CS3230 PA1

Due: 12 October 2359

1 Problem statement

You are given $2n$ distinct integers, $a_1, a_2, a_3, \ldots, a_n$, $b_1, b_2, \ldots, b_n$ from 1 to $2n$ (inclusive).

You are required to insert elements of b into the array a. Let c be the resulting array of size $2n$ after the insertion. For example, if $a = [5, 4, 1, 2]$ and $b = [8, 3, 6, 7]$, a possible way to insert elements of b into a is $c = [5, 4, \underline{3}, \underline{6}, \underline{8}, 1, \underline{7}, 2]$ (elements of b are underlined).

Note that the relative order of elements from array a must be preserved (i.e. if 5 comes before 4 in array a, then 5 must appear before 4 in array c. Among all possible insertion sequences, what is the minimum possible number of inversions c can have?

2 Input and output format

2.1 Input

The input consists of three lines. The first line of the input will contain a single integer n. The second line of the input will contain n space separated integers a_1 a_2 a_3 $\ldots$ a_n. The third line of the input will contain n space separated integers b_1 b_2 b_3 $\ldots$ b_n.

2.2 Output

Output a single integer, containing the minimum possible number of inversions c can have.

3 Sample input and output

Sample input

```
4
5 4 1 2
8 3 6 7
```

Sample output

```
7
```

Explanation for sample: among all possible ways to insert b into a, the minimum number of inversions is minimized when $c = [3, 5, 4, 1, 2, 6, 7, 8]$.

4 Grading

This assignment is worth 4 points. Solutions which run in $\mathcal{O}(n^2)$ time will score 1 point, while solutions which run in $\mathcal{O}(n \log n)$ time will score full 4 points. For the task labelled partial:

- $n \leq 10^4$

- 1 mark is awarded for solutions in $\mathcal{O}(n^2)$

For the task labelled full:

- $n \leq 10^6$

- 4 marks is awarded for solutions in $\mathcal{O}(n \log n)$

Submit a program that solves this problem in either C++ or Java. Submissions should be done on CodeCrunch. Your program should terminate in 10 seconds for C++, or 20 seconds for Java. For submissions in Java, name your file as `Main.java` (for both full and partial). Templates have been provided in both C++ and Java. You are recommended (but not required) to use the templates.

   Your code will be ran against a separate set of test cases after the deadline, and will be judged purely for producing the correct output. No proof of correctness is required (although you should try to convince yourself that your code words). You will not be graded on programming style but the teaching team may ask you to explain your code if we see something suspicious.

   You are reminded that plagiarism is an offence – you are free to discuss problem ideas with your friends but sharing of code (which includes asking your friends to debug code for you) is not allowed.

5 FAQ

1. What if my algorithm meets the required time complexity but does not pass the test cases?

   This is unlikely as the time limits are loose. However, if you strongly believe that your algorithm meets the required time complexity, you may discuss your solution with the teaching team and we will judge you accordingly. We may ask you to provide a proof of correctness and/or runtime if this is the case.

2. I pass the test cases for partial but I'm getting wrong output for full. Why is this so?

   This is likely due to integer overflow. Make sure to use the appropriate 64-bit data types (`long` in Java, `int64_t` or `long long` in C++) to prevent integer overflows.

3. Programs in Java tend to run slower than equivalent programs in C++. Will I be disadvantaged for using Java?

   Firstly, we have calibrated the time limits for C++ and Java accordingly, and allocated more time for Java programs to run. Secondly, if you strongly believe that your program should pass but it does not, you may discuss this with the teaching team (see above).

   For any other questions, post on Canvas forum or email me at `lingyh@nus.edu.sg`.