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Experiment 4

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Subject Name: Advanced Programming Lab-2

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- **Aim:**

1. To find the longest substring where every character appears in both lowercase and uppercase.
2. To reverse the bits of a given 32-bit unsigned integer.
3. To count the number of 1 bits in a given 32-bit integer (Hamming Weight).
4. To find the contiguous subarray (within a one-dimensional array) that has the largest sum (Kadane's Algorithm / Divide & Conquer).
5. To search for a target integer in a matrix where each row is sorted left to right and each column is sorted top to bottom.
6. To compute (a^b) % 1337 efficiently using modular exponentiation.
7. To construct an array that avoids arithmetic sequences while keeping distinct integers.
8. To determine the skyline formed by a given set of buildings using a Divide & Conquer or Heap-based approach.
9. To count the number of reverse pairs (i, j) where i < j and nums[i] > 2 * nums[j], using a Merge Sort-based approach**.**
10. To find the longest increasing subsequence with a maximum difference constraint using a Segment Tree**.**

- **Code:**

1. Longest Nice Substring

```
class Solution {
    public String longestNiceSubstring(String s) {
        if (s.length() < 2) return "";
        Set<Character> set = new HashSet<>();
        for (char c : s.toCharArray()) {
            set.add(c);
        }
        for (int i = 0; i < s.length(); i++) {
            char c = s.charAt(i);
            if(set.contains(Character.toUpperCase(c))&&set.contains(Character.toLowerCase(c)))
{
                continue; }
            String left = longestNiceSubstring(s.substring(0, i));
            String right = longestNiceSubstring(s.substring(i + 1));
            return left.length() >= right.length() ? left : right;
        }
        return s;
    }
}
```

2. Reverse Bits

```
class Solution {
    // Function to reverse bits of a given 32 bits unsigned integer
    public int reverseBits(int n) {
        int result = 0;
        for (int i = 0; i < 32; i++) {
            result <<= 1; // Shift result to the left by 1
            result |= (n & 1); // Extract the last bit of n and add it to result
            n >>= 1; // Shift n to the right by 1 to process the next bit
        }
        return result;
    }
}
```

3. Number of 1 Bits

```
class Solution {
    // Function to count the number of 1 bits in a given 32 bits unsigned integer
    public int hammingWeight(int n) {
        int count = 0;
        while (n != 0) {
            count += (n & 1); // Add the last bit of n to count
            n >>>= 1; // Unsigned right shift n to process the next bit
        }
        return count;
    }
}
```

4. Maximum Subarray

```
class Solution {
    // Function to find the maximum subarray sum using Kadane's Algorithm
    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;
    }
}
```

5. Search a 2D Matrix

```
class Solution {
    public boolean searchMatrix(int[][] matrix, int target) {
        int rows = matrix.length;
        int cols = matrix[0].length;
        int row = 0, col = cols - 1;
        while (row < rows && col >= 0) {
            if (matrix[row][col] == target) {
                return true;
            } else if (matrix[row][col] > target) {
                col--;
            } else {
                row++;
            }
        }
        return false;
    }
}
```

6. Super Pow

```
class Solution {
    public int superPow(int a, int[] b) {
        int mod = 1337;
        a %= mod;
        return powerMod(a, b, mod);
    }
    private int powerMod(int a, int[] b, int mod) {
        int result = 1;
        for (int i = 0; i < b.length; i++) {
            result = power(result, 10, mod) * power(a, b[i], mod) % mod;
        }
        return result; }
    private int power(int x, int y, int mod) {
        int result = 1;
        while (y > 0) {
            if (y % 2 == 1) {
                result = result * x % mod;
            }
            x = x * x % mod;
            y /= 2;
        }
        return result;
    }
}
```

7. Beautiful Array

```
class Solution {
    public int[] beautifulArray(int n) {
        List<Integer> result = new ArrayList<>();
        result.add(1);
        while (result.size() < n) {
            List<Integer> temp = new ArrayList<>();
            for (int num : result) {
                if (num * 2 - 1 <= n) {
                    temp.add(num * 2 - 1); // Odd numbers
                }
            }
            for (int num : result) {
                if (num * 2 <= n) {
                    temp.add(num * 2); // Even numbers
                }
            }
            result = temp;
        }
        return result.stream().mapToInt(i -> i).toArray();
    }
}
```

8. The Skyline Problem

```
import java.util.*;
class Solution {
    public List<List<Integer>> getSkyline(int[][] buildings) {
        if (buildings == null || buildings.length == 0) return new ArrayList<>();
        return divideAndConquer(buildings, 0, buildings.length - 1);
    }
    private List<List<Integer>> divideAndConquer(int[][] buildings, int left, int right) {
        if (left == right) {
            List<List<Integer>> result = new ArrayList<>();
            result.add(Arrays.asList(buildings[left][0], buildings[left][2]));
            result.add(Arrays.asList(buildings[left][1], 0));
            return result;
        }
        int mid = left + (right - left) / 2;
        List<List<Integer>> leftSkyline = divideAndConquer(buildings, left, mid);
        List<List<Integer>> rightSkyline = divideAndConquer(buildings, mid + 1, right);
        return mergeSkylines(leftSkyline, rightSkyline);
    }
    private List<List<Integer>> mergeSkylines(List<List<Integer>> left, List<List<Integer>>
right) {
```

```
        List<List<Integer>> merged = new ArrayList<>();
        int h1 = 0, h2 = 0, x = 0, height = 0;
        int i = 0, j = 0;
        while (i < left.size() && j < right.size()) {
            List<Integer> point1 = left.get(i);
            List<Integer> point2 = right.get(j);
            if (point1.get(0) < point2.get(0)) {
                x = point1.get(0);
                h1 = point1.get(1);
                i++;
            } else if (point1.get(0) > point2.get(0)) {
                x = point2.get(0);
                h2 = point2.get(1);
                j++;
            } else {
                x = point1.get(0);
                h1 = point1.get(1);
                h2 = point2.get(1);
                i++;
                j++;
            }
            int maxHeight = Math.max(h1, h2);
            if (merged.isEmpty() || merged.get(merged.size() - 1).get(1) != maxHeight) {
                merged.add(Arrays.asList(x, maxHeight));
            }
        }
        while (i < left.size()) merged.add(left.get(i++));
        while (j < right.size()) merged.add(right.get(j++));
        return merged;
    }
}
```

9. Reverse Pairs

```
class Solution {
    public int reversePairs(int[] nums) {
        if (nums == null || nums.length == 0) 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);
        count += countPairs(nums, left, mid, right);
        merge(nums, left, mid, right);
```

```
        return count;
    }
    private int countPairs(int[] nums, int left, int mid, int right) {
        int count = 0, j = mid + 1;
        for (int i = left; i <= mid; i++) {
            while (j <= right && (long) nums[i] > 2L * nums[j]) {
                j++;
            }
            count += (j - (mid + 1));
        }
        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);
    }
}
```

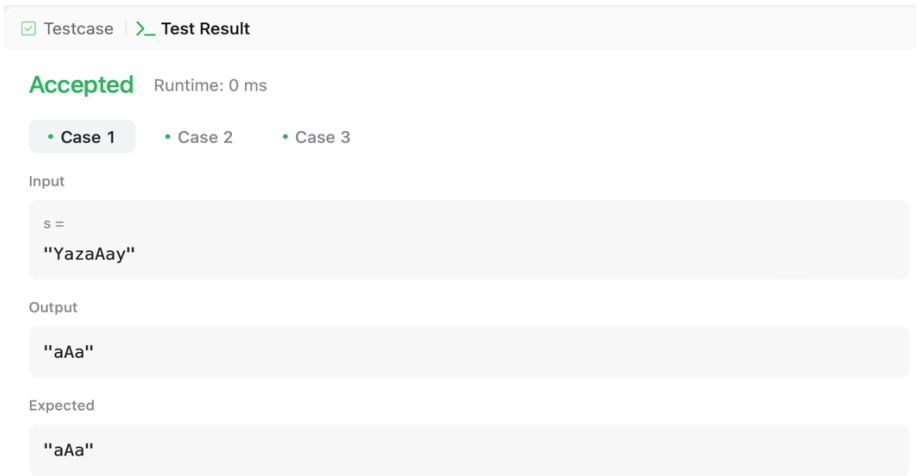
10. Longest Increasing Subsequence

```
class SegmentTree {
    int[] tree;
    int n;
    public SegmentTree(int size) {
        n = size;
        tree = new int[4 * n];
    }
    public void update(int index, int value, int left, int right, int node) {
        if (left == right) {
            tree[node] = value;
            return;
        }
        int mid = left + (right - left) / 2;
        if (index <= mid) {
```

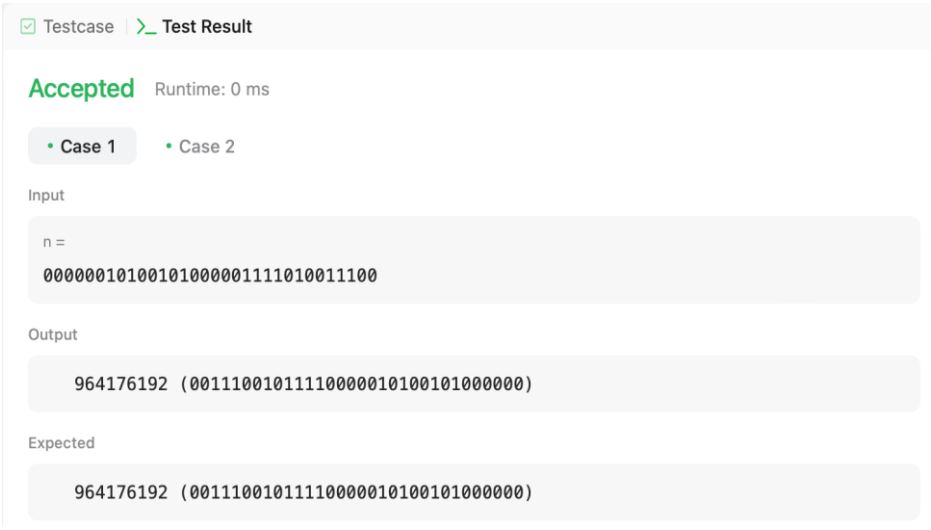
```
            update(index, value, left, mid, 2 * node + 1);
        } else {
            update(index, value, mid + 1, right, 2 * node + 2);
        }
        tree[node] = Math.max(tree[2 * node + 1], tree[2 * node + 2]);
    }
    public int query(int start, int end, int left, int right, int node) {
        if (start > right || end < left) return 0;
        if (start <= left && right <= end) return tree[node];
        int mid = left + (right - left) / 2;
        return Math.max(query(start, end, left, mid, 2 * node + 1), query(start, end, mid + 1, right, 2
* node + 2));
    }
}
class Solution {
    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 maxLength = 0;
        for (int num : nums) {
            int bestPrev = segTree.query(Math.max(0, num - k), num - 1, 0, maxVal, 0);
            int newLength = bestPrev + 1;
            segTree.update(num, newLength, 0, maxVal, 0);
            maxLength = Math.max(maxLength, newLength);
        }
        return maxLength;
    }
}
```

- **Output:**

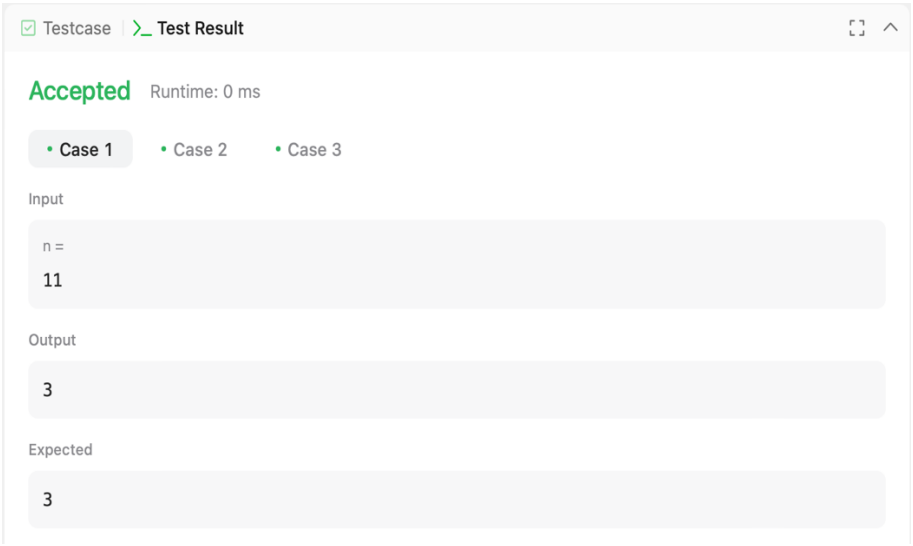
1.



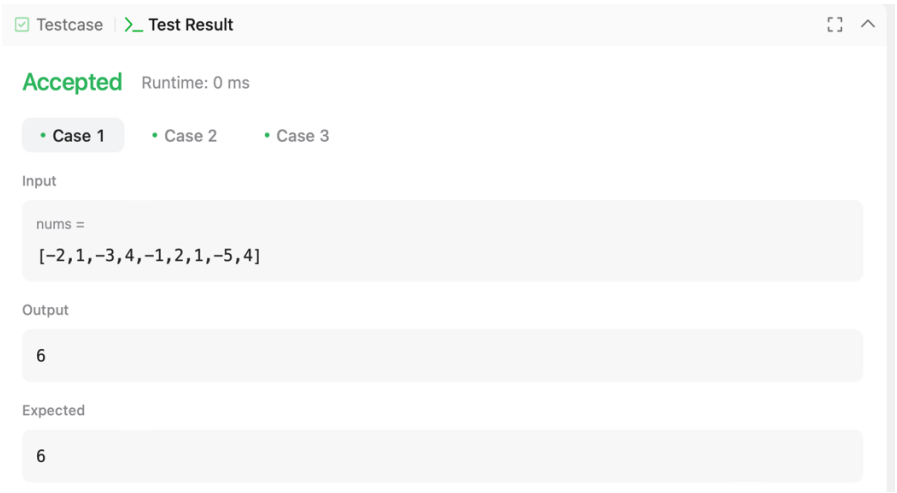
2.


Testcase
Test Result
Accepted
Runtime: 0 ms
Case 1
Case 2
Input
n =
00000010100101000001111010011100
Output
964176192 (00111001011110000010100101000000)
Expected
964176192 (00111001011110000010100101000000)

3.


Testcase
Test Result
Accepted
Runtime: 0 ms
Case 1
Case 2
Case 3
Input
n =
11
Output
3
Expected
3

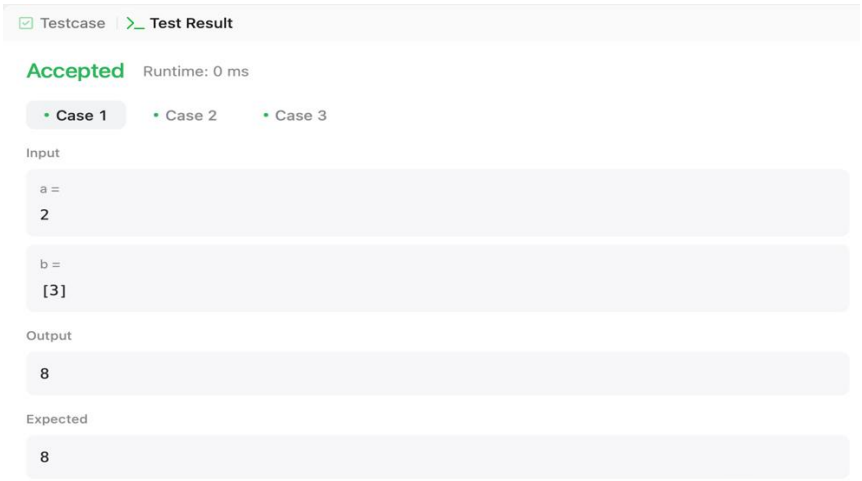
4.


Testcase
Test Result
Accepted
Runtime: 0 ms
Case 1
Case 2
Case 3
Input
nums =
[-2,1,-3,4,-1,2,1,-5,4]
Output
6
Expected
6

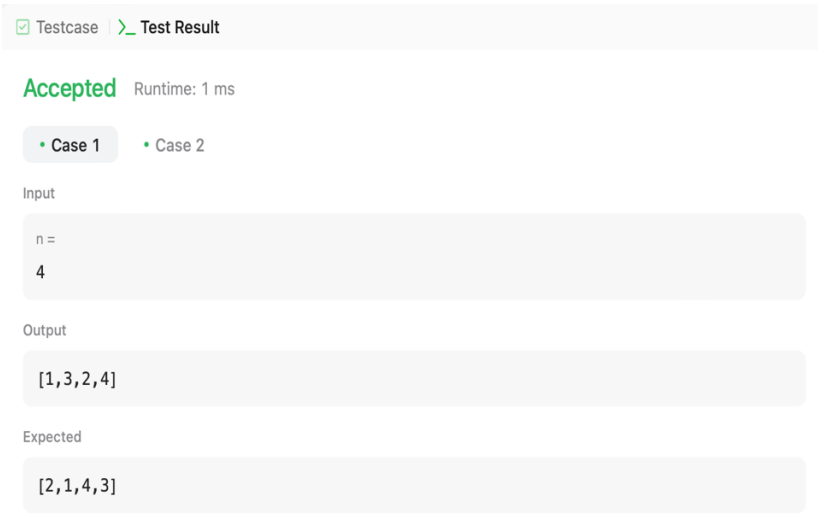
5.


Testcase
Test Result
Accepted
Runtime: 0 ms
Case 1
Case 2
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 =
5
Output
true
Expected
true

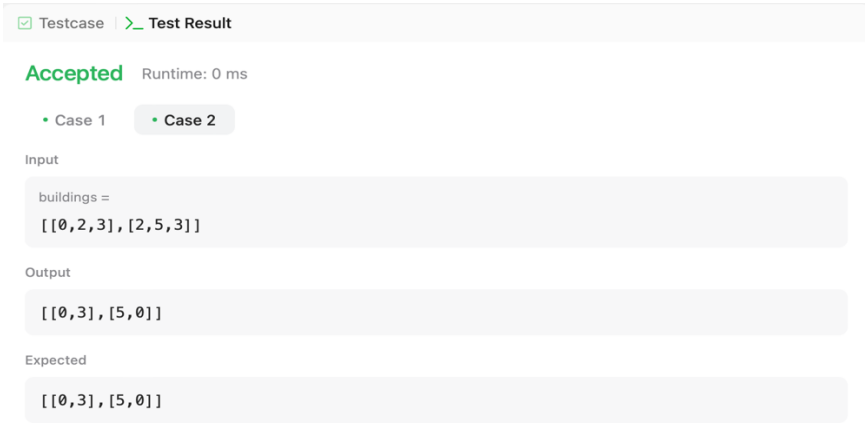
6.


Testcase
Test Result
Accepted
Runtime: 0 ms
Case 1
Case 2
Case 3
Input
a =
2
b =
[3]
Output
8
Expected
8

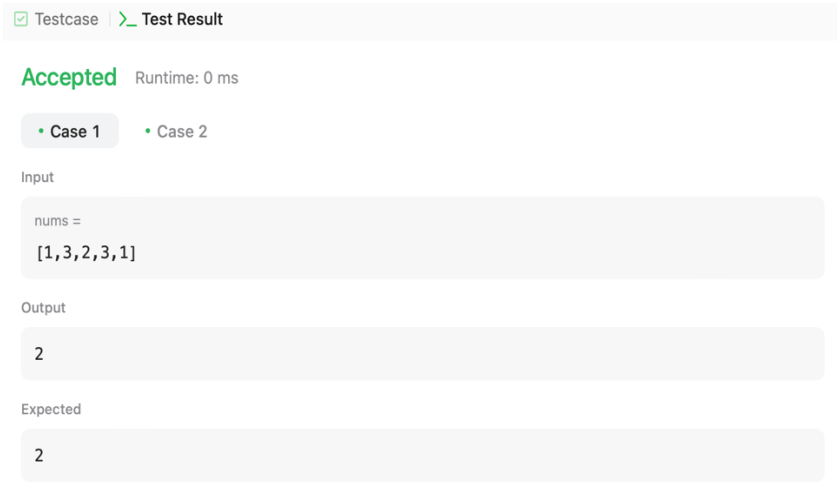
7.


Testcase
Test Result
Accepted
Runtime: 1 ms
Case 1
Case 2
Input
n =
4
Output
[1,3,2,4]
Expected
[2,1,4,3]

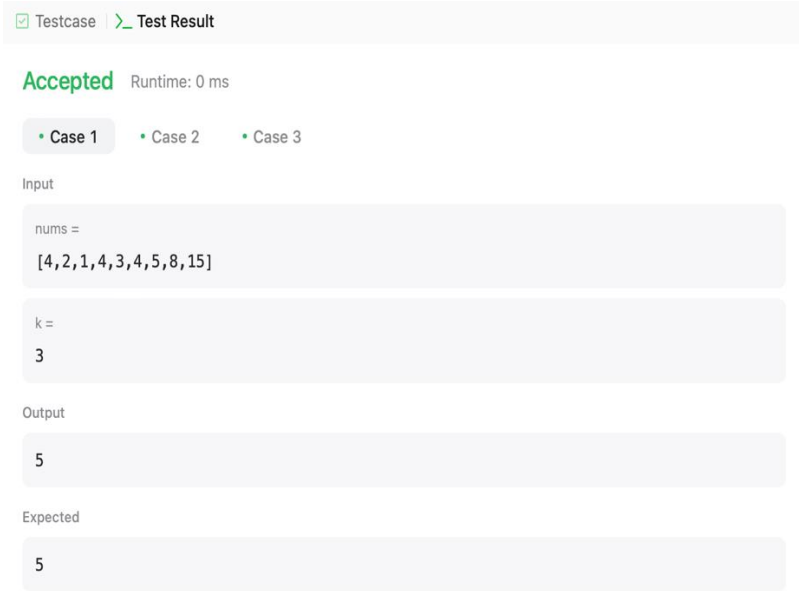
8.


Testcase
Test Result
Accepted
Runtime: 0 ms
Case 1
Case 2
Input
buildings =
[[0,2,3],[2,5,3]]
Output
[[0,3],[5,0]]
Expected
[[0,3],[5,0]]

9.


Testcase
Test Result
Accepted
Runtime: 0 ms
Case 1
Case 2
Input
nums =
[1,3,2,3,1]
Output
2
Expected
2

10.


Testcase
Test Result
Accepted
Runtime: 0 ms
Case 1
Case 2
Case 3
Input
nums =
[4,2,1,4,3,4,5,8,15]
k =
3
Output
5
Expected
5