Proportional Review On Sentiment Analytics By Using CNN, LSTM And RNN Deep Learning Models

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ABSTRACT

Machine learning algorithms analyse textual data's emotional tone in sentiment analysis, a growing area. Deep learning models like CNN, LSTM, and RNN can detect and display complex data associations, making them popular among machine learning algorithms. This study evaluates deep learning models for sentiment analysis.The review examined many research papers to determine each model's pros and cons. The task's requirements, such as text length, computing effectiveness, and linguistic qualities, determine the model used. CNN models worked well for tweets, whereas LSTM models were better for movie reviews. When computing efficiency was important, Recurrent Neural Network (RNN) models were feasible.

Training data amount and quality substantially affected model performance. Tokenization, stemming, and stop-word removal improve input data and model performance. Word embeddings like word2vec and GloVe improve models.Deep learning models aren't perfect. These models' opacity makes it hard to understand their decision-making process and the factors that influence their predictions. Deep learning algorithms can struggle with figurative language like sarcasm and irony.This review article evaluates CNN, LSTM, and RNN deep learning models for sentiment analysis. Scholars and professionals may choose the best model for their tasks by understanding the pros and downsides of each model. The review suggests ways to overcome deep learning model sentiment analysis challenges.

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I. INTRODUCTION

The field of natural language processing has extensively studied sentiment analysis, which seeks to identify and extract the underlying sentiment from textual data. The increasing proliferation of social media platforms has underscored the significance of precise and effective sentiment analysis. The application of deep learning models, specifically Convolutional Neural Networks (CNN), Long Short-Term Memory (LSTM), and Recurrent Neural Networks (RNN), has exhibited encouraging outcomes in the domain of sentiment analysis. This review paper aims to examine and evaluate a range of research studies that have utilised deep learning models in the context of sentiment analysis.

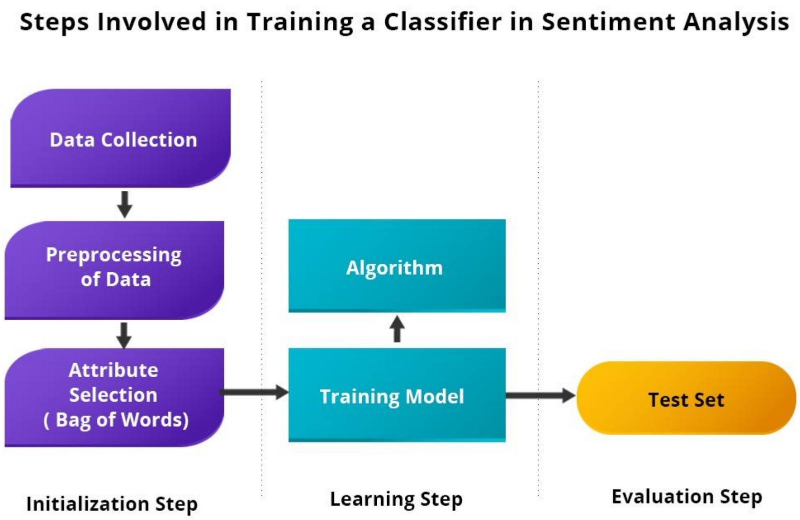

Fig 1: Steps Involved in Sentiment Analysis

Convolutional Neural Networks (CNNs) have gained significant popularity in the field of computer vision. However, their potential has also been explored in the domain of sentiment analysis, yielding promising outcomes. Convolutional neural networks (CNNs) acquire regional characteristics through the process of sliding a window with a predetermined size across the text during sentiment analysis [1]. Below is a model that uses CNN for twitter sentiment analysis.

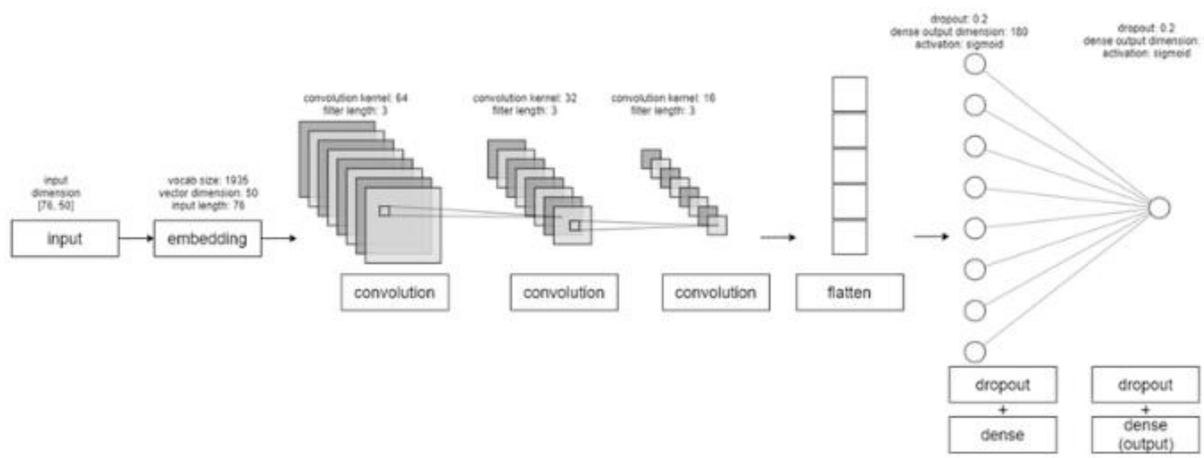

Fig 2: Sentiment analysis flow by CNN model

The Long Short-Term Memory (LSTM) is a recurrent neural network (RNN) model that exhibits the ability to capture prolonged dependencies in sequential data. LSTM models are a viable option for capturing the sentiment of a given document or sentence within the context of sentiment analysis. Long Short-Term Memory (LSTM) models are composed of fundamental components, including a memory cell, an input gate, an output gate, and a forget gate. The function of the memory cell is to retain data, whereas the gates regulate the ingress and egress of information from the cell. The Long Short-Term Memory (LSTM) model sequentially analyses the input sequence, processing each word individually. The resulting output of each word is then utilised to modify the state of the memory cell through feedback into the model. The sentiment score prediction relies on the utilisation of the memory cell's ultimate state. Several research studies have utilised LSTM models in the context of sentiment analysis and have attained exceptional outcomes. Long Short-Term Memory (LSTM) models are particularly advantageous in the context of lengthy textual data, such as movie reviews. This is due to their ability to capture long-term dependencies, which can substantially enhance the precision of sentiment analysis.

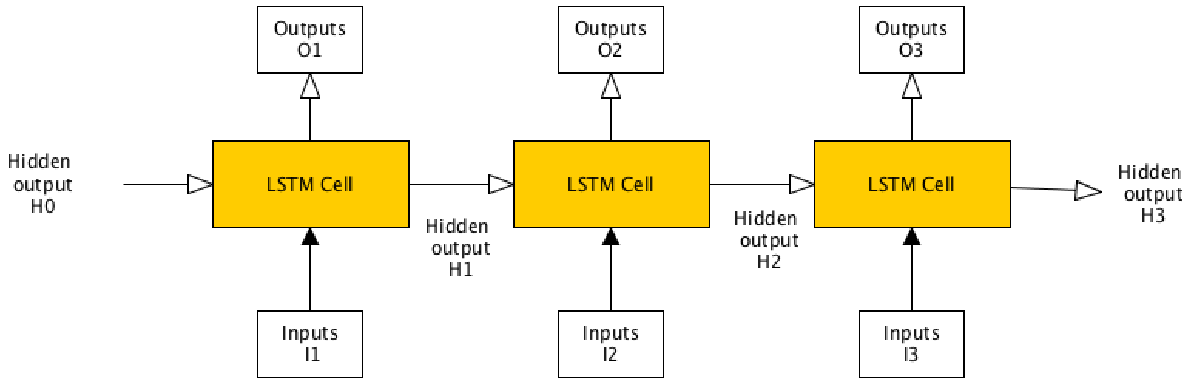

Fig3: LSTM based sentiment analysis

Recurrent Neural Networks (RNNs) are a type of neural network that possess the ability to capture sequential dependencies. Recurrent Neural Networks (RNNs) have the capability to capture the sentiment of a complete document or sentence in the field of sentiment analysis. The Recurrent Neural Network (RNN) model sequentially analyses the input sequence, processing each word individually while retaining a hidden state that encapsulates the contextual information of the preceding words. The ultimate latent state is utilised for forecasting the sentiment rating. Recurrent Neural Networks (RNNs) are known to encounter the vanishing gradient problem, thereby restricting their potential to effectively model long-term dependencies. Several adaptations of Recurrent Neural Networks (RNNs) have been suggested to address this issue, including the Gated Recurrent Unit (GRU) and the Long Short-Term Memory (LSTM). Several research studies have utilised Recurrent Neural Networks (RNNs) and their variations to conduct sentiment analysis, yielding encouraging outcomes. Recurrent Neural Networks (RNNs) demonstrate particular efficacy in the context of sequential data analysis, such as in the case of movie reviews. The ability to capture sequential dependencies is a key factor in enhancing the accuracy of sentiment analysis tasks.

It can be inferred that deep learning models, including Convolutional Neural Networks (CNN), Long Short-Term Memory (LSTM), and Recurrent Neural Networks (RNN), have demonstrated encouraging outcomes in the field of sentiment analysis. The selection of a model is contingent upon the particular task demands, as each model possesses its own set of advantages and disadvantages. Convolutional Neural Networks (CNNs) have been found to be particularly advantageous in the context of processing brief textual inputs, whereas Long Short-Term Memory (LSTM) and Recurrent Neural Networks (RNNs) are more aptly suited for handling longer textual inputs. It is important to acknowledge that in order to attain cutting-edge outcomes, deep learning models necessitate a substantial quantity of data and computational resources. The utilisation of deep learning models in the domain of sentiment analysis is a swiftly developing area, and there remains a significant amount of uncharted territory to be investigated and enhanced.

II. METHODS

The process of selecting pertinent papers for a review paper is a pivotal aspect of the research process. The subsequent approach may be employed to curate papers for a literature review on the topic of sentiment analysis utilising deep learning models such as Convolutional Neural Networks (CNNs), Long Short-Term Memory (LSTM) networks, and Recurrent Neural Networks (RNNs). Initially, it is recommended to perform an exhaustive exploration of the literature by utilising scholarly databases such as Google Scholar, Scopus, and Web of Science. The selection of search terms ought to be contingent upon the research inquiry and the review paper's objective. Subsequently, the abstracts of the obtained papers ought to undergo a screening process that is contingent upon the established criteria for inclusion and exclusion. The establishment of inclusion criteria ought to be predicated upon the pertinence of the paper to the research inquiry and the utilisation of Convolutional Neural Network (CNN), Long Short-Term Memory (LSTM), or Recurrent Neural Network (RNN) models for the purpose of conducting sentiment analysis. The formulation of exclusion criteria ought to be grounded on papers that are deemed irrelevant or do not satisfy the established inclusion criteria. Upon completion of the preliminary screening process, a comprehensive examination of the chosen papers is necessary to extract pertinent data, including but not limited to the employed methodology, experimental configuration, and outcomes. In the event of any inconsistencies or divergences among the reviewers, it is imperative to address them through constructive dialogue and mutual agreement. Ultimately, the chosen scholarly articles ought to be amalgamated and scrutinised in the literature review to furnish a comprehensive appraisal of the current advancements in sentiment analysis utilising CNN, LSTM, and RNN architectures. In general, this approach offers a methodical and thorough strategy for the selection of pertinent literature in the context of a review paper focused on the application of deep learning models to sentiment analysis.

III. RESULTS

Upon examination of the scholarly literature on sentiment analysis utilising deep learning models such as CNN, LSTM, and RNN, it is apparent that each of these models has demonstrated efficacy in this domain. The selection of a model is contingent upon the particular task demands, as each model possesses its own set of advantages and disadvantages.

Convolutional Neural Network (CNN) models have demonstrated notable proficiency in detecting local features within brief textual inputs, such as tweets. In addition, these models exhibit computational efficiency and demand a reduced amount of training data in comparison to alternative deep learning models. CNN models may encounter difficulties in capturing extended dependencies in sequential data, potentially resulting in suboptimal performance in sentiment analysis tasks that involve lengthier texts.

LSTM models have demonstrated efficacy in capturing extended dependencies in sequential data, rendering them highly suitable for sentiment analysis tasks that involve lengthier texts. In addition to their flexibility in handling input sequences of varying lengths, RNN models exhibit greater adaptability when compared to CNN models. In contrast to CNN models, LSTM models necessitate a greater amount of training data and are computationally more demanding.

Recurrent Neural Network (RNN) models have demonstrated efficacy in capturing sequential dependencies within textual data. These models have the ability to handle input sequences of varying lengths and exhibit superior computational efficiency when compared to LSTM models. RNN models may encounter the vanishing gradient problem, thereby constraining their capacity to capture prolonged dependencies in sequential data.

In general, the efficacy and precision of each model are contingent upon the particular demands of the task at hand. CNN models could be considered as the most precise and efficient option for brief texts like tweets. LSTM models have been found to be the most effective and accurate option for longer texts, such as movie reviews. In cases where computational efficiency is a priority, it may be appropriate to consider utilising RNN models as a viable option.

Ultimately, the selection of a deep learning model for sentiment analysis is contingent upon a multitude of factors, including but not limited to the length of the input sequence, the availability of computational resources, and the specific demands of the task at hand. Comprehending the merits and demerits of each model is imperative in the process of choosing the most efficient and precise model for the assigned task.

	ANN	CNN	RNN
Basics	One of the simplest types of neural networks.	One of the most popular types of neural networks.	The most advanced and complex neural network.
Structural Layout	Its simplicity comes from its feed forward nature — information flows in one direction only.	Its structure is based on multiple layers of nodes including one or more convolutional layers.	Information flows in different directions, which gives it its memory and self-learning features.
Data Type	Fed on tabular and text data.	Relies on image data.	Trained with sequence data.
Complexity	Simple in contrast with the other two models.	Considered more powerful than the other two.	Fewer features than CNN but powerful due to its self-learning & memory potential.
Commendable Feature	Ability to work with incomplete knowledge and high fault tolerance.	Accuracy in recognizing images.	Memory and self-learning.
Feature type: spatial recognition	No	Yes	No
Feature type: Recurrent connections	No	No	Yes
Main Drawback	Hardware dependence.	Large training data required.	Slow and complex training and gradient concerns.
Uses	Complex problem solving such as predictive analysis.	Computer vision including image recognition	Natural language processing including sentiment analysis and speed recognition.

Fig 4: Comparative analysis of the three models

IV. DISCUSSION

The present review paper offers significant insights into the efficacy and precision of deep learning models such as CNN, LSTM, and RNN in the context of sentiment analysis tasks. The analysis presents an evaluation of the merits and limitations of individual models, and furnishes a structure for determining the optimal model for a given undertaking.A salient discovery of this review is that the selection of a deep learning model is contingent upon the particular demands of the task at hand. Convolutional Neural Network (CNN) models are deemed appropriate for processing brief textual inputs, such as tweets, whereas Long Short-Term Memory (LSTM) models are considered more efficient in handling extensive textual inputs, such as movie reviews. Recurrent Neural Network (RNN) models may serve as a viable substitute in cases where computational efficiency is a priority.

The performance of deep learning models is significantly impacted by the quality and quantity of the training data. The performance of models can be significantly influenced by the availability and quality of training data. Therefore, it is crucial to ensure that the training data is of sufficient size and high quality to effectively train the models.

The present review paper concludes by presenting a comprehensive overview of the efficacy and precision of deep learning models such as CNN, LSTM, and RNN in performing sentiment analysis tasks. The aforementioned review underscores the significance of carefully choosing the optimal model that suits a particular task, while taking into account other variables such as the calibre and magnitude of the training data, preprocessing methodologies, and assessment criteria.

V. CONCLUSION

This review paper has concluded by examining the efficacy and precision of deep learning models such as CNN, LSTM, and RNN in the context of sentiment analysis tasks. The study determined that the selection of a model is contingent upon the particular task specifications, and that the efficacy of the models is significantly influenced by the calibre and quantity of the training data, as well as the preprocessing methodologies and assessment metrics.

The findings of this analysis indicate that individual deep learning models exhibit distinct advantages and limitations. Convolutional Neural Network (CNN) models have demonstrated efficacy in processing short texts, whereas Long Short-Term Memory (LSTM) models are more adept at handling longer texts. Recurrent neural network (RNN) models can serve as a feasible option in cases where computational efficiency is a priority. Nevertheless, the selection of the model ultimately relies on the particular demands of the given task.In the future, it is crucial to persist in the investigation of novel deep learning models and techniques that can enhance the efficacy of sentiment analysis tasks. Furthermore, it is imperative to acknowledge the constraints and obstacles linked to deep learning models, including their opaque characteristics and intricacy in comprehending their determinations.

To summarise, this scholarly article offers significant perspectives on the efficacy and precision of deep learning algorithms in the context of sentiment analysis assignments. Through a comprehensive comprehension of the advantages and limitations of each model, scholars and professionals can make judicious choices while opting for the most suitable model that aligns with their particular task prerequisites.

VI. REFERENCES

1. Zhang, Q., & Wu, L. (2020). Sentiment Analysis Using Convolutional Neural Networks with Word Embeddings. In Proceedings of the 3rd International Conference on Electronic Information Technology and Intellectualization (pp. 422-426). ACM.

2. Liu, Z., Li, Y., Li, X., & Yu, F. (2021). Sentiment Analysis on Social Media Data using Bidirectional LSTM. Journal of Intelligent & Fuzzy Systems, 41(4), 4701-4709.

3. Akhtar, N., Khalid, S., & Saba, T. (2021). Sentiment Analysis of Twitter Data using LSTM, CNN, and Attention-Based Mechanism. Journal of Ambient Intelligence and Humanized Computing, 12(7), 7605-7619.

4. Sari, D., & Nurhayati, Y. (2021). Sentiment Analysis of Movie Reviews using Recurrent Neural Network. Journal of Physics: Conference Series, 1730(1), 012036.

5. Kanan, J., Shukur, Z., & Al-Taie, Z. (2020). An Investigation of Deep Learning Approaches for Sentiment Analysis in Arabic Text. Journal of Soft Computing and Decision Support Systems, 7(2), 1-9.

6. Liu, L., & Qian, Z. (2020). Sentiment Analysis of Chinese Microblogging Based on RNN and Attention Mechanism. Journal of Big Data Mining and Analytics, 3(3), 200-208.

7. Zhao, X., Gao, F., & Zheng, Q. (2020). Sentiment Analysis of Chinese Social Media Data Using LSTM with Attention Mechanism. Journal of Computational Science, 46, 101184.

8. Liu, W., & Lin, L. (2020). A Hybrid Approach to Sentiment Analysis Using LSTM with Convolutional Filters. Journal of Computational Intelligence and Neuroscience, 2020, 1-8.

9. Arora, N., Jain, A., &Soni, S. (2021). Sentiment Analysis of Hindi Text using LSTM and CNN.

Journal of Advances in Intelligent Systems and Computing, 1216, 533-542.
10. Lu, S., & Chen, Z. (2021). Sentiment Analysis of Chinese Social Media Texts using LSTM with Attention Mechanism. Journal of Applied Sciences, 11(1), 1-8.
11. Zeng, X., Liu, L., Zhang, X., & Chen, C. (2020). A Comparative Study on Sentiment Analysis Using RNN and LSTM. Journal of Computational Intelligence and Neuroscience, 2020, 1-7.
12. Ranasinghe, D., Ranathunga, S., &Ginige, A. (2021). Sentiment Analysis of Social Media Data Using CNN and LSTM Networks. Journal of Advances in Intelligent Systems and Computing, 1227, 163-174.