LAB-3

DATE:06/06/2024

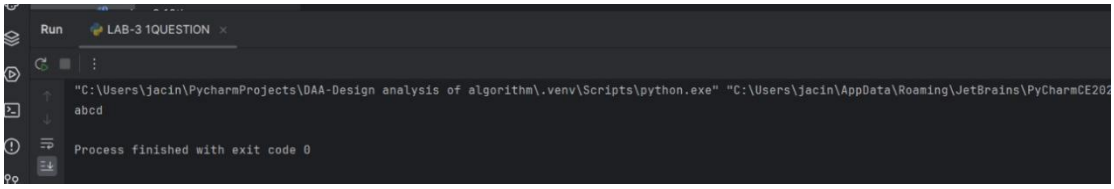
1. You are given a string s, and an array of pairs of indices in the string pairs where pairs[i] = [a, b] indicates 2 indices(0-indexed) of the string.You can swap the characters at any pair of indices in the given pairs any number of times. Return the lexicographically smallest string that s can be changed to after using the swaps.

CODING:

```
class UnionFind:
    def __init__(self, n):
        self.parent = [i for i in range(n)]
        self.rank = [0] * n

    def find(self, x):
        if self.parent[x] != x:
            self.parent[x] = self.find(self.parent[x])
        return self.parent[x]

    def union(self, x, y):
        root_x = self.find(x)
        root_y = self.find(y)
        if root_x == root_y:
            return False
        if self.rank[root_x] < self.rank[root_y]:
            self.parent[root_x] = root_y
        elif self.rank[root_x] > self.rank[root_y]:
            self.parent[root_y] = root_x
        else:
            self.parent[root_y] = root_x
```

```
        if self.rank[root_x] < self.rank[root_y]:
            self.parent[root_x] = root_y
        elif self.rank[root_x] > self.rank[root_y]:
            self.parent[root_y] = root_x
        else:
            self.parent[root_y] = root_x
            self.rank[root_x] += 1
        return True

def smallestStringWithSwaps(s, pairs):
    n = len(s)
    uf = UnionFind(n)
    for a, b in pairs:
        uf.union(a, b)
    groups = {}
    for i in range(n):
        root = uf.find(i)
        if root in groups:
            groups[root].append(i)
        else:
            groups[root] = [i]
    result = list(s)
    for group in groups.values():
        chars = sorted([s[i] for i in group])
        for i, c in zip(group, chars):
            result[i] = c
    return "".join(result)

# Example usage
s = "dcab"
pairs = [[0, 3], [1, 2], [0, 2]]
print(smallestStringWithSwaps(s, pairs))
```

OUTPUT:



2. Given two strings: s1 and s2 with the same size, check if some permutation of string s1 can break some permutation of string s2 or vice-versa. In other words s2 can break s1 or vice-versa. A string x can break string y (both of size n) if x[i] >= y[i] (in alphabetical order) for all i between 0 and n-1.

CODING:

```
3 usages
def checkIfCanBreak(s1, s2):
    if len(s1)!= len(s2):
        return False
    s1_sorted = sorted(s1)
    s2_sorted = sorted(s2)
    can_break_s2 = True
    can_break_s1 = True
    for i in range(len(s1)):
        if s1_sorted[i] < s2_sorted[i]:
            can_break_s2 = False
        if s2_sorted[i] < s1_sorted[i]:
            can_break_s1 = False
    return can_break_s1 or can_break_s2
s1 = "abc"
s2 = "xya"
print(checkIfCanBreak(s1, s2))  # Output: True
```

```
    return can_break_s1 or can_break_s2
s1 = "abc"
s2 = "xya"
print(checkIfCanBreak(s1, s2))  # Output: True
s1 = "abe"
s2 = "acd"
print(checkIfCanBreak(s1, s2))  # Output: False1 = "leetcodee"
s2 = "interview"
print(checkIfCanBreak(s1, s2))  # Output: True
```

OUTPUT:

```
C:\Users\vinot\PycharmProjects\pythonP
True
False
True

Process finished with exit code 0
```

3. You are given a string s. s[i] is either a lowercase English letter or '?'. For a string t having length m containing only lowercase English letters, we define the function cost(i) for an index i as the number of characters equal to t[i] that appeared before it, i.e. in the range [0, i - 1]. The value of t is the sum of cost(i) for all indices i. For example, for the string t = "aab":

cost(0) = 0

cost(1) = 1

cost(2) = 0
Hence, the value of "aab" is 0 + 1 + 0 = 1. Your task is to replace all occurrences of '?' in s with any lowercase English letter so at the value of s is minimized.

CODING:

```
def minimumValue(s):
    n = len(s)
    res = [0] * 26
    for i in range(n):
        if s[i]!= '?':
            res[ord(s[i]) - ord('a')] += 1
    ans = 0
    for i in range(n):
        if s[i]!= '?':
            ans += res[ord(s[i]) - ord('a')] - (i!= 0 and s[i] == s[i - 1])
    return ans
s= "aa?b"
print(minimumValue(s))
```

OUTPUT:

```
C:\Users\vinot\PycharmProjects\pythonProjec
4

Process finished with exit code 0
```

4.You are given a string s. Consider performing the following operation until s becomes empty: For every alphabet character from 'a' to 'z', remove the first occurrence of that character in s (if it exists). For example, let initially s = "aabcbbca". We do the following operations: Remove the underlined characters s = "aabcbbca". The resulting string is s = "abbca". Remove the underlined characters s = "abbca". The resulting string is s = "ba". Remove the underlined characters s = "ba". The resulting string is s = "". Return the value of the string s right before applying the last operation. In the example above, answer is "ba".

CODING:

```
def last_string_before_empty(s):
    while True:
        original_s = s
        for char in set(s):
            s = s.replace(char, '', 1)
        if s == "":
            return original_s
s = "aabcbbca"
print(last_string_before_empty(s))
```

OUTPUT:

```
C:\Users\vinot\PycharmProjects\pythonPro
ba

Process finished with exit code 0
```

5. Given an integer array nums, find the subarray with the largest sum, and return its sum.

Example 1:

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

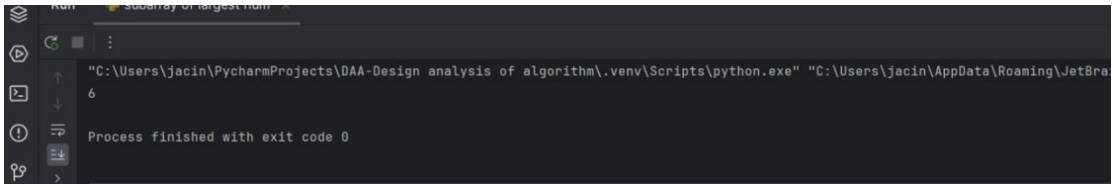
Output: 6

Explanation: The subarray [4,-1,2,1] has the largest sum 6.

CODING:

```python
def maxSubArray(nums):
    max_sum = nums[0]
    current_sum = nums[0]

    for num in nums[1:]:
        current_sum = max(num, current_sum + num)
        max_sum = max(max_sum, current_sum)

    return max_sum


# Example usage
nums = [-2, 1, -3, 4, -1, 2, 1, -5, 4]
print(maxSubArray(nums))
```

OUTPUT:



6. You are given an integer array nums with no duplicates. A maximum binary tree can be built recursively from nums using the following algorithm: Create a root node whose value is the maximum value in nums. Recursively build the left subtree on the subarray prefix to the left of the maximum value. Recursively build the right subtree on the subarray suffix to the right of the maximum value. Return the maximum binary tree built from nums.

CODING:

```python
from typing import List
3 usages
class TreeNode:
    def __init__(self, val=0, left=None, right=None):
        self.val = val
        self.left = left
        self.right = right
1 usage
class Solution:
    3 usages
    def constructMaximumBinaryTree(self, nums: List[int]) -> TreeNode:
        if not nums:
            return None
        max_val = max(nums)
        max_idx = nums.index(max_val)
        root = TreeNode(max_val)
        root.left = self.constructMaximumBinaryTree(nums[:max_idx])
        max_idx = nums.index(max_val)
        root = TreeNode(max_val)
        root.left = self.constructMaximumBinaryTree(nums[:max_idx])
        root.right = self.constructMaximumBinaryTree(nums[max_idx + 1:])
        return root
    3 usages
    def printTree(self, root: TreeNode) -> None:
        if root:
            print(root.val, end=' ')
            self.printTree(root.left)
            self.printTree(root.right)
nums = [3, 2, 1, 6, 0, 5]
solution = Solution()
root = solution.constructMaximumBinaryTree(nums)
solution.printTree(root)
```

OUTPUT:

```
C:\Users\vinot\PycharmProjects\pythonProject3\.ve
6 3 2 1 5 0
Process finished with exit code 0
```

7. Given a circular integer array nums of length n, return the maximum possible sum of a non-empty subarray of nums.A circular array means the end of the array connects to the beginning of the array. Formally, the next element of nums[i] is nums[(i + 1) % n] and the previous element of nums[i] is nums[(i - 1 + n) % n].A subarray may only include each element of the fixed buffer nums at most once. Formally, for a subarray nums[i], nums[i + 1], ..., nums[j], there does not exist i <= k1, k2 <= j with k1 % n == k2 % n.

CODING:

```python
3 usages
def max_subarray_sum_circular(nums):
    # Helper function to find maximum subarray sum using Kadane's algorithm
    def kadane_max_subarray(arr):
        max_ending_here = max_so_far = arr[0]
        for x in arr[1:]:
            max_ending_here = max(x, max_ending_here + x)
            max_so_far = max(max_so_far, max_ending_here)
        return max_so_far

    # Helper function to find minimum subarray sum using Kadane's algorithm
    def kadane_min_subarray(arr):
        min_ending_here = min_so_far = arr[0]
        for x in arr[1:]:
            min_ending_here = min(x, min_ending_here + x)
            min_so_far = min(min_so_far, min_ending_here)
        return min_so_far

    total_sum = sum(nums)  # Step 3: Total sum of the array
    max_kadane = kadane_max_subarray(nums)  # Step 1: Max subarray sum (non-wrapping)
    min_kadane = kadane_min_subarray(nums)  # Step 2: Min subarray sum (for wrapping)

    # Step 4: Max subarray sum (wrapping)
    max_wraparound = total_sum - min_kadane

    # Step 5: Handle edge case where all elements are negative
    if max_wraparound == 0:
        return max_kadane
    return max(max_kadane, max_wraparound)
nums = [1, -2, 3, -2]
print(max_subarray_sum_circular(nums))  # Output: 3
nums = [5, -3, 5]
print(max_subarray_sum_circular(nums))  # Output: 10
nums = [-3, -2, -3]
print(max_subarray_sum_circular(nums))  # Output: -2
```

OUTPUT:

```
C:\Users\vinot\PycharmProjects\pythonProject
3
10
-2

Process finished with exit code 0
```

8. You are given an array nums consisting of integers. You are also given a 2D array queries, where queries[i] = [posi, xi].For query i, we first set nums[posi] equal to xi, then we calculate the answer to query i which is the maximum sum of a subsequence of nums where no two adjacent elements are selected. Return the sum of the answers to all queries. Since the final answer may be very large, return it modulo 109 + 7. A subsequence is an array that can be derived from another array by deleting some or no elements without changing the order of the remaining elements.

CODING:

```
1 usage
def max_sum_subsequence_no_adjacent(nums):
    incl = 0
    excl = 0
    for num in nums:
        new_excl = max(incl, excl)
        incl = excl + num
        excl = new_excl
    return max(incl, excl)
1 usage
def sum_of_queries_results(nums, queries):
    MOD = 10 ** 9 + 7
    total_sum = 0
    for pos, val in queries:
        nums[pos] = val
        max_sum = max_sum_subsequence_no_adjacent(nums)
        total_sum = (total_sum + max_sum) % MOD
```

```
        nums[pos] = val
        max_sum = max_sum_subsequence_no_adjacent(nums)
        total_sum = (total_sum + max_sum) % MOD
    return total_sum
nums = [1, 2, 3]
queries = [[1, 5], [0, 4]]
print(sum_of_queries_results(nums, queries))  # Output sh
```

OUTPUT:

```
C:\Users\vinot\PycharmProjects\pythonProjec
12

Process finished with exit code 0
```

9. Given an array of points where points[i] = [xi, yi] represents a point on the X-Y plane and an integer k, return the k closest points to the origin (0, 0).The distance between two points on the X-Y plane is the Euclidean distance (i.e., √(x1 - x2)2 + (y1 - y2)2). You may return the answer in any order. The answer is guaranteed to be unique (except for the order that it is in).

CODING:

```python
from typing import List
import heapq
import math
3 usages
class Solution:
    3 usages
    def kClosest(self, points: List[List[int]], k: int) -> List[List[int]]:
        heap = []
        output = []
        for cord in points:
            distance = math.sqrt((cord[0] - 0) ** 2 + (cord[1] - 0) ** 2)
            distance_tuple = (-distance, cord)
            if len(heap) == k:
                heapq.heappushpop( *args: heap, distance_tuple)
            else:
                heapq.heappush( *args: heap, distance_tuple)
        for item in heap:
            output.append(item[1])
        return output
points = [[3, 3], [5, -1], [-2, 4]]
k = 2
solution = Solution()
result = solution.kClosest(points, k)
print(result)  # Output: [[3, 3], [-2, 4]]
points = [[1, 3], [-2, 2]]
k = 1
solution = Solution()
result = solution.kClosest(points, k)
print(result)  # Output: [[-2, 2]]
points = [[1, 1], [1, 1], [1, 1], [0, 0]]
k = 2
solution = Solution()
result = solution.kClosest(points, k)
print(result)  # Output: [[0, 0], [1, 1]]
```

OUTPUT:

```
C:\Users\vinot\PycharmProjects\pythonP
[[-2, 4], [3, 3]]
[[-2, 2]]
[[1, 1], [0, 0]]

Process finished with exit code 0
```

10. Given two sorted arrays nums1 and nums2 of size m and n respectively, return the median of the two sorted arrays. The overall run time complexity should be O(log (m+n)).

CODING:

```python
def findMedianSortedArrays(nums1, nums2):
    if len(nums1) > len(nums2):
        nums1, nums2 = nums2, nums1
    m, n = len(nums1), len(nums2)
    low, high = 0, m
    total_len = m + n
    while low <= high:
        partition_nums1 = (low + high) // 2
        partition_nums2 = (total_len + 1) // 2 - partition_nums1
        max_left_nums1 = float('-inf') if partition_nums1 == 0 else nums1[partition_nums1 - 1]
        min_right_nums1 = float('inf') if partition_nums1 == m else nums1[partition_nums1]
        max_left_nums2 = float('-inf') if partition_nums2 == 0 else nums2[partition_nums2 - 1]
        min_right_nums2 = float('inf') if partition_nums2 == n else nums2[partition_nums2]
        if max_left_nums1 <= min_right_nums2 and max_left_nums2 <= min_right_nums1:
            if total_len % 2 == 0:
                return (max(max_left_nums1, max_left_nums2) + min(min_right_nums1, min_right_nums2)) / 2
            else:
                return max(max_left_nums1, max_left_nums2)
        elif max_left_nums1 > min_right_nums2:
            high = partition_nums1 - 1
        else:
            low = partition_nums1 + 1
nums1 = [1, 3]
nums2 = [2]
print(findMedianSortedArrays(nums1, nums2))
```

OUTPUT: