Artificial Intelligence.

UNIT I

① Artificial Intelligence: Composed of 2 words Artificial & Intelligence.

Artificial → "man-made"

Intelligence → "thinking power"

Artificial Intelligence therefore means, "a man-made thinking power".

→ It is a branch of computer science by which we can create intelligent machines which can behave & think like humans and be able to make decisions.

→ Examples of fields where AI is being used:

(a). Self-driven cars

(b). Playing chess & music

(c). Painting.

② Goals of AI:

(a). Replicate Human Intelligence.

(b). Solve knowledge intensive tasks.

(c). Intelligent Connection of Perception and action.

(d). Building a machine that can perform tasks that require human intelligence.

(e). Creating some system that can exhibit intelligent behaviour, learn and demonstrate new things by itself and advise to its user.

③ Advantages of AI:

(a) High accuracy with less errors.

(b). High speed.

(c). High reliability.

(d). Useful for risky areas.

(e). Digital assistant.

(f). Useful as public utility.

④. Disadvantages of AI:

(a). High cost
(b). Can't think out of the box.
(c). No feelings & emotions.
(d). Increase in dependency on machines.
(e). No original creativity.

⑤. Applications of AI:

Gaming, Finance, Data Security, Social Media, Robotics, Entertainment, Education, Transport, Healthcare, etc.

⑥. AI Techniques:

→ Methods that can be used to develop and create computer programs commonly viewed as forms of AI.
→ The different AI techniques are as follows:
  * Heuristic
  * SVM (Support Vector Machine)
  * Artificial Neural Network
  * Natural Language Processing.
→ The AI Techniques need to handle many problems.

PROBLEM SOLVING IN AI:

→ Before solving any problem, you need to identify the kind of problem.
→ Problems can be categorized as:
  ①. Structured
  ②. Non Structured
  ③. Linear
  ④. Non Linear.

→ The aim of AI is to develop a system which can solve various problems on its own.

→ Steps involved in solving a problem:

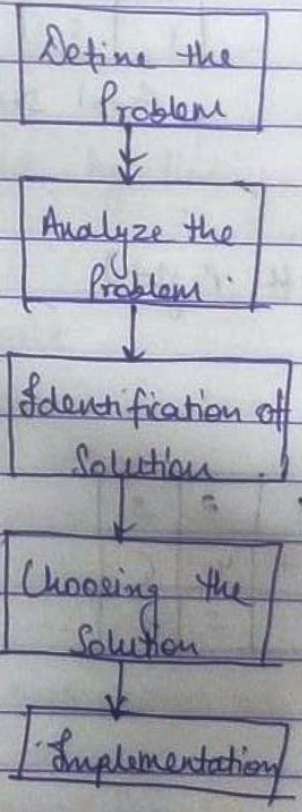
(a). Define a problem

(b). Form the state space.

(c). Gather Knowledge

(d). Planning

(e). Applying & executing.



→ Goal formulation: Organizes the steps required to formulate one goal out of multiple goals.

→ Problem formulation:

(a). Initial state: Starting step towards goal.

(b). Actions: Description of possible agents.

(c). Transition model: Describes model function.

(d). Goal Test: Determines if current state is goal state.

(e). Path cost: Assigns a numeric cost to each path that follows a goal. An optimal solution has minimum path cost.

Examples: Travelling salesman, N-Queens Problem, water jug Problem, 8 puzzle problem, etc.

Example: 8 - puzzle Problem:

1	2	3
	4	6
7	5	8

Initial State

1	2	3
4	5	6
7	8	

Goal State

Possible moves: (Up, Down, Left, Right)

1	2	3
4		6
7	5	8

	2	3
1	4	6
7	5	8

1	2	3
7	4	6
	5	8

... (Continue until goal state is obtained).

Algorithm — I

Problem Types and Characteristics:

1. Deterministic or observable:
→ Each state is fully observed and goes to definite state after taking any action.
→ Also called single state problem.
→ Goal state is reachable in one single action or sequence of actions.
Ex→ Doors with sensor, Sudoku game, etc.

② · Non-Observable:
→ Also called multiple state problem.
→ Problem solving agent does not have any information about the state. (this leads to multiple states)
→ Solution may or may not be reached.
Ex→ Vacuum cleaner with sensor.

③ · Non-Deterministic or Partially Observable:
→ The effect of action is not very clear.
→ In every new state, some new information is added and then the operator acts on the state.
→ Solution is found out by finding path from Initial to final Node in Problem Tree.

④ · Unknown state space:
→ Exploration of problem is done.
→ State and impact of action is not known.
→ No complete knowledge of new search state.
Ex→ Online search Portal.

DATA ACQUISITION AND LEARNING ASPECTS IN AI:

① · Knowledge Discovery: (Data Mining & Machine Learning).
→ Process of extracting useful info. that is previously unknown.
→ Machine learning is concerned with study of algorithms that will improve the performance with experience.

② · Computational learning Theory / Computational Logic Theory (COLT):
→ Formal Mathematical Problems are defined.
→ These models help in analyping and predicting efficiency in terms of feasibility of algorithm.

③ Neural and evolutionary computation:
→ Helps in speading up the mining process.
→ The neural behaviour of Human Being is stimulated.
→ Evolutionary computing is related to the study and use of biological properties consisting of evolutionary algorithms that are used to solve multidimensional problems.

④ Intelligent agents and Multiagents System:
→ Intelligent Agent is flexible in terms of its action to get desired outcome.
→ It is goal directed, reacts with the enviornment and acts accordingly.
→ Complex tasks and decision making demands combination of more than one agent to solve to solve the problem. So Multiagents are created where every agents capability and efficiency are exploited so that overall performance is improved.

⑤ Multi perspective Integrated Intelligence:
→ Different perspective used for decision making.
Utilizing and exploiting this knowledge from different perspective to build up an Intelligent system giving accurate results builds MPII) framework.

Problem Space and Search:

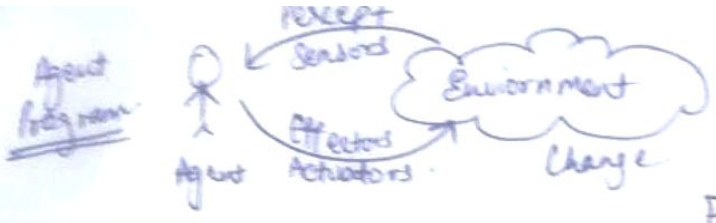
→ Search is a general algorithm that helps in finding the path in state-space.
→ The path may lead to solution or might be dead-end.
→ Search algo. makes use of controlled strategies like forward or backward search.

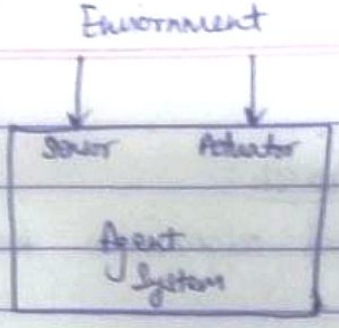
2 types of Search strategy:

Informed: Does not guarantee a soln. but there is ↑ probability of soln.
Uninformed: It does not consider specific nature of problem. It generates all possible states in state space and checks for goal state.

→ The idea behind state-space search is that a given problem can be solved by checking the steps considering the fact that they might lead us towards the soln.
→ The goal is properly formulated while designing state space search for a problem.

The issues observed while designing search problems are:
→ State representation and identifying relationships among states.
→ Proper selection of forward and backward movement.
→ Rule selection.





AGENTS

→ Agent can be anything that makes decisions as a person, firm, etc.
→ An AI system is composed of agent and its environment.
→ An agent: perceives its environment through sensors.
acts upon the environment through actuators.

Agent = Architecture + Agent Program.

→ Machinery that agent executes on. → Device with sensors & actuators. eg: Robotic Car, Camera, etc.	Implementation of agent function. Agent function is history of all that the agent has perceived till date.

Examples of Agents:

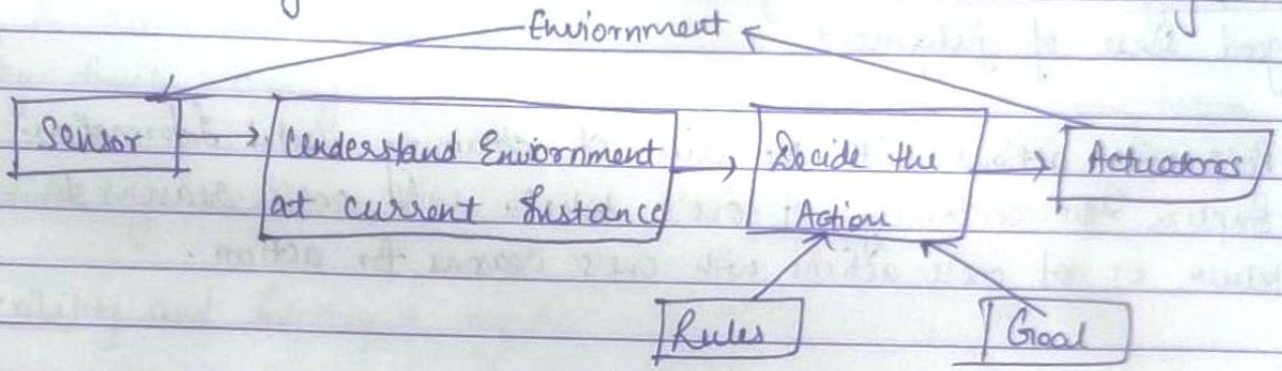
→ Software agent → has keystrokes, file contents, etc. that act as sensors and display on the screen. But n/w packets act as actuators.
→ Human agent has eyes, ears and other organs that act as sensors & hands, legs, etc. acting as actuators.
→ A Robotic agent has camera and IR range finders that act as sensors and various motors acting as actuators.

An Intelligent agent:

→ works without assistance, interprets inputs, senses the environment, makes choices, acts to achieve goals.

Agent → Percept → Decision → Action.

→ Intelligent Agent is autonomous in nature.
→ IA is a good observant to detect Enviornmental changes.



PERCEPTS :

→ An impression or sensation of something perceived at any instant
→ A percept sequence is the history of everything the agent has captured.
→ Percept is the window of agent to the enviornment through which it observes the enviornment.

AGENT FUNCTION:

→ Used to represent behaviour of agent mathematically.
→ Actions are tabulated against percept sequence.
→ This table is used for mapping and selecting actions.
→ Agent program uses agent function to achieve goal.

$$f : P \rightarrow A$$

f → function
P → Percept
A → Action.

Eg: Automatic door opening and closing system.
If area is empty, then close the door, if occupied then open the door

Rationality and Rational Agents:

Rationality: → Sense of being reasonable, sensible and having good sense of judgement.

→ Performing actions with the aim of obtaining useful information.
→ Implies the conformity of one's beliefs with one's reasons to believe, or of one's actions with one's reasons for action.

Rational Agent:
→ has clear preferences
→ anything that makes decisions
→ always performs right actions.
→ performs the action that causes the agent to be most successful.
→ capable of taking best possible action in any situation.

Rational Action → Right action.

MODEL / Factors for Agents:

P : Performance
E : Environment
A : Actions
S : Sensors.

Eg: Automated Car:
P: Safe, fast, comfort, max profit.
E: Road, traffic
A: Steering, brake, accelerator, horn, etc.
S: Wipers, Sensor, Cameras, speedometer, etc.

Performance Measure:

→ Determines how successful an agent is.
→ Measured in terms of efficiency, solution obtained, energy consumed, etc.
Eg, In auto door opening, and closing system, performance is measured by timely opening & closing of door & Time delay in opening/closing.

Rationality maximizes Performance ~~Measure~~ of an agent.

Flexibility and Intelligent Agent:

→ Agent should be able to adapt with changing scenarios.
→ It should exhibit rational behaviour in those scenarios.
→ for an agent to be flexible, it has to be: ① Responsive
② Proactive
③ Social.
Other properties → Mobility, Rationality, Learning, etc.

TASK ENVIORNMENT AND ITS PROPERTIES:

→ Task enviornment is the enviornment in which tasks take place.
→ Task enviornment should be clearly defined for efficient working.
→ Defined on the basis of

P, E, A, S

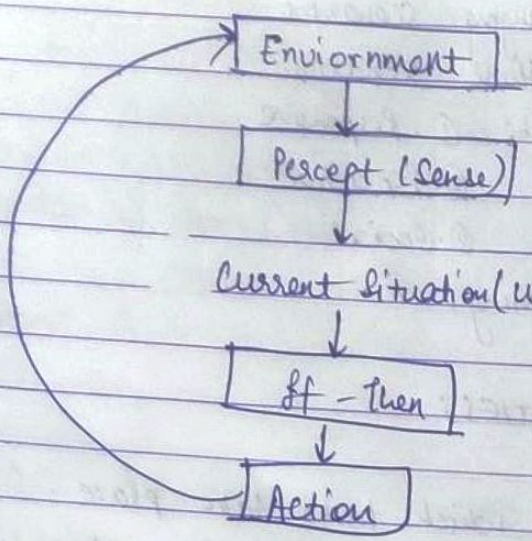
Performance, Enviornment, Actions, Sensors.

Enviornment types: ① Fully Observable
② Deterministic
③ Discrete
④ Episodic
⑤ Static
⑥ Single.

TYPES OF AGENTS:

① Simple Reflex Agents:

→ Reflex: Immediately / Spontaneously. Without any calculations.
→ Simplest agents.
→ Acts only on basis of current situation.
→ Ignores the past history / percept history.
→ Based on If - Then rules - works on the base of condition.
→ Enviornment should be fully observable.
→ Ex: Sneezing, Tic Tac Toe, Chess game, etc.

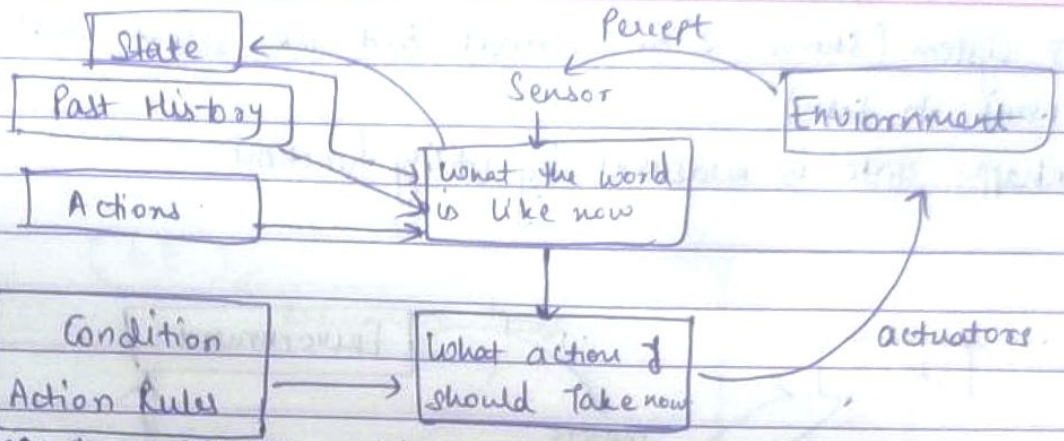


eg: if temp > 45° then switch on AC. [Agent has knowledge about the enviornment.]

Problems: → They have limited intelligence.
→ Mostly too big to generate and store.
→ Not adaptive to changes in Enviornment.

② Model - Based Reflex Agent:

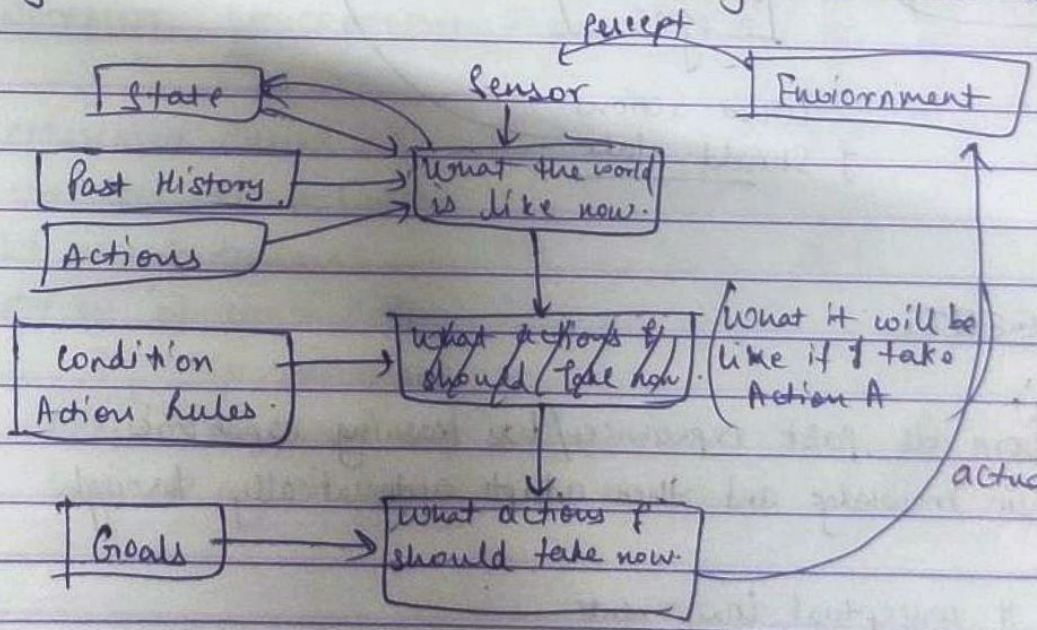
→ Knowledge based.
→ Uses past history in decision making (Internal Model)
→ Partially Observable Enviornment (Agent does not have full knowledge about enviornment).



Eg: self driving cars.

③ Goal Based Agents:

→ Expansion of model based Reflex agents.
→ The agent needs to know its goal.
→ An example of supervised learning.
→ Based on searching & planning.
→ They choose an action so that they can achieve the goal.

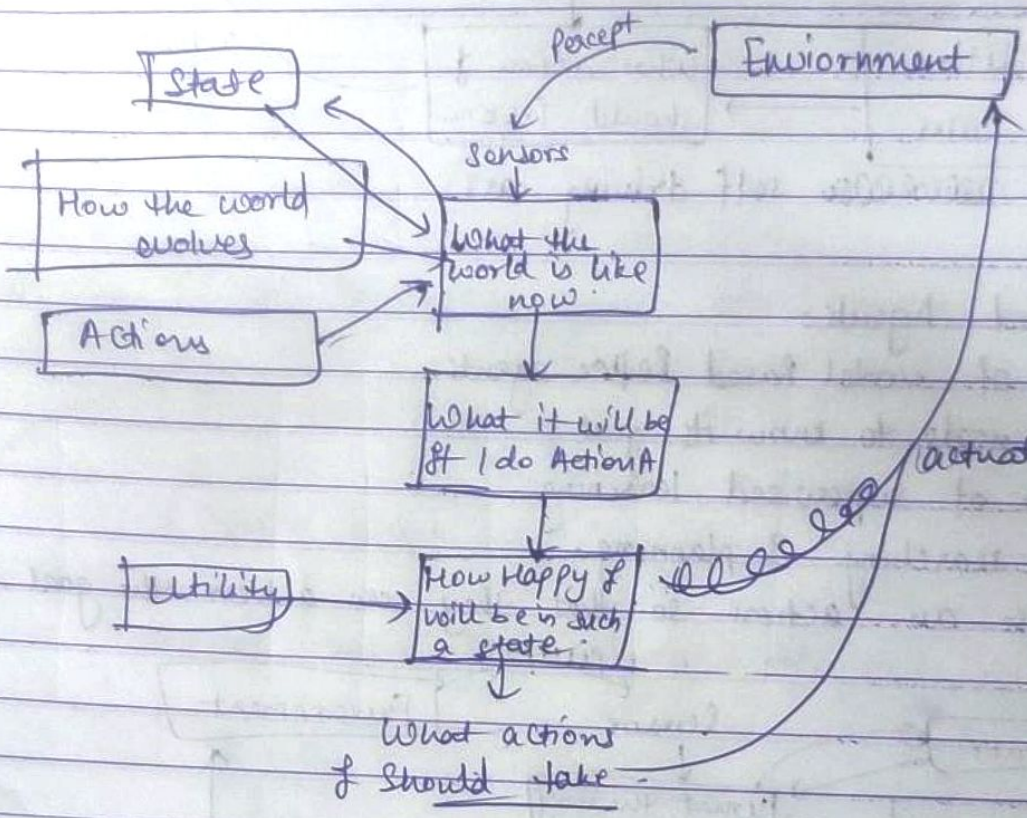


④ Utility Based Agents:

→ focus on utility not goal.
→ Checks if after performing the action, whether the agent is in happy state or unhappy state.

→ eg → GPS system. (shows 2 or 3 roads but we select what we want to take).

→ Happy / unhappy state is measured by utility function.



LEARNING AGENTS :

→ Can learn from its past experiences / has learning capabilities.

→ Starts with basic knowledge and then adapts automatically through learning.

→ Has mainly 4 conceptual components:

① - learning element: element that enables agent to learn things.

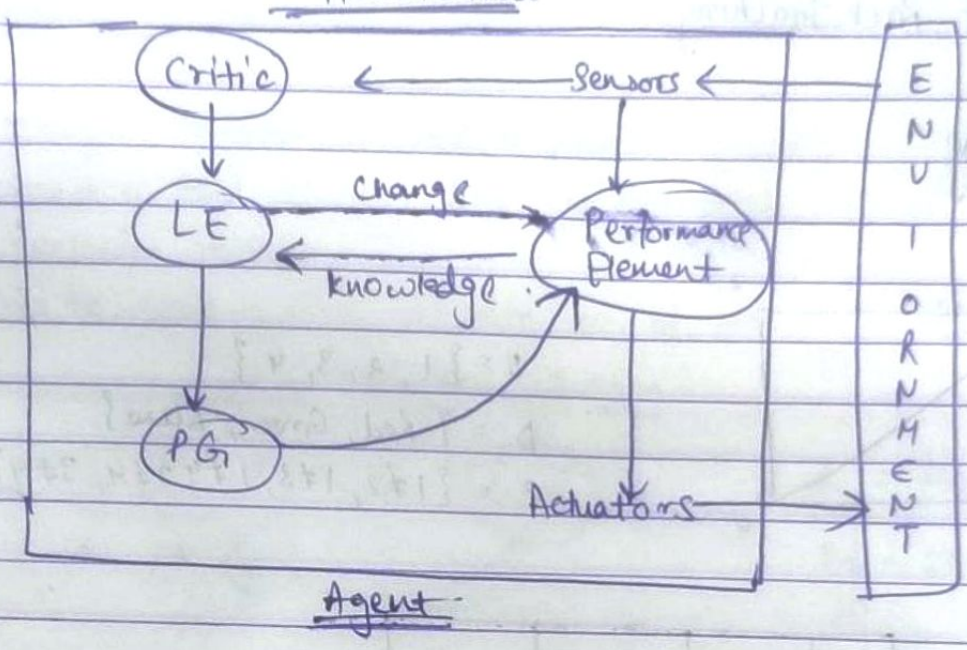
② - Critic: Reduces errors.

③ - Performance element: deals with performance of agent. How to do everything?

④ - Problem generator: Suggest actions that lead to informative experiences.

When to do what?

Architecture



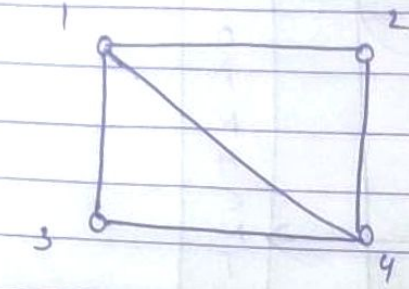
Drawbacks of Agents: ① No overall system controller
② No Global perspective.

→ CONSTRAINT SATISFACTION PROBLEM (CSP)

→ Represented using 3 components: V, D, C
V → set of variables $\{V_1, V_2, V_3 \ldots V_n\}$
D → set of domains $\{D_1, D_2, D_3 \ldots D_n\}$.
C → set of constraints. $\{C_1, C_2, C_3\}$.
C_i = (scope, relation)
Scope → Variables that participate in constraint
Relation → defines values that variable can take.

CSP → Intelligent Back Tracking.

Ex: Graph Coloring.



V = {1, 2, 3, 4}

D = {Red, Green, Blue}

C = {1≠2, 1≠3, 1≠4, 2≠4, 3≠4}

	1	2	3	4	
Initial Domain	RGB	RGB	RGB	RGB	
1=R	R	GB	GB	GB	
2=G	R	G	GB	B	
3=B	R	G	B	(B)	Empty value.
3=G	R	G	G	B	

(Backtracking)

(Use Backtracking)

↓

we go to the position where problem occurs.

CRYPTO ARITHMETIC PUZZLES:

BASE
+ BALL
GAMES ←

B - 7
A - 4
S - 8
E - 3
L - 5
G - 1
M - 9

Ans.

E + L = S — ① (No carry)

E + L = S + 10 — ② (Carry)

↳ E = S - L + 10

S + L = E

S + L = S - L + 10

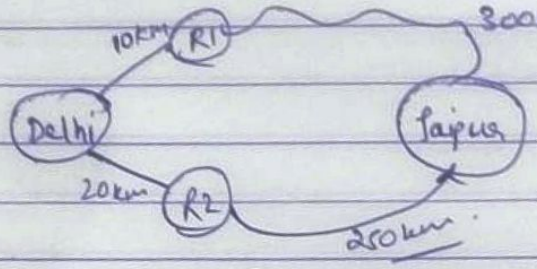
2L = 10

L = 5

Find (S, E) and B to satisfy the problem.

Heuristic in AI

→ Technique designed to solve a problem quickly.
→ Guarantees Good Solution, does not guarantee optimal solution.
Ex: Eucledian distance.
→ Tries to solve problem in min no. of steps.



$R_1 = 10 + 300 = 310$

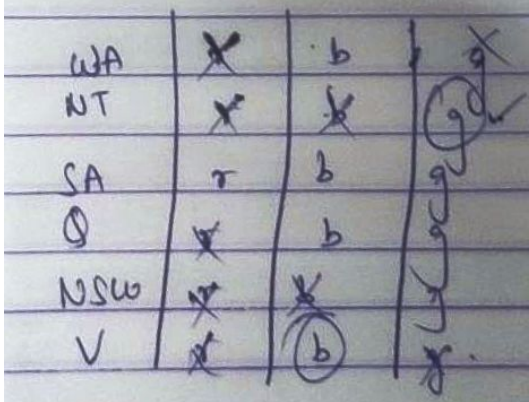
$R_2 = 20 + 250 = 270$

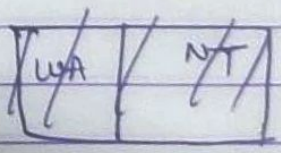
↓

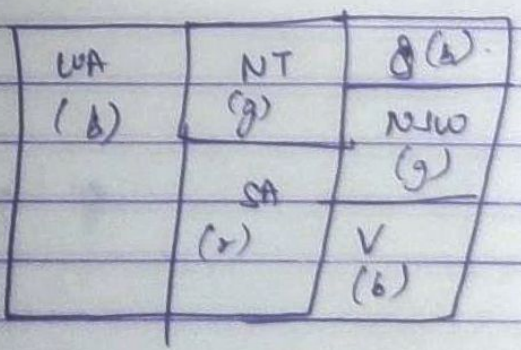
We will choose R_2.

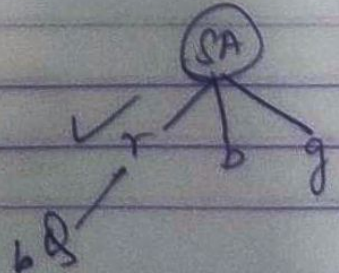
Checks the distance of Goal state from each node.

CSP: forward Checking: when assigning a variable, remove all conflicting values for all connected variables.









SA → r (remove all conflicting values for neighbours)