Problem A
The Bento Box Adventure

Time limit: 1 second

Problem Description

Generated by ChatGPT 4o

Boxed meals in Taiwan are very common, offering convenient and affordable nutrition-balanced choices for students and office workers. These meals typically include a variety of vegetables, protein, and rice, providing a well-rounded diet. With numerous options available at local self-service restaurants, they are a popular choice for those looking for a quick, healthy lunch.

There are five Taiwanese self-service restaurants numbered from 1 to 5. You plan to visit a different restaurant each day from Monday to Friday to pack a boxed meal for lunch. You've already visited one restaurant from Monday to Thursday, each time visiting a different one. Now, it's Friday, and you want to visit the last remaining restaurant that you haven't been to yet this week.

Write a program that takes as input the four restaurants you've already visited (one for each day from Monday to Thursday) and outputs the restaurant you should visit on Friday.

Input Format

A single line of input containing four integers a, b, c, d, each between 1 and 5 (inclusive), representing the restaurant numbers you visited from Monday to Thursday, in order.

Output Format

Output the restaurant number you should visit on Friday.

Technical Specification

- $1 \leq a, b, c, d \leq 5$
- All four numbers will be different.

Sample Input 1

```
1 3 2 5
```

Sample Output 1

```
4
```

Sample Input 2

```
2 5 4 3
```

Sample Output 2

```
1
```

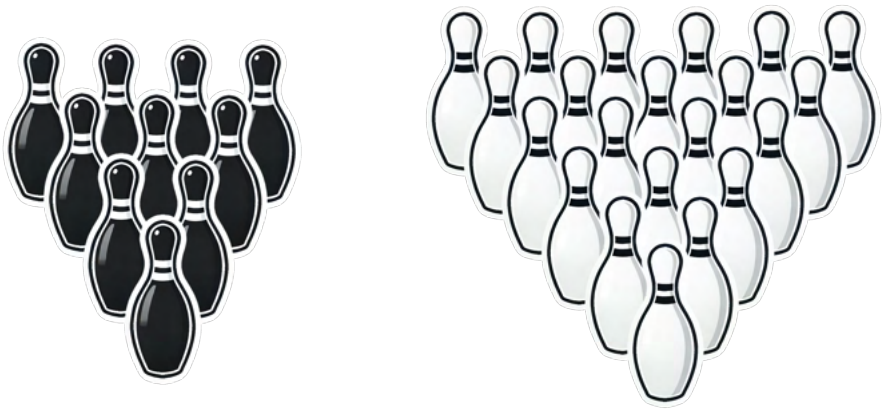
Problem B
Bowling Frame

Time limit: 1 second

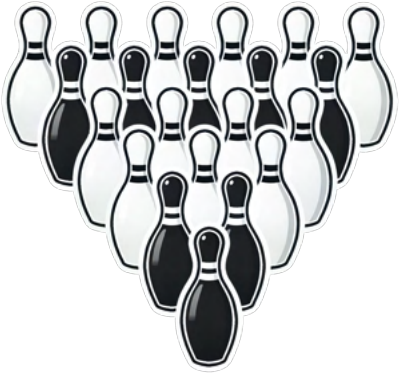
Problem Description

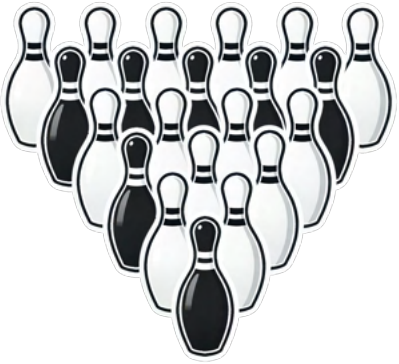
Bowling is a national sport in Taiwan; everyone in the country plays the sport on a daily basis since their youth. Naturally, there are a lot of bowling alleys all over the country, and the competition between them is as intense as you can imagine.

Maw-Shang owns one such bowling alley. To stand out from other competitors in the industry and draw attention from customers, he decided to hold a special event every month that features various unorthodox bowling rules. For the event this month, he came up with a new version of the game called *X-pin bowling*. In the traditional 10-pin bowling game, a *frame* is built out of ten bowling pins forming a triangular shape of side length four. The pin closest to the player forms the first row, and the two pins behind it form the second row, and so on. Unlike the standard version, the game of X-pin bowling Maw-Shang designed allows a much larger number of pins that form a larger frame. The following figure shows a standard 10-pin frame on the left, and on the right it shows a 21-pin frame that forms a triangular shape of side length six which is allowed in the game of X-pin bowling.



Being the national sport, the government of Taiwan strictly regulates and standardizes the manufacturing of bowling pins. There are two types of bowling pins allowed, one in black and the other in white, and the bowling alley Maw-Shang owns has w white pins and b black pins. To make this new game exciting for the customers, Maw-Shang wants to build the largest possible frame from these $w + b$ pins. However, even though he is okay with using both colors in building the frame, for aesthetic reasons, Maw-Shang still wants the colors of the pins on the same row to be identical. For example, the following figure shows two possible frames of side length six, but only the left one is acceptable to Maw-Shang since the other one has white and black pins mixed in the third row.





The monthly special event is happening in just a few hours. Please help Maw-Shang calculate the side length of the largest frame that he can build from his $w + b$ pins!

Input Format

The first line of the input contains a single integer t, the number of test cases. Each of the following t lines contains two integers w and b, the number of white and black pins, respectively.

Output Format

For each test case, output in a single line the side length k of the largest pin satisfying Maw-Shang's requirement you can build with the given pins.

Technical Specification

- $1 \leq t \leq 100$
- $0 \leq w, b \leq 10^9$

Sample Input 1

```
4
1 2
3 2
3 3
12 0
```

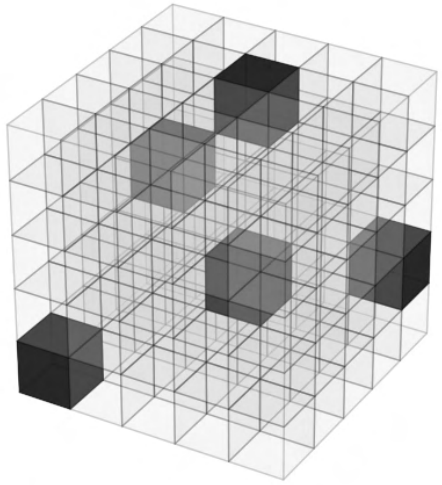
Sample Output 1

```
2
2
3
4
```

Problem C
Cube

Time limit: 3 seconds

Problem Description



You are given an $n \times n \times n$ big three-dimensional cube that contains n^3 numbers. You have to choose n of those numbers so that their sum is as small as possible. It is, however, forbidden to choose two numbers that are located in the same plane. That is, if we identify the positions in the cube by three Cartesian coordinates, then choosing two numbers from positions (x, y, z) and (x', y', z') is forbidden if $x = x'$, $y = y'$, or $z = z'$.

Input Format

The input consists of the number n followed by n^3 numbers in the cube. The numbers are presented as n two-dimensional matrices, one for each layer of the cube. More precisely, there will be n^2 lines follow, each having n numbers. For each x, y, z $(1 \le x, y, z \le n)$, the number at the position (x, y, z) is listed as the z-th number in the $(x \times (n-1) + y)$-th line.

Output Format

The output consists of a single number. It is the minimum sum of n numbers chosen from the cube according to the above rules.

Technical Specification

- $2 \le n \le 12$
- All numbers in the cube are integers between 0 and 2×10^7.

Sample Input 1

```
3
1 2 3
4 5 6
7 8 9
1 1 1
2 2 2
3 3 3
4 3 0
2 1 4
9 8 9
```

Sample Output 1

```
5
```

Problem D
Drunken Maze

Time limit: 2 seconds

Problem Description

Generated by ChatGPT 4o

You are given a two-dimensional maze with a start and end position. Your task is to find the fastest way to get from the start to the end position. The fastest way is to make the minimum number of steps where one step is going left, right, up, or down. Of course, you cannot walk through walls.

There is, however, a catch: If you make more than three steps in the same direction, you lose balance and fall down. Therefore, it is forbidden to make more than three consecutive steps in the same direction. It is okay to walk three times to the right, then one step to the left, and then again three steps to the right. This has the same effect as taking five steps to the right, but is slower.

Input Format

The first line contains two numbers n and m, which are the height and width of the maze. This is followed by an ASCII-representation of the maze where `#` is a wall, `.` is an empty space, and `S` and `T` are the start and end positions.

Output Format

The minimum number of steps to reach the end position from the start position or `-1` if that is impossible.

Technical Specification

- $12 \leq n \times m \leq 200000$
- $3 \leq n, m \leq 10000$
- Characters are only `.#ST` and there is exactly one `S` and one `T`.
- The outer borders are only `#` (walls).

Sample Input 1

```
7 12
############
#S........T#
#.########.#
#..........#
#..........#
#..#..#....#
############
```

Sample Output 1

```
15
```

Sample Input 2

```
5 8
########
#......#
#.####.#
#...T#S#
########
```

Sample Output 2

```
14
```

Sample Input 3

```
5 8
########
#.#S...#
#.####.#
#...T#.#
########
```

Sample Output 3

```
-1
```

Problem E
Beautiful Array

Time limit: 1 second

Problem Description

A-Ming's birthday is coming, and his friend A-May decided to give him an integer array as a present. A-Ming has two favorite numbers a and b, and he thinks an array is *beautiful* if its mean is exactly a and its median is exactly b. Please help A-May find a beautiful array so her gift can impress A-Ming.

Generated by ChatGPT 4o

The mean of an array is its sum divided by its length. For example, the mean of array $[3, -1, 5, 5]$ is $12 \div 4 = 3$.

The median of an array is its middle element after sorting if its length is odd, or the mean of the two middle elements after sorting if its length is even. For example, the median of $[1, 1, 2, 4, 8]$ is 2 and the median of $[3, -1, 5, 5]$ is $(3 + 5) \div 2 = 4$.

Note that the mean and median are not rounded to an integer. For example, the mean of array $[1, 2]$ is 1.5.

Input Format

The only line contains two integers a and b.

Output Format

In the first line, print the length of the array.

In the second line, print the elements of the array.

If there are multiple solutions, you can print any. It can be proved that, under the constraints of the problem, a solution always exists.

Technical Specification

- $-100 \leq a, b \leq 100$
- The length of the array must be between 1 and 1000.
- The elements of the array must be integers, and their absolute values must not exceed 10^6.

Sample Input 1

```
3 4
```

Sample Output 1

```
4
3 -1 5 5
```

Sample Input 2

```
-100 -100
```

Sample Output 2

```
1
-100
```

Problem F
Segmentation Folds

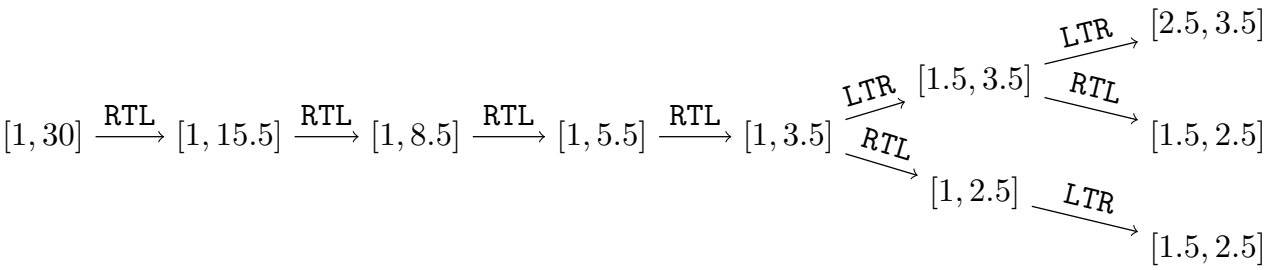
Time limit: 1 second

Problem Description

Peter loves folding segments. There is a segment on a number line occupying the interval $[\ell, r]$. Since it is the prime time for folding the segments, Peter decides to fold the segment carefully. In each step, he chooses one of the two following operations whenever possible:

1. Operation `LTR`: he folds the segment from left to right, where ℓ coincides with a point x ($\ell < x \leq r$) such that $\ell + x$ is a *prime number*[1]. When Peter chooses this operation, he always chooses the *largest* possible value x. Note that the segment occupies the interval $[\frac{1}{2}(\ell + x), r]$ afterwards.
2. Operation `RTL`: he folds the segment from right to left, where r coincides with a point x ($\ell \leq x < r$) such that $r + x$ is a *prime number*. When Peter chooses this operation, he always chooses the *smallest* possible value x. Note that the segment occupies the interval $[\ell, \frac{1}{2}(r + x)]$ afterwards.

A *folding sequence* refers to a sequence of operations specified above. Peter wants to fold the segment several times, resulting in the **shortest possible interval** whose length cannot be further reduced. The length of an interval $[\ell, r]$ is defined naturally to be $r - \ell$. Let's consider the following example. Suppose that we are folding a segment initially occupying the interval $[1, 30]$. There are three folding sequences that lead to the shortest possible resulting interval, as shown in the following figure.



Please help Peter determine the number of folding sequences such that the resulting interval has the shortest possible length. Output the number modulo 998244353.

Input Format

The first line contains an integer t, denoting the number of test cases. In each of the following t lines, there are two integers ℓ and r.

[1]Recall that an integer $p > 1$ is a *prime number* if there do not exist integers $a, b > 1$ such that $p = ab$.

Output Format

For each test case, please output a line denoting the number of ways to fold the given segment such that the resulting segment has the shortest possible length, modulo 998244353.

Technical Specification

- $1 \leq t \leq 10$
- $1 \leq \ell < r \leq 10^{12}$
- $r - \ell \leq 10^5$

Sample Input 1

```
3
1 30
16 18
142857 240135
```

Sample Output 1

```
3
1
63
```

Problem G
Grid Game

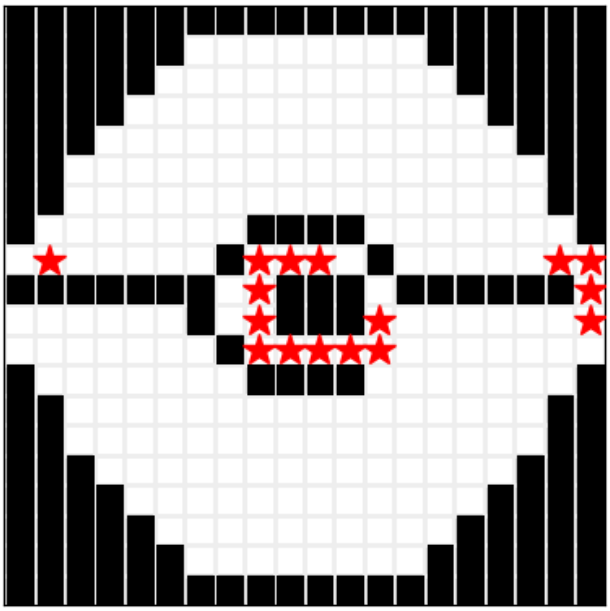
Time limit: 3 seconds

Problem Description

Claire loves drawing lines. She receives a sheet of paper with an $n \times n$ grid and begins drawing "lines" on it. Well—the concept of a "line" here is not what we usually think of. Claire refers to each *line* as a set of consecutive vertical grid cells. When she draws a line, these cells are all covered with black ink. Initially, all the cells are white, and drawing lines turns some of them black. After drawing a few lines, Claire wonders: how many ways she can color an additional white cell black so that the remaining white cells do not form a single connected component?

Two cells are directly connected if they share an edge. Two cells x and y are indirectly connected if there exists a sequence of cells $c_0, c_1, \ldots, c_k$ with $k > 1$ such that $c_0 = x$, $c_k = y$, and for every $i \in \{1, 2, \ldots, k\}$ the cells c_i and c_{i-1} are directly connected. A set of cells forms a single connected component if each pair of cells in the set is either directly or indirectly connected.

The grid has n rows and n columns, both indexed from 1 to n. Claire will draw q lines. The i-th line is drawn in the y_i-th column, from the s_i-th row to the f_i-th row, where $s_i \leq f_i$ for each $i \in \{1, 2, \ldots, q\}$. Note that the cells that are passed by at least one of the q lines are colored black. The following figure shows an example of a 20×20 grid with $q = 67$ lines. The grid cells marked with red star symbols refer to the cells such that, if Claire colors that cell black, all white cells no longer form a single connected component.



You may assume that, after drawing the q lines, the remaining white cells form a single connected component with at least three white cells.

Input Format

The first line contains exactly one integer t, indicating the number of test cases. Each test case begins with a line containing exactly two integers n and q. This indicates that the grid is n by n and that Claire draws q lines on it. Then q lines follow. For each $i \in \{1, 2, \ldots, q\}$, the i-th line among the q lines contains exactly three integers y_i, s_i, and f_i.

Output Format

Print an integer on a line, indicating how many ways Claire can color an additional white cell black so that the remaining white cells do not form a single connected component.

Technical Specification

- $1 \leq t \leq 125$
- $2 \leq n \leq 10^9$
- $q \geq 1$; the sum of all q values is at most 10^5.
- $1 \leq y_i \leq n$
- $1 \leq s_i \leq f_i \leq n$
- There are at least three white cells, and all white cells form a connected component.

Sample Input 1

```
2
3 1
2 1 2
5 2
2 1 4
4 2 5
```

Sample Output 1

```
5
15
```

Problem H
Sheet Music

Time limit: 1 second

Problem Description

Generated by ChatGPT 4o

Alice likes singing. As a singing enthusiast, Alice has listened to countless songs and has tried singing them many times. However, occasionally, some songs make Alice feel bored. After some research, Alice believes that this is because even though the songs she chose are all different, due to her instinctive preference, they all turn out to be musically similar to one another.

To thoroughly analyze this, Alice decided to study the sheet music of the songs. For convenience, Alice represented a song of length n as an integer sequence $a_1, a_2, \ldots, a_n$, where a_i is the pitch of the i-th note. Then she defined the musical equivalence between songs. Two songs $a_1, a_2, \ldots, a_n$ and $b_1, b_2, \ldots, b_n$ of length n are *musically equivalent* if for all $1 \leq i < n$, both a_i, a_{i+1} and b_i, b_{i+1} have the same pitch relationship. More specifically, a_i, a_{i+1} and b_i, b_{i+1} have the same pitch relationship if either

- $a_i < a_{i+1}$ and $b_i < b_{i+1}$,
- $a_i = a_{i+1}$ and $b_i = b_{i+1}$, or
- $a_i > a_{i+1}$ and $b_i > b_{i+1}$.

For example, $1, 2, 3, 3, 2$ and $5, 9, 13, 13, 1$ are musically equivalent, while $1, 2, 3, 2, 1$ and $1, 2, 2, 2, 1$ are not.

Having practiced consistently for a long time, Alice is able to sing any note in the range of $[1, k]$. She wants to know how many different songs of length n within her range there are, if we treat musically equivalent songs as the same one. Can you help her calculate the number?

Since the answer might be large, print the answer modulo 998244353.

Input Format

The only line contains two integers n, k.

Output Format

Output the number of different songs modulo 998244353.

Technical Specification

- $1 \leq n \leq 10^6$
- $1 \leq k \leq 10^9$

Sample Input 1

```
3 2
```

Sample Output 1

```
7
```

Sample Input 2

```
5 3
```

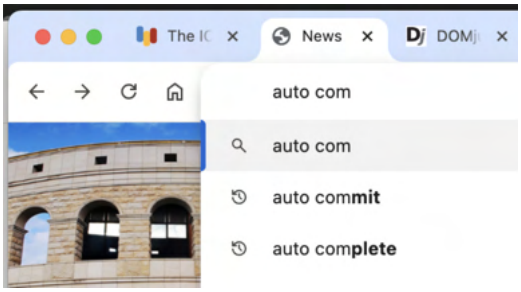
Sample Output 2

```
67
```

Problem I
Auto Complete

Time limit: 4 seconds

Problem Description



You are designing a snazzy new text editor, and you want to add a nifty auto-complete feature to help users save time. Here is how it will work: if a user types "`App`", your editor will magically suggest the word "`Application`"! Even better, users can personalize the words that auto-complete in your editor.

Your editor will support 4 kinds of operations (Let's say the current text in your editor is t):

1. Add an auto complete pattern p_i.
2. Delete an auto complete pattern p_i.
3. Append a string s to the end of t.
4. Delete c characters from the end of t. Note that if c is larger than the length of t, delete all the characters from t.

After each action, your editor should suggest an auto-complete candidate i that matches the following criteria:

1. The string p_i has a prefix equal to t.
2. If there are multiple p_i, pick the longest one.
3. If there are still multiple p_i, pick the one with the smallest lexicographic order.
4. If there are still multiple p_i, pick the one with the smallest ID.

To simplify the question, for each action, print the suggested auto complete pattern ID. If there's no match, print `-1`.

For example, let us say we have three candidates: "`alice`", "`bob`", and "`charlie`", with ID 1, 2, and 3. At first, there is nothing on the screen, so "`charlie`" (3) should be suggested because it is the longest. Then, let us say the user types "`b`". You should suggest "`bob`" (2) because it is the only one that starts with "`b`". Finally, let us say the user types "`body`". You should print `-1` because there is no matching pattern.

Input Format

The first line contains an integer n, followed by n lines, with each line containing an action.

There are four types of actions:

1. `add` i p_i
2. `delete` i
3. `append` s
4. `backspace` c

The `add` actions are followed by an integer i and a pattern p_i, which means the user wants to add a pattern with ID i. The `delete` actions are followed by an integer i, which means the user wants to delete p_i from the pattern set. The `append` actions are followed by a string s, which means the user appends s to the end of t. The `backspace` actions are followed by an integer c, which means the user deletes c characters from the end of t. All parameters are separated by a single space character.

Output Format

The program should output n lines. For each action, output an integer i, which means that after the action, p_i is the suggested auto complete candidate. If there is no p_i that matches the requirement, output `-1`.

Technical Specification

- $1 \leq n \leq 10^6$
- The total number of characters in all p_i and s does not exceed 2×10^6.
- $1 \leq c \leq 2 \times 10^6$
- The strings p_i and s may contain any printable characters, excluding all space characters (ASCII numbers in the range from 33 to 126).
- The ID i for each `add` operation is unique.
- The ID i for each `delete` is guaranteed to be valid.
- Each ID i satisfies $0 \leq i \leq n$.

Sample Input 1

```
6
add 1 pattern1_alice
add 2 pattern2_bob
add 3 pattern3_charlie
append pattern
append 2_bobabc
backspace 3
```

Sample Output 1

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

Sample Input 2

```
6
append pattern
add 1 pattern1_alice____
add 2 pattern2_bob______
add 3 pattern3_charlie__
delete 1
delete 2
```

Sample Output 2

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

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Problem J
Bottle Arrangement

Time limit: 5 seconds

Problem Description

Generated by ChatGPT 4o

Mayaw works in a renowned Epah (aboriginal Taiwanese millet wine; Epah is its Pangcah[2] name) bar in the Fata'an Village. To showcase the depth of its collections, the bar has a two-row wine rack where each row can fit exactly n bottles. There are already n bottles placed on the back row of the rack, where the i-th bottle from the left has height a_i. The owner of the bar has another n bottles with **distinct** heights $b_1, \ldots, b_n$ that he would like Mayaw to put on the first row. To ensure that all bottles on the rack are visible, the owner requires that each bottle on the back row should not be blocked by the one put in front of it. That is, if a bottle of height h is put on the i-th spot (from the left) in the first row, then h must be less than a_i. However, not all such arrangements are good for the owner. To pay tribute to the Maxi Mountain nearby, he additionally demands that the bottles in the front row should display a mountain-like shape. In particular, the heights of the bottles, when listing from left to right, should form a sequence that is first (non-strictly) increasing and then (non-strictly) decreasing.

Unfortunately, sometimes it is impossible to achieve the owner's requirements. That is why Mayaw is also allowed to slightly reduce a bottle's height by removing its cap that has a height of 1. In other words, after the removal of the cap, the height of the bottle decreases by exactly 1. Of course, exposing the Epah inside the bottle to the open air is detrimental to its quality, and therefore it is desirable to remove as few bottle caps as possible.

Can you help Mayaw determine the minimum number of caps needed to be removed so that he can arrange the bottles in a way that satisfies the owner's requirements? Note that the positions of the bottles in the back row are fixed and Mayaw is not allowed to modify them.

Input Format

The first line contains an integer n which represents the number of bottles in each row. The second line contains n integers $a_1, \ldots, a_n$, the height of the bottles in the back row. The third line contains n **distinct** integers $b_1, \ldots, b_n$, the height of the bottles in the front row.

[2]The language is used by the Pangcah people, the largest indigenous group in Taiwan.

Output Format

Output the minimum number of bottle caps needed to be removed so that Mayaw can arrange the bottles in the desired way. If it is impossible to achieve that (regardless of the number of caps removed), output `-1` instead.

Technical Specification

- $1 \leq n \leq 5 \times 10^5$
- $1 \leq a_i, b_i \leq 10^9$
- All b_i's are distinct.

Sample Input 1

```
5
2 4 6 5 4
1 2 3 4 5
```

Sample Output 1

```
0
```

Sample Input 2

```
5
2 3 6 5 4
1 2 3 4 5
```

Sample Output 2

```
0
```

Sample Input 3

```
5
6 2 6 6 6
1 2 3 4 5
```

Sample Output 3

```
1
```

Sample Input 4

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

Sample Output 4

```
-1
```

Sample Input 5

```
10
18 20 16 18 16 10 13 6 4 10
19 10 9 15 4 16 6 12 3 17
```

Sample Output 5

```
4
```

Problem K
Trophic Balance Species

Time limit: 3 seconds
Memory limit: 128 megabytes
Please note the unusual memory limit.

Problem Description

Generated by ChatGPT 4o

In an interdisciplinary collaboration, an ecosystem scientist and a computer scientist join forces to analyze the structure of a complex ecosystem using computational methods. The ecosystem scientist models the ecosystem as a directed graph $D = (V, A)$, where each species is represented by a node $v \in V$, and each feeding relationship is represented as a directed edge $(x, y) \in A$ from prey x to predator y. This graph structure allows them to simulate the flow of energy throughout the ecosystem from one species to another.

Two essential features of the ecosystem are defined:

- **Independent Trophic Group**: A set S of animal species is classified as an *independent trophic group* if no species $x \in S$ can reach another species $y \in S$ (for some $y \neq x$) through a series of directed feeding relationships, meaning there is no directed path in D from x to y.
- **Trophic Balance Species**: A species is termed a *trophic balance species* if it has a nearly equal number of species that affect it as directly or indirectly predators (species it can reach via a directed path in D, excluding itself) and species that affect it as directly or indirectly prey (species that can reach it via a directed path in D, excluding itself). Specifically, trophic balance species are those for which the absolute difference between the above two numbers is minimum among all species in the ecosystem.

Consider an ecosystem with $n = 4$ species and $m = 3$ feeding relationships:

- Species 1: Grass (Node 1)
- Species 2: Rabbits (Node 2)
- Species 3: Foxes (Node 3)
- Species 4: Hawks (Node 4)

The directed edges representing the feeding relationships are as follows:

- $(1, 2)$: Grass is eaten by Rabbits.

- $(2, 3)$: Rabbits are eaten by Foxes.
- $(2, 4)$: Rabbits are also eaten by Hawks.

Now, consider the set $S = \{3, 4\}$ (Foxes and Hawks). There are no directed paths between Foxes (Node 3) and Hawks (Node 4); Foxes cannot reach Hawks, and Hawks cannot reach Foxes through any directed paths. Therefore, this set qualifies as an independent trophic group.

Examination of Species

- Species 1 (Grass):
  - Can reach: 3 (Rabbits, Foxes, and Hawks)
  - Can be reached by: 0 (None)
  - Absolute difference: $|3 - 0| = 3$
- Species 2 (Rabbits):
  - Can reach: 2 (Foxes and Hawks)
  - Can be reached by: 1 (Grass)
  - Absolute difference: $|2 - 1| = 1$
- Species 3 (Foxes):
  - Can reach: 0 (None)
  - Can be reached by: 2 (Grass and Rabbits)
  - Absolute difference: $|0 - 2| = 2$
- Species 4 (Hawks):
  - Can reach: 0 (None)
  - Can be reached by: 2 (Grass and Rabbits)
  - Absolute difference: $|0 - 2| = 2$

Among these species, Rabbits have the smallest absolute difference of 1, indicating that they are a trophic balance species within the ecosystem.

It is known that any independent trophic group in the ecosystem has a size of at most k. The task is to find the set of all trophic balance species in the ecosystem.

Input Format

The first line contains exactly two integers n and m, where n (resp. m) denotes the number of nodes (resp. edges) in the directed graph D induced by the investigated ecosystem. The nodes are numbered as $1, 2, \ldots, n$. Then, m lines follow. The i-th line contains two integers x_i and y_i indicating a directed edge from node x_i to node y_i.

Output Format

Output on a single line the node identifiers of all trophic balance species in ascending order. For any two consecutive node identifiers, separate them by a space.

Technical Specification

- $1 \leq n \leq 2 \times 10^5$
- $0 \leq m \leq \min\{n(n-1), 4 \times 10^5\}$
- k is not an input value, and it is guaranteed that $1 \leq k \leq 16$ for each investigated ecosystem.
- For all i $(1 \leq i \leq m)$, $1 \leq x_i, y_i \leq n$ and $x_i \neq y_i$.
- Each ordered pair (x_i, y_i) appears at most once in the input.

Sample Input 1

```
4 3
1 2
2 3
2 4
```

Sample Output 1

```
2
```

Sample Input 2

```
4 5
1 2
1 3
1 4
2 3
3 2
```

Sample Output 2

```
2 3 4
```

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Problem L
Building Castle

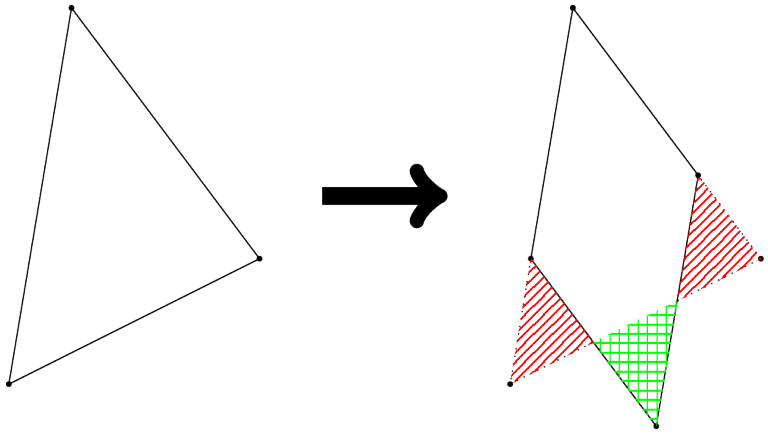
Time limit: 8 seconds

Problem Description

A-Ju has a gorgeous castle in which she often enjoys living. However, she gets tired of living in the castle for a long time. Thus, she decides to rebuild her castle into some specific shape to make it more beautiful.

Let's say we represent A-Ju's castle as a **2D convex polygon**[3] on the 2D plane. A-Ju aims to rebuild her castle into a **point symmetric** convex polygon. Here, a polygon is point symmetric if there exists a center c such that for every point p in the polygon, the reflection p' of p across c is also in the polygon.

While designing an arbitrary point symmetric convex polygon shape is easy, the cost of rebuilding is very high. After some estimation, A-Ju found that the cost of rebuilding is proportional to the area of the symmetric difference[4] between the original castle and the new castle. See the following figure for an example:



In the example above, A-Ju's castle is a shape of the convex polygon formed by points $(3,7) - (2,1) - (6,3)$. After rebuilding her castle into the shape of the polygon formed by $(3,7) - (\frac{7}{3},3) - (\frac{13}{3},\frac{1}{3}) - (5,\frac{13}{3})$, the area of the symmetric difference between these two polygons will be $\frac{11}{3}$. The difference can be calculated as the sum of the additional area (represented by the green grid region) and the shaved area (represented by the red line region).

Please write a program that helps A-Ju design a blueprint of the new castle, such that the area of the symmetric difference between the original one and the new one is minimized. You only need to output the minimum value since A-Ju wants to estimate her cost first.

[3] A polygon P is *convex* if for every two points $p, q \in P$, the line segment connecting them is also contained in P, i.e., $tp + (1-t)q \in P$ for all $t \in [0,1]$. Equivalently, it is a polygon whose interior angles are all less than $180°$.

[4] The *symmetric difference* of two polygons is the part of the 2D plane that belongs to exactly one polygon.

Input Format

The first line contains an integer n, representing the number of vertices of the polygon that forms A-Ju's castle.

Then, n lines follow, the i-th of which contains two integers x_i, y_i, representing the coordinates of the i-th vertex. The vertices are given in a counterclockwise order.

Output Format

Print a single real number in one line, representing the minimum area of the symmetric difference between the original castle and the new castle.

Your answer will be accepted if the absolute or relative error does not exceed 10^{-4}. Formally, let your answer be a, and the jury's answer be b. Your answer is considered correct if $\frac{|a-b|}{\max(1,|b|)} \leq 10^{-4}$.

Technical Specification

- $3 \leq n \leq 500$
- $|x_i|, |y_i| \leq 10^4$
- The vertices are given in a counterclockwise order and are guaranteed to form a convex polygon without three collinear points.

Sample Input 1

```
3
2 1
6 3
3 7
```

Sample Output 1

```
3.666666666667
```

Sample Input 2

```
4
0 0
5 0
5 5
0 5
```

Sample Output 2

```
0.000000000000
```

Problem M
Selection Sort

Time limit: 2 seconds

Problem Description

Every student enrolled in the algorithms course is required to submit an assignment this week. The task is to implement an $O(n^2)$-time algorithm to sort n given integers in non-decreasing order. Alice has already completed her assignment, and her implementation is shown below.

```
int alice_sort(int *s, int n){
  for(int i = 0; i < n; ++i){
    for(int j = i + 1; j < n; ++j){
      if(s[i] > s[j]){
        int swap = s[i];
        s[i] = s[j];
        s[j] = swap;
      }
    }
  }
  return 0;
}
```

While you have access to Alice's code, you prefer not simply to copy it. Instead, you want to use Alice's sorting function as a building block for your own solution. There are two ways, as listed below, you can utilize her function, but each of them can be applied at most **once**. The order in which these two operations are invoked can be arbitrary.

- Prefix sort: choose a length $i \in \{1, 2, \ldots, n\}$ and call `alice_sort(`s, i`)`. This sorts the first i elements in the array s.
- Suffix sort: choose a length $i \in \{1, 2, \ldots, n\}$ and call `alice_sort(`$s + n - i, i$`)`. This sorts the last i elements in the array s.

Due to the time complexity of the sorting algorithm, the cost of performing either a prefix or suffix sort is i^2, where i is the length of the chosen subarray. Your goal is to determine the minimum cost to sort the input array s of n integers in non-decreasing order using Alice's function, following the rules mentioned above.

For example, let $s = [3, 2, 5, 5, 4, 1]$. We can first perform a suffix sort of length 4, and the array becomes $[3, 2, 1, 4, 5, 5]$. Then, we perform a prefix sort of length 3, and the array becomes $[1, 2, 3, 4, 5, 5]$, which is a sorted array. The cost is $4^2 + 3^2 = 25$. Here is another example, let $s = [4, 3, 2, 1]$. We can complete the sorting by performing only a prefix sort of length 4, and the cost is $4^2 = 16$.

Input Format

The first line contains exactly one integer n which indicates the number of integers in the array s. The second line contains the n integers in $s = [s_0, s_1, \ldots, s_{n-1}]$.

Output Format

Output an integer on a line, indicating the minimum cost to sort the input array s of n integers in non-decreasing order using Alice's function, following the rules mentioned above.

Technical Specification

- $1 \leq n \leq 10^6$
- For all i $(0 \leq i < n)$, $0 \leq s_i < 2^{31} - 1$.

Sample Input 1

```
6
3 2 5 5 4 1
```

Sample Output 1

```
25
```

Sample Input 2

```
4
4 3 2 1
```

Sample Output 2

```
16
```

Problem N
Railway Construction

Time limit: 3 seconds

Problem Description

The country of Truckski is located in a rugged, mountainous region, and the geological condition has engendered a wide range of issues. The challenging terrain separates the different states in the country, resulting in an extremely inconvenient inter-state commute and, more crucially, a lack of central governmental control. Adding on top of that is a rampant crime rate that increases annually, and this severely disrupts the everyday lives of innocent citizens.

A recent protest finally shed light on the situation, as the newly elected president has announced an ambitious project to resolve these issues. Her plan consists of two major components. The first is the construction of high-speed railways between the states to facilitate better connections and unity across the country. Since the states are mostly running independently from each other, to construct a railway between states u and v, the government has to pay a fee of $a_u + a_v$ dollars, with a_u dollars given to state u and a_v dollars given to state v. The railway operates bidirectionally, meaning that once it is built, people from state u can now travel to state v and vice versa. A railway can be built between almost any pair of states, except for m particular pairs for which the terrain dividing them is so treacherous that the construction of a *direct* railroad between the two states becomes impossible.

The second component of the project is to build a centralized prison that manages all criminals across the country. Given the large number of estimated prisoners, the president decided to pick one of the states to build the central prison and sever the connection from the state to the rest of the country.

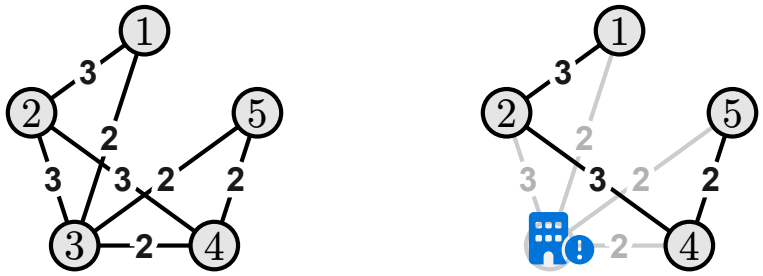


Figure 1: An illustration for the sample input 1. (a) The costs of building direct railways between the states. (b) Consider building the central prison in State #3. All direct railroads that do not involve State #3 have to be built, with a total cost of $3 + 3 + 2 = 8$ dollars.

Given the above, the president would like to search for the minimum cost plan to construct railroads between the states so that:

- the state with the central prison should not have any railway connecting it to any other states, and
- all the other states should be connected, i.e., people should be able to travel from one such state to another, possibly by taking more than one train.

You are working for the team in charge of the overall planning of the construction. The meeting with the president is happening in just a few hours, at which time you will have to brief her on the cost of different construction plans. Please calculate, for each state u, the minimum cost plan to construct railroads between states meeting the above conditions when u is where the central prison is built.

Input Format

The first line of the input contains two integers n and m, the number of states in Truckski and the number of pairs for which railroad construction is not feasible. The next line contains n integers $a_1, \ldots, a_n$, the construction fee the government needs to pay to the i-th state. Then, m lines follow. The i-th line contains two integers u_i and v_i meaning that it is impossible to build a (direct) railway between states u_i and v_i.

Output Format

Output n integers in one line. The i-th integer is the minimum construction cost when the i-th state is where the prison is built. If it is impossible to find a feasible railroad construction, output `-1` instead.

Technical Specification

- $2 \leq n \leq 10^5$
- $0 \leq m \leq 10^5$
- $1 \leq a_i \leq 10^9$
- $1 \leq u_i < v_i \leq n$
- For all $i \neq j, (u_i, v_i) \neq (u_j, v_j)$.

Sample Input 1

```
5 3
1 2 1 1 1
1 4
1 5
2 5
```

Sample Output 1

```
7 6 8 7 7
```

Sample Input 2

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

Sample Output 2

```
-1 4 -1
```