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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A Fuzzy Classifier Based On Product And Sum Aggregation:

Computer Vision, Graphics and Image Processing Prem Kalra,Shmuel Peleg,2007-01-01 This book constitutes the refereed proceedings of the Indian Conference on Computer Vision Graphics and Image Processing ICVGIP 2006 held in Madurai India December 2006 Coverage in this volume includes image restoration and super resolution image filtering visualization tracking and surveillance face gesture and object recognition compression content based image retrieval stereo camera calibration and biometrics **Neural Nets** Maria Marinaro,Roberto Tagliaferri,2003-06-30 This book constitutes the thoroughly refereed post proceedings of the 13th Italian Workshop on Neural Nets WIRN VIETRI 2002 held in Vietri sul Mare Italy in May June 2002 The 21 revised full papers presented together with three invited papers were carefully reviewed and revised during two rounds of selection and improvement The papers are organized in topical sections on architectures and algorithms image and signal processing applications and learning in neural networks **Knowledge-Based Intelligent Information and Engineering Systems** Vasile Palade,2011-04-08 2 1 Text Summarization Text summarization is the process of distilling the most important information from a source or sources to produce an abridged version for a particular user or users and task or tasks 3 Basic and classical articles in text summarization appear in Advances in automatic text summarization 3 A literature survey on information extraction and text summarization is given by Zechner 7 In general the process of automatic text summarization is divided into three stages 1 analysis of the given text 2 summarization of the text 3 presentation of the summary in a suitable output form Titles abstracts and keywords are the most common summaries in Academic papers Usually the title the abstract and the keywords are the first second and third parts of an Academic paper respectively The title usually describes the main issue discussed in the study and the abstract presents the reader a short description of the background the study and its results A keyword is either a single word unigram e g learning or a collocation which means a group of two or more words representing an important concept e g machine learning natural language processing Retrieving collocations from text was examined by Smadja 5 and automatic extraction of collocations was examined by Kita et al 1 **Swarm Intelligence for Electric and Electronic Engineering** Fornarelli, Girolamo,2012-12-31 With growing developments in artificial intelligence and focus on swarm behaviors algorithms have been utilized in solving a variety of problems in the field of engineering This approach has been specifically suited to face the challenges in electric and electronic engineering Swarm Intelligence for Electric and Electronic Engineering provides an exchange of knowledge on the advances discoveries and improvements of swarm intelligence in electric and electronic engineering This comprehensive collection aims to bring together new swarm based algorithms as well as approaches to complex problems and various real world applications **Soft Computing and Intelligent Systems** Madan M. Gupta,1999-10-28 The field of soft computing is emerging from the cutting edge research over the last ten years devoted to fuzzy engineering and genetic algorithms The subject is being called soft computing and computational intelligence With

acceptance of the research fundamentals in these important areas the field is expanding into direct applications through engineering and systems science This book cover the fundamentals of this emerging filed as well as direct applications and case studies There is a need for practicing engineers computer scientists and system scientists to directly apply fuzzy engineering into a wide array of devices and systems *Fuzzy Systems Conference (FUZZ), 2000* IEEE Neural Networks Council,2000 **Annual Meeting of the North American Fuzzy Information Processing Society--NAFIPS.** North American Fuzzy Information Processing Society. Annual Meeting,2000 <u>Fuzzy Theory Systems</u> Cornelius T. Leondes,1999 *Dissertation Abstracts International* ,1999 **International Aerospace Abstracts** ,1999 *The Engineering Index Annual* ,1993 Since its creation in 1884 Engineering Index has covered virtually every major engineering innovation from around the world It serves as the historical record of virtually every major engineering innovation of the 20th century Recent content is a vital resource for current awareness new production information technological forecasting and competitive intelligence The world s most comprehensive interdisciplinary engineering database Engineering Index contains over 10 7 million records Each year over 500 000 new abstracts are added from over 5 000 scholarly journals trade magazines and conference proceedings Coverage spans over 175 engineering disciplines from over 80 countries Updated weekly **Government Reports Announcements & Index** ,1992 <u>Fuzzy Classification Based On Fuzzy Association Rule Mining</u> ,2004 In fuzzy classification of high dimensional datasets the number of fuzzy rules increases exponentially with the increase of attributes Fuzzy association rule mining with appropriate threshold values can help to design a fuzzy classifier by significantly decreasing the number of interesting rules In this dissertation we investigate the way to integrate fuzzy association rule mining and fuzzy classification First the framework of fuzzy association rule mining is presented which incorporates fuzzy set modeling in an association rule mining technique It avoids the sharp boundary problem caused by arbitrary determination of intervals on the domain of quantitative attributes meanwhile presenting natural and clear knowledge in the form of linguistic rules We study the impact of different fuzzy aggregation operators on the rule mining result The selection of the operator should depend on the application context Based on the framework of fuzzy association rule mining we propose a heuristic method to construct the fuzzy classifier based on the set of fuzzy class association rules We call this method the FCBA approach where FCBA stands for fuzzy classification based on association The objective is to build a classifier with strong classification ability In the FCBA approach we use the composite criteria of fuzzy support and fuzzy confidence as the rule weight to indicate the significance of the rule Through our study we find it is important to find a good combination of these two rule interestingness threshold values The classification of each record is achieved by applying the classic fuzzy reasoning method in which each record is classified as the consequent of the rule with the maximum product of the compatibility grade and the rule weight We use the well known classification problems such as the Iris dataset and high dimensional classification problem the Wine dataset to compare the proposed FCBA approach with other non fuzzy

and fuzzy classificatio   Fuzzy Classifier Design Ludmila Kuncheva,2000-04-26 Fuzzy sets were first proposed by Lotfi Zadeh in his seminal paper 366 in 1965 and ever since have been a center of many discussions fervently admired and condemned Both proponents and opponents consider the argu ments pointless because none of them would step back from their territory And stiH discussions burst out from a single sparkle like a conference pa per or a message on some fuzzy mail newsgroup Here is an excerpt from an e mail messagepostedin1993tofuzzy mail vexpert dbai twvien ac at by somebody who signed Dave Why then the logic in fuzzy logic I don t think anyone has successfully used fuzzy sets for logical inference nor do I think anyone wiH In my admittedly neophyte opinion fuzzy logic is a misnomer an oxymoron 1 would be delighted to be proven wrong on that I carne to the fuzzy literature with an open mind and open wal let high hopes and keen interest I am very much disiHusioned with fuzzy per se but I did happen across some extremely interesting things along the way Dave thanks for the nice quote Enthusiastic on the surface are not many of us suspicious deep down In some books and journals the word fuzzy is religiously avoided fuzzy set theory is viewed as a second hand cheap trick whose aim is nothing else but to devalue good classical theories and open up the way to lazy ignorants and newcomers   *Dealing with Imbalanced and Weakly Labelled Data in Machine Learning using Fuzzy and Rough Set Methods* Sarah Vluymans,2018-11-23 This book presents novel classification algorithms for four challenging prediction tasks namely learning from imbalanced semi supervised multi instance and multi label data The methods are based on fuzzy rough set theory a mathematical framework used to model uncertainty in data The book makes two main contributions helping readers gain a deeper understanding of the underlying mathematical theory and developing new intuitive and well performing classification approaches The authors bridge the gap between the theoretical proposals of the mathematical model and important challenges in machine learning The intended readership of this book includes anyone interested in learning more about fuzzy rough set theory and how to use it in practical machine learning contexts Although the core audience chiefly consists of mathematicians computer scientists and engineers the content will also be interesting and accessible to students and professionals from a range of other fields   **Fuzzy Classifier Design** Ludmila Kuncheva,2014-09-01   ART-based Fuzzy Classifiers: ART Fuzzy Networks for Automatic Classification Elena Sapojnikova,2004-04-22 Quality testing plays an important role in modern industry producing a huge amount of elaborate technical products Due to the increasing complexity of design and the high automation of technological processes it is becoming more crucial for industrial companies than it was in past decades Constantly rising demands on product quality cost pressure from customers and the increased prices of raw materials are forcing manufacturers to explore novel ways of quality testing The objective is to monitor in process data as a means of indicating product quality and to react to unexpected technological disturbances as soon as possible If a problem is not recognized quickly many defective devices will be produced in the meantime More and more complicated technology has resulted in more severe requirements for quality testing even as it has caused an escalation of the information stream to be

processed Statistical methods used in the branch earlier cannot provide adequate speed and quality of data analysis in response to a continuously strengthened load Another limitation of these tools is a lack of automation adaptive behavior and flexibility which has to be compensated by involving additional human resources However a hot trend in industry is the development of diagnostic systems with minimum functions for an operator Therefore the need for automatic and intelligent methods of data analysis has arisen and seems likely to become ubiquitous in the near future

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