

# Preface

In this book, a neural network learning method with type-2 fuzzy weight adjustment is proposed. The mathematical analysis of the proposed learning method architecture and the adaptation of type-2 fuzzy weights are presented. The proposed method is based on research of recent methods that handle weight adaptation and especially fuzzy weights.

The internal operation of the neuron is changed to work with two internal calculations for the activation function to obtain two results as outputs of the proposed method. Simulation results and a comparative study among monolithic neural networks, neural network with type-1 fuzzy weights, and neural network with type-2 fuzzy weights are presented to illustrate the advantages of the proposed method.

The proposed approach is based on recent methods that handle adaptation of weights using fuzzy logic of type-1 and type-2. The proposed approach is applied to the cases of prediction for the Mackey-Glass (for  $\tau = 17$ ) and Dow-Jones time series, and recognition of person with iris biometric measure. In some experiments, noise was applied in different levels to the test data of the Mackey-Glass time series for showing that the type-2 fuzzy backpropagation approach obtains better behavior and tolerance to noise than the other methods.

The optimization algorithms that were used are the genetic algorithm and the particle swarm optimization algorithm and the purpose of applying these methods was to find the optimal type-2 fuzzy inference systems for the neural network with type-2 fuzzy weights that permit to obtain the lowest prediction error.

We describe in Chap. 1 a brief introduction to the potential of the use of type-2 fuzzy weights in the neural networks. We also mention the applications of the proposed methods.

In Chap. 2, some basic theoretical and technical concepts about the areas of computational intelligent, forecasts, and recognition as well as a brief introduction and operation of each are addressed, as all of them are of great importance for the development of this book.

We present in Chap. 3 a clear and accurate explanation of the proposed method of neural network with fuzzy weights; also, the mathematical analysis of the type-1 and type-2 fuzzy weights, and all information used to carry the optimization of the type-2 fuzzy inference systems for the ensemble neural network and monolithic neural network with type-2 fuzzy weights are shown.

In addition, it shows all the architectures of the ensemble neural network and neural network with type-1 and type-2 fuzzy weights implemented; also an explanation of the chromosome with the GA used to optimize the neural network and membership functions for the ensemble neural network with type-2 fuzzy weights are shown. It also shows how type-1 and type-2 fuzzy weights fuzzy Inference System are Implemented for type-2, the membership functions used, and also shows the representation of the chromosome with the GA and the representation of the particles with PSO for the optimization of the membership functions of the type-2 fuzzy systems.

In Chap. 4, we present the results for the proposed method for all study cases: recognition of persons using iris biometric measure with neural network with type-2 fuzzy weights, ensemble neural network with type-2 fuzzy weights and its optimization with GA, neural network with type-1 and type-2 fuzzy weights for triangular and Gaussian membership functions and its optimization with GA, and PSO algorithms for the Mackey-Glass time series with which we work during the development optimization of the book.

In Chap. 5, we presented the conclusions of the proposed method based on the results obtained. In addition, possible future work is outlined.

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