Lab01-Algorithm Analysis

CS214-Algorithm and Complexity, Xiaofeng Gao, Spring 2021.

∗ If there is any problem, please contact TA Haolin Zhou. Also please use English in homework.

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1. *Complexity Analysis.* Please analyze the time and space complexity of Alg. 1 and Alg. 2.

Algorithm 1: QuickSort

Input: An array $A[1, \cdots, n]$
Output: $A[1, \cdots, n]$ sorted nondecreasingly

```
pivot ← A[n]; i ← 1;
for j ← 1 to n − 1 do
    if A[j] < pivot then
        swap A[i] and A[j];
        i ← i + 1;
swap A[i] and A[n];
if i > 1 then
    QuickSort(A[1, ··· , i − 1]);
if i < n then
    QuickSort(A[i + 1, ··· , n]);
```

Algorithm 2: CocktailSort

Input: An array $A[1, \cdots, n]$
Output: $A[1, \cdots, n]$ sorted nonincreasingly

```
i ← 1; j ← n;sorted ← false;
while not sorted do
    sorted ← true;
    for k ← i to j − 1 do
        if A[k] < A[k + 1] then
            swap A[k] and A[k + 1];
            sorted ← false;
    j ← j − 1;
    for k ← j downto i + 1 do
        if A[k − 1] < A[k] then
            swap A[k − 1] and A[k];
            sorted ← false;
    i ← i + 1;
```

(a) Fill in the blanks and **explain** your answers. You need to answer when the best case and the worst case happen.

Algorithm	Time Complexity[1]	Space Complexity
QuickSort		
CocktailSort		

[1] The response order can be given in *best*, *average*, and *worst*.

(b) For Alg. 1, how to modify the algorithm to achieve the same expected performance as the **average** case when the **worst** case happens?

2. *Growth Analysis.* Rank the following functions by order of growth with brief explanations: that is, find an arrangement $g_1, g_2, \ldots, g_{15}$ of the functions $g_1 = \Omega(g_2), g_2 = \Omega(g_3), \ldots, g_{14} = \Omega(g_{15})$. Partition your list into equivalence classes such that functions $f(n)$ and $g(n)$ are in the same class if and only if $f(n) = \Theta(g(n))$. Use symbols "=" and "$\prec$" to order these functions appropriately. Here $\log n$ stands for $\ln n$.

1	n	$\log n$	$\log(\log n)$	$n \log n$
$\log_4 n$	2^n	4^n	$2^{\log n}$	2^{2^n}
$\log(n!)$	$n!$	$(2n)!$	$n^{1/2}$	n^2

Remark: You need to include your .pdf and .tex files in your uploaded .rar or .zip file.