

Algorithms in C++: Assignment 5

1. Objective

Your goal is to write a program that will enable you to make use of MergeSort to solve a seemingly unrelated problem. [This is a common interview question!]

2. Problem

You have been asked to find the number of inversions in an array. An inversion is when a larger number appears before a smaller number. In the follow example, there are 3 inversions.

```
[3, 2, 1]
1) 3 before 2
2) 3 before 1
3) 2 before 1
```

You need to write two different algorithms to solve this problem. One is “slow”: it is the naïve approach using two nested loops. The other, fast approach uses a modified MergeSort that counts the number of inversions and returns that count. Your program will always run the fast algorithm by default unless the user explicitly specifies “slow” as the (only) command-line argument.

Here are some examples of how the program should run:

```
$ ./inversioncounter
Enter sequence of integers, each followed by a space: x 1 2 3
Error: Non-integer value 'x' received at index 0.

$ ./inversioncounter
Enter sequence of integers, each followed by a space: <some spaces>
Error: Sequence of integers not received.

$ ./inversioncounter slow
Enter sequence of integers, each followed by a space: 1 1 1 1
Number of inversions (slow): 0

$ ./inversioncounter
Enter sequence of integers, each followed by a space: 3 1 0 1 2 9
Number of inversions (fast): 5
```

3. Advice

Use the template file provided. We store the input in a vector, since we don’t know how many values the user will enter. You can easily pass the internal array of the vector to the function with `&values[0]`.

Make sure you test your program on large inputs, with up to 100,000 numbers. You are allowed up to 8 seconds on the Ubuntu virtual machine for the “slow” version and up to 1 second for the fast version. Your code should have no trouble meeting these timing requirements.

Important: Change the `-g` in the makefile to be `-O3` (that’s a capital O) when you are ready to test your code for speed. This flag tells the compiler to optimize the code it generates, which will enable you to meet the time constraints imposed by the test script.