OSLOMET

ACIT4830 – Special Robotics and Control Subject

Topic6 – Neural Networks

Evi Zouganeli
OsloMet – Oslo Metropolitan University
(evizou@oslomet.no)

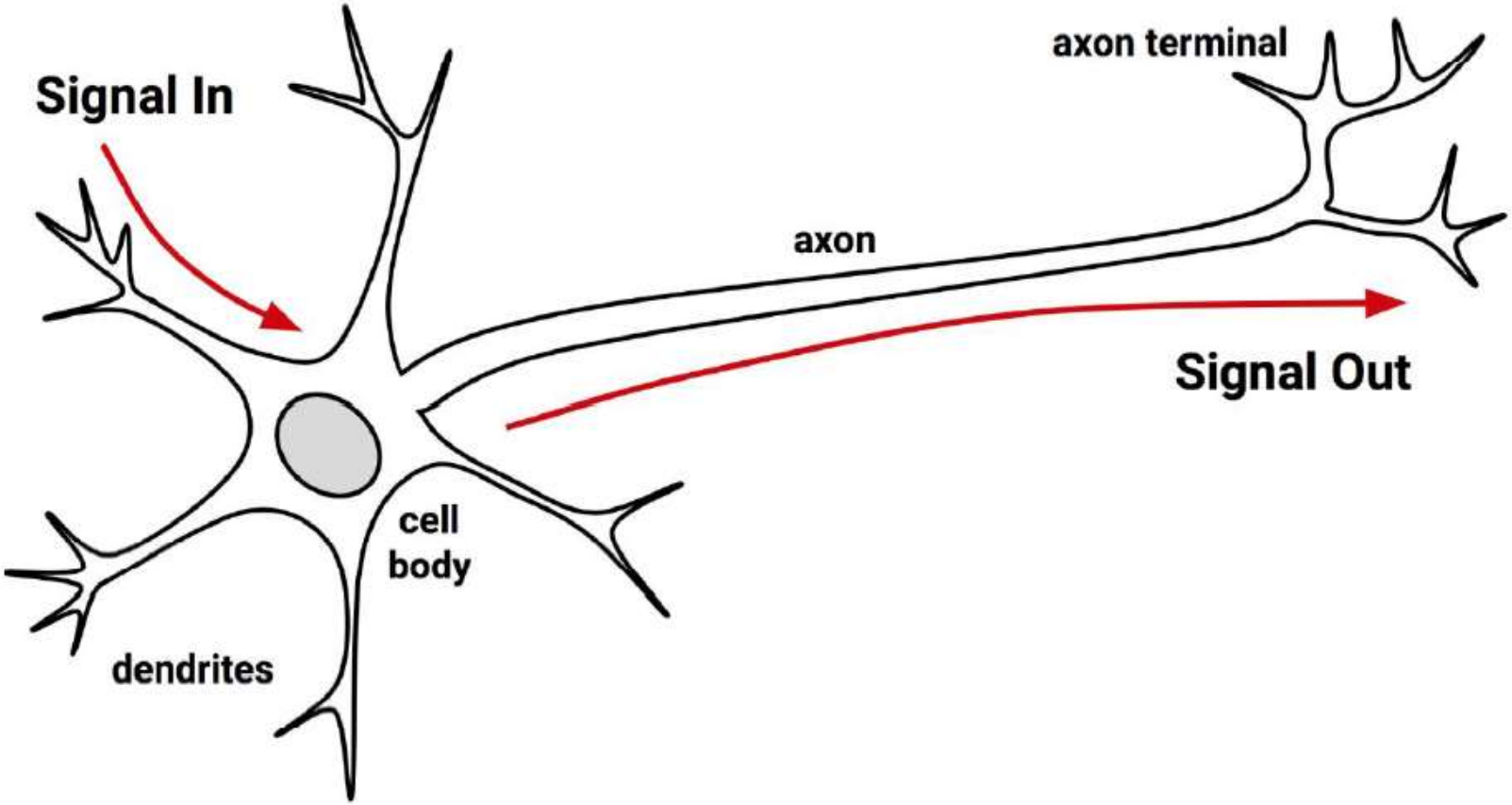
Content

(Chapter 7 Lantz book – Neural Networks
+ check Chapters 11 and 12 Alpaydin book (for reference see front page in Canvas))

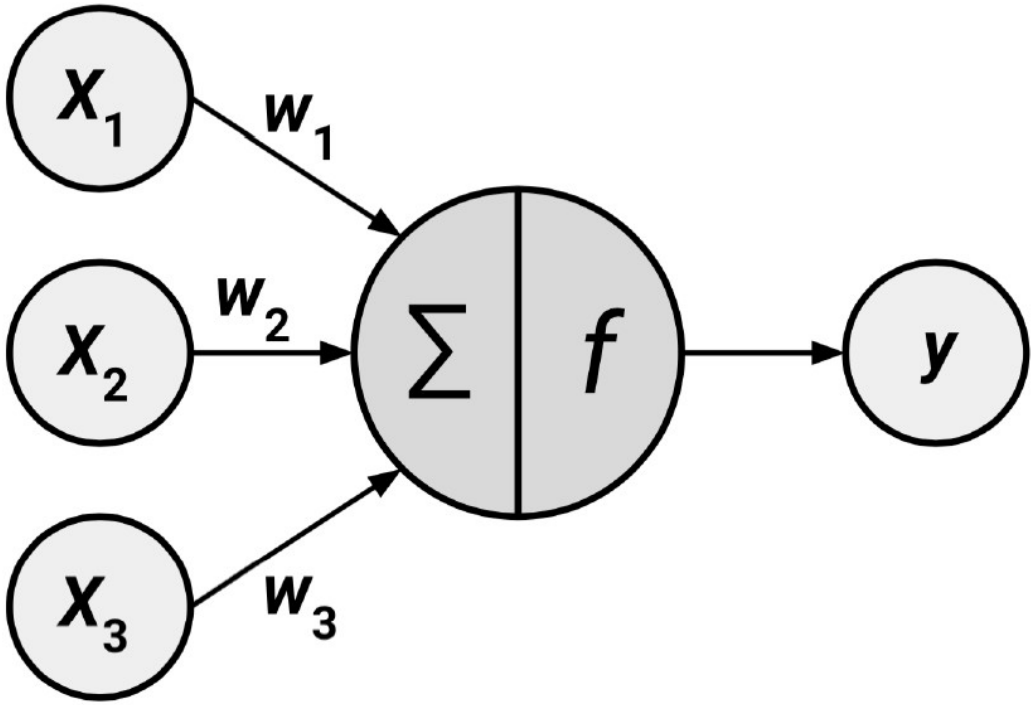
- Intro
- Perceptron
- Multilayer perceptron
- Backpropagation, Gradient descent
- Neural Network
- Recurrent Neural Network
- Convolutional Neural Network

- Hands-on exercises NN, RNN
- Homework, CNN

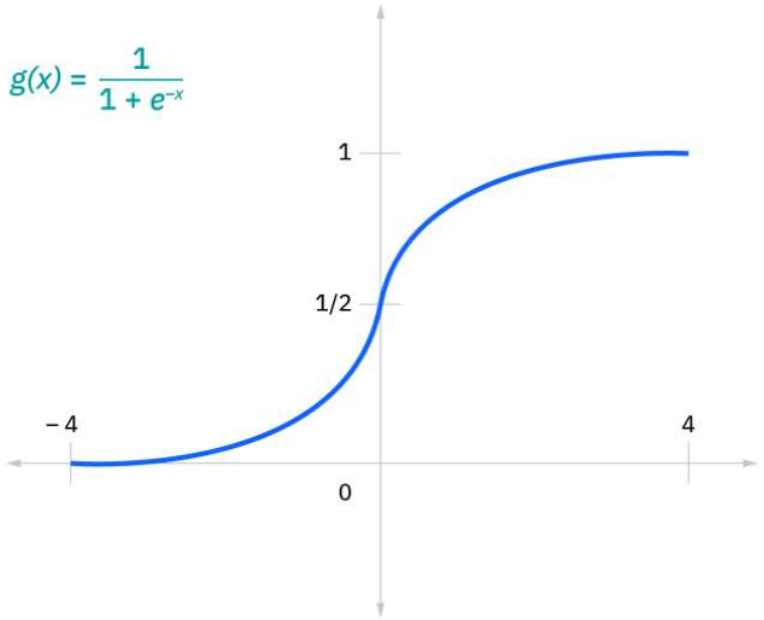
neuron


Signal In
axon terminal
axon
Signal Out
cell
body
dendrites

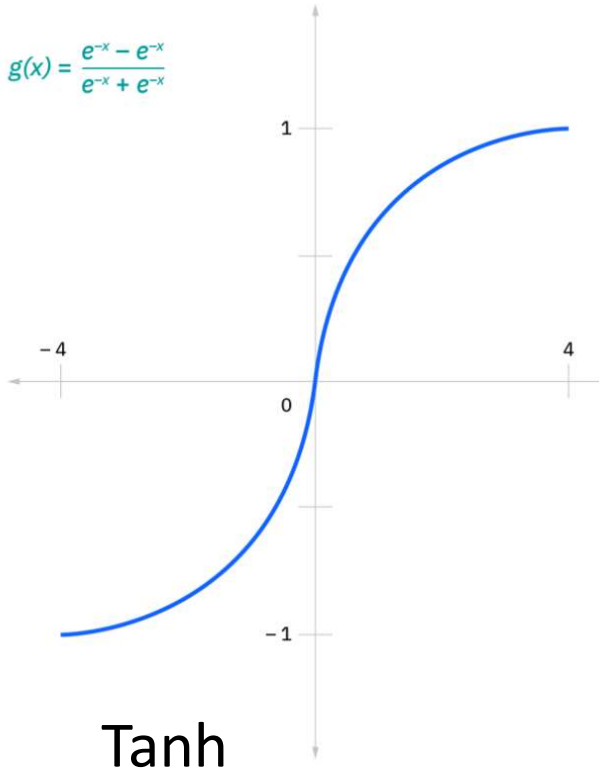
Perceptron



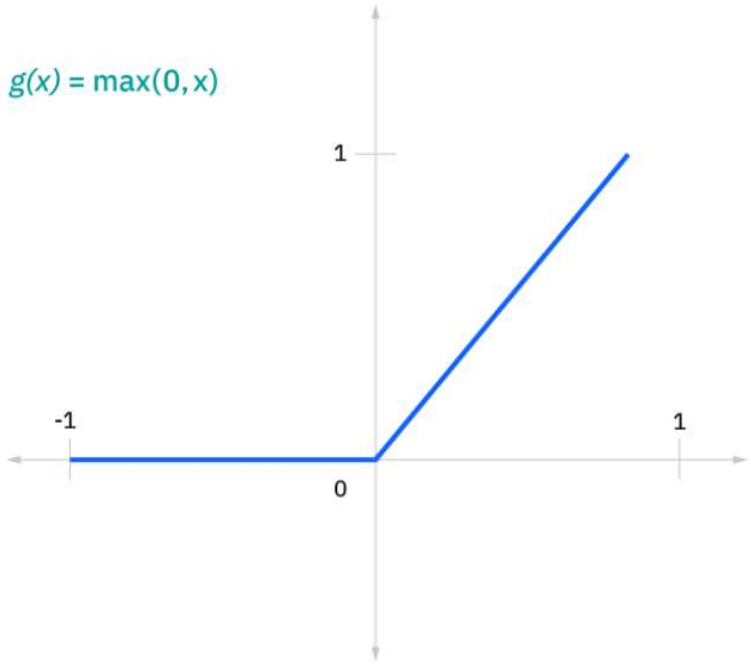
Activation functions f(x)



Sigmoid

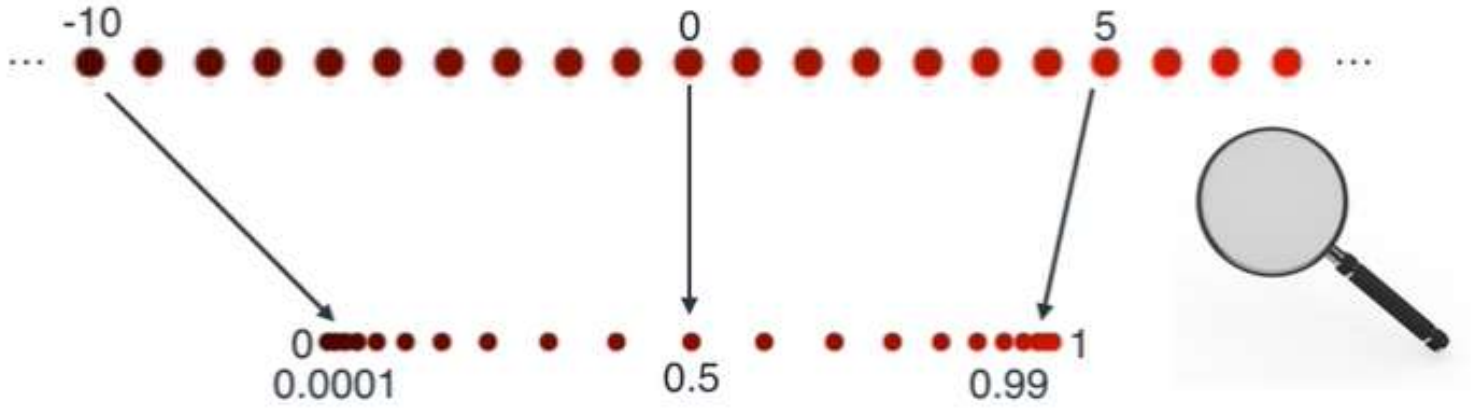


Tanh

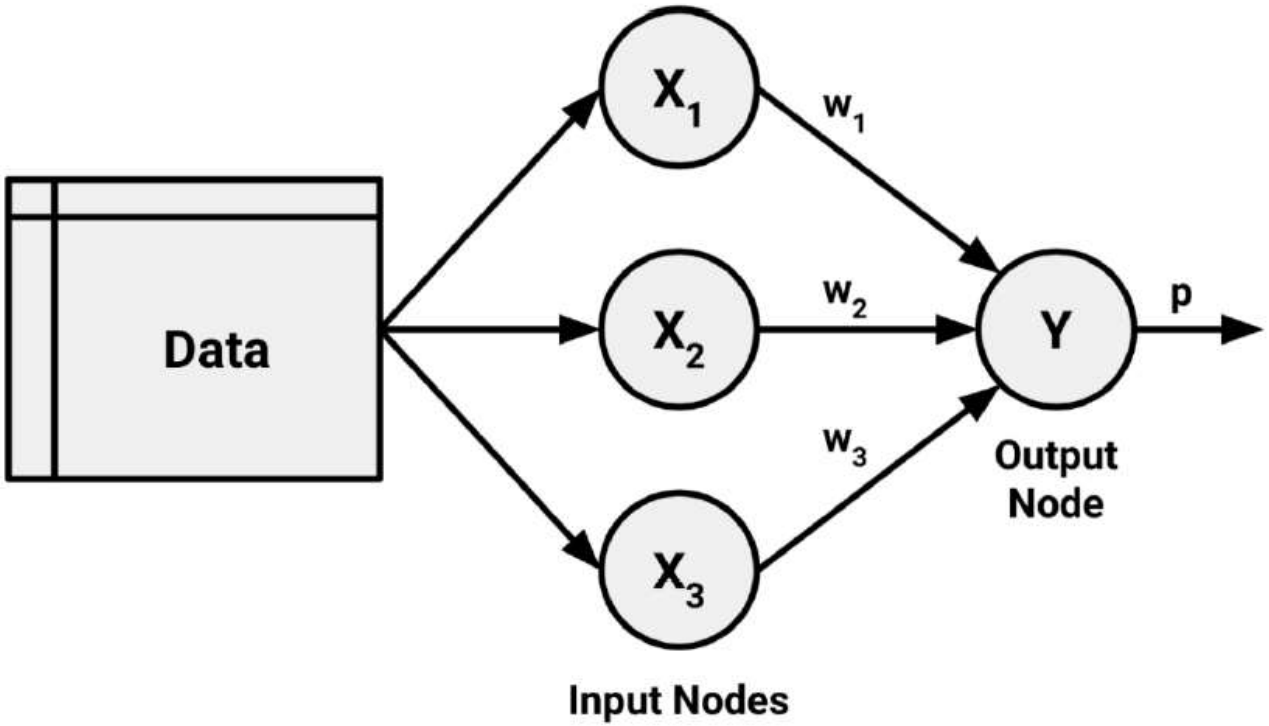


ReLu

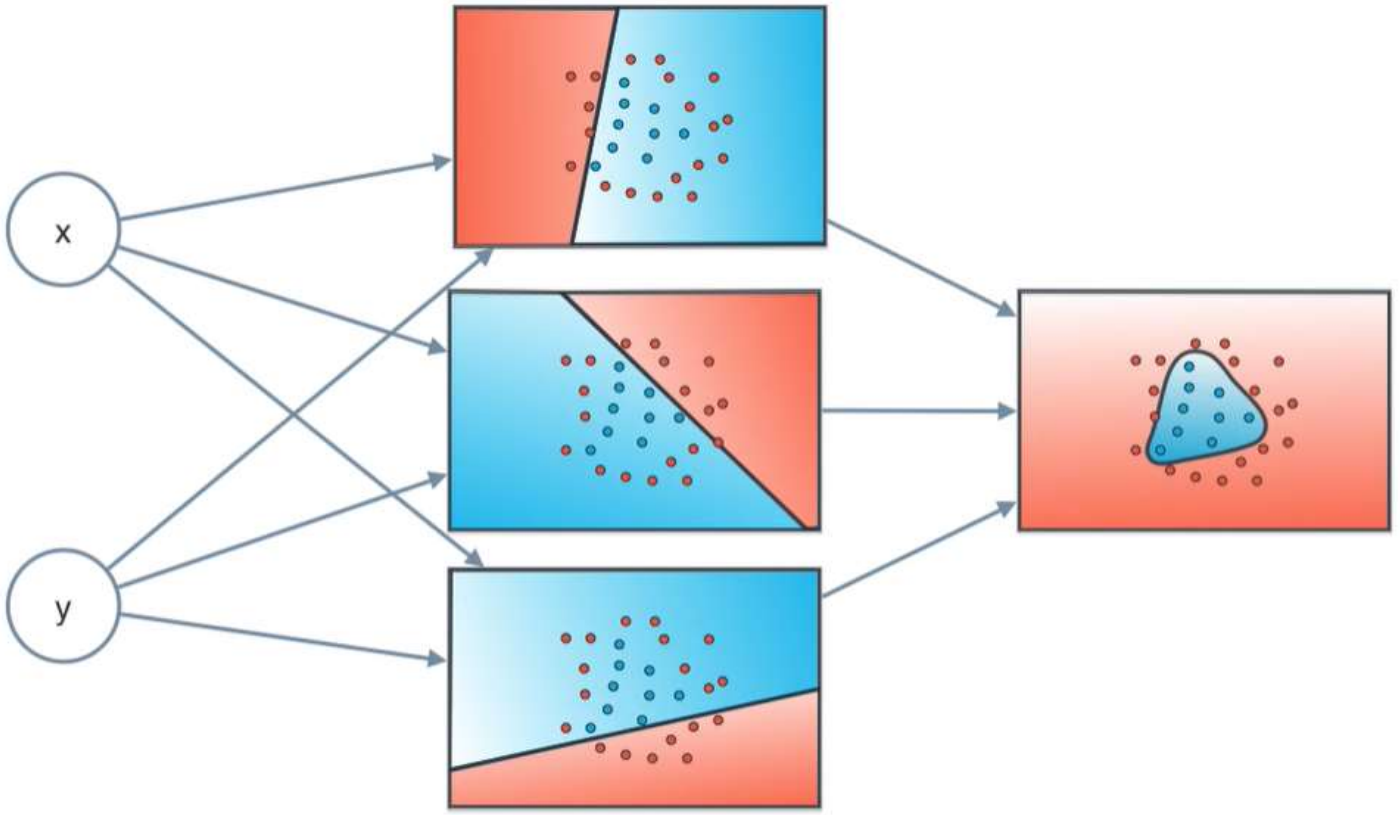
Activation function

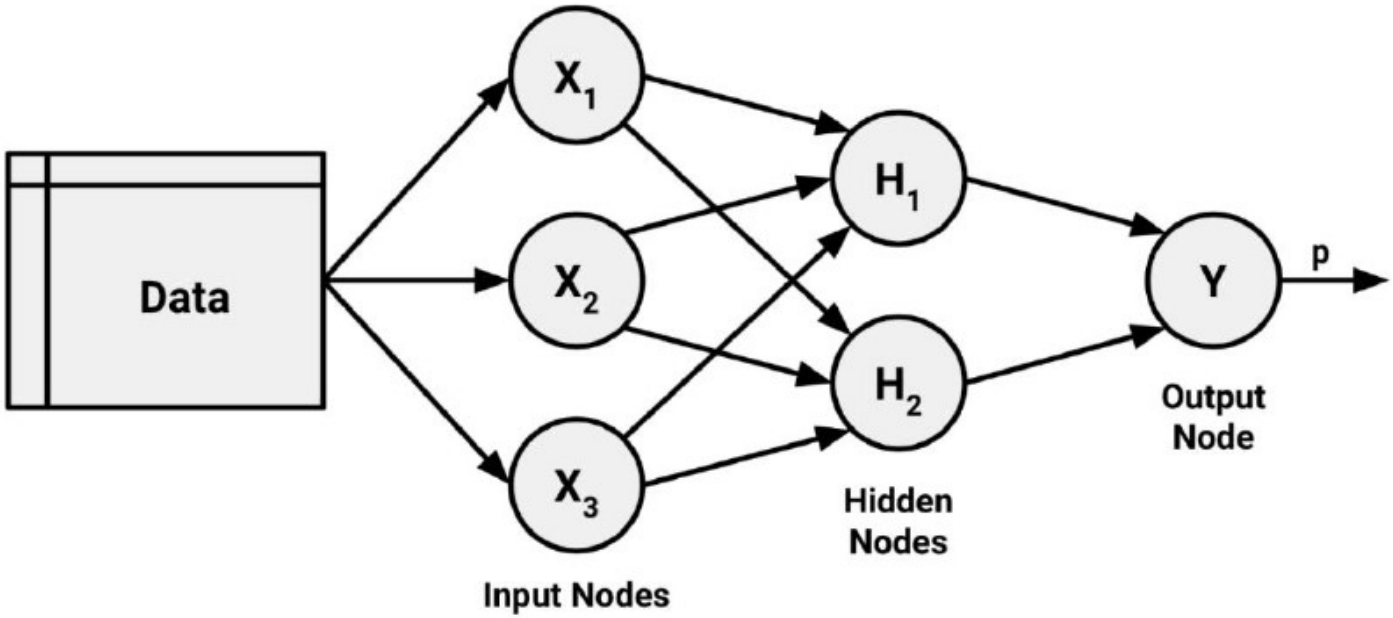


$$F(x) = \frac{1}{1 + e^{-x}}$$

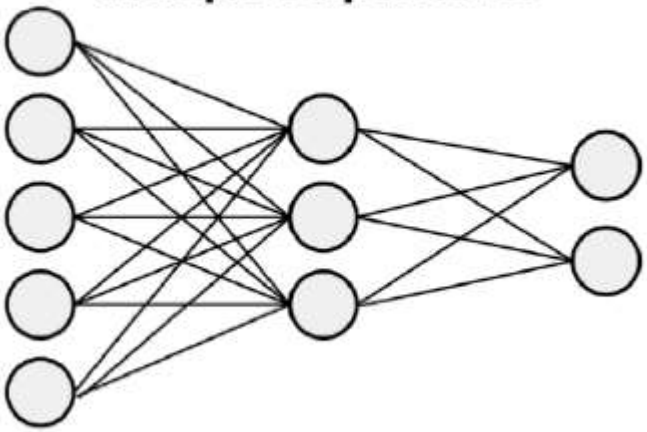

Data
X1
X2
X3
w1
w2
w3
Y
p
Output Node
Input Nodes

Visualisation

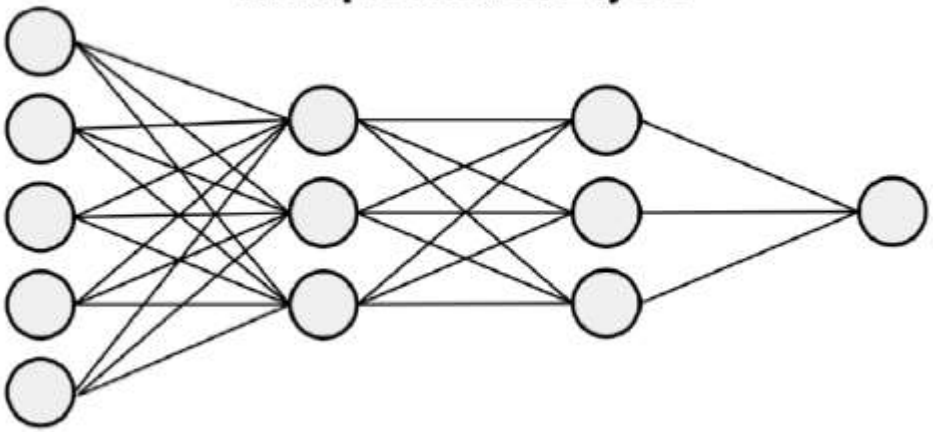



Data
X1
X2
X3
H1
H2
Y
p
Input Nodes
Hidden Nodes
Output Node

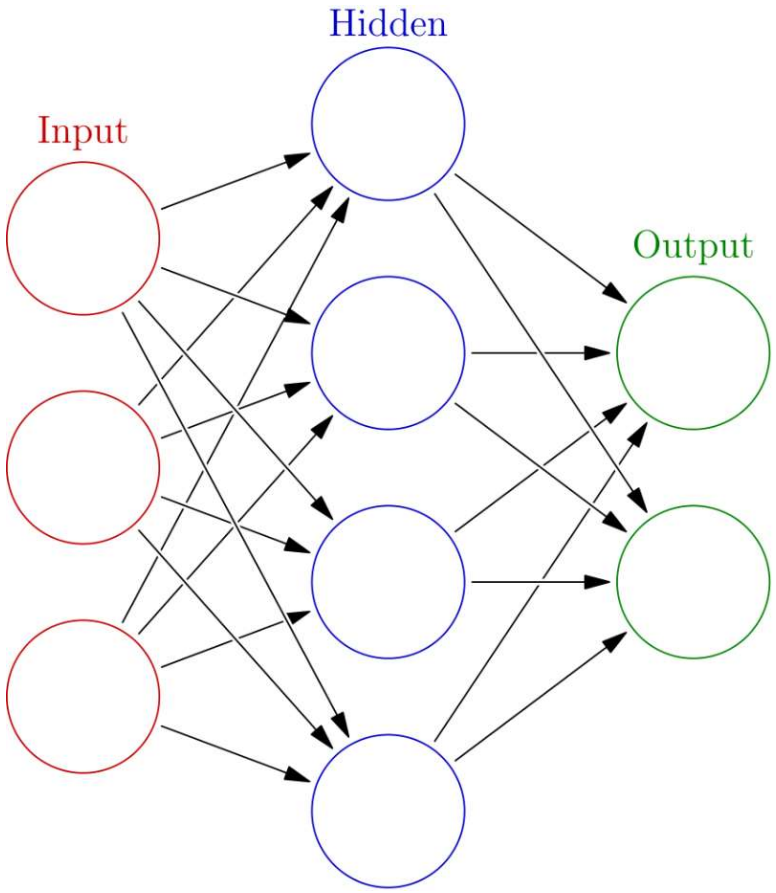
Multiple Output Nodes



Multiple Hidden Layers



Artificial Neural Network



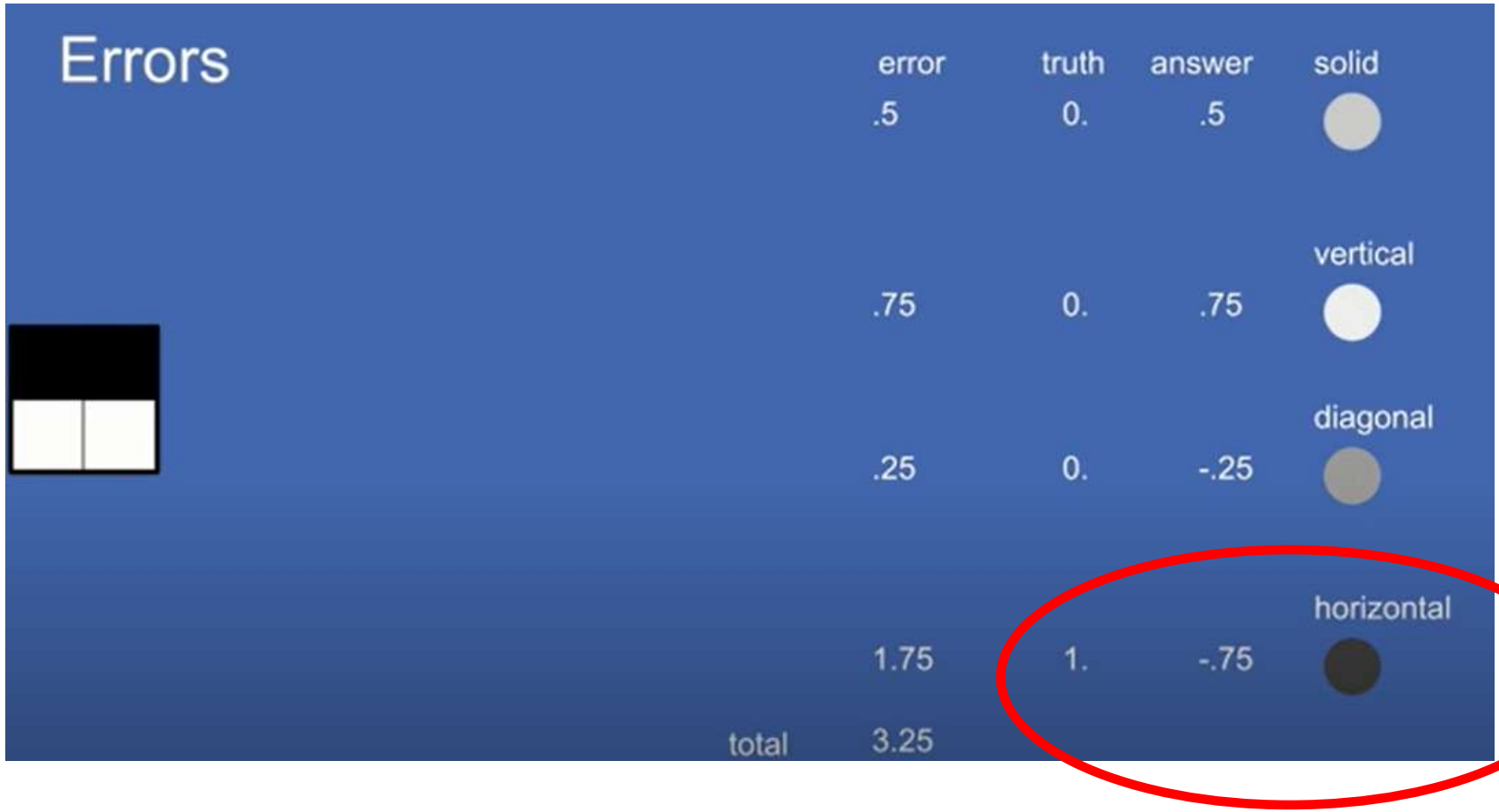
Neural Networks – example applications

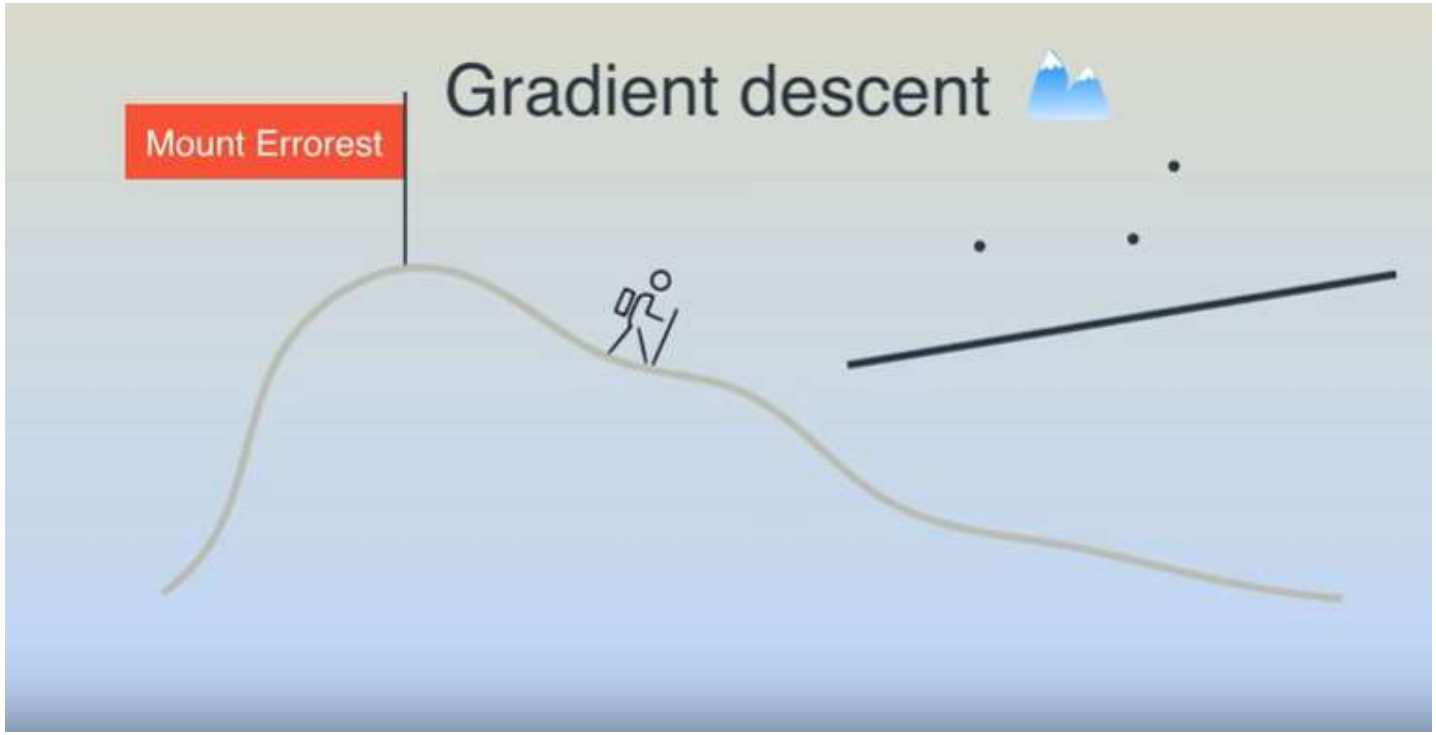
- Speech and handwriting recognition programs like those used by voicemail transcription services and postal mail sorting machines
- The automation of smart devices like an office building's environmental controls or self-driving cars and self-piloting drones
- Sophisticated models of weather and climate patterns, tensile strength, fluid dynamics, and many other scientific, social, or economic phenomena

How do neural networks learn?

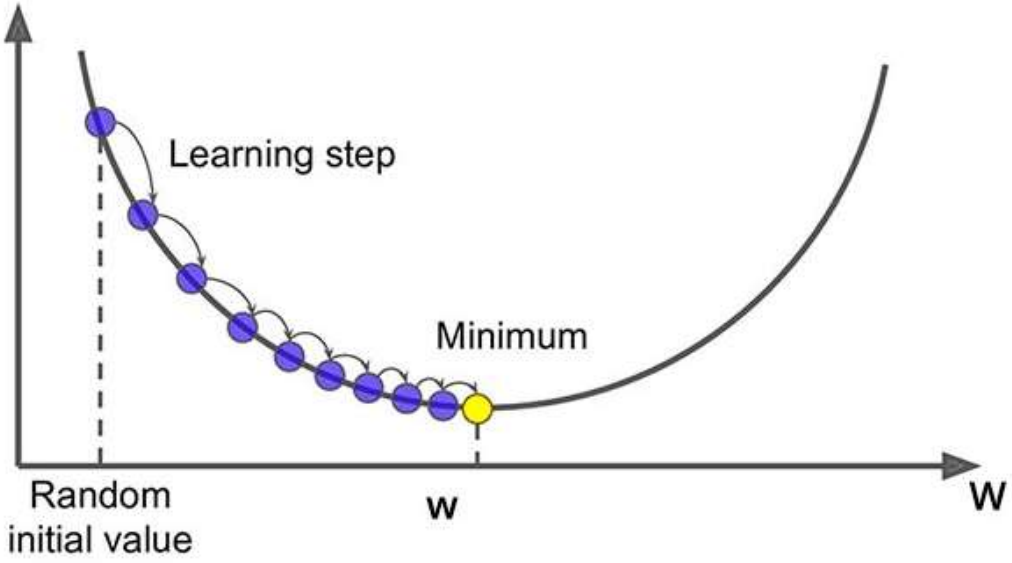
Optimisation – backpropagation of errors

Horizontal

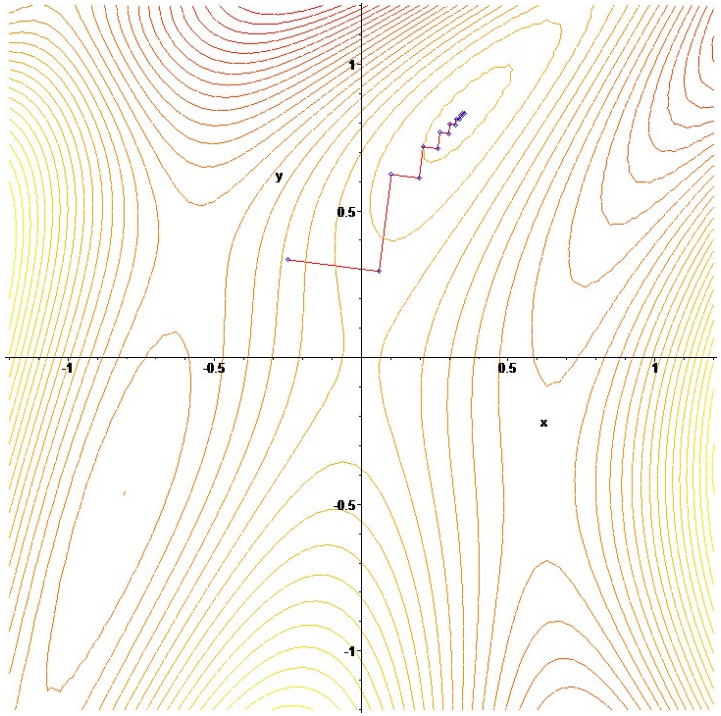


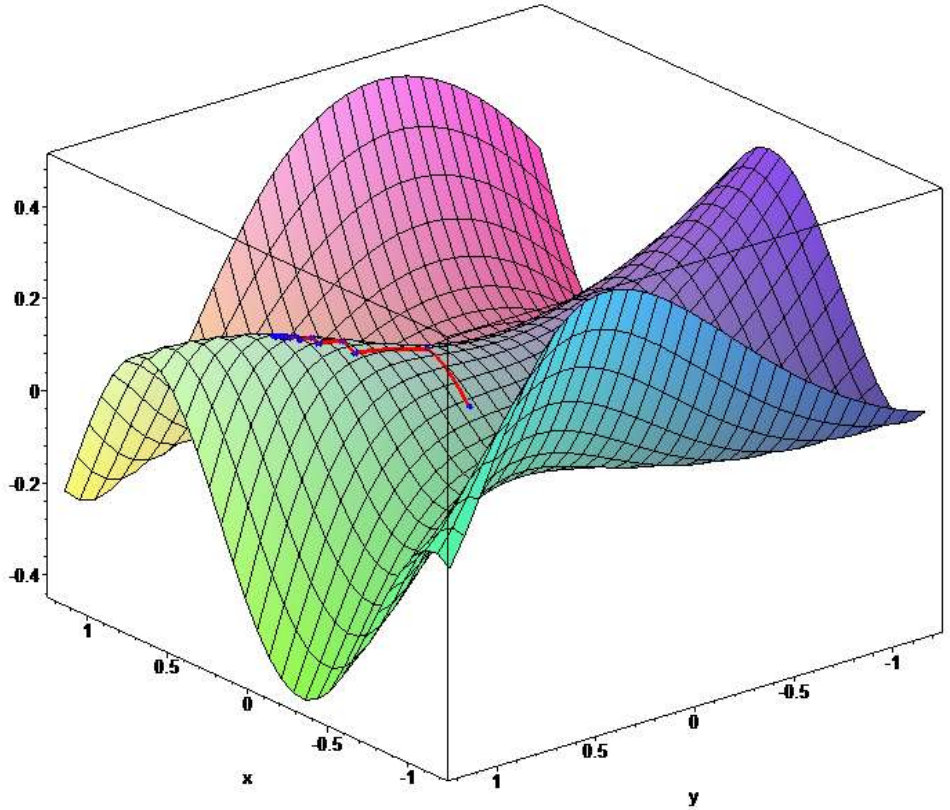

Gradient descent
Mount Errorest


Gradient descent
Mount Errorest


Learning step
Minimum
Random
initial value
w
W

Gradient descent



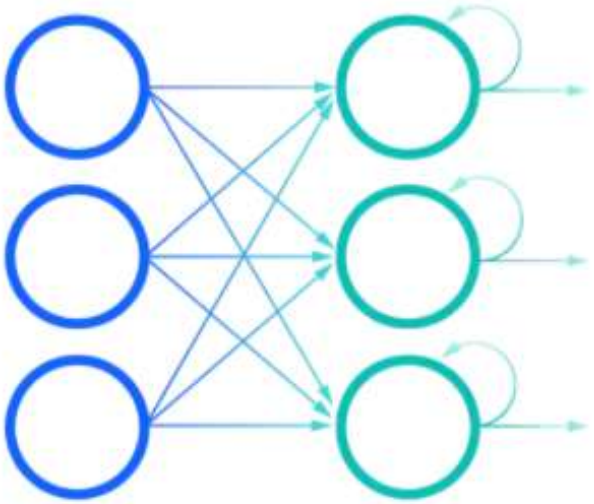


Multilayer Neural Network w/ backpropagation

Strengths	Weaknesses
• Can be adapted to classification or numeric prediction problems • Among the most accurate modeling approaches • Makes few assumptions about the data's underlying relationships	• Reputation of being computationally intensive and slow to train, particularly if the network topology is complex • Easy to overfit or underfit training data • Results in a complex black box model that is difficult if not impossible to interpret

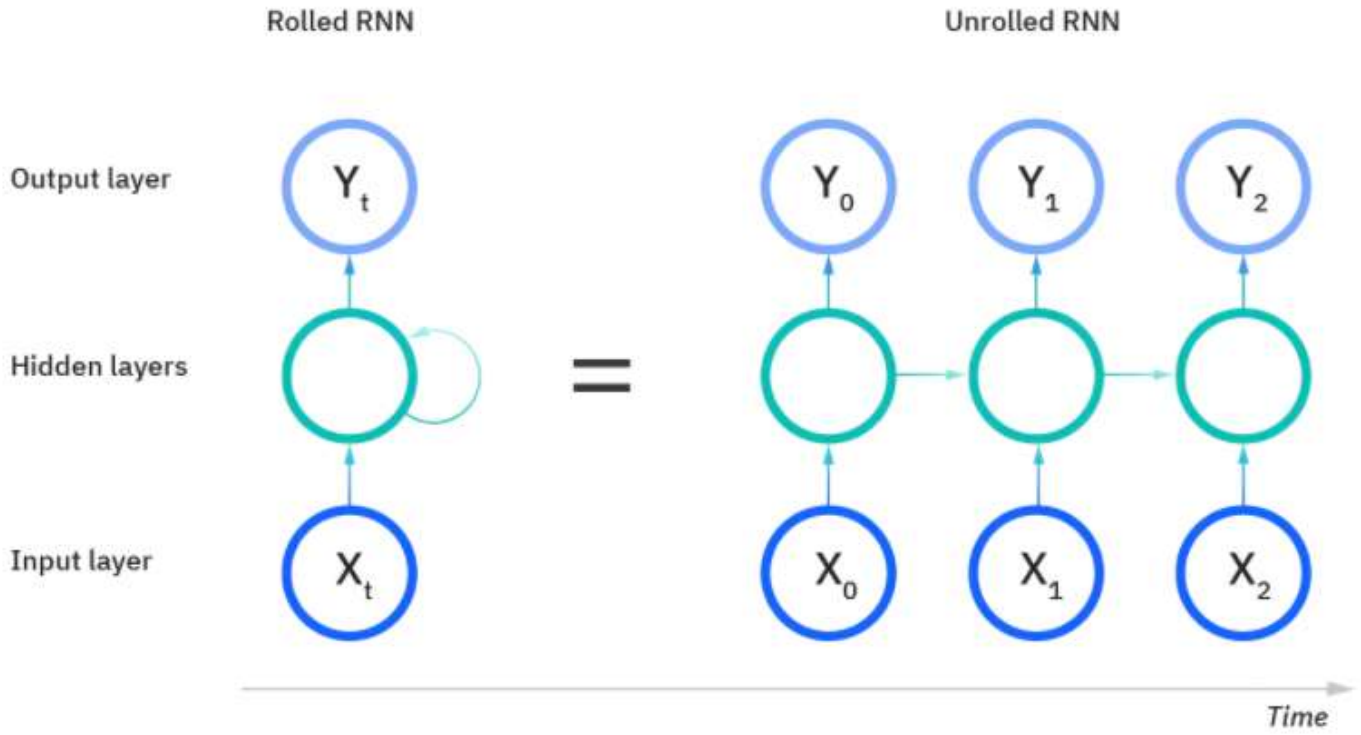
Recurrent Neural Network

Recurrent Neural Network



- Remember previous events and output(s)
- Used for processing sequential data

Recurrent Neural Network



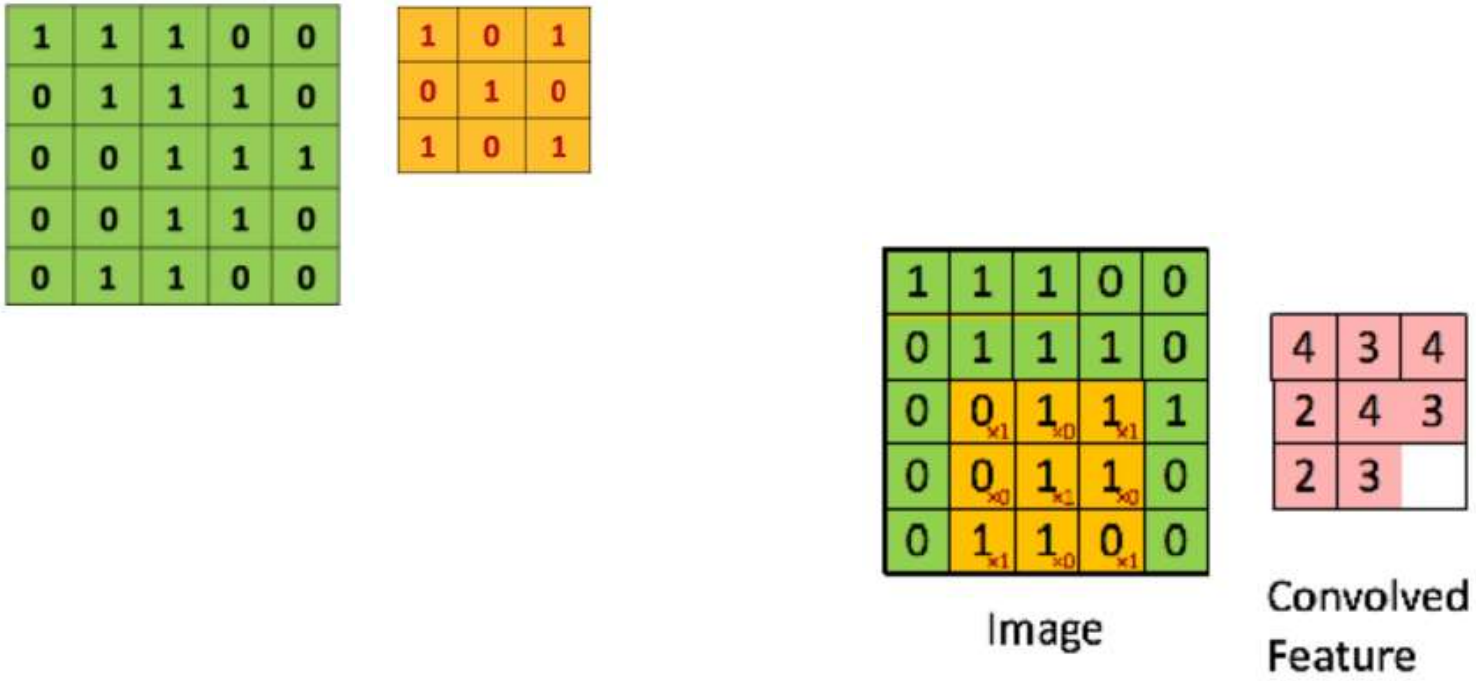
Long-Short Term Memory RNN – LSTM

"Alice is allergic to nuts. She can't eat *peanut butter*."

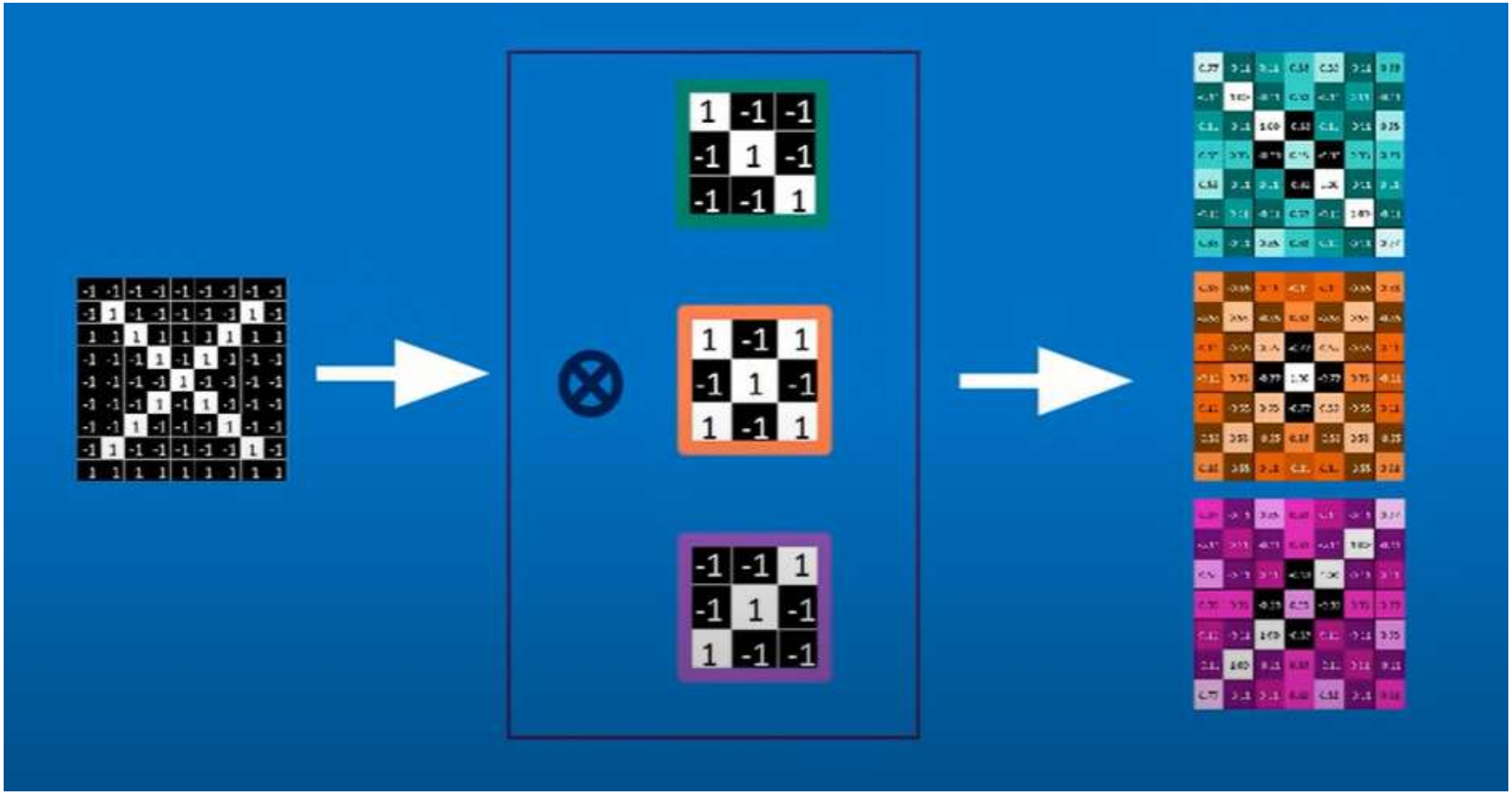
two types of memory -
short- and long-term

Convolutional Neural Network

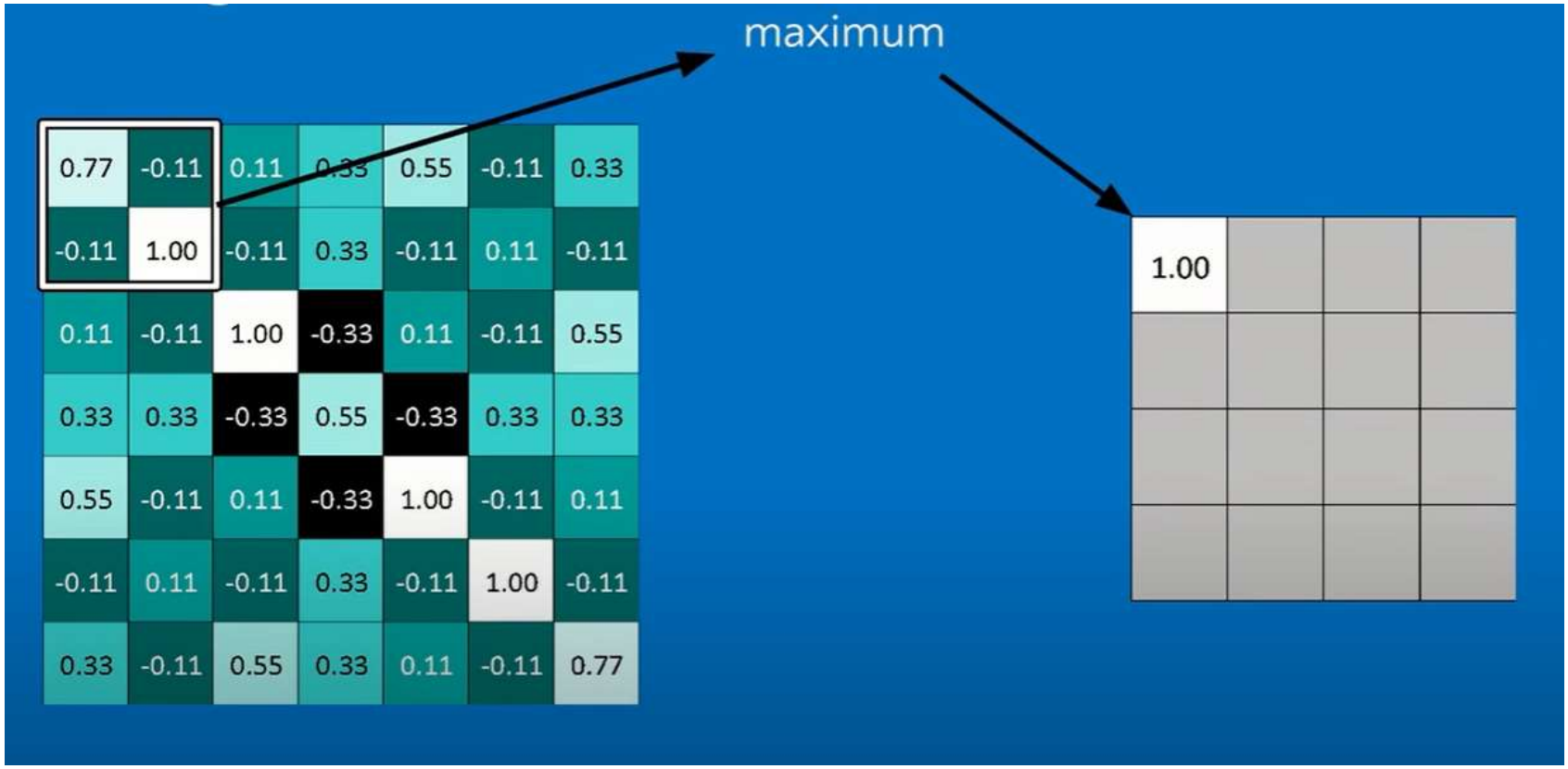
Convolution



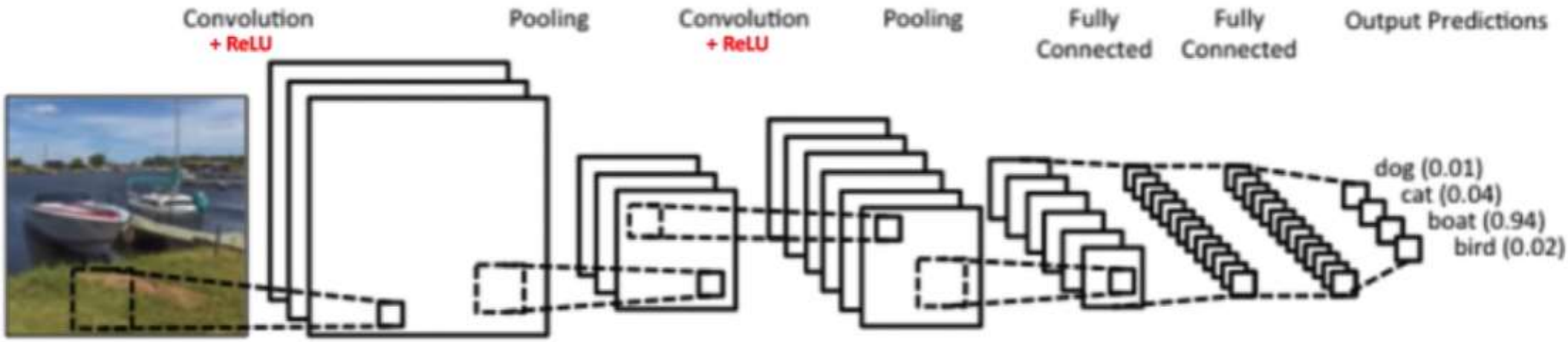
Convolution

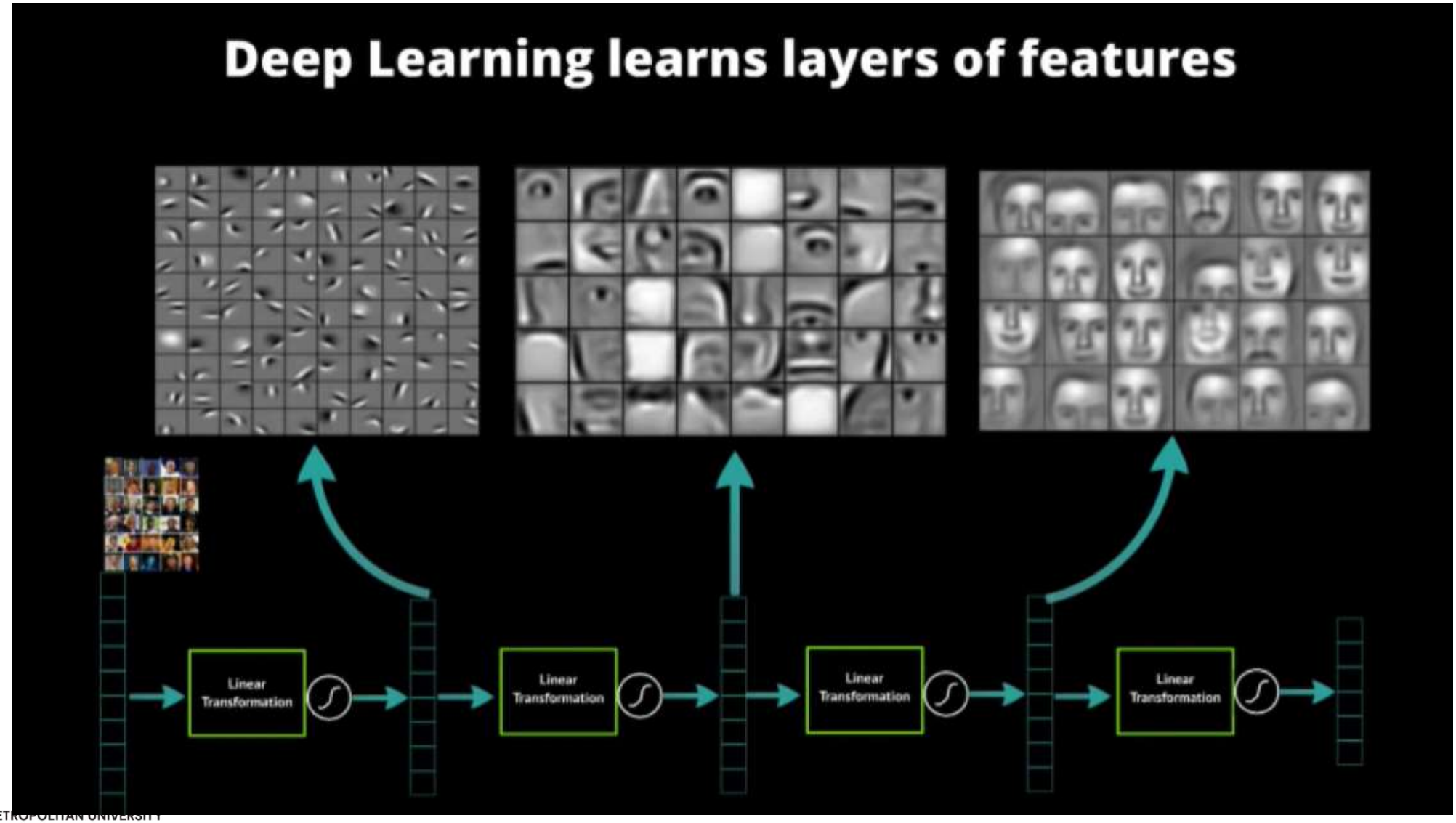


Pooling


maximum
0.77 -0.11 0.11 0.33 0.55 -0.11 0.33
-0.11 1.00 -0.11 0.33 -0.11 0.11 -0.11
0.11 -0.11 1.00 -0.33 0.11 -0.11 0.55
0.33 0.33 -0.33 0.55 -0.33 0.33 0.33
0.55 -0.11 0.11 -0.33 1.00 -0.11 0.11
-0.11 0.11 -0.11 0.33 -0.11 1.00 -0.11
0.33 -0.11 0.55 0.33 0.11 -0.11 0.77
1.00

Convolutional Neural Network




Deep Learning learns layers of features
Linear Transformation
Linear Transformation
Linear Transformation
Linear Transformation

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