1. If $h_1(s)$ is a consistent heuristic, and $h_2(s)$ is an admissible heuristic, then the minimum of the two must be consistent.

(A) True
(B) False

B

2. Consider a state space where the states are all positive integers. State i has two neighbors i − 1 and i + 1 (except for i = 1 which only has one neighbor i = 2). State i has score $\frac{(-1)^i}{i}$. If one runs the greedy hill climbing algorithm, how many initial states can reach the global maximum?

(A) 0
(B) 1
(C) 2
(D) 3
(E) more than 3

C

3. If h is an admissible heuristic (non-negative), which of the following can *never* be admissible.

(A) $h + 1$
(B) $\sqrt{h}$
(C) $2h$
(D) they can all be admissible under some situations.

A

4. If h_1 and h_2 are admissible heuristics (non-negative), which of the following are guaranteed to be admissible

(A) $2h_1 - h_2$
(B) $\sqrt{h_1 h_2}$
(C) $max(h_1,h_2)$
(D) $\alpha.h_1 + (1-\alpha)h_2$ for $\alpha \in [0,1]$

B, C, D

5. A* search will never expand more search nodes than uniform cost search.

(A) True
(B) False

B

6. IDA* implementation does not need a priority queue.

(A) True
(B) False

A

7. Pattern databases for 24 puzzle usually compute inadmissible heuristics.

(A) True
(B) False

B

8. The unprecedented success of deep learning has had relatively less impact on

(A) Automated Speech Recognition
(B) Computer Vision
(C) Chess Playing

C

9. Which of the following will generally not be considered AI

(A) studying animals for their behavioral patterns
(B) finding a new approximation bound for a given algorithm
(C) finding an algorithm for an NP-hard problem that often has good empirical performance
(D) solving a task at which today humans are much better than machines

A

10. In a graph where the goal is neither the root nor at depth one, iterative deepening search will definitely expand more nodes than breadth-first search.

(A) True
(B) False

A

11. If I knew that the mini-max value of the root is between 10 and 100, how will I modify the mini-max algorithm to use this information

(A) Set $\alpha = 10$ and $\beta = 100$ at the root
(B) Set $\alpha = 100$ and $\beta = 10$ at the root
(C) This information cannot be used directly by mini-max.

A

12. Facebook's Go bot defeated Lee Sedol, a well-known human Go player.

(A) True
(B) False

B

13. With perfect ordering alpha-beta pruning can effectively ______ the depth of search.

(A) double
(B) triple
(C) make 1.5x
(D) none of these

A

14. Studying human brain as a means towards AI corresponds to which definition of AI?

(A) acting like humans
(B) thinking like humans
(C) thinking rationally

B

15. Doubling your computer's speed allows you to double the depth of a tree search given the same amount of time.

B

(A) True
(B) False

16. Identify all differences between simulated annealing (SA) and genetic algorithms (GA)

A B

(A) GA maintains multiple candidate solutions
(B) SA is used for minimization problems whereas GA is used for maximization problems.
(C) SA has no parameters to set whereas GA requires you to set several parameters such as the crossover rate.
(D) GA will always converge to an optimal solution faster than SA on any given problem.

17. Greedy hill climbing gets stuck because of

A B C

(A) Local optima
(B) Ridges
(C) Plateaus
(D) Low temperature parameter

18. Genetic algorithms without crossing over (each offspring is a mutation of only one parent) is equivalent to local beam search.

B

(A) True
(B) False

19. Minimax algorithm outputs the best play even if the opponent is known to be suboptimal.

B

(A) True
(B) False

20. Which of the following games are not zero-sum

A B D

(A) Tic-Tac-Toe
(B) Chess
(C) Rock-Paper-Scissors
(D) Tennis
(E) None of the above

21. [12 pts] Answer briefly (1-2 sentences each). Assume no duplicate detection.

(a) Give one benefit of depth first search branch and bound over iterative deepening A*.

Depth first search branch & bound perform well when a suboptimal solution is easy to construct ~~and~~ or exist at finite depth d. Then DFS B&B prunes a lot of option to give faster results than IDA* that iterates over again & again.

2

(b) Give one benefit of uniform cost search over iterative deepening search.

Uniform cost search don't reexpand a node i.e is systematic ~~node then ensure~~ ensuring that all lower cost paths are explored making it more suitable for situations ~~case~~ involving combinatorial problems like TSP.

0

So?

(c) Give one benefit of enforced hill climbing over tabu search.

Enforced hill climbing helps to get out of local optimas & plateaus both by scanning neighbourhood which is better than current whereas tabu search ~~helps only in plateaus~~ where they keep certain states not to repeat.

not always

1 1/2

(d) Give one benefit of iterative deepening search over beam search.

Iterative deepening is complete whereas beam search may not reach the goal state at all.

2

(e) Give one benefit of weighted A* over A*.

weighted A* converges faster than A* and guarantees a solution within W * cost of optimal solution.

2

(f) Give one benefit of genetic algorithms over greedy hill climbing with random restarts.

Cross overs in genetic Algorithms are not completely random and due to which when they jump using cross-over, they jump to better states and take care of randomness through mutation.

Nice

2

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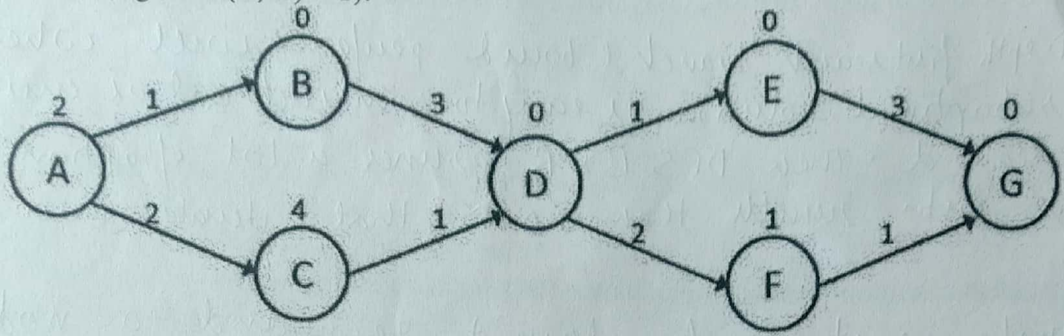
22. [17 pts] In the following graph that we are searching from start A to goal G. The number above each node is its heuristic value (e.g., h(A) = 2). The number above each edge is the transition cost (e.g., cost(C, D) = 1).



(A) Seema implemented the graph search version of A* -- when it visits a node n that has already been expanded, it immediately skips n instead of checking if it needs to reinsert n into the priority queue. Show the expansion sequence of this algorithm by showing the fringe nodes with their f-values and expanded node at each step. Assume the fringe starts with (A, 2). What is the path outputted by this algorithm?

$(A,2) \xrightarrow{(A)} [(B,1); (C,6)] \xrightarrow{(B)} [(D,4); (C,6)] \xrightarrow{(D)} [(E,5); (C,6); (F,7)]$

$\downarrow (E)$

$[(G,8); (C,6); (F,7)] \xrightarrow{(C)} [(G,8); (F,7)] \xrightarrow{(F)} [(G,8); (G,7)] \xrightarrow{(G)}$ expands (G,7) to get goal

(Above arrow we show expanded node)

Path output → A → B → D → F → G

3

(B) Sunita implemented the tree search version of A* but made a mistake. It declares completion when it first visits the goal node G instead of waiting until G is popped off the priority queue. Show the expansion sequence of this algorithm by showing the fringe nodes with their f-values and expanded node at each step. What is the path outputted by this algorithm?

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..., (C,6)] → [(E,5); (C,6); (F,7)]

↓(E)

[(G,8); (C,6); (F,7)]

not to inserted in fringe.

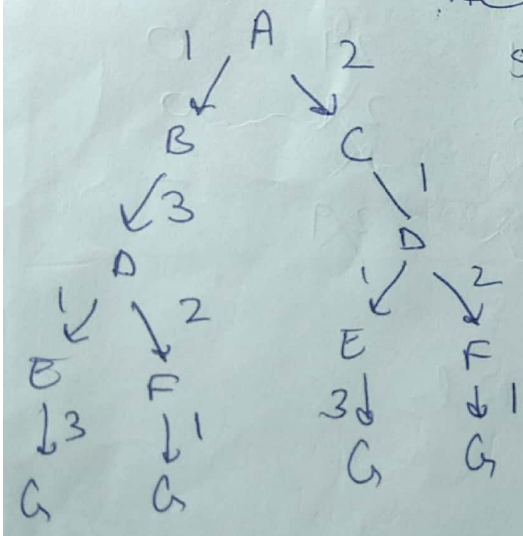
Sunita declares complete as G is visited here So she will stop.

Path → A → B → D → E → G

5½

(C) Sujatha implemented depth first branch and bound search (no duplicate detection, branch policy=lowest cost edge first) with upper bound starting from infinity and lower bound based on the heuristic function. Show the order of nodes visited (along with associated lower and upper bounds at each step) and pruned (along with pruning inequalities). What is the path outputted by this algorithm?

~~ACEBED~~ & (order of visits)



Step-1) A → B → D → E → G

Upper bound Cost set to 8

Step 2) Continuing from G above

F → G (Upper bound sets to 7)

Step 3) Continuing from step 2 G above

C → D → E → G

Back track

Step 4) Continue from G in step 3

F → G (~~Cost~~ Upper bound set to 6

Bounds at each step!

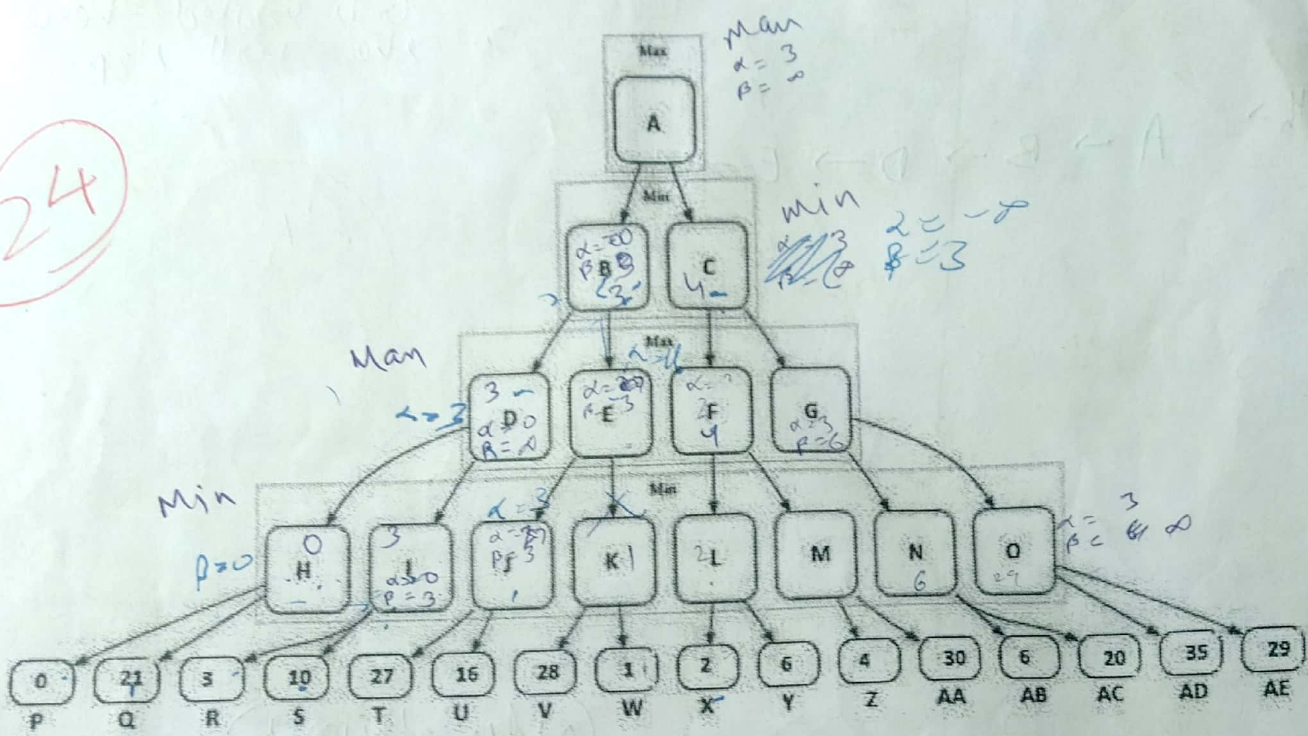
Back track

final path output = A → C → D → F → G (cost 6)

4

24

23. [31 pts] The following figure shows an adversarial search tree. If the minimax search always chooses the children from left to right, find the output of the search procedure, i.e., the value for each node in the tree. Assume that the search procedure is using alpha-beta pruning. If a subtree is pruned then label all nodes (including the leaves) of the subtree as X.



A= 4	B= 3	C= 4	D= 3	E= 27 16	F= 4	G= 29 6	H= 0
I= 3	J= 16 27	K= X	L= 2	M= 4	N= 6	O= ~~29~~	P= 0
Q= 21	R= 3	S= 10	T= 27	U= X 16	V= X	W= X	X= 2
Y= X	Z= 4	AA= 30	AB= 6	AC= 20	AD= ~~35~~	AE= ~~29~~	

$\ell_1 (\ell_3) \ell_2$

$\alpha \geq \beta$

$\alpha = -\infty$

$\beta = \infty$

Mayank

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