CodeNection 2024 Final Round Problems

Competition Team of CodeNection 2024

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Codey and Exit

Problem Statement

Codey is in its bedroom, standing at point (a, b) on a 2D grid, and the door is located at some point (x, y).

Codey has four possible moves:

- Move Up: moves from (a, b) to $(a, b + 1)$
- Move Down: moves from (a, b) to $(a, b - 1)$
- Move Left: moves from (a, b) to $(a - 1, b)$
- Move Right: moves from (a, b) to $(a + 1, b)$

Codey needs your help to find the minimum number of moves required to reach the exit.

Input Format

The first line contains two integers a and b, which represents the coordinate of Codey.

The second line contains two integers x and y, which represents the coordinate of the door.

Constraints

$1 \leq a, b, x, y \leq 10^5$

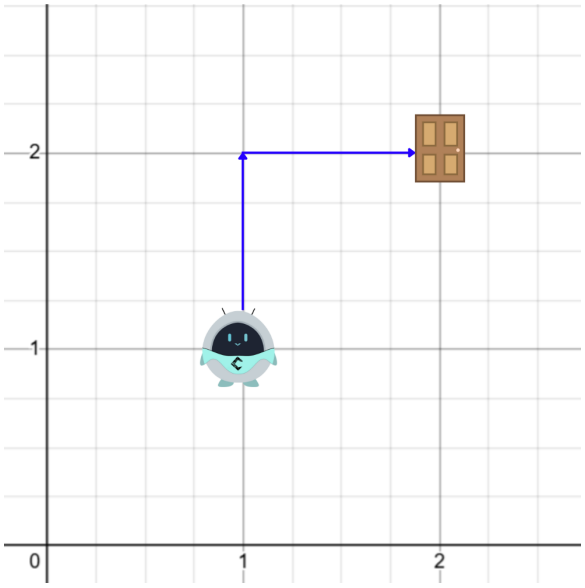
Output Format

Output the minimum number of moves required for Codey to reach (x, y) from (a, b).

Sample Test Case 1

1 1 2 2	2

Codey can take the following steps to the exit:



Hence, the minimum number of moves required is 2.

Codey and Gardening

Problem Statement

The city of CodeNation is having a Gardening Contest, where participants strive to grow as many plants as possible.

The progress of participants is recorded in an array of length n. Each record will have the format a p, where a_i represents the participant's name, and p_i represents how many plants they gained or lost that month. A positive number p_i means they added plants to their garden, while a negative number indicates that they lost some due to harsh weather.

If multiple gardeners end up with the same total, they will get the same ranking.

Zoey, the president of CodeNation, needs assistance in determining the ranking of Codey in the contest.

Input Format

The first line contains an integer n, where n represents the number of records.

The following n lines contain the participant's monthly performance in a p format in chronological order, where a_i is a string of lowercase English letters and p_i is an integer.

Constraints

- $1 \leq n \leq 1000$
- $1 \leq |a| \leq 32$
- $-1000 \leq p \leq 1000$

Output Format

Output an integer, the ranking of Codey in the contest.

Sample Test Case 1

3 codey 10 zoey 5 codey -5	1

Since both Codey and Zoey have 5 plants each, they share the top rank. Codey's rank is 1.

Codey and Symbol

Problem Statement

Codey was working on an equation but accidentally spilled water on its notes, blurring one of the symbols. Now, it can't tell the correct relationship between the two sides of its equation.

The equation is given as:

$$a - (\frac{b}{c}) \ ? \ (\frac{d}{e}) - f$$

Help Codey find the relationship ?.
Print $>$ if the left side is bigger, $<$ if the right side is bigger, otherwise $=$.

Input Format

The first line contains six integers, a, b, c, d, e and f.

Constraints

- $0 \leq a, b, c, d, e, f \leq 10^5$
- $c \neq 0, e \neq 0$

Output Format

Print a single character:

- $>$, if the left side is greater.
- $<$, if the right side is greater.
- $=$, if both sides are equal.

Sample Test Case 1

5 6 2 8 4 1	>

Left side: $5 - (\frac{6}{2}) = 2$

Right side: $(\frac{8}{4}) - 1 = 1$

$2 > 1$, so the output is $>$.

Codey and Rectangles 2

Problem Statement

Codey is playing with rectangles again, but this time it's even more fun! Codey decorates the floor with n rectangular sheets of paper. Each side of the sheets is parallel to the x-axis or y-axis.

Each sheet's position on the floor is defined by four integers:

- a_i and b_i: The x-coordinates of the left and right edges of the sheet.
- c_i and d_i: The y-coordinates of the bottom and top edges of the sheet.

Help Codey calculate the **total area covered by the rectangular sheets of paper** on the floor.

Input Format

The first line contains an integer n, where n represents the number of rectangular sheet of paper Codey has.

The following n lines contain four integers, a_i, b_i, c_i and d_i, where a_i and b_i represent the left and right edges of the sheet on the x-axis, while c_i and d_i represent the bottom and top edges of the sheet on the y-axis.

Constraints

- $2 \leq n \leq 100$
- $0 \leq a_i < b_i \leq 100$
- $0 \leq c_i < d_i \leq 100$

Output Format

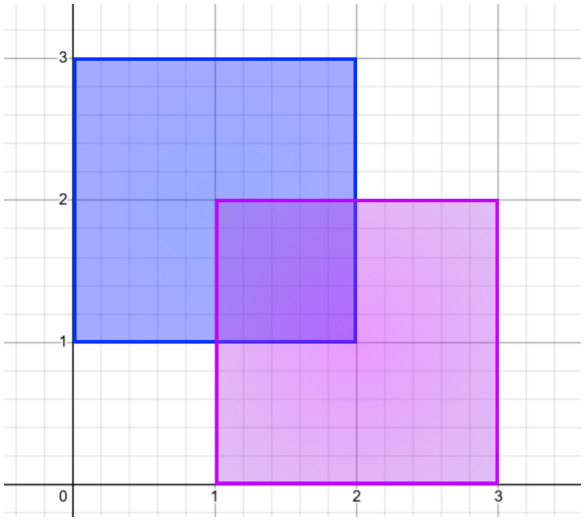
Output an integer, the total area covered by the sheets of paper.

Sample Test Case 1

2 1 3 0 2 0 2 1 3	7

The first rectangle spans from $(1, 0)$ to $(3, 2)$, covering an area of 4 square units. The second rectangle spans from $(0, 1)$ to $(2, 3)$, covering an area of 4 square units.

Since there is an overlap of 1 square unit, the total area covered by both sheets is $4 + 4 - 1 = 7$ square units.



Codey and Jutsu

Problem Statement

Codey has mastered the clone jutsu recently, and it's now on a mission with its weapon to fire n aliens.

Codey creates n copies of itselves, each **positioned on the y-axis** of a 2D plane, while the n aliens are **positioned on the x-axis**. No one will be at the origin and they can't move around. Every "Codey" should fire exactly **one** alien. If Codey at point (a, b) uses his weapon to fire an alien at point (c, d), the fire distance will be $\sqrt{(a-c)^2 + (b-d)^2}$ (the distance between the points).

Help Codey find the minimum sum of all fire distances.

Input Format

The first line of contains an integer n, where n represents the number of Codey copies and aliens.

The next $2 \cdot n$ lines contains two space-separated integers x and y, which represent a clone or alien's position.

Constraints

- $1 \leq n \leq 10^5$
- $-10^5 \leq x, y \leq 10^5$
- It is guaranteed that no point is at the origin.
- It is guaranteed that the number of points on the x-axis is equal to n and the number of points on the y-axis is equal to n.

Output Format

Output the minimal sum of all fire distances. Your answer is considered correct if its absolute or relative error does not exceed 10^{-9}.

Formally, let your answer be a, and the jury's answer be b. Your answer is accepted if and only if $\frac{|a-b|}{\max(1,|b|)} \leq 10^{-9}$.

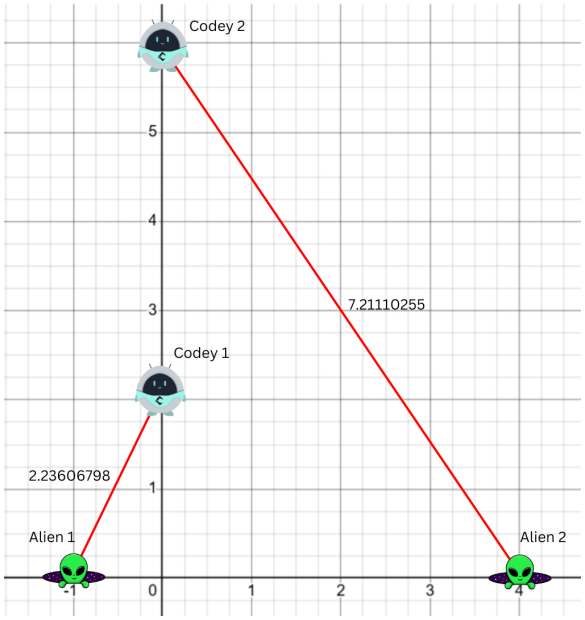
To set precision when printing values you can use:

- `print(f"{distance:.9f}")` in Python;
- `std::cout << fixed << std::setprecision(9) << distance << std::endl;` in C++;
- `System.out.printf("%.9f\n", distance);` in Java;
- `console.log(distance.toFixed(9));` in JavaScript;
- `printf("%.9f\n", distance);` in C;

Sample Test Case 1

2 -1 0 0 6 0 2 4 0	9.447170528427769

Codey(s) are at $(0, 2)$ and $(0, 6)$, while the aliens are at $(-1, 0)$ and $(4, 0)$. To minimize the total fire distance, we pair Codey 1 with Alien 1, and Codey 2 with Alien 2:



Hence, the minimum sum of all fire distances will be $\sqrt{52} + \sqrt{5}$.

Codey and Toy Kingdom 2

Problem Statement

Earlier, Codey built a toy kingdom with islands and bridges but soon realized it wasn't the best way to construct a kingdom. To impress Zoey, Codey now wants to build an outstanding toy kingdom.

Therefore, Codey decided to rebuild the kingdom with n islands and m bridges, where each bridge connects two different islands. However, the kingdom might be disconnected and may contain redundant bridges.

Help Codey figure out how many bridges need to be burned and how many need to be built to ensure all islands are connected without any redundant bridges, so it can impress Zoey!

Input Format

The first line contains two integers, n and m, where n represents the number of islands, and m represents the number of bridges.

The following m lines contain two integers, u and v, which indicates the bridge between island u and v.

Constraints

- $1 \leq n \leq 10^5$
- $0 \leq m \leq \min(10^5, \frac{n \cdot (n-1)}{2})$
- It is guaranteed that there is no self loop & multiple edges for each test case.

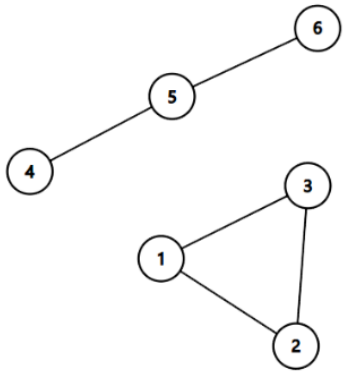
Output Format

Output two integers, a and b in a single line separated by a space, where a represents the number of bridges need to be burned and b represents the number of bridges need to be built.

Sample Test Case 1

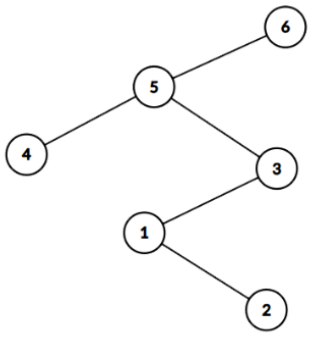
6 5 1 2 2 3 3 1 4 5 5 6	1 1

The initial toy kingdom looks like this:



- We burn the bridge between island 2 and 3 to ensure there is no redundant bridge.
- We add a bridge between island 3 and 5 to ensure all islands are connected.

This results in the following toy kingdom:



Codey and Speeches

Problem Statement

Codey is feeling extra motivated today (because it is the CodeNection Final day!) and wants to give motivational speeches! Codey has found n of its friends, lined up from left to right. Codey plans to deliver speeches starting **from the leftmost friend and moving to the rightmost friend.** For each friend, Codey **can choose whether to deliver a speech or skip them.**

Giving a speech to friend i will result in receiving a feedback score of a_i. The score a_i **can be negative** because some friends might find Codey's speech boring!

Codey wants to give as many speeches as possible and stay motivated at the same time. This means that the total feedback score from the speeches delivered at any point **must remain greater than or equal to** 0.
Find the maximum number of speeches Codey can deliver while satisfying all the conditions!

Input Format

The first line contains a integer n, which represents the number of friends.

The second line contains n integers, $a_1, a_2, ..., a_n$, each representing the feedback score of the i-th friend.

Constraints

- $1 \leq n \leq 10^5$
- $-10^9 \leq a_i \leq 10^9$

Output Format

Output an integer representing the maximum number of speeches Codey can give.

Sample Test Case 1

4 -5 10 -5 5	3

Codey will skip the first friend and give speeches to the rest of the friends. Codey cannot give a speech to the first friend because it would cause Codey to become demotivated immediately.

Sample Test Case 2

4 10 -8 -1 -1	4

Codey will give a speech to every friend.

Codey and Zoey 2

Problem Statement

The final day of CodeNection is very meaningful to both Codey and Zoey. Just like CodeNection 2023, Codey plans to go on a date with Zoey on this special day.

The two find themselves on a 2D grid, with Codey starting at $(0, 0)$ excited to meet Zoey, who is waiting at (x, y). However, once again, Zoey isn't going to make this date easy. To test if Codey is truly the one, she only allows Codey to take exactly n steps to reach her. Additionally, each step i must meet the following conditions:

- The step has a distance of a_i
- It must be taken either to the left or right of the direction Codey is currently facing.

Codey took the first step to the right, landing at $(a_1, 0)$. Can Codey reach Zoey using the remaining steps?

Input Format

The first line contains an integer t, which represents the amount of test cases for the problem.

The first line of each test case contains three integers, n, x and y, where n represents the number of steps Codey should take, and x, y represent Zoey's position on the grid.

The second line of each test case contains n integers, $a_1, a_2, ..., a_n$ each representing the distance of the i-th step.

Constraints

- $1 \leq t \leq 10$
- $1 \leq n \leq 10^3$
- $1 \leq a_i \leq 10$
- $1 \leq |x|, |y| \leq 10^4$
- It's guaranteed that the sum of n across all test cases doesn't exceed 5000.

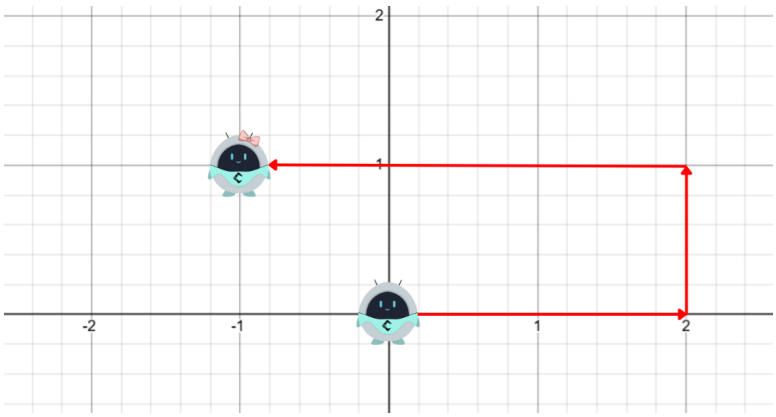
Output Format

For each test case, if Codey is able to meet Zoey, output `YES`. Otherwise, output `NO`.

Sample Test Case 1

2 3 -1 1 2 1 3 3 -1 1 2 2 3	YES NO

In the first test case, Codey can take the following path to meet Zoey:



1. Codey first heads to $(2, 0)$.
2. Codey takes the next step to the left and ends up at $(2, 1)$.
3. Codey takes the next step to the left and ends up at $(-1, 1)$.
4. Codey meets Zoey.

In the second test case, it is impossible for Codey to meet Zoey.

Codey and NectionCode

Problem Statement

Codey is organizing a national coding competition - NectionCode, which has a format that is different from CodeNection.

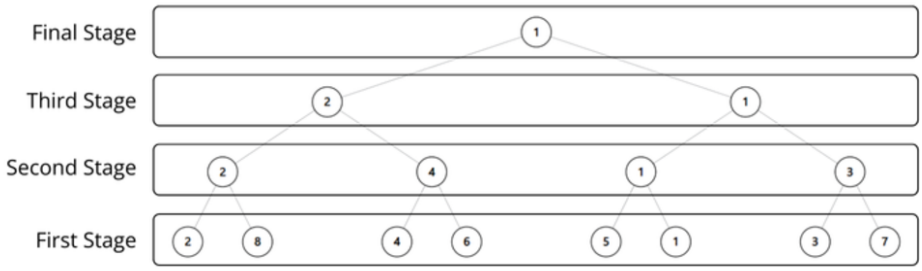
In NectionCode, there are 2^n teams numbered from 1 to 2^n, each assigned a seed. They are represented by a seed array a where a_i is the number of the team with the i-th seed. An interesting property of the teams participating in NectionCode is that the team numbered j is guaranteed to take j minutes to solve a problem.

In each matchup, two teams are given the same problem to solve, and the team that solves it in the shorter time advances to the next round.

NectionCode consists of multiple stages, each with several matchups. In the first stage, seed 1 competes against seed 2, seed 3 competes against seed 4, and so on. In the following stage, the winner of the match between seeds 1 and 2 competes against the winner of the match between seeds 3 and 4, while the winner between seeds 5 and 6 faces the winner between seeds 7 and 8, and so forth. This process is repeated until only one team remains as the overall winner.

Each team is assigned a ranking based on how far they advanced in the competition. A team's ranking is defined as the total number of teams that advanced further than it, plus one.

For example, consider the seed array $a = [2, 8, 4, 6, 5, 1, 3, 7]$:



- Team 1 ranked 1, as no teams advanced further than it.
- Team 2 ranked 2, because only one team advanced further.
- Team 3 ranked 3, because two teams advanced further.
- Team 4 ranked 3, because two teams advanced further.
- Team 5 ranked 5, because four teams advanced further.
- Team 6 ranked 5, because four teams advanced further.
- Team 7 ranked 5, because four teams advanced further.
- Team 8 ranked 5, because four teams advanced further.

Unfortunately, Codey, the organizer of the competition, has lost the team number for some seeds, denoted as -1. This turns out to be a blessing in disguise, as Codey wants to manipulate the competition so that the ranks follow the teams' strength. Specifically, Codey wants the team rankings to follow the pattern $[1, 2, 3, 3, 5, 5, 5, 5, ...]$, where team 1 has a rank of 1, team 2 has a rank of 2, team 3 has a rank of 3, and so on.

Your task is to determine how many different ways Codey can assign the seed array so that the competition results in the desired rankings modulo $10^9 + 7$.

Input Format

The first line contains an integer, n where there are 2^n number of teams.

The second line contains 2^n integers, $a_1, a_2, ..., a_{2^n}$ each representing the team that has the i-th seed.

Constraints

- $0 \leq n \leq 19$
- $1 \leq a_i \leq 2^n$ or $a_i = -1$
- For $a_i \neq -1$, $a_i \neq a_j$ if $i \neq j$

Output Format

Output an integer representing the total number of ways Codey can assign the seed array so that the competition results in the desired rankings modulo $10^9 + 7$.

Sample Test Case 1

`3` `-1 -1 4 6 -1 1 -1 7`	`4`

The four ways to manipulate the seeds are:

- $[2, 8, 4, 6, 5, 1, 3, 7]$
- $[2, 5, 4, 6, 8, 1, 3, 7]$
- $[8, 2, 4, 6, 5, 1, 3, 7]$
- $[5, 2, 4, 6, 8, 1, 3, 7]$