Design and Analysis of Computer Algorithms
Homework 1

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Homework Exercises: Problems 9.3-7, 9.3-8

1. (Exercise 9.3-7)

Algorithm

(1) Find the median of set S with $SELECT$ algorithm $\Rightarrow O(n)$

(2) Calculate the distances $Distance$ (i.e., $abs(S[i] - median)$)$\Rightarrow O(n)$

(3) Find the K^{th} small element d_k in $Distance$ $\Rightarrow O(n)$

(4) Traverse $Distance$, find elements that is smaller than d_k $\Rightarrow O(n)$

Time Complexity: $O(n)$

Algorithm 1 **SELECT-K(S, k)**

```
1: if (n == k) then
2:    return S
3: end if
4: median = SELECT(S, 1, n, n/2)
5: Distance = [], Result = []
6: for (i = 1 to n) do
7:    Distance[i] = abs(S[i] − median)
8: end for
9: d_k = SELECT(Distance, 1, n, k)
10: for (i = 1 to n) do
11:    if (Distance[i] ≤ d_k) then
12:       Result[i] = S[i]
13:    end if
14: end for
15: return Result
```

2. (Exercise 9.3-8) Suppose that X and Y are in increasing order. The algorithm used a various of binary search which can be generalized to find the kth element in two sorted arrays.

Algorithm

(1) Get the two median mx and my from X and Y. Since X, Y are sorted, it costs $O(1)$.

(2) If $mx == my$, then return mx.

(3) If $mx > my$, then then median is present in one of the below two subarrays.

a. From first element of X to mx (X[0...n/2])

b. From my to the last of Y (Y[n/2...n])

(4) If $my > mx$, then the median is present in one of the below two subarrays.

a. From mx to the last of X (X[n/2...n])

b. From first element to my (Y[0...n/2])

Time Complexity: O(lg(n))

Algorithm 2 **MEDIAN**$(X, x_1, x_2, Y, y_1, y_2)$

$mx = X[(x_1 + x_2)/2]$
$my = Y[(y_1 + y_2)/2]$
if $(mx == my)$ **then**
    return mx
end if
if $(mx < my)$ **then**
    return $MEDIAN(X, (x_1 + x_2)/2 + 1, x2, Y, y_1, (y_1 + y_2)/2 + 1)$
else
    return $MEDIAN(X, x_1, (x_1 + x_2)/2, Y, (y_1 + y_2)/2 + 1, y_2)$
end if