Soft Computing

Lection 1

Introduction

What is SC?

"***Soft computing is a collection of methodologies that aim to exploit the tolerance for imprecision and uncertainty to achieve tractability, robustness, and low solution cost***.
Its principal constituents are fuzzy logic, neurocomputing, and probabilistic reasoning. Soft computing is likely to play an increasingly important role in many application areas, including software engineering. The role model for soft computing is the **human mind**."

[Zadeh, 1994]

What is SC?

Soft computing is not precisely defined.

It consists of distinct concepts and techniques which aim to overcome the difficulties encountered in real world problems. These problems result from the fact that our world seems to be imprecise, uncertain and difficult to categorize.

Possibly our world is uncertain really (see Quantum Theory, theory of relativity).
But question what is in reality and what is appeared in mind is senseless (R.A.Wilson, “Quantum Psychology”)

What is SC?

Another possible definition of soft computing is to consider it as an anti-thesis to the concept of computer we now have, which can be described with all the adjectives such as hard, crisp, rigid, inflexible and stupid. Along this track,
one may see soft computing as an attempt to **mimic natural creatures**: plants, animals, human beings, which are soft, flexible, adaptive and clever. In this sense soft computing is the name of a family of problem-solving methods that have analogy with biological reasoning and problem solving (sometimes
referred to as cognitive computing).

The basic methods included in cognitive computing are fuzzy logic (FL), neural networks (NN) and *genetic algorithms* (GA) - the methods which do not derive from classical theories.

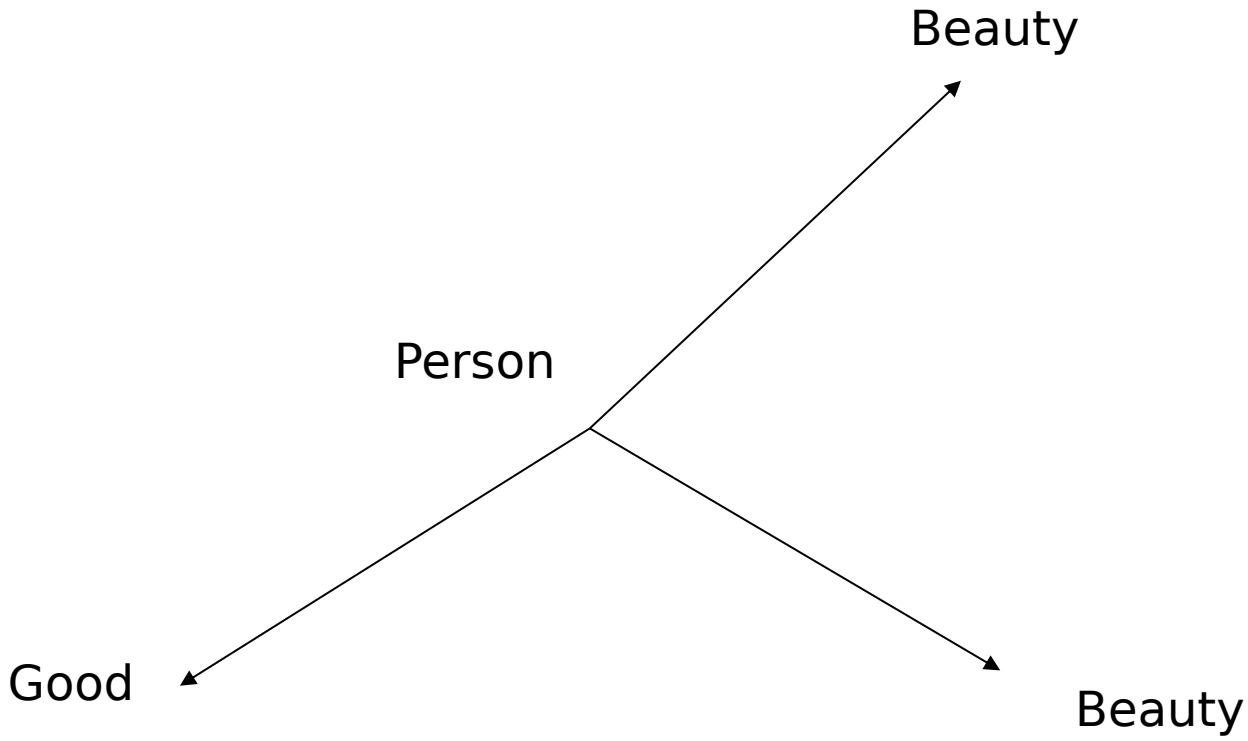
Reasons of necessary of uncertainty in AI

- Objective (features of whole environment)
  - Uncertainty of our world and limited capabilities of our senses
- Subjective (features of interaction with concrete environment)
  - Different experience of different persons and peoples, in particular, it maps on features of semantics of different languages

Single absolute truth is exist:

Absolute truths are not exist

Different representations of concepts by different persons



Different representations of concepts in different languages

The tools for soft computing

- Fuzzy logic models
- Neural networks
- Genetic algorithms
- Probabilistic reasoning

What is Fuzzy Logic Models?

Its are based on Fuzzy Set Theory by L.Zadeh

In classical set theory any Jones may member of this set or not, but not at once

In Fuzzy Set Theory Jones at once may be member of this set and no with any confidence

Examples of tasks solving by Fuzzy models

- Control of clothes washer
- Making of decision in diagnostic systems (expert systems in medicine, for example)
- Making of decision in business planning

May be used knowledge such as:

If *temperature* is *high* then *diagnose* is *grippe* with confidence 80%

If *speed* is *slow* then *increase transfer of fuel*

What is Neural Networks (NN)?

- NN consists of many number of simple elements (neurons) connected between them in system
- Whole system is able to solve of complex tasks and to learn for it like a natural brain
- For user NN is black box with Input vector (source data) and Output vector (result)

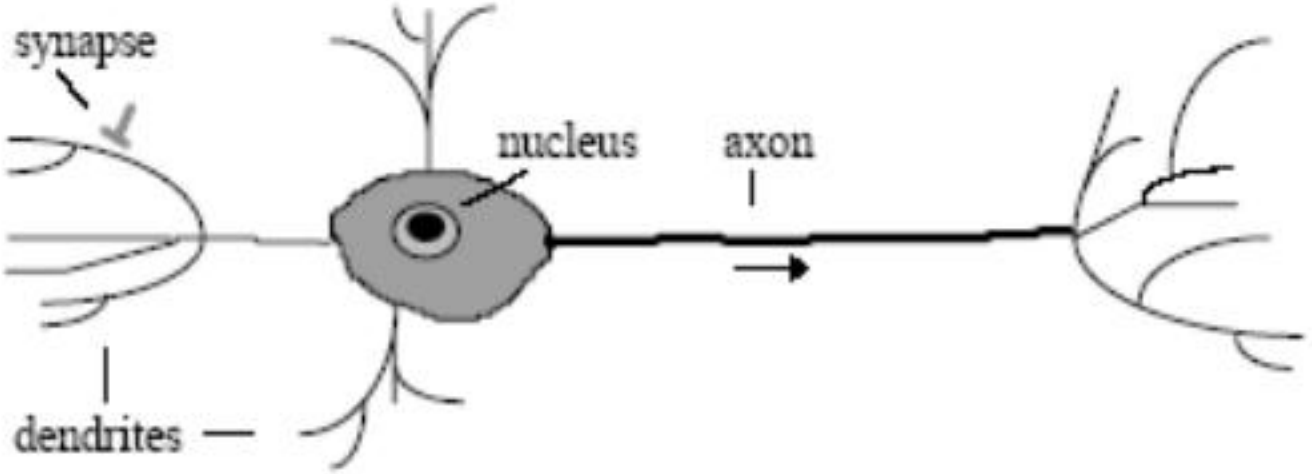
  Examples of tasks:

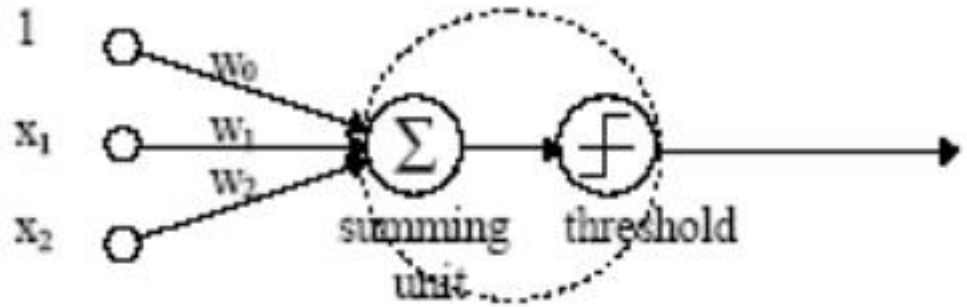
  Recognition of images (visual, speech and so on)

  Prediction of situations (cost of actions, currency)

  Classification and clusterization of images (for example, in diagnostic systems)

What is Neural Networks (NN)?





What is Genetic Algorithms or Evaluation Programming?

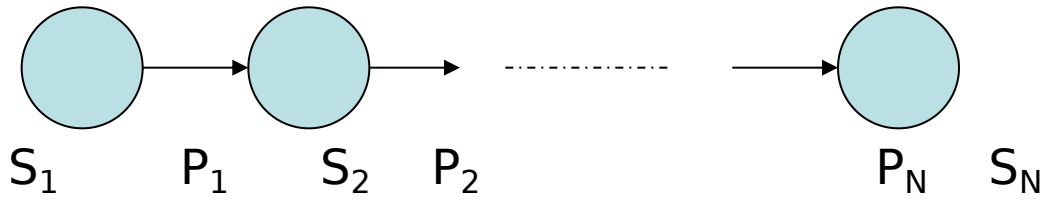
- Solving is described as vector of features
- Function of estimation of solving (of vector)
- Process of birth and selection of vectors of features
- Result is suboptimal solving of problem:

  Examples of application:
  Finding of optimal (suitable) path,
  Finding of better structure of neural network
  Finding of configuration of robot
  Optimal cutting

What is probabilistic reasoning?

- Uncertainty is described by probabilities
- Relations between events are described as conditional probabilities (Bayesian nets) or probabilities of transition probabilities (Markovian process)

  For example, action of system may be described as graph of states -



Examples of applications of probabilistic reasoning

- Recognition of speech
- Navigation of mobile robots
- And so on

Difference between fuzziness and probability (from modeling of world)

- Probability deal with unknown entity (time, property before any event). After any event the entity become known.
- Fuzziness is own property of any entity or (concept or object or property). It may be more or less but not disappears practically.
- May be fuzzy probability and probability of fuzziness
- Probability may be use for simulation of fuzziness