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# Social Emotion Prediction: A Review of Sentiment Analysis Techniques Used in Social Networks

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***Abstract***

*Social media has become the most substantial resource of information due to its rapid growth from last one and half decade. Web users share their ideas, thoughts, experiences, and opinions about different entities and events through social networks, blogging platforms, forums, and reviews. Social media tends to attract more and more researchers to analyze this tremendous amount of unstructured data for creating new insights. This data is used for sentiment and emotional analysis. Affective computing deals with the emotional analysis and is used by different people (Biomedical Researchers, Financial Professionals, and Intelligent analysts) and organizations (Government, Companies). This paper presents the review of different techniques and approaches that are used in sentiment analysis, challenges faced by the researchers and the evaluation scheme that is used to evaluate the performance of these techniques.*

***Keywords:*** *Sentiment analysis, emotion analysis, opinion mining, neural networks*

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## INTRODUCTION

Social media are the web-based communication tools where people can create, share content and reticulate it at an exceptional rate. It has given users a platform where they can interact and socially connect with other people around the world. With the popularity of low-cost internet access, social media has become part of almost everyone's daily routine. The roots of social media are traced back to mid-19th century. Although it seems like a new trend, sites like Facebook and Twitter are the outcomes of the creative development in the field of social media. The first recognizable social media site is known as six degrees. It enabled users to upload their profiles and make friends with other users. Six degrees at that time created a social media sensation. Typical examples of social media networking sites are Facebook, Twitter, and Instagram [1–3].

Sentiment analysis is a challenging task of building a system capable of determining people's emotions, attitudes, sentiments, appraisals and opinions concerned about different entities. Twitter is a free micro-blogging website [1–5]. It is a valuable source of valuable information. Users on Twitter exchange views on current topics of interest, like, marketing and advertisement are done on social media, so users can give a detailed analysis and assessment of things. On Twitter, users can update any post of 140 characters in length known as tweets. Thus, users get the whole tweet in a single short message service [1]. A wide range of research has been done in recent years with varying results by taking the datasets from Twitter for opinion mining, sentimental and emotional analysis and there has been very less focus on research towards Facebook which is attributed to the fact that Facebook has given limited access to its data.

Facebook is a social networking website which is available in 37 different languages. Users create profiles, upload and download photos and videos, send messages to the people who are a part of a Facebook generation. Facebook users post news and contents that are important to them. Users post news related to the entertainment industry, politics, sports, news of international importance, etc. Facebook has around 2.2 billion monthly active users. Facebook is a platform where one can preferably connect

 

with the known people, unlike another social networking platform which is used for professional relationships [6, 7]. On Facebook, users share information with their friends as the relationship between users on Facebook is called friends. Facebook users express themselves more genuinely. Facebook users can make their profile visibility as "public" wherein everyone on Facebook can see the user's profile updates, the visibility can also be set to "private" wherein no Facebook users including the user's Facebook friends can see the profile updates, it can also be set to "friends only "wherein only the user's Facebook friends can see his profile updates. Facebook collects the vast quantity of users' data but not until and unless access provided by the user to collect the data, as Facebook follows strict guidelines for protecting user's privacy [7]. Facebook posts are best suited for sentiment analysis as the users write these posts simultaneously related to users' life happenings, experiences, feelings and opinions [3, 6, 7].

Affective computing is defined as the study of the interaction between a human and a computer in which the computer can say something in response to user's emotions. Affective computing involves emotional analysis [8, 9]. Emoticons are emotional icons that enable users to express their emotions, feelings, empathy, and grief easily without the prior knowledge of code [1, 3, 7]. Presently, Facebook has provided six different emotional reactions that are used to comment on a Facebook post. Affective computing has a broader range of application; some of which are mentioned below [5–7, 10]:

1. Personalized Marketing.
2. Adaptive e-learning Systems.
3. Recommendation Systems.
4. Human-computer interactions.
5. Business Intelligence.
6. Government Organizations.

Rest of the paper is organized as:

Next part of the paper presents related work describing:

1. Levels of sentiment analysis.
2. Challenges in sentiment analysis.
3. Feature Selection.
4. Approaches.
5. Evaluation Scheme.

This is followed by the conclusion and future scope.

## RELATED WORK

### Levels of Sentiment Analysis

The three different levels on which sentiment analysis is differentiated are [5, 10–12]:

***Document Level***

This level deals in determining the polarity of a document, i.e., whether the document expresses the positive, negative or neutral opinions about products and services.

***Sentence Level***

This level deals in identifying the assertiveness of a sentence to predict whether the sentence expresses the positive, negative or neutral opinions about product service.

***Aspect Level (or Attribute Level)***

This enables us to extract the attributes/features of the related concerned Subject.

### Challenges in Sentiment Analysis

There are numerous challenges in identifying the sentiments related to concerned subject, topic or an event [5, 9]:

i. Words related to different contexts convey different meanings. Some words appear to be positive in one particular situation and may appear to contradict in other situation.
ii. Every person has its way of expressing his/her opinions.
iii. Some statements may be contradictory containing both positive and negative sentiments.
iv. The system used for sentiment analysis should be language specific to perform efficiently for finding out the emotions accurately in that particular language.

### Feature Selection

Sentiment analysis is a challenging task of classifying the emotions in different categories. In sentiment classification, first step is to extract the features from the text. Features are lexical, contextual, syntactic features or entity features. Some of the feature selection methods are [2, 7, 12]:

***Parts of Speech (POS)***

POS is used to segregate the words that do not bear any sentiments. POS looks for the adjectives in the text as they are most important constituents for determining opinions [2, 7, 12].

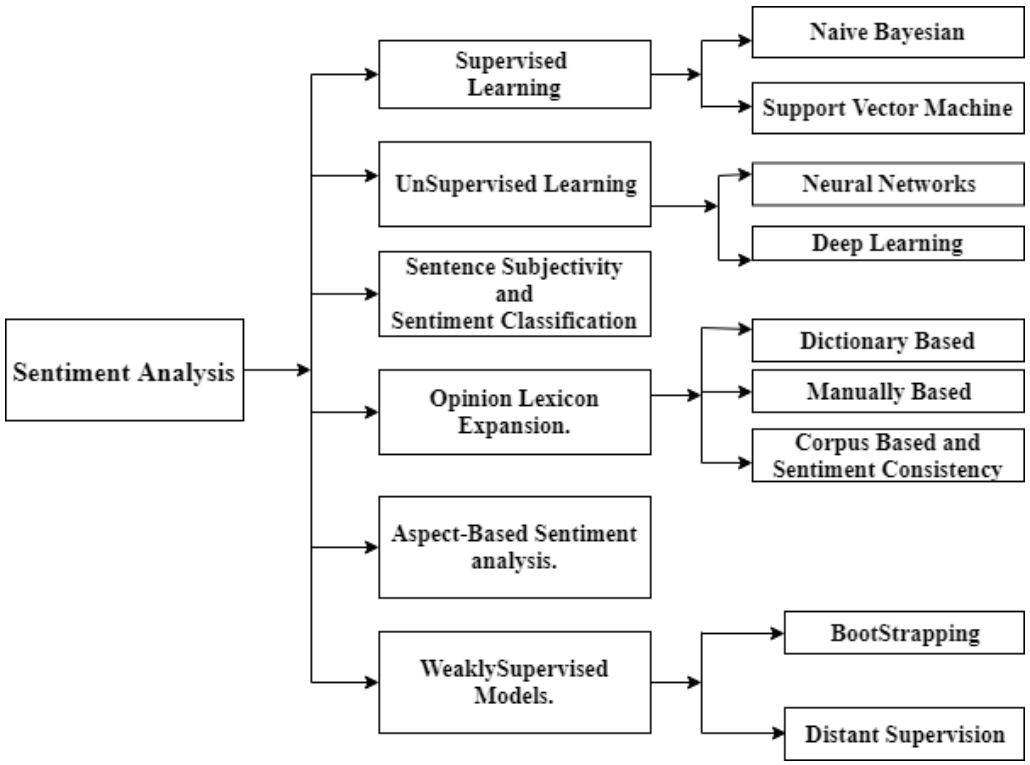


***Fig. 1:*** *Approaches to Sentiment Analysis.*

***Negations***

Negation refers to reversing the polarity of words that can change the opinion of a particular event or topic [7, 12].

***Opinion Idioms, Phrases, and Words***

Opinion idioms and words are used to convey opinions. Some phrases express opinions without opinion words [7].

***Term Presence and Frequency***

This is used to calculate the frequency of features. Features are simple words or n-gram words [2, 7].

**Approaches**

The different approaches that are used in the sentiment analysis are (Figure 1):

1. Supervised Learning.
2. Unsupervised Learning.
3. Sentence Subjectivity and Sentiment Classification.
4. Opinion Lexicon Expansion.
5. Aspect-Based Sentiment analysis.
6. Weakly Supervised Models.

***Supervised Learning***

The supervised learning used for sentiment classifications included the testing and labeled training data for classification problem [1–3, 6, 13]. Supervised learning enables us to build learning algorithms with known labels for future predictions. In sentiment analysis, classification is mainly done into three classes: positive, negative and neutral. The supervised learning used in sentiment analysis includes different methods. The most commonly used methods are:

a) *Naïve Bayesian Classification:* Naïve Bayesian Classifiers are the statistical classifiers based on Bayes rule [2, 6, 13]. It is a conditional probability that states that an event can occur only if its evidence is given. Mathematically [6]:

$$P(Sentiment|Sentence) = \frac{P(Sentiment)P(Sentence|Sentiment)}{P(Sentence)}$$

b) *Support Vector Machine:* Support Vector Machine (SVM) is a classifier that classifies the data according to predefined labels. SVM is used in sentiment polarity classification, decision making systems and business intelligence.

***Unsupervised Learning***

In unsupervised learning, there is no need to build a training set for classification.

Unsupervised learning enables us to find the hidden features which are used to map the data into different emotional classes.

a) *Neural Networks:* The concept of neural networks learning algorithm, has been started by psychologists and neurobiologists. A neural network is a connected network of inputs and output units where each node is triggered to provide the desired output using a mathematical function called transfer function. The network learns by adjusting the weights to predict the correct class labels. Neural networks are also called connectionist learning as they learn from connections through back propagation [12]. Neural networks are used in medical science, marketing, and credit evaluation. neural networks that are used for sentimental analysis are:
   i. Convolutional Neural Network: Convolutional networks are the neural networks that use different convolving filters to extract features. These have proven useful for sentence modeling and natural language processing. The CNN model uses regularization, pooling and feature map for extracting the features (Figure 2) [12, 14].
   ii. Recurrent Neural Networks: RNNs are the networks that contain at least one feedback path, and these are the networks that take the current and previous input as a new input. RNNs enable the networks to perform temporal processing and learn sequences, e.g., RNNs can use their internal state (memory) to process sequences of inputs and is used for sequence recognition, reproduction, temporal association and prediction [11, 14, 15]. Figure 3 represents the recurrent neural network.

b) *Deep Learning:* Deep learning is the advanced field of machine learning that utilizes neural networks for the learning process. The characteristics of deep learning are: there are different parameters at different layers; inputs are fed at the same time; and the inputs are independent of each other.

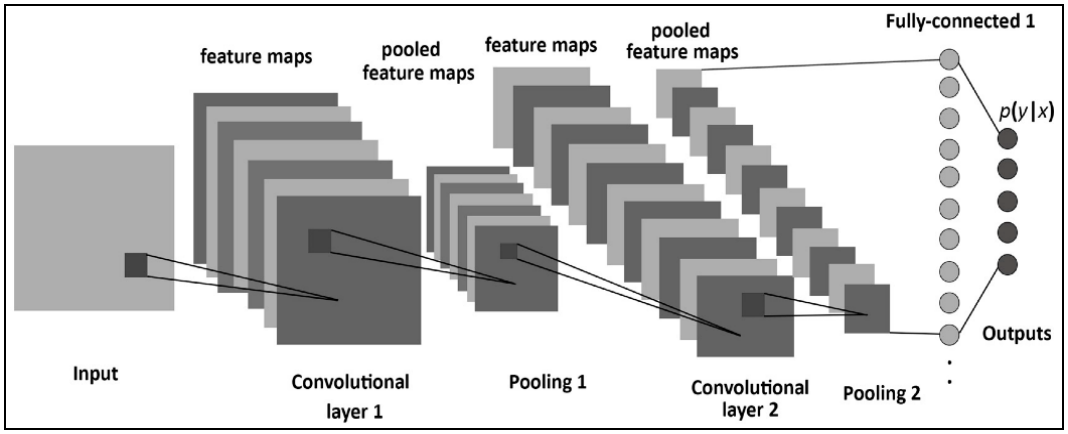


***Fig. 2:*** *Convolutional Neural Network.*

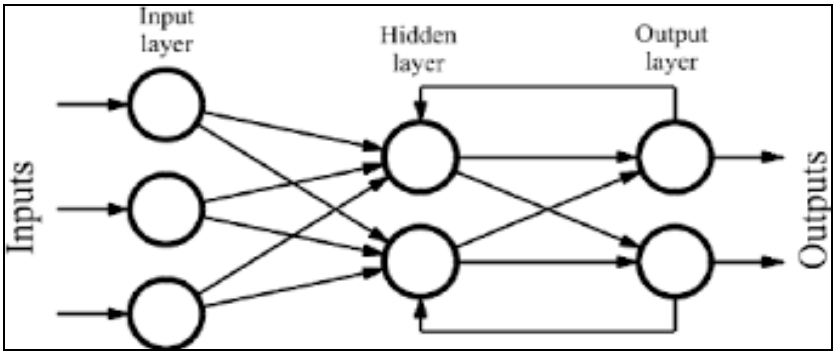


***Fig. 3:*** *Recurrent Neural Networks.*

***Sentence Subjectivity and Sentiment Classification***

Sentence subjectivity refers to techniques or methods that can be used for classification of the sentence to determine whether a sentence is objective or subjective. Sentiment classification deals with the subjective sentence to determine its polarity.

***Opinion Lexicon Expansion***

Opinion lexicon are like the tools for sentiment analysis and opinion mining to determine opinions from opinion idioms and phrases, opinion bearing words and sentiments [7, 9, 11].

a) *Dictionary-Based Approach:* It is the most straightforward technique of collecting opinion lexicon with known labels and then finding the synonyms and antonyms from online dictionary or WordNet and adding them to seed words and start next iterations. Iterations stop when no matching words are found [5, 8, 10]. Dictionary-based approach is not domain and context specific and deals with small corpora.
b) *Manual Approach:* This approach is time-consuming and inefficient but is used with automated approaches for making final judgments [8, 12].
c) *Corpus-based Approach and Sentiment Consistency:* Corpus-based approaches deal in determining the syntactic and co-occurrences patterns of words to determine their polarity. This technique starts with the finding of adjectives and uses them with other connectives to identify their polarity. Sentiment consistency refers to designing rules for connectives [5, 8, 12].

***Aspect-Based Sentiment Analysis***

This approach consists of two steps: Aspect extraction; and aspect sentiment classification. In aspect extraction, different extracted aspects (Features) are evaluated. Aspect sentiment classification deals with these aspects to determine whether the opinions are positive, negative or neutral [2, 9, 12]. The commonly used features are syntactic contextual features, lexical, contextual features and entity features.

***Weakly Supervised Learning Approach***

Weakly supervised learning approaches use less training data [9]. The weakly supervised learning methods include bootstrapping and distant supervision. Bootstrapping determines the small relations. It starts from small seed relation instances and learns more relation instances recursively. It also evaluates the quality of extracted relation patterns, e.g., Snowball. Distant supervision determines the strong relations to build the training sets and uses multiclass regression methods to define syntactic, named and lexical aspects, e.g., Free Base, Wikipedia etc.

## LITERATURE SURVEY

Khan *et al*. presented a hybrid approach for tweet classification in real time [1]. The proposed method is based on three-way classification to improve the problems of identifying excessive tweets as neutral and data sparsity. The three classifiers of the proposed system are Enhanced Emoticon Classifier (EEC), Improved Polarity Classifier (IPC) and SentiwordNet classifier (SWNC). EEC utilizes regular expressions for emoticon classification. IPC utilizes manually annotated positive and negative lists for word classification. SWNC classifies tweets using SentiwordNet Dictionary. Pre-processing data is done before feeding the data to classifiers, thereby increasing classification accuracy efficiently by 85.7% with 85.3% precision and 82.2% recall.

According to Saad *et al.*, social media sites are the significant sources of information, and thus social media data regarding the products, experience, politics, and services is utilized for sentiment analysis [2]. Twitter is a significant and popular social media site for the researchers with nearly about 91000 tweets per second [5]. This paper presents a framework that uses machine learning and data mining techniques for the sentiment analysis by using Twitter data. Data is collected by using crawler and API (Application Program Interface) and then pre-processed to eradicate the noisy data. Naïve Bayes along with TF-IDF proved to be the better technique with 81.24% accuracy as compared to other sentiment classifiers.

Hakak *et al.* presented the work that has been done in the domain of emotion analysis on text data [8]. The emotional analysis is the branch

of affective computing which is the most challenging and hottest research area nowadays. The paper presented the different models of finding emotional expressions and approaches used for detection of emotions.

Melba and Suguna examined different supervised techniques (Naïve Bayes, Maximum Entropy and Support Vector Machines) and concluded that Support Vector Machine and Naïve Bayes classification methods are the most widely adopted techniques for emotions and sentiment classification problems [10]. Some researchers use corpus and dictionary-based approaches for sentiment analysis. However, still, some objectives and strains of sentiment analysis are not met.

Sharma presented various machine learning techniques that are used for sentiment analysis [4]. Sentiment analysis had a wide range of applications in determining sentiments from movie reviews, social media sites and from different views of political parties. This paper presents a review of the text and sentimental analysis that provides new insights and motivations for research in sentimental analysis and utilizing them in real-life applications.

According to Gupta, a large number of users express their feelings, emotions, ideas, and experiences on social media sites, by making social media an exciting platform to obtain and explore their sentiments [11]. Social media is one of the most potent platforms where a large number of instant messages are expressed on a daily basis, making it a perfect platform for collecting the opinions towards concerned subjects like goods or celebrities, product, etc. The proposed method presents an overview of latest updates in sentiment analysis and classification strategies, and it includes the challenges that are faced by researchers in sentiment analysis. The proposed method states that the majority of the research in sentiment analysis is based on machine learning technique instead of the lexicon based technique.

Troussas *et al.* presented an approach how sentiment analysis could help in language learning, inspiring the educational process (e-learning) and the evaluation results of three classifiers namely Rocchio, Perceptron, and Naïve Bayes classifier [6]. The most important features that have been presented, achieved better gain over a unigram state of the art. The dataset for each classifier was selected randomly from Facebook statuses. Among these three classifiers, Naive base classifier and Rocchio classifier performed well, but Naïve base classifier had lower recall than later.

As per Aman *et al*., emotion analysis is the hottest research area [16]. They proposed an emotion annotation task for the identification of the category of emotions, the intensity of emotions, and the phrases that indicate emotion in the text. The emotion categories that they used for classification were happiness, sadness, anger, disgust, surprise, and fear. The proposed work also introduced an annotation scheme and also presented the results of annotation study of blog posts. The average inter-annotator for labeling a sentence as emotion or non-emotion was 0.76 and the range was 0.6 to 0.79. The results showed the accuracy of 73.89%; that is significantly above the baseline approaches. According to Medhat *et al.*, sentiment analysis is one of the hottest buzzwords nowadays [12]. This paper presented how sentiment analysis has attracted researchers towards itself. The objective of this survey paper is to provide the overview of sentiment analysis techniques and its related fields with their brief introduction. The main beneficence of this paper includes large recent trends of research in the sentiment analysis and its related fields.

Kim described some experiments using Convolutional Neural Networks (CNN) that were built on word2vec for sentence classification [14]. The experiments were performed on different datasets namely: Movie Reviews (MR), SST1 (Stanford Sentiment Treebank), SST2 (Stanford Sentiment Treebank without neutral reviews), Subj (Subjectivity dataset), TREC (Question dataset), CR (Customer Reviews) and MPQA. The results gave a clear proof that in deep learning, the unsupervised training of vectors provides excellent results. CNN uses different convolving filters on different layers to extract features.

Ortigosa *et al*. used SentBuk to collect Facebook data and combined the approaches of machine learning and lexical based techniques for sentiment analysis of Facebook status updates [7]. Machine learning approaches perform better in specific domain fields and require a training set of predefined labels. Lexicon based approaches require a dictionary of words which are annotated by semantic orientations. The performance of this hybrid approach was excellent with 83.27% accuracy. According to Tian *et al.,* Facebook reactions enable us to express our feelings and emotions [13]. They used a dataset of 21,000 Facebook posts and 100,000 emoji-containing comments and processed them by matching them against a dictionary of emojis. Facebook reactions can determine the emotional behavior. Facebook reactions and emojis are easily counted and matched with the emoji sentiment score. Their results showed that emoji's and Facebook reactions have a strong relationship to each other.

Mohammad defined sentiment analysis as the automatic system capable of determining the polarity of text [3]. This paper provided the overview of automatic sentiment analysis and problems associated with it and its applications in medicine, detecting emotional

***Table 1:*** *Prior Work.*

| Prior Work | Year | Dataset | Emotion Labels | Approaches Used | Features Used | Performance (Accuracy %) |
|---|---|---|---|---|---|---|
| Khan *et al.* [1] | 2014 | 5 Sample Datasets from Twitter4J | Positive (Accurate, Beautiful, capable, Decent, Ease, Faith) Negative (Abnormal, Bad, Danger, Enemy, Fake). | Supervised Learning | WordNet, Netlingo, Spell-check, JSpell, Stanford, Textifier. | 85.70 |
| Ahmed *et al.* [2] | 2017 | Twitter Data | Positive and Negative | Supervised Learning (Naïve Bayes along with TF-IDF) | Normalization, Tokenization, POS Tagging | 81.24 |
| Kim [14] | 2014 | Movie Reviews, SST-1, SST-2, Subj, TREC, CR | Pre-trained Word2vec vectors | Convolutional Neural Networks | Word2vec, Convolving Filters, Regularization, Pooling. | MR: 81.5, SST-1: 48.7 SST-2: 88.1 Subj: 90.6, TREC: 91.2 CR: 81.7 |
| Troussas *et al*. [6] | 2013 | 7000 Facebook Status Updates | Positive Sample Examples, Negative Sample Examples | Supervised Learning (Naïve Bayes classifier) | Conditional Probability | 80.00% |
| Ortigosa *et al.* [7] | 2013 | 7000 Facebook Status Updates | Positive (Positive emotions, Positive sentiment, Optimistic) Negative (Negative emotions, sadness, death, to swear) | Machine learning and Lexicon-Based | Segmentation, Tokenization(I), Emotion Detection, Tokenization(II) POS tagging, Syntactical Analysis) | 82.27 |
| Wang *et al.* [15] | 2016 | Short Text (Movie Reviews, SST-1, SST-2) | | Convolutional Neural Networks and Recurrent Neural Networks | Word Embeddings LSTM, GRU, Convolution. | MR: 82.28, SST-1: 51.50, SST-2: 89.90) |
| Aman *et al.* [16] | 2007 | Blogs | Happiness, Sadness, Anger, Disgust, Surprise, Fear. | Supervised Learning (Naïve Bayes classifier and Support Vector Machine) | WordNet-Affect (WNA), General Inquirer (GI), | 73.89 |
| Tian *et al.* [13] | 2017 | Facebook posts (21,000) and Emoji-containing comments (100,000) | Facebook Reactions (Like, Love, Haha, Wow, Sad, Angry) | Supervised Learning (Emojis sentiment analysis). | Emoji Sentiment Score | Reaction ratios (no. of Shares/No. of Reactions) Like: 0.16, Sad: 0.24, Angry: 0.33. |

flow, gender differences, and personal traits. He also described the different objectives of automatic sentiment systems, and the different approaches, feature extractors, and datasets that are used in sentiment analysis.

Othman *et al.* presented the different approaches used for opinion mining in three dimensions: System domain, Dataset, and the Techniques used [9]. They also described the challenges and evaluation method that are used for evaluating the performance of different approaches. The evaluation scheme consists of accuracy, precision, recall, and F-measure.

Agarwal *et al*. presented the survey of all the general techniques, methods and algorithms that are used in text mining [5]. Text mining has gained much importance in recent years because social networks generate a tremendous amount of data. Thus, there is a need for efficient methods and algorithms for text mining.

The table mentioned below summarizes the prior work done in sentiment analysis (Table 1).

**Evaluation Scheme**

The evaluation scheme used to measure information effectiveness [1, 2, 5–7]:

1. Accuracy,
2. Precision,
3. Recall, and
4. F-Score.

These parameters are evaluated using confusion matrix. A confusion matrix is a table that is used to evaluate the performance of a "classifier" on a set of test data, for which the actual values are known. Figure 4 shows the confusion matrix.

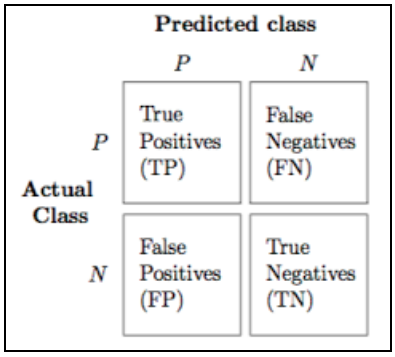


***Fig. 4:*** *Confusion Matrix.*

***True Positives (TP)***

These are the correctly predicted positive values which mean the value of both the actual class and the predicted class is yes.

***True Negatives (TN)***

These are the correctly predicted negative values which mean value of both the actual class and predicted class is no.

***False Positives (FP)***

When actual class is no and predicted class is yes.

***False Negatives (FN)***

When actual class is yes but predicted class in no.

False positive and false negative values occur when our actual class contradicts with the predicted class.

***Accuracy***

Accuracy is the most intuitive performance measure, and it is merely a ratio of correctly predicted observation to the total observations [1–3, 6, 7, 13, 14].

$$Accuracy = \frac{TP + TN}{TP + FP + FN + TN}$$

Where, TP=True positive, TN=True Negative, FP=False Positive, and FN= False Negative.

***Precision (Positive Predictive Value)***

Precision is the ratio of correctly predicted positive observations to the total predicted positive observations. High precision relates to the low false positive rate [1, 5, 6].

$$Precision = \frac{TP}{TP + FP}$$

Where TP=True Positive, and FP=False Positive.

***Recall (Sensitivity)***

Recall is the ratio of correctly predicted positive observations to all observations in actual class, i.e., correctly classified positives by the classifier and manual classified positives [1, 5, 6].

$$Recall = \frac{TP}{TP + FN}$$

Where, TP=True Positive, and FP=False Negative.

***F1 Score***

F1 score is the harmonic mean of precision and recall [1].

$$F1\ Score = 2 * \frac{Recall * Precision}{Recall + Precision}$$

## CONCLUSIONS

Social media has become one of the largest platforms with a tremendous amount of information known as Big Data. Social media enables its users to share their ideas, thoughts, experiences, and opinions about different entities and events through social network sites. This survey paper summarizes all the techniques, approaches, methods used for feature selection, issues and challenges faced by researchers and the evaluation scheme for evaluating the performance of the system in the field of sentiment analysis. Nowadays, much work done in this domain is based on machine learning and deep learning techniques. Deep learning is the advanced field machine learning that utilizes neural networks for the learning process. Sentiment analysis has become an active and inspirational research area in recent years.

## FUTURE SCOPE

Majority of research in the field of sentimental and emotional analysis is done on Twitter datasets despite the fact that the character length of messages is limited (140 characters). Datasets from Facebook can prove better for sentiment analysis as the Facebook users' posts are simultaneously and genuinely related to users' life happenings, experiences, feelings, and opinions. Moreover, a system that is used for determining sentiments should have immense semantic, syntactic and lexical knowledge and capable of learning new methods of affective computing to detect emotions and feelings.

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