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Enriching Comment Classification through NLP and Fuzzy Classification

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Abstract – Communication and interaction socially are one of the basic needs of a human being. This has been instrumental in achieving large-scale improvements in the communication platform leading to the growth of the internet and the advent of social media networks. This approach has been significant in providing effective social interaction between individuals over large distances through the use of the internet platform and social media networks. These social media platforms have been improved significantly over the past few years and have added the ability to write posts with various media such as photos and videos that can be uploaded for other individuals to look at and comment. There has been a rise of people that are highly negative there are a lot of negative comments and sarcastic comments being posted on these platforms. There is a need to reduce these instances which can be highly damaging to the reputation of the social media network as well as lead to dissatisfaction in the users. Therefore to achieve highly accurate comment classification an effective methodology has been presented in this research article that utilizes Term Frequency and Inverse Document Frequency along with Artificial Neural Networks and Fuzzy Logic to achieve precise comment classification. The approach has been extensively tested through rigorous experimentation that has achieved satisfactory results

Keywords: Natural Language Processing, Fuzzy Classification, TF-IDF, Artificial Neural Networks.

I. INTRODUCTION

A human being is extremely social and requires social interaction for the purpose of achieving a sound mind and a fulfilling life. Communication is one of the most important aspects of human life and without it, there can be serious developmental problems that can be long-lasting and have a negative impact on the life of the individual. This is noticed in a lot of exceptional cases wherein individuals did not have social contact or communication with anyone for a large period of time that has led to disastrous circumstances. This indicates that social interaction and specifically communication play an extremely vital role in an individual's life.

The early human beings when first stepped foot on this planet there was very minimal communication as the means of communication were not as extremely developed as they are today. In the start, most human beings communicated with each other in

the form of gestures and other sounds that help them coordinate with each other to achieve bigger goals. This was important and it is the reason why human language developed significantly over the years. The human language has been extremely revolutionary and has improved considerably over the early stages of human beings on this planet. This is due to the fact that the language is a lot more complex nowadays with a lot of words that are added to the vocabulary every year.

With the advent of technology and improvement in the approaches that are properly human beings further and further towards the Pinnacle of achievement there has been increased interest in improving the social dynamics and interactions of individuals across the world. This is necessary as it has achieved considerable improvements in a large number of different fields that is evident every day. Therefore to enhance the social dynamics and utilize the ever-growing internet platforms the rise of social media was extremely obvious under the natural path for improvement. The implementation of the internet platform and social media websites has led to the world becoming an even smaller place as a large number of individuals can now communicate and interact with each other over a large number of distances.

But there are also experienced incidences of a lot of individuals with nefarious intents getting connected onto the internet platform. With the increasing affordability of the internet platform, these individuals have also steadily increased which has been problematic for a lot of implementations especially online social networks. These incidences on social media can lead to disturbance of a safe environment for the users and can provoke a lot of problematic occurrences on the platform. As the ability for sharing an extensive amount of information on the online platform has grown exponentially and individuals can post their media such as photos videos and other content on their pages for other individuals to look at. These individuals can comment on these posts which can range from helpful and highly motivating to sarcastic and downright evil.

These comments can be highly discouraging for a lot of individuals utilizing this platform. This is especially problematic for individuals that are highly susceptible to this form of online harassment and bullying. And can lead to extensive problems for individuals with mental health problems and other disorders. This also makes the social network lose its popularity due to these negative effects on the platform which can be damaging to the social network creators. Therefore there should be an effective

approach for minimizing these instances and achieving a safe and sound environment on the online social networks. For this purpose, a number of researchers have been performed but due to the underlying problems in the detection of sarcasm, this can be an extremely complex task to achieve.

Therefore for this purpose, effective approaches are outlined in this research article for the purpose of reducing such instances and classify the comments accurately. The paradigm of natural language processing is highly useful for such approaches which can lead to significant improvements in the comment classification platform and its accuracy. The prescribed approach in our methodology achieves effective realization of the natural language processing approach through term frequency and inverse document frequency which is combined with artificial neural networks and classified through Fuzzy logic to achieve highly accurate comment classification.

This research paper dedicates section 2 for analysis of past work as literature survey, section 3 deeply elaborates the proposed technique and whereas section 4 evaluates the performance of the system and finally section 5 concludes the paper with traces of future enhancement.

II. LITERATURE SURVEY

J.Wang introduces a unique feature for Chinese comment spam detection by utilizing Jaccard similarity and intercomment similarity features of stopwords ratio. Naïve Bayes, and Neural Network for several classification algorithms. [1] Communication among social communities has become one of the most popular ways. To distinguish between humans and computer programs CAPTCHA is usually deployed. For estimating the affinity between comments they have used Jaccard and Dice coefficients.

J.Savigny in Indonesia YouTube is known as one of the most famous videos sharing platforms. By commenting on the video the viewer can react to a video. [2] The comment made by the viewer can be emotional that can be identified spontaneously. Thus the proposed paper introduces an emotion classification experiment on Indonesian YouTube comments. In NLP word embedding is a famous technique for classification tasks. By using Convolutional Neural Network (CNN) algorithm namely average word vector, average word vector with TF-IDF.

M.Zhang discusses the rapid development of big data technology as there is the use of more and more internet. For understanding customers' attitudes e-commerce platform has turned up is known as an important source of information.[3] The comment is classified in positive class, neutral class, and negative class for sentiment polarity. A sentiment lexicon and CNN algorithm is model-based sentiment classification. Thus the proposed methodology provides an effective approach for comment classification.

Rahul specifies in starting days internet communication was done by email. [4] At that time it was very hard to classify the email as positive or negative and whether it is spam or not – spam. By restricting the dissenting opinions of people is the main aim of the system. There are many people who leave the social platform because of toxic people who use abusive, or unreasonable comments. For toxic comments classification, the proposed paper

proposes the best machine learning algorithm to solve the problem of text classification.

S.Hong explains as there is a vast growth in the field of computer technology a huge amount of financial text data is collected on the internet which also contains comments in the stock bar. As there is a large amount of data there can be useful data that can be useful to the stock investors. [5] It is very hard to go through this data and it will be a very time-consuming task thus solution for this the author proposed text data mining technology which will extract valuable information from this financial text data.

Ye Ziming describes an extensive amount of comments that have seen as there is growth in educational big data due to the development of MOOCs. MOOCs are mass open online courses that have 10 million users. As there is a huge count of users the data is collected on a large scale it is very difficult to manage the data. [6] Thus by using deep learning and natural language processing text classification is done thus to display the important information. Thus the proposed paper promises effective results comparing with the traditional technique.

LI Aiwu narrates blog is becoming one of the famous economic means of communication with the rapid growth of the Internet.[7] As blog writing has become an important tool of communication and also a useless information carrier so it is very important to deal with these toxic comments. The classification algorithm is implemented for text classification the algorithm called Bayes classification algorithm, Naive Bayes NB with the combination of decision tree and neural network comparable classification algorithm.

A.N.M. JuBaer proposes a toxic comment classification system in the Bangla language. [8] There are many types of research of text classification made in English thus the researcher of the proposed paper develops the classifier for a Bangla language. The toxic comments can spread hates among the community thus to keep the environment clean they have introduced discrete features, Gaussian and SVM for classification by using the Binary Relevance method with the combination of Neural Network known for the best classifier

M.Andriansyah discusses cyberbullying on Instagram as becoming an important issue on the social media platform. [9] The dataset is collected from the famous Indonesian Instagram celebrities/Selebgram. In which 34 comments were taken as a test document and 1053 comments were taken as a training document. Support Vector Machine (SVM) is implemented to classify the text. The result of the proposed paper is 79 % which shows the classification of comments by using the Support Vector Machine (SVM) method.

W.Jitsakul expresses Internet is known as one of the important factors for communication. The Internet has connected many people from different countries to talk and also exchange information between many people. [10] The proposed paper provides item feedback classification in e-commerce combination of text classifier and word centrality measures. The results of the proposed paper provide an accuracy of 80.9%.

M.Ibrahim expresses harassment and cyber-bullying has become a very serious issue causing it can create many psychological problems like suicide and depression. [11] The solution for this classification system to overcome this issue. The proposed system implements a convolutional neural network (CNN) and bidirectional long short-term memory (LSTM). The framework provides a promising result and achieves a 0.828 F1-score for the toxic/non-toxic classification system.

M.Anand expresses social media has become one place where people can discuss their views and comments. Some people can create drift between two communities by committing on the characters such as race, ethnicity, gender, and sexual orientation. [12] In recent years social media platforms have upgraded their platform of detecting abusive content. The classification of the content is done by using deep learning algorithms such as Convolution Neural Network and Long Short Term Memory with the combination of Glove.

Jiangbo Liu narrates the traditional approach of the review text classification method to upgrade the classification model it is very necessary of two conditions there are for a good classification model enough training data is important and also training data and test data should be divided in distribution form [13]. In data mining classification is known as important methods and other important methods are the k-nearest neighbor algorithm, Rocchio algorithm, and support vector machine, and naïve Bayes algorithm.

III PROPOSED METHODOLOGY

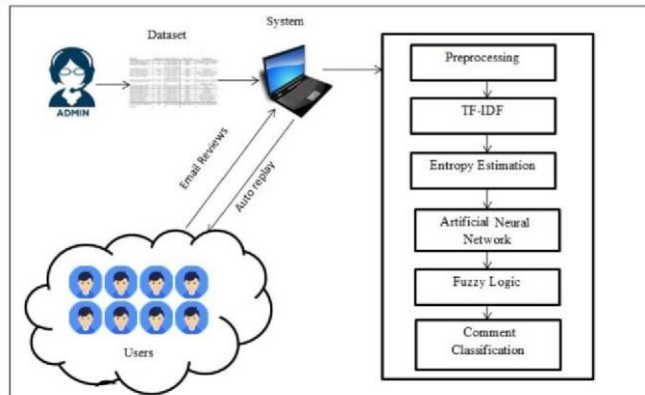


Figure 1: Proposed model System Overview

The proposed methodology for the purpose of achieving an effective comment classification approach through the use of Artificial Neural Networks and Fuzzy Logic has been depicted in the system overview given in figure 1. The steps deployed for the realization of this methodology have been illustrated below.

Step 1: Data collection and Data feeding – The proposed approach for the comment classification uses a synthetic dataset acquired from an e-commerce web page. The dataset is aggregated by the extraction of reviews from the URL - <https://app.feedcheck.co/amazon-review-exporter> which are then used to populate an excel sheet with the customer reviews for the input to the methodology.

The dataset consists of a collection of attributes, such as the title of the review along with the customer feedback about the quality and the performance and the quality of the product. These reviews assist in the determination of the classification according to the content of the reviews. The acquired dataset is then provided to the next step of the system for the preprocessing.

Step 2: Preprocessing – This is the initial step of the system that performs the logical operation. The dataset consisting of reviews from the e-commerce website is taken as an input in this step. The input dataset is read in the form of an excel sheet that is interfaced with the java code using the JXL API. This library allows the java code to take the workbook input and store the contents in the format of a double dimension list.

The process of preprocessing reduces the redundancy of the data by eliminating the unnecessary elements from the text which can reduce the performance of the execution. The comments are also transformed into their light weight counter parts which reduce the errors that are encountered in the execution. The preprocessing is achieved by a number of steps elaborated below.

Special Symbol removal – The special symbols are not crucial for the realization as an input for our comment classification approach. These symbols such as , ? , ! , @ , etc. are eliminated to reduce the redundancy.

Stemming – Most of the words in the English language are the different forms of the same word. These words are used to denote slightly different notations and essentially mean the same, but with added postfix. Therefore, these words are stemmed or the post fix is removed to transform it to the root word. Such as, ‘going’ will become ‘go’.

Stop Word Removal – The stopwords are words such as from, and, is, the, etc. these are the words that provide connection between two sentences and are aesthetic in nature. Therefore, these words are not as useful in understanding the content and are removed from the string.

Step 3: Term Frequency and Inverse Document

Frequency – The preprocessed string is provided as an input to this step of the procedure. This is the initial step of the Natural Language Processing approach that is the most important part of this proposed system. In this step of the process, the importance of the words is measured. This allows for the accurate assessment of the sarcasm in the comments and allows for a more precise extraction of the meaning of the comment.

The equation used for extraction of the Term Frequency and Inverse Document Frequency is given in the equation 1 below.

$$TF - IDF = TF \times \log \frac{\text{Number of Documents}}{\text{Number of Documents Containing Word } W}$$

The initial step in determining these NLP parameters are the evaluation of the amount of time a number is encountered in the particular comment. This is a useful metric that allows the effective realization of the importance of the word in the comment. This parameter is referred to as the Term Frequency, where the term is the word and the frequency is the number of times this word W has appeared in the comment given as input.

The Inverse Document Frequency is another most useful and potentially insightful parameter that is used to determine to achieve the frequency of the word in several other documents. This value is helpful in determining the relative importance of the word in a number of documents, facilitating the development of precise sarcasm detection based on these values.

The TF-IDF is measured and then stored in the form of a list along with the words. This list is then sorted in the descending order of the TF-IDF values which sends the words with the most amount of TF-IDF value to the top of the list. These words are important as they facilitate the extraction of the importance of these words, which forms an integral aspect of the NLP paradigm being implemented. The sarcasm is also accurately detected through this approach. These words are then supplied to the next step of the approach for further evaluation.

Step 4: Entropy Estimation – The list containing the TFIDF value is utilized as an input in this step of this procedure. This procedure allows the evaluation of the information gain values of the words for the evaluation of the entropy. These values facilitate the distribution factor of the words which is a useful metric for the further determination of the semantics of the comment.

Each of the words is utilized for the calculation of the scalar weight. This is done by utilizing the word count and the frequency to determine the information gain through the Shannon Information Gain equation given below in equation 2.

$$IG = -\frac{P}{T} \log \frac{P}{T} - \frac{N}{T} \log \frac{N}{T} \quad (2)$$

Where

P= Matched number of the words using TF-IDF

T= Total number of words

N= T-P

IG = Information Gain for Comment

The evaluation of the Shannon Information gain through the equation above yields values between 1 and 0. Any value closer to 1 indicates a higher distribution factor and values closer to 0 depict smaller distribution factor. The gain list is created by storing these values along with the words for further evaluation.

Step 5: Artificial Neural Network and Fuzzy Logic – This is the integral part of our methodology that facilitates the actual comment classification. The implementation of the deep learning approach allows for an improved and useful realization of the classification of the reviews. This step utilizes the comments as well as the information gain values for the same as input to this step of the procedure.

The Artificial Neural Networks have been implemented to achieve the accurate comment classification through the creation of neurons. These neurons utilized random weights along with some bias weights for the hidden layer estimation to achieve the hidden layer value according to the two target values T1 and T2. The evaluation of the output layer achieves a probability score for the input comments depicting the accurate segregation. These probability values need to be accurately segmented to achieve the comment classification.

The fuzzy classification approach is utilized to facilitate accurate classification of the probability score values achieved in the previous step as an input. The fuzzy classification approach utilizes fuzzy crisp values for the purpose of achieving an effective improvement in the classification protocol through the implementation of fuzzy crisp values. These values utilize the probability scores to achieve 5 segregations namely, VERY HIGH, HIGH, MEDIUM, LOW, and VERY LOW. These values are then used to classify the probability scores in 5 distinct segregations which are then displayed to the user in a graphical user interface according to their selected level of comment classification.

The whole process is depicted in the algorithm 1.

ALGORITHM 1: Comment Classification

```

//Input : List of Comment Scores LCS
//Output: List of Classified Comments LCC
1: Start
2: Set min=0.5, max=0.5
3:   For i=0 to size of LCS
4:     TMPs = LCSi [ TMPs = Temporary Set]
5:     CSCRE = TMPs[1] [ Comment Score]
6:     IF (CSCRE < min)
7:       min = CSCRE
8:     IF(CSCRE >max)
9:       max = CSCRE
10:    End For
11: RANGE1=0 , RANGE2=0 ,RL= ∅ [Rule List]
12: DF=( max-min)/5 [ DF= Diffrence Distance ]
13:   For i=0 to 5
14:     RANGE1=min
15:     RANGE2=RANGE1+DF
16:     min=RANGE2
17:     TL[0]= RANGE1 [TL= Temporary List]
18:     TL[1]= RANGE2
19:     RL= RL+ TL
20:   End For
21:   For i=0 to Size of RL
22:     SCL [ Single Classified List] 23:     TMPL =
RL [ TMPL = Temporary Set]
24:     R1= TMPL[0], R2= TMPL[1] 25:
For j=0 to size of LCS
26:   TS = LCSi [ TS = Temporary Set]
27:   CS = TMPLST[1] [ Comment Score]
28:   IF(CS >= R1 AND CS <=R2)
29:     SCL= SCL+ TMPL[0]
30:   End IF 31:
End For
32:   LCC = LCC + SCL
33:   END For
34: return LCC
35: Stop

```

V. RESULTS AND DISCUSSIONS

The proposed system for the comment classification has been derived through the use of NetBeans IDE which is used to code this approach in java programming language. The laptop used for the purpose of deploying this approach consists of 500 GB of storage along with 4 GB of RAM and powered by an Intel Core i5 processor. The database requirements and responsibilities are designated to the MySQL Database server.

The presented approach needs to be evaluated efficiently to determine the performance and real world implementation of the approach. This is achieved through the use of intensive experimentation achieved through the realization of the Precision and Recall Metrics.

Performance Evaluation based on Precision and Recall

The comment classification of the performance of the prescribed approach achieved through the use of Artificial Neural Networks and Fuzzy Classification. The prescribed approach utilizes the reviews extracted from the Amazon Review exporter. This extractor takes the product link as an input and extract the reviews from the given product link. The reviews then can be downloaded in the form of a workbook containing all the relevant attributes and the comments. These reviews are effectively processed and classified using the Artificial Neural Networks and Fuzzy classification into 5 different categories. This is done through the use of the fuzzy crisp values which determine the level of the comment classification. The performance of this technique has been determined using the Precision and Recall performance metric.

The Precision and Recall are extremely useful parameters that are used to determine the execution accuracy of the comment classification approach defined in this research article. The precision determines the relative accuracy of the module and provides an in-depth accuracy of the module.

The precision metric in our implementation has been determined as the division between the number of accurate classifications attained and the total number of comments that have been provided. On the other hand, the recall parameters are an additional measure to the precision metric and allow for the calculation of absolute accuracy of the results obtained.

The recall in our execution has been illustrated as the division of accurate classification of the comments to the combined number of inaccurate classification of the comments. This has been elaborated mathematically in the equations illustrated below.

Precision can be depicted as below

- A = The number of accurate classifications for the given comments extracted
- B = The number of inaccurate classifications for the given comments extracted
- C = The number of accurate classifications that are not done for the given comments

So, precision can be defined as

$$\text{Precision} = (A / (A + B)) * 100$$

$$\text{Recall} = (A / (A + C)) * 100$$

The outcomes of the experimental evaluation through the measurement of the above equation parameters are listed in table 1 below. These tabulated outcomes are used to provide a graphical representation in the form of a line graph given in figure 2.

No of Reviews Extracted	Accurate Classifications (A)	Inaccurate Classifications (B)	Accurate Classifications not done (C)	Precision	Recall
10	10	1	2	90.90909	83.33333
20	17	4	2	80.95238	89.47368
30	30	2	2	93.75	93.75
40	34	4	5	89.47368	87.17949
50	43	6	4	87.7551	91.48936
60	51	6	5	89.47368	91.07143
70	58	10	4	85.29412	93.54839
80	69	7	7	90.78947	90.78947
90	74	11	8	87.05882	90.2439
100	81	12	9	87.09677	90

Table 1: Precision and Recall Measurement Table for the Fuzzy classification analysis

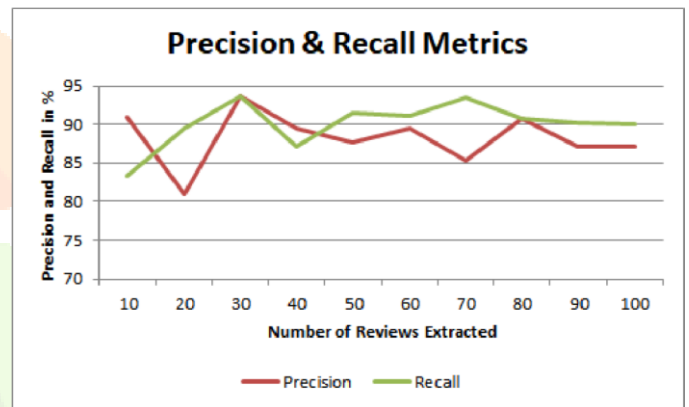


Figure 2: Comparison of Precision and Recall for the Fuzzy classification analysis

The table and the graph of the outcomes have demonstrated that the Artificial Neural Network and Fuzzy classification have been a good choice for the approach and have been implemented accurately. The Precision and Recall performance metric of X and y have been highly satisfactory in the realization of the comment classification. This performance is extremely suitable for an initial implementation of such a system.

V. CONCLUSION AND FUTURE SCOPE

The methodology for precise comment classification on online social networks has been elaborated extensively in this research article. A data set containing various comments are provided to the system along with the email reviews with autoreply to the users. The input data set is provided for preprocessing which makes the entire input text lightweight and efficient. This preprocessed data set is utilized for the purpose of achieving term frequency and inverse document frequency. These values of term frequency and inverse document frequency are utilized for the next step of the approach for the purpose of estimating the entropy through the

implementation of Shannon information gain. The achieved information given values is useful for implementation as input in the next module that performs an Artificial Neural Network to accurately detect sarcasm and unwanted content in the comments. Once the probability scores have been achieved from the Artificial Neural Networks have been provided for classification through Fuzzy logic to improve the accuracy of the results. The extensive experimentation has resulted in the realization of the performance metrics of the prescribed approach which are extremely satisfactory.

Future research on this approach can be in the direction of achieving an effective API for ease of integration into various different implementations.

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