

Problem B

Squares

B. Kordiemski in his book on mathematical puzzles has included the following task:
Let's consider a square of size $N \times N$ ($N \leq 100$). The square is filled with all the integer numbers from 1 to $N \cdot N$ located in it randomly. Each position is described by its coordinates $[r, c]$ where r describes the row number and c is the column number ($r, c \geq 1$). See the following figure:

```
4 6 9
3 8 2   (Fig. 1)
7 1 5
```

You have to place the numbers in the ascending order - the final square should be as follows:

```
1 2 3
4 5 6   (Fig. 2)
7 8 9
```

In order to obtain such a result you can swap 2 positions in a square. For instance you can swap positions $[3, 2]$ and $[1, 1]$ in Fig. 1. After that you will obtain the following square:

```
1 6 9
3 8 2   (Fig. 3)
7 4 5
```

Then, you can swap another pair of positions. Each swapping is a single move. Your goal is to determine the minimal number of moves necessary to obtain the ascending order of numbers for a given square. To avoid the unnecessary moves you should try to invent a kind of swapping strategy (which pairs should be swapped in what order).

Input
The input contains:
◆ N - the number of rows equal to the number of columns
◆ a square - sequence of integer numbers constituting the square

Output
The output should contain the minimal number of moves necessary to obtain the ascending order in a given square.

Suggestion
Let's consider the following square:

```
3 2 5
4 7 8   (Fig. 4)
1 9 6
```

In that case, if you want to obtain the minimal number of swappings, you have to move number 1 from position $[3,1]$ to

[1,1], number 7 from [2,2] to [3,1], number 5 from [1,3] to [2,2] and number 3 from [1,1] to [1,3]. You can do it by the following swappings:

```
swap [3,1 ] and [1, 1];      swap [3, 1] and [2, 2];
swap [2, 2] and [1, 3]
```

Another group of swappings is connected with numbers 6, 8 and 9. You have to move number 6 from [3,3] to [2,3], number 8 from [2,3] to [3,2] and number 9 from [3,2] to [3,3]. You can do it by swappings:

```
swap [2, 3] and [3, 3];      swap [3, 2] and [3,3]
```

(Note that, the numbers 2 and 4 remain untouched as they are at the right positions in the input square).

Making the above 5 swappings gives you (as a result) the ordered square and this is also the minimal number of swappings necessary to get such a square.

EXAMPLE 1

Input

```
3
3 1 5
4 2 8
6 7 9
```

Output

Movements: 5

EXAMPLE 2

Input

```
4
16 15 14 13
12 11 10 9
8 7 6 5
4 3 2 1
```

Output

Movements: 8

Solution

Rozpatrzmy kwadrat:
4 6 9
8 2 1
7 3 5

Minimalna liczba przestawien moze byc osiagnieta gdy bedziemy zamieniali liczby wedlug nastepujacego schematu:

Zapiszmy liczby w ciagu:

| | | | | | | | | | |
|------------|---|---|---|---|---|---|---|---|---|
| liczba | 4 | 6 | 9 | 8 | 2 | 1 | 7 | 3 | 5 |
| numer pola | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

Na pozycji 1 musi byc jedynka. Zamieniamy wiec liczby 4 i 1. W wyniku tego liczba cztery znajdzie sie na pozycji 6:

| | | | | | | | | | |
|------------|---|---|---|---|---|---|---|---|---|
| liczba | 1 | 6 | 9 | 8 | 2 | 4 | 7 | 3 | 5 |
| numer pola | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

Na tej pozycji powinna byc 6, wiec kolejna zamiana bedzie dotyczyła

liczb 4 i 6. Czworka znajdzie sie teraz na pozycji 2:

| | | | | | | | | | | |
|------------|---|---|---|---|---|---|---|---|---|---|
| liczba | | 1 | 4 | 9 | 8 | 2 | 6 | 7 | 3 | 5 |
| numer pola | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |

I tak dalej, az 4 nie znajdzie sie na pozycji 4. Wowczas bierzemy kolejna liczbe, ktora jeszcze nie znalazła sie na swojej pozycji i rozpoczynamy podobny ciag zamian. Kontynuujemy tak dlugo, az wszystkie liczby znajda sie na swoich pozycjach. W naszym przypadku otrzymujemy nastepujacy ciag zamian: (w ogolnosci takich ciagow moze byc kilka)

4 - 1, 4 - 6, 4 - 2, 4 - 5, 4 - 9, 4 - 3, 4 - 8

W sumie: 7 zamian - i to jest nasze rozwiazanie

Zadanie zaczerpnieto z ksiazki:
B. Kordiemski " Rozrywki Matematyczne ", Wiedza Powszechna,
Warszawa 1956, wyd. I
Tests

TEST 1

input 3
 4 6 9
 8 2 1
 7 3 5

output Movements: 7

TEST 2

input 5
 7 24 10 19 3
 12 20 8 22 23
 2 15 25 18 13
 11 21 5 9 16
 17 4 14 1 6

output Movements: 19

TEST 3

input 4
 16 15 14 13
 12 11 10 9
 8 7 6 5
 4 3 2 1

output Movements: 8

TEST 4

input 3
 3 1 5
 4 2 8
 6 7 9

output Movements: 5

TEST 5

input matrix of the size 100 x 100
output Movements: 5943

Listing

```
#include

int N;
int *tab;

int change(int from)
{
    int i,a;

    if (tab[from]==from) return 0;

    for (i=0;i
```

💡 [zwir](#), [wierzej](#),
Mon Oct 28 23:01:26 MET DST 1996