Chapter 5
Type-2 Fuzzy Interface for Artificial Neural Network

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ABSTRACT

Artificial Neural Network (ANN) based systems are bio-inspired mechanisms for intelligent decision support with capabilities to learn generalized knowledge from the large amount of data and offers high degree of self-learning. However, the knowledge in such ANN system is stored in the generalized connection between neurons in implicit fashion, which does not help in providing proper explanation and reasoning to users of the system and results in low level of user friendliness. On the other hand, fuzzy systems are very user friendly, represent knowledge in highly readable form and provide friendly justification to users as knowledge is stored explicitly in the system. Type-2 fuzzy systems are one step ahead while computing with words in comparison to typical fuzzy systems. This chapter introduces a generic framework of type-2 fuzzy interface to an ANN system for course selection process. Resulting neuro-fuzzy system offers advantages of self-learning and implicit knowledge representation along with the utmost user friendliness and explicit justification.

INTRODUCTION

Artificial Neural Network (ANN) is a step towards simulation of human brain, where knowledge is stored in the interconnected processing elements called neurons. ANN systems have been widely used for classification, pattern recognition, forecasting, and learning. These systems can learn automatically from large number of data sets and hence overcome need of documenting knowledge manually. One of the major limitations of ANN is that, they operate on crisp data. Preparation of such large crisp data sets is a tedious and time consuming procedure, which can be avoided by facilitating an interface that directly inputs the environmental fuzzy data. This chapter describes design of a fuzzy interface system which enables users to input environmental
linguistic values of the input parameters to a base ANN instead of crisp data.

The fuzzy interface system proposed here is based on type-2 fuzzy sets. Traditional fuzzy logic i.e. type-1 fuzzy logic operates on fuzzy membership functions, mapping fuzzy to crisp values whereas type-2 fuzzy system has grades of membership that are fuzzy. There are some perceptions which cannot be modeled by traditional mathematical techniques, not even with traditional fuzzy logic. The type-2 fuzzy membership grades can be used to model perceptions like health, comfort, etc. more effectively than the type-1 fuzzy sets. Type-2 fuzzy system offers significant improvement on type-1 fuzzy system where data is more imprecise or vague. Second section of the chapter covers introduction of fuzzy logic, fuzzy membership functions, and type-1 and type-2 fuzzy systems for the benefit of novice readers to provide conceptual clarity. The second section elucidates related work in fuzzy systems and introduces type-2 fuzzy logic. Third section presents the concept of ANN and discusses structure, advantages and applications of ANN. Fourth section elaborates need of hybridization of ANN and Fuzzy Logic (FL) and discusses the approaches available for modeling of neuro-fuzzy system. To facilitate fuzzy vague linguistic parameters to a base ANN, a general structure of the interface with detailed methodology of the type-2 fuzzy interface is discussed in the fifth section.

Sixth section illustrates an experimental prototype with fuzzy interface and base ANN. ANN system used in the experiment is meant for course selection process assisting users in taking effective and timely decision while selecting suitable course. The course selection process is basically an advisory and counseling type of system, in which critical decisions are to be taken in timely and effective fashion. There are plenty of students and professionals who select study courses every academic year. However, the relevant data are not available in a desired manner to come to a generalized conclusion. That is, from the bulk of domain transactions it is difficult to derive generalized logic and rules which aid future decision making and provide necessary guidelines to the candidate users/students. The situation becomes more complex as every academic year results in increased number of institutes and novel study courses at national and international level. The ANN used here as a base system help in generalizing logic from the large training sets and help in determining broad aptitude category of the user. The decision is further fine tuned by the fuzzy interface system. The type-2 fuzzy interface is used to feed the input to the base ANN system. That is, the system operates with fuzzy inputs and output advices in user-friendly (fuzzy) fashion. In the sixth section the ANN system design, heuristic used for the hidden layers, and learning paradigm are discussed in detail for the application of course selection. Apart from fuzzy interface system design and ANN methodology, the input and output design along with a few sample screens from the experiment are also shown in sixth section.

The next section discusses the output and findings of the experiment to develop the neuro-fuzzy system at the Department of Computer Science, Sardar Patel University, India. The concluding section discusses future enhancement and enlists different multi-disciplinary application areas where such interfaces are critically required and increases the effectiveness of the system to which the interface is integrated.

FUZZY LOGIC AND FUZZY INTERFACE SYSTEM

Fuzzy Logic

Fuzzy logic, in comparison to traditional crisp logic, is a flexible machine-learning technique. Crisp logic is a bi-valued logic representing two possible solution states, often represented by yes/no, 0/1, black/white, or true/false. Fuzzy logic is a multi-valued logic that attempts at mimicking the
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