Fundamentals of Artificial Neural Networks

An Artificial Neural Network (ANN) is a computational model inspired by the biological neural networks that constitute animal brains [1]. The foundational unit of an ANN is the perceptron, which applies a non-linear activation function to a weighted sum of inputs (Rosenblatt, 1958).

The basic feedforward formula is defined mathematically as: $y = f(w * x + b)$

During the training phase, the network adjusts its internal weights to minimize the prediction error. The mean squared error for a single output is calculated using the following equation: $E = 0.5 * (t - y)^2$

To optimize these weights, the network utilizes an algorithm called backpropagation. Backpropagation computes the gradient of the loss function with respect to the weights of the network [2]. This mathematical optimization process allows the model to learn complex, multi-dimensional representations of data (LeCun, 2015).

References: [1] McCulloch, W. S., & Pitts, W. (1943). A logical calculus of the ideas immanent in nervous activity. [2] Rumelhart, D. E., Hinton, G. E., & Williams, R. J. (1986). Learning representations by back-propagating errors. (Rosenblatt, 1958) Rosenblatt, F. The perceptron: A probabilistic model for information storage and organization in the brain. (LeCun, 2015) LeCun, Y., Bengio, Y., & Hinton, G. Deep learning. Nature 521.