Coding Assignment 1

ECS 122A Algorithm Design and Analysis

Radio Tower Coverage

Problem Description

In ByteLand, there are n cities located along the x axis with the i^{th} city located at $(A_i, 0)$.

In ByteLand, a telecommunications company manufactures radio towers. A radio tower provides coverage to all cities that are at most d units from it. More precisely, if the radio tower is placed at point $(x, 0)$, it provides service to the i^{th} city if and only if $|x - A_i| \leq d$.

The citizens of ByteLand want to figure out where to place the radio tower to cover the maximum number of cities. To help them with this task, answer the following questions.

- If a radio tower is placed inside city i, i.e., at $(A_i, 0)$, then how many cities does it cover?
- What is the maximum number of cities a single radio tower can cover? Note that for this question, it is **not** necessary for the tower to be located in a city. You can place it *anywhere* on the x axis.

Print the answer to each question in a separate line.

Input

The input format is as shown below.

n	d		
A_1	A_2	$\ldots$	A_n

More precisely, the input consists of two lines:

- The first line contains two space-separated integers n, d.
- The second line contains n space-separated integers $A_1, A_2, \ldots A_n$.

It is guaranteed that the city locations are given in increasing order, i.e., $A_i > A_{i-1}$ holds for $1 < i \leq n$.

Output

Output $n + 1$ lines, where the i^{th} line contains a single integer, the answer to the i^{th} question.

- For $1 \leq i \leq n$, print the number of cities covered by a tower located at $(A_i, 0)$.
- For $i = n + 1$, print the maximum number of cities a single radio tower can cover.

Please ensure the last line ends with a newline character '\n.'

Constraints

- $1 \leq n \leq 10^5$
- $1 \leq d \leq 10^9$
- $1 \leq A_i \leq 10^9$ and $A_i > A_{i-1}$ for $i > 1$
- The time limit is 1 second for C/C++ and 3 seconds for Python.

Test Cases

Your program will be evaluated on 5 visible test cases and 5 hidden test cases. Each test case is worth 0.8 points.

Sample Input 1:

```
4 3
1 3 5 7
```

Sample Output 1:

```
2
3
3
2
4
```

Sample Explanation

The x-coordinates of the cities are $A = (1, 3, 5, 7)$. The radius of coverage is $d = 3$. The answers to the questions are as follows.

- If a tower is placed at $(1, 0)$ then it covers all cities whose x coordinates are in the range $[-2, 4]$. Only the first two towers lie in this range. Hence, the answer is 2.
- A tower is placed at $(3, 0)$ covers all towers except the fourth tower.
- A tower is placed at $(5, 0)$ covers all towers except the first tower.
- A tower is placed at $(7, 0)$ covers the third and fourth towers.
- We can cover all four towers by placing a tower at $(4, 0)$. Hence, the answer is 4. Note that in this case, there is **no city** in the optimal location at which a tower should be placed.

Submission Guideline

Write your program in either C, C++, or Python **in a single file**. Submit the file on Gradescope. The time limit on Gradescope is 1 second for C/C++ and 3 seconds for Python. You can make at most **10** submission attempts.