

Intelligent Systems/Computing

Intelligent Computing

- Ability of a computer to learn and predict from data or from some experimental observation
- Computing in terms of computer technology is a process of accomplishing a particular task with the help of a computer or a computing device.
- Solve complex problems quickly where traditional mathematical modelling fails
- Handles uncertainty
- Basically it uses methods close to human way of reasoning
- Able to produce actions in an adaptive way

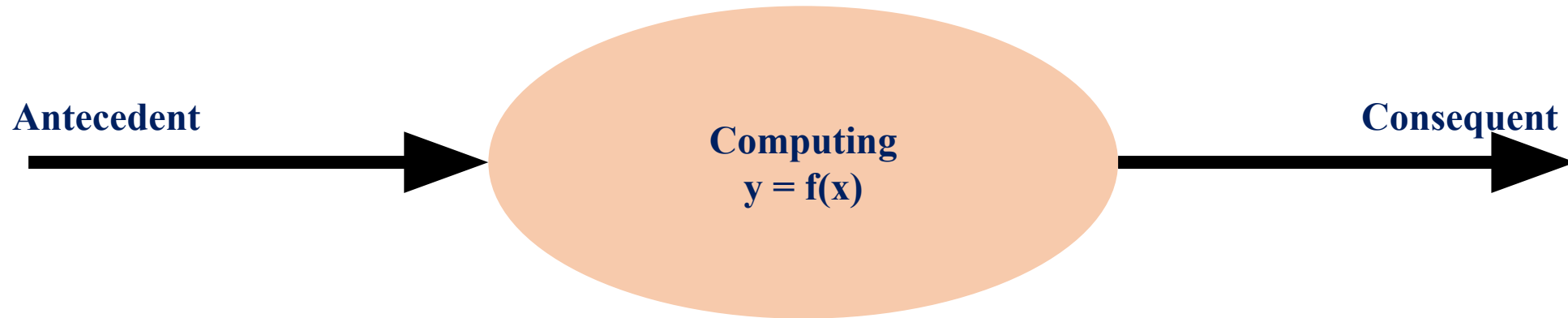
Intelligent Computing

- Can be viewed as a combination of several complementary problems, e.g.,
 - Intelligent Search
 - Machine Learning
 - Artificial Neural Network
 - Fuzzy Logic
 - Evolutionary Computation
- Branch of AI that is directly related to decision making, reasoning and inference is Computational Intelligence
- Computing can be of two types: Soft Computing and Hard Computing

Computing

- Concept of Computation
- Hard Computing
- Soft Computing
- Hard Computing vs Soft Computing
- Hybrid Computing

Concept of Computation



f is called the mapping function

f is also called a formal method or an algorithm to solve a problem

Important Characteristics of Computing

- Provides precise solution
- Control action must be unambiguous and precise
- Suitable for problems which are easy to model mathematically, i.e., for which algorithms can be formulated easily

Hard Computing

- LA. Zade introduced the term “hard computing” and “soft computing” in 1996-97
- According to him, a computing will be termed as hard computing if
 - Precise result is guaranteed
 - Control action is unambiguous and formally defined (i.e., with a mathematical model or algorithm)

Hard Computing Examples

- Solving numerical problems (e.g., roots of polynomials, integration, differentiation, etc.)
- Searching and sorting (consists of unambiguous steps and gives precise results)
- Computational geometry problems (e.g., shortest tour in a graph, finding closest pair of points given a set of points)

Soft Computing

According to LA Zadeh:

Soft computing is a collection of methodologies that aim to exploit the **tolerance of imprecision** and **uncertainty** to achieve tractability, robustness, and low solution cost. Its principal constituents are **fuzzy logic, neuro computing** and **probabilistic reasoning**. The role model for soft computing is the human mind.

Soft Computing: Characteristics

- It does not require any mathematical modeling of problem solving
- It may not yield precise solution
- Algorithms are adaptive and can adjust to the change of dynamic environment
- Use biologically inspired methodologies such as genetics, evolution, ant's behavior, particles swarming, human nervous system, etc.

Examples:

Hand-written character recognition (Can be solved with ANN)

Money allocation in different banks to maximize return (Can be solved with GA)

Find optimal path for a robot from source to destination (Can be solved with Fuzzy Logic)

How Soft Computing?

- How teacher teaches a student? Motivation for ANN
 - Teachers asks questions and tell the answers then
 - Teacher puts questions and possible answers and asks whether the answers are correct or not
 - Student learns a topic and stores in memory
 - Based on the knowledge gained he can solve new problems
- How world selects the best? Motivation for GA
 - Starts with a population (random)
 - Reproduces another population
 - Selects superior individuals based on ranking
 - GA is based on natural phenomenon
 - Here, population is synonymous to solutions
 - Selection of superior solution is synonymous to exploring the optimal solution

How Soft Computing?

- How doctor treats his patient? Motivation for Fuzzy Logic
 - Doctor asks a patient about his/her problem/sufferings
 - Doctor understands the symptoms and based on his knowledge he predicts the most probable illness
 - Doctor prescribes tests and/or medicines fuzzily
 - Symptoms are correlated with diseases with uncertainty

Soft Computing

- ❖ The idea behind soft computing is to model cognitive behavior of human mind.
- ❖ With the human mind/brain as a role model, soft computing is tolerant of partial truths, uncertainty, imprecision and approximation, unlike traditional computing models.
- ❖ Soft computing is foundation of conceptual intelligence in machines.
- ❖ Use inexact solution to computationally hard tasks (such as solution for NP-Complete problems, for which there is no known algorithm that can compute an exact solution in polynomial time). The approach makes use of approximate solutions to solve problems that may be either unsolvable or too time-consuming to solve with current hardware.
- ❖ Imprecise but usable solutions to complex computational problems allowing researchers to approach some problems that traditional computing cannot process.
- ❖ Unlike hard computing, soft computing is tolerant of imprecision, uncertainty, partial truth, and approximation.

Soft Computing vs Hard Computing

- ❖ The soft computing model is imprecision tolerant, partial truth, approximation. On the other hand, hard computing does not work on the above-given principles; it is very accurate and certain.
- ❖ Soft computing can evolve its own programs, whereas hard computing requires programs to be written.
- ❖ Soft computing employs fuzzy logic and probabilistic reasoning while hard computing is based on crisp systems.
- ❖ Hard computing has features such as precision and categoricity. As against, approximation and dispositionality are the characteristics of soft computing.
- ❖ Soft computing can be easily operated on the noisy and ambiguous data. In contrast, hard computing can work only on exact input data.
- ❖ Soft computing can produce approximate results while hard computing generates precise results.
- ❖ Soft computing needs robustness rather than accuracy. Opposite is true for hard computing.

Why Soft Computing is Useful?

- ❖ The conventional computing approach i.e., hard computing is effective when it comes to solving a deterministic problem.
- ❖ But as the problem grows in size and complexity, the design search space also increases.
- ❖ This makes it difficult to solve an uncertain and imprecise problem by hard computing.
- ❖ So, soft computing has emerged as the solution to the hard computing which also provides a lot of benefits such as fast computation, low cost, elimination of the predefined software, etc.

THANK YOU