Assignment 4

CS1.201: Data Structures and Algorithms

Sorting and Heaps

Due Date: 21 March 2024
Total Marks: 100

General Instructions

- The assignment must be implemented in C.
- The assignment needs to be submitted on OJ. This assignment comprises one question with two subtasks. Note that there will be two questions on OJ, one for each subtask. You must submit these subtasks separately in order to fetch marks for them.
- Deadline extension requests will not be entertained.
- Resorting to any sort of plagiarism (as mentioned in the policy shared) will lead to strict penalisation at the least.

Deep Sea Adventure

Percy is a deep-sea diver and explorer. Currently he is near the Mariana Trench, preparing to venture into the depths of the ocean. There is an interesting underwater cave that he wants to explore. However, he is facing certain challenges and asks you for help regarding the same:

Subtask 1 (65 points)

Percy begins his dive at the surface with a limited amount of oxygen supply. There are several underwater stations situated at various depths, each containing air tanks to refill your oxygen supply. However, it takes time to refill oxygen. The objective is to reach the underwater cave without running out of oxygen and minimizing the time that is spent at the stations.

Percy starts a depth of 0 and has an initial oxygen supply of k amount. Every unit depth that he descends, he consumes 1 unit of oxygen supply. The final depth that he needs to reach is d.
To help refill oxygen, there are n stations present at various depths. Each station fills Percy's oxygen tank with **exactly** p units of oxygen. There is no way to only partially refill. The i^{th} station is present at a depth y_{i} and takes t_{i} time to refill the p units of oxygen. You can refill oxygen from a station **only once**, that too only if you have reached its depth. Also, no two stations are present at the same depth.

You have to help Percy figure out if it is possible for him to reach the underwater cave without running out of oxygen and the minimum total time that he has to spend refilling in order to do so.

Input Format

n k d p
y_1 y_2 $\ldots$ y_{n}
t_1 t_2 $\ldots$ t_{n}

The first line contains n (the number of stations), k (initial oxygen supply), d (the final depth that has to be reached), and p (the amount of oxygen that is refilled at each station).
The second line contains the list of y_{i} corresponding to the depths of the stations.
The third line contains the list of t_{i} corresponding to the refilling time of the stations.
All these variables are integers.

Output Format

If it is possible for Percy to reach the depth d, print the minimum total time that he has to spend at the stations.
If it is not possible for him to reach depth d, print -1 followed by the maximum depth that he can reach before his oxygen level goes to 0.

Constraints

- $1 \leq n \leq 2e5$
- $1 \leq k, d, p \leq 1e9$
- $1 \leq y_{\text{i}} \leq d - 1$
- $1 \leq t_{\text{i}} \leq 1e9$
- y_{i} are all distinct

Sample Testcases

Input 1

3 10 20 6
7 2 14
3 8 4

Output 1

7

Explanation 1

Percy has to reach a depth of 20. He cannot reach it with the initial oxygen supply he has. Therefore, he refills oxygen at the stations located at depths 7 and 14, gaining 6 units of oxygen at each station, with a minimal total refilling time of 7 to be able to reach the depth of 20.

Input 2

2 7 15 4
7 11
3 5

Output 2

8

Explanation 2

Percy has to reach a depth of 15. He cannot reach it with the initial oxygen supply he has. Therefore, he refills oxygen at the stations located at depths 7 and 11, gaining 4 units of oxygen at each station, with a minimal total refilling time of 8 to be able to reach the depth of 15.

Input 3

4 12 22 3
18 8 19 16
1 2 3 4

Output 3

−1 15

Explanation 3

Percy has to reach a depth of 22. He cannot reach it with the initial oxygen supply he has. He refills oxygen at the station located at depth 8 and is able to reach a depth of 15. But he runs out of oxygen at this point and cannot go any further.

Subtask 2 (35 points)

Luckily Percy made it safely to the caves located deep on the ocean floor. Now he gets to explore the various chambers present there. However, he again has an oxygen issue. As per safety guidelines, each chamber has a certain minimum oxygen level limit that the diver needs to have before entering it. At the same time, after visiting each chamber, Percy either loses certain amount of oxygen (due to consumption) or ends up gaining some (due to presence of air pockets). Percy is curious and wants to know whether it will be possible for him to visit all the chambers without running out of oxygen.

Percy initially starts with k amount of oxygen. There are n chambers, where the i^{th} chamber has a minimum oxygen requirement of x_{i} and after visiting the chamber, his oxygen level changes by y_{i} amount.

You have to help Percy again by letting him know whether it is possible for him to visit **all** the chambers in **any order** without running out of oxygen. He can visit one chamber **only once**.

Input Format

n k
x_1 x_2 $\ldots$ x_{n}
y_1 y_2 $\ldots$ y_{n}

The first line contains n (the number of chambers), and k (initial oxygen supply).
The second line contains the list of x_{i} corresponding to the minimum oxygen requirements of entering the i^{th} chamber.
The third line contains the list of y_{i} corresponding to the change in Percy's oxygen level after he is done visiting the i^{th} chamber.
All these variables are integers.

Output Format

You need to output "YES" or "NO" (case sensitive) based on whether it is possible for him to visit all the chambers or not.

Constraints

There are two sets of constraints, which differ only in the range of n. The points of this Subtask are split based on the value of this range.

Set 1 (10 Points)

- $1 \leq n \leq 10$
- $1 \leq k \leq 30000$
- $1 \leq x_i \leq 30000$
- $-300 \leq y_i \leq 300$

Set 2 (25 Points)

- $1 \leq n \leq 100$
- $1 \leq k \leq 30000$
- $1 \leq x_i \leq 30000$
- $-300 \leq y_i \leq 300$

Sample Testcases

Input 1

3 5
3 6 1
−4 −3 6

Output 1

YES

Explanation 1

Percy wants to visit all the 3 chambers. He initially has 5 units of oxygen. He goes to the first chamber and is left with 1 unit. Then he goes to the third chamber and is left with 7 units. Lastly, he visits the second chamber and is left with 4 units of oxygen.

Input 2

2 7
7 3
−4 −3

Output 2

YES

Explanation 2

Percy wants to visit all the 2 chambers. He initially has 7 units of oxygen. He goes to the first chamber and is left with 3 units. Then he visits the second chamber and is left with 0 units of oxygen.

Input 3

2 5
2 2
−3 −4

Output 3

NO

Explanation 3

Percy wants to visit all the 2 chambers. He initially has 5 units of oxygen. One way he can try is going to the first chamber in the first go and be left with 2 units, with which he can enter the second chamber, but then run out of oxygen. The other way is he can go to second chamber in the first attempt, but this leaves him with only 1 unit afterwards, with which he cannot enter the first chamber.