Rough Fuzzy Support Vector Machine Based Opinion Mining in Tamil Using R

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Abstract: ***Data classification has been most actively used technique for effective means of conveying knowledge and information to users. With emergence of huge datasets existing classification techniques fail to produce desirable results where the challenge lies in analysing hidden characteristics of massive datasets by retrieving useful geometric and statistical patterns. In this research study, we propose a supervised rough fuzzy support vector machine (RFSVM) method for data classification on mobile product reviews. The fuzzy rough set model takes care of sensitiveness of noisy samples and handles impreciseness in training samples bringing robustness to results. The algorithm is parallelized with a view to reduce training times as well as to enhance better classification. The algorithm is tested on large datasets of over 5000 reviews collected from social media to check its feasibility and convergence. It effectively resolves outliers' effects, imbalance and overlapping class problems, normalizes to unseen data and relaxes dependency between features and labels with better average classification accuracy. The experimental results demonstrate the superiority of the proposed technique. RFSVM is scalable and reliable in nature and is characterized by order independence, computational transaction, failure recovery, atomic transactions, fault tolerant and high availability attributes as exhibited through various experiments.***

IndexTerms - Data Mining, RFSVM, Opinion Mining, Sentiment analysis, Feature Extraction.

I. INTRODUCTION

The volume of social media data is always expanding with rapid increase of global competitiveness among the organizations. It is estimated that the volume of social media data double within every two years. This fact is evident in both advanced and emerging economies. A common task often performed on social media data by the analysts and managers is data classification which categorizes data into different subgroups in which ideas and objects are recognized and understood. In this process relevant and meaningful hidden information is discovered from data. From economic perspective, knowledge obtained from the classified data can be applied directly for media application and services. However, as the amount of data increases continuously classification becomes more and more complex where present techniques produce spurious results. This in turn disturbs the integrity of data. The inherent challenge lies in analysing and interpreting characteristics of huge datasets is extraction of significant usage patterns through various machine learning techniques [14].

Knowledge discovery of meaningful information has been a topic of active research since past few years. The on-going rapid growth of online data generally referred to as big data have created an immense need for effective classification techniques. The process of extracting knowledge from data draws upon the research in pattern classification and optimization to deliver advanced business intelligence. The big data is specified using three characteristics viz. volume, variety and velocity. This means that at some point in time when volume, variety and velocity of data are increased the current techniques may not be able to process the data. Ideally these three characteristics of a dataset increase data complexity and thus the existing techniques performance may go down and may be below our expectations within given processing time. Many applications such as classification, risk analysis, business forecasting etc. suffer from this problem. These are time sensitive applications and require efficient techniques to get the best result. With this motivation this work entails the development of a hybrid-supervised classification algorithm for mining useful information [1]. In this approach, the classification is performed by the rough fuzzy version of support vector machine (SVM) for training large datasets but is computationally intensive. Given a large enough dataset the training time can range from days to weeks. In this paper, we propose rough fuzzy support vector machine (RFSVM) to classify huge data patterns in social media reviews. Basically Tamil mobile product reviews were collected to examine the best product from the collection of reviews. Using RFSVM the scalability and parallelism of splitting dataset training is improved. The fuzzy rough model is sensitive to noisy mislabelled samples which brings robustness to classification results. To the best of our knowledge RFSVM presented in this research work illustrates a robust architecture of in-stream data analytics which is first of its kind. The proposed computational framework has never been studied rigorously prior to this research work and our research work is organized as follows.

The section 2 presents prior work related to classification using fuzzy and rough versions of SVM. In section 3 a Rough fuzzy SVM approach is presented. Proposed system is described in section 4. The section 5 illustrates the Experimental results of this work. Finally conclusions are given in section 6.

II. RELATED WORK

Over the past decade data classification though fuzzy and rough versions of SVM have been rigorously used by researchers in several applications [2]. A brief illustration of few important ones is highlighted here. Shigeo Abe et al [24] studied multiclass problems using FSVM where they used truncated polyhedral pyramidal membership function for decision functions to train SVM for two different pairs of classes.

Huang et al[9] proposed new SVM fuzzy system with high comprehensibility where SVM is used to select significant fuzzy rules directly related to a fuzzy basis function. Analysis and comparative tests about SVM fuzzy system show that it possesses high comprehensibility and satisfactory generalization capability. Thiel et al [18] studied fuzzy input fuzzy output one against all SVM where fuzzy memberships were encoded in fuzzy labels to give fuzzy classification answer to recognise emotions in human speech.

Shilton et al [25] proposed an iterative FSVM classification whereby fuzzy membership values are generated iteratively based on positions of training vectors relative to SVM decision surface itself. Pitiranggon et al [16] constructed a fuzzy rule based system from SVM which has the capability of performing superior classification than the traditional SVM [3].

Li et al [11] proposed double or rough margin based FSVM algorithm by introducing rough sets into FSVM. First, the degree of fuzzy membership of each training sample is computed and then data with fuzzy memberships were trained to obtain decision hyper plane that maximizing rough margin method. Long et al [12] suggested network intrusion detection model based with Fuzzy-SVM. They concentrated on automatic detection of network intrusion behaviour using FSVM. The system composed of five modules viz. data source, AAA protocol, FSVM located in local computer, guest computer and terminals. The intrusion detection algorithm based on FSVM is implemented by training and testing process.

Duan et al [6] studied FSVM based on determination of membership. They investigated sensitivity issues relating SVM to outlier and noise points which favours use of FSVM though appropriate fuzzy membership. Yan et al [26] proposed probability FSVM based on the consideration both for fuzzy clustering and probability distributions. The model is based on consideration that probability distribution among samples exhibits superior performance [4].

III. Rough Fuzzy SVM Approach

A. *Support Vector Machine*

Support vector machine (SVM) is a promising pattern classification technique based on structural risk minimization and statistical learning theory [10]. Many complex problems have been solved by SVMs. It minimizes prediction error and models complexities. SVM formalizes classification boundary by dividing points having different labels so that boundary distance from closest point is maximized. It transforms training vectors into high dimensional feature space labelling each vector by its class. It classifies data through set of support vectors which are members of training input set that outline a hyper plane in feature space. Structural risk minimization reduces generalization error. The number of free parameters depends on margin that separates data points. SVM fits data into hyper plane surface using kernel function that allows handling of curse of dimensionality.

In training SVMs we need kernel function and its parameters to achieve good results and convergence. When solving two class classification problems each training point is treated equally and assigned to only one class. In many real word problems some training points are corrupted by noise. Some points also are misplaced on wrong side. These points are outliers and belong to two classes with different memberships [8]. SVM training algorithm makes decision boundary to severely deviate from optimal hyper plane as it is sensitive to outliers.

B. *Fuzzy Rough Set*

Let R be an equivalence relation on universal set P. The family of all equivalence classes induced on P by R is denoted by PR(O) where O is the object of that particular family. One such equivalence class in P R contains p ∈ P is denoted by [p]R. For any output class A ⊆ P lower and upper approximations approaching A closely from inside and outside are defined. Rough set R(A) is a representation of A by lower and upper approximations. When all patterns from equivalence class do not carry same output class label rough ambiguity is generated as manifestation of one-to-many relationship between equivalence class and output class labels. The rough membership function rmA (p) : A → [0,1] of pattern p ∈ P for output class A. When equivalence classes are not crisp they form fuzzy classes {FC1,.....,FCH} generated by fuzzy weak partition of input set P. Fuzzy weak partition means that each FCi;i ∈ {1,.....,H} is normal fuzzy set. The output classes Cc;c = {1,2,.....,H} may be fuzzy also. Here μCc (p) = {0,1} is fuzzy membership of input p to Cc. The fuzzy roughness appears when class contains patterns that belong to different classes [5].

C. *Rough Fuzzy Support Vector Machine*

We present rough fuzzy based support vector machine (FRSVM) to carryout classification task. To solve misclassification problem in SVM, fuzzy rough membership is introduced to each input point such that different points can make unique contribution to decision surface [7]. The input's membership is reduced so that its contribution to total error term is decreased. FRSVM also treats each input as of opposite class with higher membership. This way fuzzy rough machine makes full use of data and achieves better generalization ability [17]. It is conditionally positive definite and allows lower computational cost and higher rate of positive eigen values of kernel matrix alleviating limitations of other kernels. The sigmoid kernel has been used in several cases with appreciable success motivating its usage in fuzzy rough membership function in proposed machine.

The fuzzy rough membership values depend on fuzzy classification of input dataset. The fuzziness in classes' represents fuzzy linguistic uncertainty present in dataset [13]. The classification can be performed through either unsupervised classification which involves collecting data from all classes and classify them subsequently without considering associated class labels with data or supervised classification where separate datasets are formed for each class and classification is performed on each such dataset to find subgroups present in data from same class. Both classification tasks can be performed by some trivial classification algorithms [15]. However, there are certain problems which are to be taken care of such as: (i) number of classes which have to be fixed apriori or which may not be known (ii) it will not work in case number of class is one and (iii) generated fuzzy memberships are not possibility. To overcome the first problem evolutionary programming based method may be used. For various classification problems evolutionary methods can automatically determine number of classes. It is worth mentioning that number of classes should be determined as best as possible. Otherwise, calculation of fuzzy linguistic variables will be different and as a result fuzzy rough membership values may also vary. For the second problem if it is known apriori that only one class is present then mean and standard deviation are calculated from input dataset and π fuzzy membership curve is fitted. But while doing so care must be taken to detect possible presence of the outliers in input dataset. To overcome third problem possibility fuzzy classification algorithm or any mixed classification algorithm can be used. As of now there is no single classification algorithm which can solve all the problems. If output class is fuzzy then it may be possible to assign fuzzy memberships for output class subjectively. However, if domain specific knowledge is absent then we have to be satisfied with given crisp membership values. The fuzzy rough ambiguity plays a critical role in many classification problems because of its capability towards modelling non-statistical uncertainty [27]. The characterization and quantification of fuzzy roughness are important aspects affecting management of uncertainty in classifier design. Hence measures of fuzzy roughness are essential to estimate average ambiguity in output class. A measure of fuzzy roughness for discrete output class Cc ⊆ X is a map- ping S(X) → R+ that quantifies degree of fuzzy roughness present in Cc. Here S(X) is set of all fuzzy rough power sets defined within universal set X. The fuzzy rough ambiguity must be zero when there is no ambiguity in deciding whether an input pattern belongs to it or not. The equivalent classes form fuzzy classes so that each class is fuzzy linguistic variable. The membership is function of centre and radius

of each class in feature space and is represented with kernel. In formulation of FRSVM, fuzzy membership reduces outliers' effects. When samples are nonlinear separable fuzzy memberships are calculated in input space but not in feature space. Through fuzzy rough membership function the input is mapped into feature space. The fuzzy rough memberships are calculated in feature space. Further using kernel function it is not required to know shape of mapping function. This method represents contribution of each sample point towards separating hyper plane in feature space. Thus, the proposed machine leaning approach handles outlier' effects efficiently and has better generalization ability [17]. The higher value of fuzzy rough membership function implies importance of data point to discriminate between classes. It implies highest value is given by support vectors. These vectors are training points which are not classified with confidence. These are examples whose corresponding αi values are nonzero.

IV. Proposed System

Sentiment analysis is the process of determining whether social media publications are positive or negative. Due to ambiguities inherent in language it can be very challenging to program software analysis tools to accurately resolve whether a word is positive or negative. Most of the sentiment analysis materials available are in English. So, to interpret sentiment in a classical language Tamil, for example, which is spoken by approximately 20 per cent of Indian population, involves a time-consuming and often unreliable process of machine translation before analysis can take place". Hence the need for sentiment analysis in Tamil is essential for a particular person to take decision on whether to buy a particular product or not [16]. The overall architecture of the system is shown in figure 1.

The figure-1 shows how the data is retrieved and some pre-processing steps to be done to clean up unwanted data. Tokenization process start with taking input as raw text stream which is in our case one of the review regarding product. Task of this step is to form tokens of continued text stream. Process each word until found whitespace if whitespace found then consider it as a token. The next step is to remove the stop words which means remove the meaningless terms from a sentence. Features are extracted from the sentence and matched with opinion lexicon. Then by applying Rough Fuzzy SVM algorithm, classification will be done and opinions are summarized such as நேர்மறை (Positive), யாரும் (None) and எதிர்மறை (Negative) for three class problem and மிகவும்சாதகமான (More Positive), நேர்மறை (Positive),யாரும் (None), மிகவும்எதிர்மறை (More Negative), and எதிர்மறை (Negative) for five class problem.

Natural Language Processing technique is applied to imitate the original production process by redefining the sentence from the start symbol and the production tree is reconstructed from the top downwards. The search starts from the root node and construct the child nodes by applying the rules with left hand side and the internal node further expands using next productions with left hand side equals to internal node and continues until leaves are terminals. If the leaf nodes do not matches the input string, we need to backtrack to the latest node processed and apply another production. This technique has the advantage that it never wastes time in exploring trees.

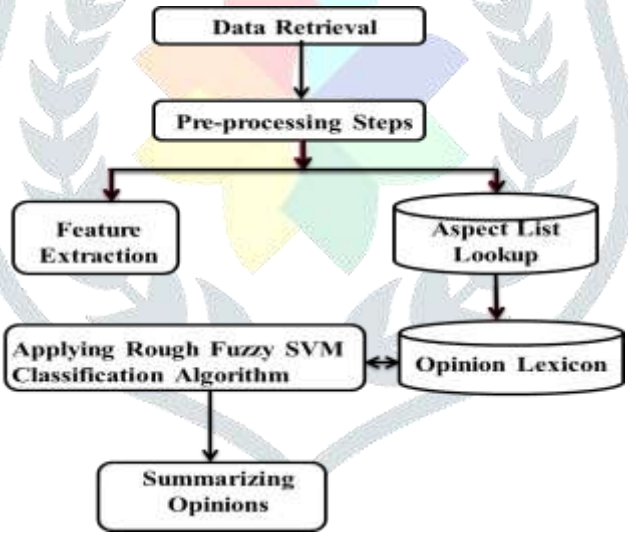

Fig 1: Flow for generating opinion from feedback

Sentiment related properties like subjectivity and orientation are well defined in this approach. Most researches were focused mainly on these domains of sentiment analysis to find out the best opinion from the list of reviews. Final result will be easier to choose the product by them. For example நல்ல, சிறந்த are positive terms while கெட்ட, தவறு and மோசமான are negative terms. செங்குத்து, மஞ்சள் and திரவ are objective terms. சிறந்த and மோசமான are more intense than நல்ல and மோசமான.

V. Experimental Results

R is a sophisticated statistical software package, which provides new approaches to data mining. We have analyzed an effect of product review dataset obtained from Opinion Lexicon [19]. The Rough Fuzzy SVM classification algorithm is executed to predict the best product by identifying the total number of positive opinions. The number of instances used for analysis of product data is 5000.

Table 1. shows result of rough fuzzy svm classification (3 class) with opinion lexicon for product reviews dataset run on R platform. It depicts the நேர்மறை (Positive), யாரும் (None), எதிர்மறை (Negative) reviews which are classified based on the number of instances 5000. It is predicted that there are 1720 நேர்மறை (Positive) reviews, 60 யாரும் (None) classified reviews with 1135 error rate and 852 எதிர்மறை (Negative) reviews in case when matched with opinion lexicon.

Table 1 Confusion Matrix of Rough Fuzzy SVM Classification (3 Class) With Opinion Lexicon

		Predicted Class		
		நேர்மறை (Positive)	யாரும் (None)	எதிர்மறை (Negative)
Actual Class	நேர்மறை (Positive)	**1720**	32	382
	யாரும் (None)	585	**60**	550
	எதிர்மறை (Negative)	758	61	**852**

The performance of opinion mining is evaluated based on the result shown below in table 2. It shows that accuracy of நேர்மறை (Positive) reviews as 0.6739, for யாரும் (None) reviews it shows 0.5790 and for எதிர்மறை (Negative) reviews it shows 0.6115.

Table 2 Performance of Rough Fuzzy SVM Classification (3 Class) with Opinion Lexicon

Machine Learning Approach			
Algorithm	**Rough Fuzzy SVM (3 Class)**		
Class	நேர்மறை (Positive)	யாரும் (None)	எதிர்மறை (Negative)
Specificity	0.7863	0.7658	0.7453
Sensitivity	0.5615	0.3922	0.4776
Precision	0.6126	0.0306	0.3568
Recall	0.344	0.012	0.1704
F1-measure	0.6619	0.0890	0.4932
G-measure	0.6728	0.1403	0.4935
Detection Rate	0.344	0.012	0.1704
Accuracy	0.6739	0.5790	0.6115

Figure.2 shows the prediction of Rough Fuzzy SVM classification for 3 class using opinion lexicon. Depending on the specificity and sensitivity the following graph is predicted for 3 class problem.

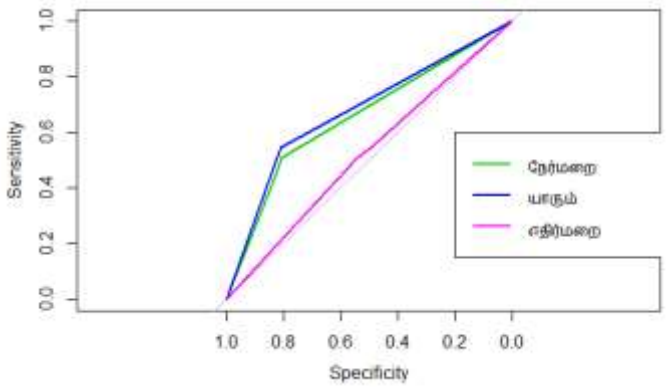

Fig.2.Rough Fuzzy SVM Classification (3 Class) with Opinion lexicon

Table 3. Shows results of rough fuzzy svm classification (5 Class) with opinion lexicon for product reviews dataset run on R platform. It depicts the மிகவும்சாதகமான (More Positive), நேர்மறை(Positive), யாரும்(None), மிகவும்எதிர்மறை(More Negative), எதிர்மறை (Negative) reviews which are classified based on the number of instances 5000. It is predicted that there are 103 மிகவும்சாதகமான(More Positive) reviews, 1540 நேர்மறை(Positive) classified reviews , 283 யாரும்(None) reviews, 163 மிகவும்எதிர்மறை(More Negative) reviews and 551 எதிர்மறை (Negative) reviews in case when matched with opinion lexicon.

Table 3 Confusion Matrix of Rough Fuzzy SVM Classification (5 Class) With Opinion Lexicon

		Predicted Class				
		மிகவும் சாதகமான (More Positive)	நேர்மறை (Positive)	யாரும் (None)	மிகவும் எதிர்மறை (More Negative)	எதிர்மறை (Negative)
Actual Class		**103**	281	0	10	27
		32	**1540**	57	22	227
		9	403	**283**	8	318
		8	111	26	**163**	87
		10	463	177	84	**551**

The performance of opinion mining is evaluated based on the result shown below in table 4. It shows that accuracy of **மிகவும்சாதகமான** (More Positive) reviews as 0.7850, **நேர்மறை** (Positive) reviews as 0.6984, for **யாரும்** (None) reviews it shows 0.6778, for **மிகவும்எதிர்மறை**(More Negative) reviews it shows 0.7594 and for **எதிர்மறை** (Negative) reviews it shows 0.6309.

Table 4 Performance of Rough Fuzzy SVM Classification (5 Class) with Opinion Lexicon

Machine Learning Approach					
Algorithm	Rough Fuzzy SVM (5 Class)				
Class	மிகவும் சாதகமான (More Positive)	நேர்மறை (Positive)	யாரும் (None)	மிகவும் எதிர்மறை (More Negative)	எதிர்மறை (Negative)
Specificity	0.9343	0.8465	0.8344	0.9508	0.8063
Sensitivity	0.6358	0.5504	0.5212	0.5679	0.4554
Precision	0.0324	0.5596	0.1086	0.0574	0.242
Recall	0.0206	0.308	0.0566	0.0326	0.1102
F1-measure	0.3533	0.6587	0.3619	0.4780	0.4417
G-measure	0.3944	0.6718	0.3801	0.4841	0.4419
Detection Rate	0.0206	0.308	0.0566	0.0326	0.1102
Accuracy	0.7850	0.6984	0.6778	0.7594	0.6309

Figure.3 shows the prediction of Rough Fuzzy SVM classification for 5 class using opinion lexicon. Depending on the specificity and sensitivity the following graph is predicted for 5 class problem.

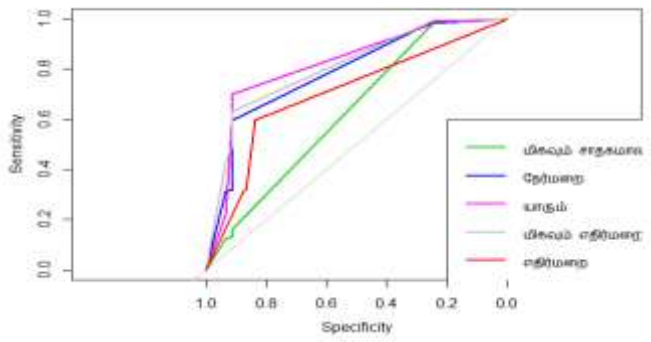

Fig.3.Rough Fuzzy SVM Classification (5 Class) with Opinion lexicon

VI. CONCLUSION

In this paper, we derived an apt methodology for an attribute subset selection for the boundary region of rough set. Attribute reduction is one of the core issues in the rough set theory. Attribute reduction maintains the knowledge base under the principle of the same classification ability to remove irrelevant and redundant attribute properties. However, it reduces the search space and improves efficiency. The effect of distance basis becomes less imperative for generating dataset, since there is no correlation. Moreover, this paper

proposes an attribute selection based on rough fuzzy svm approach. Experimental results have shown that our proposed method predicts the relevant memory requirement and also reveals that it consumes less execution time than the existing method. Our proposed algorithm outperforms the existing method. In future work, investigating the applicability of the suggested procedure attribute reduction is of enormous attention. Improving the number of the attributes in the reduction set will concern the simplicity of decision-making rules directly and it is still a hot research issue for scholars to find efficient attribute reduction algorithms.

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