BIDIRECTIONAL RECURRENT NEURAL NETWORK

Recurrent Neural Networks (RNNs) are designed to handle sequential data such as speech, text and time series. Unlike traditional feedforward neural networks which process inputs as fixed-length vectors, RNNs can manage variable-length sequences by maintaining a hidden state that stores information from previous steps in the sequence.

This memory mechanism enables RNNs to capture key features within the sequence. However traditional RNNs face challenges such as the vanishing gradient problem where gradients become too small during backpropagation making training difficult. To address this issue advanced RNN architectures like the Bidirectional Recurrent Neural Network (BRNN) have been developed. In this article, we will explore BRNNs in more detail.

Overview of Bidirectional Recurrent Neural Networks (BRNNs)

A Bidirectional Recurrent Neural Network (BRNN) is an extension of the traditional RNN that processes sequential data in both forward and backward directions. This allows the network to utilize both past and future context when making predictions providing a more comprehensive understanding of the sequence.

Like a traditional RNN, a BRNN moves forward through the sequence, updating the hidden state based on the current input and the prior hidden state at each time step. The key difference is that a BRNN also has a backward hidden layer which processes

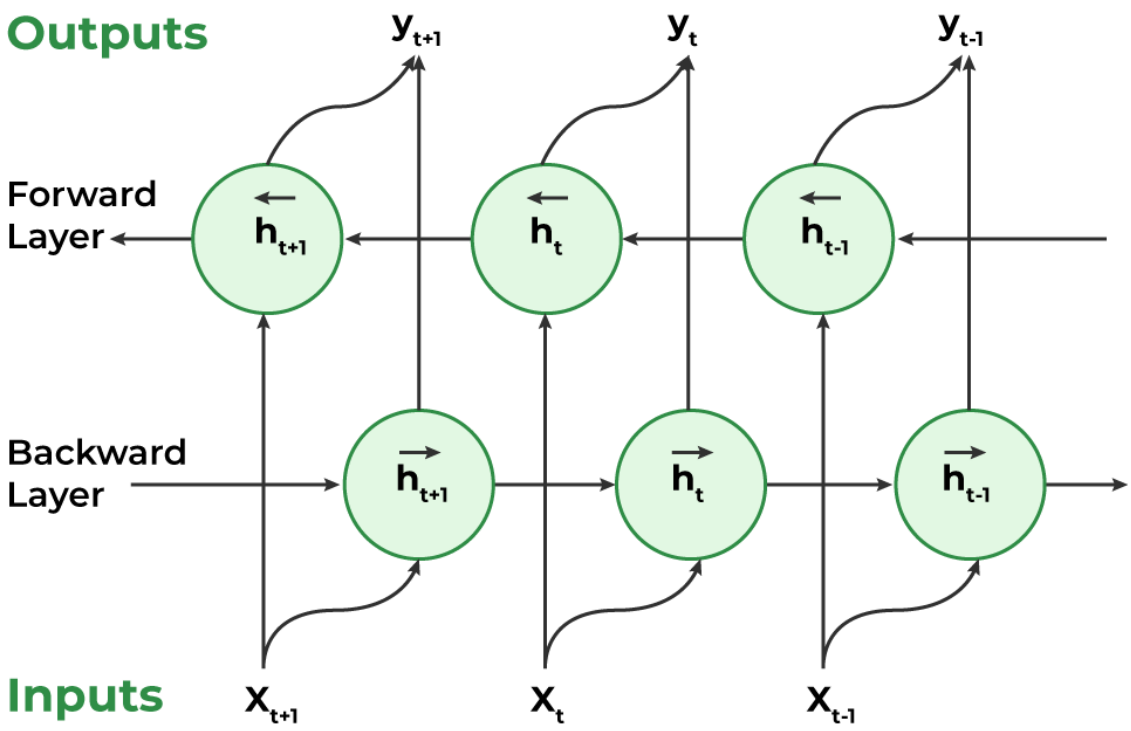
the sequence in reverse, updating the hidden state based on the current input and the hidden state of the next time step.

Compared to unidirectional RNNs BRNNs improve accuracy by considering both the past and future context. This is because the two hidden layers i.e forward and backward complement each other and predictions are made using the combined outputs of both layers.

Example:

Consider the sentence: "I like apple. It is very healthy."

In a traditional unidirectional RNN the network might struggle to understand whether "apple" refers to the fruit or the company based on the first sentence. However a BRNN would have no such issue. By processing the sentence in both directions, it can easily understand that "apple" refers to the fruit, thanks to the future context provided by the second sentence ("It is very healthy.").



Working of Bidirectional Recurrent Neural Networks (BRNNs)

1. Inputting a Sequence: A sequence of data points each represented as a vector with the same dimensionality is fed into the BRNN. The sequence may have varying lengths.

2. Dual Processing: BRNNs process data in two directions:

- **Forward direction**: The hidden state at each time step is determined by the current input and the previous hidden state.
- **Backward direction**: The hidden state at each time step is influenced by the current input and the next hidden state.

3. Computing the Hidden State: A non-linear activation function is applied to the weighted sum of the input and the previous hidden state creating a memory mechanism that allows the network to retain information from earlier steps.

4. Determining the Output: A non-linear activation function is applied to the weighted sum of the hidden state and output weights to compute the output at each step. This output can either be:

- The final output of the network.
- An input to another layer for further processing.