CS 420 Programming Assignment I : Analysis of Algorithms

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In this project you are given two unidentified algorithms written in pseudocode[1]. Each algorithm takes as input an array of integers. For each algorithm you will:

1. Implement the algorithm in Java. (Of course, to convince yourself that your implementation is correct, you will probably have to figure out what the algorithm is actually supposed to be doing!)

2. Add some instrumentation to (approximately) count the number of basic operations executed by the algorithm. Plot these results in excel for inputs of various sizes. What do you think the asymptotic running time of each algorithm is?

[1]The code follows the book's convention of starting arrays at index one. The easiest way to handle this in your Java implementation is to just ignore $A[0]$ and let N be $A.length - 1$, so the input to the algorithm is $A[1 \cdots N]$

Algorithm 1

```
1  j = 1
2  B = new int[N]
3  while j ≤ N − 1
4        i = 1
5        while i ≤ N − j
6              m = i + j − 1
7              r = min(m + j, N)
8              for u = i to r
9                    B[u] = A[u]
10             u = i
11             v = m + 1
12             for w = i to r
13                   if (u > m) or (v ≤ r and B[v] < B[u])
14                         A[w] = B[v]
15                         v = v + 1
16                   else
17                         A[w] = B[u]
18                         u = u + 1
19             i = i + 2j
20       j = 2j
```

To run this algorithm on input array A, call COMPUTE$(A, [0, 0, \cdots], 1)$ where the second argument is an array of all zeros the same size as A (in other words, array A is the real input to the algorithm; B is just an extra variable to keep track of some things as we go along). For your Java implementation, when you print you probably want to have some space between the values and a newline at the end of the array. For counting operations, assume that PRINT is another basic operation that takes constant time.

Algorithm 2

```
COMPUTE(A, B, i)
  if i > N then
    for j = 1 to N do
      if B[j] > 0 then
        PRINT B[j]
      end if
    end for
    return
  end if
  B[i] = 0
  COMPUTE(A, B, i + 1)
  B[i] = A[i]
  COMPUTE(A, B, i + 1)
  B[i] = 0
```