

Brief history of neural networks and a perceptron implementation

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I. INTRODUCTION

There are several applications for Neural Networks nowadays and seems to be a new technology made no so much ago, but it's origins can be found between 1897 and 1904. When Santiago Ramón y Cajal published "*Histologie du système nerveux de l'homme et des vertébrés*" where brain cells were mentioned and described as the basic element of the nervous system; starting a new interest and acceptance over the "Neuron Doctrine" extending itself into ANN investigation.

II. MATHEMATICAL MODEL OF THE NEURON

With the "Neuron Doctrine" popularity the need of knowledge of neuron's inner behaviour inspired the creation of models intended to comprehend the electrical communication from electrical excitation to signal sending.

In 1943 McCulloch and Pitts [4] proposed the first model of a neuron described as a binary element with different weighed inputs $x_k w_k$ whose sum added to the bias (threshold) θ is evaluated by a nonlinear function $S(\cdot)$ called activation function or transfer function and giving the "desired" output O .

So, for any j -th neuron, the mathematical representation is given by the following expression.

$$O_j = S \left(\sum_{k=1}^n w_{jk} x_{jk} - \theta \right) \quad (1)$$

Graphically we can represent it by the following scheme.

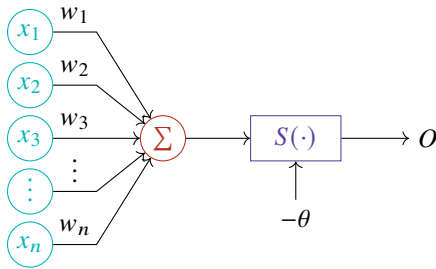


Fig. 1. First neuron model.

III. THE FIRST PERCEPTRON

The first algorithm based on the neuron model was made in 1958 and its implementation was conceived with the "Perceptron Mark I" by Rosenblatt. This algorithm was made for image recognition using potentiometers, and motors to modify each potentiometer's value.



Fig. 2. In 1957, Frank Rosenblatt built the Mark I Perceptron at the Cornell Aeronautical Laboratory [8].

A. The perceptron algorithm

Suppose any desired output Y_j for the j -th neuron, and for each iteration t the algorithm follows the operations below:

$$O_j(t) = \text{sign} \left(\sum_{k=1}^n w_k(t) x_{jk} \right) \quad (2)$$

$$\epsilon_j(t) = \frac{\sum_1^n |Y_j - O_j(t)|}{N} \quad (3)$$

$$w_j(t+1) \leftarrow w_j(t) - (Y_j - O_j(t)) r \quad (4)$$

Where Eq. 2 the output, Eq. 3 computes the error and Eq. 4 the weights update at iteration t .

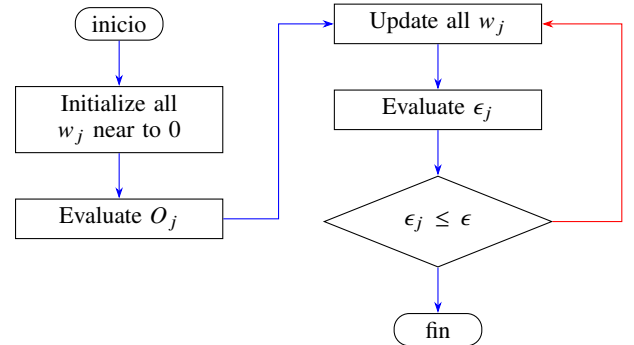


Fig. 3. Flowchart that describes Rosenblatt's perceptron algorithm.

Something important to keep in mind it that it's convergence depends on that the classes should be linearly separables.

B. Activation, update and error functions

During this period, and until today, there are different approaches to neural network implementations trying to optimize it's learning, and classifying performance.

Adaline (ADAPtive Linear Neuron Element) is a neural network developed by Widrow and Hoff, which was mainly for noise reduction, adaptive filtering, echo reduction, among other applications. Widrow and Hoff proposed LMS (Least Mean Squares) algorithm.

About activation functions, there are different activation functions we can use, such as **sign**, **sigmoid**, **gaussian**, etc. Also, some functions were defined in the search of the less loss activation functions such as **ReLU**.

IV. A PERCEPTRION IMPLEMENTATION

The implementation will be reported in the complement implemented by Quarto [7, 5, 6], which you can find aside this document.

The code is not optimized in order to get a legible representation of each part described here.

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