Bonus: CS3230 PA2 - Hashing (2%)

Due: 11 November 2359

1 Problem statement

You are given an array of n integers $a_1, a_2, \ldots, a_n$. An interval $[i, j]$ $(i < j)$ is balanced iff, among $a_i, a_{i+1}, \ldots, a_j$, every integer appears an even (possibly zero) number of times.

For example, if $a = [3, 3, 1, 2, 2, 1]$, the balanced intervals are $[1, 2], [3, 6], [4, 5], [1, 6]$ corresponding to the contiguous subarrays $[3, 3], [1, 2, 2, 1], [2, 2], [3, 3, 1, 2, 2, 1]$.

If $a = [1, 2, 3, 2, 1]$, then there are no balanced intervals.

2 Input and output format

2.1 Input

Input consists of two lines. The first line contains a single integer n, denoting the size of the array a. The second line contains n integers $a_1, a_2, \ldots, a_n$.

2.2 Output

Output a single integer, the number of balanced intervals, followed by a newline character.

3 Sample input and output

Sample input 1

```
6
3 3 1 2 2 1
```

Sample output 1

```
4
```

Sample input 2

```
5
1 2 3 2 1
```

Sample output 2

```
0
```

Sample input 3

```
7
2 2 2 2 2 2 2
```

Sample output 3

```
12
```

4 Grading

This assignment is worth 2 points. Solutions which run in $\mathcal{O}(n \log n)$ time will score 2 points. There is no partial mark for this assignment.

Your code will be run against test cases which satisfy the following constraints:

- $2 \leq n \leq 10^6$
- $0 \leq a_i \leq n - 1$

Submit a program that solves this problem in either C++ or Java. Submissions should be done on CodeCrunch. Your program should terminate in 3 seconds for C++, or 6 seconds for Java. For submissions in Java, name your file as `Main.java`. 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 works). 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 Hints

Hashing. Yes, use hashing. When done correctly, you should have a small failure probability (my solution has an error probability of 10^{-6} per test case). In cases of disputes where you believe that your algorithm works correctly but you were just 'unlucky', I will run your code against the test case 5 times and take the majority answer.

6 Notes on random numbers

For C++ users, do not use rand() to generate your random numbers. Use library functions such as `https://en.cppreference.com/w/cpp/numeric/random/uniform_int_distribution` and `https://en.cppreference.com/w/cpp/numeric/random/bernoulli_distribution` etc.

For Java users, use the Random class `https://docs.oracle.com/javase/8/docs/api/java/util/Random.html`.