Image processing with Machine Learning

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About me

- Ph.D. in Natural Language Processing and Artificial Intelligence at Masaryk University
- 10 years at seznam.cz (last 8 years as Head Of Research)
- Founder and co-organiser of ML Prague
- Author of the ML Guru blog
- Mentor at StartupYard and Startup AI Incubator
- ML Freelacer and consultant

www.mlguru.com **www.mlprague.com** **www.mlcollege.com**

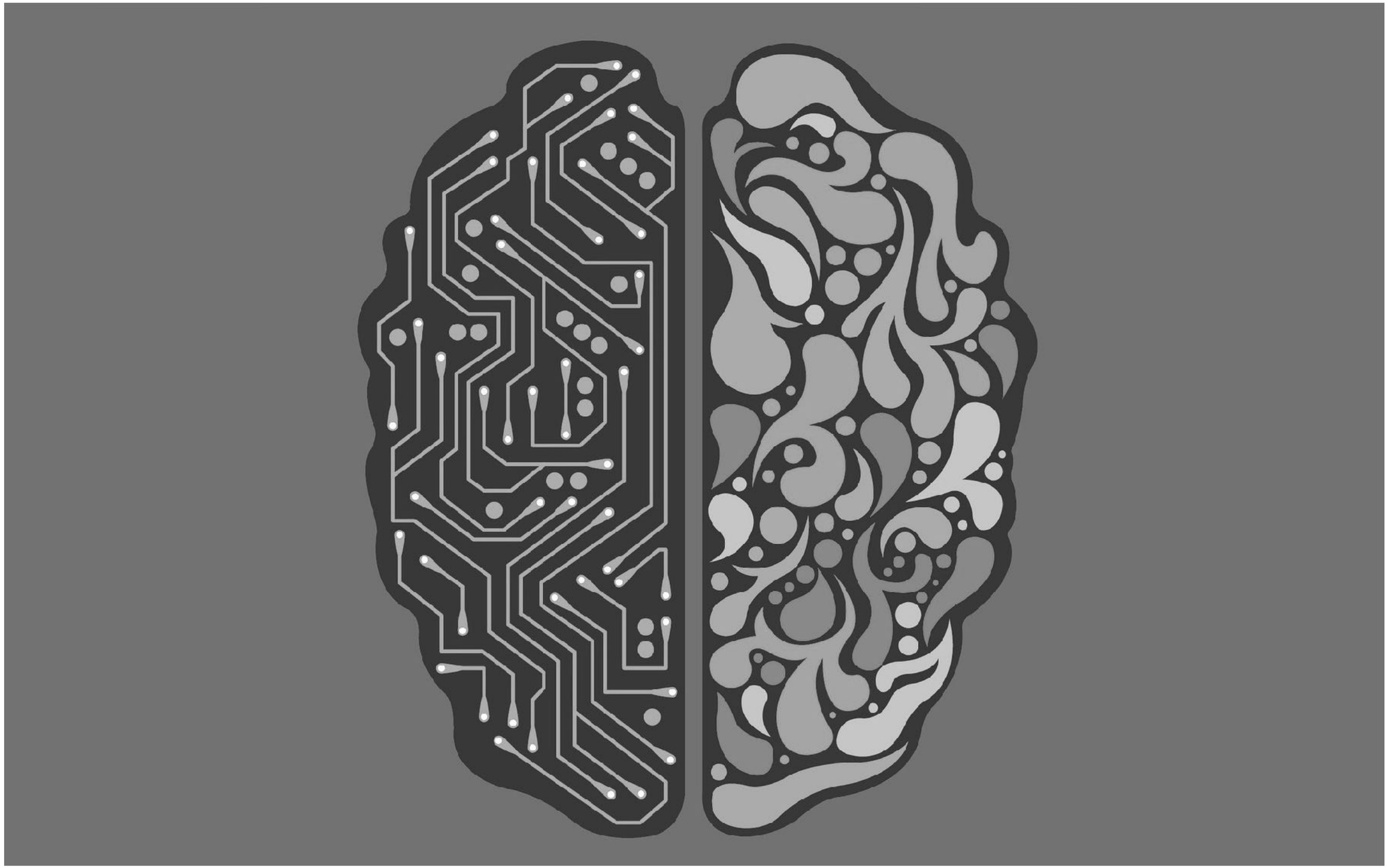
Outline

- Introduction to machine learning
- Types of ML tasks
- Data preparation
- Model evaluation
- Basic classification algorithms
- Scikit-learn tutorial
- Practical classification task
- Basic regression algorithms
- Regression model evaluation
- Practical regression task
- Dimensionality reduction

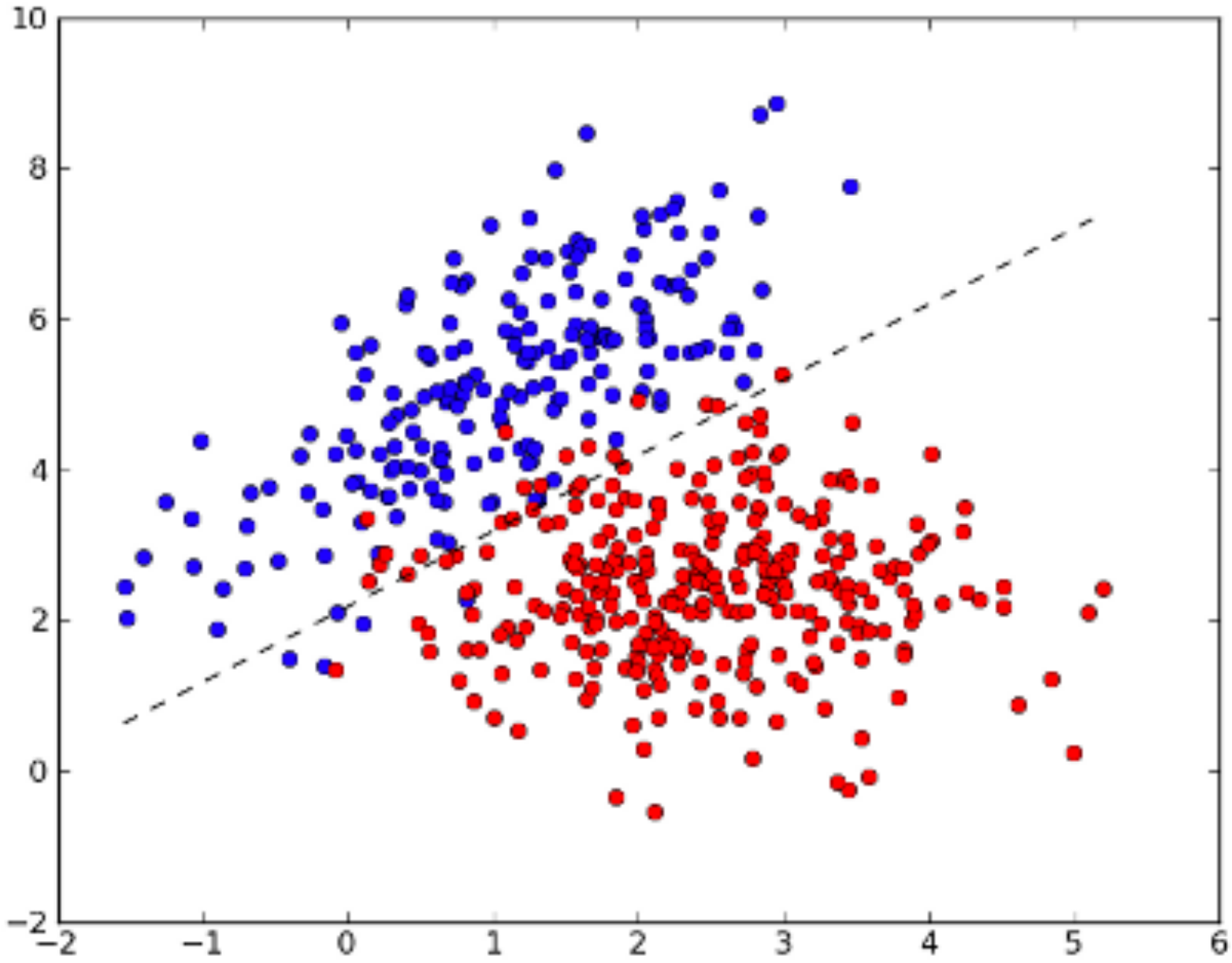
Outline

- Introduction to neural networks
- Activation functions for neural networks
- Multilayered neural networks
- Methods for training neural networks
- Kears tutorial
- Practical classification and regression tasks solved using neural networks
- ResNet
- Transfer learning and fine-tuning
- Image classification
- Image segmentation
- GANs and superresolution

What is (not) machine learning?

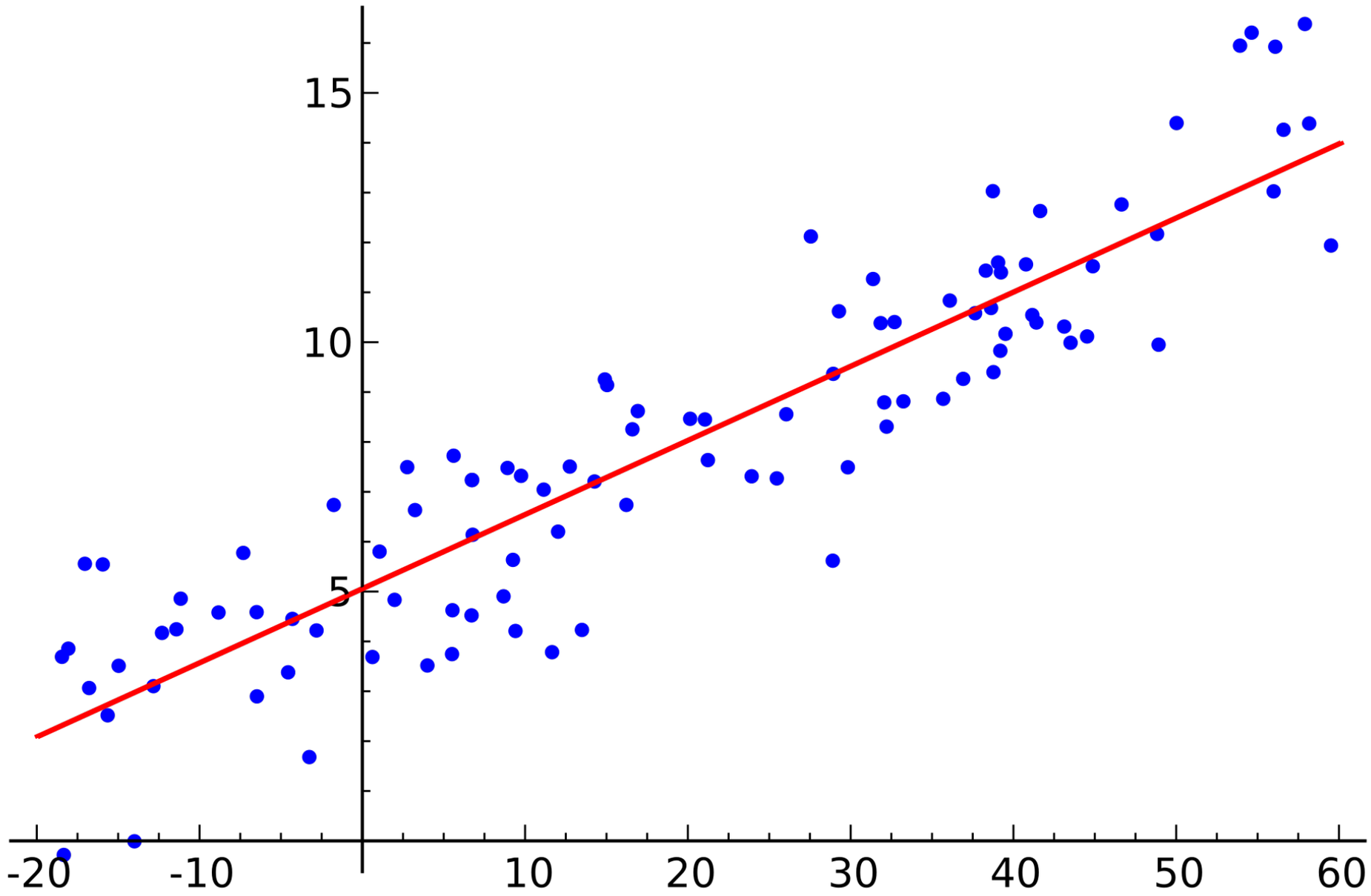


Classification



Source: http://mlpy.sourceforge.net

Regression

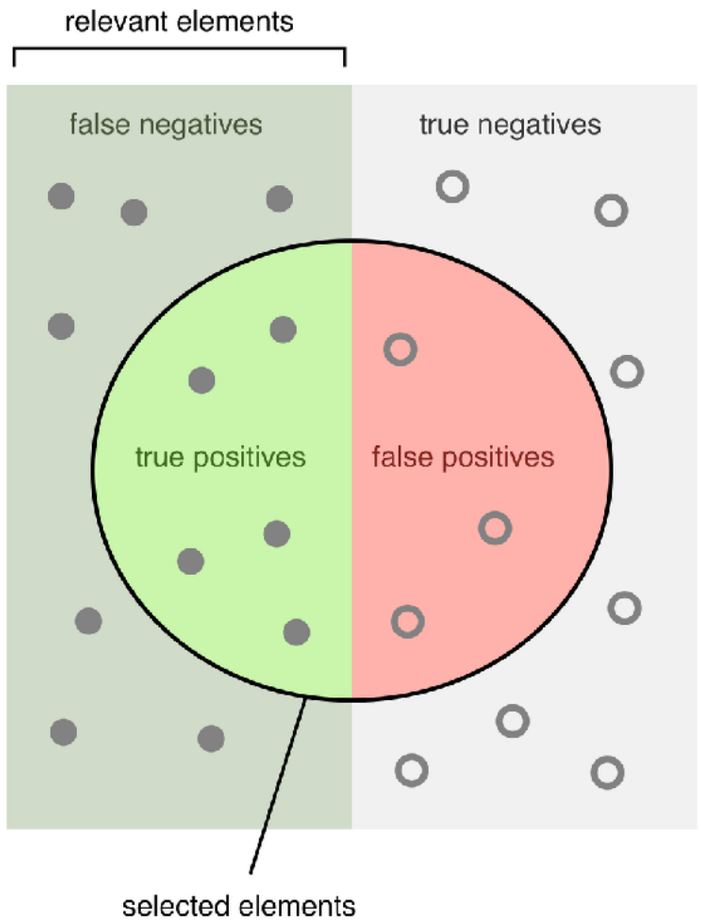


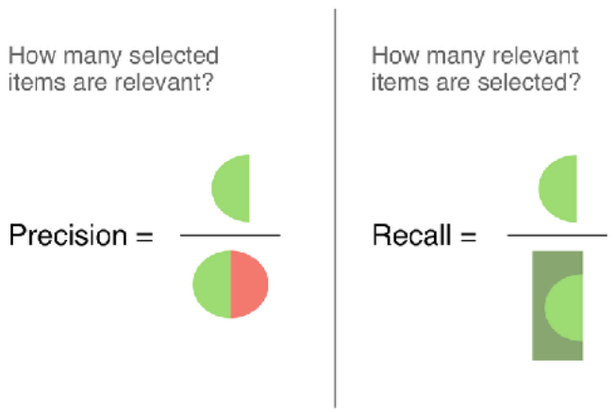
Source: www.wikipedia.org

Data

- Train, validation, test data sets
- Cross-validation
- Imbalanced data sets
- Baseline models

Model evaluation





Source: https://www.wikipedia.org

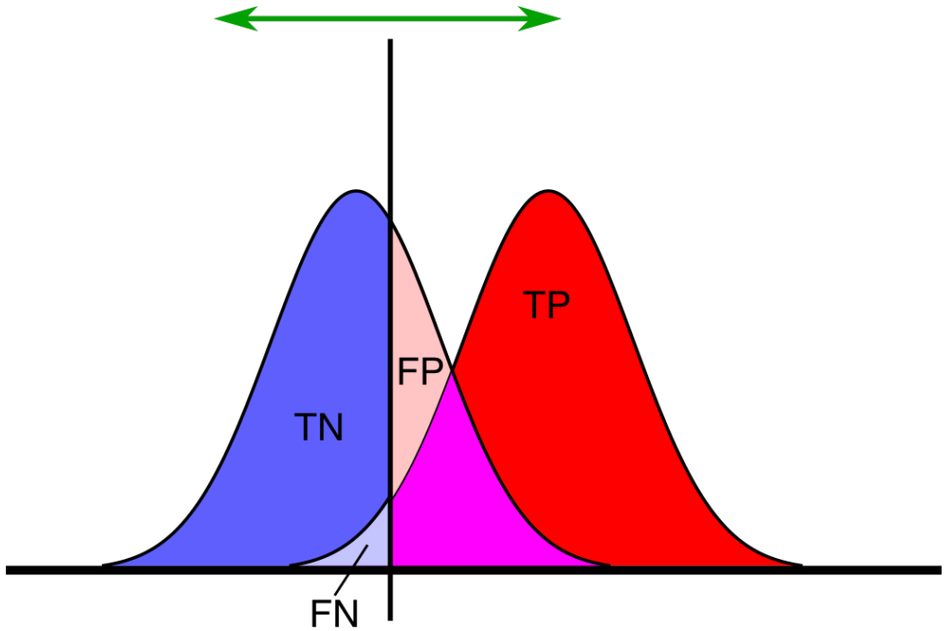
$$\text{Accuracy} = \frac{tp + tn}{tp + tn + fp + fn}$$

$$\text{Precision} = \frac{tp}{tp + fp}$$

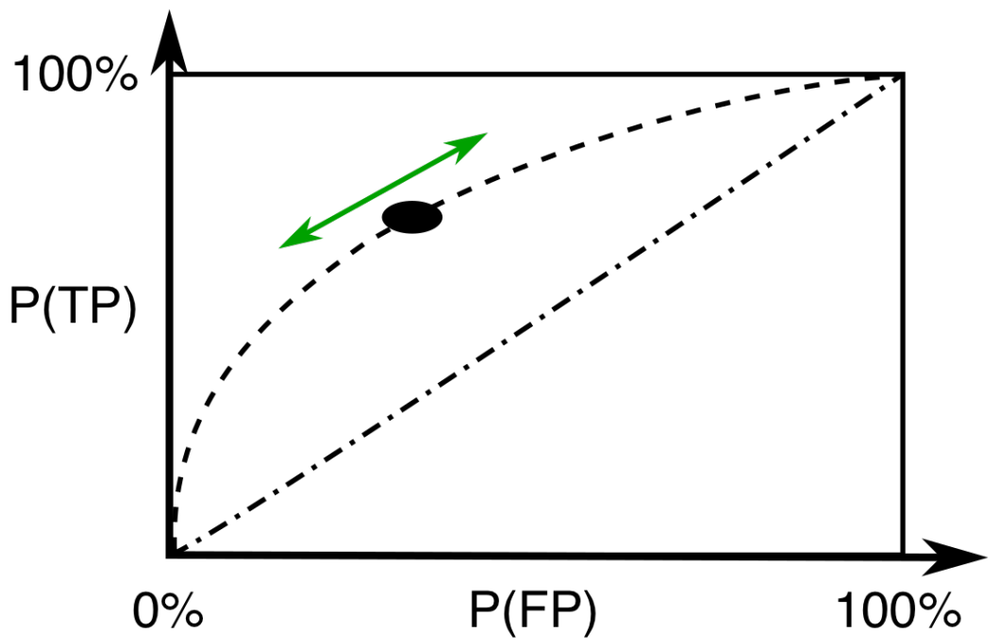
$$\text{Recall} = \frac{tp}{tp + fn}$$

$$\text{F} = 2 \cdot \frac{\text{precision} \cdot \text{recall}}{\text{precision} + \text{recall}}$$

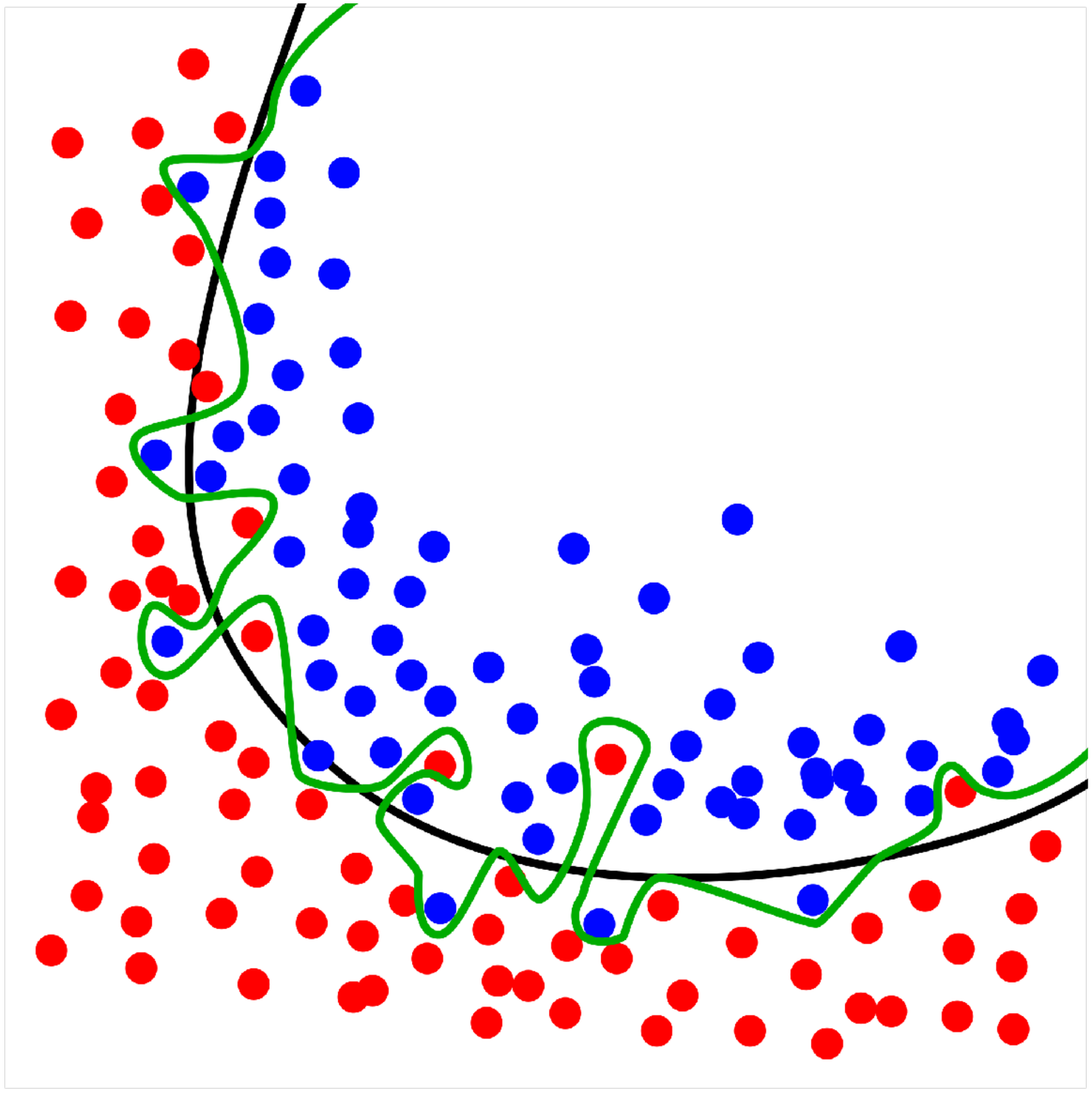
Receiver operating characteristic (ROC Curve), AUC



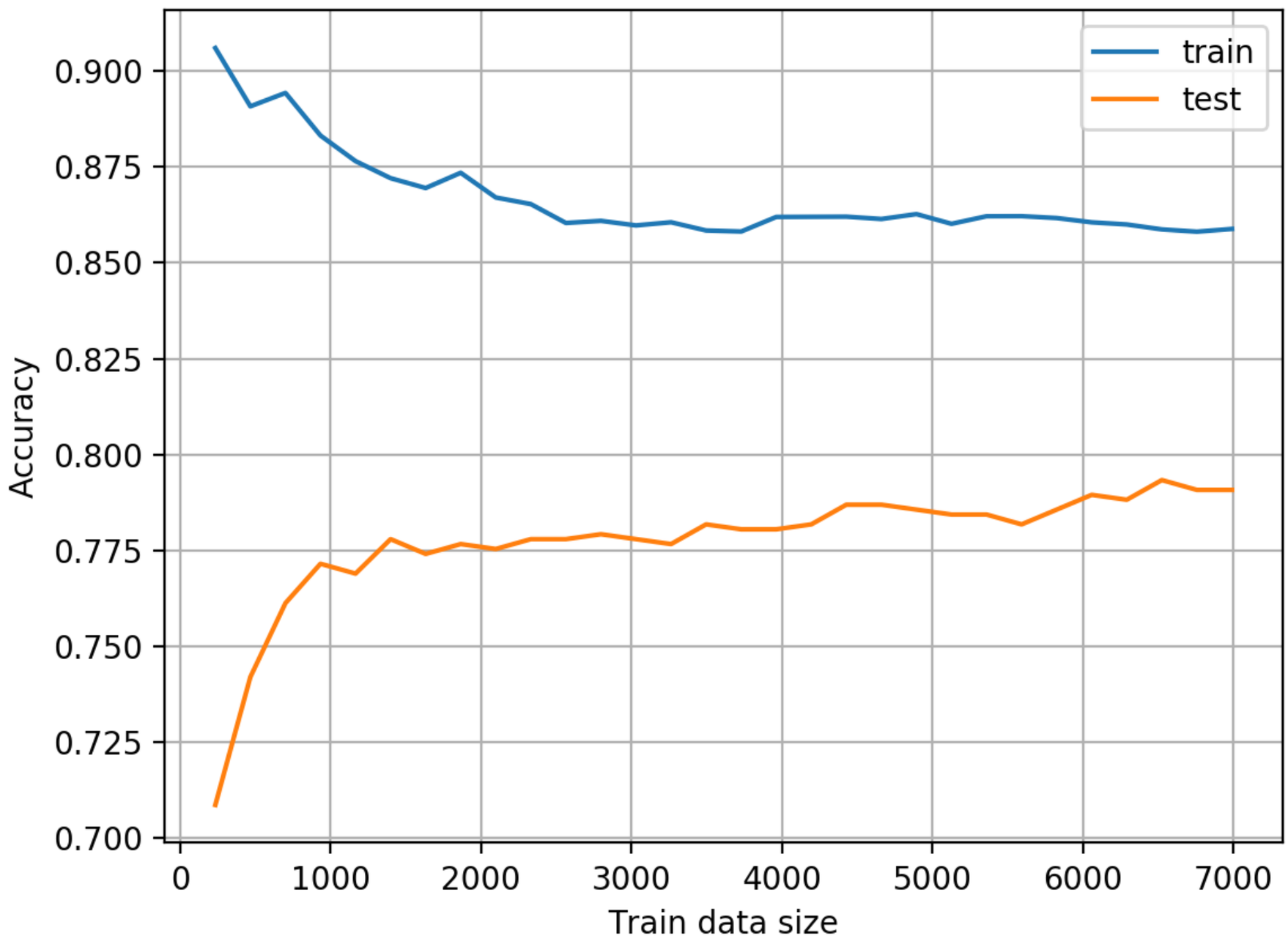
TP	FP
FN	TN



Overfitting



Overfitting detection



Conditional probability

$$P(A|B) = \frac{P(A \cap B)}{P(B)} = \frac{P(A)P(B|A)}{P(B)}$$

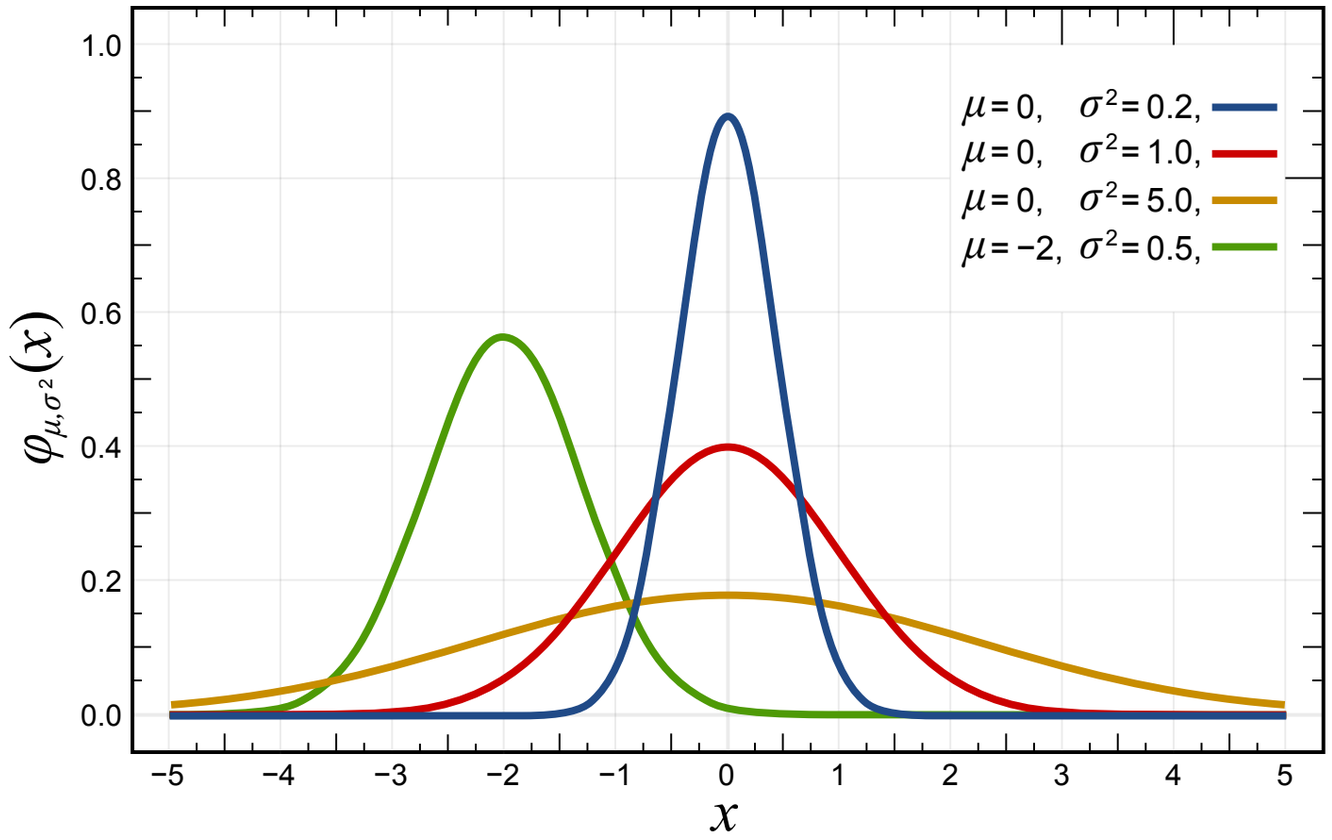
$$A \perp B \iff P(A \cap B) = P(A)P(B)$$

Naive Bayes Classifier

client	balance	income	sex	unemployed	loan
1	H	H	F	F	T
2	L	H	M	F	T
3	L	L	M	T	F
4	H	L	F	T	T
5	L	L	F	T	F
6	**H**	**L**	**M**	**F**	**?**

Gaussian Naive Bayes Classifier

$$p(x = v|C_k) = \frac{1}{\sqrt{2\pi\sigma_k^2}} e^{-\frac{(v-\mu_k)^2}{2\sigma_k^2}}$$



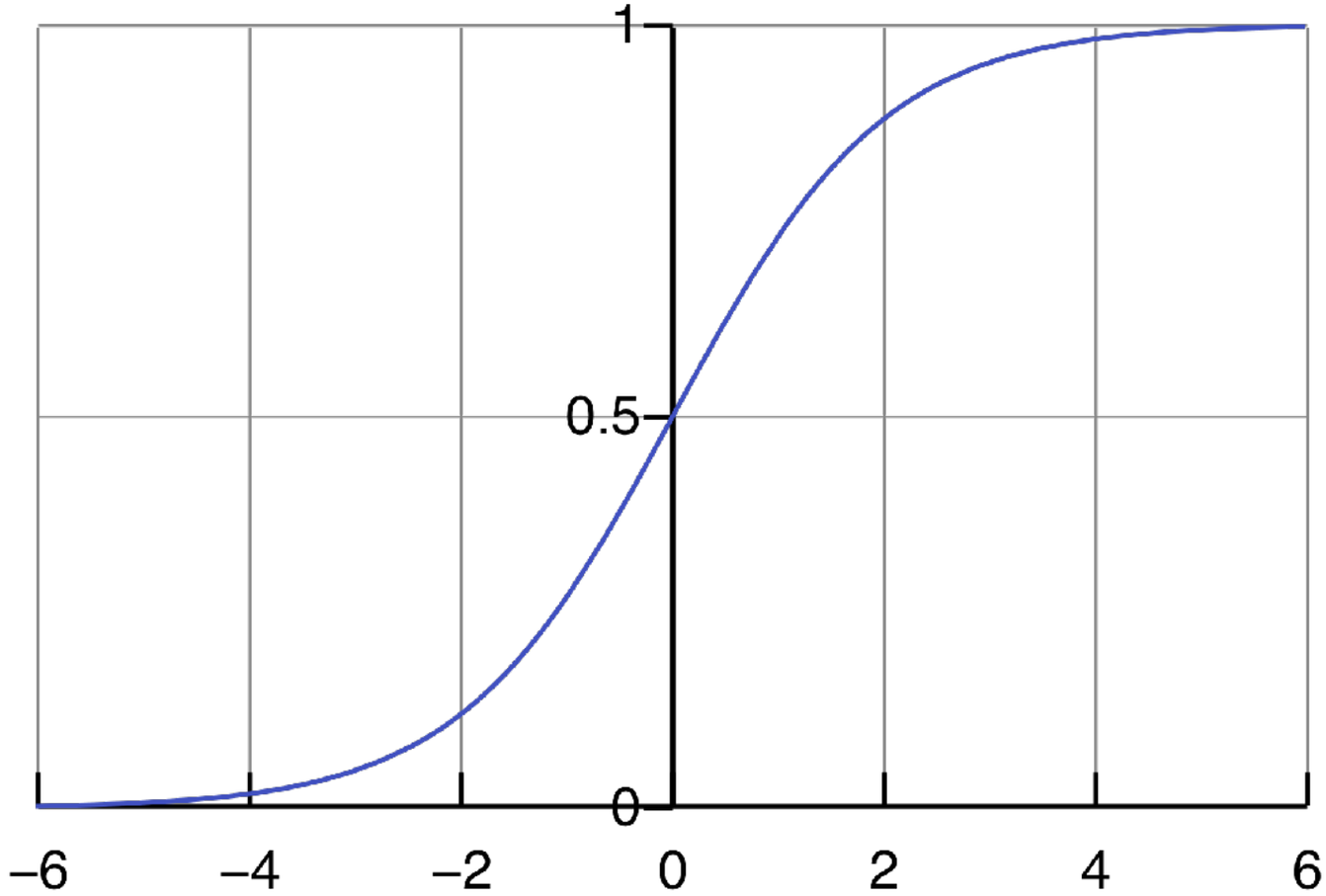
Source: https:/www.wikipedia.org

Scikit-learn tutorial

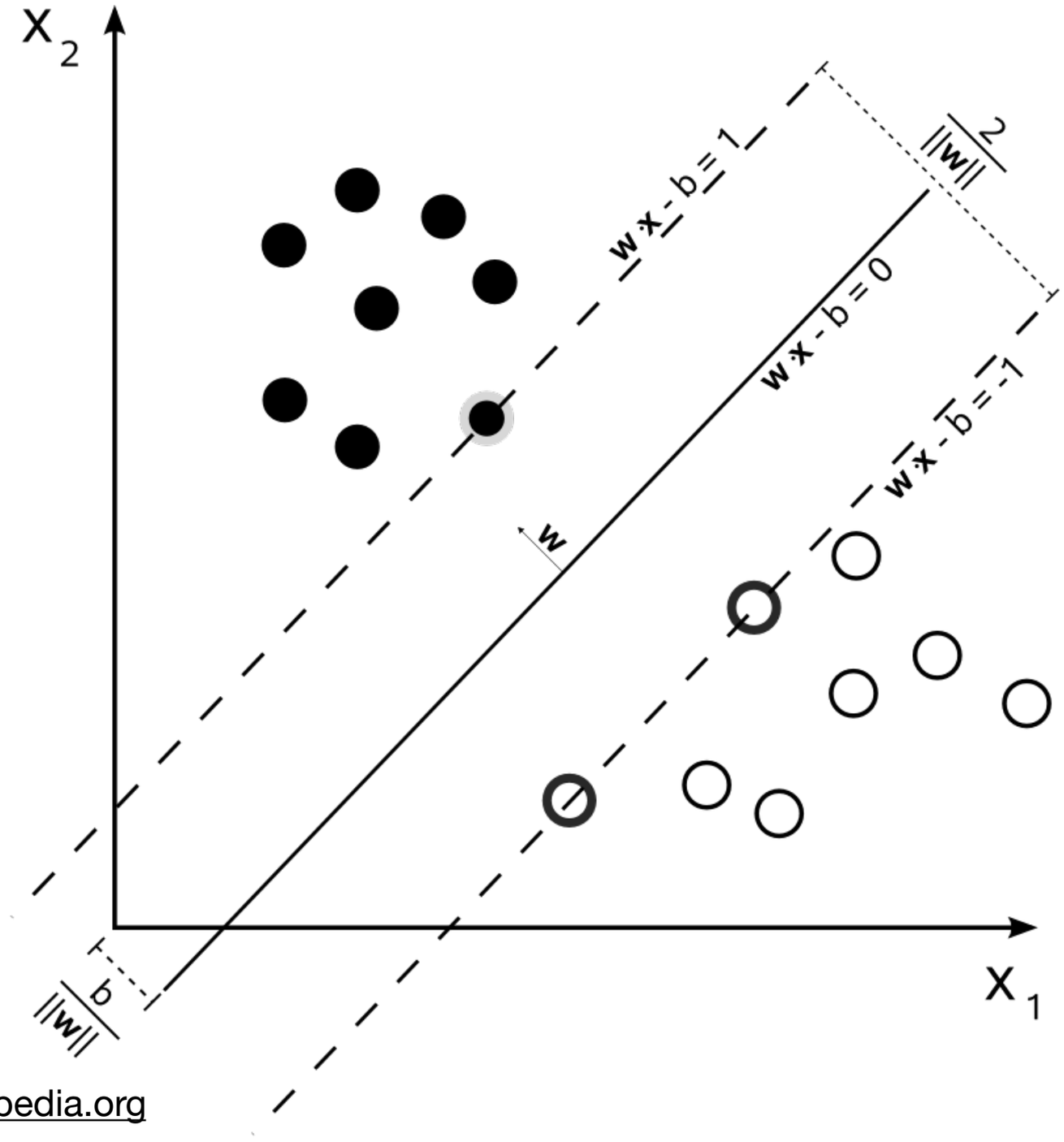
http://scikit-learn.org/stable/

Logistic regression

$$P(y|\vec{x}) = \frac{1}{1 + e^{-(\vec{x}\vec{w} + w_0)}}$$

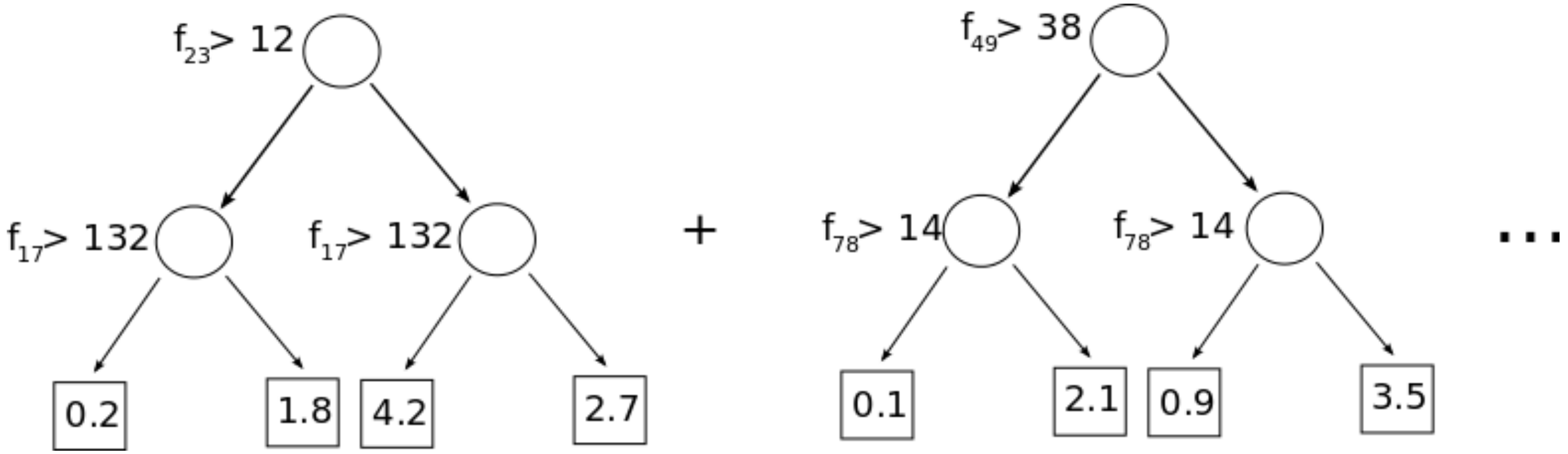


Support Vector Machines



Source: https:/www.wikipedia.org

(Boosted) Decision/ Regression Trees

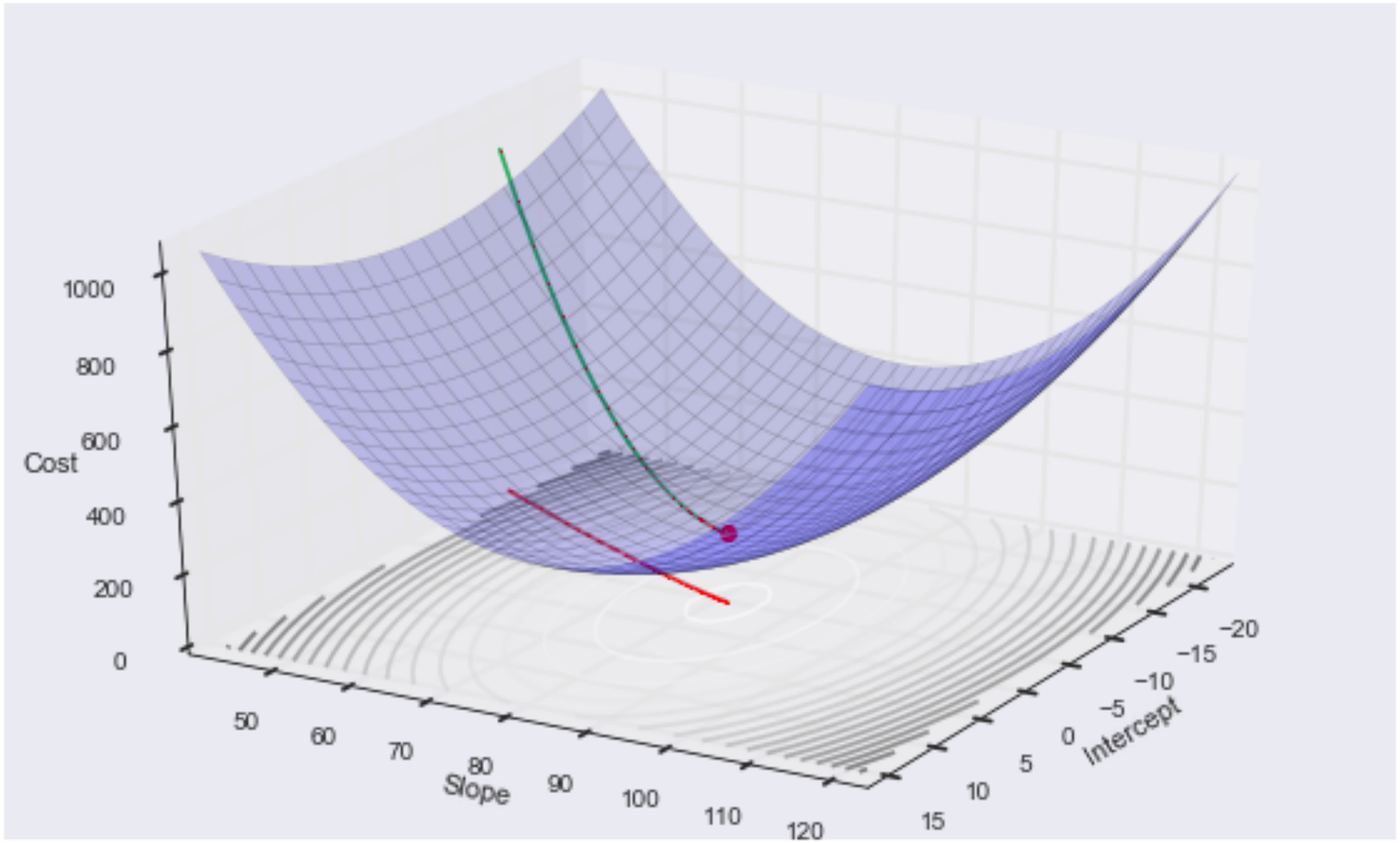


Classification task

02-Classification1-assignment.ipynb

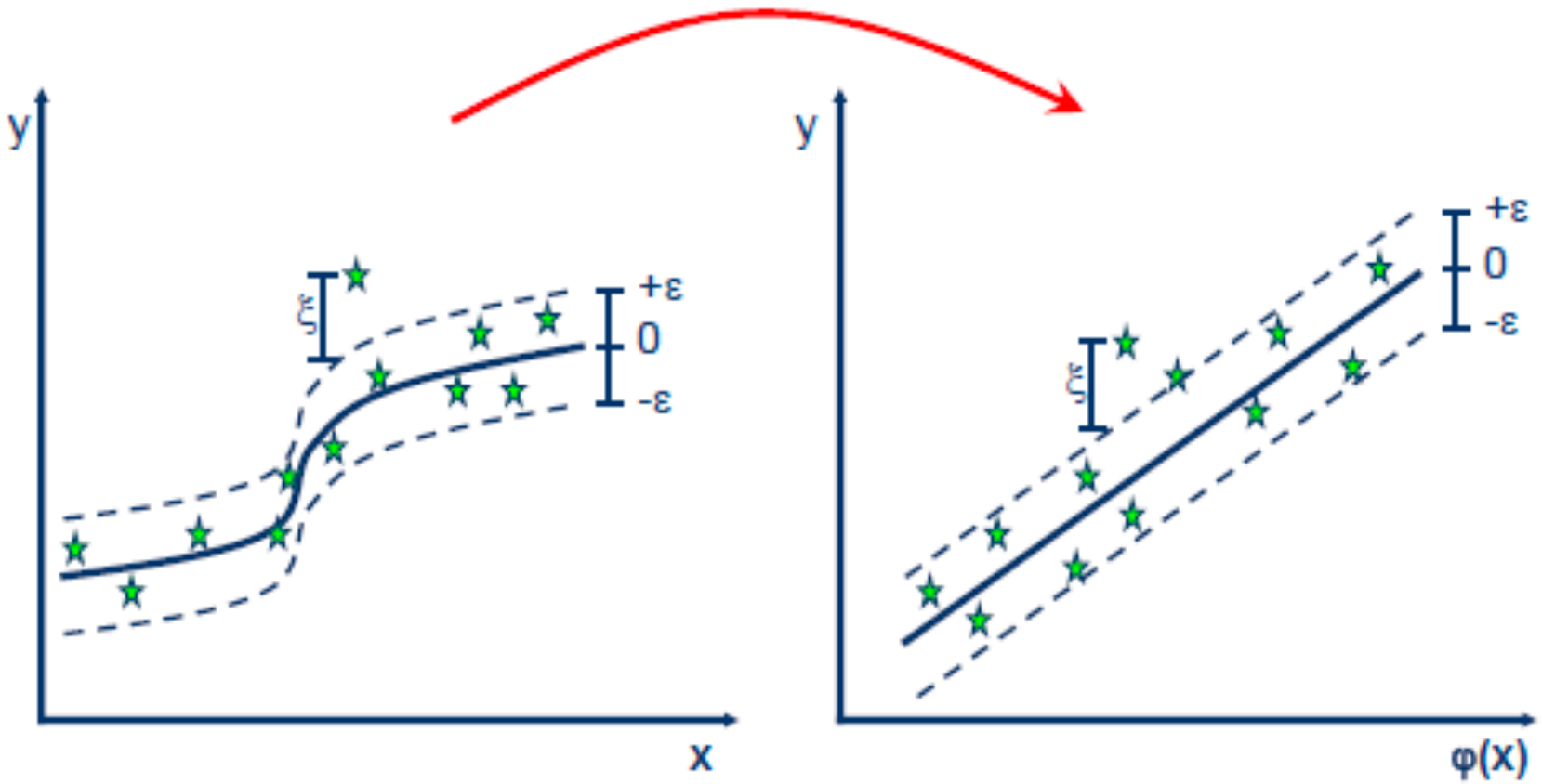
03-Classification2-assignment.ipynb

Linear regression with SGD



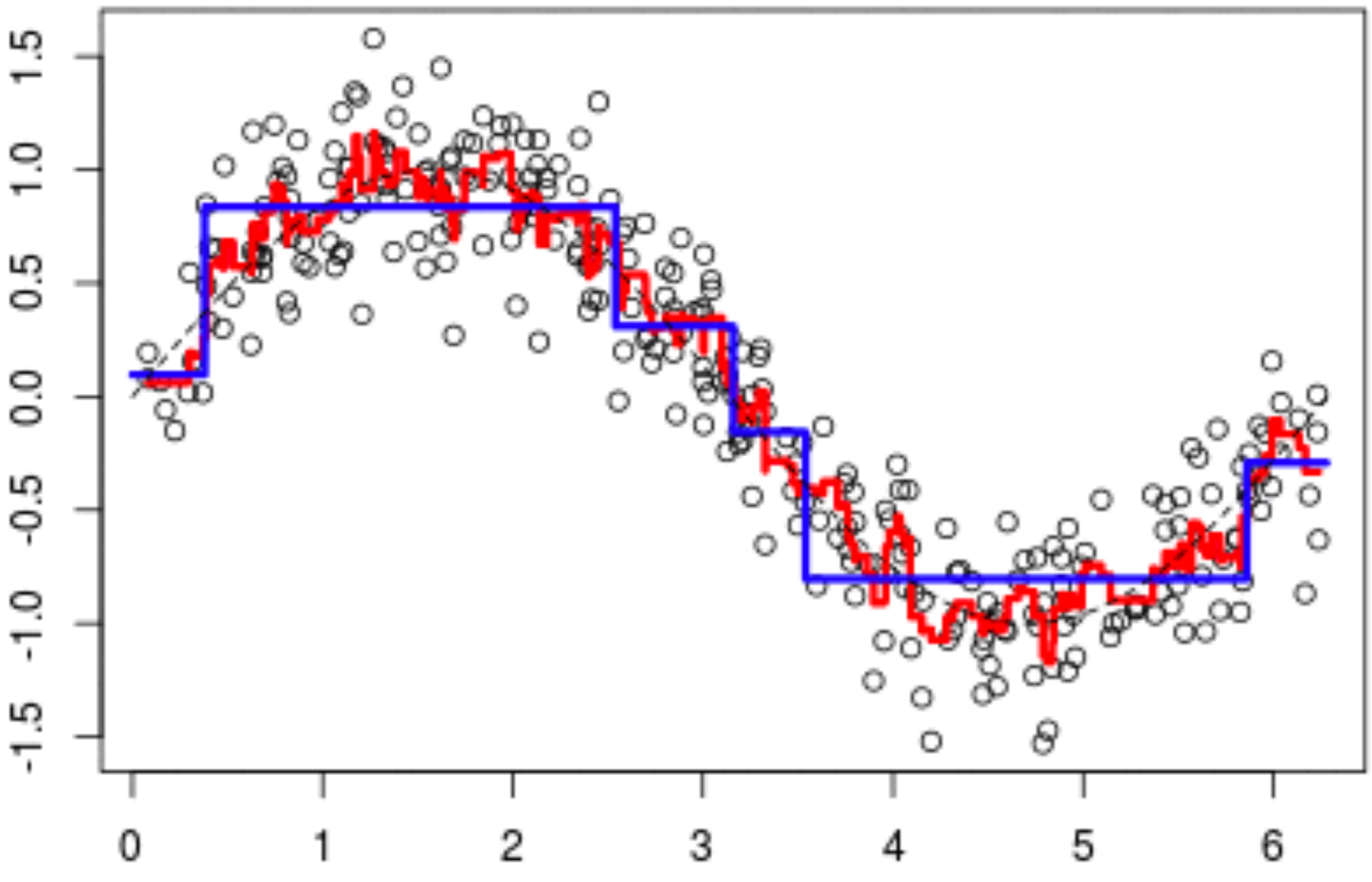
Source: https://am207.github.io/2017/wiki/gradientdescent.html

Support vector machines for Regression



Source: http://www.saedsayad.com/support_vector_machine_reg.htm

Boosted regression trees



Source: https://www.r-bloggers.com/an-attempt-to-understand-boosting-algorithms/

Evaluation of regression models

Root mean squared error

$$\mathrm{RMSE} = \sqrt{\frac{\sum_i (y_i - \hat{y}_i)^2}{n}}$$

Mean absolute error

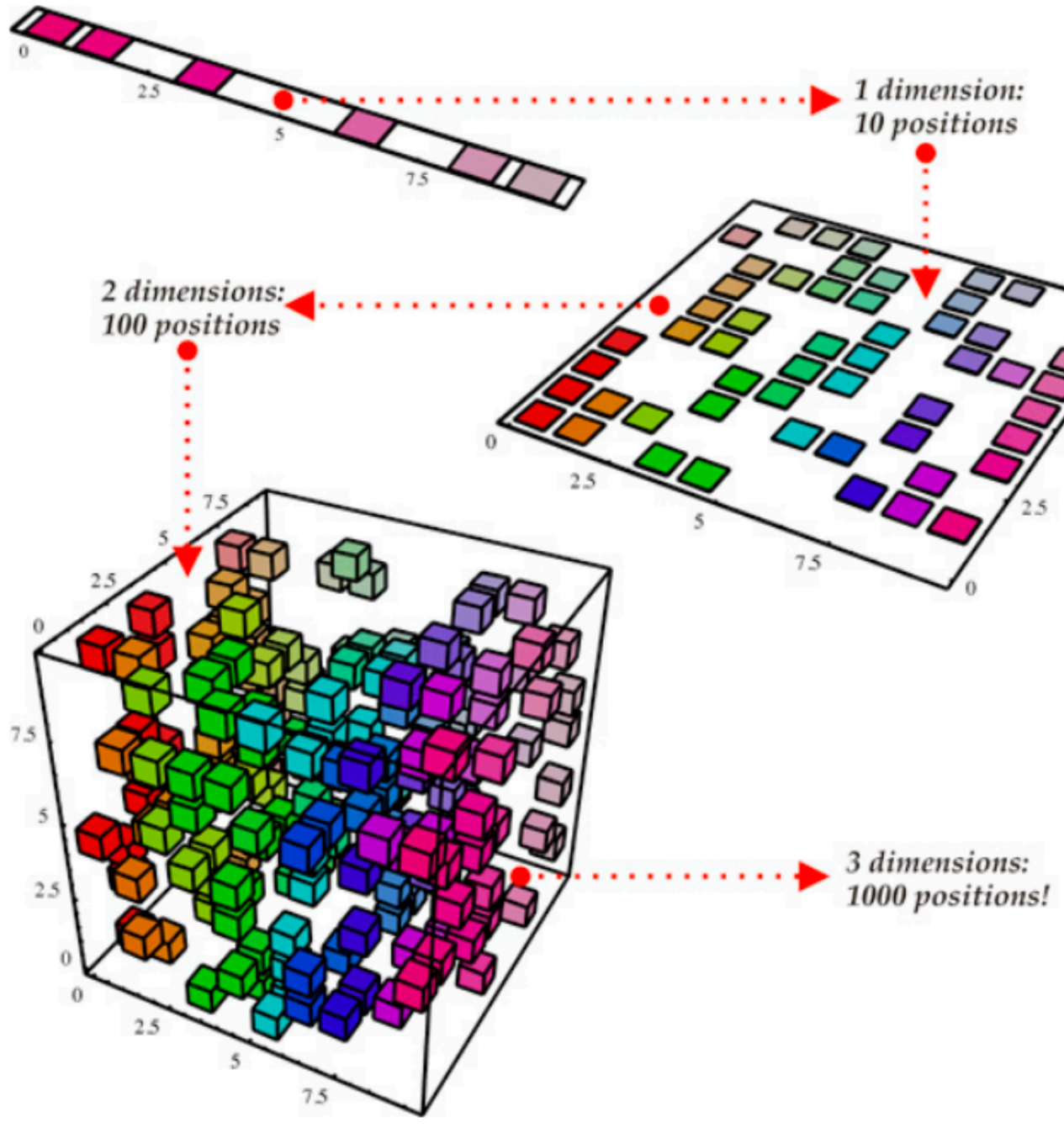
$$\mathrm{MAE} = \frac{\sum_i |y_i - \hat{y}_i|}{n}$$

Regression task

04-Regression1-assignment.ipynb

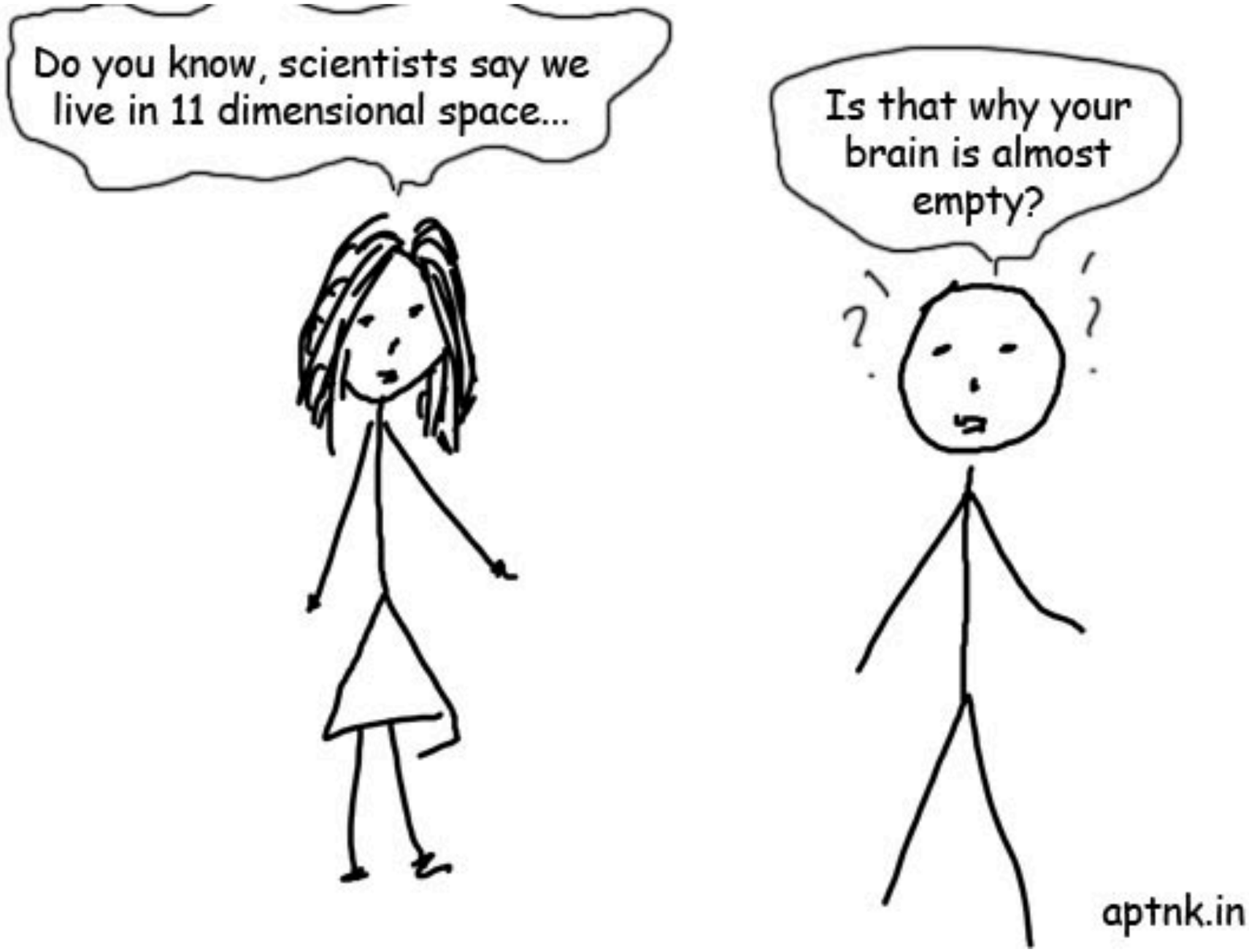
05-Regression2-assignment.ipynb

Dimensionality reduction

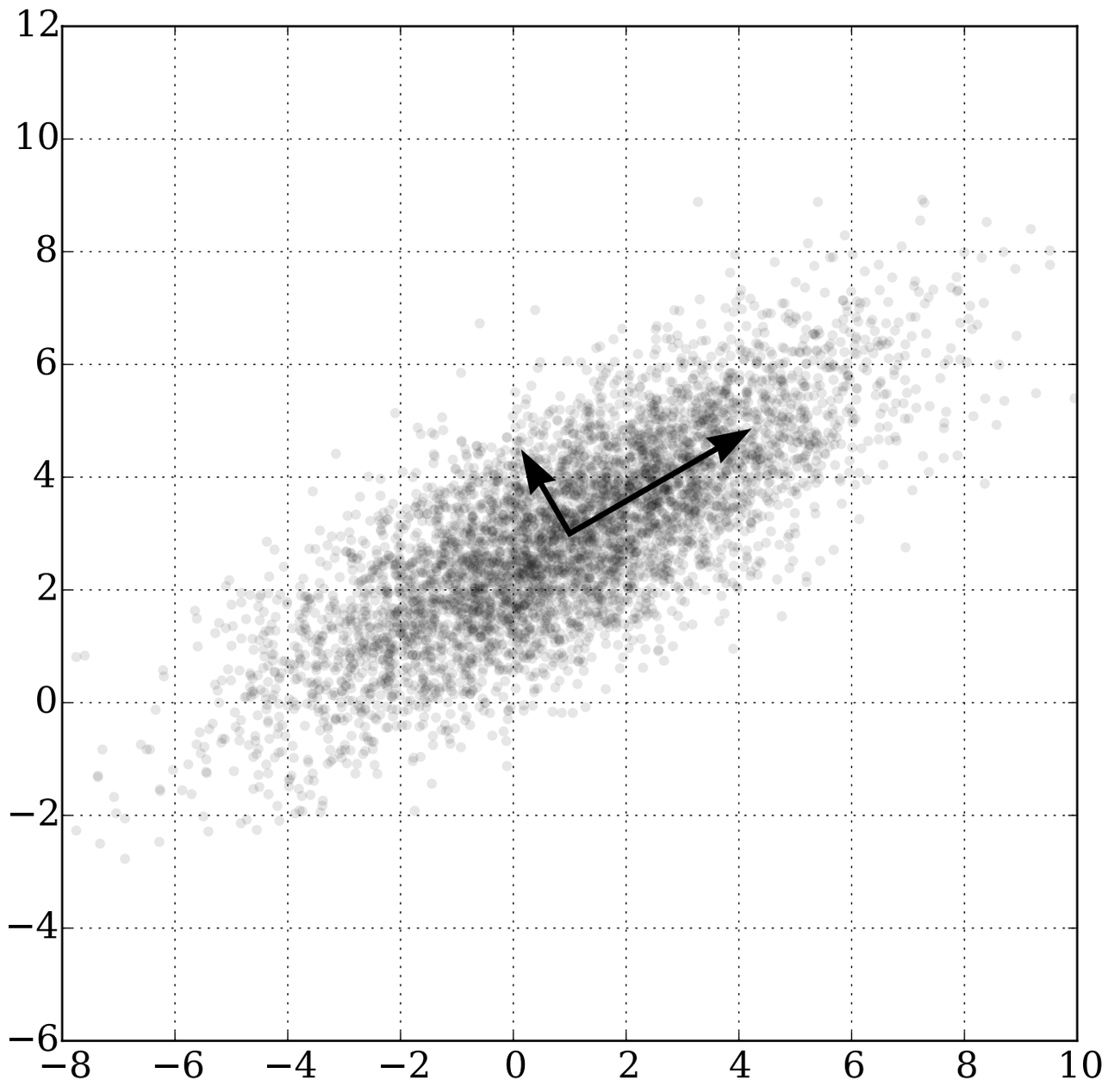


Source: https:/http://www.turingfinance.com/

Curse of dimensionality



Principal Component Analysis



Source: https:/www.wikipedia.org

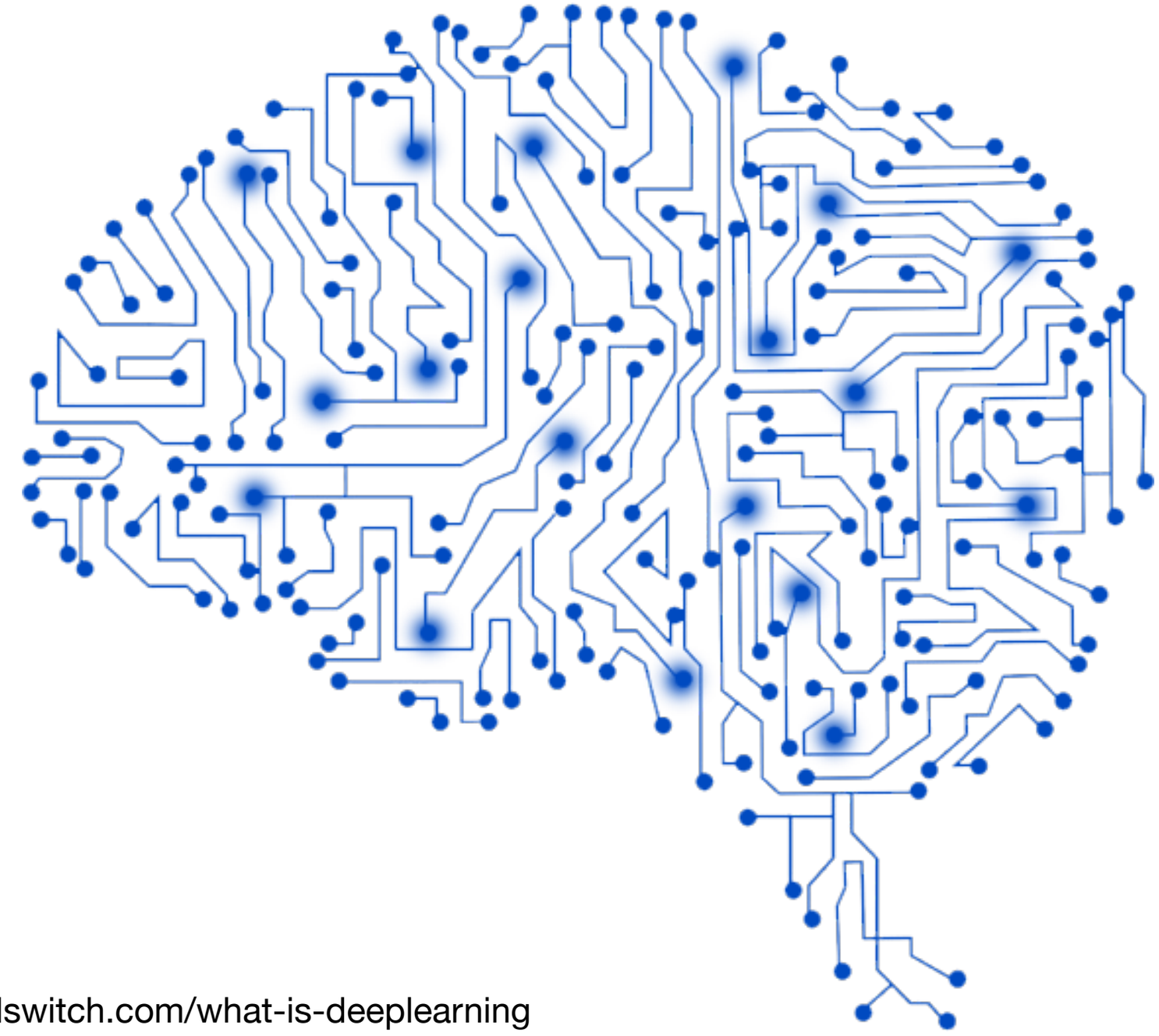
t-SNE dimensionality reduction

Illustration: https://bl.ocks.org/mbostock/4062045

Dimensionality reduction task

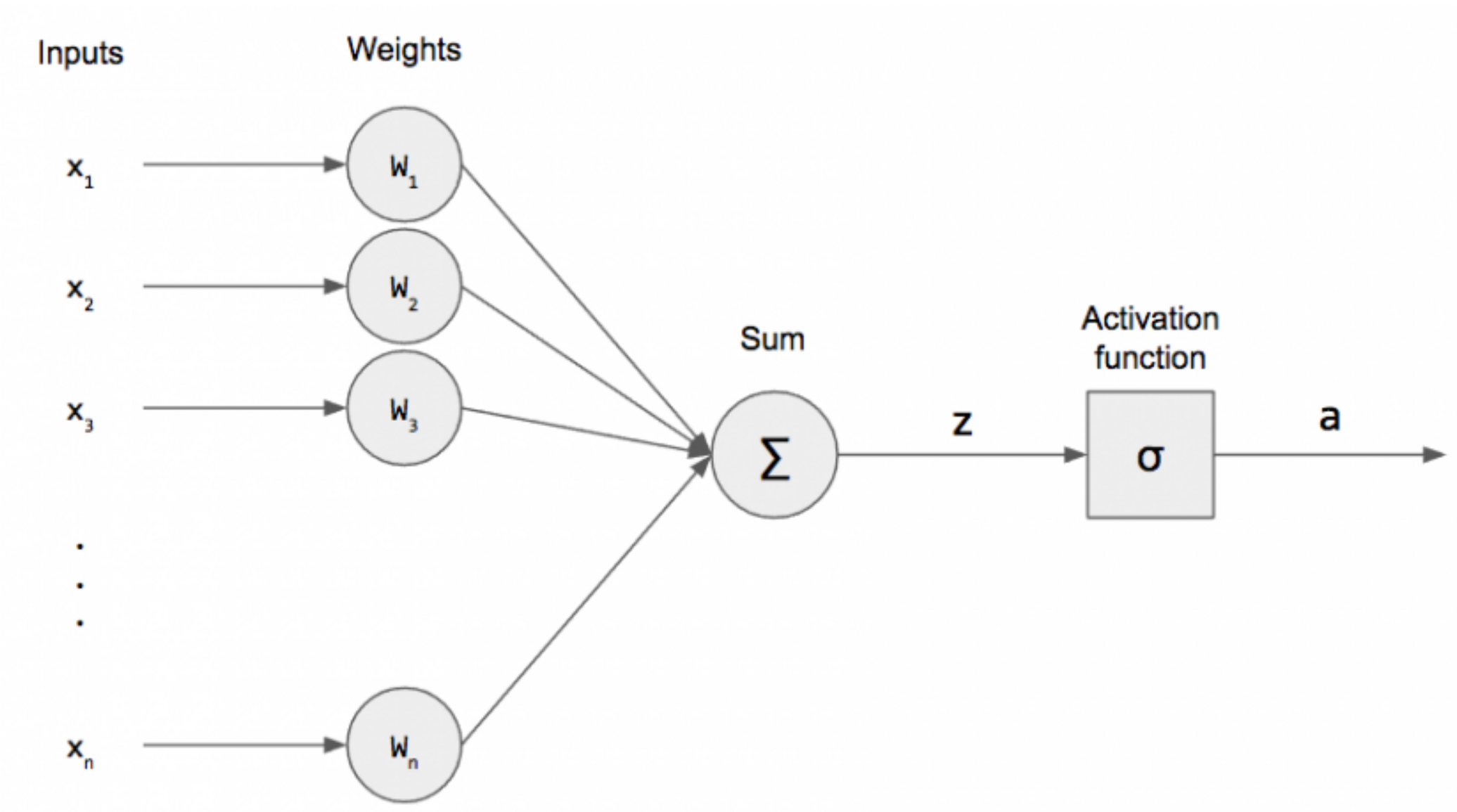
06-Dim-reduction-assignment.ipynb

Neural networks and deep learning



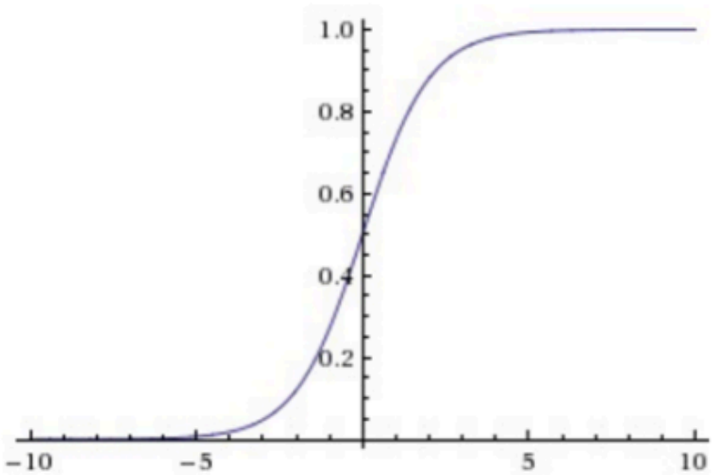
Source: http://www.rapidswitch.com/what-is-deeplearning

Perceptron

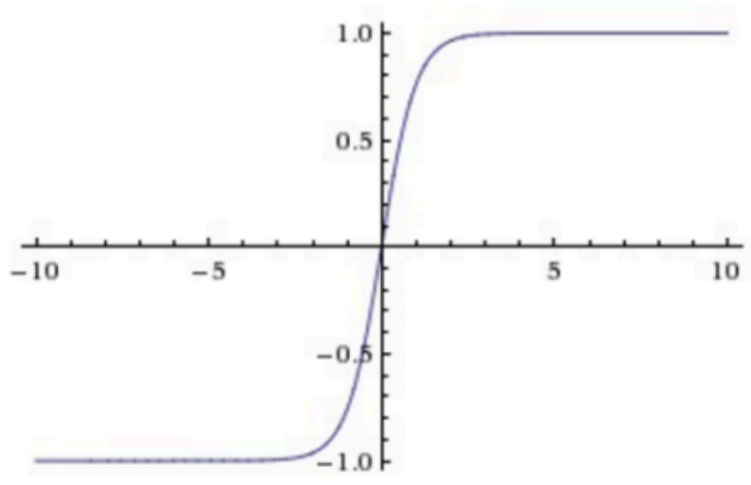


Source: https://pythonmachinelearning.pro

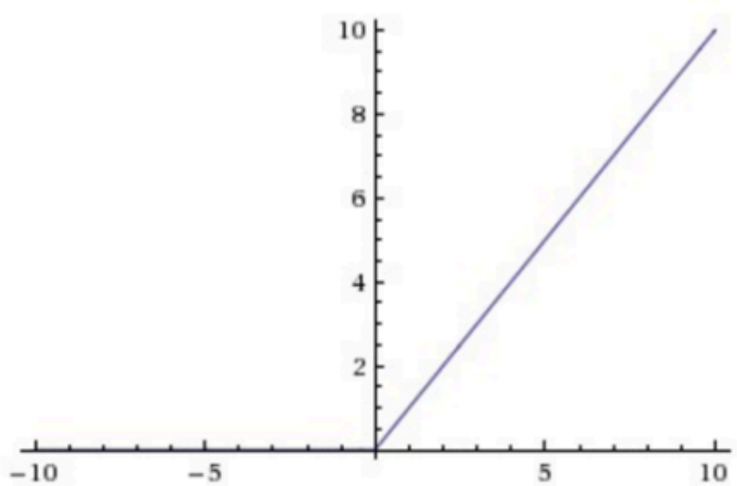
Activation functions



Sigmoid



tanh

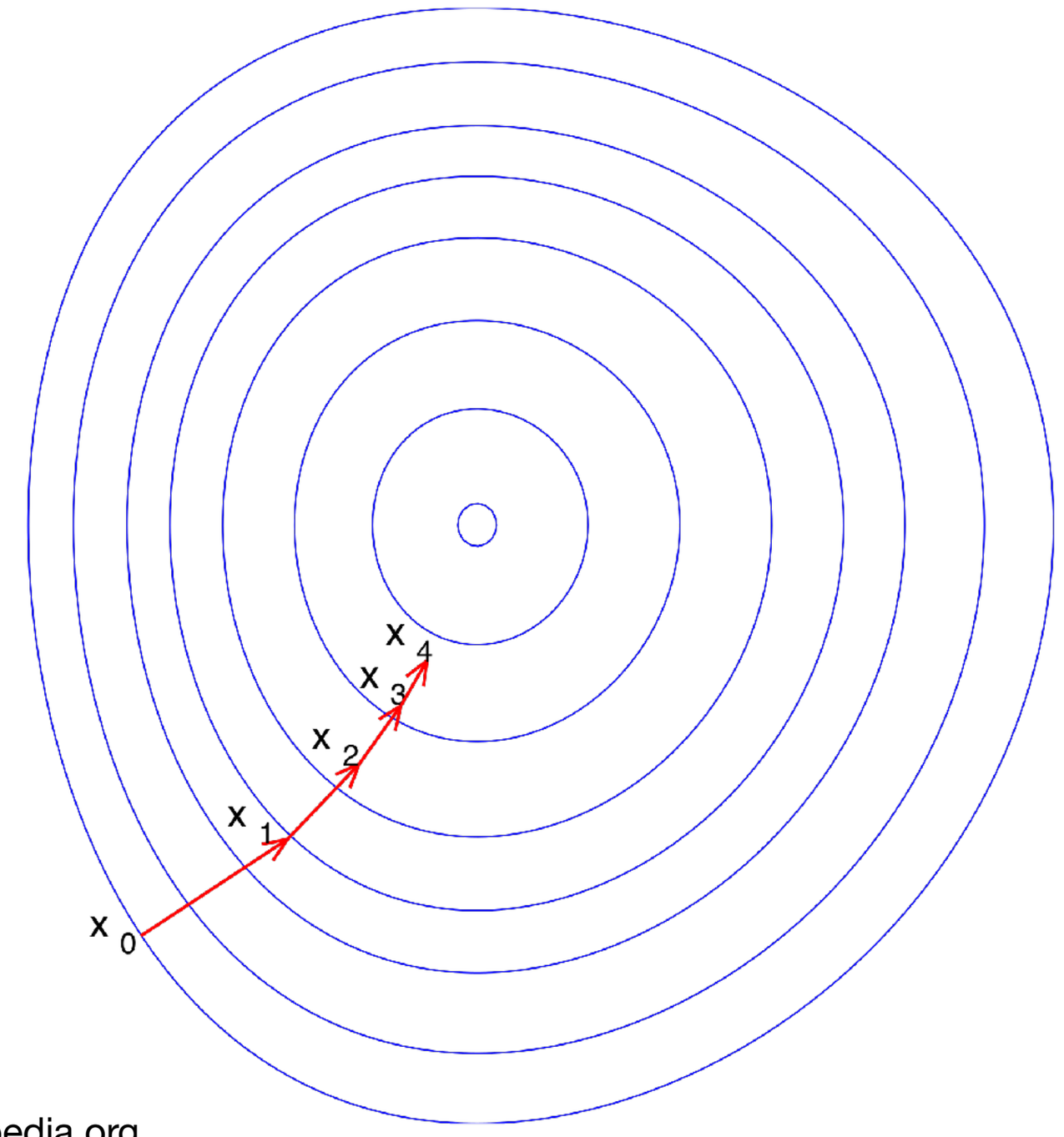


ReLU

Softmax:

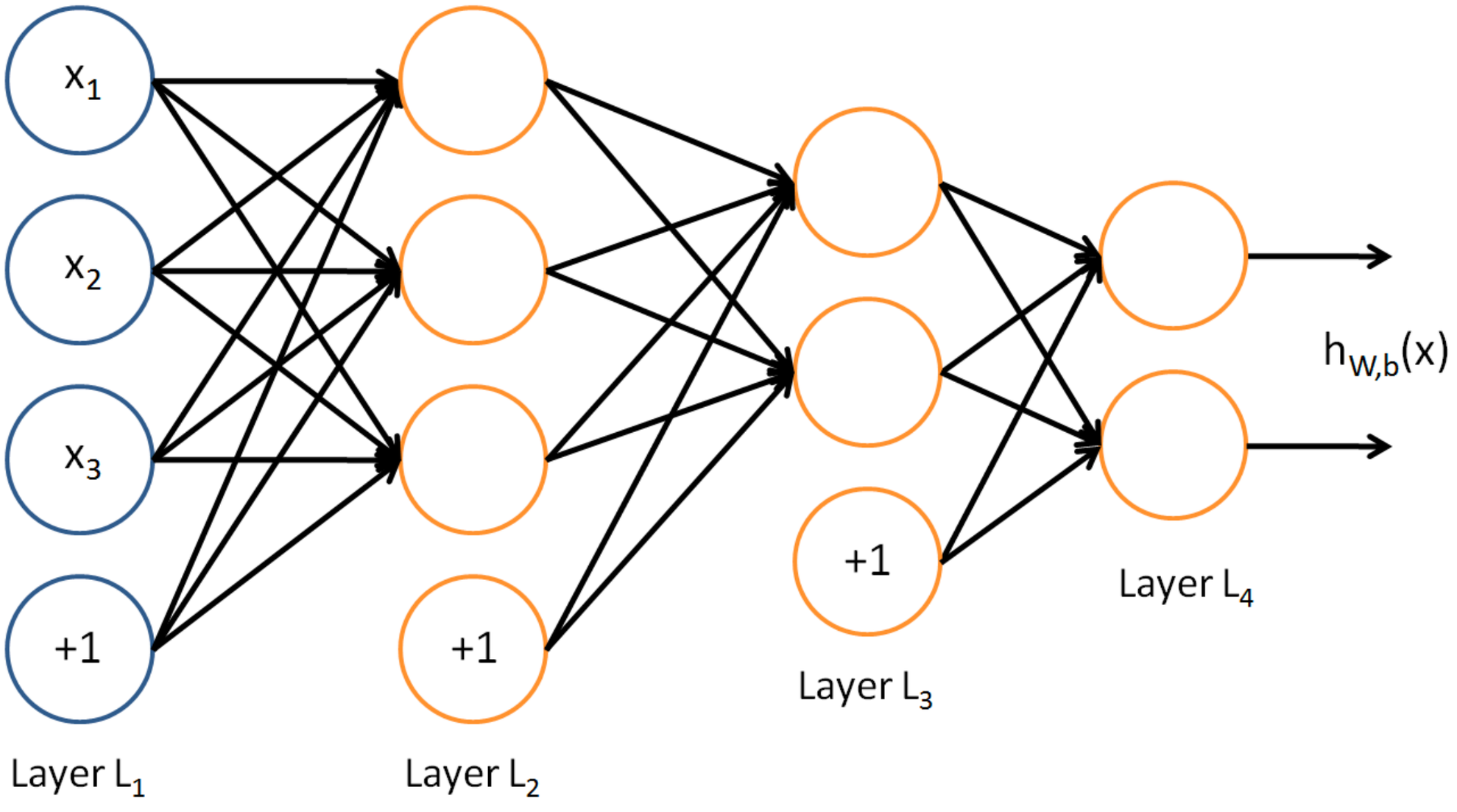
$$\sigma(\mathbf{z})_j = \frac{e^{z_j}}{\sum_{k=1}^{K} e^{z_k}}$$

Steepest gradient descent



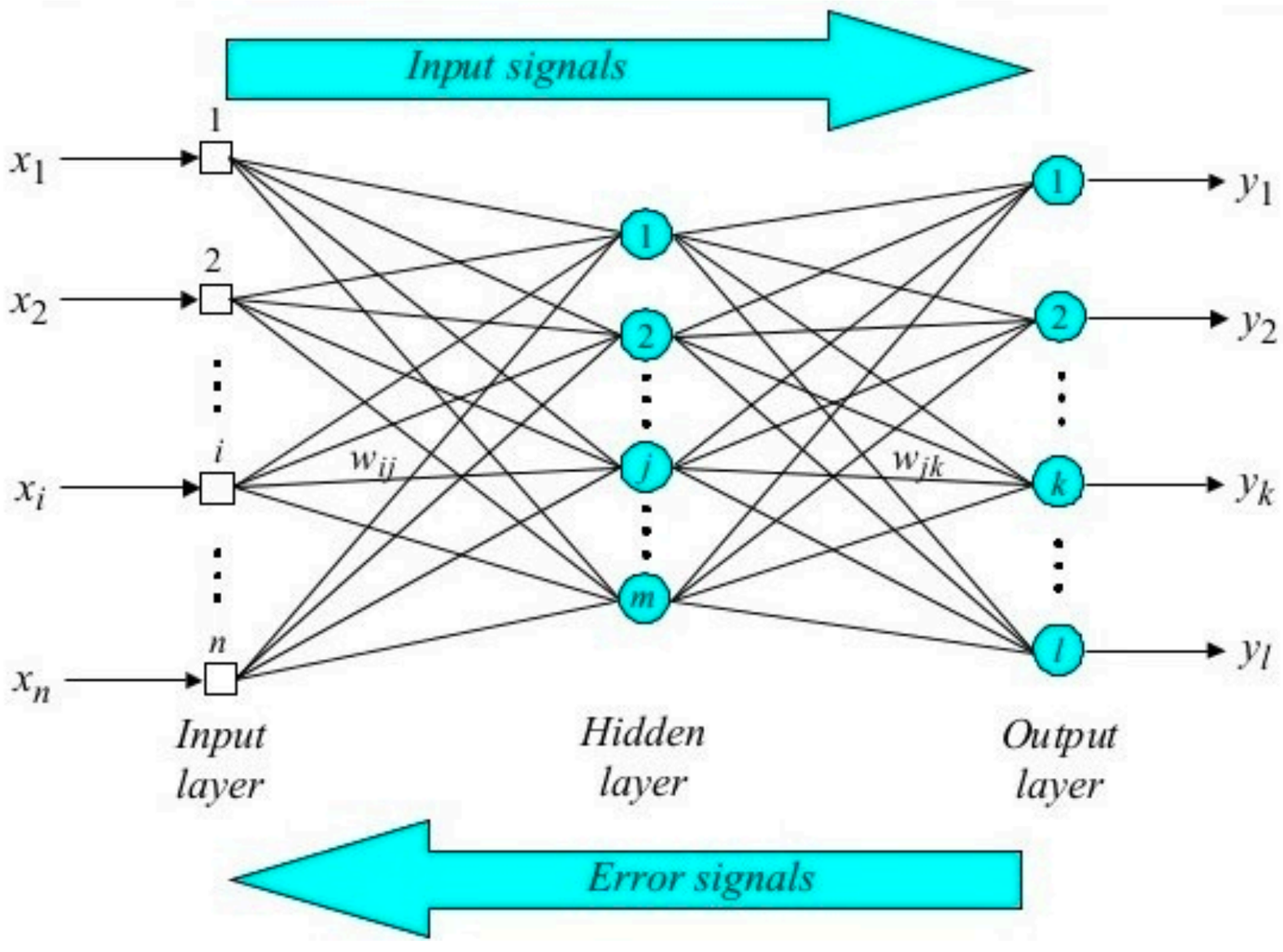
Source: https://www.wikipedia.org

Multilayer Neural Networks



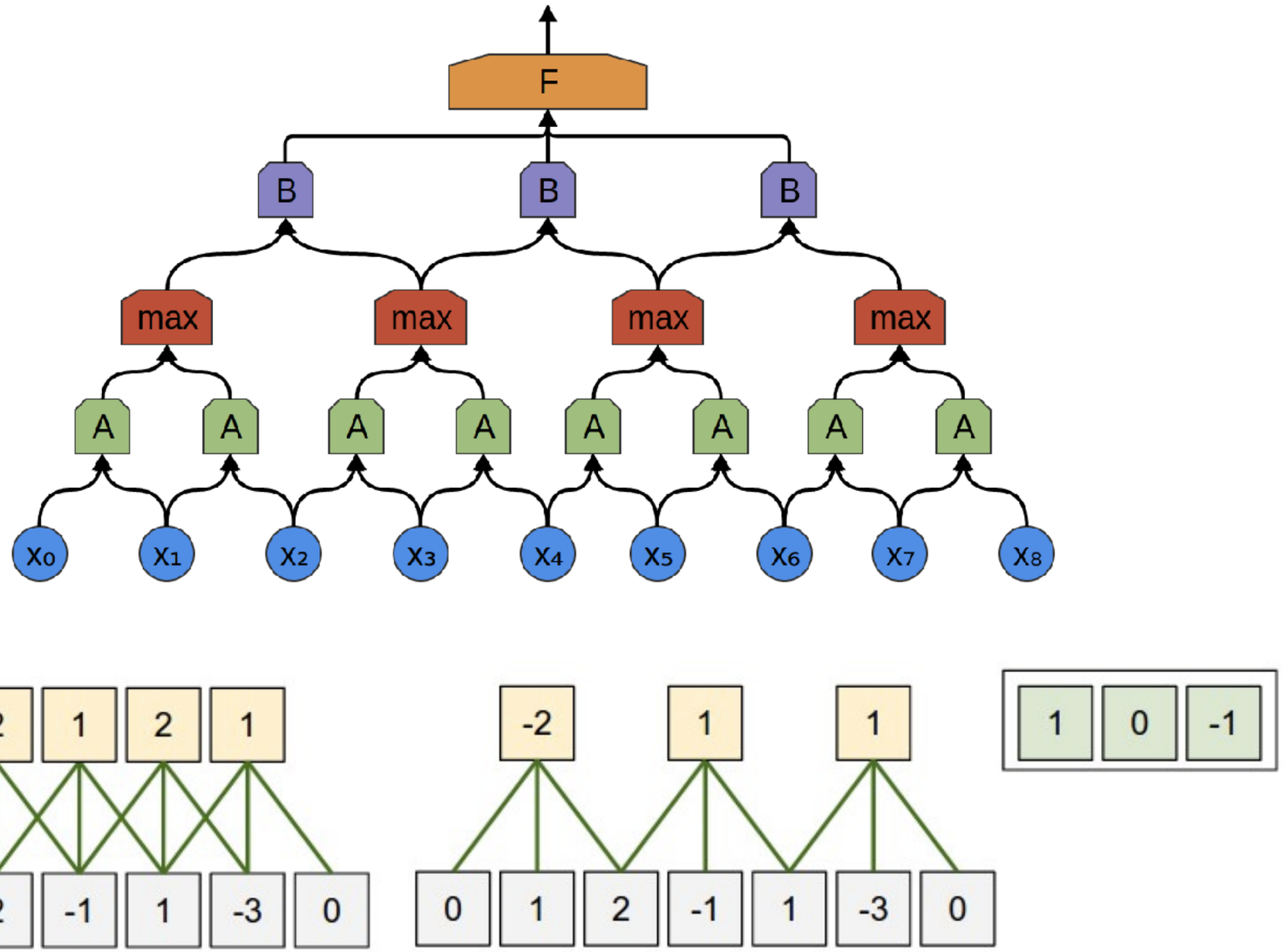
Source: http://ufldl.stanford.edu/

Back propagation



Source: https://www.quora.com/How-do-artificial-neural-networks-work

Convolution



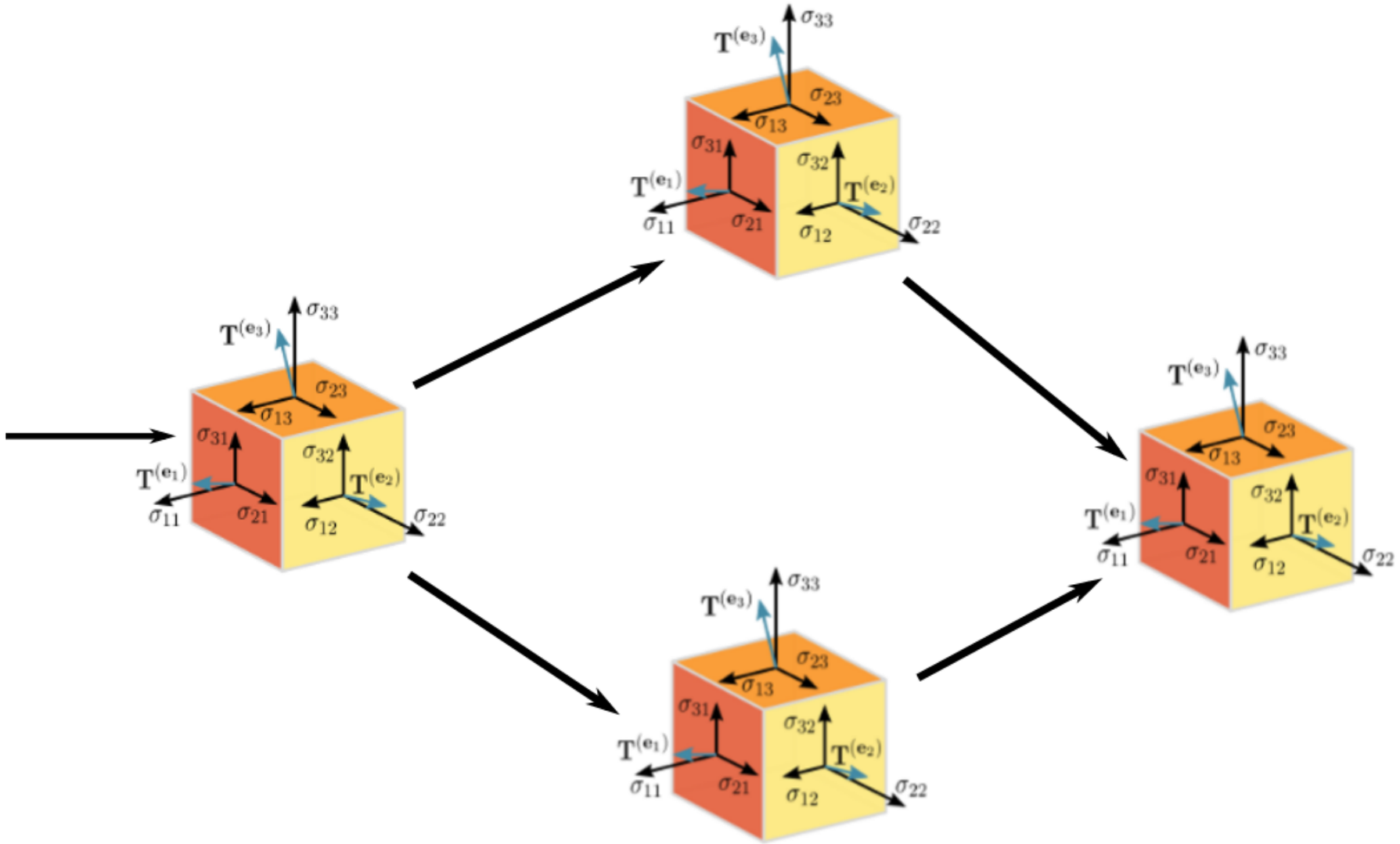
Source: https://www.tensorflow.org

Important terms

- deep learning
- stochastic gradient descent
- batch learning
- epoch
- dropout

What is not TensorFlow

What is TensorFlow?



Keras tutorial

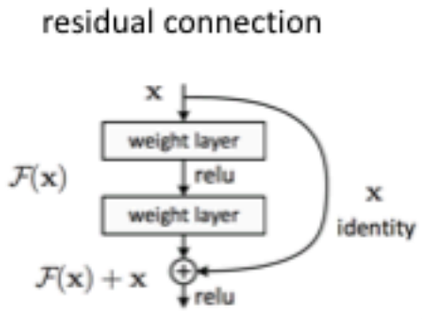
07-Keras-introduction.ipynb

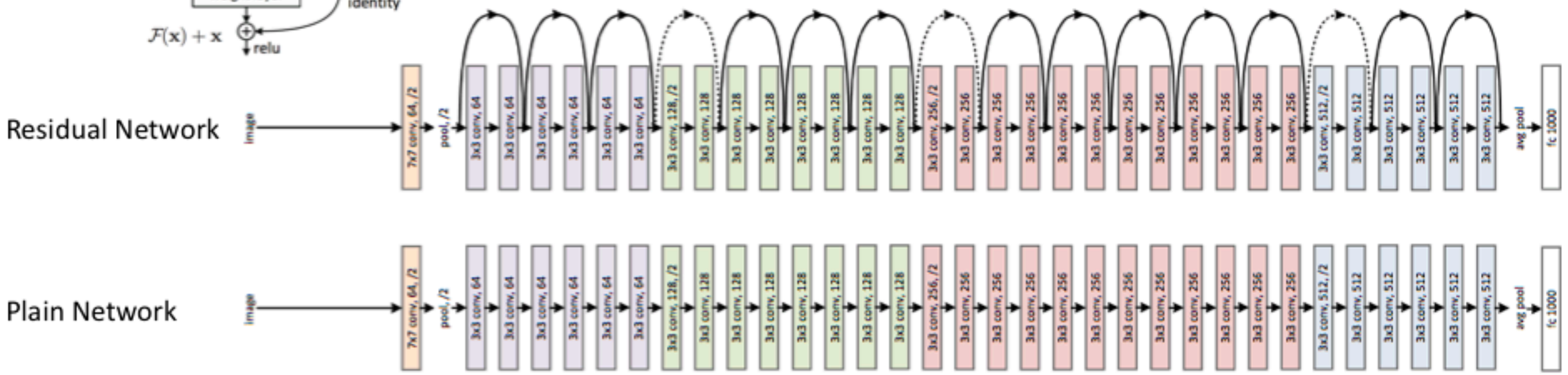
Reimplemenation of the classification and regression task using NN

08-Classification-nn-assignment.ipynb

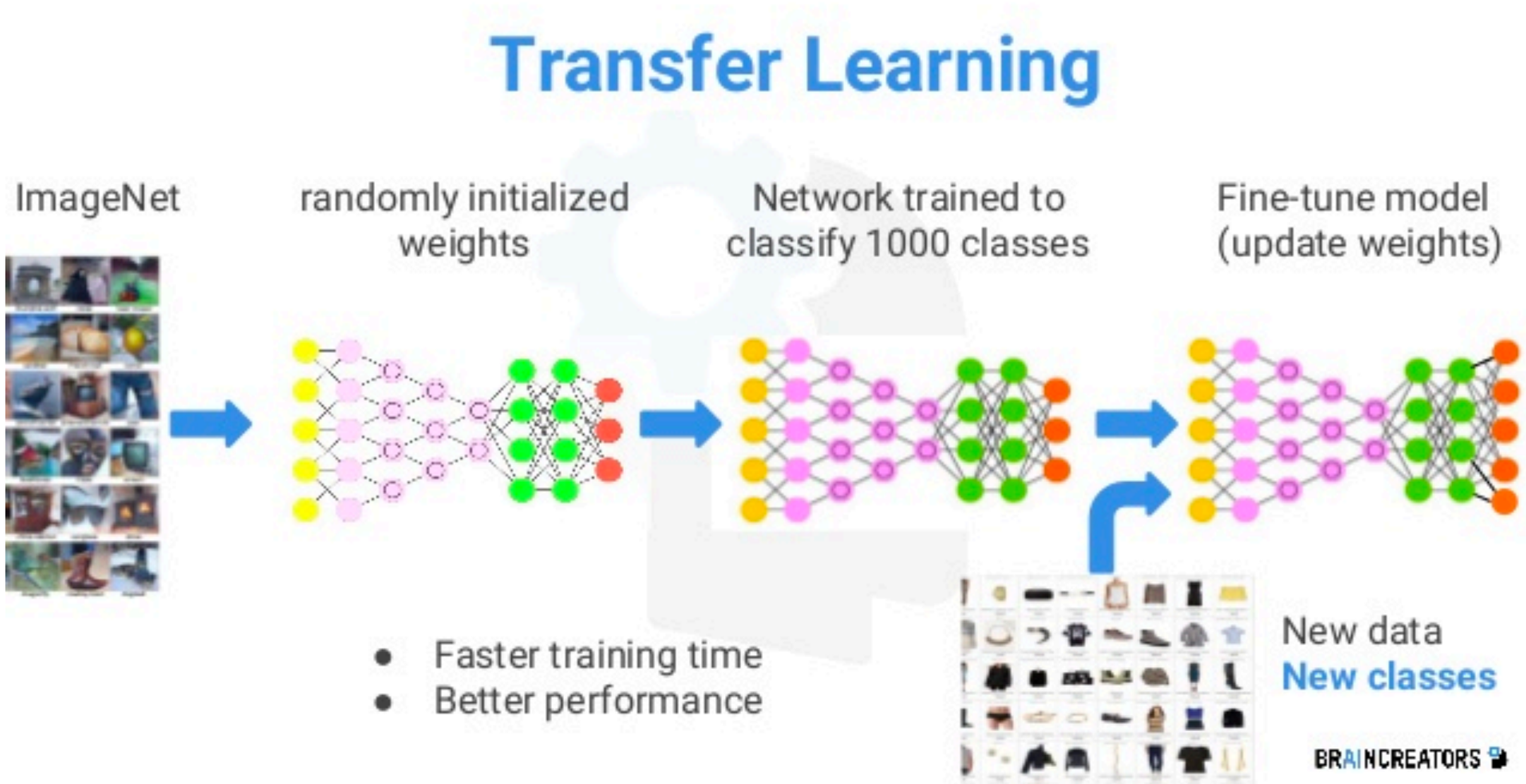
09-Regression-nn-assignment.ipynb

ResNet


residual connection
x
weight layer
relu
F(x)
weight layer
x
identity
F(x) + x
relu


Residual Network
Plain Network
image
7x7 conv, 64, /2
pool, /2
3x3 conv, 64
3x3 conv, 128, /2
3x3 conv, 128
3x3 conv, 256, /2
3x3 conv, 256
3x3 conv, 512, /2
3x3 conv, 512
avg pool
fc 1000

Finetuning


Transfer Learning
ImageNet
randomly initialized weights
Network trained to classify 1000 classes
Fine-tune model (update weights)
Faster training time
Better performance
New data
New classes
BRAINCREATORS

Adversarial Patch

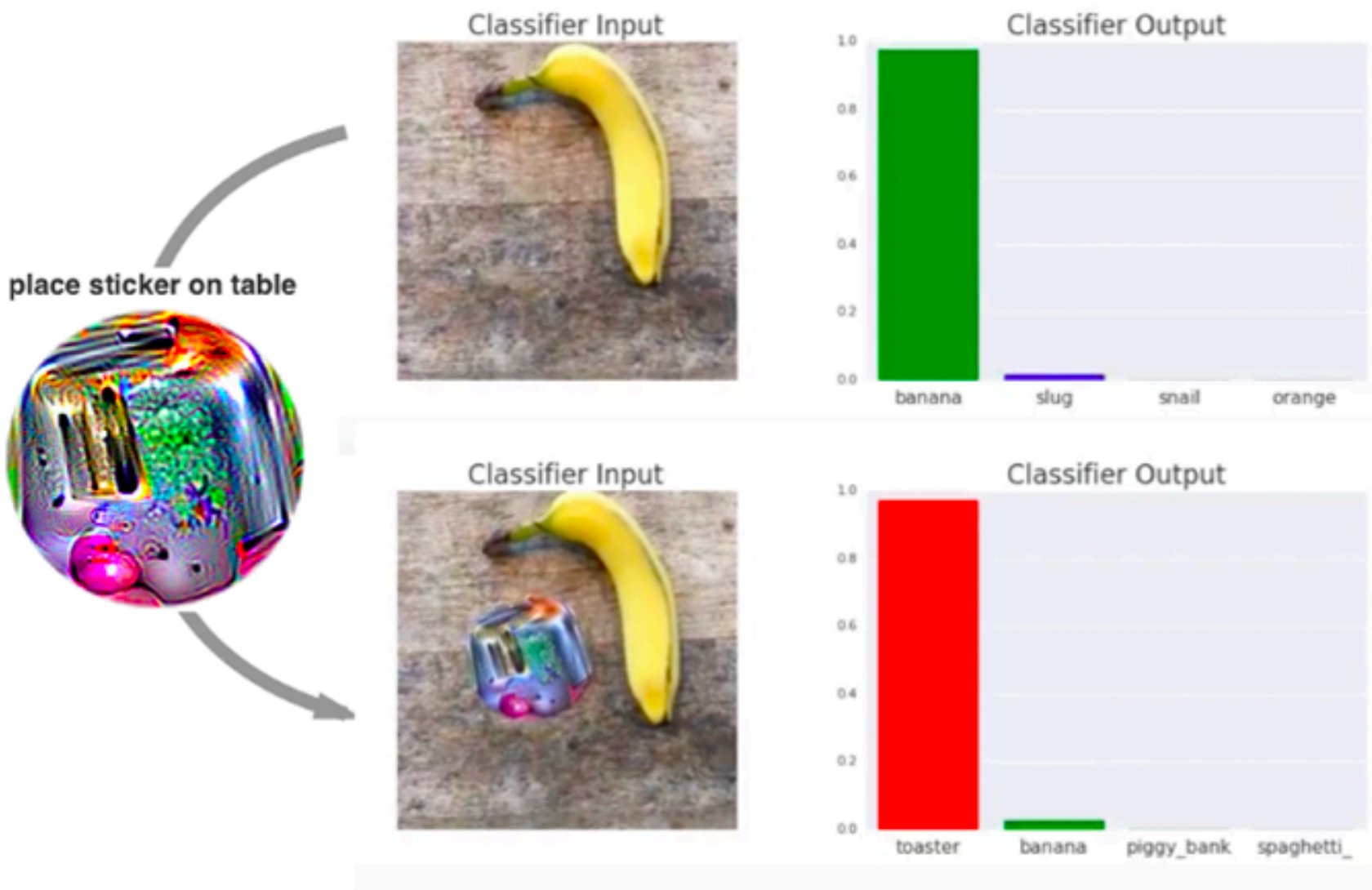
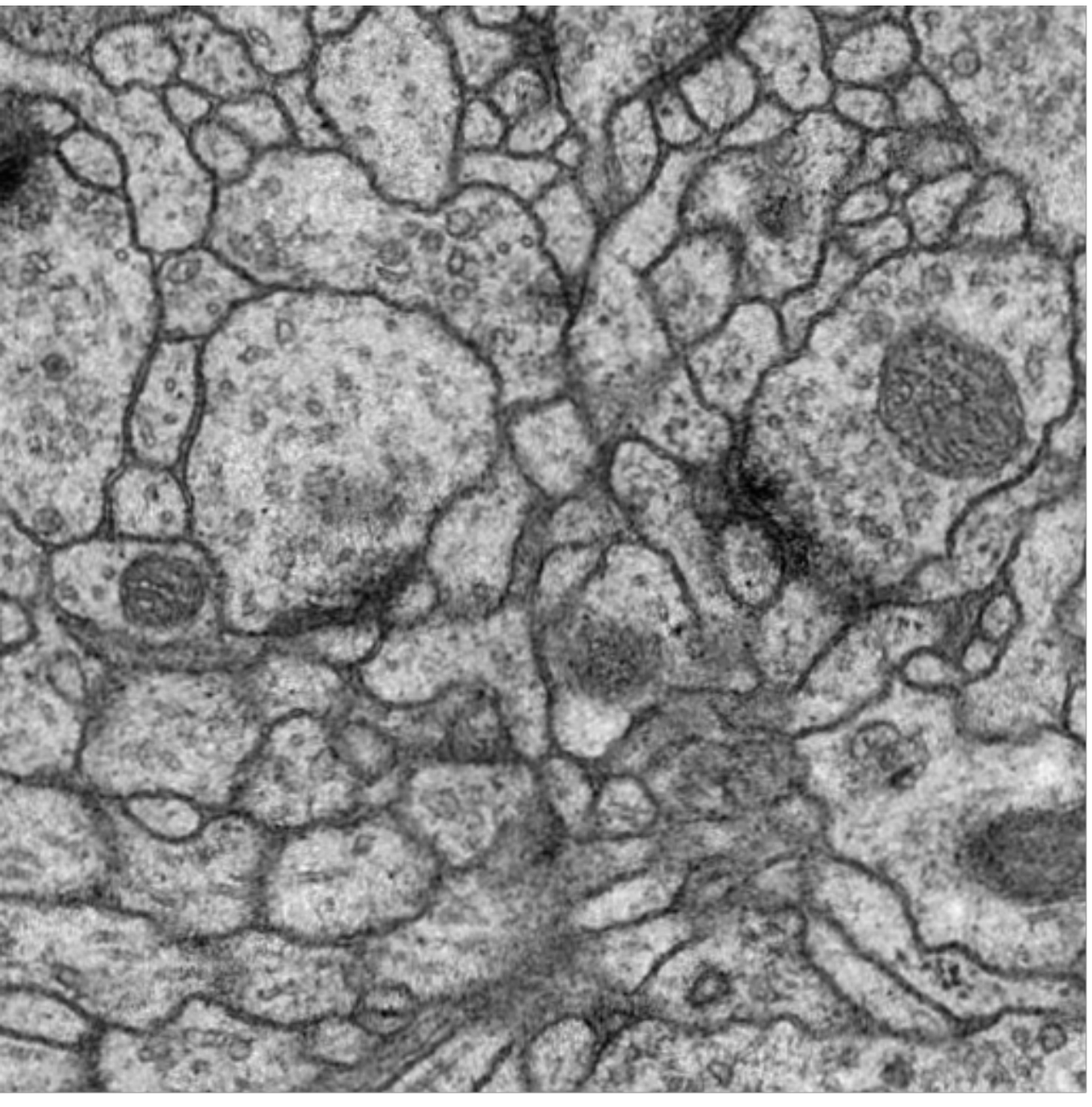
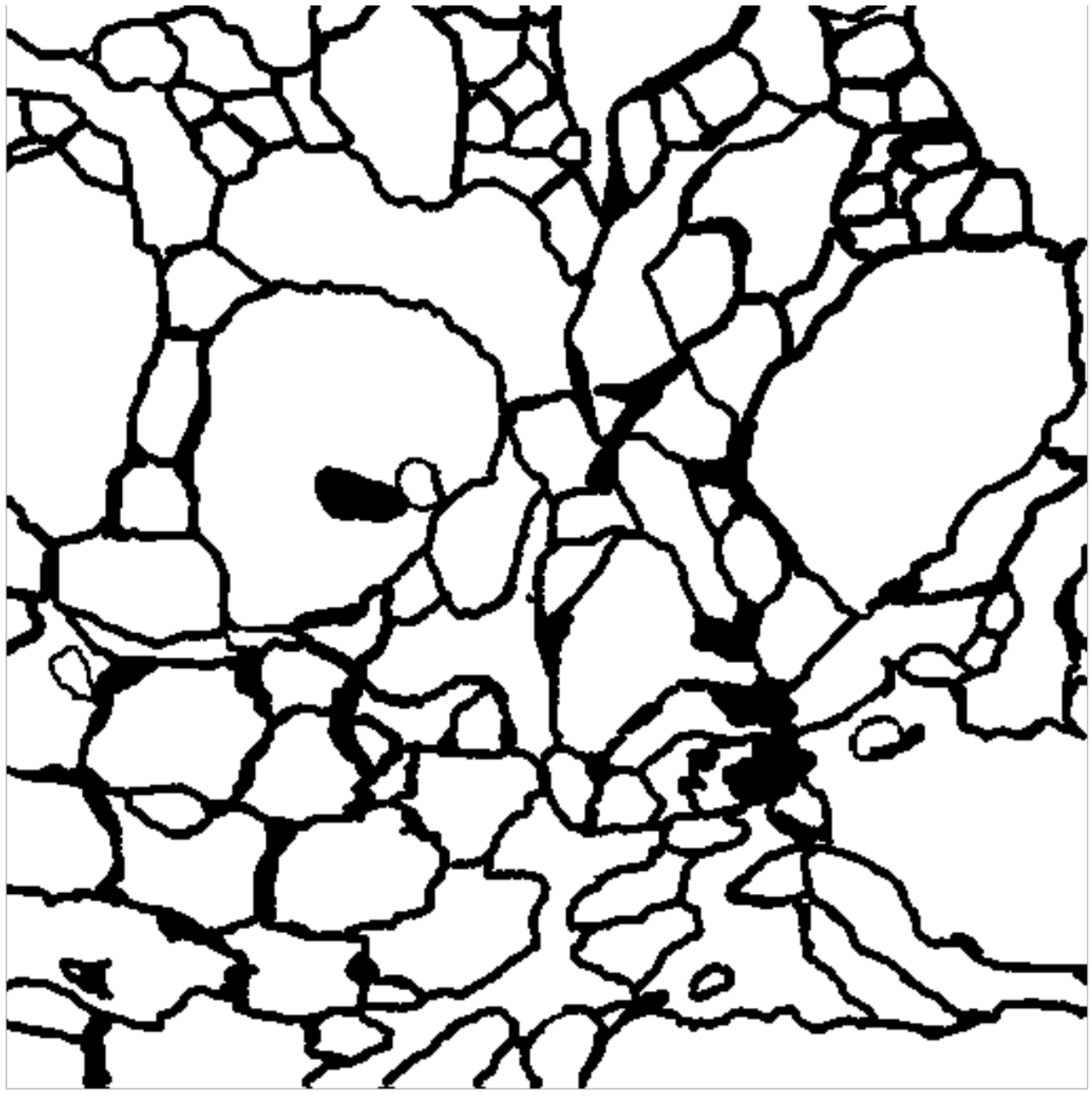


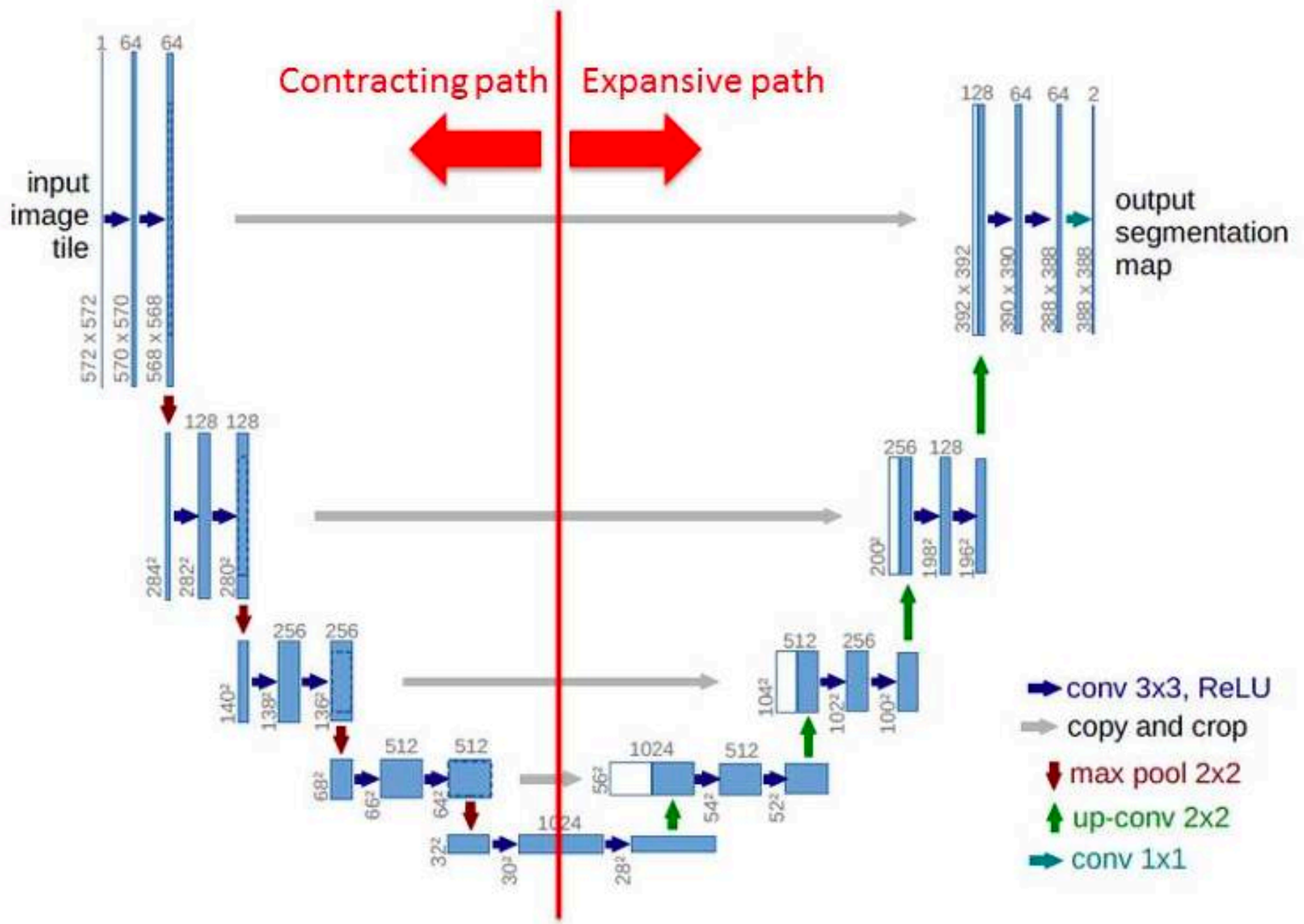
Image segmentation





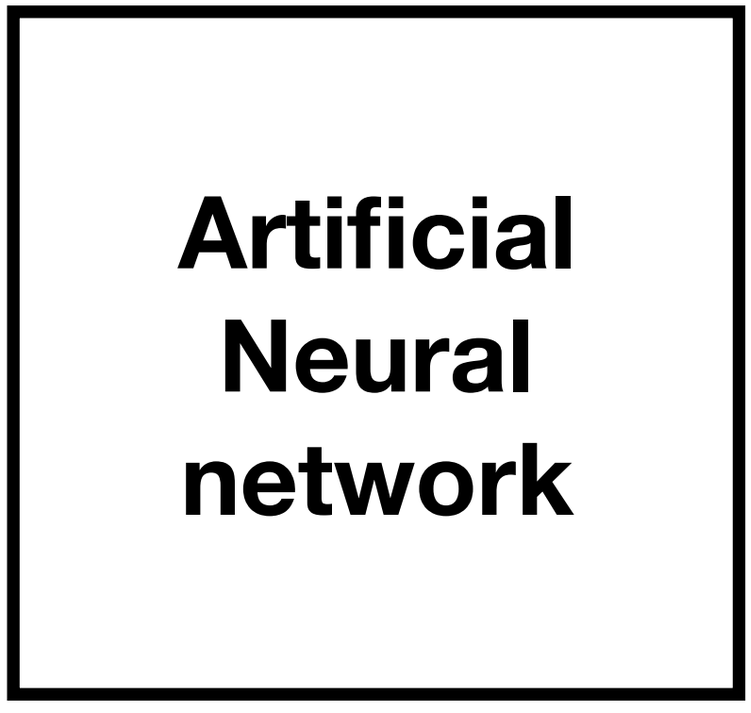
U-Net

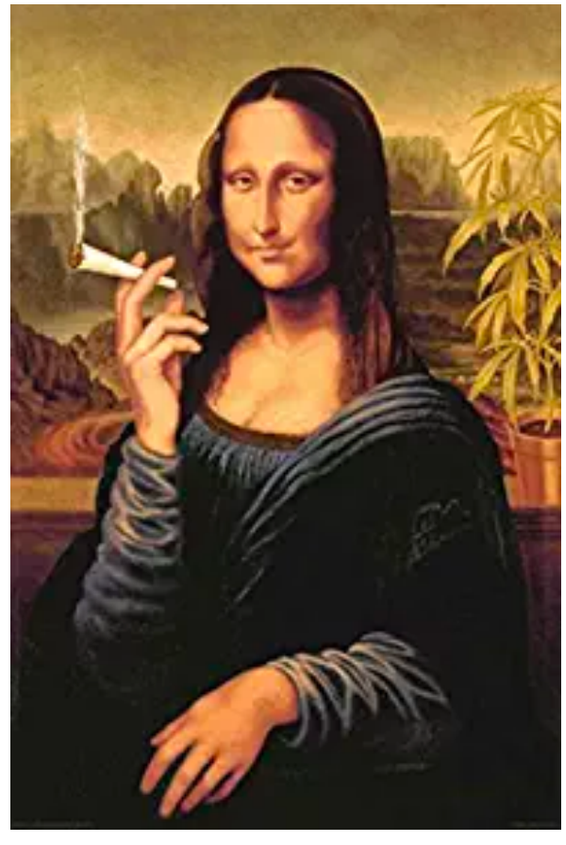
Network Architecture



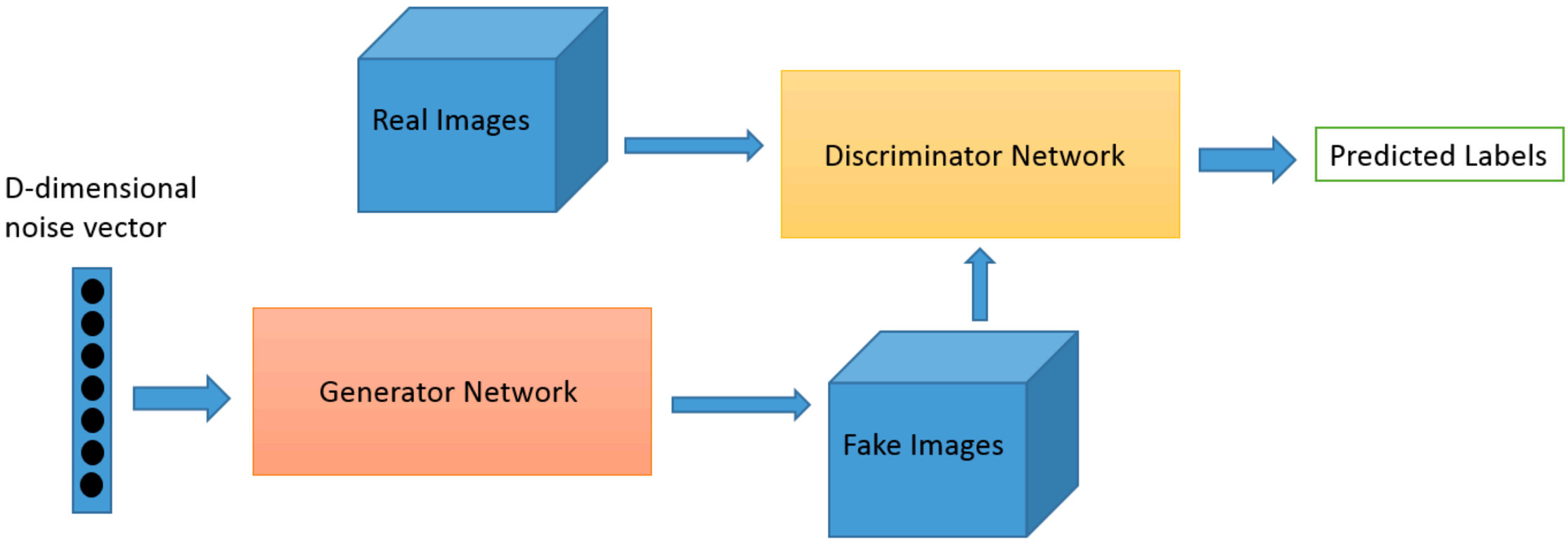
Generative models with neural networks

Random noice





Generative Adversarial Networks



Superresolution

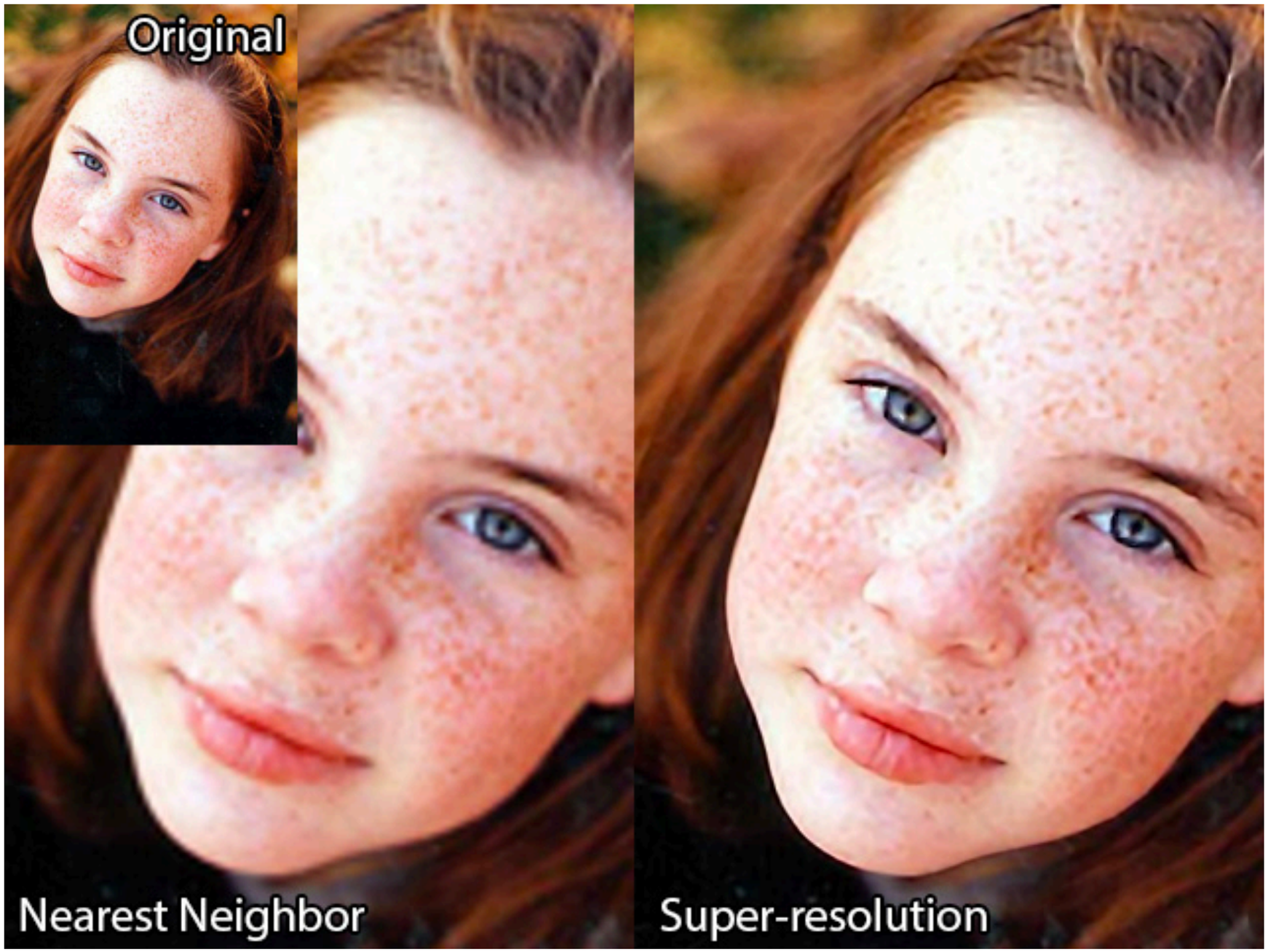
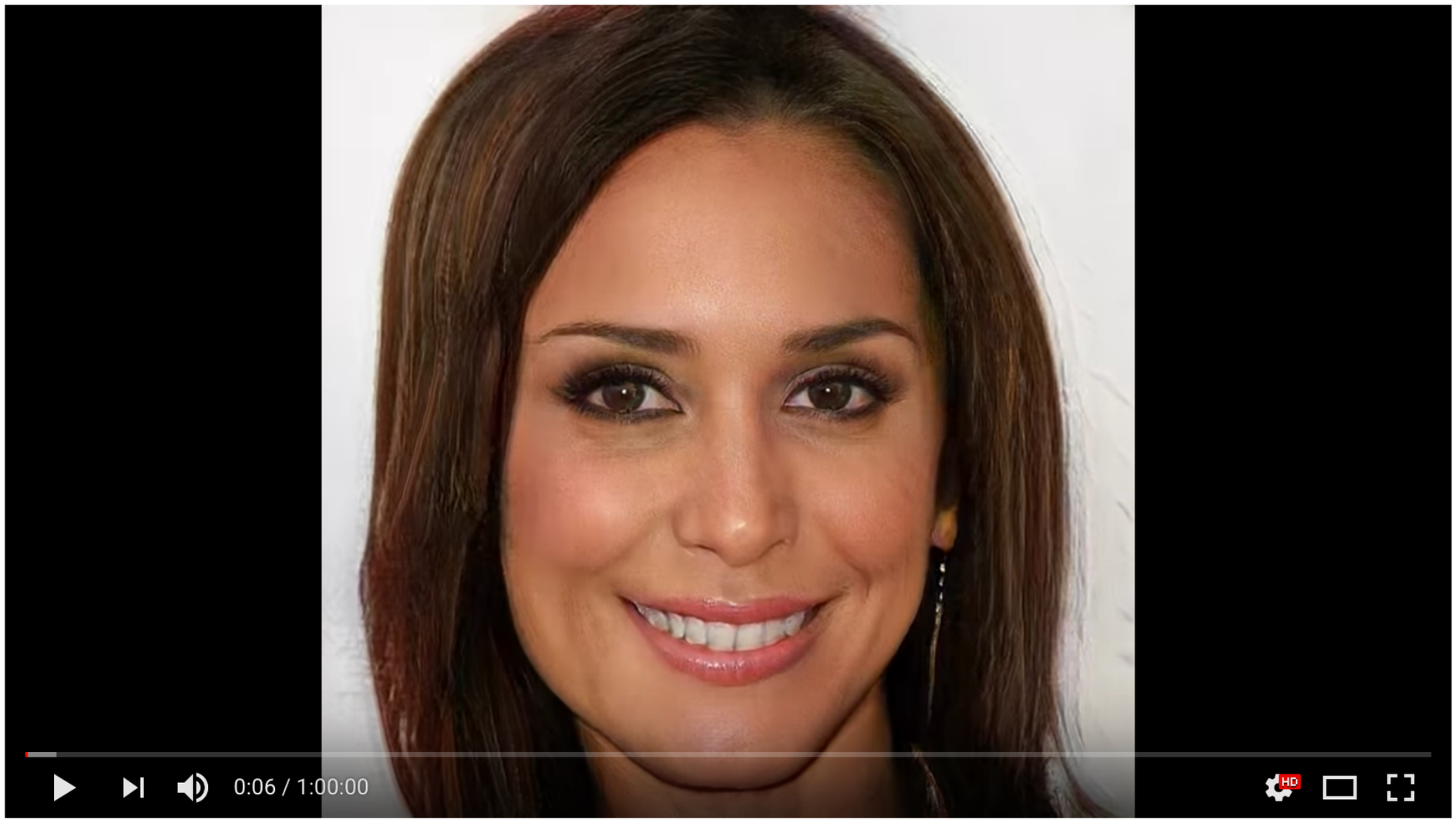


Image synthesis

YouTube CZ

Hledat



One hour of imaginary celebrities

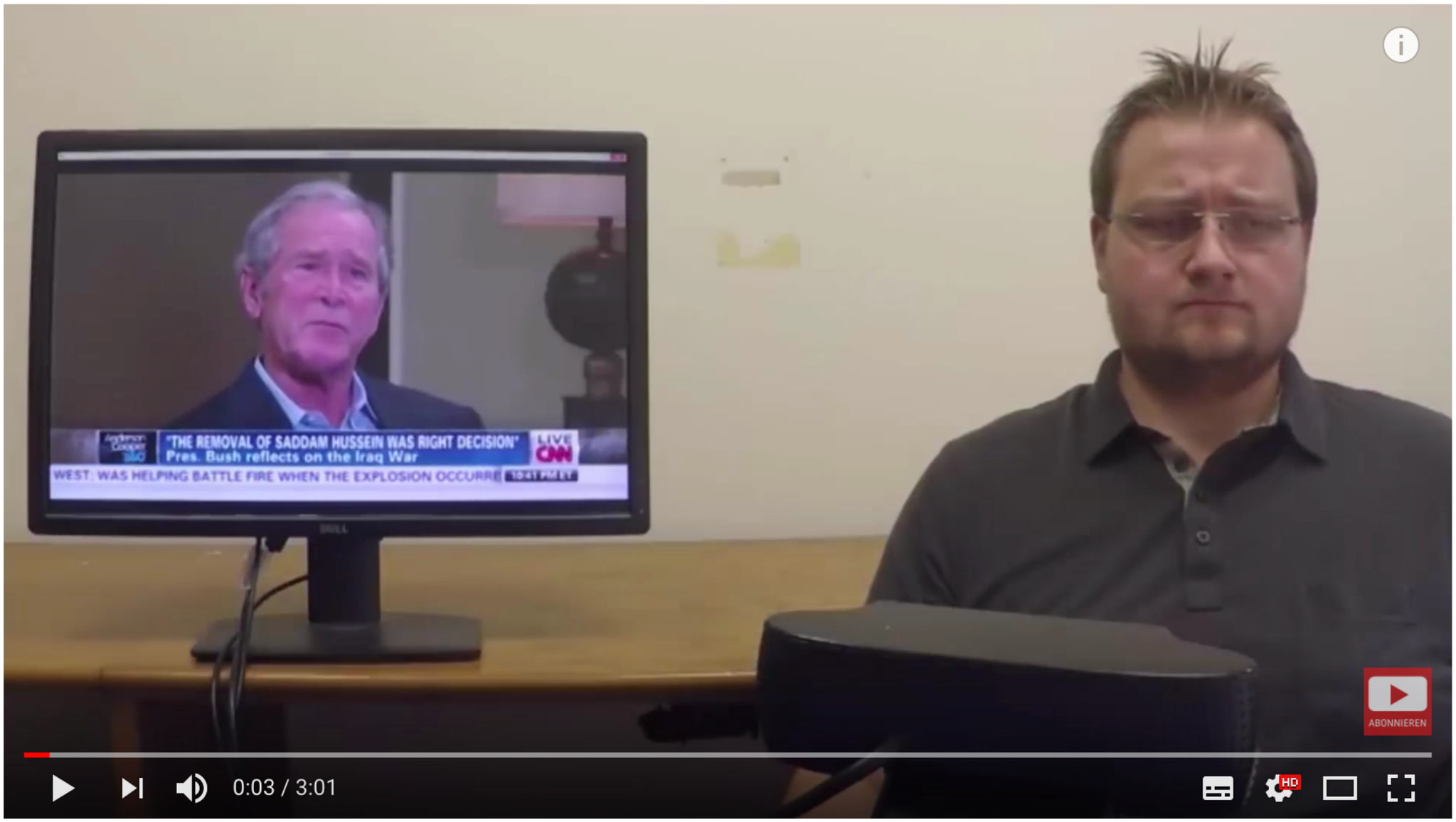
95 832 zhlédnutí

TO SE MI LÍBÍ NELÍBÍ SE SDÍLET

Image manipulation

YouTube CZ

Hledat

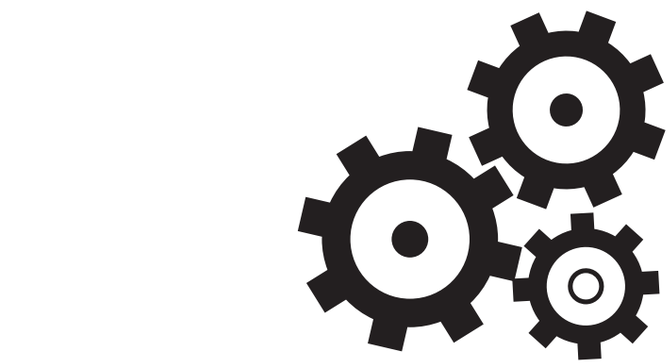


How German scientists control Putin's face

3 540 zhlédnutí

117 1 SDÍLET

What next?



Machine Learning Prague

MACHINE LEARNING
meetups

http://www.mlguru.com

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