CS231 Algorithms
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Wellesley College

Handout # 3
September 11, 2001

Problem Set 1
Due: Friday, September 21

Reading: Carefully read *CLRS* Chapters 1–3 and Sections 4.1 & 4.2. Skim Appendices A & B. (*CLR*: read Chapters 1 & 2 and Sections 4.1 & 4.2, and skim Chapter 3 and Sections 5.1–5.3.)

Sugggested Problems: *CLRS* 1.2-3, 1-1, 2.3-6, 2-4 (*CLR* 1.3-6, 1.4-2, 1-1, 1-3) (These are problems from the book that you should think about, but you should not write them up or turn them in! At least one suggested problem will be on each exam. Some suggested problems will be easy while others will be quite challenging!)

Required Problems: You should write up and turn in the solutions to the problems listed below: The points awarded per problem are given in brackets.

Problem 1 [15] *CLRS* Problem 3-2 (p. 58) (*CLR* 2-2, p. 38).

Problem 2 [25] Do *CLRS* Problem 3-3, part a, (p. 58) (*CLR* 2-3, p. 38–39), but for the following 24 functions (not the 30 given in the text):

n^n	$\lg n$	$(\sqrt{2})^{\lg n}$	n^2	$n!$	n^3
$\lg^2 n$	$2^{(2^n)}$	$\ln(\ln n)$	1	$2^{\lg n}$	$4^{\lg n}$
$(n+1)!$	$\sqrt{\ln n}$	n	2^n	$n \cdot \lg n$	$2^{(2^{n+1})}$
$\frac{1}{n}$	2^{n+1}	$\sqrt{n}$	3^n	$\ln n$	$n \cdot 2^n$

Problem 3 [10]

a. **[5]** Suppose algorithm A has worst-case running time $O(n)$ and algorithm B has running time $O(n^2)$. What can you say about the relative performance of the algorithms?

b. **[5]** Repeat part a for worst-case running times $\Theta(n)$ and $\Theta(n^2)$.

Problem 4 [10] The *natural numbers* $\mathbb{N}$ are the the non-negative integers: $\mathbb{N} = \{0, 1, 2, \dots\}$. Let a *natural number function* be a function from $\mathbb{N}$ to $\mathbb{N}$ – i.e., a that takes a natural number as an input and returns a natural number as an output.

Find two natural number functions $f(n)$ and $g(n)$ such that $f(n)$ is not $O(g(n))$ and $g(n)$ is not $O(f(n))$.

Problem 5 [40] Use the recursion tree method to solve the following recurrences. In all cases, you may assume that $T(n) = 0$ for $n < 1$. Express your solutions in Θ notation. Show your work. (Note that parts d through g generalize examples discussed in class.)

a. $T(n) = 3T(n/3) + 1$

b. $T(n) = 3T(n/3) + n$

c. $T(n) = 4T(n/2) + n$

d. $T(n) = T(n-k) + 1, k > 0$

e. $T(n) = T(n-k) + n, k > 0$

f. $T(n) = T(a \cdot n) + 1, 0 < a < 1$

g. $T(n) = T(a \cdot n) + n, 0 < a < 1$

h. $T(n) = T(a \cdot n) + T(b \cdot n) + n, 0 < (a+b) < 1$

Extra Credit 1 [20]: *CLRS* Exercise 2.3-7 (*CLR* 1.3-7).

Problem Set Header Page
Please make this the first page of your hardcopy submission.

CS231 Problem Set 1
Due Friday, September 21

Name:

Date & Time Submitted:

Collaborators (*anyone you worked with on the problem set*):

In the **Time** *column, please estimate the time you spend on the parts of this problem set. Please try to be as accurate as possible; this information will help me design future problem sets. I will fill out the* **Score** *column when grading your problem set.*

Part	**Time**	**Score**
General Reading		
Problem 1 [15]		
Problem 2 [25]		
Problem 3 [10]		
Problem 4 [10]		
Problem 5 [40]		
Extra Credit 1 [20]		
Total		