

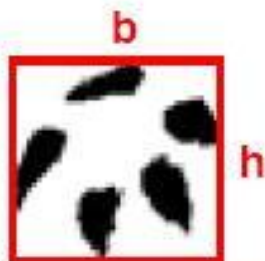
MACHINE LEARNING-INTRODUCTION

Example: Animal Footprints



What features can be used to distinguish the 3 footprint classes?

A Feature Space for Footprints



$\omega_1 = \text{wolf}$



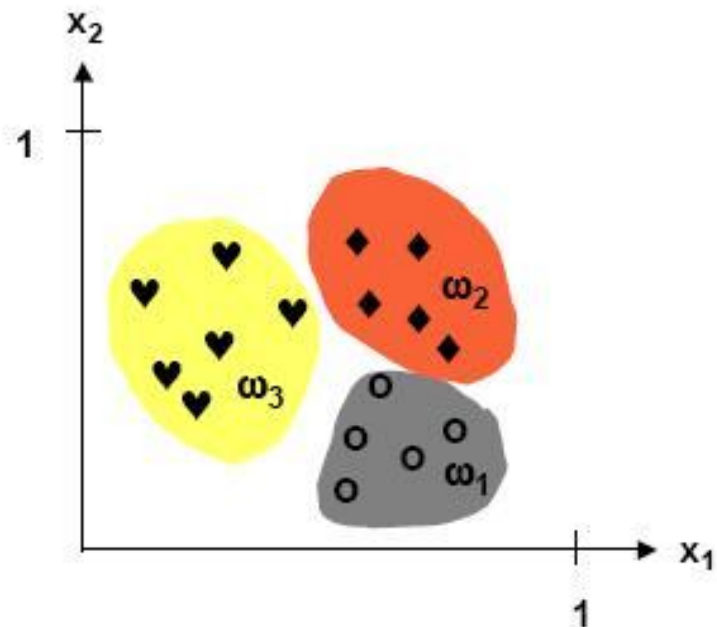
$\omega_2 = \text{bear}$



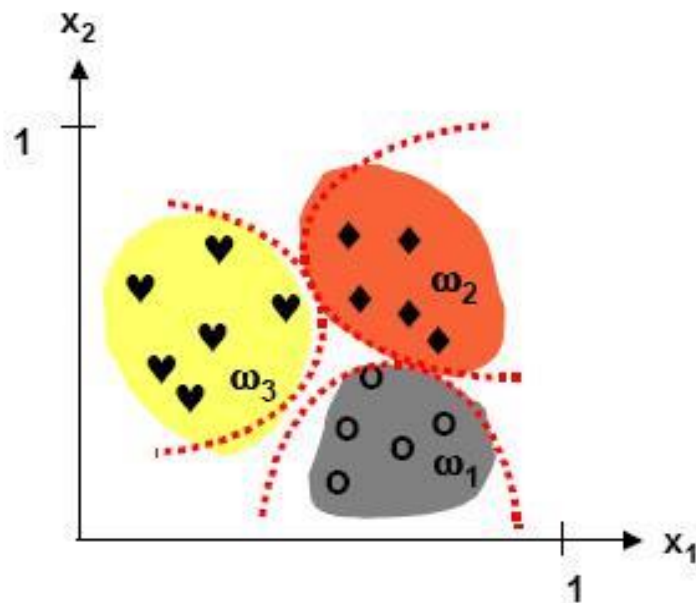
$\omega_3 = \text{hare}$

$$x_1 = \text{"squareness"} = \frac{4bh}{(b+h)^2}$$

$$x_2 = \text{"solidness"} = \frac{\text{print area}}{bh}$$



Discriminant Functions for Footprints

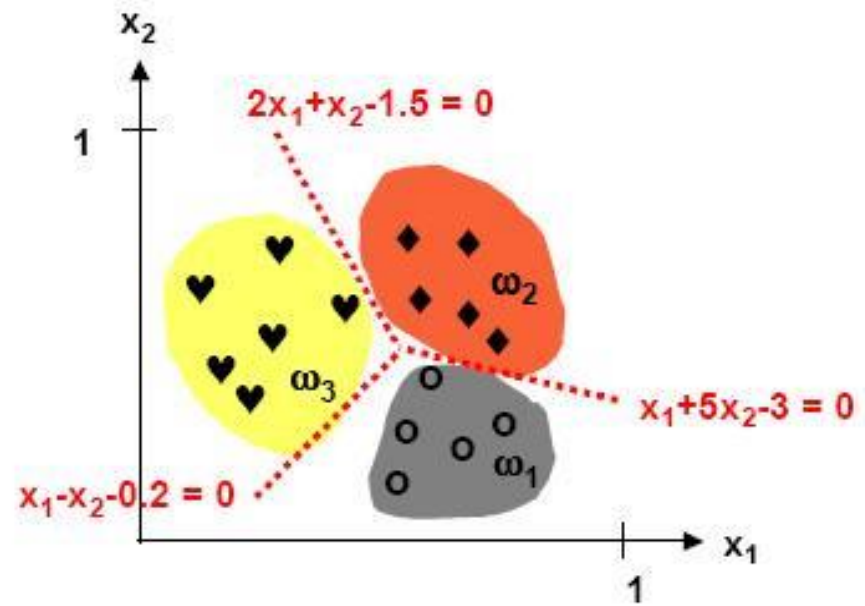


Quadratic discriminant functions:

$$g_1 = -9x_1^2 + 10.8x_1 - x_2 - 2.84$$

$$g_2 = x_1 + 20x_2^2 - 28x_2 + 9.4$$

$$g_3 = -x_1 + 5.6x_2^2 - 5.6x_2 - 1$$



Piecewise linear discriminant functions:

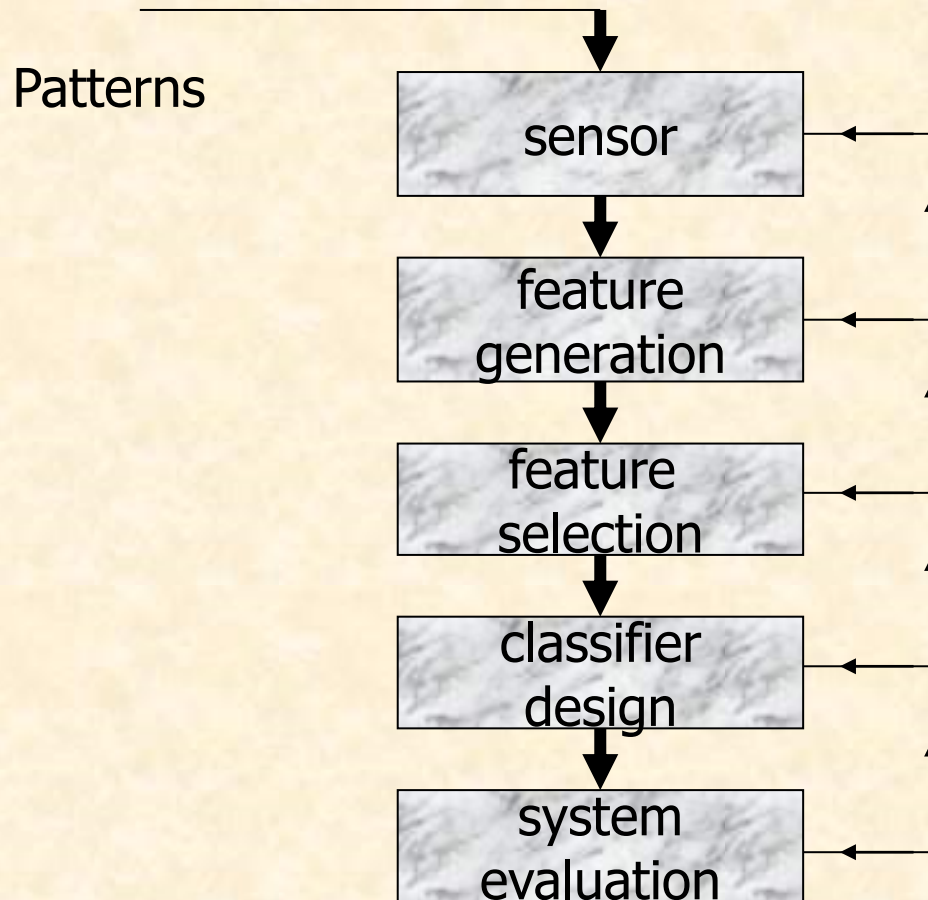
$$g_1 = (x_1 - x_2 - 0.2 > 0) \wedge (x_1 + 5x_2 - 3 < 0)$$

$$g_2 = (x_1 + 5x_2 - 3 > 0) \wedge (2x_1 + x_2 - 1.5 > 0)$$

$$g_3 = (2x_1 + x_2 - 1.5 < 0) \wedge (x_1 - x_2 - 0.2 < 0)$$

❖ The **classifier** consists of a **set of functions**, whose values, computed at \underline{x} , determine the class to which the corresponding pattern belongs

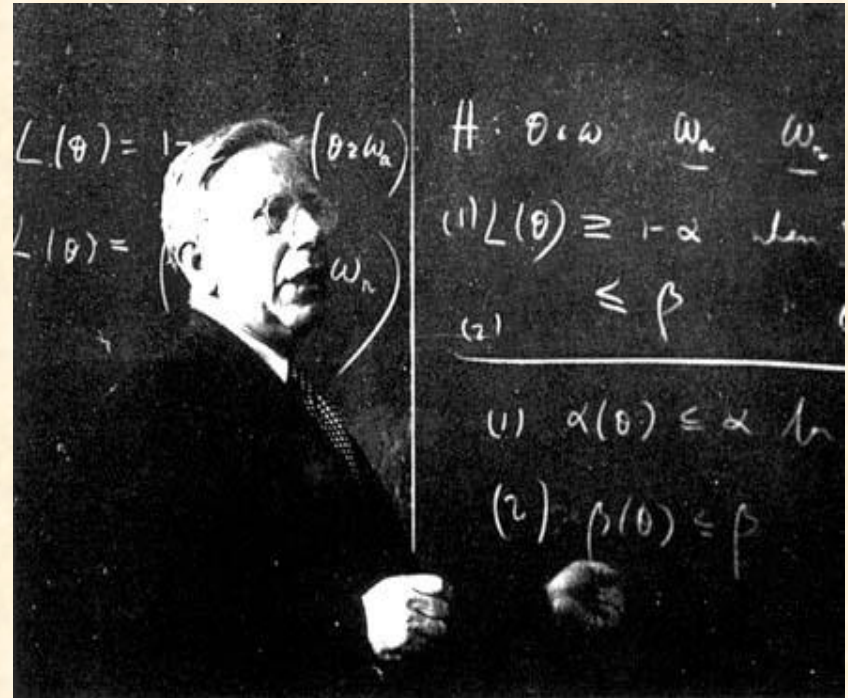
❖ Classification system overview



PIONEERS OF STATISTICALLY INSPIRED MACHINE LEARNING

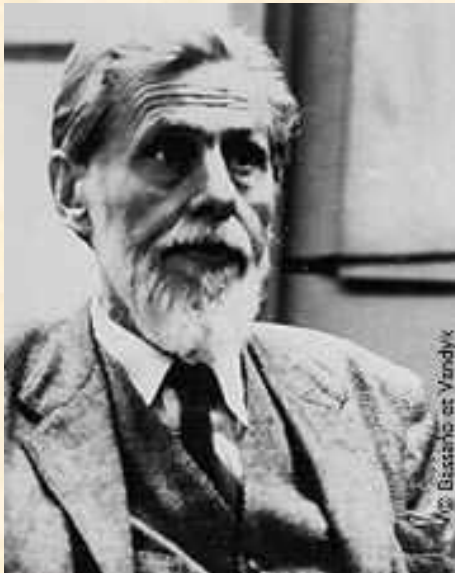


Thomas Bayes (1707-1761)



Abraham Wald (1902-1950)

PIONEERS OF BIOLOGICALLY INSPIRED MACHINE LEARNING



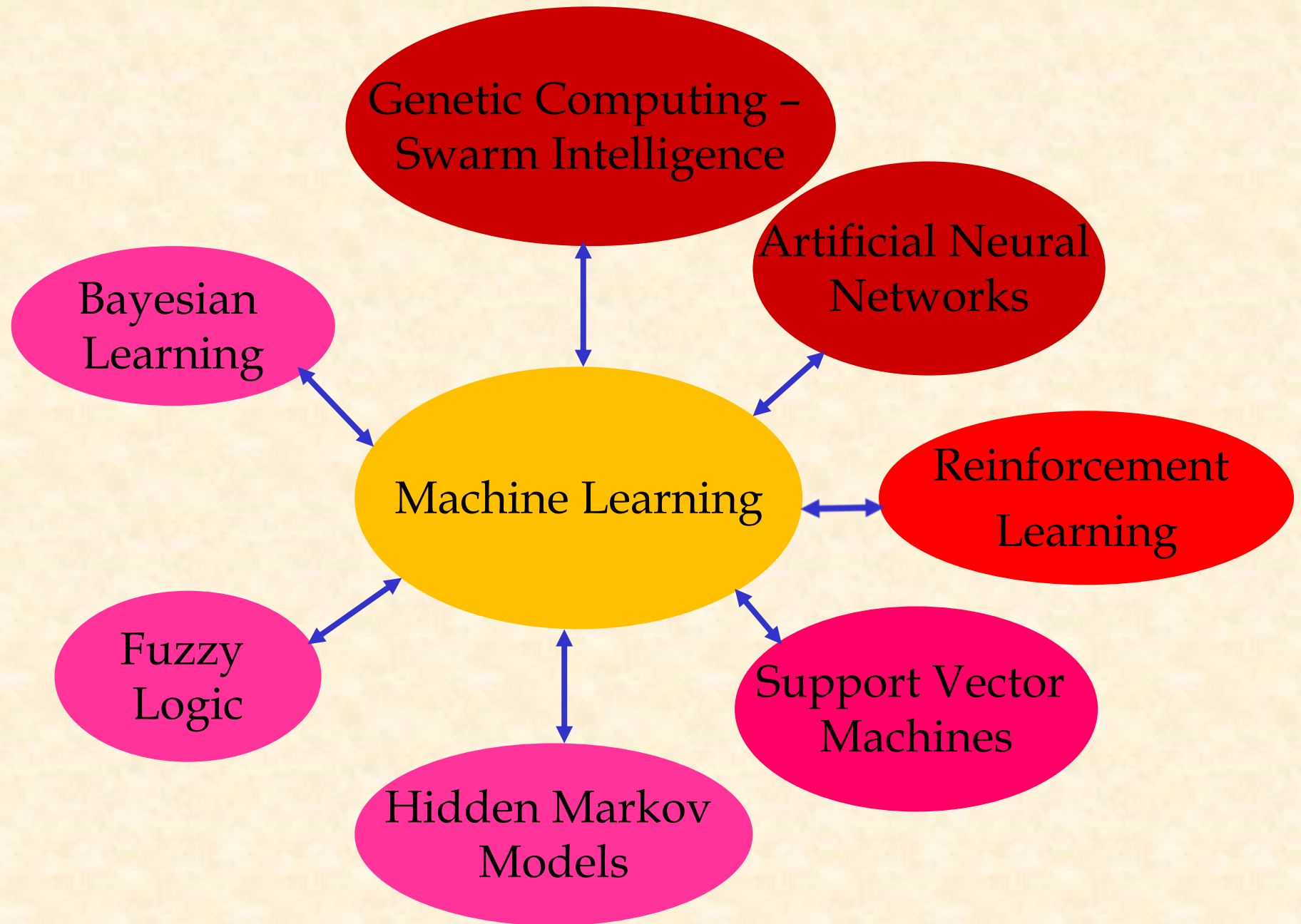
**Warren McCulloch
(1898-1969)**



**Walter Pitts
(1923-1969)**



**Donald Hebb
(1904-1985)**



Intelligent behaviour



Learning



Learning model



Optimization



Philosophical and ethical issues

Philosophical questions

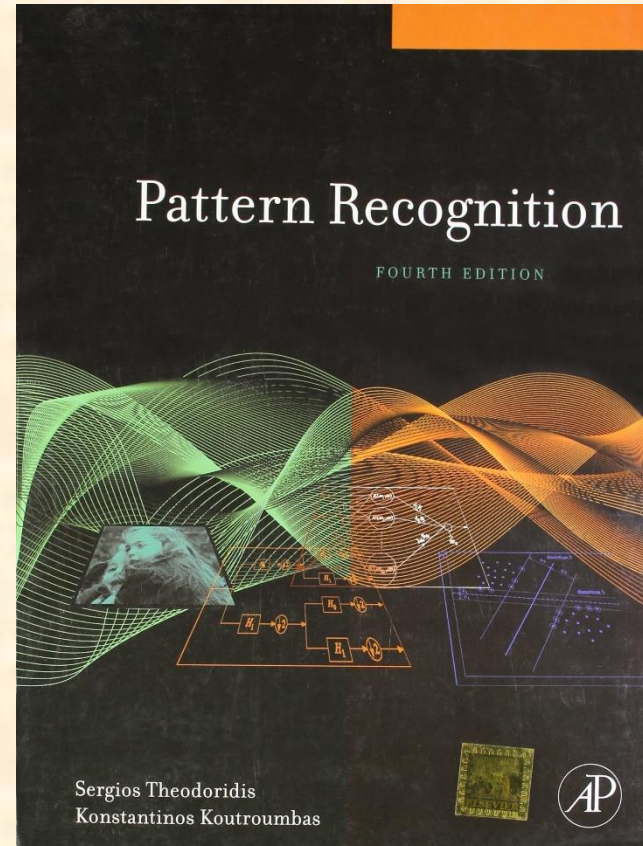
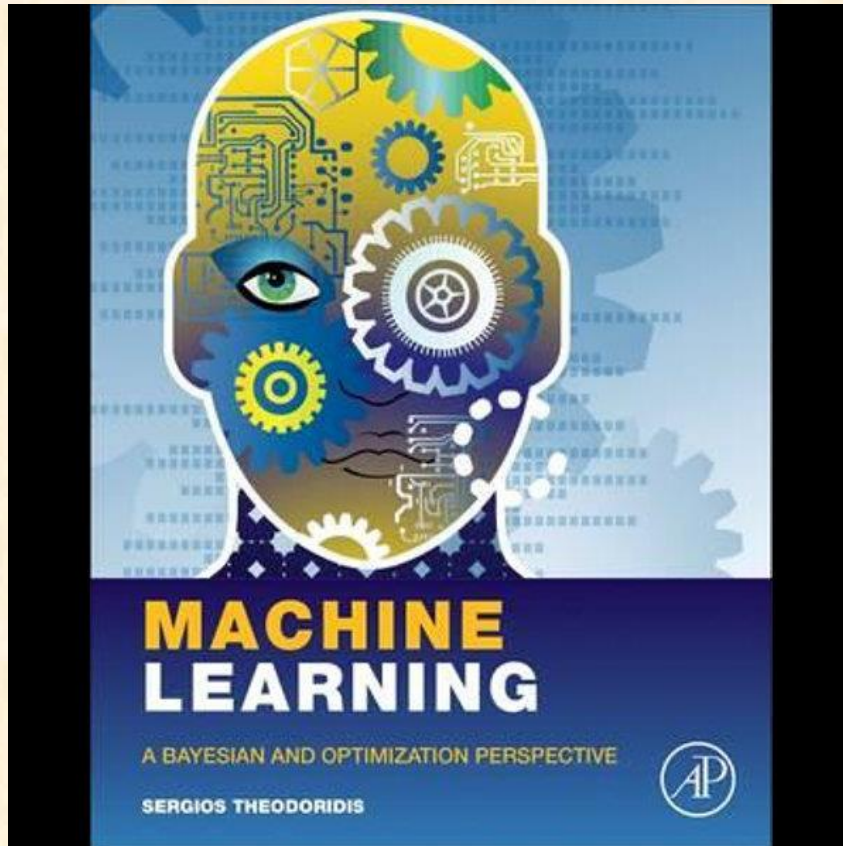
- Can a machine act intelligently? Can it solve any problem that a person would solve by thinking?
- Are human intelligence and machine intelligence the same? Is the human brain essentially a computer?
- Can a machine have a mind, mental states, and consciousness in the same sense that a human being can? Can it feel how things are?

Philosophical and ethical issues

Ethical issues

- Unemployment brought about by intelligent machine proliferation
- Wealth distribution: Inequality brought about by intelligent machine proliferation
- Machine stupidity: How do we guard against mistakes?
- Issues related to human-computer interaction. Modification of human behavior, tech addiction
- Cybersecurity
- Singularity: The point where humans are no longer the most intelligent species
- Intelligent machine rights

Textbooks



Topics to be covered

- ❖ General machine learning issues: Regression, classification. Cost function, bias, variance, estimation (biased, unbiased), overfitting, regularization, cross-validation
- ❖ Statistically inspired machine learning
 - ❑ Distribution estimation (Maximum likelihood, Maximum a posteriori probability, expectation-maximization)
 - ❑ Regression: Least squares, ridge regression, methods inspired by distribution estimation
 - ❑ Classification: Bayes classifier, naive Bayes classifier, nearest neighbours etc
 - ❑ Bayesian networks
 - ❑ Context based classification: Hidden Markov models
- ❖ Biologically inspired machine learning
 - ❑ Neural networks: Perceptron, Multi-layered networks, radial basis functions, Deep Learning
 - ❑ Support vector machines
- ❖ Not covered, or superficially covered: Clustering (unsupervised learning), feature generation-selection-extraction