Perceptron

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1958 New York Times...

NEW NAVY DEVICE LEARNS BY DOING

Psychologist Shows Embryo of Computer Designed to Read and Grow Wiser

WASHINGTON, July 7 (UPI) —The Navy revealed the embryo of an electronic computer today that it expects will be able to walk, talk, see, write, reproduce itself and be conscious of its existence.

The embryo—the Weather Bureau's $2,000,000 "704" computer—learned to differentiate between right and left after fifty attempts in the Navy's demonstration for newsmen.

The service said it would use this principle to build the first of its Perceptron thinking machines that will be able to read and write. It is expected to be finished in about a year at a cost of $100,000.

Dr. Frank Rosenblatt, designer of the Perceptron, conducted the demonstration. He said the machine would be the first device to think as the human brain. As do human beings, Perceptron will make mistakes at first, but will grow wiser as it gains experience, he said.

Dr. Rosenblatt, a research psychologist at the Cornell Aeronautical Laboratory, Buffalo, said Perceptrons might be fired to the planets as mechanical space explorers.

Without Human Controls

The Navy said the perceptron would be the first non-living mechanism "capable of receiving, recognizing and identifying its surroundings without any human training or control."

The "brain" is designed to remember images and information it has perceived itself. Ordinary computers remember only what is fed into them on punch cards or magnetic tape.

Later Perceptrons will be able to recognize people and call out their names and instantly translate speech in one language to speech or writing in another language, it was predicted.

Mr. Rosenblatt said in principle it would be possible to build brains that could reproduce themselves on an assembly line and which would be conscious of their existence.

In today's demonstration, the "704" was fed two cards, one with squares marked on the left side and the other with squares on the right side.

Learns by Doing

In the first fifty trials, the machine made no distinction between them. It then started registering a "Q" for the left squares and "O" for the right squares.

Dr. Rosenblatt said he could explain why the machine learned only in highly technical terms. But he said the computer had undergone a "self-induced change in the wiring diagram."

The first Perceptron will have about 1,000 electronic "association cells" receiving electrical impulses from an eye-like scanning device with 400 photo-cells. The human brain has 10,000,000,000 responsive cells, including 100,000,000 connections with the eyes.

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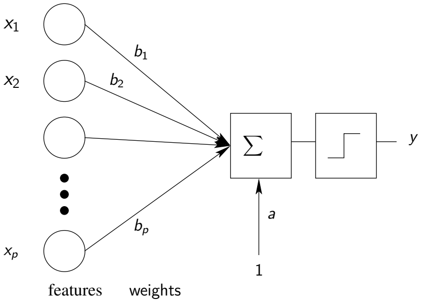
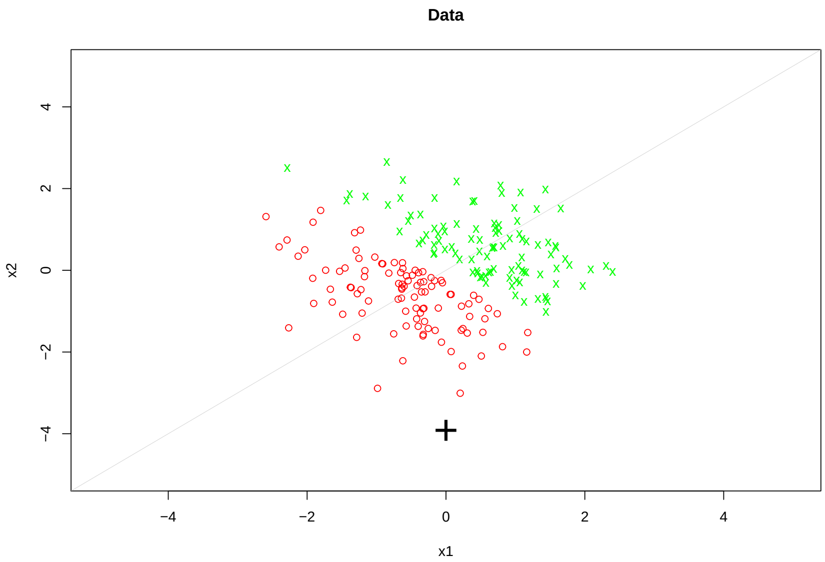
Frank Rosenblatt

Represenation with perceptron

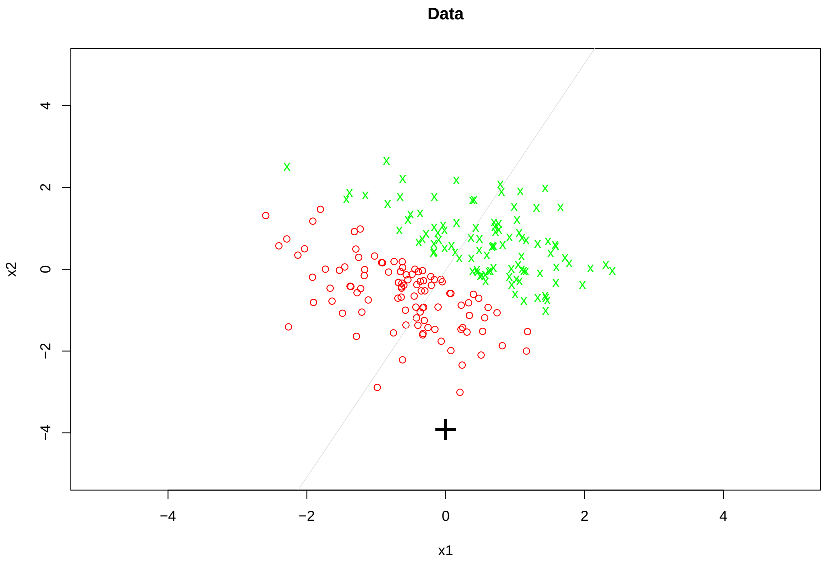


$$\text{Predict} \begin{cases} y = 1 & \text{if } a + \sum_{j=1}^{p} b_j x_j \geq 0 \\ y = 0 & \text{if } a + \sum_{j=1}^{p} b_j x_j < 0 \end{cases}$$

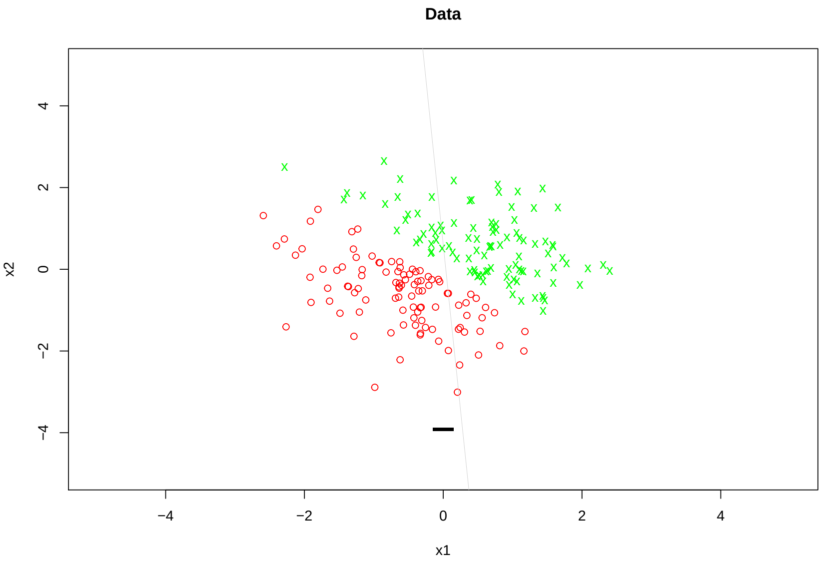
$$\text{Model } f(x) = \mathrm{sign}(a + \sum_{j=1}^{p} b_j x_j)$$


Data
x1
x2
−4
−2
0
2
4

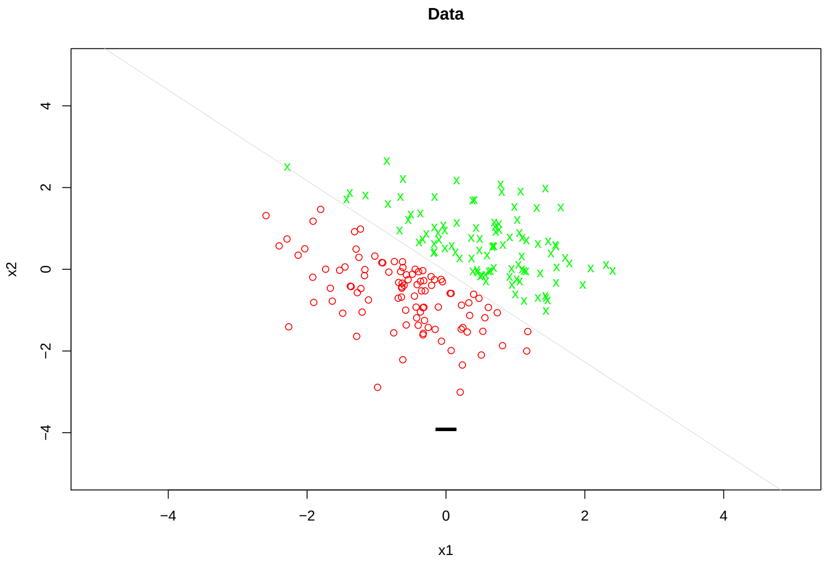
Iteration 1



Iteration 2



Iteration 10



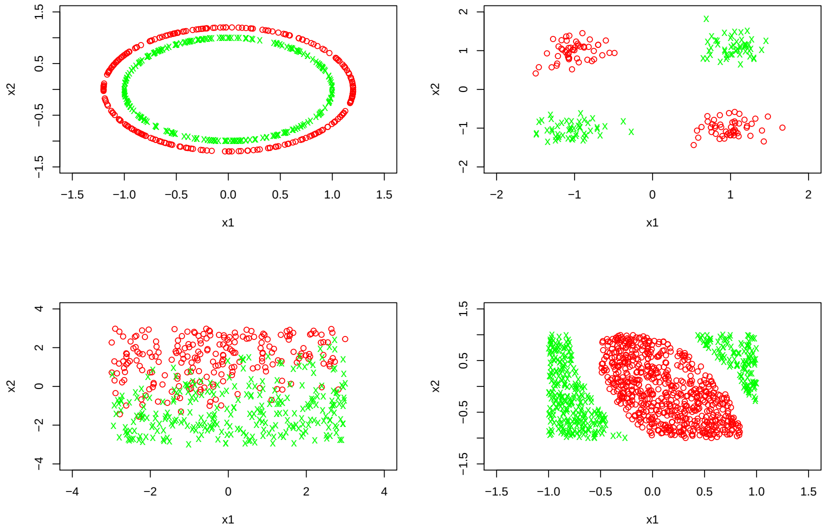
Perceptron Algorithm

Initialize $a, b_1, \ldots, b_p$ randomly or set to some value
repeat
    $g = (0, \ldots, 0)$
    for $i = 1{:}n$ **do**
        $u_i = a + \sum_{j=1}^{p} b_j \cdot x_j$
        if $y_i \cdot u_i < 0$ **then**
            $g = g - y_i \cdot x_i$
        end
    end
    $(a, b) = (a, b) - \eta \cdot g/N$
until *until train error* $= 0$;

η is the learning rate. We saw an example with $\eta = 1$.

Works well when data are linearly separable.

Data not-linearly separable



Perceptron Summary

- Works when data is linearly separable
- We can add non-linear features to make the problem separable
- Can be extended to multiple class classification
- Does not assign probability to our prediction