Multi-Class Emotion Detection (MCED) using Textual Analysis

Hajira Tabbasum [1] Shah Muhammad Emaduddin [2] Aqsa Awan [3] Rafi Ullah [4]

Abstract

Stress and mood disorder is becoming a routine life illness for any human being and it is necessary to find technology based solutions for finding cure and self-treatment of such disorders. In order to find treatment and remedy, it is important to detect ones' emotion before applying mitigation technique. Emotion plays an important role in social interaction and has strong connection with human body and brain signals. Emotions can be stated in many ways like facial expression and body language, speech and by text. Proposed technique is targeting social media platforms for such purpose. As huge textual information is available on social media platforms such as Facebook, Twitter, YouTube etc. in the form of comments, posts etc. Emotion Detection using text is basically a content – based classification problem, connecting ideas from the areas of Natural Language Processing as well as Machine Learning. In this paper we proposed a novel way to detect emotions using Naïve Bayes algorithm by collecting person's browsing history. To find emotions we used Plutchik's Wheel of Classification to check the where the given emotion lies.

Keyword: Multi-Class Emotion Detection, Content Based Classification, Natural Language Processing, Plutchik's Wheel, Keyword Based Emotion Detection

1 Introduction

Emotion plays a vital role in the human life. Emotions are an important element of human nature [30]. Emotions are the strong feelings describing moods, behavior, and sentiments. It can be recognized through body language, facial expressions, heartbeat, voice, movement and text knowledge [33]. Emotion Detection is the process of identifying the spontaneous feeling as distinguished from reasoning or knowledge that is derived from one's current circumstance. On the other hand, technology has become an essential element of our routine lives; one can easily communicate with each other by various means like calls, text messengers and comments on social media. Textual data collected from these communications can play a vital role in detecting mood and emotions of a person. Online searches, browser history and cookies could also be used for the subject.

Textual Analysis is the detailed approach to examine or gather one's information by using their text. As people have directly interacted with a computer or any technology by means of text because now day's maximum of material is accessible on the web in the form of text. Thus, it is useful to extract the feeling for different determination from text. Data mining is used to expert the system because large amount of data is needed for finding the emotions

[1] *Karachi Institute of Economics & Technology, Karachi | hajiratabbasum96@gmail.com*
[2] *Karachi Institute of Economics & Technology, Karachi | shahmuhammademad@gmail.com*
[3] *Karachi Institute of Economics & Technology, Karachi | aqsadilfaraz@gmail.com*
[4] *Karachi Institute of Economics & Technology, Karachi | rafiafridi783@gmail.com*

in textual data. Emotions can be categorized into two types, either positive or negative emotions.

Robert Plutchik created an emotion wheel consist of 8 basic emotions and eight advanced emotions each consist of two basic emotions [32]. Basic emotions are joy, fear, trust, surprise, sadness, disgust, anger, anticipation and the advanced emotions from these basic emotions are optimism, love, submission, awe, disappointment, remorse, contempt and aggressiveness.

The lot of work has been done in the field of emotion detection by different approaches like reacting, body language, face expressions and so on in different papers. But using text needs more improvement.

In order to find and evaluate the intensity of the emotion, Naive Bayes algorithm is applied towards emotionally positive or negative or neutral. It checks the probability of the emotion in which category that emotion lies.

Rest of the paper is divided as follow; Section II is about related work, Section III is the explanation of Emotion Classification Techniques, Section IV is the Methodology Explanation, Section V is Result of Methodology, Section VI us Concluding the Research Work and Section VI is future potential work.

2 Related Work

In literature, some classifications and approaches are presented for emotion to check where the emotion lies through basic emotions classifications [6, 30]. In this work, we consider Plutchik wheel of emotion categorized emotion in 3 categories:

1. Primary
2. Secondary
3. Tertiary.

In literature [6, 30], 3 text approaches are presented. First is keyword based approach, in which emotions can be detected by the keyword used in the given text. Second is learning based approach, where large amount of dataset is trained to the system. Third one is hybrid based approach, this approach uses both keyword based approach and learning based approach for appropriate results.

Robert Plutchik proposed a Plutchik's wheel of emotion theory having eight basic emotions: joy, trust, fear, surprise, sadness disgust, anger and anticipation. This wheel of emotion was influenced by Plutchik's Ten Postulates. It has also twenty four primary, secondary and tertiary dyads (feelings composed of two emotions).this wheel of emotion can categorized in four categories, they are:

1. Primary dyad
2. Secondary dyad
3. Tertiary dyad
4. Opposite emotions

Authors of [1] used different unsupervised machine learning algorithm to classify emotions. For this purpose, authors created a corpus using comments on social media, particularly users' comments in different YouTube videos to train its system. Since the authors used Unsupervised ML techniques are used to classify new entries, emotion labeling is not required in this phase. Limited emotions are the main disadvantage of their research.

Keyword Analysis (KA) and Keyword Negation Analysis (KNA) is another methodology used for emotion detection [2]. Authors try to solve the problem of detecting the emotion in the case of sentence level and emoticon (emojis). KA and KNA is based on a set of proverbs, emoticon, short form of words, exclamatory word. Authors used different keyword based approach like use of basic emotions classifiers e.g. Ekman, Izard or Plutchik, keyword analysis (KA) and keyword negation analysis (KNA). Authors have used paragraph based emotion detection which is a limitation of their research rather than working on sentence structure.

Authors of [3] discuss the idea to detect emotions from input text as well as for training a custom emotion classifier from scratch, based on manually annotated data. Data collected from stack overflow containing 4800 posts was annotated by 12 raters. Limited emotions and described data set were the main disadvantages of this research.

Ekman text is another classification technique used for used for text classification and sentiment analysis [4]. Probabilistic Machine learning algorithm, Support Vector Machine (SVM) has been used for text classification using Hadoop Map Reduce Framework. Limited described emotions are major disadvantage of this research.

Authors of [5] presented an idea with an experiment, which concerned with detection of emotion class at sentence level using an algorithm which calculates the emotion vector of sentence by emotion vector of word. Then on the basis of emotion vector categorized the sentence into appropriate emotion class. Limited emotions, removed stop words from sentences, described dictionary, if the word were not in the described emotion list it would not check and text detection was only for sentences based text, these are the main disadvantages of this research paper.

Authors of [6] evaluated the quality of the emotion lexicons by jointly modeling emotionality and neutrality of words (blogs, news, headlines, and tweets) generated by the proposed method (unigram mixture model) and by state-of-the-art baseline methods on two emotion detection tasks (word-emotion classification and document-emotion ranking). However, their proposed methodology was not working on multi-words.

Authors of [8] uses Naive Bayes algorithm for the word probability checking. However the method has a high time complexity the emotion dictionary was too limited.

Authors of [9] presented a concept of Machine Learning for Emotion Detection using Support Vector Machine. Python based NLTK library was used for word based search, removal of unnecessary words, tagging of words. Emotions are predefined in tabular form which includes the emotions in the first column and the words related to it included in the second & third

column and the last column includes the emotion label set in which that line or paragraph will be added and check emotion. They made the dataset for training and testing, machine which contain extracted tweets in one column and the authors another tweet in 2nd column and another column which contain predefined emotion .Although the paper have limited emotions and only those words which highly show some emotions were considered.

Emotions could also be defined from the context of used word [10]. Authors use NB algorithm which uses word frequency to compute probabilities and makes the Naive assumption that the probability of occurrence of each word is independent of others in a sentence. They use Hand-crafted features, Ontology Model, Statistical Model, and Latent Dirichlet Model for subjectivity detection syntactic method. Although paper have no emotion class defined to find an emotion and work whether the opinions and emotions are positive or negative.

3 Emotion Classification Techniques

Emotion detection Methods are classified in three different classes.

i. Keyword based.
ii. Learning Based.
iii. Hybrid based.

A Keyword Based Approach

In keyword-based approach emotions can be detect by the keyword used in text. It typically involves steps such as pre-processing with a parser and search based on an emotion dictionary.

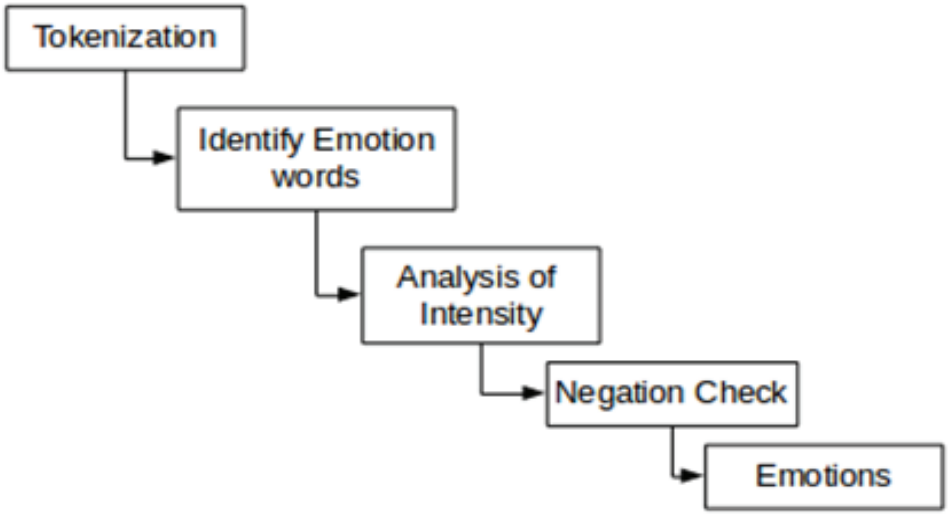

Figure 1: Keyword Spotting Technique

Advantages:

- ✓ Niches and Competitive targeting
- ✓ Search behavior insight
- ✓ Topic cultivation
- ✓ Assumption and bias corrections

Disadvantages:

- × Increased risk of keyword suffering
- × Favoring search engines over users
- × limited ranking data insight
- × Tunnel vision in keyword research

B Learning Based Approach

In machine learning we required large data to train the system. The input text classifies into the suitable emotion class using earlier trained classifier. This is done means of various learning based algorithm such as support vector machine and conditional random field etc. In literature several machine learning algorithms such as Naive Bayes Algorithm, Support Vector Machine and State of the art Neural Networks are used for emotion detection problem. The correctness depends on the training data set. The result of this method is better than keyword-based approach but required a lot of data to train learning algorithm. Advance data pre-processing techniques are required to clean data obtain from sources such as YouTube, Facebook etc. Internet users normally used many languages such for communication and searches. These languages include pure English, roman style languages and other languages. In roman style people normally used different spelled words. Such as given in following comment from YouTube

1. you are reallyyyyyyyy good singer
2. you are gr8 (y)
3. bohat pyara song hain
4. I loveeeeeeee this soooooong :) <3

Sentence 1 contains elongated words which usually people write in case of strong emotions they want to show.

Sentence 2 contains shortened word (usually people used when they sound same, such as great – “eat” in great sounds like “8”, so normally people write “gr8”)

Sentence 3 contains roman Urdu words, where one word usually people write in several form such as “hain”, “hai”, “hay” etc.

Sentence 4 contains emoticon which also shows the strong representation of emotion.

C Hybrid Based Approach

The learning and keyword-based approaches both have some limitations and could not give suitable result. So, to recover the accuracy hybrid-based approach is well. One for hybrid system which uses both learning based approaches to extract semantic and Chinese lexicon ontology to extract quality.

Hybrid Approach is the mixture of Keyword based approach and training datasets. When the system obtains the input and checks that the text has keyword emotion or not. If the input text has one or more emotional keyword then we use keyword approach if word found in the dictionary then we have specific output of the system.

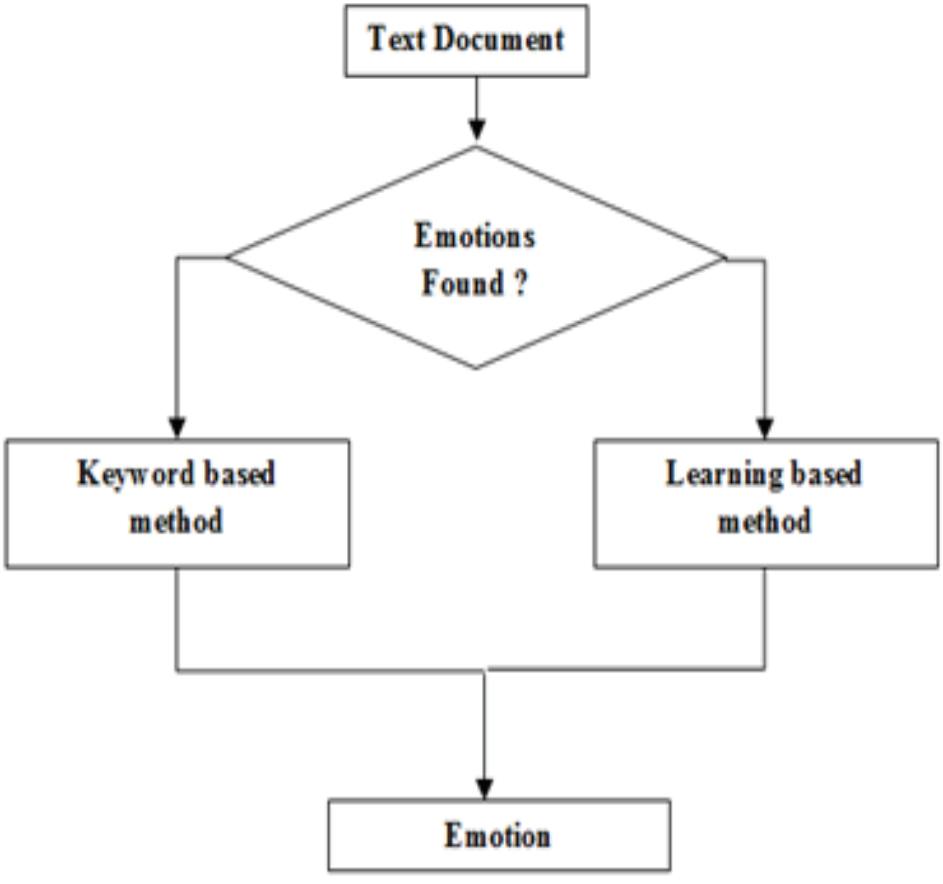

Figure 2: Emotion Class Comparison

Text can be classified form these approaches and from this text depression can be detect by checking probability and intensity level of text.

4 Proposed Methodology

The methodology of this research paper is based on emotion detection by textual analysis with the help of Plutchik's wheel of emotion classification to identify different emotions with the color wheel defined in Plutchik's Wheel. This paper have different classes of emotion compared against different others observed during this research.

Table I: Emotion Class Comparison

Class	P-1 [9]	P-2 [7]	P-3 [2]	P-4 [3,6,7]	P-5 [30]	This Paper
Anger	1	1	1	1	1	1
Disgust	1	1	0	0	1	1
Fear	1	1	0	1	1	1
Joy	1	1	0	1	1	0
Sad	1	1	1	1	1	1
Guilt	0	1	0	0	0	0
Shame	0	1	0	0	0	1
Happy	0	0	1	0	0	1
Love	0	0	0	1	0	0
Surprise	0	0	0	1	1	1
Trust	0	0	0	0	1	1
Anticipation	0	0	0	0	1	1
Advise	0	0	1	0	0	1
Hurt	0	0	1	0	0	0
Confuse	0	0	1	0	0	0

Naive Bayes formula is used to check the probability of the text whether the certain emotion lies in that text or not. Proposed methodology is explained in figure 3.

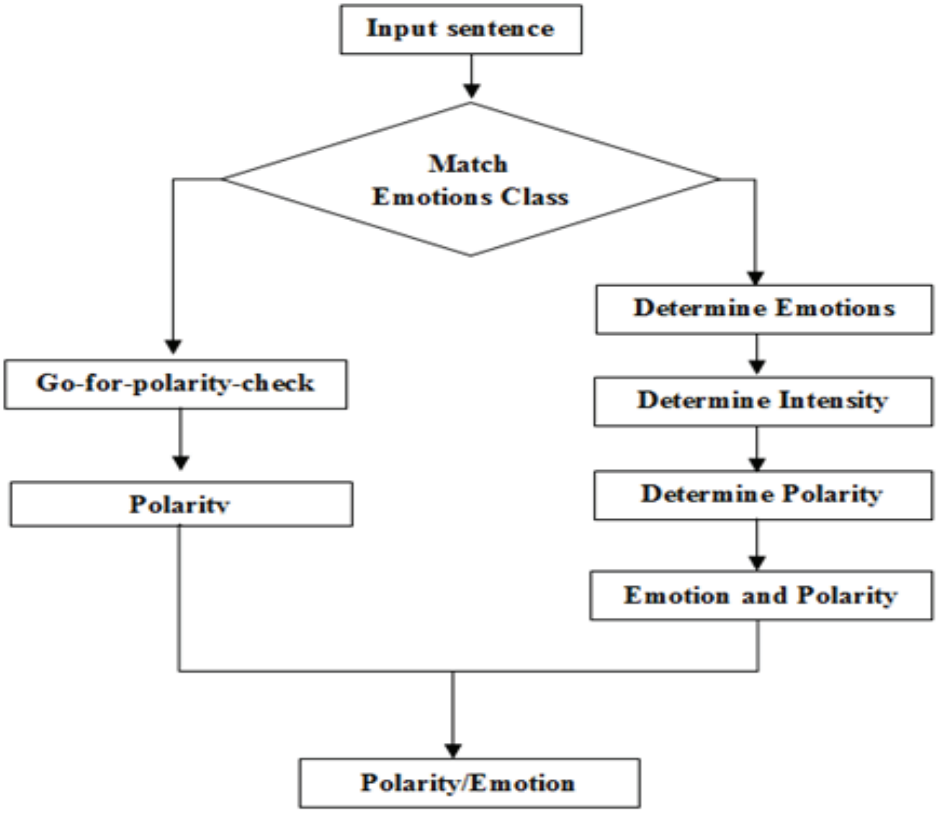

Figure 3: Proposed System Flow Chart

A Extract Text

Extract the text from browser search history of the person. Once a text will extracted it will save in a file then division will takes place. All the basic Natural Language Processing Tasks such as sentence tokenization, word tokenization, stop-word removal, Stemming, Lemmatization and possibly the spell corrections techniques.

B Division

Extract the sentence from the given text. Sentence is basically a set of words that is complete in itself, typically containing a subject and predicate, conveying a statement, question, exclamation, or command, and consisting of a main clause and sometimes one or more subordinate clauses. Sentence will be extracted from text like where there any punctuation mark will detect including dot '., Exclamation mark '!', question mark '?'. Make a file of sentences.

Advantage: we can break the paragraph into small sentences.

Disadvantage: due to sentence breaker, we will have a problem that if someone put these marks (".", "?", "!") By mistake then our system will break it in sentence and we will not be able to find correct emotion class.

C Breaking

Break a sentence into a word. Remove stop (inappropriate) words which cannot show any type of emotion. Then save these words in a file and then check the intensity of each word which is saved in the file.

Advantage: we can break the sentences into single words, because our system will work on single word.

Disadvantage: may be sometime some words don't lies in that particular text class due to combination of three to four words.

D Check Intensity (for single word)

Check out the intensity of each word to categorize them in different emotions. By using Naive Bayes algorithm check out the probability of each word and then save these words in the file whether the word lies in positive/negative/neutral state. Intensity can be simply calculated as

$$\text{Intensity}={}^{C}/_{R} \quad (1)$$

Where "C" is sum of all intensities of same emotion class and "R" is no of emotional words count.

Advantage: from checking the intensity of the word, we can find the emotion class of that particular word.

Disadvantage: it is time consuming.

E Combination

Combine two consecutive words that are meaningful and are used in a sentence make sense to describe an emotion.

Advantage: due to combine the words, we can tell about the emotion with structure of the given sentence.

Disadvantage: sometime noun and verb combining does not make any sense.

Example: I am, you are, he is, etc.

F Check Intensity (for double word)

Check out the probability of combination of these 2 words and save these words in a new file. Intensity of two words can be calculated by equation 1.

Advantage: from checking the intensity of the word, we can find the emotion class of that particular word.

Disadvantage: it is time consuming.

G Slangs

Check out the word if word is present in slangs or not. If it is presented then take a word from word file or words from a double word file. Search it in a slang words file. Slang words file store slangs according to the location. If slang word is found, check out the meaning of the sentence. Then find the emotion of that meaning. Same as describe for word in a sentence.

Advantage: some words have different meaning which they are showing.
Example: street dogs

Disadvantage: data size will be increase, because slangs meaning is change by location or region. Different terms are used as slang in different locations.

H Idiomatic Word

Check out the word if word is present in idioms or not. Take a word from word file or words from a double word file. Search it in an idioms word file. Idiomatic words file store idioms and their meanings. If slang found, extract the meaning of the sentence. Then find the emotion of that meaning. Same as describe for words in a sentence. Now check the probability of the word whether the word is in high and low intensity level of positive and negative emotions.

Advantage: some words have different meaning which they are showing.
Example: once in a blue moon

Disadvantage: data size will be increase, because idioms meaning is changed by location or region.

I Categorization

Categorize a, b, c category according to the categorized emotions. High intensity emotions, medium intensity emotions and low intensity emotions. Place these emotions in the concerned emotion category.

J Words / Sentenses Checking

Check if the word/words/sentences present in emotion category is/are positive/negative/neutral. Positive/negative/neutral emotions will check with intensity by using Naive Bayes formula.

Advantage: it describe that emotion lies in which category.

Disadvantage: data gathering and time management and data set will be crucial.

5 Results

Results were generated by comparing our own algorithm proposed in Section IV against state of the art technique found in literature review.

Table 2: Selected Sentences Results

Sentence	Polarity	Emotion Class	Emotion Intensity
I am unhappy today	Negative	Sad	60%
He get good marks in his exam	Positive	Happy, Surprise	50% 30%
I will see you	Neutral	–	–
Nothing is impossible	Neutral	–	–
I am getting mad due to happiness	Positive (50%) Negative (50%)	Happy, Angry, Disgust, Surprise	25%, 15%, 15%, 25%
This must be so hard for you	Neutral	–	–
Jump for Joy	Positive	Happy	100%

Any emotion classified as positive or negative can be further classified in to sub-classes (Happy, Disgust, Surprise etc.). In table 2, example sentence "I am getting mad due to happiness", after applying pre-processing steps the only dominant terms that are present in emotion keyword dictionary are "mad" and "happiness", individually "mad" is indicator for negative and "happiness" is for positive. So as per keywords there, the example sentence can be 50% positive and 50% negative. But further classification in to sub-classes will be as follow, 25% happy, 15% Angry, 15% Disgust and 25% surprise as per weight-age and keywords in emotion dictionary and given methodology. For Neutral class, there will be no emotion sub-classes as shown in table 2.

Word	Anger	Anticipation	Disgust	Fear	Joy	Sadness	Surprise	Trust	Negativity	Positivity
abnormal	0	0	1	0	0	0	0	0	1	0
provoking	1	0	1	0	0	0	0	0	1	0
reassure	0	0	0	0	0	0	0	1	0	1
punch	1	0	0	1	0	1	1	0	1	0
muck	0	0	1	0	0	0	0	0	1	0
revolution	1	1	0	1	0	1	1	0	1	1

Figure 4: Word Emotion Lexicon in [7]

In [7] difference emotions classes are categorized on the basis of keywords. For example Anger can be detected when terms like provoking, punch and revolution. There is no words given in the first column that describes joy. Similarity words like abnormal, provoking, punch, muck, revolution and unclean shows negativity. And same as case for other emotion classes such as Anticipation, Disgust, Fear, Sadness, Surprise, Trust and Positivity.

Table 3: Selected Sentences Results

S. No	Text	Polarity	Emotion Class	Emotion Intensity
1	Abnormal	Negative	Disgust	60%
2	Provoking	Negative	Anger Disgust	50% 50%
3	Reassure	Positive	Trust	100%
4	Punch	Negative	Sadness, surprise, anger fear	25%, 15%, 25%, 15%,
5	Muck	Negative	Disgust	100%
6	Revolution	Positive 50% Negative 50%	Sadness, Anticipation, disgust, Anger, Surprise, Fear.	16.66%, 3.33%, 3.33%, 16.66%, 16.66%, 16.66%
7	Unclean	Negative	Ashamed, Disgust, Angry.	6.66%, 33.33%, 6.66%

Words emotions lexicons in [7] are tested against proposed methodology for emotion classes and their intensities as per proposed methodology. Word "punch" is classified as Negative and Sadness with 25%, Surprise with 15%, Anger with 25% and Fear with 15%, which shows the minute details of word punch for emotion classification and this classification become more realistic and clear in real world.

Table 4 represents an example sentence from [7]. This sentence is tokenized as follows.

Table 4: Example from [7] Example of tweets

give	a	Listen	and	a	like	these	guys	are	awesome

After tokenization, stop words has been removed from the sentence as shown in Table 5.

Table 5: After Removing stop-words [7]

give		Listen	and		like				awesome

Table 6 represents the structure of the sentence after tokens have been replaced by emotion class labels as per corpus provided in [7]

Table 6: after replacing with CORPUS [7]

Neutral		Neutral	Neutral		Joy				Neutral

Table 7 represents the same example of table 3 after removing stops word from our customized algorithm.

Table 7: After Removing stop-words

		Listen			like		guys		awesome

Table 4, 5, 6 and 7 shows successive pre-processing steps that will be applied on a sentence. Those pre-processing steps are stop word removal, word replacement and so on.

Table 8: Checking Polarity and Intensity of Example Sentence

Emotion	Intensity	Polarity
Happy	40%	Positive
Surprise	20%	

Polarity of tokens are identified in table 8. Polarity of given sentence is detected as positive, because keywords lies in positive polarity and The intensities of sub-classes "Happy" and "Surprise" are calculated as 40% and 20% respectively These values of intensities are calculated using equation 1.

Table 9: Emotion Category Result of Example Sentence

S no.	Words	Emotion	Intensity	Polarity
1	Give	-	-	Neutral
2	Listen	-	-	Neutral
3	Like	Happy	19.99%	Positive
4	Guys	-	-	Neutral
5	Awesome	Happy	50%	Positive
		Surprise	30%	

After applying pre-processing steps, the remaining sentence as shown in Table 9. **"Give"** is not classified as any emotion class, so polarity is calculated as Neutral. Same as case for **"listen"** and **"guys"**. Like and Awesome with emotion sub-classes Happy (19.99%) and Happy (50%) & Surprise (30%). So overall polarity identified as Positive.

6 Conclusion

Emotions are the most important feature of any human being. There are many methods to find the emotions of a person, however language and communication is one of the basic attribute through which emotion can be determined. Emotions play an important role in finding mood disorder. Some of the emotions cannot be easily recognizable because these emotions are dyads and these dyads can be check through Plutchik's wheel of emotion. Emotions cannot be identified only by handling the polarity of words or sentences but we can also use "bi-word" and "tri-word" combination in order to identify emotions correctly. Context of the word and intensity is also important.

7 Future Work

The potential future work on mentioned problem is very vast and might be need in such digital word. First of all advance natural language pre-processing will be applied to add elongated words and emojis score as well to calculate the emotion class and secondly depression detection will be targeted using similar techniques as discussed for emotion detection using textual analysis as huge amount of data is available on social sites. It is very important to find depression in one's textual information and then do some mitigation accordingly. Mitigation techniques may vary from person to person and from intensity to intensity of depression. Depression is becoming a daily base illness for any human being and it is necessary to find its easy cure with the help of technology. And mixture of straight forward keyword-based technique and machine learning techniques (especially Artificial Neural Network) will be combined along with technique used in this paper to achieve high performance in depression detection and mitigation domain.

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