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SENTIMENT ANALYSIS USING DEEP LEARNING MODELS

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Abstract: Sentiment analysis with deep learning is an emerging subfield of natural language processing that leverages neural networks to analyze and classify the sentiment or emotion expressed in text. Deep learning models can automatically learn complex features and patterns in data, making them well-suited for sentiment analysis tasks. Deep learning models, such as Long short term memory (LSTM) and Convolutional Neural Networks (CNN), have been shown to achieve state-of-the-art performance on sentiment analysis tasks, including sentiment classification, aspect-based sentiment analysis, and emotion detection. These models were applied to the IMDB dataset consisting of 50K movie reviews. the data was preprocessed using word embedding. Sentiment analysis with deep learning has many practical applications, including social media monitoring, brand reputation management, customer feedback analysis, and political opinion tracking. This paper provides an overview of sentiment analysis with Deep learning, including the architecture of deep learning models, training and evaluation techniques, and current research challenges and trends.

Keywords: Deep learning, Neural network, CNN, LSTM, Movie Review

1. Introduction

Sentiment analysis, a subfield of natural language processing, is to categorize a text's sentiment or emotion.. The sentiment could be positive or negative and the task of sentiment analysis is to recognize and extricate this feeling from the text information. The opinion of a particular piece of text (such as a tweet or product review, for example) is shown by sentiment analysis. Deep learning is based on how the human brain works and how it is structured. Multiple layers of artificial neurons connected to one another makeup deep learning models. In order to learn more complex features, the model's layers process each other's output. Deep learning shown to be particularly effective in tasks such as image and speech recognition, natural language processing, and robotics. Deep learning models like neural networks are used the most frequently for sentiment analysis. The human brain's structure and function serve as inspiration for neural networks. Simple Neural Networks, Convolutional Neural Networks (CNN), and Long Short Term Memory (LSTM) networks are among the neural networks that can be utilized for sentiment analysis. A SNN consists of an input layer, one or more hidden layers, and an output layer. It is trained using a set of labeled data, where each data point has a sentiment label attached to it. During training, the network learns to associate the features of the input data with the corresponding sentiment label. Once trained, the model can be used to predict the sentiment of new data. A CNN is also one of the neural networks that is useful for analyzing text data, such as reviews or posts on social media. It is based on the concept of convolution, in which relevant features are extracted from the input data by applying a filter. The output of the convolutional layer is then fed into one or more fully connected layers to predict the sentiment label. Sentiment analysis tasks have demonstrated that CNNs achieve high accuracy. LSTM networks are also another type of neural network that is commonly used for NLP tasks, including sentiment analysis. They are particularly useful for analyzing sequences of text data, where the order of the words matters. LSTM networks are designed

to catch long-term dependencies in the input sequence, making them well-suited for sentiment analysis tasks that require understanding the context of the text. we are also going to check both standard and bidirectional LSTM.
Overall, neural networks, including simple neural networks, CNNs, and LSTM networks, are powerful tools for performing sentiment analysis. By training these models on labeled data, it is possible to accurately classify the sentiment expressed in text data.

2. Literature Review

In recent years, many studies have been conducted on Sentiment analysis using Deep learning models. we will review some of the most important papers.
The researchers of the first paper have taken Sentiment analysis on Indian farmers' protests using Twitter data. they collected around 18000 tweets with 4 different attributes. they applied different machine learning models and classified the tweet into positive, negative, or neutral.[1]
In the second work the authors have taken sentiment analysis on Amazon data that contains reviews, they used bag of words and built a model with RNN with GRU and support vector machine .with sentiment analysis using review embedding and product they got a classification accuracy of 81.82%.[2]
Sentiment Analysis of Persian Movie, Both machine and Deep learning algorithms like Logistic regression, support vector machine, multilayer perceptron, 1D convolutional neural network, 2D-CNN, stacked long short-term memory, and Bidirectional LSTM algorithms. the authors collected data from different Persian Movie websites. NLTK tokenizer and normalization replace words, and Word embedding is used to convert the sentence into a 3D vector. the authors achieved good accuracy with stacked-LSTM and Stacked-BiLSTM .further they evaluated the performance of deep learning models with many layers.[3]
Attention-Based Recurrent Neural Network Models for Joint Intent Detection and Slot Filling by Bing Liu and Ian Lane (2016) , This paper proposes an attention-based RNN model for joint intent detection and slot filling, which can be applied to sentiment analysis tasks as well.[4]
One of the authors named Tang et al. proposed a novel approach for sentiment analysis based on sentiment embeddings. The proposed model uses a deep neural network with multiple layers to learn sentiment embeddings that capture the sentiment information of words and phrases. The model achieved state-of-the-art results on several benchmark datasets, including the Stanford Sentiment Treebank and the Movie Review dataset.[5]
Another paper proposed a pretraining method called XLNet, which achieved state-of-the-art results on several benchmark datasets, including the GLUE benchmark and the SQuAD 2.0 dataset. The XLNet model uses an autoregressive language modeling objective that allows it to capture bidirectional context information more effectively than previous models.[6]
Investigating the use of convolutional NN for Sentiment Analysis by D. Nogueira and R. R. Lotufo.This paper investigates the use of CNN for sentiment analysis, focusing on the impact of different hyperparameters on the model's performance. The authors conduct experiments on several datasets and show that their model achieves competitive performance compared to other deep learning models.[7]
This paper proposes an attention-based bidirectional long short-term memory network (AB-LSTM) for relation classification, which can also be applied to sentiment analysis tasks. The authors conduct experiments on several datasets and show that their model achieves state-of-the-art performance.[8]

3. Proposed Model and Discussion

The problem statement for sentiment analysis on IMDB movie review dataset using deep learning models could used be to build a model that accurately predicts the sentiment and rating of movie reviews based on their text content. Specifically, the objective could be to train a deep learning model using a movie review dataset to predict the sentiment of new, unseen movie reviews with high accuracy. The dataset used for this problem is a collection of movie reviews, where each review is labeled as either positive or negative. The deep learning models used for this task include simple neural networks, Convolutional Neural Networks (CNNs), and LSTM.
The evaluation metric for the model could be accuracy on a held-out test set, and the model could be deployed to perform sentiment analysis on new movie reviews dataset. The goal would be to build a model that is capable of accurately predicting the sentiment of movie reviews with ratings in order to help movie-goers make informed decisions about which movies to watch.
Sentiment analysis with deep learning typically involves the following process:
Data collection: The first thing that needs to be done is to gather a large amount of text data, including sentiment labels (positive or negative) for each piece of text.

Data preprocessing: Preprocessing, which includes cleaning, tokenizing, and normalizing the collected data, follows.
Embedding: Word embeddings are used to turn the preprocessed text into a numerical representation in the following step. The meaning of words and how they relate to other words in the text are captured by word embeddings.
Model building: Once the text data is in numerical form, a deep learning model is trained to predict the sentiment of the text. Common deep learning models used for sentiment analysis include Convolutional Neural Networks (CNNs) and both standard and bidirectional Long Short-Term Memory (LSTM) networks.
Model evaluation: The trained model is evaluated on a held-out test set to measure its accuracy.
Model deployment: Finally, the trained model can be deployed to perform sentiment analysis on another new dataset or text data.

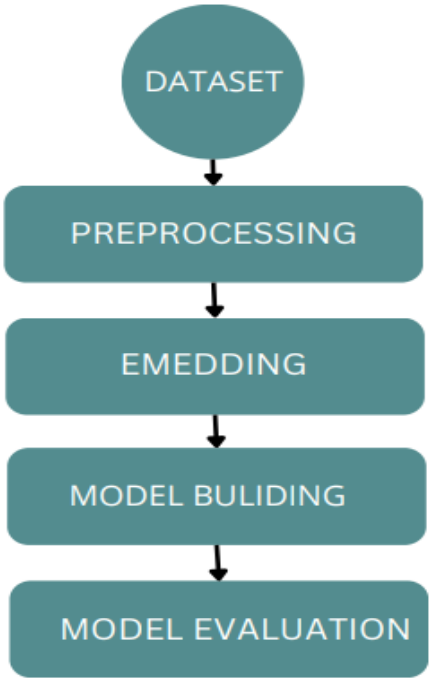

Figure 1:flow of the proposed model

3.1 Dataset Description:

In deep learning, datasets play a crucial role in training neural networks to perform specific tasks. A dataset for deep learning typically consists of a very large amount of labeled data, such as images, text, or audio, that the algorithm will use to learn how to recognize and classify new inputs. Deep learning datasets often require preprocessing, such as normalization or feature scaling, to ensure that the data is suitable for training the neural network. the dataset we have taken is the IMDB movie dataset which consists of 50k reviews, Each review is labeled as either positive or negative based on the sentiment expressed in the text. The dataset was created by collecting movie reviews from the IMDB website and preprocessing them to remove HTML tags, punctuation, and stop words. The resulting text was then converted into a numerical representation using the Bag-of-Words model, which represents each review as a vector of word counts. The dataset which is used for implementing our algorithm has been downloaded from the Kaggle website [9]

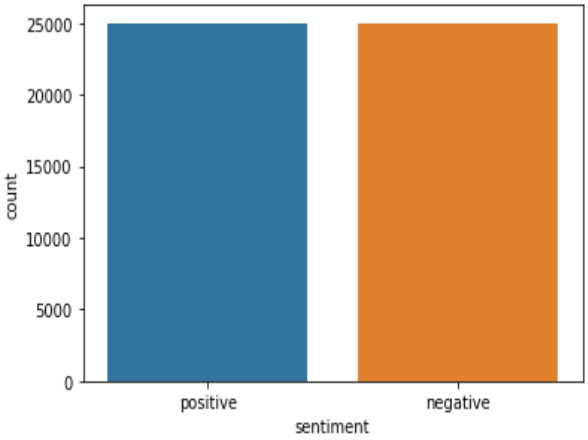

Figure 2: dataset Visualization

3.2 Preprocessing Techniques:

Preprocessing is one of the important steps in deep learning, i.e. it helps to develop the data for input into neural networks. With the considered data set HTML tags are typically removed, while stop words are also removed as they do not carry any sentiment and add noise to the data. And also Remove punctuations, numbers, Single characters, and multiple spaces. then Converting sentiment labels to 0 & 1.

3.3 Deep learning algorithms:

Sentiment analysis is an NLP task that involves identifying the sentiment expressed in text, such as positive, negative, or neutral. Deep learning algorithms have shown great success in sentiment analysis, outperforming traditional machine learning methods in many cases. An overview of the deep learning algorithms commonly used for sentiment analysis includes.

Recurrent neural networks (RNNs) are a popular choice for sentiment analysis tasks because they can model the sequential nature of text data. RNNs use a

hidden state that is updated at every time step based on the current input and the previous hidden state, allowing the network to capture long-term dependencies in the input sequence. RNNs can be used for both sentence-level and document-level sentiment analysis tasks.

The fundamental RNN architecture is a version that includes both standard LSTMs and BLSTMs. In contrast to standard RNNs, LSTMs feature a more intricate design that enables them to selectively store, read, and erase data in their memory cells. This helps them avoid the vanishing gradient problem. Contrarily, BLSTMs analyze input data both forward and backward, permitting them to collect data from both past and future contexts.

Convolutional neural networks (CNNs) are another popular choice for sentiment analysis, particularly for sentence-level analysis. CNNs use multiple layers of convolutional, pooling, and fully connected layers to extract and transform features from the input text. These networks can be used to learn local and global representations of the input text, making them effective for sentiment analysis.

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4. Results and discussions

Sentiment analysis using deep learning involves using neural network architectures to classify the sentiment of text data. The goal is to automatically determine whether a text expresses a positive or negative sentiment and predict the rating of the movie based on the text.it is a binary classification problem.

4.1 Models prediction:

TABLE 1:comparison of Deep learning models with different metrics

Evaluation measure	CNN	SNN	Standard LSTM	Bidirectional LSTM
Accuracy	84.7	72.6	85.5	86.5
Precision	0.88	0.72	0.81	0.84
Recall	0.81	0.74	0.93	0.88
f1-score	0.84	0.73	0.86	0.86

The bidirectional LSTM model had the best test accuracy, scoring 86.5%, according to the findings. The regular LSTM model came in second with 85.0% accuracy, followed by the CNN model with 84.7% accuracy, and the SNN model with 72.6% accuracy. Because it can process input sequences in both forward and backward orientations, the bidirectional LSTM (BiLSTM) model has outperformed the other models in terms of performance because it can capture both the past and the future context of the input.

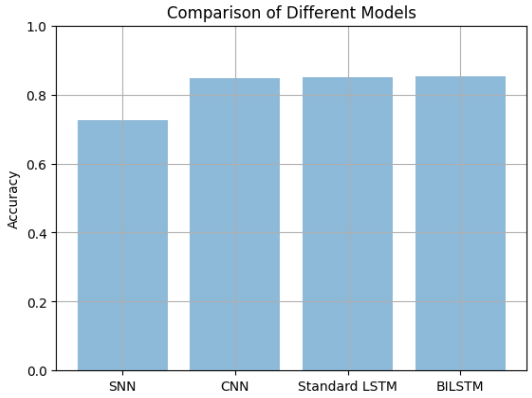
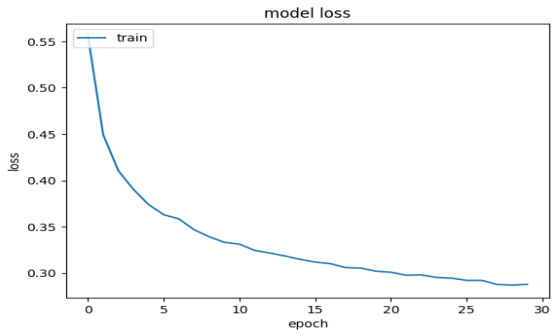
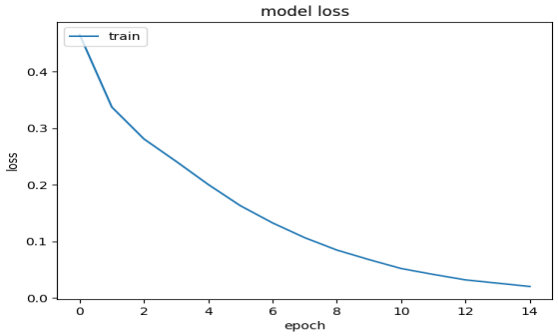


Figure 3: Visualization of different models' accuracy



(a)



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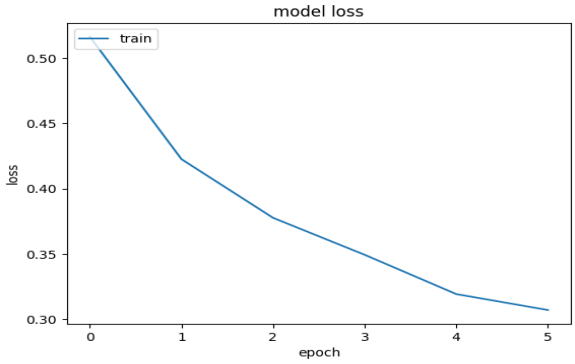

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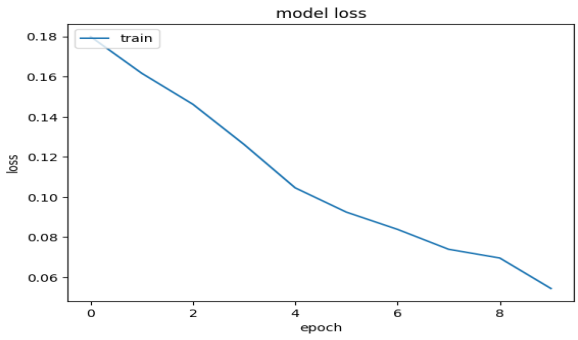

(d)

Figure 4: representation of loss during the training phase

(a)SNN,(b) CNN,(c) standard LSTM,(d) Bidirectional LSTM

It can be observed that bidirectional LSTM has performed well then all other models, where standard LSTM and CNN also performed well in sentiment analysis for the IMDB movie dataset.

Conclusion:

In conclusion, identifying movie reviews as positive or negative using sentiment analysis with deep learning models on the IMDb movie dataset has proven to be a highly successful method. We can effectively anticipate the emotion of a certain movie review by using neural network architectures like convolutional neural networks (CNNs) and recurrent neural networks (RNNs), which may be used to capture the underlying patterns and correlations in text data.

Several studies have shown that deep learning models can achieve state-of-the-art performance on the IMDb movie dataset. This is due to the ability of deep learning models to learn and generalize from large amounts of data, as well as their ability to capture the complex and subtle nuances of natural language. However, it's important to note that while deep learning models have shown impressive results on the IMDb dataset, their performance can be highly dependent on the quality and quantity of the training data, the choice of hyperparameters, and the specific architecture used. Additionally, the interpretation of the results can be challenging, as deep learning models are often considered "black boxes" that are difficult to explain or understand. Regarding the sentimental analysis, the language barrier is a major limitation. As of now, most sentiment analysis models are trained on English language data, so they may not be able to accurately analyze reviews written in other languages. Additionally, if the reviews are sarcastic or ironic, the model may not be able to correctly classify the sentiment.

As the field of deep learning continues to evolve and improve, we can expect even more accurate and reliable sentiment analysis models to be developed in the future.

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