

Problem 9: Rock-a-bye baby—okay that's a bit *too* much 3+7 Points

Problem ID: earthquake

Rank: 2+3

Introduction

Between CALICO Spring '25 and CALICO Fall '25, an [earthquake](#) happened in California. Unfortunately, the seismographs failed to record any data about the earthquake as they were being used to mine CALICOin at the time. However, since earthquakes tend to wake people up [\[citation needed\]](#), the [United States Geological Survey \(USGS\)](#) received detailed reports about who was woken up by the earthquake. Please help the USGS determine the position of the earthquake.

Problem Statement

There is an earthquake of unknown strength $s_E > 0$ with an epicenter at an unknown position (x_E, y_E) . This information is not directly given to you.

There are N people numbered $1, \dots, N$. For each person, you are given their position (X_i, Y_i) , their sleep depth S_i and their response to the earthquake R_i , a string determined by the following:

$$R_i = \begin{cases} \text{awaken,} & s_E > S_i \cdot ((X_i - x_E)^2 + (Y_i - y_E)^2) \\ \text{slept_through,} & \text{otherwise} \end{cases}$$

In other words, a person awakens if the strength of the earthquake exceeds their sleep-depth weighted squared Euclidean distance from their position to the position of the epicenter.

Given this information, find the unique floor and ceil bounds $\lfloor x_E \rfloor$, $\lfloor y_E \rfloor$, $\lceil x_E \rceil$, and $\lceil y_E \rceil$ that could have resulted in the given data. It is guaranteed that this can be deduced using the given information.

There are some additional quirks to how the input will be generated. We recommend carefully reading the Constraints section before attempting this problem.

Input Format

The first line of the input contains a single integer **T** denoting the number of test cases that follow.

For each test case:

- The first line contains a single integer **N** denoting the number of people.
- The next **N** lines each contain four space-separated values **X_i Y_i S_i R_i** where:
 - **X_i** is a floating point number denoting the x-coordinate of the person's position.
 - **Y_i** is a floating point number denoting the y-coordinate of the person's position.
 - **S_i** is a floating point number denoting the person's sleep depth.
 - **R_i** is a string denoting the person's response to the earthquake that can either be `awaken` or `slept_through` as determined by the equation in the problem statement.

Output Format

For each test case, output a single line containing four space-separated integers denoting the floor and ceil bounds of the epicenter of the earthquake: $\lfloor x_E \rfloor \lfloor y_E \rfloor \lceil x_E \rceil \lceil y_E \rceil$

Constraints

$$1 \leq T \leq 20$$

$$1 \leq s_E \leq 10^6$$

$$-10^6 \leq X_i, Y_i \leq 10^6$$

$$10^{-15} \leq S_i \leq 10^{15}$$

At least 20 among the N persons in a test case are randomly created as follows:

- Their position (X_i, Y_i) is uniformly sampled from a square of side length 40 centered around the epicenter of the earthquake.
- The maximal sleep depth s_i^{\max} for a person at position (X_i, Y_i) to sleep through is computed.
- The actual sleep depth S_i is uniformly sampled from the interval $[0.95 \cdot s_i^{\max}, 1.05 \cdot s_i^{\max}]$.

The persons created this way are guaranteed to determine the floor and ceil of x_E and y_E . That is, test cases where this is not the true are eliminated from the input. The persons created this way appear in no particular order among all other persons which are also randomly created but using an undisclosed method.

Main Test Set

$$20 \leq N \leq 1000$$

$$-50 < x_E, y_E < 50$$

x_E and y_E have fractional part 0.5.

Bonus Test Set

$$20 \leq N \leq 10000$$

$$-65536 < x_E, y_E < 65536$$

x_E and y_E have fractional part not equal to 0 (or 1).

Sample Test Cases

Main Sample Input

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```
1
21
33.6239 -31.4136 1089.34 awaken
-455271 -295916 5.59319e-06 slept_through
20.384 -16.3127 1259.84 slept_through
10.7386 -31.3388 6233.21 awaken
19.3955 -30.7652 71961.8 slept_through
16.1209 -44.3118 1828.68 slept_through
12.4368 -50.9239 718.874 awaken
-2.32518 -14.9587 465.911 slept_through
10.5647 -20.3886 1747.09 slept_through
11.8555 -30.9808 9017.88 awaken
28.3334 -15.8029 786.009 awaken
8.16466 -40.2186 1851.97 slept_through
37.1651 -36.0378 762.005 slept_through
8.4499 -42.2115 1488.97 awaken
12.8582 -29.2644 11449.2 slept_through
14.0778 -32.6948 22568.8 awaken
4.32715 -14.6896 663.094 slept_through
10.1237 -12.5952 693.265 awaken
25.436 -14.0386 847.733 slept_through
31.1306 -20.0385 900.013 awaken
27.9654 -33.0316 2611.11 awaken
```

Sample Output

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```
17 -32 18 -31
```

Main Sample Explanation

The earthquake's position and strength used to generate the only test case are $(x_E, y_E) = (17.5, -31.5)$ and $s_E = 297198.008$.