2024 NORTHERN INDIANA HIGH SCHOOL CODING COMPETITION

Round One

Acknowledgement: Some problems used in this competition are modified from **AP Computer Science A Exam Questions,** which are available at https://apcentral.collegeboard.org/courses/ap-computer-science-a/exam/past-exam-questions

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Problem 1. Majic Function

Write a program to implement the following function.

$$F(n) = 3 + \frac{4}{2 \times 3 \times 4} - \frac{4}{4 \times 5 \times 6} + \frac{4}{6 \times 7 \times 8} - \frac{4}{8 \times 9 \times 10} + \cdots + (-1)^{n+1} \frac{4}{2n \times (2n+1) \times (2n+2)}$$

The input to your program is an integer **n** that is greater than or equal to 1. The output is a floating point number with at least 5 decimal points.

Sample input (red color) and output (blue color):

Input: 1
Output: 3.166666

Input: 2
Output: 3.1333333

Input: 3
Output: 3.1452380

Problem 2. Substring Score

Write a program to calculate the score of a substring in a parent text. The input of your program has **two** lines. The first line is a string (less than 100 characters) representing the parent text. The second line is also a string, representing a substring. The score of the substring is returned based on the following formula.

Number of occurrences of the substring in the Parent Text * Square of the length of the Substring

Note: Any character in the Parent Text can only be counted in one occurrence.

Examples to calculate substring score are shown in the following table.

Parent Text	Substring	Occurrences	Length	Score
"I live in Mississippi"	"iss"	2	3	2*3*3 ➔18
"I live in Mississippi"	"I live"	1	6	1*6*6 ➔36
"I live in Mississippi"	"Indiana"	0	7	0*7*7 ➔ 0
"AAA is a company"	"AA"	1	2	1*2*2 ➔ 4

Sample input (red color) and output (blue color):

Input:
I live in Mississippi
Indiana

Output: 0

Input:
I live in Mississippi
i

Output: 6

Input:
I live in Mississippi
issipp

Output: 36

Input:
AAA is a company
AA

Output: 4

Problem 3. Grid Count

You are given a two-dimensional array of numbers. You are asked to count the number of columns in the array that are in increasing order. A column is in increasing order if the element in each row after the first row is greater than or equal to the element in the previous row. A column with only one row is considered to be in increasing order.

The input contains several lines. The first line contains two positive integer numbers **m n**, separated by a space, representing the dimension of the array: **m** rows and **n** columns. Assume that both **m** and **n** are less than 20. The rest of the lines are the array of numbers separated by spaces, each row on its own line.

Sample input (red color) and output (blue color):

Input:

```
1  4
10      9        6       -8
```

Output:

```
4
```

Input:

```
2  4
10      540     440     -8
210     455     440     -9
```

Output:

```
2
```

Input:

```
3  3
10      540     440
20      455     440
30      456     -99
```

Output:

```
1
```

Problem 4. Class Rank

Students' test scores for a class are stored in a table as shown below. The first row contains student names (represented by a letter). The second row contains the scores of the corresponding students, which are non-negative whole numbers.

Test Score

Name:	B	C	D	E	F	G	H	I	J
Score:	7	29	22	11	17	9	3	2	0

Assume that no two students will get the same score.

Write a program to take this table as input and display student names in the decreasing order of their test scores. For the given table shown above, it should display the following result.

```
C D F E G B H I J
```

The input to your program has three lines. The first line is the number of students in this class. The second line contains the names of the students in the table from left to right (separated by spaces). The third line contains the scores of the students in the table from left to right (separated by spaces).

The output of your program are the names of the students sorted by their score decreasingly. These names are separated by spaces on the same line.

Sample input (red color) and output (blue color):

Input:

```
3
A  B  C
6   8   7
```

Output:

```
B  C  A
```

Input:

```
5
X  B  C  A  M
6   8   7   5   2
```

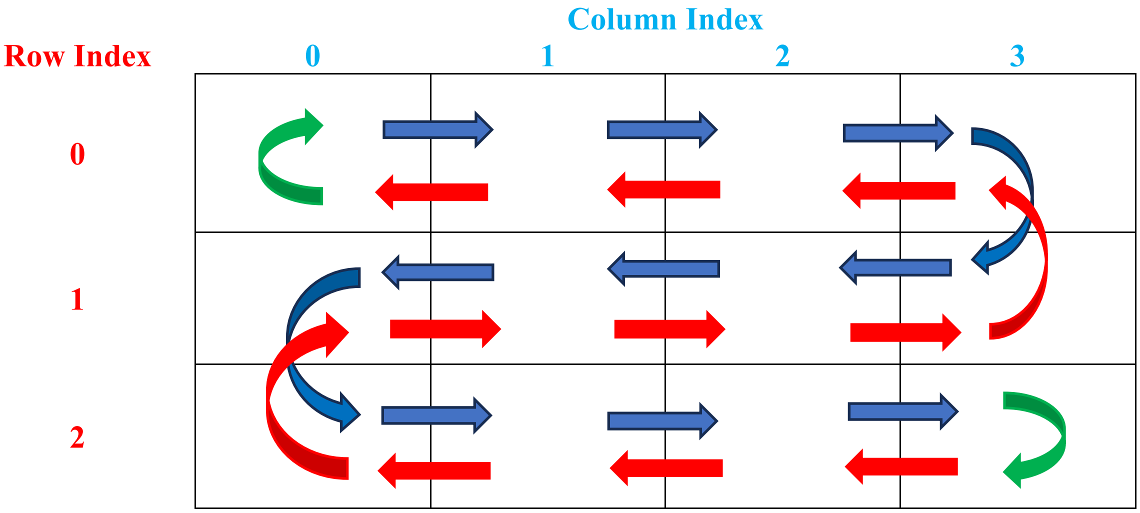
Output:

```
B  C  X  A M
```

Problem 5. Sky Scan

A radio telescope scans a rectangular area of the night sky to detect possible alien signals. Each data value scanned is a number representing the amount of signal (a decimal number between 0 and 1) detected by the telescope. The telescope scans back and forth across the sky (alternating between left to right, top to bottom, and reverse back) in the pattern indicated below by arrows. **The scanned data is stored into a 1-dimmensional array**.

For example, suppose the scanned area is represented as a 3 x 4 array (3 rows and 4 columns). The radio telescope starts with location (0, 0) and follows the blue arrows to scan the 12 areas, ending at location (2, 3). The telescope then starts with location (2, 3) and follows the red arrows to scan the 12 areas again, ending back at location (0, 0). We call this a double-full scan.



Write a program that determines the location of the rectangular area (indices of the 2D array) that has the strongest average signal, which merits further investigation. If more than two locations have the same strongest average signal, display them all.

The input to the program contains three lines. The first line has two positive integer numbers **m n**, separated by a space, representing the dimension of the array (area): **m** rows and **n** columns. Assume that both **m** and **n** are less than 20. The second line is a whole number **r** representing the number of double-full scans performed on the area. The third line is the data stored in the 1-D array with **m*n*2*r** values.

The output of the program contains array indices in the format of (**i**, **j**) representing the location of the area that has the strongest signal. If more than one location has the strongest signal, their locations should all be displayed and separated by spaces.

Sample input (red color) and output (blue color):

Input:
2 2
2
0.03 0.02 0.5 0.6 0.4 0.5 0.03 0.02 0.02 0.03 0.5 0.6 0.4 0.5 0.01 0.01

Output: (1, 0) (1, 1)

Input:
2 3
2
0.03 0.2 0.5 0.6 0.4 0.5 0.3 0.2 0.2 0.3 0.5 0.6 0.4 0.5 0.01 0.01 0.2 0.21 0.1 0.02 0.02 0.1 0.1 0.1

Output: (0, 1)

Input:
3 2
2
0.03 0.2 0.5 0.6 0.4 0.5 0.3 0.2 0.2 0.3 0.5 0.6 0.4 0.5 0.01 0.01 0.2 0.21 0.1 0.02 0.02 0.1 0.1 0.1

Output: (0, 1)

Input:
2 2
3
0.03 0.2 0.5 0.6 0.4 0.5 0.3 0.2 0.2 0.3 0.5 0.6 0.4 0.5 0.01 0.01 0.2 0.21 0.1 0.02 0.02 0.1 0.1 0.1

Output: (1, 1)

Problem 6. Latin Square

You are given a two-dimensional array of numbers, whose number of rows and number of columns are equal. You are asked to determine if the two-dimensional array is a Latin square.

A two-dimensional square array of integers is a Latin square if the following conditions are all true.

- The first row has no duplicate values.
- All values in the first row of the square appear in each row of the square.
- All values in the first row of the square appear in each column of the square.

The input contains several lines. The first line contains a positive integer numbers **m**, representing the dimension of the array: **m** rows and **m** columns. Assume that **m** is less than 20. The rest of the lines are the array of numbers separated by spaces, each row on its own line. Output is "**yes**" if the array is a Latin square or "**no**" if the array is not a Latin square.

Sample input (red color) and output (blue color):

Input:

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

Output: yes

Input:

```
4
10    30    20    0
0     20    30    10
30    0     10    20
20    10    0     30
```

Output: yes

Input:

```
2
10    540
20    455
```

Output: no