Artificial Neural Networks

Artificial neural networks (ANNs) are computational models inspired by the structure and function of biological brains. They consist of interconnected nodes or neurons arranged in layers. An input layer receives data, one or more hidden layers process the information, and an output layer generates the final results. Each neuron has an activation function that determines its output based on the weighted sum of its inputs.

During the training process, the network is fed a large dataset of labeled examples. The weights associated with connections between neurons are iteratively adjusted using algorithms like backpropagation. This adjustment aims to minimize the error between the network's predicted output and the known correct output. Over time, the network learns to recognize complex patterns within the data.

ANNs have revolutionized fields like computer vision, speech recognition, and natural language processing. Convolutional neural networks (CNNs) excel at image classification tasks due to their ability to extract spatial features. Recurrent neural networks (RNNs), particularly those with long short-term memory (LSTM) units, are adept at handling sequential data like time series or text.

However, ANNs also have limitations. They often require vast amounts of training data and can be computationally expensive. Their decision-making process can lack interpretability, leading to the "black box" phenomenon. As research progresses, advancements focus on improving the efficiency, explainability, and robustness of these powerful machine learning models.