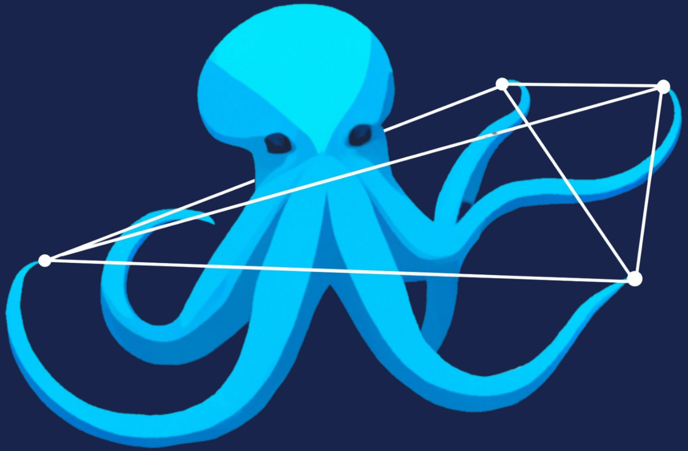
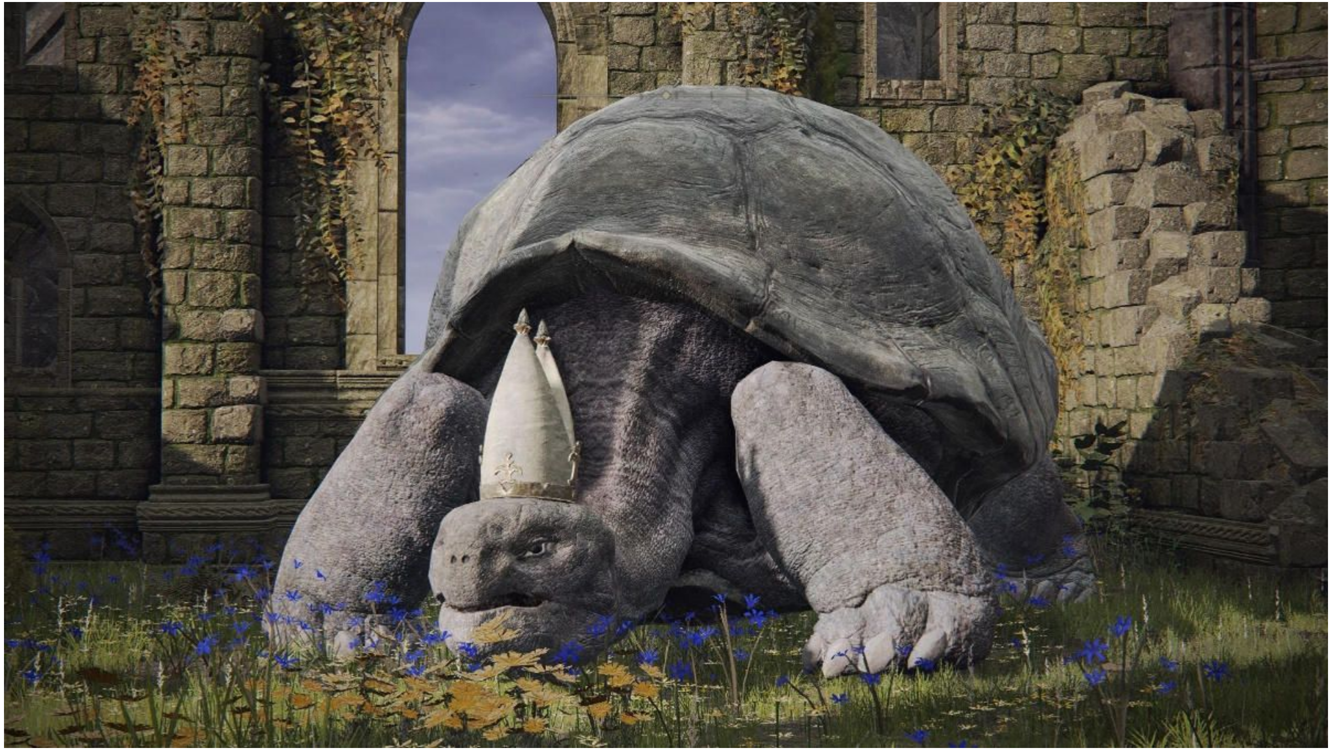


# Machine Learning Month

# Neural Networks with Tensorflow

# Plan for today

- 15:00 - 15:30 – Some Theory
- 15:30 - 16:00 – Some Practical Theory
- 16:00 - 16:15 – Break + QnA about the competition
- 16:15 - 17:00 – Practical



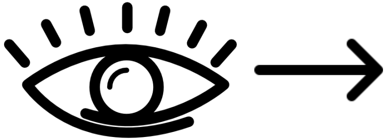
Could this be a dog?

# How do you know?

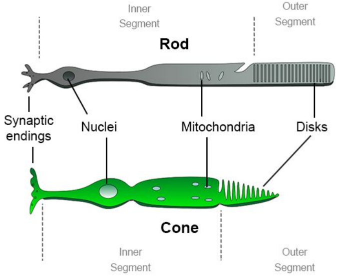
# How do you know?

Vision

# How do you know?

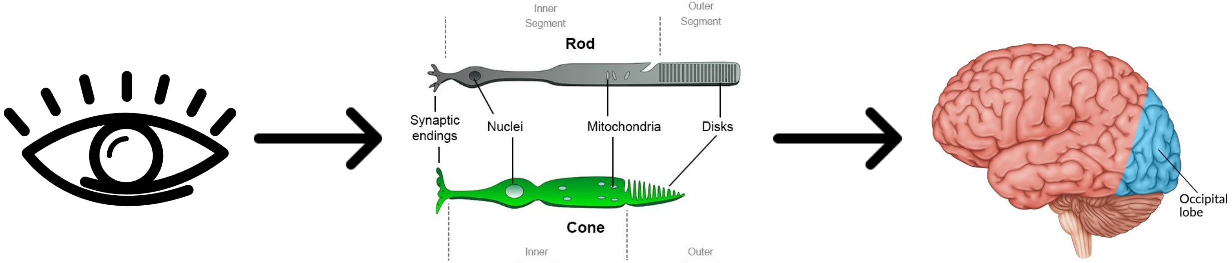


Vision



Edge detection

# How do you know?



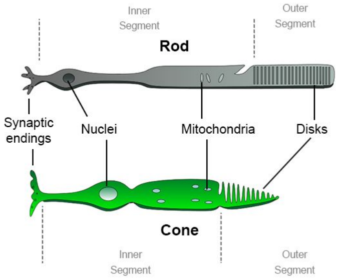
Vision

Edge detection

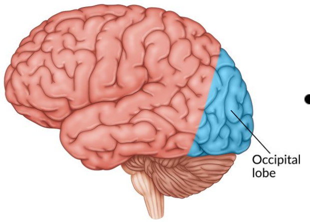
Feature extraction

# How do you know?

Vision



Edge detection



Feature extraction

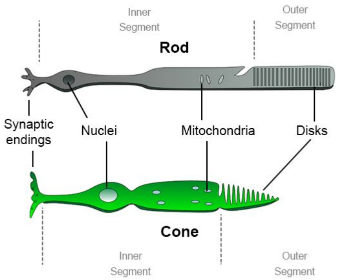
Answer

# Can a Machine do the same?

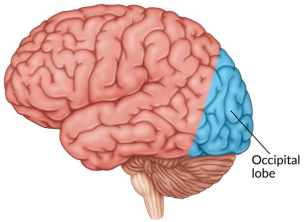
Yes!

# Science Power Go!

Vision →



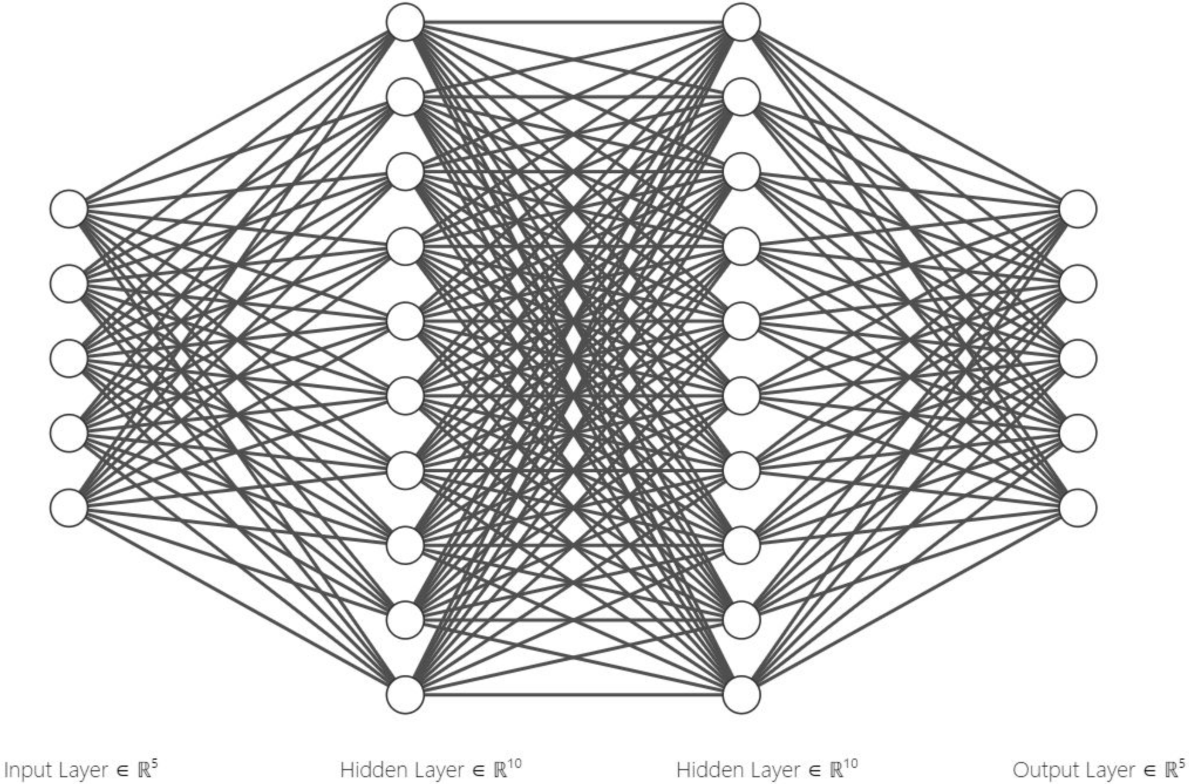
Edge detection →



Feature extraction →

Answer

# Neural Networks



# Welcome to the Third Lecture

Our Objectives:

- Overview of Neural Networks (NNs)
- Why should we use them?
- What are Keras and Tensorflow?
- NN Training
- Practical Session

# Overview of Neural Networks

# Why Neural Networks?

# Why Neural Networks?

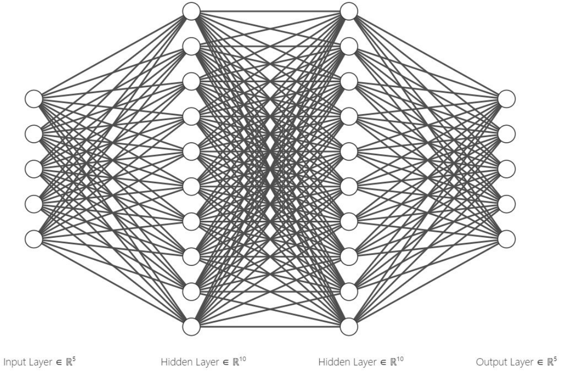
- Humans are smart! Can we copy them?

# When do we use NNs?

- We need high accuracy
- The data does not have an obvious pattern
- We have a LOT of data
- Explainability is not important

# What are Neural Networks?

- These are a series of algorithms that **attempt** to mimic the human brain


Input Layer ∈ $\mathbb{R}^5$
Hidden Layer ∈ $\mathbb{R}^{10}$
Hidden Layer ∈ $\mathbb{R}^{10}$
Output Layer ∈ $\mathbb{R}^5$

≈

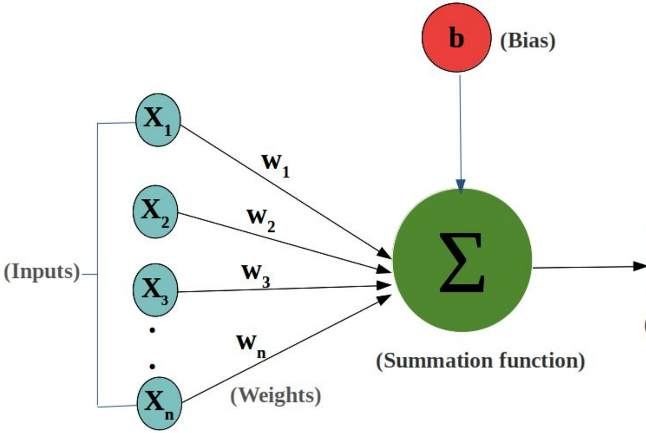
# Formally

- NNs are layers of nodes where each node can be expressed as the result of the previous layer.

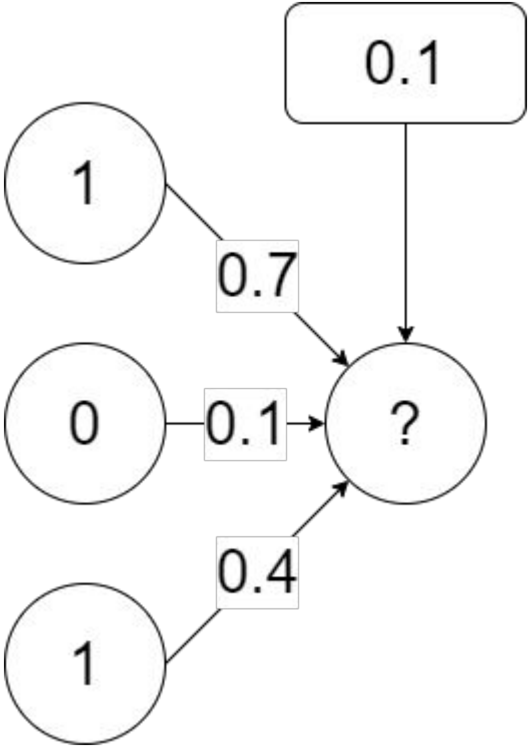
$$\sum_{i=1}^{m} w_i x_i + bias = w_1 x_1 + w_2 x_2 + w_3 x_3 + bias$$

# Weights and Biases

- The contribution of each neuron is known as a weight.
- There is also an offset value in a neuron known as a bias
- Together they determine if the neuron activates



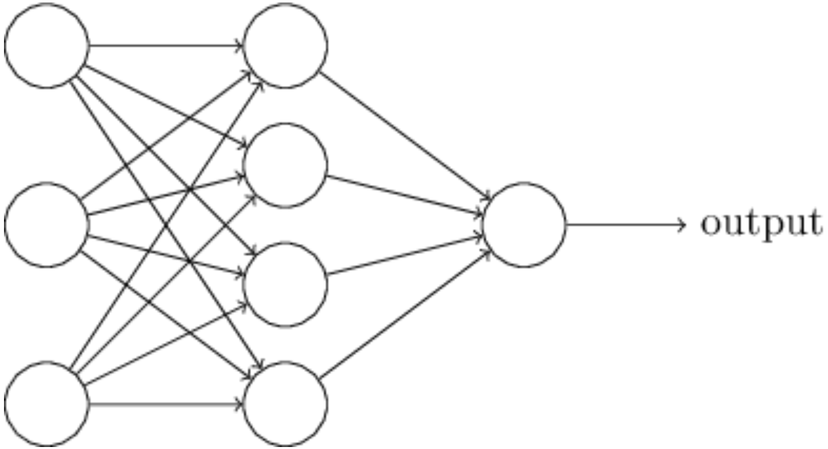
# Example:



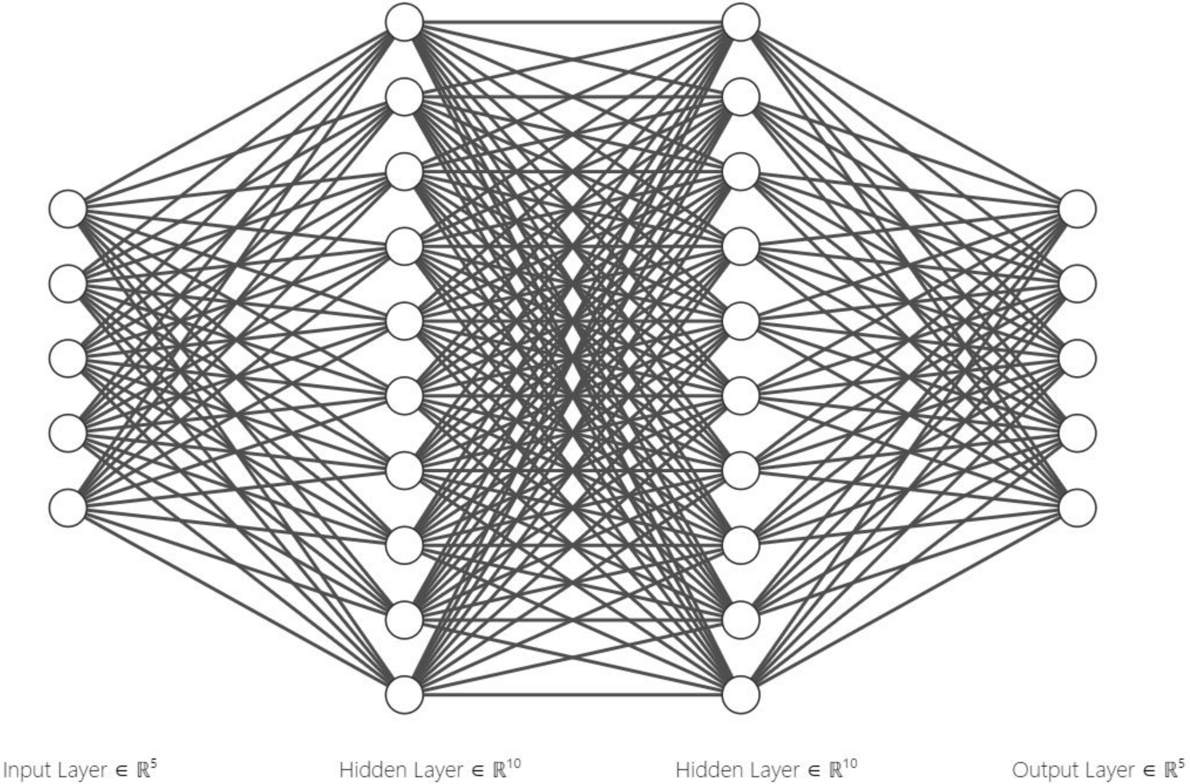
The neuron activates if a threshold of 1 is reached

# Fully Connected Neural Networks

- NN in which all nodes in one layer are connected to all nodes in the next layer

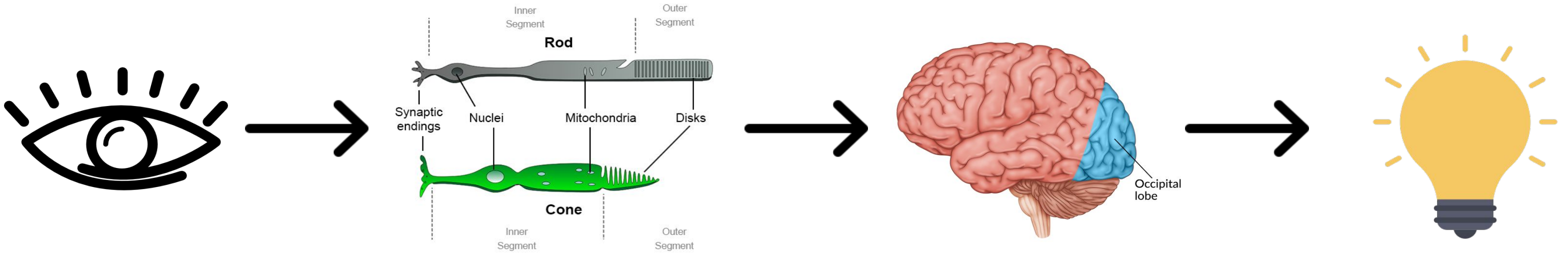


# Layers


Input Layer ∈ ℝ⁵
Hidden Layer ∈ ℝ¹⁰
Hidden Layer ∈ ℝ¹⁰
Output Layer ∈ ℝ⁵

# Idea

- Each subsequent layer in the Neural Network represents an increase in abstraction



Vision

Edge detection

Feature extraction

Answer

Increase in complexity

# Definitions

# Activation Functions

These determine whether or not a neuron fires

Examples:

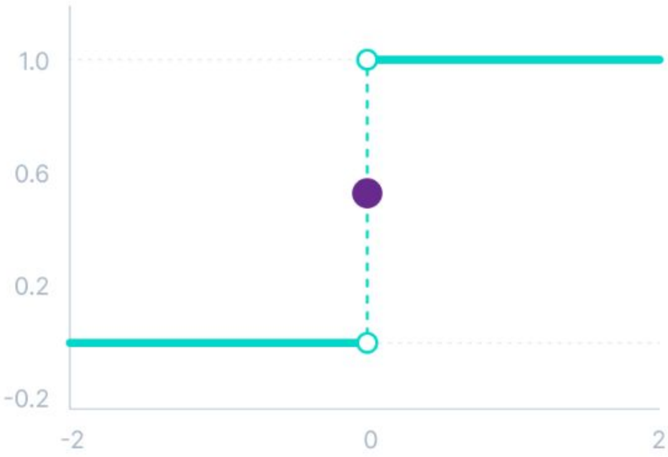
- Binary
- Linear
- Sigmoid
- ReLu

$$\sum_{i=1}^{m} w_i x_i + bias = w_1 x_1 + w_2 x_2 + w_3 x_3 + bias$$

Remember

# Binary

Binary Step Function

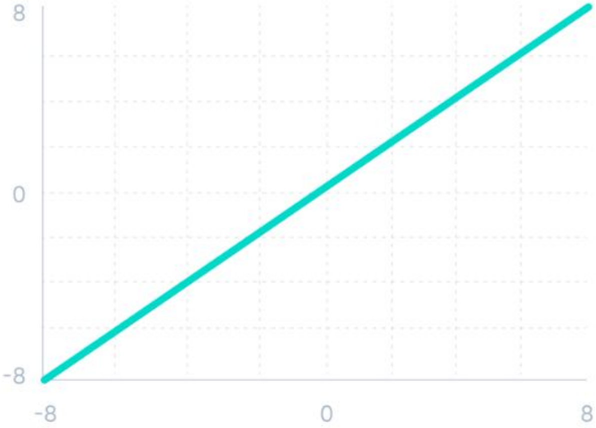


*Binary step*

$$f(x) = \begin{cases} 0 & for\ x < 0 \\ 1 & for\ x \geqslant 0 \end{cases}$$

# Linear

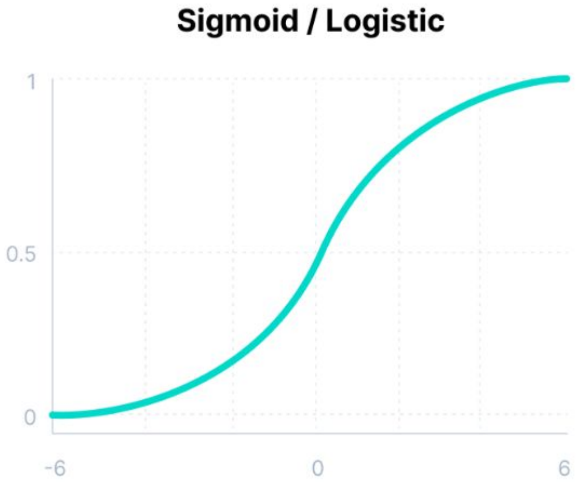
Linear Activation Function



*Linear*

$$f(x) = x$$

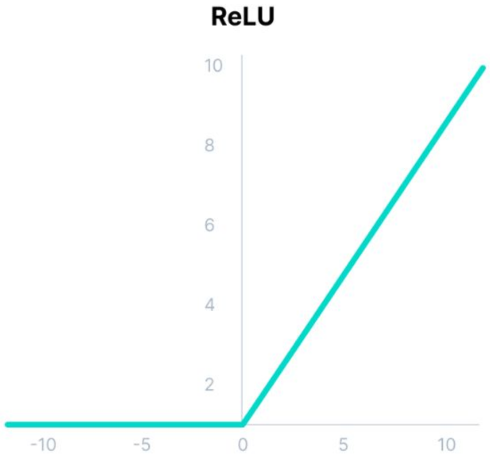
# Sigmoid



*Sigmoid / Logistic*

$$f(x) = \frac{1}{1 + e^{-x}}$$

# ReLu



*ReLU*

$$f(x) = max\ (0, x)$$

# Optimizers

These determine how we update the weights

Examples:

- Gradient Descent
- Stochastic Gradient Descent
- Adam
- RMS prop

# Optimizers

These determine how we update the weights

Examples:

- Gradient Descent
- Stochastic Gradient Descent
- Adam
- RMS prop

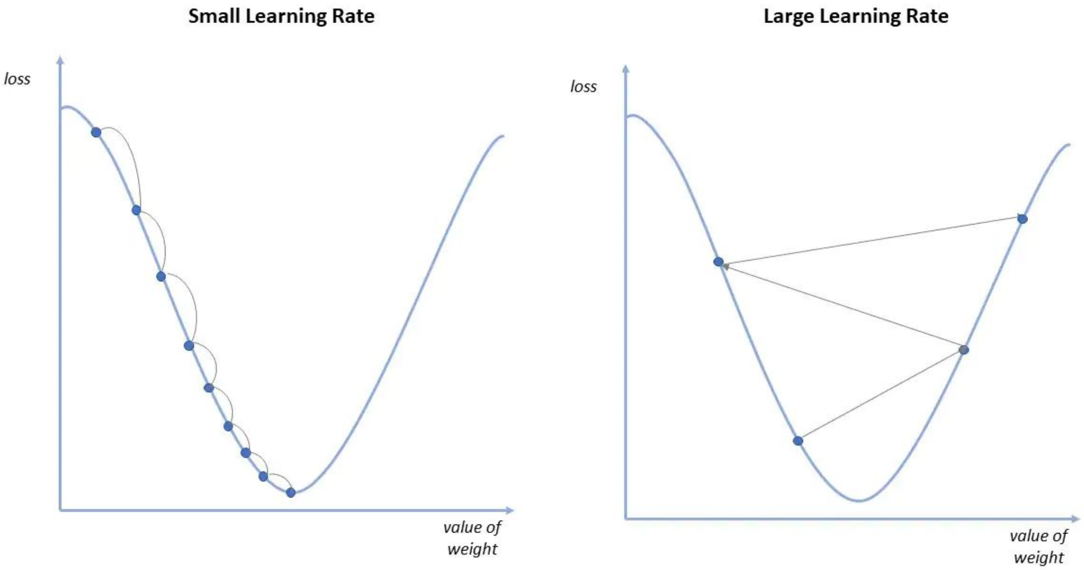
# Gradient Descent

- Minimizes error by calculating the slope of the loss function

$$W_{new} = W_{old} - \alpha * \frac{\partial(Loss)}{\partial(W_{old})}$$

α = Learning Rate
W = Neuron Weight
Loss = Loss function (MAE, MSE, Accuracy …)

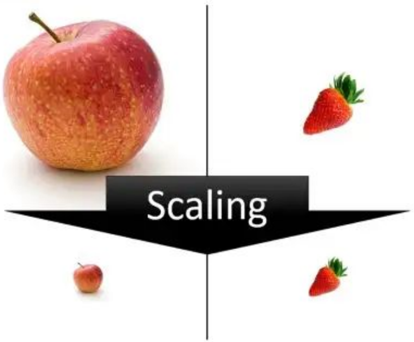
# We need to select a carefully



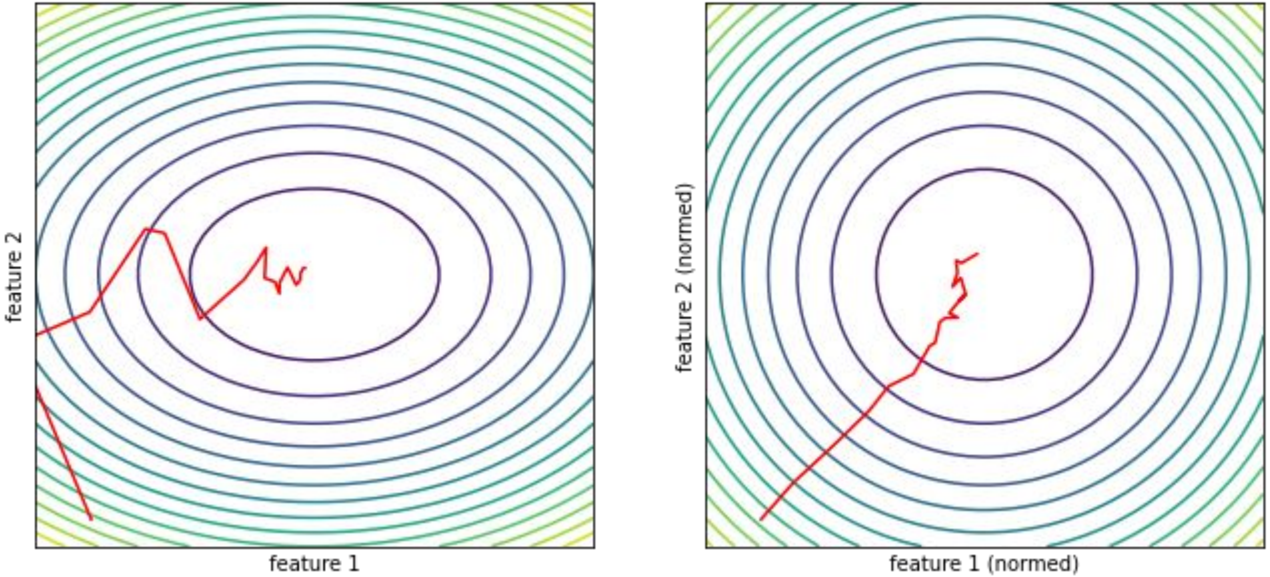
# Additional Pre-processing

# Scaling

- We should ensure that all data posses the same scale
- Otherwise, variables with greater distance between their values would given higher weightage



# Effect of Scaling



# Tools

# How will build NNs?

- Tensorflow is an open source python library created by Google

- Algorithms are implemented in C++ for blazing fast performance

TensorFlow

# How will build ANNs?

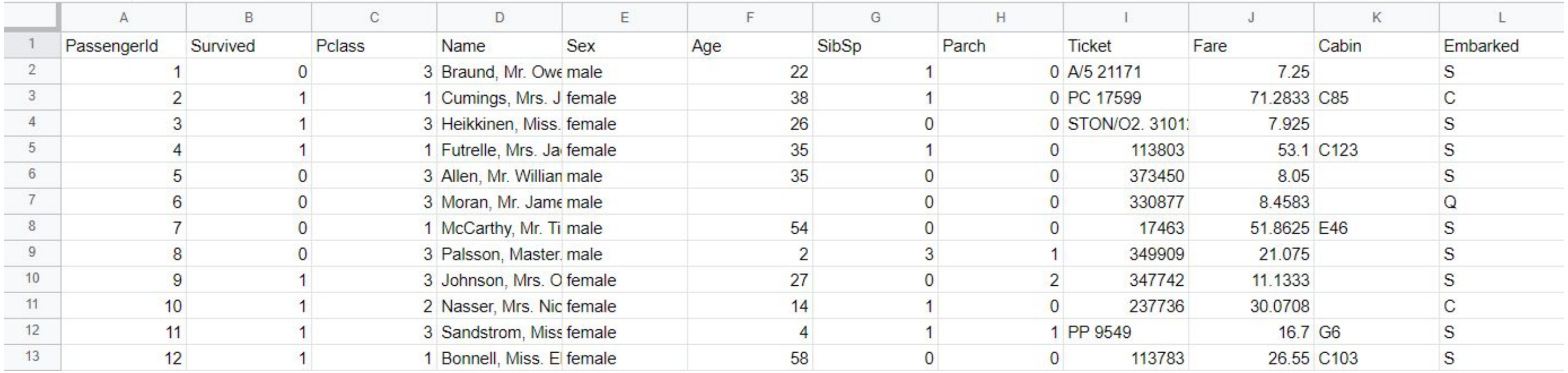
- Keras is a high level API for tensorflow

- It is designed to be human readable and simple

Keras

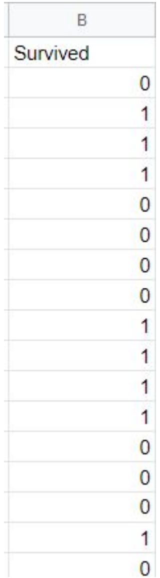
Easy to work with

# Let’s try an example



| | A | B | C | D | E | F | G | H | I | J | K | L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | PassengerId | Survived | Pclass | Name | Sex | Age | SibSp | Parch | Ticket | Fare | Cabin | Embarked |
| 2 | 1 | 0 | 3 | Braund, Mr. Owe | male | 22 | 1 | 0 | A/5 21171 | 7.25 | | S |
| 3 | 2 | 1 | 1 | Cumings, Mrs. J | female | 38 | 1 | 0 | PC 17599 | 71.2833 | C85 | C |
| 4 | 3 | 1 | 3 | Heikkinen, Miss. | female | 26 | 0 | 0 | STON/O2. 3101 | 7.925 | | S |
| 5 | 4 | 1 | 1 | Futrelle, Mrs. Ja | female | 35 | 1 | 0 | 113803 | 53.1 | C123 | S |
| 6 | 5 | 0 | 3 | Allen, Mr. Willian | male | 35 | 0 | 0 | 373450 | 8.05 | | S |
| 7 | 6 | 0 | 3 | Moran, Mr. Jame | male | | 0 | 0 | 330877 | 8.4583 | | Q |
| 8 | 7 | 0 | 1 | McCarthy, Mr. Ti | male | 54 | 0 | 0 | 17463 | 51.8625 | E46 | S |
| 9 | 8 | 0 | 3 | Palsson, Master. | male | 2 | 3 | 1 | 349909 | 21.075 | | S |
| 10 | 9 | 1 | 3 | Johnson, Mrs. O | female | 27 | 0 | 2 | 347742 | 11.1333 | | S |
| 11 | 10 | 1 | 2 | Nasser, Mrs. Nic | female | 14 | 1 | 0 | 237736 | 30.0708 | | C |
| 12 | 11 | 1 | 3 | Sandstrom, Miss | female | 4 | 1 | 1 | PP 9549 | 16.7 | G6 | S |
| 13 | 12 | 1 | 1 | Bonnell, Miss. E | female | 58 | 0 | 0 | 113783 | 26.55 | C103 | S |

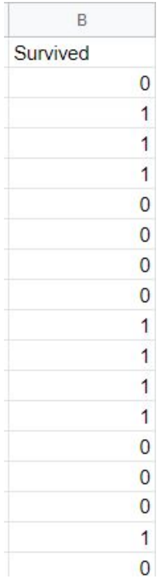
# Analysis



| B |
|---|
| Survived |
| 0 |
| 1 |
| 1 |
| 1 |
| 0 |
| 0 |
| 0 |
| 0 |
| 1 |
| 1 |
| 1 |
| 1 |
| 0 |
| 0 |
| 0 |
| 1 |
| 0 |

# Analysis

- Our target is binary
- It does not make sense for a person to be 0.4 alive
- We need to re-evaluate our methods

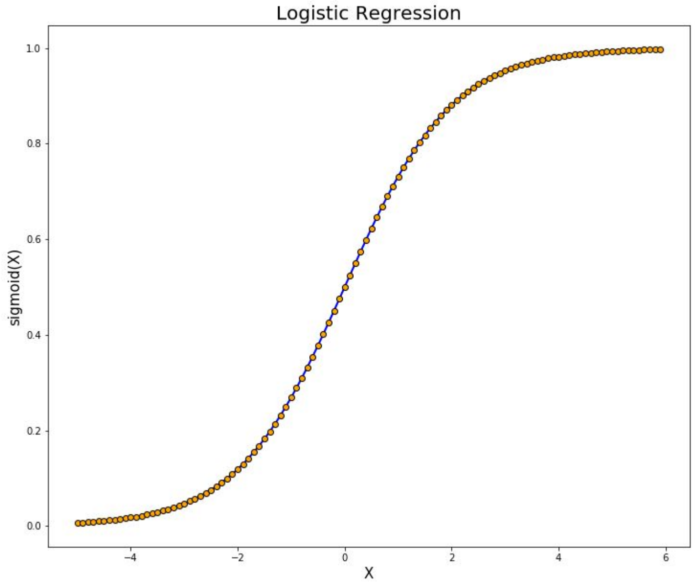


| B |
|---|
| Survived |
| 0 |
| 1 |
| 1 |
| 1 |
| 0 |
| 0 |
| 0 |
| 0 |
| 1 |
| 1 |
| 1 |
| 1 |
| 0 |
| 0 |
| 0 |
| 1 |
| 0 |

# Logistic Regression

- What if we calculated the probability of an item being a value?

- If P(alive) > P(dead), then let the person be alive



# How do we do it in Keras?

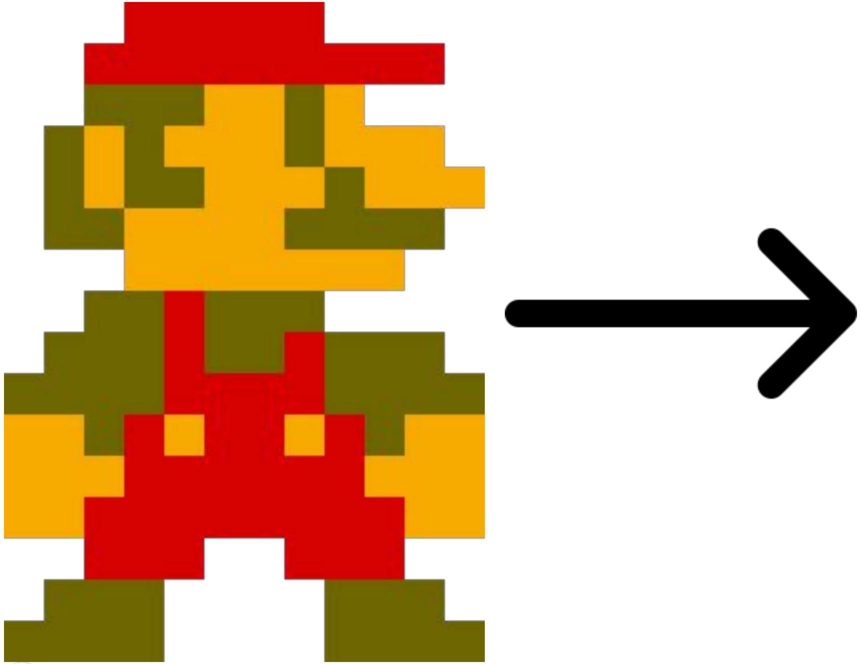
Refer to Colab Notebook

# Practice Session

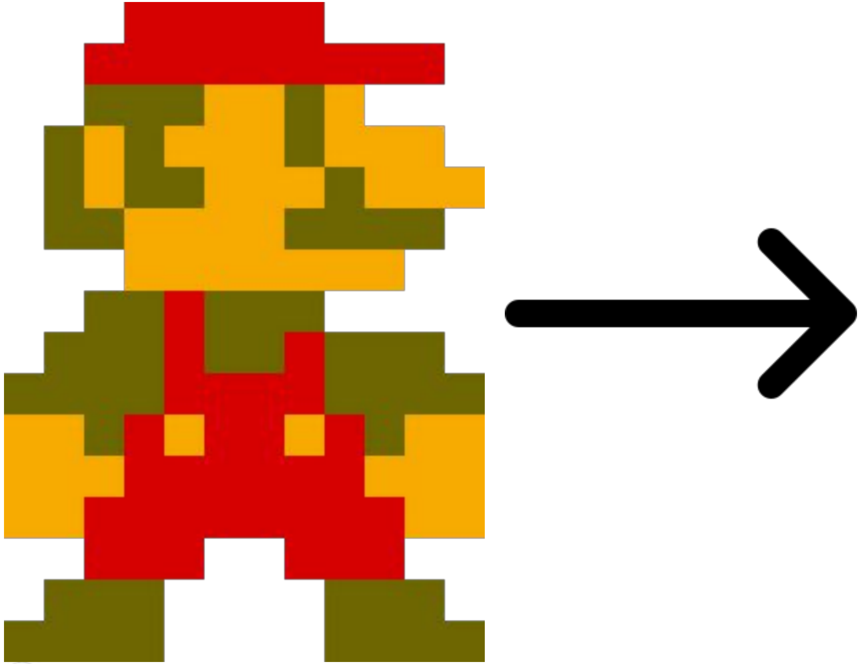
# Let’s build an image classifier

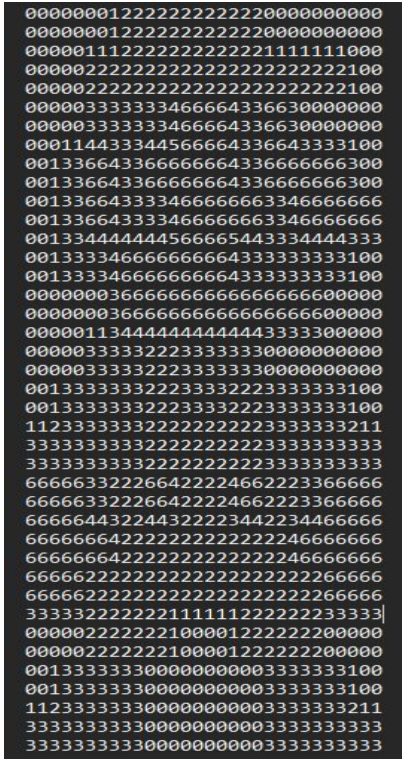
## But How?

# How do we represent images?



# Images as 2d arrays





```
000000012222222222220000000000
000000012222222222220000000000
000001112222222222221111111000
000002222222222222222222222100
000002222222222222222222222100
000003333333466664336630000000
000003333333466664336630000000
000114433344566664336643333100
001336643366666664336666666300
001336643366666664336666666300
001336643333466666663346666666
001336643333466666663346666666
001334444444566665443334444333
001333346666666664333333333100
001333346666666664333333333100
000000036666666666666666600000
000000036666666666666666600000
000001134444444444443333300000
000003333322233333330000000000
000003333322233333330000000000
001333333322233332223333333100
001333333322233332223333333100
112333333322222222223333333211
333333333322222222223333333333
333333333322222222223333333333
666663322266422224662223366666
666663322266422224662223366666
666664432244322223442234466666
666666642222222222222246666666
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333332222222111111222222233333
000002222222100001222222200000
000002222222100001222222200000
001333333300000000003333333100
001333333300000000003333333100
112333333300000000003333333211
333333333300000000003333333333
333333333300000000003333333333
```
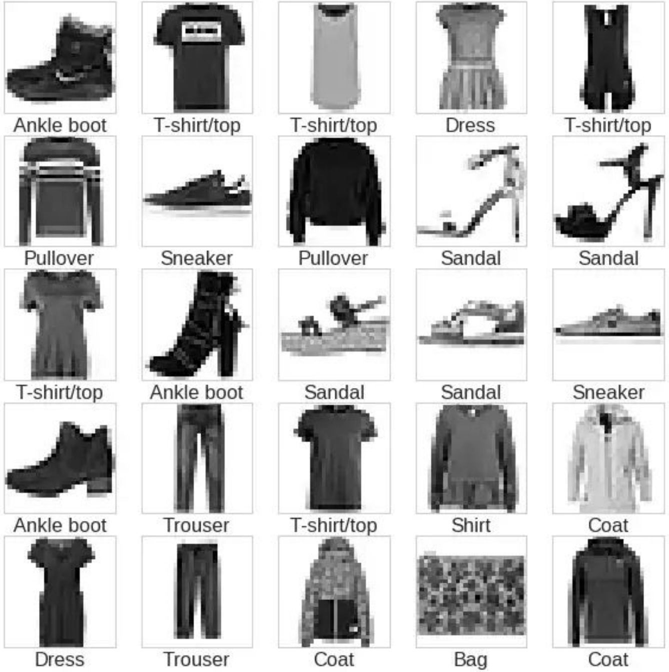
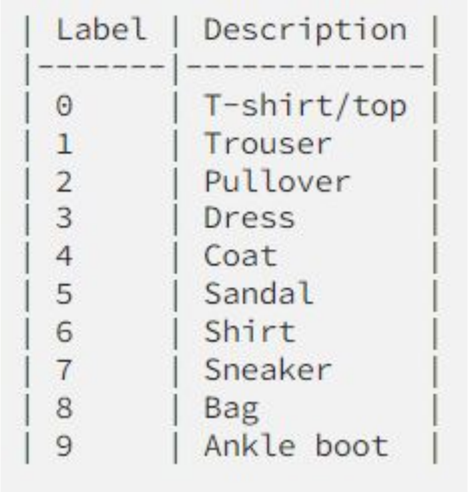

# Clothing Identification

- Dataset - Fashion MNIST
- 28 * 28 Pixels
- Grayscale (0 - 255)





| Label | Description |
|-------|-------------|
| 0 | T-shirt/top |
| 1 | Trouser |
| 2 | Pullover |
| 3 | Dress |
| 4 | Coat |
| 5 | Sandal |
| 6 | Shirt |
| 7 | Sneaker |
| 8 | Bag |
| 9 | Ankle boot |

# Practical Time

Link to Notebook

# Reminder!

## Deadline: 7th December

# Thank you for your attention!

Do you have any more questions? Join our Discord server