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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

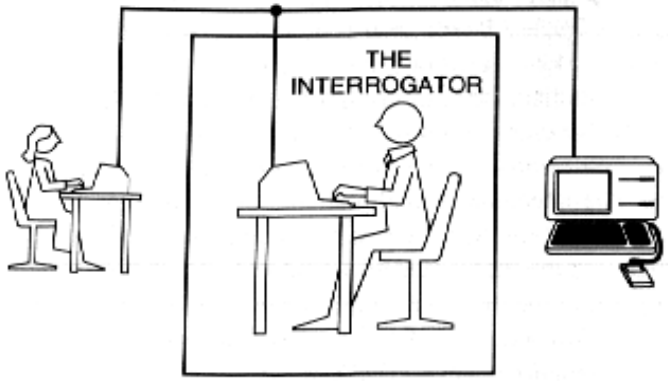
- John McCarthy in 1950
  - *Every aspect of learning or every other characteristic of intelligence can be described in such a precise way as to allow the construction of a machine capable of simulating it*

- 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
    - McCarthy introduced the expression Artificial Intelligence

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



Turing test

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

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

AI periods

- 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

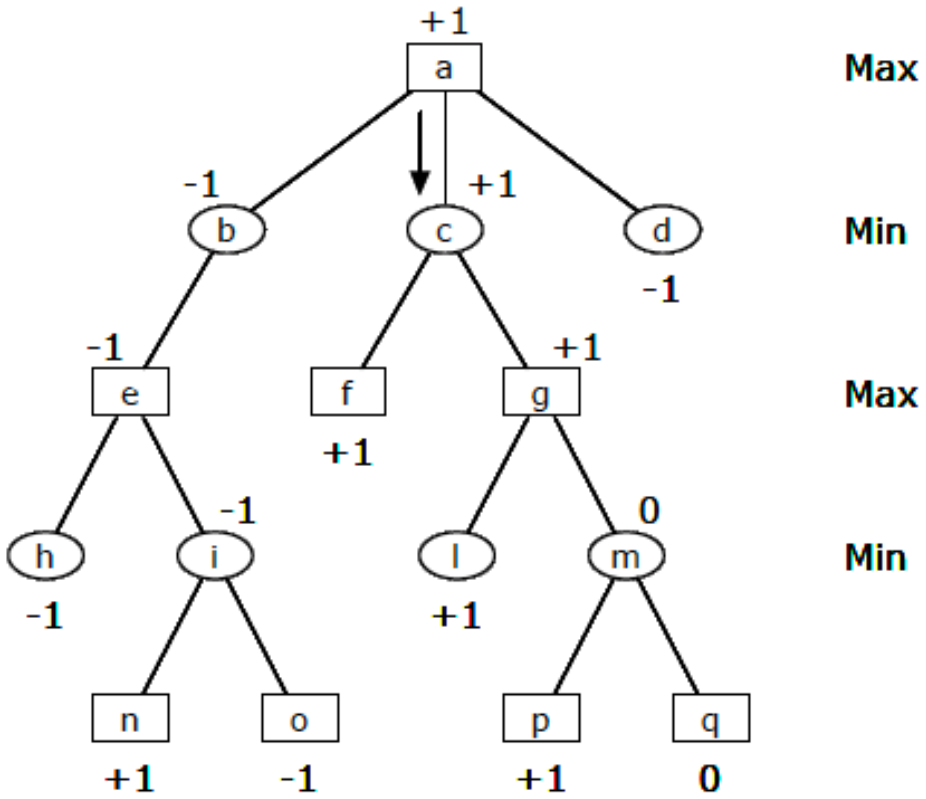
- Cognitive science
  - Try to model human behavior and its processes information
  - Approach of philosophers, psychologists, linguists, biologists
  - The computer is a means of experimentation
  - We are still a long way from the construction of the «intelligent» machine, so for now we have limited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

Hard and Soft Computing

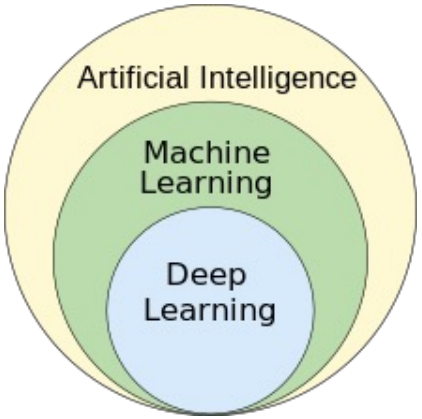
- Hard computing
  - traditional mathematical methods to solve problems, such as algorithms and mathematical models
  - It is based on deterministic and precise calculations and is ideal for solving problems that have well-defined mathematical solutions

- Soft Computing
  - techniques such as fuzzy logic, neural networks, genetic algorithms, and other heuristic methods to solve problems
  - It is based on the idea of approximation and is ideal for solving problems that are difficult or impossible to solve exactly

Machine Learning

- Machine Learning
  - Term coined in 1959 by Arthur Samuel (IBM employee and pioneer in the filed of AI)
  - Formal definition of the algorithms studied in the machine learning field:

    A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P if its performance at tasks in T, as measured by P, improves with experience E, Tom M. Mitchell



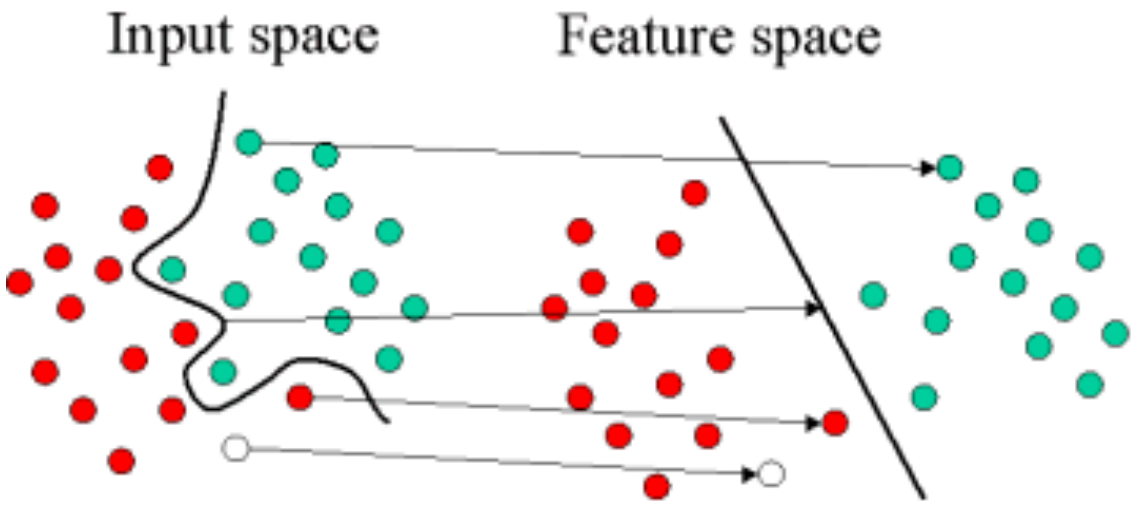
Computational Intelligence

- Computational Intelligencee
  - Set of nature-inspired computational methodologies and approaches to address complex real-world problems
  - The methods used are close to the human's way of reasoning
    - it uses inexact and incomplete knowledge, and it is able to produce control actions in an adaptive way
  - Five main principles
    - Fuzzy Logic
    - Neural Networks
    - Evolutionary computation
    - Learning theory
    - Probabilistic methods

AI Methodologies

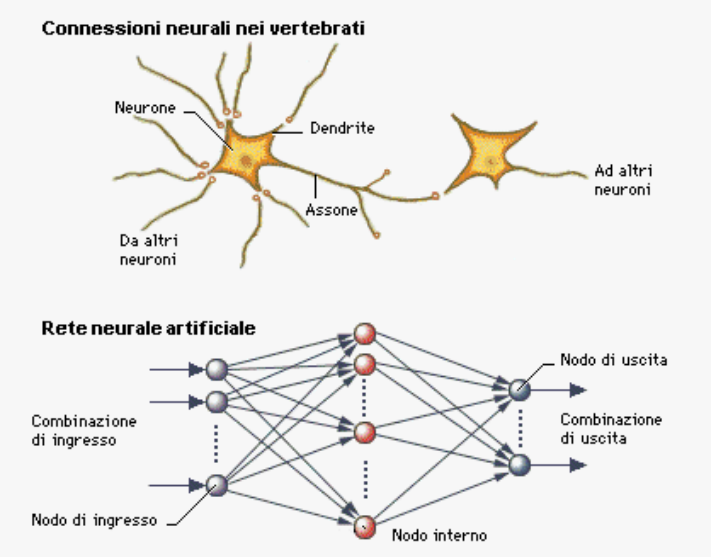
- Machine Learning
  - Support Vector Machine
  - Bayesian Nets
  - Statistical learning
- Computational Intelligence
  - Neural Networks
    - Shallow Neural Networks
    - Deep Neural Networks
  - Fuzzy Logic
    - Neuro-Fuzzy
  - Evolutive Approaches
    - Genetic algorithms
    - Swarm optimization
    - Anton Colony
    - Bee Colony

Support Vector Machine



SVM transformation

Neural Networks



Biological and artificial neurons

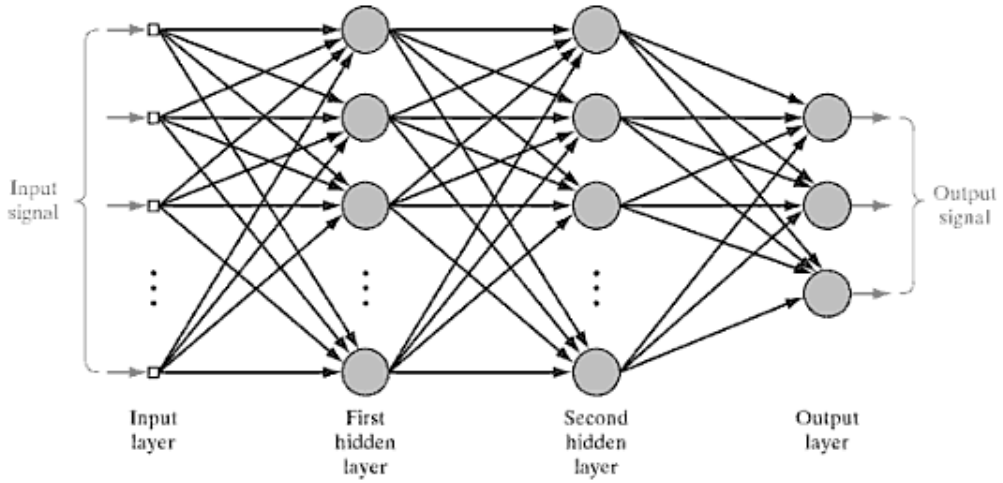
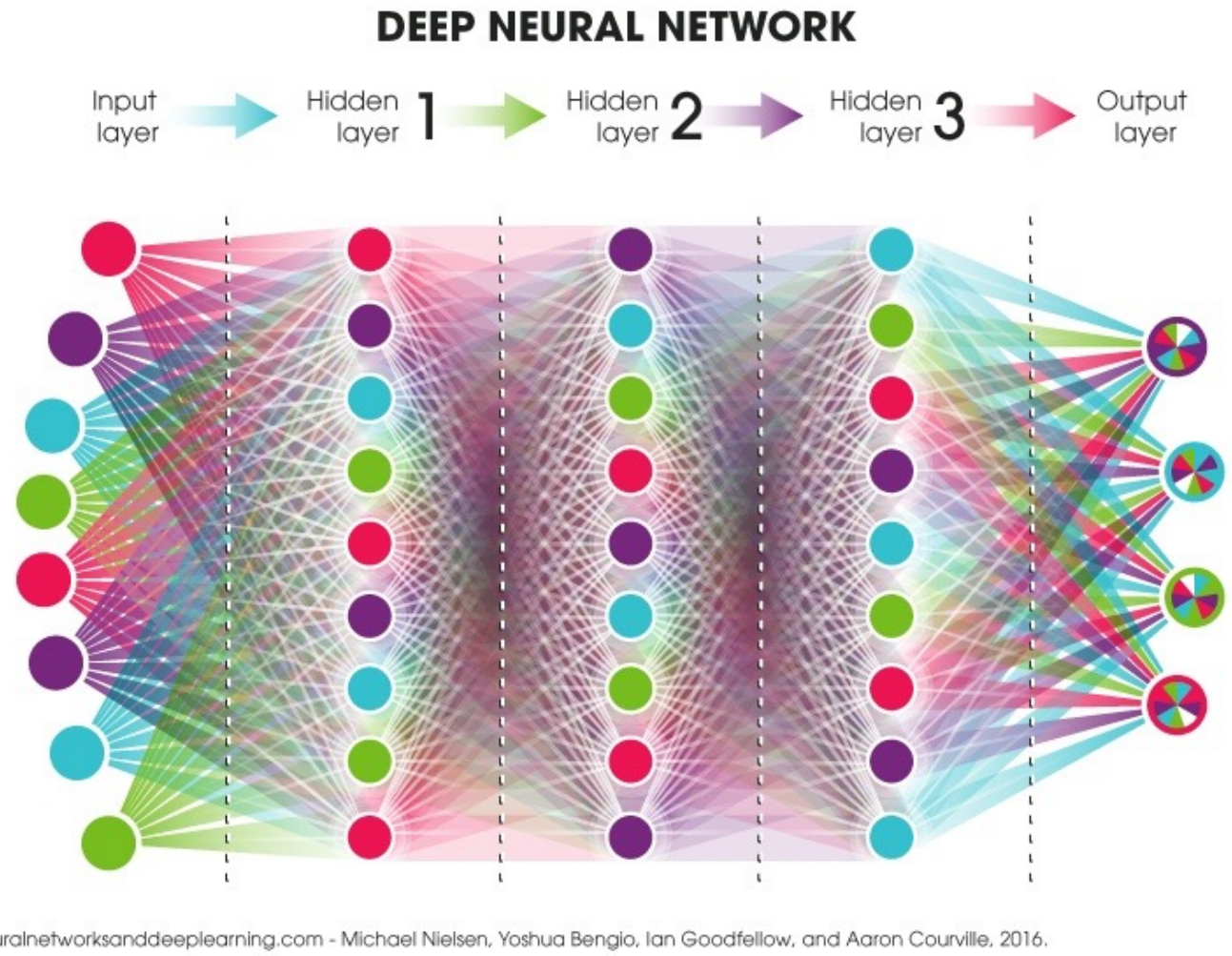


FIGURE 4.1 Architectural graph of a multilayer perceptron with two hidden layers.

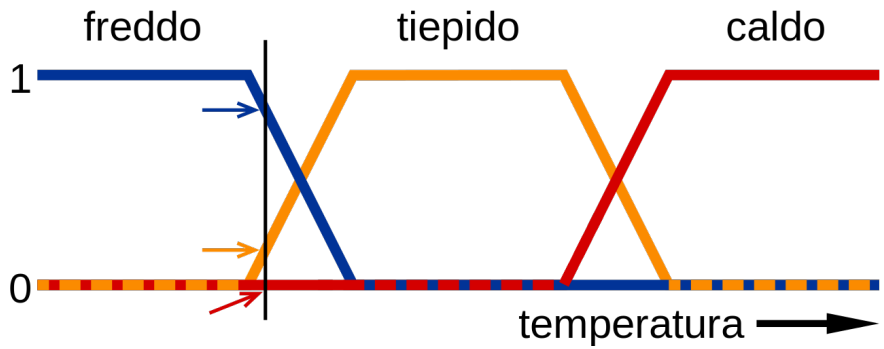
Multi-Layer Perceptron

Neural Networks

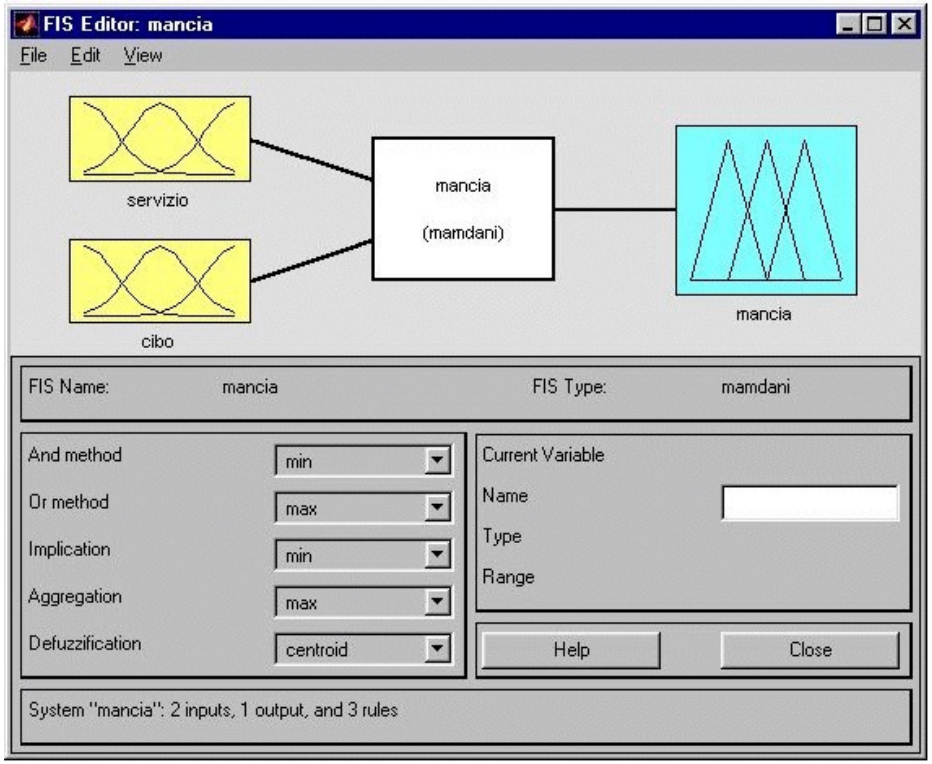


Deep Neural Network

Fuzzy Logic

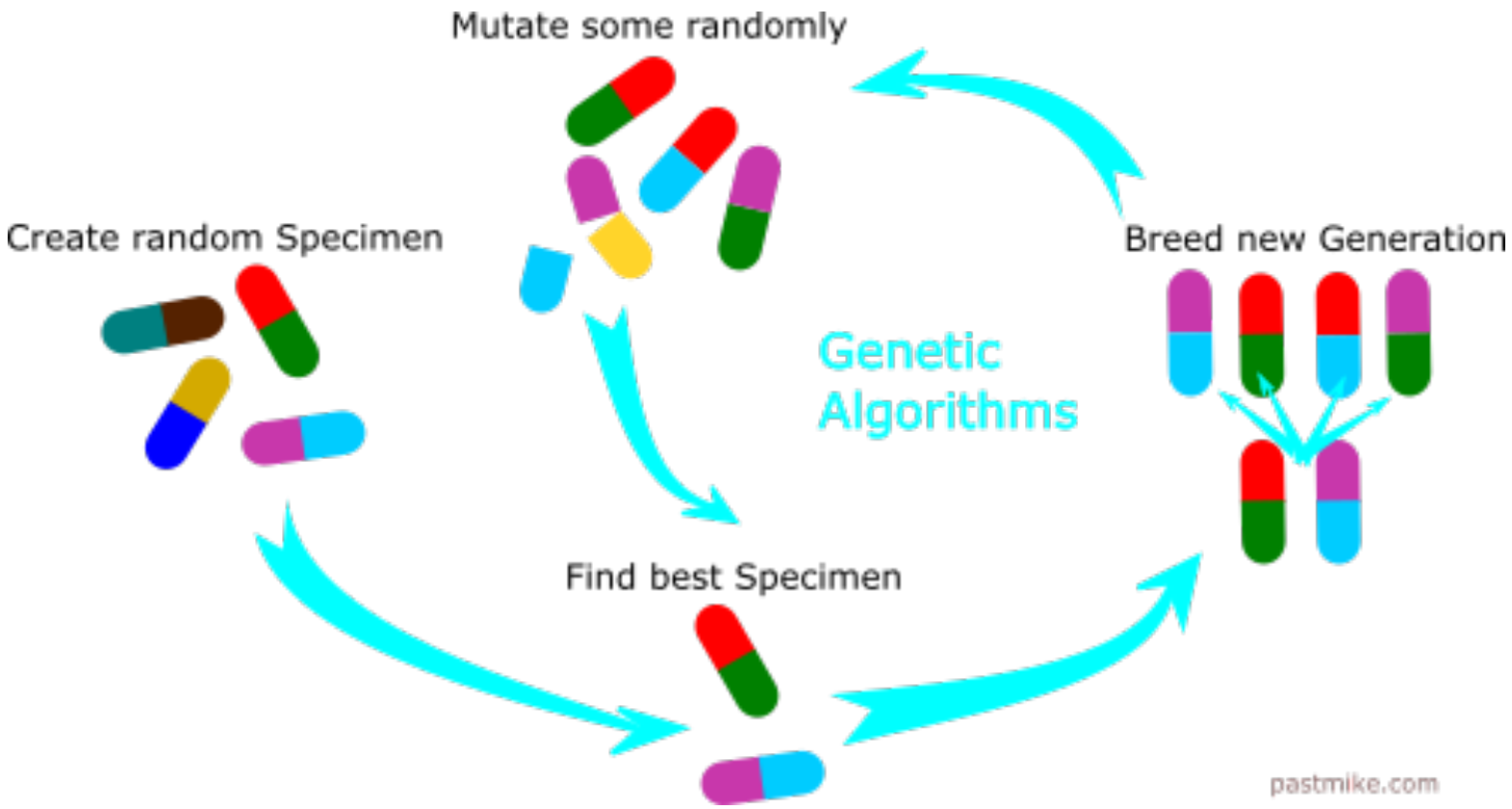


Linguistic variables



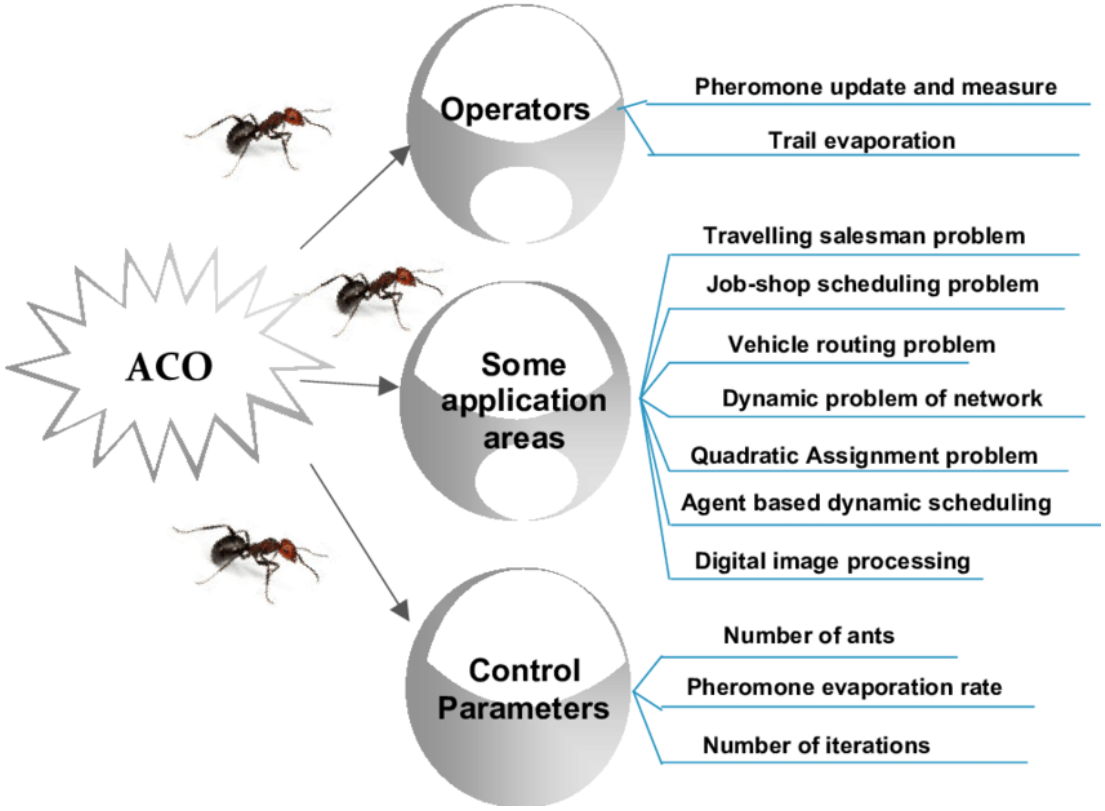
Fuzzy infenrece

Genetic Algorithms



Genetic Algorithms

Ant Colony Optimization



ACO scheme