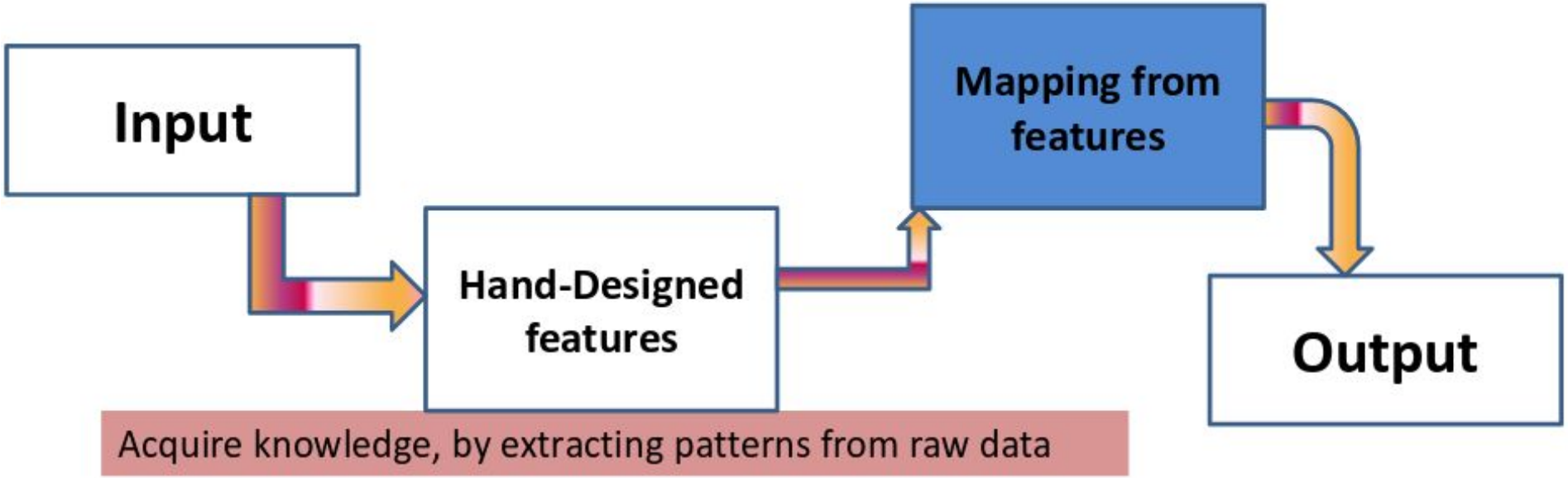
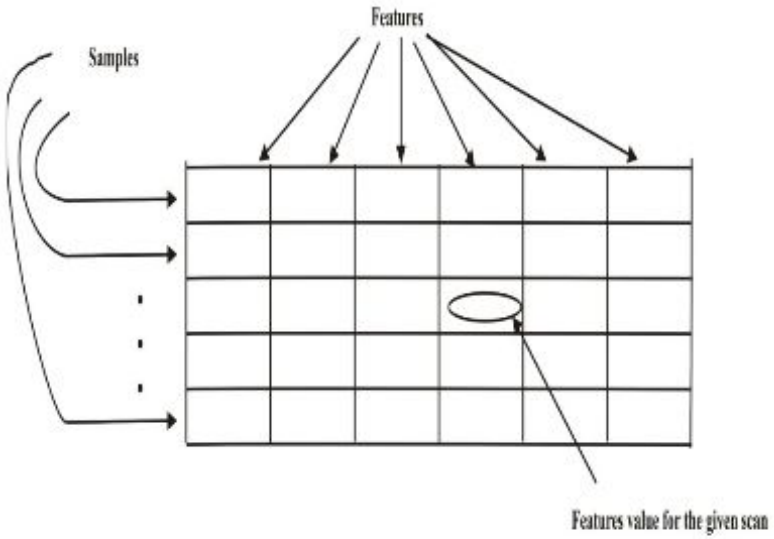
MACHINE LEARNING

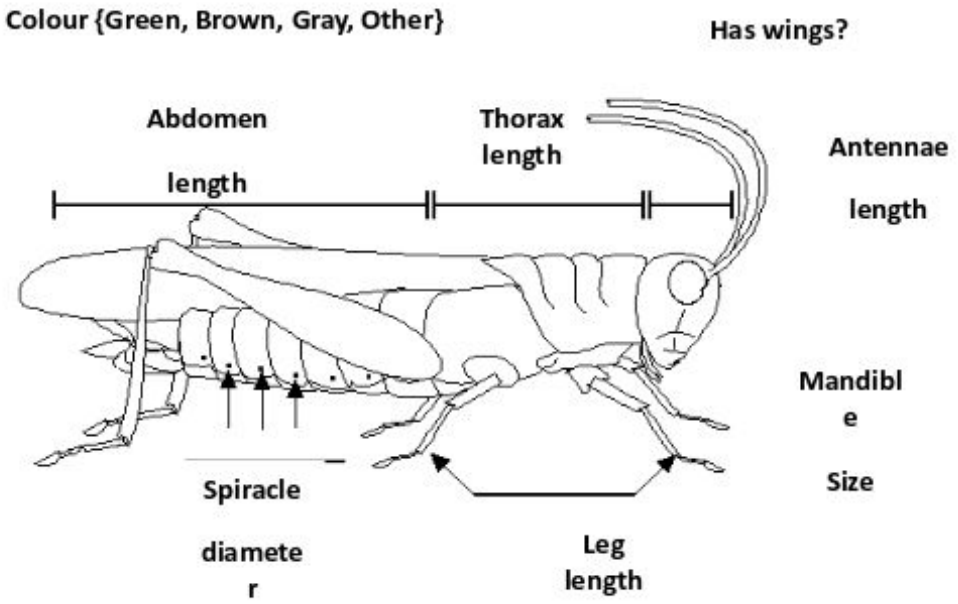
What is Machine Learning?

- A study of algorithms that gives the computers the ability to learn without being explicitly programmed.
- Reduces human/machine efforts required to perform a task (time optimization).
- Increases the performance of a task (efficiency optimization).

Classical machine learning



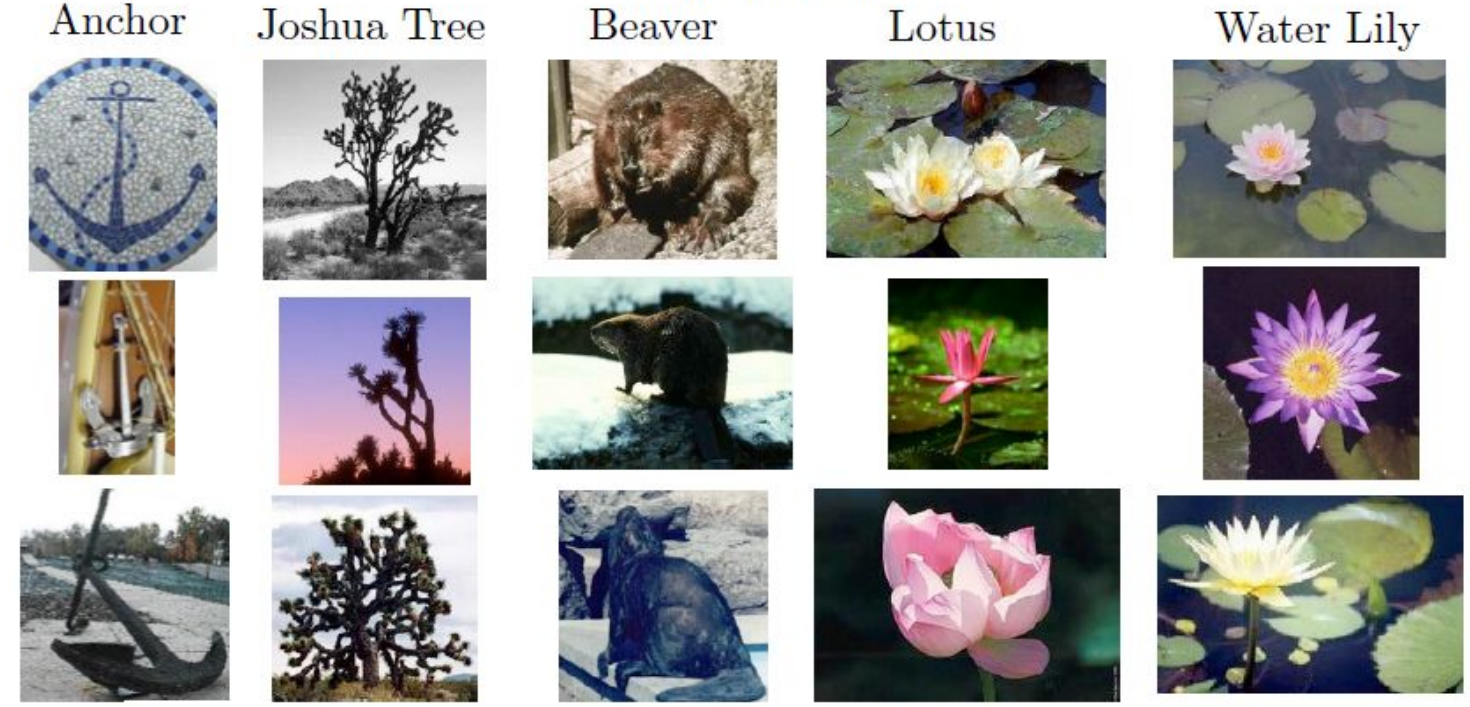




Challenges in ML

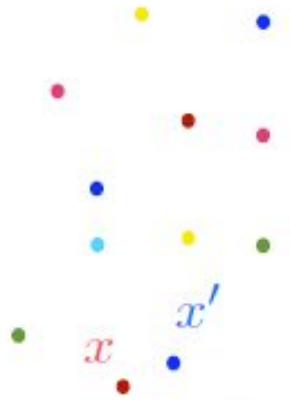
High Dimensional Classification

CalTech 101



- Considerable variability in each class.
- Euclidean distances are meaningless.
- Need to find Informative Invariants.

High dimension

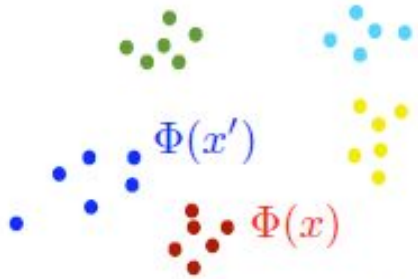


$\|x - x'\|$
uniformative

Representation
An Art

Φ

- MFCC (audio)
- SIFT (images)
- Gauss. Mixt. Mod.
- Clustering
- Histograms
- Bag of words (parts)
- **Deep Neural Networks**



$\|\Phi(x) - \Phi(x')\|$
similarity measure

Statistical Decision Theory

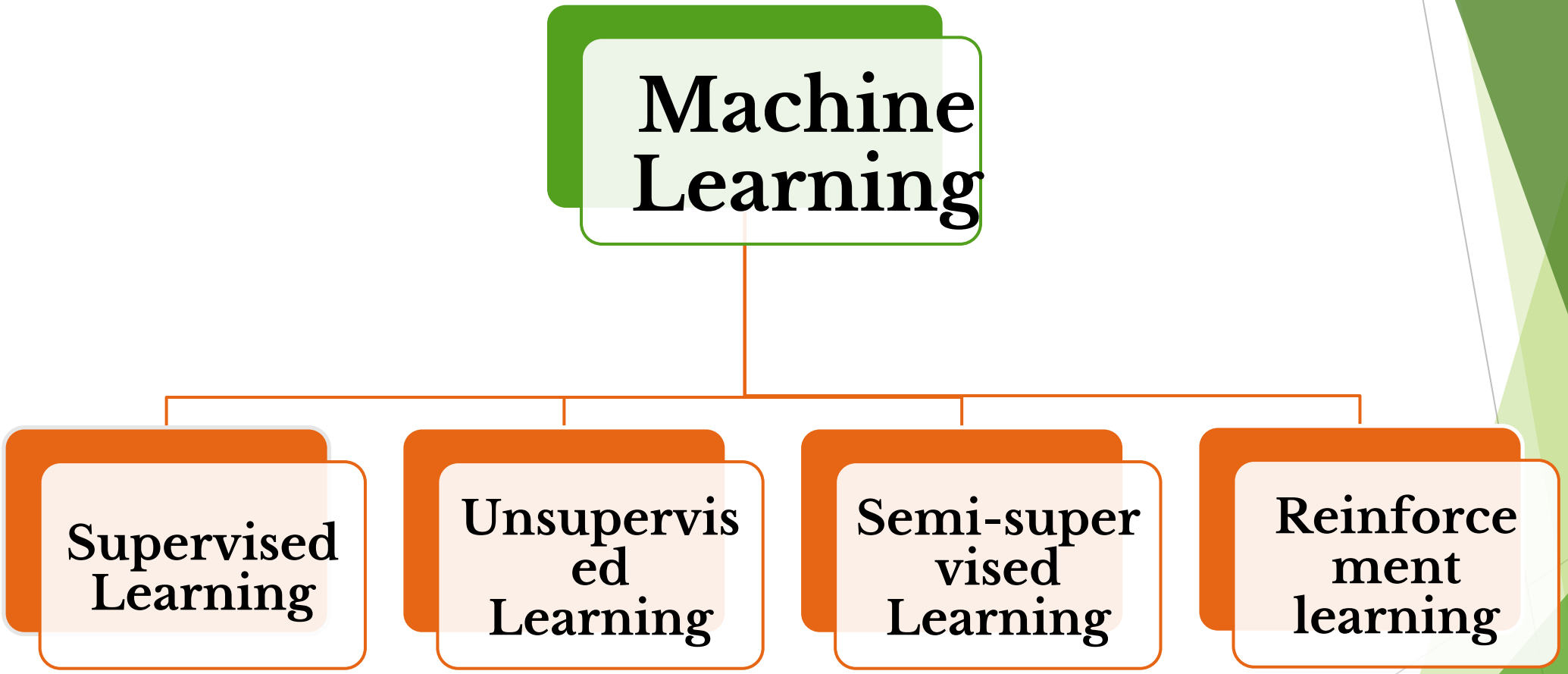
Classifier

y

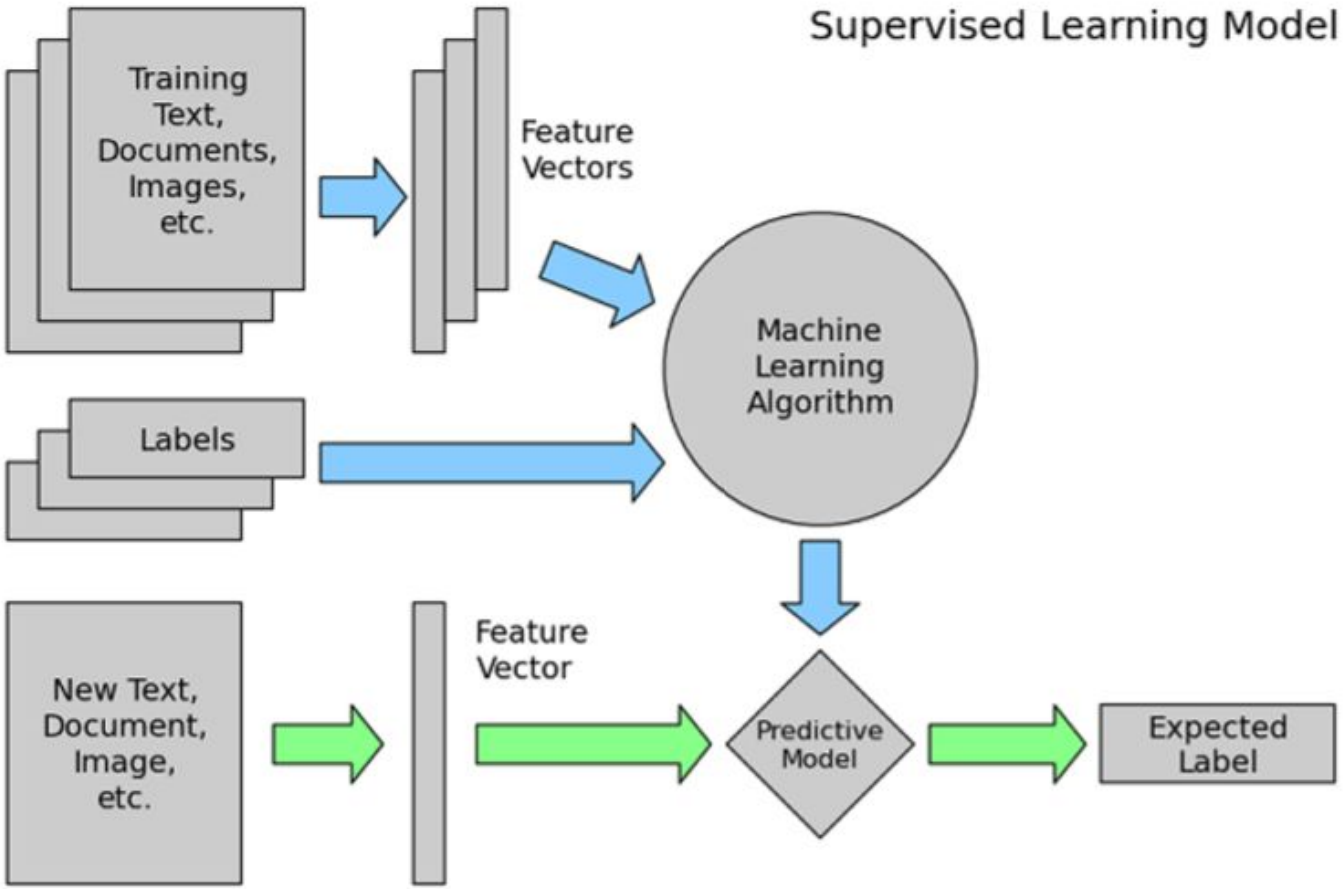
Steps in Machine Learning

- Collecting data
- Preparing the data
- Training a model
- Evaluating the model
- Improving the performance

Types of ML …

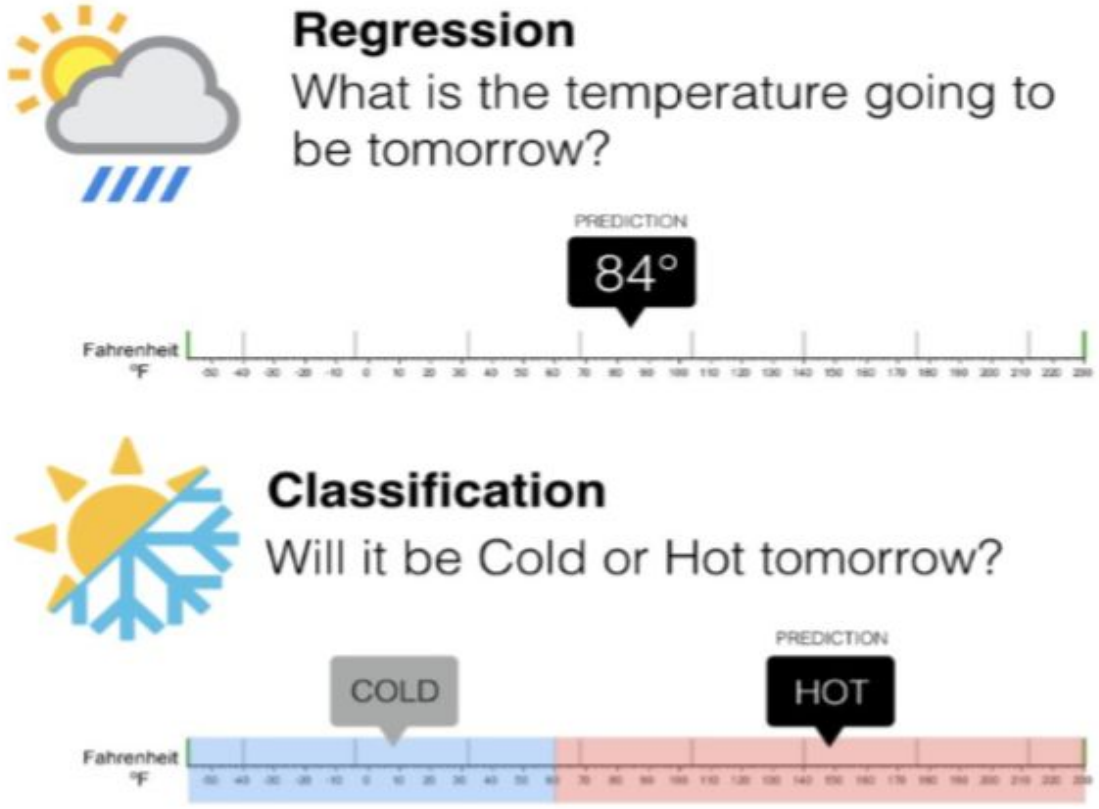

Machine Learning
Supervised Learning
Unsupervised Learning
Semi-supervised Learning
Reinforcement learning

Supervised Learning



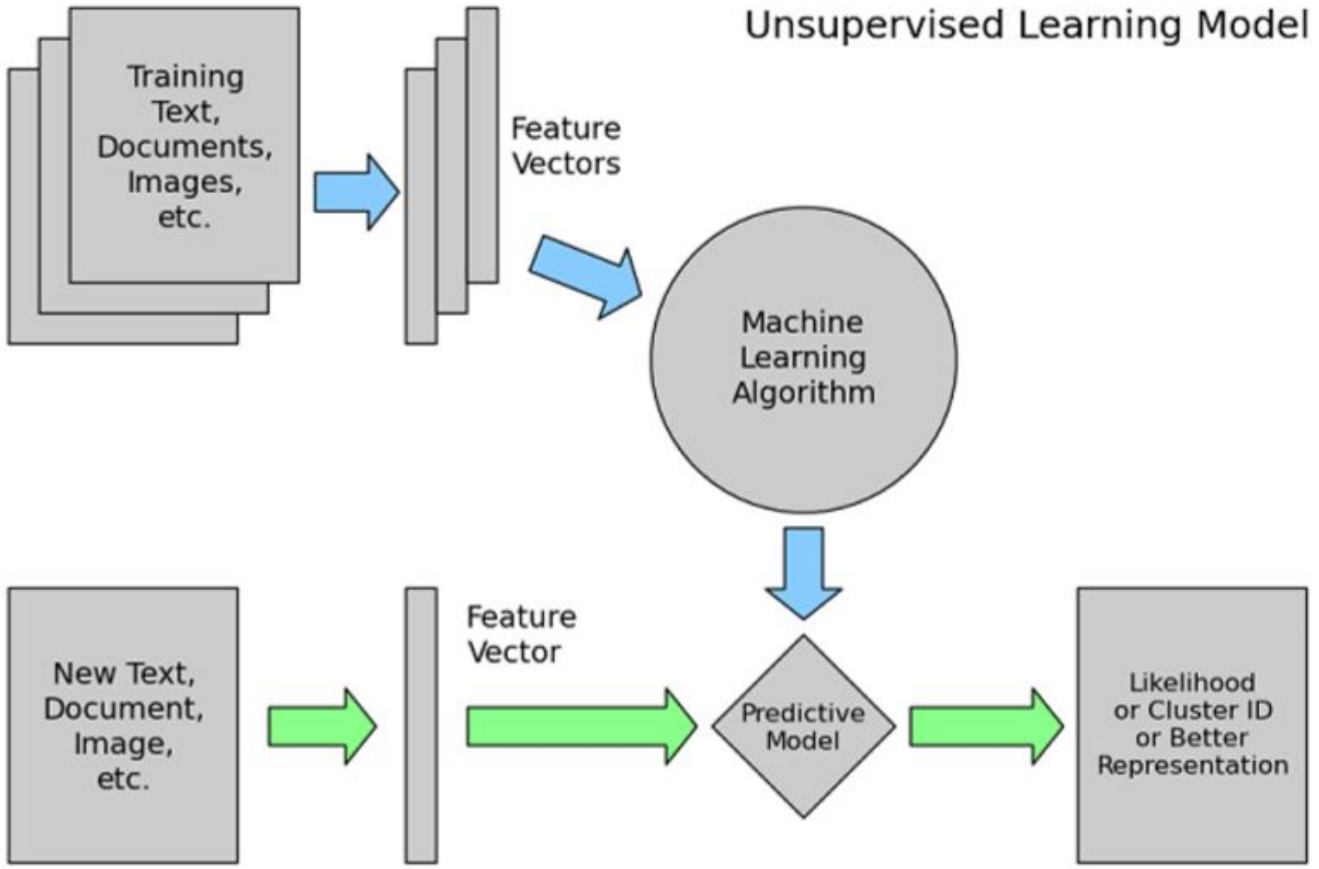
source: www.allprogrammingtutorials.com/tutorials/introduction-to-machine-learning.php

Regression and Classification



source: https://medium.com/@ali_88273/regression-vs-classification-87c224350d69

Unsupervised Learning



source: www.allprogrammingtutorials.com/tutorials/introduction-to-machine-learning.php

Clustering

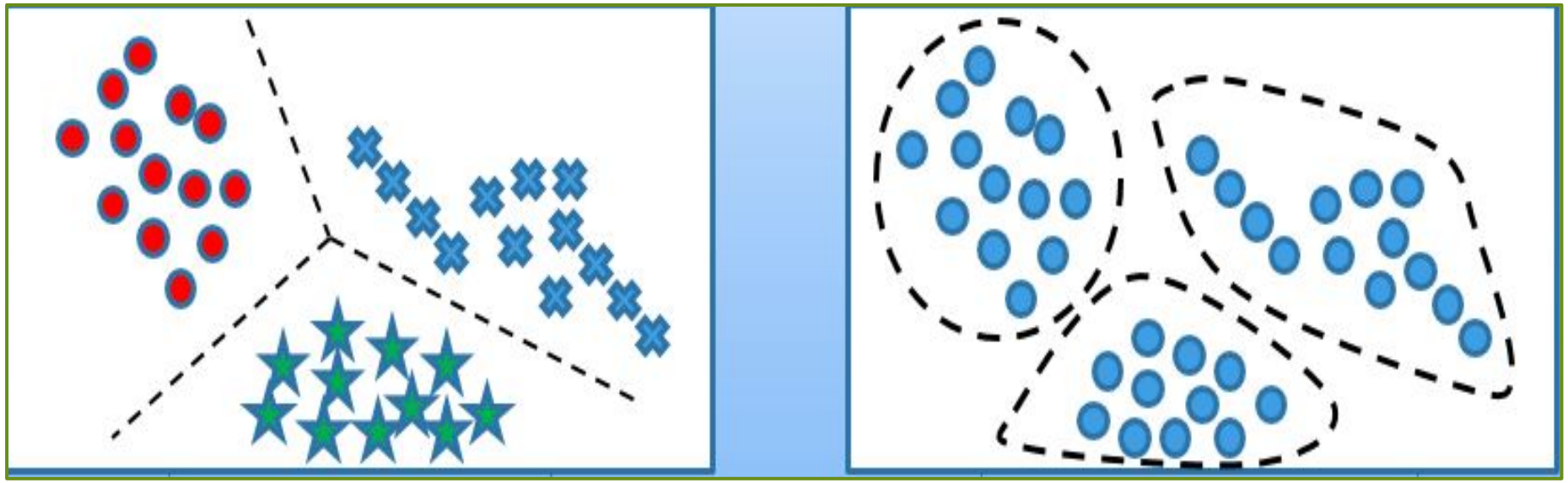
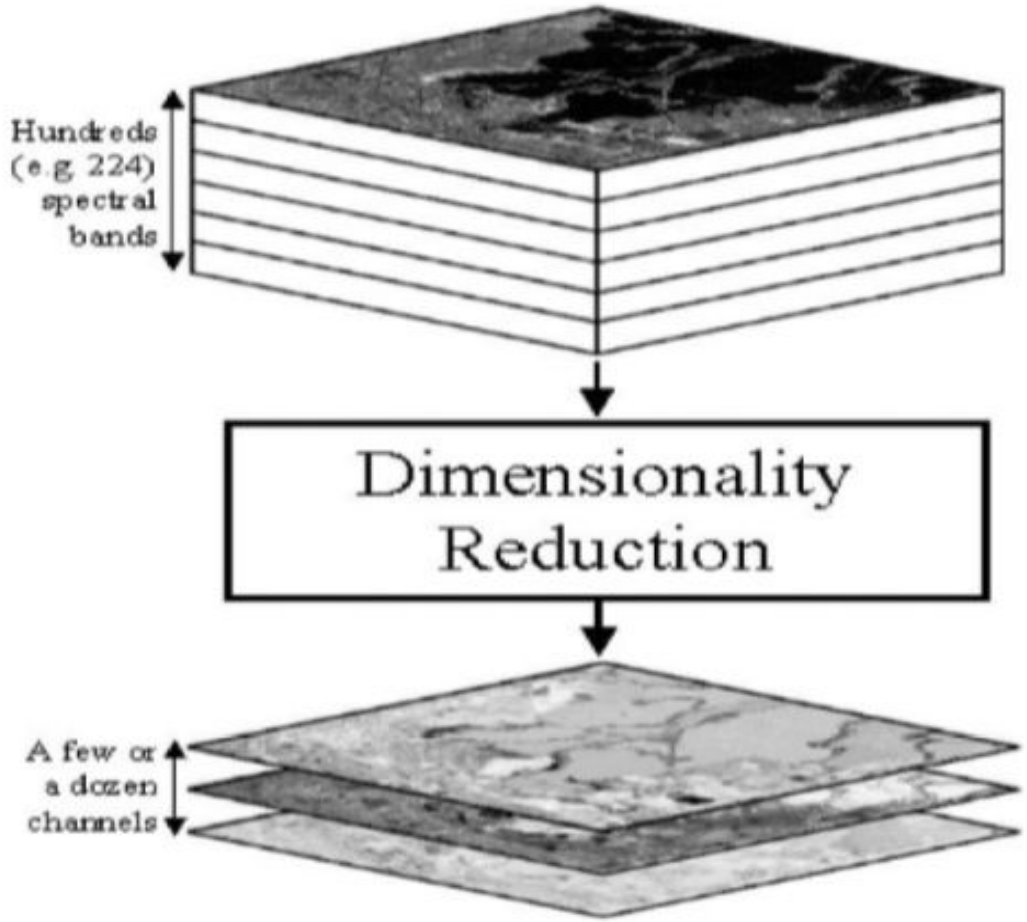


Fig.(a) Supervised learning

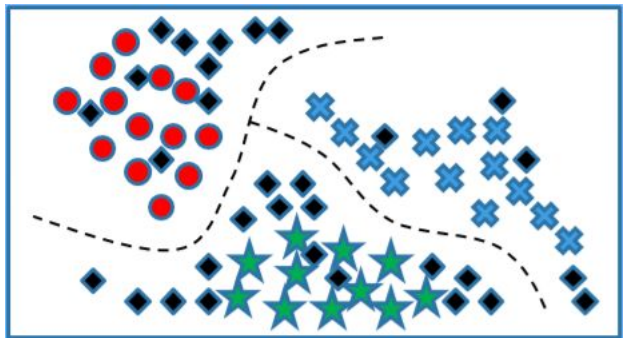
Fig.(b) Clustering

Dimensionality Reduction



source: http://spie.org/newsroom/3560-dimensionality-reduction-of-multidimensional-satellite-imagery?SSO=1

Semi-supervised Learning & Reinforcement Learning



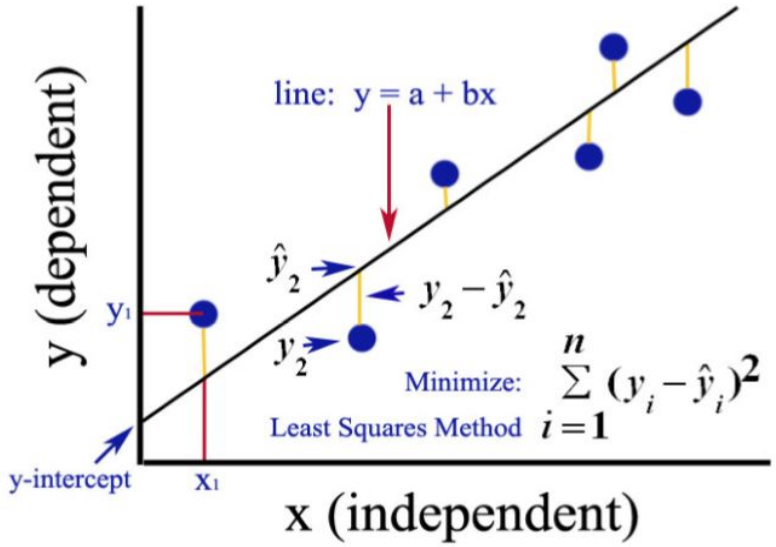
Semi-supervised Learning

- **Reinforcement learning** deals with Decision making (robot, chess machine)

Supervised Learning Techniques

LINEAR REGRESSION

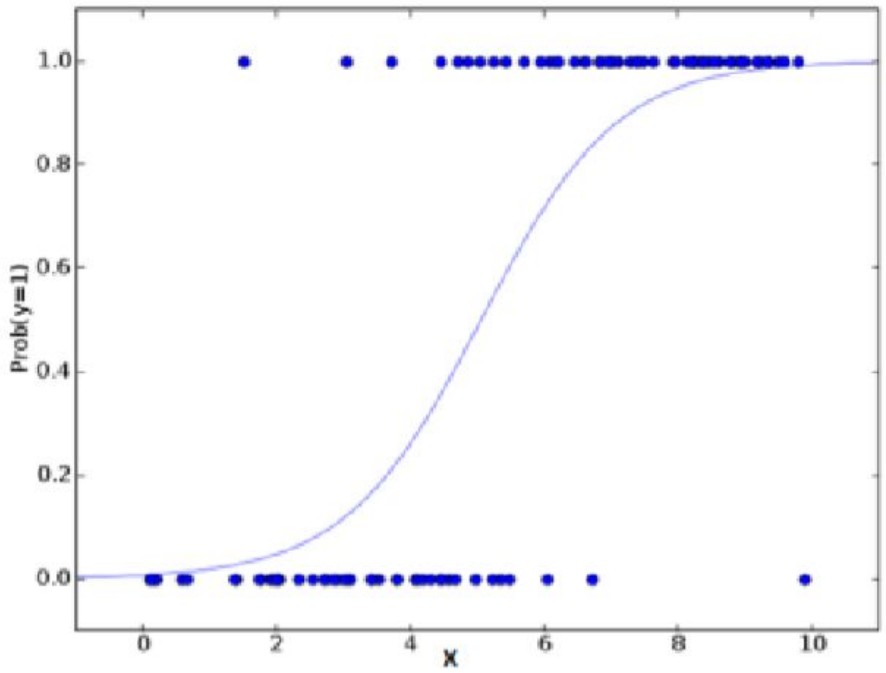
- The core idea is to obtain a line/plane that best fits the data (continuous data).
- Linear regression models a linear relationship between input and output.
- The best fit line/plane is the one for which total prediction errors of all data points are as small as possible.
- Error is the distance between the point to the regression line.



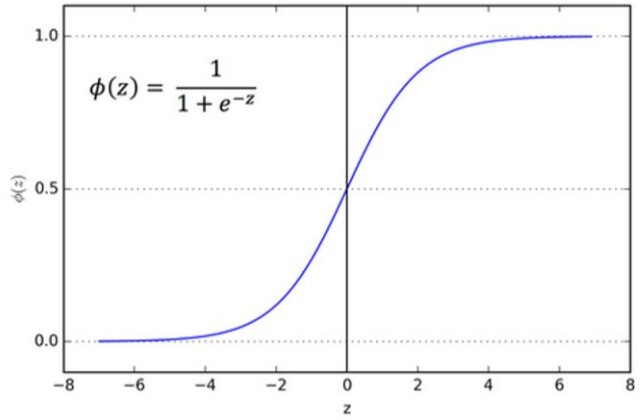
source: solutions4statistics.com

LOGISTIC REGRESSION

- It's a classification algorithm, that is used where the response variable is *categorical* (discrete).
- The idea of Logistic Regression is to find a relationship between features and probability of particular outcome.



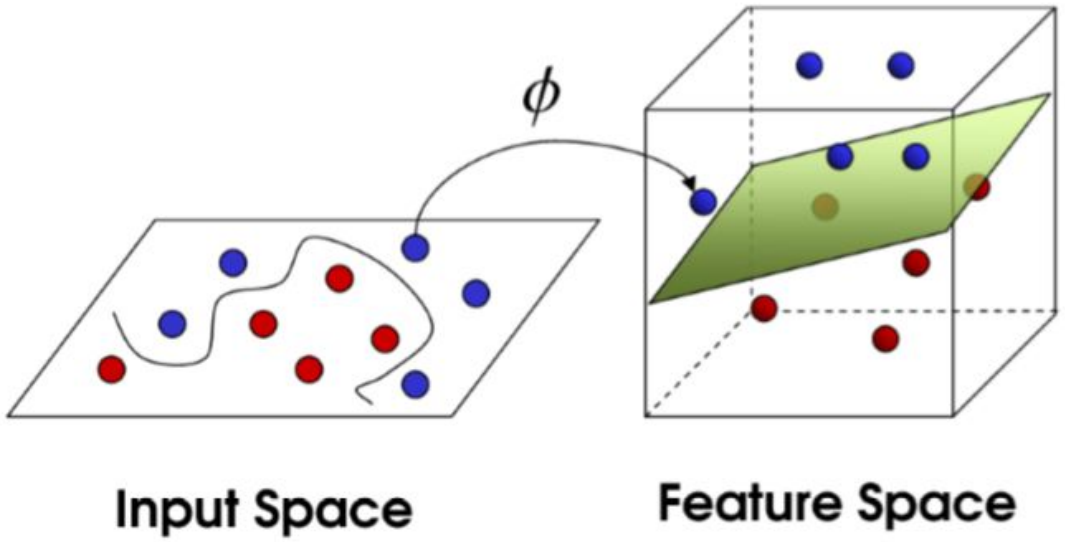
source: solutions4statistics.com



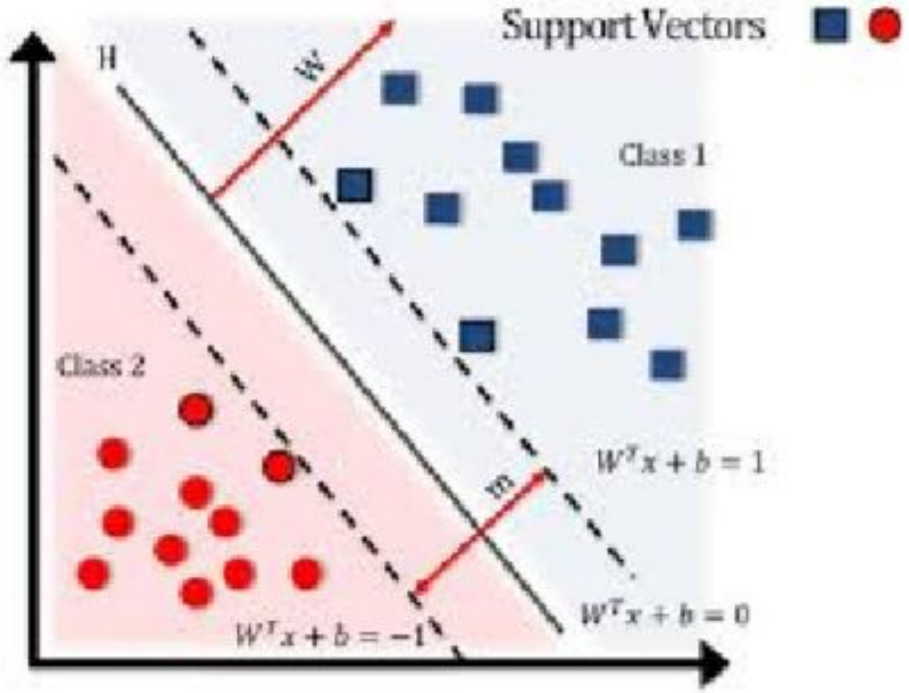
https://sebastianraschka.com/images/faq/logisticregr-neuralnet/sigmoid.png

SUPPORT VECTOR MACHINES (SVM)

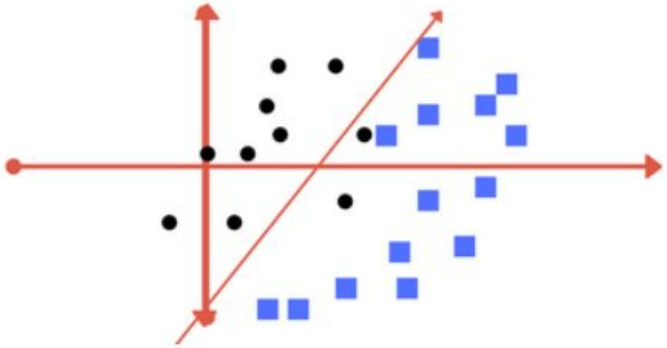
- Discriminative classifier formally defined by a separating hyperplane

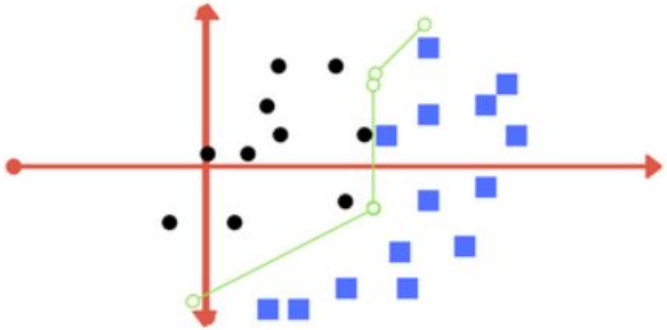


source: https://www.linkedin.com/pulse/support-vector-machine-srinivas-kulkarni/



How SVM works?

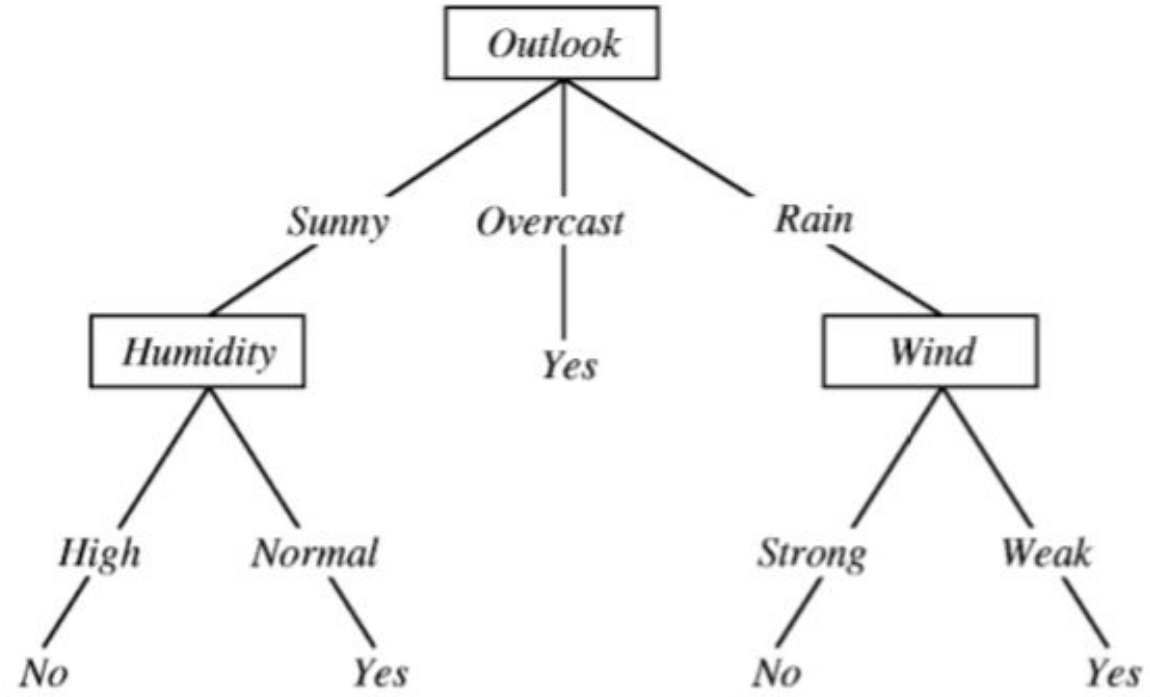




Left: low regularization value, right: high regularization value

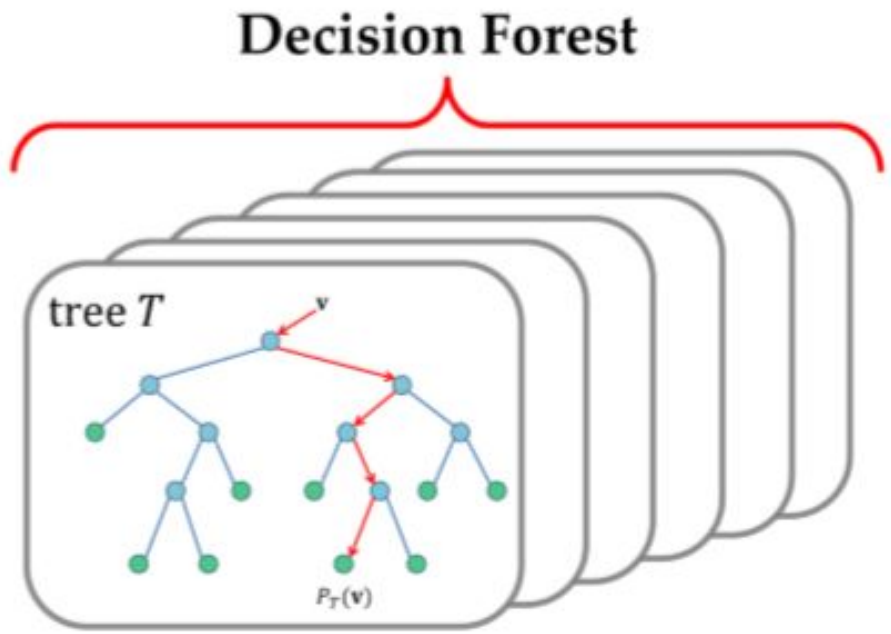
DECISION TREES

- A decision tree is a binary tree.
- Each node partitions data according to a splitting rule.
- Leaf node returns a label for the classification.



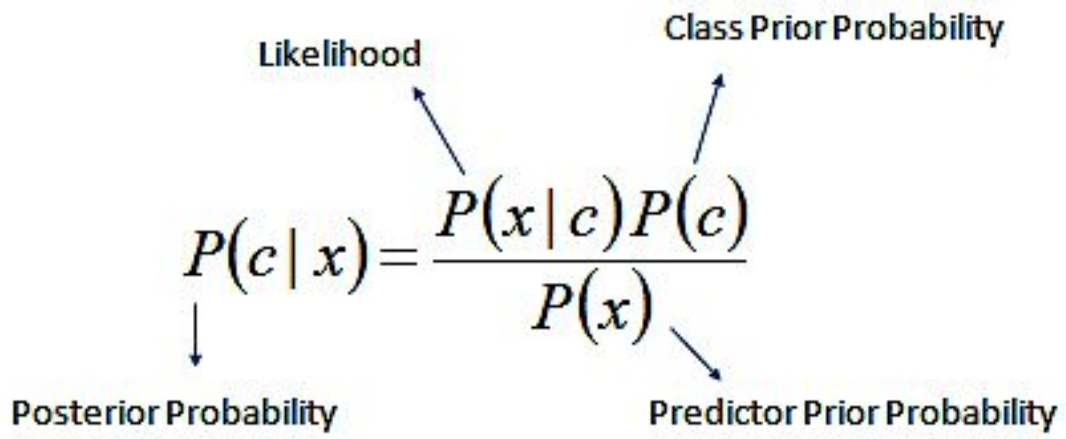
RANDOM FOREST TREES

- Random forest builds multiple decision trees and merges them together to get a more accurate and stable prediction.



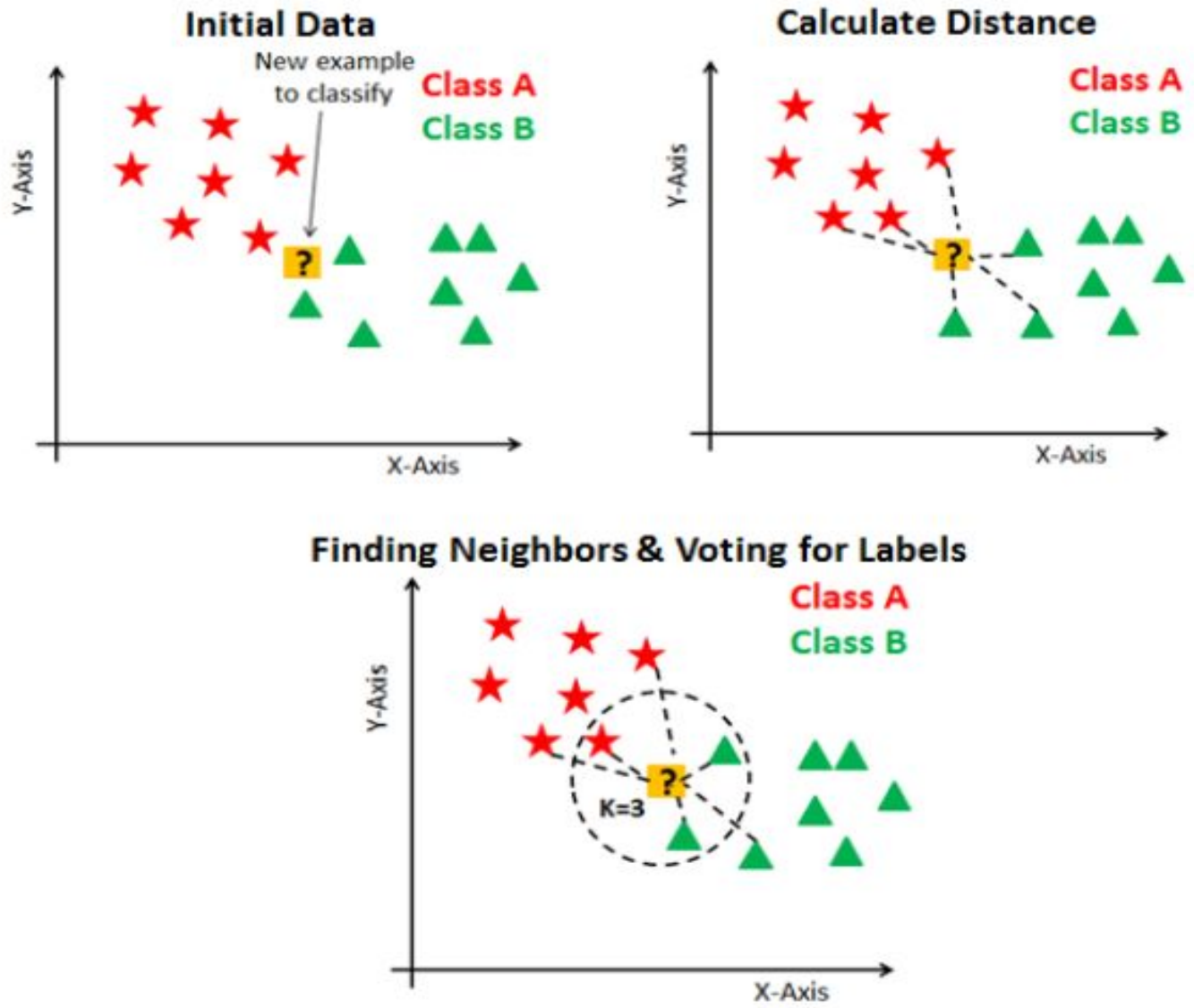
NAÏVE BAYES

- Simple "probabilistic classifiers" based on applying Bayes' theorem with strong (naive) independent assumptions between the features.



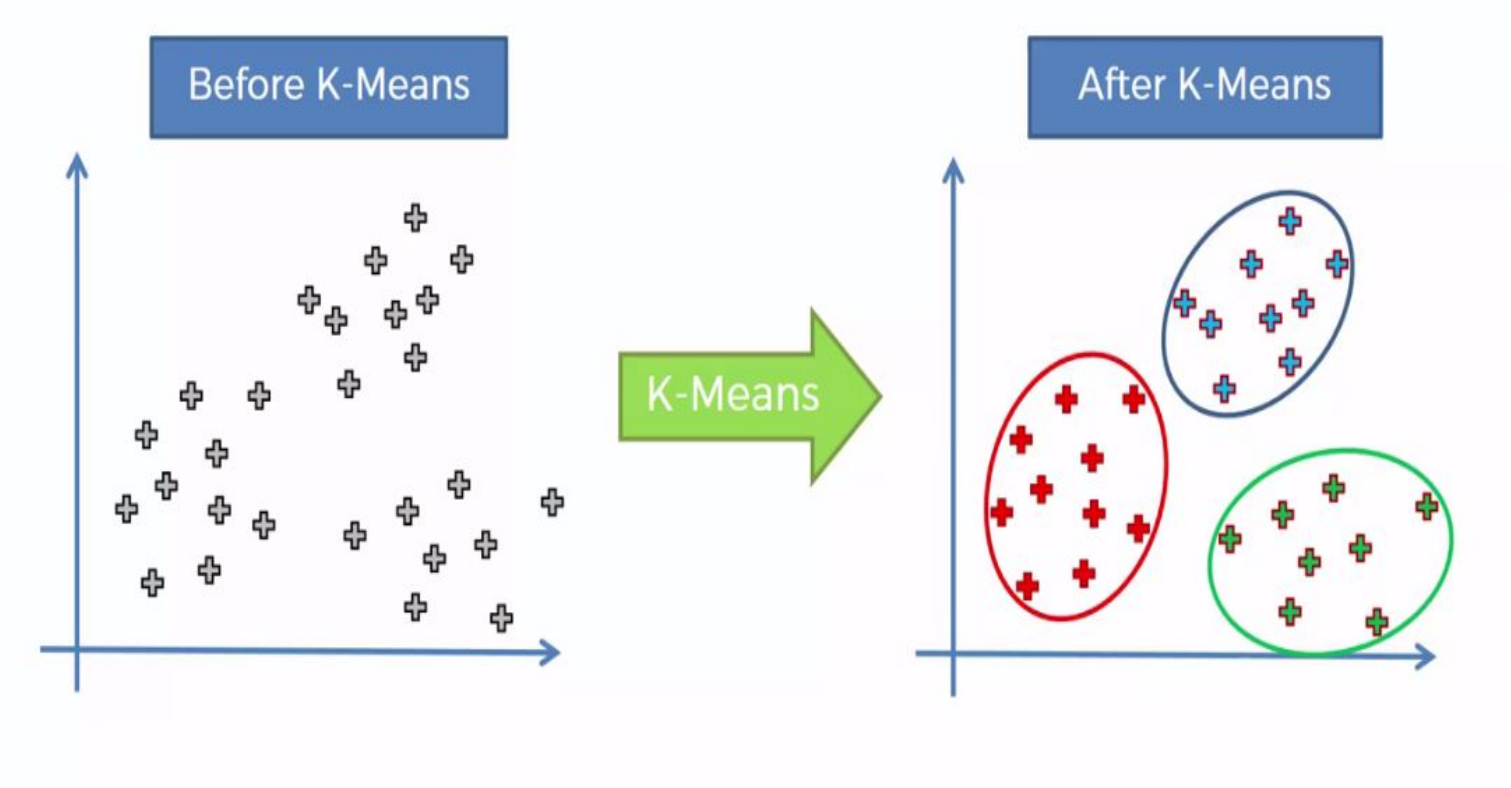
$$P(c \mid \mathrm{X}) = P(x_1 \mid c) \times P(x_2 \mid c) \times \cdots \times P(x_n \mid c) \times P(c)$$

K Nearest Neighbors (KNN)



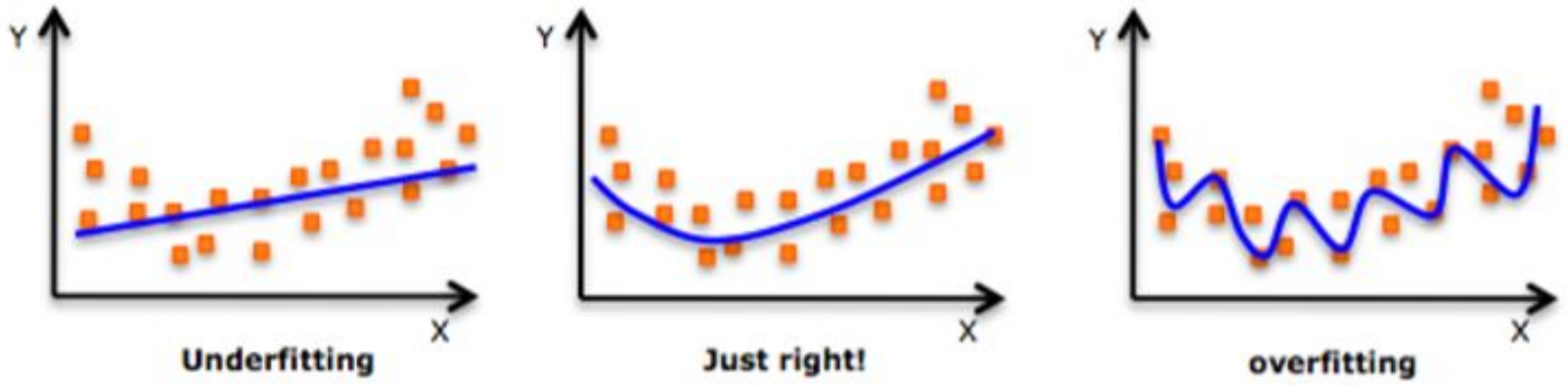
Unsupervised Learning Techniques

K-Means Clustering



Model Evaluation Techniques

- Fitting of Data



❑ Performance Metrics

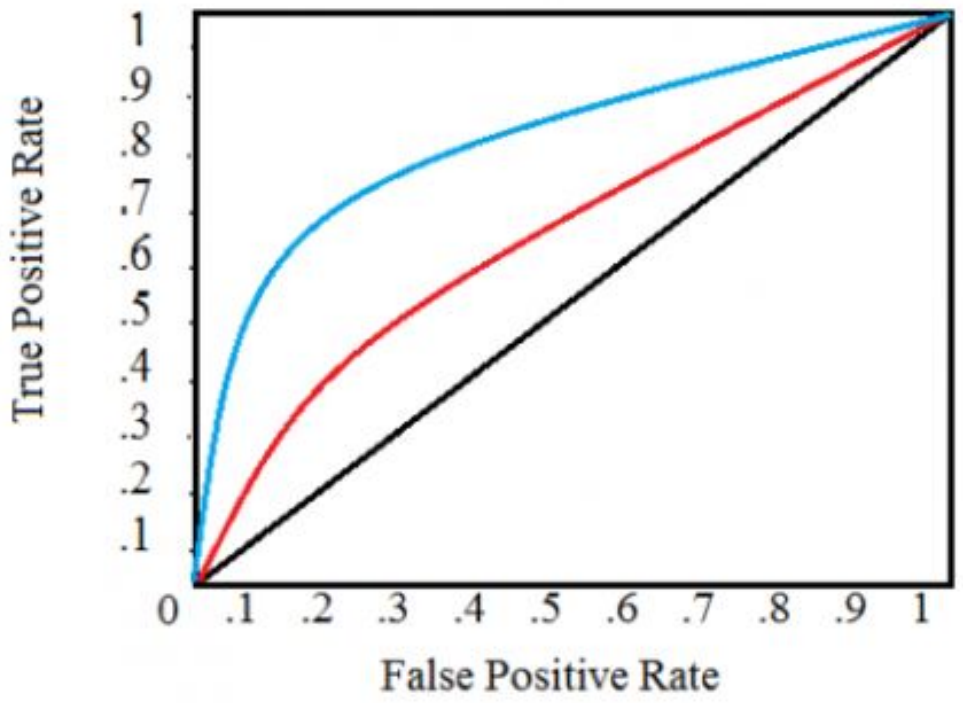
		Actual	
		Positive	Negative
Predicted	Positive	True Positive	False Positive
	Negative	False Negative	True Negative

$$\textbf{Precision} = \frac{\text{True Positive}}{\text{Actual Results}} \quad \text{or} \quad \frac{\text{True Positive}}{\text{True Positive + False Positive}}$$

$$\textbf{Recall} = \frac{\text{True Positive}}{\text{Predicted Results}} \quad \text{or} \quad \frac{\text{True Positive}}{\text{True Positive + False Negative}}$$

$$\textbf{Accuracy} = \frac{\text{True Positive + True Negative}}{\text{Total}}$$

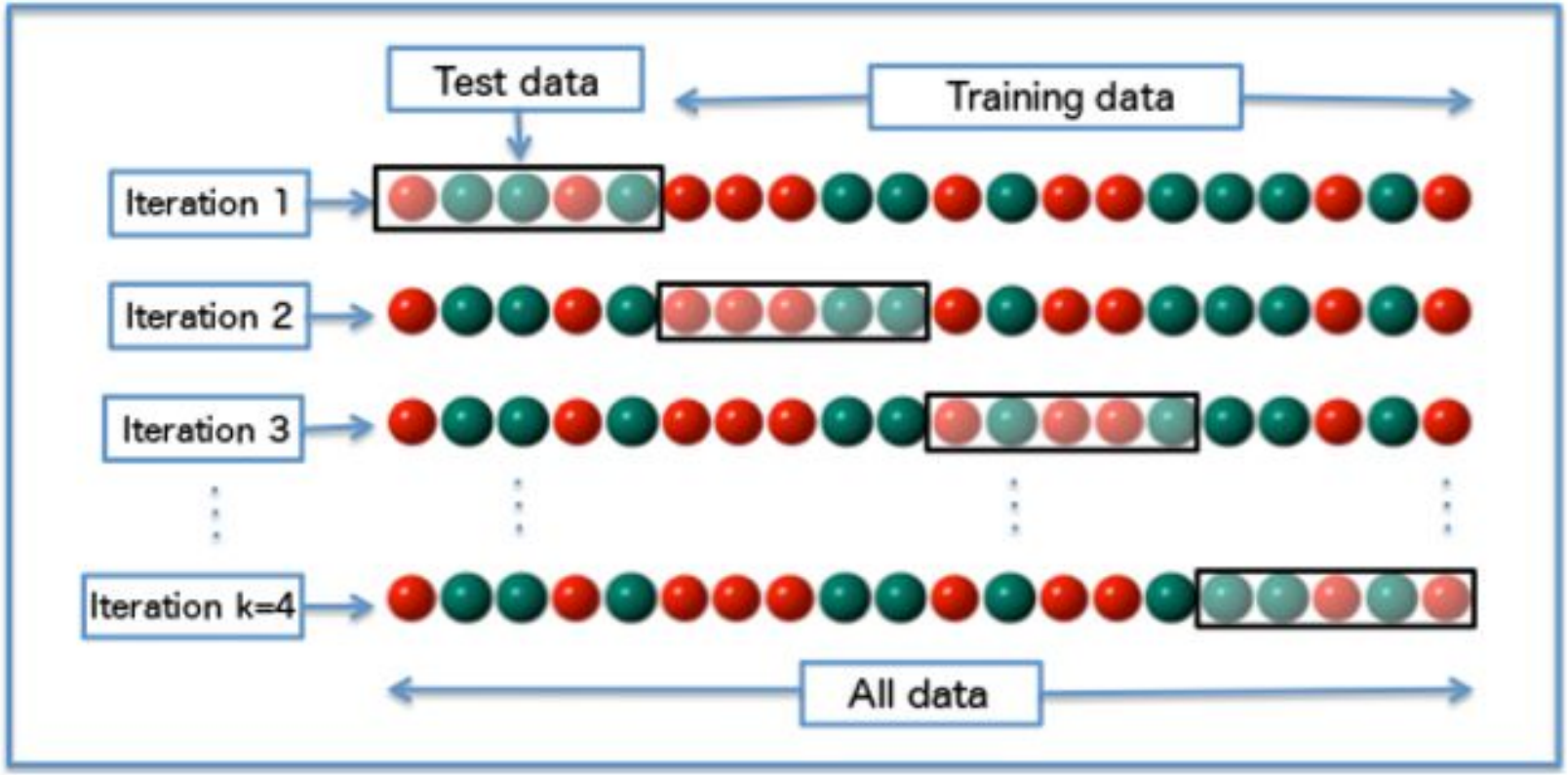
$$\text{F1 Score} = 2 * \frac{\text{Precision} * \text{Recall}}{\text{Precision} + \text{Recall}}$$



Receiver Operating Characteristics

Performance Enhancement

- **Cross Validation**




Thank
you