Sentiment Detection

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I. Introduction

Sentiment detection, is a special niche of text classification, that emerged as a new research area at the beginning of the 2000s due to the enormous increase of subjective texts in the social media, forums, and blog [1]. Sentiment detection is also commonly referred to as sentiment analysis, opinion mining, review mining, subjectivity extraction, and opinion extraction [2]. In this paper, we will continue referring to it as sentiment detection. The applications of sentiment detection are growing with the times, it has been applied for mental illness detection [3], sarcasm detection [4], movie review sentiment detection, etc.

Social media platforms contain a wealth of free, readily available data that can be gathered, analyzed and used to measure the public's perception of a company, the services it provides, or the products it produces. Twitter, is one such platform, that has become one of the biggest social media platforms. As of last year, Twitter had approximately 300 million active users per month. Millions of tweets are sent a day. It stands to reason that a large amount of data is generated by Twitter users. Among the daily tweets, are subjective reviews of companies, products, movies, and commentary on political issues. This generated data is used by companies and researchers for multiple sentiment detection problems. Companies require feedback from their customers to remain relevant and competitive. However, manually going through reviews or conducting focus groups can be rather cumbersome and costly. With this in mind, companies can use Twitter's publicly available *application programming interface* (API) to gather tweets about a company, the services it provides or products it produces and from those tweets analyze the general feeling of its customers towards them, their services, or the product. Large companies like Amazon and Dell are already leveraging this data to evaluate how their customers react to their service [5]. On the other hand, most of the research being done in the field is comparison research, where the performance of different machine learning techniques is compared. Also, much focus is being put on varying pre-processing and feature extraction and feature selection techniques to achieve different results.

The main contributions of this research paper are outlined as follows:

- We propose some of the machine learning techniques that have been found to perform exceptionally well in data science competitions such as *extreme gradient boosting* XGBoost and *residual (neural) network* ResNet. The performance of these techniques will be compared to the classical methods used for sentiment analysis which will be used as a baseline.
- Our training data set is the *Stanford Twitter Corpus* (STS) [6].
- In addition to more commonly used feature extraction methods we suggest the use of the *extreme learning model* (ELM).
- Finally, we will examine the effect of feature selection on performance using *information gain* (IG) and *principal component analysis* (PCA).

The rest of the paper will contain a literature review in Section 2. Other sections will include the implementation, discussion and results, and conclusions and future work.

II. Literature Review

This section will give a brief summary of the research that is currently being undertaken in the field of sentiment detection.

One research attempted to remedy the problem of making recommendations to new users in recommender systems for e-commerce websites. The authors, used naive bayes and a *support vector machine* (SVM), coupled with *term frequency-inverse document frequency* (TF-IDF) to perform sentiment analysis using the social media data that a new user of an e-commerce website volunteers to give to the system for the generation of product recommendations [7]. In their future work, they proposed using deep learning techniques to classify product categories and sentiment.

Zheng et al [8], focused on the feature extraction techniques that can be utilized in sentiment detection. The paper mainly focused on Chinese online reviews and used only a SVM to test the different techniques. For feature extraction N-Part-of-Speech-grams, TF-IDF. In the end, TF-IDF outperformed the different combinations of N-PoS-grams.

Jiaqiang and Xialoin (2017), observed that much focus is put on feature extraction in the field. In contrast, they studied the effects of pre-processing tweets by removing links, expanding acronyms and removing stop words just to mention a few. Their implementation used random forest, SVM, logistic regression and naive bayes to perform sentiment detection. For feature extraction they used N-grams and prior polarity. They

observed that the random forest and SVM algorithms are more sensitive to the different pre-processing techniques) [9].

On the other hand, the performance of different machine learning techniques was evaluated when applying feature selection using IG. They proposed that a *majority voting ensemble* (MVE) comprised of a SVM, linear regression, and naive bayes algorithm. The results showed that using IG for feature selection improves performance and that the MVE outperformed the individual algorithms [10].

Likewise, Zainuddin et al, emphasized the importance of feature selection in their implementation of a hybrid sentiment classification for Twitter [11]. The research presented a comparison of the different feature selection methods. These methods included the *principal component analysis* (PCA), *latent semantic analysis* (LSA), and *random projection* (RP). Thier implementation used only a SVM for sentiment detection. In the end, the PCA yielded the best results.

Lauren et al, expanded on their previous work where they proposed an ELM for word embeddings. In the aforementioned paper, they applied their previously designed ELM-based word embedding for sentiment detection and sequence labeling. Their implementation achieved better results than the standard word2vec word embedding and *global vectors* (GloVec) model in both sentiment detection and sequence labelling.

Furthermore, deep learning techniques that have been previously used in text classification tasks were compared to a SVM in sentiment detection for Arabic hotel reviews. In this study, the Arabic Natural Language Processing was used for pre-processing and N-grams, *parts-of-speech* tagging and word embeddings were used for feature extraction. The SVM outperformed the different deep learning techniques [12].

Similarly, in another study, a deep *convolutional neural network* (CNN) was used in an ensemble algorithm to achieve better results. The study compared the proposed (ensemble) model with other variations of a CNN and found that the proposed model achieved better results than some CNNs but not all of them. In this application, global vectors, the word2vec model, TF-IDF, and bag-of-words were used for feature extraction [13].

Given the above, it is quite evident that many of the studies conducted are comparative in nature. In the same way, our research will be comparison of different feature extraction methods; similar to Zheng et al, TF-IDF will be used for extraction. However, as opposed to Zheng et al, the TF-IDF will be compared against the word2vec and ELM word embeddings. Moreover, for feature selection, Zainuddin et al and data science competitions have proven the utility of PCA as a feature selection method. Therefore, the PCA method will be compared to IG. Furthermore, most of the papers surveyed were not using any deep learning techniques or suggested implementing deep learning approaches in their future work. Thus, in this paper we propose a ResNet as our deep learning approach which has not been used in the surveyed literature. Finally, in addition to the ResNet, we propose using the XGBoost algorithm. Both of these techniques will be compared against the standard machine learning techniques used in sentiment detection such as SVM and naive bayes.

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