Mathematical Statistician and Engineering Applications
ISSN: 2094-0343
2326-9865

Multi-Class Label Classification of Extremist Tweets

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Article Info
Page Number: 523 - 534
Publication Issue:
Vol 71 No. 3s2 (2022)

Article History
Article Received*: 28 April 2022*
Revised*: 15 May 2022*
Accepted*: 20 June 2022*
Publication*: 21 July 2022*

Abstract
Extremists use tweets for group strengthening, propaganda, brainwashing and fundraising by reaching people's mind. A tweet is a post of utmost 280 characters on Tweeter, a popular micro blogging service. Our objective is to identify extremist affiliation based on opinions expressed on tweets, in order to prevent brainwashing on public and trace terrorist activities. To overcome these issues, sentiment analysis with an automated process of understanding an opinion on given subject from written or spoken language is adapted. Traditional methods of filtering are not scalable for classifying extremist and non-extremist tweets. Overcoming conventional approach, machine learning based classification system applied to this problem, was still limited to unrigorous and vast categorization of tweets into positive and negative. Another restriction was the negligence of overall dependency related to sentences. This paper, therefore aims at distinguishing tweets as extremist and non-extremist and also investigating other types of extremism by employing Deep Learning and machine learning methods.

Keywords: - sentiment analysis; extremist; social network; tweet; deep learning; machine learning; multi-class; classification

I. INTRODUCTION

Social media refers to a website or an application that renders possible the sharing of ideas, opinion, and information by connecting individuals through virtual networks. It supports efficiently the user-generated content to travel at high speed in real time.In particular, Twitter is a micro blogging service that transcends the list of the wide range of social media applications, in terms of utilization across the world. On Twitter, the main functionality provided is the broadcasting of short posts of utmost 280 characters by the registered members. The latter being called as a tweet, is often accompanied by a visual content that might be a picture, a video or a Graphics Interchange Format (GIF) image. Hence, a tweet is basically composed of two elements. A textual context: a text or a message a user delivers followed by hash tags and can optionally contain usernames and URLs. A visual context: a picture, video or GIF image that illustrates the text by adding context to it.

Extremist activities in Twitter are defined by engagement in or promotion of violence against civilians to advance a political, religious or social cause. An estimated 90% of terrorist acts is conducted through social media, as studies reveal. Thereby, social media acts as an effective platform for Extremists to express their opinion to a large population. It therefore turns out to be a new approach to rapidly expand extremist activities. Consequently, brainwashing people and fundraising is no more a big deal. Opinions expressed on Social media provide a clue about the extremist affiliation of a user. Extremism can be portioned into the following categories. Right section extremism: a form of primitive associated with hostility towards minorities (Eg: racism).Single concern extremism: a form of primitive motivated by a sole issue (Eg: Anti-abortion, anti-feminism movements).Left section extremism: a form of primitive that focuses on anti-capitalist demands (Eg: anarchist , marxist groups).Politico-religious extremism: a form of primitive expressed by a violent defence of a religious identity.

In order to limit proliferation of extremist oriented posts and to dishearten such connected unlawful acts, detection of primitive words is primordial for analysis on user sentiment on the way to some extremist cluster. In this context, multiple approaches of sentiment analysis have been applied to social media posts for identifying extremist behaviour, including Sentiment analysis. A subjective mining from a source text is called as sentiment analysis. The practice of extracting insights from social data is being increasingly adopted across the world. Based on previous studies [1,2], the textual classification of tweets is established through sentiment analysis. The conventional methods of riddling the extremist tweets are not scalable, which leads for development of automated techniques. In previous works, Azizan and Aziz [3] investigated on the detection of extremist affiliation. They used a machine learning technique such as Bayes techniques and its algorithm for classification of user reviews into positive, negative and neutral. However, classification based on polarities is vague and does not reflect extremist affiliations and it needs the ability to take the overall dependencies related to a sentence in a document. Later, based on Deep learning, S.Ahmad et al. [4] proposed to divide the tweets into Extremist and Non-Extremist using a method in Deep Learning, named Long Short Time Memory- Convolutional Neural Networks (LSTM-CNN). In this work, the same method is applied, and extended with multiclass label classification of tweets in the consecutive step. For multiclass classification, numerous works have exploited the Support Vector Machine. Hui Qin Sun et al. [5] propose a SVM algorithm to diagnosis a transformer's faults based on quantities of gases present in the transformer. SVM is also used for splitting images into different classes as demonstrated in the study of Janee Alam et al [6]. In this paper, SVM is hence chosen for segregating tweets into multiple classes. As performed by the previous works [5,6], our study uses multiples binary SVM classifiers and chooses a one-vs-one approach of classification. In parallel to test classification, images are determined whether they are extremist or not.

Artificial Neural Network is one of the widely adopted techniques for image classification [7,8]. NurAnis Mahmon and Norsuzila Yaacob experiment [9] classification using different algorithms of ANN like back propagation and k-means. Likewise, in this paper, we propose to classify images using a type of ANN, Probabilistic Neural Network.

The main objective of this proposed work is to detect extremist content from random tweets, and also be able to specify which kind of extremism the tweet pertains to Visual content of the specific

tweet is also used for verification of the classification. The objective can be achieved by the following ways such as

1. Classifying tweets into extremist or non-extremist class
2. Further separating extremist tweets into three categories, namely religious extremism, racist extremism and single issue extremism.
3. Verifying the extremist nature of the tweet by adding the classification of the visual content of a specific tweet.

The motivation behind the segregation of tweets into classes is to highlight the polarity of the tweet in order to point out an extremist user in the future. In the initial stage, the study focuses on separating tweets by labelling them as extremist or non-extremist. Deep learning is adopted for conserving the sentence dependency of the post while classifying it. Usually, previous works were limited to the binary classification of posts and did not give emphasize on varieties among the extremist tweets. Therefore, as a matter of precision, the subdivision of the tweets is added to the work. Extremism not necessarily points out terrorist affiliation. Many reviews are presented in literature by many researchers with respect to ML and IoT in different domain.[14][15][16]. This analysis will surely enable the researchers with the idea of ML technique in different applications. [17][18][19]20][21]. Different issues also discussed in ML applications[22][23].

II. LITERATURE SURVEY

Shakeel Ahmad and Irfanullah Awan [4] proposed a classifier for separating tweets into Extremists and Non-Extremist tweets. It takes into account the dependency of sentences for classification. They use the LSTM-CNN method which comes under Deep Learning for their work. CNN is used for extraction of spatial and temporal features which provides input to LSTM model from CNN model and retains the correlation by providing the preceding data for maintaining the inclusive dependencies on a sentence in the post as regards to the extremist and non- extremist classification. 25,000 postings from Twitter and Dark Web Forums were used as dataset. However, types of extremism are not identified and visual and social contexts are not taken in account for classification.

Extremist behaviours are detected using sentiment analysis using Machine Learning in Azizan et al.'s study categorize a tweet into Positive, Negative or Neutral. The novelty brought by his research is the behavioural analysis of users, embedded to the existing algorithm. Tweet history is explored with the help of snapbird tool. Behavioural analysis will be focused on the retrieval of tweets history of users. The purpose to check a user's previous tweets, is to discover his tweets pattern. A new class of sentiment (Positive, Negative, Neutral) can be attributed based on the latest and previous tweets.

The work of Ryan Scrivens et.al [1] focuses on searching signs of extremism on the web. They developed a way to identify an extremist user by attributing each user with a radical score with the Sentimental analysis based identification of SIRA algorithm. Preceding that, a list of extremist keywords was established using Part-Of-Speech (POS) analysis. The radical score is calculated by summing up an Average sentiment score percentile (AS), the Volume of negative posts (VN), the Severity of negative posts (SN) and Duration of negative posts (DN). A high fundamental score indicate a high probability of negative content is a user's post. Users are ranked according to their 'radical score,' and those with the highest radical scores were assessed.

The work of Emilio Ferrara, Wen-Qiang Wang, Onur Varol [10] aims at informative extremist users, to predict the usage of extremist content, and the forecasting of interaction reciprocity between regular users and extremists. For achieving these tasks, the employed methods are Logistic Regression (LR) and Random Forest (RF). LR approach is well suitable for classifications that manipulate huge dataset; hence one great benefit of LR is its scalability. The loss function C is the unique parameter needed to be adjusted.

The work of Muhammad ZubairAsghar et.al [11] exploits the richness of user opinions in online forums and analyses the linguistic connotation of words by organizing them into positive and negative classes expressed in the public's feedback about the products. Lexicon-enhanced sentiment reasoning built on Rule-based classification scheme is applied for upgrading sentiment classification of users' comments in online networks. Along with general sentiment terms, emoticons, modifiers and technical terms are reached in order to rigorously scan online reviews.

The work of Jufeng yang, Liang wang [12] focuses on the sentiments emanating from images. The process implicates a high-level abstraction in the recognition mechanism. It aims at utilizing the knowledge, which is stimulated by the surveillance that both the entire image and specific section, in order to convey important sentiment information. It proposes to identify candidate emotional regions deducted with the assist of an objectness tool. Candidates are then filtered out based on their redundancy and noise. To estimate the sentiment scores, a convolutional neural network (CNN) is then coupled with each of the candidates. Combination of sentiment score and objectness score is established, from which the affective regions are discerned effortlessly. Finally, the CNN results for local regions are incorporated with the whole images to output the final prediction.

III. EXISTING WORK

The existing work has been implemented based on Shakeel Ahmad et al.'s work [4]. Hence LSTM-CNN is employed for segregating tweets into extremist and non-extremist, as illustrated in the figure 1. The traditional techniques of filtering extremist tweets are not scalable, which lead to development of automated techniques. They used a machine learning technique: Naïve Bayes algorithm. Their work classified user reviews into positive and negative. However, classification into positive and negative is vague and does not reflect extremist affiliations and that it lacks the ability to take the overall dependencies related to a sentence in a document.

IV. DATASET

A total of 100 tweets are used in the study for training and validation, among which 50 are Extremist and the rest is non-extremist. Extremist tweets have been collected from twitter website, by filtering out tweets according to extremist keywords in the search bar. Some tweets have been picked from Terrorism based dataset on www.kaggle.com. Eighty per cent of tweets are used for training set and the testing set is taken for validation. The training data set includes both the input and the expected output, that tweet along with its identifier and the corresponding label of that post (either Extremist or Non-extremist), respectively.

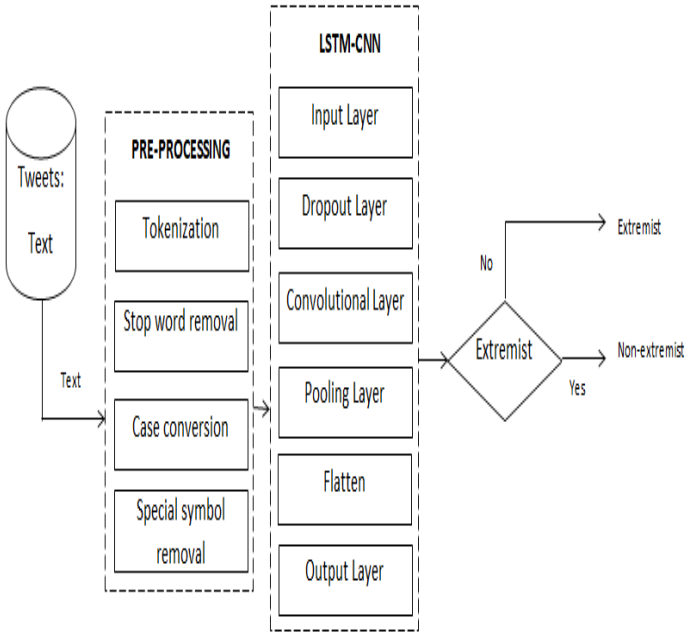

Figure 1 Architecture of the existing systemPre-processing

Pre-processing consists of transforming data into a usable one. Different pre-processing techniques have been applied. Case conversion transforms any capital letter into small letter. URLs are removed by using a function which erases HTTP and HTTPS URLs. Hash tags, which are words introduced by a hash symbol, help other users easily find messages with a specific theme or content, are also removed during this step. All marks of punctuations get erased as well. Stop words, a set of usually used words in any language are also eliminated. Some examples, in English are “the”, “is” and “and”. Stop words removal used to get rid of insignificant words, allowing applications to spotlight on the important words instead. Finally, when tweets contain only necessary content, for further processing, they need to be portioned as tokens. This is called as tokenization. Each token is a different work. A unique set of tokens is obtained.

V. TECHNIQUE/METHOD

The technique adopted for classification of tweets is LSTM-CNN algorithm. CNN is focused on extracting the spatial and temporal features, and LSTM layer used to process long-distance dependency across tweets.

(i) Word embedding (input) layer:

Input layer uses each word for tweet which is transformed and represented as real vector value. Thereby, a vocabulary of words is conceived, which is then expressed as a numerical matrix. A sentence is a sequence of words (x1, x2…xn) and each word is assigned with an index. From such indices, a D dimensional vector is obtained. As a next step, an embedding matrix of proportion “vocabulary size × embedding size” is constructed.

(ii) Dropout Layer:

The second layer function is to evade over fitting. It has a parameter called “rate parameter” which is the probability of activation or deactivation of neuron.

(iii) Long Short Term Memory layer:

LSTM layer is used to detain long-distance dependency diagonally tweets. It contains information which does not belong to the regular flow, in a cell handled by gates. Gates in closed or open status undertake storage, deletion, reading and writing of data into the cell. There are four gates: forget gate, input gate, candidate gate and output gate.

(iv) Convolutional Layer:

It performs a mathematical operation using an input matrix (P) and a filter matrix (F). It gives as result an output matrix (T). These matrices are used to form a feature map, which indicates the presence or absence of a feature in the given input.

(v)Pooling layer:

It minimizes the dimension segregation of the feature map by collective information. Max pooling function is used to get the required feature of a sentence by selecting the maximum value. Reduced feature map's dimension has been enabled by applying a window of a comparatively smaller size than it. Each time, the maximum valued element is picked from the window. All the elements arranged into a new matrix are pooled feature map.

(vi) Flatten layer:

The flatten layer transforms the feature map into a column vector.

(vii) Output layer:

In this layer, to estimate the prospect of two classes, that is extremist and non-extremist, an activation function such as softmax, sigmoid or tanh, is employed.

VI. PROPOSED WORK

The existing system distinguishes extremist from non-extremist tweets. The proposed system aims at increasing precision of the existing one. As shown in figure 2, it consists of two modules: (i) image classification into extremist and non-extremist and (ii) multiclass label classification of tweets.

Thereby, the contribution of the proposed system is to add visual context of tweets for a more refined classification and extremist tweets are further specified as a type of extremism, that is religion based extremism, racist extremism or anti-feminist extremism. Probabilistic Neural Networks is used for image classification and multiclass label classification is carried out by Support Vector Machine. Taking one tweet composed of textual and pictorial content, the text is passed to multiclass label classification and the image, to the image classification module. To verify that the textual and visual parts of a same tweet are coherent, the results of the two modules undergo a set of comparisons.

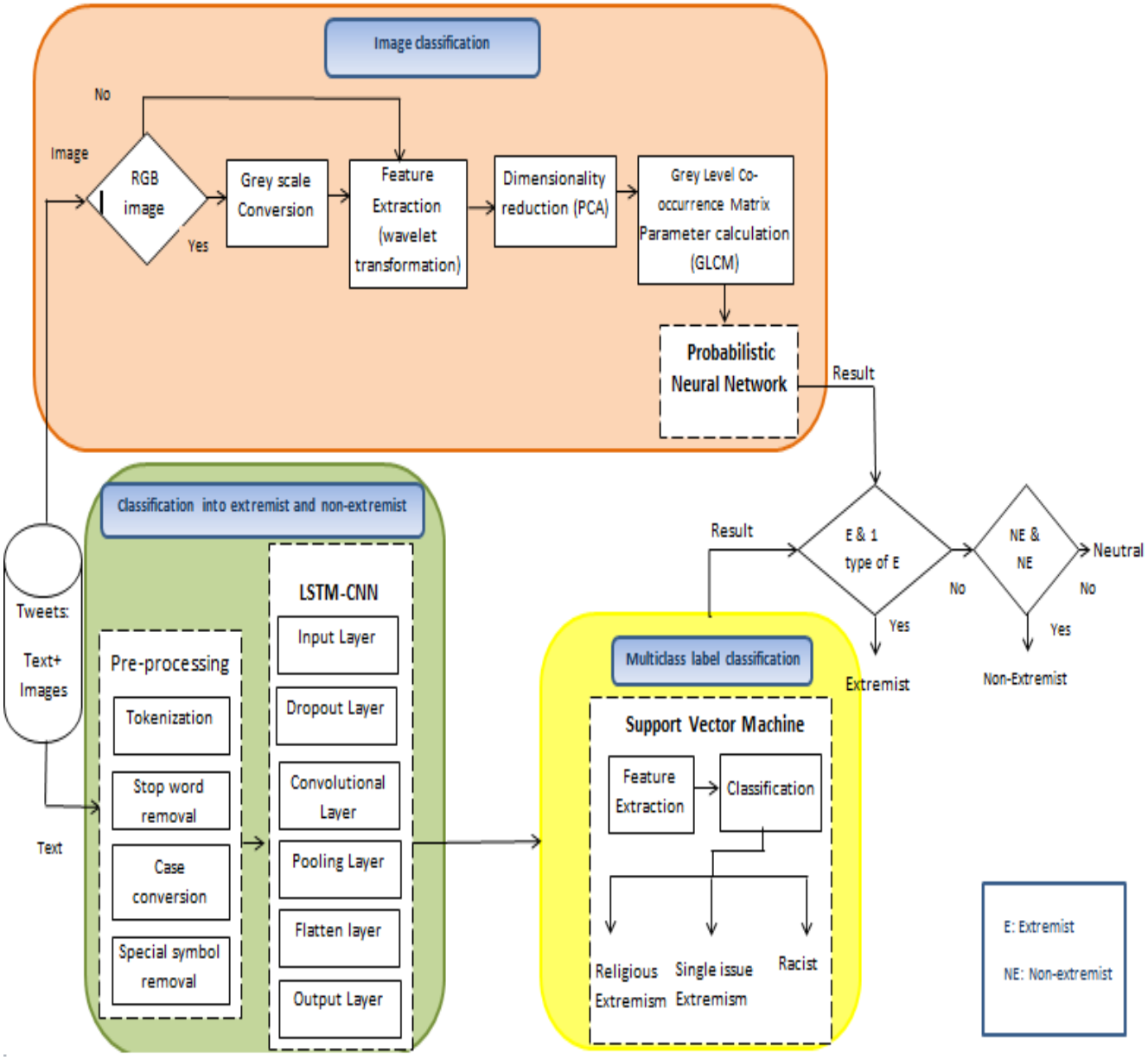

Figure 2 Architecture of the proposed system

VII. IMAGE CLASSIFICATION DATASET

Each tweet has been matched to a corresponding image. Thereby, there are 500 extremist images and 500 non-extremist ones. All pictures are gathered into a same folder. Each picture is named according to the id of the tweet it corresponds to.

VIII. PRE-PROCESSING

Pre-processing of an image consists of an development of an image data which discards undesirable distortions or optimizes some image characteristics such as sharpness and contrast. Before image enhancement, if the picture is a RGB image, it is converted into grey scale one. The

gray scale image is taken as input for image pre-processing. If this input gray scale image is affected by any kind of noise, it can be neglected through filtering technique. Otherwise if there is poor visibility, the latter can be improved by increasing the level of contrast or brightness.

IX. TECHNIQUE/METHOD

Discrete wavelet transforms provides natural signals as a sparse representation. The core features are gathered as DWT coefficients, of lesser size than the original signals. The coefficients help to reconstruct the image, remove noise from it and compress it. The subset contains the same number of coefficients than the initial signal. However, many of them converge to zero, hence are discarded. As a result, a high quality approximation of the image is obtained. The wavelet family adopted here is Daubechies. Further, the image is fed to the Principal Component Analysis (PCA) algorithm where its dimensions are reduced. A new collection of variables called principal components are generated by this method. Different combinations of original variables constitute the principal components. The principal components being orthogonal to each other, no redundant information is produced.

The reduced data is converted into Grey Level Co-occurrence Matrix (GLCM) from which we calculate parameters for each image in order to summarize the description of images into a matrix of dimension n x m where n is the number of images and m, the number of parameters. Here n is of 270 and m, of 13. The main parameters considered as a features with its contrast, correlation, energy, homogeneity and inverse difference movement.

The simplified image is passed to the Probabilistic Neural Network (PNN) algorithm; it is a kind of Artificial Neural Network (ANN) used for classification and pattern recognition. The PNN consists of three layers namely, input layer, hidden layer and output layer. The input layer consists of N nodes, each corresponding to one of the N input features of a feature vector. In this study, the feature vector comprises of various features that characterize an image such as contrast, correlation, energy, homogeneity and inverse difference movement. This leads to 13 input nodes in the input layer. Each input node branches to all hidden nodes which mean every concealed node take delivery of the complete feature vector. The number of concealed nodes corresponds to the number of training samples, which is of 270 in this work. Hidden nodes are grouped into c categories, where c is denoted as the number of classes.

This work needs images to be classified into 2 classes: extremist and non-extremist.

PNN comes under Radial Basis Function Network. A radial basis function network is a type of artificial neural network whose activation functions are radial basis functions. The working of Radial Basis Function Network is shown in Figure 3.

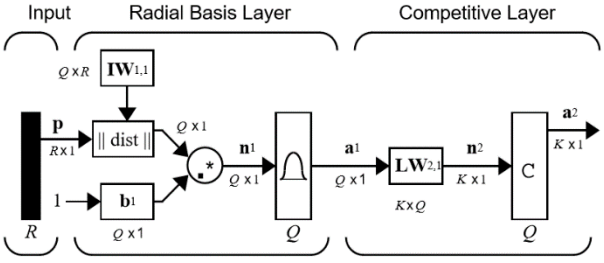

Figure 3 Probabilistic Neural Network architecture

P is the input vector of dimension Rx1.

Q is the number of training vectors, as well as target vectors.

$IW^{1,1}$ is the weight matrix of dimension QxR.

In the first layer, when an input and the weight matrix $IW^{1,1}$ are presented, the ||dist|| box produces a vector rudiments indicate how similar the input is to the vectors of the training set. These rudiments are multiplied, element wise with the bias. The bias b is used for adjusting the susceptivity of the radbas neuron. The resulting vector is sent to the Radbas transfer function. An input vector to Radbas function, having high similarity with training vector will be expressed by a number tending to one in the output vector a1.In the case of an input being similar to multiple training vectors are in unique class, it will be shown by various elements of a1 that are converging to one. More the input vector is adjacent to a training vector, more the corresponding element in a1 converges to 1.

In the second layer, the weight matrix $LW^{1,2}$ is the ensemble of target vectors. A target vector T, is a vector of dimension Kx1. It contains K elements, each specifying a different class. In this case, the number of classes is 2, hence K is also 2. Each vector is assigned a one only in the respective row corresponding to a specific of input, and zeros elsewhere. The multiplication Ta1 adds up the elements of a1 due to each of the K input classes. The "compete" transfer function, in the second layer, delivers a one denoting the greatest element of n2, and nil elsewhere. Thus, the network has provided with classified input vector into one precise class from K classes based on the highest probability of being correct.

X. MULTICLASS LABEL CLASSIFICATION OF TWEETS

In this study a total of 1000 tweets are considered for the classification of tweets and Multi-Class classification among which 500 are Extremist and the rest is non-extremist. Eighty per cent of tweets are used for set of training, and the remaining is taken for set of testing. The training data comprehends the input as well as the expected output.

A data mining technique used to convert an unprocessed content into a fruitful one is called as pre-preocessing. Different pre-processing techniques have been applied such as case conversion, URL removal, hash tags removal, punctuation removal, stop words removal and tokenization which yield a unique set of tokens. The pre-processed tweets is classified into two types namely extremist and non-extremist using LSTM-CNN(Long Short Term Memory -Convolutional Neural Network) . Extremist tweets are further classified into three types namely Single Issue Extremism (Anti-Feminism), Racist Extremism and Religious Extremism. The Multi -Class classification of Extremist tweets is done using Support Vector Machine (SVM). Support Vector Machine (SVM) is a machine learning algorithm. It is said as supervised algorithm since training data is labelled. SVM can be used for classification of the tweets. SVM are two class classifiers which require full labelling of the data. Hence for multiclass label classification, several binary SVM classifiers have been combined together. In this study, the approach which is followed is One-versus-one method. This method considers pairs of classes at a time, for classification. This work uses n(n – 1)/2 binary support vector machine (SVM) models, where n is the total of unique class labels (levels).One-vs-one method works on taking a pair of classes from a set of n classes and developing a binary classifier for each pair. Hence, given n classes (here, three), we can pick all

possible combinations of pairs of classes from n and then for each pair, conceive a binary support vector machine (SVM). The number of SVM to be used is derived as follows, where k is the number of classes in a pair and n the total number of classes:

$$C(n,k) = n!/k!(n-k)!$$
$$C(n,k) = n!/2!(n-2)!$$
$$C(n,k) = n(n-1)(n-2)!/2!(n-2)!$$
$$C(n,k) = (n(n-1))/2$$

XI. Experimental Results

The results of the classification of tweets depend upon the accuracy assessment. The percentage of accuracy of classification was calculated and analysed with confusion matrix. The accuracy can be calculated using the following formula:

Accuracy = (TP+TN)/(TP+FP+TN+TP)

Where, TP = True Positive
TN = True Negative
FP = False Positive
FN = False Negative

		Predicted Values	
		Extremist	Non-extremist
Observed Values	Extremist	148 (TP)	23 (FN)
	Non-extremist	17 (FP)	112 (TN)

Table 1 Predicted values for classification of tweets

The accuracy of binary classification of tweets into extremist and non-extremist is of 86.6% as seen in Figure 4.

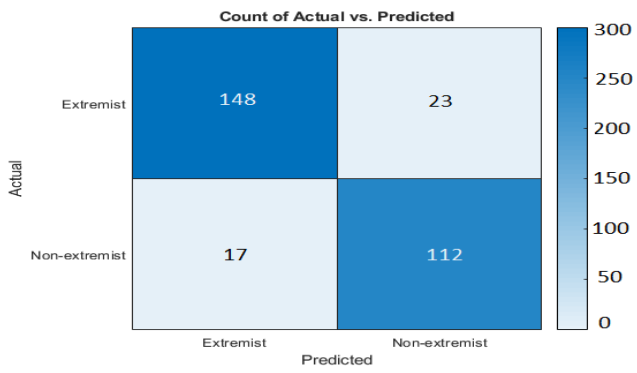

Figure 4 Confusion matrix for binary classification of tweets

Accuracy1 = (TP+TN)/(TP+TN+FP+FN)
= ((148+112))/((148+112+17+23))
=260/300
= 86.6 %

For multi-class label classification, the accuracy obtained is of 77.7 % as calculated from the confusion matrix in Figure 5.

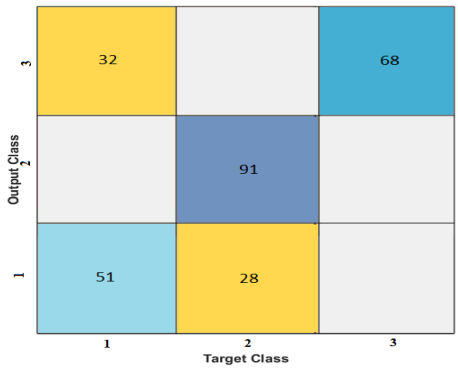

Figure 5 Confusion matrix for Multi-Class label Classification of tweets

Accuracy2 = (TP+TN)/(TP+TN+FP+FN)

= (51+91+68)/(51+91+68+32+28)

=210/270

= 77.7 %

XII. CONCLUSION

This study presents a sentimental analysis based tweets classification into extremist and non-extremist followed by further for the classification and identification of extremist tweets into different types of extremism. The binary classification of tweets is performed by LSTM-CNN. When a tweet is found to be extremist, we indicate its type using multi-class label classification which is undertaken by Multiclass Support Vector Machine algorithm to which the result of corresponding image classification is matched. Enriching this classification, image analysis is also incorporated. The visual context of a tweet provides better accuracy in classification.

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