1. The field of artificial intelligence was officially born around

(A) 1936
(B) 1946
(C) 1956
(D) 1966

C

2. The graph search version of greedy best first search is complete in finite state space.

(A) True
(B) False

A

3. A* search has a time complexity of $O(b^d)$.

(A) True
(B) False

B

4. Iterative deepening search (IDS) with depth limits of 1, 2, 4, 8, 16,... will usually be more efficient than standard IDS in terms of number of search nodes explored to find a goal

(A) True
(B) False

~~A~~ B

5. Uniform cost search with duplicate detection takes less space in practice than Djikstra's algorithm for shortest path.

(A) True
(B) False

B

6. Best first search with $f(n) = 100h(n)$ is equivalent to

(A) Iterative deepening search
(B) A*
(C) Greedy best first search
(D) Depth first search
(E) Uniform cost search
(F) None of the above

C

7. In a general CSP, after testing X→Y arc consistency for a specific X and all variables Y, if a value x remains for X, it is guaranteed that CSP will have a solution with X assigned to x.

(A) True
(B) False

A

8. Which of the following is propagation of constraints between two unassigned variables?

(A) Forward Checking
(B) Arc Consistency

A

9. The space complexity of bidirectional search after applying the iterative deepening idea is

(A) $O(b^{d/2})$
(B) $O(bd)$
(C) $O(bm)$

B

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

A C

(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.

11. Greedy hill climbing with random tie breaking, if run forever, will find the optimal solution with probability approaching 1.

B

(A) True
(B) False

12. Simulated annealing, sideways moves, and enforced hill climbing are all approaches to escape local minima in local search.

A

(A) True
(B) False

13. For what values of w is best first search with $f(n) = g(n) + w \cdot h(n)$ optimal?

(A) $w = 0$
(B) $0 < w < 1$
(C) $w = 1$

ABC

14. If a search graph has negative edge costs, which of the following algorithms return an optimal solution

(A) Uniform cost search
(B) TREE-SEARCH A* with admissible heuristic
(C) None of these

C

15. Systematic beam search and local beam search, both run with a beam of *k*, will have the same memory footprint when run on the same search space.

(A) True
(B) False

B

16. Backtracking search is essentially the A* algorithm applied to constraint satisfaction problems.

(A) True
(B) False

~~A~~ B

17. The non-local jumps in genetic algorithms arise due to

(A) Fitness function
(B) Crossing over
(C) Mutation
(D) Natural selection

B

18. Google's self-driving car was the winner of DARPA Grand challenge 2005.

(A) True
(B) False

B

19. In backtracking search after picking the variable which value will typically be tried first?

(A) One that leaves fewest remaining values for other variables
(B) One that rules out fewest values for other variables

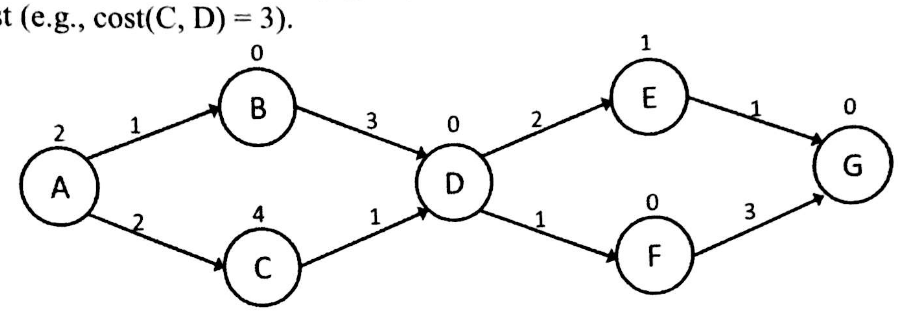
B

20. Imagine that for my constraint satisfaction problem, I get a slightly modified set of constraints every week. I would like to repair the solution with a minimum number of changes. Which of the following algorithms will be better for solving this sequence of CSPs?

(A) Backtracking search
(B) Local search

B

21. [20 points] 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) = 3).



(a) [2 points] Write down the order of nodes visited by depth first search where multiple children of a node are ordered lexicographically and there is no duplicate detection.

2

A, B, D, E, G

(b) [4 points] Write down the order of nodes visited by uniform cost search (no duplicate detection).

2

A, B, C, D, F, E, G

(c) [4 points] Write down the order of nodes visited by A* (graph search version)

4

A, B, D, F, C, E, G

(d) [5 points] Write down the order of nodes visited by DFS branch & bound (with branch policy as discussed in class and no duplicate detection).

0

A,

(e) [5 points] Now assume that all edges are undirected and we start at node D looking for goal G. Write down the order of nodes visited by iterative deepening search where multiple children of a node are ordered lexicographically (no duplicate detection).

2

~~D, (D, E, F,~~ D, (D, B, C, E, F), (D, B, A, C, A, E, G)

~~(D, B, A, B, C, A, B, E, D, E, F, D, E)~~

22. [15 points] Convert the following CSP into a binary CSP, that is a CSP in which all constraints are between at most two variables. To write the converted CSP mention the variables, their domains and all unary/binary constraints. Also make its constraint graph.

[Note that you do not have to solve the CSP. Note that all variables are discrete and Boolean]

Variables: U:: [0,1], V::[0,1], W::[0,1], X::[0,1], Y::[0,1], Z::[0, 1]

Constraints: U+W+X=1, U-V+Z=1, U+V-W ≥ 1

Variables: U, V, W, X, Y, Z ; Domains: [0, 1] for all the variables

3

$U + W + X = 1$ ——— (i)
$U - V + Z = 1$ ——— (ii)
$U + V - W \geq 1$ ——— (iii)

[A general algorithm was required, not solving for this particular problem.]

Adding (ii) and (iii), $2U + Z - W \geq 2$.

Also, $Z - W \leq 1$.

$\therefore$ $2U \geq 1$ $\Rightarrow$ $\boxed{U = 1}$

$\Rightarrow$ Substituting the value of U in (i), $W + X = 0$.

$\Rightarrow$ $\boxed{W = 0, \ X = 0}$

Substituting the values of U, and W in (iii), $V \geq 0$.

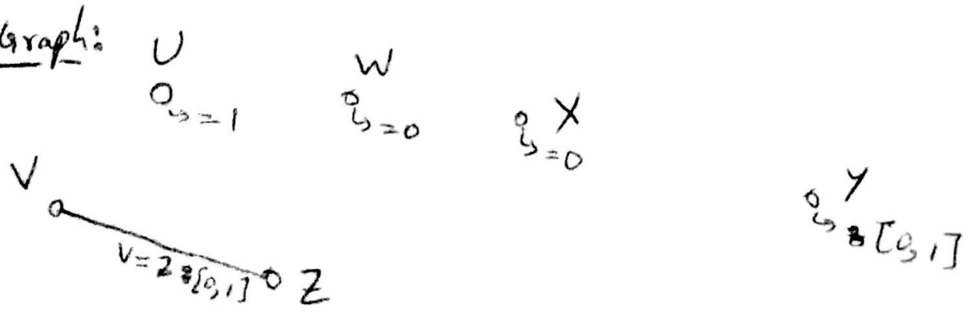
Substituting the value of U in (ii), $V = Z$.

$\Rightarrow$ Unary constraints: $U = 1$; $W = 0$; $X = 0$.

Binary constraint: $V = Z$

Constraint Graph:

1



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2/25

23. [25 points] We wish to use A* to solve the flashlight problem. The problem is stated as follows: there are n people {0,1,…,n-1}. They all are one side, and need to cross the bridge but they have just one flashlight. A maximum of two people may cross at a time. It is nighttime, so someone must carry the single flashlight during each crossing. They all have different speeds such that the time taken to cross the bridge for person i is given by T(i) minutes. You may assume without loss of generality that for i<j, T(i) <= T(j). The speed of two people crossing the bridge is determined by the slower of the two. You need to find the shortest amount of time in which all the people can cross the bridge.

(a) Define a state space representation for solving this problem as A*. What are the actions, transition function, goal test and action costs? What is the total number of possible states as per your representation?

~~A state~~.

State : ~~Number of~~ The set of people who ~~are~~ yet to cross th

Action : Two people leave the bridge

2/3

0/2

(b) What is the most uninformative admissible heuristic for this problem?

Try everything out.

(c) Suggest a polynomial time algorithm to compute a well-informed admissible heuristic. A better heuristic will fetch better marks.

(d) Compute the value of your heuristic for the start state in a problem where 7 people need to cross the bridge with crossing times: 7, 8, 10, 12, 13, 15 and 18?