

Ph.D. Research Proposal

Doctoral Program in “Department Name”

Natural Language Processing based Sentiment Analysis
for Online Social Networks based on Deep Learning
Model

by

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I. INTRODUCTION / BACKGROUND

Natural language processing (NLP) is an emerging field which aims to distinguish diverse opinions in favor or against to any product, service, issue, policy, event etc. In the last few decades much work has been done in opinion mining. Detection of events (earthquake, tsunami, floods) in online social networks such as FaceBook, Twitter, and YouTube are most widely used services nowadays [1]. As previously bring up, NLP play a major role in all fields (research centre, industry, organization and entertainment) and also individual can benefit from this application field. In NLP, sentiment analysis & opinion mining are the subfields. Some of the applications are as follows:

- Political Issue Tracking
- Feedbacks To Purchasing A Product
- Service Benchmarking
- Advertising
- Government
- Business Intelligence
- And Other Tasks

One of the most interesting research direction has been explored in this application field is Twitter Data Sentiment Analysis [4]. Here we are expressing few examples for opinions in Twitter, which are follows: Politics (“It’s wonderful day to not vote for Trump☺”), Marketing (“#apple customer service! Swapped out a new band for my watch at charge”). The focus on this discipline has increased along with the rapid growth of approaches and methods applied by the researchers.

Recent publications on opinion mining and sentiment analysis during 2000-2016 have been explored [5]. It is challenging to understand opinions about products or services which is

due to the big size and diversity of social media data. As text mining offers preprocessing for removing noise and irrelevant words from opinions. The role of preprocessing in opinion mining is discussed in-depth [6]. In opinion mining, polarity of many words are context and domain specific. For e.g. the word “long” is domain specific which is considered to be positive long battery life while in this “long shutter lag” it is considered to be negative [7]. Aspect based Sentiment Analysis is presented to classifying the overall sentiment of a document into negative or positive [8].

Recently, presented novel sentiment analysis approach based cuckoo search and k-means clustering. Various features are extracted in tweets which is play an important role to discover positive and negative opinions of the sentiment. As K-means is a very popular cluster method. However, k-means is a drawback of cluster head selection. Thus the cuckoo search is further improve the cluster heads election process. As a result that, this hybrid algorithm leads to high computational complexity. Automatic detection of ADR (Adverse Drug Reaction) is presented. In this papers, authors have used online user posts for performance evaluation. Set of feature groups such as n-grams, PoS, character n-grams, negation, heuristics, Lex, TW, drug name and charcter n-grams are used to analysis the drug tweets. More number of invalid feature sets are extracted which leads to the system with poor performance. Towards this presented automatic sentiment analysis approach for binary and ternary classification. This approach goes deeper in the classification of texts which are collected from Twitter social networks. However, the accuracy should be high to prove the better performances. This would obtain 70.1% of accuracy for ternary classification. The obtained results show poor performance in terms of accuracy. Sentence compression is the best way to reduce the lexicol footprint of a sentence. This scheme is proposed by authors The proposed scheme i.e. sentence compression is valuable for aspect based sentiment analysis. However, sentence compression becomes too complex and it’s quite diffiult to understand the useful information. Consequently, a CAMEL (Cross-collection Auto-Labeled MaxEnt-LDA) is proposed to find clear aspects with strong opinions. This model is a hybridization of maximum entropy and LDA which are unable to exploits the co-occurrence of topics to yield words with high probability predictions. In order to determine public opinions, social networks would be the best choice for experts. Tweets about iPhone 6 is considered for

opinion analysis. Additionally, feature specific polarities have been included. This work would performs well but it's considered most of tweets to be noun (neutral) and also used small amount of tweets for performance evaluation. Deep learning is an emerging research area which is much better than traditional machine learning algorithms. Proposed CNN (Convolutional Neural Network) to extract useful features from global information. The above solution is possible for large scale datasets. When the data size is small, deep learning algorithms don't perform well. Association Rule Mining (ARM) is a apriori based version technique which is widely used to determine the frequent terms. But frequent word generation using ARM is computationally expensive when use large amounts of data. Multi-class SupportVector Machine obtain impressive accuracy and F-score. TASC-t (Topic Adaptive Sentiment Classification with timeline) derived multi-classes using support vector machine. This classifier moves the problem of overfitting using regularization parameter and kernel parameter. However, the kernel model can quite sentive to overfitting the model selection criterions. To avoid the huge size of weakly labeled sentences, proposed weakly-supervised deep embedding model for analysing sentiments of the product reviews. Convolutional Neural Networks and LSTM (Long Short Term Memory) is presented in this paper. The drawback of this paper is it is difficult to load CNN feature vectors into LSTM.

1.1 Research Outline & Scope

The main aim and scope of this work is to increase the sentiment classification accuracy. Besides, we aim to evade the issues faced during sentiment analysis and mining opinions correctly for accurate recommendation.

1.2 Research Objectives

The significant objectives of the proposed work are listed as follows:

- To enhance the review comments in the dataset through preprocessing process. Here, four different processes are executed to improve the review comments. It helps to enhance classification accuracy.

- To mine most significant features from the pre-processed message to improve the further sentiment classification process.
- To reduce processing time during sentiment classification using features selection process.
- To increase the classification accuracy using an effective deep learning model thus increases the learning efficiency and faster processing. To reduce the recommendation providence time using ranking of the sentiment classified.

II. RESEARCH GAPS

There have been some of issues faced during the sentimental analysis in NLP that are discussed follows: noisy text in the sentimental analysis text such as stop words, more punctuation and more. Besides, review structure also induces many issues during processes that are semi structure adjectives, noun and so on. Huge set of diverse review comment also introduces difficulties during the classification. Various requirements of users induce issue during recommendation process. These issues reduce the classification and recommendation accuracy.

2.1 Common Problem Statement

Nowadays, recommendation system has attaining much interest among researchers. Its fully based on the sentiment analysis and opinion mining by means of NLP. Since, they don't considered sentiment ranked value, ratings and user given requirements to process the recommendation process. None of the works have ranked their classified sentiment and stored in separate database afore the recommendation process thus increases the time required provide recommendation to the users. In sentiment analysis, important feature extraction and capturing the order of words during classification are highly vital process. However, most of the works lack in extracting significant features such as slang, diminisher and more. Thus it affects the classification. Further, some of the works have utilized CNN for their sentiment classification; however it cannot able to capture the order of the words. As a result, classification result is very low. However, most of the works consider limited number of context parameters to provide recommendation to the user that affects the recommendation accuracy.

2.2 Problem Definition

Authors in [1] Genetic Algorithm (GA) based feature reduction technique is established through hybrid framework for sentiment analysis. Three main phases are performed for sentiment analysis that is data cleaning, preprocessing and analysis engine. In data cleaning phase, garbage removal, slang correction and stop word removal process are functioned. In preprocessing phase, tokenization, stemming, POS tagging process are performed. In analysis engine phase, feature extraction, feature reduction and classification process are performed. During feature extraction process, Bag of Words (BoW) features are extracted. From the BoW features, GA is proposed to reduce the selected features through fitness function evaluation. Finally, classification is performed using six classifier to classify tweets into positive, negative and neutral.

Problems

- BoW features only extracted in feature extraction phase that leads to reduce in accuracy of sentiment analysis.
- Genetic Algorithm (GA) is proposed to reduce features size this take more time to find optimal solution and chromosome with same fitness function will not have same probability of being selected. Hence, GA based feature reduction become complex for larger dataset.

Proposed Solutions

- We extract eight features such as hashtag, emotional, semantic, syntactic, unigram, negation, standardizing word and slang related feature from twitter dataset that increases accuracy effectually. In our work, Killer Whale Optimization algorithm is proposed to select the most relevant features from extracted features that perform fast.

Author proposes an ensemble classification [2] for twitter sentiment analysis. This work comprises of three major stages that are data preprocessing, feature extraction and classification. In data preprocessing, unwanted noises such as links, username, hashtags are removes and also it performs stemming, slang correction and stop word removal process. In feature extraction, BoW

features are extracted and classification is implemented. Four base classifiers are provided classified output from which aggregated final output is obtained.

Problems

- Diversity of base classifier is major problem in ensemble classifier, since more diverse the result of classifier only leads to high accuracy.
- BoW feature only extracted in feature extraction that tends to reduce accuracy of sentiment classification.

Proposed Solutions

- We propose LSTM algorithm to classify the sentiments in twitter data that comprises of five classes such as strongly positive, strongly negative, positive, negative and neutral.

In this paper [3], unsupervised method is presented for recognizing the aspect category for the online product reviews. Association Rule Mining (ARM) is applied for finding occurrence frequencies. E.g. 1. The food was very delicious 2. The food was very cheap price. For this example, frequency count obtained for food is 2 and the aspects are delicious and cheap price. In a way, aspect category is detected for product reviews.

Problems

- Mining frequent terms in a given sentence is computationally expensive for large datasets
- The term is frequent but invalid features are extracted correctly

Proposed Solutions

- Pyramid based Map Reduce Approach is proposed for finding occurrence frequency. This approach removes invalid features and feed valid features into classifier

In this paper [4], semi-supervised model named multiclass SVM is presented for topic-adaptive sentiment classification (TASC). This work focuses on minimize the structural burden of labelled data. The TASC algorithm is especially for data labelling and rating mechanism to obtain sentiment labels. Thus the feature vector content divided into two parts: topic-adaptive feature variables and fixed common feature values. Features including text and non-text features

are extracted and split into two views for training. Co-training framework is incorporated into the classifier for independent nature of two feature sets.

Problems

- Input tweets are classified into multiclass sentiments using support vector machine. Multiclass SVM model supports training and it is an advantage for co-training that are regularization parameter avoids the over-fitting problem, build expert knowledge to use kernel trick but the kernel model can be quite sensitive to over-fitting the model selection criterion since its covers only the determination parameters of the regularization and kernel parameters

Proposed Solutions

- Proposed LSTM algorithm is better in terms of training and testing for massive data sets
In [5] addresses the problem of minimize the lexicon footprint of a sentence that is number of words or characters in it. For this reason, authors proposed sentiment compression scheme for removing unnecessary words from the given sentence(s). And also it outperforms in removing unnecessary sentiment information for classifying sentiments. In order to prove the better performance, Chinese corpora was incorporated in to this paper.

Problems

- The resulting compression scheme becomes too complex and it's quick trick to understand and correctly apply the class sentiments
- Another major drawback is that it's not considered syntactic features (phrases, and clause)

Proposed Solutions

- Effective Framework where we applied preprocessing, feature extraction and selection. In preprocessing, phrase level tweet is replaced before the stemming process.

- Instead of using sentence compression technique, we process tweets in step-by-step manners. Thus, we get the accurate result in terms of accuracy, precision and recall

III. RESEARCH CONTRIBUTIONS

Proposed a new opinion mining framework by using NLP tasks which can leverage the vast amount of negative tweets for sentiment analysis. The framework comprised of four steps:

- **Data Collection and Preprocessing**
- **Feature Extraction**
- **Feature Selection**
- **Sentiment Classification**

Data Collection and Preprocessing

First this step tries to preprocess the given tweets. In cleaning step, remove URLs, remove tages (@user), remove irrelevant contents (???. Then start the tokenization, in this step, tokenize the tweets like (having, a great, chat,...), applied POS(Part of Speech)tagging (Noun, Verb, Adjective,..). Next is phrase removal, this step is necessary and must before stop words removal for analyzing the tweets. If the stop words are removed directly than the opinions of sentence changes and it becomes *positive* the opinion is **memory phone better**. But the actual meaning of this sentence is memory of the phone should be better. So that we added phrase removal, in this step **could have been removed** removed and replaced with “NOT”. Next, we go to the MORPHEMES. This step also necessary which overcomes the problem of stemming.

Assume that the word “Unbreakable”. When we use stemming here, the root word becomes “break” since it removes prefix (un) and suffix (able). Break is a Negative word but the actual opinion is “unbreak”. So that consider here MORPHEMES before applying the stemming process. In next, we apply FP (Frequent Pattern) mining using **Pyramid based MAPPING Algorithm**.

Feature Extraction

Feature extraction is an real technique where selecting a useful list of words as features and removing a huge number of words that do not contribute to the text's sentiment. This step helps to remove noise from the text by using FAST TEXT and achieve a more accurate sentiment for a tweet. List of features extracted to be mentioned below.

- Unigram, Bigram & N-Gram Features
- Emoticons Features
- Negations Features
- Position Features
- Elongated Features
- Morphemes Features

Feature selection

Feature selection is an important step in opinion mining since it reduces the number of features used to describe each term in a given dataset/sentences. Such reduction may occur by eliminating some of the redundant and invalid features and selecting a optimal set of features in the given tweet. In this research work, a optimal subset of the weighted features is thus selected as the best subset for subsequent classification of the tweets. Here, Killer Whale Optimization for feature selection method follows good optimization policy.

Sentiment Classification

Then, evaluate the proposed feature selection and weighting scheme on set of valid features by using Long Short Term Memory (LSTM) which is a deep learning model. In this step, the term classified into five classes: Strongly Positive (P_s), Strongly Negative (N_s), Positive (P), Negative (N_e) and Neutral (N). Finally, sum of sentimental score to be computed to analyse the final opinions (Positive or Negative or Neutral). *Each instane in the dataset (Mongo DB) has five fields:*

1. Tweet_Id (Tweet Id of the tweet)
2. Timestamp (The date of the tweet)
3. User_Id (The user who posted the tweet)

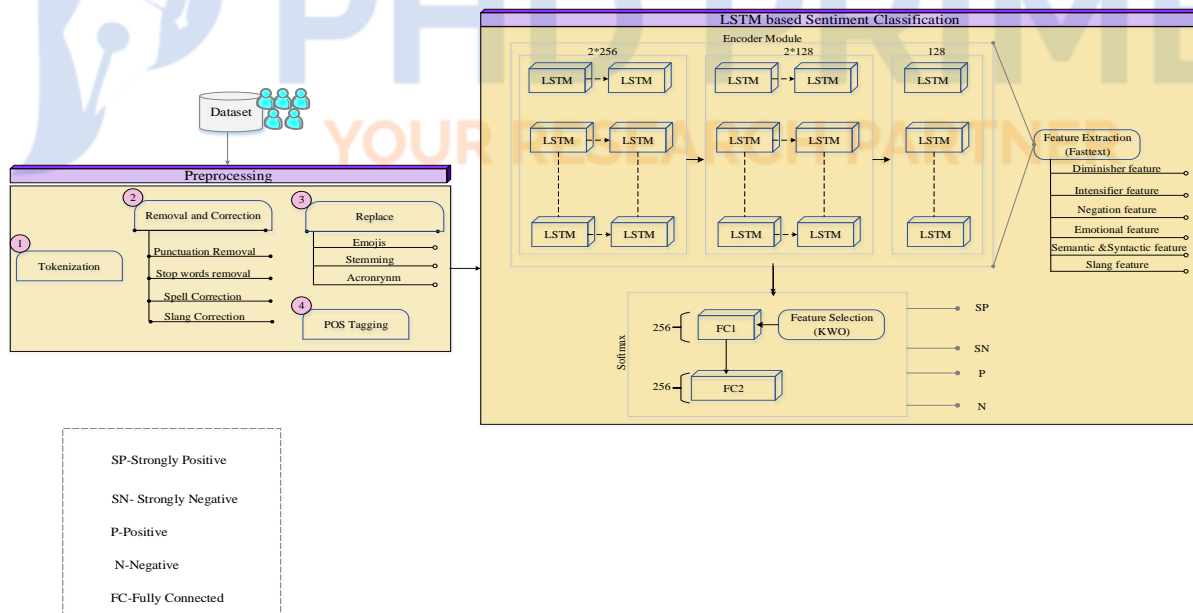
4. Tweet-Text(The text of tweet)
5. Geotag_ID (The location of the user)

Performance Evaluation

Our overall work implemented over Apache Spark framework, which is much faster than Hadoop framework. Finally, we evaluate the following results:

1. Accuracy vs. No of tweets
2. Precision vs. No of tweets
3. Recall vs. No of tweets
4. F-Score vs. No of tweets
5. Error Rate vs. No of tweets
6. Computational Time

SYSTEM ARCHITECTURE



IV. PREVIOUS WORKS & LIMITATIONS

Paper 1

Title - Twitter Sentiment Analysis with a Deep Neural Network: An Enhanced Approach using User Behavioral Information

Concept

This work proposes deep neural network framework to analysis the twitter sentiments. In this deep neural network is proposed to classify the twitter sentiment analysis. Deep learning network contains input as list of features and word embedding. Here, features extracted are number of question marks, number of words per tweet, number of exclamation marks and number of mentions and URLs. In this tweets are classified using softmax layer that are positive, negative and neutral.

Paper 2

Title - Preprocessing of Twitter's Data for Opinion Mining in Political Context

Concept

In this paper, authors discussed about preprocessing in twitter's data which is about political context. This step also includes extracting customer feedback, POS tagging, extract polarity from all the features, and determining the polarity feature wise. The selected dataset in this paper is to political context which is transformed into more structured data. After the data pre-processing process, data will be stored in the database. Finally, parsing the whole text (preprocessed data) feed in to the classifier.

Paper 3

Title - Sentiment Analysis: Measuring Opinions

Concept

In this paper, authors concerned with the opinion or mood of subjective elements within a tweet and also studied various methods used for classification. Two-step method is proposed to classifying sentiments include lexical and machine learning approaches. Lexical approach is refers to dictionary where they stored the lexicons with corresponding polarity values. To

calculate polarity of a term, polarity score of each term is presented in the dictionary. At the end, the overall polarity score is computed. In machine learning approach, set of feature vectors are extracted. Mostly, different varieties of unigrams or n-grams are chosen as feature vectors and a collection of features are helpful to the success rate of the classification. This approach is not efficient since it uses dictionary which contains limited number of positive and negative tweets

Paper 4

Title - Deep Learning for Aspect based Sentiment Analysis

Concept

Finding aspects (i.e. features) mentioned in a sentence is called aspect based sentiment analysis. SemEval 2014 dataset is focuses on polarity prediction (positive or negative) of a given sentence. Among the more NLP models, deep learning is applied to solve this task. This model is used to extract aspects and associated aspects with the corresponding sentiments.

Paper 5

Title - A Rule Induction Framework for Twitter Sentiment Analysis

Concept

This paper proposes rule induction framework for twitter sentiment analysis. In this contains three major stages that are noise reduction, feature selection, rule induction framework and sentiment classification. In noise reduction phase, tweeter cleansing, slang filtering, tokenization, spelling correction, emotion filtering and negation handling. In feature selection, subjectivity detection and sentiment scoring. In rule induction framework rough set theory is proposed along with rule induction algorithm. Finally in sentiment classification phase, tweets are classified.

Paper 6

Title - Aspect Extraction in Sentiment Analysis: Comparative Analysis and Survey

Concept

In this paper, authors have reviewed about aspect extraction and also conducted comprehensive review among different aspect based sentiment analysis approaches. This paper gives an in depth view of the aspect based approaches such as supervised, unsupervised and semi-supervised. The analysis and measures help us to further explore the aspect extraction since semi-supervised approaches are not well-performed for some datasets so there is a need to identify and focus on the solution.

Paper 7

Title - Twitter Sentiment Analysis using Hybrid Cuckoo Search Method

Concept

This paper proposed a hybrid method based on Cuckoo Search and K-means method (CSK). This method has used to determine the optimum cluster-heads from the sentimental data of twitter dataset and it covers the input tweets into three phases: pre-processing, feature extraction and hybrid clustering. In pre-processing, the raw tweets collected from Twitter and unwanted and noisy words are removed. In feature extraction, tweets are converted into feature vectors which are computed by the following set of features: total characteristics, positive emotions, negative emotions, neutral emotions, positive exclamation, negative exclamation, negation, positive words, negative words, natural words and intense words. And in last phase further analysis has been done.

Limitations

- In this paper, cluster head elected by K-means clustering algorithm. The disadvantage of the k-means clustering is that the selection of cluster centroid

Paper 8

Title - Sentiment Analysis on Tweets about Diabetes: An Aspect-Level Approach

Concept

This work proposes aspect level approach to classify the sentiment in tweet about diabetes. In this four process are executed that are data collection, preprocessing, semantic annotation and sentiment classification. Preprocessing perform stop words removal, normalization, sentence splitter, lemmatization, tokenization and POS tagging. In semantic annotation process, aspects are identified using N gram features. Finally sentiments are classified using sentiwordnet scores that are positive, negative and neutral.

Paper 9

Title - A Pattern based Approach for Multi-Class Sentiment Analysis in Twitter

Concept

In this paper, sentiment analysis is presented in social networks and microblogging. Authors propose a research towards the binary classification (positive and negative) and ternary classification (positive, negative and neutral) for automatic sentiment analysis. Tweet patterns classified into 7 different classes which are done by extracting optimal set of features (sentiment-related features, punctuation features, syntactic and stylistic features, semantic features, unigram features, top words, and pattern-related features). In addition to this seven different classes are classified in this section: fun, happiness, love, neutral, anger, hate, and sadness.

Limitations

- The proposed approach obtained 60.2% of accuracy. However, achieve high accuracy level remains a challenging task.

Paper 10

Title - Complementary Aspect based Opinion Mining

Concept

This paper presented a novel technique called CAMEL for aspect based opinion mining. CAMEL (Cross-collection Auto-Labeled MaxEnt-LDA) is an auto-labelling scheme which helps to discriminate between opinion words and aspect and also enhanced by adding word embedding

based similarity as a new feature. The proposed is based on coupled dirichlet processes. This method is further enhanced by automatic labeling scheme (maximum entropy model). Aspect Opinion Coherence is measured to evaluate the quality of an opinion.

Limitations

- Mixture models (Maximum Entropy with LDA) are unable to exploit the co-occurrence of topics which yields high probability predictions for words that are sharper than the distributions predicted by the individual topics

Paper 11

Title - Localized Twitter Opinion Mining using Sentiment Analysis

Concept

In this paper, authors discussed a methodology which allows interpretation and utilization of twitter data which determine public opinions. Here authors considered iPhone 6 twitter dataset to specific popularities and male-female specific feature polarities have been included. Data preprocessing was performed to filter out the useless data which is removed by the open source natural language processing tool (SNLP Group).

Limitations

- The proposed method is suitable when use small number of tweets
- Most of the user's tweets return zero score since this considered each tweet to be "Noun (Neutral)" so that it is not efficient

Paper 12

Title - Sentiment Analysis of Twitter Data: A Survey of Techniques

Concept

In this paper, lot of existing works of sentiment analysis is presented which is analysing the field of twitter data. Machine learning and lexicon based approaches become a prominent

technique for opinion mining. Various machine learning algorithms such as Max Entropy, Naïve Bayes, and Support Vector Machine are helpful to extract opinions from the twitter data. There are some applications in the field of sentiment analysis: reviews from websites (products), feedbacks from political issues, recommender systems, business intelligence, domains, and smart homes.

Paper 13

Title - A Survey on Opinion Mining and Sentiment Analysis: Tasks, Approaches and Applications

Concept

This presented a comprehensive review of sentiment analysis and opinion mining tasks which states the views of public news and reviews of products. For that reason, authors presented a survey which covers nearly one hundred articles published over the last decade. These articles based on the granularity of sentiment analysis that is level of analysis: document level, word level, aspect level, sentence level, concept level, phrase level, link based, clause level, and sentence level. In order to extract opinions from the text, several mining tasks (data acquisition and data pre-processing) are invoked in this research, which are briefly presented in this paper.

Paper 14

Title - Are They Different? Affect, Feeling, Emotion, sentiment and Opinion Detection in Text

Concept

In this paper, authors presented the brief description about the different automatic detection of terms in the text that are affect, sentiment, emotion, opinion, and feeling. Due to the inconsistency problem, these problems are difficult to understand which is based on the synonyms of the words (lexicon based or corpus based). Opinions play a significant role in natural language processing (NLP) and it is refers to personal interpretation. Particularly, opinions cover the following terms: topic, opinion holder, claim, fact/synonyms, feature, sentiment/emotion and time.

Paper 15

Title - Detecting Events in online social networks: Definitions, Trends, and challenges

Concept

In this paper, multiple social media sources like Flickr, YouTube and Twitter. Over the few decade, social media attracted many research scholars but it is challenging including processing of large volumes of data and high levels of noise is generated from social data. The data analysis applications is impressive since it can be used in sentiment analysis where we analyse user opinions to extract the expresses emotion which refers to products, public news, services or even political news.

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