Name : Sanket Chandrashekhar Harvande (19)
Sign :

Artificial Intelligence :- Assignment 1.

Q.1 Give a PEAS/PAGE description for

a. Automated Taxi Driver :-

(i) Performance :- Automated system should be able to maintain the optimal speed depending upon the surroundings.

(ii) Environment :-

Roads :- Automated car driver should be able to drive on any kind of a good road ranging from city roads to highways.

Traffic conditions :- You will find different sort of traffic conditions for different type of roads.

(iii) Actuators :-

steering wheel : used to direct car instead directions.

Accelator gear :- To increase or decrease speed of the car.

(iv) Sensors :- To take i/p from environment in car driving example cameras, sonar system etc

b. Medical Diagnosis System :-

i) Performance Measure :-

Patient health, cost, reputation

ii) Environment :- Patients, medical staff, insurers, courts

iii) Actuators :- Screen display, email

iv) Sensors :- Keyboard / mouse.

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c. Satellite Image Analysis System :-

i) Performance Measure :- Correct image categorization.

ii) Environment :- Downlink from orbiting satellite.

iii) Actuators :- Display of scene categorization.

iv) Sensors : Color pixel Arrays.

d. Part Picking Robot :-

i) Performance Measure :- If the objective function to judge the performance of the agent.

ii) Environment :- The real environment where the agent need to take actions in deliberate manner.

iii) Actuators :- These are the tools, equipment or organs using which agent performs actions in the environment. This works as output of the agent.

iv) Sensors :- These are tools, organs using which agent captures the state of the environment This work as input to the agent.

e. Interactive English Tutor :-

i) Performance :- Maximize student's score on test
ii) Environment :- Set of students
iii) Actuators :- Screen display (exercises, suggestions, corrections)
iv) Sensors :- Keyboard.

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Q02 Explain different types of Agents in detail.

→ Four basic kinds of agent programs that cover the principles of almost all intelligent systems.

1) Simple Reflex Agents
2) Model-based reflex Agents
3) Gaal-based agents; &
4) Utility-based Agents.

<1> Simple Reflex Agents :-

(i) In artificial Intelligence, a simple reflex agent is a 'type of Intelligent agent' that performs actions based solely on the current situation, with an intelligent Agent.

(ii) The 'simple Reflex Agent' works on 'condition-action rule, which means it maps the current state to action.

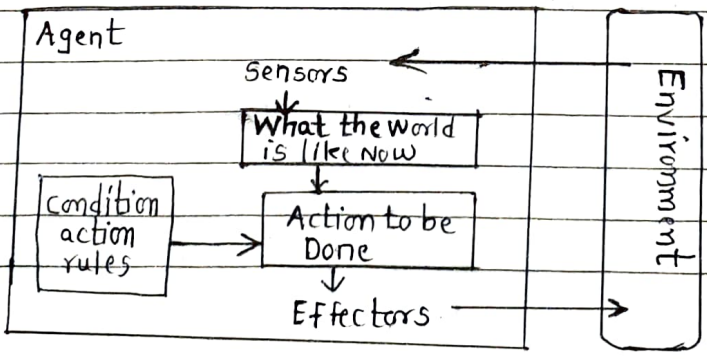
(iii) The simple reflex agent is based on designed only to respond to the currently occuring problem.

(iv) This agent selects actions based on the agent's current perception, and not based on past perceptions.

(v) This is useful when a quick automated response is needed.

[ ] (rectangles) :- To represent current internal state of the agent's decision process.

( ) (ovals) :- To represent the background information used in the process.



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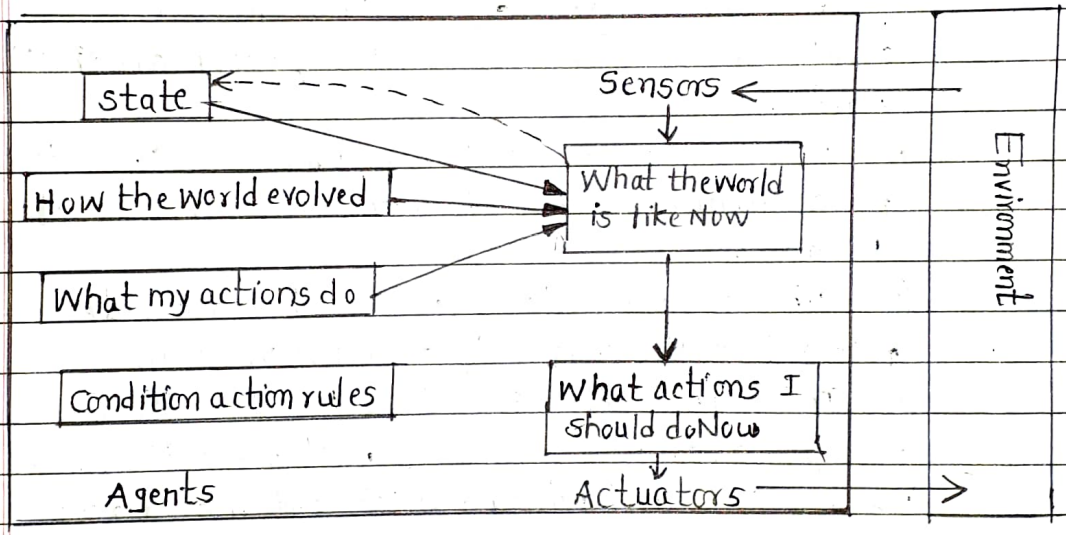
2) Model based Reflex Agent :-

i) A model-based reflex agent needs memory for storing the percept history.
ii) It uses the percept history to help to reveal current unobservable aspects of the environment.
iii) Model-based reflex agents are made to deal with partial accessibility.
iv) They do this by keeping track of the world it can see now.
v) A model based reflex agent is designed to deal with partial accessibility.



3) A Goal based Reflex Agent :-

i) A goal based reflex agent has a goal & has a necessary to reach that goal.
ii) More precisely, from set of all possible actions, it selects the one that improves the progress towards the goal
iii) A goal-based agent is capable of thinking beyond the present moment to decide the best actions to take in order to achieve its goal.
iv) Goal-based agent expands the capabilities of the model-based agent having the 'goal' information.

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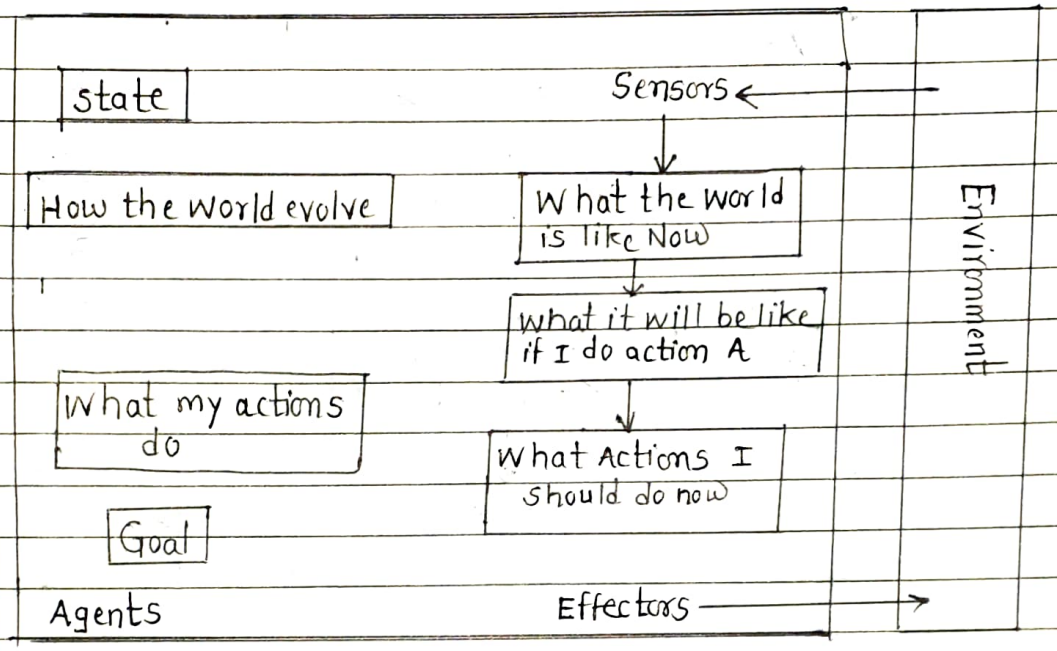

4) An Utility-based Reflex Agent :-

i) An utility-based reflex agent is like the goal-based agent but with measure of 'how much happy' an action would make it rather the goal-based binary feedback.

ii) This kind of agents provides best solution. Example is route recommendation system which solves the best route to reach a destination.

iii) The agents which are developed having their end-users as building blocks are called utility based agents.

iv) They choose an action based not Only goals but also the samples, thanks to achieving the goal.

v) The utility based agent is useful when there are multiple possible alternatives, & an agent has to choose in order to perform the best action.

vi) In AI, utility function assigns values to certain actions that AI can take.

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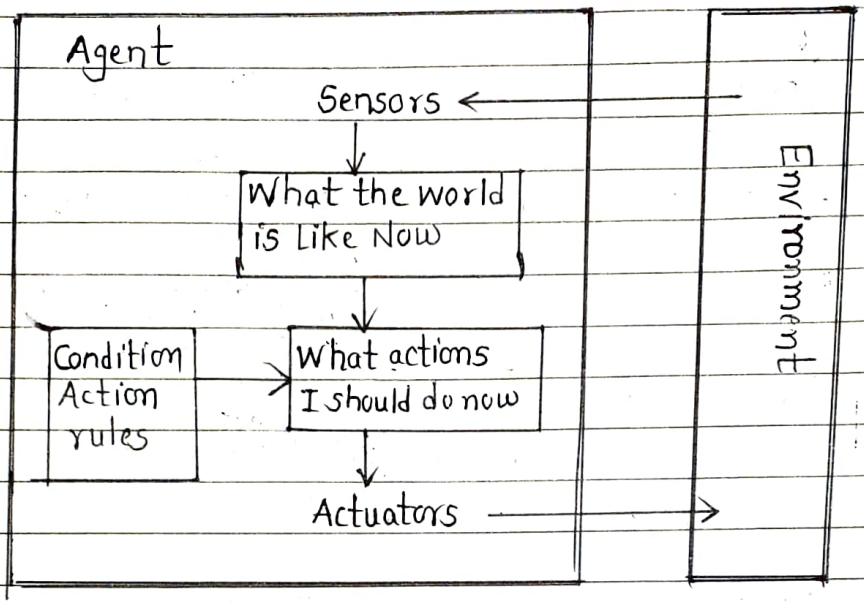


Q.3 Explain different types of Environments in detail.

→ The three types of environments are as follows :-

I) The physical Environment
II) Social Environment
III) Cultural Environment

I) The Physical Environment :-

i) It consists of all the components provided by nature & hence can be called as the natural environment.
ii) It is also referred to as physical Environment.
iii) It includes natural resources, the earth's surface, mountains, plains, land, water, deserts, storms cyclones volcanoes, oceans, climatic factors, & so on.
iv) It also refers to biological situations such as complexities associated with plants & animals.

II) Social Environment :-

i) Social Environment is the immediate environment or surroundings associated with an individual.

ii) Social Environment includes all the social practises government occupational structure, family friends, acquaintances, religious beliefs.
iii) It is closely related to population, life-style, culture, tastes, customs & traditions.
iv) Timely feedback is critical component for personal development & provides for accessing developmental gaps & progress.

III) Cultural Environment

i) Cultural Environments are environments shaped by human activities, such as cultural landskapes in the countryside, forests, urban areas, & cities.
ii) Cultural Environment influences the personality traits of people in the community as well as their ideologies.
iii) The factors of cultural environments are language social norms, religion, ethics socio-economics, traditions social regulations, nationalism, aethitics, material culture attitude, values & social organisation.

Q.4 Give the state space formulation for the missionaries & cannibals problem.

→ Solution :-
First let us consider that both the missionaries (M) & cannibals (C) are on the same side of the river
Left Right
Initially the positions are : 0M, 0C & 3M, 3C (B)
Now let's send 2 Cannibals to left of bank :
0M, 2C (B) & 3M, 1C
Send one cannibal from left to right : 0M, 1C & 3M, 2C (B)
Now send the 2 remaining Cannibals to left :
0M, 3C (B) & 3M, 0C
Send 1 cannibal to the right : 0M, 2C & 3M, 1C (B)

Now send 2 missionaries to the left : 2M, 2C (B), & 1M, 1C
Send 1M & 1C to right : 1M, 1C & 2M, 2C (B)
Send 2 missionaries to left : 3M, 1C (B) & 0M, 2C
send 1 cannibal to right : 3M, 0C & 0M, 3C (B)
Send 2 cannibals to left : 3M, 2C (B) & 0M, 1C
send 1 cannibal to right : 3M, 1C & 0M, 2C (B)
send 2 cannibals to left : 3M, 3C & 0M, 0C (B)

Here (B) shows the position of the boat after the action is performed.
Therefore all the missionaries & cannibals have crossed the river safely.

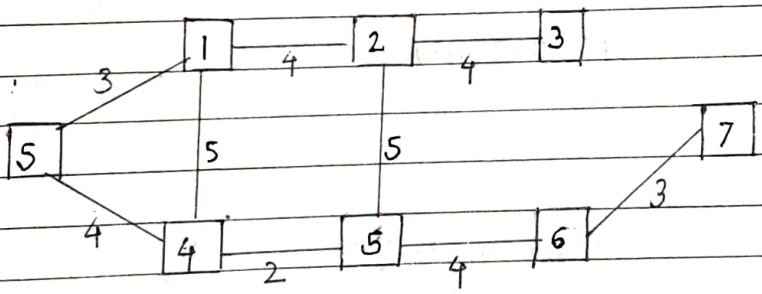
Q.5 There is a farmer who wishes to cross a river but he is not alone. He also has a goat, a wolf & a cabbage along with him. There is only one boat available which can support the farmer & either the goat, wolf or the cabbage. So at a time, the boat can have only two objects (farmer & one other). The farmer wants to cross the river with all three of his belongings : goat, wolf, & cabbage. What strategy should he use to do so?

⟹ Solution :-

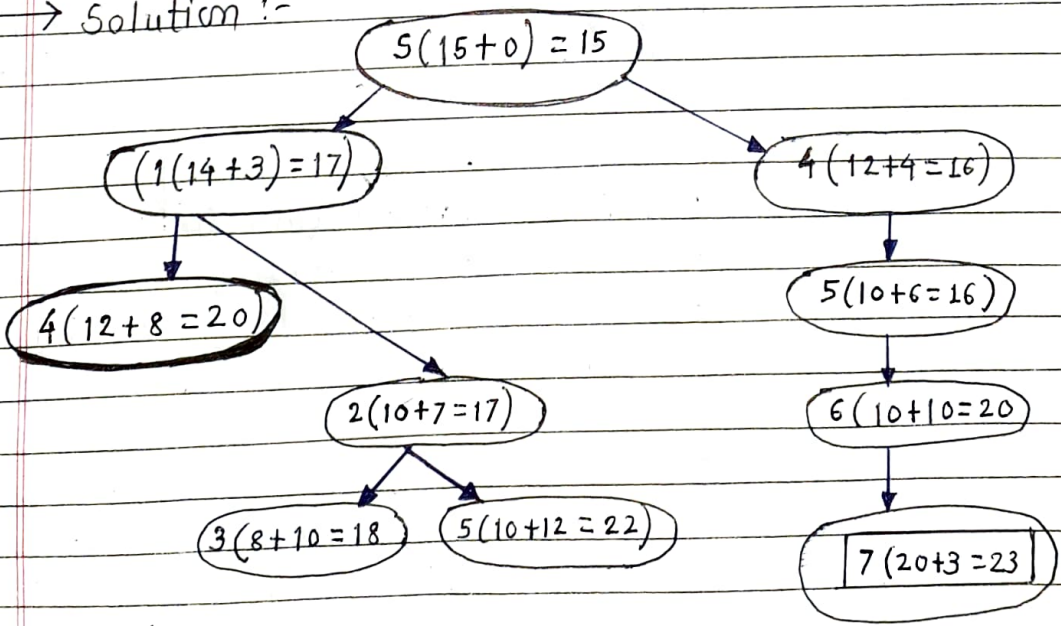
Taking the wolf on other side will leave goat & cabbage together. Also taking away cabbage will make wolf & goat be alone.
Hence, the farmer will first take goat on the other side.
Now, he will take the wolf along, drop the wolf on the other side & return with the goat. So, now on one side, we have farmer, cabbage & the goat and on the other side, we have wolf.
Now, he takes the cabbage along & returns alone. So now the scenario is : farmer, goat on one side

& the wolf, cabbage on the other side.
Now, finally, he crosses the river with the goat & hence succeds in taking all his belongings with him.

Q.7 Consider the graph given in fig. below. Assume that the initial state is S & goal state is 7. Find a path from initial state to the goal state using A* search. Also report the solution cost. The straight line distance heuristic estimates for the nodes as follows
h(1) = 14, h(2) = 10, h(3) = 8, h(4) = 12, h(5) = 10, h(6) = 10, h(S) = 15.



→ Solution :-



Result :-
path = S-4-5-6-7
solution cost = 23.

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~~1 hour~~

Q.6 Compare following state space search algorithms with respect to time, space optimality & completeness criterions.

a. Breadth first search
b. Uniform cost search
c. Depth first search
d. Depth Limited search
e. Iterative Deepening search
f. Bidirectional search.

→ Solution :-

Parameters	Breadth First Search	Uniform Cost Search	Depth First Search
Time :	Equivalent to No. of Nodes. $T(n) = O(n^s)$	C^* be the cost of optimal solution, ϵ be step closer to goal Node $\Rightarrow C^*/\epsilon + 1$	If entire tree is traversed then time complexity = $O(V)$; V = No. of Nodes.
Space :	Equivalent to how large can the fringe get : $S(n) = O(n^s)$	$O(b^{1+[C^*/\epsilon]})$	The space complexity for DFS algorithm is $O(h)$; where h is max^m height of Tree.
Optimality	BFS is optimal as long as the cost of all edges are equal.	Uniform cost search is optimal.	DFS is Not optimal as cost spent in reaching is high.
Completeness	BFS is complete meaning for a given search tree BFS will come up with a sol^n if it exists.	Uniform Cost search complete, when it finds the solution.	DFS is complete, if tree is finite.

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Parameter	Depth Limited Search	Iterative Deepening Search	Bidirectional Search
Time :	It is similar to DFS, i.e. $O(b^l)$, where l is the specified depth limit.	The time complexity of IDS is $O(b^d)$ where 'b' is the branching factor & d is the depth of the shallowest goal.	Time complexity of bidirectional search is $O(b^{d/2})$.
Space :-	It is similar to DFS, it is $O(b^l)$ where l is specified depth limit.	IDS has space complexity of $O(b^d)$.	Space complexity for Bidirectional search is $O(b^{d/2})$.
Optimality :-	The DLS is non-optimal algorithm since the depth that is chosen can be greater than $d (l > d)$. Thus DLS is Not optimal if $l > d$.	It is optimal when the path cost is a non-decreasing function of the depth of the node.	It is 'Optimal' if BFS is used for search & paths have uniform cost.
Completeness	The DLS is a complete algorithm in general except the case when the goal node is the shallowest node.	It is complete 'when b is finite' & is optimal when the path cost is a non-decreasing function of depth.	Bidirectional Search is complete if BFS (Breadth-First Search) is used in both searches.

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Q.8 Prove that A* is complete & optimal.

→ Solution :-

If a graph has finite branching factor & all weights are greater than some $\epsilon > 0$ then A* is complete. "The proof is straightforward : If the path from the start to the end is of weight d, then in the worst case all vertices distance <= d are visited before the end node.

A* is optimal if two conditions are met.
(1) The heuristic is admissible, as it will never overestimate the cost.
(2) The heuristic is monotonic, that is $h(n_i) < h(n_{i+1})$ then real-cost (n_i) < real-cost (n_{i+1})

Proof :-

Let G be an optimal goal & let n be an unexpanded node in the fringe such that n is on a shortest path.
Let some suboptimal goal G_1 has been generated & it is in the fringe.

$f(G_1) = g(G_1) + h(G_1)$

$f(G_1) = g(G_1)$

[$\because h(G_1) = 0$, $\because G_1$ is in the fringe & is an optimal goal]

Again $f(G) = g(G)$

$\because h(G) = 0$

Now, $f(G_1) \geq f(G)$ [$\because$ heuristic is monotonic] .... (i)

$\therefore h(n) \leq h^*(n)$ [$\because$ h is admissible]

$\therefore g(n) + h(n) \leq g(n) + h^*(n)$

$\therefore f(n) \leq f(G) < f(G_1)$ .... From equations (ii)

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$\therefore f(G_1) > f(n)$,

$\therefore A^*$ will never select G_1 for expansion.

$\therefore A^*$ is an optimal algorithm.