

CSCI4622 Machine Learning

2020 Spring

Neural Networks (1)

Geena Kim

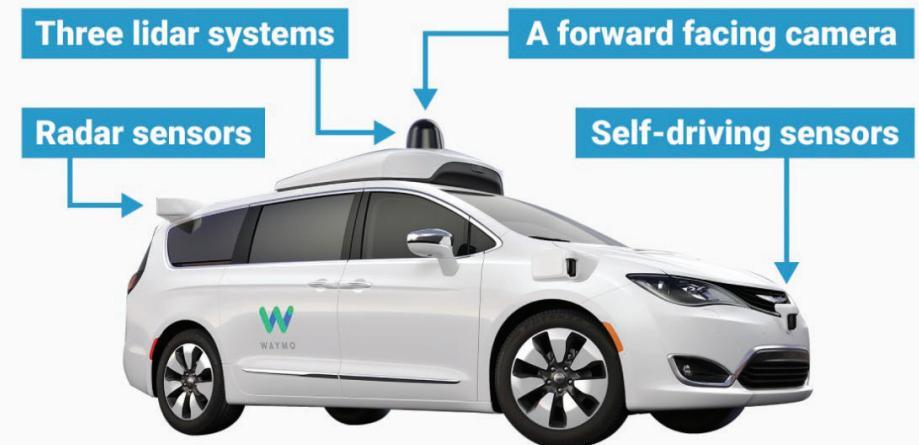
*Some of the slide/diagram adopted from CMU deep learning course



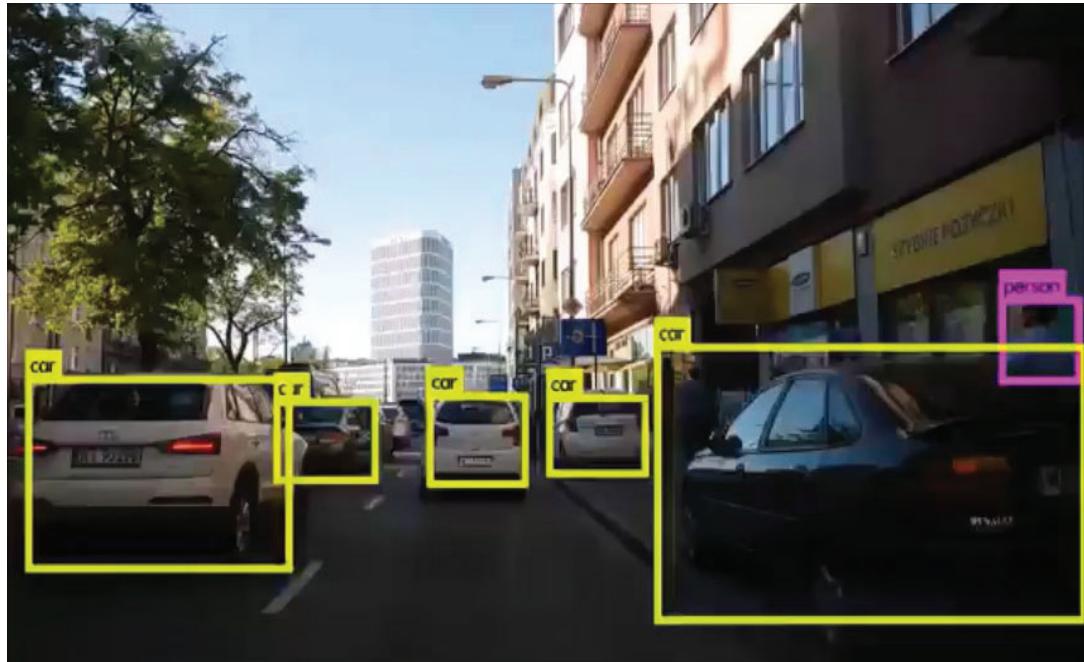
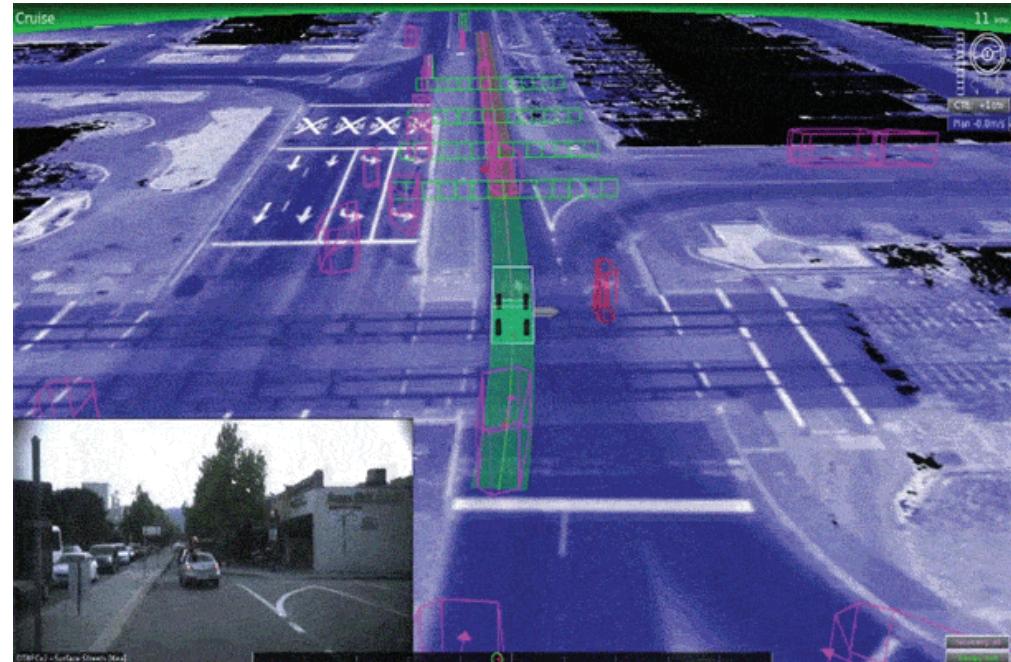
Why Deep Learning?



Self-driving Cars



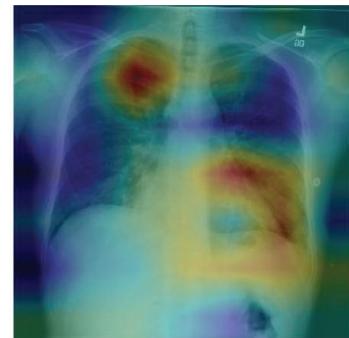
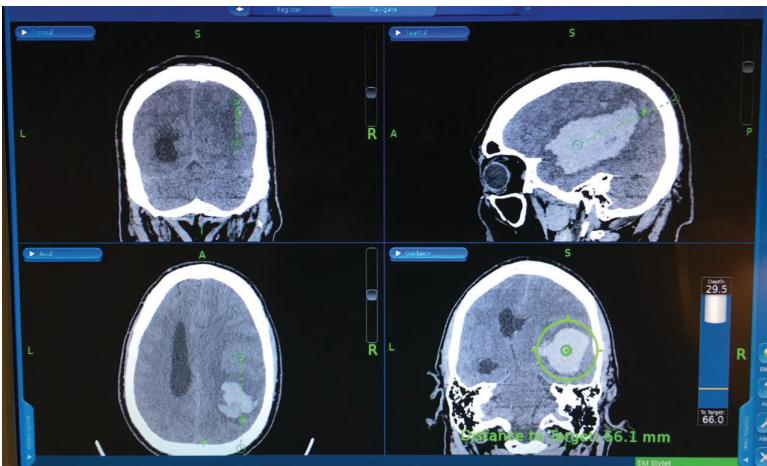
Why Deep Learning?



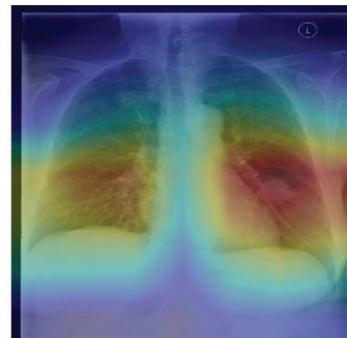
<https://www.youtube.com/watch?v=EhcpGpFHCrw>

Why Deep Learning?

***Medical Imaging,
AI in Medicine***



(a) Patient with multifocal community acquired pneumonia. The model correctly detects the airspace disease in the left lower and right upper lobes to arrive at the pneumonia diagnosis.



(b) Patient with a left lung nodule. The model identifies the left lower lobe lung nodule and correctly classifies the pathology.



(c) Patient with primary lung malignancy and two large masses, one in the left lower lobe and one in the right upper lobe adjacent to the mediastinum. The model correctly identifies both masses in the X-ray.



(d) Patient with a right-sided pneumothorax and chest tube. The model detects the abnormal lung to correctly predict the presence of pneumothorax (collapsed lung).



(e) Patient with a large right pleural effusion (fluid in the pleural space). The model correctly labels the effusion and focuses on the right lower chest.

P. Rajpurkar et al., arXiv:1711.05225v3



(f) Patient with congestive heart failure and cardiomegaly (enlarged heart). The model correctly identifies the enlarged cardiac silhouette.

Why Deep Learning?



News Startups Mobile Gadgets Enterprise Social Europe

Trending Amazon Tesla Microsoft

eBay

shopping

Search

eCommerce

eCommerce

Popular Posts

***Shopping,
e-commerce***

eBay launches visual search tools that let you shop using photos from your phone or web

Posted Oct 26, 2017 by Sarah Perez (@sarahintampa)



Next Story



Crunchbase

eBay

FOUNDED
1995

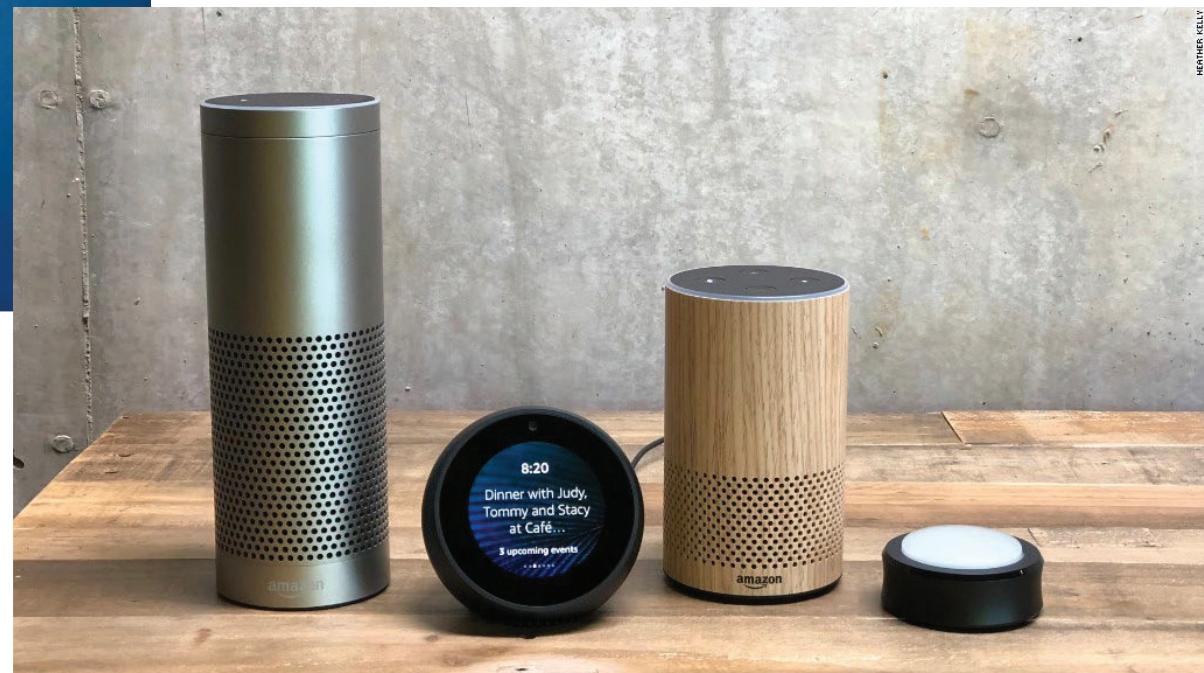
OVERVIEW

eBay is an online marketplace. The platform connects millions of buyers with sellers globally utilizing PayPal to ensure secure transactions. eBay products can be sold either via a silent auction in which users are able to input the maximum price they are willing to pay and for which the site will automatically increase bids as necessary up to that maximum, or via the Buy It

Why Deep Learning?



*Voice Recognition,
Smart Devices*

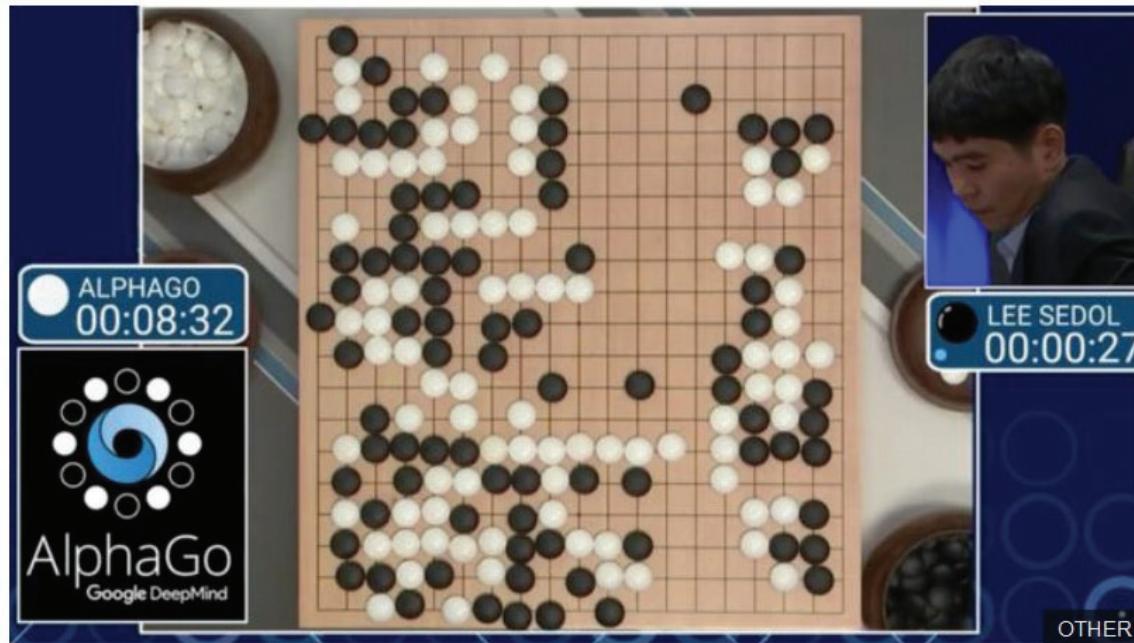


Breakthrough of Deep learning

Artificial intelligence: Google's AlphaGo beats Go master Lee Se-dol

⌚ 12 March 2016

f 📢 🌐 📧 Share



A computer program has beaten a master Go player 3-0 in a best-of-five competition, in what is seen as a landmark moment for artificial intelligence.

Success of deep learning



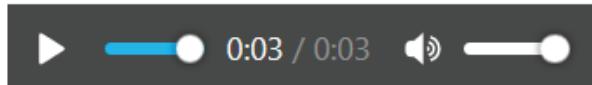
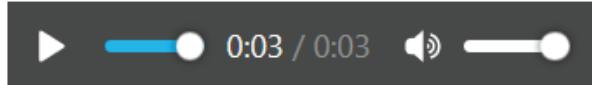
A few sample faces — all completely fake — created by ThisPersonDoesNotExist.com

Success of deep learning

The embedding can also transfer fine time-aligned prosody from one phrase to a slightly different phrase, though this technique works best when the reference and target phrases are similar in length and structure.

Reference Text: For the first time in her life she had been danced tired.

Synthesized Text: For the last time in his life he had been handily embarrassed.

Reference prosody (American)		
Synthesized without prosody embedding (American)		
Synthesized with prosody embedding (American)		

Excitingly, we observe prosody transfer even when the reference audio comes from a speaker whose voice is not in Tacotron's training data.

<https://ai.googleblog.com/2018/03/expressive-speech-synthesis-with.html>

Success of deep learning

Multimodal Recurrent Neural Network

<https://cs.stanford.edu/people/karpathy/deepimagesent/>

Our Multimodal Recurrent Neural Architecture generates sentence descriptions from images. Below are a few examples of generated sentences:



"man in black shirt is playing guitar."



"construction worker in orange safety vest is working on road."



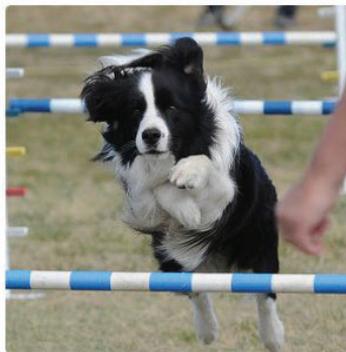
"two young girls are playing with lego toy."



"boy is doing backflip on wakeboard."



"girl in pink dress is jumping in air."



"black and white dog jumps over bar."

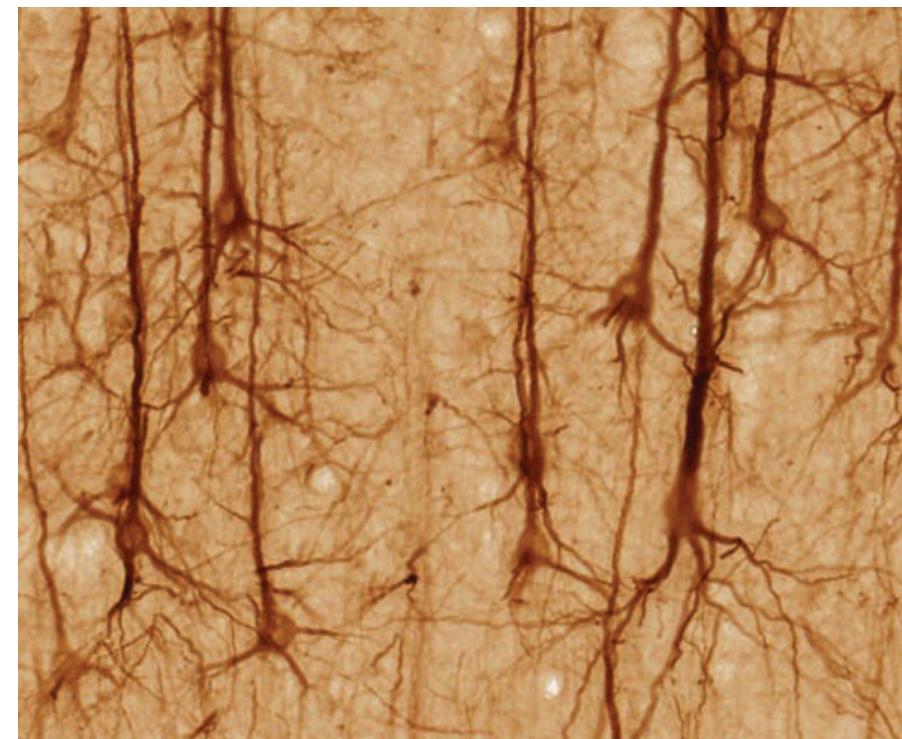
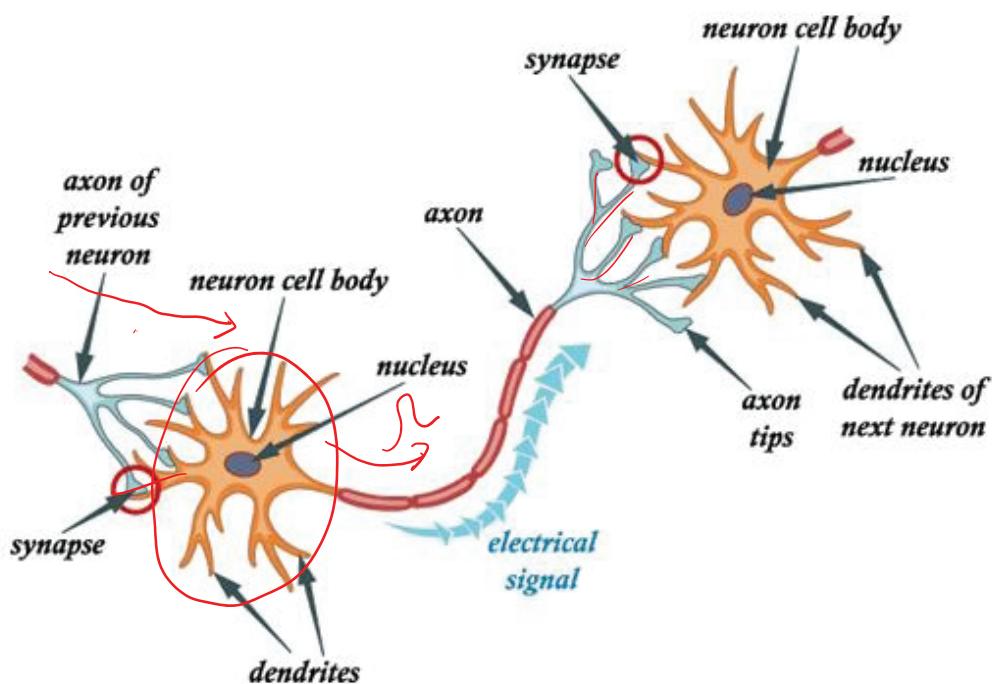


"young girl in pink shirt is swinging on swing."

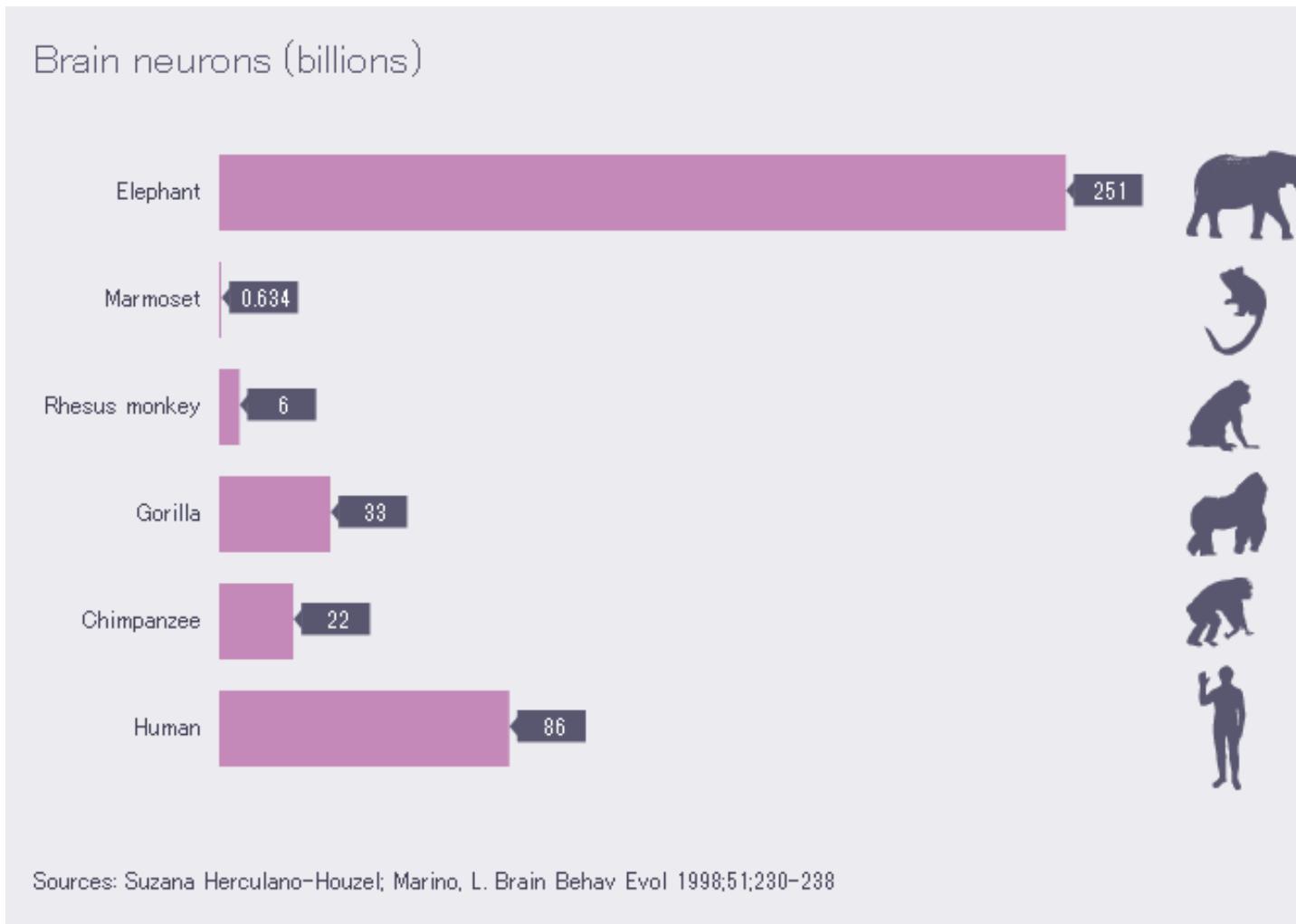


"man in blue wetsuit is surfing on wave."

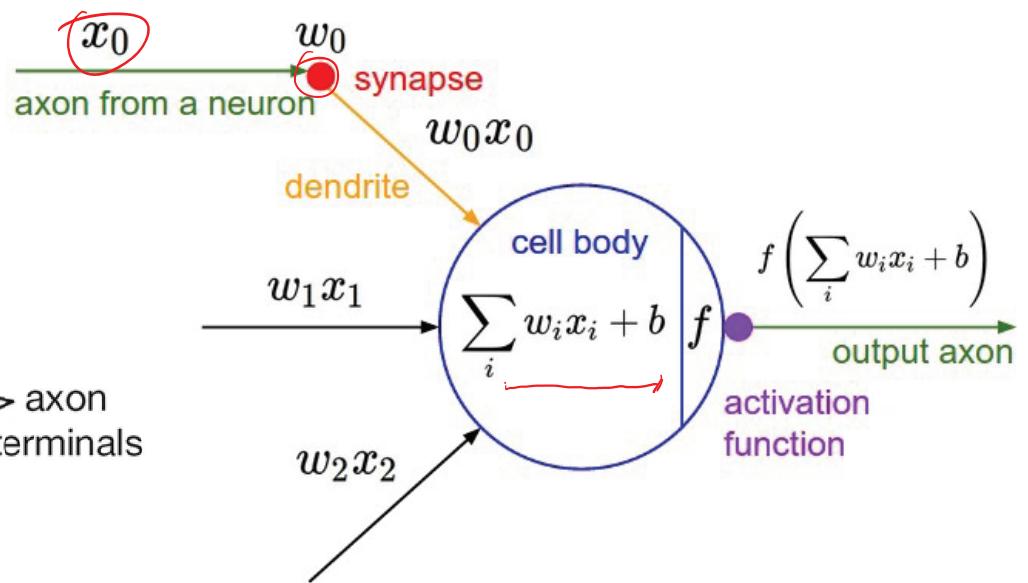
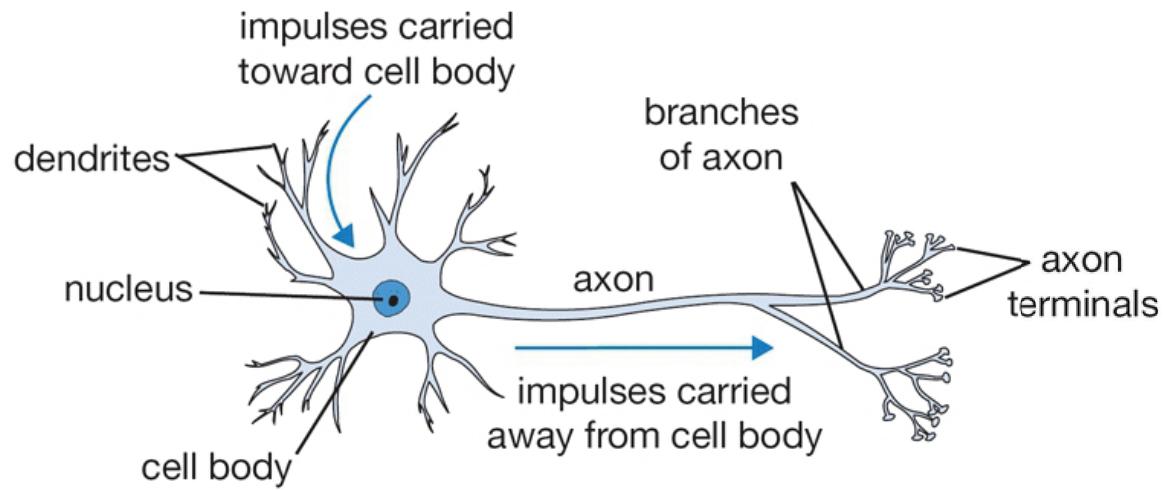
Neurons in Biological Systems



Neurons in Biological Systems



What is Artificial Neuron (Perceptron)



History of neural networks



- Mid 1800s: The brain is a mass of interconnected neurons

History of neural networks

“Connectionism”



- Alexander Bain, philosopher, psychologist, mathematician, logician, linguist, professor
- 1873: The information is in the ***connections***
 - *Mind and body* (1873)

History of neural networks

“Perceptron”



- Frank Rosenblatt
 - Psychologist, Logician
 - Inventor of the solution to everything, aka the Perceptron (1958)

History of neural networks

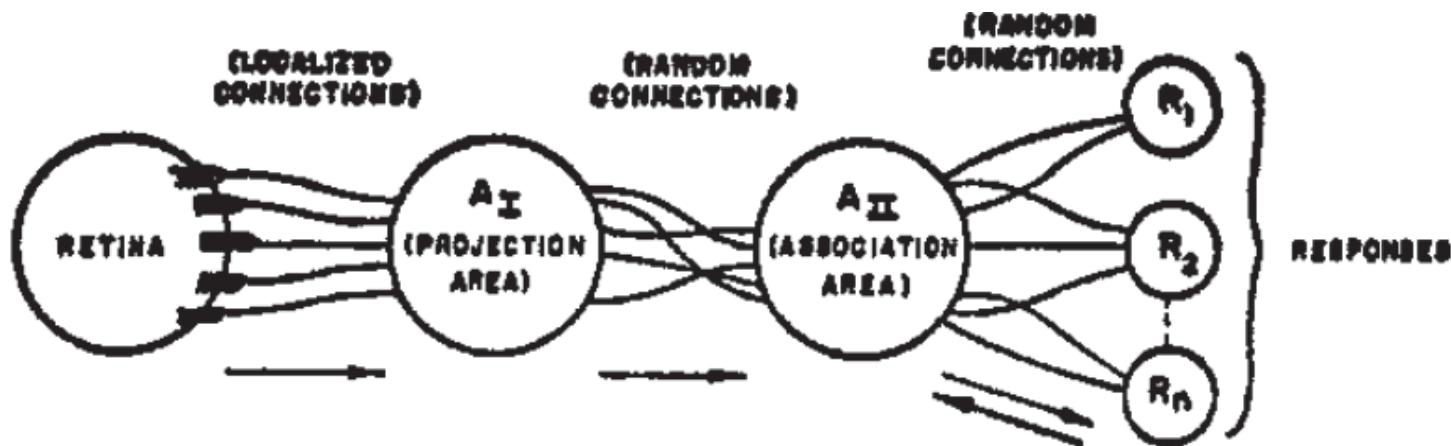
“Perceptron”

Psychological Review
Vol. 65, No. 6, 1958

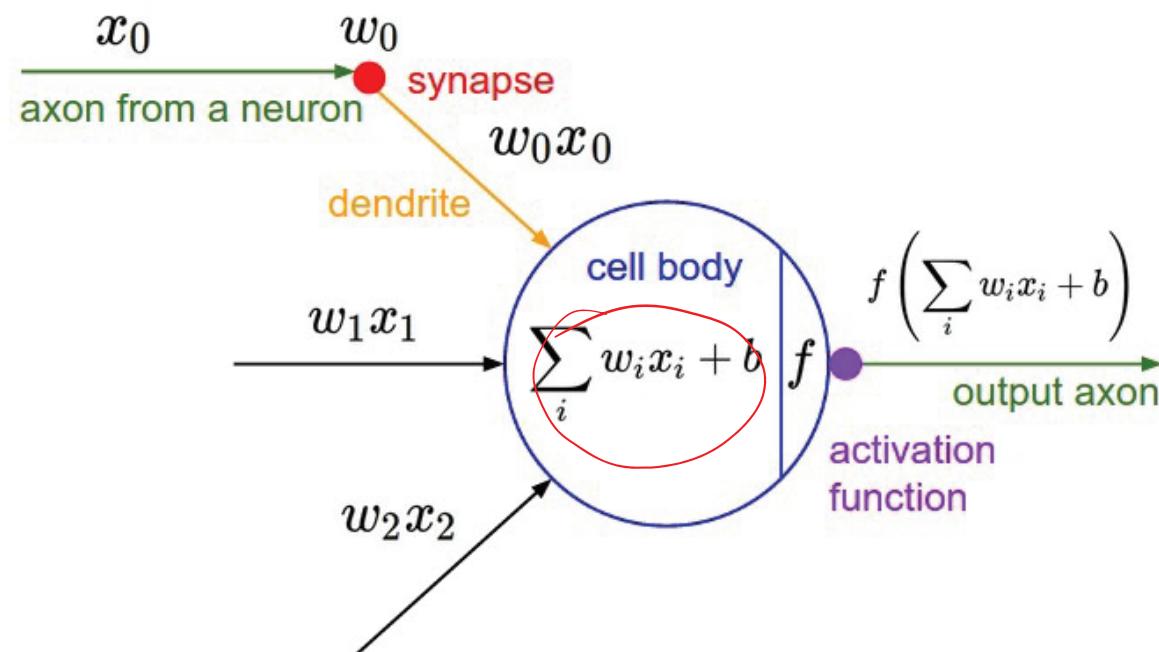
THE PERCEPTRON: A PROBABILISTIC MODEL FOR INFORMATION STORAGE AND ORGANIZATION IN THE BRAIN¹

F. ROSENBLATT

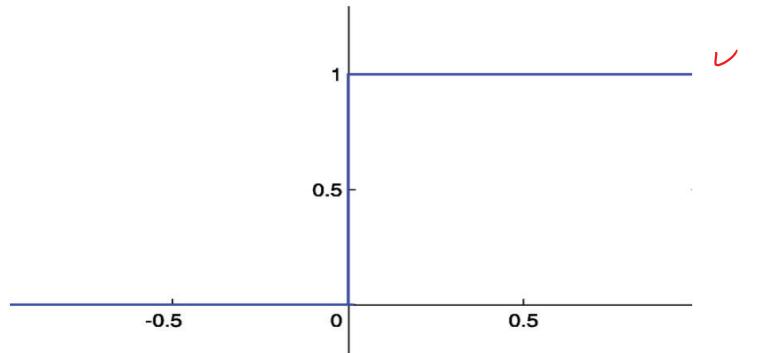
Cornell Aeronautical Laboratory



Perceptron

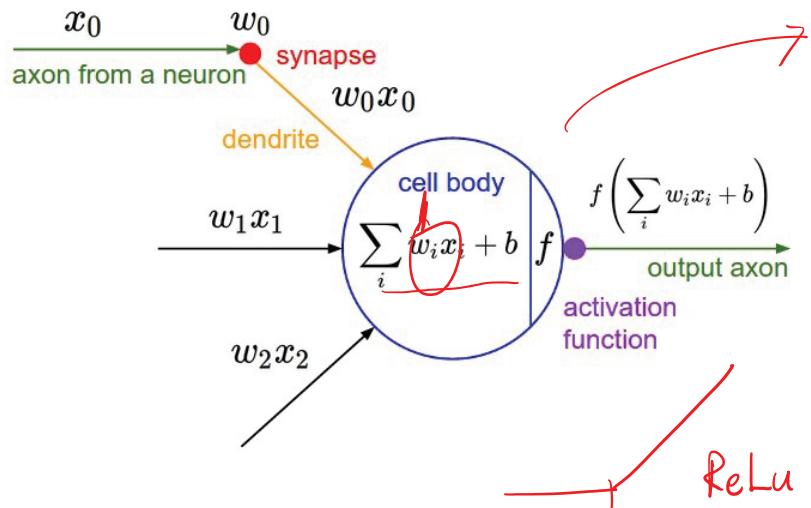


- Binary Threshold (Step function)

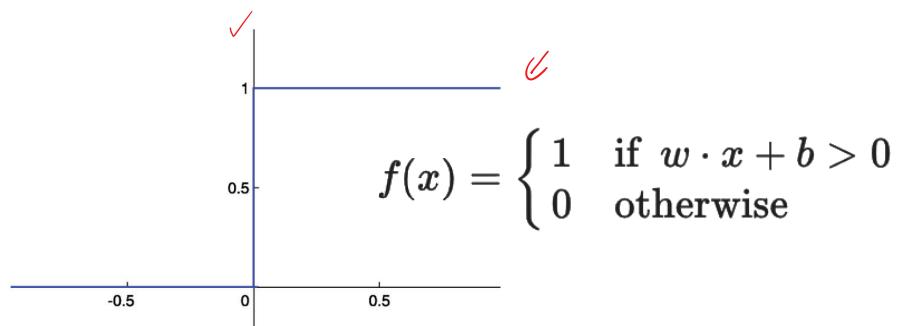


$$f(x) = \begin{cases} 1 & \text{if } w \cdot x + b > 0 \\ 0 & \text{otherwise} \end{cases}$$

Activation functions

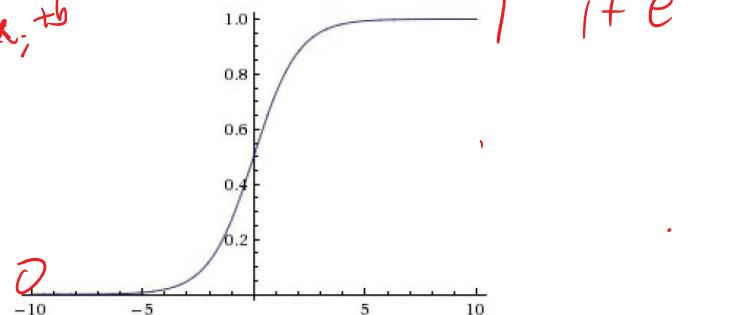


- Binary Threshold (Step function)

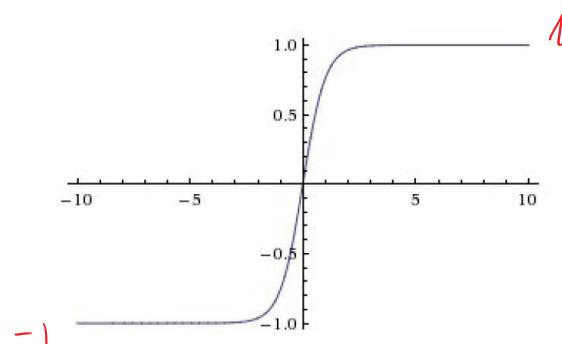


- Sigmoid

$$z = \sum w_i x_i + b$$



- Tanh



Perceptron

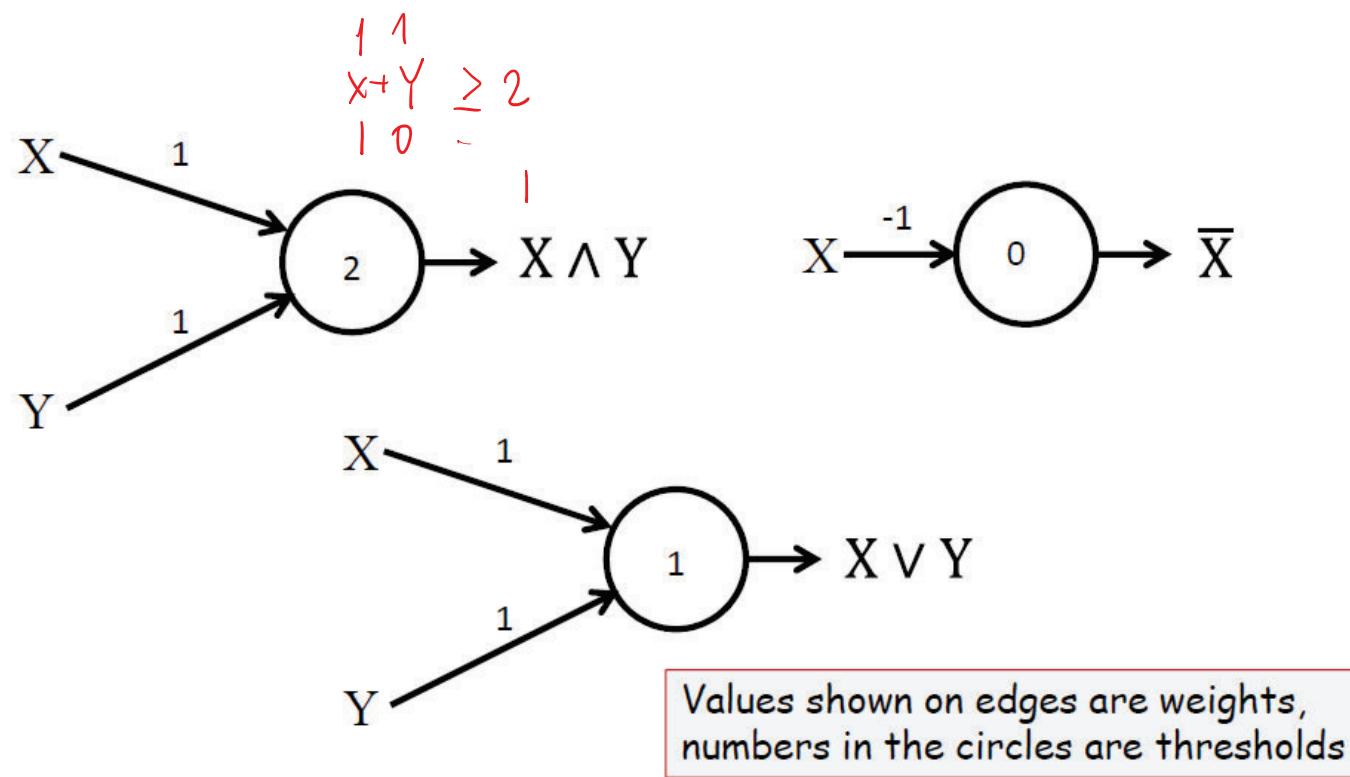
What can a perceptron do?

- Boolean tasks
- Update the weights whenever the perceptron output is wrong
- Proved convergence for linearly separable classes

Perceptron

Learning in perceptron

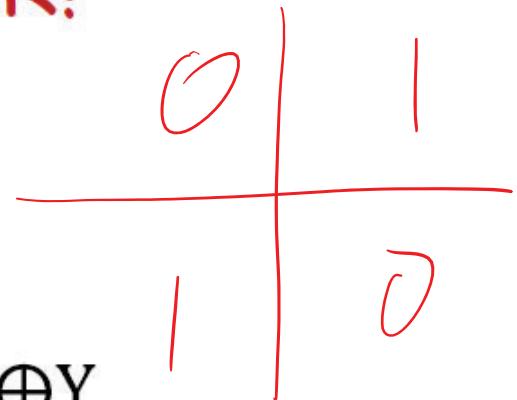
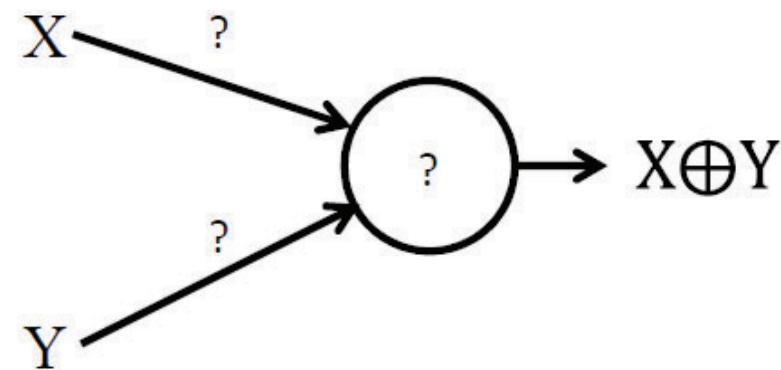
Perceptron



- Easily shown to mimic any Boolean gate
- But...

Perceptron

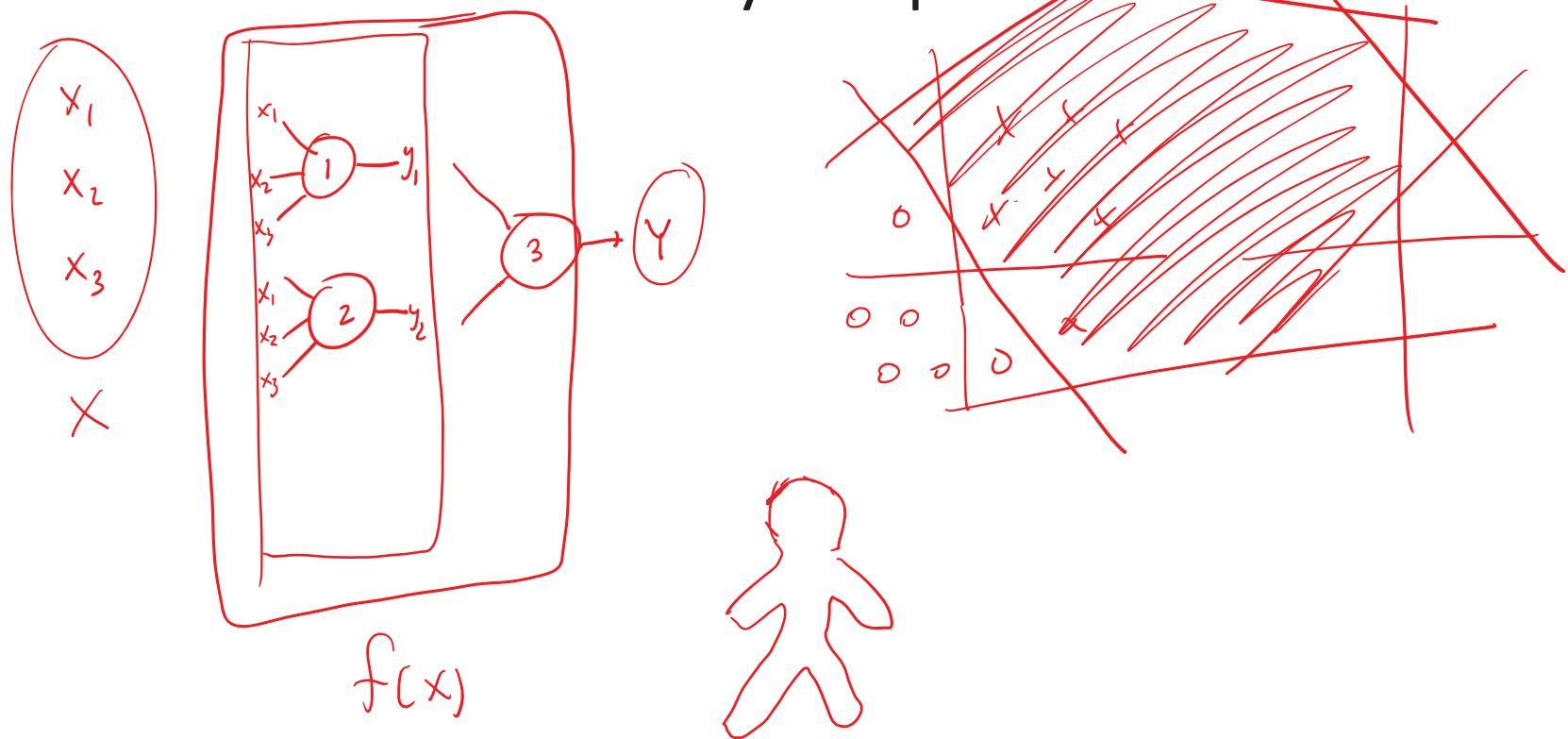
No solution for XOR!
Not universal!



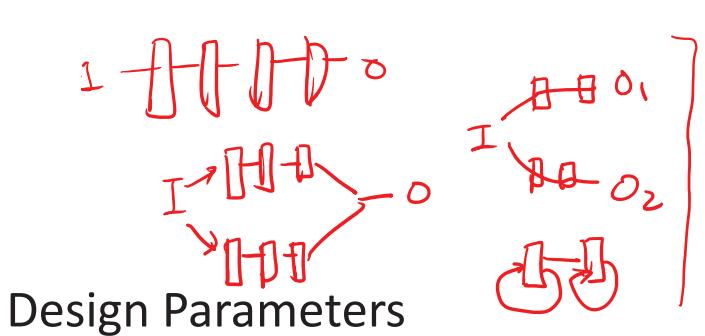
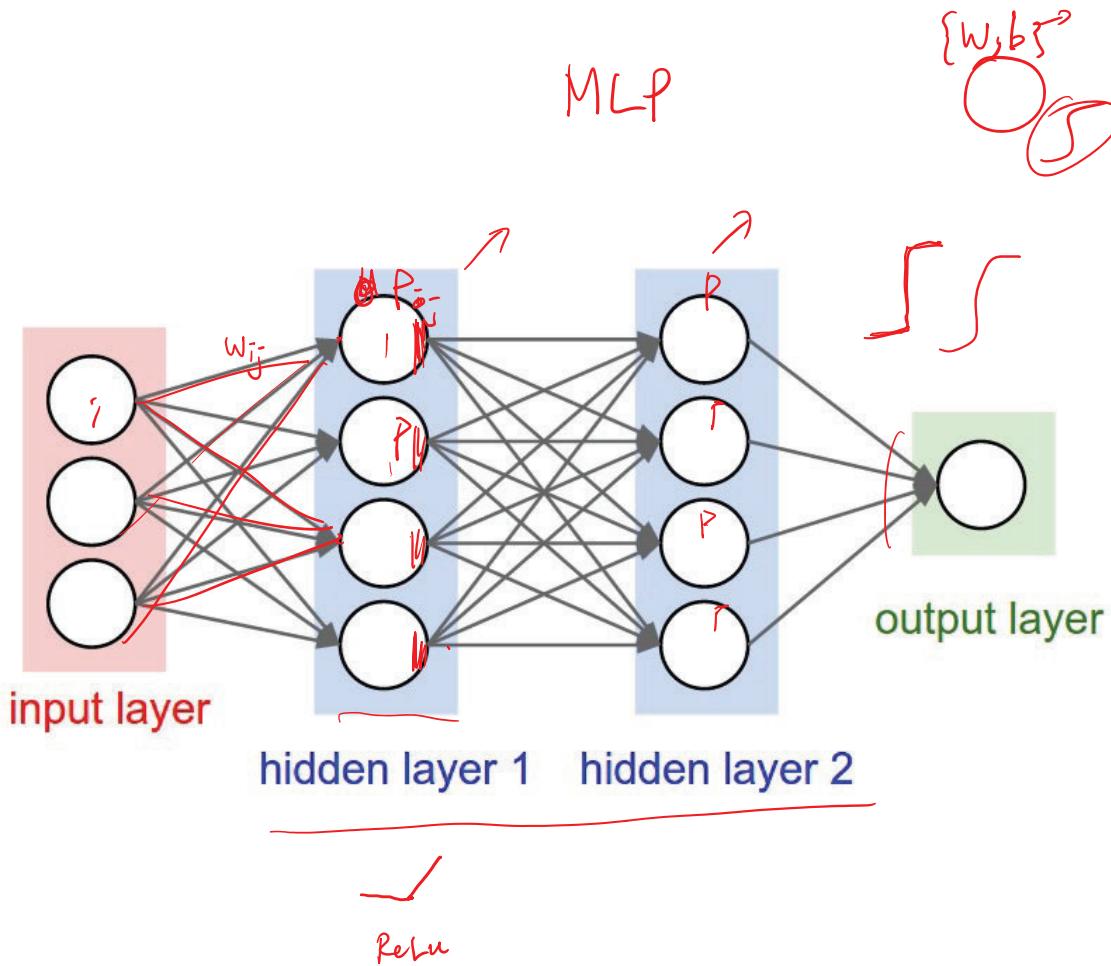
- Minsky and Papert, 1968

Perceptron

How do we handle linearly inseparable cases?



Multi-layer Perceptron (Neural network)



- Architecture
- Number of layers
- Number of neurons in a layer
- Activation functions

Artificial Neural Network facts

Can approximate any non-linear function

-> Nonlinearity comes from nonlinear activation function

Deeper layer and larger number of neurons in a layer

-> more model capacity

ANN/MLP: fully-connected neural network

Weights for every connection

Weights = parameters

(cf) Hyperparameters = design parameters