



MasonML

# Introduction to Neural Networks

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## Research Project Topics

### **Samuel Schmidgall (Theoretical Focus)**

- ▶ Deep Generative Models (ft. Emily Pho)
- ▶ Motion Planning using Deep Reinforcement Learning

### **Albert Lam**

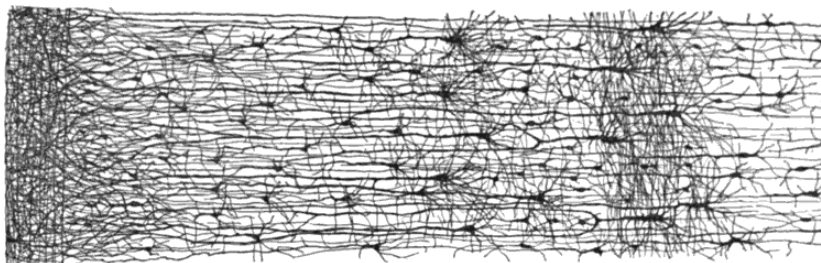
- ▶ Quantitative Finance

### **Carlos Guerra**

- ▶ Dimensionality Reduction

# What is a Neural Network?

A neural network is a population of neurons interconnected by synapses to carry out a specific function when activated. Neural networks interconnect to one another to form large scale brain networks.



# What is a Neural Network?

Neurons connect to each other through synapses, which propagate action potential (electrical impulses) by releasing neurotransmitters

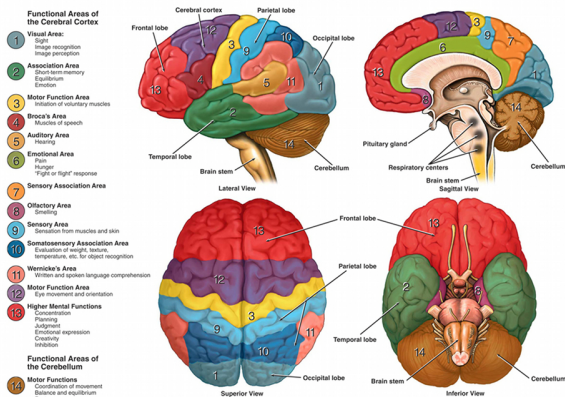
Learning occurs through the synapses' plasticity: They exhibit long term changes in the strength of connection between other neurons

There are about  $10^{11}$  Neurons in the human brain

Different areas of the brain develop different functionalities as a result of the emergent behavior that occurs between neurons (evolution).

We aren't sure how different functions are acquired.

### Anatomy and Functional Areas of the Brain



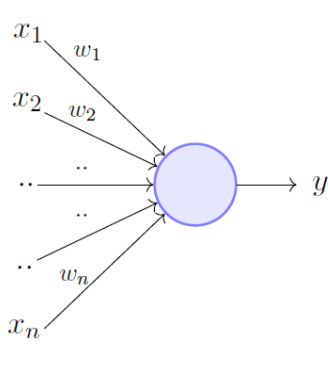
# What is an Artificial Neural Network?

The original design for the Neural Network was an attempt to write a program that mimics the 1960s idea of how a brain worked.

They were popular in the 80s and then their usage suddenly disappeared in the 90s. We'll talk about why soon.

# The Perceptron

The first successful model was proposed by McCulloch and Pitts



$$y = 1 \quad \text{if} \sum_{i=1}^n w_i * x_i \geq \theta$$
$$= 0 \quad \text{if} \sum_{i=1}^n w_i * x_i < \theta$$

Rewriting the above,

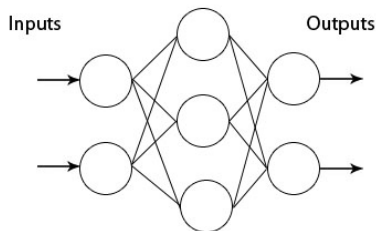
$$y = 1 \quad \text{if} \sum_{i=1}^n w_i * x_i - \theta \geq 0$$
$$= 0 \quad \text{if} \sum_{i=1}^n w_i * x_i - \theta < 0$$

What does this look like?



# The Hidden Layer

The next step in developing the perceptron was to add an extra layer between the inputs and the outputs. This is called the hidden layer.



(There is also a bias term for each neuron)

Universal Approximation

Neural Networks as Linear Function