

# Soft Computing (CS1503)

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# *Instructor*

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## Evaluation Pattern

1. End Semester and Mid semester as per Institute rule
2. Teacher Assessment will divided as follows
  - a) Unit Project : At the end of each unit student have to implement one small project (Total- 10 marks)
  - b) Course project: After mid semester each group (3 students) have to implement a course project and every group have to present the work. (10 marks)
  - c) Quiz, Involvement in class and Attendance – 10 marks

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## Pre-requisites of the course

- ✓ High school mathematics
- ✓ C/C++ programming skill, MatLab, Python etc
- ✓ Probabilistic Methods
- ✓ Basics of calculus
- ✓ Set theory, matrix and determinant

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# Course Plan

## **Introduction to fuzzy set theory**

Probabilistic reasoning, Fuzzy sets, mathematics of fuzzy set theory, operations on fuzzy sets, comparison of fuzzy and crisp set theory.

## **Fuzzy mapping**

one to one mapping, max-min principle, extension principle, implication rules – mamdani implications. Membership functions: Universe of discourse, mapping inside fuzzy domain, fuzzy membership mapping methods, and application to real world problems.

## **Artificial Neural Networks (ANN)**

Artificial Neural Networks (ANN) and their biological roots and motivations. Comparison between Artificial and Biological Neural Networks, Applications of Neural network. Network Architecture, Merits and limitations of neurocomputing.

**Types of learning**, supervised and unsupervised learning laws . Learnig Laws : Hebb's rule, Delta rule, Widrow - Hoff (The Least-Mean-Square ) learning rule, correlation learning rule, instar and outstar learning rules.

**The Perceptron and its learning law**, Classification of linearly separable patterns, Multi-Layer Perceptron, Supervised Learning, Back-Propagation Learning law. Feed forward networks, Recurrent Networks.

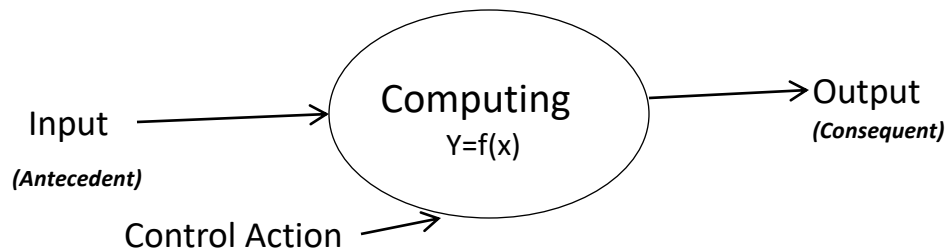
# What is Soft Computing

Concept of Computing

- Hard Computing
- Soft Computing

How Soft Computing

- Hard Computing Vs Soft Computing
- Hybrid Computing



$Y=f(x)$ ,  $f$  is mapping function

$f$ , is also called a **formal method** or an **algorithm** to solve a problem.

Computing is nothing but mapping of set of inputs to outputs.

# What is Soft Computing ?

## (Ref: L.A. Zadeh)

Soft computing differs from conventional (hard) computing in that, unlike hard computing, it is tolerant of imprecision, uncertainty, partial truth, and approximation. In effect, the role model for soft computing is the human mind.

# Important Characteristics of Computing

- Should provide **precise** solution.
- It should follow a unambiguous and **accurate**.
- Suitable for problem, which is easy to **model mathematically**.

## Hard Computing

- In 1996, L. A. Zade (LAZ) introduced the term **Hard Computing**.
- According to LAZ: We term a computing as Hard Computing, if
  - **Precise** result is **guaranteed**.
  - Control action is **unambiguous**.
  - control action if **formally defined**.



# What is Hard Computing ?

- Hard computing, i.e., conventional computing, requires a precisely stated analytical model and often a lot of computation time.
- Many analytical models are valid for ideal cases.
- Real world problems exist in a non-ideal environment.

## Examples of Hard Computing

- Solving numerical problems (for example roots of polynomials, integrations etc).
- Searching and Sorting Algorithms.

# What is Soft Computing ?

The principal constituents, i.e., tools, techniques, of Soft Computing (SC) are

- Fuzzy Logic (FL),
- Artificial Neural Networks (ANN),
- Evolutionary Computation (EC),
- Swarm Intelligence (i.e. Ant colony optimization and Particle swarm optimization, )
- Additionally Some Machine Learning (ML) and Probabilistic Reasoning (PR) areas.

# Premises of Soft Computing

- The real world problems are pervasively imprecise and uncertain
- Precision and certainty carry a cost

The guiding principle of soft computing is:

- Exploit the tolerance for imprecision, uncertainty, partial truth, and approximation to achieve non-conventional solutions, tractability (easily handled, managed, or controlled), robustness and low costs.



# Hard Computing

- Premises and guiding principles of Hard Computing are
  - Precision, Certainty, and Rigor.
- Many contemporary problems do not lend themselves to precise solutions such as
  - Recognition problems (handwriting, speech, objects, images, texts)
  - Mobile robot coordination, forecasting, combinatorial problems etc.
  - Reasoning on natural languages

# Implications of Soft Computing

- Soft computing employs ANN, EC, FL etc, in a complementary rather than a competitive way.
- One example of a particularly effective combination is "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.

# Unique Property of Soft computing

- Learning from experimental data → generalization
- 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.

# Current Applications using Soft Computing

- Handwriting recognition
- Automotive systems and manufacturing
- Image processing and data compression
- Architecture
- Decision-support systems
- Data Mining
- Power systems
- Control Systems

# Future of Soft Computing

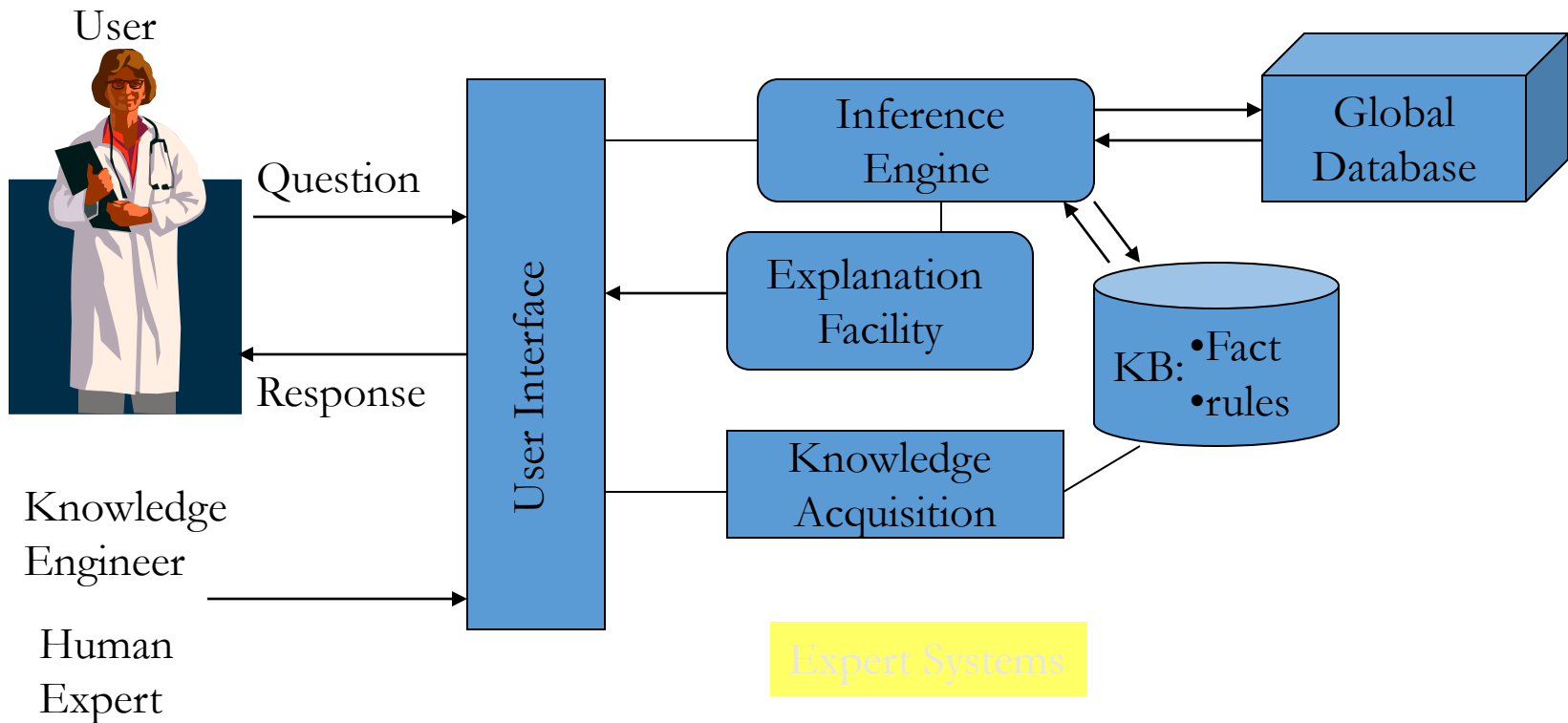
## (Ref: L.A. Zadeh)

- Soft computing is likely to play an especially important role in science and engineering, but eventually its influence may extend much farther.
- Soft computing represents a significant paradigm shift in the aims of computing
  - A shift which reflects the fact that the human mind, unlike present day computers, possesses a remarkable ability to store and process information which is pervasively imprecise, uncertain and lacking in categoricity.

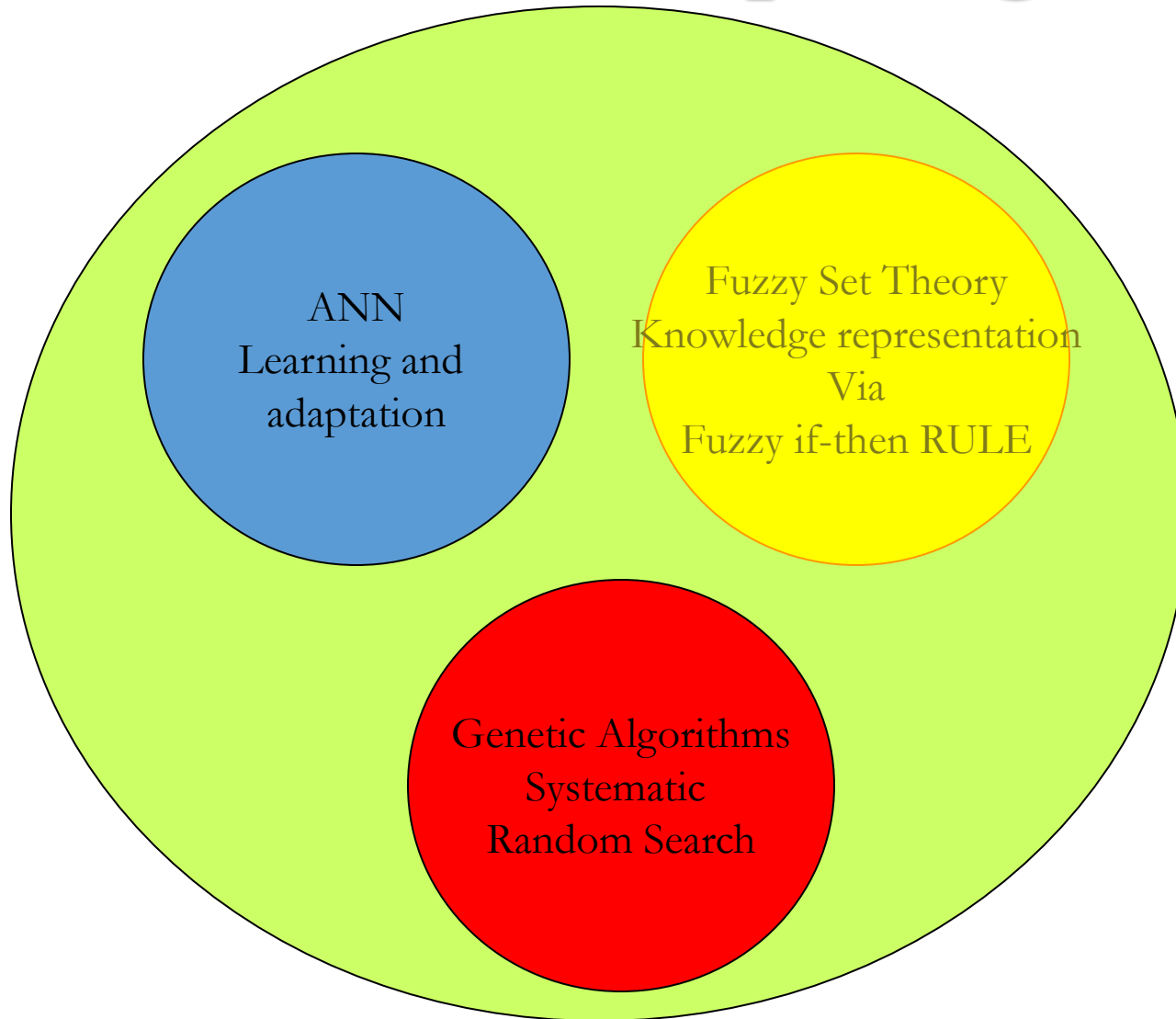


# AI and Soft Computing: A Different Perspective

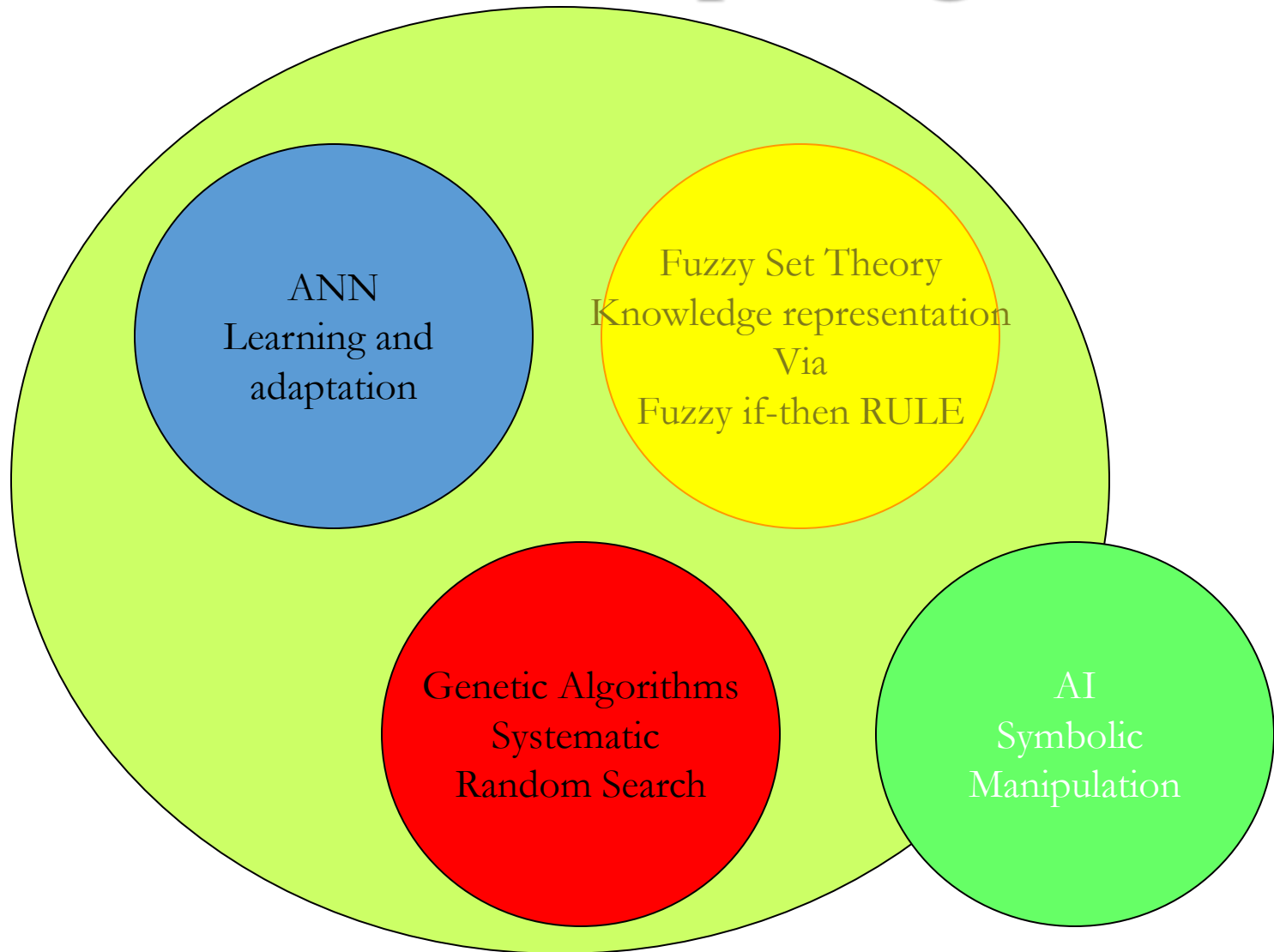
- AI: predicate logic and symbol manipulation techniques



# AI and Soft Computing



# AI and Soft Computing



# AI and Soft Computing

