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SUBJECT:- AI.
BTECH CSE

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AI THEORY ASSIGNMENT -1

Q.1 Explain classification of environments in detail & also explain PEAS analysis for automated taxi agent.

ANS:- Types of environments:-

- Complete vs Incomplete :- Complete AI environments are those on which, at any given time, the agents have enough info to complete a branch of the problem. Chess is a classic example of complete environment. Poker is an incomplete environment and they focus on finding a good "equilibrium" at any given time.
- Single Agent vs Multiple Agent :- One of the most obvious dimension to classify and AI envs. is based on no. of agents. The vast majority of AI models focus on environments involving a single agent but there is an increasing expansion in multiagent settings. The introduction of multi agents in a AI problem raises challenges such as collaborative or competitive dynamics which are not present in single agent environments.
- Fully observable vs partially observable :- A fully observable AI environment has access to all required info to complete target task. Partially observable envs often rely on statistics techniques to extrapolate knowledge of environment.
- Competitive vs Collaborative :- Competitive AI envs face AI agents against each other in order to optimize a specific outcome. Games such as chess are eg. of competitive AI envs. Collaborative AI envs rely on

co-op between multiple AI agents. Self driving vehicles are eg. of this ~~env~~. envs.

- Static vs Dynamic - Static AI envs rely on data knowledge sources that don't change frequently over time. Dynamic env. deal with data sources that change quite frequently.
- Discrete vs Continous - Discrete envs are when a finite set of possibilities can drive the final outcome of the task. Continous AI envs rely on unknown and rapidly changing data sources.
- Deterministic vs Stochastic :- Deterministic envs are those on which outcome can be determined base on a specific state. Most real world envs are not deterministic. Instead they are classified as stochastic.

PEAS analysis of Taxi agent (Automated):-

Performance Measure:- Maximise profile : get most profitable route.

- Safety :- Automated system should be able to drive safely without dashing anywhere.
- Optimum speed and Route :- Maintain optimal speed and route.
- Comfortable Journey : should give comfortable journey to users.

Environment :-

- Roads : City Roads and high ways.
- Traffic :- Able to navigate traffic.

Actuators :-

- Steering wheel, accelarator, brake, gear,

Sensors :

- Sensors :- Taxi i/p from env., radar etc.

Q2 Define three different heuristic functions to solve 8 puzzle problem and Explain admissibility ~~problem~~ property of A* algorithm in detail.

9 represents blank tile.

Eg:-

2	9	6
1	3	4
7	5	8

Current Node

→

1	2	3
4	5	6
7	8	9

Goal Node

- h1 :- No of misplaced tiles / Hamming distance :-
In the above configs :- all the tiles except tile(7) are out of position.
∴ $h_1 = 7$.

h1 is admissible heuristic, since it is clear that every tile except tile(7) is out of position & must be moved at least once. The cost of the goal is atleast hamming distance of puzzle in this case : 7.

- h2 :- Sum of Manhattan distances of the tiles from their goal positions.
$h_2 = \Sigma$ distance (tile, correct position).
$\Rightarrow h_2 = 1 + 1 + 2 + 2 + 1 + 1 + 0 + 1 + 3 = 12$
∴ $h_2 = 12$

- h3 :- Gaschnig Heuristic function.
→ Introduced GMAXSWAP problem.
→ Relaxed problem assume that a tile can move from eg. A to B if B is blank, but A & B do not need to be adjacent.

→ Underestimates distance func. of 8-puzzle. It's a closer approx of 8 puzzles distance.

<u>Max Sort Algo</u> :- One way to solve gMAX SWAP / NMAX SWAP

P - Current state

B - the location of element (i) in permutation state.

Basic Idea :- Swaps iteratively P[B(n)] with P[B(b(n))] for n-puzzle.

To apply "Maxsort" as a heuristic for 8-puzzle, we take no. of switches as heuristic cost at any search node

Current Node :- 2, 9, 6, 1, 3, 4, 7, 5, 8

Goal Node :- 1, 2, 3, 4, 5, 6, 7, 8, 9.

(position of elements)

iteration	permutation	b array
1	2, 9, 6, 1, 3, 4, 7, 5, 8	4, 1, 5, 6, 8, 3, 7, 9, 2
2	9, 2, 6, 1, 3, 4, 7, 5, 8	4, 2, 5, 6, 8, 3, 7, 9, 1
3	1, 2, 6, 9, 3, 4, 7, 5, 8	1, 2, 5, 6, 8, 3, 7, 9, 4
4	1, 2, 6, 4, 3, 9, 7, 5, 8	1, 2, 5, 4, 8, 3, 7, 9, 6
5	1, 2, 9, 4, 3, 6, 7, 5, 8	1, 2, 5, 4, 8, 6, 7, 9, 3
6	1, 2, 3, 4, 9, 6, 7, 5, 8	1, 2, 3, 4, 8, 6, 7, 9, 5
7	1, 2, 3, 4, 5, 6, 7, 9, 8	1, 2, 3, 4, 5, 6, 7, 9, 8
8	1, 2, 3, 4, 5, 6, 7, 8, 9	1, 2, 3, 4, 5, 6, 7, 8, 9

AN

$\therefore h_3 = 8$

All 3 heuristic functions are admissible in nature.

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If the heuristic function used by A* is admissible, then A* may be admissible. Intuitive proof :- when A* terminates its search, it has found a path from start to goal whose actual cost is lower than the estimated cost of any path from start to goal through any open node (node's f value). A* will never overlook the possibility of a lower cost path from start to goal. so it will continue to search until no such possibilities exist. The actual proof is a bit more involved because of (f value) of open nodes are not guaranteed to optimistic even if the heuristic is admissible. This is because the (g value) of open nodes are not guaranteed to be optimal. So the sum (g+h) is not guaranteed to be optimistic.

Q3 Explain Minmax Algorithm with Alpha-beta pruning using chess game example in figure given.

ANS → Alpha beta pruning is an optimization technique for the minmax algorithm. In minmax algorithm its search/traversal time is exponential to depth of tree. Since we cannot eliminate the exponent, but we can cut it to half. Here is a technique by which we can remove without reviewing them. It is called pruning. Alpha beta parameters pruning involves ~~them~~ two threshold parameters, Alpha & beta.

The two parameters :-

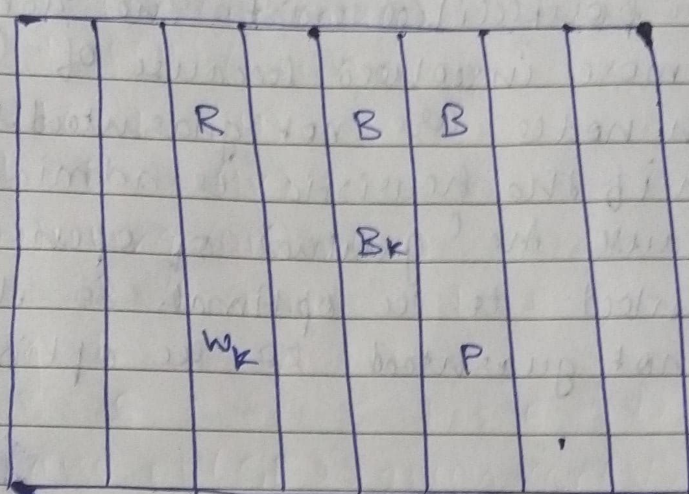
Alpha :- Only max player can update it. Starting value is $(-\infty)$.

Beta :- Only min player can update it. Starting value is $(+\infty)$.

Condition for Alpha beta pruning : $\alpha \geq \beta$.

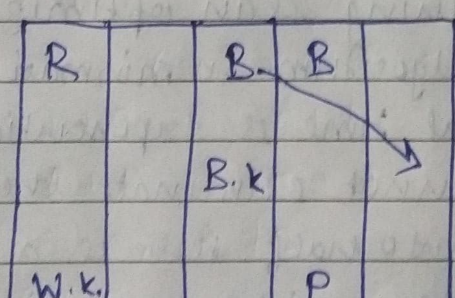
Example ⇒

King = K = 900
Rook = R = 50
Bishop = B = 30
Pawn = P = 10
W.king = W.k.
B. king = B.k.



In order to simply the PS, we take 5x5 section of board, first turn will be white.

White turn : Bg5



$\alpha_i = -\infty$, $\beta_i = \infty$

$\alpha_i = \alpha$ initial

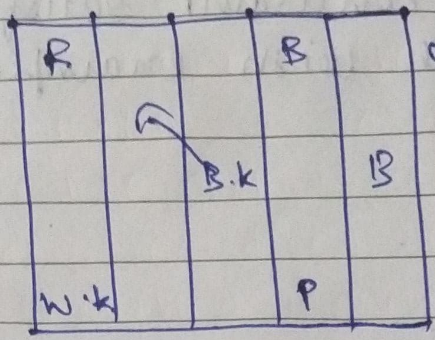
$\beta_i = \beta$ initial.

$\alpha = 1020$, $\beta = 0$.

as $\alpha \geq \beta$

$\alpha_i = \infty$ $\beta_i = -\infty$

Black Turn : Kol 6

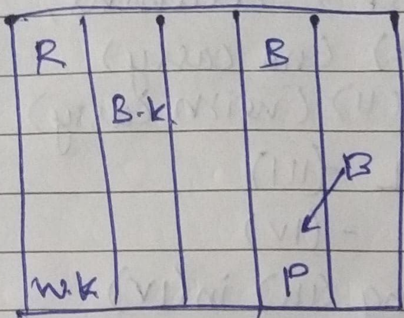


$\alpha = 1020$, $\beta = 0$

as $\alpha \geq \beta$.

$\alpha_i = \infty$, $\beta_i = -\infty$

White turn : Bf4 #

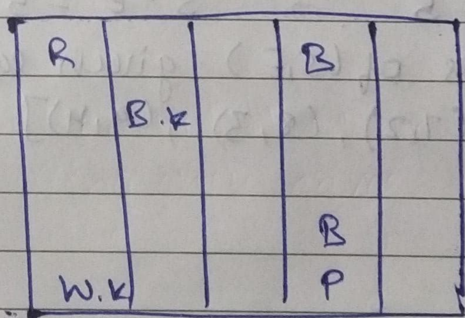


$\alpha = 1020$, $\beta = 0$

as $\alpha \geq \beta$.

$\alpha = 0$, $\beta = 0$.

Black Turn (checkmate).



as it is a checkmate, $\beta = 0$ as $\alpha = 1020$.

as $V(\text{king}) + V(\text{Rook}) + 2V(\text{Bishop}) + V(\text{Pawn}) = 1020$

Q.4 Explain constraint satisfaction problem in detail with example given below.

$$\begin{array}{r} BASE \\ +\ BALL \\ \hline GAMES \end{array}$$

ANS → As G is a carry over, G=1

Observing last 2 columns,

$E+L=S$ -(I) (no carry)

$E+L = S+10$ (II) (with carry)

↳ $E = S+10-L$ -(III)

$S+L=E$ -(IV)

Substituting (III) in (IV)

$S+L = S-L+10 \Rightarrow L=5$

Putting L=5 in (I)

$E+5=5 \Rightarrow S-E=5$ -(V)

Possible pairs of (S,E) given eqn (V)

$(S,E) = [(7,2),(8,3),(9,4)]$ (5,0) & (6,1) cannot be taken as 1 & 5 are already assigned

By trial & error,

Let $(S,E) = (7,2)$ & $B=6$.

$B+B = 10+A$

$6+6 = 10+A \Rightarrow A=2.$

As $E=2$, $A \neq 2$

Let $(S,E) = (8,3)$.

$$\begin{array}{r} BASE \\ +\ BALL \\ \hline GAMES \end{array} \rightarrow \begin{array}{r} 7A83 \\ +\ 7A55 \\ \hline 1AM38 \end{array} \Rightarrow \begin{array}{l} 2A+1 = M \\ 14 = 10+A \\ \rightarrow A=4 \end{array}$$

$(S, E) = (8, 3)$ & $B = 7$ $\underline{\underline{M = 9}}$

final table

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