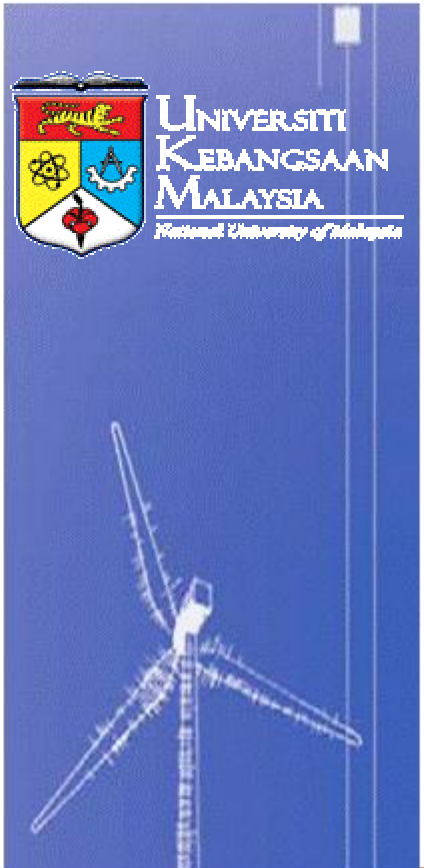
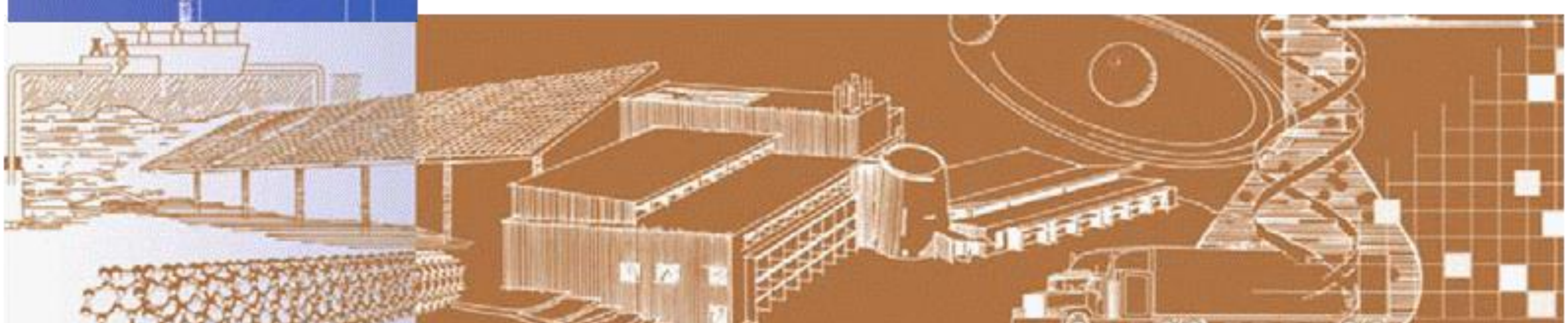


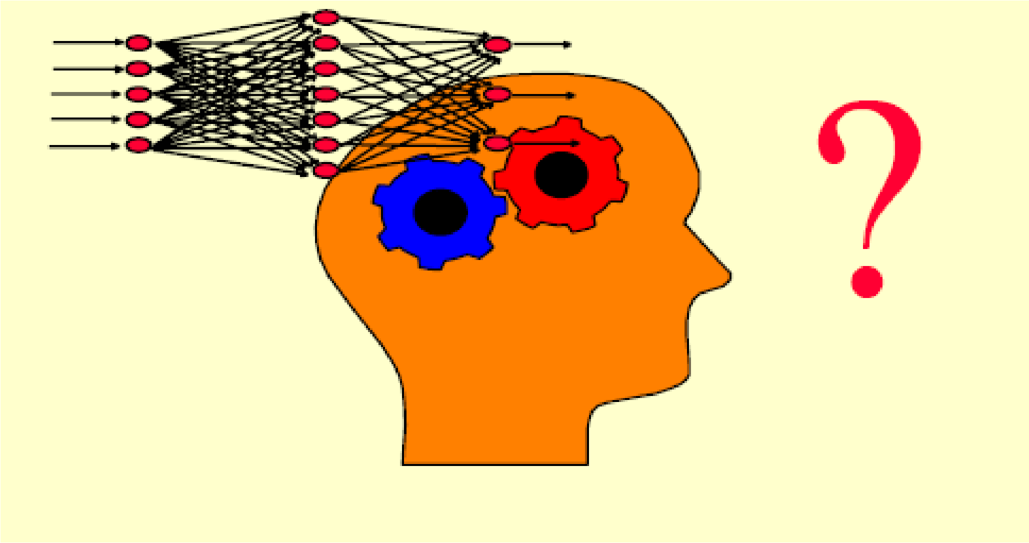
Artificial Intelligence in Manufacturing Engineering

Dr. Rizauddin Ramli



What is Artificial Intelligence?

- AI is a “tool” that has been developed to imitate human intelligence and decision making functions, providing basic reasoning and other human characteristics



- It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence.

- Along with modern genetics, it is regularly cited as the "field I would most like to be in" by scientists in other disciplines

History of Artificial Intelligence

- The research on AI started after WWII. The English mathematician Alan Turing was the first to give a lecture on AI in 1947. He decided that AI was best researched by programming computers rather than by building machines.

Abridged history of AI

- 1943 McCulloch & Pitts: Boolean circuit model of brain
- 1950 Turing's "Computing Machinery and Intelligence"
- 1956 Dartmouth meeting: "Artificial Intelligence" adopted
- 1952—69 Look, Ma, no hands!
- 1950s Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
- 1965 Robinson's complete algorithm for logical reasoning
- 1966—73 AI discovers computational complexity
Neural network research almost disappears
- 1969—79 Early development of knowledge-based systems
- 1980-- AI becomes an industry
- 1986-- Neural networks return to popularity
- 1987-- AI becomes a science
- 1995-- The emergence of intelligent agents

But What is Intelligence?

- Intelligence is the computational part of the ability to achieve goals in the world. Varying kinds and degrees of intelligence occur in people, many animals and some machines.

What is AI?

Views of AI fall into four categories:

Thinking humanly	Thinking rationally
Acting humanly	Acting rationally

The textbook advocates "acting rationally"

WHAT is AI?

"The exciting new effort to make computers think . . . *machines with minds,* in the full and literal sense" (Haugeland, 1985) "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978)	"The study of mental faculties through the use of computational models" (Charniak and McDermott, 1985) "The study of the computations that make it possible to perceive, reason, and act" (Winston, 1992)
"The art of creating machines that perform functions that require intelligence when performed by people" (Kurzweil, 1990) "The study of how to make computers do things at which, at the moment, people are better" (Rich and Knight, 1991)	"A field of study that seeks to explain and emulate intelligent behavior in terms of computational processes" (Schalkoff, 1990) "The branch of computer science that is concerned with the automation of intelligent behavior" (Luger and Stubblefield, 1993)

Figure 1.1 Some definitions of AI. They are organized into four categories:

3

1

Systems that think like humans.	Systems that think rationally.
Systems that act like humans.	Systems that act rationally.

4

2

Definitions of AI by 4 categories.

1- *thought processes* and *reasoning*
2- behavior.
3-human performance
4-an *ideal* concept of intelligence or **rationality.**

Acting humanly: The Turing Test approach

- **The Turing Test,** proposed by Alan Turing (1950), was designed to provide a satisfactory operational definition of intelligence.

- Turing defined intelligent behavior as the ability to achieve human-level performance in all cognitive tasks, sufficient to fool an interrogator.

- The test he proposed is that the computer should be interrogated by a human via a teletype, and passes the test if the interrogator cannot tell if there is a computer or a human at the other end.

What is the Turing Test?

- The Turing test is a one-sided test through the method of teletype. If machine could successfully pretend to be human to a knowledgeable observer then it should be considered intelligent.

- Turing proposed a test that begins with three people: a man (A), a woman (B), and an interrogator (C).

- The interrogator is to be separated from both A and B, say, in a closed room (Figure 1-1) but may ask questions of both A and B. The interrogator’s objective is to determine which (A or B) is the woman and, by consequence, which is the man.

- It is A’s objective to cause C to make an incorrect identification.

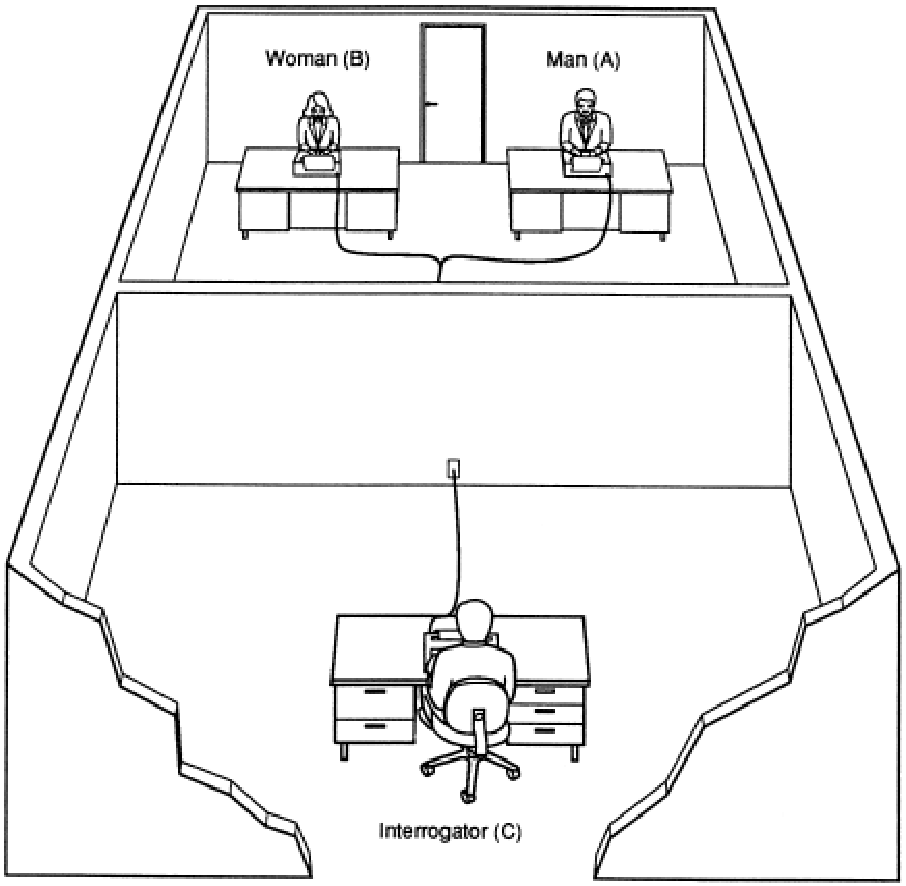
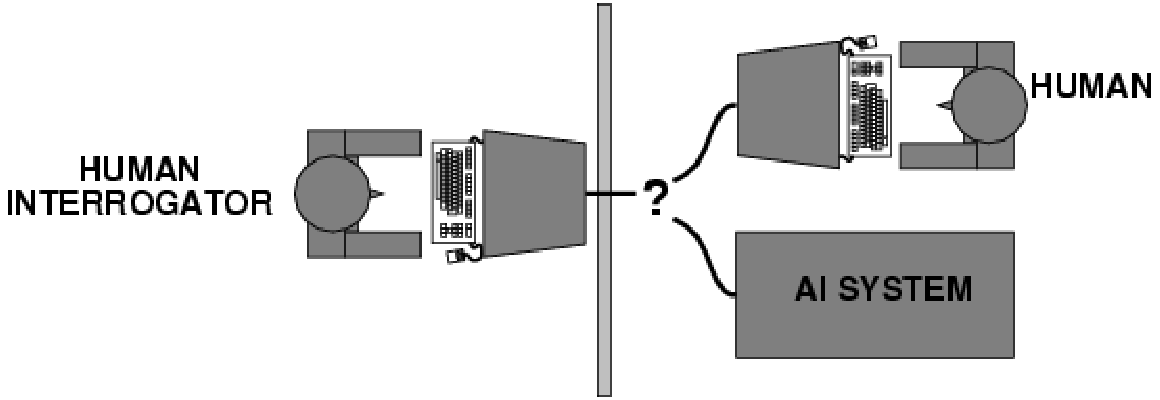


Figure 1-1 The Turing Test. An interrogator (C) questions both a man (A) and a woman (B) and attempts to determine which is the woman.



- Turing then replaced the original question, “Can machines think?” with the following:
- “We now ask the question, ‘What will happen when a machine takes the part of A in this game?’ Will the interrogator decide wrongly as often when the game is played like this as he does when the game is played between a man and a woman.”
- This question separates the physical and intellectual capabilities of humans.
- The form of interrogation prevents C from using sensory information regarding A’s or B’s physical characteristics.
- Presumably, if the interrogator were able to show no increased ability to decide between A and B when the machine was playing as opposed to when the man was playing, then the machine would be declared to have passed the test.

- Mathematics
- Control Theory
- Computer Science
- Physics
- Operational Research
- ....

- Neuroscience
- Psychology
- Philosophy
- Biological Science
- Physiology
- ....

Artificial Intelligence

Symbolic AI

- KBS
- Symbolic M. L.
- Logic Prog.
- Nat. Lang. Proc.
- Search techniques
- ....

Micro. Bio. Models

- ANN
- GA
- A. Life
- ....

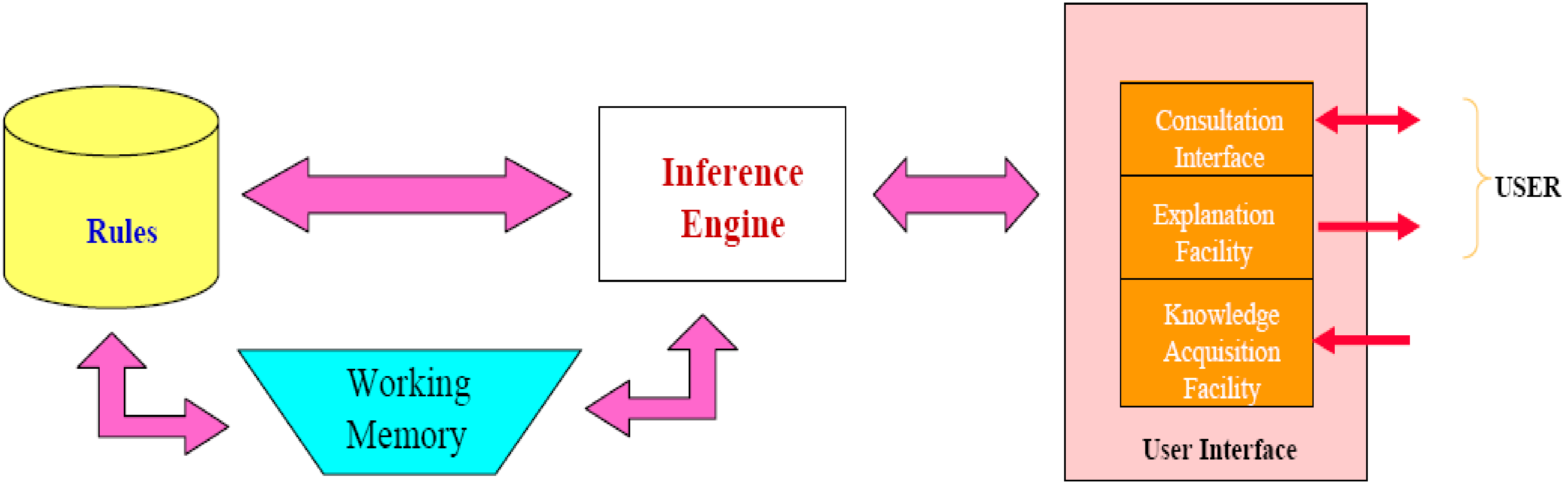
New AI

- Fuzzy
- Rough Sets
- Chaos
- ....

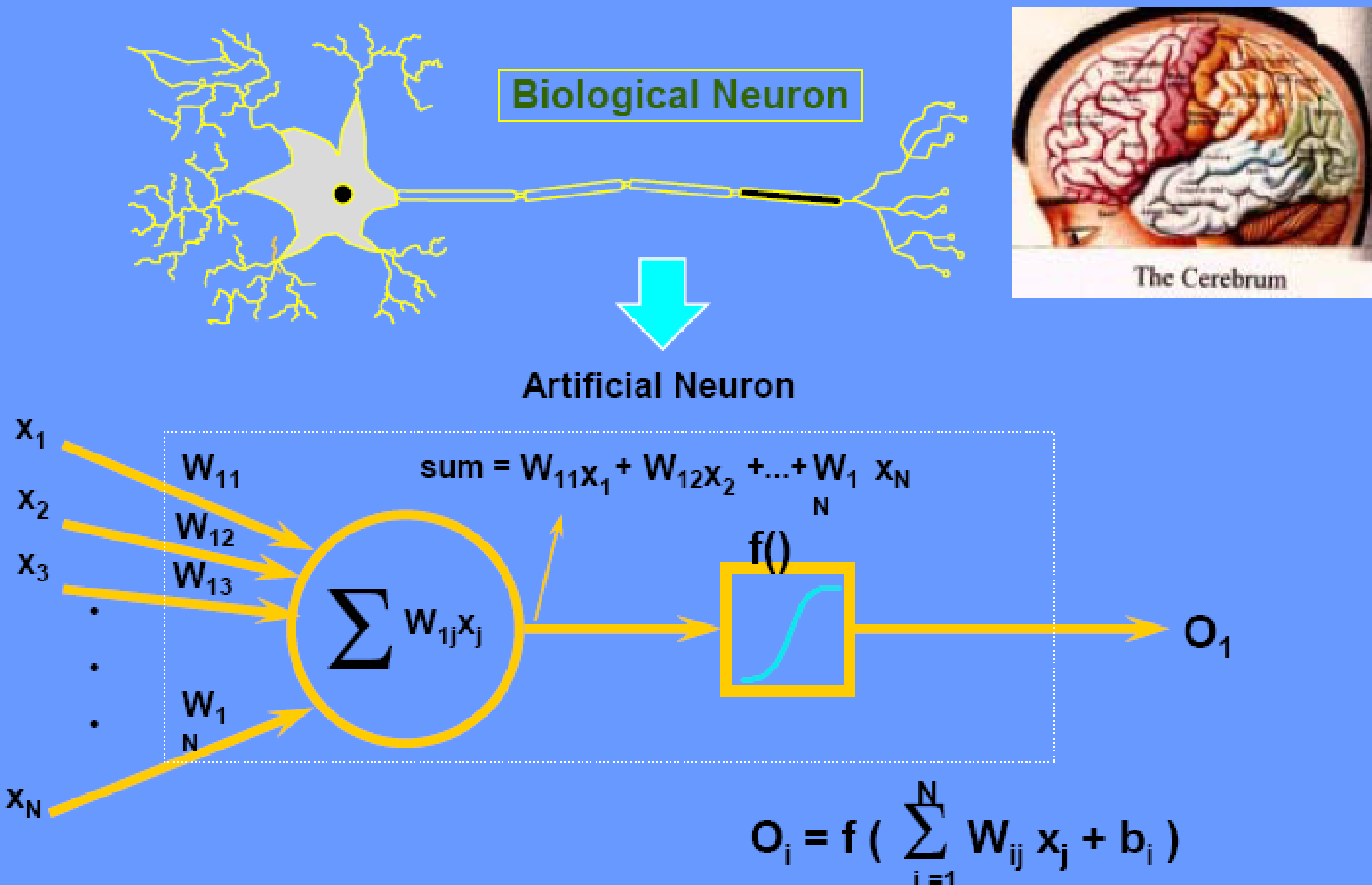
A Brief Insight on several AI TOOLS

- Expert Systems
- Fuzzy Logic
- Neural Networks
- Genetic Algorithms

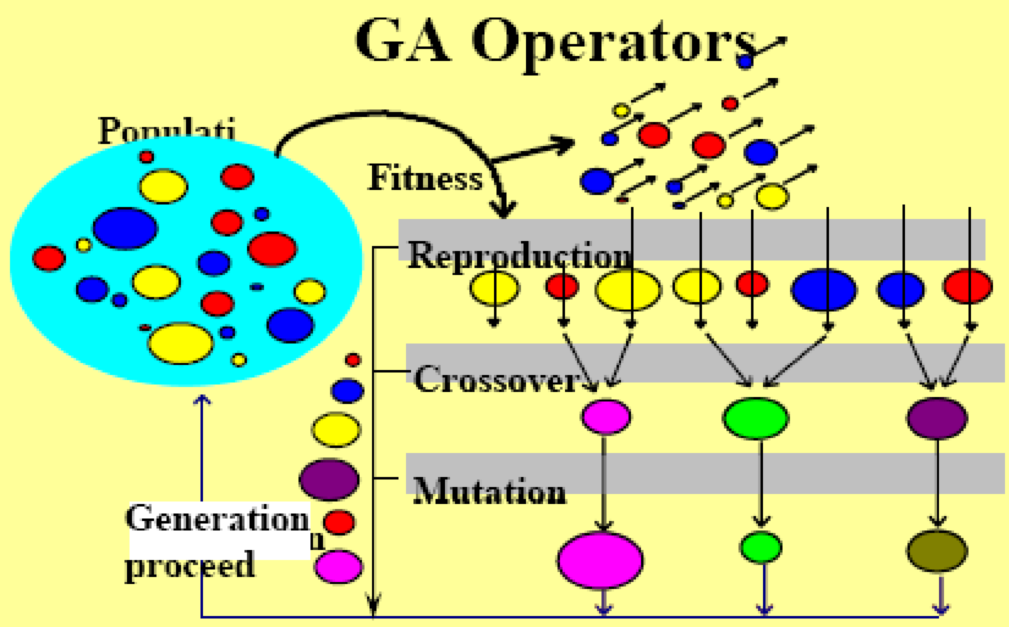
A Typical Expert System Architecture

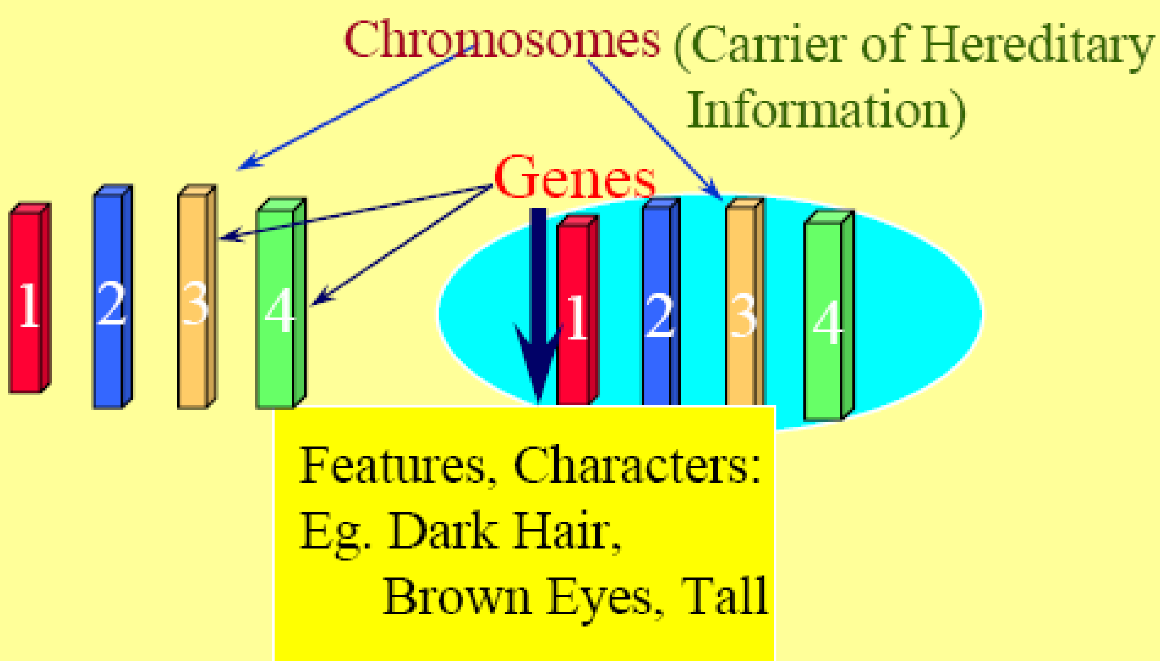


An ANN is a computer model of the biological brain

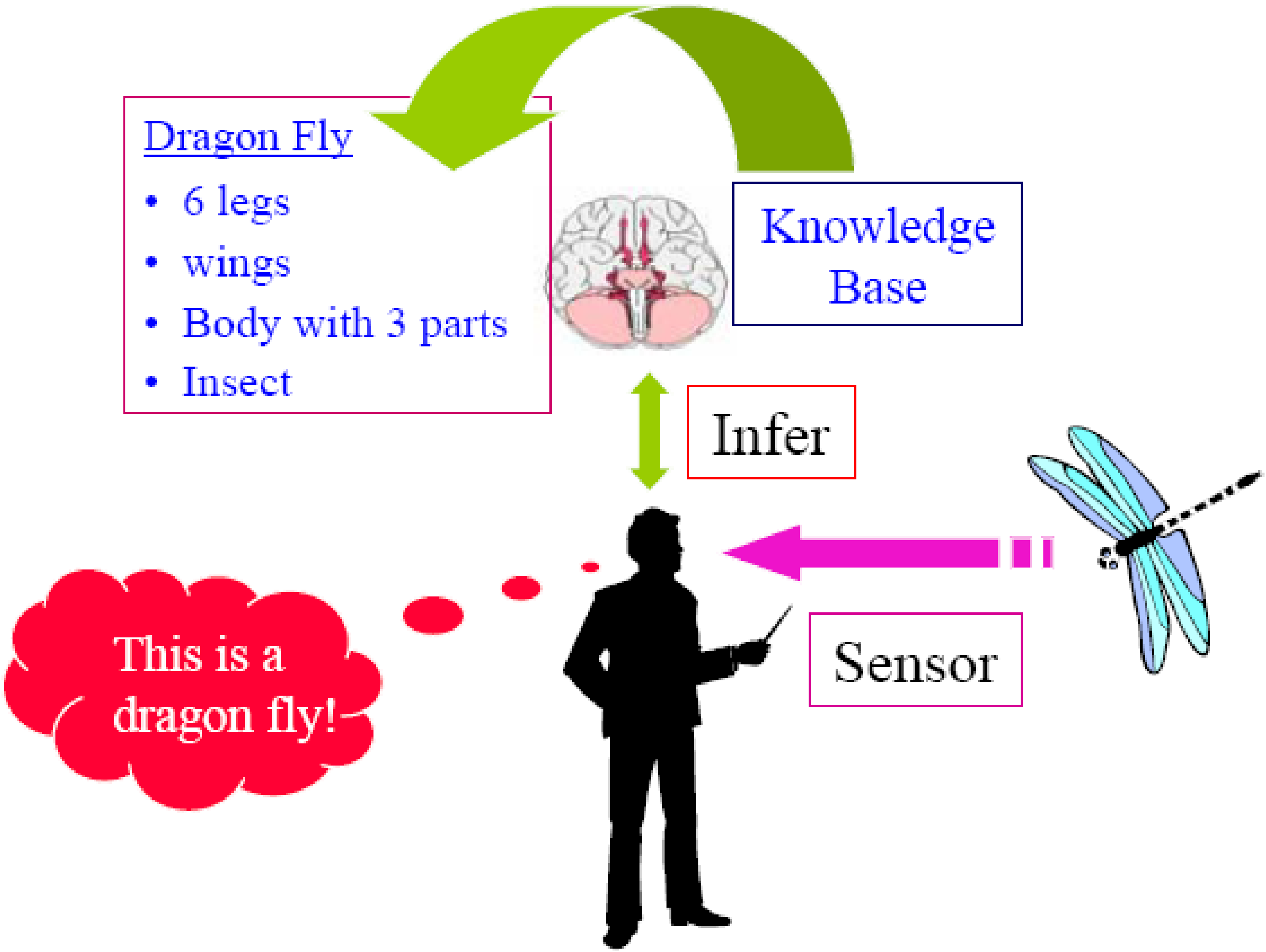


Genetic Algorithms have been derived from the human reproduction process

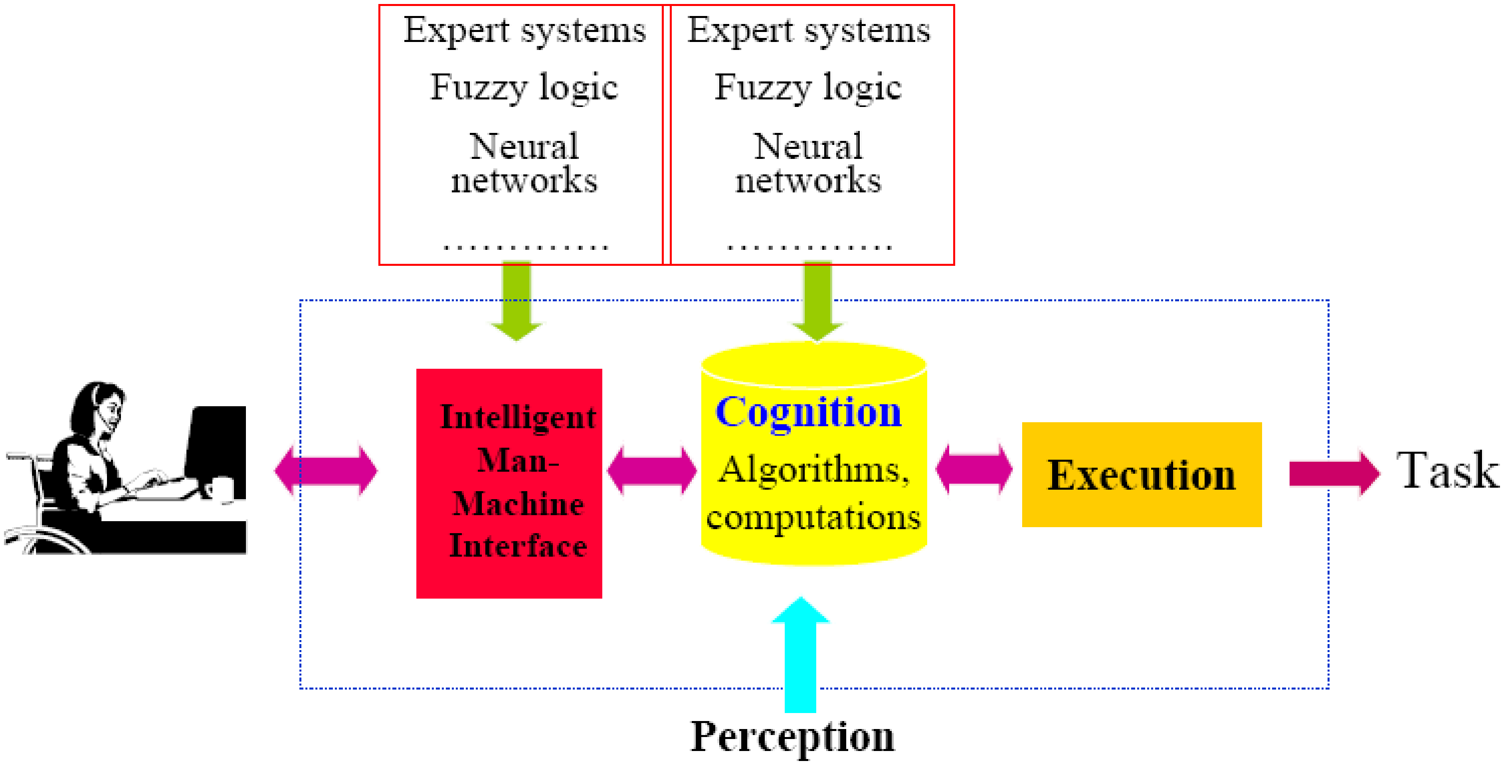




Fuzzy logic has been developed from the human reasoning process



Intelligent Systems Design



Successful Applications of Fuzzy Logic Technology

Vacuum Cleaner

Camera

Rice Cooker

Television

Sendai Subway Control

ABS Braking System

Elevator Group Control

Air Conditioner

Washing Machine

Refrigerator

Stock Trading

Camcorder Stabilizer

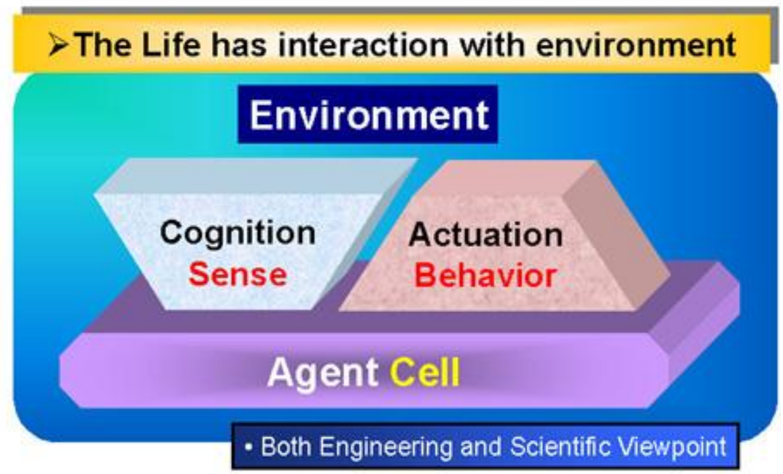
Cement Kiln Control

Artificial Intelligence / Life

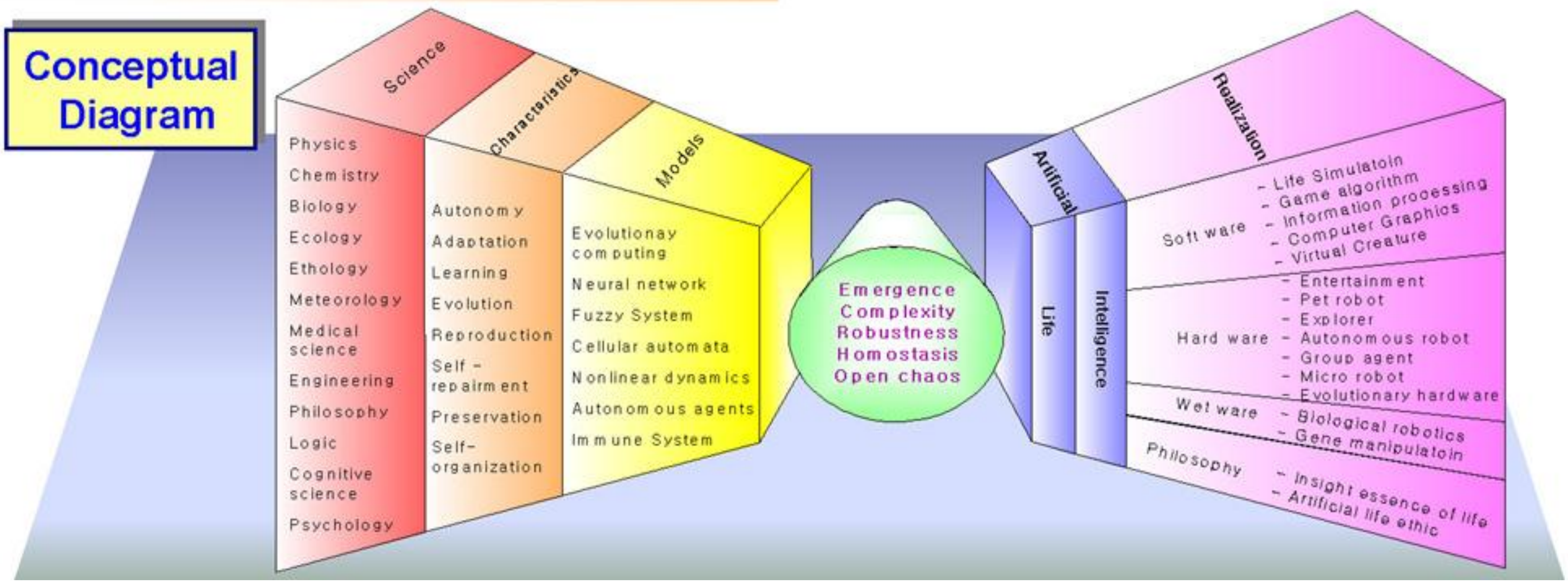
❖ Establishing Artificial Creature is that
Artificial Life and Artificial Intelligence

- **Artificial Life :**
  Human-made systems that possess some of the key properties of natural life. It has self-preservation in through changeable environment.

- **Artificial Intelligence :**
  Science and engineering of making intelligent machines in which behaviors maximize the chances for self-preservation of that system in a particular environment



Conceptual Diagram



ADVANTAGES

Smarter artificial intelligence promises to replace human jobs, freeing people for other pursuits by automating manufacturing and transportations.

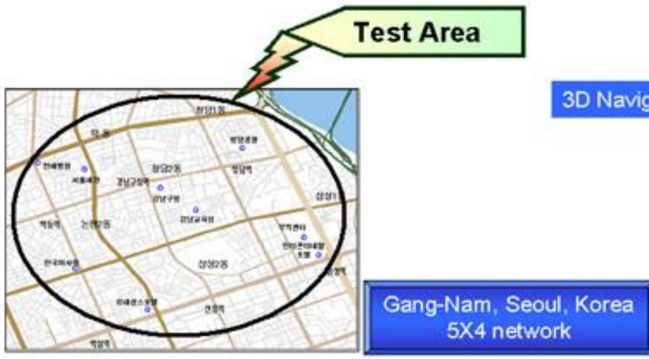
Self-modifying, self-writing, and learning software relieves programmers of the burdensome task of specifying the whole of a program′s functionality—now we can just create the framework and have the program itself fill in the rest (example: real-time strategy game artificial intelligence run by a neural network that acts based on experience instead of an explicit decision tree).

Self-replicating applications can make deployment easier and less resource-intensive.

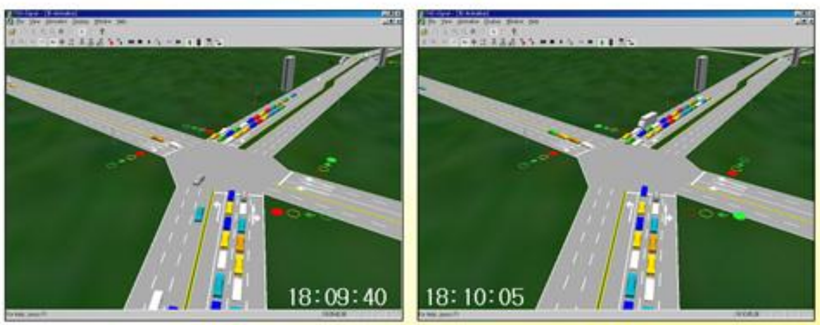
AI can see relationships in enormous or diverse bodies of data that a human could not

Intelligent Transport Systems

- Web-Based Traveler Guide System
- Traffic Flow Analyzing System

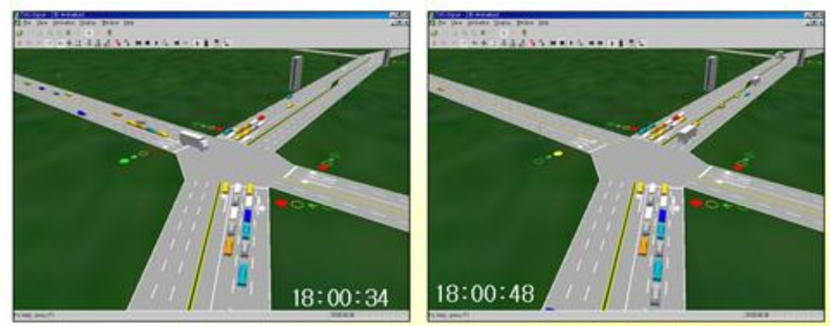


TOD(Time Of Day) Signal Control



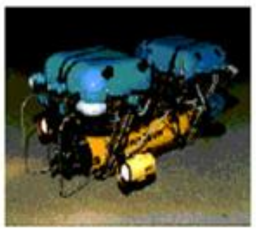
Although there are no moving cars, unnecessary display lasts for 25 seconds.(Signal periods are independently uniformed with the existence of vehicles on standby)

Adaptive Signal Control



If there are no cars between minimum and maximum time, screen will show the next display.(Signal periods vary with the existence of vehicles on standby)

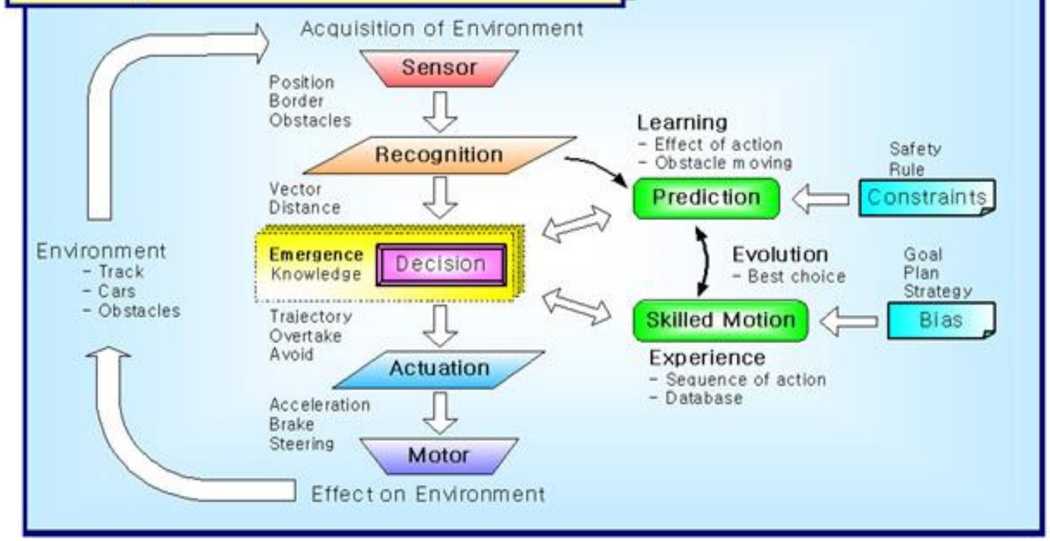
Realization



Implementation

- Autonomous Mobile Agent (Robot Car Race)
  - Intelligence in Competing Environment with Real time
  - Multiple Agent with Changing Environment

System Architecture



Computational Intelligence

•*Computational intelligence* refers to intelligence artificially realised through computation.

•Artificial intelligence emerged as a computer science discipline in the mid-1950s.

•Since then, it has produced a number of powerful tools, some of which are used in engineering to solve difficult problems normally requiring human intelligence.

•Five of these tools are reviewed in this chapter with examples of applications in engineering and manufacturing:

- knowledge-based systems
- fuzzy logic
- inductive learning
- neural networks
- genetic algorithms

Knowledge-Based Systems

Knowledge-based systems, or expert systems, are computer programs embodying knowledge about a narrow domain for solving problems related to that domain.

The knowledge base contains domain knowledge which may be expressed as any combination of “If-Then” rules, factual statements (or assertions), frames, objects, procedures, and cases. The inference mechanism is that part of an expert system which manipulates the stored knowledge to produce solutions to problems.

Knowledge manipulation
methods include the use of inheritance and constraints (in a frame-based or object-oriented expert
system), the retrieval and adaptation of case examples (in a case-based expert system), and the application
of inference rules such as *modus ponens* (If A Then B; A Therefore B) and *modus tollens* (If A Then B;
Not B Therefore Not A) according to “forward chaining” or “backward chaining” control procedures and
“depth-first” or “breadth-first” search strategies (in a rule-based expert system).

KNOWLEDGE BASE
(Initial State)

Fact :

F1 - A lathe is a machine tool

Rules :

R1 - If X is power driven Then X requires a power source
R2 - If X is a machine tool Then X has a tool holder
R3 - If X is a machine tool Then X is power driven

⇓ **F1 & R2** match

KNOWLEDGE BASE
(Intermediate State)

Fact :

F1 - A lathe is a machine tool
F2 - A lathe has a tool holder

Rules :

R1 - If X is power driven Then X requires a power source
R2 - If X is a machine tool Then X has a tool holder
R3 - If X is a machine tool Then X is power driven

⇓ **F1 & R3** match

KNOWLEDGE BASE
(Initial State)

Fact :

F1 - A lathe is a machine tool
F2 - A lathe has a tool holder
F3 - A lathe is power driven

Rules :

R1 - If X is power driven Then X requires a power source
R2 - If X is a machine tool Then X has a tool holder
R3 - If X is a machine tool Then X is power driven

⇓ **F3 & R1** match

KNOWLEDGE BASE
(Initial State)

Fact :

F1 - A lathe is a machine tool
F2 - A lathe has a tool holder
F3 - A lathe is power driven
F4 - A lathe requires a power source

Rules :

R1 - If X is power driven Then X requires a power source
R2 - If X is a machine tool Then X has a tool holder
R3 - If X is a machine tool Then X is power driven

FIGURE 1.1(a) An example of forward chaining.

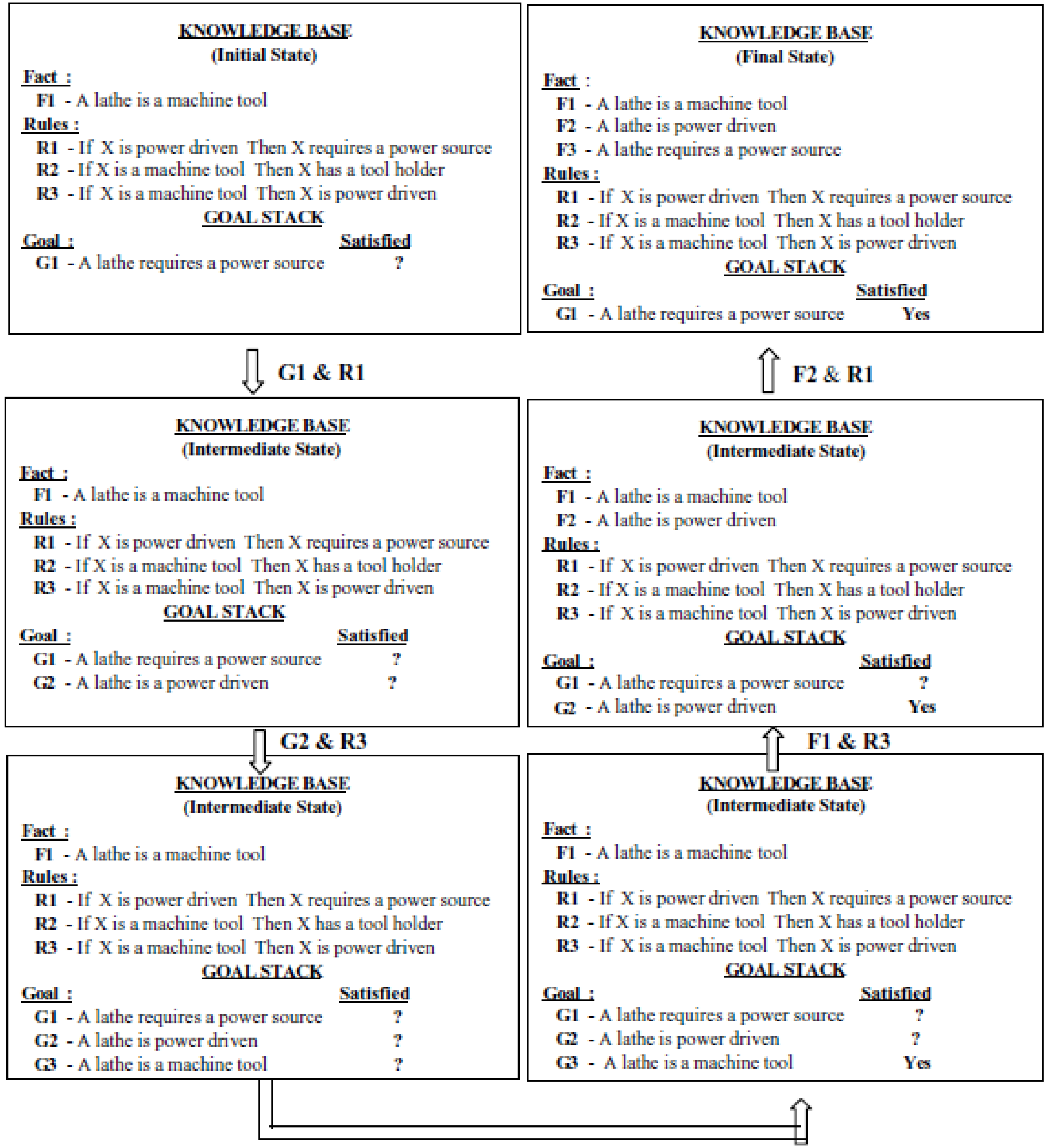


FIGURE 1.1(b) An example of backward chaining.