Data Structures in Java - Homework 1

Problem 1

2.1 Order the following functions by growth rate: N, $\sqrt{N}$, $N^{1.5}$, N^2, $N \log N$, $N \log \log N$, $N \log^2 N$, $N \log(N^2)$, $2/N$, 2^N, $2^{N/2}$, 37, $N^2 \log N$, N^3. Indicate which functions grow at the same rate.

Answer: $2/N < 37 < \sqrt{N} < N < NloglogN < NlogN = Nlog(N^2) < Nlog^2N < N^{1.5} < N^2 < N^2logN < N^3 < 2^{N/2} < 2^N$

Problem 2

2.6 In a recent court case, a judge cited a city for contempt and ordered a fine of \$2 for the first day. Each subsequent day, until the city followed the judge's order, the fine was squared (that is, the fine progressed as follows: \$2, \$4, \$16, \$256, \$65,536, ...).

a. What would be the fine on day N?

b. How many days would it take the fine to reach D dollars? (A Big-Oh answer will do.)

a) **Answer:** $\$2^{2^N}$

b) **Answer:** $O(loglogD)$

Problem 3

a) **Answer:** $O(N)$

b) **Answer:** $O(N)$

c) **Answer:** $O(logN)$

d) **Answer:** $O(N^3)$

Problem 4

2.10 Determine, for the typical algorithms that you use to perform calculations by hand, the running time to do the following:

a. Add two N-digit integers.

b. Multiply two N-digit integers.

c. Divide two N-digit integers.

a) **Answer:** $O(N)$

b) **Answer:** $O(N^2)$

c) **Answer:** $O(N^2)$

Problem 5

2.15 Give an efficient algorithm to determine if there exists an integer i such that $A_i = i$ in an array of integers $A_1 < A_2 < A_3 < \cdots < A_N$. What is the running time of your algorithm?

Answer: Binary Search - $O(logN)$:

```
public static <E extends Comparable<E>>
int BinarySearch(E[] a, E value) {

    int start = 0;
    int stop = a.length - 1;

    while (start<=stop) {
        int mid = (start+stop)/2;

        int compareResult = a[mid].compareTo(value);
        if(compareResult == 0) {
            return mid;
        } else if (compareResult > 0) {
            stop = mid - 1;
        } else {
            start = mid + 1;
        }
    }

    return -1;

}
```