2025 Canadian Computing Olympiad
Day 2, Problem 1
2025 Canadian Informatics Workshop
Day 2, Problem 3

Restaurant Recommendation Rescue

Time Limit: 2 seconds

Problem Description

A certain aspiring musician K loves going for shabu-shabu! Recently, she's been to N shabu-shabu restaurants, numbered $1, 2, \ldots, N$, following the following algorithm:

1. K keeps an ordered list of recommendations, starting with restaurant 1.
2. On the i-th day, she visits the next recommended restaurant on her list, which recommends her restaurants $R_i = \{r_{i,1}, \ldots, r_{i,\ell_i}\}$.
3. K appends R_i to her list of restaurants to visit.
4. K repeats steps 2-4 until she runs out of recommended restaurants.
5. K writes down the array $A_0, \ldots, A_{N-1}$, where A_i equals the number of restaurants she was recommended on the $(i+1)$-th day. That is, $A_i = |R_{i+1}|$.

It is guaranteed that $\bigcup_{i=1}^{N} R_i = \{2, \ldots, N\}$ and $R_i \cap R_j = \varnothing$ for $i \neq j$, that is, every restaurant, other than the first, will be recommended by exactly one other restaurant.

Once K finishes her list, K's delinquent friend H decides to play a prank on her! She replaces the array $A_0, \ldots, A_{N-1}$ with another array $B_0, \ldots, B_{N-1}$! K thinks that this new array B_i might just be a cyclic shift of her array, so she asks you to determine all possible $0 \leq k < N$ such that $A_i = B_{(i+k) \bmod N}$, for all $0 \leq i < N$ and **any** valid output of her algorithm $A_0, \ldots, A_{N-1}$.

Furthermore, K will then perform Q operations, where for the i-th operation, she swaps B_{x_i}, B_{y_i} and asks you to do the same on the new array. Can you help K see through her friend's prank?

Input Specification

The first line of input will contain two integers, N ($1 \leq N \leq 500\,000$) and Q ($0 \leq Q \leq 300\,000$).

The next line of input will contain N space-separated non-negative integers, $B_0, B_1, \ldots, B_{N-1}$ ($0 \leq B_i < N$), the initial sequence.

The i-th of the next Q lines of input will contain two integers each, x_i and y_i ($0 \leq x_i, y_i < N$ and $x_i \neq y_i$), indicating you are to swap B_{x_i} with B_{y_i}.

The following table shows how the available 25 marks are distributed:

Marks Awarded	**Bounds on N**	**Bounds on Q**
3 marks	$1 \leq N \leq 8$	$Q = 0$
7 marks	$1 \leq N \leq 5\,000$	$Q = 0$
10 marks	$1 \leq N \leq 500\,000$	$Q = 0$
5 marks	$1 \leq N \leq 500\,000$	$0 \leq Q \leq 300\,000$

Output Specification

For each of the $Q + 1$ arrays (including the initial array $B_0, \ldots, B_{N-1}$), let $S = \{k_1, \ldots, k_m\}$ denote the set of integers $0 \leq k_j < N$ such that there exists a valid output $A_0, \ldots, A_{N-1}$ of K's algorithm such that $A_i = B_{(i+k_j) \bmod N}$ for all $0 \leq i < N$. Output, on a single line, the integers m and $\sum_{i=1}^{m} k_i \pmod{998\,244\,353}$, separated by a space.

In particular, if $S = \varnothing$, your output should be `0 0`.

Sample Input

```
5 3
1 2 0 0 1
0 2
1 3
3 2
```

Output for Sample Input

```
1 4
1 1
1 2
1 2
```

Explanation of Output for Sample Input

The array A is $[1, 1, 2, 0, 0]$; it can be shown this is the only valid output of K's algorithm that corresponds to the array $B = [1, 2, 0, 0, 1]$. One input for K's algorithm that yields this array A is:

$$R_1 = \{2\}$$
$$R_2 = \{3\}$$
$$R_3 = \{4, 5\}$$
$$R_4 = \varnothing$$
$$R_5 = \varnothing.$$

After swapping B_0 and B_2, we get the array

$$B = [0, 2, 1, 0, 1].$$

It can be shown the only valid output of K's algorithm that corresponds to this is

$$A = [2, 1, 0, 1, 0].$$

One possible input to K's algorithm that yields this array A is

$$\begin{aligned} R_1 &= \{2, 3\} \\ R_2 &= \{4\} \\ R_3 &= \varnothing \\ R_4 &= \{5\} \\ R_5 &= \varnothing. \end{aligned}$$

Tips for Python (CIW Only) You are recommended to use fast input (for example, `sys.stdin.read()` and `sys.stdout.write()`) if you are attempting the final subtask.