Marco Lazzari, Paolo Salvaneschi, & Luisito Brembilla (1996). Looking for analogies in structural safety management through connectionist associative memories, *Proc. of the IEEE International Workshop on Neural Networks for Identification, Control, Robotics, and Signal/Image Processing (NICROSP '96)*, Los Alamitos, CA, USA: IEEE Computer Society, 392 - 400
DOI: http://dx.doi.org/10.1109/NICRSP.1996.542783

Looking for Analogies in Structural Safety Management through Connectionist Associative Memories

Marco Lazzari Paolo Salvaneschi Luisito Brembilla
ISMES - via Pastrengo, 9 - 24068 Seriate BG - ITALY
tel: +39 35 307 243/237 fax: +39 35 302 999
email: {mlazzari, psalvaneschi}@ismes.it

Abstract *This paper describes the first successful achievements of an experimental application of connectionist hashed associative memories for realising analogical reasoning.*
The application field is the management of structural safety, where analogical reasoning is used to retrieve, given the qualitative description of the state of a structure, the closest-matching cases stored in a case base, which can help safety managers to interpret the current situation.
This work extends the use of Greene's associative memories by proposing a complex data structure and a compositional algorithm able to access the case base through structured keywords.

1. Introduction

Model-based reasoning is the core of the evaluation process carried out by knowledge-based systems developed by ISMES to cope with engineering problems such as the vulnerability assessment of masonry buildings and the safety management of dams and historical monuments [0].

Those systems integrate different kinds of knowledge and information to identify the current state of the structure to be assessed. The results of their processing are used by safety managers to understand the situation and to define proper actions to be undertaken.

All the data used and generated by these systems are stored into a database. Moreover, the users may add their own comments and conclusions (expert interpretation of the state; results of inspections). The key idea of this paper is that this additional knowledge may be used to warn the users, whenever the current situation is *similar* to past ones.

2. The context: a knowledge-based system for the management of dam safety

ISMES has developed a knowledge-based system (MISTRAL) for the management of dam safety [2] to support safety managers when interpreting monitoring data.

MISTRAL receives data from the automatic monitoring system of a dam, identifies the state of the structure and generates natural-language explanations of the results of the evaluation. The result of the evaluation is a set of qualitative *alarm indexes*, which express the state of the entities which have been assessed (instruments, dam blocks, foundation, physical processes, ...) in terms of values ranging from *normal* to *highly anomalous*.

[…]

3. The problem: taking advantage of past experts' evaluations

[…]

4. A viable solution: associative memories and analogical reasoning

[…]

5. A working solution: a software environment for implementing analogical reasoning

On the ground of the ideas introduced in the previous paragraphs, two tools were implemented - DEFTOOL and XANALOGY - which are used to build and run the aforementioned associative memories.

The first tool builds the net and data structures to perform at runtime the analogical search; the second one is the process which drives the use of such nets and data structures.

[…]

6. An example

[…]

7. Final remarks

Connectionist hashed associative memories have proved useful in developing tools for implementing analogical reasoning. These tools have been applied to diagnostic problems in civil engineering, but their use seems to be promising whenever a database of cases described by qualitative attributes has to be accessed to find similarities to a situation under evaluation, given an adequate indexing procedure. In our specific domain the indexing phase of the case-based reasoning was naturally achieved by mapping MISTRAL's qualitative indexes to integers.

The tools described were tested off-line on a reference database of real cases and provided results comparable to those achieved by other analogical tools developed at ISMES.

The study of post-optimisation strategies and the comparison with other viable neural techniques (e.g. radial basis functions) shall be the next step of the research. Moreover, the extension to more structured sets of indexes will be among our future challenges.

The design and training of the networks were performed on a personal computer using NeuralWorks Professional II Plus. The tools were developed in FORTRAN.

References

[1] P. Salvaneschi, M. Cadei, M. Lazzari, Applying AI to structural safety monitoring and evaluation, *IEEE Expert*, **11**(4), 1996.

[2] M. Lazzari, P. Salvaneschi, Improved monitoring and surveillance through integration of artificial intelligence and information management systems, *IEEE Conf. on Artificial Intelligence Applications*, San Antonio, TX, 1994.

[3] R.L. Greene, Connectionist hashed associative memory, *Artificial Intelligence*, **48**(1), 87-98, (1991).

[4] R.L. Greene, Efficient retrieval from sparse associative memory, *Artificial Intelligence*, **66**(2), 395-410, (1994).

[5] J. Hertz, A. Krogh, R.G. Palmer, *Introduction to the theory of neural computation*, Addison-Wesley, Reading, MA, 1991.

[6] D.E. Rumelhart, G.E, Hinton and R.J. Williams, Learning internal representations by error propagation, in: D.E. Rumelhart, J.L. McClelland and the PDP Research Group, eds., *Parallel Distributed Processing: Explorations in the Microstructure of Cognition*, **1**, Bradford Books/MIT Press, Cambridge, MA, 1986.