

# Deep Learning part 1

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08.11.18

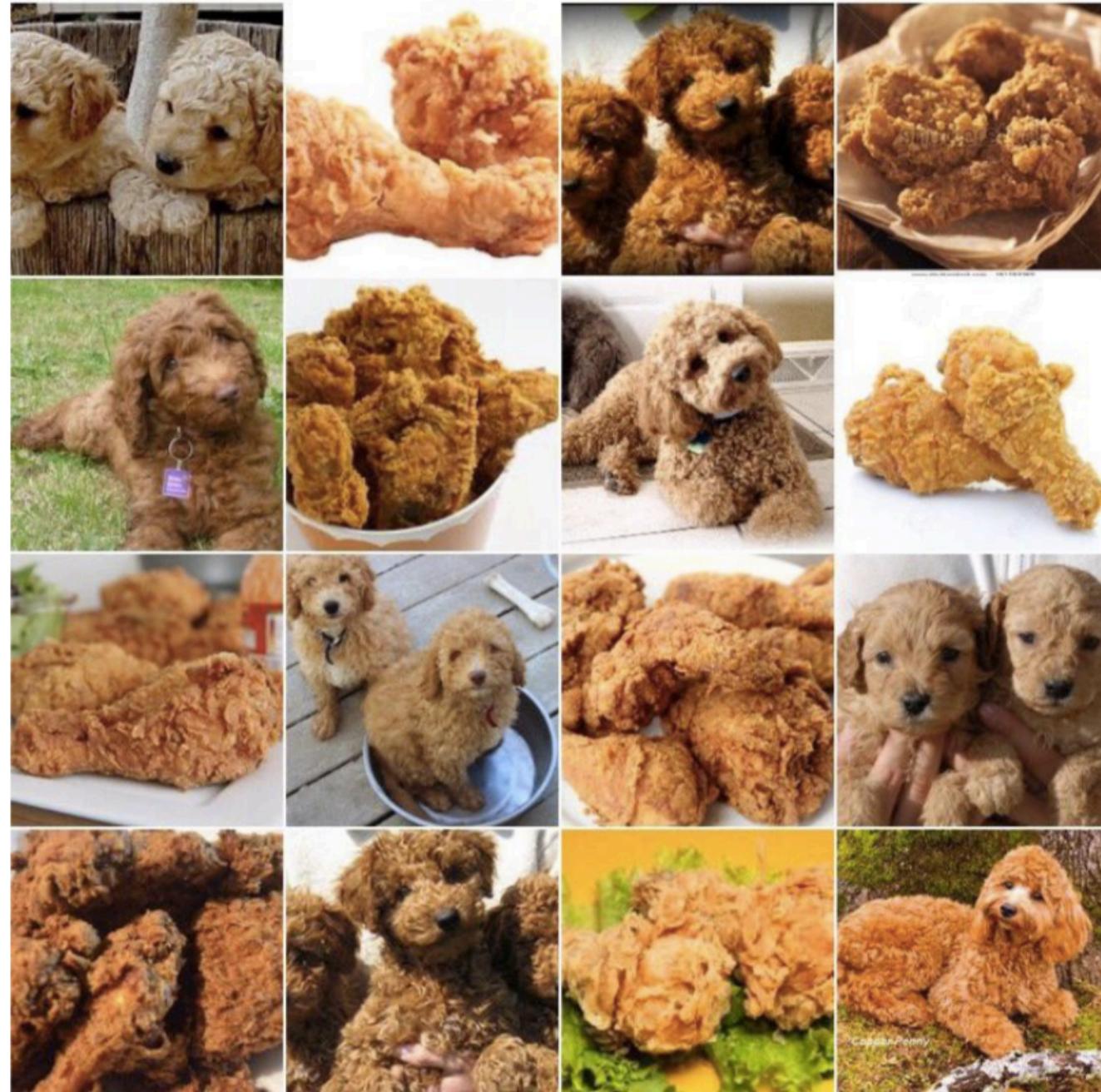
Legchikov Dmitry

# Course plan

- Artificial Neural Networks
- Deep Learning
- MNIST (Image recognition practice)
- Image classification (Transfer Learning practice)
- Reinforcement Learning (OpenAI Gym practice)

# Simple task

Labradoodle  
or  
fried chicken?



Puppy  
or  
bagel?



Sheepdog  
or  
mop?



# and one more

Chihuahua  
or  
muffin?



@teenybiscuit

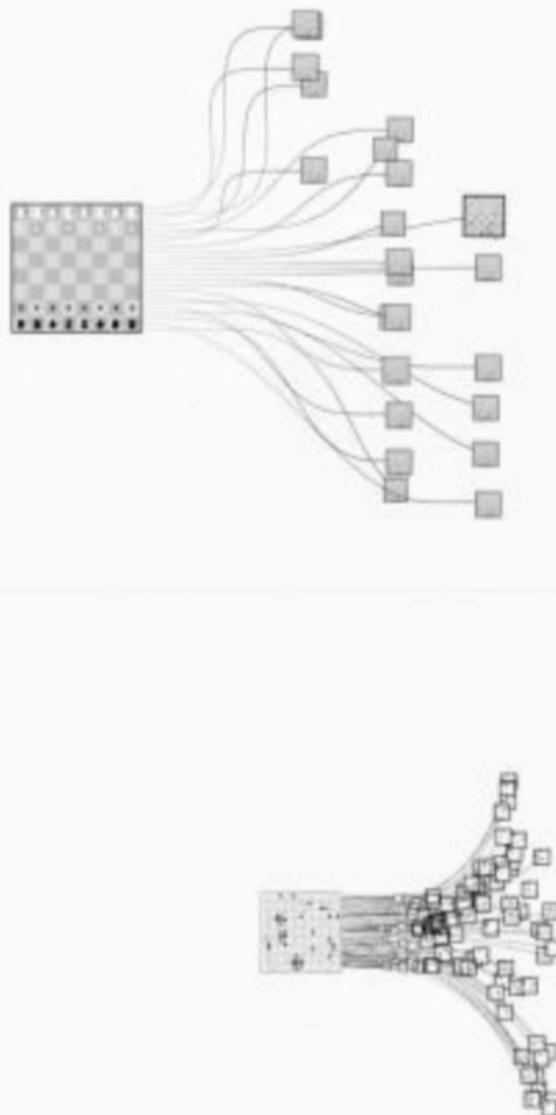
# We human actually lose!

A demo that shows we, human, lose, on  
the classification task

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

# We human lose on Go!





**Chess:  $10^{47}$**

Deep Blue, Feb 10, 1996

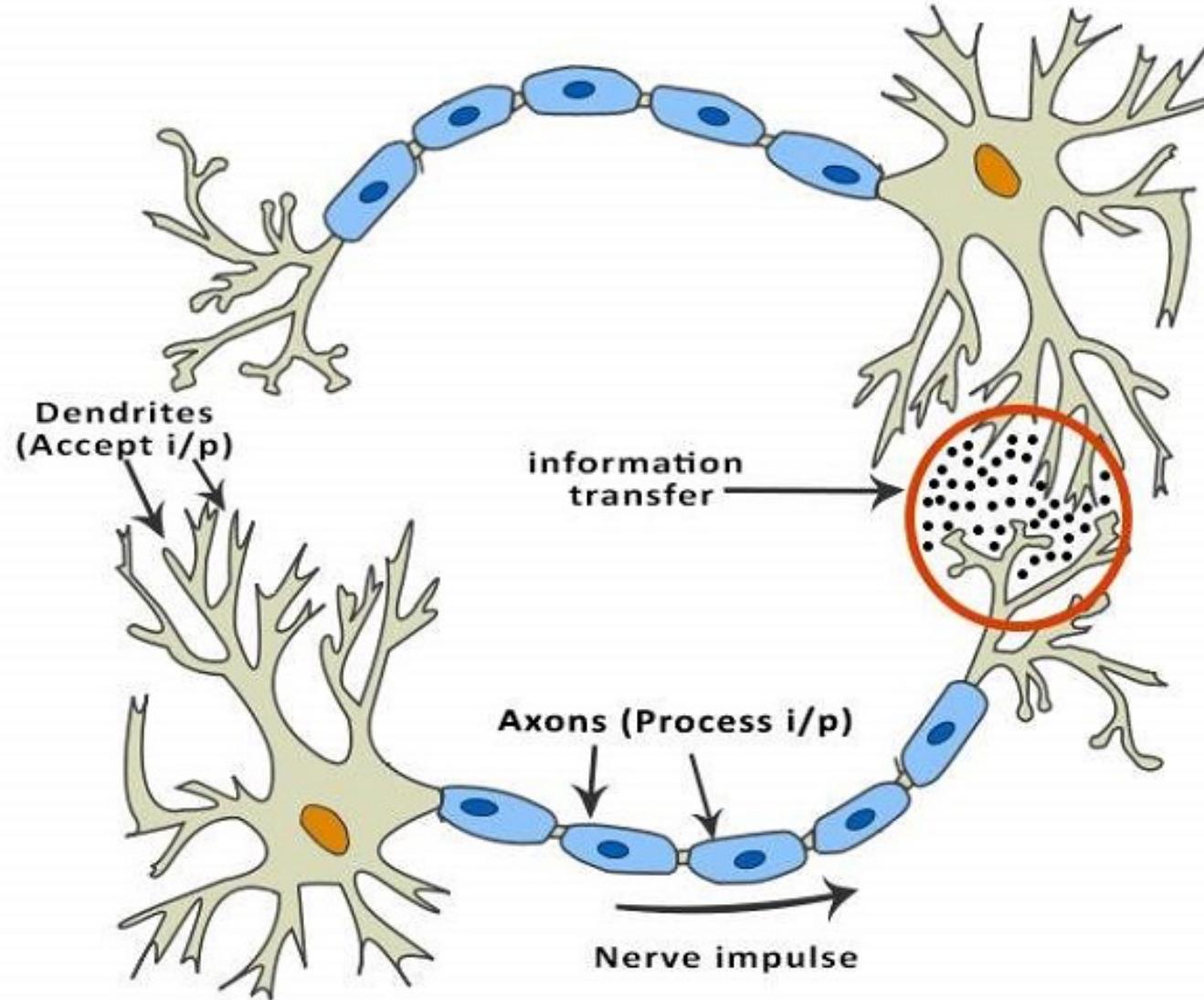
**Go:  $10^{170}$**

AlphaGo, March, 2016

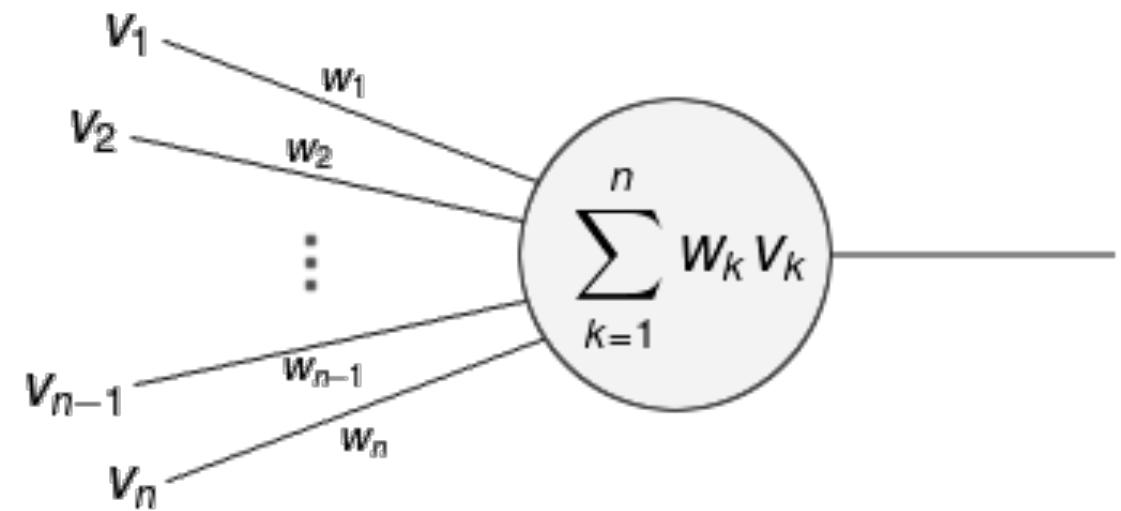
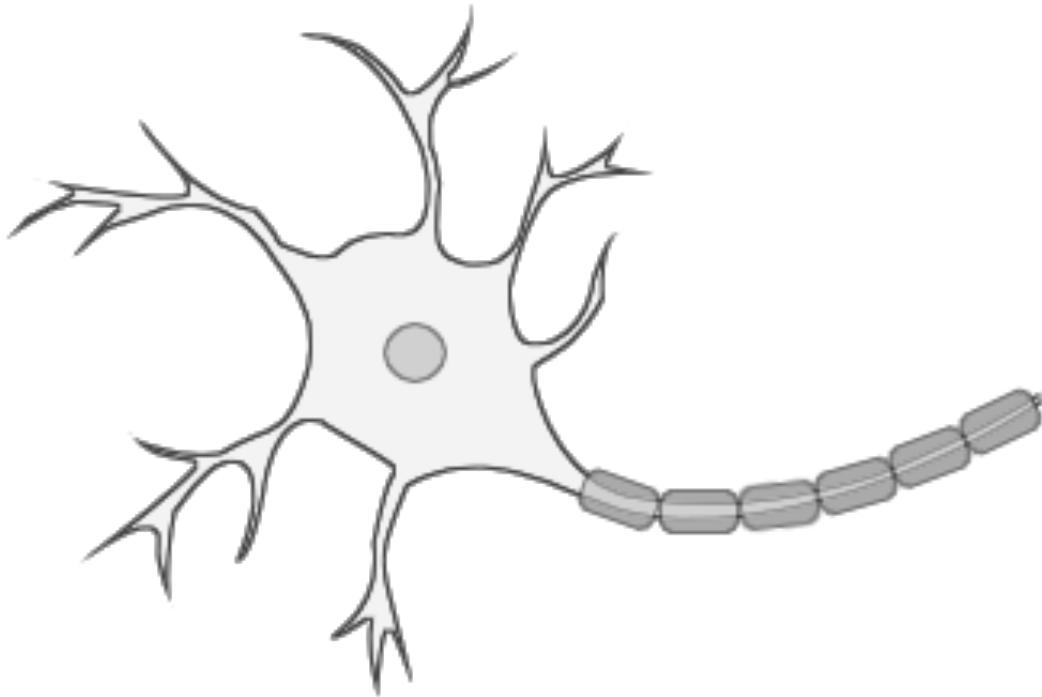
# We (will) lose on many **specific** tasks!

- Image classifier with deep learning (with fewest lines of code)
- Multi-label classification and different kinds of images (e.g. satellite images)
- Structured data (e.g. sales forecasting)
- Language: NLP classifier (e.g. movie review classification)
- Collaborative filtering (e.g. recommendation engine)
- Generative language model

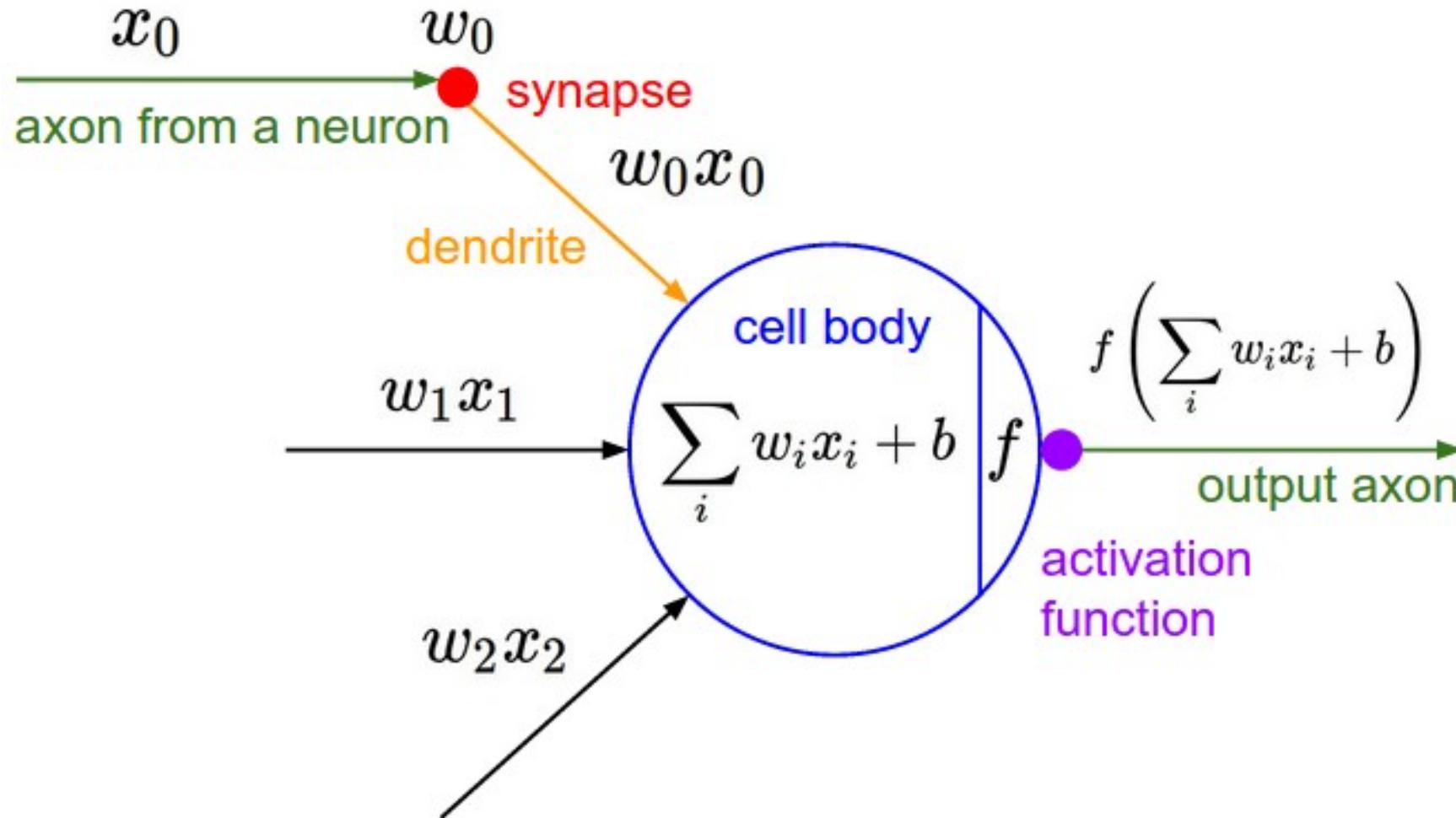
# Biological neuron



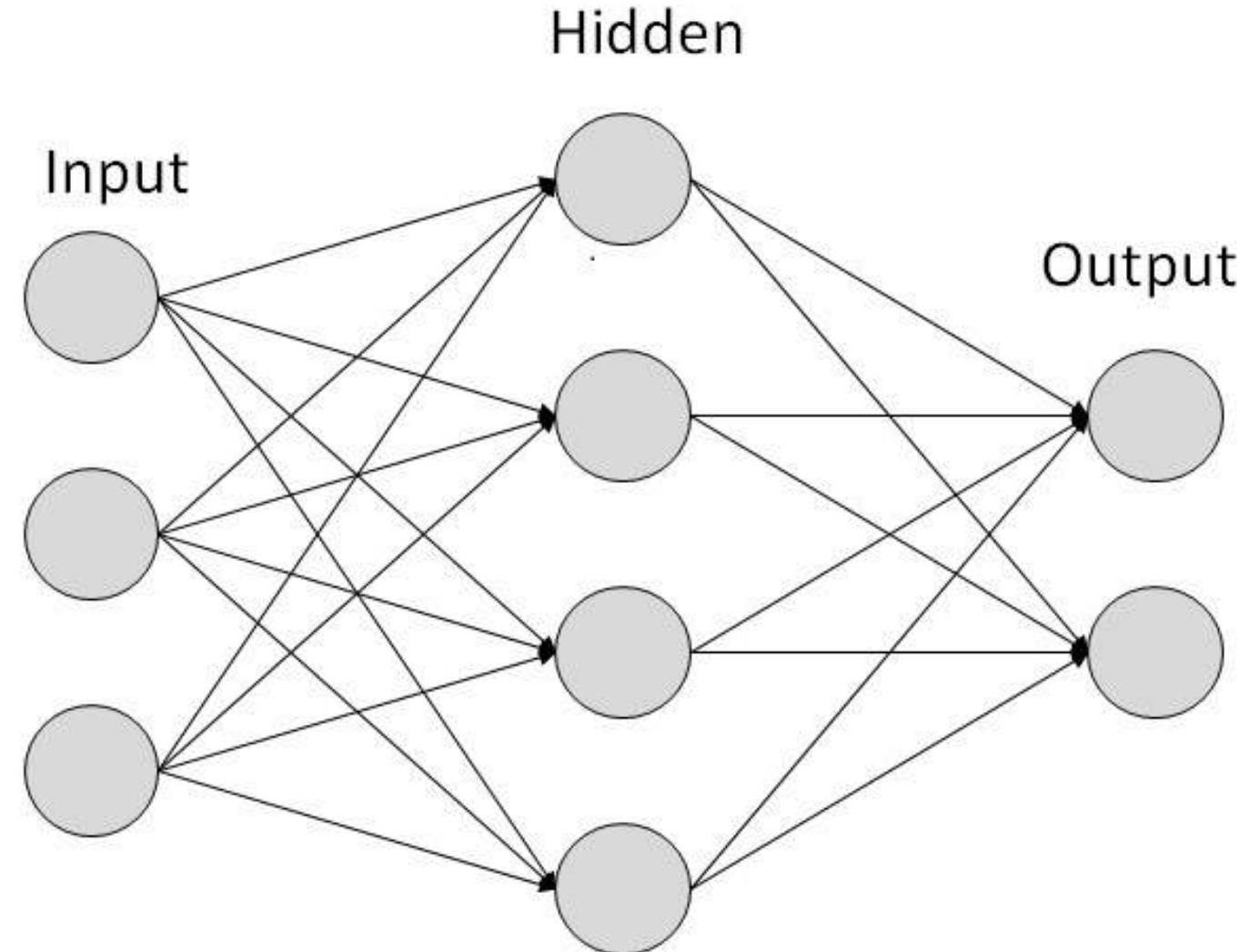
# Artificial neuron



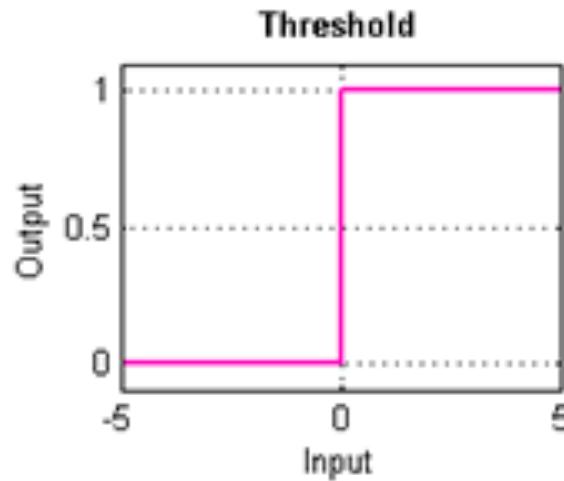
# Artificial neuron



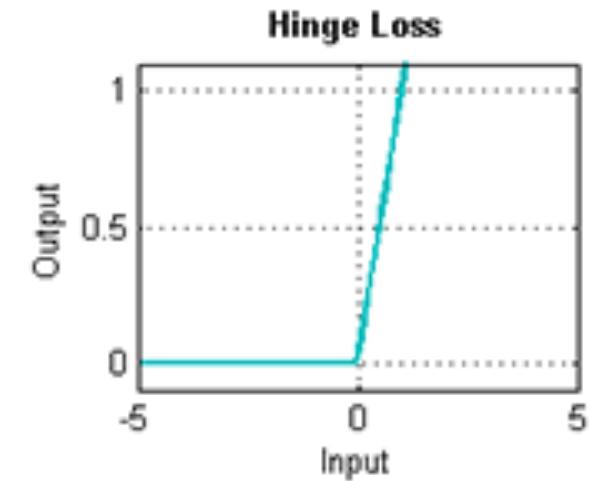
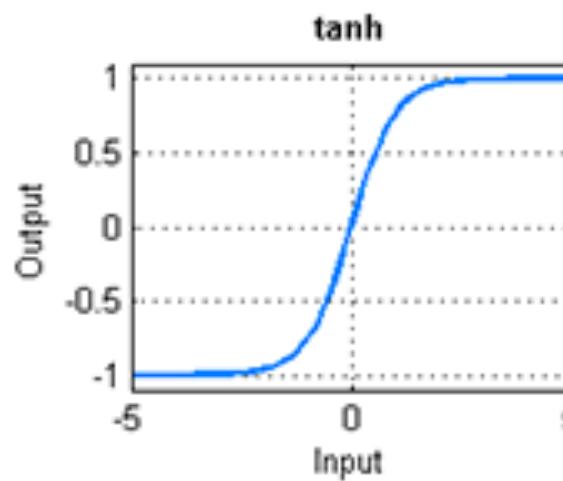
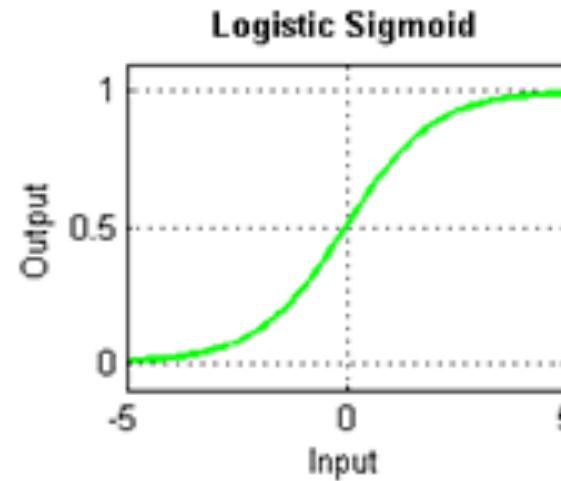
# Artificial neural network (ANN)



# Activation function



Undefined gradient  
Can't be used



New default activation

# but “AI Winter” was started

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- No theoretical base

# but “AI Winter” was started

- No theoretical base
- How to teach ANN?

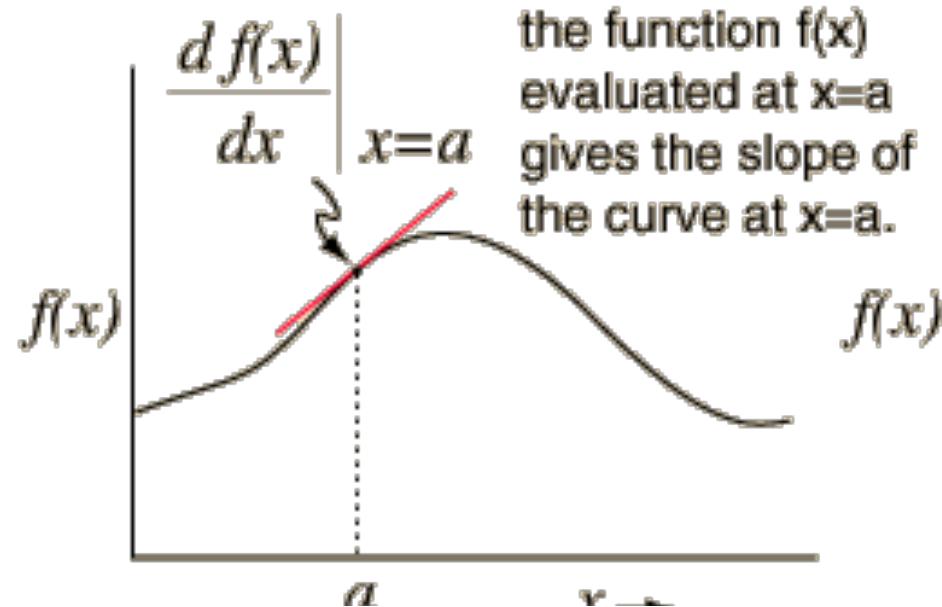
- Universal approximation theorem

“A feedforward network with a single layer is sufficient to represent any function, but the layer may be infeasibly large and may fail to learn and generalize correctly.”

- Backpropagation algorithm

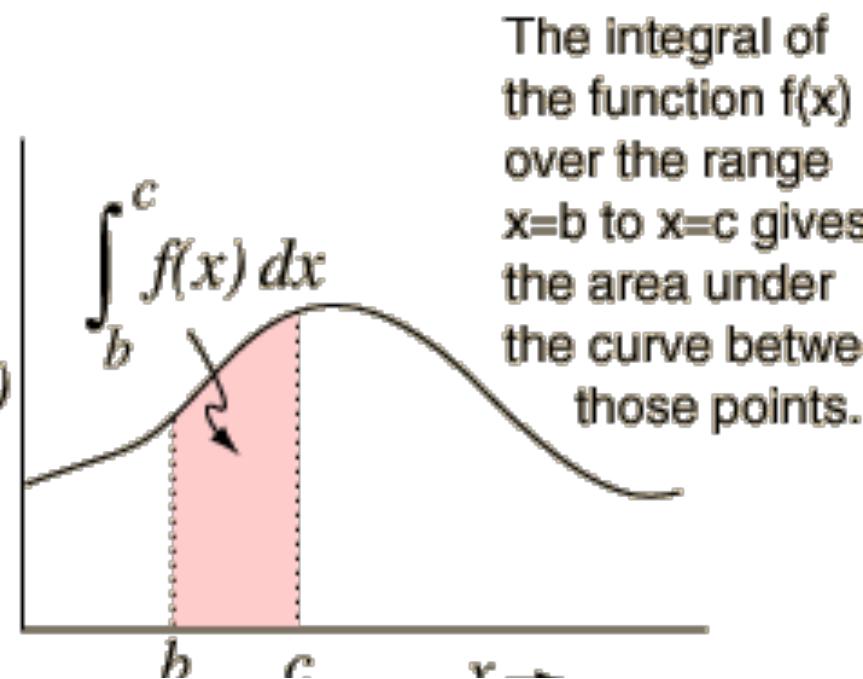
## Derivative

$$\frac{d f(x)}{dx}$$

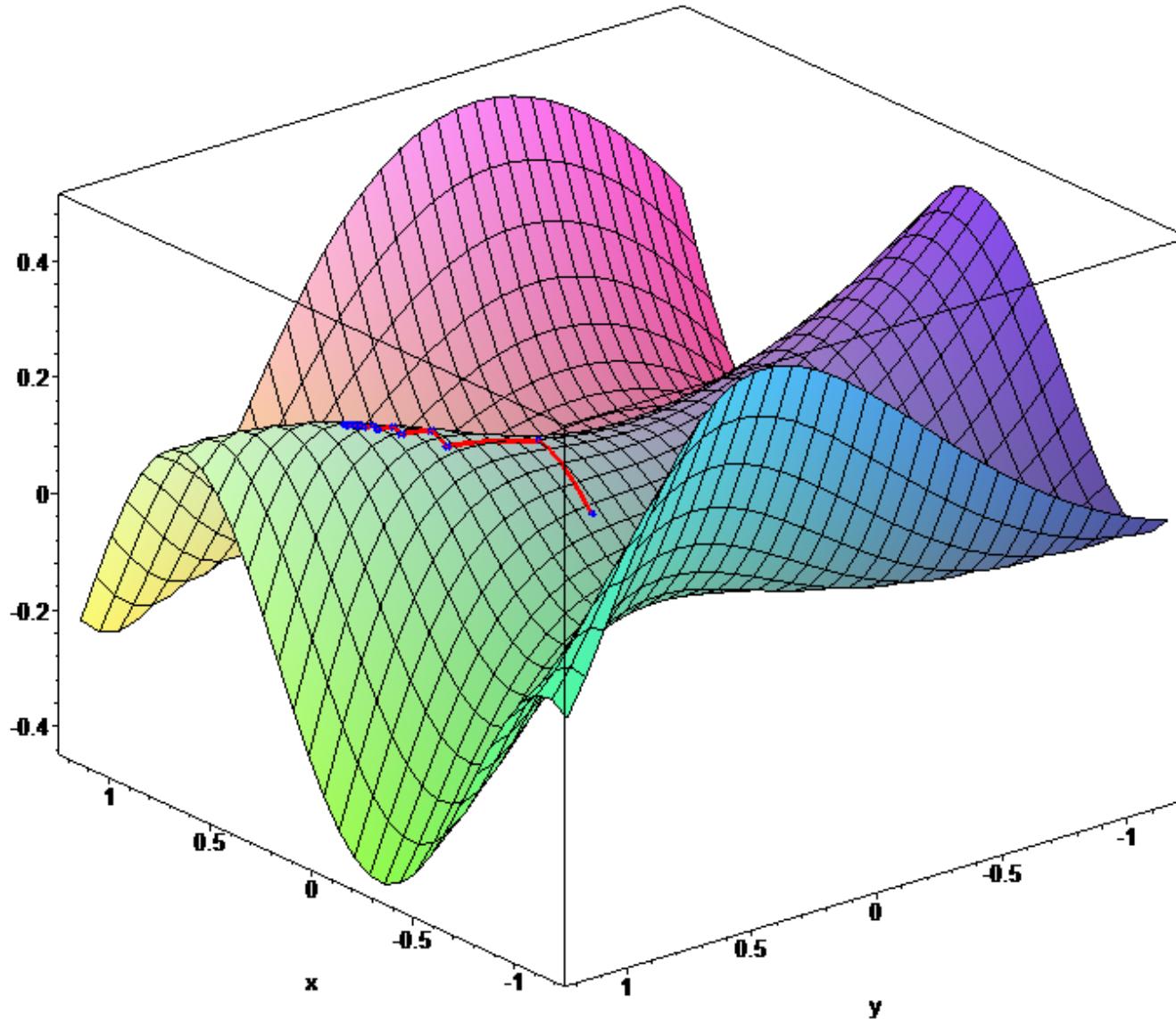


## Integral

$$\int f(x) dx$$

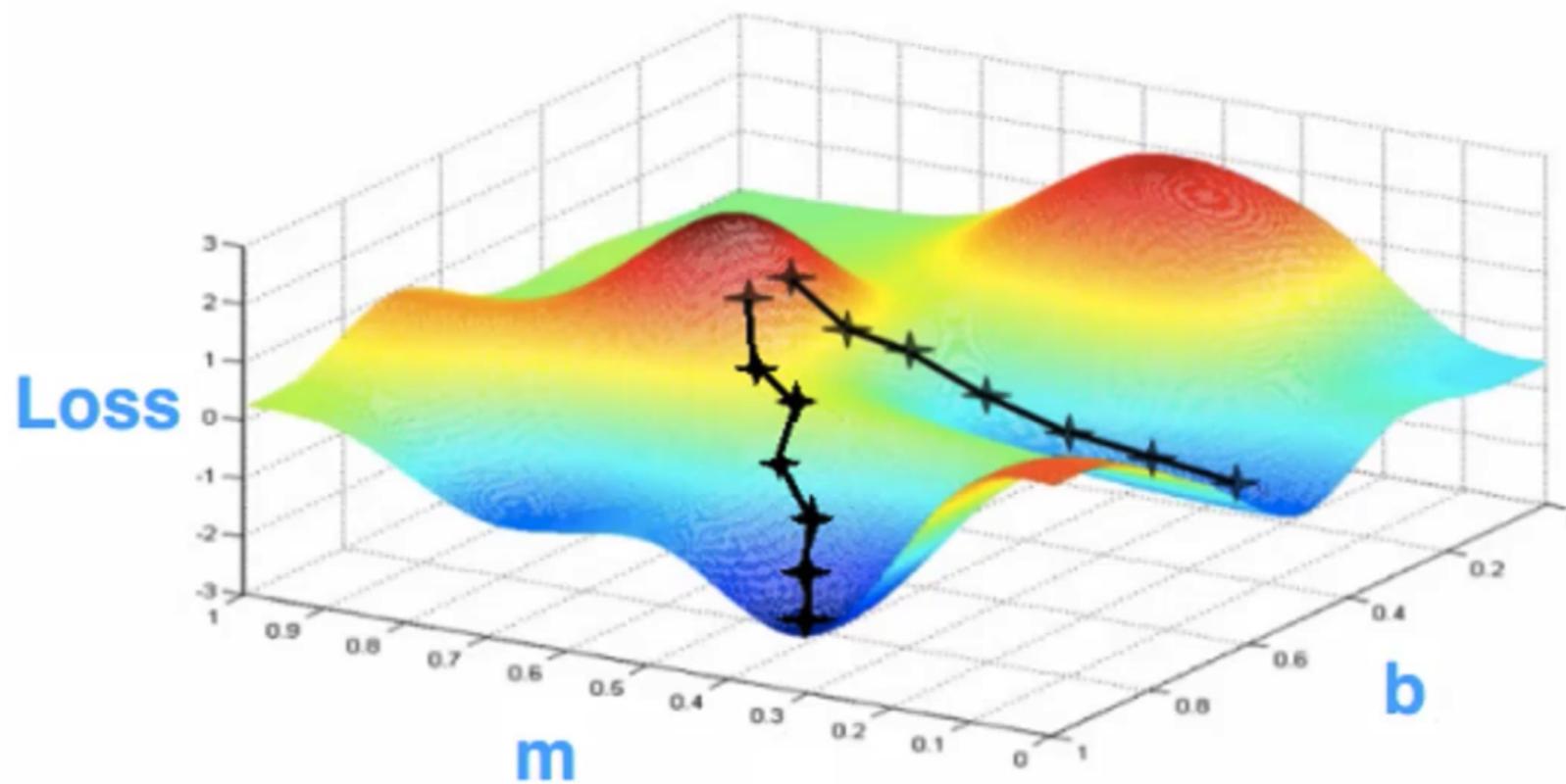


# What if N-dimensional?



# Gradient Descent

*f(x) = nonlinear function of x*

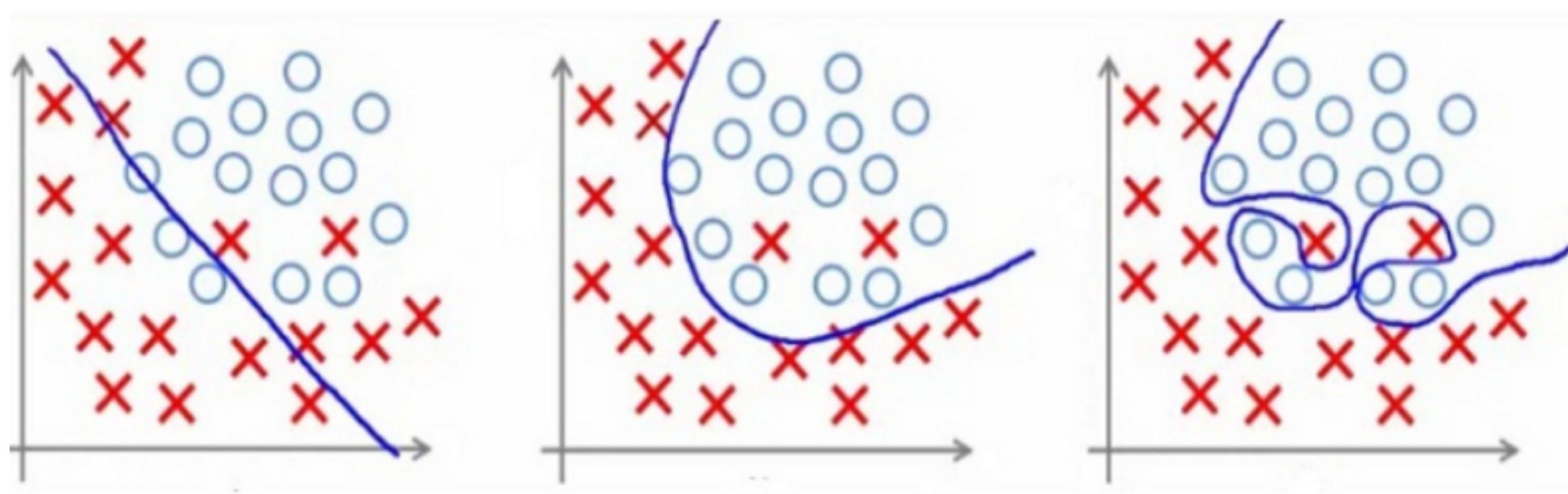


# Backpropagation

## LIVE DEMO

<https://google-developers.appspot.com/machine-learning/crash-course/backprop-scroll/>

# Overfitting



**Under-fitting**

(too simple to explain the variance)

**Appropriate-fitting**

**Over-fitting**

(forcefitting – too good to be true)

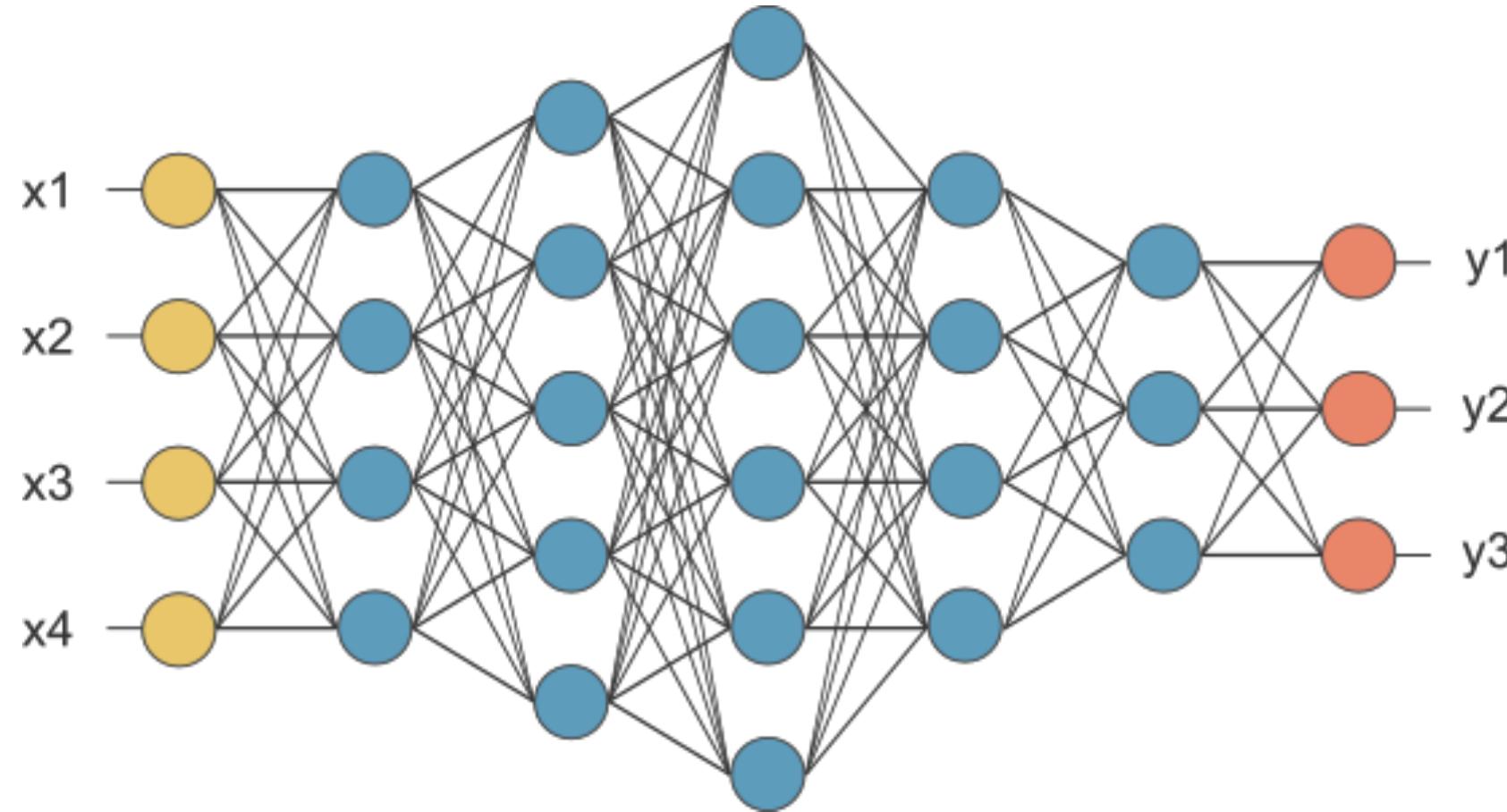
# Artificial neural network (ANN)



LIVE DEMO

# Deep Learning

# Deep Neural Networks (DNN)





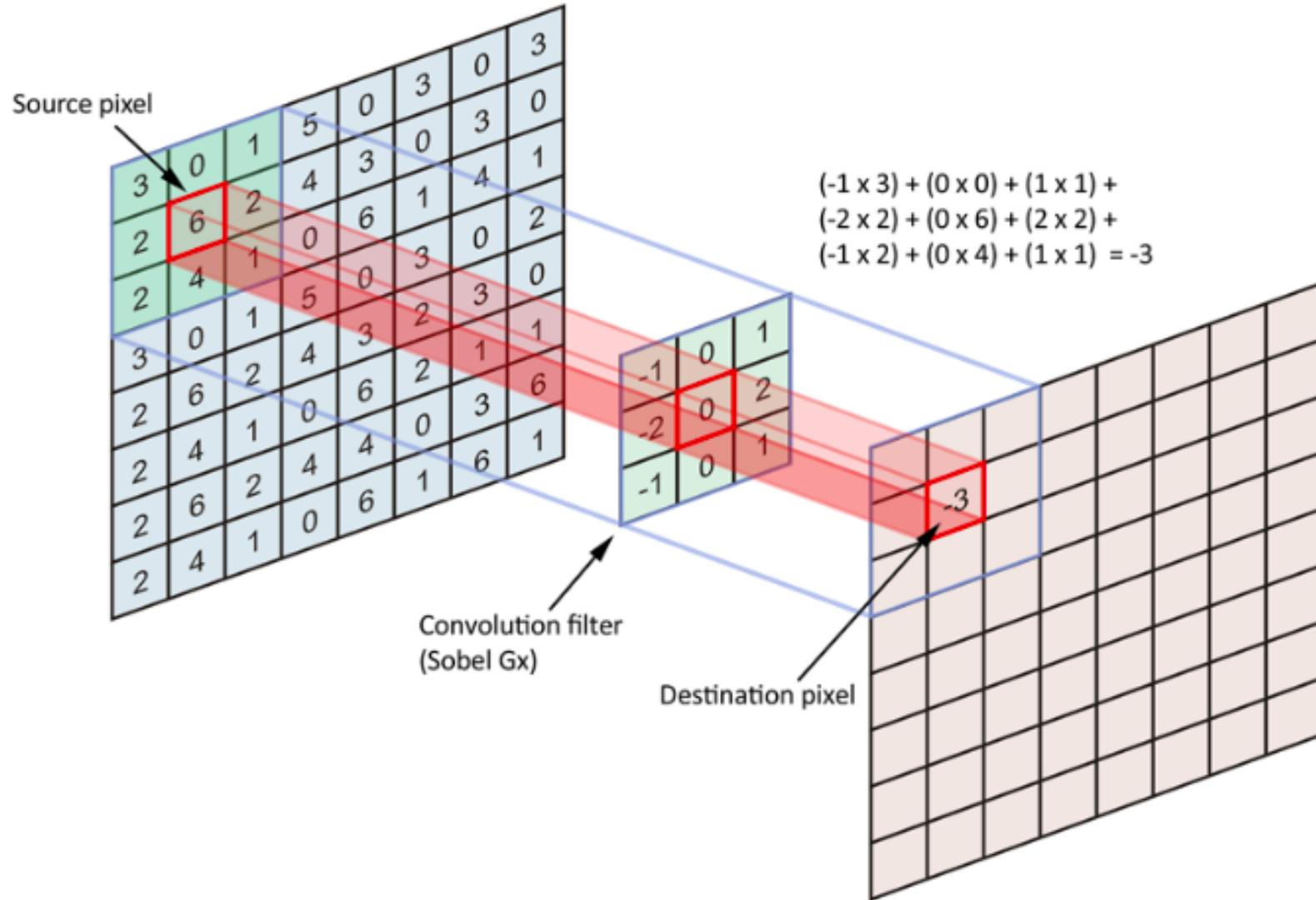
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49	49	99	40	17	81	18	57	60	87	17	40	98	43	69	48	04	56	62	00
81	49	31	73	55	79	14	29	93	71	40	67	58	88	30	03	49	13	36	65
52	70	95	23	04	60	11	42	62	31	68	56	01	32	56	71	37	02	36	91
22	31	16	71	51	67	63	89	41	92	36	54	22	40	40	28	66	33	13	80
24	47	38	60	99	03	45	02	44	75	33	53	78	36	84	20	35	17	12	50
32	98	81	28	64	23	67	10	26	38	40	67	59	54	70	66	18	38	64	70
67	26	20	68	02	62	12	20	95	63	94	39	63	08	40	91	66	49	94	21
24	55	58	05	66	73	99	26	97	17	78	78	96	83	14	88	34	89	63	72
21	36	23	09	75	00	76	44	20	45	35	14	00	61	33	97	34	31	33	95
78	17	53	28	22	75	31	67	15	94	03	80	04	62	16	14	09	53	56	92
16	39	05	42	96	35	31	47	55	58	88	24	00	17	54	24	36	29	85	57
86	56	00	48	35	71	89	07	05	44	44	37	44	60	21	58	51	54	17	58
19	80	81	68	05	94	47	69	28	73	92	13	86	52	17	77	04	89	55	40
04	52	08	83	97	35	99	16	07	97	57	32	16	26	26	79	33	27	98	66
23	34	68	87	57	62	20	72	03	46	33	67	46	55	12	32	63	93	53	69
04	42	16	73	38	39	11	24	94	72	18	08	46	29	32	40	62	76	36	
20	69	36	41	72	30	23	88	34	62	99	69	82	67	59	85	74	04	36	16
20	73	35	29	78	31	90	01	74	31	49	71	48	88	81	16	23	57	05	54
01	70	54	71	83	51	54	69	16	92	33	48	61	43	52	01	89	19	67	48

What the computer sees

image classification

82% cat  
15% dog  
2% hat  
1% mug

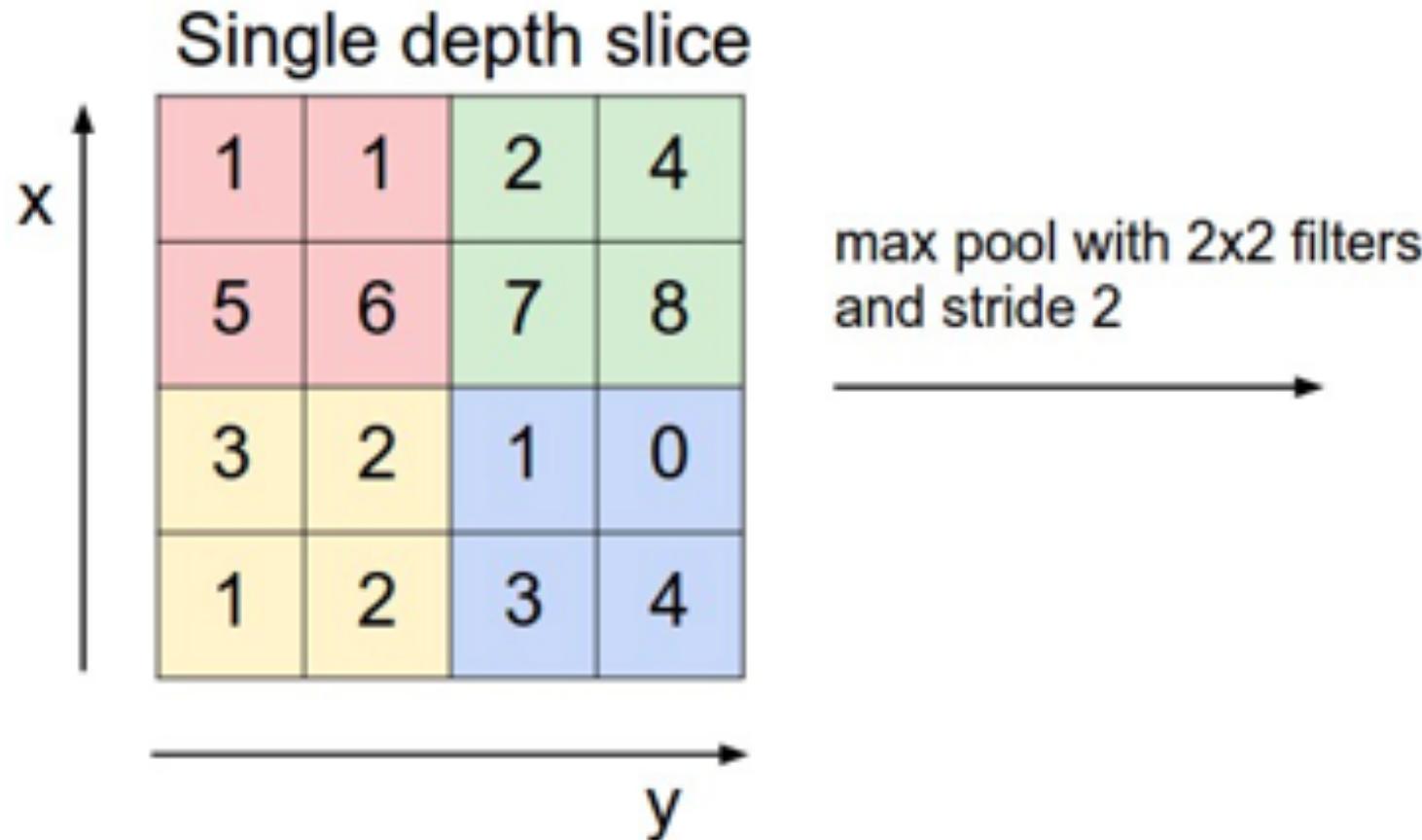
# Convolution layer



# Image Kernel Visualisation

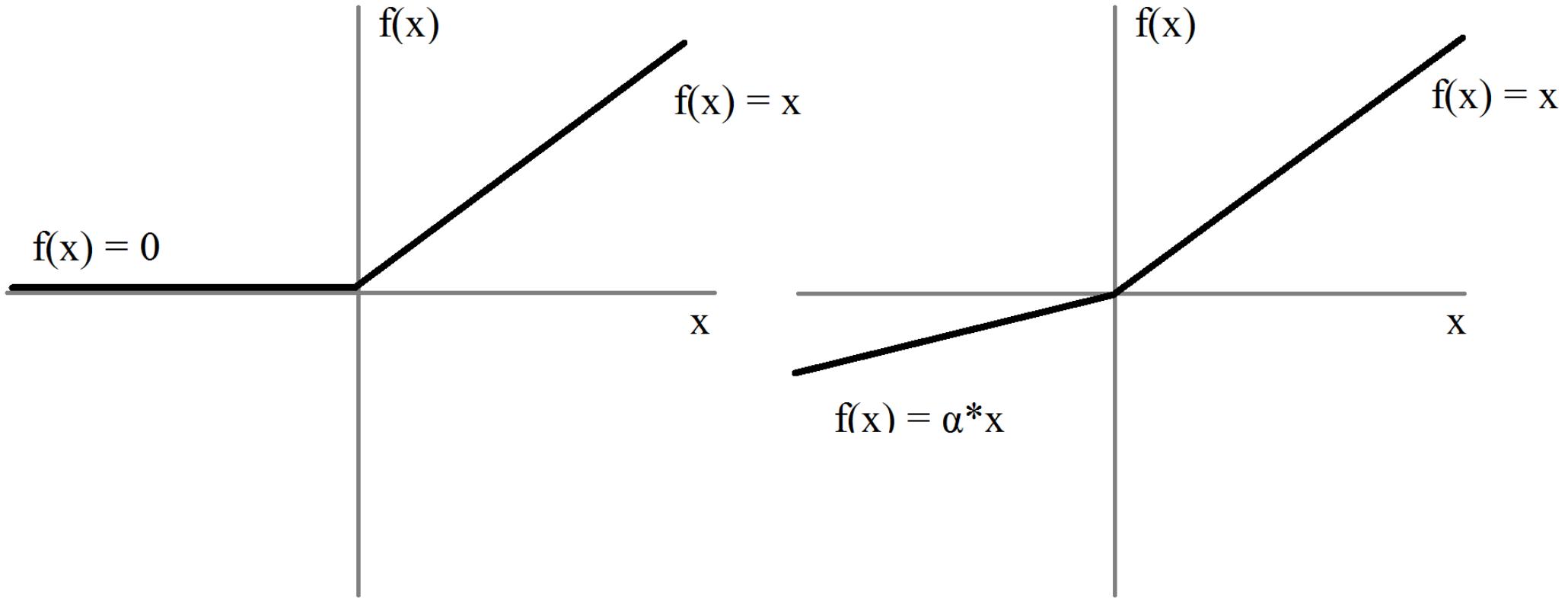
<http://setosa.io/ev/image-kernels/>

# Max pooling layer

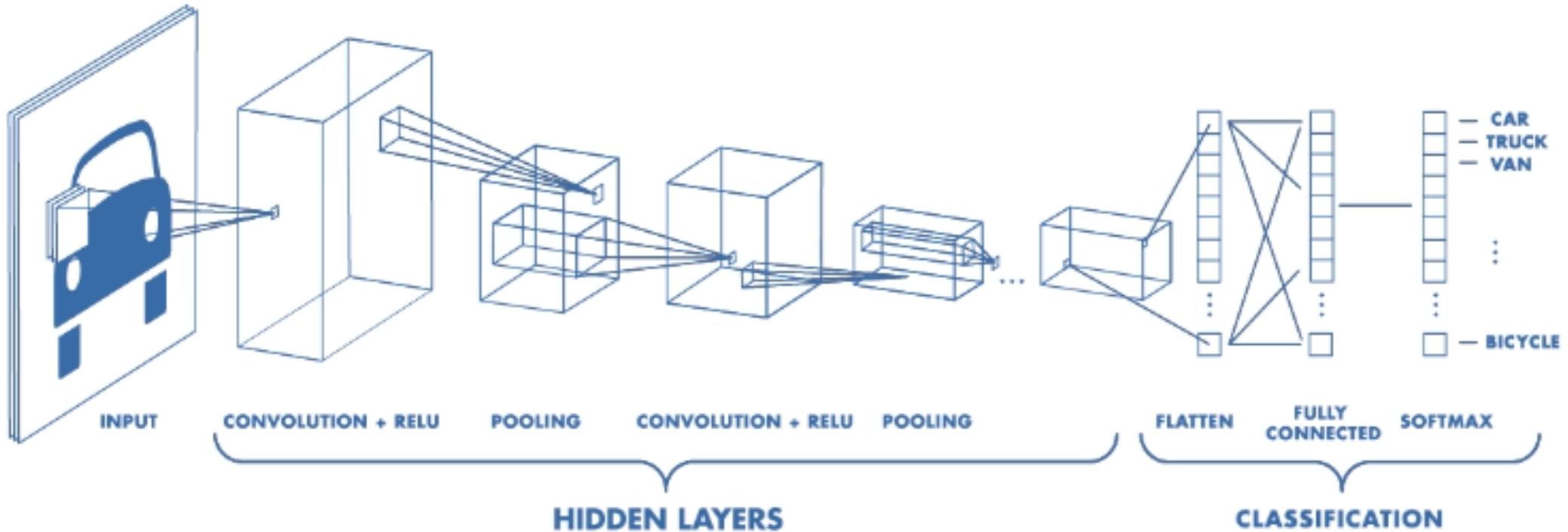


6	8
3	4

# ReLU layer



# Convolution Neural Networks (CNN)



# Convolution Neural Networks

## Visualisation

[https://www.youtube.com/watch?time\\_continue=267&v=Oqm9vsf\\_hvU](https://www.youtube.com/watch?time_continue=267&v=Oqm9vsf_hvU)

# Summary

- Artificial Neural Networks
- Backpropagation Algorithm
- Deep Neural Networks
- Convolution Neural Networks

# Books

## **Deep Learning**

By Ian Goodfellow, Yoshua Bengio and Aaron Courville

<https://www.deeplearningbook.org/>

## **Deep Learning: Methods and Applications**

By Li Deng and Dong Yu

## **Neural Networks and Learning Machines (3<sup>rd</sup> edition)**

By Simon Haykin

# Online courses

## **Deep Learning Specialization**

<https://www.coursera.org/specializations/deep-learning/>

## **Deep Learning For Coders**

<http://course.fast.ai/>

## **CS231n: Convolutional Neural Networks for Visual Recognition**

<http://cs231n.stanford.edu/>

# Next time

- Deep Neural Network Architectures
- Kaggle competition
- MNIST classification (practice)

# Thank you!