School of Computing

Model-Based Neural Networks For Invariant Pattern Recognition

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This thesis is presented as part of the requirements for
the award of the Degree of Doctor of Philosophy
of the
Curtin University of Technology

October 27, 1996

Acknowledgments

All attempts to acknowledge those who have helped a large project to completion are prone to the risk that someone may be left out. Nevertheless, I commence by thanking my supervisor, Terry Caelli. I cannot imagine a PhD. student being more fortunate than to have Terry as a supervisor. Throughout the entire process he has remained enthusiastic, encouraging and stimulating. Moreover, he has been a friend, providing support of all kinds.

Special thanks must go to my two good friends Tom Wild and Michael Merrylees. It is due to them that I commenced working towards this thesis. Tom introduced me to Terry Caelli, and we shared an introduction to neural networks programming together. There are functions in the **Xnet** package for which he is responsible. Michael was responsible for convincing me that taking on this project was a good idea, and has always been a fount of good cheer and good ideas. My other close friends, though perhaps not directly involved academically, have been vital in sustaining me. They know who they are.

All the members of the Vision Group, in both its Melbourne University and Curtin University incarnations, have collaborated to produce a happy, stimulating environment. In particular, I would like to thank Craig Dillon and Mark Ollila for help at various times with C programming and typesetting with LaTeX. John Krivitsky has provided similar help, and has also responded promptly and effectively to my system administration requests, which were no doubt less than reasonable at times. Tom Drummond was a marvelous universal sounding-board, particularly in mathematical matters. All of them have become friends.

Finally, I must thank my parents, who have been constantly supportive throughout the years I have worked towards this thesis, as indeed they have always been. They have always encouraged me, and fostered self-belief with their faith and love.

David Squire
February 10, 1997

Abstract

In this thesis, the notion of *Model-Based Neural Networks* is introduced. Model-Based Neural Networks, whilst retaining the essential structure and advantages of traditional neural networks, enable explicit modeling of the target system. This can result in dramatically improved generalization of classification performance to patterns not present in the training data, and representation in considerably lower-dimensional state spaces.

An important problem in many areas of computer vision is invariant pattern recognition. This is the chosen domain for demonstrating the efficacy of the Model-Based Neural Network approach. Model-Based Neural Networks can be constructed which have responses which are invariant to specified transformations of the input data. Such networks can be trained with much smaller training sets than are required by traditional networks, since it is no longer necessary to provide examples of transformed versions of the input prototypes. This, coupled with the reduction in the dimensionality of the parameter space, means that training such networks is often much less computationally-expensive than the traditional alternative.

To situate this work, a review of existing general techniques for invariant pattern recognition is presented in Chapter 2, and of previous neural network-based approaches in Chapter 3. Chapter 4 presents a variety of different forms of Model-Based Neural Network, and demonstrates their utility on a range of invariant pattern recognition problems, both real and synthetic. Included is a comparison with an earlier study, which reveals the great improvements possible with Model-Based Neural Networks.

Chapter 5 introduces a new invariant feature of two-dimensional contours, the Invariance Signature. It is shown in Chapter 6 that a Model-Based Neural Network can be constructed which calculates this multi-dimensional feature, and classifies patterns on this basis. Chapter 7 reports experimental results demonstrating that such Invariance Signature-based MBNNs can be employed successfully for shift-, rotation- and scale-invariant optical character recognition.

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