19CST302 - Neural Networks & Deep Learning

Back propagation Networks

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Definition

Backpropagation is an algorithm used to train neural networks by efficiently computing the gradients of the loss function with respect to the network's parameters (weights and biases).

It involves propagating the error backward through the network, layer by layer, to compute the gradients using the chain rule of calculus.

Overview

The primary purpose of backpropagation is to enable neural networks to learn from training data by adjusting their parameters to minimize the discrepancy between predicted outputs and actual outputs. By computing the gradients of the loss function, backpropagation guides the optimization process, allowing the network to iteratively update its parameters and improve performance.

Loss Computation

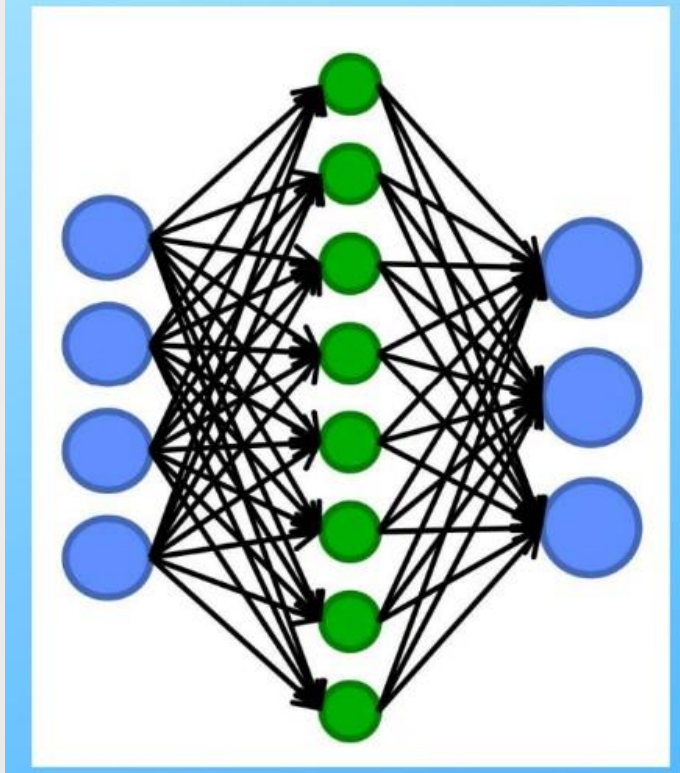
- The loss function quantifies the discrepancy between predicted outputs and actual outputs for a given set of input data. It serves as a measure of the network's performance on the training data.
- The loss function computes the difference between predicted outputs generated by the network and the true labels provided in the training data. This discrepancy represents the prediction error that the network aims to minimize during training.

Backward Pass

The backward pass involves propagating the error or loss backward through the network to compute gradients of the loss function with respect to the network's parameters. This step is crucial for guiding parameter updates and optimizing model performance.

Backpropagation

Learning algorithms use backpropagation to:



- Compute a gradient descent with respect to weights.
- Comparing outputs to desired system outputs.
- Adjust connection weights to narrow the difference between the two.

Types of Backpropagation

- **Static backpropagation:** Static backpropagation is a network developed to map static inputs for static outputs. Static networks can solve static classification problems, such as optical character recognition (OCR).
- **Recurrent backpropagation:** The recurrent backpropagation network is used for fixed-point learning. This means that during neural network training, the weights are numerical values that determine how much nodes -- also referred to as neurons -- influence output values. They're adjusted so that the network can achieve stability by reaching a fixed value.

Advantages

- They don't have any parameters to tune except for the number of inputs.
- They're highly adaptable and efficient, and don't require prior knowledge about the network.
- They use a standard process that usually works well.
- They're user-friendly, fast and easy to program.
- Users don't need to learn any special functions.

Disadvantages

- They prefer a matrix-based approach over a mini-batch approach.
- Data mining is sensitive to noisy data and other irregularities. Unclean data can affect the backpropagation algorithm when training a neural network used for data mining.
- Performance is highly dependent on input data.
- Training is time- and resource-intensive.

Conclusion

In conclusion, backpropagation is a foundational algorithm in training neural networks, allowing them to learn from data and make accurate predictions. Its iterative computation of gradients guides parameter updates, optimizing model performance and enabling the development of sophisticated AI systems. Understanding the mechanics of backpropagation is crucial for effectively training neural network models and leveraging their capabilities in solving real-world problems.