CSE 3131: ALGORITHM DESIGN 1

ASSIGNMENT 4:

Submission due date: 02/01/2023

- *Assignment scores/markings depend on neatness and clarity.*
- *Write your answers with enough detail about your approach and concepts used, so that the grader will be able to understand it easily. You should ALWAYS prove the correctness of your algorithms either directly or by referring to a proof in the book.*
- *The marking would be out of 100.*
- *You are allowed to use only those concepts which are covered in the lecture class till date.*
- *Plagiarized assignments will be given a zero mark.*

CO4: to understand various types and aspects of ***Greedy Method.***

Sl.No.	***Question***	***PO***	***Level***
1.	In the Interval scheduling problem, we always choose the earliest finishing interval $a(s,f)$,where 's' is starting time and 'f' is finish time. Assume that instead of always choosing the first interval to finish, we choose the last interval to start that is compatible with every interval that we have already chosen. Explain how this strategy is a greedy algorithm and show that it produces the optimal solution.	PO2,PO3,PO4	L2
2.	Think about some modification in the interval scheduling problem so that each interval has a start time, an end time and a value of the interval. In notation, an interval (s,f,v) . The goal is now to maximize the total value of the selected intervals rather than the number of selected intervals. In other words, we want to pick a group A of compatible activities so that $\sum_{a_i \in A} v_i$ is maximized. Give a polynomial-time solution for this problem.	PO2,PO3,PO4	L4
3.	Let a cache with a capacity of storing 5 data items contains (a, b, c, d) initially. If the memory requests are coming in the order a, c, f, d, e, c, g, b, h, f, a, d, c, b, e. How many cache miss will occur using the following scheduling strategies? i. Farthest-In-Future scheduling (FF: evict the data item that will be requested after the longest period of time) ii. Last In First Out (LIFO: evict the data item that has entered the cache last) Least Recently Used (LRU: evict the data item that has been requested before the longest period of time) [See the Optimal Cache problem in **Text Book**]	PO2,PO3,PO4	L2, L3, L4

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<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>4.</td><td>The time required to access the cache is 100 nano seconds and that of the main memory is 1 micro second. Let the cache has a capacity of 3 and contains (a, b, c) initially. The memory requests are coming in the order a, d, c, f, d, b, g, a, e, c, b, f, a, d, g. What is the percentage of data access time saved by the optimal scheduling over Last In First Out and Least Recently Used?</td><td>PO2,PO3,PO4</td><td>L2, L3, L4</td></tr>
<tr><td>5.</td><td>Let $A=\{a,b,c,d,e\}$ be a set of independent letters with their probabilities $p(a)=\frac{1}{16}$, $p(b)=\frac{1}{2}$, $p(a)=\frac{1}{16}$, $p(a)=\frac{1}{8}$, $p(a)=\frac{1}{4}$. Give a Huffman code for these letters.</td><td>PO2,PO3,PO4</td><td>L5</td></tr>
<tr><td>6.</td><td>Optimal Caching: Suppose cache size k=3 and sequences of request are {b, a, c, a, d, c, f, a, c, d, g, f, e, a, c, b}. Let assume cache already contain only {a, c} request. How many miss will you get with “farthest-in-future” method? [See the Optimal Cache problem in Text Book]</td><td>PO2,PO3,PO4</td><td>L5</td></tr>
<tr><td>7.</td><td>Give a complete mathematical formulation of the Interval Scheduling problem to maximize the number of mutually compatible jobs that can be scheduled on a single available resource. Identify the input, output and formulate the objective function(s) and the constraint function(s). Discuss the possible greedy choices to solve the problem. Verify, which of the greedy choice strategies gives the optimal solution and discuss the non-optimality of the other choices using suitable counterexamples. Find the maximum number of mutually compatible jobs to be scheduled on a single available resource using each of these greedy strategies. Each interval j has the starting time s_j and finishing f_j as given.
<table>
<tr><td>Interval (j)</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr>
<tr><td>Starting time (s_j)</td><td>0</td><td>3</td><td>3</td><td>0</td><td>2</td><td>0</td><td>4</td><td>7</td><td>6</td><td>8</td></tr>
<tr><td>Finishing time (f_j)</td><td>2</td><td>4</td><td>7</td><td>1</td><td>4</td><td>4</td><td>7</td><td>9</td><td>10</td><td>10</td></tr>
</table></td><td>PO2,PO3,PO4</td><td>L2,L4</td></tr>
<tr><td>8.</td><td>Give a complete mathematical formulation of the scheduling problem to minimize the lateness of the schedule. Identify the input, output and formulate the objective function(s) and the constraint function(s). Discuss the possible greedy choices to solve the problem. Verify, which of the greedy choice strategies gives the optimal solution and discuss the non-optimality of the other choices using suitable counterexamples. Find the maximum lateness associated with the given set of intervals if they are to be scheduled on a single available resource using each of the following greedy strategies. Each interval j has the running time t_j and deadline d_j as given.</td><td>PO2,PO3,PO4</td><td>L2,L3</td></tr>
</table>

Interval (j)	1	2	3	4	5	6	7	8	9	10
Running time (t_j)	2	5	3	1	7	5	6	4	3	2
Deadline (d_j)	9	14	8	15	7	11	12	16	21	22

i. Earliest deadline first

ii. Shortest running time first

iii. Shortest slack time first

9.	Its examination time and all the students are in hurry to prepare study materials for the semester. There is a severe rush at all the nearby copier shop. A shop *X* claims that it will copy the materials without any delay has announced a discount of ₹ 2 for every minute over the permissible delay. The store *X* charges ₹ 1 per page to make copies and has a single copier machine available. A group of 10 students has visited the store X at time 10 AM. Each student has some materials with different amount of pages to make copies. The ideal copying time of the machine is one minute per 10 pages. The number of pages needed by each student is given in the following table. Students can wait a maximum of 2 minutes over their estimated copying time without counting any delay. Discuss a greedy strategy that the shopkeeper should follow so that the discount amount will be as minimum as possible, ignoring the setup and little idle time between the copying jobs. Find the net income (actual amount - discount) of the shop *X* from the 10 students.	PO2,PO3,PO4	L2,L3

Students	1	2	3	4	5	6	7	8	9	10
No. of pages	200	150	180	250	300	170	100	80	230	340

10.	The frequencies of the characters present in a symbol set are given as 0.19, 0.23, 0.03, 0.45, 0.05, and 0.05. i. Construct the Huffman's tree corresponding to the optimal prefix encoding. ii. Find the average bits needed per character for the optimal prefix code. Find the percentage of bits saved over a fixed length encoding with minimum number of bits per letter.	PO2,PO3,PO4	L2, L3
11.	Find the Huffman's code to encode the string "abbaccbaadddeefggeea" and find the encoded message. Find the minimum number of bits required to encode the given string using a fixed length encoding. Compute the data compression per character achieved by the Huffman's encoding over the fixed length encoding.	PO2,PO3,PO4	L2, L3, L4

12.	Solve the Exercises: question no. 1, Chapter 4: Greedy algorithms, Text Book: Algorithm Design by Jon Kleinberg and Eva Tardos,	PO2,PO3,PO4	L2,L3,L4
13.	Solve the Exercises: question no. 2, Chapter 4: Greedy algorithms, Text Book: Algorithm Design by Jon Kleinberg and Eva Tardos,	PO2,PO3,PO4	L2,L3,L4
14.	Solve the Exercises: question no. 13, Chapter 4: Greedy algorithms, Text Book: Algorithm Design by Jon Kleinberg and Eva Tardos,	PO2,PO3,PO4	L2,L3,L4
15.	Solve the Exercises: question no. 25, Chapter 4: Greedy algorithms, Text Book: Algorithm Design by Jon Kleinberg and Eva Tardos,	PO2,PO3,PO4	L2,L3,L4

Submission and Grading:

Submit the hard copy of your assignment by the due date, i.e. 02.01.2023.

Part of your assignment grade comes from its "external correctness." This is based on correct output on various sample inputs.

The rest of your assignment's score comes from "internal correctness." Internal correctness includes:
1. Use of methods to minimize the number of steps.
2. Appropriate use of rules, axioms, and suitable diagrams to enhance readability of your responses.

Send a zip folder (name of the zip folder must be your registration number_AD1) containing the code and output file/screen-shot of each program implementation mentioned to the official email id of your AD1 class teacher. On the top of each program, you must mention your full name, registration number, title of the program and date.