The Effects of Using Problem Knowledge in a Neural Network for Image Processing Tasks

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To the memory of my father Dr. K. G. Gunetileke

ABSTRACT

This thesis is concerned with aspects of computational intelligence. Computational intelligence is a new paradigm of artificial intelligence based on biological intelligence. Computational Intelligence explores the potential for biologically inspired intelligent adaptive machines and behavior. A relatively new and important sub discipline within the field of computational intelligence, is that of neural networks. Neural networks are networks of artificial neurons with a high degree of interconnectivity. The networks capture and accumulate knowledge as the pattern of weights in the interconnections between neurons. Neural networks are iteratively trained to perform tasks by "learning" from examples. These networks are often slow to train. One of the reasons for this is that the starting weights of the network are conventionally not related to the problem being solved. In this thesis a methodology is explored that maps problem knowledge to the starting weights of a fuzzy neural network window filter (FuNNWF). The FuNNWF architecture was developed from the combination of fuzzy logic and artificial neural networks for image processing tasks. The effects of the use of problem knowledge on FuNNWF training are investigated. The problem knowledge mapping procedure is extended from boolean rule mapping to conditional rule mapping, which allows better representation of the problems. Four real world image processing problems are investigated using the new weight initialization methodology. The experiments reported in this thesis demonstrate that the use of problem knowledge improves the robustness and convergence of the neural network. It is also shown that the use of the methodology is most effective on network training when the training data is noisy, unreliable and ambiguous.

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LIST OF FIGURES

PUBLICATIONS

Publications prepared during the course of the research for this thesis are listed below. Refereed publications are highlighted:

1. Gunetileke S., Chaplin R. I., Siroki M., Hodgson R. M., The Development of Neural Network Technologies for Image Processing, Proceedings of the 5th Annual New Zealand Engineering and Technology Postgraduate Conference, Palmerston North, New Zealand, November 1998, pp 103-104.

2. **Chaplin R. I., Siroki M., Hodgson R. M. & Gunetileke S., The Development of Mapping Techniques to Incorporate Image Processing Problem Specific Rules into Neural Networks, Proceedings of the Image & Vision Computing New Zealand International Conference (IVCNZ '98), Auckland, New Zealand, November 1998, pp 357-362 (Refereed publication).**

3. **Chaplin R. I., Hodgson R. M. & Gunetileke S., Towards the Use of Problem Knowledge in Training Neural Networks for Image Processing Tasks, Proceedings of IEE Seventh International Conference on Image Processing and its Applications, Manchester, UK, July 1999, pp 62-66 (Refereed publication).**

4. **Chaplin R. I., Hodgson R. M. & Gunetileke S., Automatic Wane Detection in the Images of Planks using a Neural Network, Proceedings of the 5th International Symposium on Signal Processing and its Applications (ISSPA '99), Brisbane, Australia, August 1999, pp 657-660 (Refereed publication).**

5. **Chaplin R. I., Hodgson R. M. & Gunetileke S., Seeding an ANN From Problem Knowledge for Image Processing Tasks, Proceedings of the Image & Vision Computing New Zealand International Conference (IVCNZ '99), Christchurch, New Zealand, August 1999, pp 277-282 (Refereed publication).**

6. Chaplin R. I., Hodgson R. M. & Gunetileke S., Towards the Use of Problem Knowledge in Training Neural Networks for Image Processing Tasks, 6th National New Zealand Postgraduate Conference, Christchurch, New Zealand, November 1999.

7. **Chaplin R. I., Hodgson R. M. & Gunetileke S., Seeding an ANN from Problem Knowledge for Image Processing Tasks, *in* Emerging Knowledge Engineering and Connectionist-Based Information Systems, Proceedings of the ICONIP/ANZIIS/ANNES '99 International Workshop, Dunedin, New Zealand, November 1999, pp 83-87 (Refereed publication).**

8. Gunetileke S., Chaplin R. I. & Hodgson R. M., A Tutorial on how to Insert Problem Knowledge into a Fuzzy Neural Network, Proceedings of the 7th Annual New Zealand Engineering and Technology Postgraduate Conference, Palmerston North, New Zealand, November 2000, pp 411-416.

9. **Gunetileke S., Chaplin R. I. & Hodgson R. M., The Use of Problem Knowledge to Improve the Robustness of a Fuzzy Neural Network, *in* Neural Networks for Signal Processing X, Proceedings of the 2000 IEEE Signal Processing Society Workshop, Sydney, Australia, December 2000, pp 682-691 (Refereed publication).**

10. **Chaplin R. I., Gunetileke S. & Hodgson R. M., Initializing Neural Networks with A-Priori Problem Knowledge, *in* Neural Networks for Signal Processing X, Proceedings of the 2000 IEEE Signal Processing Society Workshop, Sydney Australia, December 2000, pp 165-174 (Refereed publication).**