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Machine Learning Based Optimization of Students' Sentiment Analysis for Assessment of Web Based Learning Management System

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Abstract

Emergent popularity of opinion-rich resources learning such as online review sites and personal blogs and web based learning, brought a new opportunities and challenges to fathom the opinions and sentiments of others. Opinion-Mining deals with the computational treatment of opinion, sentiment, and subjectivity in text, that occurs at least in part as a direct response.Machine- learning is one of the most commonly used techniques for measuring, visualizing and predicting interaction. A machine learning optimization technique has various approaches to analyze feelings, emotions from text. The ML model for text classification contains large no of features. It is always preferable to reduce the number of features to reduce the computational cost of modeling and to improve the performance of the model. In this paper feature selection techniques Ant Colony Optimization(ACO) along with classification technique Naïve Bayes(NB), Support Vector Machine(SVM),Decision Tree(DT),Random Forest(RF), Exploratory Data Analysis (EDA) and the modified models RF with ACO , RF with GA, RF with PSO, EB with ACO,EB with GA and EB with PSO are applied which improves the performance of the model with better Accuracy , Precision ,Recall and F Measure parameters.

Keywords: Machine Learning (ML), Web Based Learning Management System (WBLMS),Natural Language Processing (NLP), Opinion Mining,Feature Selection Technique(FST), Sentiment Analysis(SA),Classification, Artificial Intelligence(AI).

1. Introduction

Sentiment analysis comprises various research studies such as natural language processing, data mining and text mining, and becoming a major concern in organization as they embrace computer intelligence in their operations. In sentiment analysis, or opinion mining, (SAOM), efficiently uncover people's thoughts expressed in written language material!. Sentiment means "what one feels about something", "personal experience, one's own feeling", "an attitude toward something" or "an opinion". Opinions are central to almost all human activities and are key influencers of our behaviors[1]. Our beliefs and perceptions of reality, and the choices we make, are, to a considerable degree, conditioned upon how others see and evaluate the world. Nowadays , web based learning is used all over the world and it is booming the education system. The web based learning is increasingly being used for the delivery of educational material and distance education. Web-based learning

allows students to learn at their own pace, access the information at a time that is convenient for them, and provides education to remote[2].Among many changes that the country is undergoing at present, the 'New Education Policy' (NEP) 2020' is preludes of changing thedirections in Educational system. The new policy, which has come after 34 years is expected to brought a new avenues for India's education sector in the 21st century. It is set to provide a vital inducement to the role of technology in all aspects of education. The creation of more and more virtual labs will give students remote access to hands-on experiment-based learning. Digital technologies lays a strong impetus on experiential learning. Hence, the adoption of these cutting-edge technologies will result in enhancing the immersive learning experiences [3]. In this paper students sentiment were analyzed during digital learning that is web based learning, in this how students were reacted during web based learning was observed.

2. Sentiment Analysis(SA):-

Student sentiments is an important factor in the Web-Based Learning System(WBLS). Feedback of the Students is used for measuring the effectiveness. The Analysis of feedback or comments is known Sentiment Analysis. Sentiment analysis identify the opinion or emotions behind the comments. SA classification tool that focuses on the polarity of the emotions (happy, sad, angry) also text (positive, negative, neutral) [4]. In This paper, we applied optimized feature selection techniques namely ACO. Along with that comparative analysis of the performance of the machine learning algorithms for classification like Support Vector Machine (SVM), Naive Bayes(NB), Decision Tree (DT) , Random Tree ,Eda and Random forest with optimization over Web based learning models to classify the Student Feedback Dataset (SFD),. Sentiment analyses are tremendously important as they help to understand someone's overall opinions quickly. By invariably sorting the feelings behind reviews, social media conversations, one can make faster and more precise action plans. Sentiment analysis can be used in a variety of fields, such as marketing, political and sociological prospect, education sector. Positive, negative, neutral, polarity as well as emotions and feelings (angry, happy, sad) and even intentions are the subject of sentiment analysis modeling. Commonly used sentiment analysis techniques such as Emotion Detection, Fine-grained Sentiment Analysis, Aspect-based Sentiment Analysisand Multilingual Sentiment Analysis. In sentiment analysis models, there are different algorithms, like Rule-based approach, Automatic Approach and Hybrid Approach In orders to identify thesentimental changes of students learning pattern various ML techniques can be used. Analysis offeelings according to the subject matter must therefore be identified. The sentiment analysis methods can be broadly classified into three categories. These are machine learning, lexicon-based and hybrid approaches [5].

3. Literature Survey

Author applied several text analytics methods on students' feedback. In this sentiment analysis based metric correlated with the aggregated Likert scale scoresalong with that teacher's performance is shown with the help of tag clouds, sentiment score [6]

The survey covers databases that are considered as data sets for algorithms detecting the emotions by facial expressions. Microsoft HoloLens (MHL) device ass introduced for observing emotion recognition in Augmented Reality (AR) and results of emotion recognition by the MHL and a regular webcam are compared [7]

Lexicon-enhanced sentiment analysis based on Rule-based classification techniques used in improving sentiment classification. Apart from integrate emoticons, modifiers and domain specific terms to analyze the reviews posted in online communities. The results obtained from different experiments were compared [8]

This paper deals with Arabic Sentiment Analysis. Authors developed framework to analyze Twitter comments ,framework has many novel aspects such as handling Arabic dialects, Arabizi and emoticons. Crowdsourcing was used to collect a large dataset of tweets.[9]

Author used systematic mapping to structure the published information that are available. Also, PRISMA framework usedto guide the search process Author identified 92 relevant studies out of 612 that were initially found on the sentiment analysis of students' feedback in learning platform environments. The need of having structured datasets, standardized solutions and increased focus on emotional expression and detection were discussed.[10]

Author proposed teaching evaluation method based on the lexicon-based approach, in this the students' feedback comments analysed as strongly negative, or moderately negative, or weakly negative, or strongly

positive, or moderately positive, or a weakly positive or neutral category using two lexicons. A heuristic technique was used for semantic analysis [11].

In this paper an enhanced framework for sentiment analysis using the student's responses and preprocessed data is applied to the classifier model to classify the document whether positive or negative sentiment. This framework showed 0.8 accuracy. Authors [12] proposed a model to analyze user opinions and reviews posted on social media websites. The proposed model uses machine learning techniques and a fuzzy approach for opinion mining and classification of sentiment on textual reviews, Support vector machines (SVM) and Maximum entropy are used for sentiment classification purpose.

Author analyze the sentiments on a topic which are extracted from the Twitter and conclude a remark (positive/negative) of the defined topics. They implemented an easier procedure to analyze sentiments on any interested field or topic.[13]

Authors [14] presented a tool that applies sentiment analysis to Arabic text tweets using different parameters. The experiments showed that the Naive Bayes machine-learning approach is the most accurate in predicting. Comparison between the performance of the lexicon-based method and machine-learning method using Naïve Base and SVM.

Web-based learning includes a wide range of information to be divided into two: student reviewinformation and learning resources [15]. Authors [16]suggested a model for conducting sentiment analysis on education data basedon deep learning approach. Educational data set is taken out of the Kalboard 360 repository and is fed into a numberof classifications, including SVM, MLP, Decision Tree, K-star and the Bayesian Network. Authors [17] implemented a common metaheuristic optimization algorithm (TLBO).Recently, was used as a robust and revolutionary method for addressing the global optimizationproblem, motivated by the phenomenon of education.TLBO utilizes population knowledge toprovide high-quality solutions for a range of more than 20 optimization features such as unimodal and multimodal compared with two other metaheuristic ones, such as GA and PSO.TLBO is simple, vigorous and intersects fast and achieves optimal results in nearly every round[18]. Apart from these various other papers were studied.

4. Proposed Framework

4.1 About Dataset:

Figure 1 shows the proposed framework for the research work. The data collection for the student feedback dataset, pre-processingn of the data set, reduced data set with Feature selection Technique and comparison of the performance of classifier models.

In this paper, we used the student feedback dataset (SFD from the web portal – http://elaerningit.co.in developed for students learning. The feedback is collected in the form of text fromthe enrolledstudents in the web portal. Based on the comments dataset can be classified into two class labels Positive and Negative.

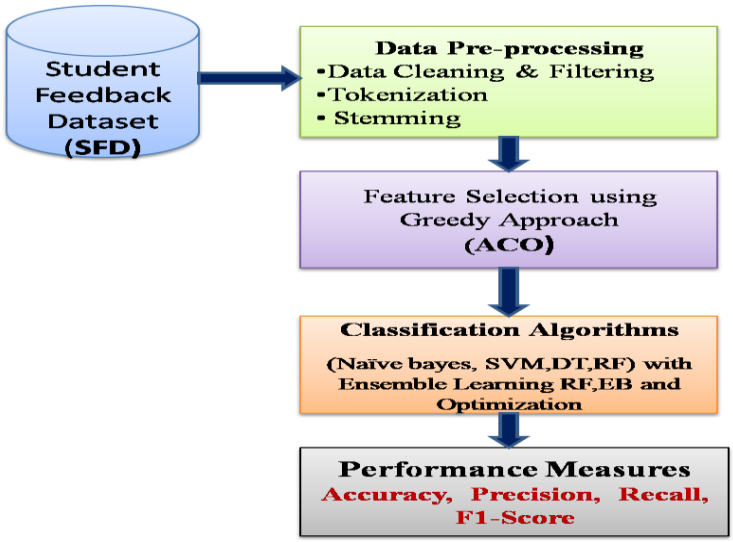

Figure 1. Proposed Frameworks

4.2 Text Preprocessing and Filtering: The feedbacks taken by the students are in form text so first we need to convert the text into feature vector ornumber so that it can be applied to the machine learning model.As the input data may contain noises in various form so first data preprocessing and filtering process is applied. [5]

Data Cleaning: Cleaning of data involves handling of missing values by ignoring that particular tuple. If any tuple or cell is empty then that will be filled with some specific value. Inconsistency of data may be handled manually. It also handles noisy data by implementing machine inspection, clustering, binning methods and regression. All the quotes ("") from the sentences are removed, URL's are removed and other characters that are not considered to be in the category of texts are removed.**Dataintegration:**This step will integrate the data collected from various sources.**Data transformation:** Transformation of data means to change the data from one form to another. For this purpose, various methods like smoothing, normalization, aggregation and generalization are available for the transformation. Transformation steps are as follows:**Sentence Splitting:** The first step involved is sentence splitting is splitting of string into words. **Tokenization:** Tokenization of words means to split a sentence into tokens or smallest unit of a sentence. Tokenization is an important task because many succeeding components need tokens clearly identified for analysis.**Stop Word Filtering:** There are a lot of words that do not have any meaning and can be removed from the input file. Words like "the", "and", "for", "or", "if" ,"that"; are referred to as stop words because they don't signify any meaning or sentiment. Therefore, removal of such words means stop word filtering and it also improves the performance of the system.**Stemming:** A stemming calculation is a procedure of semantic normalization. In this process, the variations of a word are lessened to a typical frame.

4.3 Feature Selection using Greedy Approach

The greedy optimization algorithm which aims to find the best performing feature subset. It repeatedly creates models and keeps aside the best or the worst performing feature at each iteration. It constructs the next model with the left features until all the features are exhausted. It then ranks the features based on the order of their elimination.Feature selection is an action that lessens the number of input variables when a predictive model is created. It is always beneficial to reduce the number of features to reduce the computational price of modeling and to increase the efficiency of the model. The purpose of the feature selection of machine-learning capabilities is to find the best collection of features for creating useful models of studied phenomena. In computer training there are several practical selection algorithms, but this study only focuses on the:Ant Colony Optimization (ACO) Ant colony optimization (ACO) was inspired from the behavior of real ant colonies, and it is used to solve discrete optimization problems The aim of the colony is to find the shortest path between a food source and the nest. The behavior of an ant colony is a good example of a self-organized system such that it is based on positive feedback [19]. ACO algorithm was able to obtain the optimum subset of features and can improve the accuracy of sentiment classification[20].

Ant Colony Optimisation

Initialization Initially,population of ants and intensity of pheromone trail associated with any feature is determined. Moreover, maximum number of allowed iterations is defined.

Heuristic Desirability In ACO algorithm, constructive heuristic is a basic requirement for probabilistically constructing solutions. A solution construction is empty in the beginning and solutions are assembled as sequences of elements from finite set of solution components. After that, a feasible solution component is added to the current partial solution at each construction step. Heuristic desirability of choosing between features could be any subset evaluation function. In the proposed algorithm, CFS subset evaluation is used as heuristic desirability.

Update Pheromone Unlike, Ant Colony system, in this approach only one single ant which is best-so-far ant is allowed to deposit pheromone and update pheromone trails.

Solution Construction The overall process of feature selection begins by generating a number of ants which are then placed randomly on the graph i.e. each ant starts with one random feature. From these initial positions, they traverse nodes probabilistically until a traversal stopping criterion is satisfied. The resulting subsets are gathered and then evaluated. If an optimal subset has been found or the algorithm has executed a certain number of times, then the process halts and outputs the best feature subset encountered. If none of these conditions hold, then the pheromone is updated, a new set of ants are created and the process iterates once more.

4.6CLASSIFICATION ALGORITHMS

Data science offers a wide range of classification algorithms including logistical regression, vector support, naive bayes classification, and decision-making bodies

Support Vector Machine (SVM) :

SVMs are set of related supervised learning methods used for classification and regression [21]. A special property of SVM is , SVM simultaneously minimize the empirical classification error and maximize the geometric margin. So SVM called Maximum Margin Classifiers. SVM is based on the Structural risk Minimization (SRM). SVM map input vector to a higher dimensional space where a maximal separating hyperplane is constructed. [22]

SVM- Support vector machines are universal learners. Remarkable property of SVM is that their ability to learn can be independent of dimensionality of feature space. SVM measures the complexity of Hypothesis based on margin that separates the plane and not number of features[23].

5.2 Naïve Bayes

A naïve Bayes classifier is a probabilistic classifier based on applying Bayes' theorem with strong independence assumptions.[24]
It is an approach of supervised classification that uses marked or marked data. The training includes a series of documents already identified as positive or negative feelings. For this type of classifier, the data set labelled is mandatory. [25]

DT are a successive model that unites a series of the basic test efficiently and cohesively where a numeric feature is compared to a threshold value in each test [26].Decision trees are a type of system monitored where the data is constantly broken down by a certain parameter.

Decision tree classifiers are regarded to be a standout of the most well-known methods to data classification representation of classifiers. Different researchers from various fields and backgrounds have considered the problem of extending a decision tree from available data, such as machine study, pattern recognition, and statistics[27].

Random Forest (RF)

Random forests are a combination of tree predictors such that each tree depends on the values of a random vector sampled independently and with the same distribution for all trees in the forest.[28]

RF is a flexible, user-friendly machine learning algorithm that results greatly, even without hyperparameter set-up.Due to its simplicity and diversity it is one of the most widely used algorithms. It can be used for classification as well as for regression.The number of trees in the forest has a direct relation to the results; the higher the number of trees, the more exact is the result.the security of ride-sourcing and day-to-day journey time to recreation have become main predictors of the frequency of use for recreation and neighborhood facilities at a walking distance have resulted in the most relevant predictor of frequent use of ride-sourcing.

EnsembleLearning

Ensemble learning contributes to the improvement of machine learning outcomes. Compared to one single model, this approach enables better predictive performance. This is why, in several prestigious machine learning events, like the Netflix Competition, KDD 2009 and Kaggle, the Ensemble methods has taken the lead. Meta-algorithms combine various ensemble techniques in one predictive model to reduce variance (bagging), bias (boosting) or improvement of predictions(stacking). [29]

EDA

The estimation of distribution algorithm (EDA) intends to explicitly model the probability distribution of uniformly sampled solutions from those which have a fitness value greater than a threshold. Through selection on elitism to form the next population, the fitness threshold is increasingly strict along the number of generations until the elite individuals in the population cannot be further improved. EDA thus iteratively approximates the probability distribution of the global optima. The probability model can render the dependence between variables, and the linkage relationship is reserved during sampling on the model. The variable dependence modeling is performed through the factorization technique. Mutually [30].

5.2 Performance Parameters [31]

The following performance parameters are measured for In this work, a confusion matrix for 2 classes is used for evaluating the performance of the classifier models. The confusion matrix contains four groups True positive (TP), False Positive (FP), True Negative (TN), False Positive (FN) . The different parameters used for classification performance evaluation are shown in equations (1) to (4).

Precision: Precision means percentage that indicates how many results are correct

Precision = TP / (TP + FP) ---------- (1)

Recall: Recall means percentage that indicates how many of the correct results are found

Recall = TP / (TP + FN)) ---------- (2)

F1-Score: An F1-Score is the harmonic mean of Precision and Recall values of a system.

F1-Score = (2 * Precision * Recall) / (Precision + Recall) ------- (3)

Accuracy: Accuracy is a scoring system in binary classification means determining if an answer or returned information is correct or not.

Accuracy= (TP+TN)/ (TP+TN+FP+FN) ---------- (4)

5. Result and Discussion

5.1 Simulation

For analyzing the behavior of various classification algorithms an interface is designed on swing using weka tool. Figure 2-6 shown below shows the interface designed for simulation of various classification approach for machine learning

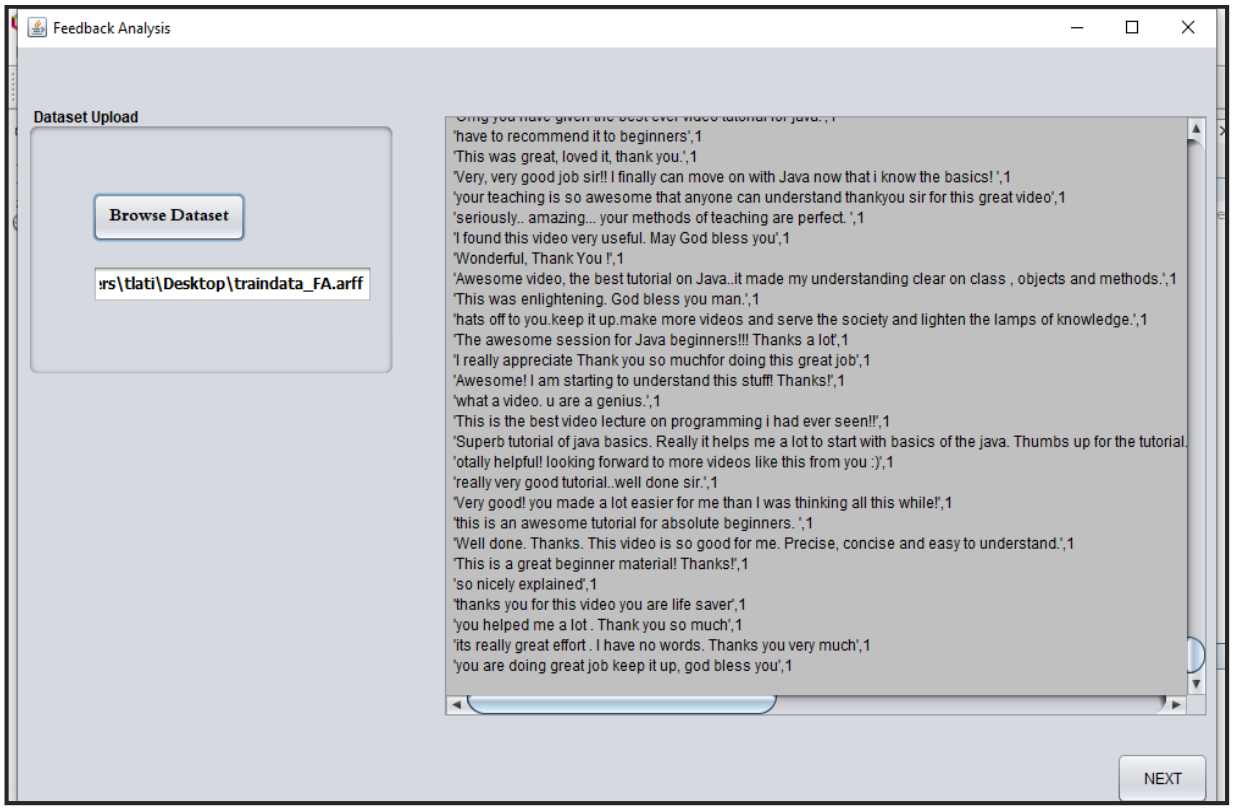

Figure 2: Data upload page

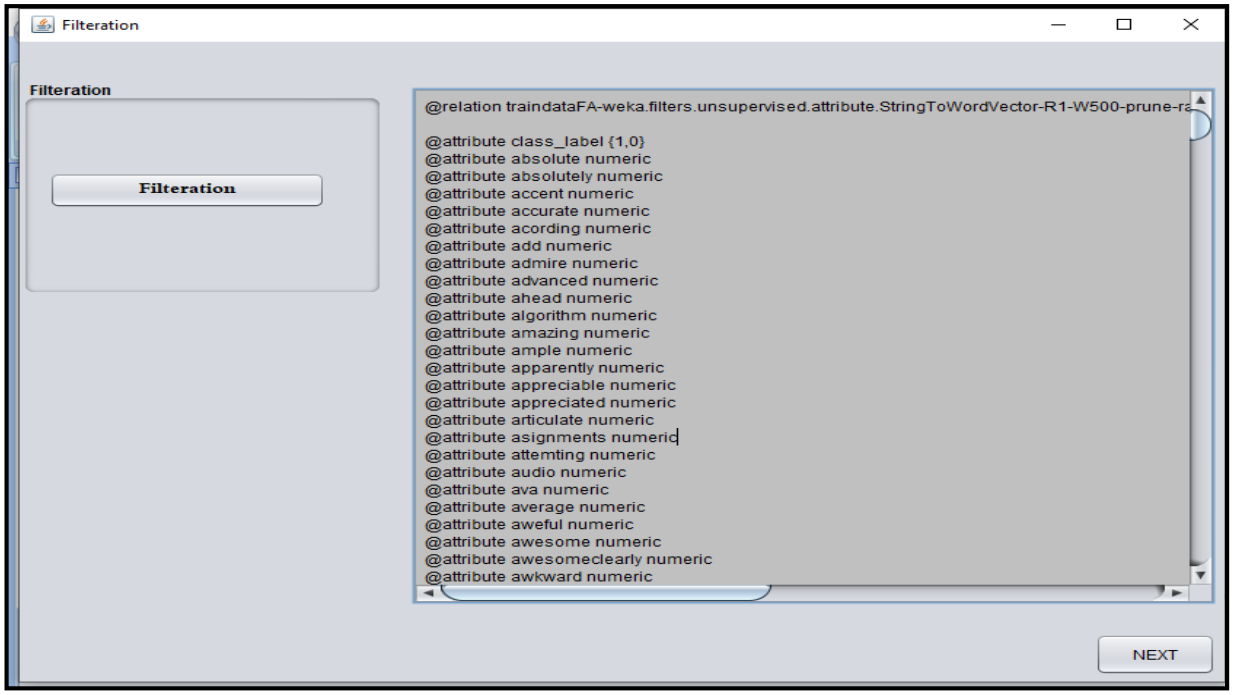

Figure 3: Filteration

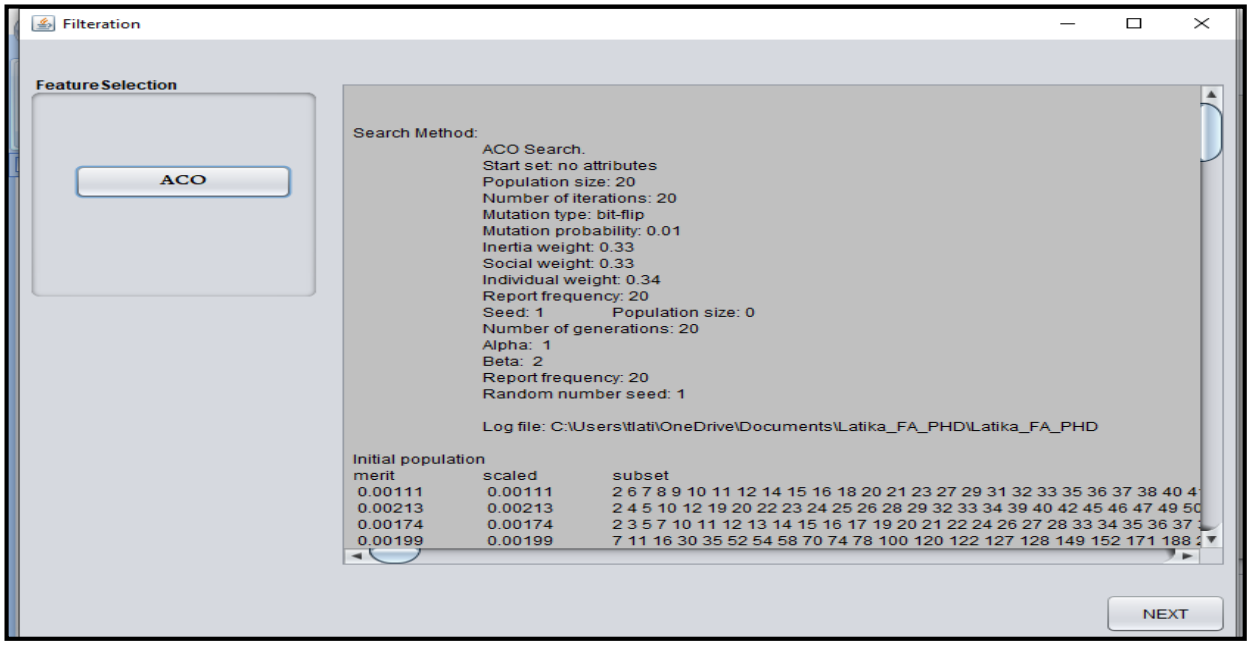

Figure 4: Feature selection 1

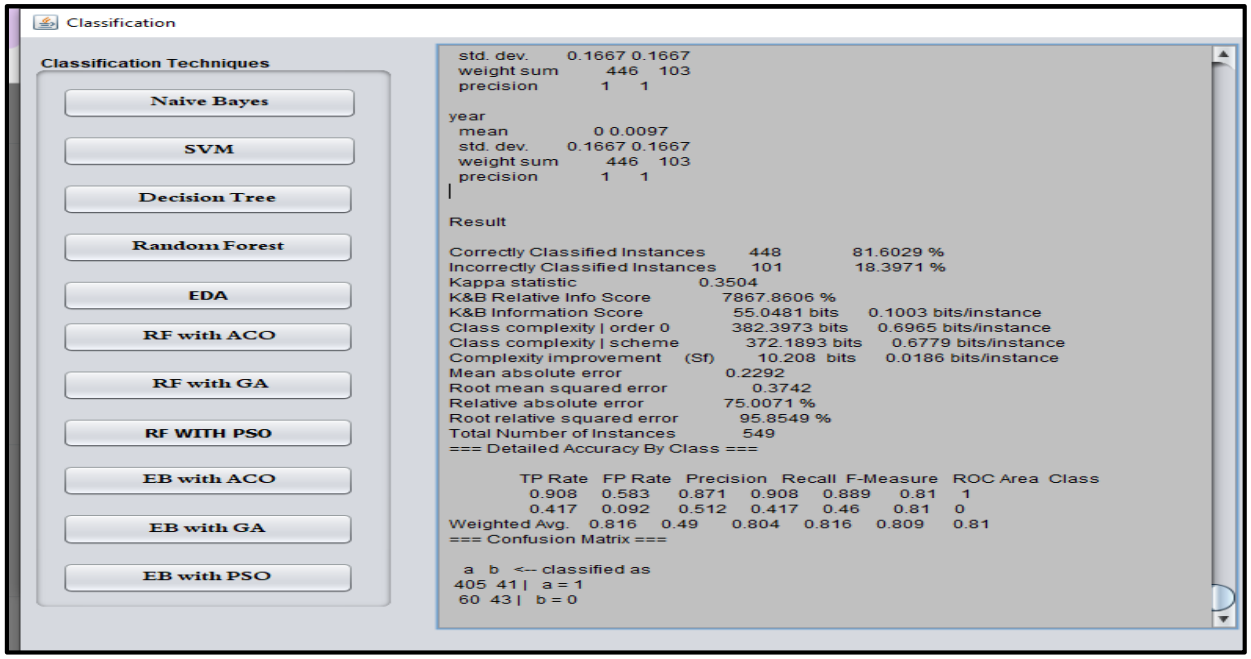

Figure 6: Classification Techniques

5.3 Result Analysis

On the basis of designed interfaced result of different classification algorithms were analyzed. And observation is shown in the table 1 and graphs (figure 6-9) is drawn on the basis of observations.

Table 1. Ant Colony Optimization as FST

Name of Classifiers	TP	FN	FP	TN	Accuracy	Recall	Precision	F1-Score
Naïve Bayes	405	41	60	43	81.60	87.10	0.91	88.91
SVM	408	36	54	51	83.61	0.92	88.32	90.07
Decision Tree	446	0	103	0	81.24	81.24	1.00	89.65
Random Forest	420	26	55	48	85.25	88.42	0.94	91.21
EDA	418	28	51	52	85.61	89.13	0.94	91.37
RF with ACO	435	9	66	39	86.34	86.83	0.98	92.06
RF with GA	435	9	50	55	89.25	89.69	0.98	93.65
RF with PSO	439	3	76	31	85.61	85.24	0.99	91.75
EB with ACO	435	7	49	58	89.80	89.88	0.98	93.95
EB with GA	434	8	54	53	88.71	88.93	0.98	93.33
EB with PSO	439	3	78	29	85.25	84.91	0.99	91.55

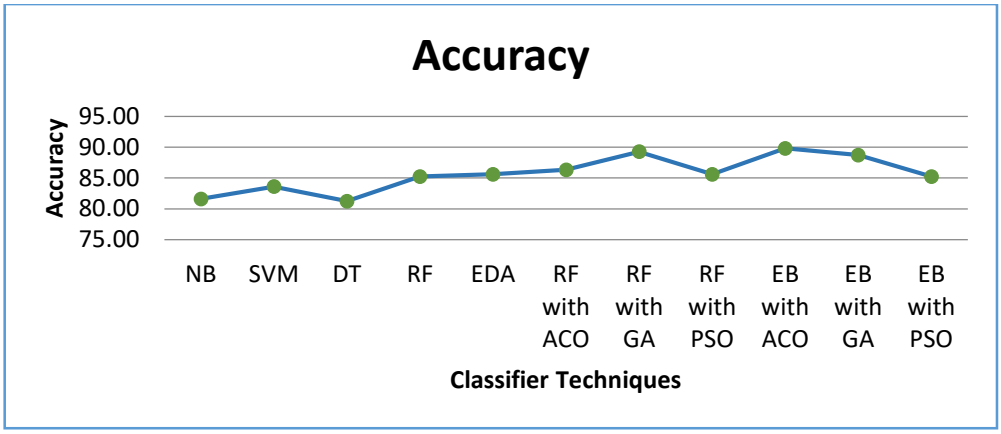

Figure 6. Graph for Accuracy of various classifier techniques

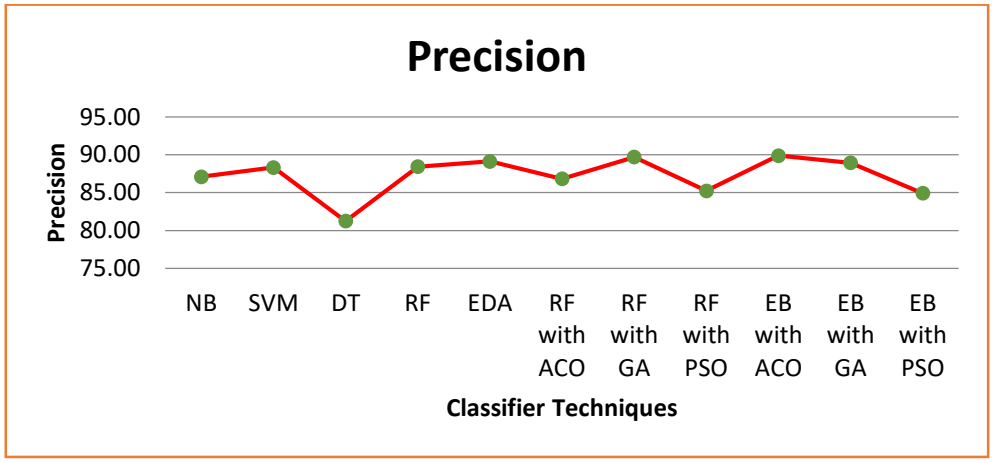

Figure 7.Graph for Precision of various classifier techniques

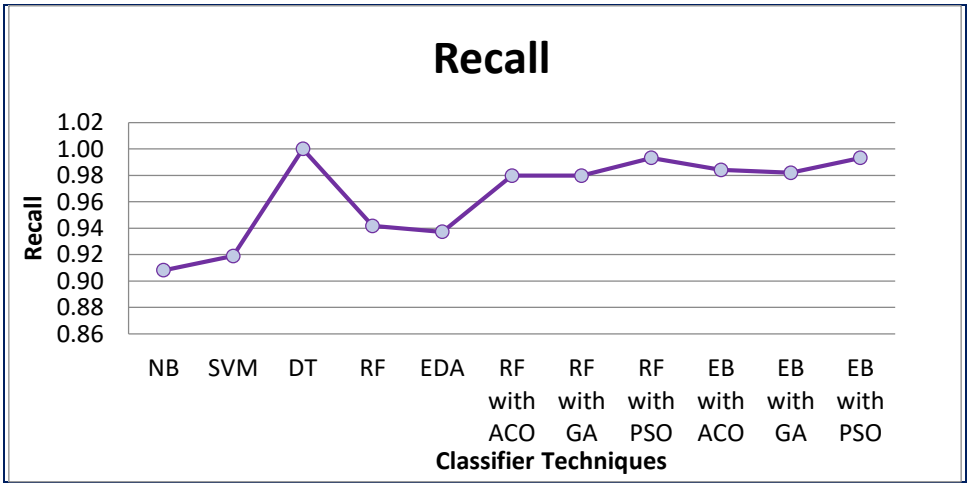

Figure 8.Graph for Recall of various classifier techniques

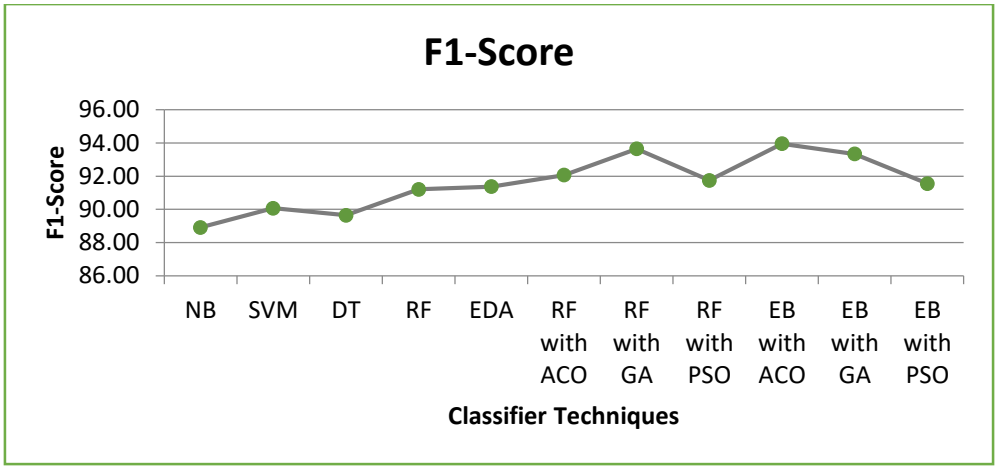

Figure 9 graph for F1_Score of various classifier techniques

Conclusion

Student sentiments play a vital role on Web-Based Learning System(WBLS). Feedback of the Students is used for measuring the effectiveness. In this study an interface is designed in Swing with Weka tool and comparison of various classification techniques namely NB, SVM, DT,RF,EDA,RF and the modified models RF with ACO , RF with GA, RF with PSO, EB with ACO,EB with GA and EB with PSO were done . On comparison it was found that while using ACO as feature selection technique the performance of EB with ACO are better as compare to other classifier techniques. In future studies other metaheuristic optimization techniques with this classifier would be used.

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