

A Fuzzy Knowledge Map Framework for Knowledge Representation

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I declare that this thesis is my own account of my research and contains as its main content work which has not previously been submitted for a degree at any tertiary education institution.

.....
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ABSTRACT

Cognitive Maps (CMs) have shown promise as tools for modelling and simulation of knowledge in computers as representation of real objects, concepts, perceptions or events and their relations. This thesis examines the application of fuzzy theory to the expression of these relations, and investigates the development of a framework to better manage the operations of these relations.

The Fuzzy Cognitive Map (FCM) was introduced in 1986 but little progress has been made since. This is because of the difficulty of modifying or extending its reasoning mechanism from causality to relations other than causality, such as associative and deductive reasoning. The ability to express the complex relations between objects and concepts determines the usefulness of the maps. Structuring these concepts and relations in a model so that they can be consistently represented and quickly accessed and manipulated by a computer is the goal of knowledge representation. This forms the main motivation of this research.

In this thesis, a novel framework is proposed whereby single-antecedent fuzzy rules can be applied to a directed graph, and reasoning ability is extended to include non-causality. The framework provides a hierarchical structure where a graph in a higher layer represents knowledge at a high level of abstraction, and graphs in a lower layer represent the knowledge in more detail. The framework allows a modular design of knowledge representation and facilitates the creation of a more complex structure for modelling and reasoning.

The experiments conducted in this thesis show that the proposed framework is effective and useful for deriving inferences from input data, solving certain classification problems, and for prediction and decision-making.

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PUBLICATIONS

Some contents of this thesis have been peer-reviewed and published. The chapters with the contents so peer-reviewed and published are listed below:

Chapter 2:

Relevant publications:

1) S. W. Khor and M. S. Khan, "Scenario planning using fuzzy cognitive maps," in *ANZIIS 2003, Eighth Australian and New Zealand Intelligent Information Systems Conference*, 2003, pp. 311-316.

2) M. S. Khan, S. W. Khor and A. Chong, "Fuzzy cognitive maps with genetic algorithm for goal-oriented decision support," *IJUFKS, International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems*, vol. 12(supplementary 2), pp. 31-42, Sep 2004.

Chapter 3:

Relevant publications:

1) S. W. Khor, M. S. Khan and K. W. Wong, "Using single-antecedent fuzzy rules in fuzzy knowledge map," in *TAAI 2005, 10th Conf. on Artificial Intelligence and Applications*, CD ROM, International trek: Fuzzy System I, Trek 229, 2005.

2) S. W. Khor, M. S. Khan and K. W. Wong, "Fuzzy inferencing using single-antecedent fuzzy rules," in *PEECS 2005, Postgraduate Electrical Engineering and Computing Symposium*, 2005, pp. 1-6.

Chapter 4:

Relevant publications:

1) S. W. Khor, "An experimental study of a fuzzy rules reduction method using the Sugeno and Yasukawa's qualitative modeling," in *FIP 2003, International Conference on Fuzzy Information Processing: Theories and Applications*, 2003, pp. 461-466.

2) S. W. Khor, M. S. Khan and K. W. Wong, "Efficient fuzzy modelling using single-antecedent fuzzy knowledge map," *International Journal of Fuzzy Systems*, (In print).

3) S. W. Khor, M. S. Khan and C. C. Fung, "Fuzzy modelling using a simplified rule base," in *CIS 2004, IEEE Conference on Cybernetics and Intelligent Systems*, 2004, pp. 312-317.

4) S. W. Khor, J. Payakpate, M. S. Khan and C. C. Fung, "A new approach to fuzzy knowledge representation," in *PEECS 2004, Postgraduate Electrical Engineering and Computing Symposium*, 2004, pp. 210-216.

Chapter 5:

Relevant publications:

1) M. S. Khan and S. W. Khor, "A framework for fuzzy rule-based cognitive maps," in *PRICAI 2004, 8th Pacific Rim Intl. Conf. on Artificial Intelligence*, 2004, pp. 454-463.

2) S. W. Khor, M. S. Khan and C. C. Fung, "Fuzzy modelling using reduced rule sets," in *PEECS 2004, Postgraduate Electrical Engineering and Computing Symposium*, 2004, pp. 169-174.

3) M. S. Khan, S. W. Khor and J. Payakpate, "Fuzzy knowledge representation for decision support," in *KBCS 2004, fifth International Conference on Knowledge Based Computer Systems*, 2004, pp. 186-195.

Chapter 6:

Relevant publications:

1) M. S. Khan and S. W. Khor, 2006, A Fuzzy Modeling Framework for Stock Market Analysis, *Journal of Business Information Technology*, vol. 6, no. 1. (in print).