Introduction to Computer Vision & Traditional ML

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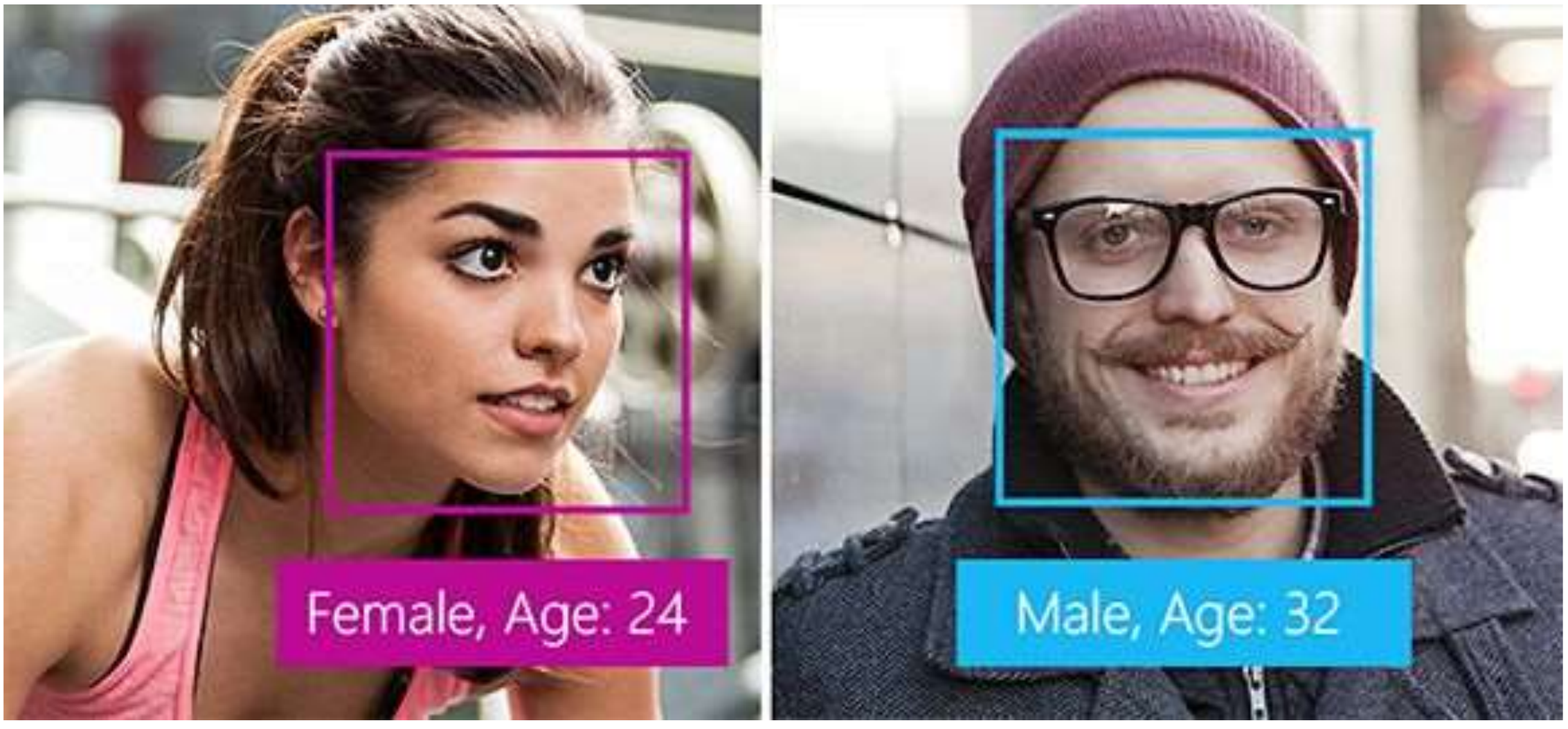
What is Computer Vision?

Deeplab Image Semantic Segmentation Network
(Source: https://sthalles.github.io/deep_segmentation_network/)

What is Computer Vision?



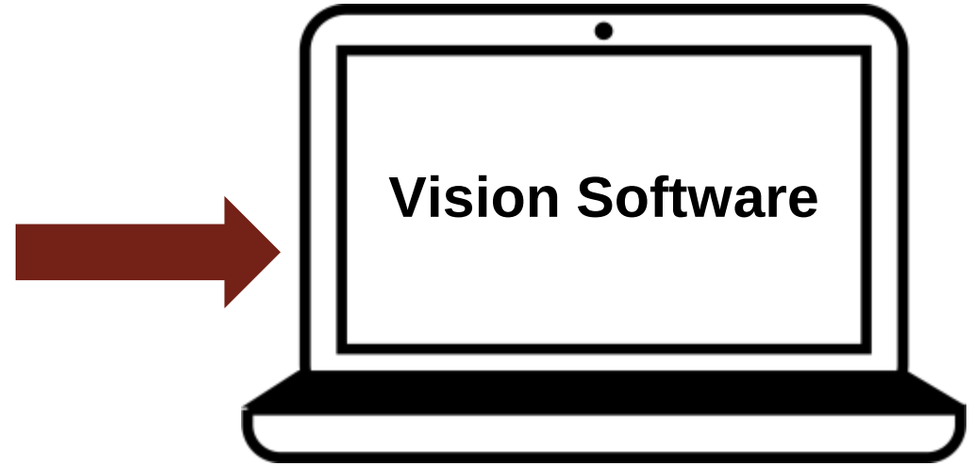
Microsoft Face API

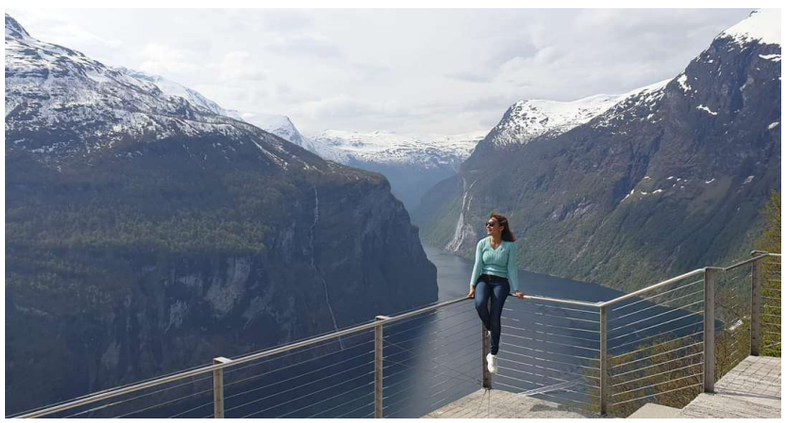
What is Computer Vision?

[Zhe Cao, Tomas Simon, Shih-En Wei, Yaser Sheikh. ‘Realtime Multi-Person 2D Human Pose Estimation’, CVPR 2017]

Basic Components

Sensing device

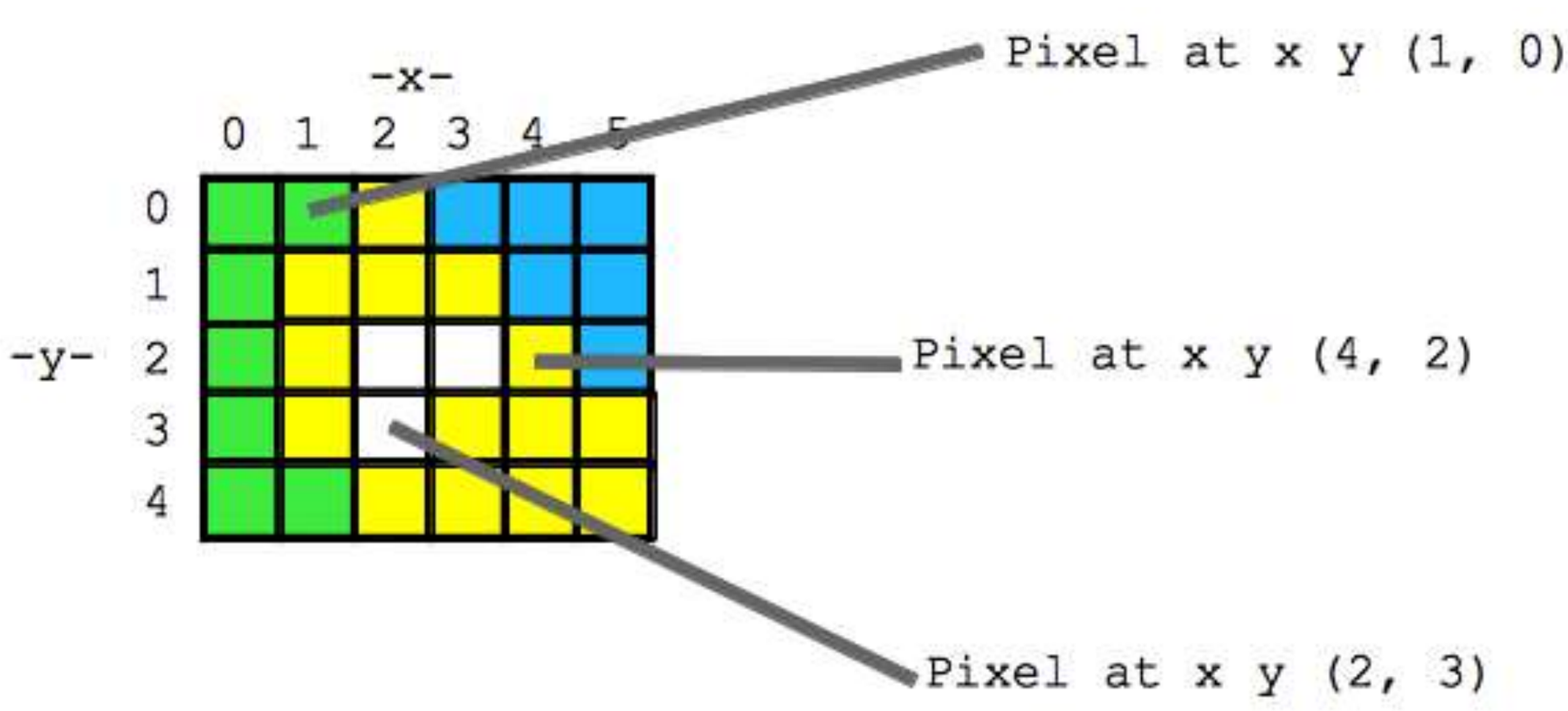




Scene Interpretation and Understanding

An image

- Image is an array of pixels
- Video is a sequence of images



WHAT HUMANS SEE

WHAT COMPUTERS SEE

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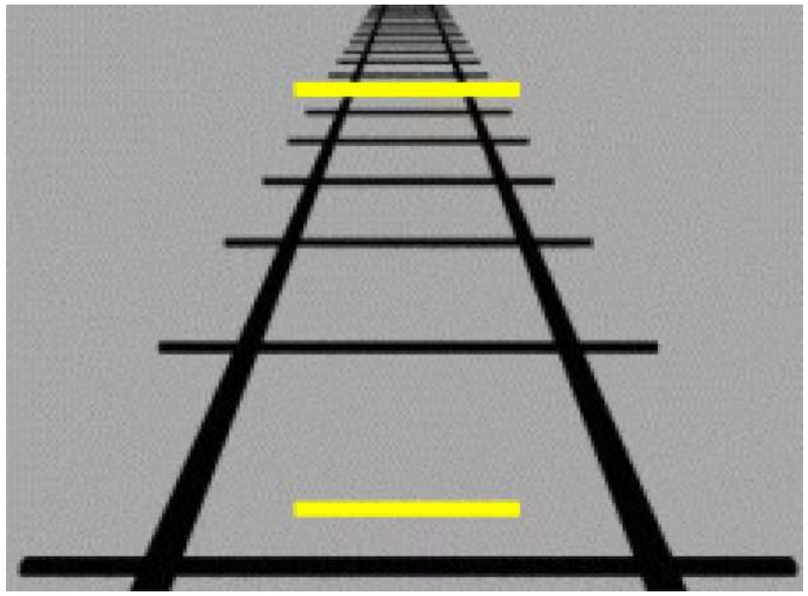
08 02 22 97 38 15 00 40 00 75 04 05 07 78 52 12 50 77 91 08
49 49 99 40 17 81 18 57 60 87 17 40 98 43 69 48 04 56 62 00
81 49 31 73 55 79 14 29 93 71 40 67 53 88 30 03 49 13 36 65
52 70 95 23 04 60 11 42 69 24 68 56 01 32 56 71 37 02 36 91
22 31 16 71 51 67 63 89 41 92 36 54 22 40 40 28 66 33 13 80
24 47 32 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
88 36 68 87 57 62 20 72 03 46 33 67 46 55 12 32 63 93 53 69
04 42 16 73 38 25 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 86 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
```

https://medium.datadriveninvestor.com/convolutional-neural-networks-explained-7fafea4de9c9

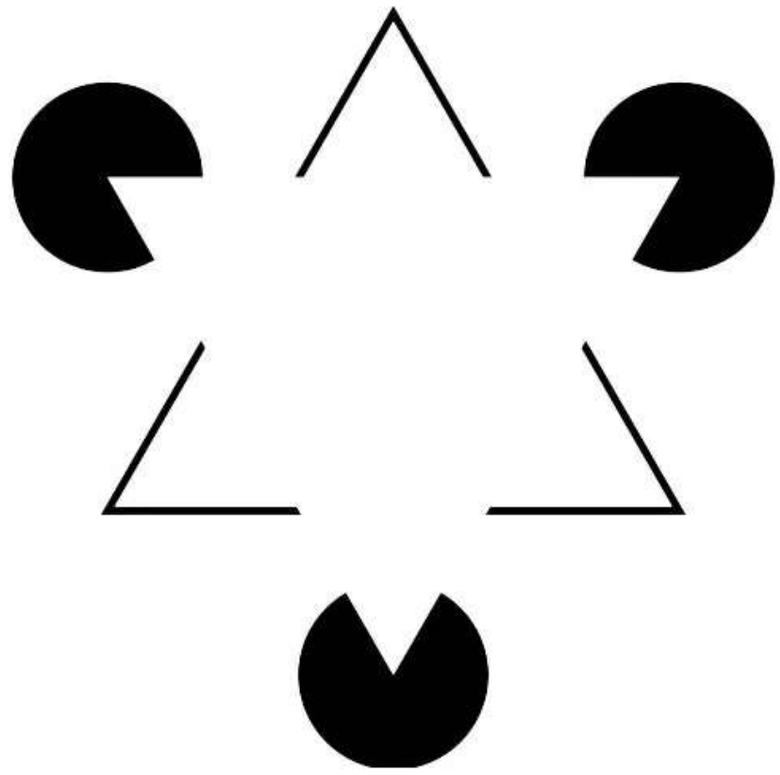
Can we copy human vision ?

- Better precision
- Better processing power
- Optical illusions

Examples

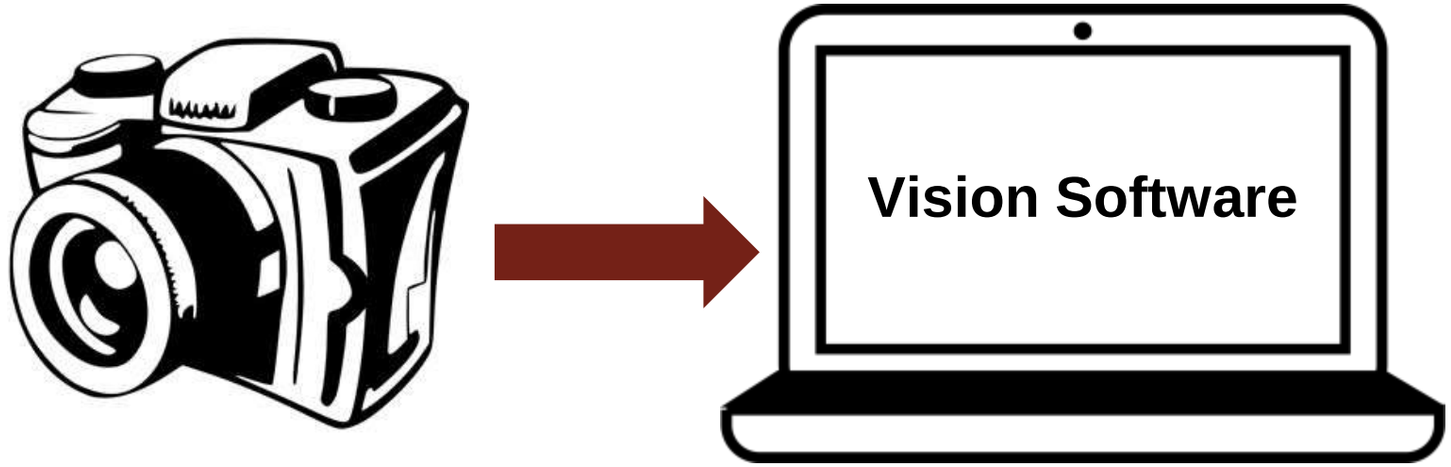


The Ponzo Illusion

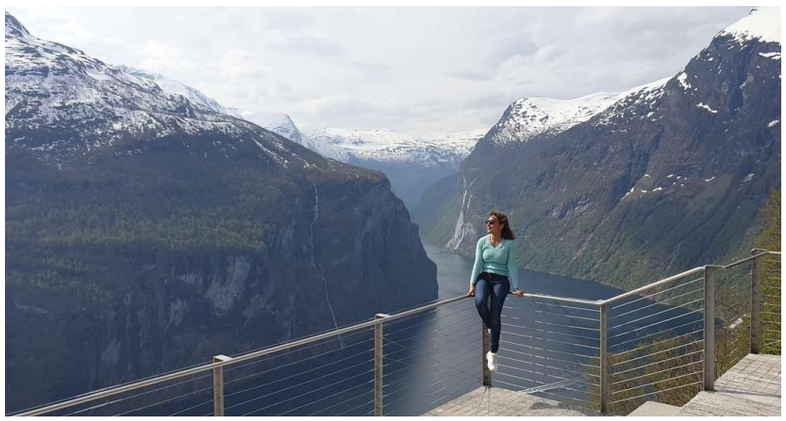


The Kanizsa Triangle Illusion

Wikimedia Comms

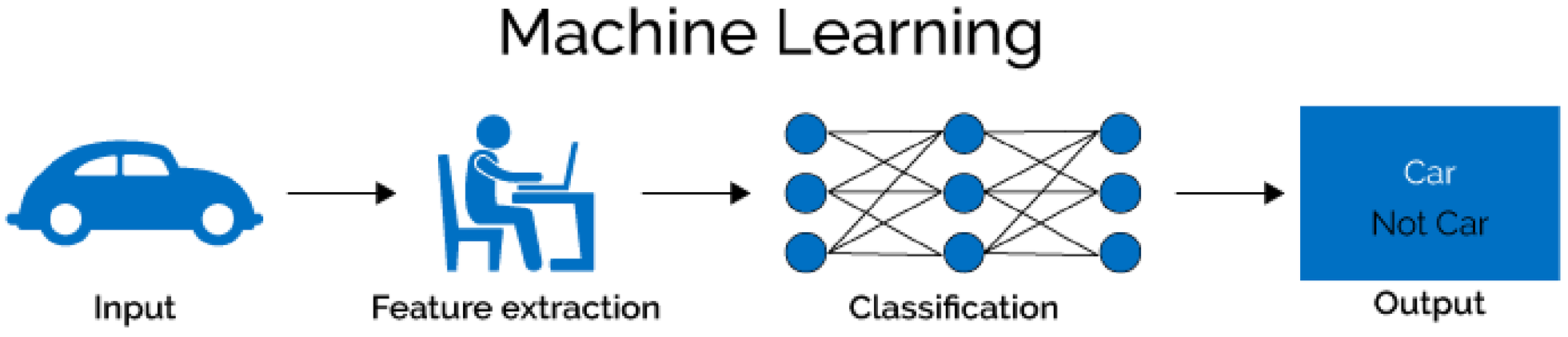


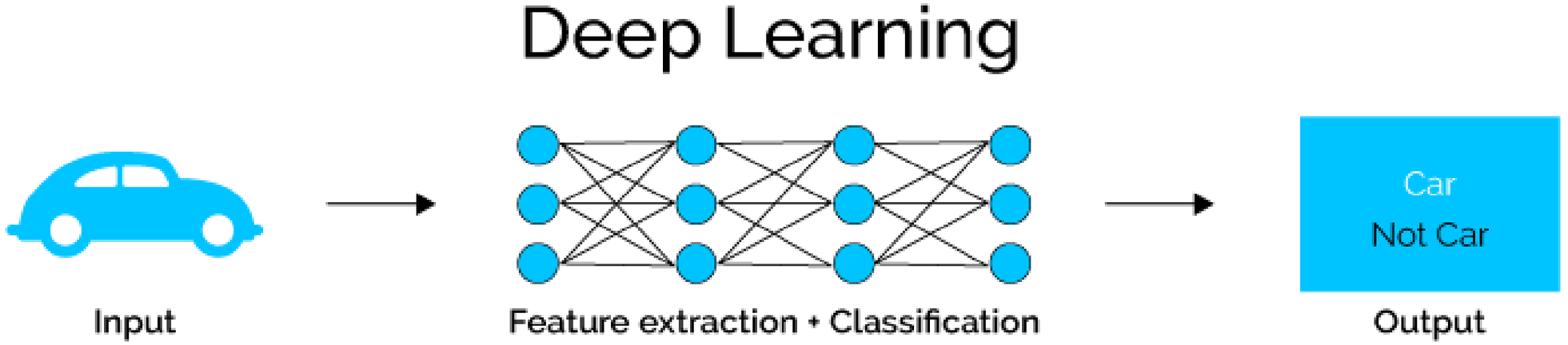
Sensing device



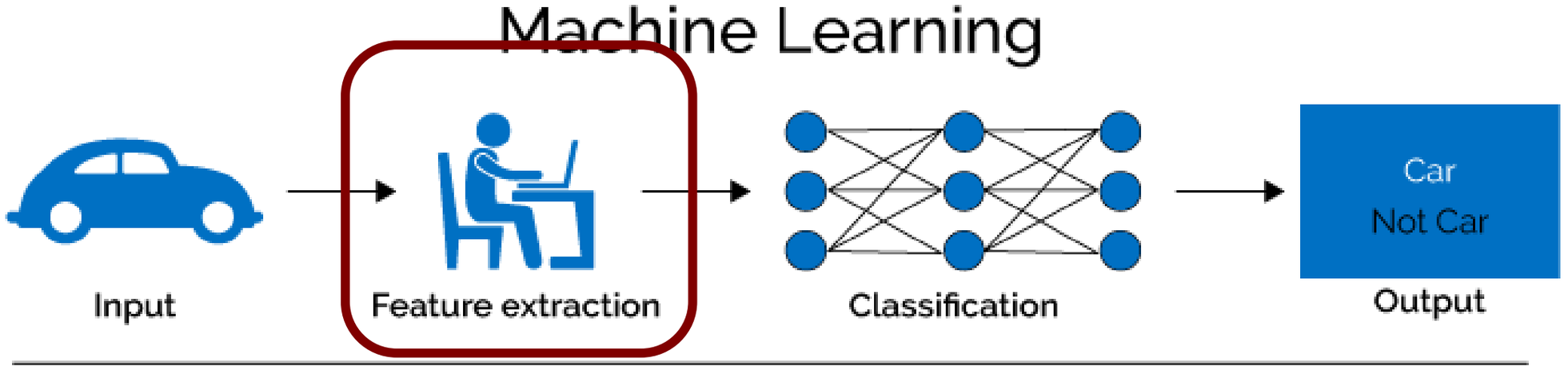
Scene Interpretation and Understanding

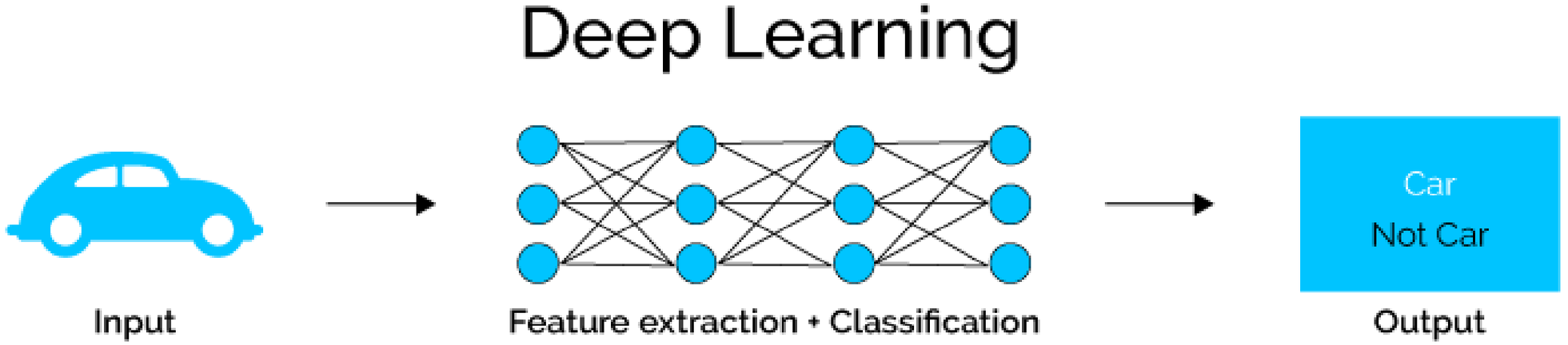
Machine learning for computer vision



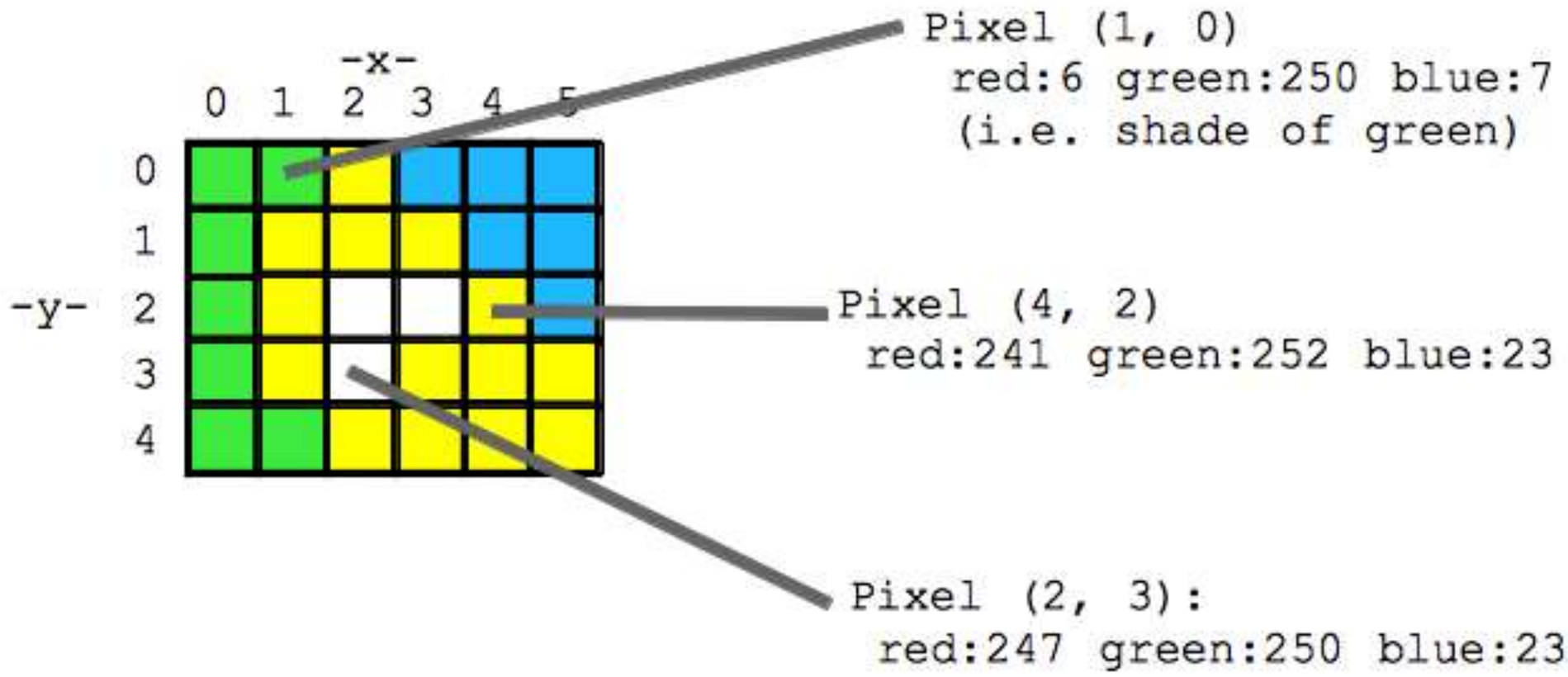


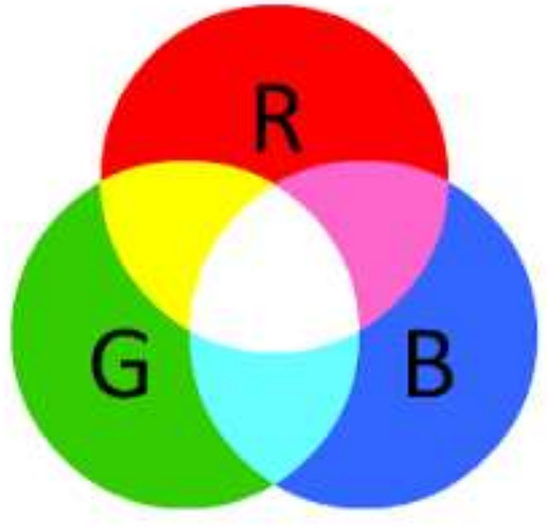
Machine learning for computer vision





RGB representation





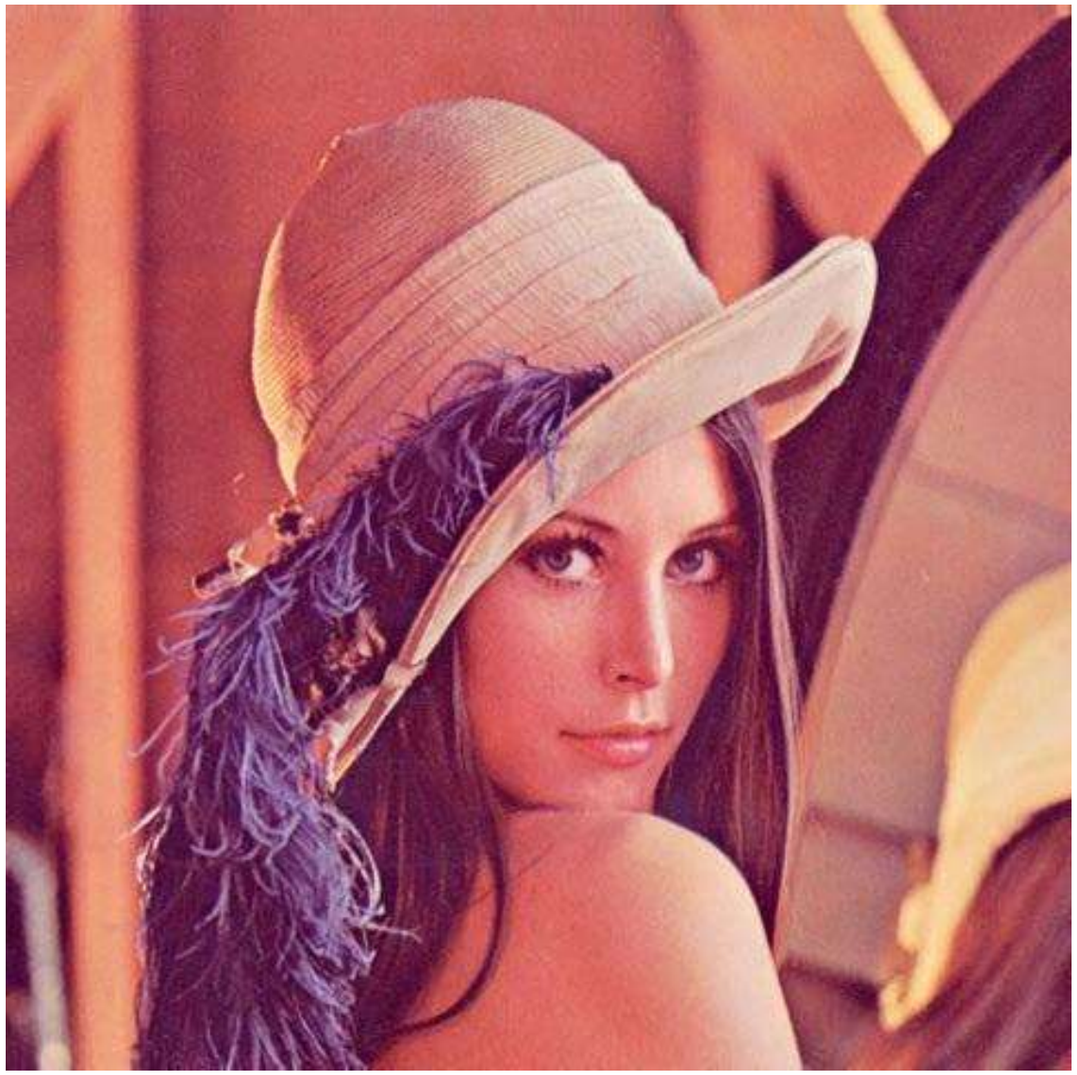
Colour features

Colour features

Histograms – Colour histograms
(how to create histogram of RGB values?)

Sample application:
Search by image!!

Edge features



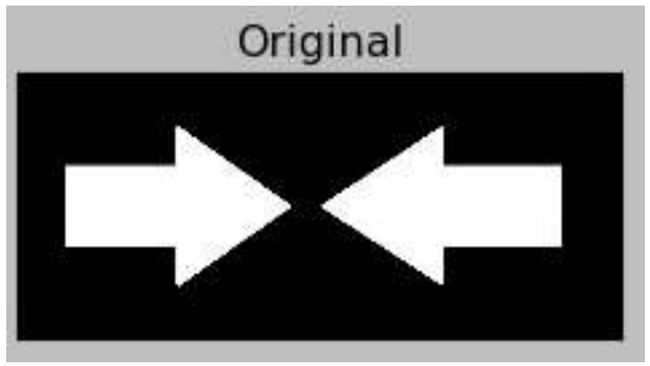
Edge features

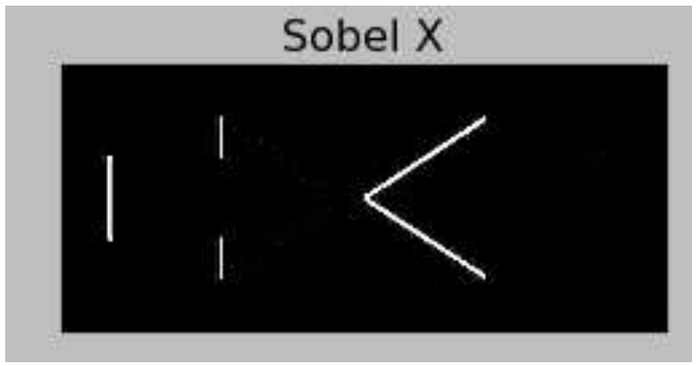
-1	0	+1
-2	0	+2
-1	0	+1

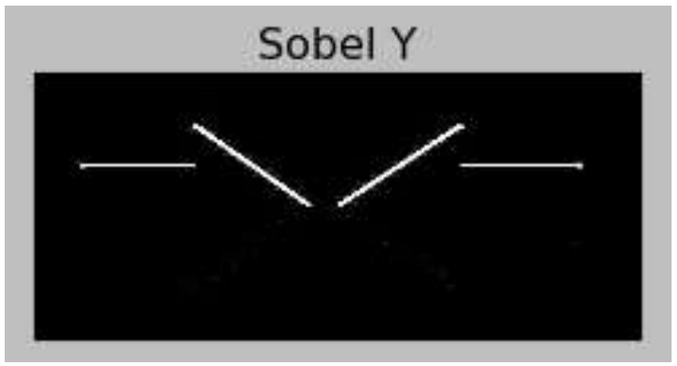
x filter

+1	+2	+1
0	0	0
-1	-2	-1

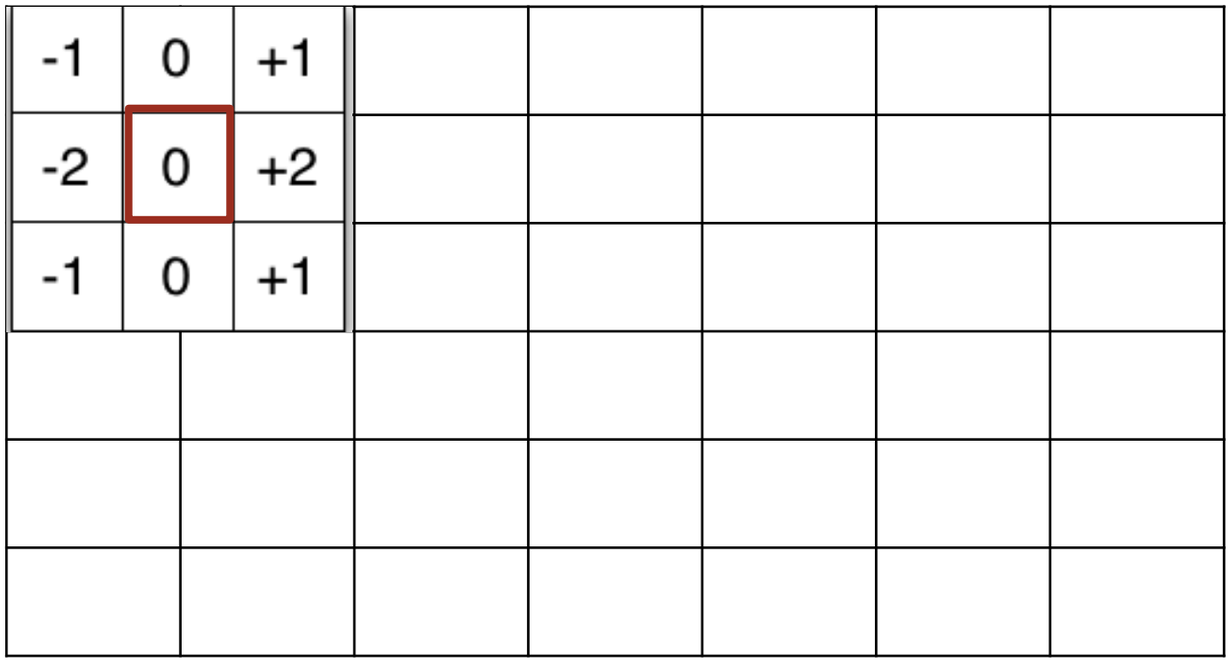
y filter



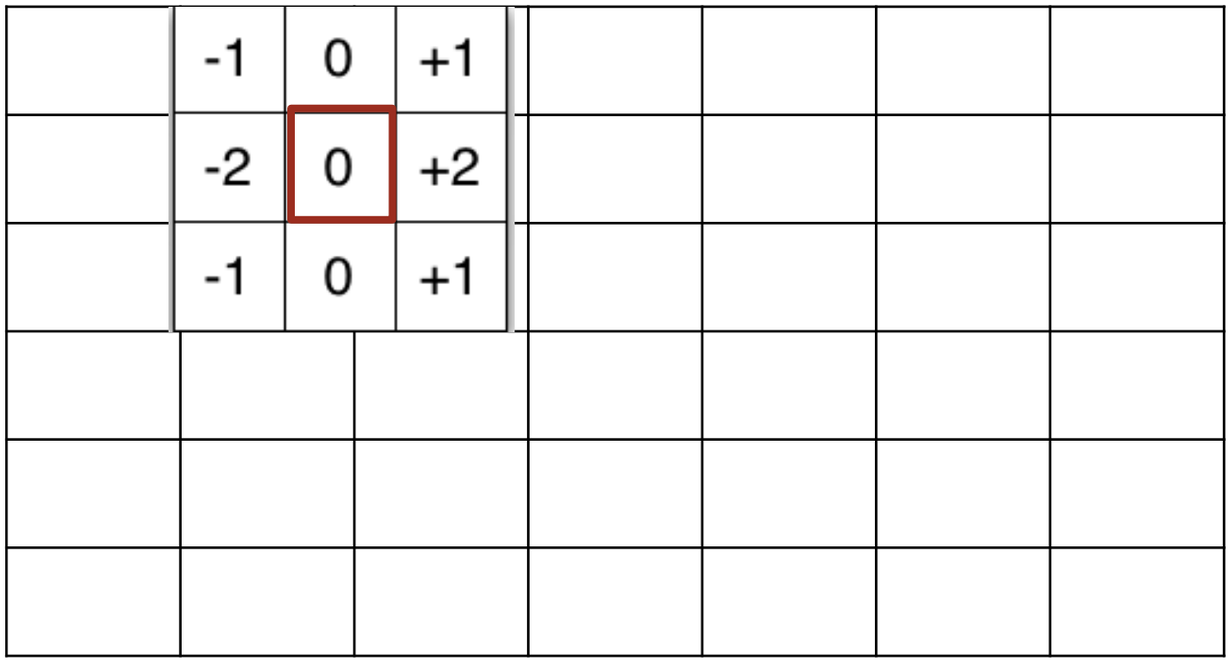




What is convolution



What is convolution



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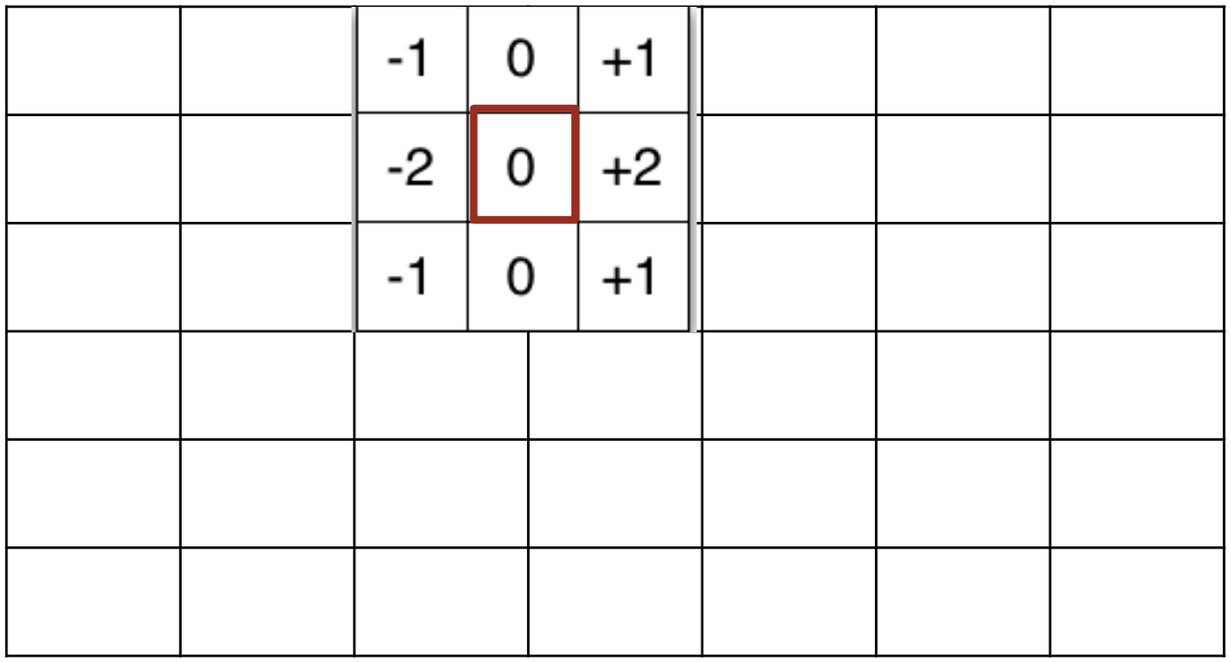
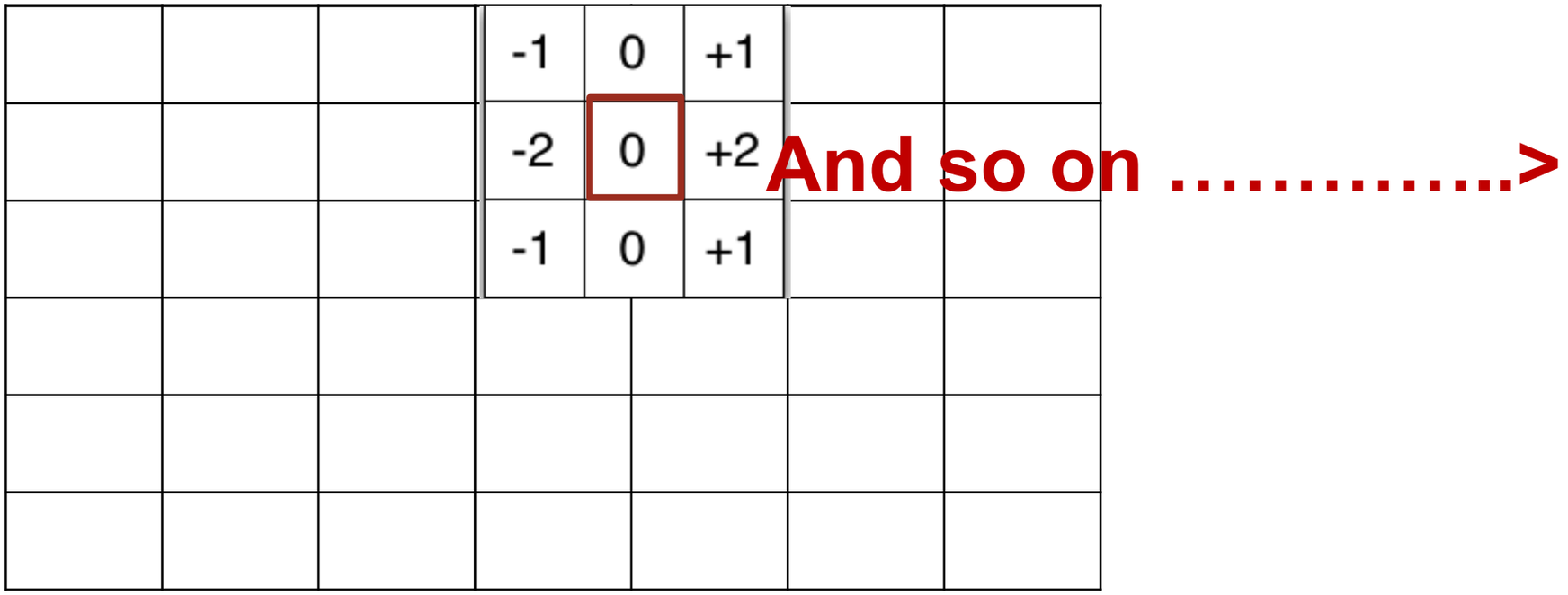
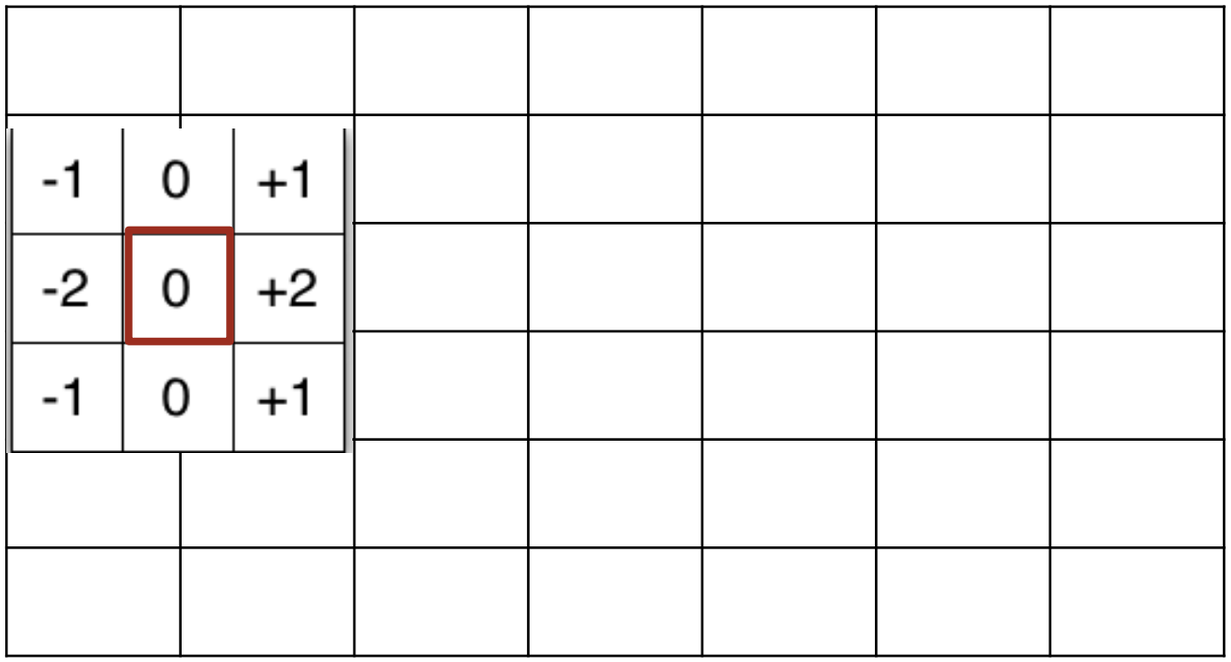


What is convolution



And so on ……..>

What is convolution



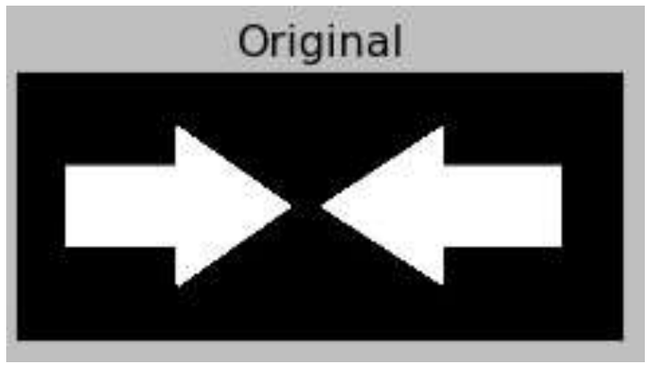
Edge features explained

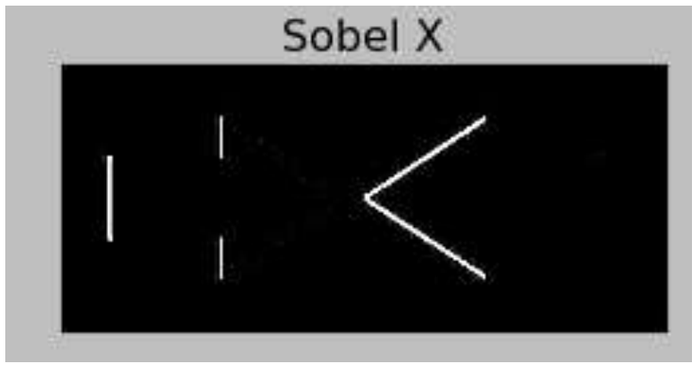
-1	0	+1
-2	0	+2
-1	0	+1

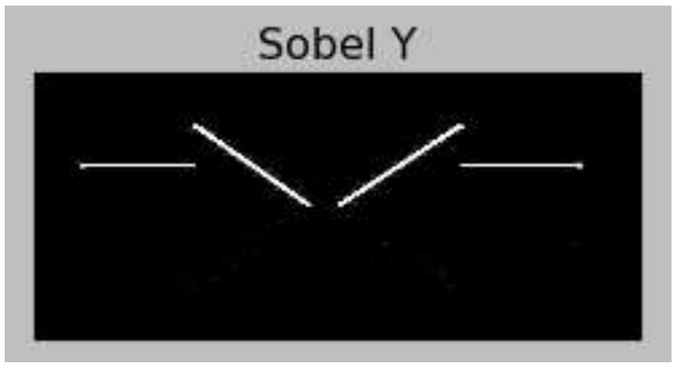
x filter

+1	+2	+1
0	0	0
-1	-2	-1

y filter







Other filters & features

Example of Histograms of Oriented gradients

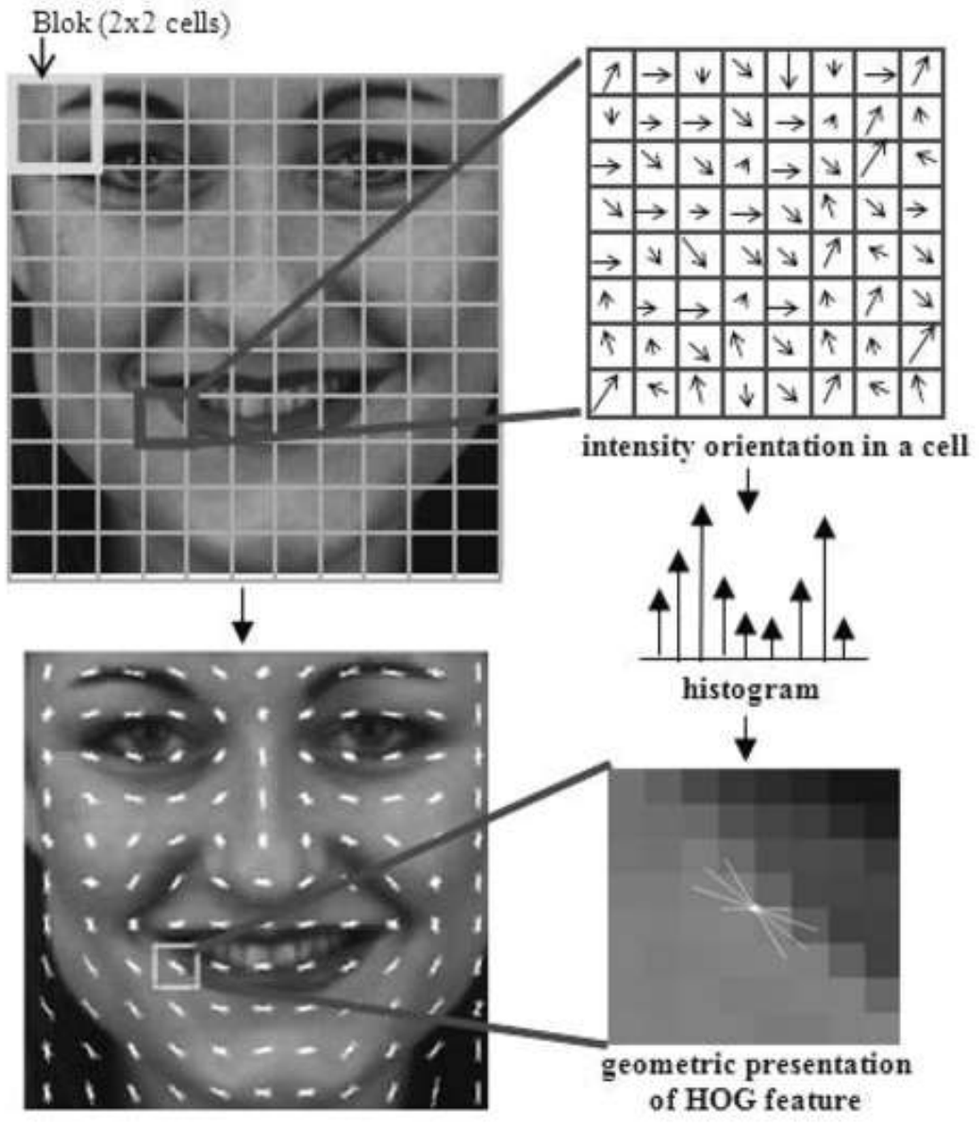
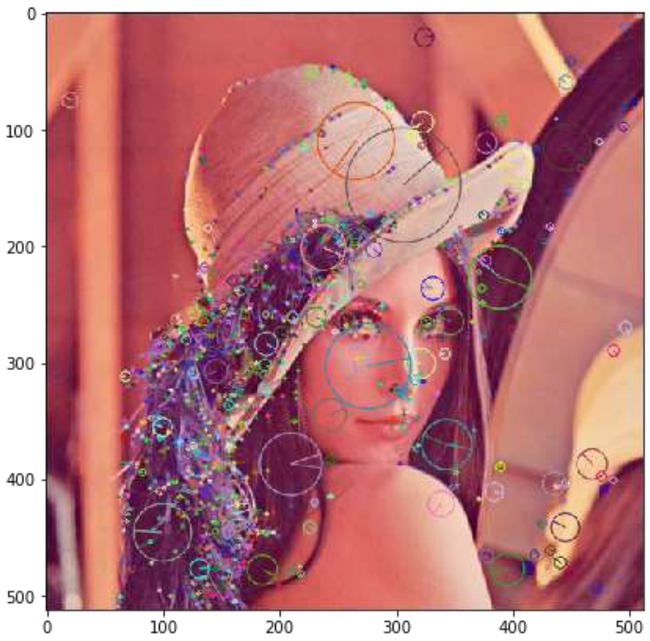


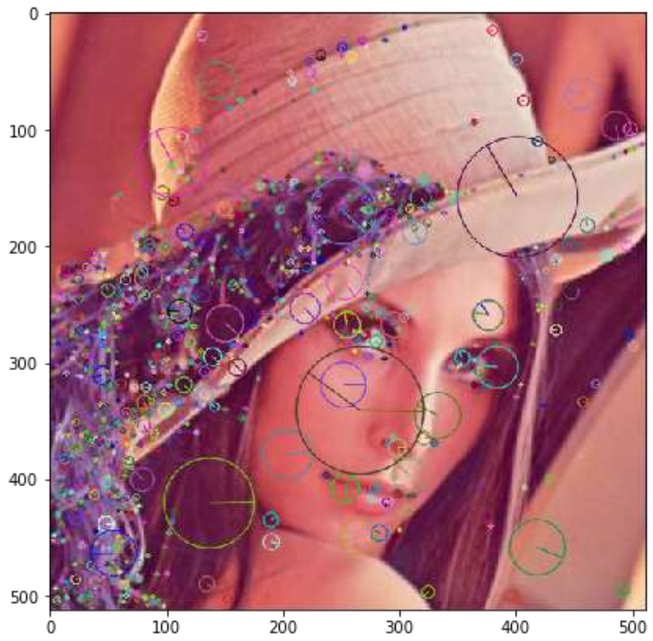
Fig. 3. Histogram of oriented gradient extraction from face.

Latifa Greche, Najia Es-Sbai. " Automatic system for facial expression recognition based histogram of oriented gradient and normalised cross correlation", 2016

Other filters & features

- SIFT : Scale-invariant feature transform





Temporal features

- Optical flow

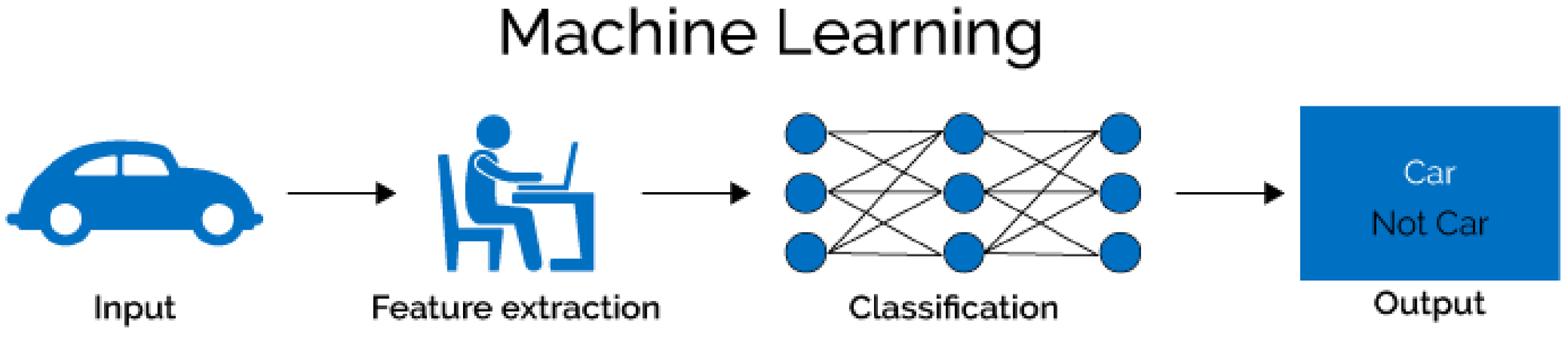
Optical flow

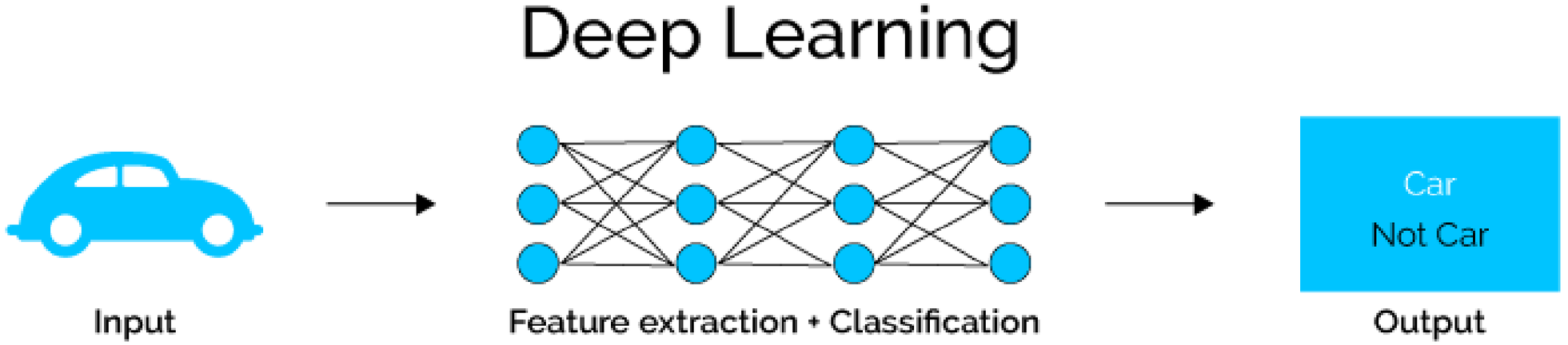
- Magnitude (*length of arrow*) and orientation (*direction*)

- Simple, efficient but time consuming

- Different implantation for faster computation time

Machine learning for computer vision

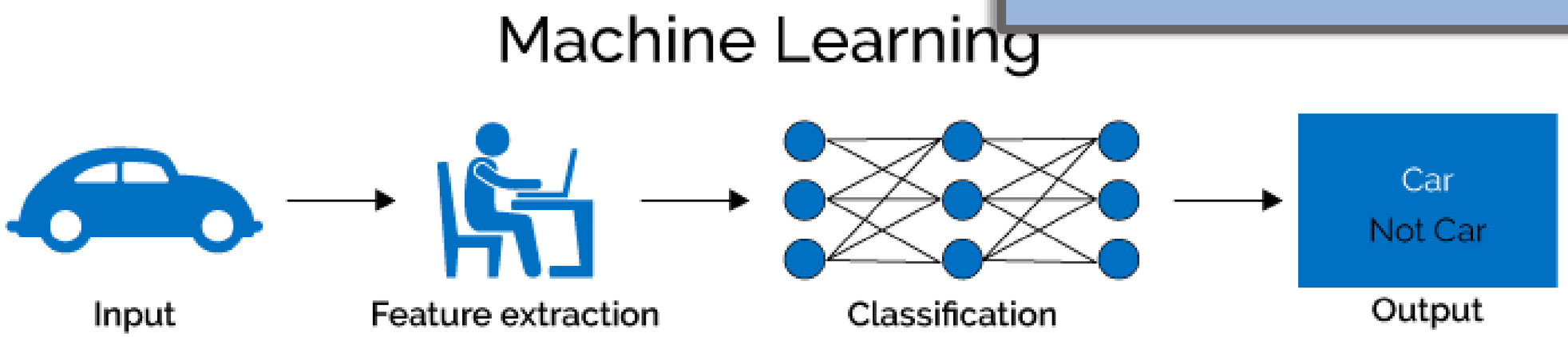


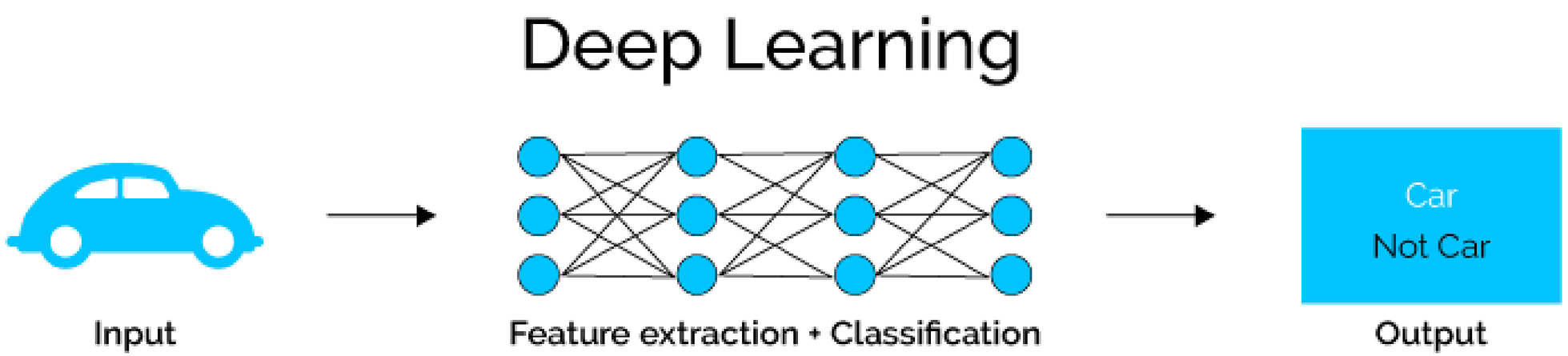


Machine learning for Computer vision

What is the output of machine learning ?

A Model!





Machine learning

1- Rule based

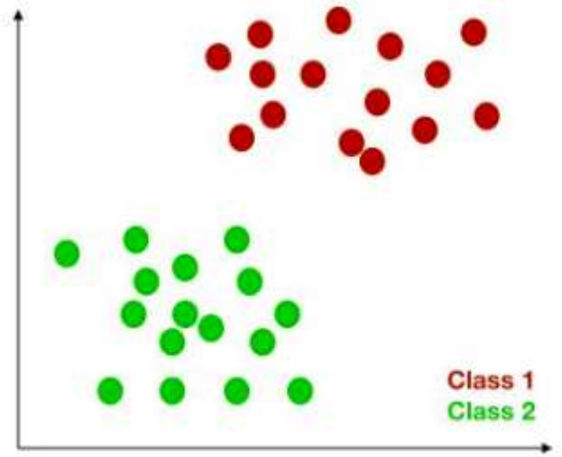
2- Traditional machine learning

3- Artificial neural networks/ Deep learning

Types of machine learning algorithms

1- Supervised learning (labelled data):

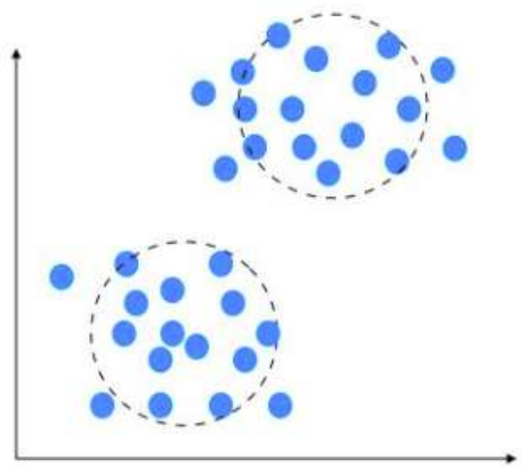
ex. Classification , regression, … etc



2- Unsupervised learning:

ex. Clustering, k-means, .. etc

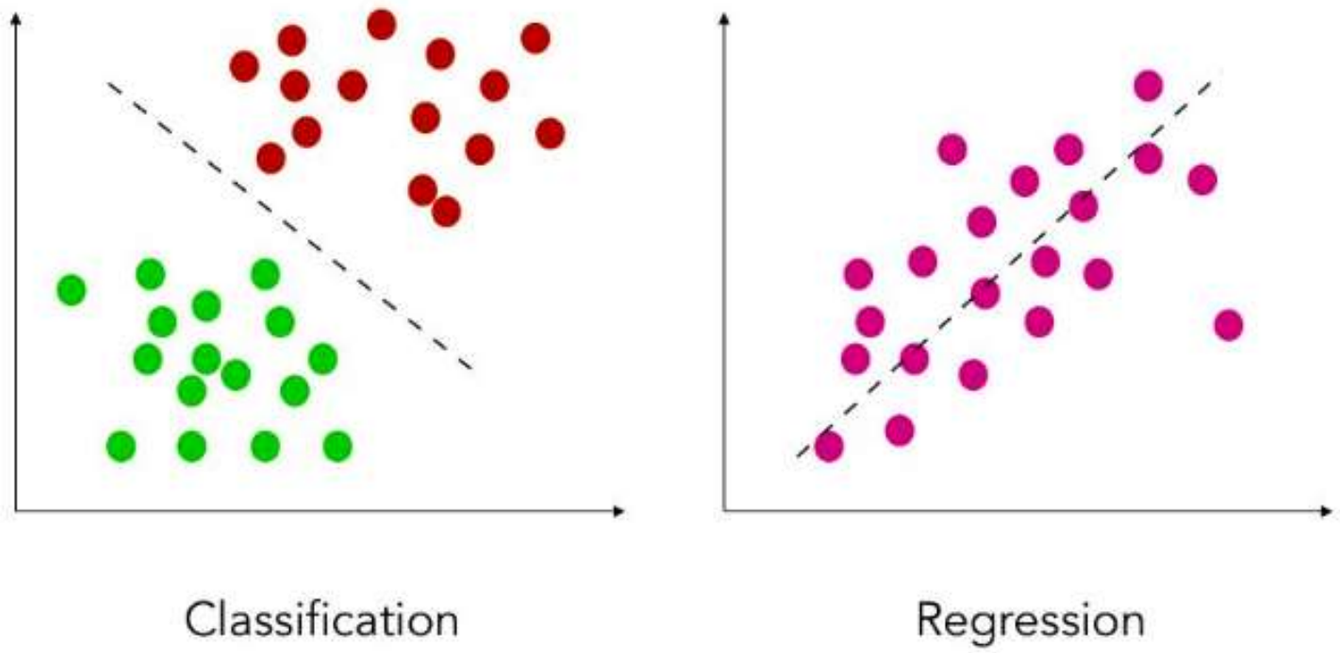
[dimensionality reduction (PCA)]



3- Reinforcement learning:

ex. MarKov decision process

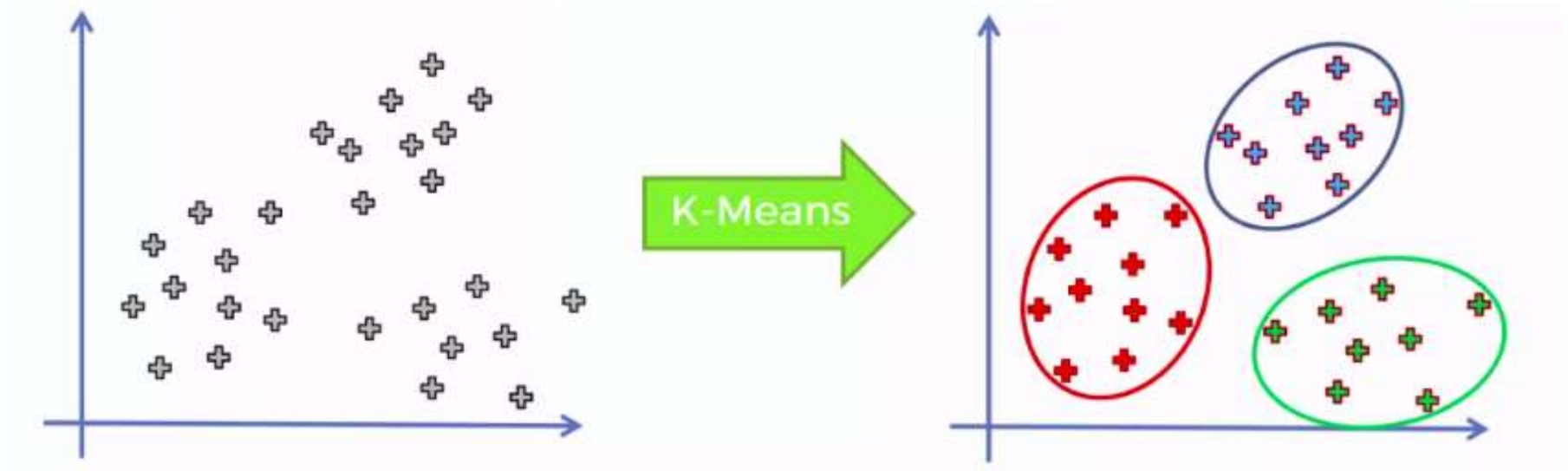
Regression vs. Classification



Classification

Regression

Unsupervised learning



Ex: K- means and KNN (nearest neighbour)

The goal of K Means algorithm is to minimize the Within Cluster Variation and maximize the Between Cluster Variation. K in K means clustering corresponds to the number of clusters needed.

Unsupervised learning

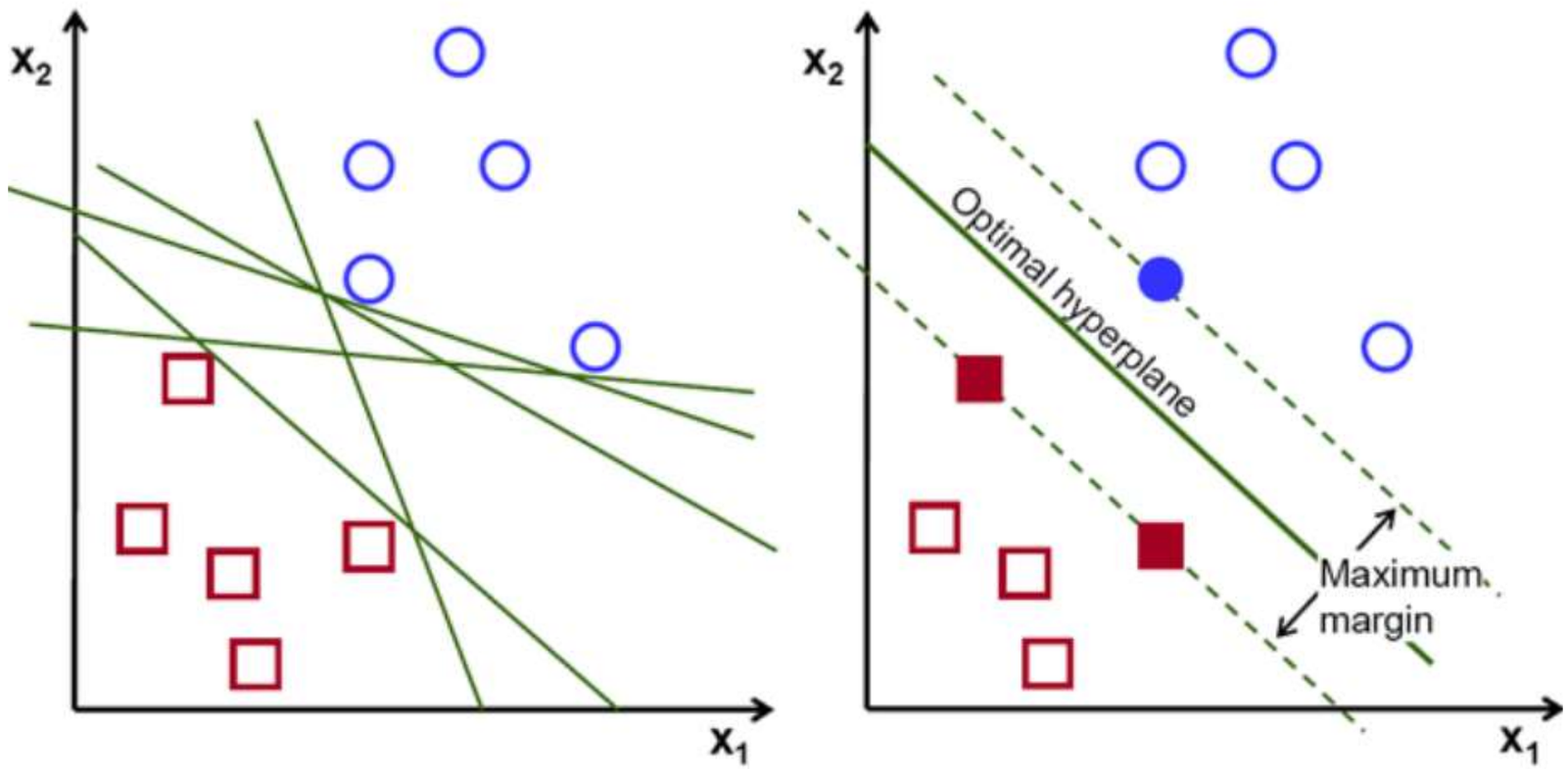
Ex: Dimensionality reduction for features : popular method PCA – Principal Component Analysis

- Compress the information in the data keeping its variance

statistical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components.

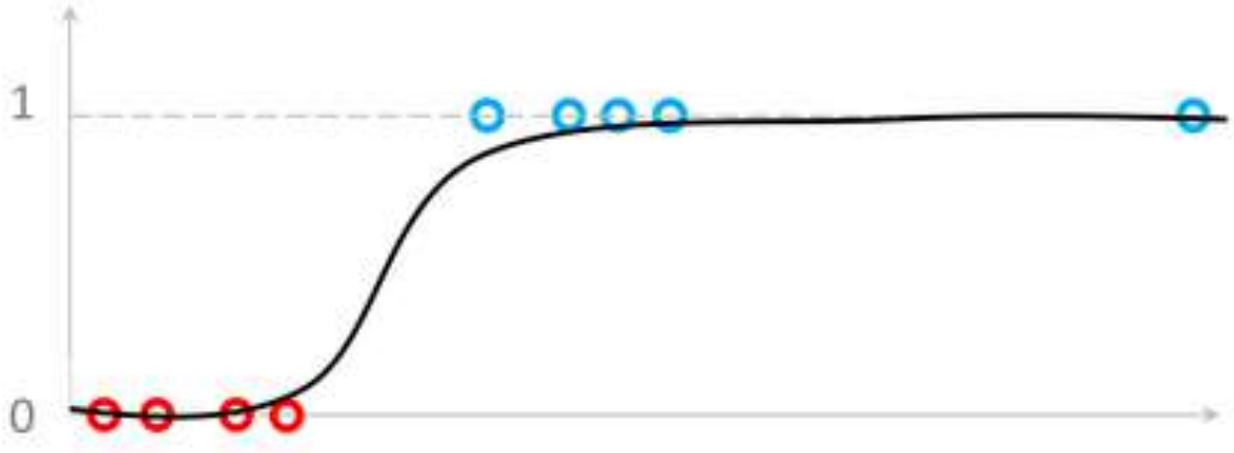
Support Vector Machines

- Popular, simple and easy.
- Powerful when we don’t have enough data



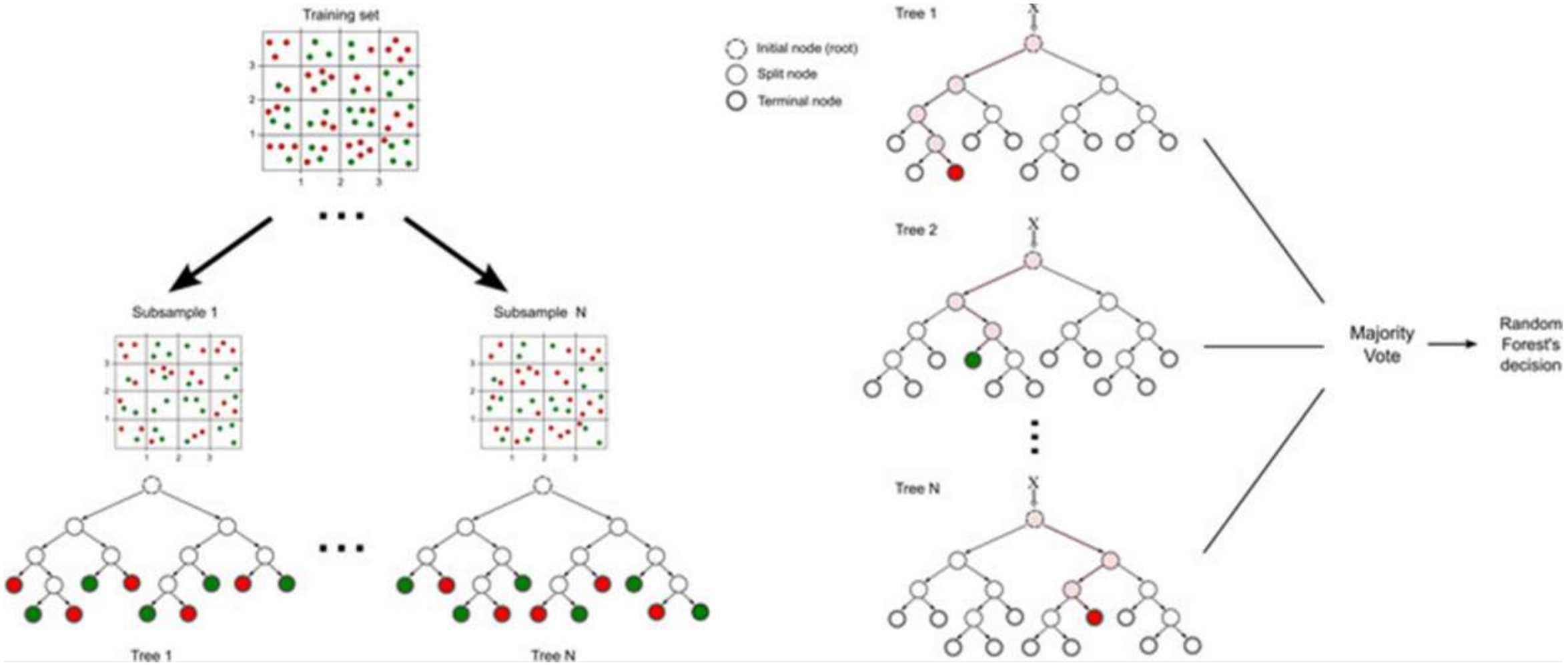
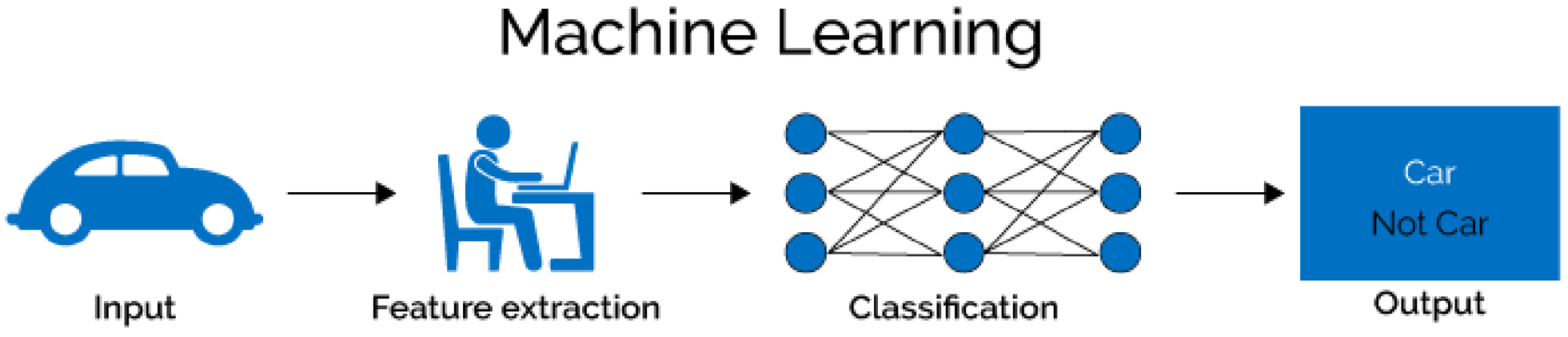
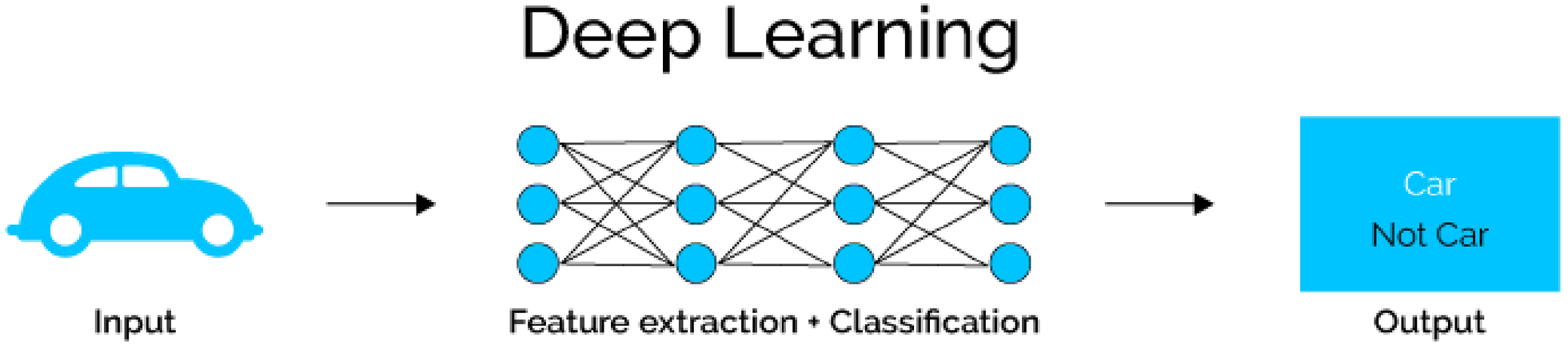
Logistic Regression

Logistic regression is a statistical analysis method to predict a binary outcome.



Decision trees & random forests

Each leaf node corresponds to a class label and attributes are represented on the internal node of the tree.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