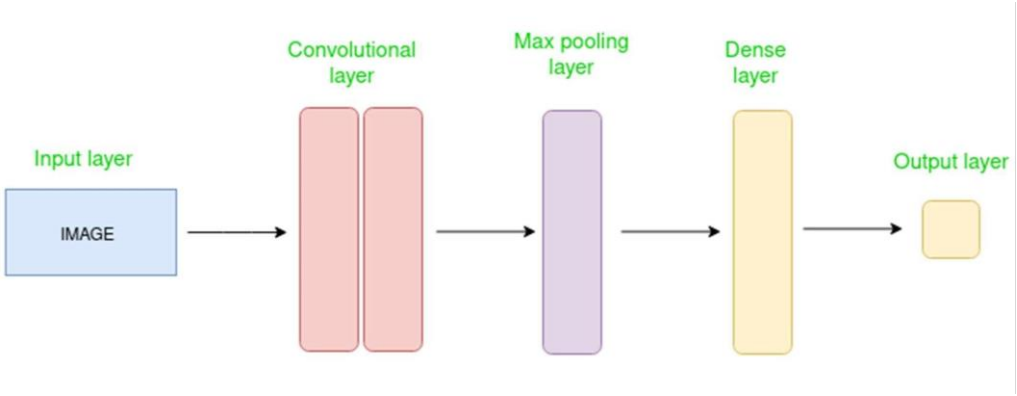
DEEP LEARNING – ASSIGNMENT 2

You need to choose between an RNN and CNN to classify movie reviews based on sentiment. What are the key differences, and which would you choose?

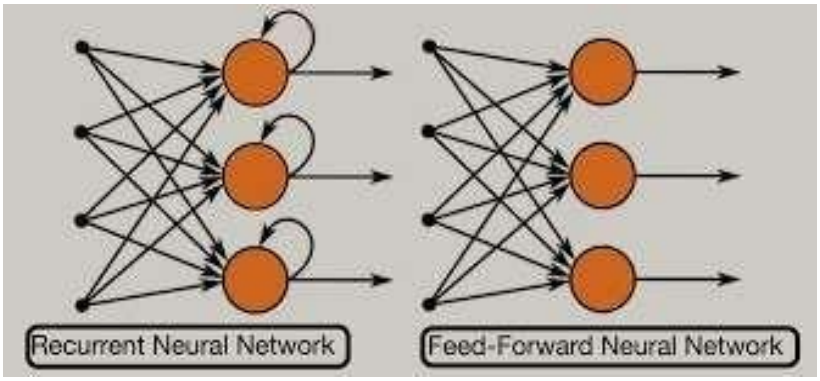
Convolutional Neural Network:

A Convolutional Neural Network (CNN) is a type of Deep Learning neural network architecture commonly used in Computer Vision. Computer vision is a field of Artificial Intelligence that enables a computer to understand and interpret the image or visual data. Convolutional Neural Network (CNN) is the extended version of artificial neural networks (ANN) which is predominantly used to extract the feature from the grid-like matrix dataset. For example, visual datasets like images or videos where data patterns play an extensive role.



Recurrent Neural Network:

Recurrent Neural Network(RNN) is a type of Neural Network where the output from the previous step is fed as input to the current step. In traditional neural networks, all the inputs and outputs are independent of each other. Still, in cases when it is required to predict the next word of a sentence, the previous words are required and hence there is a need to remember the previous words. Thus RNN came into existence, which solved this issue with the help of a Hidden Layer. The main and most important feature of RNN is its Hidden state, which remembers some information about a sequence. The state is also referred to as Memory State since it remembers the previous input to the network. It uses the same parameters for each input as it performs the same task on all the inputs or hidden layers to produce the output. This reduces the complexity of parameters, unlike other neural networks.

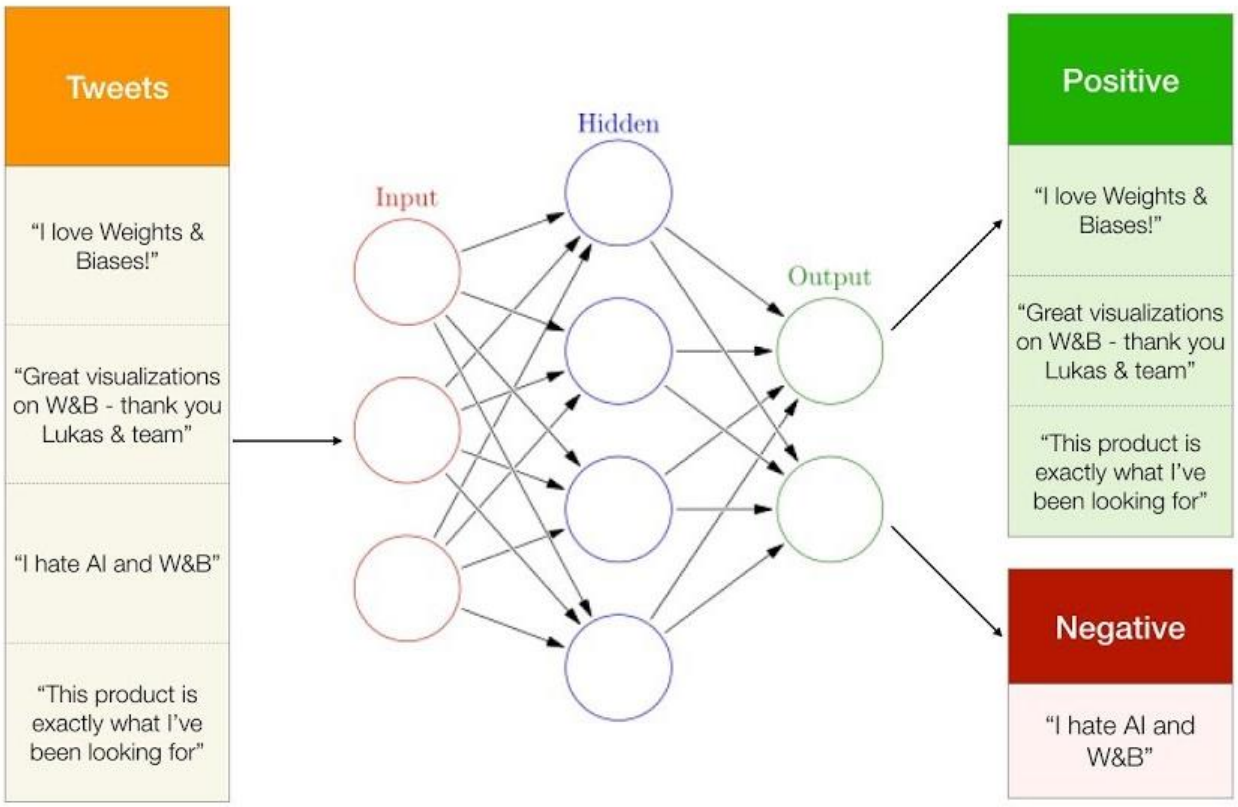


Sentimental Analysis:

Sentiment analysis, also known as opinion mining, is a technique within natural language processing (NLP) that involves analyzing text to determine the sentiment or emotional toneexpressed by the writer. The objective is to categorize the sentiment as positive, negative, or neutral based on thelanguage used. This analysis is widely used in applications like customer feedback, product reviews, andsocial media monitoring to gauge public opinion.

Key Steps in Sentiment Analysis:

- **Text Preprocessing**: The text undergoes cleaning, such as the removal of punctuation, stopwords, and irrelevant symbols, to ensure only meaningful words are analyzed.
- **Feature Extraction**: Relevant features—such as keywords, phrases, or even emojis—areextracted to identify indicators of sentiment.
- **Classification:** Using machine learning models or rule-based methods, the processed text isthen categorized according to the identified sentiment. Models like Recurrent Neural Networks (RNNs) or Convolutional Neural Networks (CNNs) are commonly applied for deeper sentiment analysis tasks.



Sentimental analysis using CNN:

Data Acquisition:

- Use the IMDb dataset, a widely-used collection of movie reviews labelled for sentiment (positive or negative). This dataset is pre-processed into text data and labels, making it suitable for sentiment classification tasks.

Tokenization:

- Convert each review into a sequence of integers representing word indices.

Padding/Truncation:

- Ensure each sequence has the same length by padding shorter sequences and truncating longer ones. This step is necessary to maintain uniformity for the CNN input.

Word Embedding:

- Apply word embedding (like GloVe or Word2Vec) to transform words into dense vectors. This step captures semantic relationships between words, which improves the CNN's ability to detect sentiment patterns.

Model Architecture (CNN Design):

- Use an embedding layer to input the pre-processed text.
- Add convolutional layers with filters that act on n-grams (phrases of fixed length) to capture sentiment-relevant features.
- Apply pooling layers to reduce the spatial dimensions, focusing on the most important features.

Classification Layers:

- Use fully connected layers following the CNN to consolidate features and map them to sentiment labels.
- End with a sigmoid or softmax activation function to output a probability score for positive or negative sentiment.
- Training and Optimization: Train the model on the dataset using an optimizer (like Adam) and binary cross-entropy as the loss function.
- Evaluate the model on validation data, adjusting parameters to improve performance.

Evaluation:

- Assess model performance using metrics such as accuracy and F1 score, focusing on whether it generalizes well on unseen data.

Testing and Predictions:

- Test the model on a new set of IMDb reviews to evaluate its sentiment prediction accuracy.

Processing Speed:

- CNNs are faster since they process data in parallel, unlike RNNs, which process sequences step-by-step. This speed makes CNNs ideal for large datasets.

Feature Extraction:

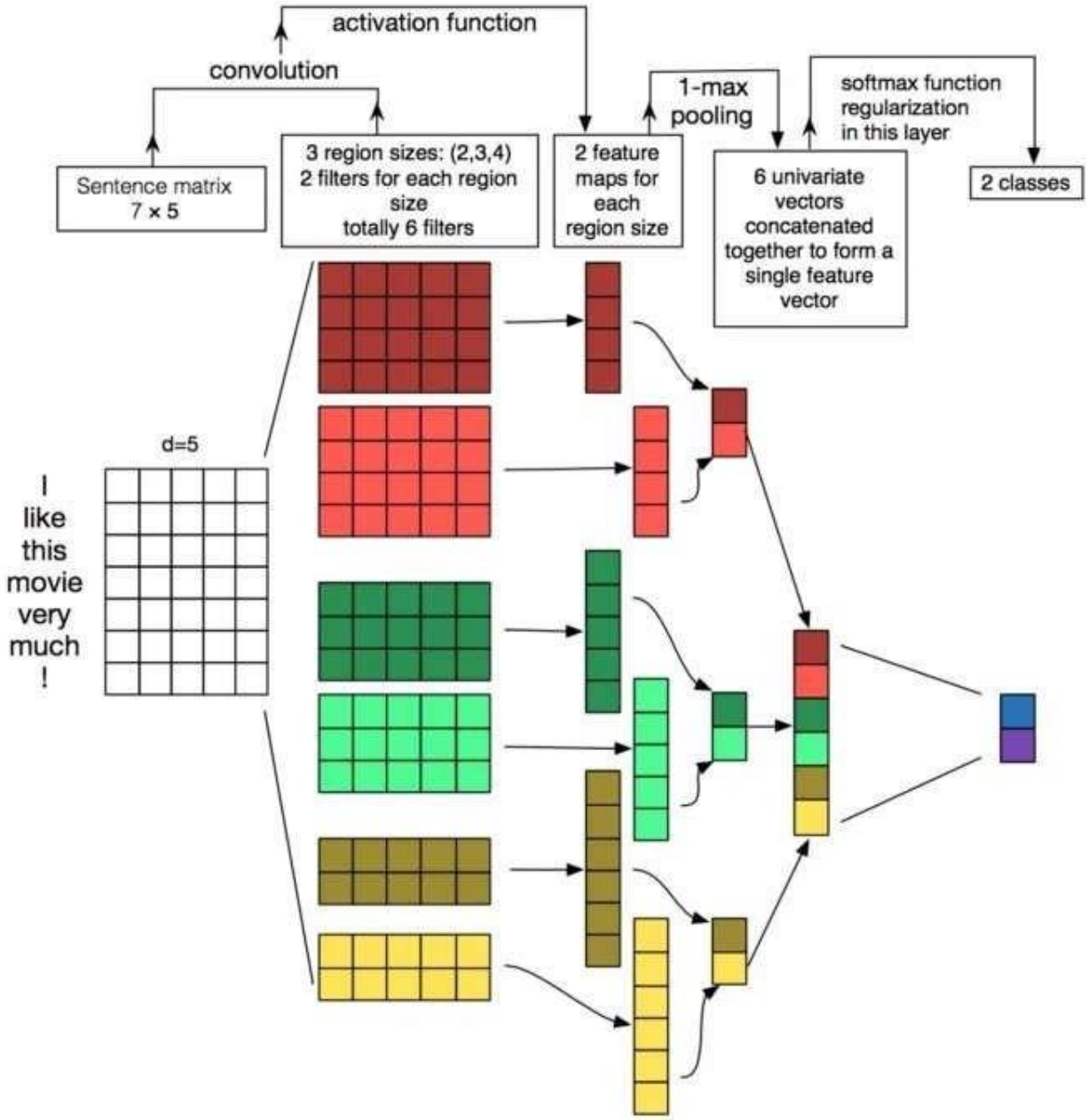
- CNNs excel at capturing local patterns, such as phrases or common word combinations, without needing sequential information.

Less Memory Issue:

- CNNs avoid the vanishing gradient problem often seen in RNNs with long sequences, making them more efficient in terms of memory and training stability.

Flexibility:

- While RNNs are better with context in long text, CNNs can handle shorter sequences or cases where phrase structure matters more than order.



Sentimental analysis using RNN:

Data Acquisition and Preprocessing:

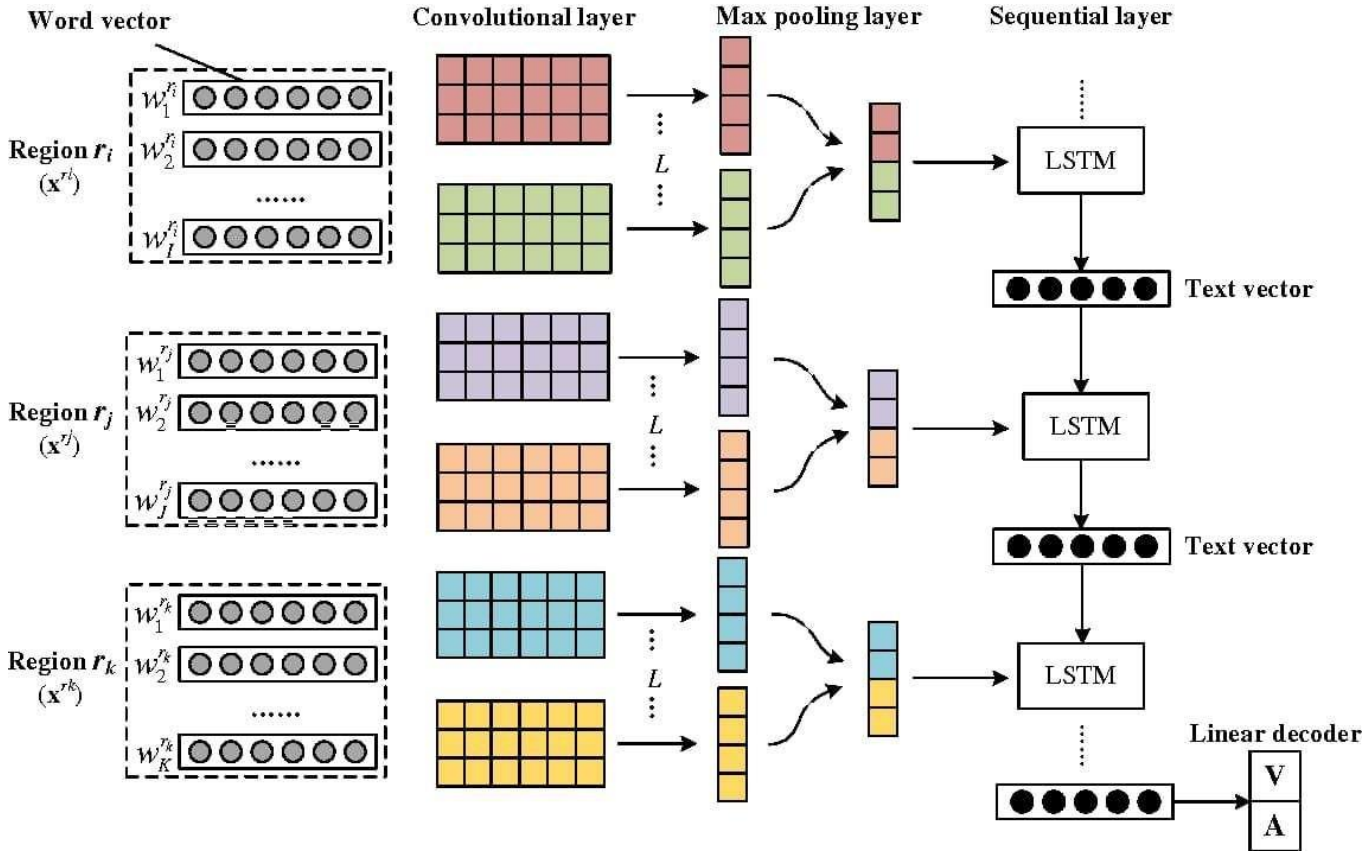
- Use IMDb dataset for sentiment classification, tokenizing text and padding sequences for uniformity.
- Word embedding like GloVe or Word2Vec capture word semantics, enhancing sentiment detection.

RNN Model Design:

- An embedding layer inputs text, followed by LSTM layers to capture context across sequences.
- Dense layers map features to sentiment labels, using sigmoid/softmax for probability output.

Training, Evaluation, and Testing:

- Train using Adam optimizer and binary cross-entropy, evaluating on accuracy/F1.
- RNNs capture longer text dependencies but may be slower and less efficient than CNNs.



Key aspects of Convolutional Neural Network:

- **Processing Speed**: CNNs are faster due to parallel processing, making them ideal for large datasets.
- **Feature Extraction:** They excel at capturing local patterns like n-grams without sequential data.
- **Efficiency**: CNNs avoid the vanishing gradient issue, optimizing memory and training stability.
- **Flexibility**: Best for shorter text or when phrase structure matters more than sequence order.

Key aspects of Recurrent Neural Network:

- **Contextual Understanding**: RNNs, especially LSTMs, capture long-term dependencies, retaining context over text.
- **Sequential Data Handling**: They analyze text sequences step-by-step, preserving word order and sentiment context.
- **Deeper Insights**: Ideal for nuanced sentiment where the order impacts meaning.

Conclusion

For sentiment analysis on movie reviews, RNNs (especially LSTMs) generally outperform CNNs because they capture the review context and nuances better. However, CNNs are faster and may be preferred for large datasets or simpler analysis tasks