Introduction to Soft Computing

Soft Computing:

- *Soft computing* is an umbrella term used to describe types of algorithms that produce approximate solutions.

- Soft computing, as opposed to traditional computing, deals with approximate models and gives solutions to complex real-life problems.

- The principle of soft computing is to exploit the tolerance for imprecision, uncertainty, partial truth, and approximation to achieve tractability, robustness, and low solution cost. (L.A. Zadeh, 1965)

Hard Computing vs Soft Computing

Hard Computing:

Hard computing is traditional computing. It requires a precisely stated analytical model and usually a lot of computation time. It strictly follows known steps to solve a task

- Based on the clearly written algorithm (structured)
- Based on mathematical formulae
- Mathematical formula (algorithm, program)
- Intelligence is missing
- It is deterministic in nature.
- The input data should be exact and the output will be precise and verifiable.
- Deals with binary logic (0 or 1, true or false) and follows strict mathematical models.

Hard Computing:

Hard computing relies on deterministic algorithms (*produce the same output for a given input every time they are run*) to ensure precision and accuracy.

For example, traditional numerical methods, sorting algorithms, and algorithms for solving linear equations are deterministic and form the backbone of hard computing.

Advantages:

- Accurate solutions can be obtained
- Faster

Disadvantages:

- Not suitable for real-world problems

Soft Computing

Soft computing is the use of approximate calculations to provide imprecise but usable solutions to complex computational problems.

- Emphasizes approximation, uncertainty, and adaptability.
- Suitable for real-world problems where precision is less critical, and flexibility is more important.
- In contrast with hard computing which deals with the models that can provide precise solutions.
- Includes techniques like fuzzy logic, genetic algorithms, neural networks, and probabilistic reasoning.

Soft Computing

- *Prof Lotfi Zadeh* introduced the term, Soft Computing.

- The objective was to emulate the human mind as closely as possible. The word, soft means flexible, adjustable, random, vague, approximate, imprecise, perceivable and non-deterministic.

- Soft computing utilizes non-deterministic algorithms to handle complex, ill-defined problems where an approximate solution is acceptable.

- Fusion of soft and hard computing techniques are also useful in applications such as robotics.

Soft Computing

Advantages:

- Robustness
- Low cost
- Ability to solve complex problem

Applications:

It has enormous applications in many application areas such as medical diagnosis, computer vision, handwritten character recondition, pattern recognition, speech recognition, machine intelligence, data compression, weather forecasting, network optimization, VLSI design and many more...
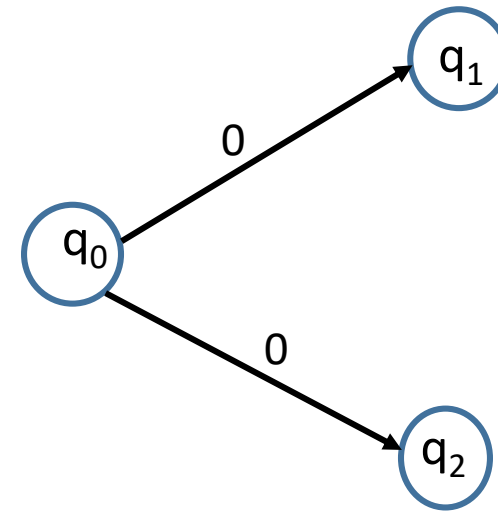
Deterministic vs Non-Deterministic

A deterministic algorithm produces only a single output for the same input even on different runs.

Non-deterministic A non-deterministic algorithm can provide different outputs for the same input on different runs.
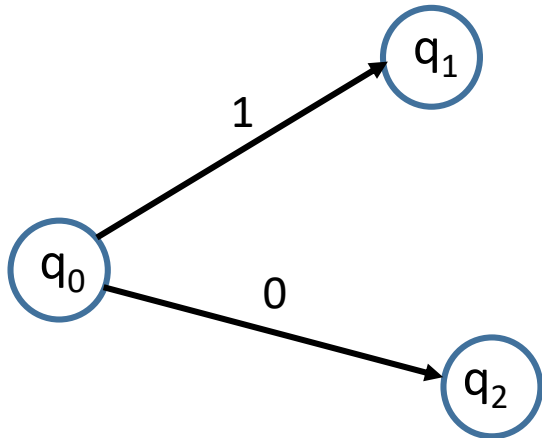
Deterministic algorithm

Non - deterministic algorithm

Heuristic Approach:

- A heuristic technique, often called simply a heuristic, is any approach to problem solving, learning, or discovery that employs a practical method not guaranteed to be optimal or perfect, but sufficient for the immediate goals.

- Where finding an optimal solution is impossible or impractical, heuristic methods can be used to speed up the process of finding a satisfactory solution.

- Heuristics are a method of problem solving which *uses shortcuts in a given limited time frame* to produce an approximate solution.