

ALGORITHMS, DATA AND SECURITY A.Y. 2024/25
Midterm on April 11th, 2025

Surname _____	Name _____
ID number _____	

Question 1 (points 7)

- a) Consider the fibonacci1 and fibonacci2 algorithms and explain the problems they suffer from.
- b) What are the running times of the two algorithms using big O notation? (You don't need to prove them.)
- c) Consider the fibonacci3 algorithm: describe how it works (using either pseudo-code or your own words), which algorithmic technique it employs, and what its running time is.
- d) Considering only the running time of fibonacci1 and fibonacci3, which one would you use and why?

Question 2 (points 6)

- a) Describe the goal of the Gale-Shapley algorithm and explain what a blocking pair is.
- b) Perform the Gale-Shapley algorithm on the following sets of men and women, choosing either a women stable marriage or a men stable marriage. Show all the steps of the algorithm (not just the final solution).

Women = {1, 2, 3, 4}

Men = {A, B, C, D}

Men's preference:

A: 1 2 3 4 (i.e., A prefers 1 to 2 to 3 to 4)

B: 1 3 2 4

C: 2 3 4 1

D: 4 3 2 1

Women's preference

1: B A C D (i.e., 1 prefers B to A to C to D)

2: A C B D

3: A B D C

4: D A C B

- c) Is Gale-Shapley algorithm an efficient algorithm? Justify your answer.

Question 3 (points 11)

- a) Explain the SelectionSort sorting algorithm (using either pseudo-code or your own words).
- b) Describe how you apply SelectionSort to sort the list: 25, 21, 11, 12, 9.
- c) What is its running time? Prove it.
- d) SelectionSort employs for loops. Explain in general the goal of the for loop and compare it to the while loop. Can we use in SelectionSort the while loop rather than the for loop?
- e) How do you sort the same list 25, 21, 11, 12, 9 using MergeSort?
- f) Which algorithm technique is used by BinarySearch and MergeSort? Explain it and how the two algorithms use it.

Question 4 (points 8)

- a) What is a hash table and why do we use it?
- b) Explain how the open addressing technique handles collisions and explain the different options for finding the probing sequence.
- c) Consider a hash table of size 7, using open addressing with linear probing and the hash function $h(k) = k \bmod 7$. Insert the keys 5, 18, 27, 15, and 2 (in that order) and write down the entries of the hash table, explaining how each slot is chosen.
- d) Consider the same hash table and the same sequence of keys to be inserted, but now use separate chaining to handle collisions, starting with an empty hash table. Show the resulting hash table.
- e) What are the advantages and disadvantages of the two techniques?