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Amrita School of Computing, Coimbatore

B.Tech Second Assessment Examinations – December 2022

Fifth Semester

Computer Science and Engineering

19CSE302 Design and Analysis of Algorithms

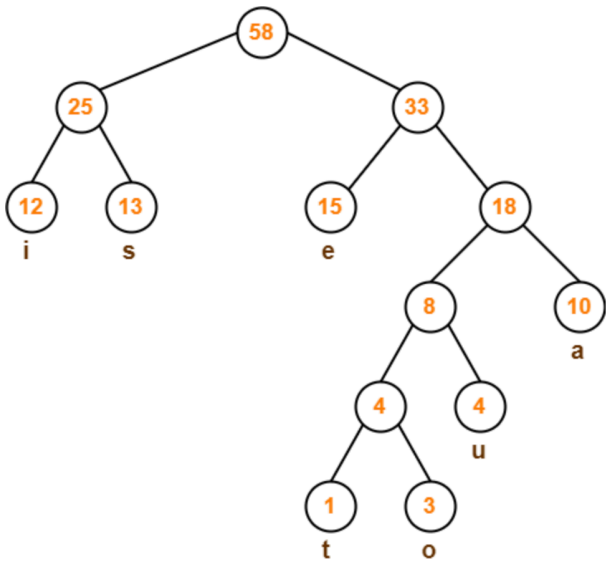
Duration: Two hours Maximum: 50 Marks

Course Outcomes (COs):

CO	Course Outcomes
CO01	Evaluate the correctness and analyze complexity of algorithms.
CO02	Understand and implement various algorithmic design techniques and solve classical problems.
CO03	Design solutions for real world problems by identifying, applying and implementing appropriate design techniques..
CO04	Design solutions for real world problem by mapping to classical problems.
CO05	Analyze the impact of various implementation choices on the algorithm complexity .

Answer all questions

1) Answer the following questions related to the Huffman Tree given in the figure



   A. Identify the characters which occur more frequently.
   B. Find the average Code Length.
   C. Decode 0100110001000011101011O using the code generated by the given tree. How is it ensured that no bit-sequence encoding of a character is the prefix of the bit-sequence encoding of any other character?
   D. What is the running time of the Huffman encoding algorithm if we maintain the trees in a priority queue and if the priority queue is done using linked lists? Give justification. [4 Marks] [CO01] [BTL Level 2]

2) There are 'n' Rotis to be cooked on a small Tawa that can hold only two rotis at a time. Each roti has to be cooked on both sides; frying one side of a roti takes 1 minute, regardless of whether one or two roti are cooked simultaneously. Consider the following recursive algorithm for executing this task in the minimum amount of time. If $n \leq 2$, cook the roti or the two Roti on each side. If $n > 2$, fry any two roti together on each side and then apply the same procedure recursively to the remaining $(n - 2)$ Rotis. [4 Marks][CO03] [BTL 3]

   A. Set up and solve the recurrence for the amount of time this algorithm needs to fry n roti. Briefly explain whether this algorithm can fry the roti in the minimum time for n>0.

   B. Solve the following Recurrence relation

      1. $T(n)= 2\ T(n/4) + squareroot(n) + 42$
      2. $T(n)= 3\ T(n/2) + 3/4n + 1$

3) Given an integer array with n elements on which the following function is applied where the value of variable left is index 0 and value of right is n - 1 and k < n. [5 Marks][CO02][BTL Level 2]

   a. For an *n*-element Array *A*, the call FiFa(a,0,n-1,k) What is returned by the function? Explain your answer.

   b. Write the best-case and worst-case recurrence relation for the given pseudocode and find the time complexity of the code.

```
int FiFa(Integer Array A, int left, int right, int k)
   {
       int pivot = Partition(A,left,right)
        if (pivot == k)
                  return a[k];
       else if (k < pivot)
                  return FiFa(a, left, pivot-1, k);
       else
                  return FiFa(a,pivot+1, right, k);
   }
```

4) A chess rook can move horizontally or vertically to any square in the same row or the same column of a chessboard. Find the number of shortest paths by which a rook can move from one corner of a chessboard to the diagonally opposite corner. The length of a path is measured by the number of squares it passes through, including the first and the last squares.

   A. Establish a recurrence relation for the above problem. [5 Marks] [CO02] [BTL Level 3]

   B. Solve the problem by a dynamic programming algorithm. Briefly explain your algorithm.

5) In an Insurance company, 'n' employees market their several products to customers. The company decides to find the most popular product; the most popular product is the one which got sold out maximum. Given an array of elements $p_1, p_2, \ldots p_n$, each element represents the product ID sold by its employees. Use the divide and conquer approach to find the popular product.

   A. Define the subproblem of your divide and conquer algorithm.

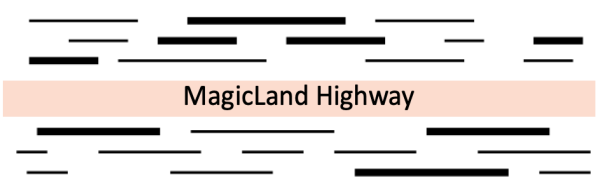
   B. Describe an algorithm and analyse the running time of your algorithm.

[8 Marks][CO03][BTL Level 3]

6) In a buffet party, a sequence of 'n' foods is arranged in a dining hall linearly. Each guest has their taste satisfaction value (v_i) for any i^{th} food (which can take a high value if the guest likes the food and can take a low value if the guest dislikes the food). Each guest should select a subset of food that can maximise the satisfaction value. The guest can choose to start with any food and finish with any food, and they cannot skip any food in between or randomly pick food from other intervals. Identify the optimal interval for the guest to maximise the satisfaction value (v_i). [8 Marks][CO04][BTL Level 4]

7) A newly constructed long straight highway in MagicLand, a set of 'm' mobile - phone towers are providing service to the entire stretch. The Mayor of MagicLand understands that there are too many towers in that stretch to maintain; in-order to reduce the maintenance cost, he asked an algorithmic expert to remove as many mobile towers as possible without sacrificing the requirement that the entire highway must still be covered. The bold lines represent a set of towers chosen that can serve the whole stretch of the highway. [8 Marks][CO04][BTL Level 3]

The range of the tower is defined as an interval $[Sr_i, Er_i]$ with $Sr_i < Er_i$ (Sr_i and Er_i represent Starting and Ending range of i^{th} tower). The highway stretches from $L = min_i(Sr_i)$ to $R = max_i(Er_i)$. An algorithmic expert has to find a minimum set of intervals whose union is the entire interval [L, R].



A. Provide an efficient greedy algorithm to solve this problem.

B. Comment on the following greedy choice strategies: Longest first, Maximum overlap first, Minimum overlap first.

8) You are in a dance competition. There are 'n' songs you are given, and for each song, you have a score s_i you can obtain if you dance to it. However, if you dance for the k^{th} song, you cannot dance for the next k song in 'n'. You cannot go back to a song that you had to skip. You must decide on a subset of songs to choose to maximise your chances of winning. [8 Marks][CO05][BTL Level 4]

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CO	Marks	BTL	Marks
CO01	**4**	BTL 1	
CO02	**10**	BTL 2	**9**
CO03	**12**	BTL 3	**25**
CO04	**16**	BTL 4	**16**
CO05	**8**	BTL 5	
CO06		BTL 6	