* Concept of AI :

from the ancient times, human beings tried to get their work done by human slaves or inanimate machines. In order to carry out an activity by a slave, the master must:

1) Have a total control over the slave.
2) Have a means of communication with the slave for ordering.

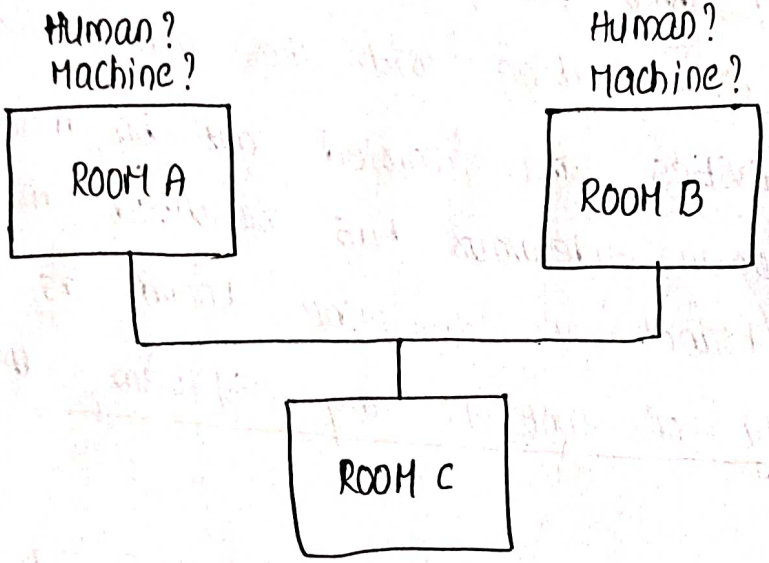
→ The majority of the activities are carried out by machines. The culmination of such a human endeavour has resulted in the development of a new branch of discipline known as cybernetics.

"Cybernetics is the study of controls any system using the technology."

→ With the invention of digital computers, the time consuming and error-prone numerical computations are done with relative ease and accuracy. It then struck to humans "why not seek the help of the computers in the reasoning process?" The seed for this thought was sown by Turing.

→ Turing in 1950, published an article in the Mind magazine, which triggered a controversial topic "can a Machine Think?". Turing proposed an "imitation game" in that players are 3 humans: a male, a female and an interrogator. The interrogator who is shielded from the other two humans, asks questions and based on their typewritten answers determines who is male and who is female. The aim of the male is to imitate the female and deceive the interrogator and the role of the female

is to provide replies that would inform the interrogator about her true sex. By slightly modifying the imitate game the Turing later proposed "Turing Test". In the Turing Test the interrogator (human) now communicates via teletype with the other players [(humans) + (machines)].




Turing proposed that if the human interrogator in ROOM C is not able to identify who is in Room A or in Room B, then the machine possesses intelligence. Turing considered this as a sufficient test for attributing thinking capacity to a machine for the thought of "can/why not seek the help of the computers in the reasoning process?". However, the test is not that easy as proposed because humans are far more superior in creativity, common sense and reasoning. If any question is put on these topics, humans are sure to excel. on the numerical computations part, machines are accurate and faster and doesnot give incorrect answers, but humans may give incorrect answers after taking sufficient long time.

Yes of today, Turing test is the ultimate test a machine must pass in order to be called as intelligent. Turing test has come under severe criticism for the following reasons:

1) Assuming that the machine has passed the Turing test, the question that has to be answered is what level of proficiency it has achieved. It is easier to say that it is the level of the programmer who has programmed it. In fact, the machine demonstrates the intelligence of the human being only.

2) Searle proposed an argument called chinese room argument to bring into limelight the major flaw in Turing Test. Searle who did not know chinese was locked in a room with a set of chinese alphabets and was provided with a small chinese writing to answer the questions asked by the person outside the room. Searle has given english instructions to answer the question (chinese). Searle claimed that he could manipulate the chinese symbols in a very formal way and provide satisfactory answers to the people creating an illusion that he knows chinese. Searle argued that the machine that passes the Turing Test assumed to be intelligent but lacks understanding.

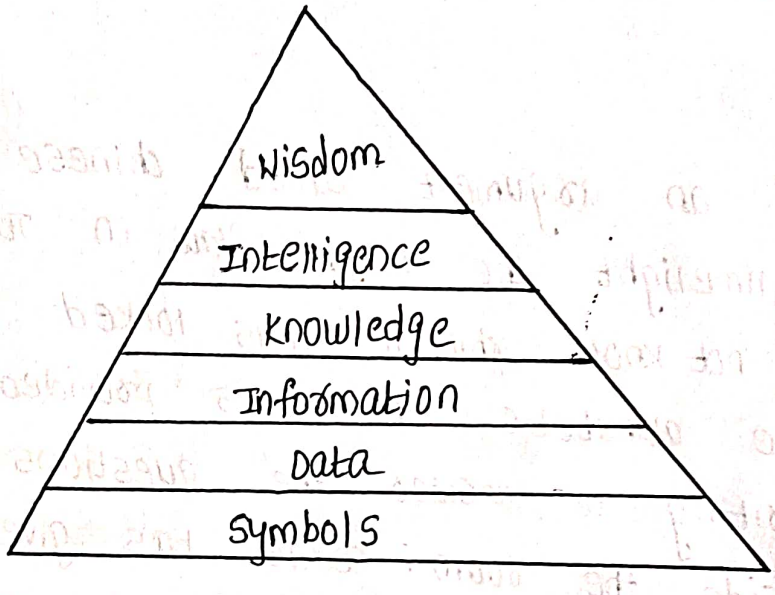
These two arguments which highlight the deficiencies of Turing Test, bring us to the major question "what is intelligence?"

## What is Intelligence?

"The ability to reason, to trigger new thoughts, to perceive and learn is defined as intelligence."

## Knowledge:

"The underlying push/thrust force behind every intelligent system is considered as knowledge."




Knowledge pyramid.

→ Symbols forms the means of representation.

→ Data can be defined as a collection of mere symbols.

→ Collection of data is considered as information.

→ Knowledge is a piece of information that helps in decision-Making.

→ Intelligence is the ability to reason, to perceive and learn.

→ Wisdom means the quality of being wise, the quality of having experience or knowledge.

## UNIT - I

**Introduction**: What is AI? The foundations of AI, History of AI, The state of the art applications.

**Intelligent Agents:** Agents and Environment, Good behavior: The concept of Rationality, The nature of environment, The structure of Agents.

### * What is AI?

AI definition is vary along two dimensions i.e thought process or reasoning(think) and behavior(act). These two dimensions further categorised into four approaches.

1) systems that think like humans.
2) systems that think rationally.
3) systems that act like humans
4) systems that act rationally.

| 1) systems that think like humans. | 2) systems that think rationally |
|---|---|
| "Machines with minds in the full and literal sense", by Haugeland in 1985 | "The study of computations that provide ability to perceive, reason and act", by Winston 1992 |
| 3.) systems that act like humans. | 4) systems that act rationally. |
| "The study of how to make computers do things at which humans do better", by Rich & knight in 1991. | "AI is cosidered / concerned with intelligent behavior in artifacts" by Nilsson in 1998. |

The given 4 approaches are followed by AI, each and every approach considers a test. The following are the 4 tests used in 4 approaches.

1) Thinking humanly uses cognitive Modeling approach: If we are going to say that a given system/machine thinks like a human, we must have some way to determine how humans think. This cognitive Modeling approach uses

a) Introspection: With individual human emotions one can find how humans think.

b) Psychological experiment: Based on the experiments conducted on others we can determine how humans can think.

2) Thinking rationally uses Laws of thought approach: Thinking rationally means thinking rightly based on the statements or the logics given/provided by others.

eg: Greek philosopher Aristotle syllogisms yields correct conclusions if the given premises are correct.

3) Acting humanly uses Turing Test: In 1950 Alan Turing proposed Turing Test for identifying if "systems/machines can think or act". Based on imitation game he developed Turing test in which the human interrogator doesnot identify if the answers were answered by human or system.

4) Acting rationally uses Rational agent approach: Acting rationally means acting rightly by not considering any logics. The rational agent is someone who acts and do the right thing. A rational agent acts to achieve the best outcome when there is uncertainty.

* The fundations of AI:

fundations means the brief history of the disciplines that contributed ideas, viewpoints and techniques to AI. The below are the fundamental areas of AI.

1) philosophy
2) Mathematics
3) Economics
4) Neuroscience
5) psychology
6) computer Engineering
7) control Theory & cybernetics
8) Linguistics.

1) Philosophy: It is the study of knowledge and reality.
→ can formal rules be used to get/draw valid conclusion?
→ How does knowledge connects to action/reality?

2) Mathematics: It is the study of science, maths, change, quality & space.

→ What can be computed?

→ What are the formal rules to get/draw valid conclus*

3) Economics: It is the study of decision making, how people use resources.

→ How should we make decisions to get maximum output?

→ How should we make decisions if others may not along wi you?

4) Neuroscience: It is the study of Nervous system.

→ How do brain process information?

5) Psychology: It is the study of human behavior.

→ How do humans & animals think & act?

6) Computer Engineering: It is the study of computers & computational systems.

→ How can we build an efficient computers?

7) Control Theory & cybernetics: It is the study of how to control humans & systems using Technology (cybernetics). The study of how to humans.

→ How can artifacts operates under technology?

→ How can human operates under their own control?

8) Linguistics: It is the study of Language.

→ How does Languages relate to thought?

## * History of AI:

### 1) Maturation / Gestation of AI (1943 - 1952):

→ In 1943 the first work recoginizes as AI was done by Waren and Walted Pits. Now their work was called as artificial neurons. Artificial Neurons uses hebbian learning [When our brain learn something, neurons are activated & connected with other neurons which forms neural network].

→ In 1950 Alan Turing who was english Mathematician proposed Turing test to test if machines can think or act.

### 2) The Birth of AI (1952 - 1956):

→ In 1955 Allen and Simon created first artificial intelligence program which was named as logic Theorist. It solved 38 out of 52 problems and gives new elegant proofs for some theorems.

→ In 1956 the word AI was adopted by John Mc carthy. He named intelligent system Machine intelligence as Artificial Intelligence (AI), so he is called as father of AI.

→ In 1956 highlevel computer languages such as fortran, Lisp or COBOL were invented.

### 3) Early enthusiam / Great expectations (1956 - 1974):

→ In 1966 Joseph created first chatbot which was named as ELIZA.

→ In 1972 the first intelligent humanoid robot was built Japan which was named as WABOT-I.

4) First AI Winter (1974-1980):

→ AI programs were miserably failed while toying new.

5) BOOM of AI (1980-1987):

→ AI came with expert system. It is a program that uses logical rules that are derived from the knowledge of experts to answer or solve problems. Expert systems (XCON) was used for:

→ Monitoring stock market, diagnose diseases, instructing miners to locate minerals.

6) Second AI Winter (1987-1993):

→ XCON was very cost effective.

→ XCON doesnot provide efficient results.

7) The emergence of intelligent agents (1993-present):

→ In 1997, IBM's Deep Blue beats world best chess champion and become a first computer to beat a world chess champion.

→ In 2002 AI entered in the home as vaccum cleaner which was named as Rombaa.

→ In 2006 AI enters into business companies like

facebook, twitter, netflix also started using AI.

→ Google developed first virtual assistant which attends the call and behaves like human.

→ Now-a-days companies like google, facebook, IBM, amazon are working with AI and creating amazing devices.

## * The state of art of Applications:

→ State of art is the level of development of AI as device, process, technique, science, technology reached at any particular time by using Modern methods.

→ State of art tells what is AI do today? AI can do many activities in so many fields. Here consider the development of AI in the following applications:

1) Autonomous planning & scheduling
2) Game playing
3) Autonomous control (Robotic vehicles)
4) Diagnosis
5) Robotics
6) Language processing/understanding (Machine Translation) & problem solving
7) Logistics planning:

1) Autonomous planning & scheduling: NASA's Remote Agent program became the first on-board autonomous planning program to control the scheduling of operations for space craft. Remote agent generate high-level goals, monitors the operations of

spacecraft as planned (detecting, diagnosing & recovering from problems as they occurred).

2) Game playing: IBM's Deep Blue won the chess championship conducted against world best human champion.

3) Autonomous control (Robotic vehicles): The ALVINN system was trained to steer a car based on the best direction & experience from previous training runs.

4) Diagnosis: Medical diagnosis program were developed based on probabilistic analysis for performing as an expert physician in several areas of Medicine. In 1991 Heckerman describes a case where Medical diagnosis program points out the major factors influencing its decision and solves the case.

5) Robotics: Many surgeons now use robot assistants in surgery. HipNav developed in 1996 uses computer vision techniques to create a 3-D model of a patient's internal anatomy. HipNav uses computer vision and guided the insertion of hip replacement.

6) Language processing/understanding & problem solving: Machine Translation or language processing is the process of automatically translating contents from one language to another language. PROVERB was developed in 1991 for problem solving is a computer program that solves crossword puzzles

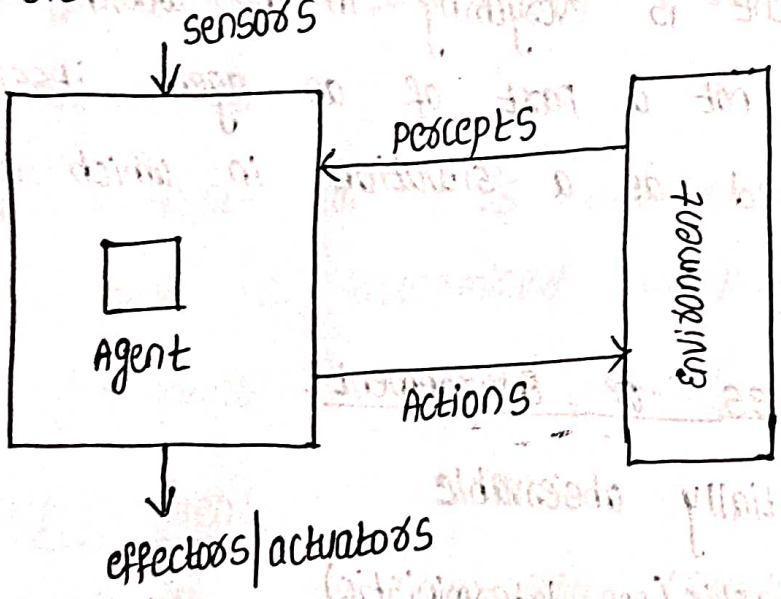
better than humans.

1) Logistics planning: During Persian-Gulf / Gulf crisis in 1991, the U.S forces deployed Dynamic Analysis and Replanning Tool [DART] program for logistics planning & scheduling transportation.

* Intelligent Agents: Agents & Environments:

AI system consists of agent and its environment.

Agent: An agent can be anything (human, robot, software) that percepts the environment through sensors. and acts on that environment through effectors (actuators). Agent act upon the environment.




Types of Agents: These are 3 types of agents. They are:

1) Human agent: Human agent accepts the input through the sensors (eyes, nose, ears, mouth, hands) from environment. and acts on that environment through effectors (mouth, hands, legs).

2) Robot agent: Robot agent accepts the input through the sensors (camera, microphone) and acts on that environment

through effectors (actuators).

3) Software agent: S/W agent accepts the input through the sensors (programs, keystrokes) and acts on that environment through effectors (output).

Rules of agent:

→ Agent must have the ability to perceive the environment.
→ Agent must observe the environment to make decisions
→ Decisions should result in action.
→ The actions must be rational action.

Environment: An environment is everything in the world which surrounds the agent, but it is not a part of an agent itself. An environment is described as a situation in which an agent is present.

Types / features / properties of Environment:

1) fully observable / partially observable
2) Deterministic / stochastic (non-deterministic)
3) episodic / sequential
4) single-agent / multi-agent
5) static / dynamic
6) Discrete / continuous
7) known / unknown.

1) fully observable / partially observable:

→ An agent can always sees the entire state of environment is considered as fully observable.

eg: chess

→ An agent can never see the entire state of environment is considered as partially observable.

eg: card game.

2) Deterministic / stochastic:

→ In deterministic an agent's current state & selected action can completely determines the next state of environment.

eg: Tic Tac Toe

→ In stochastic an agent's environment is random in nature and cannot be determined completely by an agent.

eg: dice games

3) episodic / sequential:

→ In episodic only the current percept (input) is required for the action.

eg: part picking robot.

→ In sequential an agent requires the memory of past action to determine next actions & current decision could affect future actions.

eg: chess.

4) Single-agent / multi-agent :

→ If only one agent is involved in an environment & operates itself then such environment is called single-agent environment.

Eg: Haze, Temple run, candy crush.

→ If multi agents is involved in an environment & agents depends on other agents then such environment is called multi-agent environment.

Eg: football, Ludo.

5) Static / dynamic :

→ The environment doesnot change while an agent is acting, is considered as static environment.

Eg: crossword puzzles.

→ The environment may change over time is considered as dynamic environment.

Eg: self car driving.

6) Discrete / continuous :

→ In discrete environment finite no. of actions are used to obtain the output.

Eg: chess

→ The environment actions cannot be numbered is said to be continuous.

Eg: self driving cars.

1) Known/unknown:

→ The result for all the actions are known to the agent in known environment.

Eg: card game & already played games

→ In unknown environment the agent need to learn how it works in order to perform an action.

Eg: A new game.

* Good Behavior: The concept of rationality:

Rationality means good/correct thinking. We can consider the rationality of an agent based on four things:

1) Performance measure
2) Prior knowledge
3) actions
4) Percept sequence.

1) Performance Measure: Performance measure is the unit to define the success of action performed by agent.

2) Prior knowledge: The agent's prior knowledge of the environment.

3) Actions: The actions that the agent can perform.

4) Percept sequence: The agent's percept sequence to date.

Rational agent: Rational agent is the agent that always do right/correct thing. It can perform the best possible action &

maximize the performance measure. Rational agent is a component of AI. Doing right thing is better than doing wrong thing. Doing right thing is categorized as rationality.

PEAS

Eg: Vaccum cleaner agent's performance measure is based on the no.of squares cleaned get one point. Then the performance measure of giving one point to each cleaned square/tile is valid, so the rational agent does the good thing.

If the performance measure is based on one point for clean tile and one point deduction for agent moving into non-dirty tile then the rational agent does the bad thing/wrong thing.

Omniscience, Information gathering, Learning, autonomy:

Omniscient agent: An agent is omniscient if the agent knows the actual outcome of its actions and can act accordingly. But omniscience is not possible in reality.

Information gathering: Doing actions inorder to modify the future percepts is called as information gathering.

Learning: Rational agent not only gather information but also learn as much as possible from what it perceives/percepts.

Autonomy: Agent relies on prior knowledge rather than its own percepts, then that agent lacks autonomy. prior knowledge + percepts leads to autonomous.

PEAS system is used to categorize similar agents.

P - Performance measure
E - Environment
A - Actuators
S - Sensors

* The Nature of Environment:

Environment is everything in that world that surrounds an agent. Environment is must for the agent to get the outcome based on input. Here we specify task environment for the agents.

Task environment is an environment which will pose a problem to which the agent/rational agent will find the solution.

Specifying the task environment: specify the task environment of the agent using PEAS system.

→ Performance Measure (P): performance measure is the unit to the rational agent success

→ Environment (E): everything that surrounds the agent is considered as environment.

→ Actuators (A): Actions or output given by the agent to the environment.

→ Sensors (S): The input percepts by an agent from the environment.

| Agent Type | Performance Measure | Environment | Actuators | Sensors |
|---|---|---|---|---|
| Vacuum cleaner | points based on no. of squares/tiles cleaned. | Room | cleaned floor | no. of tiles/ squares |
| Medical diagnosis system | Healthy patient, reduced cost | Hospital | diagnosis, tests, treatment | symptoms, patients answers |
| Self driving car | safe, fast, time | Roads, traffic | display, brake | cameras, Gps, sensors, speedometer |

PEAS description of the task environment for agents

Properties of Task environment:

1) fully observable / partially observable
2) deterministic / stochastic
3) episodic / sequential
4) single agent / multi agent
5) static / dynamic
6) discrete / continuous
7) known / unknown

→ Based on the above properties we can categorize the task environment because the range of task environments

that might arise in AI is obviously vast.

| Task Environment | Observable (Fully / Partially) | Determinism (Deterministic / Stochastic) | Episodicity (Episodic / Sequential) | Agents (Single / Multi) | Static (Static / dynamic) | Discrete (Discrete / Continuous) | Known (Known / unknown) |
|---|---|---|---|---|---|---|---|
| Crossword Puzzle | fully | Deterministic | sequential | single | static | Discrete | |
| chess | fully | Deterministic | sequential | multi | semi | Discrete | |
| self driving car | Partially | stochastic | sequential | multi | Dynamic | continuous | |
| Medical diagnosis | Partially | stochastic | sequential | single | Dynamic | continuous | |
| Part-picking Robot | Partially | stochastic | episodic | single | Dynamic | continuous | |

Examples of task environments and their characteristics

* The structure of agents:

The agents are described using behavior. The job of AI is to design an agent program that implements the agent function. Agent uses architecture and agent program to generate the action.

**Agent = Architecture + Agent program**

Architecture: some sort of computing device with physical sensors and actuators.

Agent program: some sort of software program. The agent program takes the current percept as input from sensors and return an action to the actuators. Agent program implements the agent function [Mapping from percepts to actions]. Agent program takes current percept as input, while agent function takes the entire percept sequence.

→ The agent program for vaccum cleaned agent as follows:

function Vaccum-cleaned-agent (percepts) returns an action.

(or)

function Vaccum-cleaned-agent([clocation, status]]) returns an action

if status = Dirty then return cleaning

else if location = A then return Right

else if location = B then return left

else return cleaned room Action.

Types/kinds of agent programs:

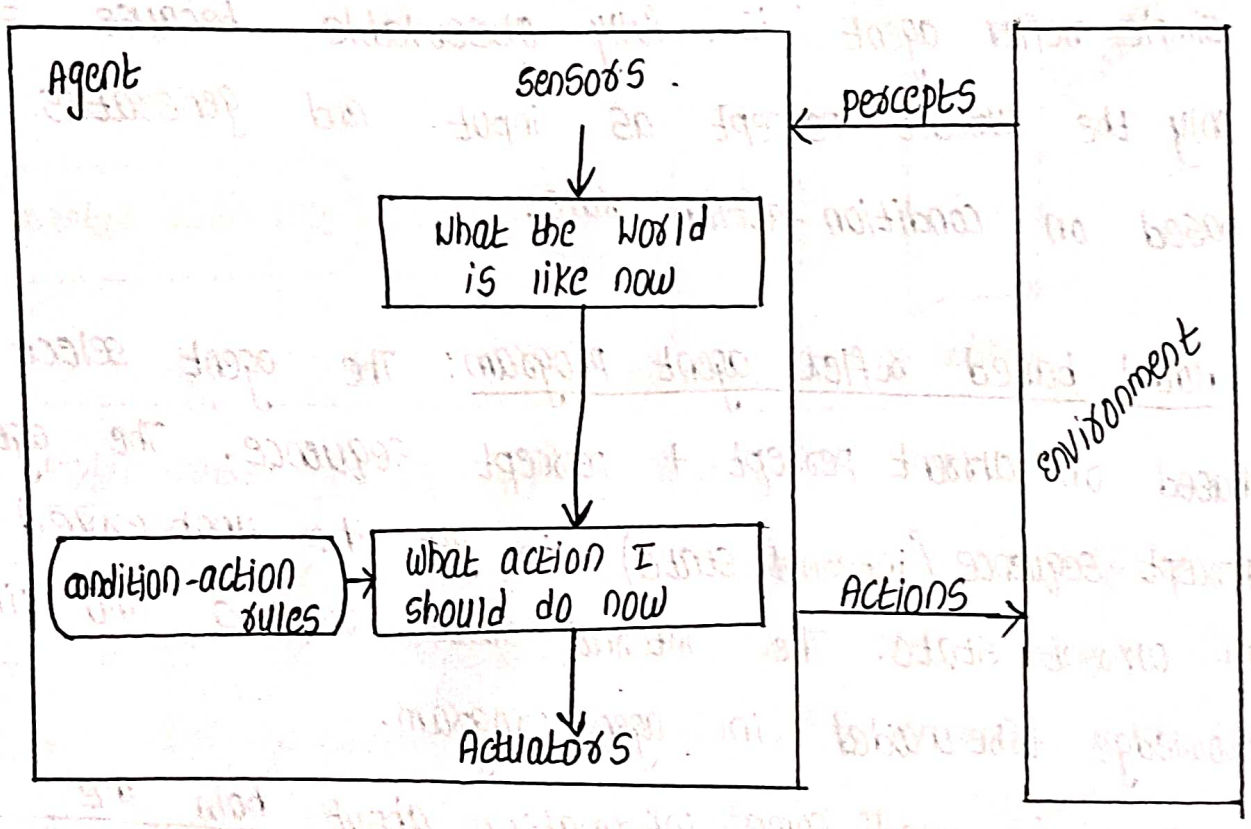
1) Simple-reflex agent program
2) Model-based reflex agent program
3) Goal-based agent program
4) Utility-based agent program
5) Learning agent program.

i) Simple-reflex agent program: The agent select actions on the basis of the current percept and ignores the rest of percept history.

(or)

The agents actions (output) is based on the current percept (input) its

Eg: Vaccum cleaner agent is a simple reflex agent because decision is based only the current location and on whether that location contains dirt.




Schematic diagram of a simple-reflex agent.

Simple-reflex agent program uses condition-action rule to generate the actions based on current percept. We use rectangles to denote the current state of the agent's decision process and use ovals to represent the background information used in decision process.

agent program for simplereflex

function Reflexvacuumcleaneragent ([location, status]) returns an
if status = Dirty then return cleaning
else if location = A then return right
else if location = B then return left
else
return action.

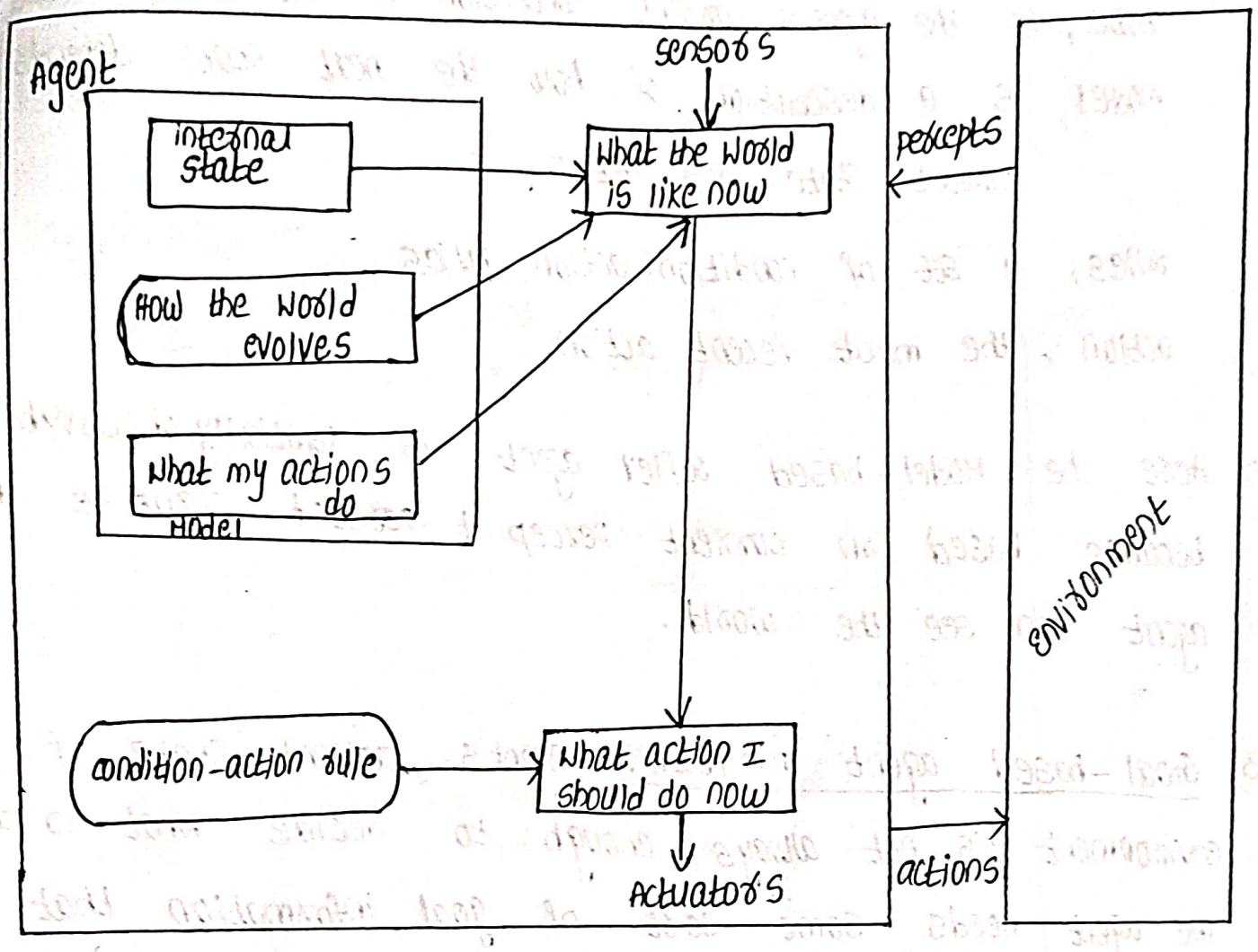
→ Simple reflex agent is fully observable because it takes only the current percept as input and generates action based on condition-action rule.

2) Model based reflex agent program: The agent select actions based on current percept + percept sequence. The agent uses percept sequence (internal state) to get the unobserved aspects of current state. The internal state requires two kinds of knowledge tobe encoded in agent program.

→ first, we need some information about how the world evolves independently of the agent.

→ second, we need some information about how the agents own actions affect the world (what my actions do)

→ The knowledge about "how the world works" is consider as model of the world. An agent that uses such a model is called model-based agent.




Model-based reflex agent diagram

The model-based reflex agent with internal state shows how the current percept is combined with the old internal state to generate the updated description of current state, based on the agent's model of how the world works.

Model-based agent program

function Model base agent (percept) returns an action

state ← updatestate (state, action, percept, model)

rule ← ruleMatch (state, rules)

action ← rule.action

return action.

where,

state, is the agent's current conception of the world state.

model, is a description of how the next state depends current state and action.

rules, a set of condition-action rules

action, the most recent action.

→ Here the Model-based reflex agent is partially observable because based on current percep + percept sequence the agent can see the world.

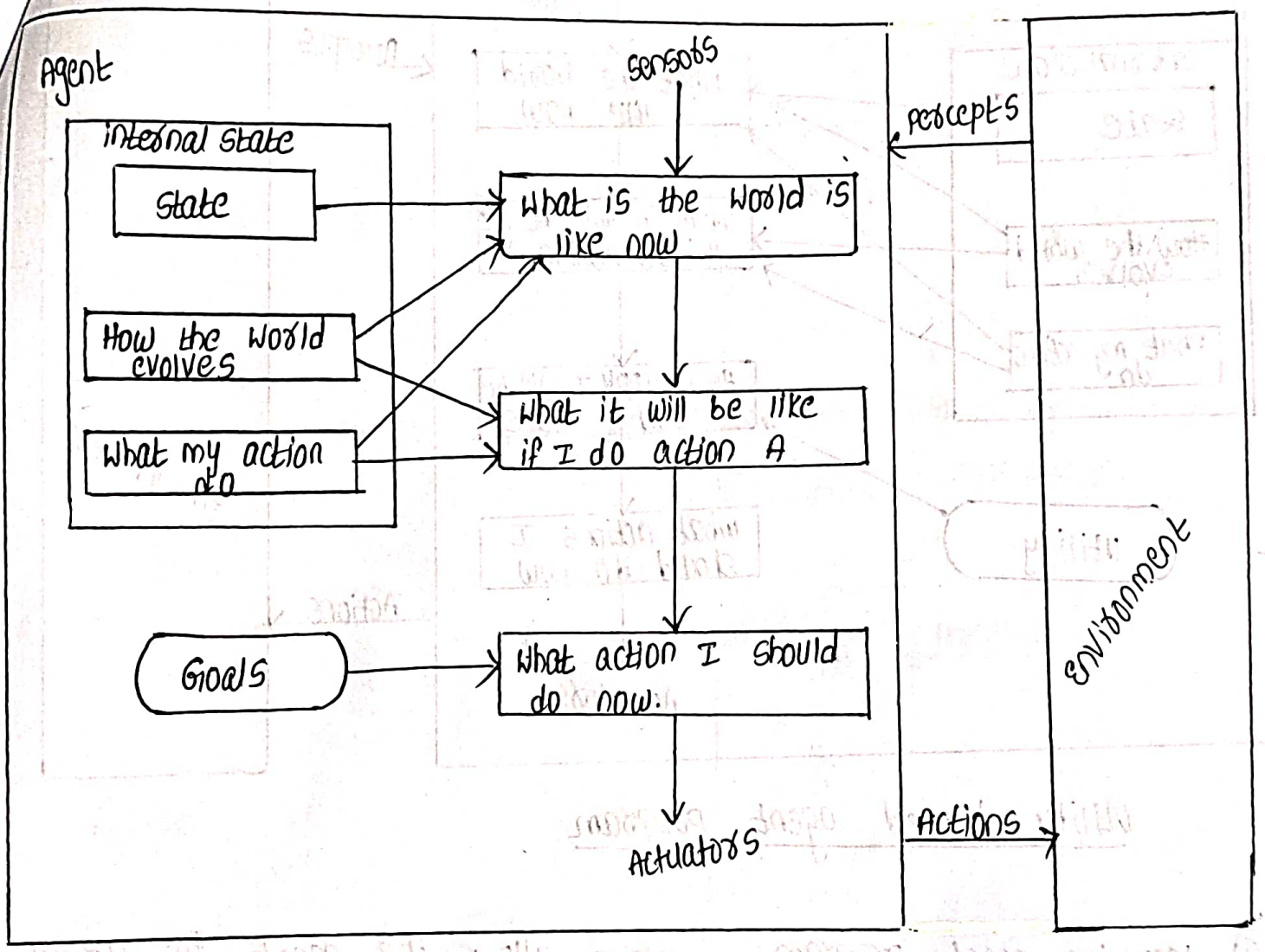
3) Goal-based agent program: Agent's current state of the environment is not always enough to decide what to do. The agent needs some sort of goal information that describes situations that are desirable. The agent program can combine this with the model to choose actions that achieve the goal.

Eg: At the road junction, the taxi can turn left or turn right or go straight on, the correct decision depends on where the taxi is trying to get to.

→ if the goal results immediately from a single action then goal-based agent program is best.

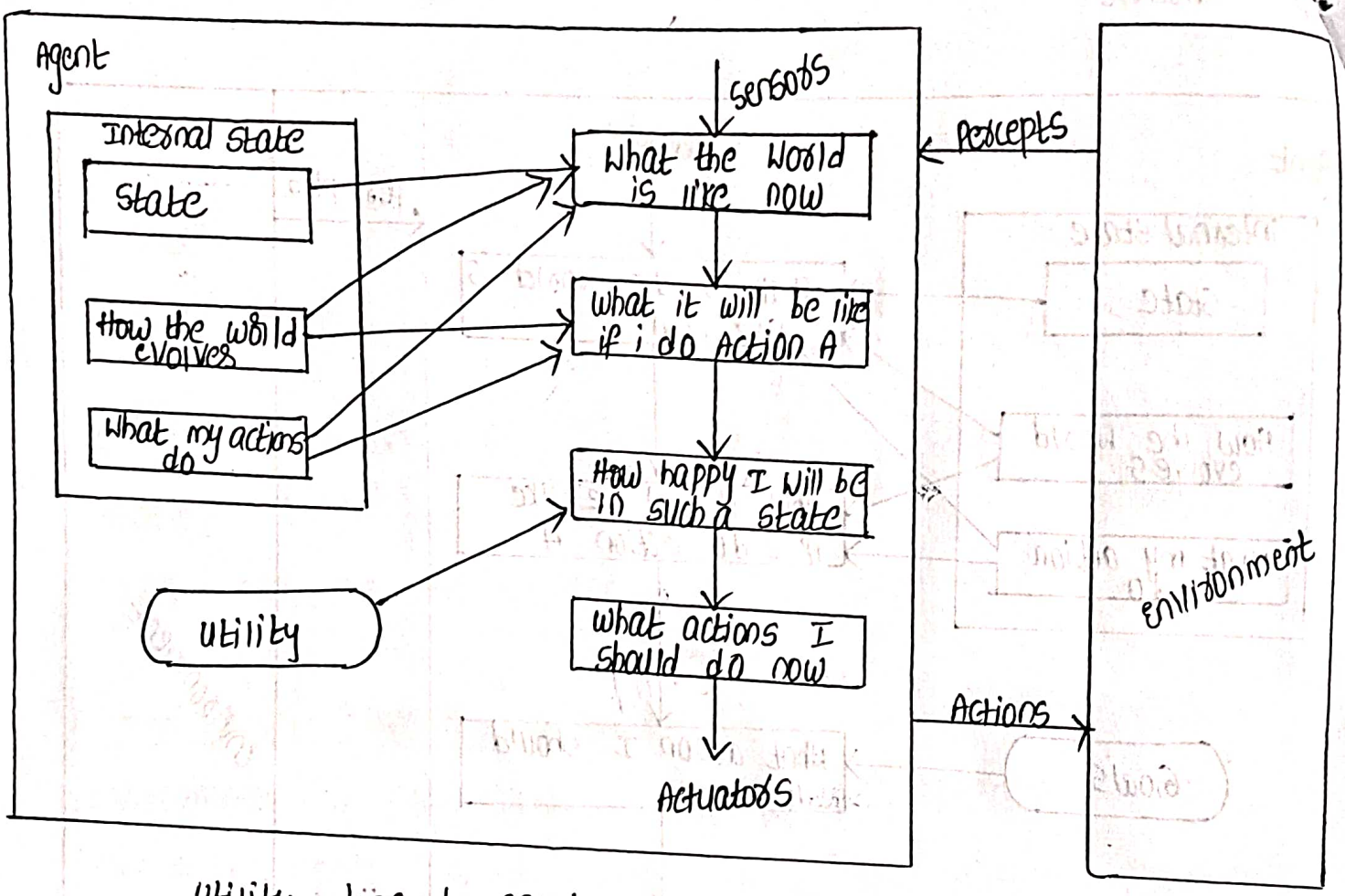
→ When the agent has to consider long sequences of twists and turns in order to find a way to achieve the goal then goal-based agent program is

not suitable.




Goal-based agent program

4) Utility-based agent program: Goals alone are not enough to generate high-quality behavior in most environments. A more general performance measure should allow a comparison of different world states according to exactly how happy they would make the agent. The word utility refers to the quality of being useful. If the utility function and the external performance measure are in agreement, then an agent that chooses actions to maximize its utility will be rational.




Utility-based agent program

5) Learning agent program: Learning allows the agent to operate in initially unknown environments and to become more competent than its initial knowledge. A learning agent can be divided into four conceptual components

a) Learning element

b) performance element

c) critic

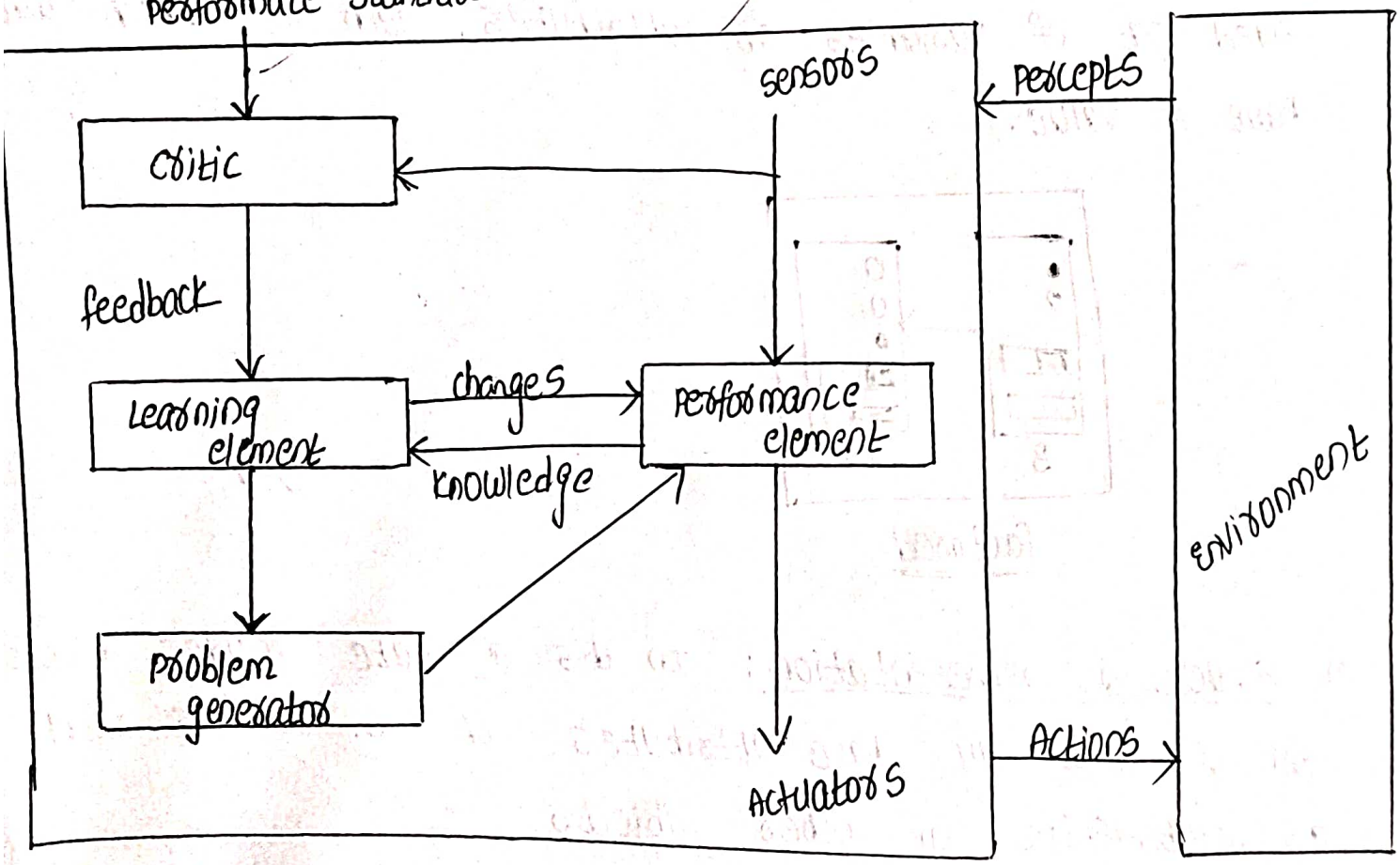
d) problem generator.

a) Learning element: It is responsible for making improvements based on performance.

b) Performance element: It is responsible for selecting external actions. It takes percepts and decides on actions.

c) Critic: It determines how the agent is doing and determines how the performance element should be modified to do better in future.

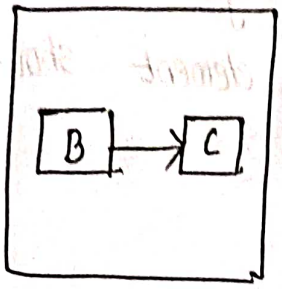
d) Problem generator: It is responsible for suggesting actions that will lead to new and informative experiences.




How the components of agent program work?

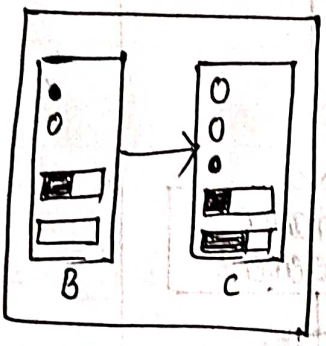
agent program consists of components like "How the world is like now?" or "What my actions do" etc. TO represent the components there are 3 representations. They are:

1) Atomic representation: each state of the world is indivisible (it has no internal structure).



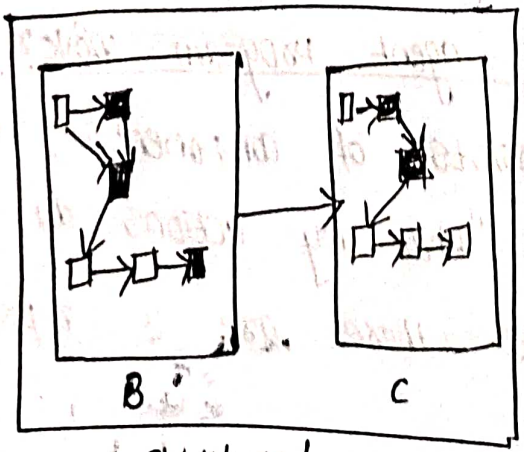

atomic

2) factored representation: It splits up each state into a fixed set of variables or attributes, each of which can have a value.




factored

3) structured representation: In this a state includes objects, each of which may have attributes of its own as well as relationships to other objects




structured