# UNIT II (COGNITIVE PSYCHOLOGY)

The **mind** is a set of cognitive faculties like consciousness, perception, thinking, judgement, and memory. The mind is the faculty of a human being's reasoning and thoughts. It holds the power of imagination, recognition, and appreciation, and is responsible for processing feelings and emotions, resulting in attitudes and actions.

Cybernetics is a transdisciplinary approach for exploring regulatory systems, their structures, constraints, and possibilities. In the 21st century, the term is often used in a rather loose way to imply "control of any system using technology." Cybernetics is relevant to the study of systems, such as mechanical, physical, biological, cognitive, and social systems. Cybernetics is applicable when a system being analyzed incorporates a closed signaling loop; that is, where action by the system generates some change in its environment and that change is reflected in that system in some manner (feedback) that triggers a system change, originally referred to as a "circular causal" relationship.

There are two types of knowledge--declarative and procedural. Declarative knowledge corresponds to things we are aware we know and can usually describe to others. Examples of declarative knowledge include "George Washington was the first president of the United States" and "Three plus four is seven." Procedural knowledge is knowledge that we display in our behavior but we are not conscious of. Procedural knowledge basically specifies how to bring declarative knowledge to bear in solving problems.

Perception is the organization, identification, and interpretation of sensory information in order to represent and understand the environment. All perception involves signals in the nervous system, which in turn result from physical or chemical stimulation of the sense organs. For example, vision involves light striking the retina of the eye, smell is mediated by odor molecules, and hearing involves pressure waves. Perception is not the passive receipt of these signals, but is shaped by learning, memory, expectation, and attention. Perception can be split into two processes. Firstly, processing sensory input, which transforms these low-level information to higher-level information (e.g., extracts shapes for object recognition). Secondly, processing which is connected with a person's concepts and expectations (knowledge) and selective mechanisms (attention) that influence perception.

Memory is the process in which information is encoded, stored, and retrieved. Encoding allows information from the outside world to be sensed in the form of chemical and physical stimuli. In the first stage the information must be changed so that it may be put into the encoding process. Storage is the second memory stage or process. This entails that information is maintained over short periods of time. Finally the third process is the retrieval of information that has been stored. Such information must be located and returned to the consciousness.

Problem solving consists of using generic or ad hoc methods, in an orderly manner, for finding solutions to problems. Some of the problem-solving techniques developed and used in artificial intelligence, computer science, engineering, mathematics, or medicine are related to mental problem-solving techniques studied in psychology. The term problem-solving is used in many disciplines, sometimes with different perspectives, and often with different terminologies. For instance, it is a mental process in psychology and a computerized process in computer science. Problems can also be classified into two different types (ill-defined and well-defined) from which appropriate solutions are to be made. Ill-defined problems are those that do not have clear goals, solution paths, or expected solution. Well-defined problems have specific goals, clearly defined solution paths, and clear expected solutions. These problems also allow for more initial planning than ill-defined problems. Being able to solve problems sometimes involves dealing with pragmatics (logic) and semantics (interpretation of the problem). The ability to understand what the goal of the problem is and what rules could be applied represent the key to solving the problem. Sometimes the problem requires some abstract thinking and coming up with a creative solution.

**General Problem Solver** (**GPS**) was a computer program created in 1957 by Herbert Simon and Allen Newell to build a universal problem solver machine.

The order in which the program considered,subgoals and possible actions was similar to that in w hich humans approached the same problems. Any problem that can be expressed as a set of well-formed formulas (WFFs) or Horn clauses, and that constitute a directed graph with one or more sources (viz., axioms) and sinks (viz., desired conclusions), can be solved, in principle, by GPS. Proofs in the predicate logic and Euclidean geometry problem spaces are prime examples of the domain the applicability of GPS. of predicate logic theorems. It was based on Simon and

Newell's theoretical work on logic machines. GPS was the first computer program which separated its knowledge of problems (rules represented as input data) from its strategy of how to solve problems (a generic solver engine). GPS was implemented in the third-order programming language, IPL. While GPS solved simple problems such as the Towers of Hanoi that could be sufficiently formalized, it could not solve any real-world problems because search was easily lost in the combinatorial explosion. Put another way, the number of "walks" through the inferential digraph became computationally untenable. (In practice, even a straightforward state space search such as the Towers of Hanoi can become computationally infeasible, albeit judicious prunings of the state space can be achieved by such elementary AI techniques as alpha-beta pruning and min-max.) The user defined objects and operations that could be done on the objects, and GPS generated heuristics by Means-ends analysis in order to solve problems. It focused on the available operations, finding what inputs were acceptable and what outputs were generated. It then created subgoals to get closer and closer to the goal.

**Agents and environments**

An **agent** is anything that can be viewed as perceiving its **environment** through **sensors** and acting upon that environment through **actuators.**

SENSOR

A human agent has eyes, ears, and other organs for sensors and hands, legs, mouth, and other body, parts for actuators.

A robotic agent might have cameras and infrared range finders for sensors and various motors for, actuators.

A software agent receives keystrokes, file contents, and network packets as sensory inputs and acts, on the environment by displaying on the screen, writing files, and sending network packets.

**Percept**

We use the term **percept** to refer to the agent's perceptual inputs at any given instant.

**Percept Sequence**

An agent's **percept sequence** is the complete history of everything the agent has ever pe rceived.

**Agent function**

Mathematically speaking, we say that an agent's behavior is described by the **agent fun ction,** that maps any given percept sequence to an action.

**Problem Solving by Search**

An important aspect of intelligence is ***goal-based*** problem solving.The **solution** of many **problem s** can be described by finding a **sequence of actions** that lead to a,desirable **goal.** Each action cha nges the ***state*** and the aim is to find the sequence of actions and,states that lead from the initial (s tart) state to a final (goal) state.

A well-defined problem can be described by:

**Initial state**

**Operator or successor function** - for any state x returns s(x), the set of states reachable from x with one action

**State space** - all states reachable from initial by any sequence of actions

**Path** - sequence through state space

**Path cost** - function that assigns a cost to a path. Cost of a path is the sum of costs of individual actions along the path

**Goal test** - test to determine if at goal state

**Search:**

**Search** is the systematic examination of **states** to find path from the **start/root state** to the **goal state.**

The set of possible states, together with *operators* defining their connectivity constitute the *searc hspace*.

The output of a search algorithm is a solution, that is, a path from the initial state to a state that satisfies the goal test.

**Problem-solving agents**

A Problem solving agent is a **goal-based** agent . It decide what to do by finding sequence of actions that lead to desirable states. The agent can adopt a goal and aim at satisfying it.
To illustrate the agent's behavior ,let us take an example where our agent is in the city of Arad,which is in Romania. The agent has to adopt a **goal** of getting to Bucharest.

**Goal formulation**,based on the current situation and the agent's performance measure,is the first step in problem solving.The agent's task is to find out which sequence of actions will get to a go al state.

**Problem formulation** is the process of deciding what actions and states to consider given a goal.

**Search**

An agent with several immediate options of unknown value can decide what to do by exami ning,different possible sequences of actions that leads to the states of known value,and then ch oosing the,best sequence. The process of looking for sequences actions from the current state t o reach the goalstate is called **search.**

The **search algorithm** takes a **problem** as **input** and returns a **solution** in the form of **action sequence.** Once a solution is found,the **execution phase** consists of carrying out the recommend edaction..

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**function** SIMPLE-PROBLEM-SOLVING-AGENT( *percept*) **returns** an action

**inputs** : *percept*, a percept

**static**: *seq*, an action sequence, initially empty

*state*, some description of the current world state

*goal*, a goal, initially null

*problem*, a problem formulation

state UPDATE-STATE(*state, percept*)

**if** seq is empty **then do**

*goal* FORMULATE-GOAL(*state*)

*problem* FORMULATE-PROBLEM(*state*, *goal*)

**Problem solving is fundamental to many AI-based applications.**

There are two types of problems.

- The Problems like, computation of the sine of an angle or the square root of a value. These can be solved through the use of deterministic procedure and the success is guaranteed.
- In the real world, very few problems lend themselves to straightforward solutions.

**Most real world problems can be solved only by searching for a solution.**

AI is concerned with these type of problems solving.

- **Problem solving is a process** of generating solutions from observed data.
  - a problem is characterized by a set of goals,
  - a set of objects, and
  - a set of operations.

  These could be ill-defined and may evolve during problem solving.

- **Problem space** is an abstract space.
  - A problem space encompasses all *valid states* that can be generated by the application of any combination of *operators* on any combination of *objects*.
  - The problem space may contain one or more *solutions*.

  **Solution is a combination of operations and objects that achieve the goals.**

- **Search** refers to the search for a solution in a problem space.
  - Search proceeds with different types of *search control strategies*.
  - The *depth-first search and breadth-first search* are the two common search strategies.

**Game Playing:**

The term Game means a sort of conflict in which n individuals or groups (known as players) participate.

• Game theory denotes games of strategy.

• John von Neumann is acknowledged as father of game theory. Neumann defined Game theory in 1928 and 1937 and established the mathematical framework for all subsequent theoretical developments.

• Game theory allows decision-makers (players) to cope with other decision-makers (players) who have different purposes in mind. In other words, players determine their own strategies in terms of the strategies and goals of their opponent.

• Games are integral attribute of human beings. Games engage the intellectual faculties of humans.

• If computers are to mimic people they should be able to play games.

Game playing, besides the topic of attraction to the people, has close relation to "intelligence", and its well-defined states and rules. The most commonly used AI technique in game is "Search". A "Two-person zero-sum game" is most studied game where the two players have exactly opposite goals. Besides there are "Perfect information games" (such as chess and Go) and "Imperfect information games" (such as bridge and games where a dice is used). Given sufficient time and space, usually an optimum solution can be obtained for the former by exhaustive search, though not for the latter. However, for many interesting games, such a solution is usually too inefficient to be practically used.

A game has at least two players. Solitaire is not considered a game by game theory.

The term 'solitaire' is used for single-player games of concentration.

• An instance of a game begins with a player choosing from a set of specified (game rules) alternatives. This choice is called a move.

• After first move, the new situation determines which player to make next move and alternatives available to that player. In many board games, the next move is by other player. In many multi-player card games, the player making next move depends on who dealt, who took last trick, won last hand, etc.

• The moves made by a player may or may not be known to other players. Games in which all moves of all players are known to everyone are called games of perfect information. Most board games are games of perfect information. Most card games are not games of perfect information.

• Every instance of the game must end.

• When an instance of a game ends, each player receives a payoff. A payoff is a value associated with each player's final situation. A zero-sum game is one in which elements of payoff matrix sum to zero. In a typical zero-sum game : win = 1 point, draw = 0 points, and loss = -1 points.

**Game Theory:**

Game theory does not prescribe a way or say how to play a game. Game theory is a set of ideas and techniques for analyzing conflict situations between two or more parties. The outcomes are determined by their decisions.

**General game theorem :** In every two player, zero sum, non-random, perfect knowledge game, there exists a perfect strategy guaranteed to at least result in a tie game.

The frequently used terms : The term "game" means a sort of conflict in which n individuals or groups (known as players) participate. A list of "rules" stipulates the conditions under which the game begins. A game is said to have "perfect information" if all moves are known to each of the players involved. A "strategy" is a list of the optimal choices for each player at every stage of a given game. A "move" is the way in which game progresses from one stage to another, beginning with an initial state of the game to the final state. The total number of moves constitute the entirety of the game. The payoff or outcome, refers to what happens at the end of a game. Minimax - The least good of all good outcomes. Maximin - The least bad of all bad outcomes. The primary game theory is the Mini-Max Theorem. This theorem says : "If a Minimax of one player corresponds to a Maximin of the other player, then that outcome is the best both players can hope for."

**Reasoning:**

• Reasoning is the act of deriving a conclusion from certain premises using a given methodology.

• Reasoning is a process of thinking; reasoning is logically arguing; reasoning is drawing inference.

• When a system is required to do something, that it has not been explicitly told how to do, it must reason. It must figure out what it needs to know from what it already knows.

- Many types of Reasoning have long been identified and recognized, but many questions regarding their logical and computational properties still remain controversial.
- The popular methods of Reasoning include abduction, induction, model- based, explanation and confirmation. All of them are intimately related to problems of belief revision and theory development, knowledge assimilation, discovery and learning.

Any knowledge system to do something, if it has not been explicitly told how to do it then it must reason. The system must figure out what it needs to know from what it already knows.

Example If we know : Robins are birds. All birds have wings. Then if we ask : Do robins have wings? Some reasoning (although very simple) has to go on answering the question.

Human reasoning capabilities are divided into three areas:

1. Mathematical Reasoning – axioms, definitions, theorems, proofs
2. Logical Reasoning (Studied in AI) – deductive, inductive, abductive
3. Non-Logical Reasoning – linguistic , language

These three areas of reasoning, are in every human being, but the ability level depends on education, environment and genetics. The IQ (Intelligence quotient) is the summation of mathematical reasoning skill and the logical reasoning. The EQ (Emotional Quotient) depends mostly on non-logical reasoning capabilities.

Logical Reasoning Logic is a language for reasoning. It is a collection of rules called Logic arguments, we use when doing logical reasoning. Logic reasoning is the process of drawing conclusions from premises using rules of inference. The study of logic is divided into formal and informal logic. The formal logic is sometimes called symbolic logic. Symbolic logic is the study of symbolic abstractions (construct) that capture the formal features of logical inference by a formal system. Formal system consists of two components, a formal language plus a set of inference rules. The formal system has axioms. Axiom is a sentence that is always true within the system. Sentences are derived using the system's axioms and rules of derivation are called theorems.