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ARTIFICIAL INTELLIGENCE

What is Artificial Intelligence?

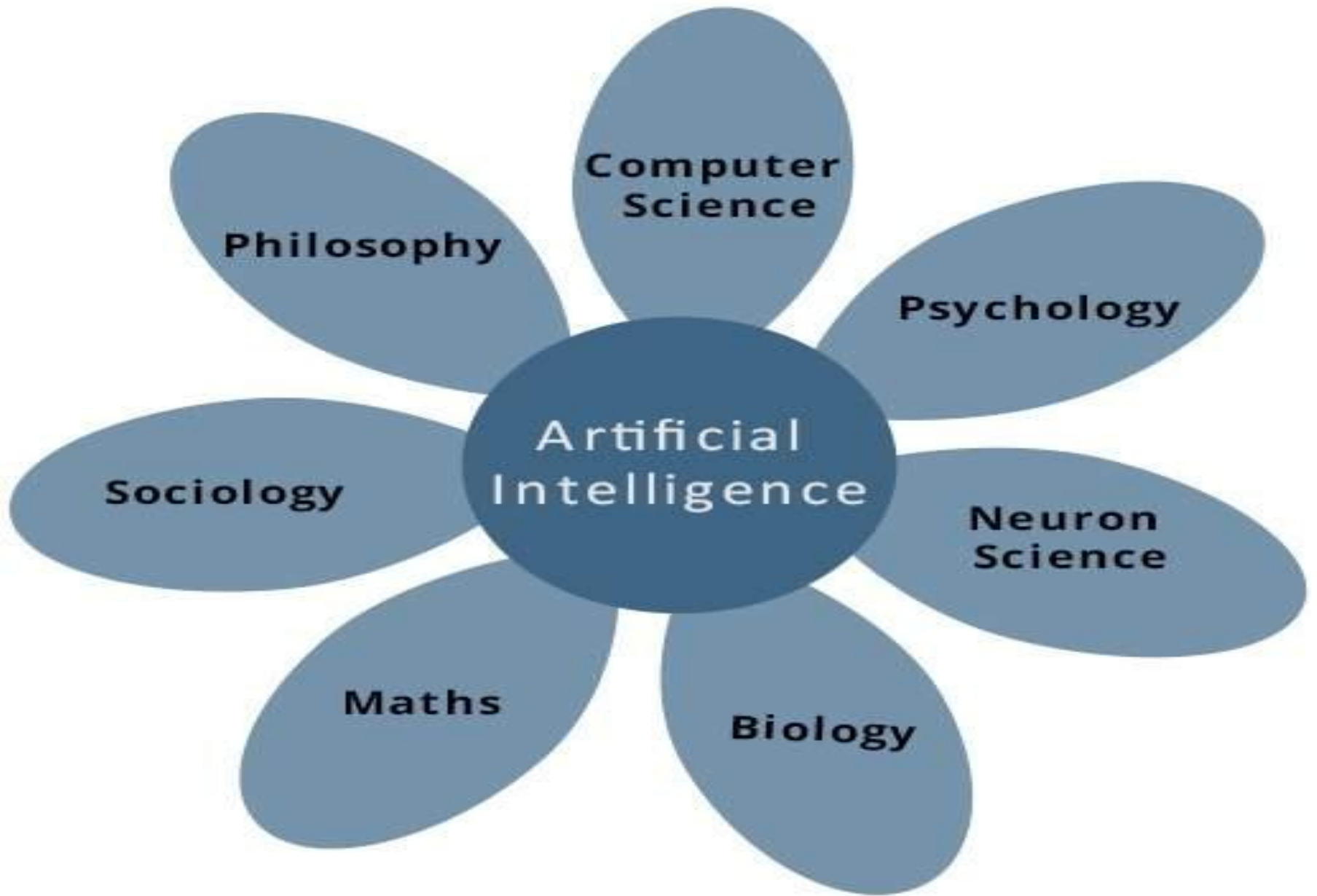
- *“The science and engineering of making intelligent machines, especially intelligent computer programs”*

-John McCarthy (Father of AI)

- AI is accomplished by studying how human brain thinks, and how humans learn, decide, and work while trying to solve a problem, and then using the outcomes of this study as a basis of developing intelligent software and systems.

What Contributes to AI?

- Artificial intelligence is a **science and technology based on disciplines** such as **Computer Science, Biology, Psychology, Linguistics, Mathematics, and Engineering.**
- A major **thrust of AI** is in the **development of computer functions associated with human intelligence, such as reasoning, learning, and problem solving.**



Programming Without AI

Programming With AI

A computer program without AI can answer **the specific questions** it is meant to solve.

A computer program with AI can answer **the generic questions** it is meant to solve.

Modification in the program leads to **change in its structure**.

AI programs can absorb new modifications by putting highly independent pieces of information together. Hence you can **modify even a minute piece of information of program without affecting its structure**.

Modification is not quick and easy.
It may lead to affecting the program adversely.

Quick and Easy program modification.

What is AI Technique?

In the real world, the **knowledge** has some unwelcomed **properties** –

- ü Its volume is huge, next to unimaginable.
- ü It is not well-organized or well-formatted.
- ü It keeps changing constantly.

AI Technique is a **manner to organize and use the knowledge efficiently in such a way** that –

- ü It should be **perceivable by the people who provide it.**
- ü It should be **easily modifiable to correct errors.**
- ü It should be **useful in many situations though it is incomplete or inaccurate.**

Applications of AI

- Gaming
- Natural Language Processing
- Expert Systems
- Vision Systems
- Speech Recognition
- Handwriting Recognition
- Intelligent Robots

Intelligent Systems

- **What is Intelligence?**

The ability of a system to calculate, reason, perceive relationships and analogies, learn from experience, store and retrieve information from memory, solve problems, comprehend complex ideas, use natural language fluently, classify, generalize, and adapt new situations.

Types of Intelligence

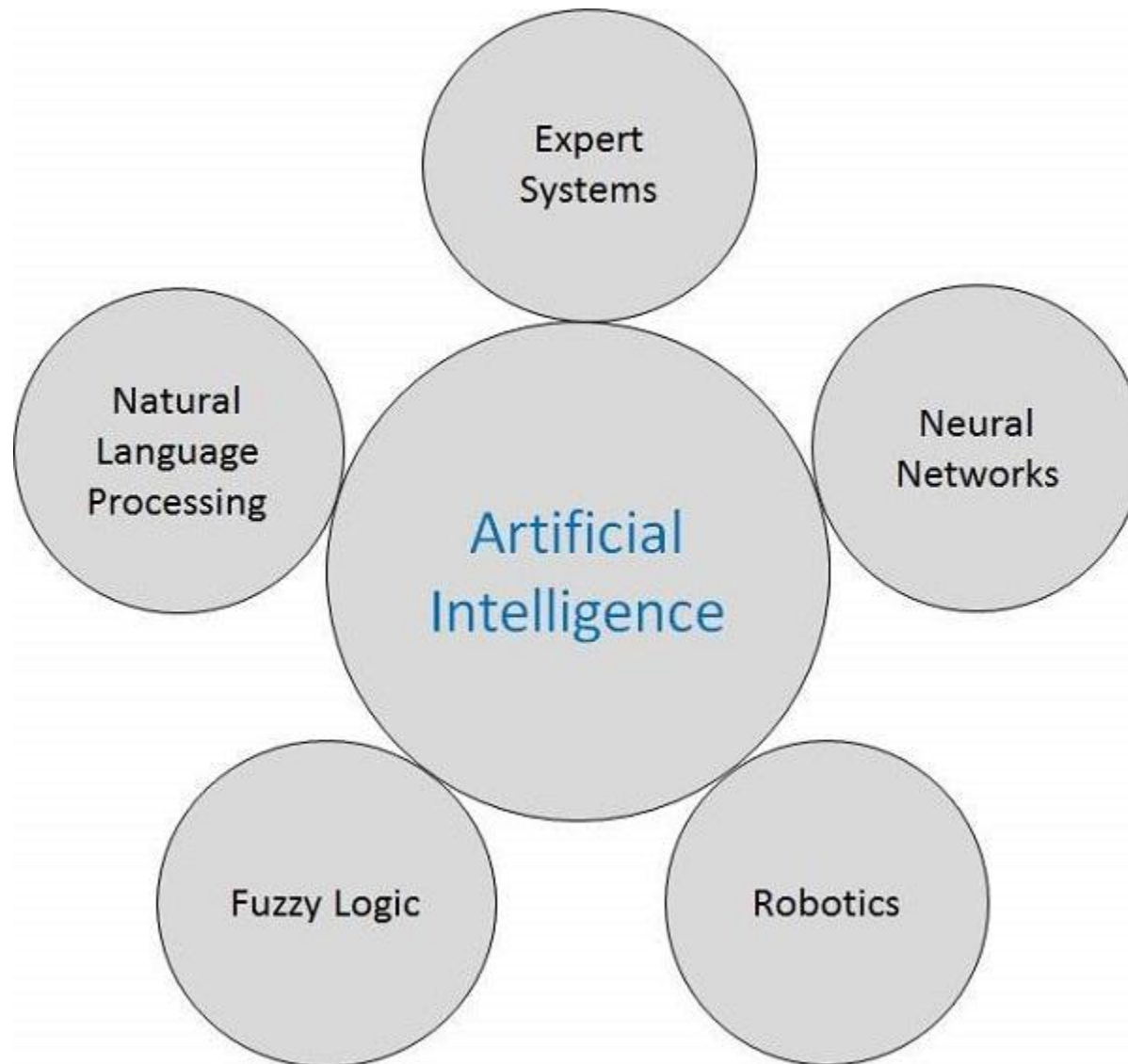
- Linguistic intelligence
- Musical intelligence
- Logical-mathematical intelligence
- Spatial intelligence
- Bodily-Kinesthetic intelligence
- Intra-personal intelligence
- Interpersonal intelligence

What is Intelligence Composed of?

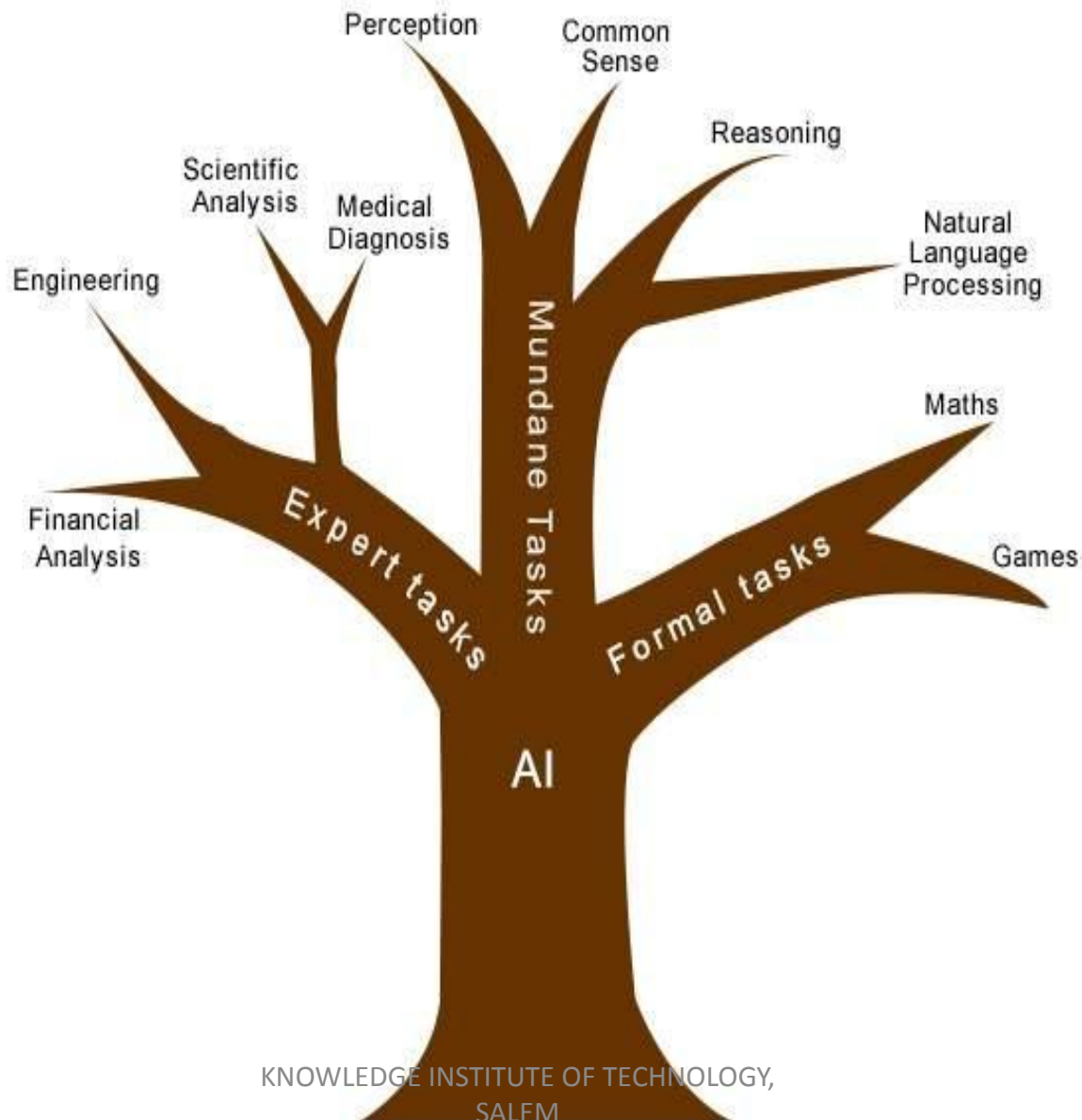


Real Life Applications of AI Research

Areas



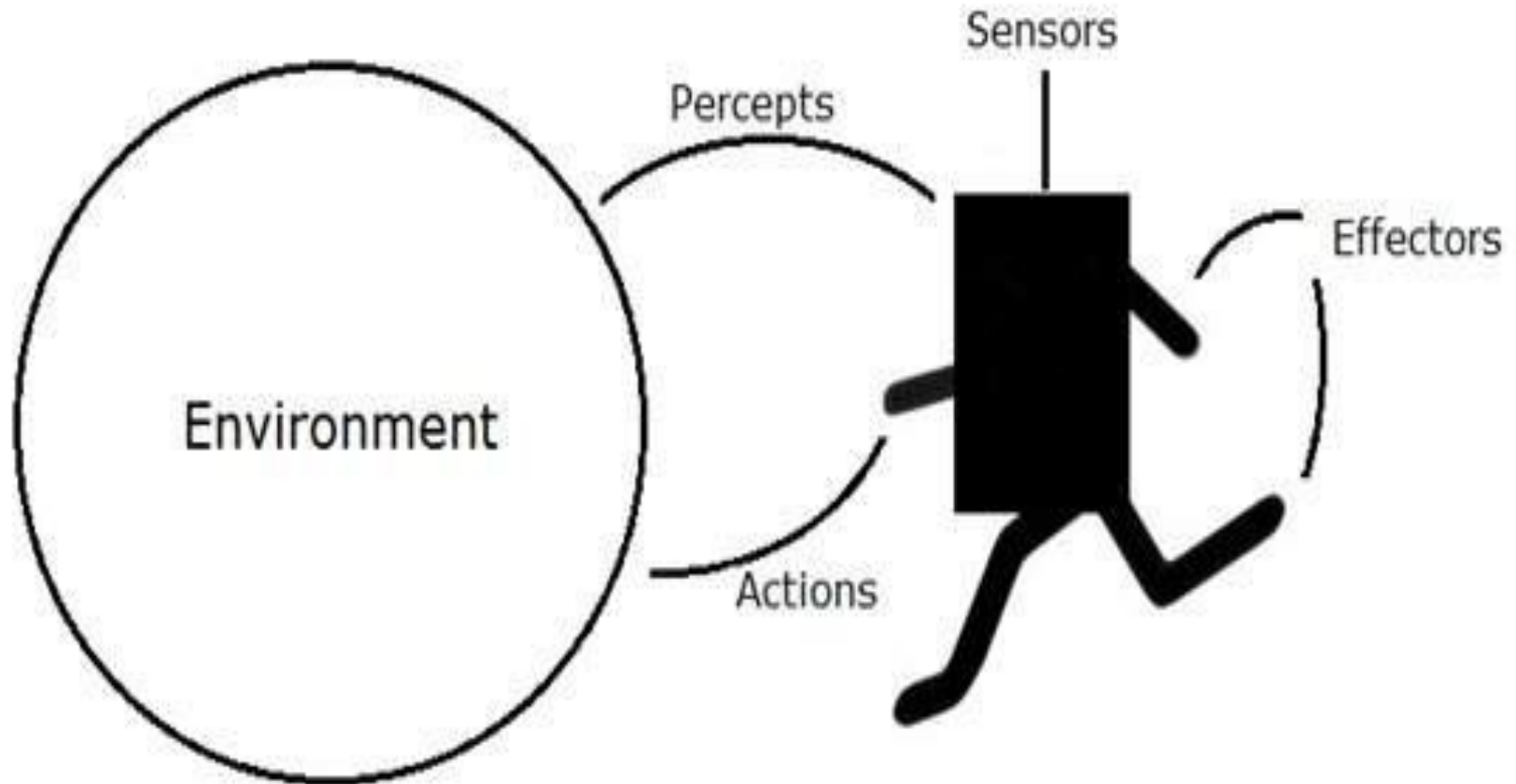
Task Classification of AI



Task Domains of Artificial Intelligence

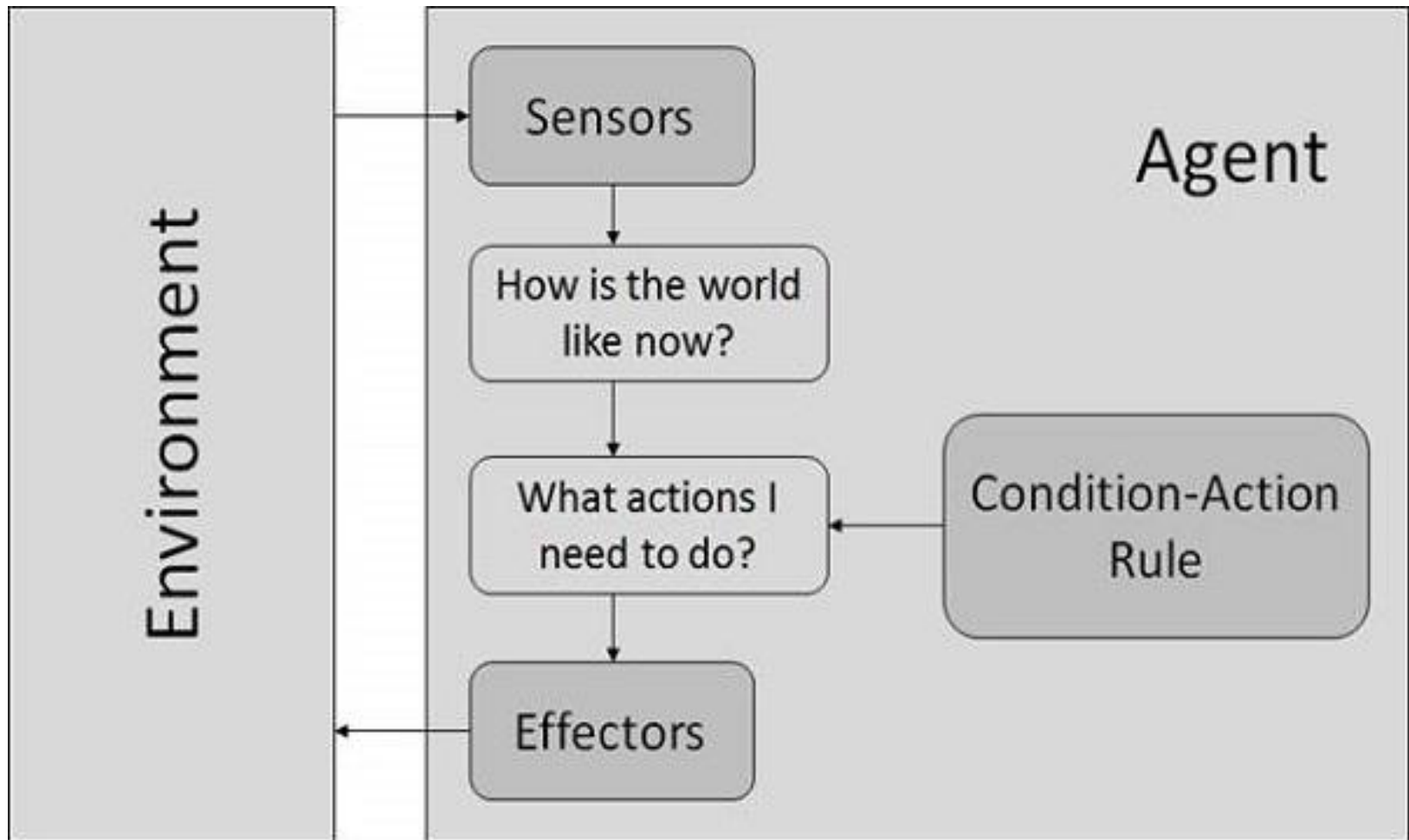
Mundane (Ordinary) Tasks	Formal Tasks	Expert Tasks
Perception ✓ Computer Vision ✓ Speech, Voice	✓ Mathematics ✓ Geometry ✓ Logic ✓ Integration and Differentiation	✓ Engineering ✓ Fault Finding ✓ Manufacturing ✓ Monitoring
Natural Language Processing ✓ Understanding ✓ Language Generation ✓ Language Translation	Games ✓ Go ✓ Chess (Deep Blue) ✓ Ckeckers	Scientific Analysis
Common Sense	Verification	Financial Analysis
Reasoning	Theorem Proving	Medical Diagnosis
Planing	-	Creativity
Robotics ✓ Locomotive	-	-

AI - Agents & Environments

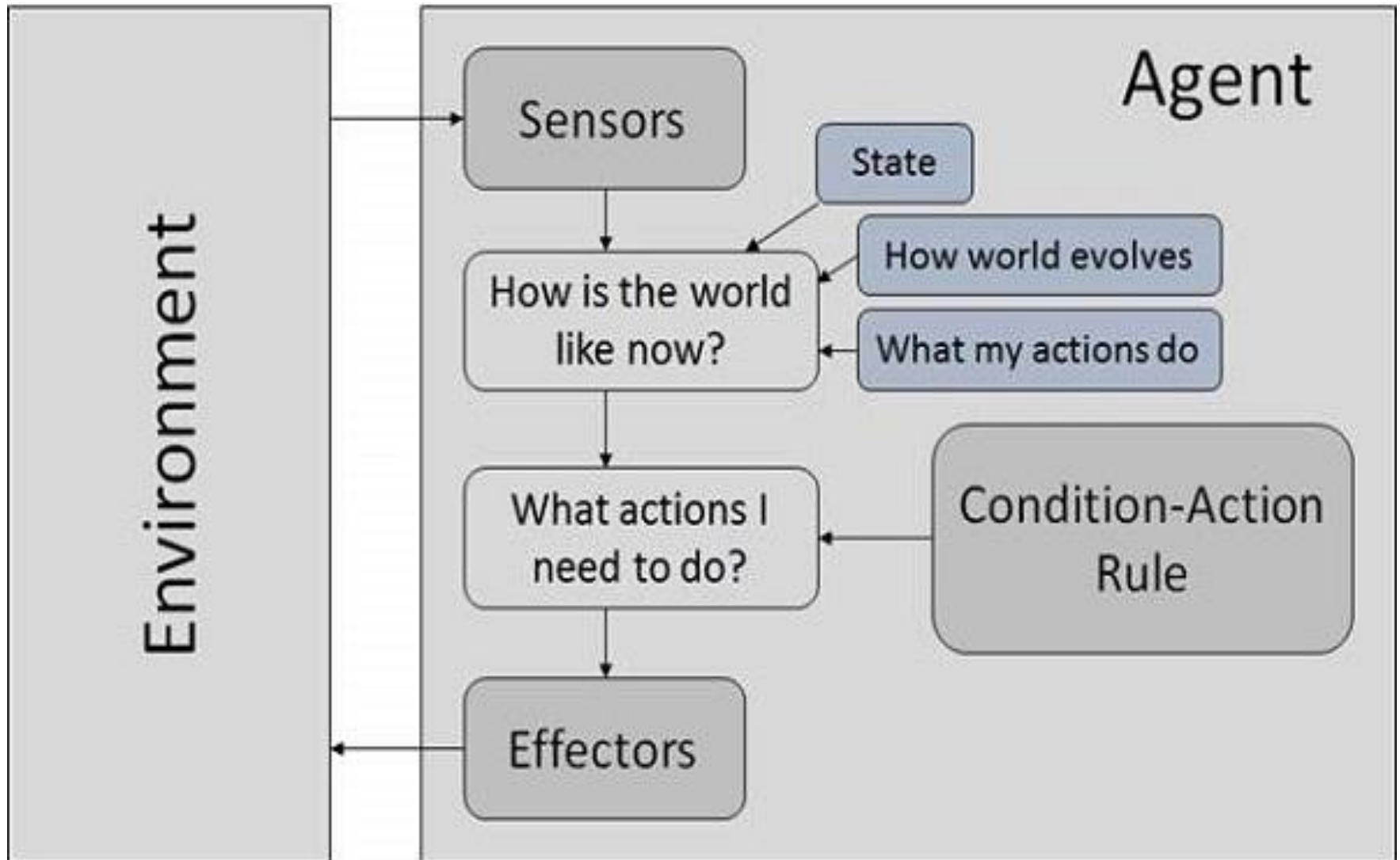


The Structure of Intelligent Agents

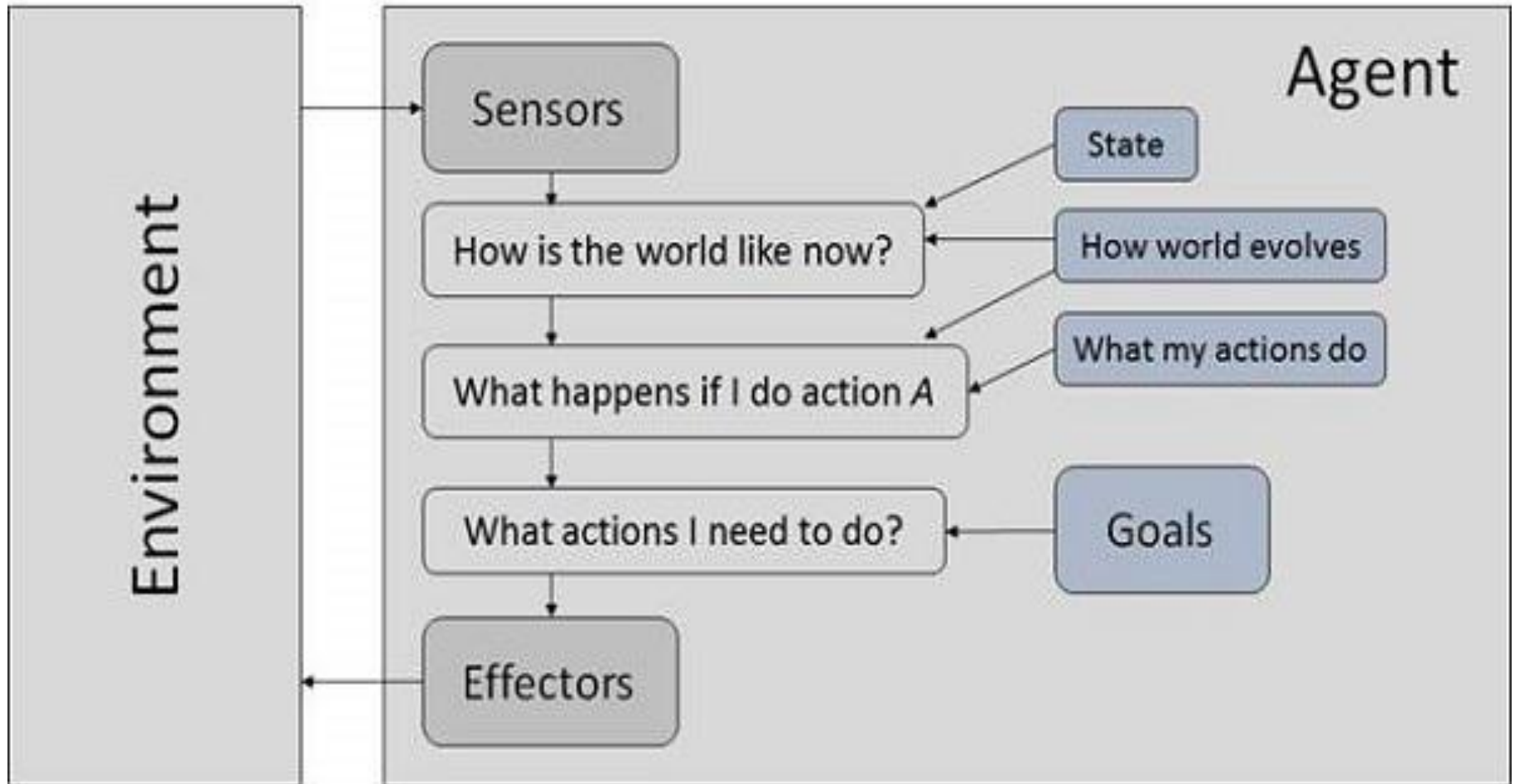
(i) Simple Reflex Agents



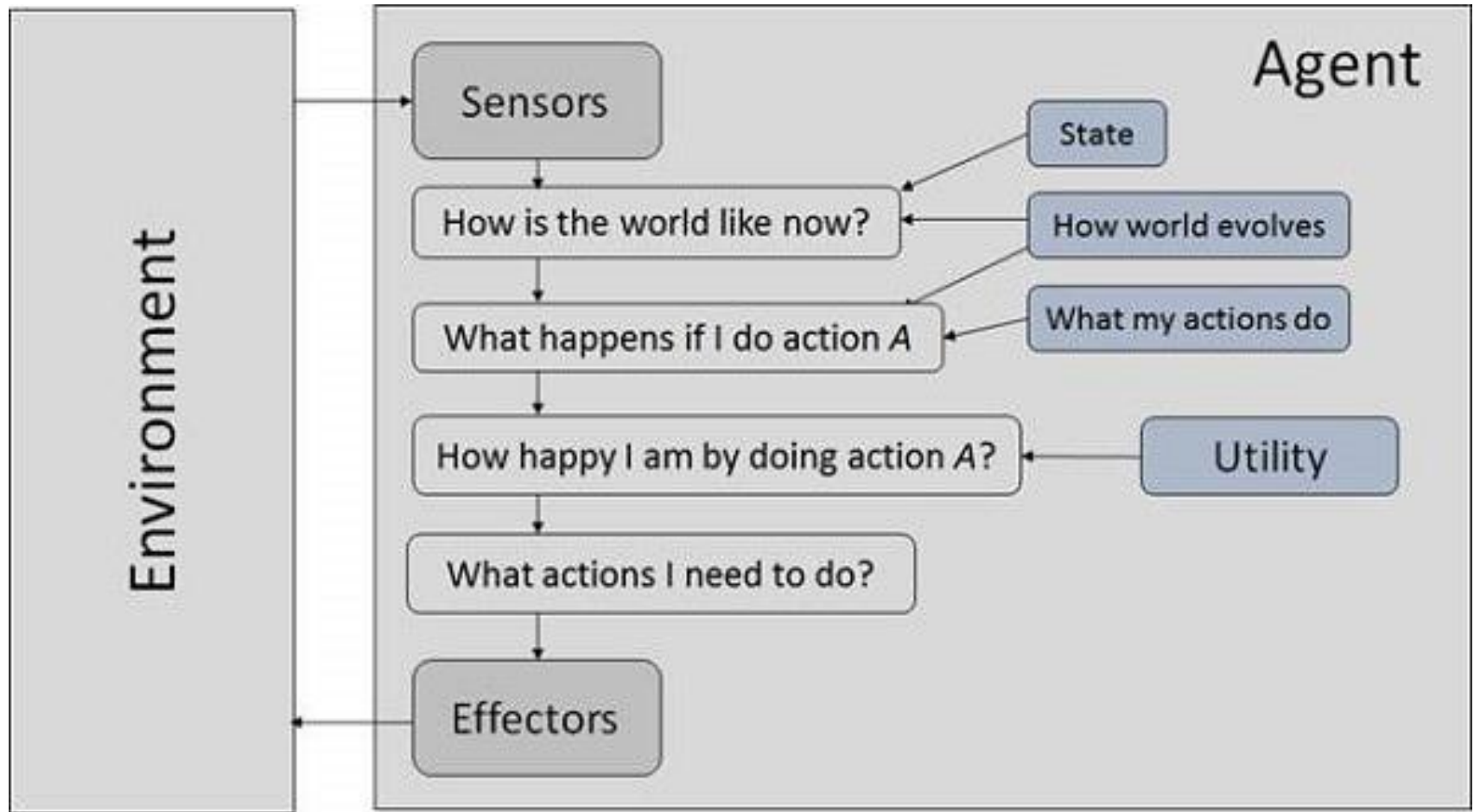
(ii) Model Based Reflex Agents



(iii) Goal Based Agents



(iv) Utility Based Agents



AI - Popular Search Algorithms

- Brute-Force Search Strategies
- Breadth-First Search
- Depth-First Search
- Bidirectional Search
- Uniform Cost Search
- Iterative Deepening Depth-First Search
- Informed (Heuristic) Search Strategies

Pure Heuristic Search

A * Search

Greedy Best First Search

- Local Search Algorithms

Hill-Climbing Search

Local Beam Search

Simulated Annealing

Travelling Salesman Problem

Fuzzy Logic Systems

ü What is Fuzzy Logic?

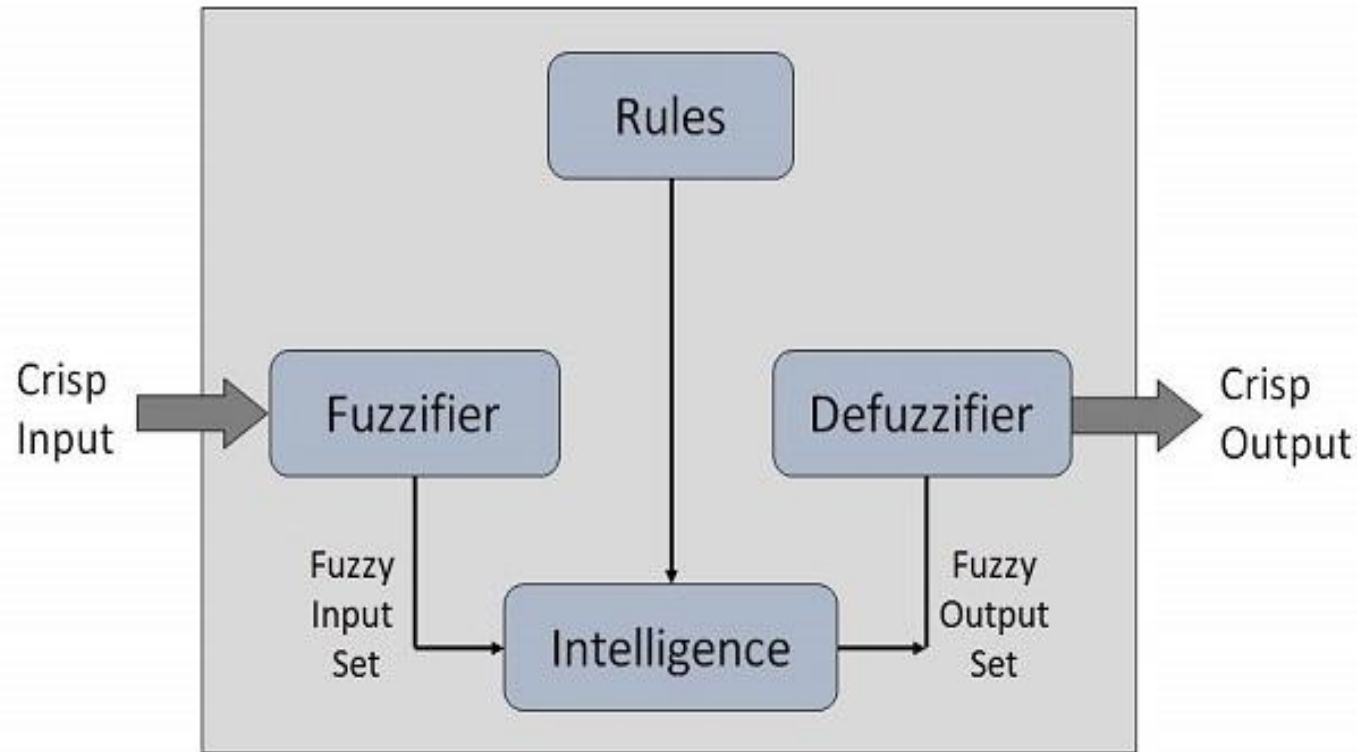
The approach of FL imitates **the way of decision making in humans** that **involves all intermediate possibilities between digital values YES and NO.**

ü Why Fuzzy Logic?

Fuzzy logic is useful for **commercial and practical purposes.**

- It can **control machines and consumer products.**
- It may **not give accurate reasoning, but acceptable reasoning.**
- Fuzzy logic **helps to deal with the uncertainty in engineering.**

Fuzzy Logic Systems Architecture



Four main parts:

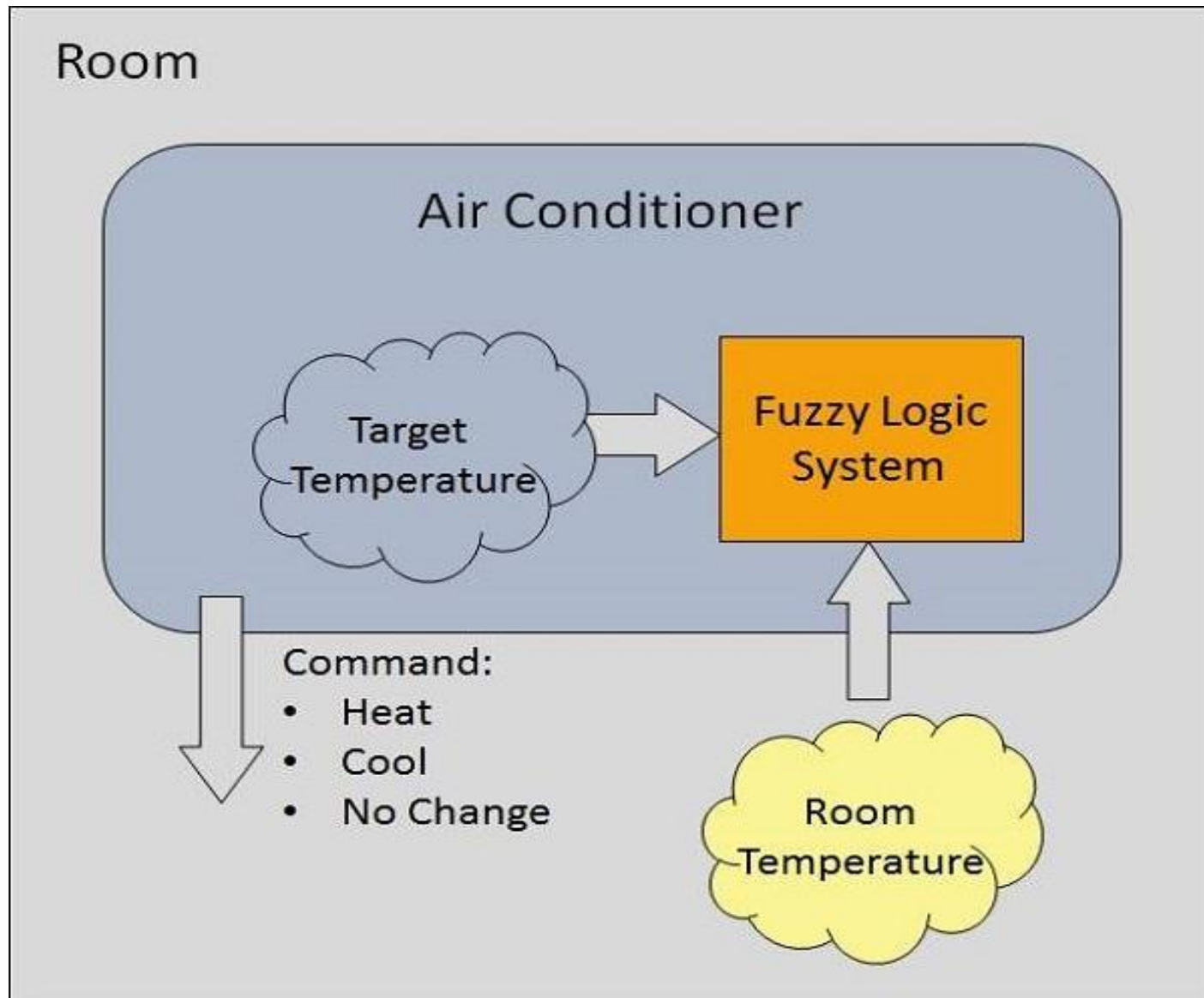
ü Fuzzification Module

ü Knowledge Base

ü Inference Engine

ü Defuzzification Module

Example of a Fuzzy Logic System



Application Areas of Fuzzy Logic

- Automotive Systems
- Consumer Electronic Goods
- Domestic Goods
- Environment Control

Advantages of FLSs

- **Mathematical concepts** within fuzzy reasoning **are very simple**.
- You can modify a FLS by **just adding or deleting rules due to flexibility** of fuzzy logic.
- Fuzzy logic Systems can **take imprecise, distorted, noisy input information**.
- FLSs are **easy to construct and understand**.
- Fuzzy logic is a **solution to complex problems in all fields of life**, including **medicine**, as it resembles human reasoning and decision making.

Disadvantages of FLSs

- There is **no systematic approach** to fuzzy system designing.
- They are **understandable only when simple**.
- They are suitable for **the problems which do not need high accuracy**.

AI - Natural Language Processing

- Natural Language Processing (NLP) refers to AI method of communicating with an intelligent systems using a natural language such as English.

Components of NLP

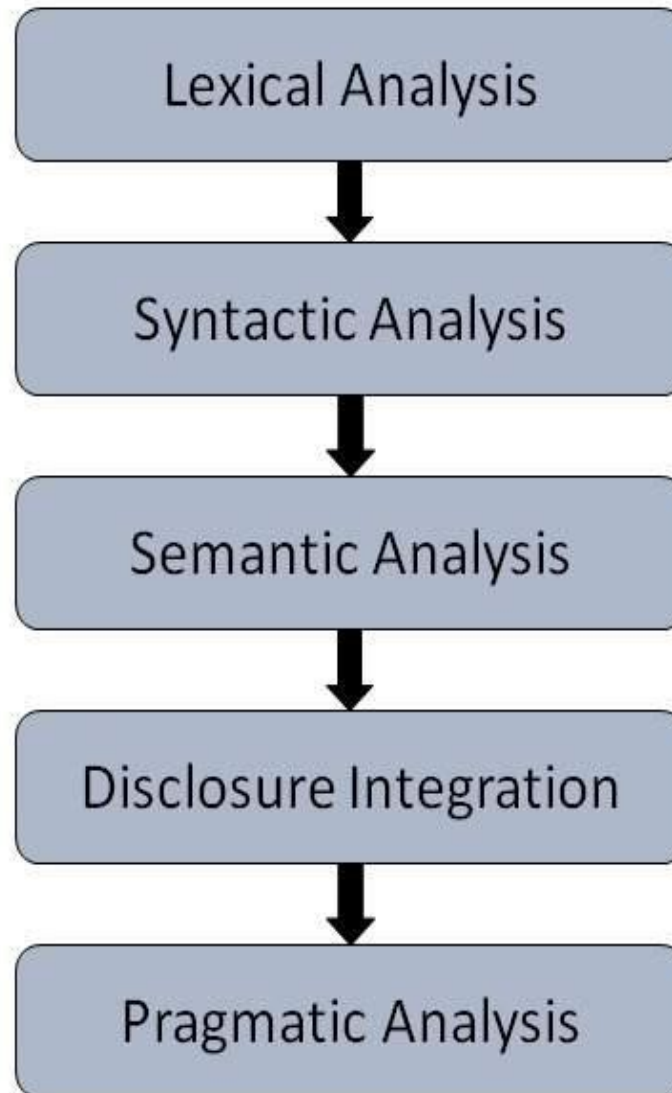
ü Natural Language Understanding (NLU)

ü Natural Language Generation (NLG)

NLP Terminology

- **Phonology** – It is study of organizing sound systematically.
- **Morphology** – It is a study of construction of words from primitive meaningful units.
- **Morpheme** – It is primitive unit of meaning in a language.
- **Syntax** – It refers to arranging words to make a sentence. It also involves determining the structural role of words in the sentence and in phrases.
- **Semantics** – It is concerned with the meaning of words and how to combine words into meaningful phrases and sentences.
- **Pragmatics** – It deals with using and understanding sentences in different situations and how the interpretation of the sentence is affected.
- **Discourse** – It deals with how the immediately preceding sentence can affect the interpretation of the next sentence.
- **World Knowledge** – It includes the general knowledge about the world.

Steps in NLP



Artificial Intelligence - Expert Systems

What are Expert Systems?

- The expert systems are the computer applications developed to solve complex problems in a particular domain, at the level of extra-ordinary human intelligence and expertise.

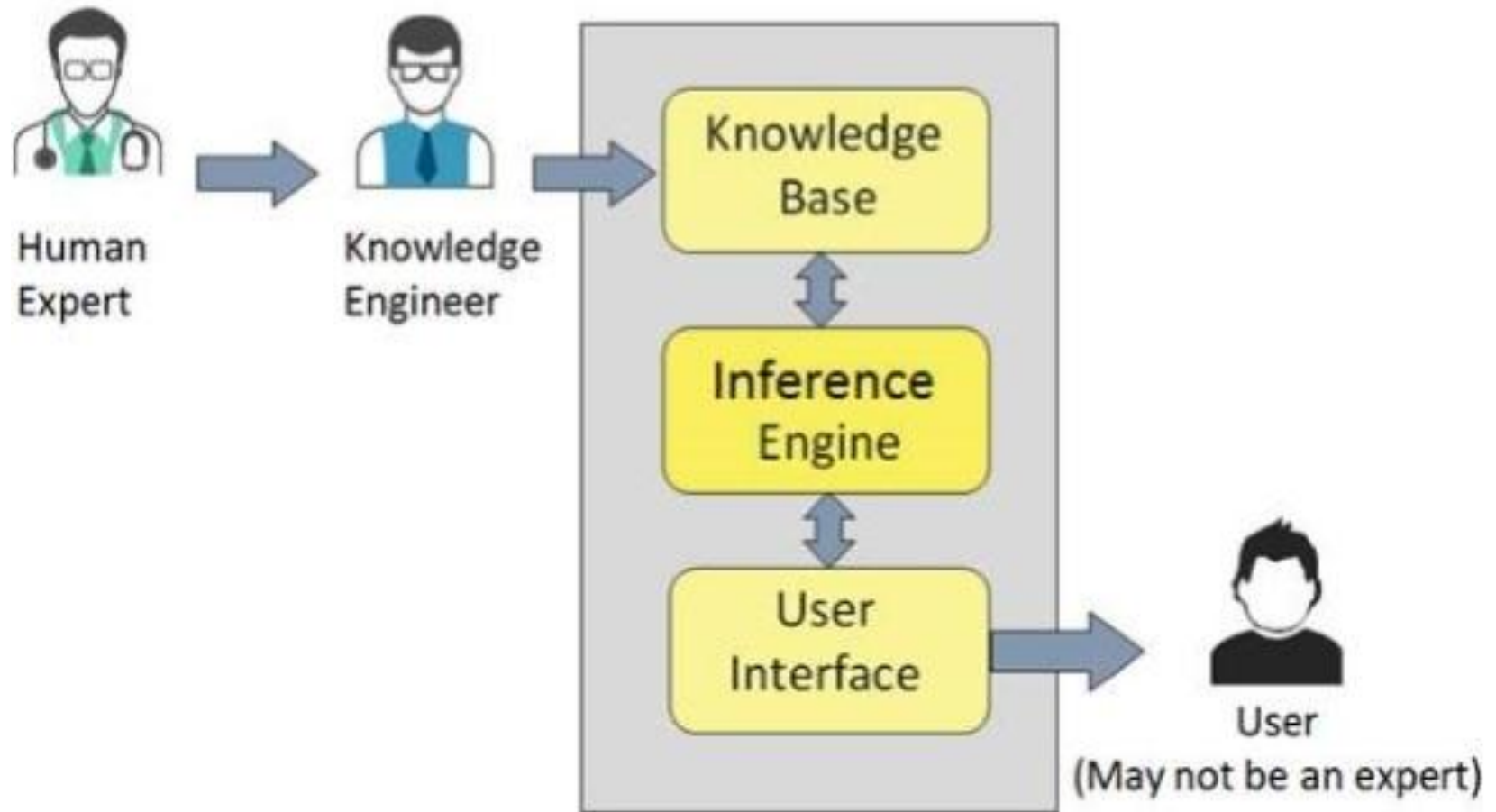
Characteristics of Expert Systems

- High performance
- Understandable
- Reliable
- Highly responsive

Capabilities of Expert Systems

- The expert systems are capable of –
- Advising
- Instructing and assisting human in decision making
- Demonstrating
- Deriving a solution
- Diagnosing
- Explaining
- Interpreting input
- Predicting results
- Justifying the conclusion
- Suggesting alternative options to a problem
- They are incapable of –
- Substituting human decision makers
- Possessing human capabilities
- Producing accurate output for inadequate knowledge base
- Refining their own knowledge

Components of Expert Systems



Expert Systems Limitations

- No technology can offer easy and complete solution. Large systems are costly, require significant development time, and computer resources.

ESs have their limitations which include:

- Limitations of the technology
- Difficult knowledge acquisition
- ES are difficult to maintain
- High development costs

Applications of Expert System

Application	Description
Design Domain	Camera lens design, automobile design.
Medical Domain	Diagnosis Systems to deduce cause of disease from observed data, conduction medical operations on humans.
Monitoring Systems	Comparing data continuously with observed system or with prescribed behavior such as leakage monitoring in long petroleum pipeline.
Process Control Systems	Controlling a physical process based on monitoring.
Knowledge Domain	Finding out faults in vehicles, computers.
Finance/Commerce	Detection of possible fraud, suspicious transactions, stock market trading, Airline scheduling, cargo scheduling.

Expert System Technology:

- Expert System Development Environment
- Tools
- Shells

Development of Expert Systems: General Steps

- Identify Problem Domain
- Design the System
- Develop the Prototype
- Test and Refine the Prototype
- Develop and Complete the ES
- Maintain the ES

Benefits of Expert Systems

- **Availability** – They are easily available due to mass production of software.
- **Less Production Cost** – Production cost is reasonable. This makes them affordable.
- **Speed** – They offer great speed. They reduce the amount of work an individual puts in.
- **Less Error Rate** – Error rate is low as compared to human errors.
- **Reducing Risk** – They can work in the environment dangerous to humans.
- **Steady response** – They work steadily without getting motional, tensed or fatigued.

Artificial Intelligence - Robotics

What are Robots?

- Robots are the artificial agents acting in real world environment.

Objective

- Robots are aimed at manipulating the objects by perceiving, picking, moving, modifying the physical properties of object, destroying it, or to have an effect thereby freeing manpower from doing repetitive functions without getting bored, distracted, or exhausted.

What is Robotics?

- Robotics is a branch of AI, which is composed of Electrical Engineering, Mechanical Engineering, and Computer Science for designing, construction, and application of robots.

Aspects of Robotics

- The robots have mechanical construction, form, or shape designed to accomplish a particular task.
- They have electrical components which power and control the machinery.
- They contain some level of computer program that determines what, when and how a robot does something.

Robot Locomotion

Locomotion is the mechanism that makes a robot capable of moving in its environment.

There are various types of locomotion:

- Legged
- Wheeled
- Combination of Legged and Wheeled Locomotion
- Tracked slip/skid

Legged Locomotion

Six possible different events:

- Lifting the Left leg
- Releasing the Left leg
- Lifting the Right leg
- Releasing the Right leg
- Lifting both the legs together
- Releasing both the legs together



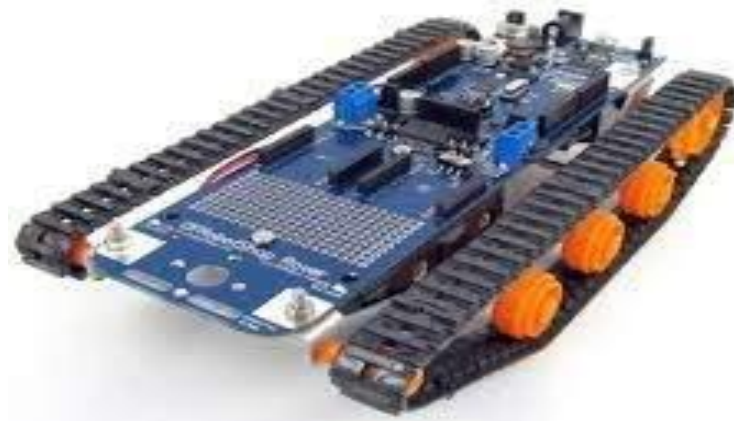
Wheeled Locomotion

- **Standard wheel** – Rotates around the wheel axle and around the contact
- **Castor wheel** – Rotates around the wheel axle and the offset steering joint.
- **Swedish 45° and Swedish 90° wheels** – Omni-wheel, rotates around the contact point, around the wheel axle, and around the rollers.
- **Ball or spherical wheel** – Omnidirectional wheel, technically difficult to implement.



Slip/Skid Locomotion

- In this type, the vehicles use tracks as in a tank.
- The robot is steered by moving the tracks with different speeds in the same or opposite direction.
- It offers stability because of large contact area of track and ground.



Components of a Robot

- **Power Supply** – The robots are powered by batteries, solar power, hydraulic, or pneumatic power sources.
- **Actuators** – They convert energy into movement.
- **Electric motors (AC/DC)** – They are required for rotational movement.
- **Pneumatic Air Muscles** – They contract almost 40% when air is sucked in them.
- **Muscle Wires** – They contract by 5% when electric current is passed through them.
- **Piezo Motors and Ultrasonic Motors** – Best for industrial robots.
- **Sensors** – They provide knowledge of real time information on the task environment.

Applications of Robotics

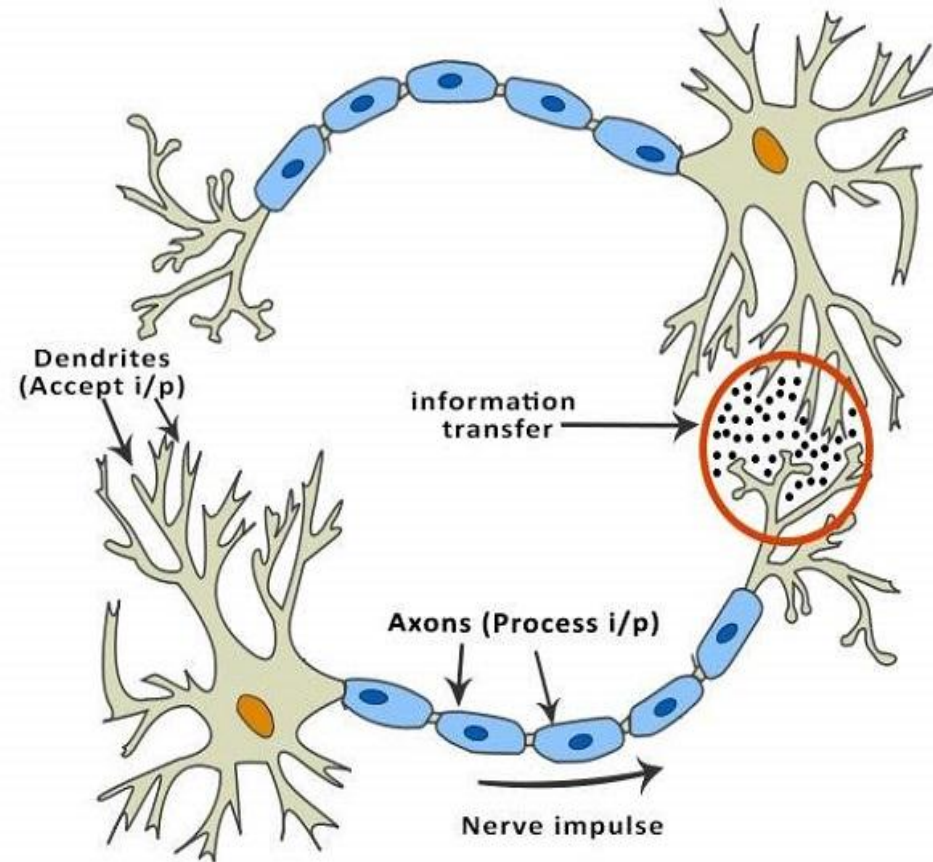
- **Industries** – Robots are used for handling material, cutting, welding, color coating, drilling, polishing, etc.
- **Military** – Autonomous robots can reach **inaccessible and hazardous zones during war**. A robot named *Daksh*, developed by Defense Research and Development Organization (**DRDO**), is in function to destroy life-threatening objects safely.
- **Medicine** – The robots are capable of carrying out hundreds of **clinical tests simultaneously**, **rehabilitating permanently disabled people**, and performing **complex surgeries such as brain tumors**.
- **Exploration** – The **robot rock climbers** used for space exploration, **underwater drones** used for ocean exploration are to name a few.
- **Entertainment** – Disney's engineers have created hundreds of **robots for movie making**.

Artificial Intelligence - Neural Networks

What are Artificial Neural Networks (ANNs)?

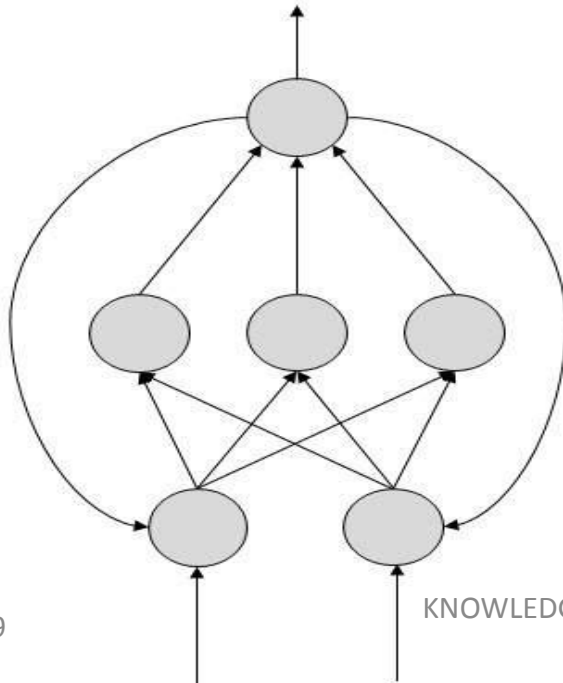
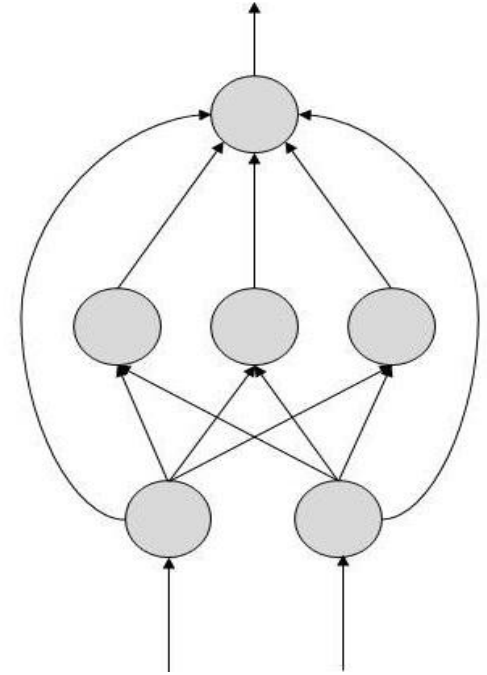
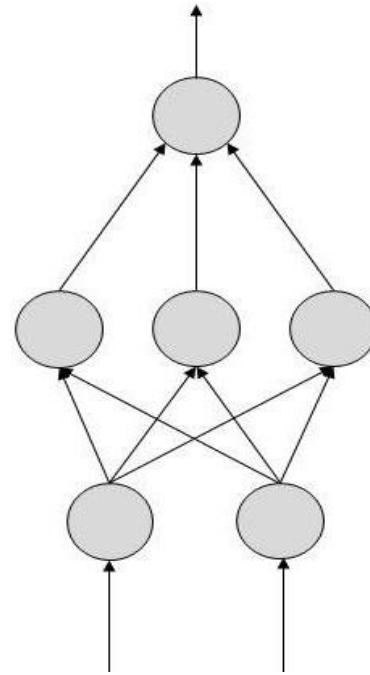
Dr. Robert Hecht-Nielsen, defines a neural network as:

“A computing system made up of a number of simple, highly interconnected processing elements, which process information by their dynamic state response to external inputs.”



Types of Artificial Neural Networks

- FeedForward ANN



FeedBack ANN

Applications of Neural Networks

- **Aerospace** – Autopilot aircrafts, aircraft fault detection.
- **Automotive** – Automobile guidance systems.
- **Military** – Weapon orientation and steering, target tracking, object discrimination, facial recognition, signal/image identification.
- **Electronics** – Code sequence prediction, IC chip layout, chip failure analysis, machine vision, voice synthesis.
- **Financial** – Real estate appraisal, loan advisor, mortgage screening, corporate bond rating, portfolio trading program, corporate financial analysis, currency value prediction, document readers, credit application evaluators.
- **Industrial** – Manufacturing process control, product design and analysis, quality inspection systems, welding quality analysis, paper quality prediction.
- **Medical** – Cancer cell analysis, EEG and ECG analysis, prosthetic design, transplant time optimizer.
- **Speech** – Speech recognition, speech classification, text to speech conversion.
- **Telecommunications** – Image and data compression, automated information services, real-time spoken language translation.
- **Transportation** – Truck Brake system diagnosis, vehicle scheduling, routing systems.
- **Software** – Pattern Recognition in facial recognition, optical character recognition, etc.
- **Time Series Prediction** – ANNs are used to make predictions on stocks and natural calamities.
- **Signal Processing** – Neural networks can be trained to process an audio signal and filter it appropriately in the hearing aids.

Artificial Intelligence - Issues

- **Threat to Privacy**

An AI program that recognizes speech and understands natural language is theoretically capable of understanding each conversation on e-mails and telephones.

- **Threat to Human Dignity**

AI systems have already started replacing the human beings in few industries. It should not replace people in the sectors where they are holding dignified positions which are pertaining to ethics such as nursing, surgeon, judge, police officer, etc.

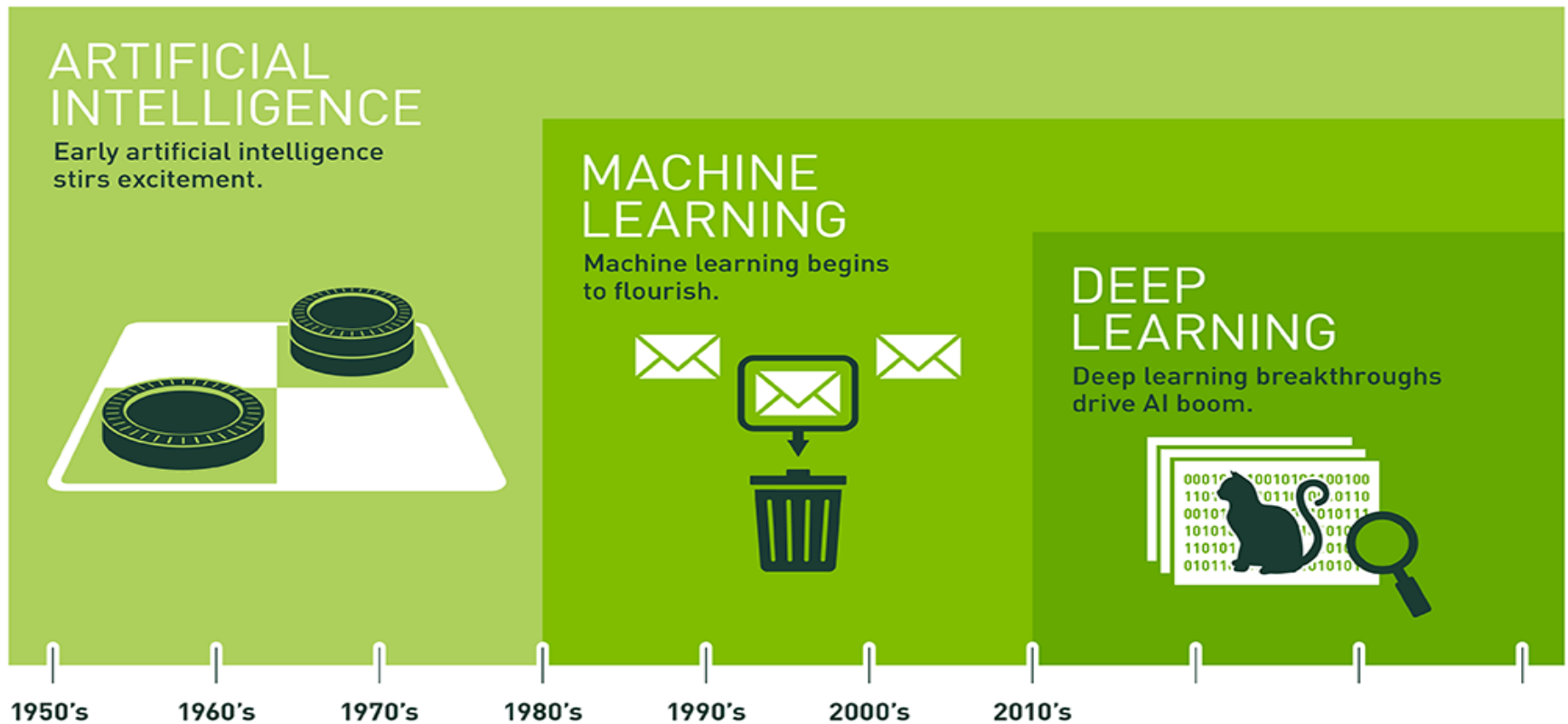
- **Threat to Safety**

The self-improving AI systems can become so mighty than humans that could be very difficult to stop from achieving their goals, which may lead to unintended consequences.

Artificial Intelligence - Terminology

Sr.No	Term & Meaning
1	Agent: Agents are systems or software programs capable of autonomous, purposeful and reasoning directed towards one or more goals.
2	Autonomous Robot: Robot free from external control or influence and able to control itself independently.
3	Backward Chaining: Strategy of working backward for Reason/Cause of a problem.
4	Blackboard: It is the memory inside computer, which is used for communication between the cooperating expert systems.
5	Environment: It is the part of real or computational world inhabited by the agent.
6	Forward Chaining: Strategy of working forward for conclusion/solution of a problem.
7	Heuristics: It is the knowledge based on Trial-and-error, evaluations, and experimentation.
8	Knowledge Engineering: Acquiring knowledge from human experts and other resources.
9	Percepts: It is the format in which the agent obtains information about the environment.
10	Pruning: Overriding unnecessary and irrelevant considerations in AI systems.
11	Rule: It is a format of representing knowledge base in Expert System. It is in the form of IF-THEN-ELSE.
12	Shell: A shell is a software that helps in designing inference engine, knowledge base, and user interface of an expert system.
13	Task: It is the goal the agent is tries to accomplish.
14	Turing Test: A test developed by Allan Turing to test the intelligence of a machine as compared to human intelligence.

Difference Between Artificial Intelligence, Machine Learning, and Deep Learning



Since an early flush of optimism in the 1950s, smaller subsets of artificial intelligence – first machine learning, then deep learning, a subset of machine learning – have created ever larger disruptions.

Contd...

- Artificial Intelligence - Human Intelligence Exhibited by Machines
- Machine Learning at its most basic is the practice of using algorithms to parse data, learn from it, and then make a determination or prediction about something in the world.
- Deep Learning - A Technique for Implementing Machine Learning

THANK YOU...