

Midterm Exam

Instructor: Fatima Abu Salem

Name:

Duration: 75 minutes

Question 1 (15%)

True or false? Justify your answer either way: Let $f(n) = (\log n)^{\log n}$ and $g(n) = n/\log n$. Then $f(n) = O(g(n))$. *Hint: Use a change of variable $m = \log n$.*

Question 2 (15%)

We have seen in class that the recurrence tree method for $T(n) = 3T(n/4) + n^2$ yields a guess given by $T(n) = O(n^2)$. Use the substitution method to prove this guess.

Question 3 (15%)

Why does Bucket Sort use an array of lists to process the buckets, rather than, say, a 2D array or a list of lists? Justify your answer against those two choices.

Question 4 (15%)

State and prove a loop invariant for Build-Max-Heap.

Question 5 (40%)

In this exercise we wish to develop a divide and conquer algorithm to solve merge. Given two sorted lists L and R , we wish to produce $A = L \cup R$ such that A is sorted. The idea is to divide both L and R into L_1 and L_2 , say, R_1 and R_2 , and then recursively merge L_1 with R_1 into A_1 , and L_2 with R_2 into A_2 , and finally to concatenate A_1 and A_2 into A .

- (a) (10%) Use select to find a reasonable element s_l to split L . What would such a splitter be?
- (b) (10%) Use binary search to find an element s_r to split R in such a way that $R_1 \leq L_1$. What would that splitter be?
- (c) (10%) How can you now implement the strategy of recursive merge? Develop the full pseudo-code.
- (d) (10%) Which aspects of the pseudo-code are parallelizable?

Answer Sheet 1

Answer Sheet 2

Answer Sheet 3

Answer Sheet 4

Answer Sheet 5

Answer Sheet 6

Answer Sheet 7

Answer Sheet 8

Answer Sheet 9

Answer Sheet 10