entrance***	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0020	0.0003	0.0520	0.0003
2	***secondary entrance***	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0113	0.0003
3	public access	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0542	0.0003
4	restricted access	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0064	0.0003	0.0018	0.0003
5	exit only	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0684	0.0003
6	***gives access to: air lock, vestibule or foyer***	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0018	0.0003	0.0018	0.0003
7	***gives access to: corridor or aisle***	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0022	0.0003
8	***gives access to: shop or working room***	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0044	0.0003	0.2610	0.0003
9	aligned to the facade	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0342	0.0003
10	pulled out from the facade	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.1739	0.0003
11	pulled in from the facade	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0066	0.0003
12	***flat door top***	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0179	0.0003
13	***semi-circular door top arch***	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0071	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
14	***segmental door top arch***	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.9856	0.0003	0.2554	0.0003
15	***pointed door top arch***	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.4913	0.0003	0.0022	0.0003
16	***round trefoil door top arch***	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0030	0.0003	0.0003	0.0003	0.0003
17	top flat moulding	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0184	0.0003	0.0201	0.0003
18	top curved moulding	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.5472	0.0003	0.0081	0.0003
19	triangular pediment	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.3831	0.0003	0.2618	0.0003
20	semi-circular or segmental pediment	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0008	0.0003	0.0003	0.0003	0.0005	0.0003
21	***squared fanlight***	0.0232	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0384	0.0003
22	***fanlight with undulate top***	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.1585	0.0003	0.0147	0.0003
23	***pointed arch fanlight***	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.3326	0.0003
24	***semi-circular or segmental arch fanlight***	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0208	0.0003
25	pointed arch tympanum	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0125	0.0003	0.0005	0.0003
26	semi-circular arch tympanum	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0162	0.0003	0.0005	0.0003
27	***tracery or steelwork on fanlight or tympanum***	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0301	0.0003	0.0271	0.0003
28	***stained glass on fanlight***	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0061	0.0003	0.0193	0.0003
29	flat retangular porch	0.9998	0.0003	0.0003	0.0003	0.0003	0.0003	0.1434	0.0003	0.0003	0.0003	0.0003	0.0005	0.0049	0.0003
30	flat semi-circular porch	0.0003	0.3914	0.0003	0.0003	0.0003	0.1280	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.1060	0.0003
31	pediment porch	0.0003	0.0003	0.9998	0.0003	0.0003	0.9991	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0005	0.0003
32	segmental (concave) porch	0.0003	0.0003	0.0003	0.9998	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0010	0.0003
33	convex porch	0.0003	0.0003	0.0003	0.0003	0.9988	0.0003	0.0003	0.9998	0.0003	0.0003	0.0003	0.0003	0.0013	0.0003
34	***columns supporting porch***	0.0203	0.0003	0.0003	0.0003	0.0003	0.9998	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.5555	0.0003
35	***walls supporting porch***	0.9939	0.0003	0.0003	0.0003	0.0003	0.0003	0.9998	0.0003	0.0003	0.0003	0.0003	0.0005	0.1001	0.0003
36	***cables supporting porch***	0.8035	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.9998	0.0003	0.0003	0.0005	0.0003	0.1228	0.0003
37	lateral squared section column	0.0005	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0069	0.9998	0.0003	0.0003	0.0003	0.0210	0.0003
38	lateral cylindrical section column	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.9974	0.0059	0.0003	0.0127	0.0003
39	lateral vertical moulding	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.9998	0.0003	0.0171	0.0003
40	window in one side	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.9998	0.0003	0.0003
41	windows in both sides	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0008	0.0003	0.9996	0.0003
42	***vertical glass tower***	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0027	0.0088	0.9998
43	***angular connection with glass tower***	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0015	0.5393	0.0003
44	***decorative sculptures***	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.9856	0.0003	0.4117	0.0003
45	Surroundings material: glass	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0127	0.0003	0.2684	0.0003
46	Surroundings material: brick	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0093	0.0003
47	Surroundings material: smooth stone	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0074	0.0003	0.0018	0.0003
48	Surroundings material: rough stone	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0039	0.0003
49	Surroundings material: concrete blocks	0.2957	0.0003	0.0003	0.0003	0.0003	0.0003	0.9756	0.0003	0.0003	0.0003	0.0003	0.0003	0.3931	0.0003
50	Surroundings material: concrete exposed	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0064	0.0003	0.0003	0.0003	0.0374	0.0003
51	Surroundings material: timber	0.0003	0.0003	0.0003	0.0003	0.0003	0.0010	0.0003	0.0003	0.0003	0.0003	0.0003	0.0281	0.0210	0.0003
52	Surroundings material: smooth plasterwork	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0057	0.0003	0.0005	0.0003
53	Surroundings material: rusticated plasterwork	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.5740	0.0003	0.0003	0.0003	0.0003	0.1817	0.2200	0.0003
54	Surroundings materials: tiles or small tiles	0.0003	0.0003	0.0003	0.0003	0.9935	0.0003	0.0003	0.9998	0.0003	0.0003	0.0003	0.0003	0.0015	0.0003
55	Surroundings material: metal	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.2627	0.0003
56	***swinging door: one single***	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0010	0.0003	0.0047	0.0003
57	***swinging door: two singles***	0.3435	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.4397	0.0003	0.0018	0.0003
58	***swinging door: one double***	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0035	0.0003
59	***swinging door: triple, two doubles or more***	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0848	0.0003
60	***revolving door (with four leaves)***	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0091	0.0003	0.2432	0.0003
61	***sliding door (one or more leaves)***	0.0252	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0025	0.0003	0.0030	0.0035
62	leaf: plain opaque	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0005	0.0003	0.0137	0.0003	0.0003	0.0003
63	leaf: plain transparent	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0928	0.0003
64	leaf: semi-opaque plain with one or more light cross panels	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0318	0.0003	0.0069	0.0003
65	leaf: paneled opaque	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0599	0.0003	0.0022	0.0003
66	leaf: paneled semi-opaque with one or more light cross panels	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0005	0.0003	0.0047	0.0003
67	leaf: framed with one or two light cross panels	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0132	0.0003
68	leaf: framed with three or more light cross panels	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0804	0.0003
69	***steelwork leaf decoration***	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.7488	0.0003	0.2251	0.0003
70	leaf mat.: non-stained glass	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0608	0.0003
71	leaf mat.: stained glass	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.3936	0.0003	0.0350	0.0003
72	leaf mat.: metal	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0252	0.0003
73	leaf mat.: timber	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0005	0.0003	0.0025	0.0003
74	***round knob or ring handle***	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0008	0.0003
75	***retangular, squared or trapezoid handle***	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0010	0.0342	0.0003
76	***lever handle***	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.1080	0.0003
77	***long horizontal static handle***	0.0164	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0289	0.0003
78	***long vertical static handle***	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0018	0.4026	0.0003
79	***short vertical static handle***	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0005	0.0003	0.0081	0.0003
80	***curved static handle***	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0254	0.0003

<< Active input unit	Levels of support of each output unit >>	43 *angular connection with glass tower*	44 *decorative sculptures*	45 Surroundings material: glass	46 Surroundings material: brick	47 Surroundings material: smooth stone	48 Surroundings material: rough stone	49 Surroundings material: concrete blocks	50 Surroundings material: concrete exposed	51 Surroundings material: timber	52 Surroundings material: smooth plasterwork	53 Surroundings material: rusticatec plasterwork	54 Surroundings materials: tiles or small tiles	55 Surroundings material: metal	56 *swinging door: one single*
1	*main entrance*	0.0003	0.0003	0.4092	0.0013	0.0716	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0061	0.0147
2	*secondary entrance*	0.0003	0.0003	0.0445	0.0003	0.3152	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0171	0.0015
3	public access	0.0003	0.0003	0.1914	0.0003	0.1133	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0032	0.0003
4	restricted access	0.0003	0.0003	0.4183	0.0862	0.0037	0.0003	0.0003	0.0003	0.0003	0.0018	0.0003	0.0003	0.0669	0.0498
5	exit only	0.0003	0.0003	0.0303	0.0164	0.0098	0.9876	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0013	0.9158
6	*gives access to: air lock, vestibule or foyer*	0.0003	0.0003	0.2322	0.0003	0.0303	0.0003	0.0003	0.0003	0.0003	0.0027	0.0003	0.0003	0.0010	0.0276
7	*gives access to: corridor or aisle*	0.0003	0.0003	0.2732	0.0047	0.0350	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0364	0.3611
8	*gives access to: shop or working room*	0.0003	0.0003	0.0398	0.0003	0.8589	0.0003	0.0003	0.0003	0.0003	0.0015	0.0003	0.0003	0.0906	0.0003
9	aligned to the facade	0.0003	0.0003	0.6944	0.0003	0.0315	0.0003	0.0003	0.0003	0.0003	0.0015	0.0003	0.0003	0.0352	0.0599
10	pulled out from the facade	0.0003	0.0003	0.0008	0.9537	0.0003	0.0003	0.0003	0.0003	0.0003	0.0018	0.0003	0.0003	0.0818	0.0039
11	pulled in from the facade	0.0003	0.0003	0.1773	0.0115	0.0201	0.0003	0.0003	0.0003	0.0003	0.0008	0.0003	0.0003	0.0108	0.0201
12	*flat door top*	0.0003	0.0003	0.9397	0.0037	0.0101	0.0003	0.0003	0.0003	0.0003	0.0030	0.0003	0.0003	0.0032	0.0455
13	*semi-circular door top arch*	0.0003	0.0003	0.0022	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0057	0.0003	0.0003	0.0003	0.0003
14	*segmental door top arch*	0.0003	0.0003	0.0079	0.2063	0.5816	0.3811	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.1502	0.0003
15	*pointed door top arch*	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0005	0.0003	0.0003	0.0005	0.0003
16	*round trefoil door top arch*	0.0003	0.0003	0.0008	0.0008	0.3243	0.0032	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0169	0.1768
17	top flat moulding	0.0003	0.0003	0.4895	0.0003	0.4893	0.0003	0.0003	0.0003	0.0003	0.0066	0.0003	0.0003	0.0005	0.0003
18	top curved moulding	0.0003	0.0003	0.0401	0.0003	0.1177	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0022	0.0064
19	triangular pediment	0.0003	0.0008	0.0279	0.0003	0.9158	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
20	semi-circular or segmental pediment	0.0003	0.0003	0.9986	0.0003	0.8540	0.0003	0.0003	0.0003	0.0003	0.0039	0.0003	0.0003	0.0057	0.0003
21	*squared fanlight*	0.0003	0.0003	0.9268	0.0083	0.0835	0.0003	0.0003	0.0003	0.0003	0.0086	0.0003	0.0003	0.0044	0.0418
22	*fanlight with undulate top*	0.0003	0.0003	0.9632	0.9859	0.0025	0.0003	0.0003	0.0003	0.0003	0.1048	0.0003	0.0003	0.9837	0.0005
23	*pointed arch fanlight*	0.0003	0.0003	0.9998	0.0015	0.0408	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.3533
24	*semi-circular or segmental arch fanlight*	0.0003	0.0003	0.9942	0.0003	0.0010	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.2317	0.1490
25	pointed arch tympanum	0.0003	0.0003	0.0003	0.0003	0.9312	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
26	semi-circular arch tympanum	0.0003	0.0003	0.0037	0.0745	0.0025	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
27	*tracery or steelwork on fanlight or tympanum*	0.0003	0.0003	0.9778	0.0008	0.4598	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0879	0.0257
28	*stained glass on fanlight*	0.0003	0.0003	0.6372	0.0003	0.2759	0.0003	0.0003	0.0003	0.1995	0.0042	0.0003	0.0003	0.0052	0.4395
29	flat retangular porch	0.0003	0.0003	0.6509	0.2376	0.1065	0.0003	0.0003	0.0003	0.0003	0.0489	0.0003	0.0003	0.4622	0.0003
30	flat semi-circular porch	0.0003	0.0003	0.6980	0.0481	0.9217	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0044	0.0005
31	pediment porch	0.0003	0.0003	0.0015	0.6631	0.0545	0.0003	0.0003	0.0003	0.1983	0.0044	0.0003	0.0003	0.4178	0.9998
32	segmental (concave) porch	0.0003	0.0003	0.6560	0.0594	0.0003	0.0003	0.0003	0.0003	0.0003	0.2674	0.0003	0.0003	0.0821	0.0047
33	convex porch	0.0003	0.0003	0.0025	0.0003	0.0220	0.0003	0.0003	0.0003	0.0003	0.9212	0.0003	0.7752	0.9707	0.0003
34	*columns supporting porch*	0.0003	0.0003	0.0122	0.0337	0.0162	0.0003	0.0003	0.0003	0.0079	0.0083	0.0003	0.0003	0.0201	0.0320
35	*walls supporting porch*	0.0003	0.0003	0.6526	0.0047	0.0440	0.0003	0.0003	0.0003	0.0020	0.0191	0.0003	0.0003	0.0411	0.0032
36	*cables supporting porch*	0.0003	0.0003	0.0174	0.5635	0.0162	0.0003	0.0003	0.0003	0.0003	0.0132	0.0003	0.0027	0.0022	0.0003
37	lateral squared section column	0.0003	0.0003	0.1192	0.0037	0.0472	0.0003	0.0003	0.0015	0.0503	0.0391	0.0003	0.0003	0.0010	0.0003
38	lateral cylindrical section column	0.0003	0.0003	0.0066	0.0003	0.0406	0.0003	0.0003	0.0003	0.0003	0.0025	0.0003	0.0003	0.0044	0.0210
39	lateral vertical moulding	0.0003	0.0003	0.0630	0.0003	0.2510	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0220
40	window in one side	0.0003	0.0003	0.6434	0.0005	0.0660	0.0003	0.0003	0.0003	0.0003	0.0144	0.0003	0.0003	0.0144	0.0010
41	windows in both sides	0.0003	0.0003	0.9956	0.0027	0.0061	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.1507	0.0982
42	*vertical glass tower*	0.0003	0.0003	0.8362	0.2347	0.1075	0.0003	0.0003	0.0003	0.0003	0.0013	0.0003	0.0003	0.9229	0.0005
43	*angular connection with glass tower*	0.9346	0.0003	0.9949	0.0057	0.5823	0.0003	0.0003	0.0003	0.0003	0.0193	0.0003	0.0003	0.9490	0.0005
44	*decorative sculptures*	0.0003	0.9991	0.9253	0.0498	0.1936	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.2205	0.0113
45	Surroundings material: glass	0.0003	0.0003	0.9991	0.0103	0.0396	0.0003	0.0003	0.0003	0.0003	0.0018	0.0003	0.0003	0.0691	0.0623
46	Surroundings material: brick	0.0003	0.0003	0.1053	0.9986	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0237	0.0039
47	Surroundings material: smooth stone	0.0003	0.0003	0.8140	0.0003	0.9998	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0027	0.0003
48	Surroundings material: rough stone	0.0003	0.0003	0.0008	0.0010	0.0005	0.9998	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.9283
49	Surroundings material: concrete blocks	0.0003	0.0003	0.9893	0.0003	0.0030	0.0003	0.9229	0.0003	0.0181	0.0003	0.5577	0.0003	0.0057	0.0315
50	Surroundings material: concrete exposed	0.0003	0.0003	0.0987	0.0015	0.0003	0.0003	0.0003	0.9998	0.0135	0.0003	0.0003	0.0003	0.0003	0.0003
51	Surroundings material: timber	0.0003	0.0003	0.9414	0.0108	0.0039	0.0003	0.0003	0.0003	0.9998	0.0030	0.0003	0.0003	0.0003	0.0054
52	Surroundings material: smooth plasterwork	0.0003	0.0003	0.1622	0.0003	0.0013	0.0003	0.0003	0.0003	0.0003	0.9981	0.0003	0.0003	0.0838	0.0350
53	Surroundings material: rusticated plasterwork	0.0003	0.0003	0.3006	0.0003	0.0005	0.0003	0.0003	0.0003	0.0003	0.0054	0.9998	0.0003	0.0777	0.0830
54	Surroundings materials: tiles or small tiles	0.0003	0.0003	0.0042	0.0003	0.1814	0.0003	0.0003	0.0003	0.0003	0.9065	0.0003	0.8975	0.9783	0.0003
55	Surroundings material: metal	0.0003	0.0003	0.9676	0.0486	0.0154	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.9998	0.4720
56	*swinging door: one single*	0.0003	0.0003	0.3294	0.0010	0.0110	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0039	0.9998
57	*swinging door: two singles*	0.0003	0.0003	0.1646	0.0003	0.7259	0.0003	0.0003	0.0003	0.0003	0.0025	0.0003	0.0003	0.0010	0.0003
58	*swinging door: one double*	0.0003	0.0003	0.0354	0.0013	0.0201	0.0003	0.0003	0.0003	0.0083	0.0079	0.0003	0.0003	0.0105	0.0003
59	*swinging door: triple, two doubles or more*	0.0003	0.0003	0.7603	0.0003	0.2000	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
60	*revolving door (with four leaves)*	0.0003	0.0003	0.8765	0.0003	0.6792	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0005	0.0220
61	*sliding door (one or more leaves)*	0.0003	0.0003	0.9104	0.6409	0.0235	0.0003	0.0003	0.0044	0.0003	0.0025	0.0003	0.0003	0.7539	0.0201
62	leaf: plain opaque	0.0003	0.0003	0.2879	0.0108	0.0049	0.0003	0.0003	0.0003	0.0003	0.9666	0.0003	0.0003	0.0008	0.0003
63	leaf: plain transparent	0.0003	0.0003	0.8750	0.0655	0.2881	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.4947
64	leaf: semi-opaque plain with one or more light cross panels	0.0003	0.0003	0.0730	0.1263	0.8484	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.1409	0.5918
65	leaf: paneled opaque	0.0003	0.0003	0.0027	0.0003	0.0130	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
66	leaf: paneled semi-opaque with one or more light cross panels	0.0003	0.0003	0.6802	0.0005	0.0686	0.0003	0.0003	0.0003	0.2713	0.0003	0.0003	0.0003	0.1875	0.1326
67	leaf: framed with one or two light cross panels	0.0003	0.0003	0.7681	0.0003	0.0035	0.0003	0.0003	0.0003	0.0003	0.0008	0.0003	0.0003	0.1045	0.0005
68	leaf: framed with three or more light cross panels	0.0003	0.0003	0.1175	0.3465	0.0008	0.0003	0.0003	0.0003	0.0003	0.0005	0.0003	0.0003	0.0916	0.0342
69	*steelwork leaf decoration*	0.0003	0.0003	0.0979	0.0044	0.6612	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.9693	0.0003
70	leaf mat.: non-stained glass	0.0003	0.0003	0.5310	0.0003	0.2264	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0362	0.0115
71	leaf mat.: stained glass	0.0003	0.0020	0.6731	0.0003	0.0130	0.0003	0.0003	0.0003	0.0618	0.1575	0.0003	0.0003	0.1048	0.8487
72	leaf mat.: metal	0.0003	0.0003	0.3907	0.0005	0.0054	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0821	0.0025
73	leaf mat.: timber	0.0003	0.0003	0.0686	0.0003	0.0350	0.0003	0.0003	0.0003	0.9275	0.0059	0.0003	0.0003	0.0003	0.0025
74	*round knob or ring handle*	0.0003	0.0003	0.0650	0.0003	0.2271	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
75	*retangular, squared or trapezoid handle*	0.0003	0.0003	0.7959	0.1675	0.0008	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0552	0.0008
76	*lever handle*	0.0003	0.0003	0.9366	0.8909	0.0325	0.0003	0.0003	0.0003	0.0003	0.0005	0.0003	0.0003	0.9283	0.8843
77	*long horizontal static handle*	0.0003	0.0003	0.4488	0.0061	0.0091	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0025	0.0003
78	*long vertical static handle*	0.0003	0.0003	0.8428	0.0003	0.0201	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0081	0.0003
79	*short vertical static handle*	0.0003	0.0003	0.6346	0.0433	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0257	0.7771
80	*curved static handle*	0.0003	0.0003	0.0242	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003

Levels of support of each output unit >>

<< Active input unit

		57	58	59	60	61	62	63	64	65	66	67	68	69	70
		swinging door: two singles	*swinging door: one double*	*swinging door: triple, two doubles or more*	*revolving door (with four leaves)*	*sliding door (one or more leaves)*	leaf: plain opaque	leaf: plain transparent	leaf: semi-opaque plain with one or more light cross panels	leaf: paneled opaque	leaf: paneled semi-opaque with one or more light cross panels	leaf: framed with one or two ligh cross panels	leaf: framed with three or more light cross panels	*steelwork leaf decoration*	leaf mat.: non-stained glass
1	*main entrance*	0.0003	0.0130	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0501
2	*secondary entrance*	0.0003	0.7549	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0015	0.0003	0.0003	0.0003	0.9998
3	public access	0.0003	0.5320	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0008	0.0003	0.0003	0.0003	0.9270
4	restricted access	0.0003	0.0310	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.2320
5	exit only	0.0003	0.0044	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.6053	0.0003	0.0003	0.0022	0.0003	0.0003
6	*gives access to: air lock, vestibule or foyer*	0.0003	0.0098	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0005	0.0003	0.0003	0.0003	0.6351
7	*gives access to: corridor or aisle*	0.0003	0.1128	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.9703
8	*gives access to: shop or working room*	0.0003	0.9966	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0013	0.1543	0.3977
9	aligned to the facade	0.0003	0.2437	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.1631
10	pulled out from the facade	0.0003	0.8902	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.9800	0.0003	0.5271
11	pulled in from the facade	0.0003	0.0162	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.5892
12	*flat door top*	0.0003	0.0332	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0027	0.0003	0.9737
13	*semi-circular door top arch*	0.0003	0.4512	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0005	0.0003	0.0003	0.0003	0.8665
14	*segmental door top arch*	0.0003	0.9808	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0076	0.0003	0.0003	0.0003	0.0008	0.1365
15	*pointed door top arch*	0.0003	0.9910	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0008	0.0003	0.0003	0.0003	0.0003	0.0003
16	*round trefoil door top arch*	0.0003	0.0354	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.7615	0.0003	0.0003	0.0003	0.0003	0.0008
17	top flat moulding	0.0003	0.0298	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.1333
18	top curved moulding	0.0003	0.7002	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0213	0.0003	0.0003	0.0003	0.0003	0.1590
19	triangular pediment	0.0003	0.9832	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0066	0.0037	0.0003	0.0003	0.0003	0.0708
20	semi-circular or segmental pediment	0.0003	0.8775	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.2002	0.0003	0.0003	0.0003	0.0003	0.0035
21	*squared fanlight*	0.0003	0.0166	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0015	0.0003	0.4580
22	*fanlight with undulate top*	0.0003	0.8081	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.7037
23	*pointed arch fanlight*	0.0003	0.0037	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.9983
24	*semi-circular or segmental arch fanlight*	0.0003	0.7767	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.9722
25	pointed arch tympanum	0.0003	0.4678	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.2681	0.0003	0.0003	0.0003	0.1277
26	semi-circular arch tympanum	0.0003	0.9996	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.4060	0.0003	0.0003	0.0003	0.0003	0.0074
27	*tracery or steelwork on fanlight or tympanum*	0.0003	0.0032	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0721	0.0003	0.1001
28	*stained glass on fanlight*	0.0003	0.0113	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.7303	0.0003	0.0274	0.0003	0.8953
29	flat retangular porch	0.0003	0.6170	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.9978
30	flat semi-circular porch	0.0003	0.8694	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0005	0.0003	0.0003	0.0223	0.0003	0.8956
31	pediment porch	0.0003	0.0005	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0025	0.0003	0.9886
32	segmental (concave) porch	0.0003	0.9942	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0096	0.0003	0.7359
33	convex porch	0.0003	0.9976	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0337	0.0003	0.0003	0.9808
34	*columns supporting porch*	0.0003	0.4349	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0008	0.0003	0.0010	0.0003	0.0003	0.9102
35	*walls supporting porch*	0.0003	0.2044	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0020	0.0010	0.0003	0.0003	0.9917
36	*cables supporting porch*	0.0003	0.3750	0.0013	0.0003	0.0003	0.0003	0.0332	0.0025	0.0003	0.0003	0.0003	0.0003	0.0003	0.1995
37	lateral squared section column	0.0003	0.9561	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0013	0.0003	0.0003	0.1255
38	lateral cylindrical section column	0.0003	0.0066	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0447	0.0003	0.0003	0.0003	0.0003	0.0030
39	lateral vertical moulding	0.0003	0.0459	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.8799	0.0003	0.0003	0.0003	0.0003	0.0003
40	window in one side	0.0003	0.1238	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0008	0.0003	0.0003	0.0003	0.9998
41	windows in both sides	0.0003	0.2288	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.8179
42	*vertical glass tower*	0.0003	0.1097	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0281	0.0003	0.9275
43	*angular connection with glass tower*	0.0003	0.0169	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0931	0.0003	0.9922
44	*decorative sculptures*	0.0003	0.0806	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.2664
45	Surroundings material: glass	0.0003	0.0044	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.9717
46	Surroundings material: brick	0.0003	0.8694	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0035	0.0003	0.3108
47	Surroundings material: smooth stone	0.0003	0.8003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.9783
48	Surroundings material: rough stone	0.0003	0.2373	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0042	0.0005	0.0003	0.0003	0.0003	0.0962
49	Surroundings material: concrete blocks	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0179	0.0003	0.0003	0.0003	0.9996
50	Surroundings material: concrete exposed	0.0003	0.9932	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0008	0.1739	0.0003	0.8260
51	Surroundings material: timber	0.0003	0.9097	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0005	0.0003	0.0003	0.0003	0.0003	0.8257
52	Surroundings material: smooth plasterwork	0.0003	0.1910	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0252
53	Surroundings material: rusticated plasterwork	0.0003	0.0061	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0015	0.0003	0.0003	0.0003	0.9944
54	Surroundings materials: tiles or small tiles	0.0003	0.9988	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0476	0.0003	0.0003	0.9944
55	Surroundings material: metal	0.0003	0.0130	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0013	0.0003	0.0003	0.9993
56	*swinging door: one single*	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0083	0.0003	0.0039	0.0003	0.7662
57	*swinging door: two singles*	0.9998	0.0013	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0039	0.0003	0.0003	0.0003	0.0003	0.0127
58	*swinging door: one double*	0.0003	0.9998	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.9642
59	*swinging door: triple, two doubles or more*	0.0003	0.0003	0.9998	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.2212
60	*revolving door (with four leaves)*	0.0003	0.0003	0.0003	0.9998	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.9610	0.0003	0.0003	0.9939
61	*sliding door (one or more leaves)*	0.0003	0.2190	0.0003	0.0003	0.0738	0.0003	0.0003	0.0003	0.0003	0.0003	0.0357	0.1729	0.0003	0.9964
62	leaf: plain opaque	0.0003	0.0957	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
63	leaf: plain transparent	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.9998	0.0003	0.0003	0.0003	0.0003	0.0010	0.0003	0.9803
64	leaf: semi-opaque plain with one or more light cross panels	0.0003	0.0928	0.0003	0.0003	0.0003	0.0003	0.0003	0.9998	0.0015	0.0003	0.0003	0.0003	0.0003	0.9927
65	leaf: paneled opaque	0.0003	0.8206	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.9998	0.0003	0.0003	0.0003	0.0003	0.0003
66	leaf: paneled semi-opaque with one or more light cross panels	0.0003	0.1026	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.9998	0.0003	0.0003	0.0003	0.9998
67	leaf: framed with one or two light cross panels	0.0003	0.0892	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.7510	0.0003	0.0003	0.9891
68	leaf: framed with three or more light cross panels	0.0003	0.5664	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.9998	0.0003	0.9988
69	*steelwork leaf decoration*	0.0003	0.8851	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.7183	0.0003	0.0003	0.9998	0.3030
70	leaf mat.: non-stained glass	0.0003	0.1268	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0022	0.0003	0.0008	0.0003	0.9998
71	leaf mat.: stained glass	0.0003	0.0030	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.9539	0.0003	0.0003	0.0018	0.1307
72	leaf mat.: metal	0.0003	0.1075	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.7767
73	leaf mat.: timber	0.0003	0.7325	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.2456	0.0003	0.0003	0.0003	0.0003	0.0730
74	*round knob or ring handle*	0.0003	0.2979	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.2674	0.0018	0.0003	0.0003	0.0003	0.0037
75	*retangular, squared or trapezoid handle*	0.0003	0.1683	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.9961
76	*lever handle*	0.0003	0.0018	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.7290
77	*long horizontal static handle*	0.0003	0.1477	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0445
78	*long vertical static handle*	0.0003	0.6499	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.9664
79	*short vertical static handle*	0.0003	0.1722	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.9913
80	*curved static handle*	0.0003	0.9639	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.6084

<< Active input unit	Levels of support of each output unit >>	71 leaf mat.: stained glass	72 leaf mat.: metal	73 leaf mat.: timber	74 round knob or ring handle	75 retangular, squared or trapezoid handle	76 lever handle	77 long horizontal static handle	78 long vertical static handle	79 short vertical static handle	80 curved static handle
1	main entrance	0.0003	0.5545	0.0325	0.1932	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
2	secondary entrance	0.0003	0.7840	0.9202	0.0315	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
3	public access	0.0003	0.2593	0.8724	0.0122	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
4	restricted access	0.0003	0.9314	0.8916	0.2083	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
5	exit only	0.0003	0.0267	0.8621	0.0005	0.0003	0.0003	0.9986	0.0003	0.0003	0.0003
6	gives access to: air lock, vestibule or foyer	0.0003	0.7947	0.2515	0.2320	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
7	gives access to: corridor or aisle	0.0003	0.1133	0.9998	0.0035	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
8	gives access to: shop or working room	0.0003	0.9859	0.0113	0.1268	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
9	aligned to the facade	0.0003	0.5240	0.3929	0.1004	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
10	pulled out from the facade	0.0003	0.9490	0.0003	0.0152	0.0003	0.0003	0.0003	0.0440	0.0003	0.0003
11	pulled in from the facade	0.0003	0.7908	0.6392	0.0022	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
12	flat door top	0.0003	0.2618	0.7435	0.0047	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
13	semi-circular door top arch	0.0003	0.8558	0.9998	0.5227	0.0103	0.0003	0.0003	0.0003	0.0049	0.0003
14	segmental door top arch	0.0003	0.9620	0.0003	0.1585	0.0003	0.0003	0.0003	0.0003	0.0005	0.0003
15	pointed door top arch	0.0003	0.7881	0.9864	0.6309	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
16	round trefoil door top arch	0.0003	0.9812	0.9414	0.9991	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
17	top flat moulding	0.0003	0.4434	0.9783	0.1563	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
18	top curved moulding	0.0003	0.4849	0.5965	0.0032	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
19	triangular pediment	0.0003	0.8934	0.8956	0.1280	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
20	semi-circular or segmental pediment	0.0003	0.2139	0.1355	0.2789	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
21	squared fanlight	0.0003	0.4756	0.3628	0.0061	0.0003	0.0003	0.0003	0.0039	0.0003	0.0003
22	fanlight with undulate top	0.0003	0.9991	0.0003	0.0972	0.0003	0.0003	0.0003	0.0003	0.0025	0.0003
23	pointed arch fanlight	0.0003	0.0086	0.9922	0.0003	0.0003	0.0003	0.0003	0.0003	0.0901	0.0003
24	semi-circular or segmental arch fanlight	0.0003	0.2835	0.8738	0.0083	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
25	pointed arch tympanum	0.0003	0.9922	0.9998	0.8597	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
26	semi-circular arch tympanum	0.0003	0.0350	0.9998	0.0027	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
27	tracery or steelwork on fanlight or tympanum	0.0003	0.8414	0.0638	0.2000	0.0003	0.0003	0.0003	0.0003	0.0005	0.0003
28	stained glass on fanlight	0.0003	0.9454	0.9983	0.2906	0.0003	0.0003	0.0003	0.0003	0.0686	0.0003
29	flat retangular porch	0.0003	0.4256	0.0184	0.0008	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
30	flat semi-circular porch	0.0003	0.4861	0.9869	0.4043	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
31	pediment porch	0.0003	0.4690	0.9998	0.0445	0.0003	0.0010	0.0003	0.0003	0.0005	0.0003
32	segmental (concave) porch	0.0003	0.9983	0.3370	0.9778	0.0003	0.0003	0.0003	0.0003	0.0044	0.0003
33	convex porch	0.0003	0.9693	0.0061	0.6783	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
34	columns supporting porch	0.0003	0.0745	0.9935	0.0013	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
35	walls supporting porch	0.0003	0.9251	0.9847	0.0564	0.0210	0.0003	0.0003	0.0003	0.0003	0.0003
36	cables supporting porch	0.0003	0.1729	0.0003	0.0005	0.0003	0.0003	0.0003	0.0003	0.0098	0.0003
37	lateral squared section column	0.0003	0.7217	0.2530	0.0032	0.0003	0.0003	0.0003	0.0003	0.1902	0.0003
38	lateral cylindrical section column	0.0003	0.5076	0.9793	0.9644	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
39	lateral vertical moulding	0.0003	0.8140	0.8934	0.2962	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
40	window in one side	0.0003	0.9810	0.0103	0.0018	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
41	windows in both sides	0.0003	0.5262	0.1228	0.0018	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
42	vertical glass tower	0.0003	0.9168	0.0030	0.0552	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
43	angular connection with glass tower	0.0003	0.9788	0.0008	0.3321	0.0003	0.0003	0.0003	0.0914	0.0003	0.0003
44	decorative sculptures	0.0003	0.2810	0.0122	0.0015	0.0154	0.0003	0.0003	0.0003	0.1844	0.0003
45	Surroundings material: glass	0.0003	0.7664	0.0267	0.0076	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
46	Surroundings material: brick	0.0003	0.0430	0.8965	0.0003	0.0003	0.0003	0.0003	0.0003	0.0284	0.0003
47	Surroundings material: smooth stone	0.0003	0.1954	0.8514	0.3531	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
48	Surroundings material: rough stone	0.0003	0.5950	0.9961	0.0428	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
49	Surroundings material: concrete blocks	0.0003	0.9971	0.0955	0.0120	0.0003	0.0003	0.0003	0.0005	0.0013	0.0032
50	Surroundings material: concrete exposed	0.0003	0.8995	0.3753	0.0003	0.0003	0.0003	0.0003	0.0003	0.0010	0.0003
51	Surroundings material: timber	0.0003	0.0037	0.9998	0.0013	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
52	Surroundings material: smooth plasterwork	0.0003	0.5027	0.9766	0.1128	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
53	Surroundings material: rusticated plasterwork	0.0003	0.9881	0.1729	0.1097	0.0003	0.0003	0.0628	0.0030	0.0003	0.0003
54	Surroundings materials: tiles or small tiles	0.0003	0.9788	0.0025	0.4532	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
55	Surroundings material: metal	0.0003	0.9996	0.0003	0.0577	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
56	swinging door: one single	0.0003	0.8438	0.8462	0.2515	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
57	swinging door: two singles	0.0003	0.9637	0.0052	0.1455	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
58	swinging door: one double	0.0003	0.4407	0.9727	0.0044	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
59	swinging door: triple, two doubles or more	0.0003	0.3775	0.0169	0.0032	0.0003	0.0003	0.0003	0.0032	0.0003	0.0003
60	revolving door (with four leaves)	0.0003	0.9993	0.0003	0.0003	0.0003	0.0003	0.0003	0.0022	0.0003	0.0003
61	sliding door (one or more leaves)	0.0003	0.9947	0.0008	0.0047	0.0003	0.0003	0.0003	0.0003	0.8992	0.8509
62	leaf: plain opaque	0.0003	0.1846	0.9996	0.9505	0.0003	0.0003	0.0003	0.0003	0.0010	0.0003
63	leaf: plain transparent	0.0003	0.2989	0.0020	0.0003	0.0003	0.0003	0.0003	0.0022	0.0008	0.0003
64	leaf: semi-opaque plain with one or more light cross panels	0.0003	0.0166	0.9983	0.0191	0.3907	0.0003	0.0003	0.0003	0.0003	0.0003
65	leaf: paneled opaque	0.0003	0.0149	0.9998	0.5408	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
66	leaf: paneled semi-opaque with one or more light cross panels	0.0003	0.9927	0.6153	0.0813	0.0003	0.0003	0.0003	0.0003	0.0088	0.0003
67	leaf: framed with one or two light cross panels	0.0003	0.9908	0.0005	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
68	leaf: framed with three or more light cross panels	0.0003	0.9749	0.0188	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
69	steelwork leaf decoration	0.0003	0.9998	0.0120	0.9524	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
70	leaf mat.: non-stained glass	0.0003	0.8968	0.0015	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
71	leaf mat.: stained glass	0.9956	0.9993	0.9981	0.9935	0.0003	0.0003	0.0003	0.0003	0.0130	0.0003
72	leaf mat.: metal	0.0003	0.9998	0.0003	0.0511	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
73	leaf mat.: timber	0.0003	0.0020	0.9998	0.0159	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
74	round knob or ring handle	0.0003	0.3655	0.9996	0.9988	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
75	retangular, squared or trapezoid handle	0.0003	0.6797	0.5855	0.0003	0.9998	0.0003	0.0003	0.0003	0.0003	0.0003
76	lever handle	0.0003	0.1775	0.3511	0.0003	0.0003	0.9998	0.0003	0.0003	0.0003	0.0003
77	long horizontal static handle	0.0003	0.9764	0.0022	0.0003	0.0003	0.0003	0.9998	0.0003	0.0003	0.0003
78	long vertical static handle	0.0003	0.9988	0.0027	0.0064	0.0003	0.0003	0.0003	0.9998	0.0003	0.0003
79	short vertical static handle	0.0003	0.2405	0.7286	0.0003	0.0003	0.0003	0.0003	0.0003	0.9998	0.0003
80	curved static handle	0.0003	0.1976	0.8323	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.9998

Appendix 7

Table of experimentation results

This appendix shows a table with the overall experimentation results. The table is divided in blocs of four or five rows. The first row of each bloc contains the user type used in that particular test. It represents how a user of a particular type might answer each of the questions from the system. If a feature has a setting 'y' the answer should be 'yes', while having a 'd' setting would require an answer 'don't know'. A blank cell would require an answer 'no'.

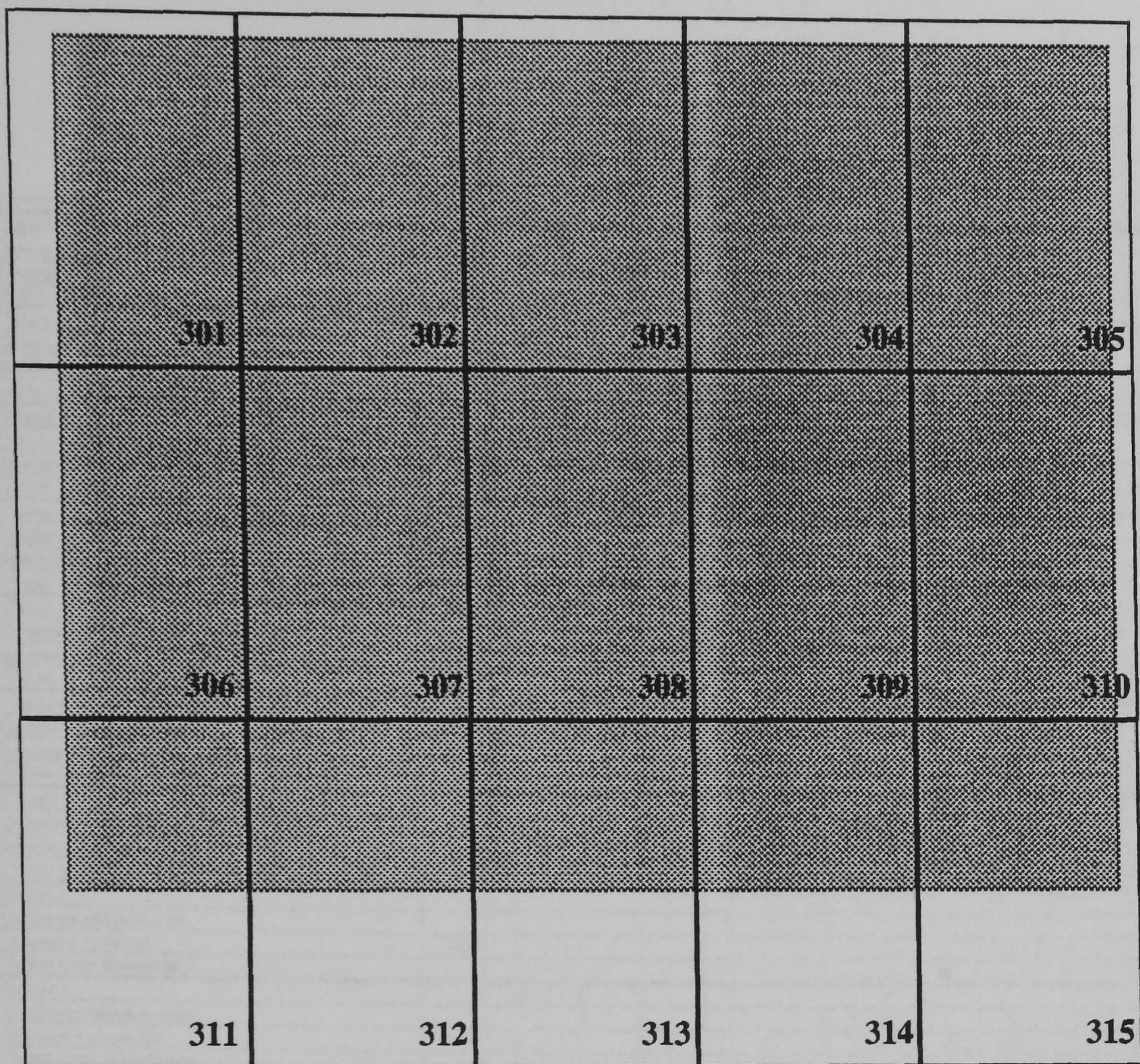
The second row of each bloc represents what questions were used by the system and what answers were given by the user. It corresponds to the problem's partial descriptions, as defined in Chapter 5. If a feature has a setting 'y' the answer was 'yes'. A feature with a 'd' means that the answer was 'don't know'. A feature with a 'n' indicates that the answer was 'no'.

The third row of each bloc, labeled 'Solution's classifier', contains the knowledge-base system solution. A few times, when there were two or more knowledge-base system solutions, two or more rows may contain the same kind of information as well, that is, the 'Solution's classifier'. In these rows a feature present is assigned the value '1' while a feature not present is assigned the value '0'.

The last row of each bloc contains the neural network solution for each of the 46 tests undertaken. In this row a feature present is assigned the value '1' while a feature not present is assigned the value '0'.

Once the table is too large to fit in a single page, it has been broken down into smaller tables, each with its own labels of columns and rows.

The key map bellow indicates the relationship between tables. The numbers indicate the page in which each table can be found.



Type of user	Case number	1 main entrance	2 secondary entrance	3 public access	4 restricted access	5 exit only	6 gives access to: air lock, vestibule or foyer	7 gives access to: corridor or aisle	8 gives access to: shop or working room	9 aligned to the facade	10 pulled out from the facade	11 pulled in from the facade	12 flat door top	13 semi-circular door top arch	14 segmental door top arch	15 pointed door top arch	16 round trefoil door top arch
Classic 1		y		y			y			y			y				
Questions and Answers		y		y			y			y			y				
Solution's classifier	87	1	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0
Output from BrainMaker		1	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0
Classic 2			y		y			y		y			y				
Questions and Answers			y				n	y					y				
Solution's classifier	86	0	1	0	1	0	0	1	0	1	0	0	1	0	0	0	0
Output from BrainMaker		0	1	0	1	0	0	0	0	1	0	1	1	0	0	0	0
Classic 3		*y*		*d*	*d*	*d*	*d*	*d*	*d*	*y*			*y*				
Questions and Answers		*y*		*d*	*d*		*d*			*y*			*y*				
Solution's classifier	87	1	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0
Output from BrainMaker		1	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0
Classic 4		y			y		y			y			y				
Questions and Answers		y		n			y						y				
Solution's classifier	109	1	0	0	1	0	1	0	0	1	0	0	1	0	0	0	0
Output from BrainMaker		1	0	1	0	0	1	0	0	0	0	1	[illegible]	0	0	0	0
Classic 5		y		y			y			y			y				
Questions and Answers		y		y			y						y				
Solution's classifier	45	1	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0
Output from BrainMaker		1	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0
Classic 6		y			y		y			y			y				
Questions and Answers		y		n			y						y				
Solution's classifier	50	1	0	0	1	0	1	0	0	1	0	0	1	0	0	0	0
Output from BrainMaker		1	0	1	0	0	1	0	0	1	0	0	[illegible]	0	0	0	0
Classic 7			*y*		*y*		*d*	*d*	*d*	*y*			*y*				
Questions and Answers		*n*	*y*	*n*			*d*	*d*					*y*				
Solution's classifier	68	0	1	0	1	0	0	1	0	0	0	1	1	0	0	0	0
Output from BrainMaker		0	1	1	0	0	0	1	0	1	0	0	1	0	0	0	0
Gothic 1		y		y			y					y	y				
Questions and Answers		y		y			y						y				
Solution's classifier	14	1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Output from BrainMaker		1	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0
Gothic 2		*d*	*d*	*d*	*d*			*y*				*y*	*y*				
Questions and Answers			*d*	*d*	*d*		*n*	*y*		*n*			*y*				
Solution's classifier	68	0	1	0	1	0	0	1	0	0	0	1	1	0	0	0	0
Output from BrainMaker		0	1	0	1	0	0	1	0	1	0	0	1	0	0	0	0
Art Nouveau 1		y			y		y			y			y				
Questions and Answers		y			y		y						y				
Solution's classifier	103	1	0	0	1	0	1	0	0	1	0	0	1	0	0	0	0
Output from BrainMaker		1	0	0	1	0	1	0	0	0	0	1	1	0	0	0	0
Art Nouveau 2		*y*		*d*	*d*	*d*	*y*			*d*	*d*	*d*	*d*		*d*		
Questions and Answers		*y*			*d*		*y*			*d*			*d*				
Solution's classifier	103	1	0	0	1	0	1	0	0	1	0	0	1	0	0	0	0
Output from BrainMaker		1	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0
Modern (functionalist 1)		y			y		y			y			y				
Questions and Answers		y			y		y						y				
Solution's classifier	3	1	0	0	1	0	1	0	0	1	0	0	1	0	0	0	0
Output from BrainMaker		1	0	0	1	0	1	0	0	1	0	0	1	0	0	0	0
Modern (functionalist 2)		y			y		y			y			y				
Questions and Answers		y		n			y						y				
Solution's classifier	63	1	0	0	1	0	1	0	0	0	0	1	1	0	0	0	0
Output from BrainMaker		1	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0
Modern (functionalist 3)			*y*	*y*				*y*		*d*	*d*	*d*	*y*				
Questions and Answers			*y*				*n*	*y*					*y*				
Solution's classifier	31	0	1	1	0	0	0	1	0	0	0	1	1	0	0	0	0
Output from BrainMaker		0	0	0	1	0	0	1	0	1	0	0	1	0	0	0	0
Modern (brutalist 1)		y		y			y					y	y				
Questions and Answers		y		y			y						y				
Solution's classifier	54	1	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0
Output from BrainMaker		0	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0
Modern (brutalist 2)		y		y			y					y	y				
Questions and Answers		y		y			y					y	y				
Solution's classifier	52	1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Output from BrainMaker		1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Modern (brutalist 3)		y		y			y					y	y				
Questions and Answers		y		y			y					y	y				
Solution's classifier	53	1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Output from BrainMaker		1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Modern (organic 1)		y		y			y			y			y				
Questions and Answers		y		y			y					n	y				
Solution's classifier	4	1	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0
Output from BrainMaker		1	0	1	0	0	1	0	0	1	0	0	[illegible]	0	0	0	0
Modern (organic 2)		y		y			y					y	y				
Questions and Answers		y		y			y					y	y				
Solution's classifier	122	1	0	1	0	0	1	0	0	0	0	[illegible]	[illegible]	0	0	0	0
Output from BrainMaker		1	0	1	0	0	1	0	0	0	0	[illegible]	[illegible]	0	0	0	0

Type of user	*Case number*	17 top flat moulding	18 top curved moulding	19 triangular pediment	20 semi-circular or segmental pediment	21 *squared fanlight*	22 *fanlight with undulate top*	23 *pointed arch fanlight*	24 *semi-circular or segmental arch fanlight*	25 pointed arch tympanum	26 semi-circular arch tympanum	27 *tracery or steelwork on fanlight or tympanum*	28 *stained glass on fanlight*	29 flat rectangular porch	30 flat semi-circular porch	31 pediment porch	32 segmental (concave) porch
Classic 1		y		y													
Questions and Answers		y	n														
Solution's classifier	*87*	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Output from BrainMaker		1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Classic 3		y		y										y			
Questions and Answers			n														
Solution's classifier	*86*	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Classic 4		*y*		*y*										*y*			
Questions and Answers		*y*	*n*														
Solution's classifier	*87*	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Output from BrainMaker		1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Classic 5		y		y										y			
Questions and Answers														y			
Solution's classifier	109	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Classic 6		y	y						y								
Questions and Answers		y															
Solution's classifier	*45*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Output from BrainMaker		0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Classic 7		y	y						y								
Questions and Answers														n			
Solution's classifier	50	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Output from BrainMaker		0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Classic 8		*y*	*y*						*y*			*d*	*d*				
Questions and Answers																	
Solution's classifier	*68*	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Gothic 1			y							y		y					
Questions and Answers		n															
Solution's classifier	*14*	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0
Output from BrainMaker		0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gothic 2			*y*					*y*				*d*	*d*				
Questions and Answers			*y*							*n*							
Solution's classifier	*68*	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Output from BrainMaker		1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Art Nouveau 1							y						y				
Questions and Answers																	
Solution's classifier	*103*	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0
Output from BrainMaker		0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Art Nouveau 2							*y*						*y*				
Questions and Answers													*y*				
Solution's classifier	*103*	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0
Output from BrainMaker		1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0
Modern (functionalist 1)																	
Questions and Answers																	
Solution's classifier	*3*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Modern (functionalist 3)						y								y			
Questions and Answers																	
Solution's classifier	*63*	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0
Output from BrainMaker		0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Modern (functionalist 5)						*y*								*y*			
Questions and Answers																	
Solution's classifier	*31*	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Modern (brutalist 1)						y								y			
Questions and Answers																	
Solution's classifier	*54*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Modern (brutalist 2)						y											
Questions and Answers		n				y											
Solution's classifier	*52*	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Modern (brutalist 3)						y											
Questions and Answers						y											
Solution's classifier	*53*	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Modern (organic 1)						y											
Questions and Answers																	
Solution's classifier	*4*	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Modern (organic 2)														y			
Questions and Answers						n								y			
Solution's classifier	*122*	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Output from BrainMaker		0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0

Type of user	Case number	33 onvex porch	34 olumns supporting porch	35 alls supporting porch	36 ables supporting porch	37 ateral squared section column	38 ateral cylindrical section column	39 ateral vertical moulding	40 window in one side	41 windows in both sides	42 ertical glass tower	43 ngular connection with glass tower	44 ecorative sculptures	45 urroundings material: glass	46 urroundings material: brick	47 urroundings material: smooth stone	48 urroundings material: rough stone
Classic 1							y	y					y			y	
Questions and Answers							y							n		y	
Solution's classifier	87	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0
Output from BrainMaker		0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0
Classic 3			y			y		y					y			y	
Questions and Answers																	
Solution's classifier	86	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
Output from BrainMaker		0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0
Classic 4			y				y	d					d			y	d
Questions and Answers						n	y							n		y	
Solution's classifier	87	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0
Output from BrainMaker		0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0
Classic 5			y			y							y		y	y	
Questions and Answers														n		y	
Solution's classifier	109	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Output from BrainMaker		0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0
Classic 6						y										y	
Questions and Answers							n							n		y	
Solution's classifier	45	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
Output from BrainMaker		0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1
Classic 7						y										y	
Questions and Answers														n		y	
Solution's classifier	50	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
Output from BrainMaker		0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	1
Classic 8						y		d	d	d			d			y	d
Questions and Answers																	
Solution's classifier	68	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0
Output from BrainMaker		0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
Gothic 1							y	y								y	
Questions and Answers							y							n		y	
Solution's classifier	14	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0
Output from BrainMaker		0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0
Gothic 2							y	y								y	d
Questions and Answers																	
Solution's classifier	68	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0
Output from BrainMaker		0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0
Art Nouveau 1														y		y	
Questions and Answers													n	y			
Solution's classifier	103	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0
Output from BrainMaker		0	0	1	0	1	0	1	1	0	0	0	0	1	0	1	0
Art Nouveau 2														y		y	
Questions and Answers													n	y			
Solution's classifier	103	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0
Output from BrainMaker		0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0
Modern (functionalist 1)									y		y			y			
Questions and Answers									y	n	y			y	n		
Solution's classifier	3	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0
Modern (functionalist 3)										y				y			
Questions and Answers										y				y	n		
Solution's classifier	63	0	0	1	0	0	0	0	0	1	0	0	0	1	0	1	0
Output from BrainMaker		1	0	0	1	0	0	0	0	1	0	0	0	1	0	1	0
Modern (functionalist 5)									d	d				y			
Questions and Answers																	
Solution's classifier	31	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	1	1	0	0	1	0	1	0
Modern (brutalist 1)				y													
Questions and Answers		n												n			
Solution's classifier	54	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Modern (brutalist 2)										y				y			
Questions and Answers										y				y			
Solution's classifier	52	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0
Modern (brutalist 3)									y					y			
Questions and Answers										n				y			
Solution's classifier	53	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Modern (organic 1)										y				y	y		
Questions and Answers														y			
Solution's classifier	4	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0
Output from BrainMaker		0	0	0	0	0	0	1	0	0	0	0	1	1	0	1	0
Modern (organic 2)				y					y					y	y	y	
Questions and Answers														y		y	
Solution's classifier	122	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0
Output from BrainMaker		0	0	1	0	0	0	0	1	0	0	0	0	1	0	1	0

Type of user	Case number	49 Surroundings material: concrete blocks	50 Surroundings material: concrete exposed	51 Surroundings material: timber	52 Surroundings material: smooth plasterwork	53 Surroundings material: rusticated plasterwork	54 Surroundings materials: tiles or small tiles	55 Surroundings material: metal	56 *Swinging door: one single*	57 *Swinging door: two singles*	58 *Swinging door: one double*	59 *Swinging door: triple, two doubles or more*	60 *Revolving door (with four leaves)*	61 *Sliding door (one or more leaves)*	62 Leaf: plain opaque	63 Leaf: plain transparent	64 Leaf: semi-opaque plain with one or more light cross panels
Classic 1											y						
Questions and Answers																	
Solution's classifier	87	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Classic 3											y						
Questions and Answers											y						
Solution's classifier	86	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
Output from BrainMaker		0	0	1	0	1	0	1	0	0	1	0	0	0	0	0	0
Classic 4					y				d		d						
Questions and Answers											d						
Solution's classifier	37	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Classic 5											y						y
Questions and Answers																	
Solution's classifier	109	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
Classic 6				y							y						
Questions and Answers																	
Solution's classifier	45	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Classic 7				y					y								y
Questions and Answers																	
Solution's classifier	50	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Classic 8				d					d		d						
Questions and Answers																	
Solution's classifier	68	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Output from BrainMaker		0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
Gothic 1										y							
Questions and Answers																	
Solution's classifier	14	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Gothic 2									d	d	d						y
Questions and Answers											d						
Solution's classifier	68	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Output from BrainMaker		0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
Art Nouveau 1					y				y								
Questions and Answers																	
Solution's classifier	103	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0
Art Nouveau 2					y				y								
Questions and Answers																	
Solution's classifier	103	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0
Modern (functionalist 1)						y		y	y								
Questions and Answers								y									
Solution's classifier	3	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Modern (functionalist 3)		y						y	y								
Questions and Answers								y									
Solution's classifier	63	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	1	0	1	1	0	0	1	0	0	0	0	0	1
Modern (functionalist 5)			y					y	d	d	d	d					
Questions and Answers																	
Solution's classifier	31	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Modern (brutalist 1)			y								y					y	
Questions and Answers																	
Solution's classifier	54	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Modern (brutalist 2)			y										y				
Questions and Answers								n					y				
Solution's classifier	52	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Modern (brutalist 3)			y						y				y			y	
Questions and Answers								n					y				
Solution's classifier	53	0	1	0	0	0	0	0	1	0	0	0	1	0	0	1	0
Output from BrainMaker		0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Modern (organic 1)				y							y						
Questions and Answers								n									
Solution's classifier	4	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Modern (organic 2)				y							y						
Questions and Answers				y													
Solution's classifier	122	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
Output from BrainMaker		0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0

Type of user	Case number	65 eaf: paneled opaque	66 eaf: paneled semi-opaque with one or more light cross panels	67 eaf: framed with one or two light cross panels	68 eaf: framed with three or more light cross panels	69 teelwork leaf decoration	70 eaf mat.: non-stained glass	71 eaf mat.: stained glass	72 eaf mat.: metal	73 eaf mat.: timber	74 ound knob or ring handle	75 ectangular, squared or trapezoid handle	76 ever handle	77 ong horizontal static handle	78 ong vertical static handle	79 hort vertical static handle	80 urved static handle
Classic 1		y								y	y						
Questions and Answers		y								y	y						
Solution's classifier	87	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Output from BrainMaker		1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Classic 3		y								y	y						
Questions and Answers										y	y						
Solution's classifier	36	0	1	0	0	0	1	0	0	1	1	0	0	0	0	0	0
Output from BrainMaker		0	0	1	0	0	1	0	1	1	0	1	0	0	0	0	0
Classic 4		y								y	d	d	d	d	d	d	d
Questions and Answers		y								y	d						
Solution's classifier	87	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Output from BrainMaker		1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Classic 5								y		y	y						
Questions and Answers										y	y						
Solution's classifier	109	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0
Classic 6		y								y	y						
Questions and Answers		y								y	y						
Solution's classifier	45	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Output from BrainMaker		1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Classic 7							y			y	y						
Questions and Answers										y	y						
Solution's classifier	50	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Output from BrainMaker		1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Classic 8		y								y	d	d	d	d	d	d	d
Questions and Answers							n										
Solution's classifier	68	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0
Output from BrainMaker		0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0
Gothic 1		y								y	y						
Questions and Answers		y								y	y						
Solution's classifier	14	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Output from BrainMaker		1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Gothic 2						d		y		y	d	d	d	d	d	d	d
Questions and Answers										y							
Solution's classifier	68	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0
Art Nouveau 1				y				y	y	y							y
Questions and Answers		n					n			y							
Solution's classifier	103	0	1	0	0	0	0	1	1	1	1	0	0	0	0	0	0
Output from BrainMaker		0	0	0	1	0	1	0	1	1	0	0	0	0	0	0	0
Art Nouveau 2				y				y	y	y	d	d	d	d	d	d	d
Questions and Answers		n					n			y							
Solution's classifier	103	0	1	0	0	0	0	1	1	1	1	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0
Modern (functionalist 1)					y		y		y						y		
Questions and Answers					y		y		y								
Solution's classifier	3	0	0	0	1	0	1	0	1	0	0	0	0	0	1	0	0
Output from BrainMaker		0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0
Modern (functionalist 3)				y			y		y				y				
Questions and Answers							y		y								
Solution's classifier	63	0	0	0	1	0	1	0	1	0	1	0	0	0	0	0	0
Output from BrainMaker		0	0	1	0	1	1	0	1	0	1	0	0	0	1	0	0
Modern (functionalist 5)				y			y		y		d	d	d	d	d	d	d
Questions and Answers										n							
Solution's classifier	31	0	0	1	0	0	1	0	1	0	0	0	0	0	0	1	0
Output from BrainMaker		0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0
Modern (brutalist 1)							y		y						y		
Questions and Answers										n							
Solution's classifier	54	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	1
Output from BrainMaker		0	1	0	0	0	1	0	1	0	1	0	0	0	0	0	0
Modern (brutalist 2)				y			y		y						y		
Questions and Answers				y			y		y						y		
Solution's classifier	52	0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	0
Output from BrainMaker		0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	0
Modern (brutalist 3)				y			y		y						y		
Questions and Answers				y			y		y						y		
Solution's classifier	53	0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	0
Output from BrainMaker		0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	0
Modern (organic 1)					y		y		y	y					y		
Questions and Answers							y		y								
Solution's classifier	4	0	0	0	1	0	1	0	1	1	0	0	0	0	1	0	0
Output from BrainMaker		0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0
Modern (organic 2)			y				y			y						y	
Questions and Answers							y		n	y							
Solution's classifier	122	0	1	0	0	0	1	0	0	1	0	0	0	0	0	1	0
Output from BrainMaker		0	1	1	0	0	1	0	1	0	0	1	0	0	0	0	0

Type of user	Case number	1 main entrance	2 secondary entrance	3 public access	4 restricted access	5 exit only	6 gives access to: air lock, vestibule or foyer	7 gives access to: corridor or aisle	8 gives access to: shop or working room	9 aligned to the facade	10 pulled out from the facade	11 pulled in from the facade	12 flat door top	13 semi-circular door top arch	14 segmental door top arch	15 pointed door top arch	16 round trefoil door top arch
Modern (organic3)		d	d	d	d		y					y	y				
Questions and Answers		d		d			y					y	y				
Solution's classifier	122	1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Output from BrainMaker		1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Modern (high tech 1)		y		y			y					y	y				
Questions and Answers		y		y			y						y				
Solution's classifier	48	1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Output from BrainMaker		1	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0
Modern (high tech 2)		d	d	d	d		y					y	y				
Questions and Answers		d		d			y					y	y				
Solution's classifier	63	1	0	0	1	0	1	0	0	0	0	1	1	0	0	0	0
Output from BrainMaker		1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Modern (high tech 3)		y		y			y					y	y				
Questions and Answers		y		y			y					y	y				
Solution's classifier	73	1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Output from BrainMaker		1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Modern (high tech 4)		d	d	d	d		y					y	y				
Questions and Answers		d		d			y					y	y				
Solution's classifier	75	1	1	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Output from BrainMaker		1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Post-Modern (neo-classic 1)		d	d	d	d		d					y	y				
Questions and Answers		d		d	d		d			n			y				
Solution's classifier	78	1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Output from BrainMaker		1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0
Post-Modern (neo-classic 2)		y		y			y					y	y				
Questions and Answers		y		y			y						y				
Solution's classifier	78	1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Output from BrainMaker		1	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0
Post-Modern (neo-classic 3)		y		y			y					y	y				
Questions and Answers		y		y			y					y	y				
Solution's classifier	79	1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Output from BrainMaker		1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Post-Modern (neo-classic 4)		d	d	d	d		y			y			y				
Questions and Answers		d		d	d		y					n	y				
Solution's classifier	93	1	0	0	1	0	1	0	0	1	0	0	1	0	0	0	0
Output from BrainMaker		1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Post-Modern (eclectic 1)		d	d	d	d		d	d	d	y			y				
Questions and Answers		d		d	d		d					n	y				
Solution's classifier	4	1	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0
Output from BrainMaker		1	0	0		0	1	0	0	0	1	1	1	0	0	0	0
Post-Modern (eclectic 2)		y			y		y				y		y				
Questions and Answers		y		n			y			n		n	y				
Solution's classifier	1	1	0	0	1	0	1	0	0	0	1	0	1	0	0	0	0
Output from BrainMaker		1	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0
Post-Modern (eclectic 3)		y			y		y					y	y				
Questions and Answers		y					y			n			y				
Solution's classifier	74	1	0	0	1	0	1	0	0	0	0	1	1	0	0	0	0
Output from BrainMaker		1	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0
Post-Modern (eclectic 4)		d	d	d	d		d	d				y	y				
Questions and Answers		d		d	d		d			n			y				
Solution's classifier	94	1	0	0	1	0	1	0	0	0	0	1	1	0	0	0	0
Output from BrainMaker		0	0	0	1	0	0	1	0	1	0	0	1	0	0	0	0
Environmental control 1 (Tight)		y		d	d	d	y					y	y				
Questions and Answers		y		d	d		y					y	y				
Solution's classifier	53	1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Output from BrainMaker		1	0	1	1	0	1	0	0	0	0	1	1	0	0	0	0
Environmental control 2 (Tight)		d	d	d	d		y					y	y				
Questions and Answers		d		d	d		y						y				
Solution's classifier	48	1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Output from BrainMaker		1	0	1	0	0	1	0	0	0	1	1	1	0	0	0	0
Environmental control 3 (loose)		y		y				y		d		d	y				
Questions and Answers			n			n	n	y					y				
Solution's classifier	91	1	0	0	1	0	0	1	0	1	0	0	1	0	0	0	0
Output from BrainMaker		1	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0
Environmental control 4 (loose)			y	y				y		d		d	y				
Questions and Answers			y	y			n	y		d		d	y				
Solution's classifier	13	0	1	1	0	0	0	1	0	0	0	1	1	0	0	0	0
Solution's classifier	61	0	1	1	0	0	0	1	0	1	0	0	1	0	0	0	0
Output from BrainMaker		0	1	1	0	0	0	1	0	0	0	1	1	0	0	0	0
Environmental control 5 (no control)		d	d	y					y			y	d	d		d	d
Questions and Answers		d		y			n	n					d				
Solution's classifier	64	1	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0
Output from BrainMaker		1	0	1	0	0	0	1	0	0	0	1	1	0	0	0	0
Environmental control 6 (no control)			y	d	d				y	d	d	d	d	d		d	d
Questions and Answers		n	y				n	n					d				
Solution's classifier	62	0	1	0	1	0	0	0	1	1	0	0	1	0	0	0	0
Output from BrainMaker		0	1	1	0	0	0	1	0	0	0	1	1	0	0	0	0

Type of user	Case number	17 Top flat moulding	18 Top curved moulding	19 Triangular pediment	20 Semi-circular or segmental pediment	21 Squared fanlight	22 Fanlight with undulate top	23 Pointed arch fanlight	24 Semi-circular or segmental arch fanlight	25 Pointed arch tympanum	26 Semi-circular arch tympanum	27 Tracery or steelwork on fanlight or tympanum	28 Stained glass on fanlight	29 Flat rectangular porch	30 Flat semi-circular porch	31 Pediment porch	32 Segmental (concave) porch
Modern (organic3)														y			
Questions and Answers						n								y			
Solution's classifier	122	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Output from BrainMaker		0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0
Modern (high tech 1)						y								y			
Questions and Answers																	
Solution's classifier	48	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0
Output from BrainMaker		0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Modern (high tech 2)						y											
Questions and Answers						y											
Solution's classifier	63	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0
Output from BrainMaker		0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Modern (high tech 3)																	
Questions and Answers														n			
Solution's classifier	73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Modern (high tech 4)						y											
Questions and Answers						y								n			
Solution's classifier	75	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0
Post-Modern (neo-classic 1)		y				y											
Questions and Answers		y															
Solution's classifier	78	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0
Output from BrainMaker		[illegible]	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0
Post-Modern (neo-classic 2)		y				y									y		
Questions and Answers																	
Solution's classifier	78	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0
Output from BrainMaker		1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Post-Modern (neo-classic 3)		y		y		y											
Questions and Answers		y				y											
Solution's classifier	79	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Post-Modern (neo-classic 4)		y	y						y								
Questions and Answers																	
Solution's classifier	93	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0
Post-Modern (eclectic 2)																y	
Questions and Answers																	
Solution's classifier	4	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Post-Modern (eclectic 3)																	
Questions and Answers																	
Solution's classifier	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Post-Modern (eclectic 4)																y	
Questions and Answers																	
Solution's classifier	94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Output from BrainMaker		1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
Post-Modern (eclectic 5)																	
Questions and Answers		n															
Solution's classifier	94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Output from BrainMaker		1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Environmental control 1 (Tight)		d	d			y											
Questions and Answers						y								n			
Solution's classifier	53	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Environmental control 2 (Tight)		d	d			y			d	d		d		y			
Questions and Answers														y			
Solution's classifier	48	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Environmental control 3 (loose)		d	d			y				d		d		d			
Questions and Answers																	
Solution's classifier	91	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Output from BrainMaker		0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Environmental control 4 (loose)		d	d			d			d	d		d		d			
Questions and Answers			d			d				d		d		d			
Solution's classifier	13	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0
Solution's classifier	61	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Environmental control 5 (no control)		d	d			y				d		d	d	d	d		d
Questions and Answers						y											
Solution's classifier	64	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0
Environmental control 6 (no control)		d	d			y				d		d	d	d	d		d
Questions and Answers																	
Solution's classifier	62	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0

Appendix 7. Table of experimentation results

Type of user	Case number	33 onvex porch	34 olumns supporting porch	35 walls supporting porch	36 ables supporting porch	37 ateral squared section column	38 ateral cylindrical section column	39 ateral vertical moulding	40 window in one side	41 windows in both sides	42 ertical glass tower	43 ngular connection with glass tower	44 ecorative sculptures	45 Surroundings material: glass	46 Surroundings material: brick	47 Surroundings material: smooth stone	48 Surroundings material: rough stone
Modern (organic3)				y					y					y	y	y	
Questions and Answers														y		y	
Solution's classifier	*122*	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0
Output from BrainMaker		0	0	1	0	0	0	0	1	0	0	0	0	1	0	1	0
Modern (high tech 1)			y											y		y	
Questions and Answers									n	n				y			
Solution's classifier	*48*	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0
Output from BrainMaker		1	0	0	1	0	0	0	0	0	1	0	0	1	0	1	0
Modern (high tech 2)										y	y	d		y			
Questions and Answers										y				y	n		
Solution's classifier	*63*	0	0	1	0	0	0	0	0	1	0	0	0	1	0	1	0
Output from BrainMaker		0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0
Modern (high tech 3)										y				y			
Questions and Answers										y				y		n	
Solution's classifier	*73*	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0
Modern (high tech 4)										y	y			y	d		
Questions and Answers										y				y			
Solution's classifier	*75*	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	1	1	1	0	1	0	1	0
Post-Modern (neo-classic 1)															y		
Questions and Answers														n		n	
Solution's classifier	*78*	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Output from BrainMaker		0	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0
Post-Modern (neo-classic 2)			y												y		
Questions and Answers														n		n	
Solution's classifier	*78*	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Post-Modern (neo-classic 3)								y		y				y		y	
Questions and Answers										y				y			
Solution's classifier	*79*	0	0	0	0	0	0	1	0	1	0	0	0	1	0	1	0
Output from BrainMaker		0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0
Post-Modern (neo-classic 4)						y		d	d	d			d	y			
Questions and Answers						y								y			
Solution's classifier	*93*	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0
Output from BrainMaker		0	0	1	0	1	0	0	1	0	0	0	0	1	0	1	0
Post-Modern (eclectic 2)			y						d	d	d		d	y	y		
Questions and Answers						n								y			
Solution's classifier	*4*	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0
Post-Modern (eclectic 3)										y	y	y		y	y		
Questions and Answers										y				y	y		
Solution's classifier	*1*	0	0	0	0	0	0	0	0	1	1	1	0	1	1	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0
Post-Modern (eclectic 4)			y												y		
Questions and Answers														n			
Solution's classifier	*94*	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Output from BrainMaker		0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0
Post-Modern (eclectic 5)															y		
Questions and Answers														n		n	
Solution's classifier	*94*	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Output from BrainMaker		0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
Environmental control 1 (Tight)									y				d	d	d	d	d
Questions and Answers									y	n				d			
Solution's classifier	*53*	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0
Environmental control 2 (Tight)			y											y		y	
Questions and Answers									n	n				y			
Solution's classifier	*48*	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0
Output from BrainMaker		0	0	0	0	0	0	0	0	1	1	1	0	1	0	1	0
Environmental control 3 (loose)			d	d		d	d	d	d	d	d		d	d	d	d	d
Questions and Answers																	
Solution's classifier	*91*	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Output from BrainMaker		1	1	0	1	0	0	0	0	0	0	0	1	1	0	1	0
Environmental control 4 (loose)			d	d		d	d	d	n	y	d		d	d	d	d	d
Questions and Answers			d	d			d	d	n					d	d	d	
Solution's classifier	*13*	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0
Solution's classifier	*61*	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0
Output from BrainMaker		0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0
Environmental control 5 (no control)			d	d	d	d	d	d	d	d	d	d	d	d	d	d	d
Questions and Answers																	
Solution's classifier	*64*	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0
Output from BrainMaker		0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0
Environmental control 6 (no control)			d	d	d	d	d	d	d	d	d	d	d	d	d	d	d
Questions and Answers																	
Solution's classifier	*62*	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0
Output from BrainMaker		0	1	[illegible]	[illegible]	[illegible]	0	0	1	0	0	0	[illegible]	1	0	1	0

Type of user	Case number	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
		Surroundings material: concrete blocks	Surroundings material: concrete exposed	Surroundings material: timber	Surroundings material: smooth plasterwork	Surroundings material: rusticated plasterwork	Surroundings materials: tiles or small tiles	Surroundings material: metal	Swinging door: one single	Swinging door: two singles	Swinging door: one double	Swinging door: triple, two doubles or more	Revolving door (with four leaves)	Sliding door (one or more leaves)	Leaf: plain opaque	Leaf: plain transparent	Leaf: semi-opaque plain with one or more light cross panels
Modern (organic3)				y				y			y						
Questions and Answers				y							y						
Solution's classifier	*122*	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
Output from BrainMaker		0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0
Modern (high tech 1)								y		y			y				
Questions and Answers								y									
Solution's classifier	*48*	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0
Output from BrainMaker		0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
Modern (high tech 2)								y		d			d			y	
Questions and Answers								y			n						
Solution's classifier	*63*	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0
Modern (high tech 3)								y				y	y				
Questions and Answers								y									
Solution's classifier	*73*	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0
Modern (high tech 4)								y			y						
Questions and Answers								y			y						
Solution's classifier	*75*	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0
Post-Modern (neo-classic 1)				y							y						
Questions and Answers																	
Solution's classifier	*78*	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
Output from BrainMaker		0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0
Post-Modern (neo-classic 2)				y							y						
Questions and Answers																	
Solution's classifier	*78*	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
Output from BrainMaker		0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
Post-Modern (neo-classic 3)													y				
Questions and Answers								n					y				
Solution's classifier	*79*	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Post-Modern (neo-classic 4)					y				y								
Questions and Answers								n									
Solution's classifier	*93*	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
Post-Modern (eclectic 2)			y	y	y						y						
Questions and Answers								n									
Solution's classifier	*4*	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Post-Modern (eclectic 3)								y			y						
Questions and Answers								y									
Solution's classifier	*1*	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Post-Modern (eclectic 4)								y	y								y
Questions and Answers																	
Solution's classifier	*94*	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1
Output from BrainMaker		0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	
Post-Modern (eclectic 5)								y	y								
Questions and Answers																	
Solution's classifier	*94*	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1
Output from BrainMaker		0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0
Environmental control 1 (Tight)			d	d	d			d	y				y			y	
Questions and Answers								d									
Solution's classifier	*53*	0	1	0	0	0	0	0	1	0	0	0	1	0	0	1	0
Output from BrainMaker		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Environmental control 2 (Tight)			d	d	d			y					y				
Questions and Answers								y									
Solution's classifier	*48*	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Environmental control 3 (loose)			d	d	d			d			y						
Questions and Answers																	
Solution's classifier	*91*	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	1
Environmental control 4 (loose)			d	d	d			d			d						
Questions and Answers								d	n		d						
Solution's classifier	*13*	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Solution's classifier	*61*	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0
Environmental control 5 (no control)			d	d	d	d		d	d	d	d	d	d			d	d
Questions and Answers											d						
Solution's classifier	*64*	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0
Output from BrainMaker		0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Environmental control 6 (no control)			d	d	d	d		d	d	d	d	d	d			d	d
Questions and Answers											d						
Solution's classifier	*62*	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Output from BrainMaker		0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0

Type of user	Case number	65 Leaf: paneled opaque	66 Leaf: paneled semi-opaque with one or more light cross panels	67 Leaf: framed with one or two light cross panels	68 Leaf: framed with three or more light cross panels	69 Steelwork leaf decoration	70 Leaf mat: non-stained glass	71 Leaf mat: stained glass	72 Leaf mat: metal	73 Leaf mat: timber	74 Round knob or ring handle	75 Rectangular, squared or trapezoid handle	76 Lever handle	77 Long horizontal static handle	78 Long vertical static handle	79 Short vertical static handle	80 Curved static handle
Modern (organic3)			y				y			y	d	d	d		d	d	
Questions and Answers							y		n	y							
Solution's classifier	122	0	1	0	0	0	1	0	0	1	0	0	0	0	0	1	0
Output from BrainMaker		0	1	1	0	0	1	0	1	0	0	1	0	0	0	0	0
Modern (high tech 1)				y			y		y					y			
Questions and Answers							y		y								
Solution's classifier	48	0	0	1	0	0	1	0	1	0	0	0	0	1	0	0	0
Output from BrainMaker		0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	0
Modern (high tech 2)							y		y					d	d	d	n
Questions and Answers							y		y								
Solution's classifier	63	0	0	0	1	0	1	0	1	0	1	0	0	0	0	0	0
Output from BrainMaker		0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	0
Modern (high tech 3)				y			y		y						y		
Questions and Answers				y			y		y								
Solution's classifier	73	0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	0
Output from BrainMaker		0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	0
Modern (high tech 4)				y			y		y		d	d			d		
Questions and Answers				y			y		y								
Solution's classifier	75	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	1
Output from BrainMaker		0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0
Post-Modern (neo-classic 1)		y								y	d	d			d		
Questions and Answers										y	d						
Solution's classifier	78	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Output from BrainMaker		1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Post-Modern (neo-classic 2)		y								y	y						
Questions and Answers										y	y						
Solution's classifier	78	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Output from BrainMaker		0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Post-Modern (neo-classic 3)				y			y		y						y		
Questions and Answers				y			y		y						y		
Solution's classifier	79	0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	0
Output from BrainMaker		0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	0
Post-Modern (neo-classic 4)				y			y		y		d	d	d	d	d	d	d
Questions and Answers							y		y								
Solution's classifier	93	0	1	0	0	0	1	0	1	1	0	0	0	0	0	1	0
Output from BrainMaker		0	0	1	0	0	1	0	1	0	0	1	0	0	0	0	0
Post-Modern (eclectic 2)				y			y		y	y	d	d	d	d	d	d	d
Questions and Answers							y		y								
Solution's classifier	4	0	0	0	1	0	1	0	1	1	0	0	0	0	1	0	0
Output from BrainMaker		0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0
Post-Modern (eclectic 3)					y		y		y						y		
Questions and Answers					y		y		y								
Solution's classifier	1	0	0	0	1	0	1	0	1	0	0	0	0	0	1	0	0
Output from BrainMaker		0	0	0	1	0	1	0	1	0	0	0	0	0	1	0	0
Post-Modern (eclectic 4)							y		y	y			y				
Questions and Answers										y	n						
Solution's classifier	94	0	0	0	0	0	1	0	1	1	0	0	1	0	0	0	0
Output from BrainMaker		1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Post-Modern (eclectic 5)							y		y	y	d	d			d	d	
Questions and Answers										y	d						
Solution's classifier	94	0	0	0	0	0	1	0	1	1	0	0	1	0	0	0	0
Output from BrainMaker		0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Environmental control 1 (Tight)				y			y		y		d	d	d	d	d	d	d
Questions and Answers				y			y		y								
Solution's classifier	53	0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	0
Output from BrainMaker		0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0
Environmental control 2 (Tight)				y			y		y	y	d	d	d	d	d	d	d
Questions and Answers							y		y								
Solution's classifier	48	0	0	1	0	0	1	0	1	0	0	0	0	1	0	0	0
Output from BrainMaker		0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	0
Environmental control 3 (loose)		d	d	d	d	d	d		d	d	d	d	d		d	d	
Questions and Answers							d			d							
Solution's classifier	91	0	0	0	1	0	1	0	0	1	0	0	1	0	0	0	0
Output from BrainMaker		0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0
Environmental control 4 (loose)		d	d	d	d	d	d		d	d	d	d	d		d	d	
Questions and Answers		d	d	d		d	d		d	d	d						
Solution's classifier	13	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Solution's classifier	61	0	1	0	0	1	1	0	1	1	1	0	0	0	0	0	0
Output from BrainMaker		0	0	1	1	0	1	0	1	0	0	0	0	0	0	0	0
Environmental control 5 (no control)		d	d	d	d	d	d		d	d	d	d	d	d	d	d	d
Questions and Answers							d		d								
Solution's classifier	64	0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	0
Output from BrainMaker		0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0
Environmental control 6 (no control)		d	d	d	d	d	d		d	d	d	d	d	d	d	d	d
Questions and Answers							d		d								
Solution's classifier	62	0	1	0	0	1	1	0	1	1	1	0	0	0	0	0	0
Output from BrainMaker		0	0	1	0	0	[illegible]	0	0	1	0	0	[illegible]	[illegible]	1	0	0

Type of user	Case number	1 main entrance	2 secondary entrance	3 public access	4 restricted access	5 exit only	6 gives access to: air lock, vestibule or foyer	7 gives access to: corridor or aisle	8 gives access to: shop or working room	9 aligned to the facade	10 pulled out from the facade	11 pulled in from the facade	12 flat door top	13 semi-circular door top arch	14 segmental door top arch	15 pointed door top arch	16 round trefoil door top arch
Function 1 (High flow)		y		y			y					y	y				
Questions and Answers		y		y			y					y	y				
Solution's classifier	29	1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Solution's classifier	33	1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Solution's classifier	42	1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Output from BrainMaker		1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Function 2 (High flow)		y		y			d	d	d	y			d	d	d	d	d
Questions and Answers		y		y			d			y		n	d				
Solution's classifier	111	1	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0
Output from BrainMaker		1	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0
Function 3 (Medium flow)			y	d	d		d	d		d		d	y				
Questions and Answers		n	y	d	d		d	d	n	d		d	y				
Solution's classifier	37	0	1	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Solution's classifier	61	0	1	1	0	0	0	1	0	1	0	0	1	0	0	0	0
Output from BrainMaker		1	0	1	1	1	1	0	[illegible]	1	[illegible]	0	1	0	0	0	1
Function 4 (Medium flow)			y		y		y			d		d	d				
Questions and Answers		n	y		y		y			d			d				
Solution's classifier	40	0	1	0	1	0	1	0	0	0	0	1	1	0	0	0	0
Output from BrainMaker		0	0	0	1	0	0	0	0	1	0	1	1	0	0	0	0
Materials 1 (Industrialised)		y			y		d	d		d	d	d	y				
Questions and Answers		y		n			d						y				
Solution's classifier	63	1	0	0	1	0	1	0	0	0	0	1	1	0	0	0	0
Output from BrainMaker		1	[illegible]	1	0	0	1	0	0	1	0	0	1	0	0	0	0
Materials 2 (Industrialised)			y	y			d	d				y	y				
Questions and Answers		n	y		n		d	d					y				
Solution's classifier	31	0	1	1	0	0	0	1	0	0	0	1	1	0	0	0	0
Output from BrainMaker		0	0	0	1	0	0	1	0	1	0	1	1	0	0	0	0
Materials 3 (Hand-crafted)			y	y			d	d		d	d	d	y				
Questions and Answers		n	y	y			d	d					y				
Solution's classifier	13	0	1	1	0	0	0	1	0	0	0	1	1	0	0	0	0
Output from BrainMaker		0	1	0	1	0	0	1	0	1	0	0	1	0	0	0	0
Materials 4 (Hand-crafted)			y	y			d	d		d	d	d	y				
Questions and Answers		n	y	y			d	d		d		d	y				
Solution's classifier	37	0	1	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Output from BrainMaker		0	1	1	0	0	0	1	0	1	0	0	1	0	0	0	0

		17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Type of user	*Case number*	op flat moulding	op curved moulding	riangular pediment	emi-circular or segmental pediment	*quared fanlight*	*anlight with undulate top*	*pointed arch fanlight*	*emi-circular or segmental arch fanlight*	ointed arch tympanum	emi-circular arch tympanum	*racery or steelwork on fanlight or tympanum*	*tained glass on fanlight*	lat rectangular porch	lat semi-circular porch	ediment porch	egmental (concave) porch
Function 1 (High flow)		*d*	*d*	*d*	*d*	*d*	*d*	*d*	*d*	*d*	*d*	*d*	*d*	*d*	*d*	*d*	*d*
Questions and Answers						*d*								*d*			
Solution's classifier	*29*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Solution's classifier	*33*	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0
Solution's classifier	*42*	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Function 2 (High flow)		*d*	*d*	*d*	*d*	*d*	*d*	*d*	*d*	*d*	*d*	*d*	*d*	*d*	*d*	*d*	*d*
Questions and Answers		*d*	*d*			*d*				*d*		*d*		*d*			
Solution's classifier	*111*	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0
Output from BrainMaker		0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Function 3 (Medium flow)		*d*	*d*			*d*				*d*		*d*		*d*			
Questions and Answers		*d*	*d*						*n*	*d*							
Solution's classifier	*37*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Solution's classifier	*61*	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Output from BrainMaker		1	[illegible]	0	0	0	0	0	1	1	0	1	0	0	0	0	0
Function 4 (Medium flow)		*d*	*d*			*d*				*d*		*d*		*d*			
Questions and Answers																	
Solution's classifier	*40*	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Output from BrainMaker		1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Materials 1 (Industrialised)						*d*								*d*			
Questions and Answers																	
Solution's classifier	*63*	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0
Output from BrainMaker		0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Materials 2 (Industrialised)		*d*				*d*								*d*			
Questions and Answers																	
Solution's classifier	*31*	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Materials 3 (Hand-crafted)		*d*	*d*			*d*			*d*	*d*		*d*		*d*			
Questions and Answers																	
Solution's classifier	*13*	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Materials 4 (Hand-crafted)		*d*	*d*			*d*			*d*	*d*		*d*		*d*			
Questions and Answers		*d*	*d*							*d*							
Solution's classifier	*37*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0

Type of user	Case number	33 onvex porch	34 olumns supporting porch	35 valls supporting porch	36 ables supporting porch	37 ateral squared section column	38 ateral cylindrical section column	39 ateral vertical moulding	40 window in one side	41 windows in both sides	42 vertical glass tower	43 ingular connection with glass tower	44 decorative sculptures	45 Surroundings material: glass	46 Surroundings material: brick	47 Surroundings material: smooth stone	48 Surroundings material: rough stone
Function 1 (High flow)		d	d	d	d	d	d	d	d	d	d	d	d	d	d	d	d
Questions and Answers				d					d	d				d	d	d	
Solution's classifier	29	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0
Solution's classifier	33	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0
Solution's classifier	42	0	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0
Output from BrainMaker		0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0
Function 2 (High flow)		d	d	d	d	d	d	d		y	d	d	d	d	d	d	d
Questions and Answers					d		d	d		y				d		d	
Solution's classifier	111	0	0	0	1	0	0	0	0	1	0	0	0	1	1	0	0
Output from BrainMaker		[illegible]	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0
Function 3 (Medium flow)			d	d		d	d	d	d	d	d			d	d	d	
Questions and Answers							d	d						d		d	
Solution's classifier	37	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
Solution's classifier	61	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0
Output from BrainMaker		[illegible]	0	0	0	0	0	1	0	0	0	0	[illegible]	1	0	1	0
Function 4 (Medium flow)			d	d		d	d	d	d	d	d			d	d	d	
Questions and Answers									d					d	d		
Solution's classifier	40	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0
Output from BrainMaker		0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
Materials 1 (Industrialised)			d	d						y	y		d	y			
Questions and Answers										y				y	n		
Solution's classifier	63	0	0	1	0	0	0	0	0	1	0	0	0	1	0	1	0
Output from BrainMaker		0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0
Materials 2 (Industrialised)			d	d		d	d	d	d	d			d	y	y		
Questions and Answers										d	n			y	y		
Solution's classifier	31	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0
Materials 3 (Hand-crafted)			d	d		d	d	d	d	d			d				y
Questions and Answers																	
Solution's classifier	13	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0
Output from BrainMaker		0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Materials 4 (Hand-crafted)			d	d		d	d	d	d	d			d				y
Questions and Answers							d	d						n			
Solution's classifier	37	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
Output from BrainMaker		0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0

Type of user	Case number	49 Surroundings material: concrete blocks	50 Surroundings material: concrete exposed	51 Surroundings material: timber	52 Surroundings material: smooth plasterwork	53 Surroundings material: rusticated plasterwork	54 Surroundings materials: tiles or small tiles	55 Surroundings material: metal	56 Swinging door: one single	57 Swinging door: two singles	58 Swinging door: one double	59 Swinging door: triple, two doubles or more	60 Revolving door (with four leaves)	61 Sliding door (one or more leaves)	62 Leaf: plain opaque	63 Leaf: plain transparent	64 Leaf: semi-opaque plain with one or more light cross panels
Function 1 (High flow)		d	d	d	d	d	d	d				y					
Questions and Answers				d	d			d			n	y	n				
Solution's classifier	*29*	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0
Solution's classifier	*33*	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0
Solution's classifier	*42*	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0
Output from BrainMaker		0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0
Function 2 (High flow)		d	d	d	d	d	d	d				y				y	
Questions and Answers									n		n						
Solution's classifier	*111*	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0
Output from BrainMaker		0	0	0	1	0	1	1	0	0	1	0	0	0	0	0	0
Function 3 (Medium flow)			d	d	d			d			y						
Questions and Answers											y						
Solution's classifier	*37*	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Solution's classifier	*61*	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Output from BrainMaker		[illegible]	[illegible]	0	0	0	[illegible]	[illegible]	0	0	1	0	0	0	0	0	0
Function 4 (Medium flow)			d	d	d			d			y						
Questions and Answers								d									
Solution's classifier	*40*	0	1	[illegible]	0	0	0	1	0	0	0	0	0	1	0	0	0
Output from BrainMaker		0	0	[illegible]	0	1	0	0	0	0	1	0	0	0	0	0	0
Materials 1 (Industrialised)								y			y						
Questions and Answers								y									
Solution's classifier	*63*	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Materials 2 (Industrialised)								y	d	d	d	d	d			y	
Questions and Answers																	
Solution's classifier	*31*	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Materials 3 (Hand-crafted)									d	d	d	d	d				
Questions and Answers																	
Solution's classifier	*13*	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Output from BrainMaker		0	0	1	0	0	0	1	1	0	1	0	0	0	0	0	0
Materials 4 (Hand-crafted)				y					d	d	d	d	d				
Questions and Answers																	
Solution's classifier	*37*	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0

Type of user	Case number	65 Leaf: paneled opaque	66 Leaf: paneled semi-opaque with one or more light cross panels	67 Leaf: framed with one or two light cross panels	68 Leaf: framed with three or more light cross panels	69 Steelwork leaf decoration	70 Leaf mat.: non-stained glass	71 Leaf mat.: stained glass	72 Leaf mat.: metal	73 Leaf mat.: timber	74 Round knob or ring handle	75 Rectangular, squared or trapezoid handle	76 Lever handle	77 Long horizontal static handle	78 Long vertical static handle	79 Short vertical static handle	80 Curved static handle
Function 1 (High flow)				y		d	d	d	d	d	d	d	d	d	d	d	d
Questions and Answers				y			d		d			d			d		
Solution's classifier	29	0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	0
Solution's classifier	33	0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	0
Solution's classifier	42	0	0	1	0	0	1	0	1	0	0	1	0	0	0	0	0
Output from BrainMaker		0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0
Function 2 (High flow)						d	d	d	d	d	d	d	d	d	d	d	d
Questions and Answers							d		d		d						
Solution's classifier	111	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
Output from BrainMaker		0	0	1	0	0	1	0	1	0	1	0	0	0	1	0	0
Function 3 (Medium flow)			y			d	y		d	d	d	d	d		d	d	
Questions and Answers			y			d	y		d	d							
Solution's classifier	37	0	1	0	0	0	1	0	0	1	1	0	0	0	0	0	0
Solution's classifier	61	0	1	0	0	1	1	0	1	1	1	0	[illegible]	0	0	0	0
Output from BrainMaker		1	1	0	0	1	1	0	1	0	1	0	0	0	0	0	0
Function 4 (Medium flow)			y			d	d		d	d	d	d	d		d	d	
Questions and Answers					n												
Solution's classifier	40	0	0	1	0	0	1	0	1	0	0	0	0	0	0	1	0
Output from BrainMaker		0	0	1	0	0	1	0	1	1	0	1	[illegible]	0	0	0	0
Materials 1 (Industrialised)				y			y		y		d	d	d	d	d	d	
Questions and Answers							y		y								
Solution's classifier	63	0	0	0	1	0	1	0	1	0	1	0	0	0	0	0	0
Output from BrainMaker		0	0	1	0	0	1	0	1	0	0	0	[illegible]	0	1	0	0
Materials 2 (Industrialised)							y		y		d	d	d	d	d	d	
Questions and Answers							y										
Solution's classifier	31	0	0	1	0	0	1	0	1	0	0	0	0	0	0	1	0
Output from BrainMaker		0	0	0	1	0	1	0	1	0	0	0	0	0	0	1	0
Materials 3 (Hand-crafted)		y				d				y	d	d	d	d	d	d	
Questions and Answers							n										
Solution's classifier	13	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Output from BrainMaker		0		0	0	0	1	0	0	1	1	0	0	0	0	0	0
Materials 4 (Hand-crafted)			y			d	y			y	d	d	d	d	d	d	
Questions and Answers						d	y		n								
Solution's classifier	37	0	1	0	0	0	1	0	0	1	1	0	0	0	0	0	0
Output from BrainMaker		0	1	0	0	0	1	0	1	1	0	0	0	0	0	0	0

Appendix 8

New solutions table

This appendix shows a table with only the experimentation results that generated new solutions. It is similar to the one contained in Appendix 7. The table is divided in blocs of four or five rows. The first row of each bloc contains the user type used in that particular test. It represents how a user of a particular type might answer each of the questions from the system. If a feature has a setting 'y' the answer should be 'yes', while having a 'd' setting would require an answer 'don't know'. A blank cell would require an answer 'no'.

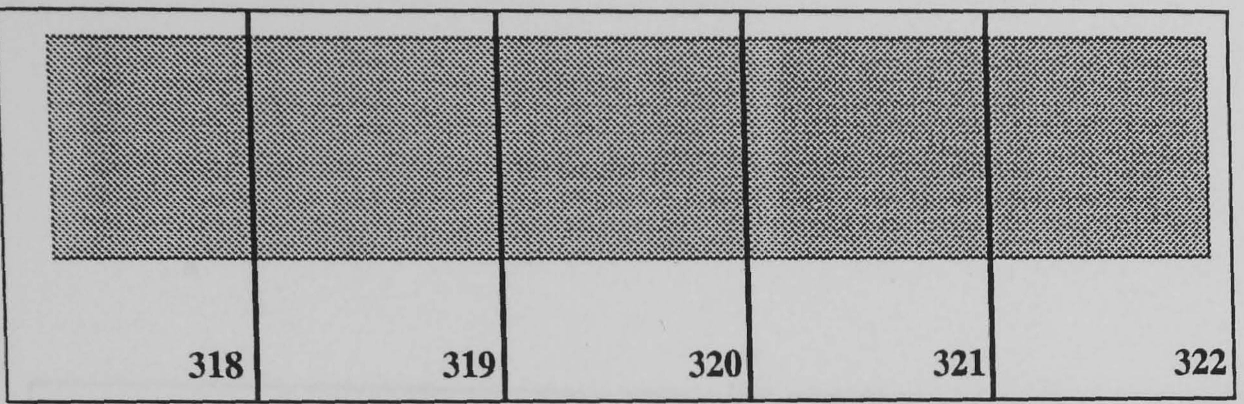
The second row of each bloc represents what questions were used by the system and what answers were given by the user. It corresponds to the problem's partial descriptions, as defined in Chapter 5. If a feature has a setting 'y' the answer was 'yes'. A feature with a 'd' means that the answer was 'don't know'. A feature with a 'n' indicates that the answer was 'no'.

The third row of each bloc, labeled 'Solution's classifier', contains the knowledge-base system solution. In one case, 'Post-Modern (eclectic 2), two rows contain the same kind of information, that is, the 'Solution's classifier', because there were two knowledge-base system solutions. A feature present is assigned the value '1' while a feature not present is assigned the value '0'.

The last row of each bloc contains the neural network solution for each of the tests undertaken. In this row a feature present is assigned the value '1' while a feature not present is assigned the value '0'.

Once the table is too large to fit in a single page, it has been broken down into smaller tables, each with its own labels of columns and rows.

The key map bellow indicates the relationship between tables. The numbers indicate the page in which each table can be found.



		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Type of user profile / Cortex Traces	ase number	*ain entrance*	*econdary entrance*	ublic access	estricted access	xit only	***ives access to: air lock, vestibule or foyer***	***ives access to: corridor or aisle***	***ives access to: shop or working room***	ligned to the facade	ulled out from the facade	ulled in from the facade	*lat door top*	***emi-circular door top arch***	***egmental door top arch***	***ointed door top arch***	***ound trefoil door top arch***
Gothic 1		y		y			y					y	y				
Questions and Answers		y		y			y						y				
Solution's classifier	*14*	1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Output from BrainMaker		1	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0
Art Nouveau 2		*y*		*d*	*d*	*d*	*y*			*d*	*d*	*d*	*d*		*d*		
Questions and Answers		*y*			*d*		*y*			*d*			*d*				
Solution's classifier	*103*	1	0	0	1	0	1	0	0	1	0	0	1	0	0	0	0
Output from BrainMaker		1	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0
Modern (functionalist 1)		y			y		y			y			y				
Questions and Answers		y			y		y						y				
Solution's classifier	*3*	1	0	0	1	0	1	0	0	1	0	0	1	0	0	0	0
Output from BrainMaker		1	0	0	1	0	1	0	0	1	0	0	1	0	0	0	0
Modern (brutalist 2)		y		y			y					y	y				
Questions and Answers		y		y			y					y	y				
Solution's classifier	*52*	1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Output from BrainMaker		1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Modern (high tech 1)		y		y			y					y	y				
Questions and Answers		y		y			y						y				
Solution's classifier	*48*	1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Output from BrainMaker		1	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0
Modern (high tech 2)		*d*	*d*	*d*	*d*		*y*					*y*	*y*				
Questions and Answers		*d*		*d*			*y*					*y*	*y*				
Solution's classifier	*63*	1	0	0	1	0	1	0	0	0	0	1	1	0	0	0	0
Output from BrainMaker		1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Modern (high tech 3)		y		y			y					y	y				
Questions and Answers		y		y			y					y	y				
Solution's classifier	*73*	1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Output from BrainMaker		1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0
Post-Modern (eclectic 2)		y			y		y				y		y				
Questions and Answers		y		n			y			n		n	y				
Solution's classifier	*1*	1	0	0	1	0	1	0	0	0	1	0	1	0	0	0	0
Output from BrainMaker		1	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0
Environmental control 4 (loose)			*y*	*y*				*y*		*d*		*d*	*y*				
Questions and Answers			*y*	*y*			*n*	*y*		*d*		*d*	*y*				
Solution's classifier	*13*	0	1	1	0	0	0	1	0	0	0	1	1	0	0	0	0
Solution's classifier	*61*	0	1	1	0	0	0	1	0	1	0	0	1	0	0	0	0
Output from BrainMaker		0	1	1	0	0	0	1	0	0	0	1	1	0	0	0	0

Type of user profile / Cortex Traces	Case number	17 top flat moulding	18 top curved moulding	19 triangular pediment	20 semi-circular or segmental pediment	21 *squared fanlight*	22 *fanlight with undulate top*	23 *pointed arch fanlight*	24 *semi-circular or segmental arch fanlight*	25 pointed arch tympanum	26 semi-circular arch tympanum	27 *tracery or steelwork on fanlight or tympanum*	28 *stained glass on fanlight*	29 flat retangular porch	30 flat semi-circular porch	31 pediment porch	32 segmental (concave) porch
Gothic 1			Y							Y		Y					
Questions and Answers		n															
Solution's classifier	*14*	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0
Output from BrainMaker		0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Art Nouveau 2							y						y				
Questions and Answers													y				
Solution's classifier	*103*	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0
Output from BrainMaker		1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0
Modern (functionalist 1)																	
Questions and Answers																	
Solution's classifier	*3*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Modern (brutalist 2)						y											
Questions and Answers		n				y											
Solution's classifier	*52*	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Modern (high tech 1)						y								y			
Questions and Answers																	
Solution's classifier	*48*	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0
Output from BrainMaker		0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Modern (high tech 2)						y											
Questions and Answers						y											
Solution's classifier	*63*	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0
Output from BrainMaker		0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Modern (high tech 3)																	
Questions and Answers														n			
Solution's classifier	*73*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Post-Modern (eclectic 3)																	
Questions and Answers																	
Solution's classifier	*1*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Environmental control 4 (loose)		d	d			d			d	d		d		d			
Questions and Answers			d			d				d		d		d			
Solution's classifier	*13*	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0
Solution's classifier	*61*	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

		33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
Type of user profile / Cortex Traces	*ase number*	onvex porch	*olumns supporting porch*	*walls supporting porch*	*ables supporting porch*	ateral squared section column	ateral cylindrical section column	ateral vertical moulding	window in one side	windows in both sides	*ertical glass tower*	*ngular connection with glass tower*	*ecorative sculptures*	Surroundings material: glass	Surroundings material: brick	Surroundings material: smooth stone	Surroundings material: rough stone
Gothic 1							y	y								y	
Questions and Answers							y							n		y	
Solution's classifier	*14*	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0
Output from BrainMaker		0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0
Art Nouveau 2														*y*		*y*	
Questions and Answers													*n*	*y*			
Solution's classifier	*103*	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0
Output from BrainMaker		0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0
Modern (functionalist 1)									y		y			y			
Questions and Answers									y	n	y			y	n		
Solution's classifier	*3*	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0
Modern (brutalist 2)										y				y			
Questions and Answers										y				y			
Solution's classifier	*52*	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0
Modern (high tech 1)			y											y		y	
Questions and Answers									n	n				y			
Solution's classifier	*48*	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0
Output from BrainMaker		1	0	0	1	0	0	0	0	0	1	0	0	1	0	1	0
Modern (high tech 2)										*y*	*y*	*d*		*y*			
Questions and Answers										*y*				*y*	*n*		
Solution's classifier	*63*	0	0	1	0	0	0	0	0	1	0	0	0	1	0	1	0
Output from BrainMaker		0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0
Modern (high tech 3)										y				y			
Questions and Answers										y				y		n	
Solution's classifier	*73*	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0
Post-Modern (eclectic 3)										y	y	y		y	y		
Questions and Answers										y				y	y		
Solution's classifier	*1*	0	0	0	0	0	0	0	0	1	1	1	0	1	1	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0
Environmental control 4 (loose)			*d*	*d*		*d*	*d*	*d*		*y*	*d*		*d*	*d*	*d*	*d*	*d*
Questions and Answers			*d*	*d*			*d*	*d*	*n*					*d*	*d*	*d*	
Solution's classifier	*13*	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0
Solution's classifier	*61*	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0
Output from BrainMaker		0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0

		49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
Type of user profile / Cortex Traces	*Case number*	Surroundings material: concrete blocks	Surroundings material: concrete exposed	Surroundings material: timber	Surroundings material: smooth plasterwork	Surroundings material: rusticated plasterwork	Surroundings materials: tiles or small tiles	Surroundings material: metal	*Swinging door: one single*	*Swinging door: two singles*	*Swinging door: one double*	*Swinging door: triple, two doubles or more*	*Revolving door (with four leaves)*	*Sliding door (one or more leaves)*	Leaf: plain opaque	Leaf: plain transparent	Leaf: semi-opaque plain with one or more light cross panels
Gothic 1										y							
Questions and Answers																	
Solution's classifier	*14*	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Art Nouveau 2					*y*				*y*								
Questions and Answers																	
Solution's classifier	*103*	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0
Modern (functionalist 1)						y		y	y								
Questions and Answers								y									
Solution's classifier	*3*	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Modern (brutalist 2)			y										y				
Questions and Answers								n					y				
Solution's classifier	52	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Modern (high tech 1)								y		y			y				
Questions and Answers								y									
Solution's classifier	*48*	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0
Output from BrainMaker		0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
Modern (high tech 2)								*y*		*d*			*d*			*y*	
Questions and Answers								*y*			*n*						
Solution's classifier	*63*	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0
Modern (high tech 3)								y				y	y				
Questions and Answers								y									
Solution's classifier	*73*	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0
Post-Modern (eclectic 3)								y			y						
Questions and Answers								y									
Solution's classifier	*1*	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Environmental control 4 (loose)			*d*	*d*	*d*			*d*			*d*						
Questions and Answers								*d*	*n*		*d*						
Solution's classifier	*13*	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Solution's classifier	*61*	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0

Type of user profile / Cortex Traces	ase number	65 eaf: paneled opaque	66 eaf: paneled semi-opaque with one r more light cross panels	67 eaf: framed with one or two light ross panels	68 eaf: framed with three or more light ross panels	69 teelwork leaf decoration	70 eaf mat.: non-stained glass	71 eaf mat.: stained glass	72 eaf mat.: metal	73 eaf mat.: timber	74 ound knob or ring handle	75 ectangular, squared or trapezoid handle	76 ever handle	77 ong horizontal static handle	78 ong vertical static handle	79 hort vertical static handle	80 urved static handle
Gothic 1		y								y	y						
Questions and Answers		y								y	y						
Solution's classifier	*14*	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Output from BrainMaker		1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Art Nouveau 2				y				y	y	y	d	d	d	d	d	d	d
Questions and Answers		n					n			y							
Solution's classifier	*103*	0	1	0	0	0	0	1	1	1	1	0	0	0	0	0	0
Output from BrainMaker		0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0
Modern (functionalist 1)					y		y		y						y		
Questions and Answers					y		y		y								
Solution's classifier	*3*	0	0	0	1	0	1	0	1	0	0	0	0	0	1	0	0
Output from BrainMaker		0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0
Modern (brutalist 2)				y			y		y						y		
Questions and Answers				y			y		y						y		
Solution's classifier	52	0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	0
Output from BrainMaker		0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	0
Modern (high tech 1)				y			y		y					y			
Questions and Answers							y		y								
Solution's classifier	*48*	0	0	1	0	0	1	0	1	0	0	0	0	1	0	0	0
Output from BrainMaker		0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	0
Modern (high tech 2)							y		y					d	d	d	
Questions and Answers							y		y								
Solution's classifier	*63*	0	0	0	1	0	1	0	1	0	1	0	0	0	0	0	0
Output from BrainMaker		0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	0
Modern (high tech 3)				y			y		y						y		
Questions and Answers				y			y		y								
Solution's classifier	*73*	0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	0
Output from BrainMaker		0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	0
Post-Modern (eclectic 3)					y		y		y						y		
Questions and Answers					y		y		y								
Solution's classifier	*1*	0	0	0	1	0	1	0	1	0	0	0	0	0	1	0	0
Output from BrainMaker		0	0	0	1	0	1	0	1	0	0	0	0	0	1	0	0
Environmental control 4 (loose)		d	d	d	d	d	d		d	d	d	d	d		d	d	
Questions and Answers		d	d	d		d	d		d	d	d						
Solution's classifier	*13*	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Solution's classifier	*61*	0	1	0	0	1	1	0	1	1	1	0	0	0	0	0	0
Output from BrainMaker		0	0	1	1	0	1	0	1	0	0	0	0	0	0	0	0

Appendix 8. New solutions table

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