New Year Chaos ☆

Editorial by rishi_07

Consider an example for n = 5. Initially, the array was A: [1, 2, 3, 4, 5].
After some number of bribes the array became A: [1, 5, 4, 2, 3].

The 5^{th} person moved from their initial position to the 2^{nd} position. For that, they must have bribed 3 people, labeled $2, 3$ and 4. Also, the 4^{th} person moved from their initial position to 3^{rd} position by bribing persons 2 and 3.

The transformation goes like this:
[1, 2, 3, 4, 5] -> [1, 2, 3, 5, 4] -> [1, 2, 5, 3, 4] -> [1, 5, 2, 3, 4] -> [1, 5, 2, 4, 3] -> [1, 5, 4, 2, 3]

Observation:

The number of people the i^{th} person (for $1 \leq i \leq n$) has bribed is equal to the number of people on the right of that person with a value less than A_i (where array A represents the given array or final state of the people).

To get to the current position, each person has to bribe all the people who are behind them and have a smaller number. This is the same as counting inversions of an array.
So, if that number is greater than 2 for any index i we print Too chaotic. Otherwise, we print the total sum of bribes.

Brute Force Approach:

Run two loops, and for every integer i, find the number of j's such that $A_i > A_j$, where $1 \leq i \leq n$ and $i < j \leq n$.
Time complexity: $O(n^2)$, but we can do better.

Optimised (Linear Time) Approach:

We start from the end of the array A. If A_i is not equal to i, where $1 \leq i \leq n$, then we know that the last element must have bribed and moved towards the left since it cannot move to the right being the last element. Also, we know that it will be present either in position $i-1$ or $i-2$. This is because if it is in the position left to $i-2$, he must have bribed more than 2 people. In that case, we just print Too chaotic and terminate our program. Else if A_i is equal to A_{i-1} just swap the two elements and increment the counter by 1. Else shift A_{i-1} to A_{i-2}, A_i to A_{i-1} and put A_i equal to i and increment the counter by 2. Repeat the process until we reach the start of the array.

Note: For the answer to be a valid count, our condition that if A_i is not equal to i, it will be present either in position $i-1$ or $i-2$ holds for all the elements because at every step we reorganize the array and make A_i equal to i for $1 \leq i \leq n$. So, if we are at index i, we are sure that A_j is equal to j for $i < j \leq n$.

Time complexity: $O(n)$.

Please check the code below for more clarity:

C++

```
void minimumBribes(vector<int> A)
{
    int n = A.size();
    int cnt = 0;
    for(int i = n - 1; i >= 0; i--)
    {
        if(A[i] != (i + 1))
        {
            if(((i - 1) >= 0) && A[i - 1] == (i + 1))
            {
                cnt++;
                swap(A[i], A[i-1]);
            }
            else if(((i - 2) >= 0) && A[i - 2] == (i + 1))
            {
                cnt += 2;
                A[i - 2] = A[i - 1];
                A[i - 1] = A[i];
                A[i] = i + 1;
            }
            else
            {
                printf("Too chaotic\n");
```

STATISTICS

Difficulty:	Medium
Time Complexity:	O(n)
Required Knowledge:	Inversions
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```
                return;
            }
        }
    }
    printf("%d\n",cnt);
    return;
}
```

s Set by Shafaet_Ashraf

Problem Setter's code:

Python 2

```
t = int(raw_input())

for _ in range(t):
    n = int(raw_input())
    arr = map(int, raw_input().split())
    org = range(n+1)
    pos = range(n+1)
    cnt = [0]*(n + 1)
    ans = 0
    invalid = 0

    for i in xrange(n - 1, -1, -1):

            if invalid:
                break

            # Get position where arr[i] should have been if no one bribed after this point

            oldp = pos[arr[i]]

            # Get the position where arr[i] currently is.

            newp = i + 1

            # oldp != newp indicates that even after this point, bribes took place
            # counting the number of furthter bribes that took place to bring arr[i] to i

            while oldp != newp:

                ans = ans + 1

                # arr[i] is at the right of org[oldp + 1] in the given array
                # that means org[oldp + 1] bribed arr[i] at some point
                # so increasing its count by 1

                cnt[org[oldp + 1]] += 1


                if cnt[org[oldp + 1]] > 2:
                    invalid = 1
                    break

                # updating the original array to match the array after this bribe took place

                org[oldp], org[oldp+1] = org[oldp+1], org[oldp]


                # update the positions also due to the change
                # caused by bribe that took place so far

                pos[org[oldp]] = oldp
                pos[org[oldp + 1]] = oldp + 1

                oldp = oldp + 1

    if invalid:
        ans = "Too chaotic"

    print ans
```

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