Sentimental Analysis of Student Feedback using Machine Learning Techniques

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ABSTRACT---Educational institutions attempt to collect feedback from students to study their sentiment towards courses and facilitates provided by the institution to improve the college environment. In present scenario, grading technique is used for feedback. This grading technique does not reveal the true sentiment of students, but the textual feedback provides a chance to the students to highlight certain aspects. In this paper, a method has been proposed for sentimental analysis of student feedback using machine learning algorithms such as Support Vector Machine, Multinomial Naïve Bayes Classifier, and Random Forest. A comparative analysis is also conducted between these machine learning techniques. The experimental results suggest that Multinomial Naïve Bayes Classifier is more accurate than other methods.

Index Terms: Sentimental analysis, Multinomial naïve Bayes, Machine Learning

I. INTRODUCTION

Feedback is the statement sent to an entity about its past behavior from which the entity can analyze the future and current behavior to achieve the expected result. Feedback plays animportant role in education and learning by helping to adopt new knowledge and prevent repetitive mistakes. In matters concerning quality in higher education, a lot of peoplewonderabout whose opinion should really be taken seriously or has greatest importance in the decision-making processes.Feedback is aprocess which helps the organization to monitor, evaluate, and regulate the overall working environment. Good feedback practice provides usefulinformation to the organization in improving the teaching and learning experience.

Depending on the feedback given by students it can be classified as textual or grading (Likert-scale based score) form.In Likert-scale based score questions are provided to the students and are asked to answerthose questions using a rating based scale. This technique mainly focuses on a question that is related to same topic and it does not express the exact sentiment of the students.

In order to know the exact sentiment of the students textual feedback technique is used. In this textual form student are given with set of questions and they need to answer it in sentences.It is helpful to both theacademic administration and the instructor to overcome the issues related to their organization.In this paper, the student feedback with varied opinion is collected using google forms. The aim is to extract expressions of opinion and classify it asnegative, positive or neutral using machine learning techniques.

Sentimental analysis is a method for identifying the sentiment expressed in texts. The need ofSentiment Analysis oftext has gained more importance in today's situations faced by the people of the world. Generally, there are three approaches in sentimental analysis. They arelexicon based,machine learning and hybrid approach. In machine learning technique, it uses unsupervised learning or supervised learning. Classification problem can be carried out using several algorithms like support vector machine, naïve bayes, randomforest. Inlexicon based method sentiment polarity of the textual content is detected using sentiment lexicon. A lexicon is a list of words with associated sentiment polarity. Hybrid approach is a combination of lexicon-based and machine learning methods. The training data set is labelled using sentiment lexicon and this is used to for the machine learning model. Then testing data is evaluated using this model.

The remaining of this paper is organised as follows: In section 'Literature Review' we provide a brief description about some work related to sentiment analysis and machine learning techniques. The process of classifying the text into different classes using feedback obtained from students is presented in section 'Methodology'. Comparative analysis of different machine learning algorithms based on accuracy and F-score are presented in section 'Performance Analysis'. Section 'Conclusion' concludes the research work.

II. LITERATURE REVIEW

Lot of research has been done in the area of sentiment analysis. However, there was not much research done in area of text classification which classifies the sentence into three classes i.e. negative, positive and neutral.

Sentiment analysis aims at identifying, analyzing and extracting opinions from texts. This paper describes hybrid approach for performing sentiment analysis and it is done using TF-IDF(term frequency-inverse document frequency)

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and domain-specific sentiment lexicon. However, the limitation of this approach is, it only computes overall sentiments of feedback that is provided by the student [1].

In [2] an overall survey is conducted in three major field to analyze the sentiment i.e. framework, feature extraction and sentiment analysis. The methods used in current research are focused and the existing problems of those studies are discussed.

In paper [3] supervised learning methods likenaive bayesandsupport vector machineare considered as standard learning method. Accuracy provided by support vector machine is good when compared to other classifiers. This paper concludes that naïve bayes learning method performs better if small data set is taken and SVM performs better if large data set is taken.

The paper[4] proposed a data mining methodology torate the facultiesinto the classes i.e. from 1 to 5 of an institution by considering certain characteristics.naivebayes classifier and text mining were used to process the feedbacks received from the students. The drawback of this paper was it did not reveal the true sentiment of students.

To process the number of feedbacks that are gathered at the end of semester was tedious job and time consuming. This paper addresses this problem and uncovers the model for analyzing these feedbacks by using machine learning techniques such as Support Vector Machine (SVM), Naïve Bayes, Maximum Entropy (ME)in [5,6].

The paper [7] explains the sentimental analysis on twitter data using decision treeand multinomial naive bayes algorithms. Results concluded that decision tree algorithm performs better using parameter accuracy,recall, precision, and F1-Score.

In paper [8], naïve bayesian approach was used for text and document classification.For the classification 1150 documents were considered and to extract the features n-gram method was used. The performance was measured by considering the performance parameters such as recall,and f-measure, precision, accuracy.

The paper [9] solves problem of sentiment polarity categorization. Online product reviews of Amazon are taken as input for the proposed work. A sentiment polarity categorization process was proposed. Categorization for both sentence and review level was performed to estimate the result.

III. METHODOLOGY& RESULTS

The student feedback collected using google form is an input data. i.e. training data using which the system is trained. On receiving test samples, the trained system classifies the sentence as negative, neutral, and positive classes using machine learning algorithms. This outcome is graphically represented. The proposed methodology consists of six steps: preparing training data, collecting student feedback, feature extraction, model training, evaluation of test data, graphical representation of the result as shown in Figure 1.

To carry out these steps data required is collected through student feedback.

1. Preparing training data:

Machine learning is classified into unsupervised and supervised learning. In supervised learning the sentences are given with label of classes, whereas labels are not provided in unsupervised learning. Training data is collected for each question which is used to train the system.

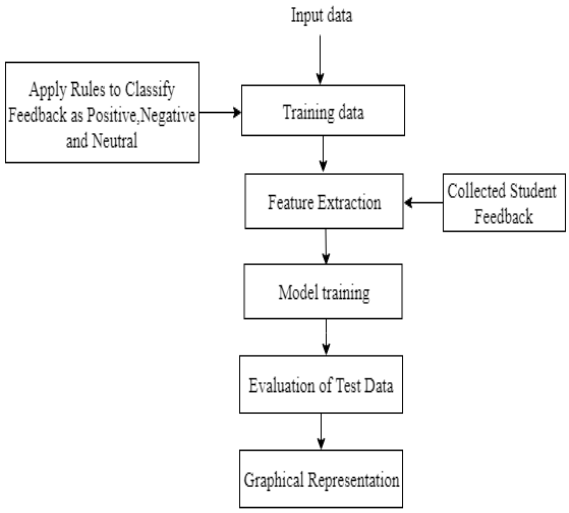

Figure 1: Methodology of sentiment analysis

This training data is the responses in the form of sentence from the students. Each sentence is converted to lower case and is given as input to the SentimentIntensityAnalyser() method which is available in package VaderSentiment.VADER(Valence Aware Dictionary and Sentiment Reasoner) sentiment analysis returns a sentiment score in the range -1 to 1 from negative to positive. Individual words have sentiment score between -4 and 4.The sentiment score (Compound Score) of a sentence is calculated by summing up the sentiment scores of each VADER-dictionary-listed word in the sentence and normalized to map it to the value between 1 and -1 [10]. The normalization used by Hutto is given in equation 1.

$$\frac{x}{\sqrt{x^2 + \alpha}} \qquad (1)$$

Where x is the sum of the sentiment scores of constituent words of a sentence and α is the normalization parameter set to 15.

If the compound score is >=0.05 the sentence is classified as positive, if the compound score is greater than -0.05 and less than 0.05 the sentence is classified as neutral, if the compound score is <=-0.05 the sentence is classified as negative.

2. Collecting Student Feedback:

The questions are sent to students through google form and the student responses are collected and stored in microsoft excel comma separated values file. Google forms containing feedback questions are shown in Figure 2.

3. Feature Extraction:

This process involves feature extraction in a format required by machine learning algorithms from thedatasets which consists of formats such asimageand text. Both train and test data are subjected to feature extraction. The Scikit-learn library offers tools to perform bothfeature extraction and tokenization of textual data. Text documents can be tokenize and vocabulary of known words are built usingCountVectorizer.
It works as follows:

a. Object ofCountVectorizer class is created.
b. To learn the vocabulary from one or more documentscall thefit() function.
c. One or more documents are encoded as vector using transform() function.

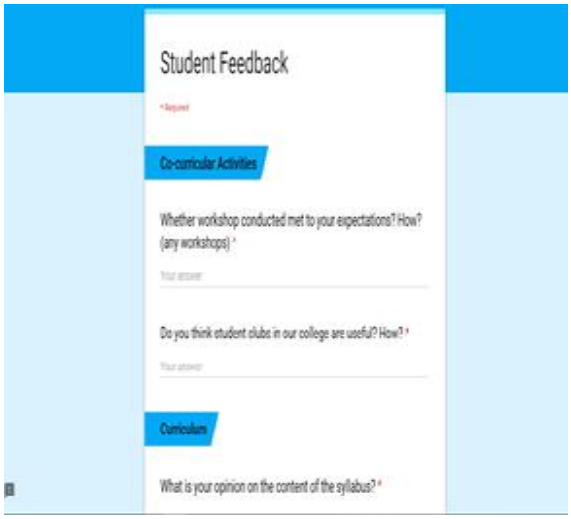

Figure 2:Google Forms containing feedback questions

4. Model Training:

There are many different algorithms fortext classificationwith machine learning.

a) Multinomial Naïve Bayes Classifier (MNBC)

The basic idea involved in naive bayes classification technique is to find theclasses probabilities assigned to texts by using joint probabilities ofclasses andwords.The features/predictors used by the classifier are the frequency of the words present in the document.

b) Support Vector Machine (SVM)

SVMs are supervised learning models that examine data used for regression analysis and classification. A support-vector machine constructs a hyperplane or set of hyperplanes in an n-dimension space, which can be used for classification, regression or another task.SVM areused to categorize the data points bymapping data to ahigh-dimensional feature space, even when the data is not linearly separable.First a separator between the categories is found, then thedata is transformed so that hyperplane is drawn as a separator. At the end, new data characteristics are used to predict the classfor a new record.

c) Random Forest (RF)

Random Forest is a supervised learning method. It can be used for bothclassification and regression task. Random Forest algorithm creates a forest with number of trees. As the number of trees in the forest increases accuracy also increases.

General steps in Random Forest:

Step 1: Creation of random vectors.

Step 2: sing random vectors to build multiple decision tree.

Step 3: Combining decision trees.

ALGORITHM

TRAIN_NAIVE_BAYES(Examples, V)

1. Collect all words, punctuations, tokens that occur in the Examples.
2. Vocabulary ← set of all distinct words and other tokens occurring in text document from Examples.
3. Calculate the required $P(V_j)$ and $P(W_k \mid V_j)$ probability terms.
4. For each target value V_j in V do
5. Doc_j ← subset of doc from text for which target value is V_j.
6. $P(V_j) \leftarrow \frac{|Doc_j|}{|Example|}$
7. $text_j \leftarrow$ single document created by concatenating all members of Doc_j.
8. n ← total numbers of distinct word positions in $text_j$.
9. For each word W_k in Vocabulary
10. $n_k \leftarrow$ numbers of times distinct word W_k occurs in $text_j$.
11. $P(W_k \mid V_j) \leftarrow \frac{n_k + 1}{n + |Vocabulary|}$

CLASSIFY_NAIVE_BAYES(Doc)

1. Positions ← all words in Doc that contains tokens found in Vocabulary.
2. Return V_{NB}, where
3. $V_{NB} \leftarrow \underset{V_j \text{ in } V}{\operatorname{argmax}} P(V_j) \pi \underset{i \text{ in Positions}}{} P(a_i \mid V_j)$

Source: [11]

5. Evaluation of the test data

Evaluation is the process of collecting and analyzing data, where the result can be used to determine whether an organization is effectively carrying out the planned activity. This corresponds to the final evaluation that the model goes through after the training phase has been completed. This step is critical to test the generalizability of the model by using test set we can get the working accuracy of the model.

6. Graphical representation

Data visualization is the presentation of data in graphical format. Python offers multiple graphical libraries that provide different features. Matplotlib is one among them.It is the library which offers lot of freedom at the cost of having to write more code.

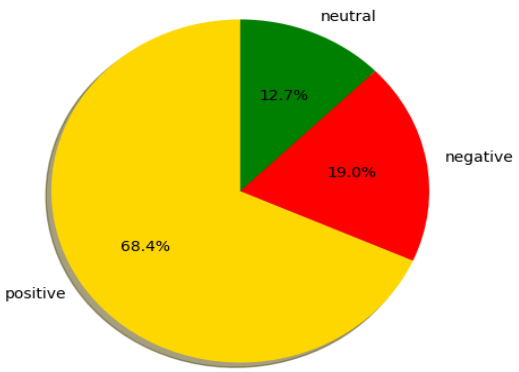

Figure 3: Graphical Representation of the result

IV. PERFROMANCE ANALYSIS

In this section, a comparative analysis is carried out using three machine learning algorithms such as Multinomial Naïve Bayes, Random ForestandSupport Vector Machine for unigram and bigram based on accuracy and F score.Unigramsis a sequence of single element from a string of tokens whereas bigram is a sequence of two element from a string of tokens.

Test dataset is used to examine the performance of learned model. The following metrics were considered: Accuracy, F Score.

Accuracy: Accuracy is defined as the ratio between number of correct predictions done by the model to the total number of rows in the dataset and it is given in equation 2.

$$Accuracy = \frac{correct\ predictions}{rows\ in\ dataset} \quad (2)$$

F-score: It is the weighted average ofrecall and precision and it is given in equation 3.

$$F\ score = \frac{2 \times Precision \times Recall}{Precision\ + Recall} \quad (3)$$

Thegraphs in figure 4 and 5 shows the accuracy oftheRandom Forest, Support Vector Machine,and Multinomial Naïve Bayes Classifier for unigrams and bigrams by keeping the test data constant and varying the size of the train set. It can be observed that as the training data increases accuracy also increases. When we compare MNBC with RF the accuracy of MNBC increases as the model is trained with more data whereas, the accuracy ofR F does not vary linearly due to lot of randomization in the training phase. Also, machine learning algorithms with unigrams perform better than bigrams.

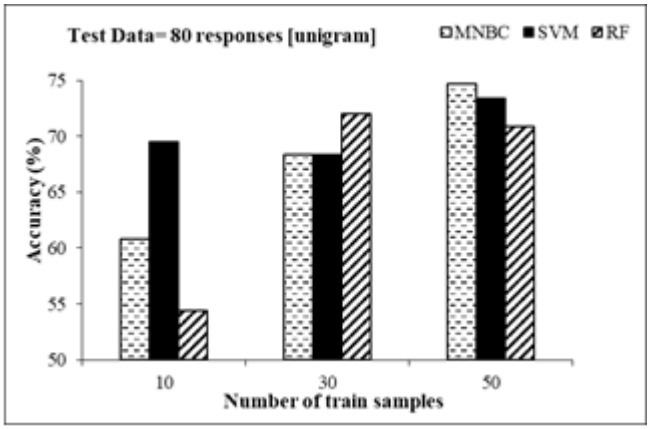

Figure 4: Performance of SVM, MNBC, RF algorithms of different train samples forunigram

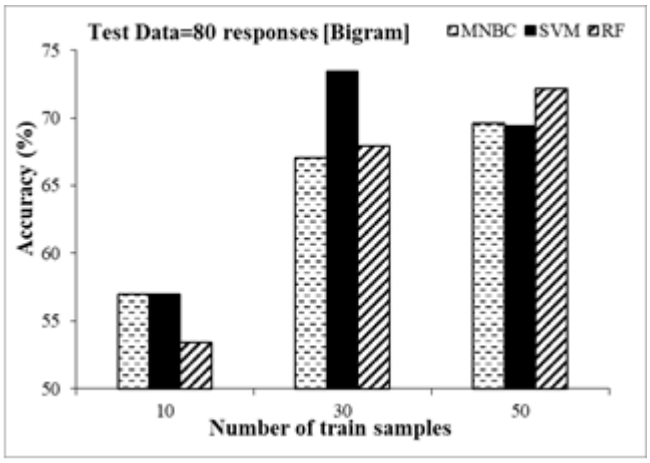

Figure 5:Performance of SVM, MNBC, RF algorithms of different train samples for bigram

The graphs in figure 6 and 7 shows the F Score of the SVM, MNBC and RF for unigrams and bigrams by keeping the test data constant and varying the size of the train set. It can be observed that F Score of MNBC and SVM algorithm increases linearly as the training data increases.

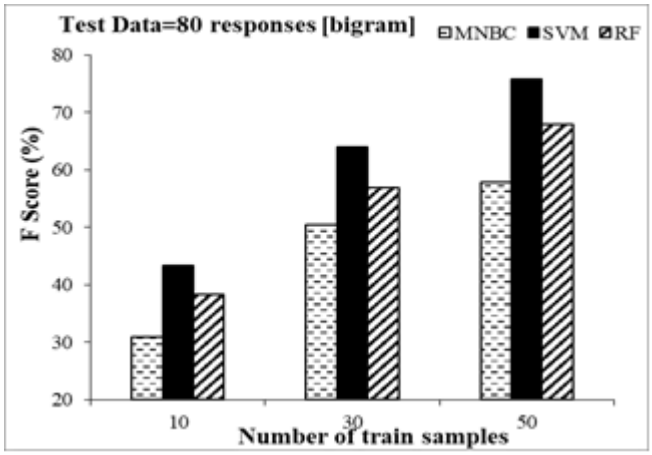

Figure 6: Plot of F Score versus number of train samples for unigram

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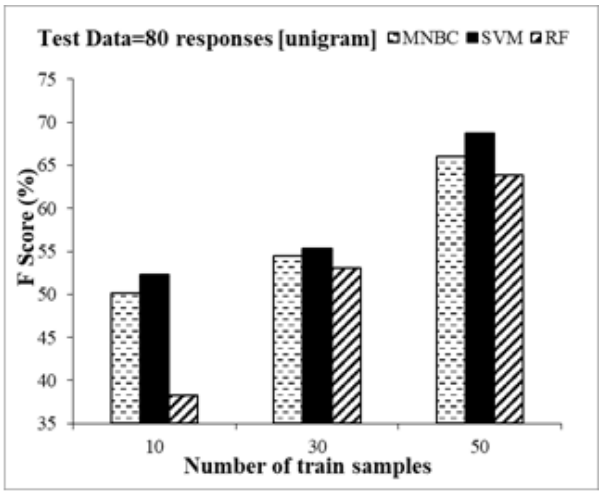

Figure 7: Plot of F Score versus number of train samples for bigram

Figure 8 depicts the accuracy of the SVM,MNBC and RF for unigrams by keeping the train data constant and varying the size of the test set. Analysis shows that accuracy of MNBC is 0.77%-1.27% better than RF, and SVM performs 0.78%-0.81% better than MNBC.

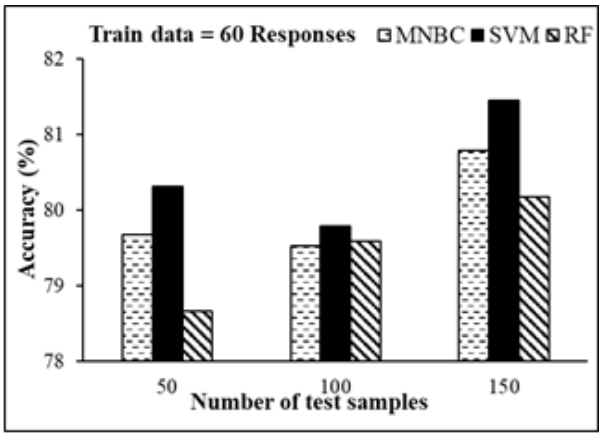

Figure 8: Plot of Accuracy versus number of test samples for unigram

V. CONCLUSION

Grading based feedback has disadvantage that it does not reveal exact sentiment of the students. To overcome this disadvantage textual feedback is used. Sentimental analysis enables institution to know the sentiments of the student using their feedback. From this analysis they can improve the quality of teaching and college environment. This project can also be used to obtain student's opinion towards an event, workshops etc.

In this paper to perform sentimental analysis, first the feedback was collected, given to the trained model and the sentiments are classified. A comparative studysuggests that multinomial naïve bayes classifier algorithm is more accurate when compared to support vector machine and random forest algorithms. From the analysis we could say that multinomial naïve bayes classifier algorithm performs better with accuracy of 80% when compared to other two algorithms.Future work in this field can be focused on increasing the accuracy of the model by considering large training data.

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