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Assignment 6

Problem Statement: Sentiment analysis using LSTM network or GRU.

Introduction:

Sentiment analysis is a natural language processing (NLP) task that involves determining the sentiment or emotional tone behind a piece of text, such as positive, negative, or neutral. It has a wide range of applications including product review analysis, social media monitoring, customer feedback analysis, and opinion mining.
Traditional machine learning methods often struggle with sequential dependencies in language data. To overcome this, **Recurrent Neural Networks (RNNs)** are used, with advanced architectures like **Long Short-Term Memory (LSTM)** and **Gated Recurrent Unit (GRU)**, which are better at capturing long-term dependencies in text sequences.

Objective:

The objectives of this assignment are:

- To understand the concept and importance of sentiment analysis in NLP.
- To preprocess text data for deep learning models.
- To implement a **LSTM** or **GRU** network for sentiment classification.
- To evaluate the model's performance using metrics like accuracy, precision, recall, and F1-score.
- To analyze how recurrent architectures handle sequential text better than traditional models.

Theory:

1 Sentiment Analysis

- Sentiment analysis involves classifying text into sentiment categories (e.g., positive, negative, neutral).
- It typically requires handling challenges like slang, sarcasm, spelling variations, and context dependencies.

2 Recurrent Neural Networks (RNNs)

- RNNs are designed for sequential data because they use a hidden state to capture information from previous time steps.
- However, simple RNNs suffer from the **vanishing and exploding gradient problem**, limiting their ability to remember long-term dependencies.

3 Long Short-Term Memory (LSTM)

- LSTMs are an improved version of RNNs that introduce **gates** (input, forget, and output gates) to control information flow.

- They effectively capture long-term dependencies in text, making them well-suited for sentiment analysis.

4 Gated Recurrent Unit (GRU)

- GRUs are a simplified variant of LSTMs that use **update and reset gates**.
- They are computationally lighter but perform comparably to LSTMs in many NLP tasks.

5 Workflow for Sentiment Analysis using LSTM/GRU

1. **Data Collection** – Gather labeled datasets (e.g., IMDB movie reviews, Twitter sentiment dataset).
2. **Text Preprocessing** – Tokenization, stop-word removal, padding sequences, and word embeddings (Word2Vec, GloVe, or pretrained embeddings).
3. **Model Building** –
    - Input Layer (tokenized sequences).
    - Embedding Layer (vector representations of words).
    - LSTM/GRU Layer(s) to capture sequential patterns.
    - Dense Layer with activation (sigmoid for binary classification or softmax for multiclass).
4. **Model Training** – Compile with a loss function (binary or categorical cross-entropy), optimizer (Adam/SGD), and train on labeled data.
5. **Evaluation** – Test the model on unseen data and evaluate using accuracy, precision, recall, and F1-score.
6. **Prediction** – Apply the trained model to new text data for sentiment classification.

Conclusion:

In this assignment, we implemented **sentiment analysis using LSTM/GRU networks**. By leveraging the sequential memory capabilities of these architectures, the model effectively captured contextual relationships in text and provided better performance than traditional machine learning approaches. LSTMs and GRUs demonstrate the power of deep learning in natural language processing, and this foundation can be extended to more advanced models like **Bidirectional LSTMs** or **Transformers (BERT, GPT)** for state-of-the-art results in sentiment analysis.