Artificial Intelligence

- AI is composed of two words artificial & intelligence where artificial defines 'man-made', & intelligence defines 'thinking power'.
- AI means a "man-made thinking power".
  eg self driven cars, playing ~~card~~ chess & music, painting etc.

Goals of AI.

- Replicate human intelligence.
- solve knowledge-intensive tasks
- An intelligent connection of perception & action.

Advantages of Artifical Intelligence

- High accuracy with less errors
- High speed
- High reliability
- Useful for risky areas
- Useful as a public utility.

Disadvantages of Artificial Intelligence

- High cost
- Can't think out of the box
- No feelings & emotions
- Increase dependancy on machines
- No original creativity

AI Techniques

There are many different artificial intelligence that can be utilized by an AI programmer, they are as follows-

- Heuristic → find best route, principle ⇒ trial & error
- SVM (support vector machine) ⇒ used by in email sys.
- Artificial Neutral Network → It consist neurons.
- Natural language processing. ⇒ convert audio to text
- Machine learning
- Markov Decision Process → Decision Making Proces

Problem Solving in AI :-

Problem can be categorized as —

① Structured
② Non-Structured
③ Linear
④ Non-Linear

- The aim of Artificial Intelligence is to develop a system which can solve the various problems on its own.

→ The steps involved in solving a problem are :-

ⓐ Define a problem
ⓑ Form the state space
ⓒ Gather knowledge
ⓓ Planning
ⓔ Applying and executing.

AI Models.

- An important aspect to solve AI problem is to first model the problem.
- Dunker introduced a maze hypothesis.
- In this creative and intelligent task handled by humans are represented using a maze of path from an inital node to certain node.
- This maze can be used to get multi alternative sol" to a problem.
- But the important thing was not all the problems could be solved using maze hypothesis.
- so focus shifted to logic theory machines
- logic theory machines were effective in general problem solving like chess problem,
- soon there was a need for NLP and man machine dialogue and the models used so far had their own limitations.

- Dynamic inductive Model were introduced for creative problem solving and overcome the limitations of previous model, they are.

① Semiotic Model

② Statistical Model.

Model	Knowledge-based model building	AI Appln building
Discover	Discover relationship.	Mapping

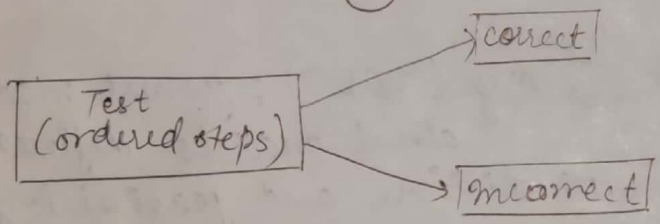
complexity →

① Semiotic Models – Based on sign process, signification or communication.

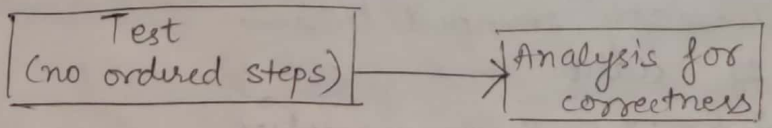
② Statistical Models – Representation and formalization of relationships through statistical techniques.

- History of data for decision making
- uses probabilistic approaches.

Problem solving with AI.



well-structured



ill-structured

AI applications -

1. Credit granting
2. Information management and retrieval
3. AI & expert systems embedded in products
4. Plan layout
5. Help desk and assistance
6. Employee performance evaluation
7. Shipping
8. Marketing
9. Nuclear management
10. Network developments
11. Satellite controls

Data Acquistion and learning Aspects in AI

1. Knowledge Discovery: Data mining and machine learning
   - Data - recorded facts
   - Information - pattern underlying the data
   - data mining or knowledge discovery - extraction of meaning information.
   - Machine learning - algorithms that improve performance with experience.
2. Computational learning Theory (COLT): formal mathematical models defined
   complexity - computation, prediction and feasibility
   analyze patterns - Probably Approximately correct (PAC).
   hypothesis mistake bound - target function.
3. Neural and evolutionary computation -
   speed up mining of data.

   evolutionary computing - biological properties
   decision making & optimization

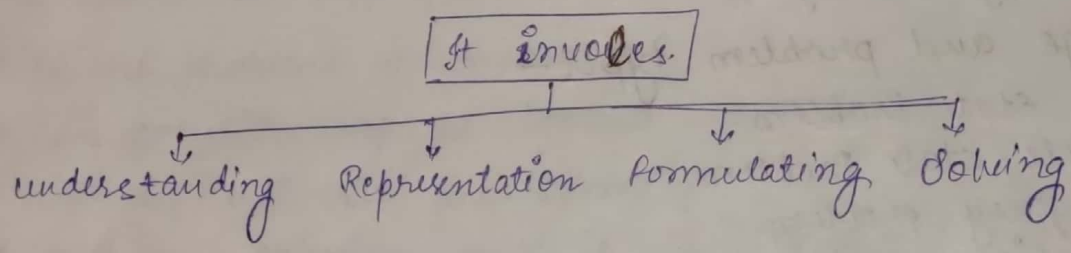
   Neural computing - neural behaviour of human being
   pattern recognition & classification.

④ Intelligent agents and multi agent systems - decision making in complex scenarios, intelligent agents - based on knowledge, available resources and perspectives multi agent system - combination of more than one percept of intelligent agents.

⑤ Multi-perspective integrated intelligence - utilizing and exploiting knowledge from different perspective.

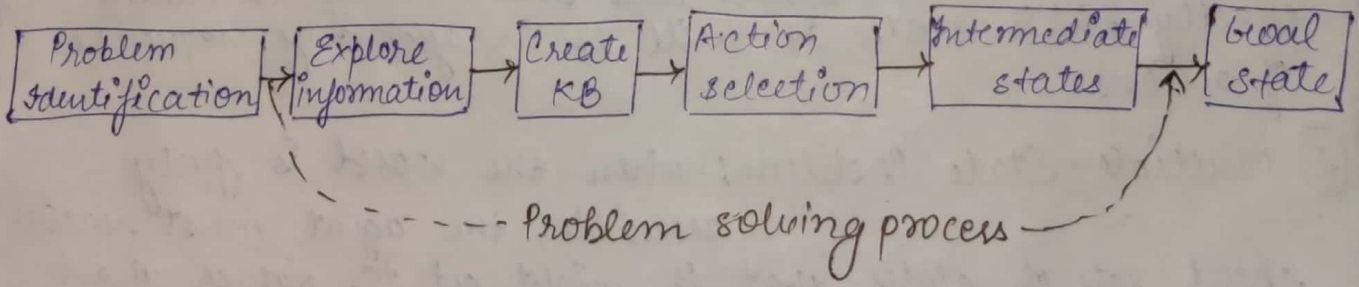
Problem Solving Process.

- Problem solving process of generating soln for the given soln.
- Problem is defined.
  1. In a context
  2. has well defined objective
  3. soln has set of activities.
  4. uses previous knowledge & domain knowledge.

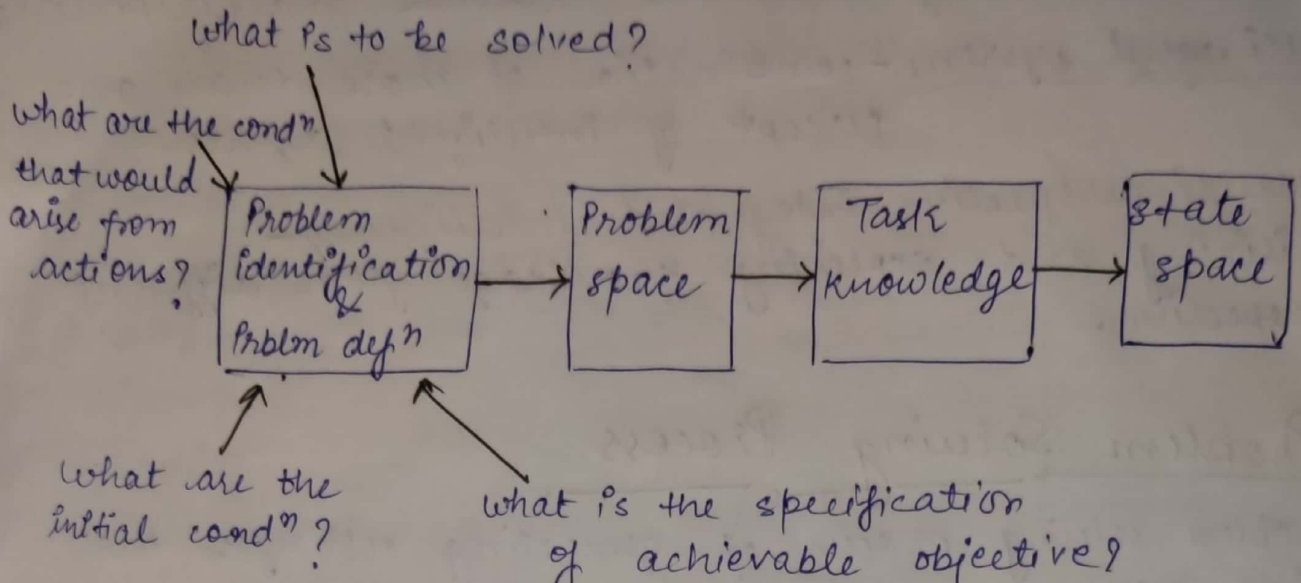


Problem types :- (1) Simple
(2) Complex

Diagram



Formulating problem :-



- Problem formulation is the process of deciding what actions and states to consider, & follows goal formulation.
- Goal formulation the agent may wish to decide on some other factors that affect the different ways of achieving the goal
- Knowledge and problem types -
  - single-state Problem
  - multiple-state Problem
  - contingency problem
  - exploration problem.

Problem types and characteristics

(1) single state Problem :- Agents knows exactly what each of its actions does and it can calculate exactly which state it will be in after any sequence of actions.

(2) Multiple-State Problem :- when the world is fully accessible, the agent must reason about sets of states that it might get to, rather than single states.

Problem types and characteristics.

(A) Single-state problem:
- complete world state knowledge
- Complete action knowledge

→ The agent always knows its world state

(B) Multiple-state problem:
- Incomplete world state knowledge
- Incomplete action knowledge

→ The agent only knows which group of world states it is in.

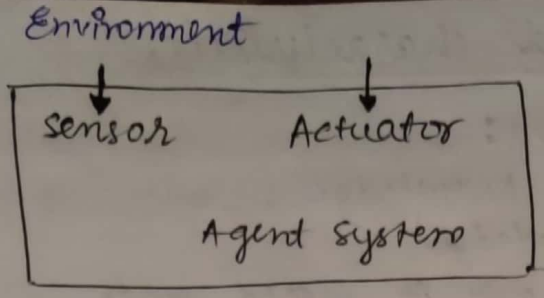
(C) Contingency problem
- It is impossible to define a complete sequence of actions that constitute a solution in advance because info. about the intermediary states is unknown.

(D) Exploration Problem
State space and effects of actions unknown. Difficult!

Problem characteristics

To choose an appropriate method for a particular Problem:-
- Is the problem decomposable?
- Can solution steps be ignored or undone?
- Is the universe predictable?
- Is a good solution absolute or relative?
- Is the soln a state or a path?
- What is the role of knowledge?
- Does the task require human-interaction.

Agent



{Basic structure of agent}.

- An agent could be anything which makes decisions, as a person, firm, machine or software.
- An AI system is composed of an agent & its environment.
- An agent is anything than can be viewed as-

① Preceiving its environment through **sensors** &

② acting upon that environment through **actuators**.

Agent = Architecture + Agent Program

- The agent fxn maps from percept histories to actions.

$$f: P^* \rightarrow A$$

{ f : P, P = Percept, A = Action }.

Examples of Agents.

(a) Software Agent (b) Human agent (c) Robotic agent

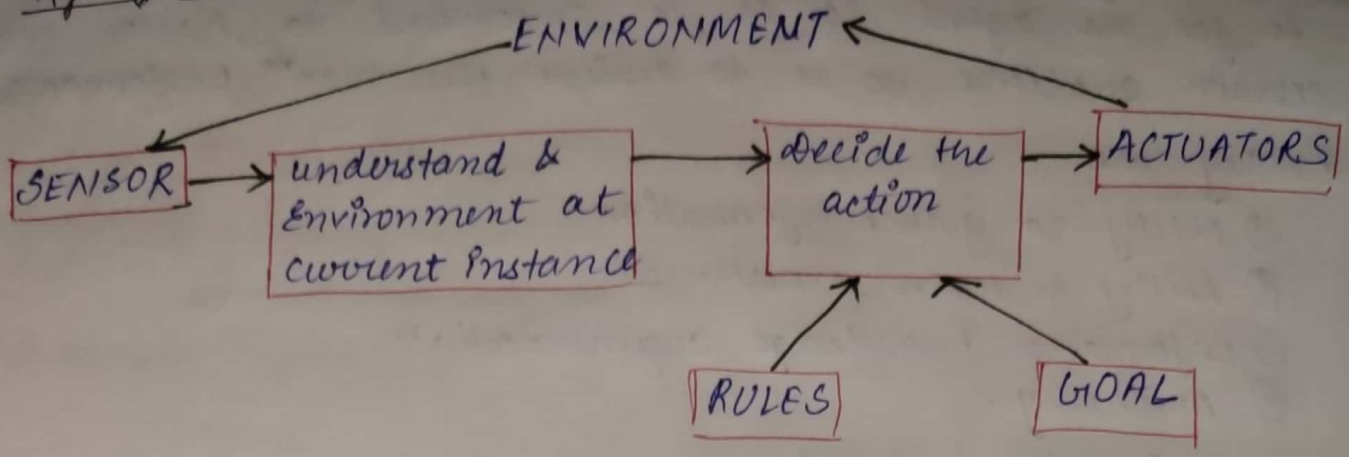
Intelligent Agent

(a) Intelligent agent is an entity that :-

- work without assistance
- Interprets inputs
- Senses the environment
- Make choices
- Acts to achieve goal.

(b) An intelligent agent is an entity that is autonomous in nature, a good observant to detect environmental changes, with a capacity to govern its action in timely fashion to achieve the goals.

Agent Environment Relationship



Rationality :-

- Rationality is nothing but status of being reasonable, sensible, and having good sense of judgement.
- Relationality implies one's action with one's reasons for actions.
- It is concerned with expected actions & results depending upon what the agent has perceived.
- Performing actions with the aim of obtaining useful information is an imp. part of rationality

Rational Agent :-

- A rational agent is an agent which has clear preferences & and models uncertainty via expected values.
- A rational agent can be anything that makes decisions, typically a person, firm, machine, or software.
- A rational agent always performs right action.
- A RA is capable of taking best possible action in any situation.

example of rational action performed by any IA.

ex. Automated Taxi Driver.

Performance measures :-

- It is the criteria, which determines how successful an agent is.
- The performance of an agent is measured in terms of efficiency, speed, soln obtained, energy consumed and so on

eg auto door opening & closing system.

- Rationality maximizes the performance of an agent, so for an agent to it is important to have certain qualities so as to achieve the max^m performance

- They are —
  1. Ability to gather information
  2. Ability to learn experiences
  3. Performance knowledge augmentation
  4. Autonomy.

eg of Rationality

Automatic car is expected to slow down when signal is yellow & stop when signal is red.

Flexibility and intelligent agent

→ Flexibility means that system should be able to adapt with the changing scenarios and should exhibit rational behaviour in those changing scenarios.

→ for an agent to be flexible it has to be
  1. Responsive
  2. Pro-active
  3. Social

→ Other properties that an agent should have is -
1. Mobility 2. Veracity 3. Rationality 4. learning

Task environment & its properties.

→ Task enviroment is the environment in which the task take place,

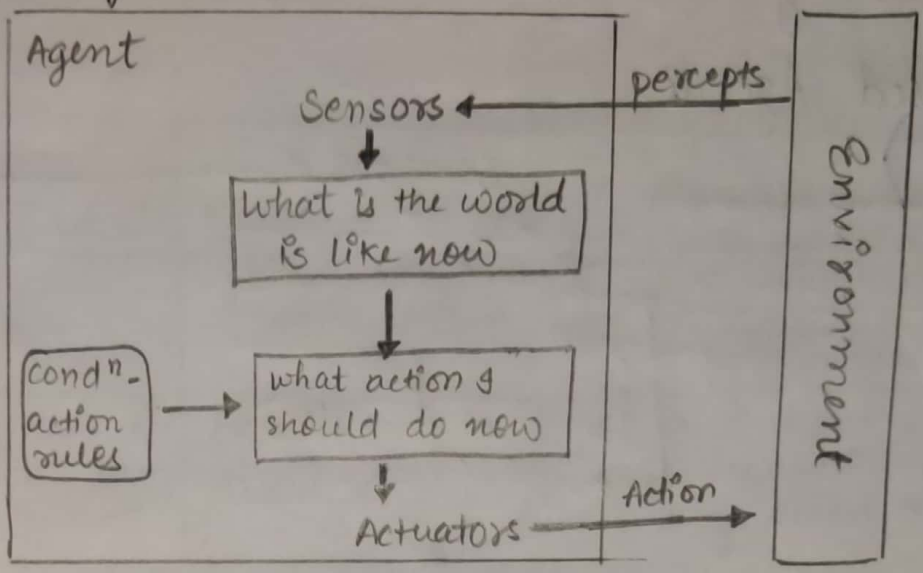
→ For any IA to work efficiently its task environment should be clearly dyined.

→ The task environment is dyined on the basis of PEAS
  - P → Performance measure
  - E → Environment
  - A → agent's actuators
  - S → Sensors.

TYPES OF AGENT :—

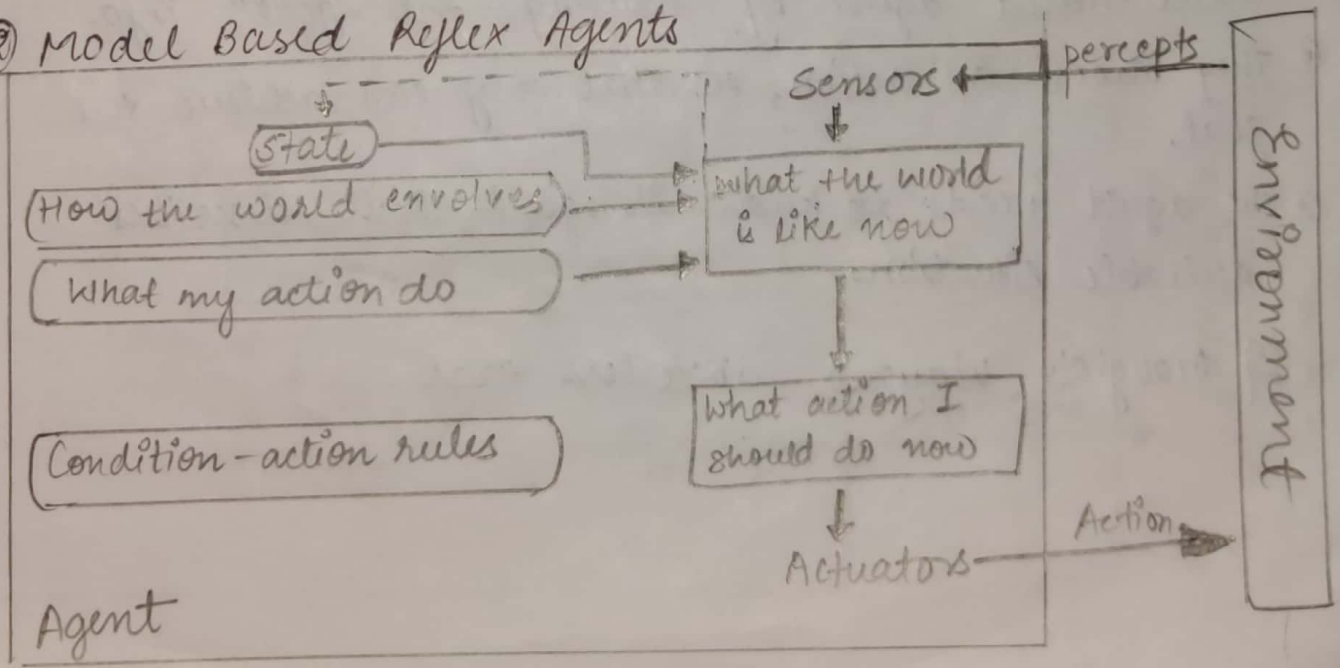
1. Simple Reflex Agent
2. Model Based Reflex Agents
3. Goal Based Agents
4. Utility - Based Agents
5. Learning Agent.

(1) Simple Reflex Agent



(a) The Simple reflex agents are the simplest agents.
(b) These agents take decisions on the basis of the current percepts & ignore the rest of the percept history.
(c) These agents only succeed in the fully observable environ.
(d) It works on condition- action rule, which means it maps the current state to action.
eg Room cleaner agent, it works only if there is dirt in the room.

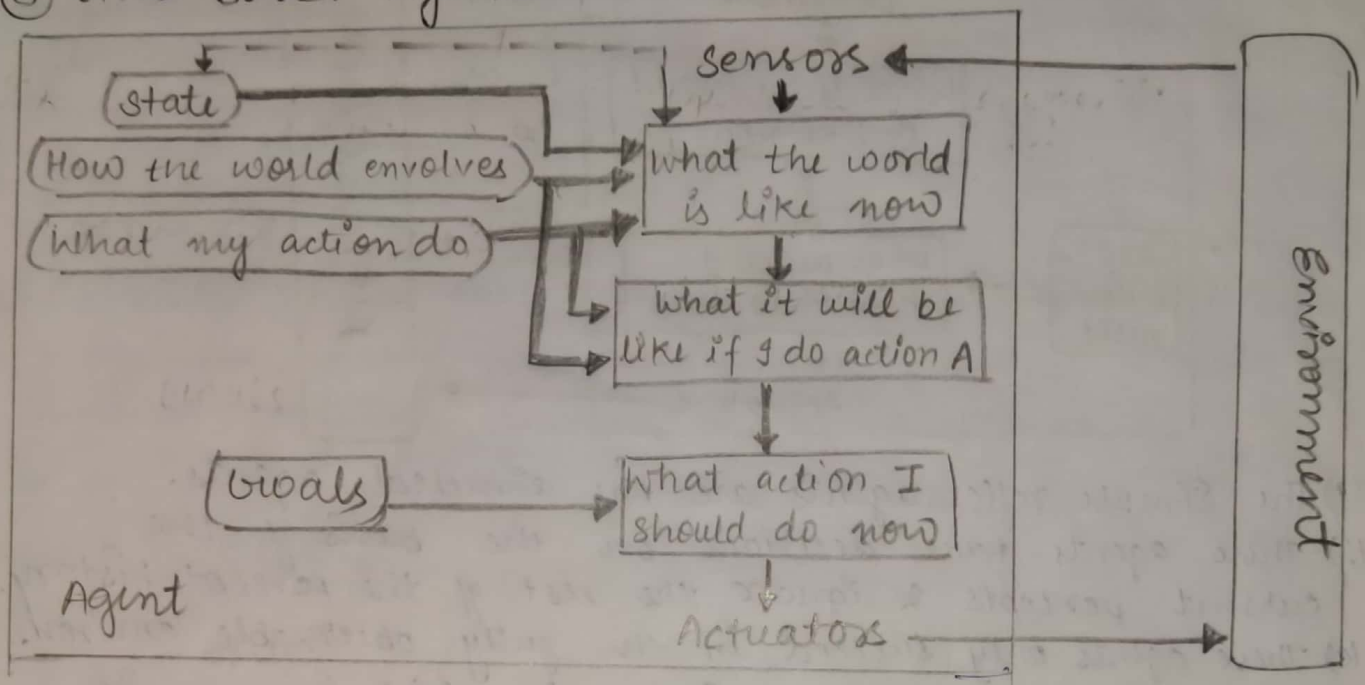
(2) Model Based Reflex Agents



- Model Based Agent can work in a partially observable enviroment & track the situation.
- It has two factors -
  - (a) Model : It is knowledge about "how things happen in the world"
  - (b) Internal State : It is a representation of current state based on percept history

eg Self driving car.

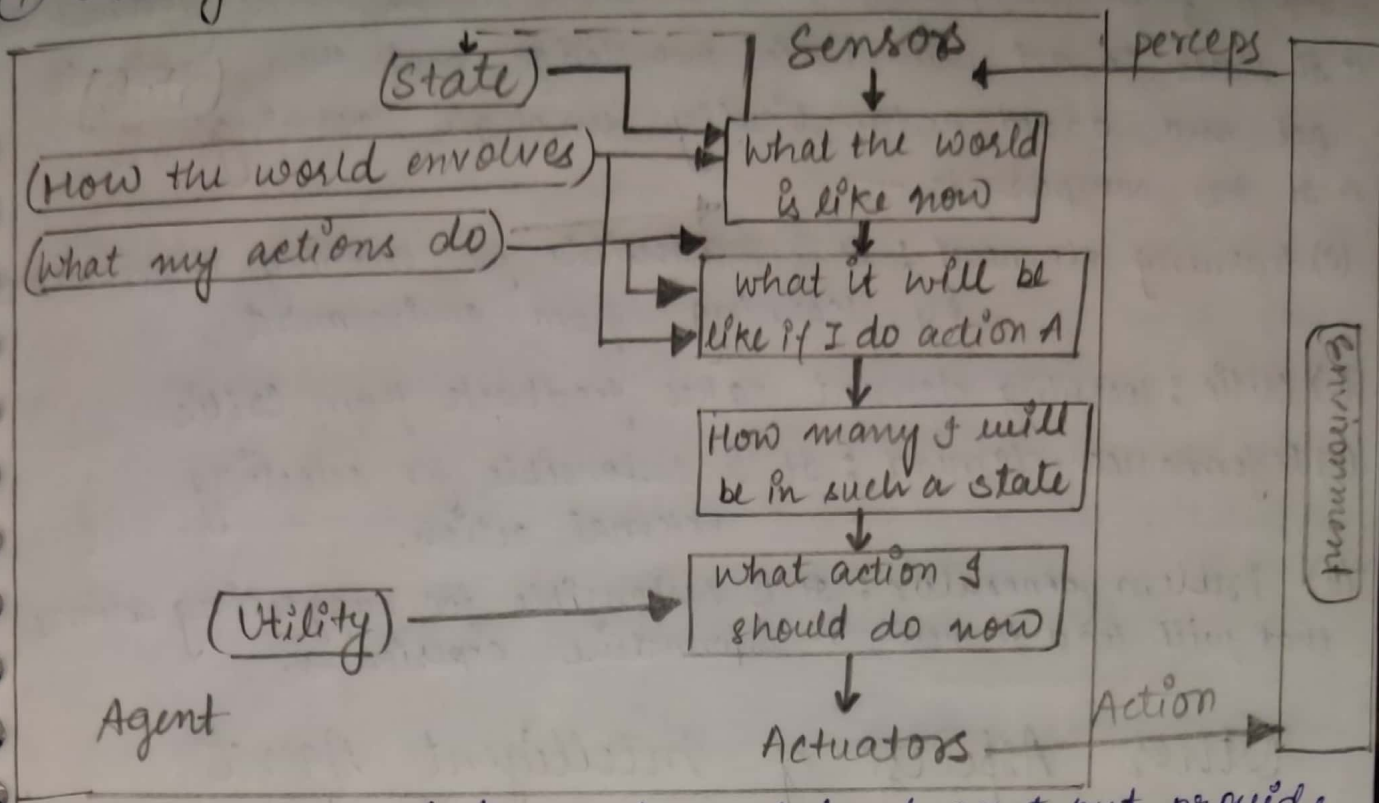
(3) Goal-Based Agents



- The knowledge of current state environ. is not always sufficient to decide for an agent to what to do.
- Goal-based agents expand the capabilities of the model-based agent by having the "goal" info.
- They choose an action, so that they can achieve the goal.
- The agent needs to know its goal which describes desirable situations.

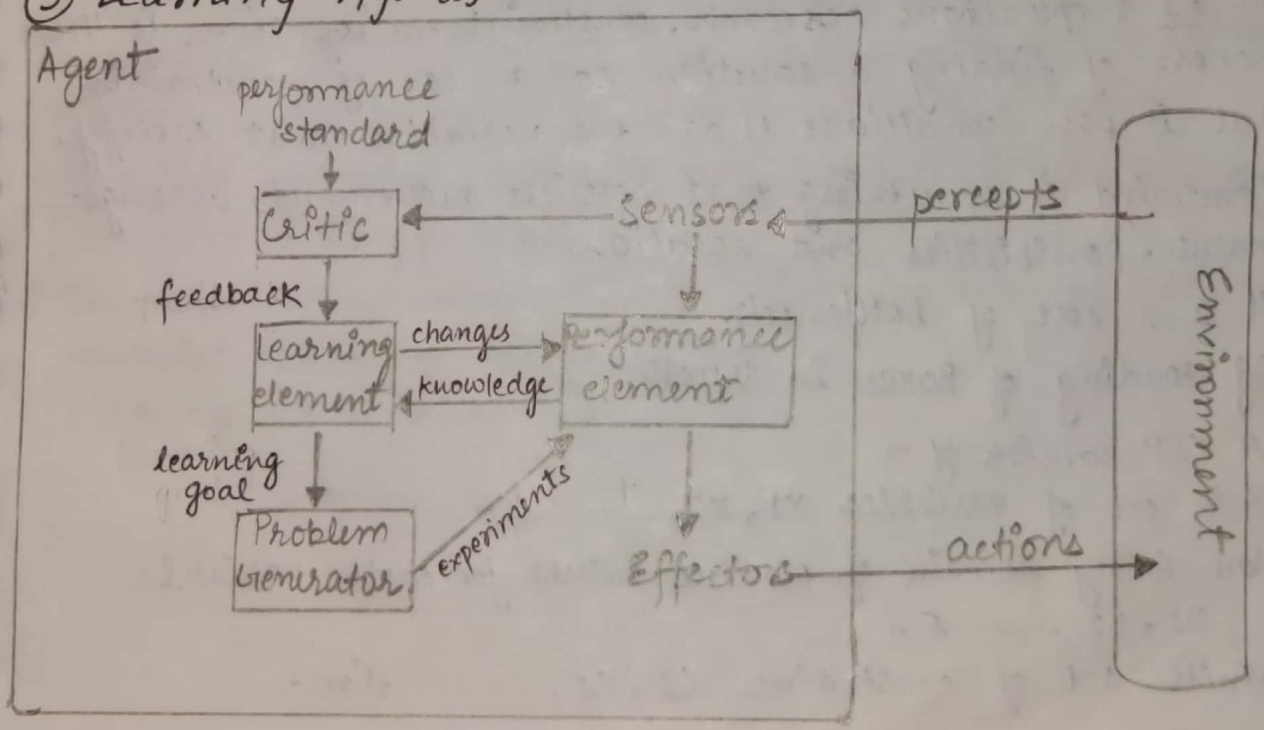
eg Google's Waymo driverless cars

④ Utility - based Agents



- These agents are similar to be goal-based agent but provide an extra component of utility measurement which makes them different by providing measure of sucess at given state.
- This bot based not only goals but also the best way to achieve the goal.
- The utility fxn maps each state to a real number to check how efficiently each action achieves the goals.
- If having multiple alternatives, but choose best action to perform.

⑤ Learning Agents



- A learning Agent in AI is the type of agent which can learn from its past experiences, or it has learning capabalities.
- It starts to act with basic knowledge and then able to act and adapt automatically through learning.
- It has components —

(a) learning element : It is responsible for making improvements by learning from environment.

(b) Critic : learning element takes feedback from critic

(c) Performance element : It is responsible for selecting external action.

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

Other Aspects of Intelligent Agent

application

(a) Process Control
(b) Manufacturing
(c) Traffic Control
(d) Information Management
(e) E- Commerce
(f) Business process management
(g) Medical domain, monitoring
(h) games.

Constraint Satisfaction Problem

- In AI & operations research, constraint satisfaction is the process of finding a solution to a set of constraints that impose conditions that the variables must satisfy.
- Constraint is something that restricts movement, arrangement, possibilities and solution.
- It is a sort of bottleneck.
  eg loading of Boxes in truck.
- A CSP consists of -

→ Finite set of variables X1, X2, ... Xn.

→ Non- Empty domain of possible values for each variable D1, D2, ——— Dn

→ Finite set of constraints C1, C2, ——— ,Cm.

- Types of Constraints
  (a) Unary constraints : Single variable
  (b) Binary " : Two variables
  (c) Higher Order " : More than 2 variables.

Crypt - Arithmetic Puzzeles

- It is represented as CSP
- eg

```
  MIKE +
  JACK =
 ------
  JOHN
 ------
```

- Replace every letter in puzzle with single number
- The domain is {0, 1, ... 9}.
- Often treated as the ten-variable constraint problem where the constraints are :-
  (a) All the variables should have a different value
  (b) The sum must work out.
- M*1000 + I*1000 + K*10 + E + J*1000 + A*100 + C*10 + K
  = J*1000 + O*100 + H*10 + N.
- Constraint Domain is represented by 5-tuple & represented by D = {var, f, O, dv, rg}.
- Var stands for set variables, f is set of fun", O stands for the set of legitimate operators to be used, dv is domain variable and rg is range of fx" in the constraint.
- Constraint without conjunction is refered as Primitive constraint (for eg. x ≠ 9)
- Constraint with conjunction is called as non-primitive constraint or a generic constraint (for eg, x < 9 ∧ x > 2)

Intelligent backtracking

- It is a general class of techniques used to enhance search and constraint satisfaction algorithms.
- Backtracking is a general mechanism in search where a problem solver encounters an unsolvable search state and backtracks to a previous search state that might be solvable.
- It is a mechanisms provide various ways of selecting the backtracking point based on past experience in a way that is likely to be fruitfull.

AI Applications

- Credit granting → credit risk management eg. Banking
- Information management and retrival
- Finance → eg. Banking
- Social Media
- Robotics
- Automotive eg. Self driving cars
- E-commerce eg. searching Product, online shopping, adds.
- Transport eg. Fastag
- Gaming
- Marketing
- Satellite controls
- Nuclear management
- Network development
- Shipping