

# EXAM Questions A

Yuetong Guo

## 1. (Stable Matching, short answer)

Given the following preference lists for a dating app, find the stable matching using the Gale-Shapley algorithm:

Men's preferences:

M1: W4, W3, W2, W1

M2: W3, W4, W1, W2

M3: W2, W1, W4, W3

M4: W1, W2, W3, W4

Women's preferences:

W1: M3, M1, M4, M2

W2: M1, M4, M3, M2

W3: M2, M1, M4, M3

W4: M4, M3, M1, M2

**Answer:** M1-W4, M2-W3, M3-W2, M4-W1

## 2. (Stable Matching, multiple choice)

In a stable matching problem with an equal number of men and women, a matching is considered stable if:

- a) There is no unmatched man or woman.
- b) There is no pair of a man and a woman who both prefer each other over their current partners.
- c) The total number of preferences for each individual is minimized.
- d) All men and women are matched with their most preferred partners.

**Answer:** A, B

## 3. (Graph Algorithms, multiple choice)

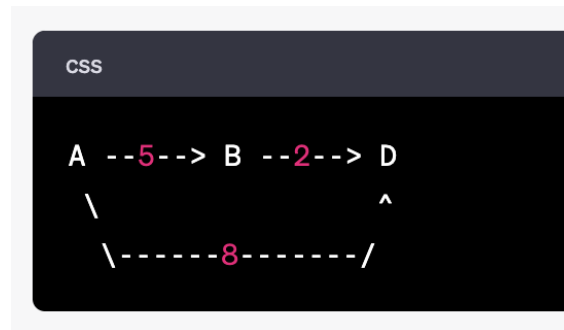
You are given an undirected graph representing a network of cities connected by roads. You need to determine if it is possible to reach all cities starting from one city. Which algorithm should you use?

- a) BFS or DFS
- b) Dijkstra's Algorithm
- c) A\* Search
- d) Kruskal's Algorithm

**Answer:** A

#### 4. (Graph Algorithms, multiple choice)

Given the following directed graph, which algorithm should be used to find the shortest path from vertex A to vertex D?



- a) BFS
- b) DFS
- c) Dijkstra's Algorithm
- d) A\* Search

**Answer:** C

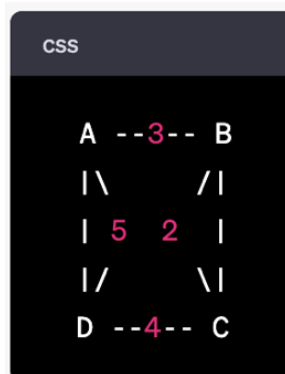
#### 5. (Greedy Algorithms, multiple choice)

You are given a list of intervals with start and end times of meetings. Your task is to find the minimum number of meeting rooms required to accommodate all meetings without any overlapping. Which algorithmic approach should you use?

- a) Greedy
- b) Dynamic Programming
- c) Divide and Conquer
- d) Backtracking

**Answer:** A

#### 6. (Greedy Algorithms, short answer)



For the given undirected graph, apply Kruskal's algorithm to find the minimum spanning tree. Show the order of selected edges and the final tree.

**Answer:**

Selected edges order: {B, C}, {A, B}, {C, D};

Final tree: (A, B), (B, C), (C, D)

### 7. (Divide and Conquer, fill-in-the-blank)

In the Master theorem,  $T(n) = aT(n/b) + f(n)$  is a recurrence relation where  $a \geq 1$ ,  $b > 1$ , and  $f(n)$  is an \_\_\_\_\_ function.

**Answer:** Asymptotically Positive

### 8. (Dynamic Programming, short answer)

A thief can steal items with weights [1, 2, 3, 4, 5] and values [15, 10, 20, 30, 40]. The knapsack has a maximum capacity of 8. What is the maximum value the thief can steal using dynamic programming?

**Answer:** 65 (by taking items with weights 1, 2 and 5)

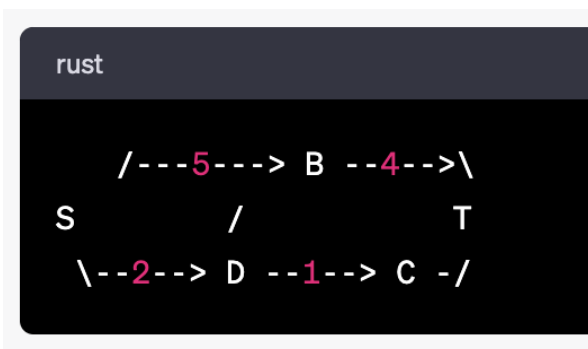
### 9. (Dynamic Programming, multiple choice)

In the Longest Common Subsequence problem, suppose the two input strings are A = "ABCDGH" and B = "AEDFHR". What is the length of their longest common subsequence?

- a) 3
- b) 4
- c) 5
- d) 6

**Answer:** A ("ADH")

### 11. (Network Flow, short answer)



Given the following flow network, find the maximum flow from the source (S) to the sink (T) using the Ford-Fulkerson algorithm.

**Answer:**  
Maximum flow = 5;

### 10. (Network Flow, multiple choice)

What is the time complexity of the Ford-Fulkerson algorithm for finding the maximum flow in a network with V vertices and E edges?

- a)  $O(V^2E)$
- b)  $O(V^3)$
- c)  $O(E \log V)$
- d)  $O(V E^2)$

**Answer:** A

**12.(Network Flow, multiple choice)**

In the context of network flow, the capacity of an edge in a flow network is:

- a) The maximum flow that the edge can support.
- b) The difference between the flow into a node and the flow out of the same node.
- c) The amount of flow currently passing through the edge.
- d) The amount of flow currently passing through the entire network.

**Answer:** A

**13. (NP-Completeness, multiple choice)**

Which of the following problems is NP-complete?

- a) 0/1 Knapsack
- b) Maximum Flow
- c) Shortest Path
- d) Minimum Spanning Tree

**Answer:** A

**14. (NP-Completeness, multiple choice)**

In a game of Sudoku, you are given a partially filled 9x9 grid. You need to fill the remaining cells such that each row, column, and 3x3 subgrid contains the numbers 1 to 9 exactly once. The problem of solving a Sudoku puzzle can be reduced to:

- a) The Vertex Cover Problem
- b) The Nurse Schedule Problem
- c) The Graph Coloring Problem
- d) The Traveling Salesman Problem

**Answer:** C

**15. (Local search, fill-in-the-blank)**

For the Traveling Salesman Problem (TSP), the \_\_\_\_\_ algorithm is a local search algorithm that repeatedly selects and reverses a subsequence of the tour to improve the total tour cost.

**Answer:** 2-opt

**16. (Randomized Algorithms, multiple choice)**

In the context of randomized algorithms, what is the expected running time of an algorithm?

- a) The average running time over all possible inputs
- b) The worst-case running time
- c) The best-case running time
- d) The average running time over all random choices made by the algorithm

**Answer:** D

**17. (Approximation Algorithms, multiple choice)**

The Vertex Cover problem can be approximated using a greedy algorithm with an approximation factor of:

- a)  $1/2$
- b) 2
- c)  $O(\log n)$
- d)  $O(n)$

**Answer:** B

**18. (Approximation Algorithms, multiple choice)**

A company wants to connect its offices, represented by nodes in a graph, with a minimum total cable length. Which algorithm should be used to find an approximate solution for this problem?

- a) Greedy Algorithm
- b) Kruskal's Algorithm
- c) Primal-dual methods
- d) Dijkstra's Algorithm

**Answer:** B

**19. (Dynamic Programming, multiple choice)**

Consider the following set of items, each with a weight and a value, and a knapsack of capacity 7. What is the maximum value that can be achieved by placing items in the knapsack?

- a) 35
- b) 40
- c) 45
- d) 50

**Answer:** C

mathematica

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Item 1: weight 2, value 15
Item 2: weight 3, value 10
Item 3: weight 4, value 25
Item 4: weight 1, value 5
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**20. (DFS, multiple choice)**

mathematica

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A-->B-->D
|       |
v       v
C----->E
```

Given the right directed graph:

Which of the following is a valid Depth-First Search traversal of the graph, starting from node A?

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

**Answer:** A, B