A Fuzzy Classifier based on Product and Sum Aggregation Reasoning Rule

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ABSTRACT

This paper proposes the algorithm ProSum to perform the supervised classification of the data. In the proposed algorithm data is fuzzified by using π-type membership function to give the feature belongingness of each pattern to each class. By using Product aggregation reasoning rule (PARR) and sum aggregation reasoning rule (SARR), the belongingness of each pattern to each class is determined. Finally by using defuzzification operation each pattern is assigned with the predicted class label. In this paper, proposed algorithm is applied to four dataset: IRIS, WINE, BUPA and PIMA. Accuracy of the results is measured by using performance measures Misclassification (MC), Percentage of overall class Accuracy (PA) and Kappa Index of Agreement (KIA). The performance of ProSum is compared with C4.5 and PARR.

General Terms

Data mining classification, fuzzy classification

Keywords

Classification, Fuzzy logic, Aggregation operator, π-type membership function.

1. INTRODUCTION

Classification is one of the most frequent decision making tasks performed by humans. A classification problem occurs when an object needs to be assigned to a predefined group or class based on the number of observed attributes related to that object [1]. Classification problems involve assigning a class C_i from a predefined class set $C = \{ C_1, C_2, \ldots, C_M \}$ to an object, described as a point in a certain feature space $x \in S_N$. The problem of designing a classifier is to find a mapping $D : S_N \rightarrow C$ optimal in the sense of a certain criterion δ (D) that determines the classifier performance [2]. Usually, the final goal is to design a classifier that assigns class labels with the smallest possible error across the whole feature space. The classifier may be a Artificial neural network (ANN), a decision tree, a Bayesian classifier, a set of fuzzy rules etc. Neural Networks are a synchronous system that gives possibility to speed up the calculations [3].

Artificial Neural Networks are one of the most commonly used classifier technique. The reason for being commonly used is to present some properties such as learning from examples and exhibiting some capability for generalization beyond the training data [4]. Also they have universal approximation property [5]. Although they may achieve high accuracy of classification, the knowledge acquired by such systems is represented in a large number of numerical parameters and network architectures, in a way that is incomprehensible for humans [6]. This may cause problems in some cases. Also the classification using ANN cannot handle overlapping class classification problem.

A decision tree is a predictive model that, as its name implies, can be viewed as a tree. Specifically each branch of the tree is a classification question and the leaves of the tree are partitions of the dataset with their classification. The approach of decision tree is used in many areas because it has many advantages [7,8,9]. A disadvantage of decision tree is its instability and the structure of the decision tree may be entirely different if some things change in the dataset. To overcome this problem, some scholars have suggested Fuzzy Decision Tree (e.g. FuzzyID3) [10, 11, 12, 13, 14] by utilizing the fuzzy set theory.

To use Bayesian decision theory a priori probabilities and the conditional probability density of all classes should be known [15,16]. Non- fuzzy classification systems are crisp in nature and cannot effectively applied for application with overlapping classes. FUZZY set and logic theory [17] is one of the most prominent tool to handle uncertainty in decision-making. The major advantages of fuzzy system models are their robustness and transparency. Fuzzy system modelling achieves robustness by using fuzzy sets which incorporates imprecision to system models. In addition, unlike some system models, such as neural networks, the fuzzy system models are highly descriptive. A summary of different fuzzy classifiers and their applications are described by Kuncheva [18]. When the classifier is a set of fuzzy rules, the resulting system is called a Fuzzy Rule-Based Classification System (FRBCS). FRBCS include a collection of if-then rules, stated using natural language. This is a form of knowledge representation that humans can easily understand, verify, and refine. Indeed, the true power of fuzzy logic lies in its ability to handle and manipulate linguistic information [19], [20], [21]. Two important aspects, namely learning and generalization capability play an important role in any pattern classification problem[22]. These can be achieved by using the feature wise belongingness of each pattern to each class. This is useful mainly when the classes are overlapping or ill-defined. The feature wise belongingness can be calculated by using π-type MF. As stated in [22], the use of π-type MF enhances the classification accuracy and this expresses its better generalization capability. In [22] PARR is proposed and applied on two conventional (completely labelled) data sets and two remote sensing images (partially labelled) to justify its potentiality. Experimental results showed promising and improved classification performance on these mentioned data sets. Also It is observed that individually the PARR has a better classification capability compared to other RRs. This is because of the fact that the fuzzy product aggregation operator works better with features which collaborate with each other in decision making process. Also with the use of type MF

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