University of Batna 2
Faculty of Math and CS
Department of Computer Science
Algorithms and Complexity

Date: 28/01/2024
Duration: 1 hour 30 minutes
Family Name:
Name:

Exercise 1(10 points)

Multiple Choice Questions (MCQs)

1. In a graph, what is the primary objective of Breadth-First Search (BFS)?
   a) Identifying the shortest path between two vertices
   b) Visiting all vertices by exploring the graph's depth first
   c) Ensuring all nodes are visited in the order of their hierarchical level
   d) Exploring the graph as wide as possible before going deeper

2. Which of the following best describes an algorithm with O(n$\hat{2}$) complexity?
   a) The execution time doubles with each addition to the input size
   b) The execution time increases exponentially with the input size
   c) The execution time is unaffected by the input size
   d) The execution time increases quadratically with the input size

3. What is a common issue when using dynamic memory allocation and how is it addressed?
   a) Memory issues from unused pointers, fixed by setting pointers to NULL after removing their data.
   b) Overflow errors, mitigated by input validation
   c) Linker errors, mitigated by including necessary headers
   d) Slow allocation, mitigated by memory pool implementation

4. For what purpose are 'push' and 'pop' operations used in stack data structures?
   a) To traverse the stack depth-first
   b) To ensure the stack is sorted
   c) To add and remove elements from the stack
   d) To merge two stacks into one

5. Big O notation is used to express what aspect of an algorithm?
   a) The accuracy of the algorithm's output
   b) The efficiency of memory usage
   c) How it performs as the amount of data increases
   d) The number of recursive calls in the algorithm

6. In C programming, what is the return type of a delete function that removes an element from an array and updates its size?
   a) double
   b) void
   c) char*
   d) unsigned int

7. Which data structure is best suited for implementing a priority queue?
   a) Array
   b) Linked List
   c) Binary Heap
   d) Stack

8. What is the time complexity of inserting an element into a binary search tree (BST)?
   a) $O(1)$
   b) $O(\log n)$
   c) $O(n)$
   d) $O(n \log n)$

9. In a balanced binary tree, what is the maximum number of nodes at height h?
   a) 2^h
   b) $2^{h+1} - 1$
   c) h^2
   d) $h!$ (h factorial)

10. Which graph term describes a path that starts and ends at the same vertex?
    a) Bipartite path
    b) Directed path
    c) Cycle
    d) Edge

11. What is the degree of a vertex in a graph?
    a) The number of graphs it is connected to
    b) The number of edges coming into the vertex
    c) The maximum distance to another vertex
    d) The number of edges connected to the vertex

Multiple Choice Answers:

Q	1	2	3	4	5	6	7	8	9	10	11
A											

Exercise 2 (4 points)

Question: Implement an optimized Bubble Sort algorithm in C to sort a singly linked list. Your solution should minimize the number of passes and swaps as much as possible. Provide a function that sorts the list in ascending order.

Exercise 3 (6 points)

Question: Choose a modern issue where graph theory could provide insightful solutions or analyses. Outline how you would construct a graph to represent this issue, including your choice between a directed or undirected graph and whether it should be weighted. Briefly justify how this graphical representation facilitates understanding or solving the issue.

Exercise 4 (3 points)

Question: Write a C function to sort two separate arrays as a collective unit while maintaining their separation. Given two arrays, arr1 and arr2, rearrange their elements so that when both arrays are considered as one continuous sequence, the entire sequence is sorted, but the elements are redistributed between arr1 and arr2 to maintain their original sizes. After sorting, the smallest elements should be in arr1 and the remaining elements in arr2, with both arrays individually sorted. you can use predefined function void heapify(int arr[], int n, int i).