

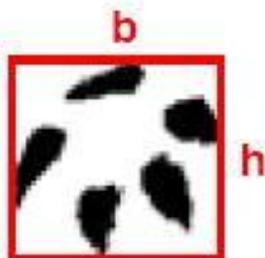
MACHINE LEARNING-INTRODUCTION

Example: Animal Footprints



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

A Feature Space for Footprints



$\omega_1 = \text{wolf}$



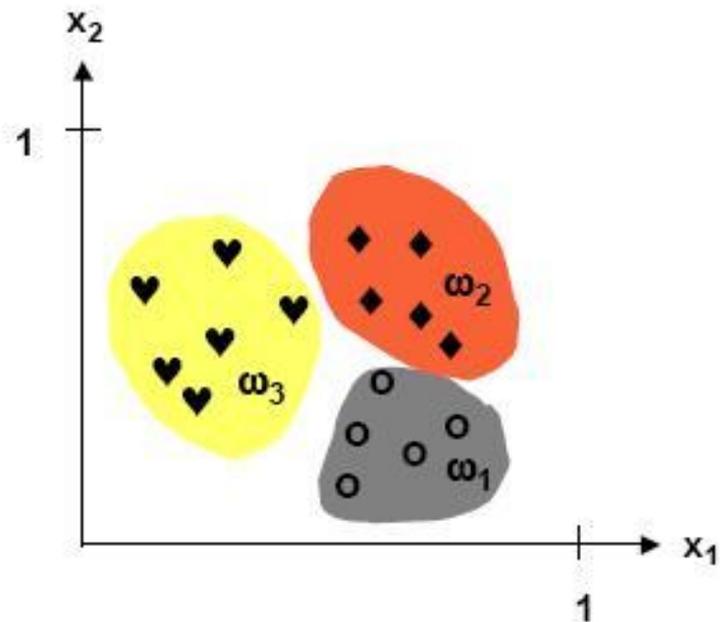
$\omega_2 = \text{bear}$



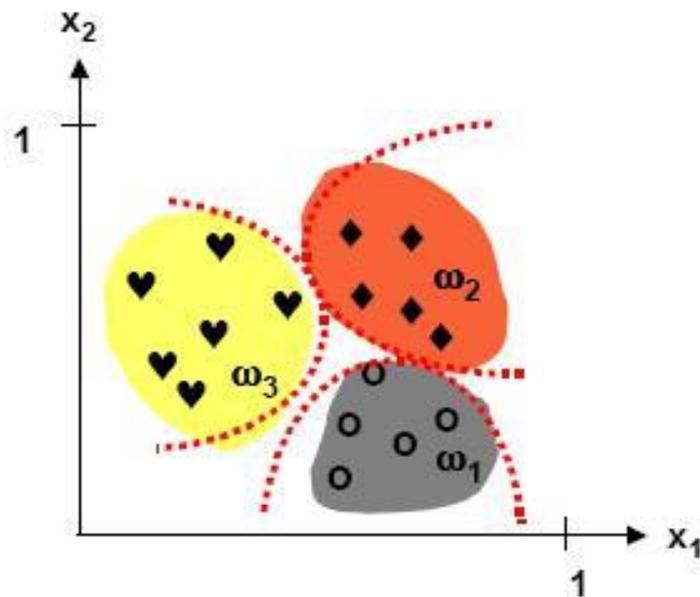
$\omega_3 = \text{hare}$

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

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



Discriminant Functions for Footprints

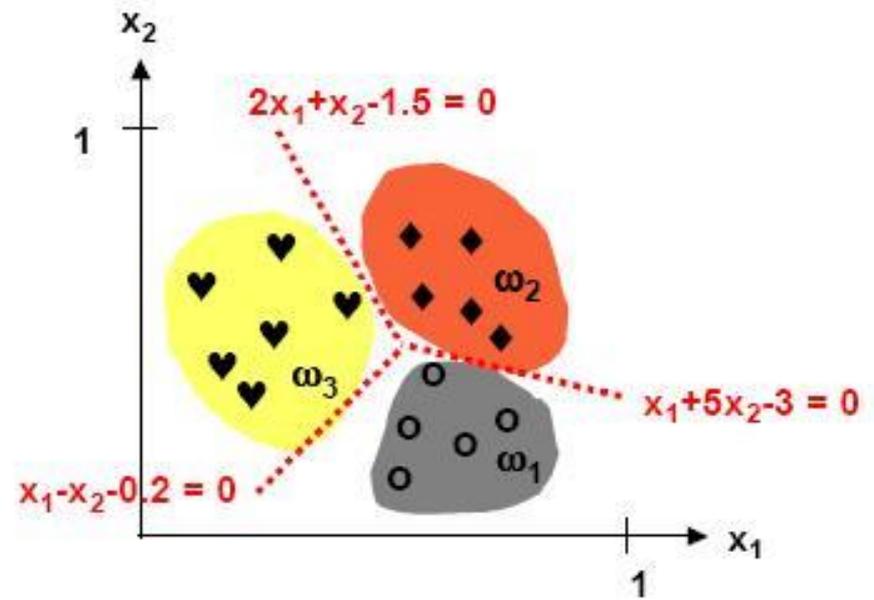


Quadratic discriminant functions:

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

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

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



Piecewise linear discriminant functions:

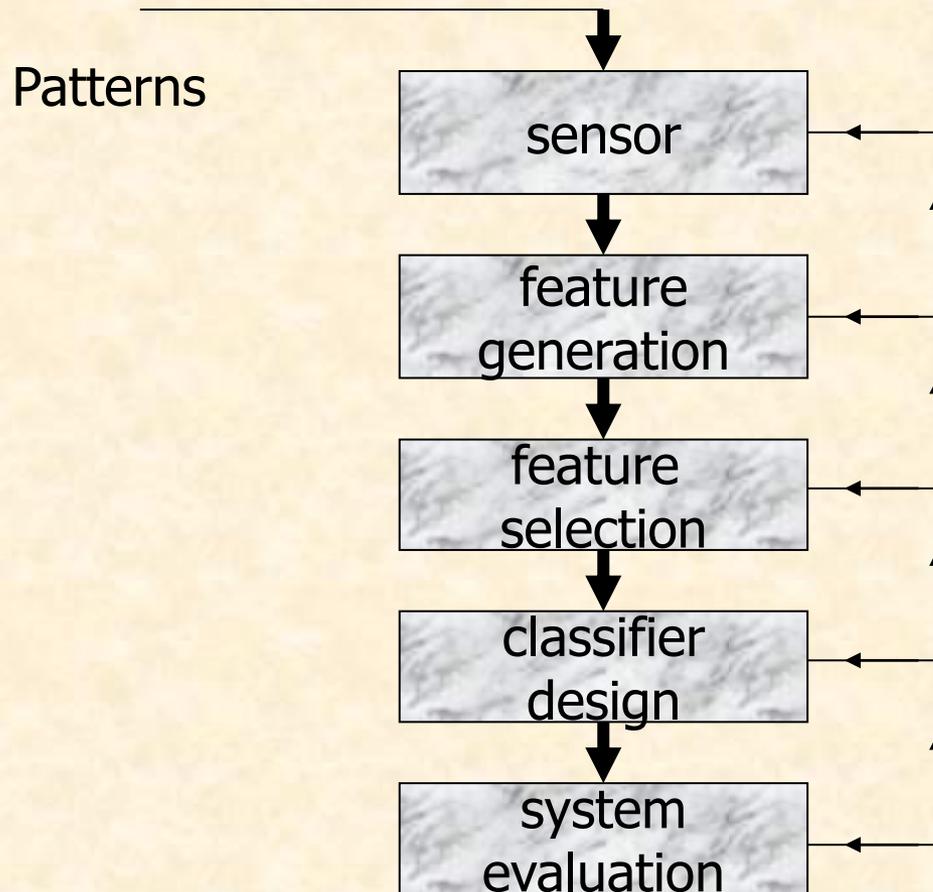
$$g_1 = (x_1 - x_2 - 0.2 > 0) \wedge (x_1 + 5x_2 - 3 < 0)$$

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

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

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

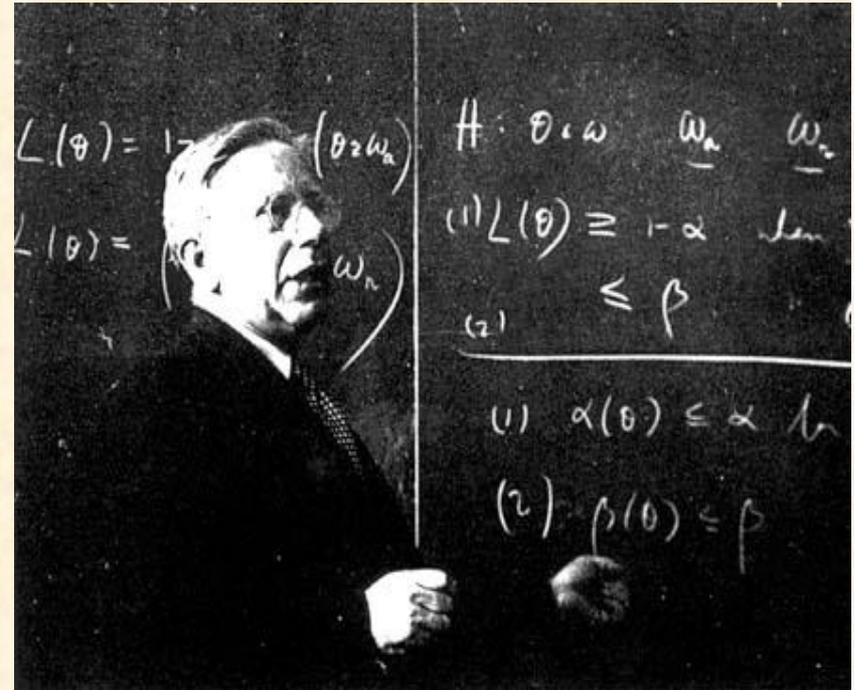
❖ Classification system overview



PIONEERS OF STATISTICALLY INSPIRED MACHINE LEARNING

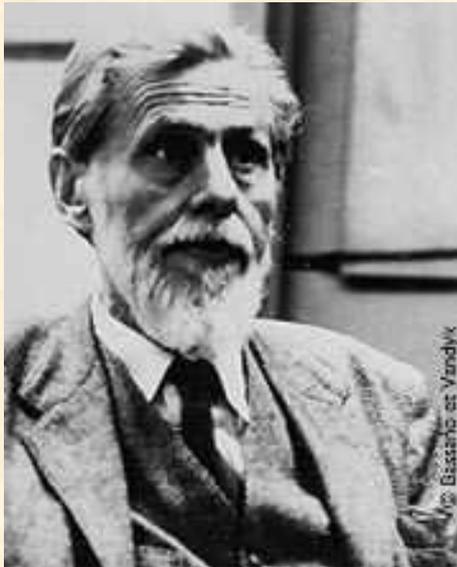


Thomas Bayes (1707-1761)



Abraham Wald (1902-1950)

PIONEERS OF BIOLOGICALLY INSPIRED MACHINE LEARNING



**Warren McCulloch
(1898-1969)**



**Walter Pitts
(1923-1969)**



**Donald Hebb
(1904-1985)**

Genetic Computing -
Swarm Intelligence

Artificial Neural
Networks

Reinforcement
Learning

Support Vector
Machines

Hidden Markov
Models

Machine Learning

Bayesian
Learning

Fuzzy
Logic

Intelligent behaviour



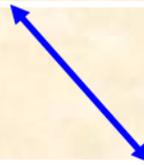
Learning



Learning model



Optimization



Philosophical and ethical issues

Philosophical questions

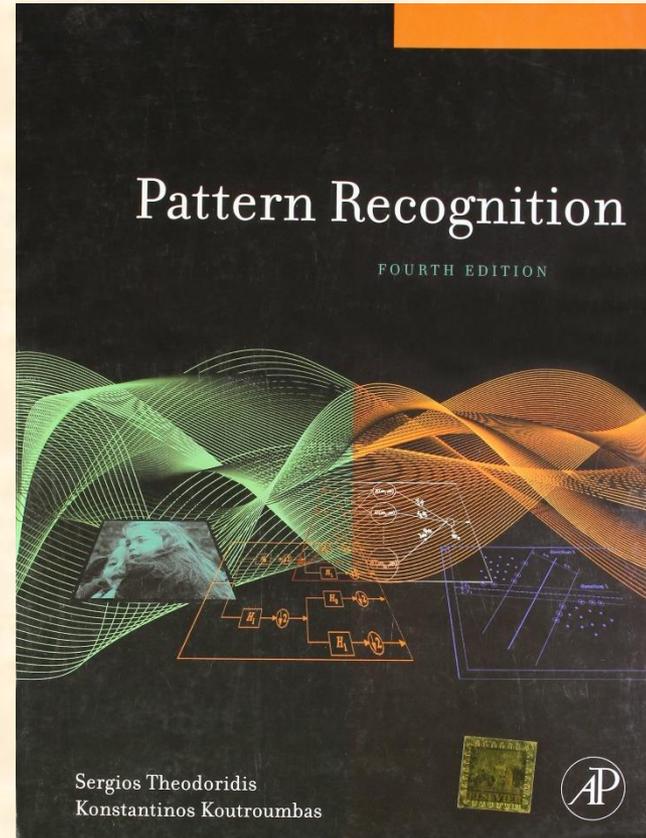
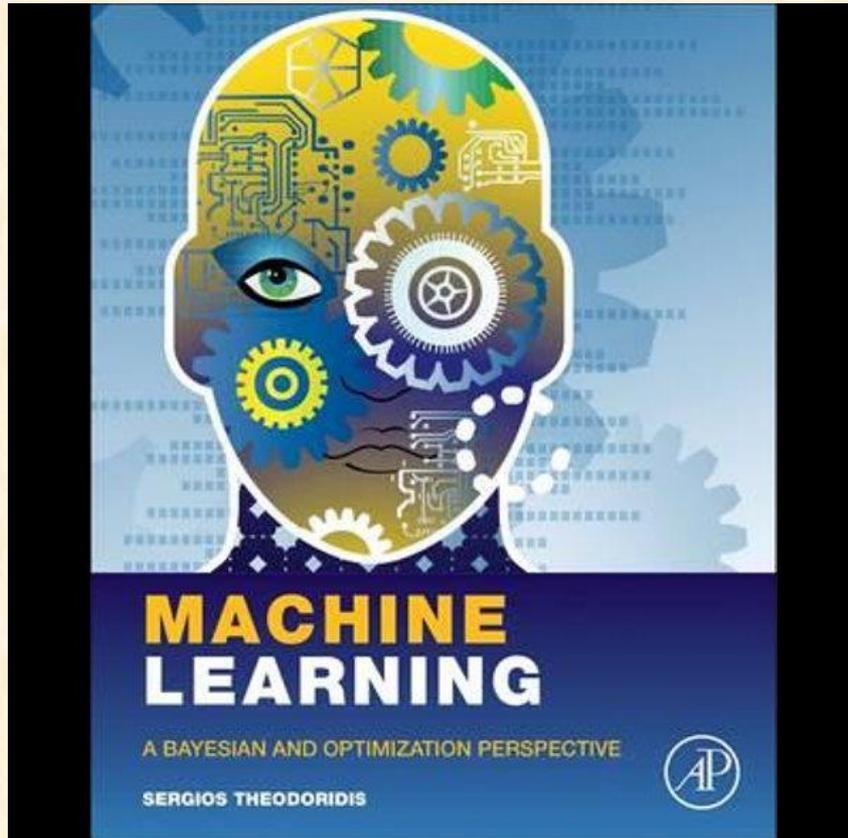
- Can a machine act intelligently? Can it solve any problem that a person would solve by thinking?
- Are human intelligence and machine intelligence the same? Is the human brain essentially a computer?
- Can a machine have a mind, mental states, and consciousness in the same sense that a human being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