

EXAM Questions B

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1. (Stable Matching, Fill-in-the-blank)

In the context of the Gale-Shapley algorithm, a matching is considered stable if there is no _____ that both prefer each other over their current partners in the matching.

Answer: man-woman pair, or other answer that has similar meaning

2. (Graph Algorithms, multiple choice)

Which of the following properties of Breadth-First Search is true?

- a) BFS always finds the shortest path between two nodes in an unweighted graph.
- b) BFS is more memory-efficient than Depth-First Search.
- c) BFS uses a queue data structure to keep track of nodes.
- d) BFS is more suitable for searching large graphs with a high branching factor.

Answer: A, C

3. (Graph Algorithms, multiple choice)

Which of the following is a potential application of Depth-First Search?

- a) Topological sorting
- b) Finding the shortest path in a weighted graph
- c) Maximum flow problem
- d) Clustering

Answer: A

4. (Graph Algorithms, multiple choice)



Using the Manhattan distance as the heuristic function, what would be the path found by the A* algorithm to reach the goal G?

- a) Right, Down, Down, Right, Right, Up, Right, Up, Up, Left
- b) Down, Right, Down, Right, Right, Up, Right, Up, Up, Left
- c) Down, Right, Down, Right, Up, Right, Up, Right, Up, Left
- d) Right, Down, Right, Down, Right, Up, Right, Up, Up, Left

Answer: B

5. (Greedy Algorithms, multiple choice)



Consider the following undirected, weighted graph? Edges and their corresponding weights: {AB: 1, AD: 2, BE: 3, BC: 1, CF: 4, EF: 1}

Apply Kruskal's algorithm to find the minimum spanning tree of this graph. Select the set of edges included in the minimum spanning tree from the following options:

- a) {AB, BC, AD, BE, EF}
- b) {AB, AD, BE, EF, CF}
- c) {BC, EF, AB, AD, BE}
- d) {AB, EF, BC, AD, BE}

Answer: A, C, D

6. (Greedy Algorithms, multiple choice)



Consider an undirected graph with weighted edges at right:

Using Prim's algorithm, starting from vertex A, which of the following is the correct order of edges selected to construct the Minimum Spanning Tree?

- a) A-B, B-D, A-C
- b) A-C, C-D, A-B
- c) A-B, B-D, D-C
- d) A-C, C-D, B-D

Answer: A

7. (Divide and Conquer, short answer)

Given a recurrence relation $T(n) = 2T(n/2) + 1$, what is the time complexity of this relation expressed in big O notation?

Answer: $O(n \log n)$

8. (Divide and Conquer, multiple choice)

Which of the following algorithms employ a divide-and-conquer strategy?

- a) Quick Sort

- b) Merge Sort
- c) Binary Search
- d) Heap Sort

Answer: A, B, C, D

9. (Dynamic Programming, multiple choice)

In the Bellman-Ford algorithm for single-source shortest paths, what is the maximum number of relaxation iterations required to guarantee that the correct shortest path distances are computed for all vertices?

- a) n
- b) $n - 1$
- c) $n - 2$
- d) $n/2$

Answer: B

10. (Dynamic Programming, multiple choice)

Which of the following is a key characteristic of the 0/1 Knapsack problem if you could just choose one option?

- a) Fractional items are allowed.
- b) Items cannot be split.
- c) The problem can be solved optimally using a greedy algorithm.
- d) The problem is solvable in polynomial time.

Answer: B

11. (Network Flow, multiple choice)

In a flow network with integer capacities, the Ford-Fulkerson algorithm terminates after a finite number of steps. What property of the capacities guarantees termination?

- a) Non-negativity
- b) Integrality
- c) Positivity
- d) Rationality

Answer: B

12. (Network Flow, multiple choice)

Which of the following best describes the push-relabel algorithm?

- a) It is a maximum flow algorithm that is based on updating height functions of vertices.
- b) It is a maximum flow algorithm that finds augmenting paths in the residual graph.

- c) It is a maximum flow algorithm that uses Dijkstra's shortest path algorithm.
- d) It is a maximum flow algorithm that finds strongly connected components.

Answer: A

13. (NP-Completeness, multiple choice)

Which of the following is a necessary condition for a decision problem to be NP-complete?

- a) The problem must be solvable in polynomial time.
- b) The problem must be in NP.
- c) The problem must be harder than any other problem in NP.
- d) The problem must be in P.

Answer: B

14. (Approximation Algorithms, multiple choice)

What is the primary goal of approximation algorithms for NP-hard problems?

- a) Find an exact solution quickly.
- b) Find an approximate solution that is within some bound of the optimal solution.
- c) Prove that a problem is NP-complete.
- d) Prove that a problem can be solved in polynomial time.

Answer: B

15. (Randomized Algorithms, multiple choice)

- a) It always produces the same output for the same input.
- b) It relies on random choices or random number generation during execution.
- c) It is guaranteed to produce the optimal solution.
- d) It has a deterministic running time.

Answer: B

16. (Nash Equilibria, short answer)

In the context of game theory, what is a Nash Equilibrium?

Answer: A Nash Equilibrium is a stable state in a game where no player can improve their outcome by unilaterally changing their strategy, assuming that the strategies of the other players remain fixed. (Same meaning could get score)

17. (Local Search, multiple choice)

In a local search algorithm, which of the following is used to measure the quality of a solution?

- a) Heuristic function
- b) Objective function
- c) Cost function
- d) Evaluation function

Answer: D

18. (Approximation Algorithms, multiple choice)

An approximation algorithm has an approximation ratio of 2. What does this mean?

- a) The algorithm always produces a solution that is at least twice as good as the optimal solution.
- b) The algorithm always produces a solution that is at most twice as good as the optimal solution.
- c) The algorithm always produces a solution that is within 2 units of the optimal solution.
- d) The algorithm always produces a solution that is within 50% of the optimal solution.

Answer: B

19. (Nash Equilibrium, multiple choice)

In a two-player, non-cooperative game, how many Nash equilibria can there be at most?

- a) 0
- b) 1
- c) 2
- d) There is no upper limit

Answer: D

20. (Union-Find, multiple choice)

What is the primary use of the Union-Find data structure?

- a) To keep track of the elements in disjoint sets and efficiently perform set operations such as union and find.
- b) To find the shortest path between two vertices in a graph.
- c) To maintain a priority queue of elements and perform insert and extract-min operations.
- d) To find the maximum flow in a flow network.

Answer: A