Sentiment Anaysis Using Deep Learning Models on Company Reviews

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***Abstract*—This project focuses on sentiment analysis of company reviews using machine learning and deep learning techniques. Reviews are preprocessed by cleaning text and mapping ratings to numeric categories. The dataset is tokenized and padded, with word embeddings initialized using GloVe vectors. Models such as CNNs and LSTMs are trained to classify sentiments into five categories: Very Negative, Negative, Neutral, Positive, and Very Positive. Results include accuracy metrics, confusion matrix visualizations, and classification reports, with custom reviews used for real-world validation. The approach demonstrates effective sentiment classification for practical applications.**

Keywords*—*Sentiment Analysis, Sentiment Classification, Multiclass Classification, Natural Language Processing, Machine Learning, Deep Learning, Simple Neural Networks (NN), Long Short-Term Memory (LSTM)

I. INTRODUCTION

Sentiment analysis is a Natural Language Processing (NLP) technique, which is used to analyze the sentiment or emotional tone of text. With increasing online platforms like social media and review websites, there is a lot of text data available that shows people's feelings about products, services, or even social issues.

Sentiment analysis is important because it helps businesses, governments, and researchers understand what people think. By analyzing large

amounts of text, organizations can improve products, respond to customer feedback, and make better decisions based on public opinion. For example, companies can track how customers feel about their products through reviews, or governments can understand public sentiment on policies.

The primary goal of this project is to build a deep learning-based sentiment analysis model to accurately classify sentiment in text data. By using natural language processing (NLP) techniques, the model aims to identify and predict the sentiment of user-generated content, such as reviews as either positive, neutral, or negative.

II. Problem Statement & Motivation

A. Problem Statement

With increasing online platforms, a large amount of text data is generated every day through social media posts, product reviews, and customer feedback. This data holds valuable insights into people's opinions, but analyzing it manually is impractical due to its huge volume. The problem is to build an efficient and accurate system that can automatically classify text as positive, negative, or neutral, providing a scalable solution for organizations to understand public sentiment without human intervention. The challenge is to create a model that can understand the nuances of language, slang, and context to make accurate sentiment predictions.

B. Motivation

Sentiment analysis is important because businesses and other organizations can use it to understand people's opinions. For example, companies want to know if customers are happy or not with their products, and social media platforms want to see how people feel about certain topics. However, doing this by hand for large amounts of data is impossible. The motivation for this project is to build an automated tool that can quickly and accurately analyze text data. This will help organizations make better decisions based on public opinion, saving time and resources.

III. Background, Literature Survey/Current Approaches & Research

A. Background

Sentiment analysis, also known as opinion mining, focuses on identifying and classifying sentiments expressed in text. This task has broad applications, from understanding consumer

opinions in product reviews to gauging public sentiment on social media. With advancements in machine learning, deep learning models, such as Convolutional Neural Networks (CNNs), have been increasingly utilized to achieve higher accuracy in sentiment classification.

B. Literature Survey / Currrent Approaches

1. Overview of Techniques:

   Traditional methods like Naive Bayes (NB), Support Vector Machines (SVMs), and Bag of Words (BoW) have been widely used for sentiment classification due to their simplicity and interpretability. The rise of deep learning has introduced models like Recursive Neural Networks (RNNs) and Convolutional Neural Networks (CNNs), which are more effective in capturing contextual and hierarchical features of text data plicity and interpretability.

2. Reference Paper Insights:

   "Sentiment Analysis Using Convolutional Neural Network" discusses uses Word2Vec for word embeddings and a custom CNN architecture for classifying movie reviews into five sentiment categories. This approach achieved competitive results compared to other deep learning methods like RNNs, showcasing CNN's potential for sentiment analysis tasks.

   "*Sentiment Analysis Algorithms and Applications: A Survey*" presents a comprehensive overview of sentiment analysis techniques, including feature selection methods and supervised learning approaches. It highlights the challenges of unbalanced datasets and proposes enhancements using hybrid approaches combining traditional and deep learning models

C. Gaps and Challanges

- Handling unbalanced datasets effectively, where specific sentiment categories are underrepresented.
- Adapting models to domain-specific sentiment nuances, such as company reviews.

D. Analysis

- Addressing data imbalance through techniques like data augmentation and synthetic review generation.

- Comparing the effectiveness of deep learning models (CNN, RNN, LSTM, GRU) on company review data.
- Enhancing model performance with pretrained embeddings (e.g., GloVe) and evaluating results using comprehensive metrics like confusion matrices and classification reports.

IV. PROPOSED APPROACH / SOLUTION

Overview:

This project aims to build a robust and efficient sentiment analysis system that classifies various company reviews into five sentiment categories: Very Negative, Negative, Neutral, Positive, and Very Positive. The proposed solution uses deep learning approaches to compare their effectiveness in handling real-world text data with challenges such as imbalance and complexity

1. Data Collection and Preprocessing
    - Input Dataset: Company reviews dataset with ratings from 1 to 5.
    - Preprocessing: Removing HTML tags, punctuation, and stop words. Converting text to lowercase and tokenizing. Padding sequences to ensure uniform input length.
    - Data Balancing: Want to handle class imbalance using synthetic data generation (GPT-based review generation) and oversampling techniques.
2. Feature Representation

    Using word embeddings like GloVe to convert text data into dense vector representations, capturing semantic relationships between words.
3. Model Development

    Deep Learning Models: Convolutional Neural Network (CNN) for spatial feature extraction. Recurrent Neural Networks (RNN) and variants like LSTM and GRU for sequence-based sentiment classification.
4. Model Evaluation

    Evaluating models using metrics such as accuracy, precision, recall, F1-score, and confusion matrices. Analyzing predictions on minority classes (e.g., ratings 2, 3, 4) to ensure balanced performance.

Simple Neural Network

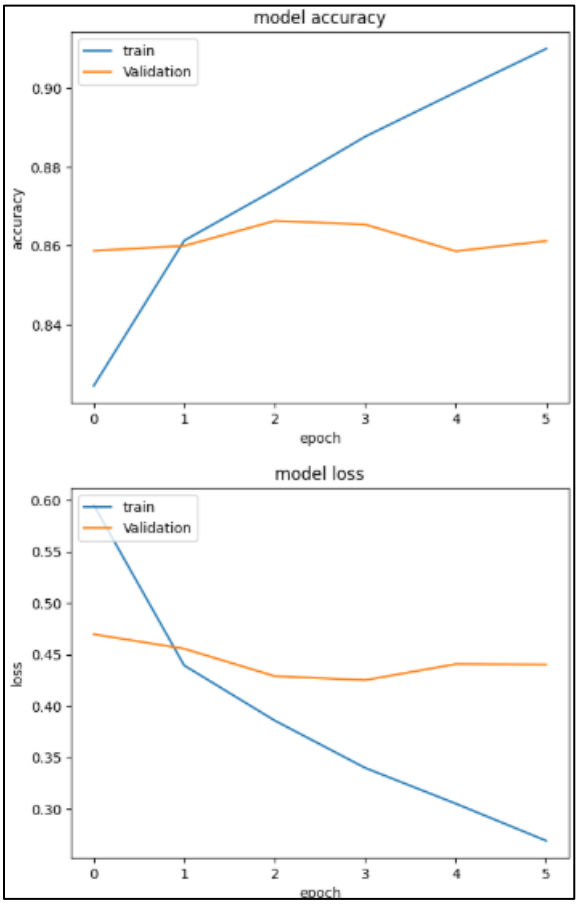

Fig. 1. Accuracy and loss for Simple neural network.

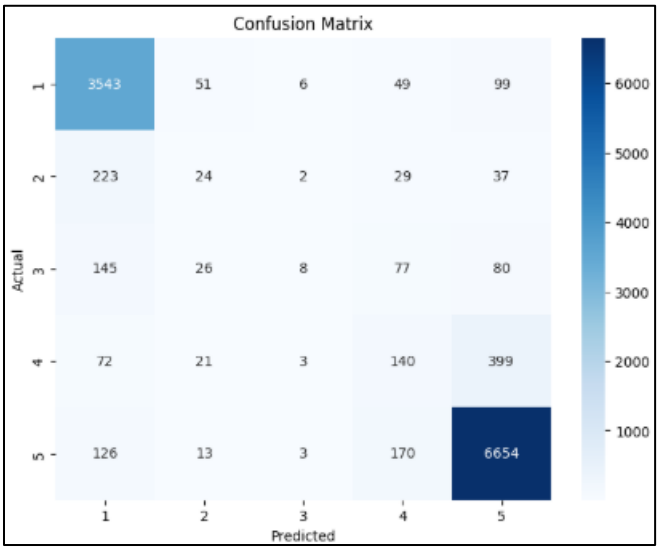

Fig. 2. Confusion Matrix for Simple neural network

LSTM

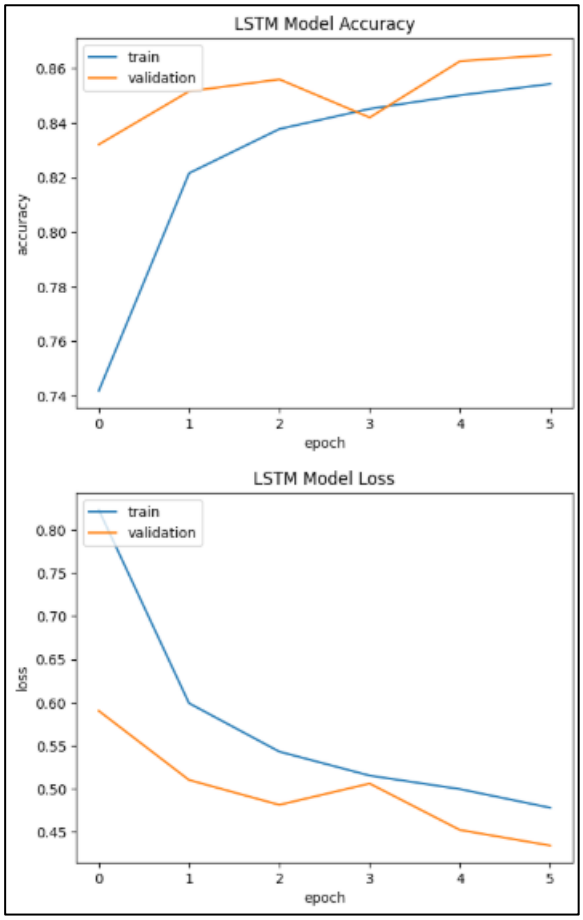

Fig. 3. Accuracy and loss for LSTM

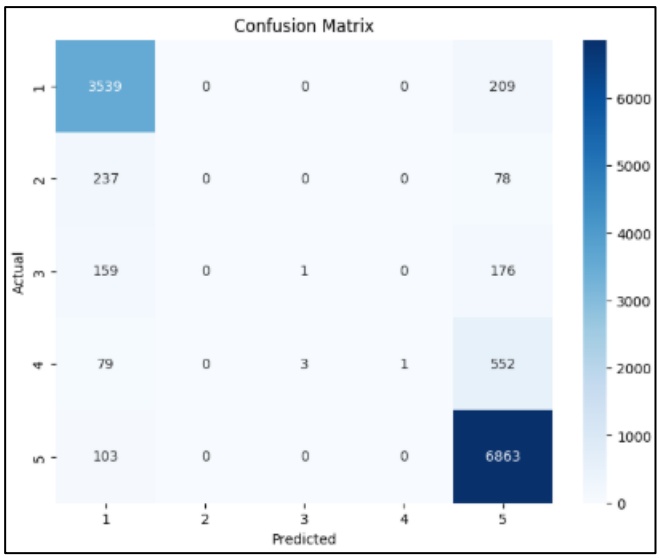

Fig. 4. Confusion Matrix for LSTM

GRU

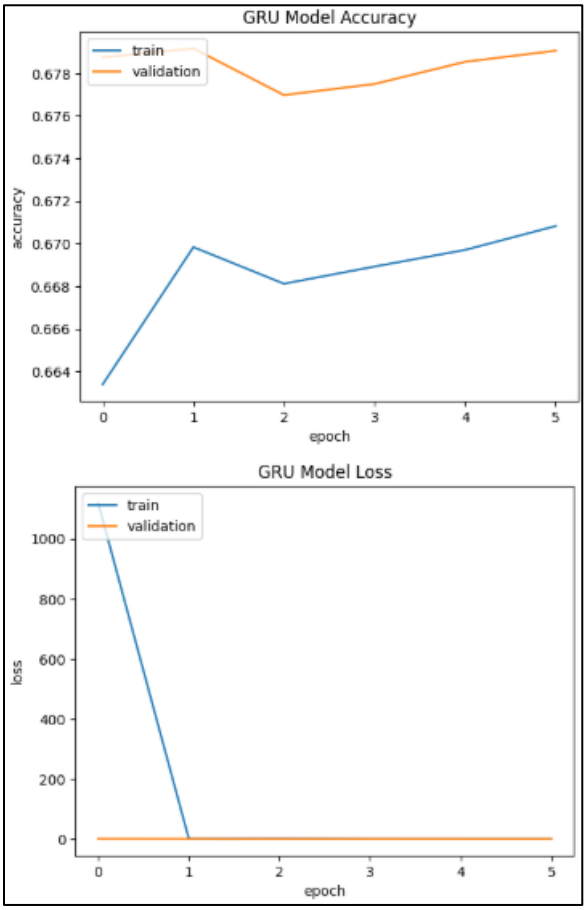

Fig. 5. Accuracy and loss for GRU

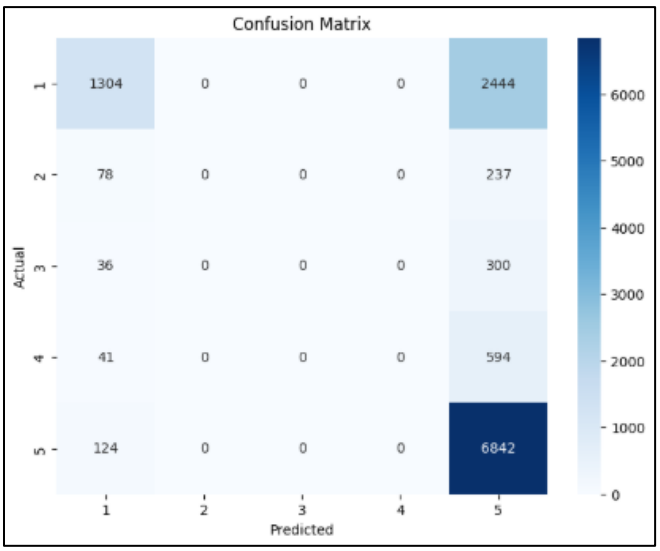

Fig. 6. Confusion matrix for GRU

RNN

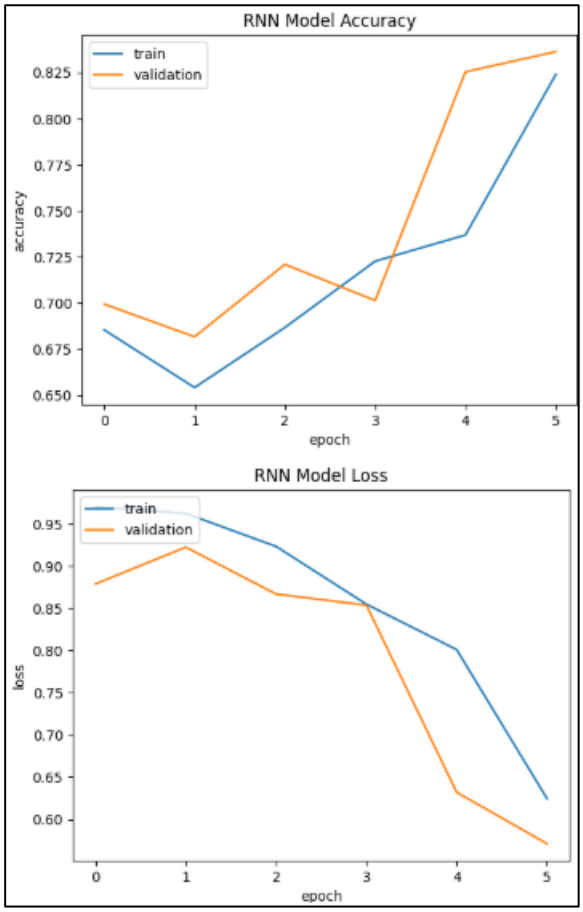

Fig. 7. Accuracy and loss for RNN

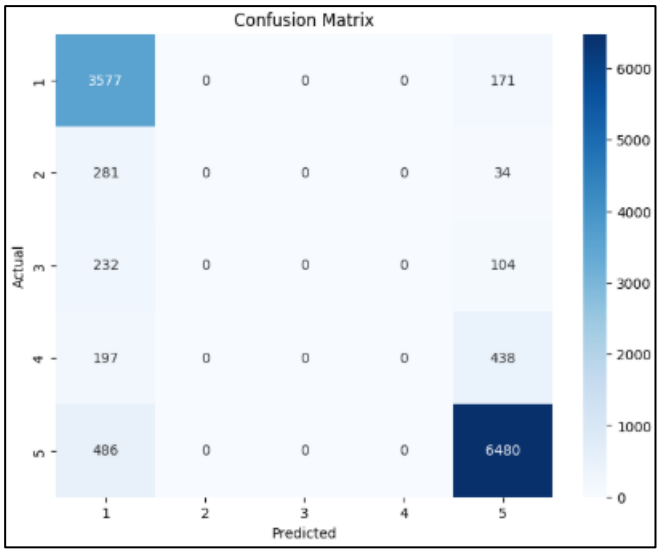

Fig. 8. Confusion matrix for RNN

5. Real-World Validation

Testing the models on custom reviews to simulate real-world scenarios and validate model generalization.

V. CONCLUSION / FUTURE WORK

Conclusion

This project successfully implemented sentiment analysis on company reviews using a deep learning model, including CNN, RNN, LSTM, and GRU. By preprocessing text data and leveraging word embeddings such as GloVe, the models were able to classify sentiments into five categories effectively. The evaluation metrics demonstrated the strengths and weaknesses of each model, providing insights into their applicability for sentiment classification tasks.

However, the imbalance in the dataset posed a significant challenge, particularly for underrepresented sentiment categories. To address this, synthetic data generation techniques using advanced language models, such as GPT-2, will be introduce as a viable solution. The project also demonstrated the value of comparing deep learning approaches to identify optimal models for sentiment analysis.

Future Work

Balancing Dataset with GPT-2, Advanced Models and Deployment.

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