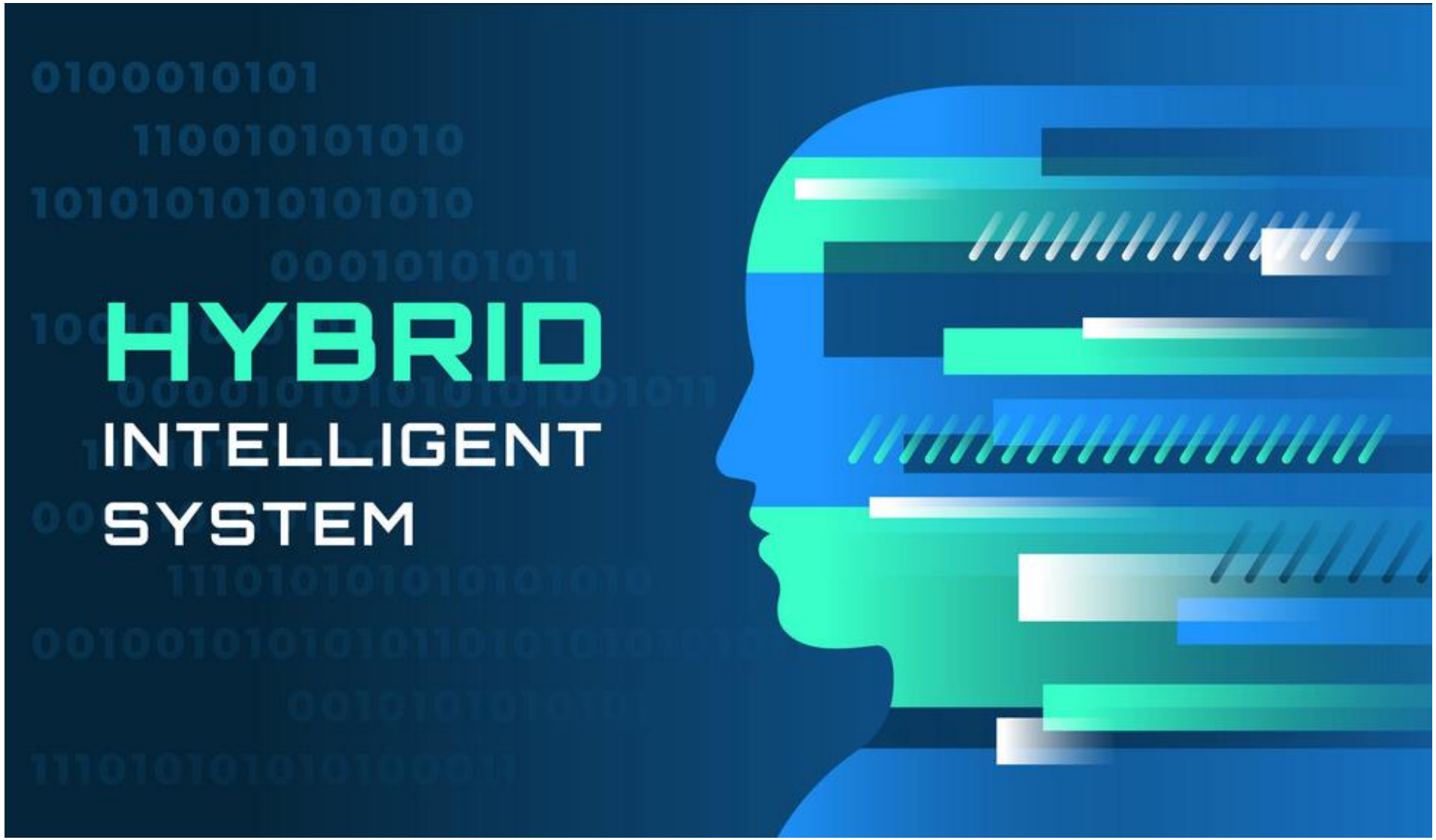
20IS603 Architecture of Intelligent Systems



Hybrid Systems

- Combines at least two intelligent technologies.
- The combination of probabilistic reasoning, fuzzy logic, neural networks and evolutionary computation forms the core approach to build hybrid intelligent systems capable of reasoning and learning in an uncertain and imprecise environment.
- Denotes a system which employs, in parallel, a combination of methods and techniques from artificial intelligence subfields.
- For example, combining a neural network with a fuzzy system results in a hybrid neuro-fuzzy system

Hybrid Systems (2)

- Comparison of Expert Systems, Fuzzy Systems, Neural Networks and Genetic Algorithms

	ES	*FS*	*NN*	*GA*
Knowledge representation	▫	▪	□	▫
Uncertainty tolerance	▫	▪	▪	▪
Imprecision tolerance	□	▪	▪	▪
Adaptability	□	▫	▪	▪
Learning ability	□	□	▪	▪
Explanation ability	▪	▪	□	▫
Knowledge discovery and data mining	□	▫	▪	▫
Maintainability	□	▫	▪	▫

* The terms used for grading are:

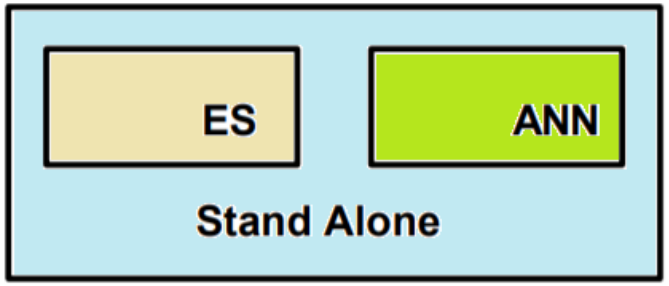
□ - bad, ▫ - rather bad, ▪ - rather good and ▪ - good

Hybrid Systems (3)

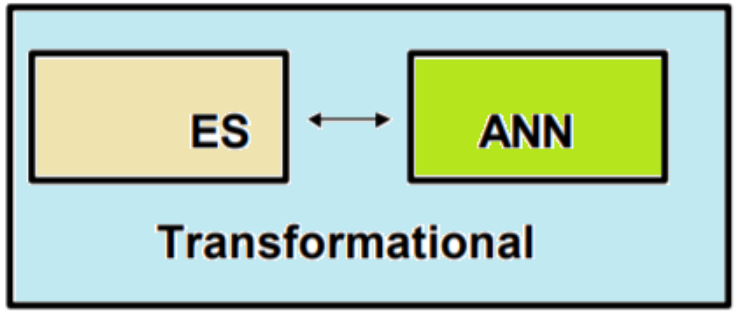
- *Dealing with multifaceted problems*
  - Most real-life problems are complex and have many facets, where each facet may be best suited to a different technique.
- *Capability enhancement*.
  - One technique may be used within another to enhance the latter's capabilities.
- *Parameter setting*
  - One technique to set the parameters of another
- *Clarification and verification*
  - Extract equivalent rules automatically and apply additional knowledge to check the validity of the output.

Hybrid Architecture Models

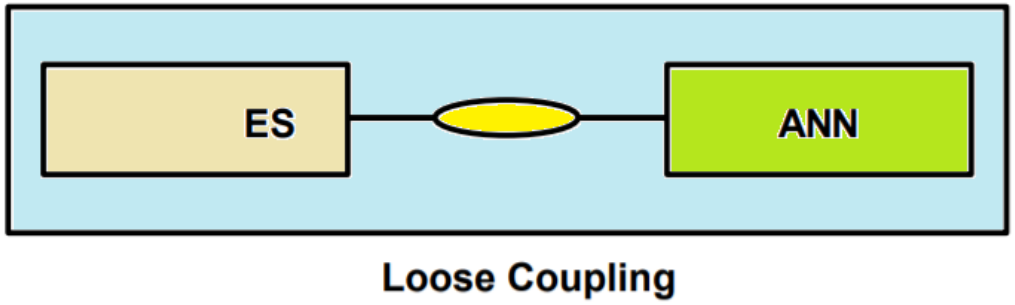
- Stand-Alone Models
  - Independent, non-interacting components
  - Allows comparison of the two



- Transformational Mode
  - Systems begin as one type and end up as another

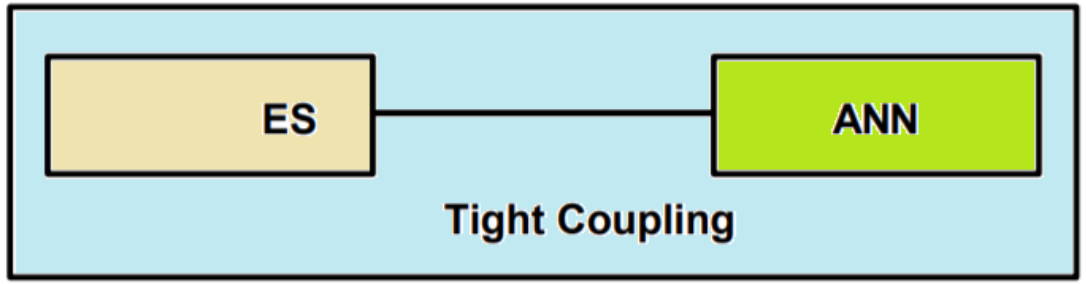


- Loosely-Coupled Models
  - Application decomposed into separate components
  - Output of one passed to the other through data files

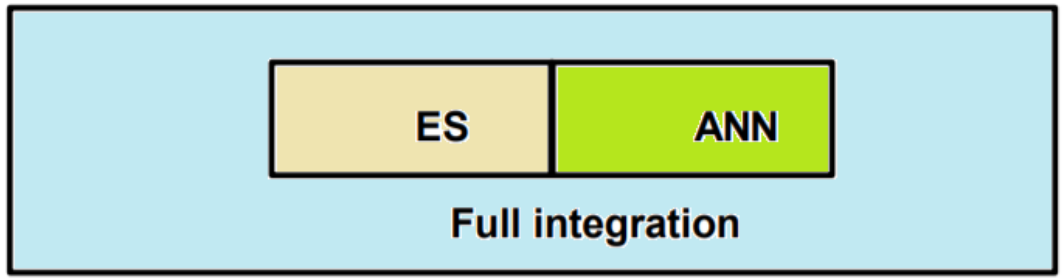


Hybrid Architecture Models

- Tightly-Coupled Models
  - Communication through memory instead of files

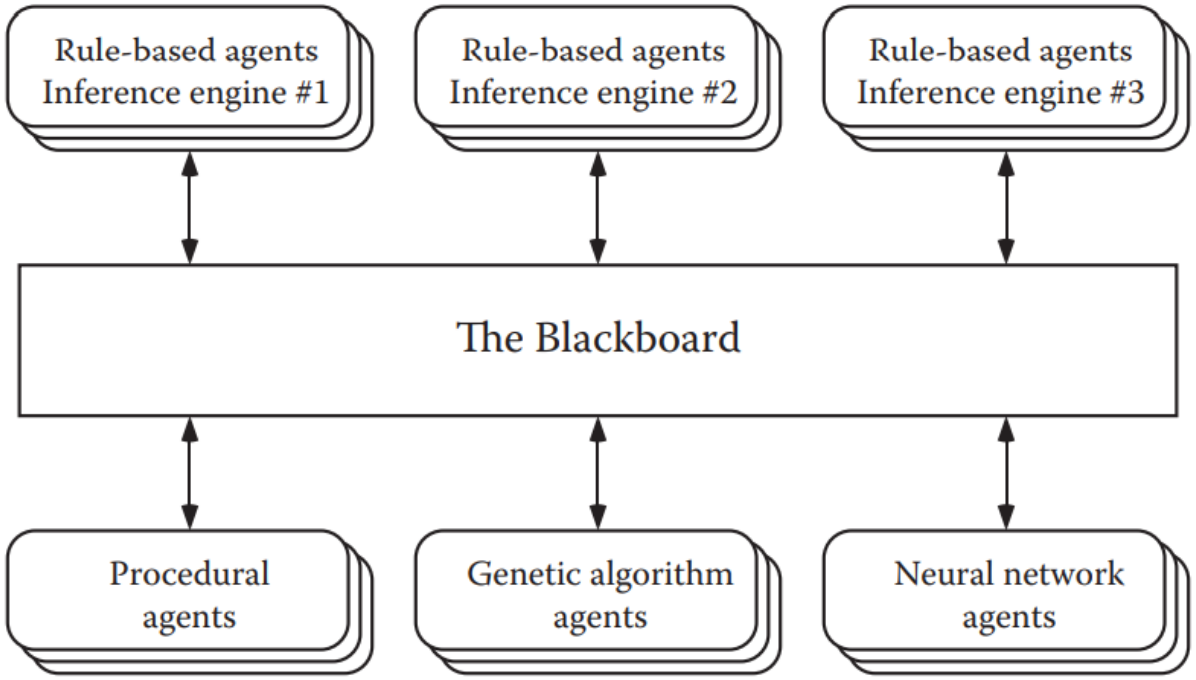


- Full-Integrated Models
  - Components share data structures and knowledge representations



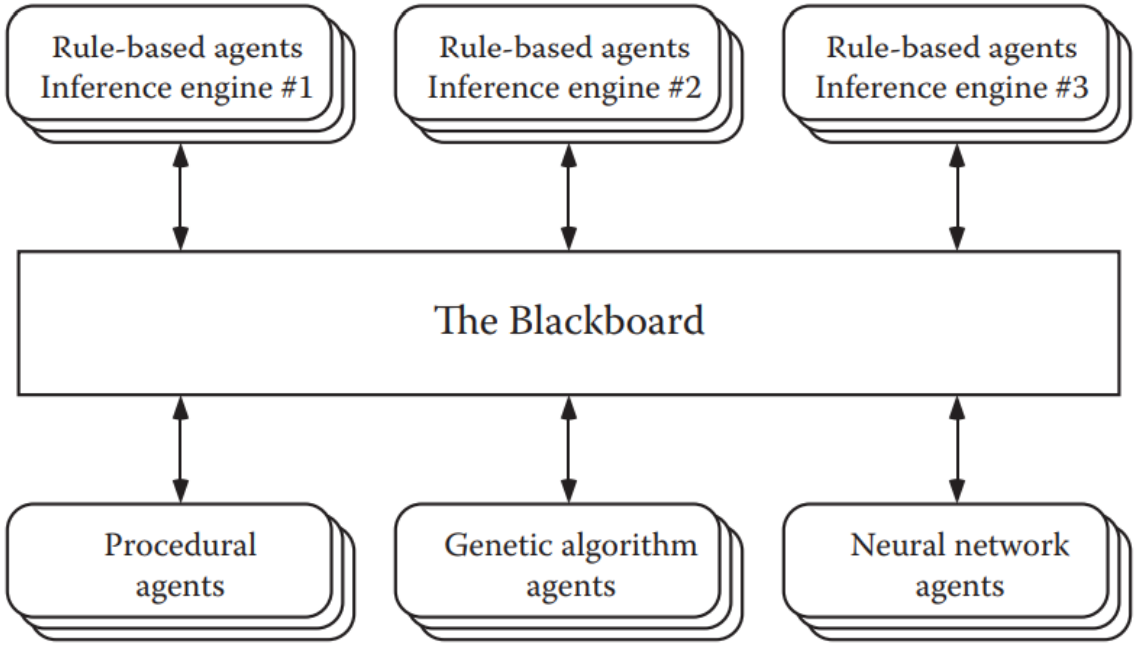
Blackboard Systems for Multifaceted Problems

- Blackboard - a globally *accessible working memory*.
- A blackboard system is analogous to a *team of experts* who communicate their ideas via a physical blackboard, by adding or deleting items in response to the information that they find there.
- Each agent represents an expert having a specialized area of knowledge designed to *tackle a particular subtask*.
- The agents are independent and can communicate only by reading from or writing to the blackboard.
- The agents can also delete unwanted information from the blackboard.



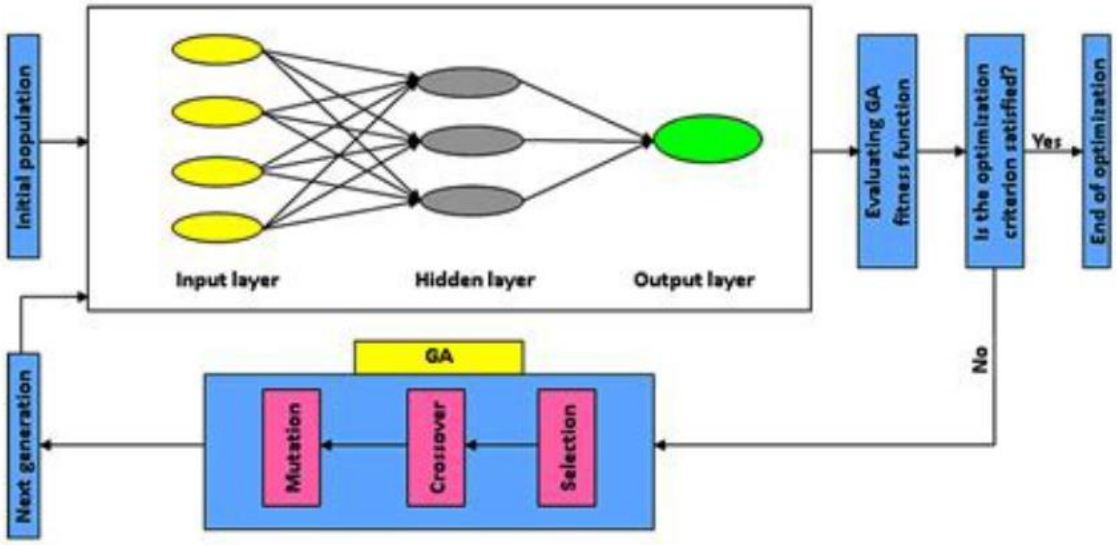
Blackboard Systems for Multifaceted Problems

- Blackboard systems offer a mechanism for the collaborative use of different computational techniques such as rules, neural networks, genetic algorithms, and fuzzy logic.
- Agents are applied in response to information on the blackboard, when they have some contribution to make.
- This leads to increased efficiency, since the detailed knowledge within an agent is only applied when that agent becomes relevant.



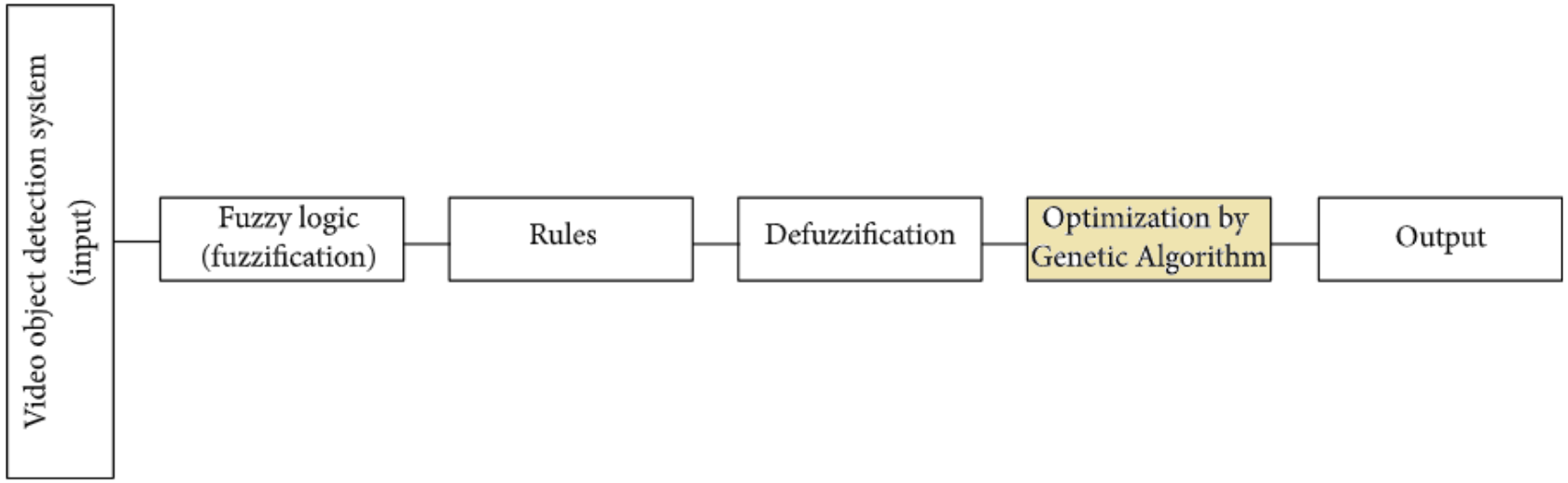
Parameter Setting

- Genetic–Neural Systems
  - Supervised training of a neural network involves adjusting its weights until the output patterns obtained for a range of input patterns are as close as possible to the desired patterns.
  - Uses a genetic algorithm to train the network - by letting each gene represent a network weight - is mapped onto an individual chromosome.
  - Each chromosome can be evaluated by testing a neural network with the corresponding weights against a series of test patterns.
  - A fitness value can be assigned according to the error, so that the weights represented by the fittest generated individual correspond to a trained neural network.



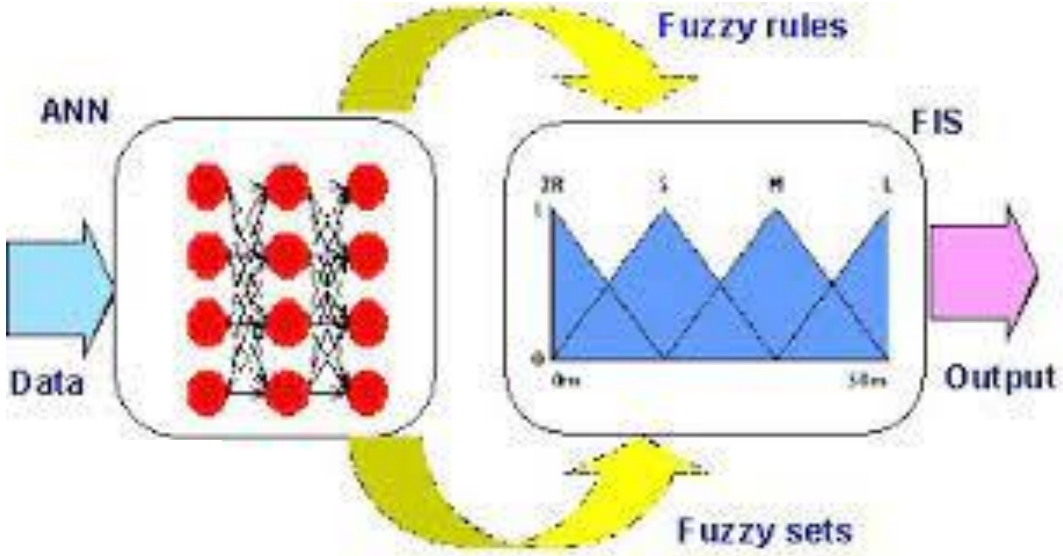
Parameter Setting

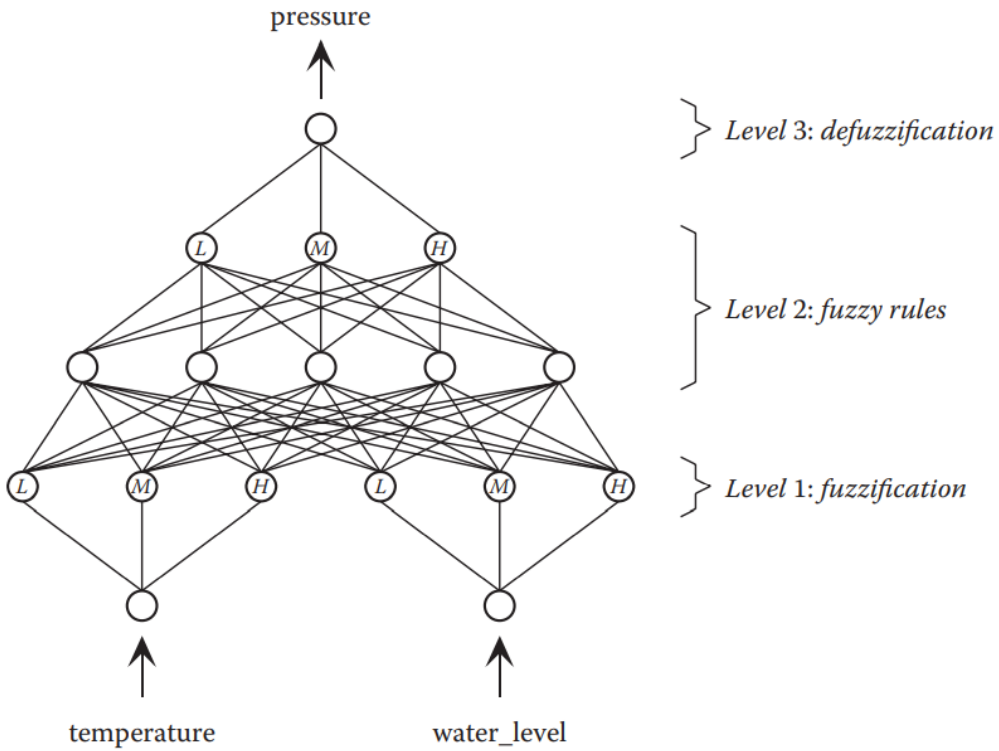
- Genetic–Fuzzy Systems
  - The performance of a fuzzy system depends on the definitions of the fuzzy sets and on the fuzzy rules.
  - As these parameters can all be expressed numerically, it is possible to devise a system whereby they are learned automatically using genetic algorithms.
  - A chromosome can be devised that represents the complete set of parameters for a given fuzzy system.



Capability Enhancement

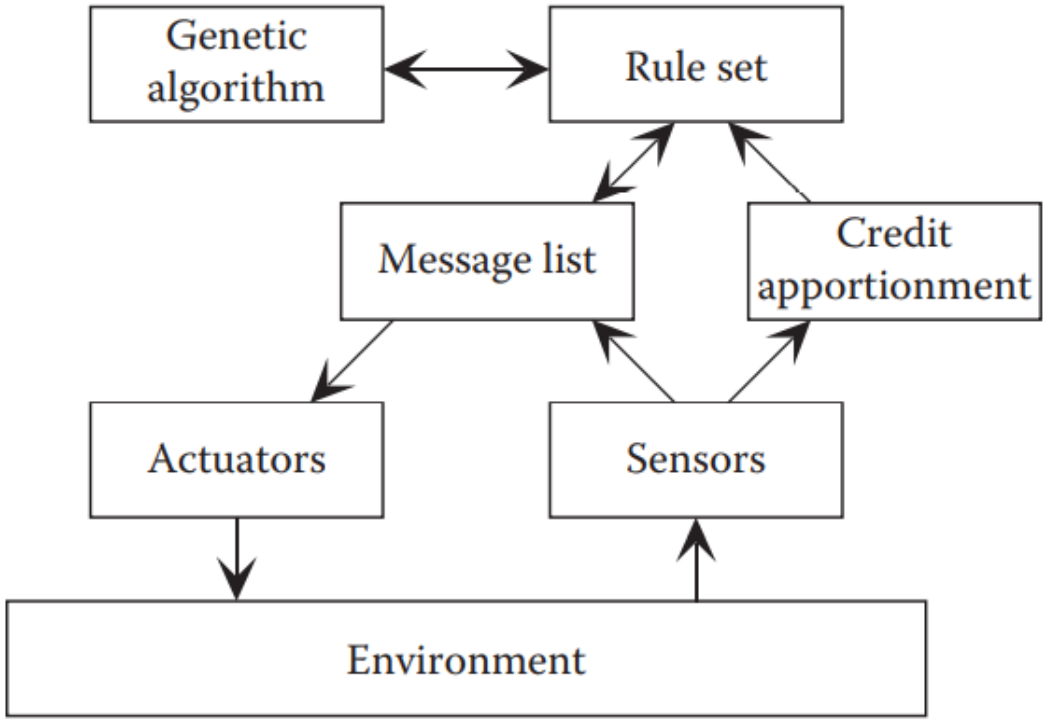
- Neuro–Fuzzy Systems
  - The parameters for a fuzzy system can be learned using neural networks,
  - A neuro–fuzzy system is a fuzzy system, the parameters of which are derived by a neural network learning technique.





Capability Enhancement

- Learning Classifier Systems
  - Combines genetic algorithms with rulebased systems to provide a mechanism for rule discovery - possible to generate new rules by means of a genetic algorithm
  - Message list - the heart of the system - similar role to the blackboard in a blackboard system.
  - Information from the environment is placed in message list, along with rule deductions and instructions for the actuators that act on the environment



Capability Enhancement

- Neural Expert Systems
- A hybrid system that combines a neural network and a rule-based expert system is called a neural expert system (or a connectionist expert system)
- Combine the advantages of expert systems and neural networks, to create a more powerful and effective expert system