Getting started with AI - Computer vision 101
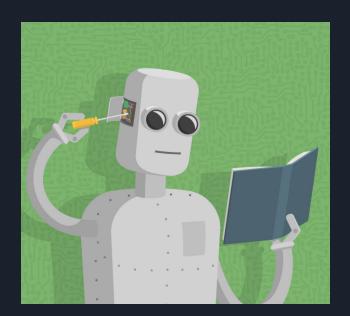
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FabLab Parma, 27/10/2018

Agenda

Machine learning and Computer vision
Digit recognition - MNIST data set
Artificial neural networks
Fully connected neural networks
Deep neural networks
Convolutional neural networks

Machine learning

A particular field of computer science that gives computers the ability to learn tasks without being explicitly programmed
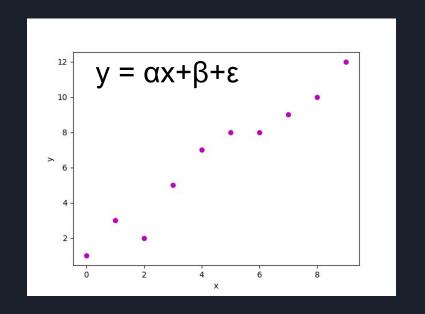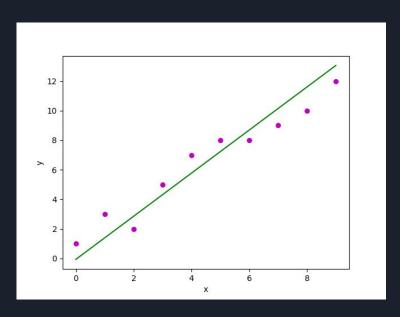
Machine learning

Learning from what?

x	y
0	1
1	3
2	2
3	5
4	7
5	8
6	8
7	9
8	10
9	12

Data!

$$y = \alpha x + \beta + \varepsilon$$

Machine learning example - Linear regression
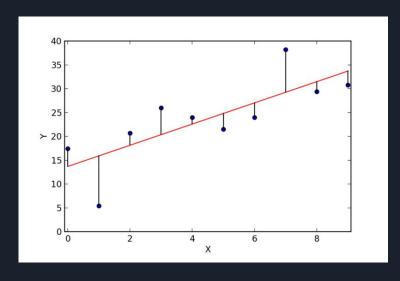
Model: y = Ax+B

Machine learning example - Linear regression

The best A and B are those who minimize the differences between the model and the real data

Coefficients:
A ~ α
B ~ β

Loss function:
RMSE

Machine learning example - Linear regression
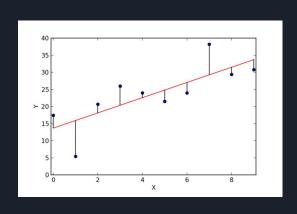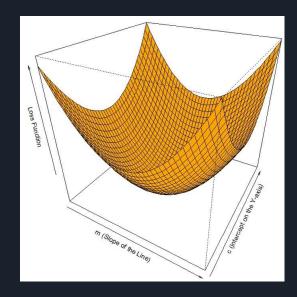
The best A and B are those who minimize the differences between the model and the real data

Coefficients:
A ~ α
B ~ β

Loss function:
RMSE

Machine learning example - Linear regression

Computer vision

Computer Vision Tasks

Classification | Classification + Localization | Object Detection | Instance Segmentation

CAT | CAT | CAT, DOG, DUCK | CAT, DOG, DUCK

Single object | Multiple objects
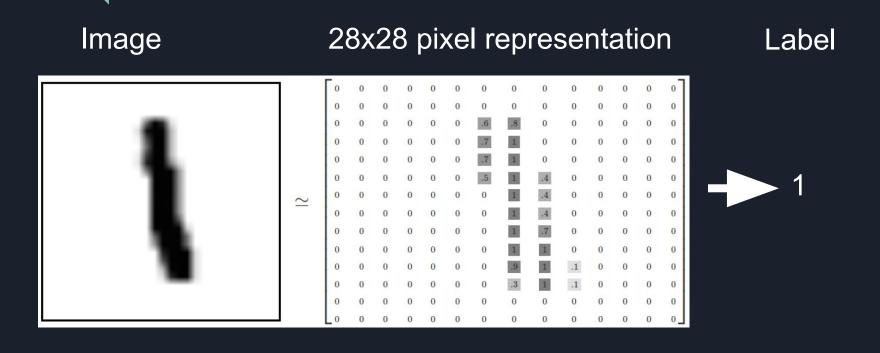
Digit recognition - MNIST dataset

MNIST dataset

Image   28x28 pixel representation   Label

1

MNIST dataset

|	label	pixel0	pixel1	pixel2	pixel3	pixel4	pixel5	pixel6	pixel7	pixel8	...	pixel774	pixel775	pixel776	pixel777	pixel778	pixel779	pixel780	pixel7
0	1	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	
1	0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	
2	1	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	
3	4	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	
4	0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	
5	0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	
6	7	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	
7	3	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	
8	5	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	
9	3	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	
10	8	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	
11	9	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	
12	1	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	
13	3	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	
14	3	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	
15	1	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	
16	2	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	

Dataset preparation
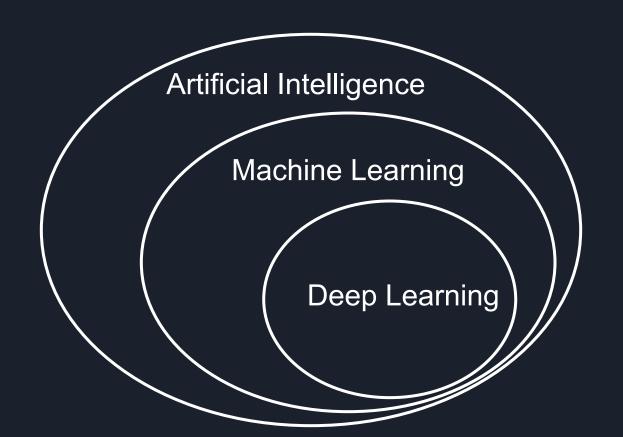
Main steps:
- ∞ Load dataset
- ∞ Split dataset in training set e validation set
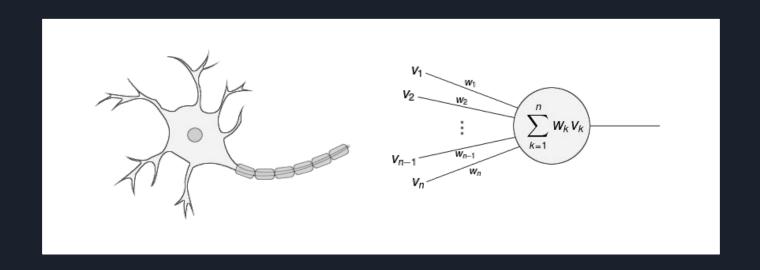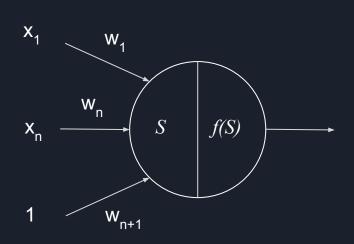- ∞ Prepare input (x) and output (y) data

Dataset preparation

Deep learning

Artificial neural networks

An artificial neural networks (ANN) are mathematical models inspired by biological neural networks

Artificial neural networks
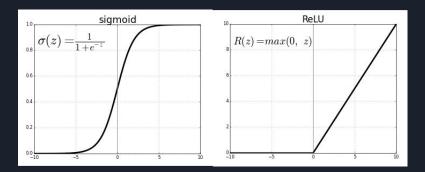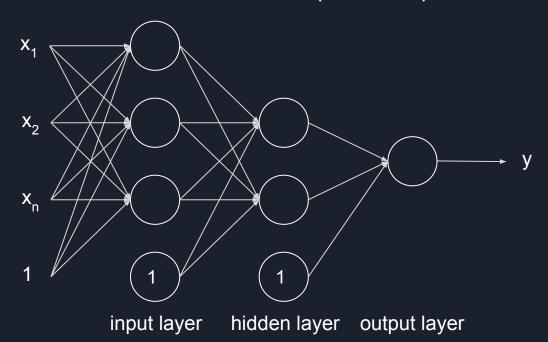
ANN are composed by artificial neurons

$$S=\sum x \cdot w$$
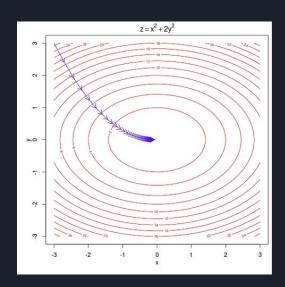
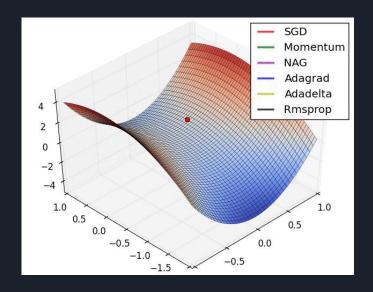$f(S)=$ *Activation function:* a non linear function applied to S

Artificial neural networks

Fully connected neural network (shallow)

Artificial neural networks

Gradient descent is used to obtain the set of weights that minimize the loss function

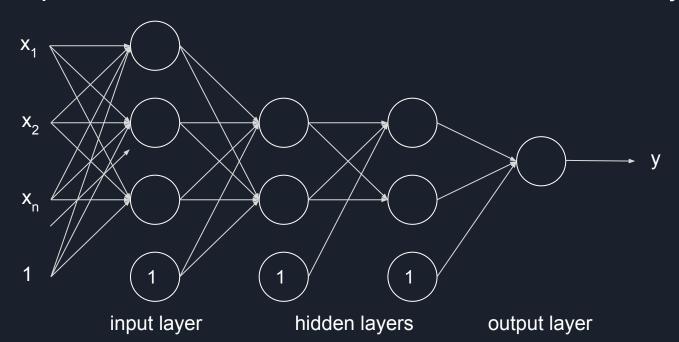# Artificial neural networks

Don't worry, there are tools to implement ANNs!
Some examples:

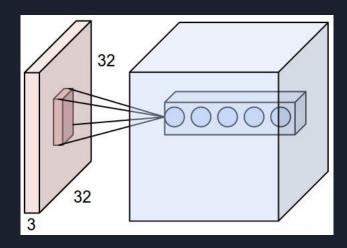# Fully connected neural networks (shallow)

Deep neural networks

Deep neural networks have more than one hidden layer

x_1

x_2

x_n

1

1

1

1

y

input layer   hidden layers   output layer
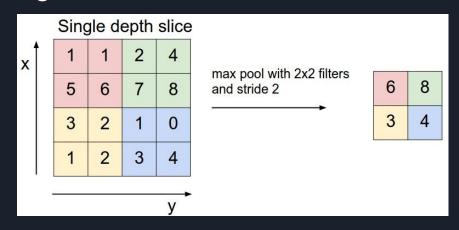
Deep neural networks

Convolutional neural networks

With data like images, it is impractical to connect neurons to all neurons in the previous layer. In CNN neurons are connected to only a local region of the input layer.

Convolutional neural networks

Pooling layers are inserted in-between successive Conv layers to progressively reduce the size of the representation and so the amount of parameters and computation to also control overfitting.

Convolutional neural networks

Stacking convolutional, pooling and fully connected layers creates the network architecture.

Input Convolution + ReLU Pooling Convolution + ReLU Pooling Fully Connected

Convolutional neural networks