Introduction to neural networks

Introduction

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Frank Rosenblatt

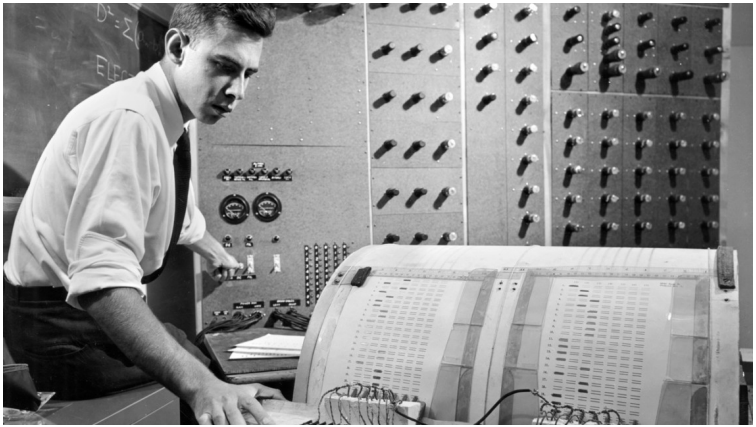
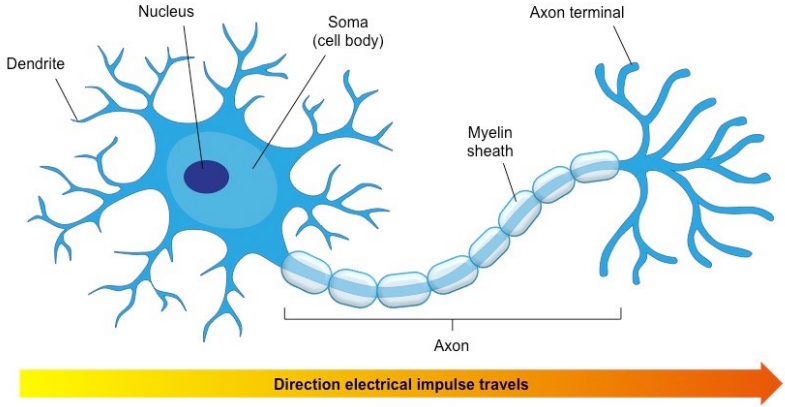


Figure: Frank Rosenblatt '50, Ph.D. '56, works on the "perceptron" [1]

[1] https://news.cornell.edu/stories/2019/09/professors-perceptron-paved-way-ai-60-years-too-soon

Neuron


Nucleus
Soma
(cell body)
Axon terminal
Dendrite
Myelin
sheath
Axon
Direction electrical impulse travels

Perceptron

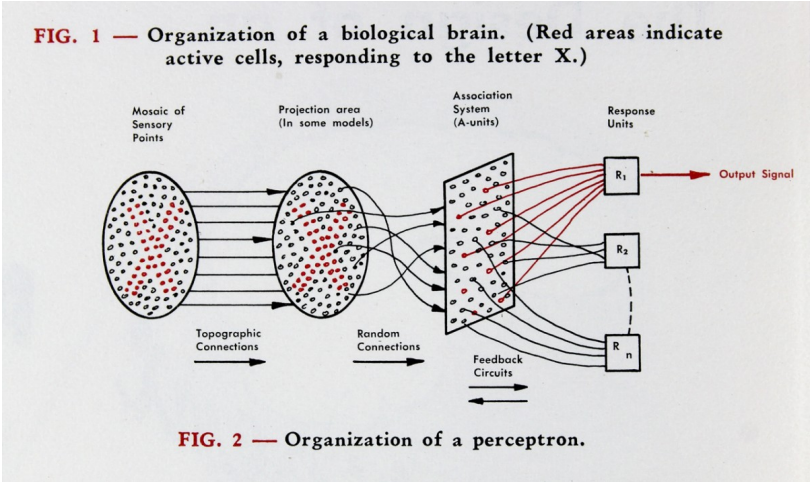


Figure: "The Design of an Intelligent Automaton," Summer 1958

Perceptron

- "Yet we are about to witness the birth of such a machine – a machine capable of perceiving, recognizing and identifying its surroundings without any human training or control." Rosenblatt
- "It is a mathematical function mapping some set of input values to output values"

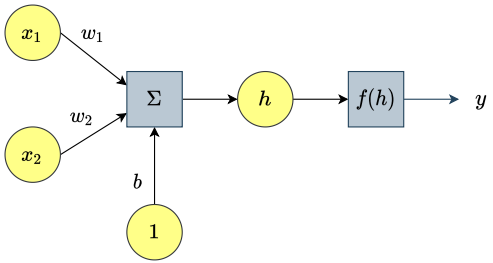


Figure: Perceptron

Perceptron

- Weights. Each input to a perceptron has an associated weight that represents its importance.

$$h = \sum_{i=1}^{n} w_i \cdot x_i \tag{1}$$

$$\hat{y} = f(h) \tag{2}$$

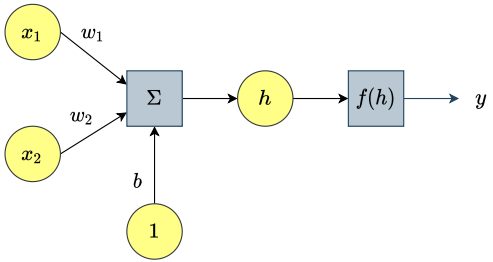
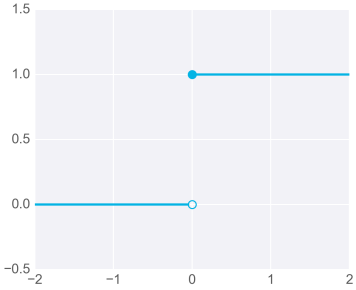
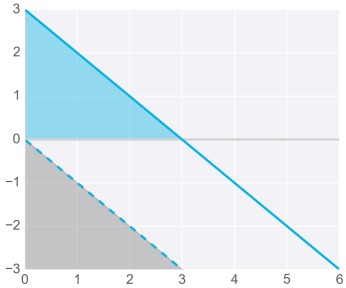


Figure: Perceptron

- Activation function $f(h)$.
- Heaviside step function.



- One way to get our function to return 1 for more inputs is to add a value to the results of our linear combination, called a bias.



Perceptron

- Full perceptron formula:

$$f(x_1, x_2, \ldots, x_n) = \begin{cases} 0 & \text{if } \sum w_i \cdot x_i + b < 0 \\ 1 & \text{if } \sum w_i \cdot x_i + b \geq 0 \end{cases} \tag{3}$$

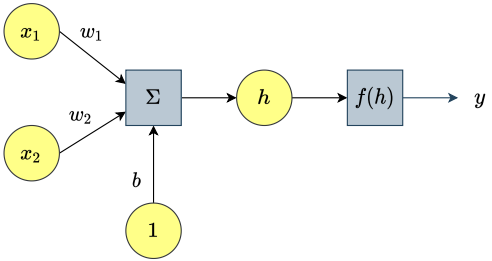


Figure: Perceptron

Amount of parameters

The amount of parameters is given by the sum of weights plus biases per layer.

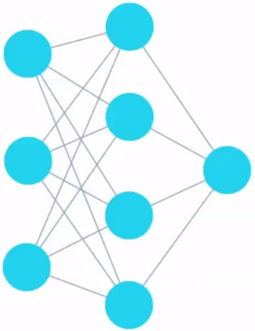
$$\Phi = \{w_1 \dots w_n, b\} \tag{4}$$

$$|\Phi| = n + 1 \tag{5}$$

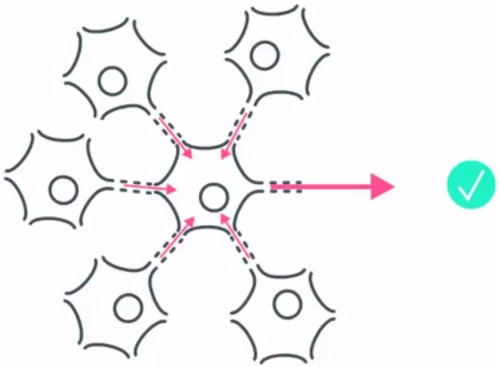
Excercise

- Build a perceptron for constructing the following functions:
  - Or
  - And
  - Not

A net of decisions



Neural Network



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