# Retrieval tools in Building Case Bases

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## Abstract

Most of the existing aids to building design rely on data base of cases representing solutions to problems that are thought to happen again at least in a similar way. Crucial for the success of the aid is the retrieval engine. In tour its efficiency depends on the way the cases are encoded. Whichever is this way cases will be represented at different levels of abstraction. The highest level will probably consist in an accessibility and adjacency graph. Another level could be a wire plan of the building. An easily workable representation of a graph is a square matrix. For any given building typology it is possible to write a list of encoded space types. This allows forming matrices that can be compared and their diversity measured. Here we present an algorithm that makes this job. Such an algorithm can be one of the case retrieval tools in the data base. It is likely that the designer has already some idea of the shape he wants for the building he is designing. A comparison between some geometric characteristics of the wire representation of the retrieved case and the corresponding ones of the imagined solution of the design problem can constitute a second test. The matching can be done comparing both the shape of the perimeter and the shape of single spaces. A shape analyser formerly presented by the authors can once more do that job.

## Introduction

In the last decade the interest of CAAD research has shifted from the search of automated design tools to intelligent assistants mainly relying to knowledge representation and storing. To the second job the computer marks an undoubted advantage on human memory.

The importance of case archives has grown together with the acknowledgement of the prototype refinement approach (and derivatives) to design.

Crucial in this view becomes the retrieval mechanism. It depends directly on the way the cases are encoded. And this in tour being a linguistic question implies a theory of the nature of architectural object.

A design process develops in a non linear way jumping abruptly to different levels of abstraction. Hence an efficient case base has to comprise different representations of buildings corresponding to the levels chosen. The most abstract one, corresponding to the conceptual net of relationships between functional spaces is the graph of accessibility and of adjacency. A second level can be a wire plan informing about dimensions and shape both of the single spaces an the overall perimeter. A third level is the complete geometrical representation of the building comprising all the dimensions of the spaces and the specification of the material elements shaping them. We will deal here with the two first levels described implementing a retrieval mechanism aimed at finding the case closest to the project situation an architectural designer is dealing with.

## A case retrieval engine: the comparison of adjacency and connection graph

The retrieval of the closest case can be done through comparison of the graph representing the problem with the graphs representing the archived cases. For this purpose the graphs are to be encoded in the form of a square matrix in which the generic term **aij** represents the type of relationship between the space s **I** and **J**. Its value will be zero if the spaces are neither adjacent nor connected; will have conventional values if they are connected or adjacent. The values can represent simply adjacency and connection or also their importance. The simpler case gives a value **1** for adjacency and a value **2** for the connection. The comparison will be done, of course, between cases of the same typology, i.e. between house and house, hospital and hospital, school and school and so on. It is then possible to encode each type of space with a number so as to let the series of the first **n** natural numbers to correspond to the n types of spaces possible in the typology. If a type of space can be met **m** times in a case, it has to be represented by **m** numbers.

In order to give sense to the comparison of two adjacency and connection matrices it is necessary that rows and columns having the same indices have also the same meaning, that is that they are corresponding to the same type of functional space. The first step of the comparison between a matrix **A** representing the project requirements and a matrix **B,** representing a building of the same typology, is then to homogenize them of obtaining the aforesaid correspondence.

The second step is computing separately the numbers **p** of adjacences and **q** of connection coincidences between all the couples of elements **aij** e **bij**. If adjacencies are valued **1** and connections **2**, and the number of spaces of **A** and **B** are respectively **h** and **k**, the expression

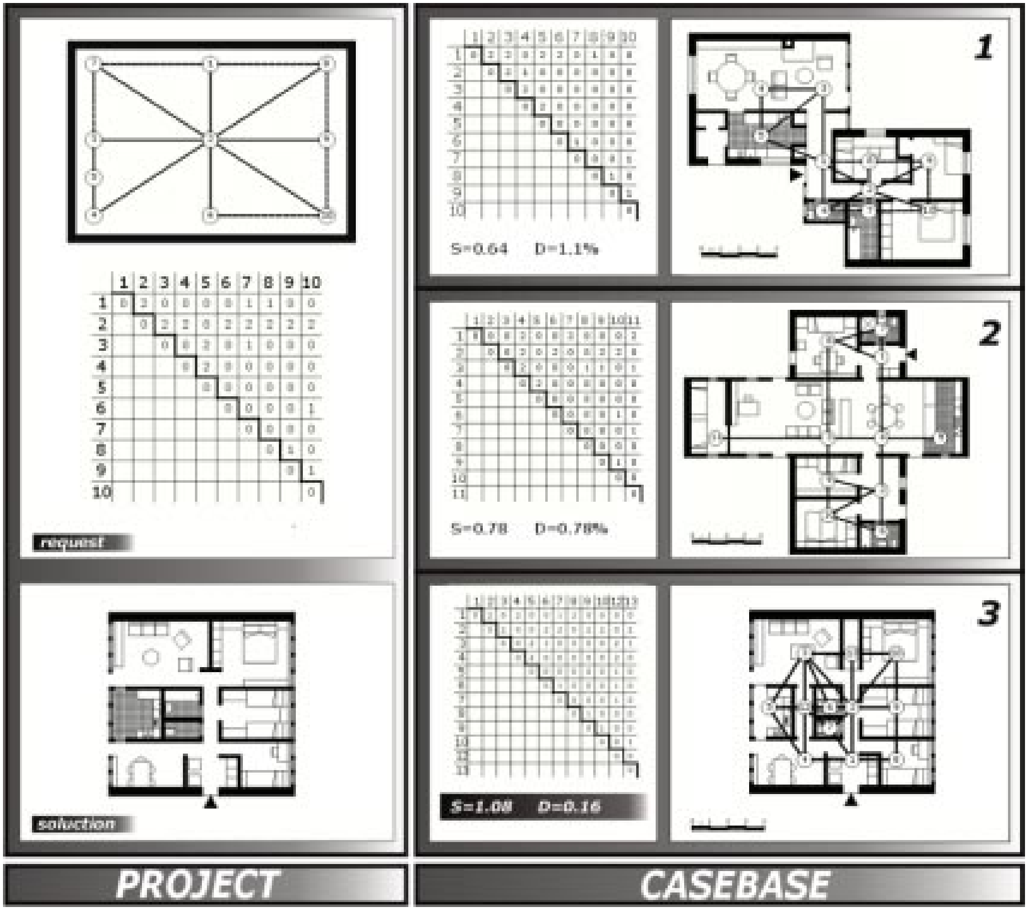
$$s = 2 (2p + q) / (h + k)$$

is a good measure of the similarity of the matrices and then of how similar the structure of the retrieved case is to the one of the design problem.

## A second retrieval engine: the comparison of shapes

The second retrieval mechanism concerns the comparison of shapes. In a previous paper [3] the authors presented a *Shape Analyser* able to recognise classes of shapes and the perceptual structures of their organisation in a plane architectural complex shape. One of its performances is the ability of computing an index of diversity between two plane shapes. Hence it is possible to employ this capability for a further or independent selection on the basis of a preference for a particular in a particular shape. For instance the choice could concern the compactness of the overall perimeter. The comparison could be done between a square and the perimeters of cases already selected on the base of others criteria, like the one presented in the preceding section.

We remind that the algorithm comparing shapes




con operate on polygons. Then if one of the shapes comprises a curve it is necessary to reduce it to a succession of right segments. The algorithm is based on the representation of a polygon as a succession of lengths of the sides on axis **X** and angles between subsequent sides on axis **Y**. The lengths of the compared polygons are normalised at unitary length and the areas comprised between the representations of the compared polygons are measured. A function of this measure represents the diversity of two shapes.

In the figure an example is given of the way the two retrieval engines work. In the left column the design situation is shown. The design graph is represented both in plane immersion and in matrix form. The rectangle around the graph represents the preferred shape to which the retrieved solutions will be compared. In the second and third column the matrices and the plans, with superposed graph, of three cases are shown, retrieved from a case base under the condition that the similitude factors were greater than 0.5. The second check executed on the distance of the perimeter shapes confirms that the last case is best suited to the design situation. In the last row of the first column the adopted plan is shown clearly derived from the third case, since this was the case having structure and shape characteristics most similar to the design problem ones.

## Conclusions

The capabilities of two simple retrieval engines in a case base are shown. They can be useful both in the didactics and in the professional activity. In the first field, particularly the graph criterion can be used in order to demonstrate the concept of typology, and in the analysis of single architectures. In the field of professional activity both can represent efficient retrieval engines in the case base of a design firm.

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