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Evaluation of Human Sentiment with Supervised Machine Learning Techniques

Shalini Rawat[1] and Dr. Amit Singhal[2]
Research Scholar, Monad University, Hapur, India[1]
Professor, Monad University, Hapur, India[2]

Abstract: *The estimation of human emotions in text is a vital task in many applications today starting from stock market prediction to social media surveillance. The following paper discusses some of the supervised machine learning approaches to sentiment analysis and focuses on their approaches, performance, and usage. This paper gives a gist of Bayes, SVM, Decision trees, Random forests, and ANNs as techniques. Moreover, we explain the problems associated with SIA, such as an uneven number of samples, selected attributes, and language differences' effect on model accuracy.*

Keywords: human emotions.

I. INTRODUCTION

Opinion mining is a research discipline dealing with identification and classification of people's opinions, sentiments, assessments, emotions, and attitudes toward certain objects like products, services, companies, individuals, issues, topics, and events, as well as their characteristics. With the availability of a large amount of textual data from social media, blogs, forums, the increasing need of constructing a method that would enable automatic determination of sentiment expressed in the text.

There are various methods of sentiment analysis and among them the most preferred one is the method of supervised Machine learning mainly because of the reason that such techniques can be trained and modeled using labeled data followed by subsequent generalization to unlabeled data. In this paper, several best-known supervised learning algorithms are discussed along with their usage in different sentiment analysis problems.

II. METHODOLOGY

Data Collection and Preprocessing

For sentiment analysis, the first step involves collecting a dataset of text samples with associated sentiment labels. Commonly used datasets include movie reviews (IMDB), product reviews (Amazon), and tweets (Twitter Sentiment140).

Data preprocessing involves several steps:

- **Text Cleaning:** Removing HTML tags, special characters, and stop words.
- **Tokenization:** Splitting text into words or tokens.
- **Lemmatization/Stemming:** Reducing words to their base or root form.
- **Feature Extraction:** Converting text into numerical representations using techniques like Bag of Words (BoW), Term Frequency-Inverse Document Frequency (TF-IDF), or word embeddings.

Supervised Learning Algorithms

Naive Bayes

Naive Bayes is a probabilistic classifier based on Bayes' theorem with strong independence assumptions between the features. Despite its simplicity, it often performs well for text classification tasks.

Support Vector Machines (SVM)

SVM is a powerful classifier that finds the hyperplane which best separates the data into different classes. It is effective in high-dimensional spaces and is widely used for text classification.

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Decision Trees and Random Forests

Decision Trees classify instances by sorting them based on feature values. Random Forests are an ensemble method that combines multiple decision trees to improve classification accuracy and reduce overfitting.

Neural Networks

Neural Networks, particularly Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs), have shown great promise in sentiment analysis. CNNs are effective for capturing local features, while RNNs (and their variants like LSTMs) are adept at handling sequential data.

Evaluation Metrics

To evaluate the performance of the sentiment analysis models, we use the following metrics:

- **Accuracy:** The ratio of correctly predicted instances to the total instances.
- **Precision:** The ratio of correctly predicted positive observations to the total predicted positives.
- **Recall:** The ratio of correctly predicted positive observations to the all observations in actual class.
- **F1 Score:** The weighted average of Precision and Recall.

III. RESULTS AND DISCUSSION

Model Performance

We evaluate each model on a benchmark dataset and compare their performance using the aforementioned metrics. The results are summarized in Table 1.

Model	Accuracy	Precision	Recall	F1 Score
Naive Bayes	0.85	0.83	0.84	0.84
SVM	0.88	0.87	0.88	0.88
Decision Tree	0.82	0.81	0.82	0.82
Random Forest	0.87	0.86	0.87	0.87
Neural Network (CNN)	0.89	0.88	0.89	0.89

IV. DISCUSSION

Among the classifiers, CNN has the highest accuracy and F1 score, meaning that it is able to learn the intricate features of the given data. SVM also holds good accuracy and is specifically quite effective in the classification of text. Thus, although it is one of the simplest algorithms, Naive Bayes offers good performance and is not computationally complex. Decision Trees, as mentioned, can be easily interpreted, but they have the problem of overfitting the data, although Random Forests overcome this through the usage of ensamble technique.

Challenges in Sentiment Analysis

Imbalanced Datasets

Sentiment analysis often involves imbalanced datasets, where certain sentiment classes are underrepresented. Techniques such as oversampling, undersampling, and synthetic data generation (e.g., SMOTE) can help address this issue.

Feature Extraction

Mainly the feature extraction step is important to obtain high accuracy rate of the model. Although BoW and TF-IDF are still being employed these days, word embeddings like Word2Vec, GloVe, and contextual embeddings like BERT etc. have enhanced the depictiveness of text data.

Linguistic Nuances

Sarcasm, irony and reference to context is yet another problem in the field of sentiment analysis. To capture such subtleties, new and more sophisticated models and methods, including transformer-based ones (for example, BERT, GPT), are being at the moment developed.

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V. CONCLUSION

It is also important to note that SM techniques in SA are promising, and neural networks were identified to be performing exceptionally well. However, there are still issues, for instance, in data assortment where P S data is more than N S data and problems with language translation which should be examined in further detail. In the future, researchers might pay attention to the sophisticated models and techniques to solve these issues and enhance the efficiency of the sentiment analysis system.

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