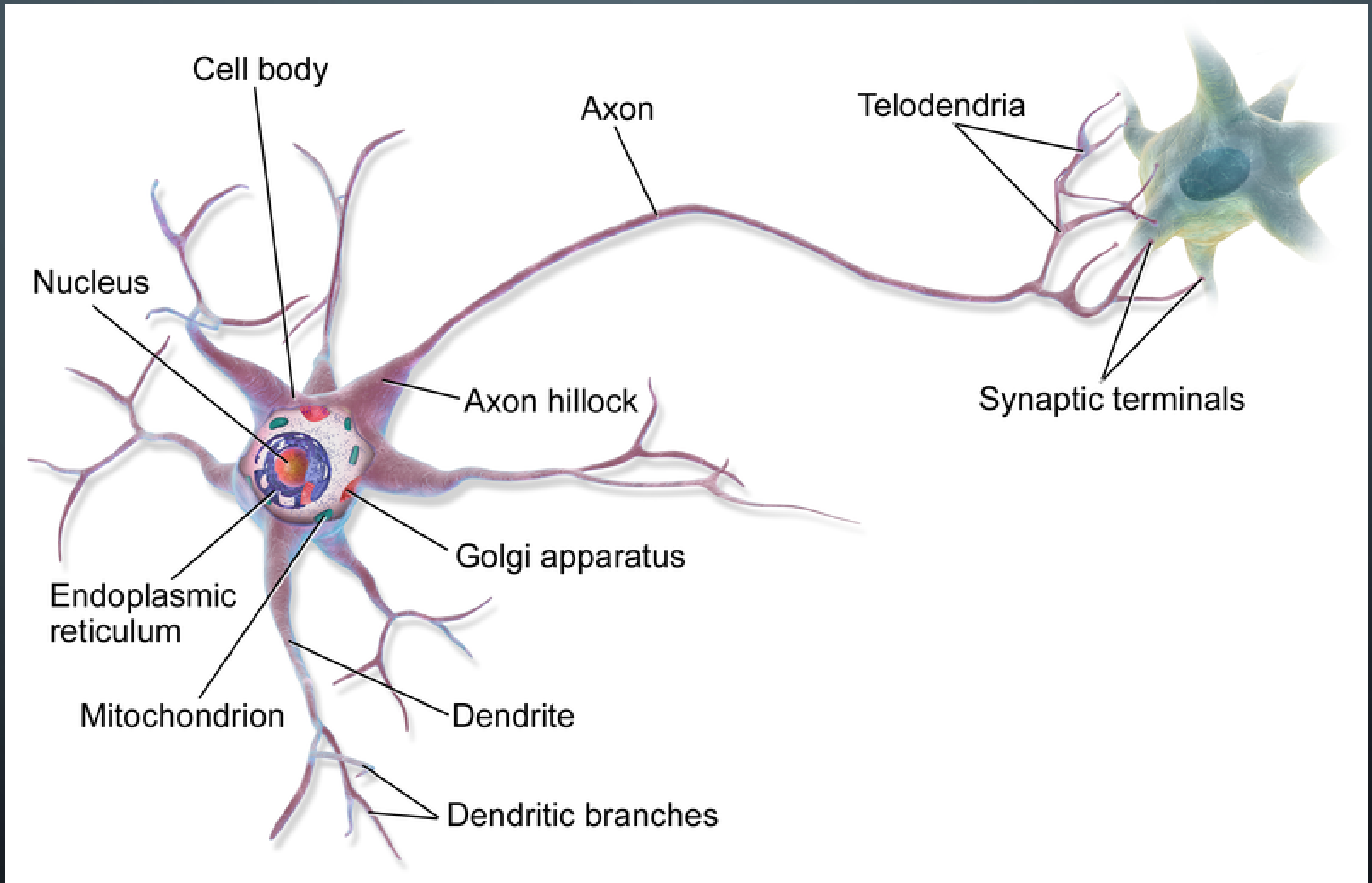
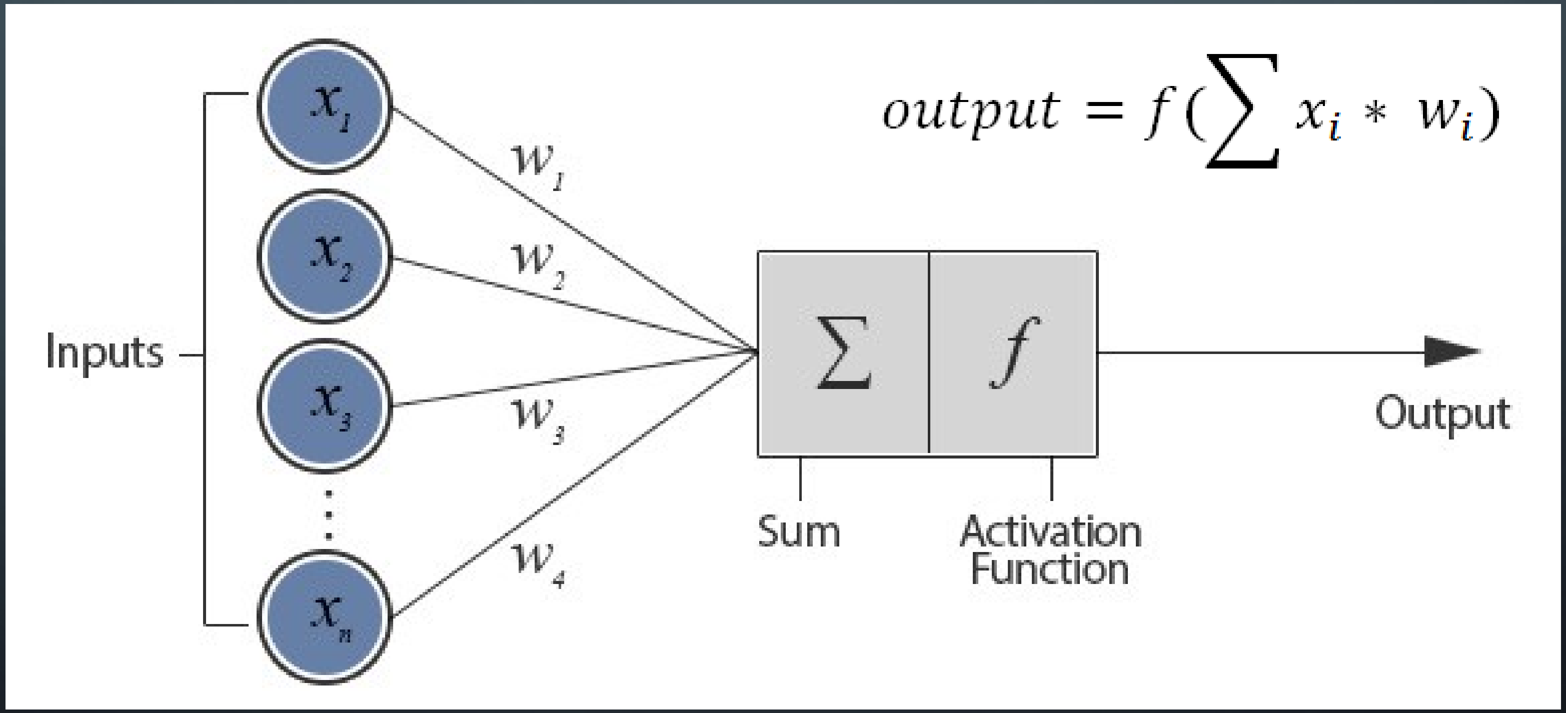
NEURAL NETWORKS

MOHAMMAD GHODDOSI

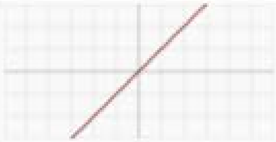
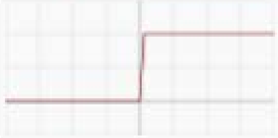
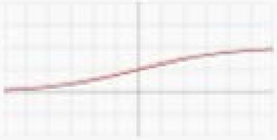
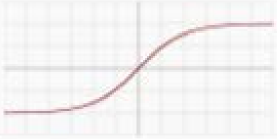
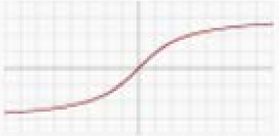
BIOLOGICAL NEURON

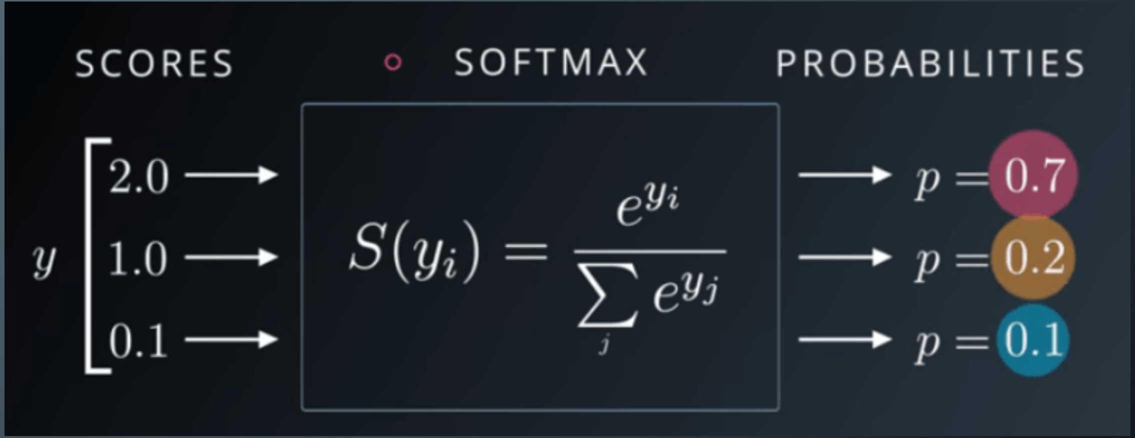


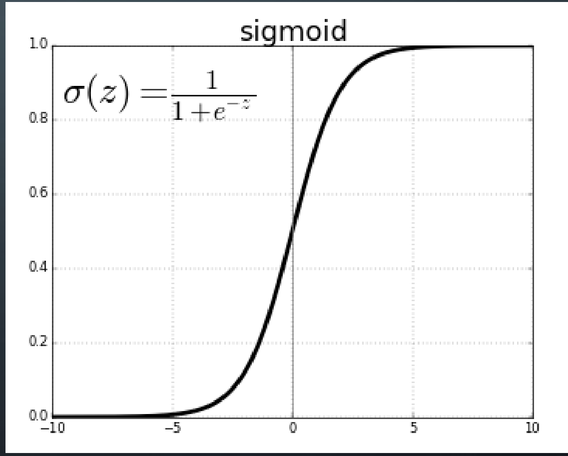
COMPUTATIONAL NEURON

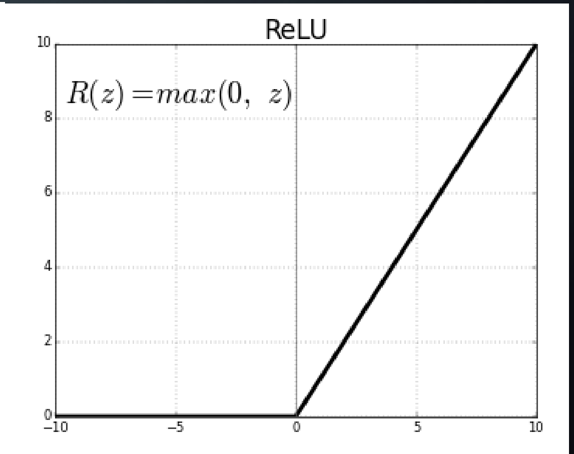


ACTIVATION FUNCTIONS

Name	Plot	Equation
Identity		$f(x) = x$
Binary step		$f(x) = \begin{cases} 0 & \text{for} \quad x < 0 \\ 1 & \text{for} \quad x \geq 0 \end{cases}$
Logistic (a.k.a Soft step)		$f(x) = \frac{1}{1 + e^{-x}}$
TanH		$f(x) = \tanh(x) = \frac{2}{1 + e^{-2x}} - 1$
ArcTan		$f(x) = \tan^{-1}(x)$





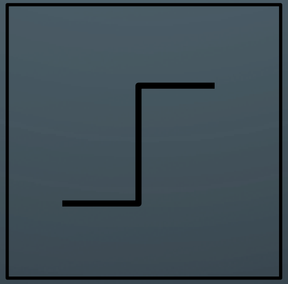


PERCEPTRON

- Old algorithm (1958)
- Perceptron is a basic algorithm for neural networks
- Much like logistic regression
- linear problems
- Hebbian learning rule

PERCEPTRON OUTPUT

- Activation function = step function
  - $f(z) = \begin{cases} 1 & z > 0 \\ 0 & z \leq 0 \end{cases}$



PERCEPTRON LEARNING RULE

- Learning rate: r
- Perceptron input: $x^{(i)}$ and label: $y^{(i)}$
- Perceptron output: $h^{(i)} = f(z^{(i)})$
- If $y^{(i)} = h^{(i)}$ then do nothing
- Else
  - If $y^{(i)} = 0\ and\ h^{(i)} = 1$ then $w(t+1) = w(t) + r * x^{(i)}$
  - If $y^{(i)} = 1\ and\ h^{(i)} = 0$ then $w(t+1) = w(t) - r * x^{(i)}$

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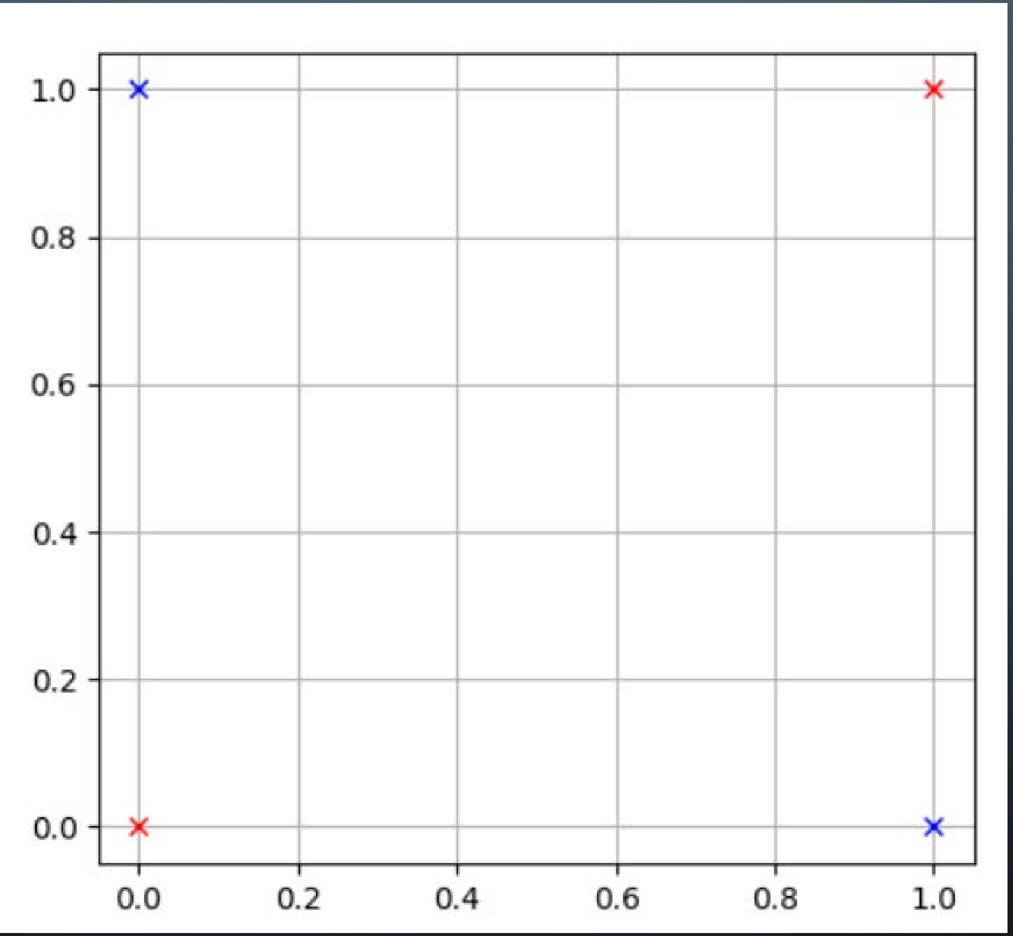
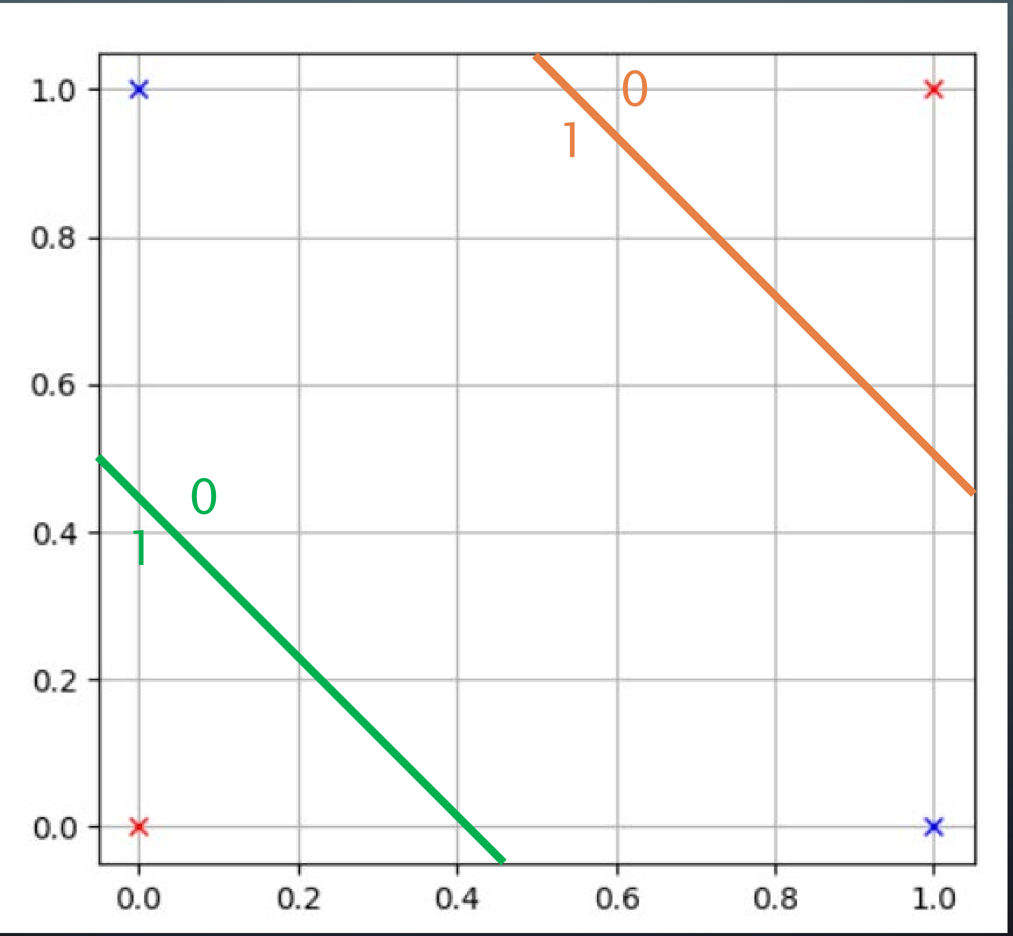
$$\boxed{w(t+1) = w(t) + r * \left(h^{(i)} - y^{(i)}\right)x^{(i)}}$$

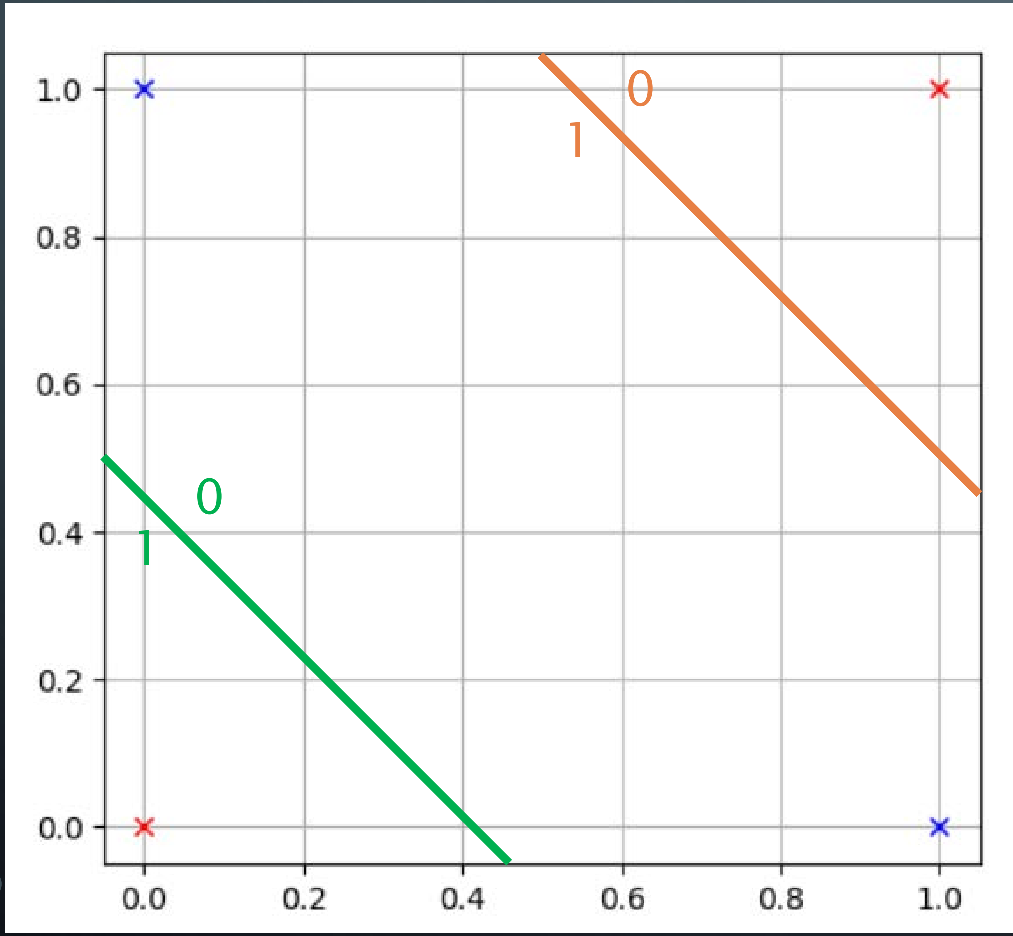
PROBLEMS WITH PERCEPTRON

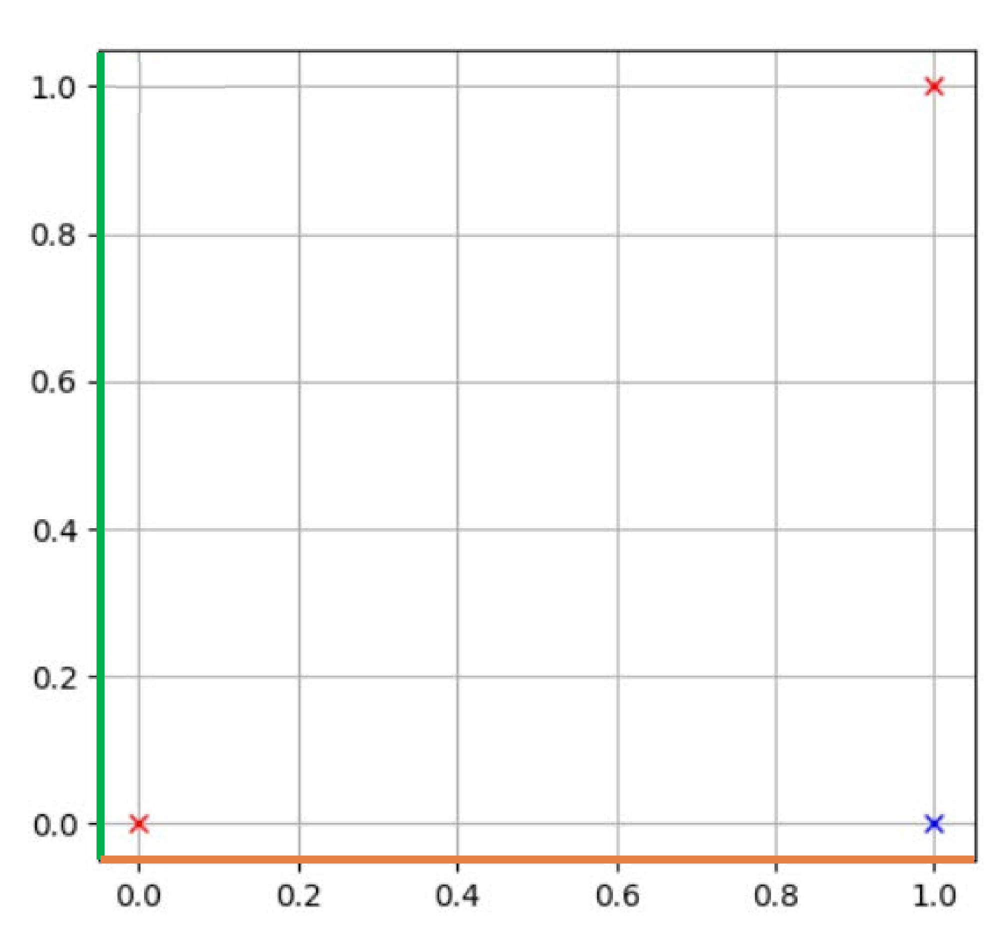


PROBLEMS WITH PERCEPTRON

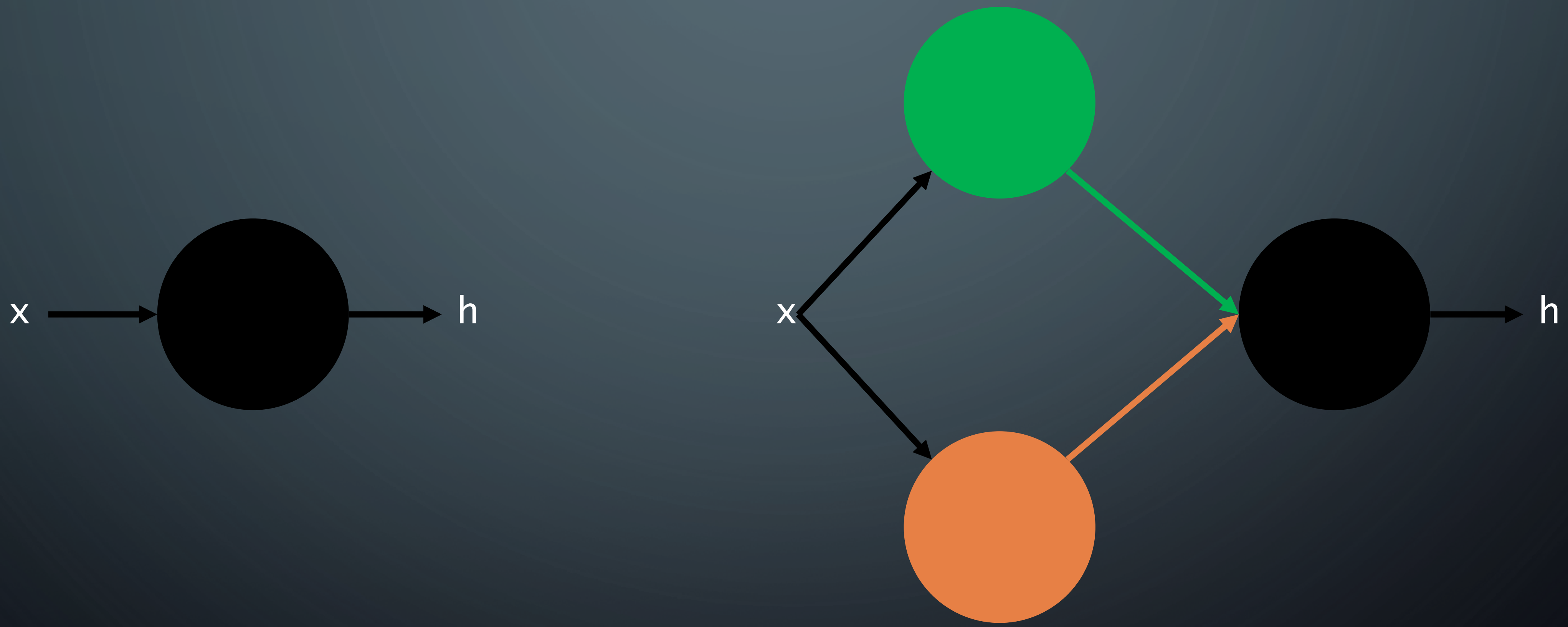


PROBLEMS WITH PERCEPTRON

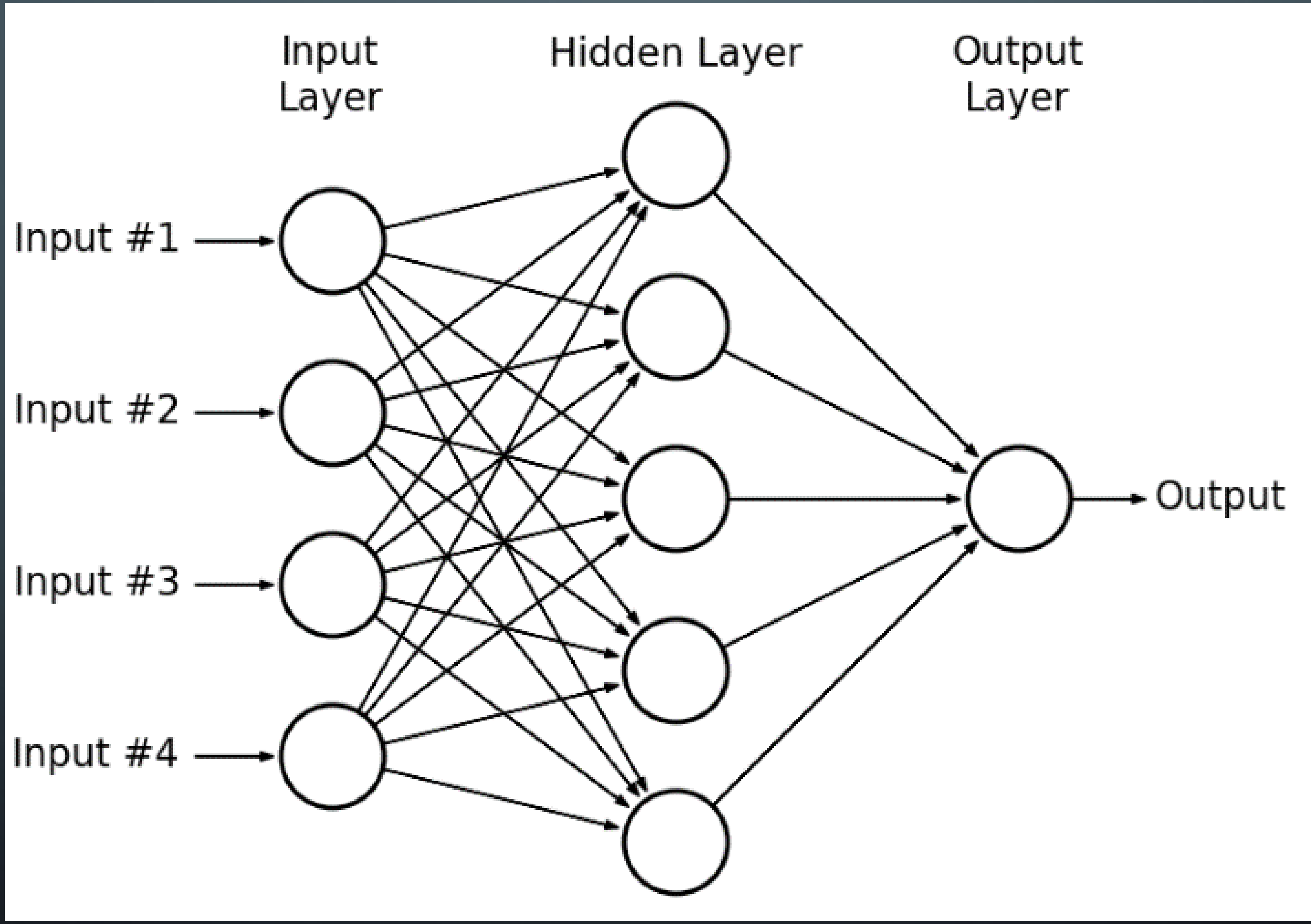




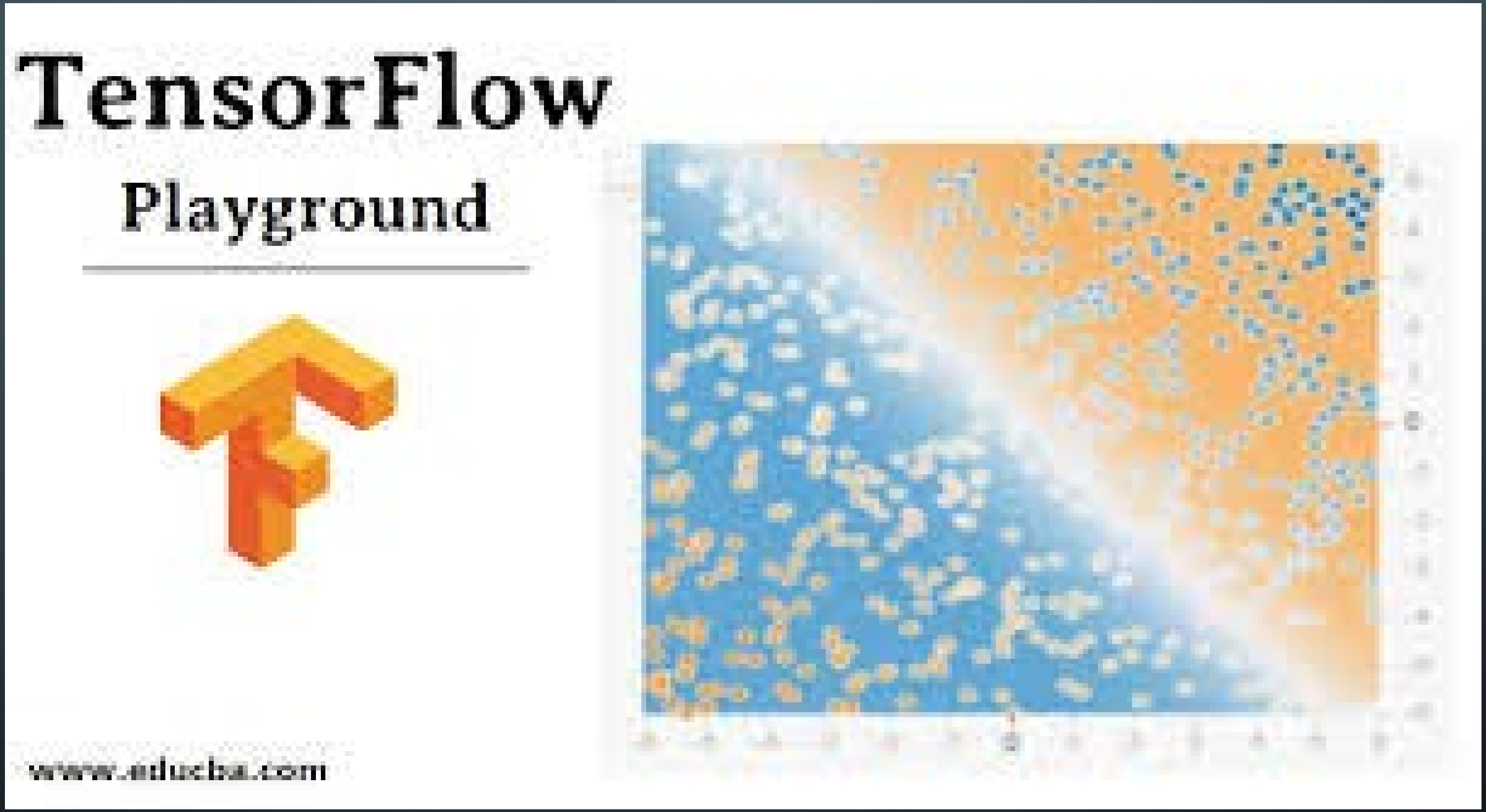
PROBLEMS WITH PERCEPTRON



MLP



Input Layer
Hidden Layer
Output Layer
Input #1
Input #2
Input #3
Input #4
Output


TensorFlow
Playground
www.educba.com

MLP PROS AND CONS

- Pros
  - Flexible
  - Both regression and classification
  - Good for nonlinear data with large number of inputs
- Cons
  - black box
  - computationally very expensive and time consuming to train
  - depend a lot on training data
  - overfitting

MLP ARCHITECTURE

- Single hidden layer is enough.
- If we have enough hidden units, we can solve every problem.
- Hidden units cant use linear (identity) activation function.

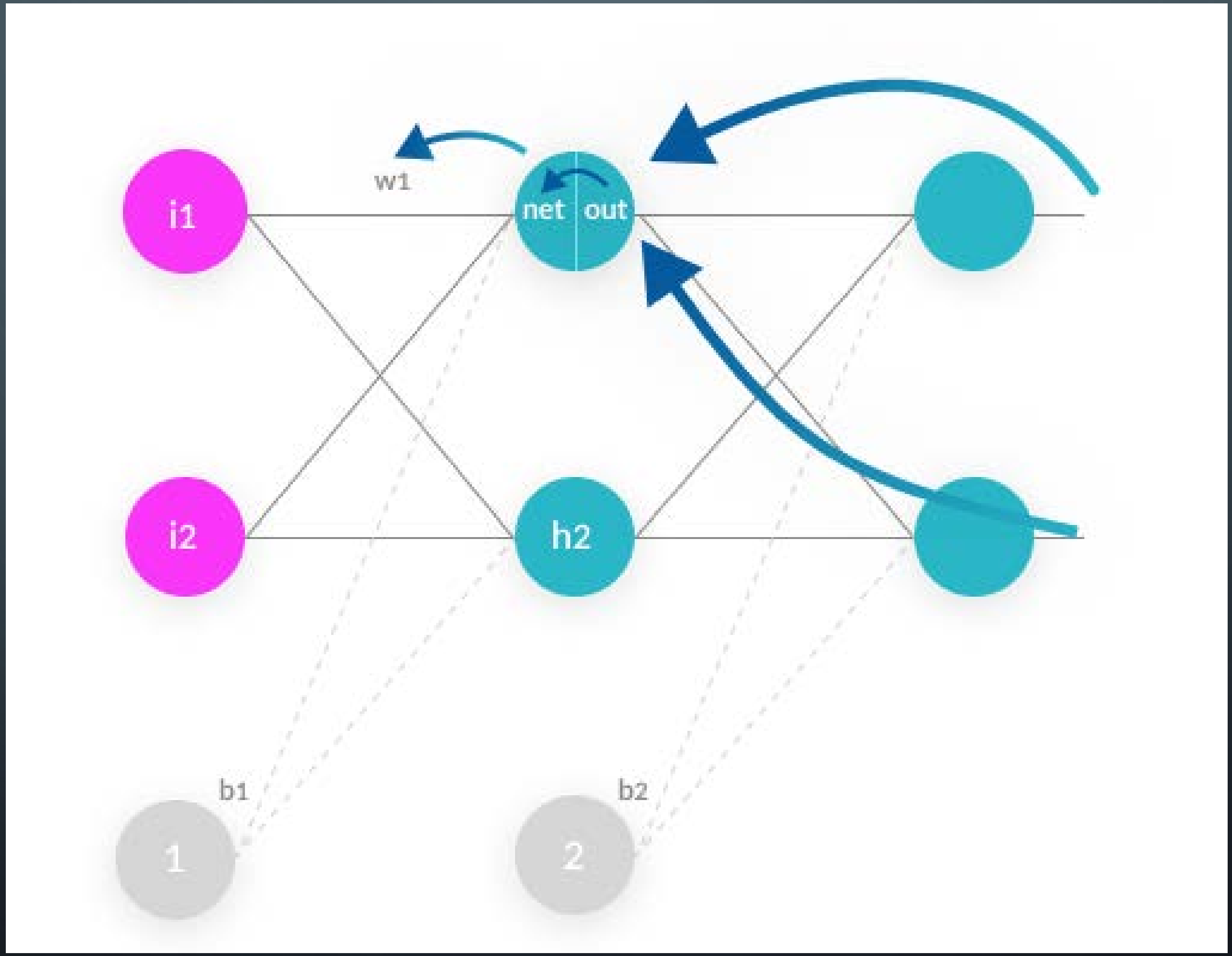
SHALLOW VS DEEP NEURAL NETWORKS

- Shallow
  - Only one hidden layer
  - Simple neurons
- Deep
  - More than one hidden layer
  - Various types of neurons
    - Convolutional
    - Recurrent
    - …

SHALLOW VS DEEP NEURAL NETWORKS

- deep NN with the right architectures achieve better results than shallow ones
- the deep models are able to extract/build better features than shallow models

BACKPROPAGATION



OPTIMIZERS

- Gradient descent
- SGD
- mini-batch GD
- Momentum
- AdaGrad
- AdaDelta
- RMSprop
- Adam

jupyter