Assignment 1
15CS30024

1)

An autonomous vehicle as an intelligent agent interacts with road and objects present on it and makes decisions with the help of actuators such that it can continue to drive safely towards a destination in minimum possible time.

PEAS for Autonomous Vehicle

Performance Measure: Safe, follow speed limit and traffic rules,reach goal with shortest and safest path, mimimal accident risk

Environment: Roads, traffic,pedestrians

Actuators: Steering wheel, accelerator , brake, signal, horn

Sensors: Camera, speedometer, GPS, odometer, engine, sensors, keyboard

2)

a) We will show that A* is admissible if it uses a monotone heuristic. A monotone heuristic is such that along any path the f-cost never decreases. But if this property does not hold for a given heuristic function, we can make the f value monotone by making use of the following trick (m is a child of n) f(m) = max (f(n), g(m) + h(m))

o Let G be an optimal goal state

o C* is the optimal path cost.

o G2 is a suboptimal goal state: g(G2) > C*

Suppose A* has selected G2 from OPEN for expansion.Consider a node n on OPEN on an optimal path to G. Thus C* ≥ f(n) Since n is not chosen for expansion over G2, f(n) ≥ f(G2) G2 is a goal state. f(G2) = g(G2) Hence C* ≥ g(G2). This is a contradiction. Thus A* could not have selected G2 for expansion before reaching the goal by an optimal path. Hence A* is admissible.

b) Let G be an optimal goal state. A* cannot reach a goal state only if there are infinitely many nodes where f(n) ≤ C*. This can only happen if either happens: o There is a node with infinite branching factor. The first condition takes care of this. o There is a path with finite cost but infinitely many nodes. But we assumed that Every arc in the graph has a cost greater than some ε> 0. Thus if there are infinitely many nodes on a path g(n) > f*, the cost of that path will be infinite. Lemma: A* expands nodes in increasing order of their f values. A* is thus complete and optimal, assuming an admissible and consistent heuristic function.

3) If the heuristic being used is admissible, then any solution found by WA* will cost no more than wC* where C* is the optimal solution cost.

4)

Search Type	**List of states**
Breadth First	A B C D E G
Depth First	A B D F K L E C G
Iterative Deepening Search	A A B C A B D E C G
Uniform Cost Search	A B D E C F G

5)

Path to State	Expanded Length of Path	Total Estimated Cost	Expanded List
A	0	5	(A)
C-A	3	4	(C A)
B-A	1	5	(B C A)
H-C-A	5	6	(H B C A)
G-H-C-A	6	6	(G H B C A)

6)

a) Yes. The heuristic is admissible because it is less than or equal to the actual shortest distance to the goal.

b) No, the heurstic is not consistent. There are two places in the graph where consistency fails. One is between A and C where the drop in heuristic is 4, but the path length is only 3. The other is between B and C where the drop in heuristic is 3 but the path length is only 1.

c) A* with a strict expanded list will not find the shortest path (which is ABCHG with cost 5). This is because the heuristic is not consistent. We can make the heuristic consistent by changing its value at C to be 3. There are other valid ways to make the graph consistent (change h(B) to 2 and h(A) to 3, for example) and those were right as well.

7)

a) **State Representation and Initial State** – we will represent a state of the problem as a tuple (x, y) where x represents the amount of water in the 4-litre jug and y represents the amount of water in the 3-litre jug. Note $0 \le x \le 4$, and $0 \le y \le 3$. Our initial state: (0,0)

Goal Predicate – state = (2,y) where $0 \le y \le 3$.

Operators – we must define a set of operators that will take us from one state to another:

1. Fill 4l jug (x,y) → (4,y) $x < 4$

2. Fill 3l jug (x,y) → (x,3) $y < 3$

3. Empty 4l jug on ground (x,y) → (0,y) $x > 0$

4. Empty 3l jug on ground (x,y) → (x,0) $y > 0$

5. Pour water from 3l jug (x,y) → (4, y - (4 - x)) to fill 4l jug $0 < x+y \geq 4$ and $y > 0$

6. Pour water from 4l jug (x,y) → (x - (3-y), 3) to fill 3l-jug $0 < x+y \geq 3$ and $x > 0$

7. Pour all of water from 3l jug (x,y) → (x+y, 0) into 4l jug $0 < x+y \leq 4$ and $y \geq 0$

8. Pour all of water from 4l jug (x,y) → (0, x+y) into 3l jug $0 < x+y \leq 3$ and $x \geq 0$

b)

Litres in 4l jug	Litres in 3l jug	Rule Applied	Cost
0	0	-	-
4	0	1.	7
1	3	6.	1
1	0	4.	0
0	1	6.	1
4	1	1.	7
2	3	6.	1

Least cost = 17

8)

a) False. Consider searching on a tree from the leaf to the root, and transitions always move towards the root. BFS is fast because branching factor is always 1, while Bidirectional BFS wastes time on the half of the reverse part tracing a lot of branches

b) FALSE. Depth-first search may possibly, sometimes, BY GOOD LUCK, expand fewer nodes than A* search with an admissible heuristic. E.g., it is logically possible that sometimes, by good luck, depth-first search may march directly to the goal with no back-tracking.

c) True. For example h(s) = 0.

d) True. Note that the inner loop in IDA* is DFS, not A*