SOFT COMPUTING

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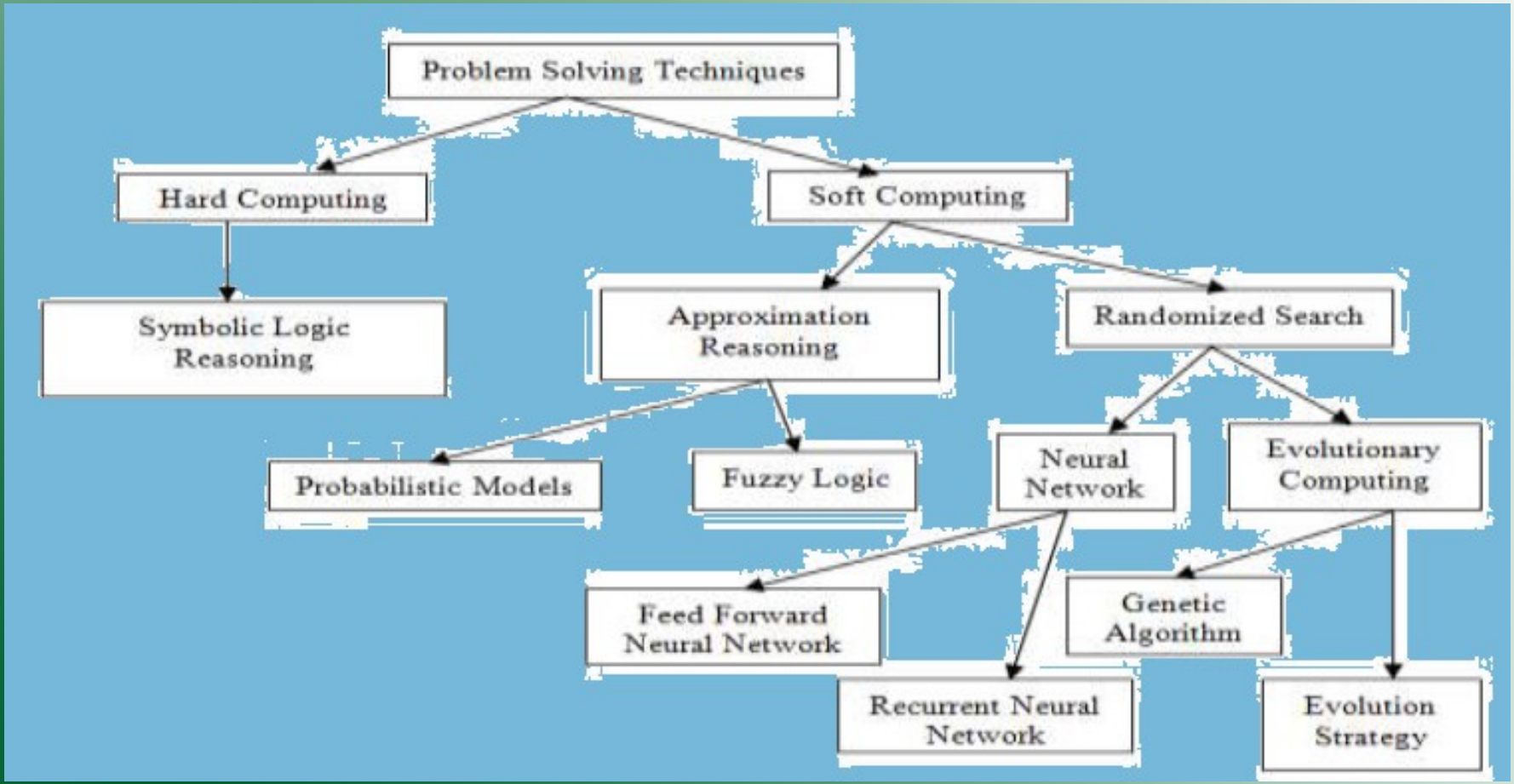
Introduction

- Logical and theoriotical problems – easy to solve by general algorithms
- Difficult to solve problems with huge resource requirements and computation time
- These problems work very systematically and coherently when solved by naturally method, a near optimal solution is sometimes enough in most practical situations.
- So these types of situations could be handled by biologically inspired methods called soft computing

Problem Solving Techniques



Problem Solving Techniques

- Soft computing is based on knowledge, common sense, and reasoning and on natural as well as artificial ideas
- Two types of problem solving technologies are Hard Computing and Soft Computing
- Hard computing deals with the precise model where exact and accurate solutions are obtained
- Soft computing is based on approximate models. It is different from hard computing i.e. conventional computing which involves symbolic logic reasoning and totally passed on numerical modeling and search

Soft Computing

- The guiding principle of soft computing is to exploit the tolerance for imprecision, uncertainty, and partial truth to achieve tractability, robustness, low solution cost, better rapport with reality
- Difficult to control the growing complexity of modern machinery using traditional control systems techniques
- Many nonlinear and time-variant plants with large time delays cannot easily be controlled and stabilized using traditional techniques.
- One of the reasons for this difficulty is the lack of an accurate model that describes the plant.
- Soft computing is proving to be an efficient way of controlling such complex plants

Soft Computing

- Soft computing is not a single method, but instead it is a combination of several methods, such as fuzzy logic, neural networks, and genetic algorithms. All these methods are not competitive
- Complimentary to each other and can be used together to solve a given problem.
- It can be said that soft computing aims to solve complex problems by exploiting the imprecision and uncertainty in decision making processes
- *The principal constituents,* are – Fuzzy Logic (FL), Neural Networks (NN), Support Vector Machines (SVM), Evolutionary Computation (EC), and – Machine Learning (ML) and Probabilistic Reasoning (PR)

Soft Computing

- Soft computing differs from conventional (hard) computing in that, unlike hard computing, it is tolerant of imprecision, uncertainty, partial truth, and approximation
- Premises of soft computing:
  - The real world problems are pervasively imprecise and uncertain
  - Precision and certainty carry a cost
- Principles of soft computing: Exploit the tolerance for imprecision, uncertainty, partial truth, and approximation to achieve tractability, robustness and low solution cost.

Soft Computing

- Implications of soft computing:
  - Soft computing employs NN, SVM, FL etc, in a complementary rather than a competitive way.
  - One example of a particularly effective combination is what has come to be known as "neurofuzzy systems."
  - Such systems are becoming increasingly visible as consumer products ranging from air conditioners and washing machines to photocopiers, camcorders and many industrial applications.

Soft Computing

- Unique Property of Soft Computing
  - Learning from experimental data
  - Soft computing techniques derive their power of generalization from approximating or interpolating to produce outputs from previously unseen inputs by using outputs from previous learned inputs
  - Generalization is usually done in a high dimensional space.

Artificial Neural Networks

- ANNs are information processing systems that are inspired by the way biological nervous system and the brain works
- ANNS work best if the relationship between the inputs and outputs are highly non-linear
- ANNs are highly suitable for solving problems where there are no algorithms or specific set of rules to be followed in order to solve the problem
- A neural network is a large network of interconnected elements called neurons.
- Each neuron performs a little operations and the overall operation is the weighted sum of these operations

Artificial Neural Networks

- A neural network has to be trained
- The learning can either be *supervised*, or *unsupervised*
- In supervised learning the network under investigation is trained by giving it inputs and matching output patterns
- In unsupervised learning the output of the network is trained to respond to input patterns
- An ANN is basically composed of three layers: input, hidden layer, and output, where each layer can have number of nodes

Artificial Neural Networks

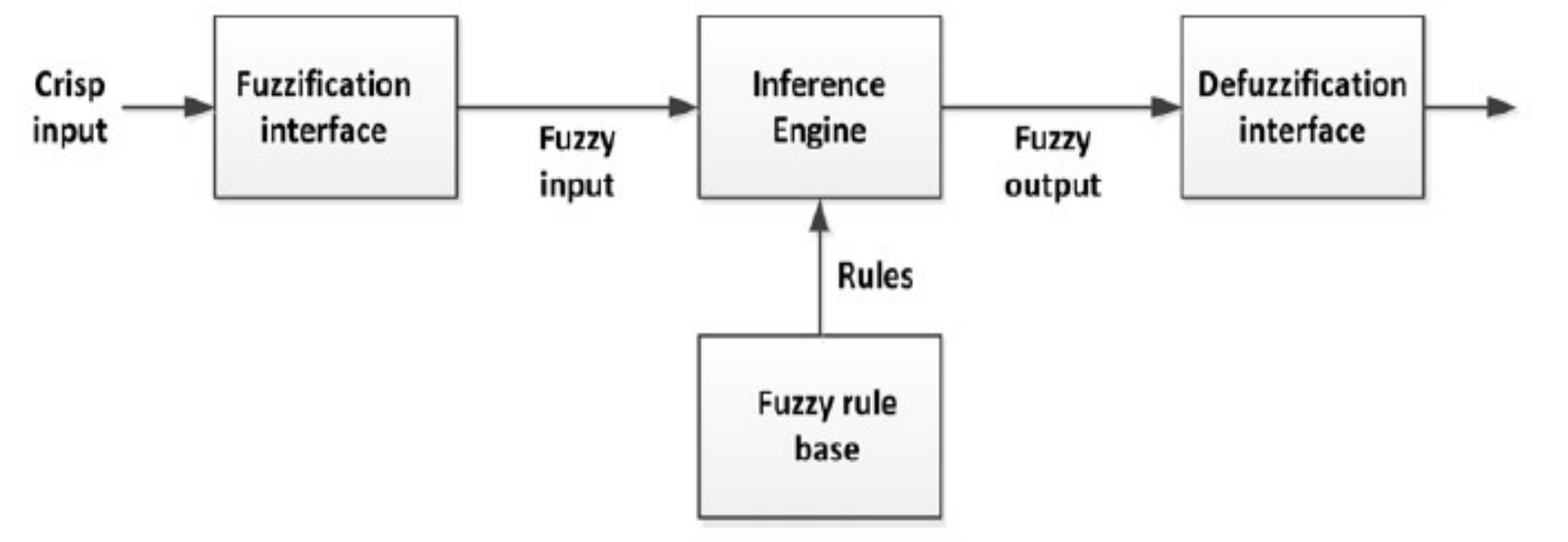
- Some of the advantages and disadvantages of neural networks are:
  - ANNs are not universal tools for solving problems as there is no methodology for training and verifying an ANN
  - The result of an ANN depends upon the accuracy of the available data
  - Excessive training may be required in complex ANN systems
  - ANNs can deal with incomplete data sets
  - ANNs are successful in prediction and forecasting applications15

Fuzzy logic

- The fuzzification interface transforms the crisp input value into a fuzzy linguistic value
- The fuzzification is always necessary in a fuzzy logic system since the input values from existing sensors are always crisp numerical values
- The inference engine takes the fuzzy input and the fuzzy rule base and generates fuzzy outputs
- The fuzzy rule base is in the form of “IF-THEN” rules involving linguistic variables
- The last processing element of a fuzzy logic system is the defuzzification which has the task of producing crisp output actions

Fuzzy logic

- Perhaps one of the biggest advantage of fuzzy logic is that it offers a practical way for designing nonlinear control systems which are difficult to design and stabilize using traditional methods



Support Vector Machines

- A set of related supervised learning methods used for classification and regression
- A support vector machine constructs a hyperplane set of hyperplanes in a high or infinite dimensional space, which can be used for classification, regression or other tasks

Genetic Algorithms in Evolutionary Computation

- A genetic or evolutionary algorithm applies the principles of evolution found in nature to the problem of finding an optimal solution to a Solver problem
- An evolutionary algorithm for optimization is different from "classical" optimization methods in several ways:
  - Random Versus Deterministic Operation
  - Population Versus Single Best Solution
  - Creating New Solutions Through Mutation
  - Combining Solutions Through Crossover
  - Selecting Solutions Via "Survival of the Fittest"

Importance of Soft Computing

- The complementarily of soft computing has an important consequence: in many cases a problem can be solved most effectively by using technique in combination rather than exclusively
- Neuro-fuzzy system
- The employment of soft computing techniques leads to systems which have high MIQ (Machine Intelligence Quotient)

Applications

- Dandwriting Recognition
- Image Processing and Data Compression
- Automotive Systems and Manufacturing
- Soft Computing to Architecture
- Decision-support Systems
- Soft Computing to Power Systems
- Neuro Fuzzy systems
- Fuzzy Logic Control
- Machine Learning Applications
- Speech and Vision Recognition Systems
- Process Control and So On

Thank You!