

Final

Data Structures and Algorithms, DatZ3168-EN

Wednesday, May 17, 2023

You must justify all your answers to get full credit

The time limit is 3 hours. It is allowed to have a A4 page with your own reference material. It has to be handed in along with your exam.

1. **Dictionary (5 points).** Explain the concept of *Dictionary* abstract data type. Describe different sensible ways to implement dictionaries. Compare advantages and disadvantages for each implementation – for criteria such as time and space complexity, ease of implementation, adaptability and adding extra features to the original ADT, real-time performance on certain architectures.
2. **Raising to a Power (5 points).** Show the design strategies (paradigms) that can be used to raise a number X to a power n and to return X^n . For each strategy write its pseudocode or verbal description. For each algorithm estimate the number of multiplication operations in terms of n . The number of multiplications can be given by an exact formula $f(n)$ (or with an asymptotic bound $\Theta(g(n))$).
3. **Catching an Elephant (5 points).** Describe the common structure of *Transform and Conquer* method, provide several variants for it and explain them with examples from the lectures or your own examples. Additionally, show how this method can be used to find the most frequent word in the text of an electronic book.
4. **Improving Quicksort (5 points).** Show several ways to improve the basic QuickSort algorithm in order to accelerate it. Explain why the time complexity can be improved. The starting point is the algorithm given below:

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QUICKSORT( $A[\ell \dots r]$ ):
1.   if  $\ell < r$ :
2.        $i = \ell$            (i increases from the left, searches elements  $\geq$  than pivot)
3.        $j = r+1$          (j decreases from the right, searches elements  $\leq$  than pivot.)
4.        $v = A[\ell]$        (v is the pivot.)
5.       while  $i < j$ :
6.            $i = i + 1$ 
7.           while  $i < r$  and  $A[i] < v$ :
8.                $i = i + 1$ 
9.            $j = j - 1$ 
10.          while  $j > \ell$  and  $A[j] > v$ :
11.               $j = j - 1$ 
12.           $A[i] \leftrightarrow A[j]$ 
13.           $A[i] \leftrightarrow A[j]$    (Undo the extra swap at the end)
14.           $A[j] \leftrightarrow A[\ell]$  (Move pivot to its proper place)
15.          QUICKSORT( $A[\ell \dots j - 1]$ )
16.          QUICKSORT( $A[j + 1 \dots r]$ )
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