This paper describes a method for growing a recurrent neural network of fuzzy threshold units for the classification of feature vectors. Fuzzy networks seem natural for performing classification, since classification is concerned with set membership and objects generally belonging to sets of various degrees. A fuzzy unit in the architecture proposed here determines the degree to which the input vector lies in the fuzzy set associated with the fuzzy unit. This is in contrast to perceptrons that determine the correlation between input vector and a weighting vector. The resulting membership value, in the case of the fuzzy unit, is compared with a threshold, which is interpreted as a membership value. Training of a fuzzy unit is based on an algorithm for linear inequalities similar to Ho-Kashyap recording. These fuzzy threshold units are fully connected in a recurrent network. The network grows as it is trained. The advantages of the network and its training method are: (1) Allowing the network to grow to the required size which is generally much smaller than the size of the network which would be obtained otherwise, implying better generalization, smaller storage requirements and fewer calculations during classification; (2) The training time is extremely short; (3) Recurrent networks such as this one are generally readily implemented in hardware; (4) Classification accuracy obtained on several standard data sets is better than that obtained by the majority of other standard methods; and (5) The use of fuzzy logic is very intuitive since class membership is generally fuzzy.

1. Introduction

1.1. Background

The advantages of the network and its training method, described here, are due to the recurrent nature of the network, the fuzzy property of the threshold units, and the fact that the training algorithm allows the network to grow to the required size. Recurrent networks are more readily implemented in hardware. Growth of a network prevents development of a network that is otherwise poor in generalisation, because it remembers its training data. Fuzzy logic is very intuitive because set membership in reality is generally fuzzy.

A class of neural networks which has proven to be useful for classification is the class of recurrent neural networks, an example of which is the Hopfield network. Recurrent networks are inherently more effective than feedforward networks because they are able to dynamically store and use state information indefinitely due to built-in feedback. They can also be modelled and trained to function like deterministic, sequential finite state automata.

A Hopfield network is fully recurrent except that no self-connections are allowed and other connections are symmetric. Several researchers have used the Hopfield network or version thereof, as a content addressable memory for the purpose of pattern classification. One of the main advantages of the Hopfield network versus MLP, for classification, is

*E-mail: rbrouwer@cariboo.bc.ca
References


