Experiment 4

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Semester: 6 **Date of Performance: 14/02/2025**
Subject Name:AP2 **Subject Code: 22ITP-351**

1. **Aim:** Implement the following problem:- Longest Nice Substring, Reverse Bits, Number of 1 bits, Max Subarray, Search 2d matrix 2,Super Pow,Beautiful Array,The Skyline Problem, Reverse Pairs, Longest increasing subsequence 2.

2. **Objective:** **T**o develop a deep understanding and proficiency in solving a variety of algorithmic challenges, including string manipulation, bit manipulation, dynamic programming, array operations, matrix manipulation, and mathematical computations. Focus will be on improving skills in problem-solving, algorithm design, and optimizing solutions for efficiency.

3. **Implementation/Code:**

(A) Longest Nice Substring

```
public class Solution {
public String longestNiceSubstring(String s) {
if (s.length() <= 1) return ""; for
(int i = 0; i < s.length(); i++) { if
(!isNice(s.charAt(i), s)) {
String left = longestNiceSubstring(s.substring(0, i));
String right = longestNiceSubstring(s.substring(i + 1));
return left.length() > right.length() ? left : right;
} }
return
s; }
private boolean isNice(char ch, String s) {
return s.contains(String.valueOf(Character.toLowerCase(ch))) &&
s.contains(String.valueOf(Character.toUpperCase(ch)));
}
}
```

(B) Reverse Bits public class

```
Solution { public int
reverseBits(int n) { int result
= 0; for (int i = 0; i < 32; i++)
{ result = result << 1;
result |= (n & 1);
n >>>= 1;
}        return
result;
}
}
```

(C) Number of 1 Bits

```
class     Solution     {
public:
int hammingWeight(uint32_t n) {
int count = 0;
while (n) { n
&= (n - 1);
count++;
}        return
count;
}
};
```

(D) Maximum Subarray

```
public  class  Solution  {  public  int
maxSubArray(int[]    nums)    {    int
maxSum = nums[0]; int currentSum =
nums[0];
for  (int  i  =  1;  i  <  nums.length;  i++)  {  currentSum  =
Math.max(nums[i], currentSum + nums[i]);
maxSum = Math.max(maxSum, currentSum);
}
return maxSum;
}
}
```

(E) Search a 2D Matrix II

```
public class Solution {
public boolean searchMatrix(int[][] matrix, int target) {
```

```
if (matrix == null || matrix.length == 0 || matrix[0].length == 0)
{ return false; } int row = 0; int col = matrix[0].length - 1; while
(row < matrix.length && col >= 0) { if (matrix[row][col] ==
target) { return true;
} else if (matrix[row][col] < target) {
row++;
} else { col-
-; } } return
false;
}
}
```

(F) Super Pow public class

```
Solution { private static final int
MOD = 1337;
public int superPow(int a, int[] b) {
a = a % MOD;
int result = 1;
for (int i = b.length - 1; i >= 0; i--) { result =
(result * modExp(a, b[i])) % MOD; a =
modExp(a, 10) % MOD;
} return
result; }
private int modExp(int base, int exp) {
int result = 1;
base = base % MOD; while (exp
> 0) { if (exp % 2 == 1) { result
= (result * base) % MOD;
}
base = (base * base) % MOD; exp
/= 2;
}
return result;
}
}
```

(G) Beautiful Array public

```
class Solution {
```

```
public int[] beautifulArray(int N) { List<Integer>
res = new ArrayList<>();
res.add(1);
while (res.size() < N) {
List<Integer> temp = new ArrayList<>();
for (int x : res) { if (x * 2 - 1 <= N) {
temp.add(x * 2 - 1);
} } for (int x :
res) { if (x * 2
<= N) {
temp.add(x * 2);
} } res =
temp; }
return res.stream().mapToInt(i -> i).toArray();
}
}
```

(H) The Skyline Problem public class Solution { public

```
List<List<Integer>> getSkyline(int[][] buildings) {
List<List<Integer>> result = new ArrayList<>();
List<int[]> heights = new ArrayList<>(); for
(int[] b : buildings) { heights.add(new int[]{b[0],
-b[2]}); heights.add(new int[]{b[1], b[2]});
}
Collections.sort(heights, (a, b) -> a[0] == b[0] ? a[1] - b[1] : a[0] - b[0]); PriorityQueue<Integer> pq
= new PriorityQueue<>(Collections.reverseOrder()); pq.add(0); int prevMaxHeight = 0; for (int[] h
: heights) { if (h[1] < 0) { pq.add(-h[1]); } else { pq.remove(h[1]);
}
int currentMaxHeight = pq.peek(); if
(currentMaxHeight != prevMaxHeight) {
result.add(Arrays.asList(h[0], currentMaxHeight));
prevMaxHeight = currentMaxHeight;
} }
return result;
}
}
```

(I) Reverse Pairs public class

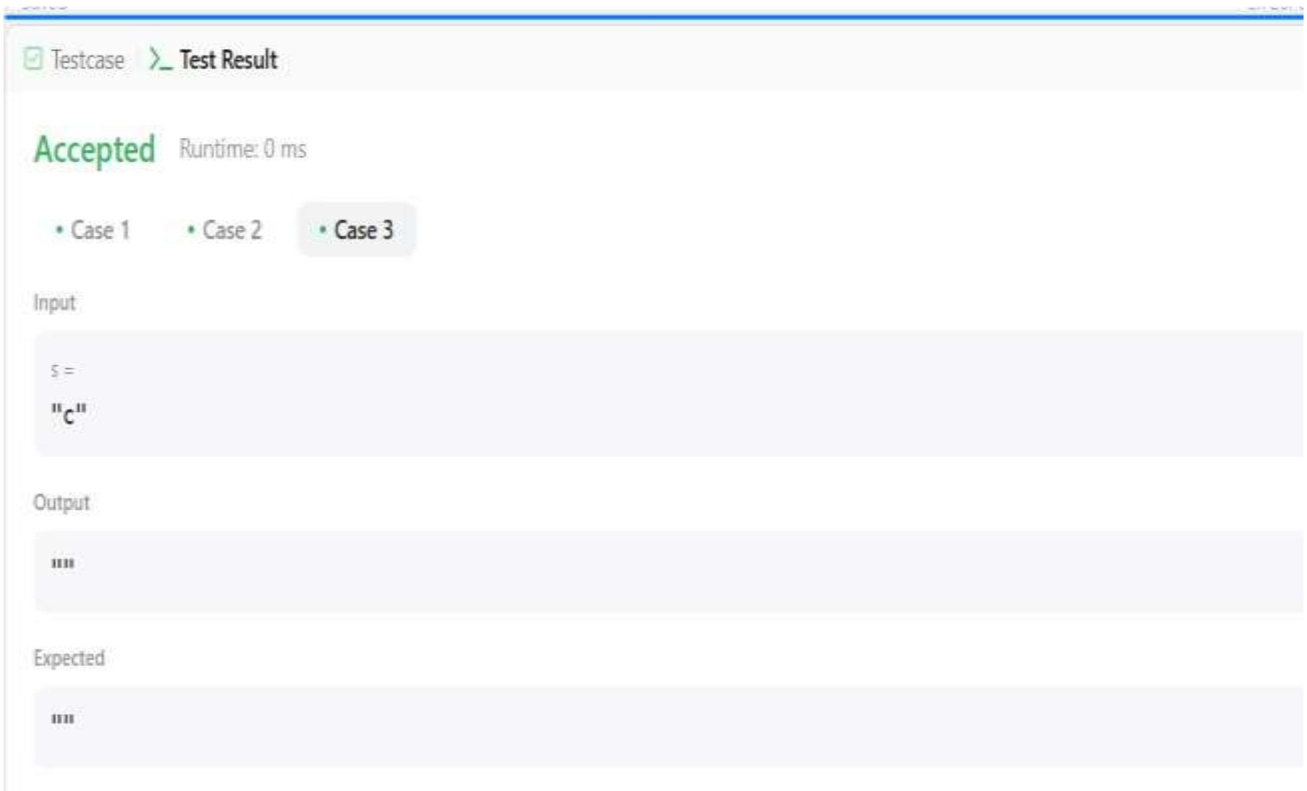
```
Solution { public int reversePairs(int[]
nums) { if (nums == null ||
nums.length <= 1) {
return 0; }
return mergeSort(nums, 0, nums.length - 1);
}
private int mergeSort(int[] nums, int left, int right) {
if (left >= right) return 0; int mid = left + (right - left)
/ 2;
int count = mergeSort(nums, left, mid) + mergeSort(nums, mid + 1, right); int
j = mid + 1;
for (int i = left; i <= mid; i++) {
while (j <= right && nums[i] > 2L * nums[j])
{ j++; }
count += (j - (mid + 1));
}
merge(nums, left, mid, right);
return count; }
private void merge(int[] nums, int left, int mid, int right) {
int[] temp = new int[right - left + 1]; int i = left, j = mid +
1, k = 0; while (i <= mid && j <= right) { if (nums[i] <=
nums[j]) {
temp[k++] = nums[i++];
} else {
temp[k++] = nums[j++];
} } while (i <=
mid) {
temp[k++] = nums[i++];
} while (j <= right)
{
temp[k++] = nums[j++];
}
System.arraycopy(temp, 0, nums, left, temp.length);
}
}
```

(J) Longest Increasing Subsequence II

```
class Solution {
class SegmentTree {
int[] tree;
int n;
SegmentTree(int size) {
n = size; tree = new
int[4 * n];
}
void update(int index, int value, int left, int right, int node) {
if (left == right) { tree[node] = value; return; }
int mid = (left + right) / 2;
if (index <= mid) update(index, value, left, mid, 2 * node + 1); else update(index, value, mid + 1,
right, 2 * node + 2); tree[node] = Math.max(tree[2 * node + 1], tree[2 * node + 2]);
}
int query(int ql, int qr, int left, int right, int node) { if
(ql > right || qr < left) return 0;
if (ql <= left && qr >= right) return tree[node]; int
mid = (left + right) / 2;
return Math.max(query(ql, qr, left, mid, 2 * node + 1), query(ql, qr, mid + 1, right, 2 * node + 2));
} void update(int index, int value)
{ update(index, value, 0, n - 1, 0);
} int query(int ql, int qr) {
return query(ql, qr, 0, n - 1, 0);
} }
public int lengthOfLIS(int[] nums, int k) { int maxVal =
0; for (int num : nums) maxVal = Math.max(maxVal,
num); SegmentTree segTree = new
SegmentTree(maxVal + 1); int result = 0; for (int num :
nums) {
int maxLen = segTree.query(Math.max(0, num - k), num - 1) + 1;
segTree.update(num, maxLen); result = Math.max(result,
maxLen);
}
return result;
}
}
```

4. Output:

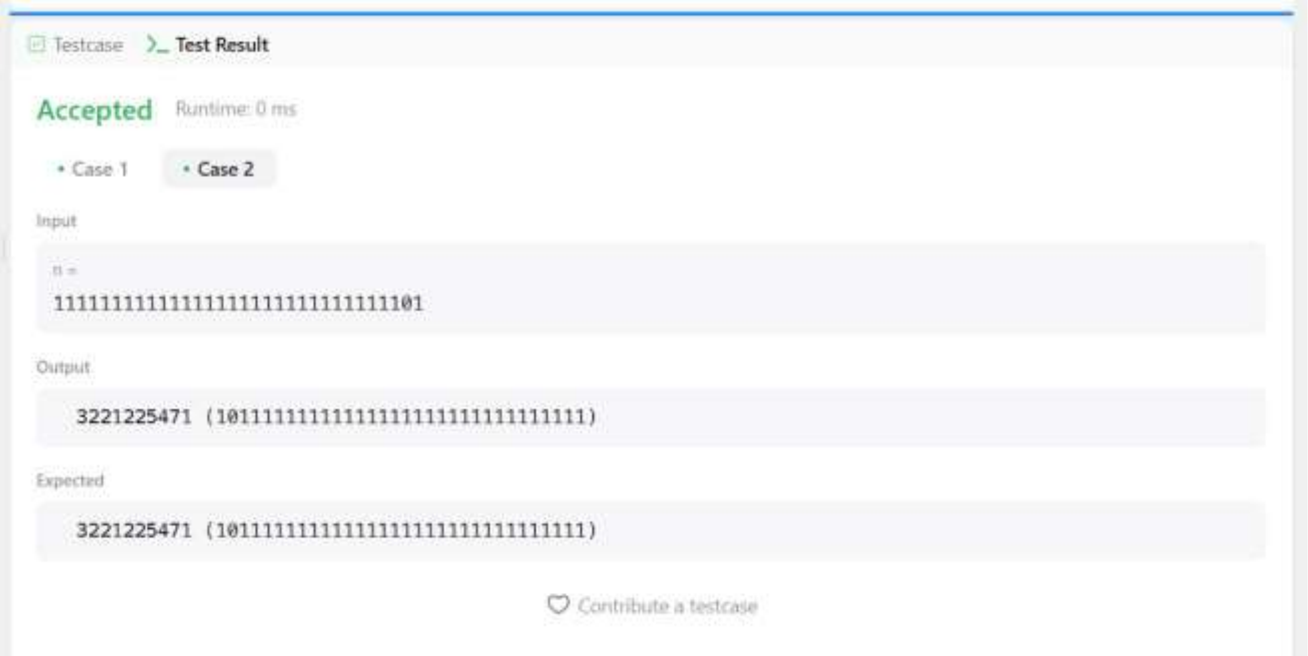
(A) Longest Nice Substring



Accepted Runtime: 0 ms

```
Input

s =
"c"

Output

""

Expected

""
```

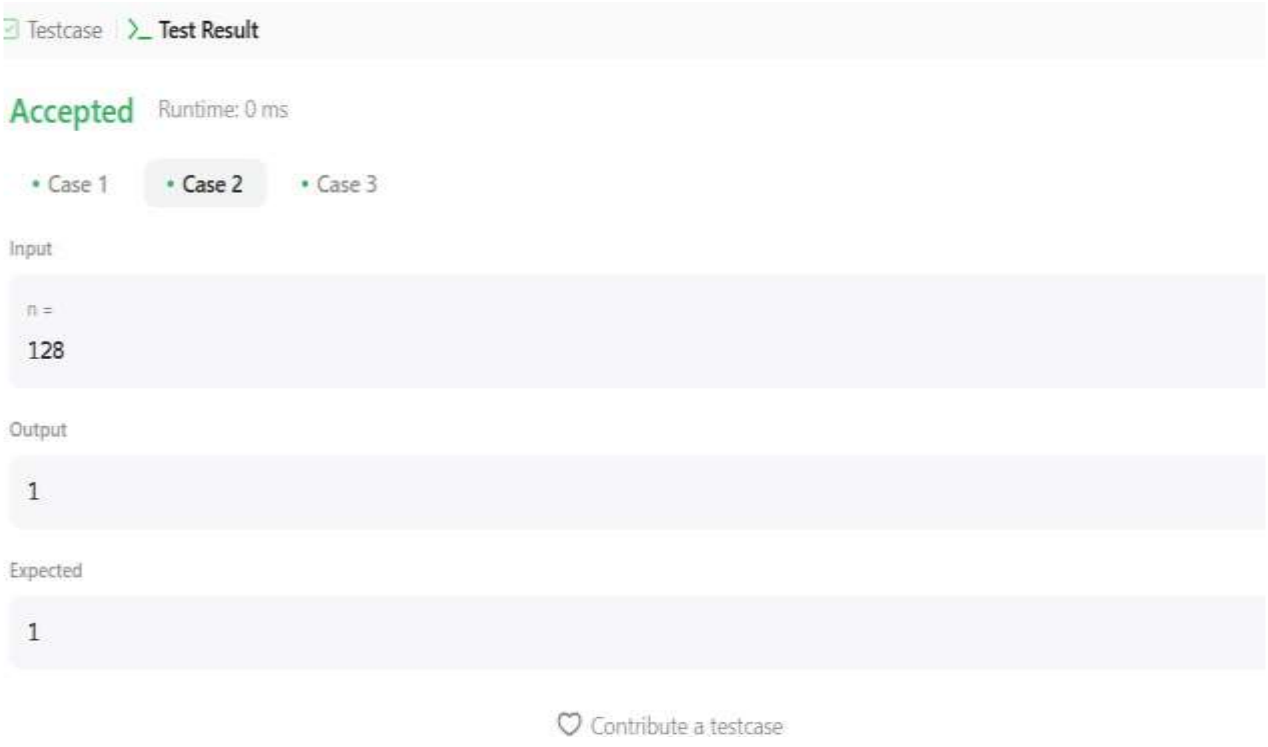
(B) Reverse Bits



Accepted Runtime: 0 ms

```
Input

n =
11111111111111111111111111111101

Output

3221225471 (10111111111111111111111111111111)

Expected

3221225471 (10111111111111111111111111111111)
```

(C) Number of 1 Bits



Accepted Runtime: 0 ms

Input

n =
128

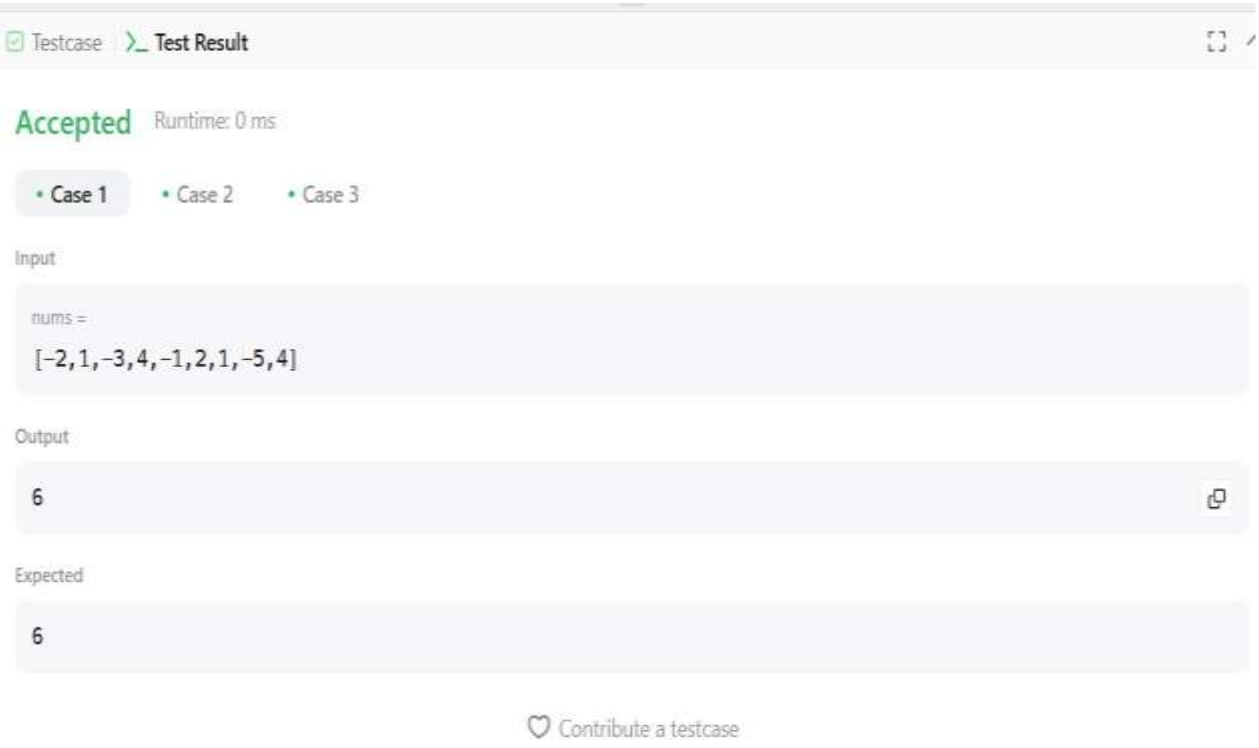
Output

1

Expected

1

(D) Maximum Subarray



Accepted Runtime: 0 ms

Input

nums =
[-2,1,-3,4,-1,2,1,-5,4]

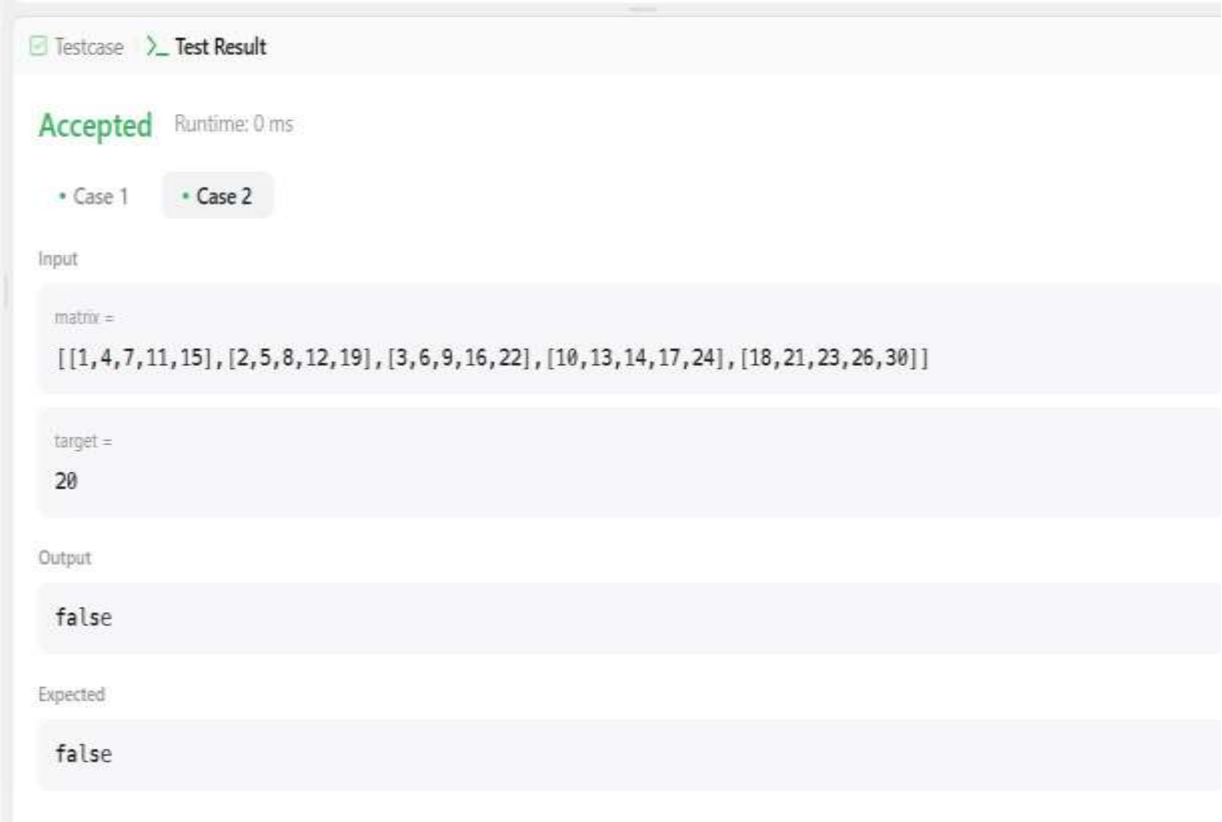
Output

6

Expected

6

(E) Search a 2D Matrix II



Accepted Runtime: 0 ms

Input

matrix =

```
[[1,4,7,11,15],[2,5,8,12,19],[3,6,9,16,22],[10,13,14,17,24],[18,21,23,26,30]]
```

target =

```
20
```

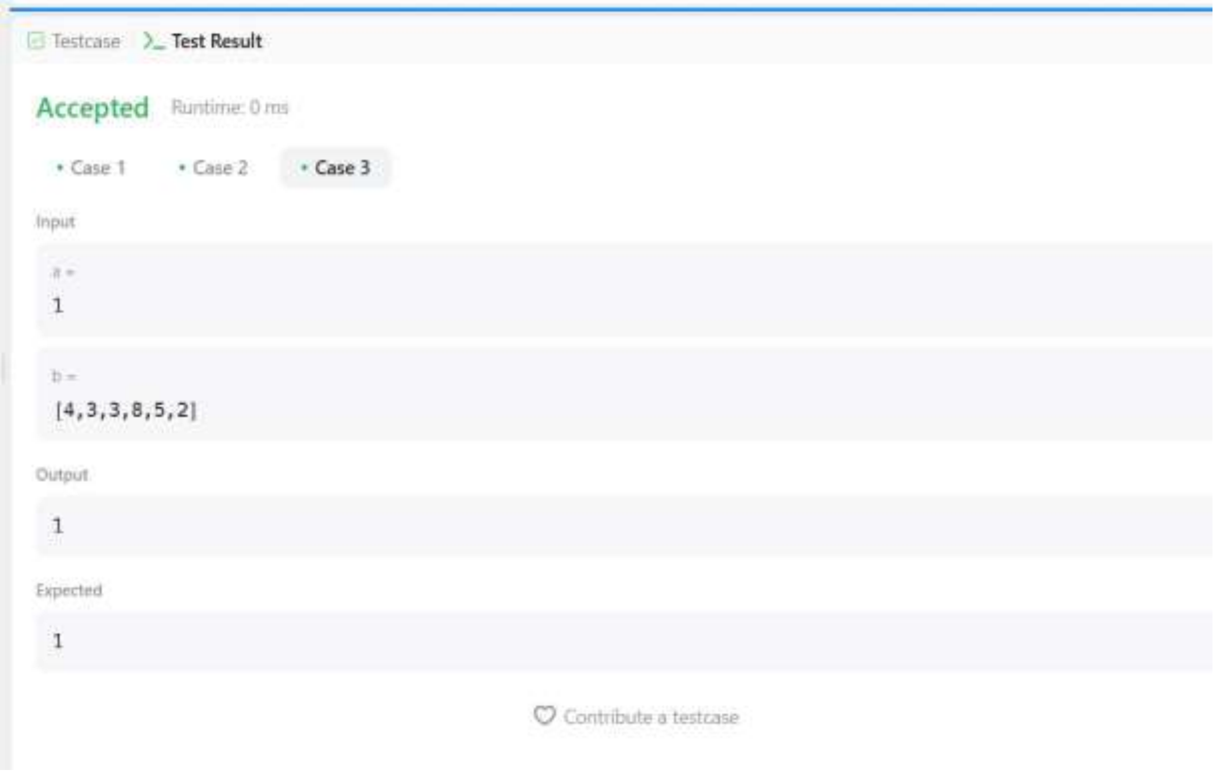
Output

```
false
```

Expected

```
false
```

(F) Super Pow



Accepted Runtime: 0 ms

Input

a =

```
1
```

b =

```
[4,3,3,8,5,2]
```

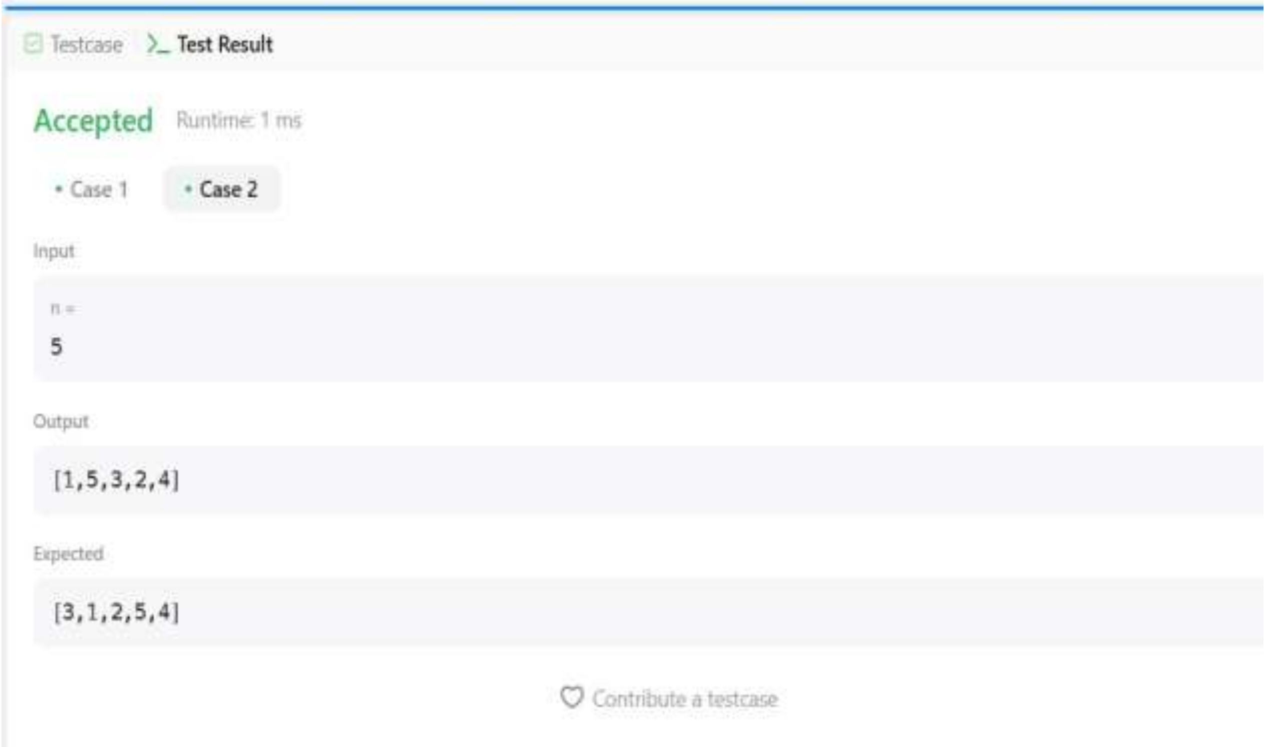
Output

```
1
```

Expected

```
1
```

(G) Beautiful Array



Accepted Runtime: 1 ms

Input

n =

```
5
```

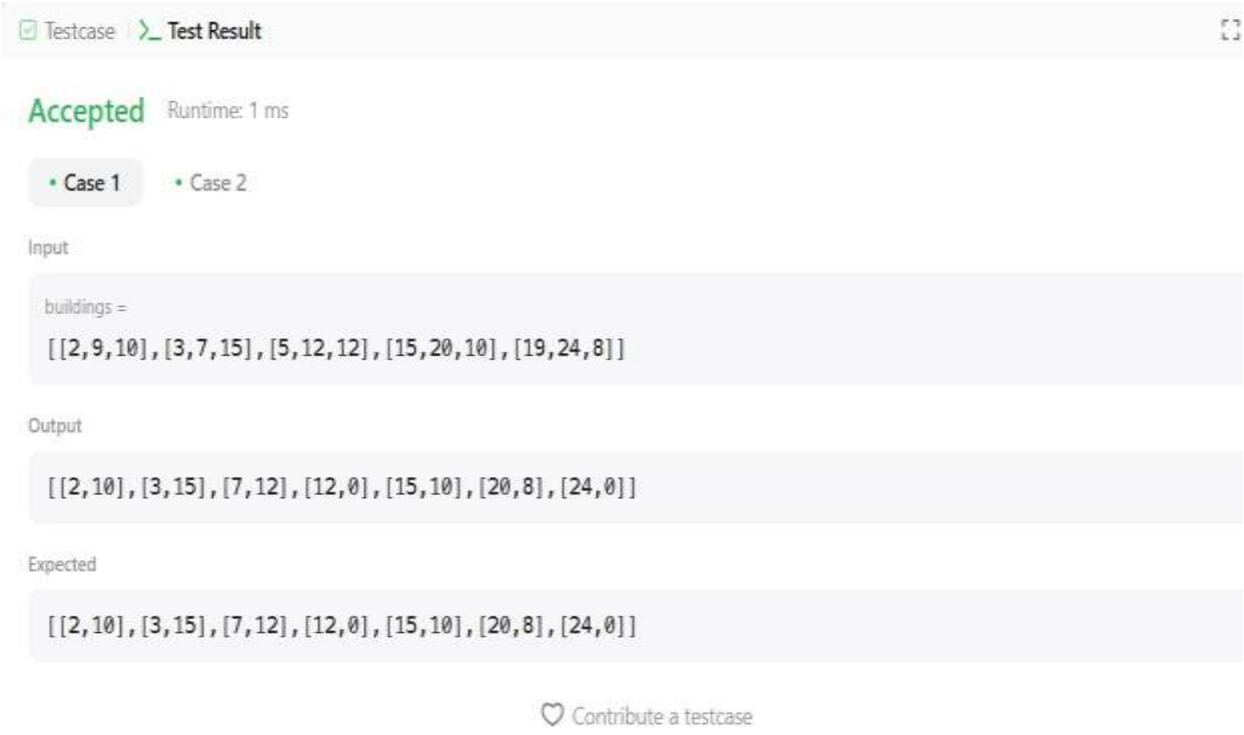
Output

```
[1,5,3,2,4]
```

Expected

```
[3,1,2,5,4]
```

(H) The Skyline Problem



Accepted Runtime: 1 ms

Input

buildings =

```
[[2,9,10],[3,7,15],[5,12,12],[15,20,10],[19,24,8]]
```

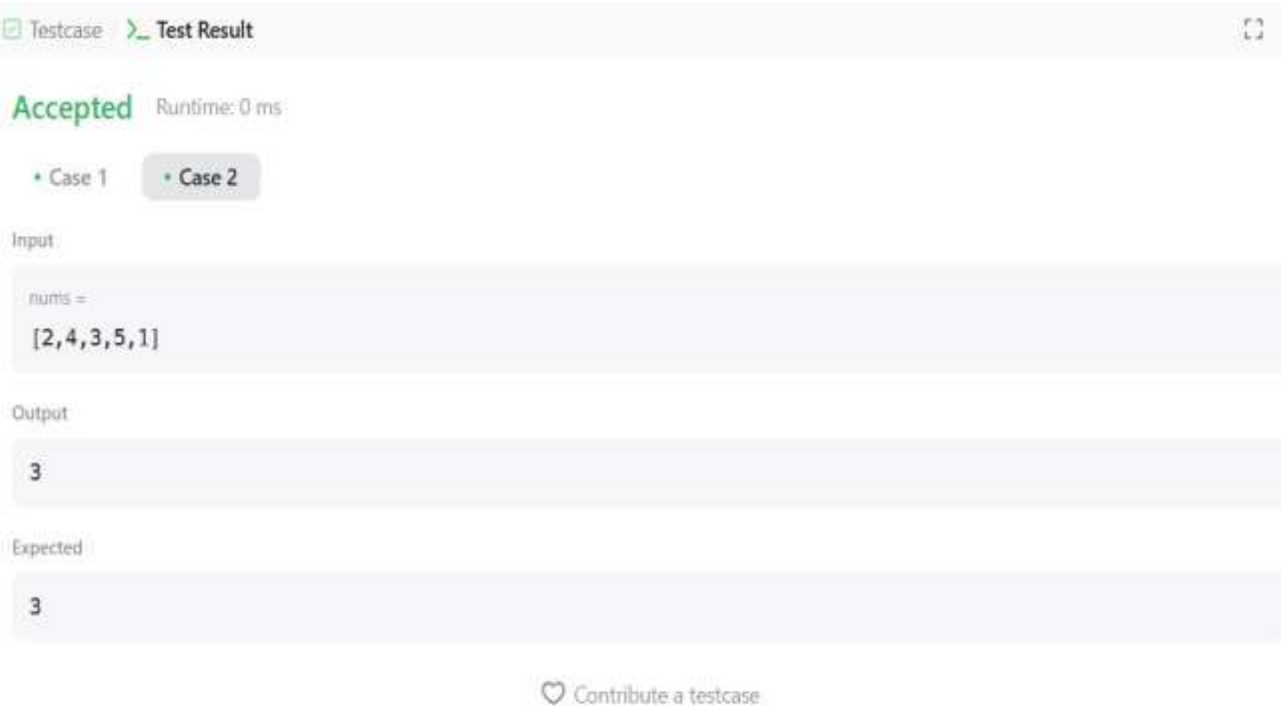
Output

```
[[2,10],[3,15],[7,12],[12,0],[15,10],[20,8],[24,0]]
```

Expected

```
[[2,10],[3,15],[7,12],[12,0],[15,10],[20,8],[24,0]]
```

(I) Reverse Pairs



Accepted Runtime: 0 ms

Input

```
nums =
[2,4,3,5,1]
```

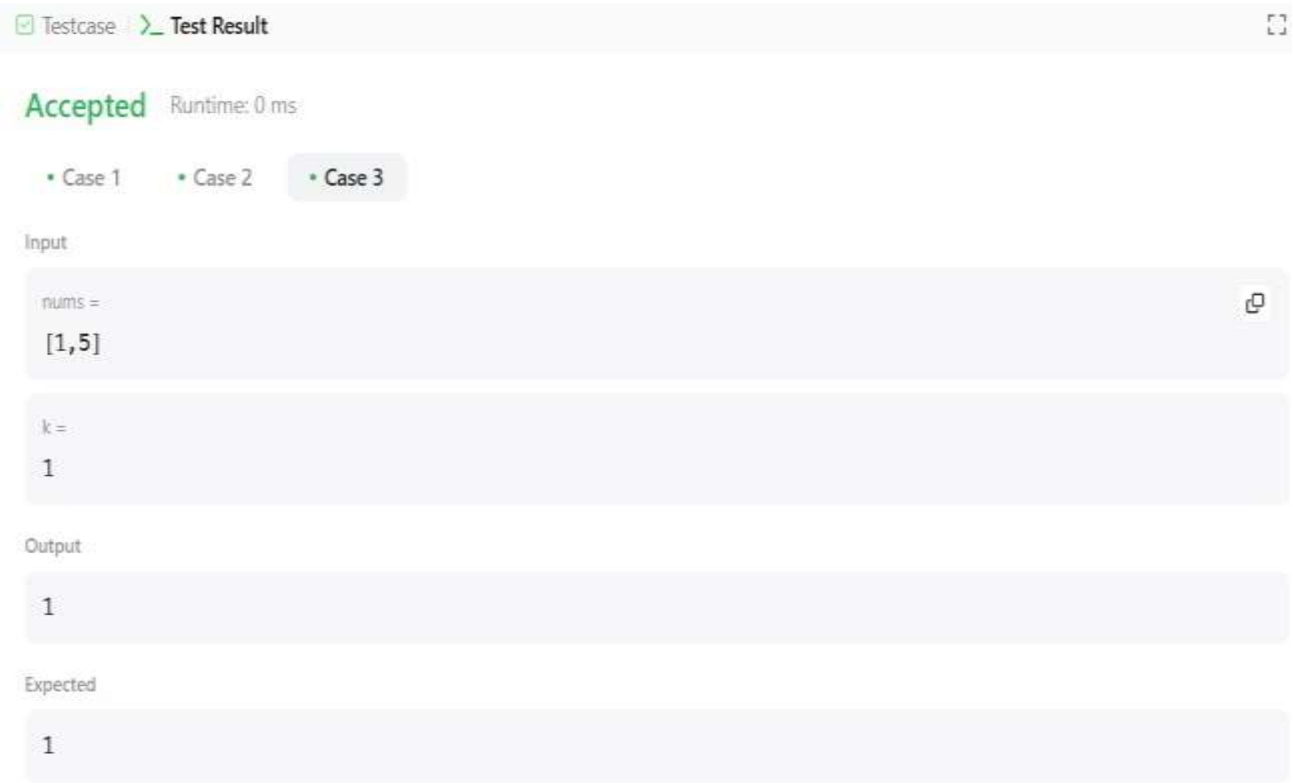
Output

```
3
```

Expected

```
3
```

(J) Longest Increasing Subsequence II



Accepted Runtime: 0 ms

Input

```
nums =
[1,5]
```

```
k =
1
```

Output

```
1
```

Expected

```
1
```

5. Learning Outcomes:-

- Understanding how binary representation and bitwise operations (&, |, ^, >>, <<) optimize problem-solving.
- Learning how to make optimal choices at each step (like Kadane’s Algorithm) to improve efficiency.
- Reducing brute-force approaches ($O(n^2)$ or worse) to more efficient ones ($O(n)$ or $O(\log n)$) for better performance.
- Breaking problems into smaller parts, identifying patterns, and applying the right algorithm.
- Writing clean, efficient code, avoiding logical errors, and testing with edge cases.