ECE 2400 Computer Systems Programming, Fall 2021
Quiz 4 – Complexity Analysis

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This is a take-home open-book, open-notes quiz. You may use a calculator if you wish. You may not talk to other students about the quiz. Please ask the instructor via Ed if you need clarification. The quiz should accurately reflect your knowledge of the material. When you are finished, please bring a hard copy of your solution to lecture on Friday, October 15th.

Problem 1. Finding k-th Largest Value in an Array of Integers

Consider the following function which takes as input three parameters: x is an array of integers, n is the number of elements in the array, and k indicates which element to return. If k is 1 then the function should return the largest element, if k is 2 then the function should return the second largest element, if k is 3 then the function should return the third largest element, and so on. *Note: This function assumes that the input array only contains positive elements, and it actually modifies the input array during its execution.* **What is the time complexity of this algorithm as a function of N (where N is n)? Use asymptotic big-O notation. Use the six-step process described in lecture for complexity analysis to justify your answer. Explicitly list each step.** *Hint: We suggest choosing N as your input variable, and your generalized equation for execution time should involve both K and N.*

```
1  int find_kth_largest( int* x, size_t n, int k )
2  {
3    int max_idx   = 0;
4    int max_value = -1;
5    for ( int i = 0; i < k; i++ ) {
6
7      // reset max idx and value
8      max_idx   = 0;
9      max_value = -1;
10
11     // find max idx and value in x
12     for ( int j = 0; j < n; j++ ) {
13       if ( x[j] > max_value ) {
14         max_idx   = j;
15         max_value = x[j];
16       }
17     }
18
19     // set max value to -1 so it
20     // is no longer the max
21     x[max_idx] = -1;
22   }
23   return max_value;
24 }
```

Problem 2. Finding the Median Value in an Array of Integers

Consider the following function which takes as input two parameters: x is an array of integers, and n is the number of elements in the array. The function returns the median value of the array of integers. The function uses the find_kth_largest function from the previous problem. **What is the time complexity of this algorithm as a function of N (where N is n)? Use asymptotic big-O notation. Justify your answer.** While we encourage you to think through the six-step process described in lecture, you are not required to explicitly show each step. A simpler high-level argument will probably be sufficient.

```
1 int find_median( int* x, size_t n )
2 {
3   return find_kth_largest( x, n, n/2 );
4 }
```