

Q9 Minimize the maximum difference b/w heights.
(Level-1)

$$i/p \rightarrow \{1, 5, 8, 10\} \quad k = 2$$

$$o/p \rightarrow 5$$

$$\text{Initial difference} = 10 - 1 = 9$$

Now we can increase tower1 height & decrease tower2 height by k .

$$1 + 2 = 3$$

$$10 - 2 = 8$$

$8 - 3 = 5$ now difference has reduced but the answer for each & every case won't be simple one.

Dry run (Sort the array first)

$$\{1, 2, 2, 2, 3, 3, 4, 6, 7, 10\}, k = 5$$

$$1) \text{mini} = \text{arr}[0] = 1$$

$$\text{maxi} = \text{arr}[n-1] = 10$$

$$\text{diff} = \text{maxi} - \text{mini} = 10 - 1 = 9$$

Loop from $i=1$ to n

$$i=1 \quad \text{fix} \uparrow \quad \text{Trying to get new min}$$

$$\text{mini} = \min(\text{arr}[0]+k, \text{arr}[i]-k);$$

$$\text{maxi} = \max(\text{arr}[i-1]+k, \text{arr}[n-1]-k);$$

\nearrow Trying to get new max \searrow fix

$$\text{mini} = \min(6, -3) = -3$$

$$\text{maxi} = \max(5, 5) = 6$$

$$\text{diff} = \min(\text{diff}, \text{maxi}-\text{mini}) = \min(9, 9) = 9$$

$$i^{\circ} = 2$$

$$\text{arr}[i] - k = 2 - 5 = -3$$

$$\text{arr}[i-1] + k = 2 + 5 = 7$$

$$\text{mini} = \min(6, -3) = -3$$

$$\text{maxi} = \max(7, 5) = 7$$

$$\text{diff} = \min(\text{diff}, \text{maxi} - \text{mini}) = \min(9, 10) = 9$$

$$i^{\circ} = 3$$

$$\text{arr}[i] - k = 2 - 5 = -3$$

$$\text{arr}[i-1] + k = 2 + 5 = 7$$

$$\text{mini} = \min(6, -3) = -3$$

$$\text{maxi} = \max(7, 5) = 7$$

$$\text{diff} = \min(9, 10) = 9$$

$$i^{\circ} = 4$$

$$\text{arr}[i] - k = 3 - 5 = -2$$

$$\text{arr}[i-1] + k = 2 + 5 = 7$$

$$\text{mini} = \min(6, -2) = -2$$

$$\text{maxi} = \max(7, 5) = 7$$

$$\text{diff} = \min(9, 9) = 9$$

$$i^{\circ} = 5$$

$$\text{arr}[i] - k = 3 - 5 = -2$$

$$\text{arr}[i-1] + k = 3 + 5 = 8$$

$$\text{mini} = \min(6, -2) = -2$$

$$\text{maxi} = \max(8, 5) = 8$$

$$\text{diff} = \min(9, 10) = 9$$

$$i^{\circ} = 6$$

$$\text{arr}[i] - k = 4 - 5 = -1$$

$$\text{arr}[i-1] + k = 3 + 5 = 8$$

$$\text{mini} = \min(6, -1) = -1$$

$$\text{maxi} = \max(8, 5) = 8$$

$$\text{diff} = \min(9, 9) = 9$$

$$i^{\circ} = 7$$

$$\text{arr}[i] - k = 6 - 5 = 1$$

$$\text{arr}[i-1] + k = 4 + 5 = 9$$

$$\text{mini} = \min(6, 1) = 1$$

$$\text{maxi} = \max(9, 5) = 9$$

$$\text{diff} = \min(9, 8) = 8$$

$$i^{\circ} = 8$$

$$\text{arr}[i] - k = 7 - 5 = 2$$

$$\text{arr}[i-1] + k = 6 + 5 = 11$$

$$\text{mini} = \min(6, 2) = 2$$

$$\text{maxi} = \max(11, 5) = 11$$

$$\text{diff} = \min(8, 9) = 8$$

$$i = 9$$

$$\text{arr}[i] - k = 10 - 5 = 5$$

$$\text{arr}[i-1] + k = 7 + 5 = 12$$

$$\text{mini} = \min(6, 5) = 5$$

$$\text{maxi} = \max(12, 5) = 12$$

$$\text{diff} = \min(8, 7) = 7$$

$\hookrightarrow 12 - 5 = 7$

Hence answer is 7.

Important questions

1) Why we are doing $\text{arr}[i-1] + k$ and $\text{arr}[i] - k$?

$\text{arr}[i-1] + k \Rightarrow$ To find new largest
 $\text{arr}[i] - k \Rightarrow$ To find new smallest.

We started $i=1$ in the loop as we were doing $i-1$ inside the index.

2) What if negative towers are not allowed i.e. height of tower can't be negative?
 Just we have to add one if condition i.e.
 $\text{if } (\text{arr}[i] - k < 0)$

continue;

↳ skip that iteration

This is the level-2 of the above question.

Code

```
int getMinDiff (int arr[], int n, int k){
```

// Step-1 Sort the array

sort (arr, arr+n);

// Initial setup

int mini = arr[0];

int maxi = arr[n-1];

int diff = maxi - mini;

// Iterate the array

for (int i=1; i<n; i++) {

// Extra condition for level - 2

if (arr[i] - k < 0) {

 continue; // skip the iteration

// Step-2 \Rightarrow Try to find new smallest tower

$mini = \min (arr[0] + k, arr[i] - k);$

// Step-3 \Rightarrow Try to find new largest tower

$maxi = \max (arr[i-1] + k, arr[n-1] - k);$

// Step-4 \Rightarrow Update final answer

$diff = \min (diff, maxi - mini);$

↳ because we have to find minimum height difference

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return diff;

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↑ Sorting

Time complexity = $O(n \log n)$

Space complexity = $O(1)$