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Machine Classification for Suicide Ideation Detection on Twitter

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***Abstract**: The tremendous rise in technology and social media sites enabled everyone to express and share their thoughts and feelings with millions of people in the world. Online social networks like Google+, Instagram, Facebook, twitter, LinkedIn turned into significant medium for communication. With these sites, users can generate, send and receive data among large number of people. Along with the advantages, these platforms are having few issues about its user safety such as the build out and sharing suicidal thoughts. Therefore, in this paper we built a performance report of five Machine Learning algorithms called Support Vector Machine, Random Forest, Decision Tree, Naïve Bayes, and Prism, with the aim of identifying, classifying suicide related text on twitter and providing to the research related to the suicide ideation on communication networks. Firstly, these algorithms identify the most worrying tweets such as suicide ideation, reporting of suicidal thoughts, etc. Also, find outs the flippant to suicide. Along with ML classifiers, One of the most powerful NLP technologies i.e: Opinion summarization is used to classify suicidal and non-suicidal tweets. The outcome of the analysis representing that Prism classifier achieved good accuracy by observing emotions of people and extracting suicidal information from Twitter than other machine learning algorithms.*

Keywords: DT, Machine Learning (ML), NB, Prism, RF, Suicide ideation, SVM, Social networks , Text classification, World Health Organization.

I. INTRODUCTION

Online communication sites like Twitter and Instagram are allowing their users to share their thoughts and communicate with each other using the web-based services provided them [1]. Even though these sites are beneficial, they are creating negative impact on people having suicidal thoughts [2]. Several researches reported the relationship between group of people with suicidal ideation and social networks [3][4][5].

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Now-a-days people are killing themselves based on the text received in social media. As per the WHO report, most of members who are attempting to the suicide are users of social media [7] [10].

In this way, these platforms are posing some issues on its users [6][9]. Social media sites are having large amount of increasing data related to the user personal lives as well as data related to society. With the proper usage of the information in social media, we can identify and prevent most of the suicide attempts [4]. In order to save the lives of people we need to study the behavior and recent communications performed by them. According to [2][6] consequences of social media, these are for supporting non-professional users of social media, rather than supporting professional users. In order to measure the efficiency of machine learning algorithms, we conduct a baseline experiment for classifying suicidal and non-suicidal tweets. Then, we perform frequent modifications in training data to check the impact of data manipulation on the results that are generated after classification. Finally, we are aimed to provide this information to the current researches on suicidal ideation in social networks.

Artificial Intelligence has many applications , one of them is Machine learning that enables a device to perform automatic access of data, also gives the capability of self learning and acting on data without any explicit training [1][2][3][4]. As per study [4], there is a rapid growth in machine learning applications from the past several years in Computer Science and Engineering. It has been used in different areas like designing of drugs, detection of frauds and searching in web and online recommender systems. Along with this, the most effective technique of ML is classification [3][4][5], which performs the judgment of new attribute.

Data classification has been done by applying multiple classifiers of machine learning For instance: Prism. In 1987,Cendrowaski developed the Prism algorithm which is rule-learning algorithm[6–8]. Even though this classifier is unpopular when contrast to other classifiers of ML like Random Forest , Decision Tree, Naive Bayes and SVM. Also, this classifier easy to understand and straight forward[7][8]. It applies sequential covering principle called Divide-and-Conquer method [10]: target values are accurately predicted by the rules, that separates the target attributes from the flippant in divide and conquer levels, this functions are is carried out until each and every instance is processed. Therefore, we are comparing the efficiency of Prism algorithm with other four algorithms such as DT, NB, RF, SVM on tweets holding suicide communication on social media.

II. RELATED WORK

Sentiment analysis and Text classification are the two well studied fields which are applied to various data, for instance: tweets.

Along with these techniques statistical analysis is used to perform the classifications of suicidal communication. Research related to suicide-related communications on social media are still in primary level; For instance, [3][4][5] noticed the association of suicide ideation , social networks, followed by elevating consequences related to the safety of people and creating more platforms for doing further analysis to serve users who are in danger.

By using the machine learning classifiers, the authors generated a list of words related to suicide ideation in order to perform the classification of suicidal and non-suicidal texts , and acquired an accuracy of 60%. The study of [3] exploring that the people with suicidal thoughts users might be identified through the social media sites. They found suicidal communications in tweets on Twitter, by focusing on the US, and identified a strong association between the geographic suicide rates and tweet on Twitter. According to their analysis, compared to the other states, western and mid western states had more proportion, for the proportion of suicidal tweets per state. After that, they identified the efficiency of online platforms in predicting suicide, at different levels [5]. While doing the research related to suicide detection, they developed various strategies and methods for predicting the people emotions.

As of now, the analysis done by [2] is more similar to objective of this project. They examined the efficiency of Machine learning algorithms by extracting the tweets that had suicide communication on Twitter using the search keywords and lexical terms of suicidal ideation. They got an F-measure of 0.716, through their base-line experiment. Also, they increased the accuracy of the results, by creating and applying an effective classifier that acquired an improved level of F-measure i.e:0.7.36. The aim of our project is to work on [2], identification and prevention of suicidal ideation on twitter.

Machine learning classifiers and techniques applied to several domains like Financial applications [9], applications related to safety and medicine , Also, used to solve some Economical issues . Even though it has many classifiers the research related to short messages on social media is not yet performed. The application of prism learning classifier is limited.

The Prism rule learning algorithm is developed to identify the problem called replicated sub-tree which generally occurs with the DT classifier. The Prism classifier is able to select instances depending on the values generated related to a particular category, as it is a rule learning classifier. First it selects an attribute after that learns few rules related to the target attribute, finally it classifies the remaining attributes from the target classes. This procedure is applied to each class by using them as the target attributes [3]. It has many applications for instance, finding the type of contact lenses and identification of soccer goals in multimedia framework, image segmentation, etc.

III. PROBLEM DEFINITION

The previous research works on detection of suicide were representing the following problem statements. In most of the cases SVM outperforms, but the parameter optimization can improve the result. Data grouping, classification and optimization variability combination is missing as it may helpful in better classification accuracy. Transfer and feature learning techniques may improve the classification. Evolutionary algorithms may play an important role when the parameters are variable in nature. Computation time analysis along with the consideration of different computational variations is missing.

IV. IMPLEMENTATION METHODOLOGY

A. Data Collection and Annotation

We need to conduct further investigation of suicide communication on twitter for detection and prevention of suicide attempts. Tweets that have suicidal ideation are selected from the news articles and websites by applying search key words and lexicon terms. The collected tweets were labeled appropriately.

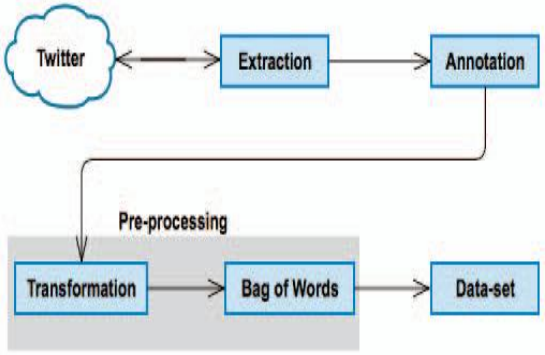

Fig. 1.Preparation of dataset

After an attentive processing 50,000 tweets were collected from social media (Twitter). The tweets were classified by the expert human annotators into seven classes.

Social media sites are having different types of data. We need to find out the data related to suicide as well as flippant from these sites. 1) Tweets are classified based on their *relevance* using scientific and logical keywords of suicide. The tweets holding suicide keywords are used for classification process.

B. Preprocessing

Data preprocessing is method that transforms the raw data (inconsistent, incomplete, has errors) into useful data. The data in online sites are noisy [2]. We need to remove the noise from tweets and increase the quality of data along with accuracy of classifiers . Preparing the data for classification is called Pre processing of data. .We created and applied several methods for collecting the tweet whose annotator agreement score is greater than 35%. Finally 936 attributes were collected, from 1064 attributes. Table 1 shows the three classes along with a short description based on their original definition. These descriptions are eventually used to detect the classes.

Table-I Total instances per class

Class	Description
C1	Suicide
C2	Non-suicide
C3	Flippant

To reduce redundancy we need to remove the stop words, URLs, non-ASCII characters .Along with these, we should perform stemming, parts of speech (POS) tagging [2]. Instead of concentrating on context BOW focuses on words .It ignores the semantic and syntactic of data and considers the text as group of words .Inverse Document Frequency is applied to the tweets [12]. Inverse document frequency, assign less weigh to more frequent words and more weigh to rare words. Using Inverse Document Frequency as a vector, vector documents are built for each word in the document. Based on the IDF's, eventually input column are created for BOW (document or word) .

C. Feature Generation

The suicidal tweets are collected from the social media by applying machine learning algorithms. To separate the flippant of suicide from suicidal ideation tweets we should train and test the classifiers effectively, as explained below:
Following are standard Attributes of text mining classifiers, such as frequent terms, phrases, Parts of Speech and structural features of the language are used for representing sentences and their lexical characteristics .Self references and other references are detected with Parts of speech technique for instance :the terms detected in past research are few evidences.

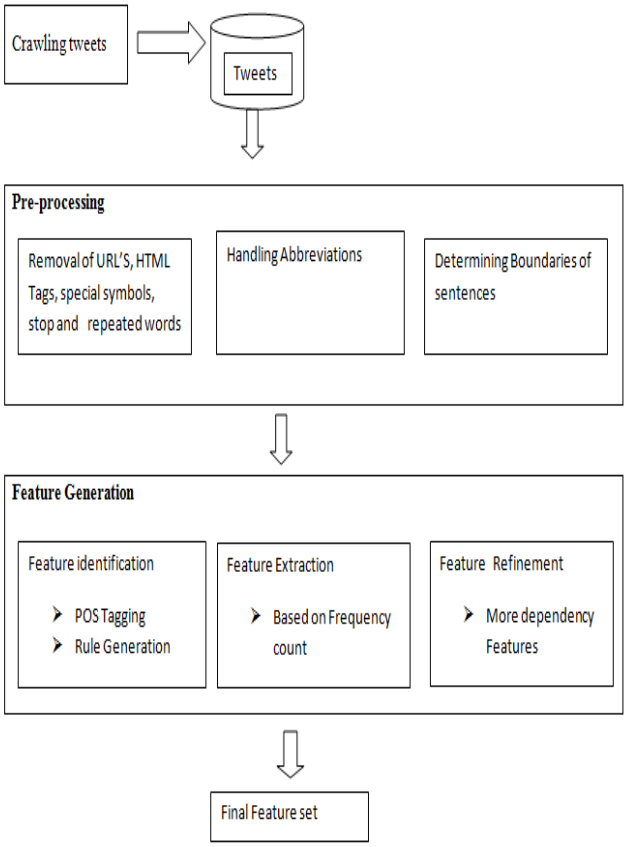

Fig. 2.feature extraction and preprocessing

a) Features showing suicidal thoughts

Different types of words such as emotional and affective attributes of the data are used for classification. These terms were included because of the emotive characteristic of the function. Aggressiveness, anger and fear are the basic causes of suicidal ideation [1].

b) *Parts of Speech*

We assigned a parts of speech label to each term using Stanford POS tagger8. Examples are nouns that classified into 1)singular, 2)plural and 3)proper. Verbs that specifies tenses like 1) Present, 2) Past 3)Present Participle. Adjective that describes the nouns, Pronouns like 1) personal, 2)possessive, References of first vs third person, then adverbs 1)superlative, 2)comparative, as well as Conjunctions, interjections determiners, symbols, and cardinal numbers. The occurrence each of the above mentioned terms are considered as a feature.

c) Structural features

We used the frequency characteristic of each sentence along with the proper usage of pronouns and first person singular/plural. Also, the features of external communication which includes the characteristics of URL in twitter communications.

d) Lexical Domains of general category

General lexical domain features are extracted from wordnet domains. This features include the lexicons like house, profession, religion, sociology , psychology , etc.

e) Lexical Domains of affective category:

These features are more related to the concepts of affective domains. Affective features consist of situations, moods, emotions and their responses for instance: anger, sadness, surprise, enthusiasm, grief, love, hate, happiness, joy. It has more specific categories like belligerence, unrest, bad temper, amicability, trepidation, etc. Opposites self pity, self consciousness, self esteem and deprecation, positive and negative fear, concern as well as suspense. These features play an important role in our examination.

f) Feature generation using sentiment score

This feature is generated by performing the addition of scores associated with each word (between 0-1) in a tweet using the SentiWordNet10.

g) Words

The training data set consist of frequently occurred terms like unigrams, bigrams, trigrams and 1st hundred n –grams.

h) *Search terms list*

The pre-filtering operation was carried out by comprising some keywords collected from different web sites for instance: `Don't want to try any more', `want to disappear', `asleep`, `end it all', `isn't worth living', `want to die', `kill myself', `My life is pointless', `to live anymore`, `want to end it', and never wake', etc. All keywords with a global binary feature were treated as individual features in one tweet.

The dataset is used to measure the efficiency of five ML algorithms such as Support Vector Machine, Random forest , Naive bayes , Decision Tree , Prism to classify suicidal ideation tweets from Twitter. These algorithms are selected based on their properties and popularity. Each of them works in the following manner: 1)The value of information gain increased by identifying features with help of Decision tree 2) the no.of false negative occurrences were reduced using Random forest[2] , 3) Support vector machine detects informal and short tweets efficiently [2, 9] 4) Based on the occurrence of likelihood feature Naive Bayes performs the classification[2].

The following section represents the efficiency of ML algorithms in the form of P:Precision ,R:Recall, A:Accuracy and F-measure.

i) DATA CLASSIFICATION

Machine learning has multiple techniques in multiple domains, one of the most effective technique among them is Classification, it is also used in the applications of sentiment analysis. The classification of data instances performed in two ways, 1) Binary classification which classifies the data into two classes (suicidal and non-suicidal), 2) Multi class classification, it classifies the data into multiple classes.

In this paper, to perform the binary class classification we organized the text in the dataset. The dataset contain the data of suicide, flippant categories (i.e. Suicide or Flippant) as well as Non-Suicide data. Flippant reference to suicide along with the classes means which doesn't have association with suicidal ideation are belongs to Non-suicide class like the campaign, memorial, support, reports, etc related to the non-suicide category. Table -I shows the number of instances per class.

V. RESULTS AND PERFORMANCE ANALYSIS

Firstly**,** we examined the efficiency of five ML classifiers with four derived features (Random forest , Decision tree, Naive bayes , Support vector machine and Prism) by conducting a baseline experiment[2].

While classifying the short informal text, support vector machine gives the best results. A line which separates the data points (i.e: Feature vectors) is called a Hyper plane (HP). These data points are plotted on high dimensional spaces. To separate the Feature vectors belongs the various human assigned categories and to identify a best way for dividing the space hyper planes are used. Optimal hyper plane is which makes more distance between the feature vectors for carrying all of this functions multiple hyper planes were used.

A feature that separates the suicidal and non-suicidal tweets from training dataset is detected in order to reduce the uncertainty using the rule

Based approaches. Rule based approaches increases the information gain with iterative processing. It creates an incremental and hierarchical rule set for implementing the classifiers.

Finally, the frequency of short and individual words that related to the suicidal attempts were given. It is good to include probabilistic classifiers(navie bayes) in the study as they perform classification of data based on the no.of occurrences of features. Classifiers were trained with search terms and phrases in text. Navie bayes makes uses likelihood of features and it is one of the probabilistic classifier implemented in our experiment.

The following figures depicts the accuracies obtained for five algorithms, the SVM, Decision tree, Naïve Bayes and Random Forest obtained 0.7925, 0.7625, 0.7925, 0.8333 respectively and the proposed prism algorithm got more accuracy than all of the above mentioned algorithms i.e:0.916.

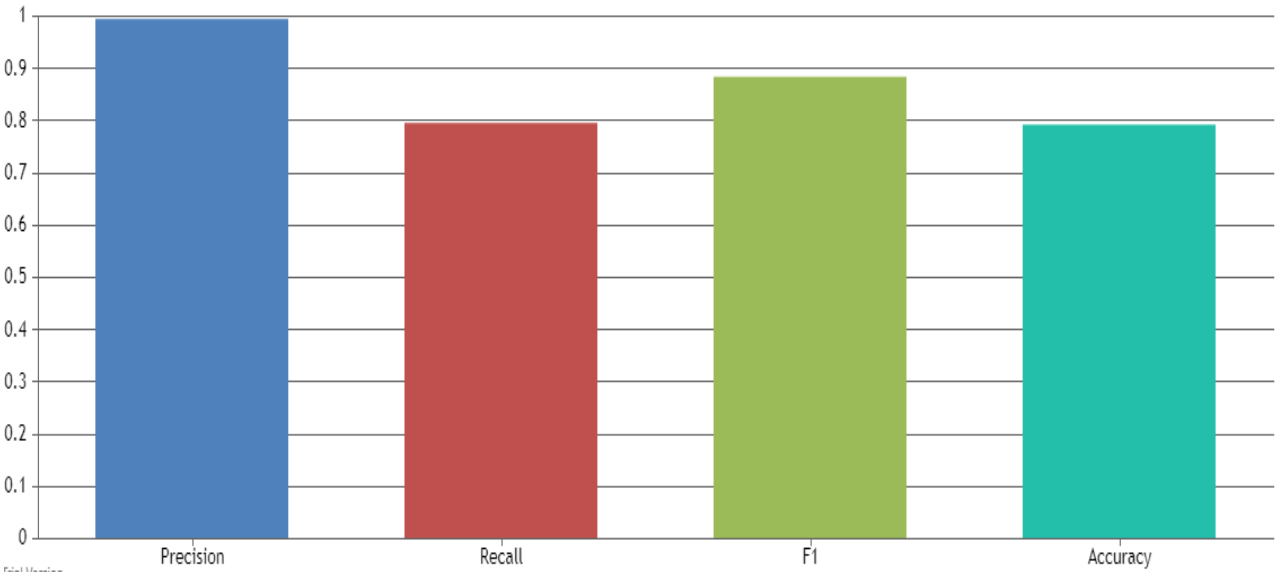

Fig. 3.SVM

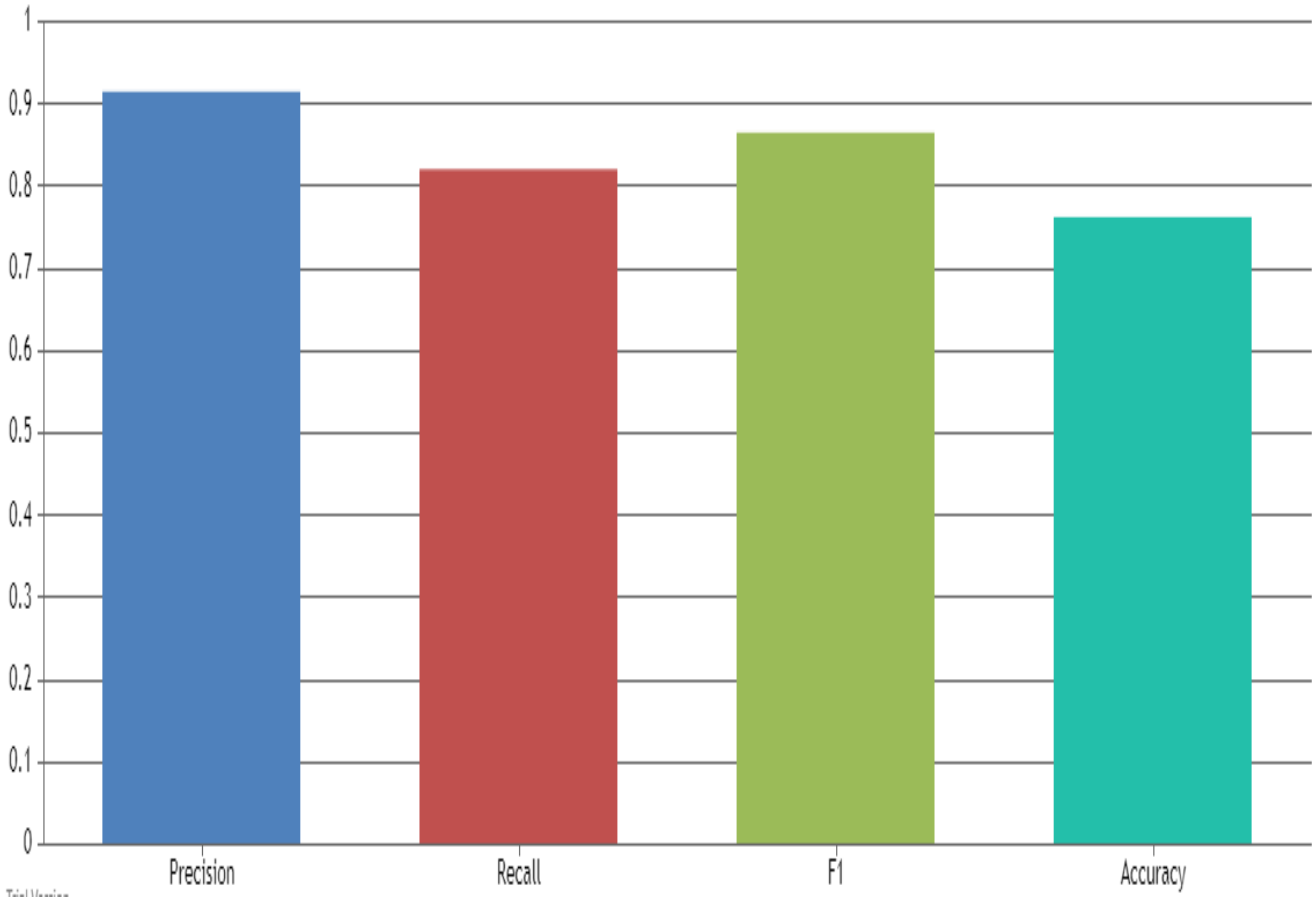

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Fig. 4.Decision Tree

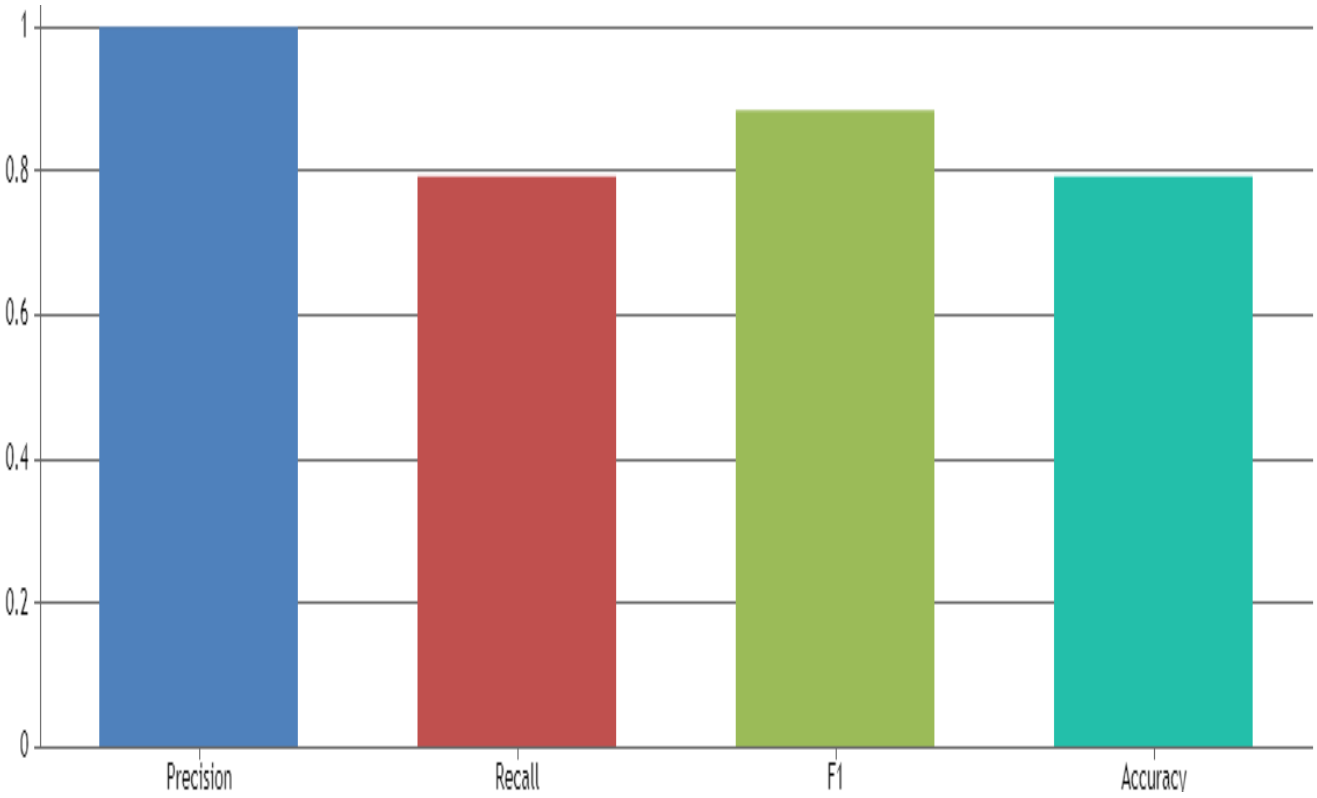

Fig. 5.Random Forest

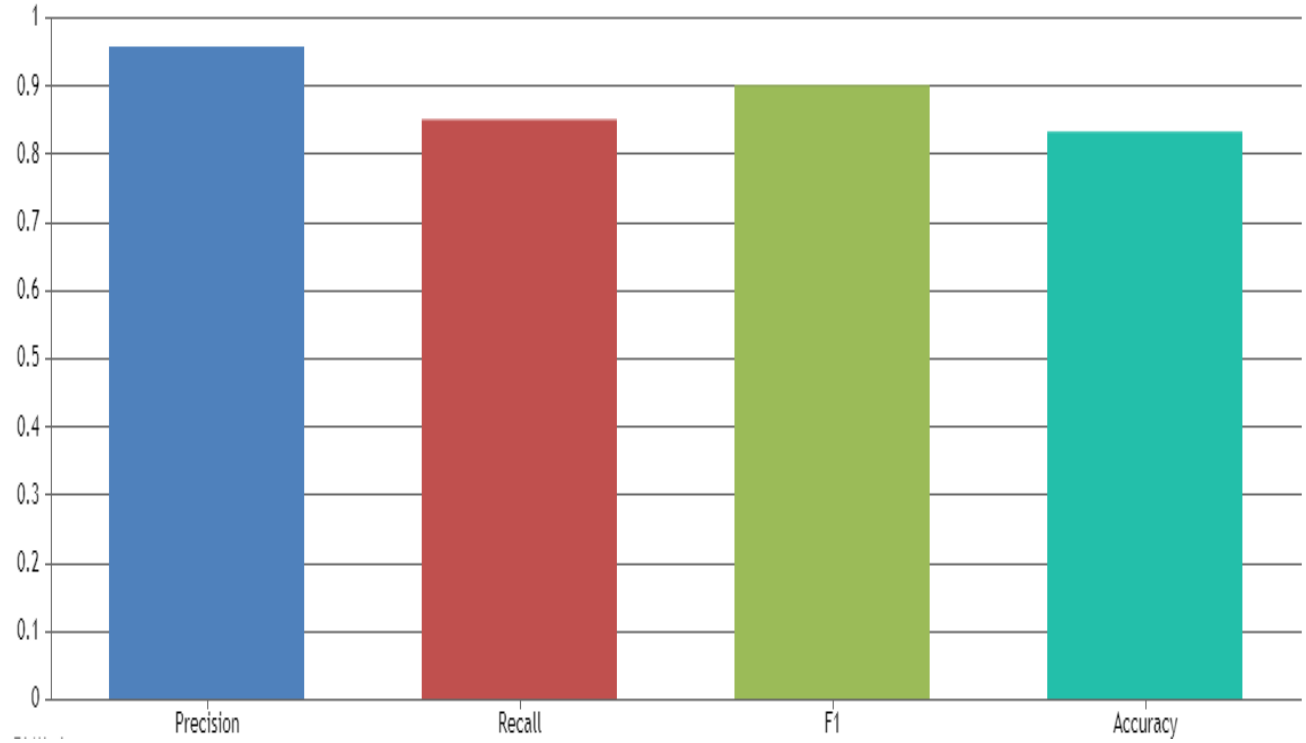

Fig. 6.Naïve Bayes

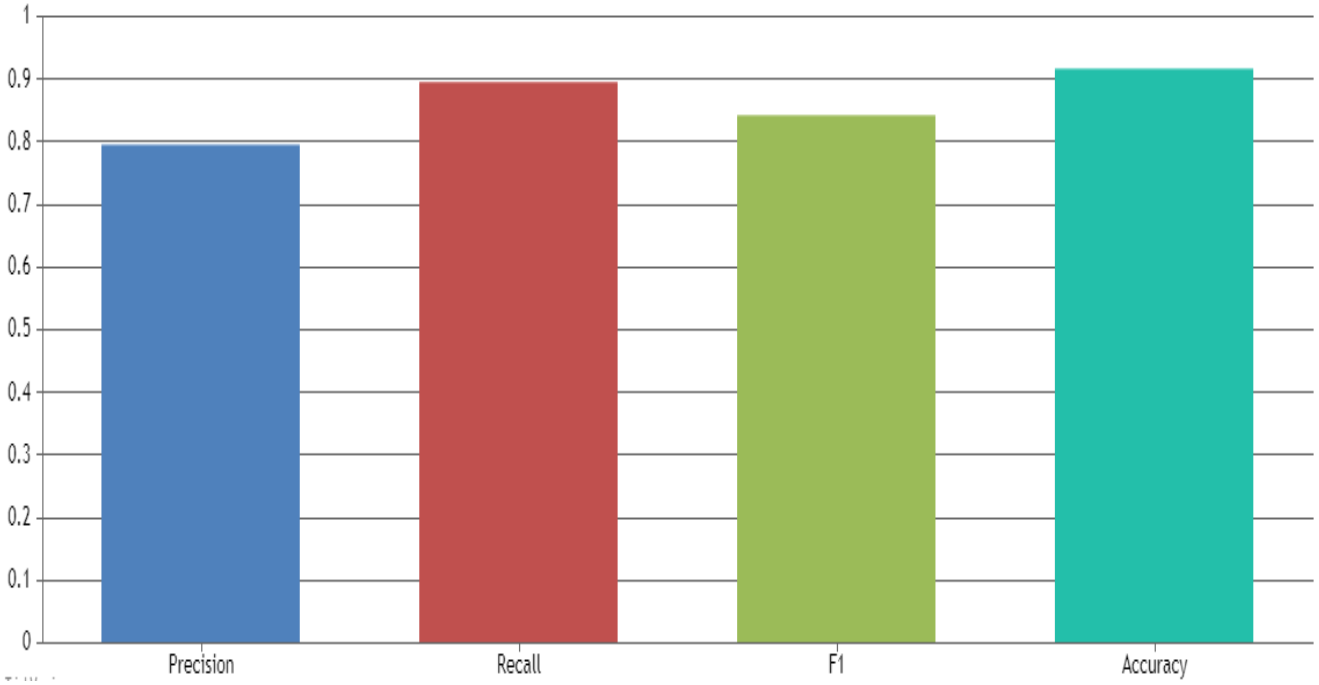

Fig. 7.Prism

VI. CONCLUSION AND FUTURE SCOPE

The objective of the paper is to compare the performance of more reliable and popular algorithms such as Support Vector Machine, Random Forest, Decision Tree and Naïve Bayes, with less popular algorithm called Prism. All of them represented their own strengths when applied to short message text. It is clear that the less popular algorithm prism has performed better than the popular machine learning algorithms. In future, we can explore more algorithms that are less popular and more beneficial, like improving classification performance and reducing dimensionality. We can also implement an idea of Multi task rule learning that may produce the more accurate results.

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