Design and Analysis of Algorithms Lab
Academic Year: 2020 - 21

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DAA Lab 1 Due Date: February 7, 2021

1. Use Selection Sort and Insertion Sort techniques to sort a set of student records by considering a specified field (Hall Ticket Number, Name, or Team Number).
2. Use Selection Sort and Insertion Sort techniques to sort a set of student records by considering all the fields in a specific order (Team Number, Hall Ticket Number, and Name).

Note:

- Input should be read from a file **DAALab_input1.txt**
- Output should be written into a file **DAALab_output1.txt**

DAA Lab 2 Due Date: February 14, 2021

1. Use Merge Sort and Quick Sort techniques to sort a set of student records by considering a specified field (Hall Ticket Number, Name, or Team Number).
2. Use Merge Sort and Quick Sort techniques to sort a set of student records by considering all the fields in a specific order (Team Number, Hall Ticket Number, and Name).

Note:

- Input should be read from a file **DAALab_input1.txt**
- Output should be written into a file **DAALab_output1.txt**

DAA Lab 3 Due Date: February 21, 2021

1. Use Linear Search technique to search a student record by considering a specified field (Hall Ticket Number, Name, or Team Number).
2. Use Binary Search technique to search a student record by considering a specified field (Hall Ticket Number, Name, or Team Number).

Note:

- Input should be read from a file **DAALab_input1.txt**
- Output should be written into a file **DAALab_output1.txt**

DAA Lab 3 Due Date: February 21, 2021

Bonus:

1. Use Fibonacci Search technique to search a student record by considering a specified field (Hall Ticket Number, Name, or Team Number).

DAA Lab 4 Due Date: March 02, 2021

1. Use a Tree Sort technique to sort a set of student records by considering Hall Ticket Number.
2. Develop a program to multiply two square-matrices of order 1024 X 1024 using Block Matrix Multiplications by considering the block sizes: 4, 8, 16, 32, and 64. Use *gettimeofday*() for calculating *runtime* (the average of 5 runs). Draw a plot using *runtime* and block-size.

Note:

- Input should be read from a file **DAALab_input1.txt**
- Output should be written into a file **DAALab_output1.txt**

DAA Lab 5 Due Date: March 14, 2021

1. Develop a program for the Defective Chessboard problem (N=1024, 2048, and 4096). Use *gettimeofday*() for calculating *runtime* (the average of 5 runs).
2. Develop a program to multiply two square-matrices of order 1024 X 1024 using Strassen's Matrix Multiplication. Use *gettimeofday*() for calculating *runtime* (the average of 5 runs).

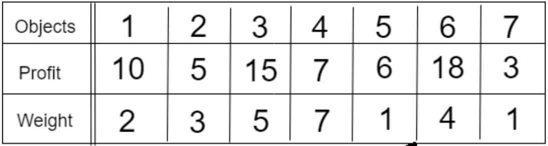
Bonus Problem Statements:

1. Given an array of n numbers and a positive integer i, write a program to find the i^{th} smallest element that runs in O(n) time.
2. Given two sorted arrays, each consisting of n numbers, write a program to find the median of $2n$ elements that runs in $\mathcal{O}(\log n)$ time.

DAA Lab 6 Due Date: March 31, 2021

1. **Kanpsack Problem:** We are given with n objects and a knapsack with capacity M. Let w_1, w_2, w_3, ... w_n and p_1, p_2, ... p_n be the weights and profits of n objects, respectively. If we place a fraction $x_i, (0 \leq \ x_i \leq 1)$ of object i into the Knapsack, then we get a profit $p_i.x_i$ and kanpsack capacity is reduced by $M - w_i.x_i$. Write a program to find a solution vector $(x_1$,x_2,x_3, ... , $x_n)$ in such a way that we have to get the maximum profit.
2. **Job Sequencing with Deadlines:** We are given with a machine and a set of n jobs. Each job i has an integer deadline (d_i) and a profit (p_i). Execution time of any job is one unit. If a job i is executed within its deadline, then we get profit p_i. Write a program to find a solution vector $(x_1$,x_2,x_3, ... , $x_n)$ in such a way that we have to get the maximum profit.

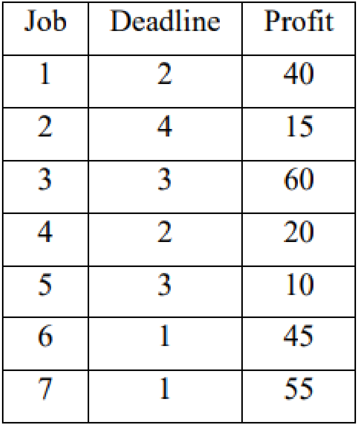
An Example of Kanpsack Problem



Objects	1	2	3	4	5	6	7
Profit	10	5	15	7	6	18	3
Weight	2	3	5	7	1	4	1

M 15

An Example of Job Sequencing with Deadlines Problem



Job	Deadline	Profit
1	2	40
2	4	15
3	3	60
4	2	20
5	3	10
6	1	45
7	1	55

DAA Lab 7 Due Date: April 4, 2021

1. **Single Source Shortest Path (SSSP):** Given a connected weighted graph (weights represent the distances between two vertices), write a program to find a shortest path from a given source vertex ‘s’ to every other vertex.
   Using the SSSP program find a shortest path between every pair of vertices.

2. **Huffman Coding:** Write a program to compress and decompress a file using a Huffman Coding. The uncompressed text file and the original text file should be the same.
   (**Size of orizinal file should be $\geq$ 1 MB**).

DAA Lab 8 Due Date: May 9, 2021

1. **Travelling Salesperson Problem (TSP):** Given a connected weighted graph (weights represent the distances between two vertices), we have to find a tour with minimum distance (cost). Write a program to find an optimal tour.

2. **Reliability Design Problem:** Let us consider, we have to design an *n*-stage system with maximum reliability under the give cost constraints using device duplication technique. Write a program to identify the number of devices that can be connected in parallel.

   $$f_n(C) = \max_{1 \leq m_i \leq u_i} \left\{ \phi_n(m_n) \,.\, f_{n-1}(C - c_n.m_n) \right.$$

   Where m_n is the number of devices that can be connected in n^{th} Stage.
   $\phi_n(m_n)$ is the reliability of Stage n.
   Base case: $f_0(x) = 1$, where $x \geq 0$
   $f_i(-ve) = 0$, where $0 \leq i \leq n$

DAA Lab 9 Due Date: May 17, 2021

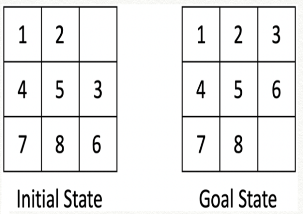
1. **Matrix Chain Multiplication**: Given a chain of n matrices (i.e., A_1, A_2, A_3, ..., A_n) and dimensions (rows and columns) of the matrices are $p_0 \times p_1$, $p_1 \times p_2$, $p_2 \times p_3$ ... $p_{n-1} \times p_n$, respectively.
   Write a program to find an order(or parenthesize the matrices) to compute the product $A_1.A_2.A_3.$ ... $.A_n$ using minimum number of scalar multiplications.
2. **Longest Common Sub-Sequence (LCS)**:Let X_i=(x_1,x_2, ..., x_i) and Y_j= (y_1,y_2, ..., y_j) are two strings, then write a program to a Longest Common Sub-Sequence of X_i and Y_i.

Bonus: Write a program to find LCS of n strings. For example LCS of 4 strings { **aaabb**, **bbaaa**, **cccbb**, **bbccc**} is **bb**.

DAA Lab 10 Due Date: May 23, 2021

1. **N-Queens Problem:** Given an N × N chessboard and N-Queens. Place N-Queens on the chessboard in non-attackable positions. Consider the different values of N =8, 12, 16, and 20. Store all the solutions in a file.
2. **Sum of Subsets Problem:** We are given with *n* distinct positive numbers (usually called weights) and a value *m*. Write a program to find all the subsets of these *n* numbers whose sums are *m* (Use Backtracking).
3. **Graph Coloring Problem:** Let *G* be a graph with *n* vertices. Write a program to assign colors to the vertices of *G* (using minimum number of colors) in such a way that no two adjacent vertices have the same color.
4. **Develop programs for 3-Puzzle, 8-Puzzle and 15-Puzzle Problems:**

8-Puzzle



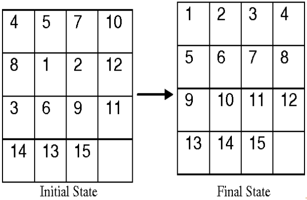
1	2	
4	5	3
7	8	6

Initial State

1	2	3
4	5	6
7	8	

Goal State

15-Puzzle



4	5	7	10
8	1	2	12
3	6	9	11
14	13	15	

Initial State

→

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	

Final State