UNIVERSITY OF LEICESTER

“MetaSent - Deep Learning for Sentiment Prediction with Meta-Learning Enhancement”

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Motivation

- Harnessing the Power of Deep Learning Models for Sentiment Analysis
- Cutting-edge Techniques with Language Model Integration

  Combining the best-performing deep learning model with a Language Model and Prompt Engineering to generate detailed sentiment label explanations.
- User-Centric Web Development

  An intuitive interface using React and Flask, ensuring that users can easily interact with and benefit from the sentiment analysis system.
- Research and Practical Contributions

  Conduct a thorough comparison of various deep learning models to identify the most effective approach for sentiment analysis.

Background & Challenges

Sentiment Analysis in the Digital Age

- Sentiment analysis is crucial for understanding public opinion, customer feedback, and social media trends. It helps businesses and researchers gauge sentiments expressed in text data.

Evolution of Deep Learning Models

- Early sentiment analysis relied on statistical methods and basic machine learning algorithms like Naive Bayes, which had limited accuracy and scalability.
- Deep Learning Breakthroughs: The advent of deep learning models, such as LSTM (Long Short-Term Memory), Bi-LSTM (Bidirectional LSTM), and CNN (Convolutional Neural Networks), has significantly improved sentiment analysis performance.

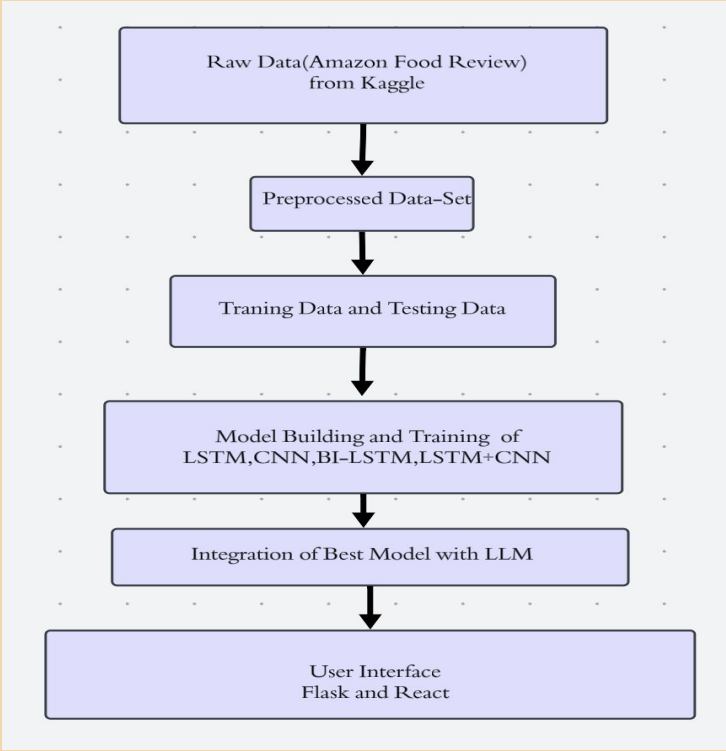
Challenges in Sentiment Analysis:

- Model Performance: Identifying the most effective model among several advanced options.
- Interpretability: Providing understandable justifications for sentiment predictions.
- User Interaction: Ensuring the analysis system is accessible and user-friendly for non-technical users.

Project Scope

- Data Cleaning & Preprocessing
- Comprehensive Comparison: Evaluate various deep learning models to determine the best performer.
- Integration with Language Models: Enhance the chosen model with LLM for generating detailed sentiment explanations.
- User-Friendly Interface: Develop a seamless front-end and back-end using React and Flask to make the system interactive and easy to use.

Technical Procedure Followed



Dataset Preprocessing

Importing Raw Data(Amazon Food Reviews from Kaggle)

Random Sampled(200000 reviews)

Cleaning Data

Splitting Data(Training(80%) and Test Data(20%)

Tokenization

Vectorization

Padding and Truncating

(Average Length by tokens of reviews is calculated 38.67)

```
d = {1:0,2:0,3:0,4:1,5:1}

df["Label"] = df["Score"].apply(lambda x :d[x])
```

5 ratings(Score) are converted to Label (1 - Positive, 0 - Negative)

```
Actual Review:
 say beef delicious much say already included product description

tweet sentence represented in terms of tokens and not padded :
  [91, 359, 66, 16, 91, 495, 1066, 9, 710]

After padding :
 [   0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0   91  359   66   16   91  495 1066    9  710]
```

Preprocessed Text or Review after Padding(Length 40 Tokens)

Models and Performance Evaluation

Deep Neural Networks:

Long short Term Memory(LSTM)
BI-LSTM
CNN
LSTM+CNN

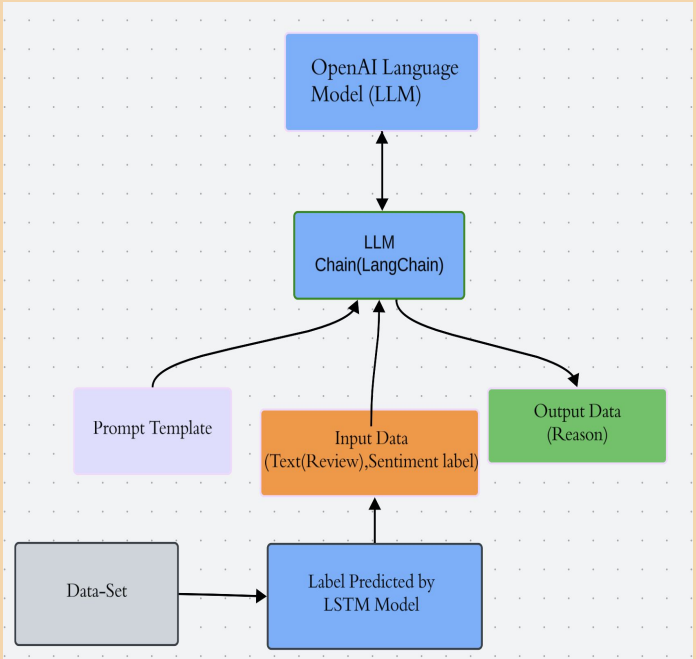
Naive Bayes Variants:

Multinomial NB
Compliment NB
Bernoulli NB

S.No	Model Name	Model Accuracy(Training Dataset - 160000)		Model Accuracy(Test Dataset - 40000)	
		Epochs -5	Epochs -10	Epochs- 5	Epochs- 10
1	LSTM	98.53	99.76	89.04	89.38
2	BI-LSTM	99.04	99.78	88.67	89.27
3	CNN	99.67	99.83	88.26	88.82
4	LSTM+CNN	98.70	99.74	89.43	88.83
5	ComplementNB	82.17			
6	MultinominalNB	83.10			
7	BernoulliNB	79.09			

Since LSTM performed well with the data set provided, it is used for project improvements.

Integration with LLM



Text Input

I ordered this product because of the Dr Oz show for anti-aging, a nice by product is I swear my knee pain has improved since I started drinking a cup a day, oh yeah and it taste good.

Output:

```
Ground Truth :  Positive

Sentiment Predicted By Deep Learning Model LSTM:  Positive

Reason Label: ```Health Benefits```
```

Web App

Steps in Building Web App

- Flask Environment Setup for Backend
- Web pages for all the features developed using React
- DataBase SQLite(User, Queries Tables)
- Integration of Developed DNN Model and LLM (GPT) in Web App

Features in WebApp

- User Authentication(Sign in, Sign Up & Sign Out)
- Single Review or Text Input for sentiment Analysis
- CSV File Upload Option - Output is Table Format
- History VIew - User can view Past queries and Output with Timestamp

Conclusion and Future Scope

In order to assess sentiment analysis and reasoning classification using deep learning models, such as LSTM, CNN, Bi-LSTM, LSTM+CNN, and Naive Bayes, this study made use of the Amazon Food Reviews dataset. By incorporating sequential dependencies, the LSTM model beat the others in terms of accuracy and generalisation. Including a linguistic model for intelligent reasoning in labels improves comprehension of underlying emotions. Moreover, sentiment analysis became interactive and accessible through an easy-to-use web interface created using Flask and React, encouraging user interaction and well-informed decision-making. With further research and innovation, this work lays a strong platform for future developments in sentiment analysis, language modelling, and user-friendly interfaces, which might have a substantial influence on society.

Future Scope:

- Model Refinement - Training with More Datasets
- Multi Model Analysis - More Hybrid Model to improve Performance
- Domain Specific

Thank you!