Neural Networks with Python and TensorFlow

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Brief History

The design of artificial neural networks were initially inspired by biological neurons. The first mathematical models of neurons was created by McCulloch and Pitts, 1943, using a simple activation rule: if at least one excitatory connection is active and all inhibitory connections are inactive, the cell will be active.

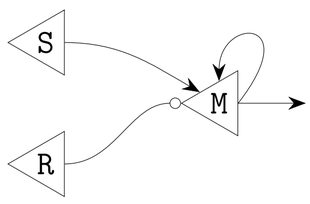

Figure 1: Example SR Flip-Flop using McCulloch's neurons.

Later, a concept called the perceptron was built by Rosenblatt, 1958. The perceptron consisted of a number of photovoltaic cells, which connected to a number of association cells, which then connected to a number of response cells.
Each photovoltaic cell was connected to every association cell, and each association cell was connected to every response cell, this kind of connectivity is referred to a being densely connected. The output of each association cell was a boolean value based on the weighted sum of the input values, where the weights are automatically adjusted by the perceptron.

Modern Neural Networks

The most common architecture for artificial neurons was outlined by McClelland, Rumelhart, and Group, 1986, where the activation is given by

$$y_i = \phi\left(b_i + \sum_j w_{i,j} x_j\right),$$

where x_j is the j^{th} input, $w_{i,j}$ is the connection weight from j to i, b_i is the input bias, and ϕ is some activation function. Learning is performed using a technique called backpropagation, which applies the chain rule to differentiate an value function with respect to each weight.

Curve Fitting

An implementation of a neural network was written in python to predict the values of houses within Boston, based on three attributes: number of rooms, highway accessibility, and percentage of lower status population. The network consisted of three input neurons and one output neuron, using tanh as the activation function.

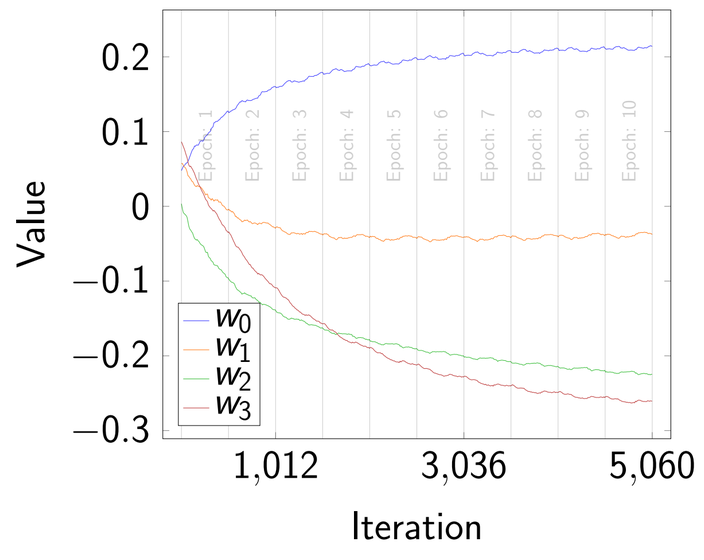

Figure 2: Network weights against iteration number.

Bibliography

- McClelland, James L, David E Rumelhart, PDP Research Group, et al. (1986). "Parallel distributed processing". In: *Explorations in the Microstructure of Cognition* 2, pp. 216–271.
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- Rosenblatt, Frank (1958). "The perceptron: a probabilistic model for information storage and organization in the brain." In: *Psychological review* 65.6, p. 386. DOI: 10.1037/h0042519.