

10. Case Based Systems: A Neuro-Fuzzy Method for Selecting Cases

Rajat K. De and Sankar K. Pal

Abstract. Various case based systems designed in soft computing paradigms are, first of all, described in brief. This is followed by a detailed description of a fuzzy neural network for selection of cases. The notion of fuzzy similarity is used for selecting the same from both overlapping and non-overlapping regions. The architecture of the network is adaptively determined through *growing* and *pruning* of hidden nodes under supervised training. The effectiveness of the cases, thus selected by the network, is demonstrated for pattern classification problem using the 1-NN rule with the cases as the prototypes. Results are presented using real-life data.

10.1 Introduction

A case based system adapts old solutions to meet new demands, explains and critiques new situations using old instances (called cases), and performs reasoning from precedents to interpret new problems [1–3]. A case may be defined as a contextualized piece of knowledge representing an experience that teaches a lesson fundamental to achieving the goals of the system. The system learns as a byproduct of its reasoning activity. It becomes more efficient and more competent as a result of storing the experience of the system and referring to them in later reasoning. The case based system, in contrast to the traditional knowledge based system, operates through a process of remembering one or a small set of concrete instances or cases and basing decisions on comparisons between the new situation and the old one. The task of selection of cases constitutes an important and integral part of a case based system, particularly when the size of the data set is large.

Incorporation of fuzzy set theory enables one to deal with uncertainties in a system, arising from deficiency (e.g., vagueness, incompleteness) in information, in an efficient manner. Artificial neural networks (ANNs) having the capability of fault tolerance, adaptivity and generalization, and scope for massive parallelism, are widely used in dealing with learning and recognition tasks. Recently, attempts have been made to integrate the merits of fuzzy set theory and ANN under the heading ‘neuro-fuzzy computing’ for making the systems artificially more intelligent [4–7]. The theories of fuzzy sets, neural networks and neuro-fuzzy computing are tools of a new paradigm of research called ‘soft computing’ [8–11,4,12].

For the last few years, attempts have been made to develop methodologies integrating the theory of case based reasoning (CBR) and the aforesaid tools of soft computing. Outcomes of such investigations using the notion of fuzzy sets include an advanced case-knowledge architecture [13], fuzzy set modeling of CBR [14], case based fuzzy system in anesthesia [15], indexing and retrieval in case based systems [16], and a case based system for financial application [17]. Similarly, using neural

networks resulted in hybrid case based connectionist systems [18–20], connectionist indexing approaches [21,22], connectionist methods for learning and retrieval of cases [23,24], case based system for oceanographic forecasting [25], and a case based legal expert system [26]. The literature on neuro-fuzzy case based systems is, on the other hand, comparatively scanty. A few attempts made under this framework are reported in [27–29] for diagnosing symptoms in electronic circuits, and for retrieval of cases and fuzzy inferencing.

In Section 10.2, we describe the basic features of some of these systems. As mentioned earlier, the issue of case selection is crucial for a case based system. In Sections 10.3–10.5, we describe a newly developed neuro-fuzzy system for selecting cases in pattern recognition problems. Here the cases are viewed as typically labeled patterns which represent different regions of the classes. A notion of fuzzy similarity is incorporated together with repeated *insertion* and *deletion* of cases in order to determine a stable case base. The architecture of the connectionist model is determined adaptively through *growing* and *pruning* of hidden nodes under a supervised mode of training. In order to demonstrate the effectiveness of the network (methodology) for pattern classification, we have considered the principle of k -NN classifier with $k = 1$ and the cases as the prototypes. Some results demonstrating its effectiveness, along with comparisons, are described using real-life speech [8] and medical data [30].

10.2 Different Soft Computing Case Based Systems

Here we describe a few case based systems which are designed in a soft computing framework for real-life applications. These include a fuzzy case based system for a financial application [17], connectionist case based system for oceanographic forecasting [25] and legal advice [26], and a neuro-fuzzy case based system for diagnosing symptoms in electronic circuits [27].

10.2.1 Fuzzy Case Based System for Financial Application

Bonissone and Cheetham [17] have developed a PROperty Financial Information Technology (PROFIT) system to estimate residential property values for real estate transactions. The system uses CBR techniques with fuzzy predicates expressing preferences in determining similarities between subject and cases. These similarities guide the selection and aggregation process, leading to the final property value estimate. The concept of fuzzy sets is used to generate a confidence value qualifying such estimate. The methodology involves:

- (i) retrieving recent sales from a case base using a small number of features to select potential cases;
- (ii) comparing the subject properties with those of the retrieved cases, and deriving a partial ordering (similarity measure) from the aggregation of fuzzy preference values;
- (iii) adjusting the sales price of the retrieved cases to reflect their differences from the subject using a rule set;