SWE2026 Problem Solving Techniques, 2021 Spring

Instructor: Younghoon Kim

PA 4: Split! & Shoot!

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1. Submission Details

1-A. Scoring Criteria

- 90% for Programming, 10% for Report.
- Programming is directly scored by *goorm* platform.
- Report is P/F based.
  - If your report has less than 4 issues (over-volume, under-explanatory, etc.), grade **P** (Pas s, full credit). Otherwise, **I** (Incomplete).
  - After you get **I**, you can submit again once. If it is okay, grade **1/2 P** (half Pass, half cred it). Otherwise, **F** (Fail, no credit).

1-B. Deadline

- **Ten days** for regular submission, two days for delayed submission.
- Regular submission due for both program code (via *goorm*) and report (via *iCampus*) is **2021/05/19(Wednesday) 23:59:00.**
- Delayed submission penalty is 25% per day, and submission will be closed on 2021/05/21 (Friday) 23:59:00.
- Be careful: *goorm* **do NOT warn** for delayed submission and penalty is automatically applied, and the last one minute of the final day is considered as late.
- **No excuse for late submissions by mistake.**

1-C. About Report

- Either **Korean or English** is acceptable.
- **Should keep the line limits**. Make your answers clearer by shortening them.
- **Do NOT handwrite** your answers. Only figures can be hand-drawn in empty spaces.
- **HANDWRITE** the signature of honor code. Writing via pen (on tablet PC) is okay.

2. Problem 1 – Split!

2-A. Problem Description

Munhae IT is a big company composed of many departments and employees in Suwon. Due to a recent increase in its sales, it is now planning to establish a branch office in Hyehwa. Before immedi ately hiring more people, *Munhae IT* is looking for a way to effectively divide employees in R&D depa rtment into two groups. These people will be sent to the new branch so that it could manage itself fro m the beginning.

The company mainly considers two aspects: 1) **cooperative relations** and 2) **the sum amount of salary**. Considering work-relatedness among employees, it is required to maintain their current relations as steady as possible. It is also important to balance the sum of salaries of all employees between the divided two groups.

An organization chart will be given as a tree figure which shows cooperative relations in detail. Assume that every employee has at least one relation (or edge) to others and that no cycle exists in the tree. To sum up these conditions, the company should split its department by **cutting only one relation** in the tree.

In this situation, what is the **minimum difference of sum of salaries** between the divided two groups?

2-B. Restriction

In the first line, the number of employees in the target department, N is given.

In the second line, salaries of N employees, S_i are given separated by one space. For example, “300 450 200” indicates that the first employee’s salary is 300, the second’s is 450 and the third’s is 200.

For next (N -1) lines, cooperative relations are defined by two consecutive numbers, e.g., “1 3” m eans that the first and third employees are sharing similar tasks.

Print the minimum difference of sum of salaries from these two groups. Difference should be a po sitive value.

Details

- For 30% of test cases, 1 <= N <= 20 and 0 <= S_i <= 1,000
- For 50% of test cases, 1 <= N <= 50 and 0 <= S_i <= 10,000
- For 100% of test cases, 1 <= N <= 1,000,000 and 0 <= S_i <= 100,000,000

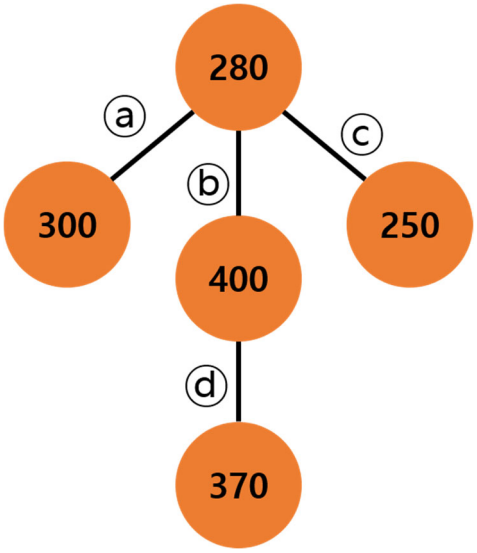
Note: For worst case, the total sum of salaries exceeds range of 32bit integer.
Therefore, using 64bit integer variable is recommended.

2-C. Example

Input	Output
5 280 300 400 250 370 1 2	60

1 3 1 4 3 5	
7 200 180 270 300 230 190 220 1 6 2 7 3 5 3 7 4 6 5 6	210

Description for example 1:



Picture in the left shows a tree of employees in the department.

1) Split groups from ⓐ:

300 ↔ 280 + 400 + 370 + 250 ⇒ Diff = 1000

2) Split groups from ⓑ:

300 + 280 + 250 ↔ 400 + 370 ⇒ Diff = **60**

3) Split groups from ⓒ:

250 ↔ 300 + 280 + 400 + 370 ⇒ Diff = 1100

4) Split groups from ⓓ:

370 ↔ 300 + 280 + 400 + 250 ⇒ Diff = 860

Therefore, the minimum difference is 60.

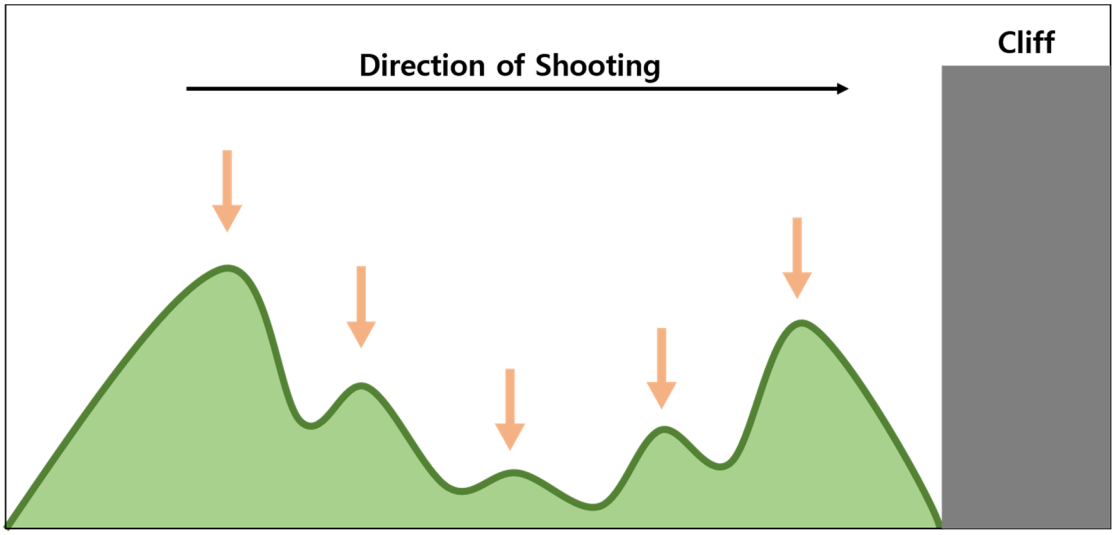
Description for example 2:

Cutting a relation between 5 and 6 will divide the department into two groups as intended: one with (200, 300, 190) and the other with (180, 270, 220, 230). This results in a minimum difference of 900 – 690 = 210.

3. Problem 2 – Shoot!

3-A. Problem Description

McCree, a skillful gunman, is practicing shooting his pistol in the rugged mountain. His skill is so f ancy that all the bullets he shot fly in a straight line. As he practices again and again, he suddenly go t curious about how far the bullets can fly if he shoots at each top point of hills. For safety issue, he al ways fires towards a cliff which is located in the rightmost end of the mountain. (See the picture belo w)



Help McCree figure out an array of distances that a bullet could fly at each point before it got blocked by other hills.

- Do not care about the shooter's height. If hill A is lower than hill B, a bullet fired from hill A will always be blocked by hill B.
- The cliff is always higher than all mountain hills.
- Suppose that all the distances between hills (or to the cliff) are 1.

3-B. Restriction

In the first line, the number of hills, N is given.

In the next line, relative value of each hill's height, H_i(1~ N) is given separated by one space. Suppo se every hill has different height in this problem. The larger the value is, the higher its height is.

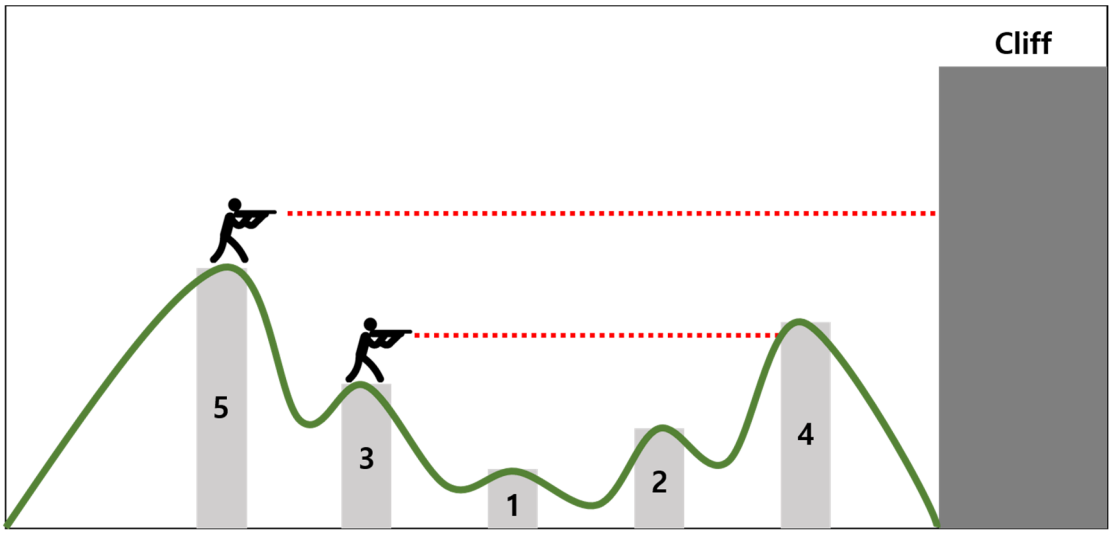
Details

- For 50% of test cases, 1 <= N <= 10,000
- For 100% of test cases, 1 <= N <= 1,500,000

3-C. Example(s)

Input	Output
5 5 3 1 2 4	5 3 1 1 1
10 5 2 3 7 6 1 4 8 9 10	3 1 1 4 3 1 1 1 1 1

Description for example 1:



- An array of height of each hill is given, which is [5 3 1 2 4]. Starting from the first point (whose height is 5), the bullet he shoots will reach the cliff, thus it flies for the amount of 5.
- In case he shoots in the second point (whose height is 3), on the other hand, the bullet will be blocked by the fifth point (whose height is 4). Therefore, it flies for the amount of 3.
- Shooting from the third point would be blocked by the fourth, and so forth. As a result, an array of [5 3 1 1 1] should be printed.

Description for example 2:

- The height of each hill is [5 2 3 7 6 1 4 8 9 10], and each will reach to hill (or cliff) whose height is [7 3 7 8 8 4 8 9 10 cliff].
- Therefore, the output would be the distance of each bullet, and it is [3 1 1 4 3 1 1 1 1 1].