Maulana Abul Kalam Azad University of Technology

Practical Examination, Even Semester, 2021

Paper name: Design and Analysis Algorithms — **Semester: 4^{th}**
Discipline: CSE — **Full Marks: 60**
Code: PCC-CS494 — **Time: 3 Hours**

Date: July 27, 2021

Important points:

- **You must write the first page of the examination copy in the format given below:**
  Maulana Abul Kalam Azad University of Technology
  Laboratory Examination, Even Semester, 2021
  Name:
  Branch:
  Semester:
  Paper Name:
  Paper code:
  Date of examination:
- **Invigilator(s) ask you to turn on your video any time during your examination.**
- **Keep your video "ON" during the viva.**
- **Keep your examination copy during the viva.**
- **You must submit your examination copy and code in the two separate links provided in your google classroom within 30 minutes of the end of the examination.**

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Marks Distribution:

- **Algorithm: 10 Marks**
- **Coding: 20 Marks**
- **Output: 10 Marks**
- **viva: 20 Marks**

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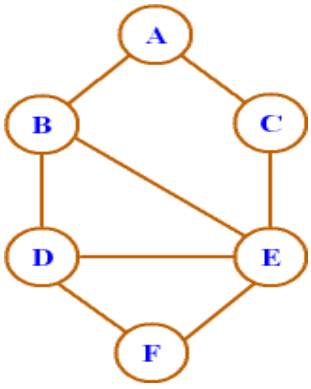
1. Write a program in C or C++ to find the maximum and minimum number from a given array using divide and conquer approach.
   (a) Read the input from user.
   (b) Display the maximum number and minimum number.

2. Write a program in C or C++ to sort a given array using Merge Sort algorithm.
   (a) Read the input from user.
   (b) If possible display the array elements for each pass.
   (c) Display the sorted array.

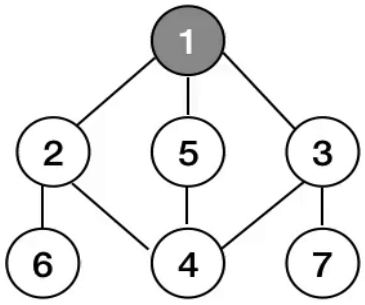
3. Write a program in C or C++ to sort a given array using Quick Sort algorithm.
   (a) Read the input from user.
   (b) If possible display the array elements for each pass.
   (c) Display the sorted array.

4. Write a program in C or C++ to implement the Breadth-First-Search algorithm using adjacency matrix/adjacency list for the following graph.



   (a) You must use the file for the graph input.
   (b) You must implement the queue data structure for your purpose.
   (c) Display the sequence of visited vertices for a given source.

5. Write a program in C or C++ to implement iterative Depth-First-Search algorithm using adjacency matrix/adjacency list of the following graph.



   (a) You must use the file for the graph input.

   (b) You must implement the stack data structure for your purpose.

   (c) Display the sequence of visited vertices for a given source.

6. Write a program in C or C++ to implement iterative Heap Sort algorithm.

   (a) Read the input from user.

   (b) If possible show the array for every steps.

7. Write a program in C or C++ to implement Fractional Knapsack algorithm. Find an optimal solution to the knapsack instance $n = 7$, $W = 15$, $(p_1, p_2, ..., p_7) = (10, 5, 15, 7, 6, 18, 3)$, and $(w_1, w_2, ..., w_7) = (2, 3, 5, 7, 1, 4, 1)$.

   (a) The input format should be item, profit and weight triplets, i.e., Items as $< item, profit, weight >$. Read the input from user.

   (b) You must implement any sorting algorithm for your requirement.

   (c) Show the maximum profit and the items those are kept in the knapsack.

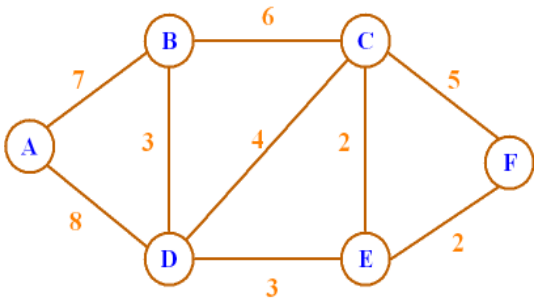
8. Write a program in C or C++ to implement Job Scheduling algorithm. What is the solution generated by the function JS when $n = 7$, $(p_1, p_2, ..., p_7) = (3, 5, 20, 18, 1, 6, 30)$, and $(d_1, d_2, ..., d_7) = (1, 3, 4, 3, 2, 1, 2)$?

   (a) The input format should be profit and deadline pairs, i.e., Jobs as $< profit, deadline >$ pairs. Read the input from user.

   (b) You must implement any sorting algorithm for your requirement.

   (c) Show the maximum profit and the sequence of jobs with their deadline in the solution.

9. Given an undirected weighted graph, write a program in C or C++ to find a minimum spanning tree by applying Kruskal's Algorithm for the following graph.

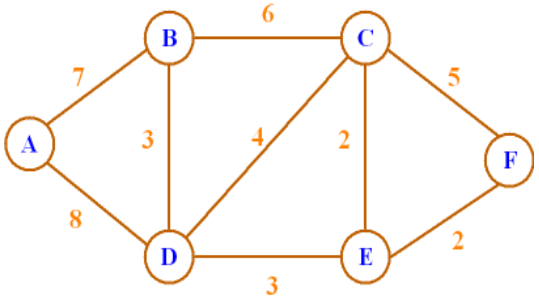


   (a) You may use the file input or user input for the graph.

   (b) Display the edges of the MST.

   (c) Show the cost of the MST.

10. Given an undirected weighted graph, write a program in C or C++ to find a minimum spanning tree by applying Prims's Algorithm for the following graph.

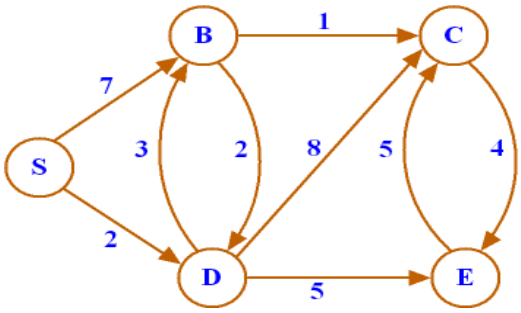


   (a) You must use the file for the graph input.

   (b) Display the edges of the MST.

   (c) Show the cost of the MST.

11. Write a program in C or C++ to find single source shortest path applying Dijkstra Algorithm of the following graph as input graph where S be the source vertices.



(a) You must use the file for the graph input.

(b) Display the path from the source to the given destination.

(c) Show the cost of the path.

12. Given an array $p[]$ which represents the chain of matrices such that the i^{th} matrix A_i is of dimension $p[i-1] \times p[i]$. Write a C or C++ program to show the minimum number of multiplications needed to multiply the chain and the optimal parenthesization for the sequence of matrices: $A_{10\times 20}B_{20\times 30}C_{30\times 10}A_{10\times 40}$.

Solution:

$$M[][] = \begin{bmatrix} 0 & 6000 & 8000 & 12000 \\ 0 & 0 & 6000 & 14000 \\ 0 & 0 & 0 & 12000 \\ 0 & 0 & 0 & 0 \end{bmatrix} \quad S[][] = \begin{bmatrix} 0 & 1 & 1 & 3 \\ 0 & 0 & 2 & 3 \\ 0 & 0 & 0 & 3 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

Minimum number of multiplications is 12000 and order $((A1(A2A3))A4)$.

(a) Read $p[]$ array from user.

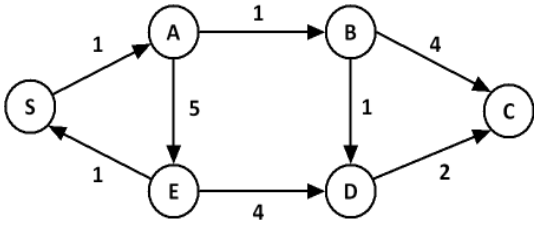
(b) Display final M table.

(c) Display final S table.

(d) Display minimum number of scalar multiplications.

(e) Using Print-Optimal-Parenthesis algorithm find the order of multiplication.

13. Write a C or C++ program to find the single source shortest path (SSSP) from the source node ***S*** of the following graph using Bellman ford algorithm.



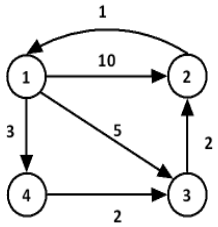
(a) You may use the file input or user input for the graph.

(b) Display the path from the source to the given destination.

(c) Show the cost of the path.

(d) Show the existence of negative weight cycle by changing the weight of the edge (A, E) from 5 to -5?

14. Write a C or C++ program to find the all pair of shortest path (APSP) of the following graph using Floyd-Warshall algorithm.



Solution:

$$D^0 = \begin{bmatrix} 0 & 10 & 5 & 3 \\ 1 & 0 & \infty & \infty \\ \infty & 2 & 0 & \infty \\ \infty & \infty & 2 & 0 \end{bmatrix}$$

$$D^1 = \begin{bmatrix} 0 & 10 & 5 & 3 \\ 1 & 0 & 6 & 4 \\ \infty & 2 & 0 & \infty \\ \infty & \infty & 2 & 0 \end{bmatrix} \quad D^2 = \begin{bmatrix} 0 & 10 & 5 & 3 \\ 1 & 0 & 6 & 4 \\ 3 & 2 & 0 & 6 \\ \infty & \infty & 2 & 0 \end{bmatrix} \quad D^3 = \begin{bmatrix} 0 & 7 & 5 & 3 \\ 1 & 0 & 6 & 4 \\ 3 & 2 & 0 & 6 \\ 5 & 4 & 2 & 0 \end{bmatrix} \quad D^4 = \begin{bmatrix} 0 & 7 & 5 & 3 \\ 1 & 0 & 6 & 4 \\ 3 & 2 & 0 & 6 \\ 5 & 4 & 2 & 0 \end{bmatrix}$$

(a) You must use file for the graph input.

(b) Display all cost table and the predecessor table.

(c) Using Print-All-Pairs-Shortest-Path algorithm display the shortest path from a given source vertex to destination vertex and the corresponding cost.

15. (a) Write a C or C++ program to implement $n - Queen$ problem using backtracking algorithm.

    (b) Test your code for $n = 1$, 2, 3, 4 and 8. Print number of solutions and all possible solutions. If there is no solution for some n, then print a message.

16. Write a C or C++ program to implement $m - Coloring$ using backtracking algorithm.

    (a) You must use file for the graph input.

    (b) Test your code for $m = 2$ and $m = 3$ for the following graph (one solution has been shown for $m = 3$). Print all possible solution.