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Sarcasm is a multifaceted linguistic phenomena characterized by the deliberate expression of ideas that are contrary to one's intended meaning, typically employed as a method of derision or mockery against a person or object. Sarcasm is a prevalent style of communication observed on various online platforms, including social media and e-commerce websites, where individuals engage in the expression of their viewpoints and feelings. Nevertheless, the utilization of sarcasm might present difficulties for natural language processing (NLP) systems, specifically in the context of emotion analysis and opinion mining. These applications heavily depend on accurately comprehending the genuine intent and polarity of the textual content. Hence, the identification of sarcasm is a significant undertaking that seeks to discern and differentiate between utterances that are sardonic and those that are not.

This work presents a novel approach to sarcasm identification via deep learning and BERT models, wherein the authors introduce a context-based feature strategy. The authors suggest that the effectiveness of sarcasm is intricately linked to various contextual factors, including the speaker's identity, the audience's composition, the subject matter at hand, and the overall situational context. Consequently, word embedding and BERT characteristics are employed to capture the semantic and contextual information of the text. In addition, feature fusion is employed to integrate BERT characteristics with other linguistic and sentiment-related information, including hashtags, syntactic patterns, and polarity shifts. The strategy employed by the authors is assessed on three benchmark datasets sourced from Twitter and the Internet Argument Corpus. Furthermore, a comparison is conducted between the proposed technique and various baseline methodologies. The findings indicate that the employed methodology attains a notable level of precision and surpasses the performance of currently available approaches in the domain of sarcasm identification. The authors additionally address the constraints and potential avenues for future research in their study.

**Motivation:**

The primary objective of this study is to introduce an innovative approach for detecting sarcasm in written text by using context-based information and employing deep learning models. This paper aims to examine and address the issues and research gaps that have been identified in the current body of literature.

The absence of contextual information inside sarcastic statements poses a challenge in accurately interpreting the intended meaning and sentiment polarity of the speaker or writer.

The user's text does not provide any information to be rewritten in an academic manner. One potential drawback of word embedding techniques that disregard the sentiment polarity of words within sarcastic expressions is the potential impact on the effectiveness of sarcasm detection models.

The user's text does not provide any information to be rewritten. One of the primary challenges in the field of sarcasm detection pertains to the limited availability of public datasets and evaluation criteria, particularly in the context of multilingual and multimodal data.

The objective of this study is to address these obstacles by:

The aim of this study is to propose a novel approach for analyzing sarcastic expressions by incorporating both local and global context information. This is achieved through the utilization of GloVe embedding and BERT model.

The user's text lacks academic language and structure. This study aims to evaluate and compare the performance of three distinct learning models. The first model is a deep learning model that utilizes a Bidirectional Long Short-Term Memory (Bi-LSTM) architecture. The second model is a transformer model that is built upon the Bidirectional Encoder Representations from Transformers (BERT) framework. Lastly, the third model is a feature fusion model that integrates several features, including BERT features, sentiment-related features, syntactic features, and GloVe embedding features, with conventional machine learning techniques.

The user's text does not provide any information to rewrite in an academic manner. The proposed technique will be assessed on three benchmark datasets, including two datasets from Twitter and one dataset from the Internet Argument Corpus. The evaluation will be conducted using a range of measures, including precision, recall, accuracy, and f-measure.

**Contribution :**

This study presents several significant contributions to the domain of sarcasm recognition in the science of natural language processing.

The proposed approach suggests a methodology that utilizes deep learning and BERT models to effectively extract contextual information and sentiment polarity inside sarcastic phrases. This strategy effectively mitigates the constraints inherent in prior methodologies that exclusively relied on content or pattern-based features.

This study presents a novel approach to feature fusion, which integrates BERT features, sentiment-related features, syntactic characteristics, and GloVe embedding features using traditional machine learning algorithms. This approach improves the efficacy of sarcasm categorization by leveraging numerous sources of information.

The suggested technique is assessed on three benchmark datasets sourced from Twitter and the Internet Argument Corpus, version two (IAC-v2). The findings demonstrate that the suggested methodology surpasses the conventional approaches and attains notable levels of precision and F-measure scores in the task of sarcasm recognition.

**Methodology:**

In this paper, we propose a context-based feature technique for sarcasm identification using deep learning and BERT model. We use two Twitter datasets and one Internet Argument Corpus dataset as our data sources. We perform the following steps to implement our technique:

* Data preprocessing: We apply tokenization, stop word removal, punctuation removal, lower case conversion, and other basic preprocessing methods to clean the text data and prepare it for feature extraction.
* Feature extraction: We extract different types of features from the text data, such as:
  + GloVe embedding: We use pre-trained GloVe vectors to represent the words in the text as dense vectors that capture semantic and syntactic information. GloVe embedding combines global and local context information of words in a corpus.
  + BERT feature: We use pre-trained BERT model to encode the text as contextualized vectors that capture the meaning of words in relation to their surrounding words. BERT feature is based on the transformer architecture that uses attention mechanism to learn the dependencies between words.
  + Sentiment related feature: We use a lexicon-based approach to extract the sentiment polarity and intensity of words in the text. We use SentiWordNet as our sentiment lexicon, which assigns positive, negative, and objective scores to each word sense in WordNet .
  + Syntactic feature: We use part-of-speech (POS) tags and dependency relations to extract the syntactic structure and function of words in the text. We use the NLTK toolkit to perform POS tagging and the spaCy library to perform dependency parsing.
  + Hashtag feature: We use hashtags as indicators of the topic and emotion of the text. We extract the hashtags from the text and assign them positive or negative labels based on a predefined list of sentiment hashtags .
* Classification: We use three different models to perform sarcasm classification on the extracted features:
  + Deep learning model: We use a bidirectional long short-term memory (Bi-LSTM) network, a variant of recurrent neural network, to learn the sequential and contextual information of the text. We feed the GloVe embedding features as input to the Bi-LSTM network and use a softmax layer as the output layer for binary classification.
  + Transformer model: We use a pre-trained BERT model as a fine-tuned classifier for sarcasm identification. We feed the BERT features as input to the BERT model and use a linear layer as the output layer for binary classification.
  + Feature fusion model: We use a combination of BERT feature, sentiment related feature, syntactic feature, and hashtag feature as input to a conventional machine learning classifier, such as logistic regression, support vector machine, or random forest. We use the scikit-learn library to implement the feature fusion model.
* Evaluation: We use four evaluation metrics to measure the performance of our models: accuracy, precision, recall, and F1-score. We use 10-fold cross-validation to split the data into training and testing sets. We compare our models with the baseline methods and report the results.

**Conclusion:**

This research study introduces an innovative approach for detecting sarcasm in textual data by utilizing context-based variables and employing several learning models. The primary focal points of the research article encompass:

The study suggests employing GloVe embedding, BERT embedding, sentiment-related features, syntactic features, and hashtag characteristics as contextual indicators to capture the contextual information and sentiment polarity in sarcastic statements. The aforementioned characteristics are derived from the textual content and combined to create a feature vector that is subsequently utilized for classification purposes.

The study utilizes three learning models to categorize text as either sardonic or non-sarcastic. These models include a deep learning model that utilizes Bidirectional Long Short-Term Memory (Bi-LSTM), a transformer model that relies on BERT, and a feature fusion model that is based on traditional machine learning methods. This study examines the performance of the aforementioned models on three benchmark datasets, specifically two datasets derived from Twitter and one dataset obtained from the Internet Argument Corpus.

The study presents the outcomes of multiple experiments conducted to assess the efficacy of the proposed methodology. The study demonstrates that the feature fusion model has superior performance compared to the other models across all datasets. Specifically, it achieves the highest precision rates of 98.5%, 98.0%, and 81.2% on the Twitter and IAC-v2 datasets, respectively. Additionally, the study demonstrates that the inclusion of context-based characteristics enhances the accuracy of classification and mitigates the occurrence of false positives.This study presents several contributions to the domain of sarcasm identification. These include the introduction of a novel technique for context-based feature extraction, the integration of BERT feature and word embedding with linguistic and sentiment-related features, and the demonstration of the significance of context and sentiment polarity in the identification of sarcastic utterances. The research additionally examines the potential consequences of the suggested technique across a range of applications, including sentiment analysis, opinion mining, and natural language understanding.

**First Limitation:**This study does not take into account the role that pragmatic characteristics have in identifying sarcasm, which could be considered one of its limitations. Pragmatic aspects are those that pertain to the aim of the speaker, the context of the speech, and the common knowledge held by the interlocutors in the conversation. For instance, the use of irony, exaggeration, rhetorical questions, or contrastive indicators can sometimes be interpreted as sarcasm in certain contexts. However, the research mainly focuses on content-based, sentiment-related, and grammatical aspects, therefore it is possible that it may not capture the complexities and nuances of sarcastic phrases. As a result, the paper can overlook some significant hints that can assist in differentiating sarcastic speech from literal speech. Incorporating pragmatic characteristics into the feature fusion technique and evaluating their efficacy in comparison to that of the features already present is one approach that might be taken to circumvent this issue.

**Second Limitation**: One of the limitations of this paper is that it relies more on the words’ patterns in the expression, which are not sufficient in capturing all the sarcastic sentiments. Here are some details about this limitation:

* The paper uses a pattern-based method for sarcasm classification on tweets, which involves grouping words into two categories: content indicators (CI) and grammatical function indicators (GFI). CI words are those that convey the main message or sentiment of the tweet, while GFI words are those that modify or qualify the CI words.
* The paper assumes that sarcastic tweets have a higher proportion of GFI words than non-sarcastic tweets, and that GFI words tend to have a negative polarity or contrast with the CI words. Based on these assumptions, the paper defines a set of rules to identify sarcasm patterns in tweets.
* However, this method has some drawbacks, such as:
  + It may not capture the subtlety and complexity of sarcasm, which can be expressed through various linguistic devices, such as irony, hyperbole, understatement, rhetorical questions, etc. These devices may not follow the simple pattern of GFI words modifying CI words, but rather create a discrepancy between the literal and intended meaning of the tweet.
  + It may not account for the context and pragmatics of sarcasm, which can be influenced by the speaker’s intention, the listener’s expectation, the topic, the situation, the tone, the mood, the culture, etc. These factors may affect how sarcasm is perceived and interpreted by different audiences, and may not be reflected by the word patterns alone.
  + It may not generalize well to other domains or languages, which may have different ways of expressing sarcasm or different conventions of using GFI words. For example, some languages may use different word orders, inflections, or particles to indicate sarcasm, which may not be captured by the pattern-based method.

**Synthesis:**   
  
The ideas in the paper have several potential applications and future scopes:

* **Sentiment Analysis**: The proposed technique can be used to improve the accuracy of sentiment analysis tools, which often struggle with detecting sarcasm. By accurately identifying sarcastic comments, these tools can provide more accurate sentiment scores.
* **Social Media Monitoring**: Companies often monitor social media platforms to understand public sentiment about their products or services. The technique proposed in this paper could help identify sarcastic comments that might otherwise be misinterpreted as positive feedback.
* **Customer Service**: In text-based customer service, understanding the sentiment of the customer is crucial. This technique could help customer service agents identify when a customer is being sarcastic, allowing for more effective communication.
* **Online Moderation**: For platforms that rely on user-generated content, moderating comments can be a significant challenge. Identifying sarcasm can help in understanding the context and sentiment of comments, aiding in effective moderation.
* **Market Research**: When conducting market research, companies often analyze customer reviews and feedback. The ability to detect sarcasm can provide a more accurate understanding of customer opinions.

As for future scopes, the paper suggests exploring more contextual features, incorporating multimodal data, applying transfer learning, and developing explainable models. These directions could further improve the performance of sarcasm identification and extend its applicability to other domains or languages. For example, incorporating multimodal data could help detect sarcasm in audio or video content, while developing explainable models could help understand why certain comments are classified as sarcastic. These advancements could contribute to the fields of natural language processing, artificial intelligence, and human-computer interaction.