Machine Learning (part II)

Artificial Intelligence
and
Machine Learning

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Artificial Intelligence

- **Artificial Intelligence** (AI)

  - science which aims to develop intelligent machines

- **two** main **theories**

  - **Hard AI**

    - machines can actually be smart

  - **Weak AI**

    - machines can behave as if they were intelligent

AI

- Human mind as a program

  - Input

    - data of stimuli

  - the human mind reasons

  - output

    - certain behavior of the body

- Brain

  - parallel hardware

    - consisting of neurons and connections between them)

  - this program is executed

Artificial Intelligence founders

- ## John McCarthy in 1950
  - *Every aspect of learning or every other characteristic of intelligence can be described in such a precise way as to allow the construction of a machine capable of simulating it*

- ## AI formally born in 1956
  - New Hampshire conference at Dartmouth College
    - John McCarthy, Marvin Minsky, Claude Shannon e Nathaniel Rochester, Allen Newell e Herbert Simon
    - Logic Theorist (LP)
      - able to demonstrate theorems starting from the principles of mathematics
   - sempre nello stesso convegno, McCarthy introdusse l'espressione intelligenza artificiale

Turing test

- ## Alan Turing (1950)

  - *Computing machinery and intelligence*

- ## Imitation Game

  - Interaction with a terminal where I can ask questions, I get answers

  - on the other side there is either a person or a computer

  - after 30 minutes I should be unable to distinguish between a person and a computer

THE INTERROGATOR
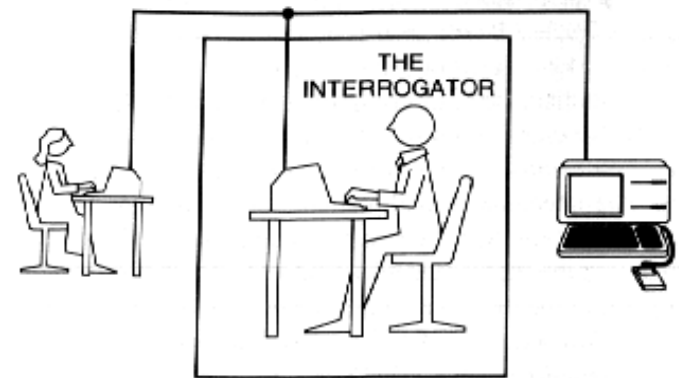
Turing test

- Computer should have the following capabilities
  - Processing of natural language;
  - Representation of knowledge;
  - Automatic reasoning;
  - Machine learning.

ML – AI and ML

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Turing's forecasting

"I believe that in about 50 years it will be possible to program computers with a memory of a billion bytes so that they play the game of imitation so well that an ordinary person will have no more than 70% chance of identifying them after 5 minutes of interrogation"

AI periods

- ## 1943-1956

  - AI starting concepts
    - Neural Networks;
    - chess game programs;
    - theorem demonstrators.

- ## 1952-1969

  - LISP language
  - Two directions
    - Logic - McCarthy (Stanford)
    - No Logic - Minsky (MIT)

AI periods

- 1966-1974

  - Some programs were not really competent
    - ELIZA was a purely syntactic translation
    - intractable (combinatorial explosion)
  - Neural networks were inadequate

- 1969-1979

  - Knowledge-based systems
  - Expert Systems
  - Fuzzy Logic

ML – AI and ML

Periodi dell'IA

- ## 1980-1988
  - AI becomes an industry
    - Expert Systems
  - Japanese fifth generation project (1981);
  - Companies for the development of AI systems;
  - Funds for research

- ## 1986-
  - return of neural networks
  - learning algorithm with backward propagation
  - Deep Learning
    - high computing power
    - pre-treined models

IA directions

- **Intelligent Machines**
  - **Programs** are built that reach a **high level of competence** in the knowledge of particular problems
  - Engineering approach
  - Are not concerned with simulating **human reasoning activity**, but with **emulating it selectively**

- **Cognitive science**
  - Try to model **human behavior** and its processes information
  - Approach of philosophers, psychologists, linguists, biologists
  - The **computer** is a means of **experimentation**
  - We are still a long way from the construction of the «**intelligent**» **machine**, so for now we have limited ourselves to simpler and more tractable problems

Chess Game

- In 1997 Deep Blue won against Kasparov
  - Is it intelligence?

- The size of the problem is huge

- We have 35^{100} nodes
  - An evaluation function is required
  - We will give a weight to each piece and to the relative position of the pieces

Brute force

- ## Minmax approach

  - ### John **von** Neumann
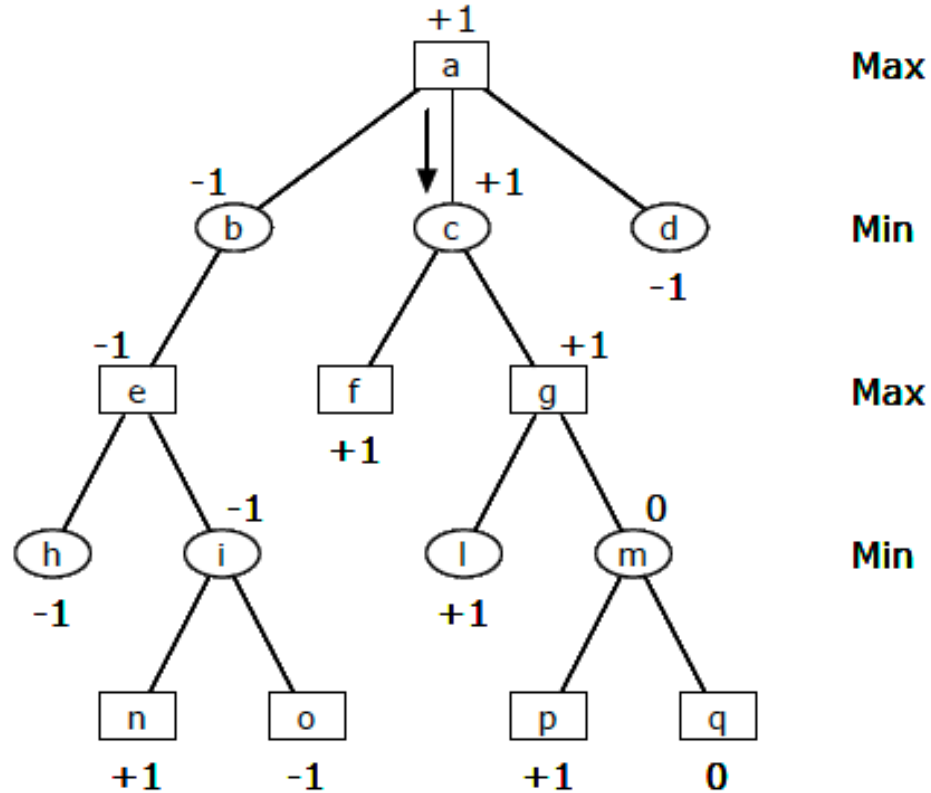
Some domains of AI

- Expert systems (medicine)
- Games
- Aircraft scheduling
- Staff shifts
- Robot for hospitals
- Blind readers
- Translation and understanding of natural language
- Biology and genomics
- Artificial vision
- Web search, online auctions

AI Methodologies

- **Machine Learning**
  - **Neural Networks**
    - Shallow Neural Networks
    - Deep Neural Networks
  - **Support Vector Machine**
  - **Bayesian Nets**
  - **Statistical learning**

- **Soft Computing**
  - **Fuzzy Logic**
  - **Neuro-Fuzzy**
  - **Evolutive Approaches**
    - Genetic algorithms
    - Swarm optimization
    - Anton Colony
    - Bee Colony

ML – AI and ML
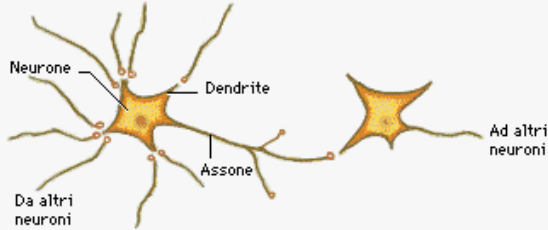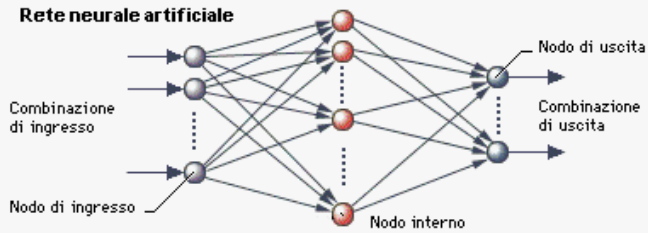
Neural Networks

Biological and artificial neurons
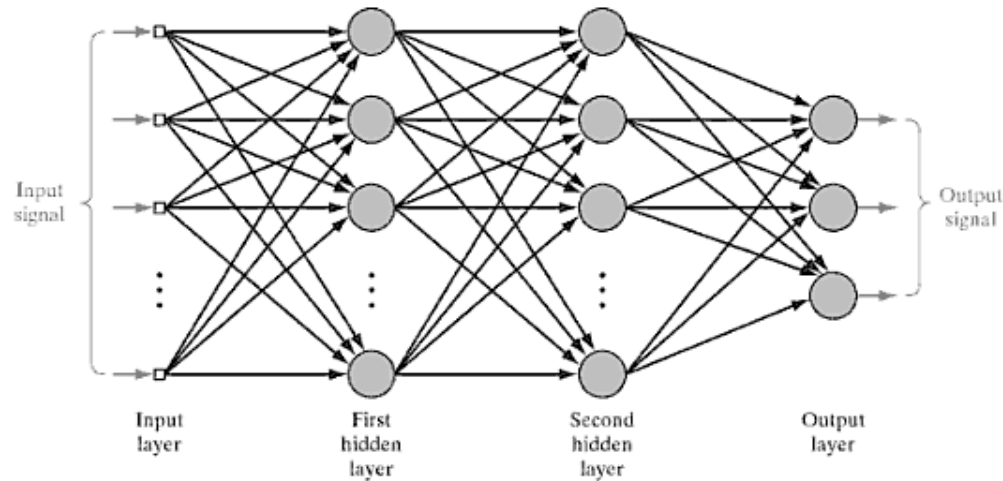
FIGURE 4.1   Architectural graph of a multilayer perceptron with two hidden layers.

Multi-Layer Perceptron

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Neural Networks

DEEP NEURAL NETWORK

Input layer → Hidden layer 1 → Hidden layer 2 → Hidden layer 3 → Output layer
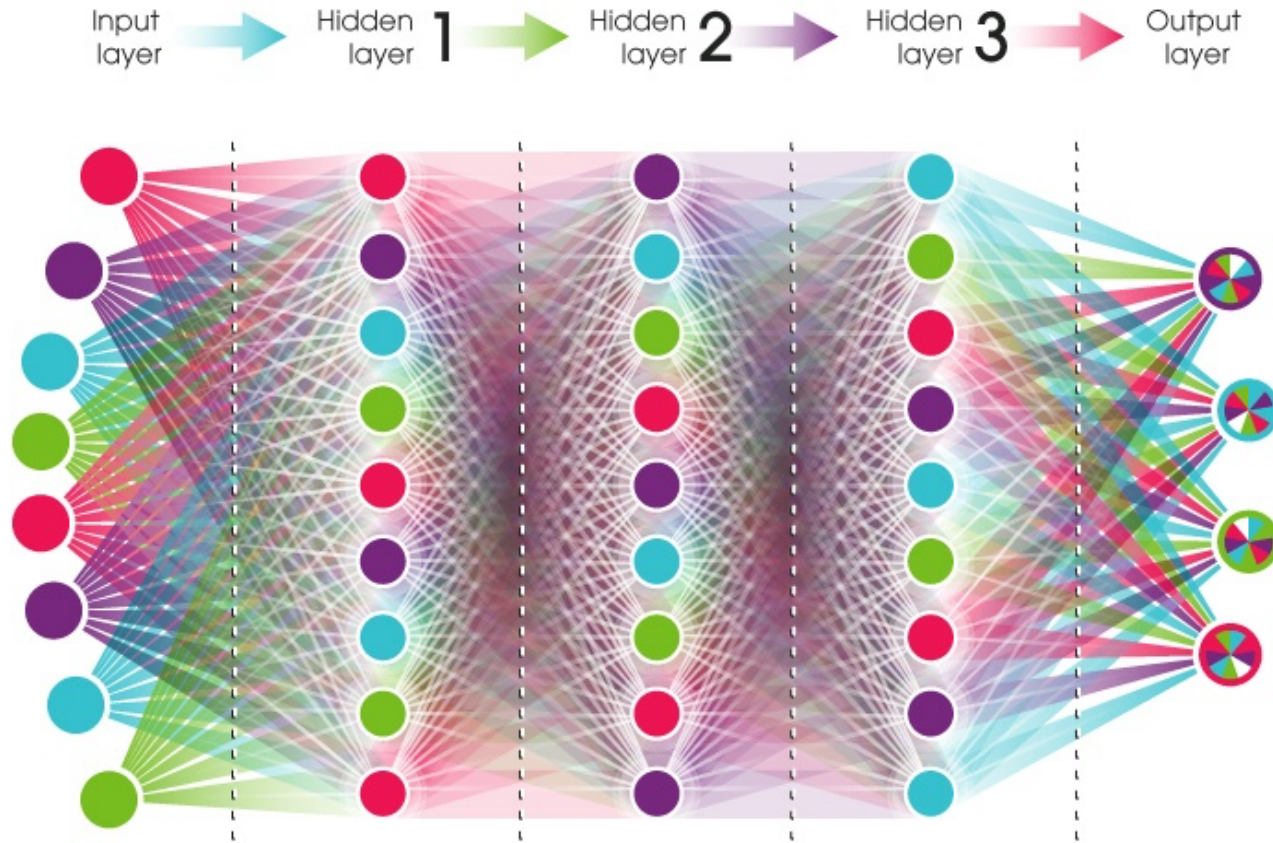
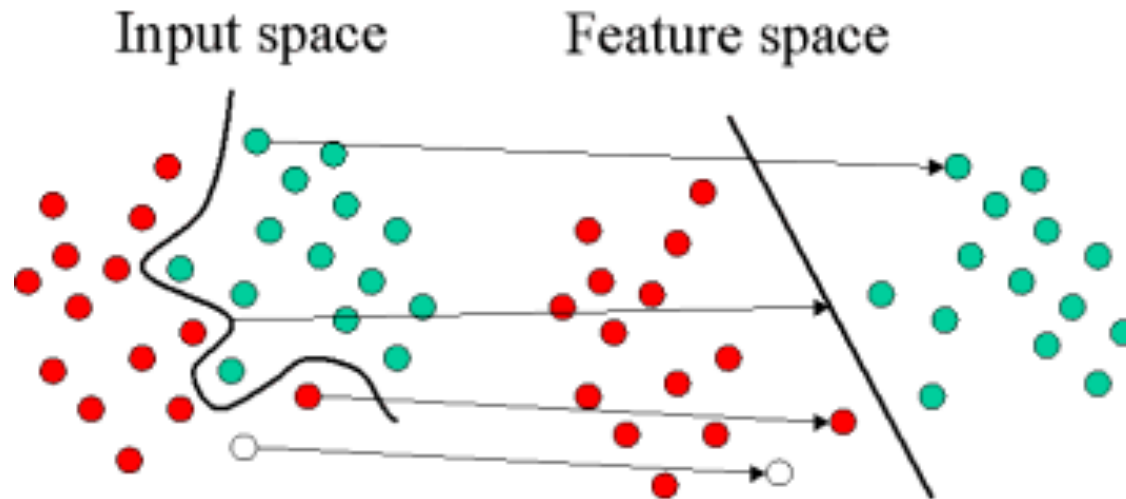neuralnetworksanddeeplearning.com - Michael Nielsen, Yoshua Bengio, Ian Goodfellow, and Aaron Courville, 2016.

Deep Neural Network

Fuzzy Logic

freddo   tiepido   caldo

temperatura

Linguistic variables

Fuzzy infenrece

Support Vector Machine

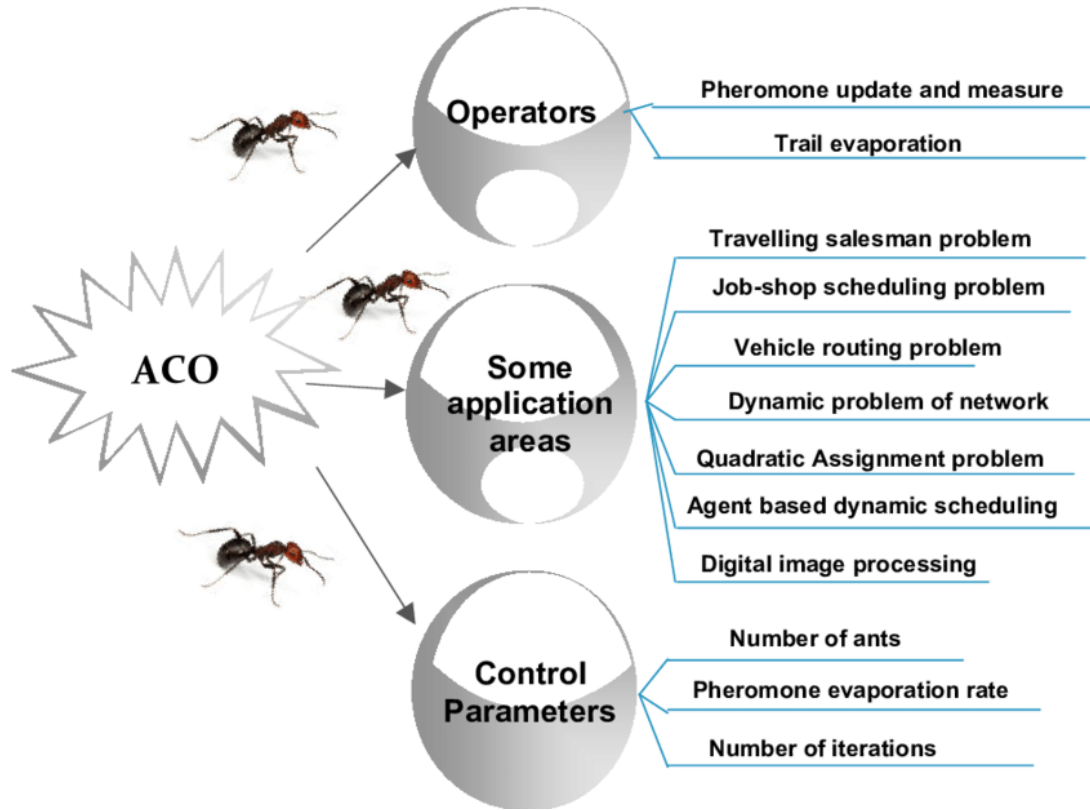Input space   Feature space

SVM transformation

Genetic Algorithms

Genetic Algorithms
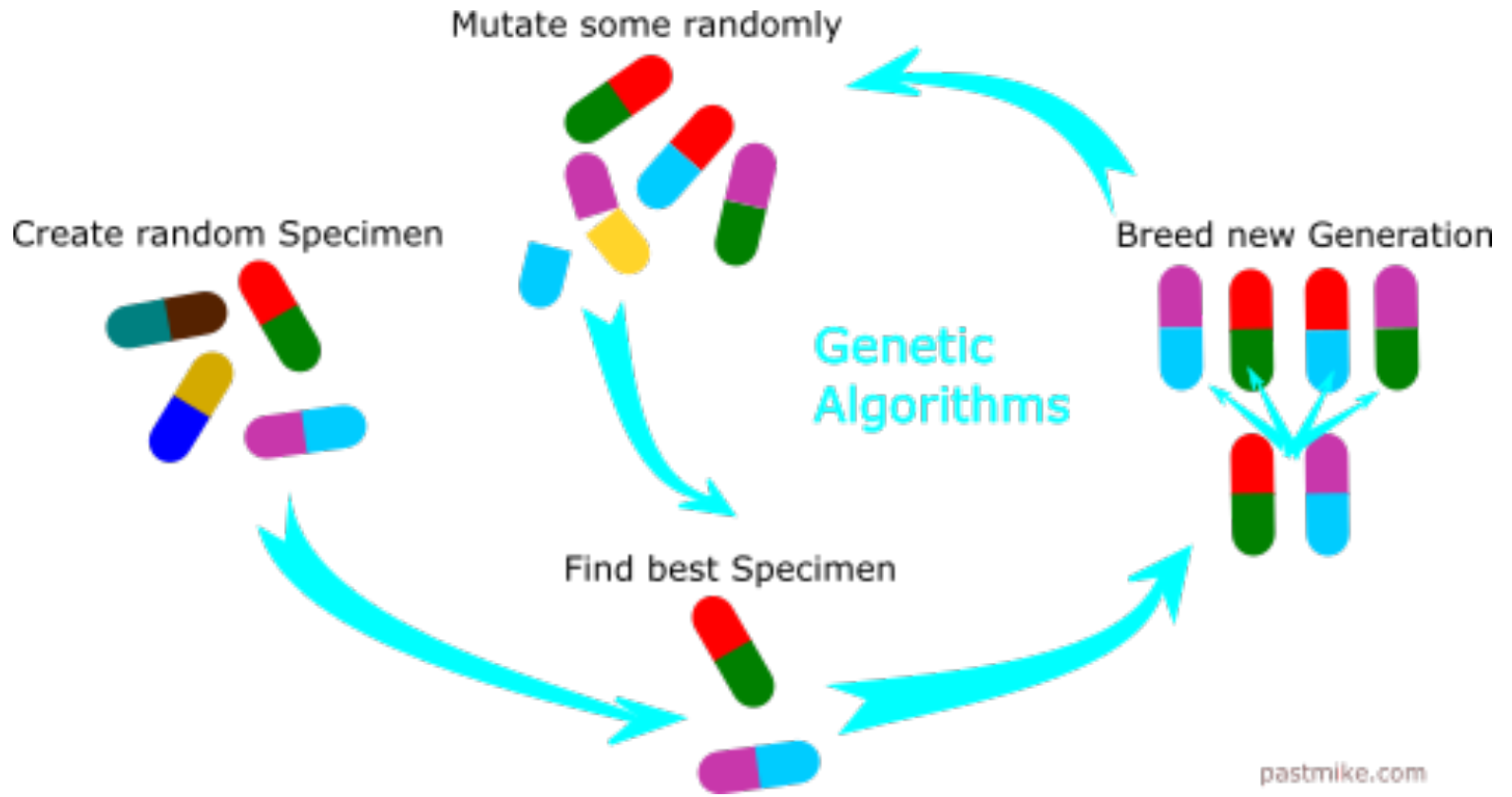
Ant Colony Optimization

ACO scheme

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