Algorithms Independent Study - Midterm Exam

Marshall University

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1. For each of the following pseudocode fragments, estimate the running time as a function of the input n.

(a)
```
int function_a(int n) {
    int total = 0;
    for (int i = 0; i < n; i++ ) {
      for ( int j = i; j < i + 3; j ++ ) {
        total = total + j*j;
      }
    }
    return total;
}
```

(b)
```
int function_b(int n) {
    int total = 0;
    for (int i = 0; i < n; i++ ) {
       int m = n/2;
       total = total + g(m); // g is O(n)
    }
    return total;
}
```

2. Suppose that a priority queue is implemented with a vector in C++. The array is kept with the smallest element at the far end, which is the first element of the queue. In other words, the vector is sorted in the opposite direction of the queue. The vector is always kept in sorted order. To perform an insertion, a binary search is used to find the location, and then the elements past that location are shifted to the right to make space for the new element.

(a) What will be the efficiency of insertion in this implementation?

(b) What will be the efficiency to access the smallest element of the queue?

(c) What will be the efficiency to pop an element from the queue?

3. Problem 12 on pages 193–194 of the textbook, parts (a) and (b).

4. Write C++ code for a dynamic algorithm the does the following: given a vector A of non-negative integers and a non-negative integer m, print the number of subsequences of A that have a product less m. For example, if $A = [1, 2, 3, 4]$ and $m = 10$, the output is 11, and the subsequences are:

$$[1], [2], [3], [4],$$
$$[1, 2], [1, 3], [1, 4], [2, 3], [2, 4],$$
$$[1, 2, 3], [1, 2, 4].$$

If $A = [1, 2, 3, 4, 5]$ and $m = 25$, the output is 23.