

PRACTICAL NO. : 04

NAME : RANVEER M. BHORTEKAR

SECTION/BATCH : A4/B1

ROLL NO. : 06

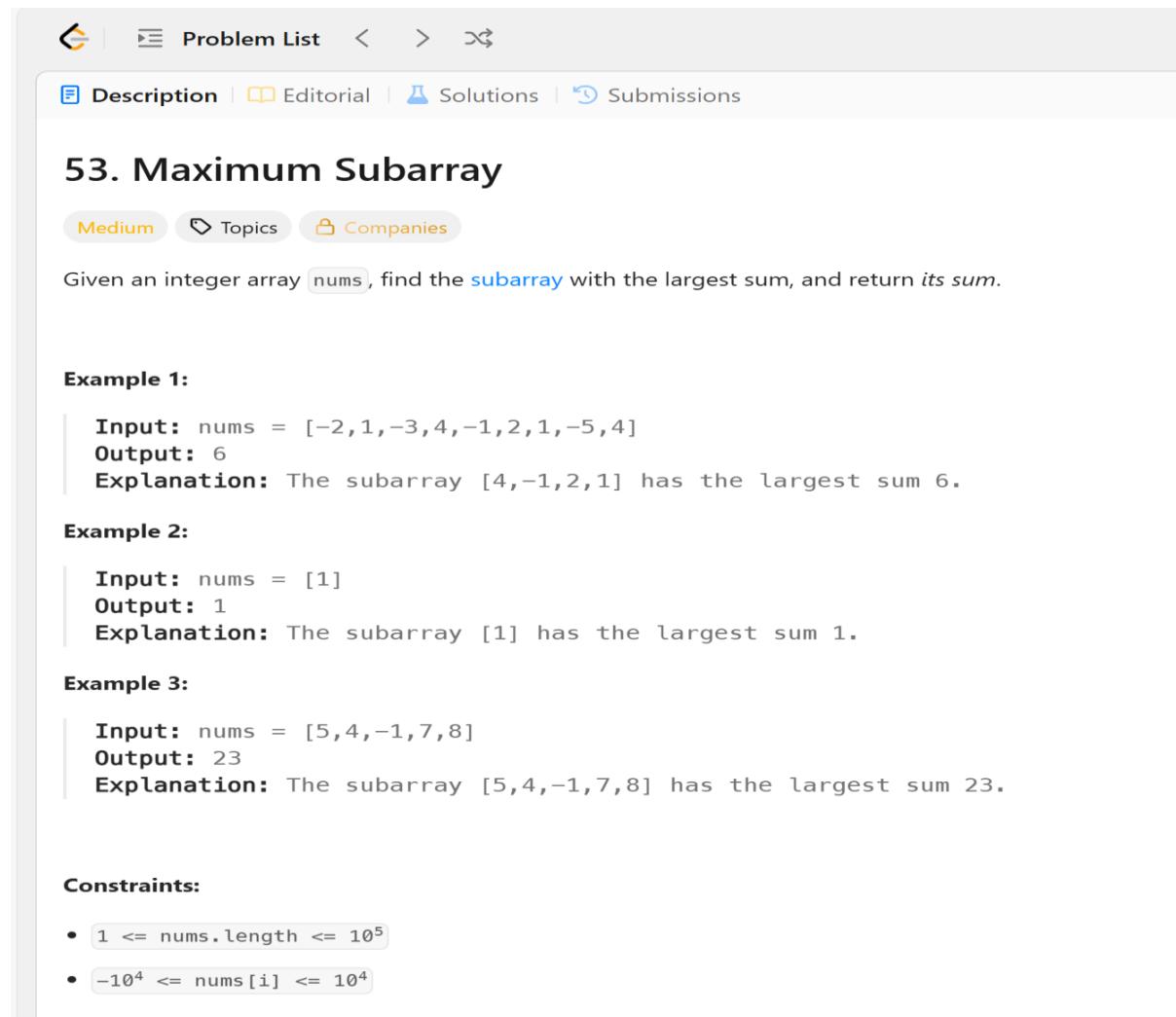
SUBJECT : DAA

LEETCODE ID : [Bhortekar Coder - LeetCode Profile](#)

AIM : Implement maximum sum of subarray for the given scenario of resource allocation using the divide and conquer approach.

LEETCODE QUESTION ID 53. MAXIMUM SUBARRAY :

PROBLEM STATEMENT :



The screenshot shows the LeetCode platform interface for problem 53. Maximum Subarray. The top navigation bar includes 'Problem List' and links for 'Description', 'Editorial', 'Solutions', and 'Submissions'. The main title '53. Maximum Subarray' is displayed, along with difficulty level 'Medium' and topics 'Topics' and 'Companies'. The problem description states: 'Given an integer array `nums`, find the **subarray** with the largest sum, and return *its sum*'. Examples are provided:

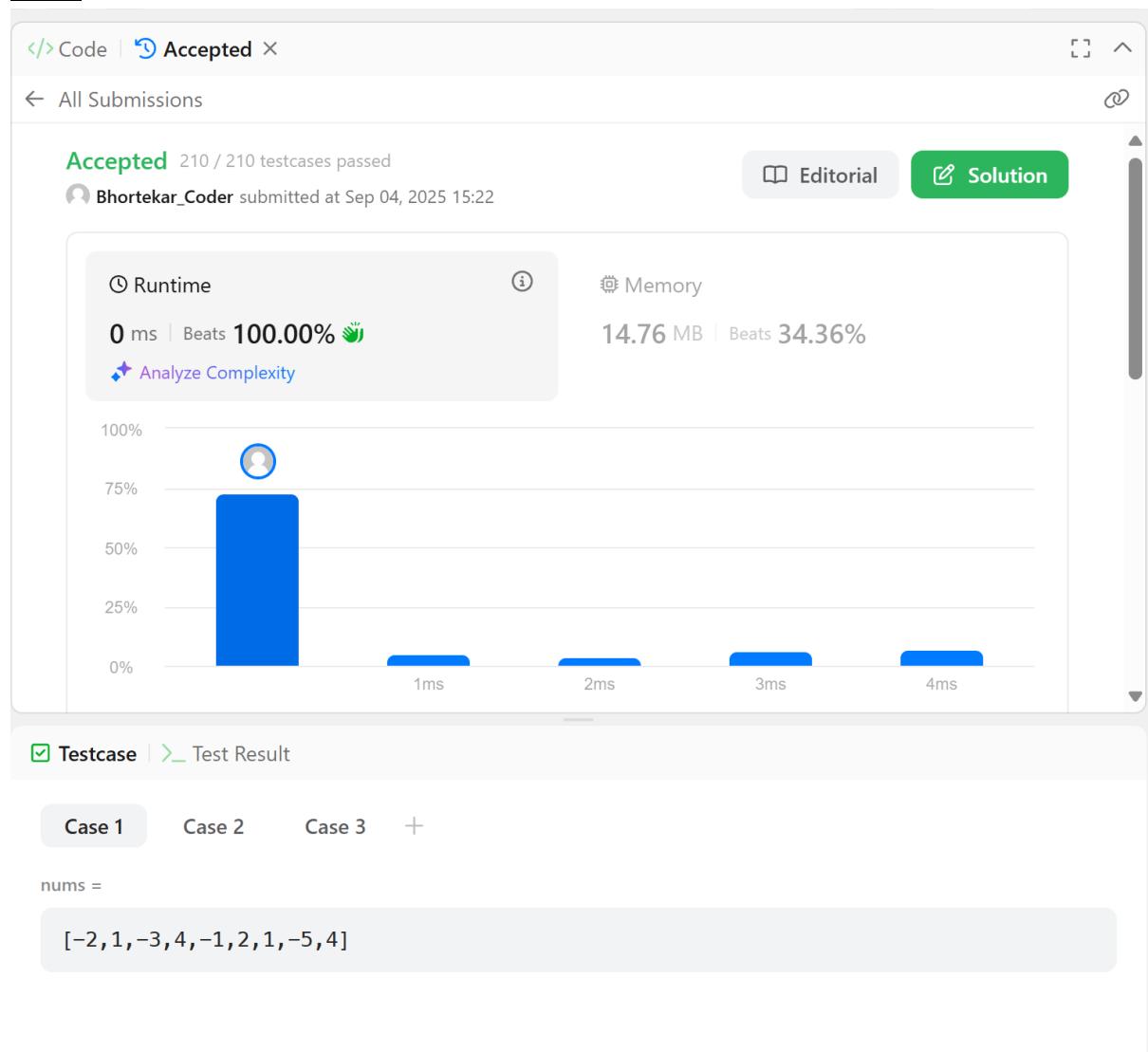
- Example 1:**
Input: `nums = [-2,1,-3,4,-1,2,1,-5,4]`
Output: 6
Explanation: The subarray `[4,-1,2,1]` has the largest sum 6.
- Example 2:**
Input: `nums = [1]`
Output: 1
Explanation: The subarray `[1]` has the largest sum 1.
- Example 3:**
Input: `nums = [5,4,-1,7,8]`
Output: 23
Explanation: The subarray `[5,4,-1,7,8]` has the largest sum 23.

Constraints:

- `1 <= nums.length <= 105`
- `-104 <= nums[i] <= 104`

SUBMISSION :

CODE



CODE IN TEXT FORMAT :

```
int maxSubArray(int* nums,int numsSize){  
    int maxSum=nums[0];  
    int maxSumSoFar=0;  
  
    for(int i=0;i<numsSize;i++){  
        maxSumSoFar = maxSumSoFar + nums[i];  
        if(maxSumSoFar>maxSum){  
            maxSum=maxSumSoFar;  
        }  
    }  
}
```

```

    }

if(maxSumSoFar<0){

    maxSumSoFar=0;

}

}

return maxSum;

}

```

SCREENSHOT OF CODE :

The screenshot shows a LeetCode post-solution page for the problem "maximum-subarray". The URL is https://leetcode.com/problems/maximum-subarray/post-solution?submissionId=1759214829. The page includes sections for intuition, approach, complexity, and code, along with a code editor and preview area.

Intuition:
<!-- Describe your first thoughts on how to solve this problem. -->

Approach:
<!-- Describe your approach to solving the problem. -->

Complexity:

- Time complexity:
- Space complexity:

Code:

```

int maxSubArray(int* nums,int numsSize){
    int maxSum=nums[0];
    int maxSumSoFar=0;

    for(int i=0;i<numsSize;i++){
        maxSumSoFar = maxSumSoFar + nums[i];
        if(maxSumSoFar>maxSum){
            maxSum=maxSumSoFar;
        }
        if(maxSumSoFar<0){
            maxSumSoFar=0;
        }
    }
    return maxSum;
}

```

Generated from the chosen submission

PROBLEM STATEMENT :

A project requires allocating resources to various tasks over a period of time. Each task requires a certain amount of resources, and you want to maximize the overall efficiency of resource usage. You're given an array of resources where $\text{resources}[i]$ represents the amount of resources required for the i th task. Your goal is to find the contiguous subarray of tasks that maximizes the total resources utilized without exceeding a given resource constraint. Handle cases where the total resources exceed the constraint by adjusting the subarray window accordingly. Your implementation should handle various cases, including scenarios where there's no feasible subarray given the constraint and scenarios where multiple subarrays yield the same maximum resource utilization.

CODE IN TEXT FORMAT :

```
#include <stdio.h>

int max(int a, int b) {
    return (a > b) ? a : b;
}

int maxCrossingSum(int arr[], int left, int mid, int right, int constraint) {
    int sum = 0;
    int left_sum = 0;
    for (int i = mid; i >= left; i--) {
        sum += arr[i];
        if (sum <= constraint) {
            left_sum = max(left_sum, sum);
        } else {
            break;
        }
    }
    sum = 0;
    int right_sum = 0;
    for (int i = mid + 1; i <= right; i++) {
```

```

        sum += arr[i];

        if (sum <= constraint) {
            right_sum = max(right_sum, sum);
        } else {
            break;
        }
    }

    int total = left_sum + right_sum;

    if (total <= constraint) {
        return total;
    } else {
        return max(left_sum, right_sum);
    }
}

int maxSubArraySumUtil(int arr[], int left, int right, int constraint) {

    if (left == right) {
        return (arr[left] <= constraint) ? arr[left] : 0;
    }

    int mid = (left + right) / 2;

    int left_sum = maxSubArraySumUtil(arr, left, mid, constraint);
    int right_sum = maxSubArraySumUtil(arr, mid + 1, right, constraint);
    int cross_sum = maxCrossingSum(arr, left, mid, right, constraint);

    return max(max(left_sum, right_sum), cross_sum);
}

```

```
int maxSubArraySum(int arr[], int n, int constraint) {  
    if (n == 0) return 0;  
    return maxSubArraySumUtil(arr, 0, n - 1, constraint);  
}  
  
int main() {  
    int arr1[] = {2, 1, 3, 4};  
    int constraint1 = 5;  
    int n1 = sizeof(arr1) / sizeof(arr1[0]);  
    printf("Test 1: Max sum = %d\n", maxSubArraySum(arr1, n1, constraint1));  
  
    int arr2[] = {2, 2, 2, 2};  
    int constraint2 = 4;  
    int n2 = sizeof(arr2) / sizeof(arr2[0]);  
    printf("Test 2: Max sum = %d\n", maxSubArraySum(arr2, n2, constraint2));  
  
    int arr3[] = {1, 5, 2, 3};  
    int constraint3 = 5;  
    int n3 = sizeof(arr3) / sizeof(arr3[0]);  
    printf("Test 3: Max sum = %d\n", maxSubArraySum(arr3, n3, constraint3));  
  
    int arr4[] = {6, 7, 8};  
    int constraint4 = 5;  
    int n4 = sizeof(arr4) / sizeof(arr4[0]);  
    printf("Test 4: Max sum = %d\n", maxSubArraySum(arr4, n4, constraint4));  
  
    int arr5[] = {1, 2, 3, 2, 1};
```

```
int constraint5 = 5;  
  
int n5 = sizeof(arr5) / sizeof(arr5[0]);  
  
printf("Test 5: Max sum = %d\n", maxSubArraySum(arr5, n5, constraint5));
```

```
int arr6[] = {1, 1, 1, 1, 1};  
  
int constraint6 = 4;  
  
int n6 = sizeof(arr6) / sizeof(arr6[0]);  
  
printf("Test 6: Max sum = %d\n", maxSubArraySum(arr6, n6, constraint6));
```

```
int arr7[] = {4, 2, 3, 1};  
  
int constraint7 = 5;  
  
int n7 = sizeof(arr7) / sizeof(arr7[0]);  
  
printf("Test 7: Max sum = %d\n", maxSubArraySum(arr7, n7, constraint7));
```

```
int arr8[] = {};  
  
int constraint8 = 10;  
  
int n8 = sizeof(arr8) / sizeof(arr8[0]);  
  
printf("Test 8: Max sum = %d\n", maxSubArraySum(arr8, n8, constraint8));
```

```
int arr9[] = {1, 2, 3};  
  
int constraint9 = 0;  
  
int n9 = sizeof(arr9) / sizeof(arr9[0]);  
  
printf("Test 9: Max sum = %d\n", maxSubArraySum(arr9, n9, constraint9));
```

```
int arr10[100000];  
  
for (int i = 0; i < 100000; i++) arr10[i] = i + 1;  
  
int constraint10 = 1000000000;  
  
int n10 = sizeof(arr10) / sizeof(arr10[0]);
```

```

printf("Test 10: Max sum = %d\n", maxSubArraySum(arr10, n10, constraint10));

return 0;
}

```

SCREENSHOT OF CODE :

The screenshot shows a code editor interface with the following details:

- File Menu:** File, Edit, Selection, View, Go, Run, Terminal, Help.
- Explorer:** Shows a project named "DAA PRAC 04" containing files "PRAC41.c" and "PRAC42.c".
- Code Editor:** Displays the content of "PRAC42.c" which contains C code for finding the maximum sum of a subarray with a constraint. The code uses two main functions: `maxCrossingSum` and `maxSubArraySumUtil`.
- Terminal:** Shows the output "DAA PRAC 04".
- Sidebar:** A "Welcome to Copilot" sidebar with the message "Let's get started". It includes buttons for "Add context (#), extensions (@), com", "Build Workspace", and "Show Config". A note at the bottom says "Review AI output carefully before use."

```

C PRAC42.c > main()
1 #include <stdio.h>
2 int max(int a, int b) {
3     return (a > b) ? a : b;
4 }
5 Tabnine | Edit | Test | Explain | Document
6 int maxCrossingSum(int arr[], int left, int mid, int right, int constraint) {
7     int sum = 0;
8     int left_sum = 0;
9     for (int i = mid; i >= left; i--) {
10         sum += arr[i];
11         if (sum <= constraint) {
12             left_sum = max(left_sum, sum);
13         } else {
14             break;
15         }
16         sum = 0;
17     }
18     int right_sum = 0;
19     for (int i = mid + 1; i <= right; i++) {
20         sum += arr[i];
21         if (sum <= constraint) {
22             right_sum = max(right_sum, sum);
23         } else {
24             break;
25         }
26     }
27     int total = left_sum + right_sum;
28     if (total <= constraint) {
29         return total;
30     } else {
31         return max(left_sum, right_sum);
32     }
33     Tabnine | Edit | Test | Explain | Document
34     int maxSubArraySumUtil(int arr[], int left, int right, int constraint) {
35         if (left == right) {
36             return (arr[left] <= constraint) ? arr[left] : 0;
37         }
38         int mid = (left + right) / 2;
39         int left_sum = maxSubArraySumUtil(arr, left, mid, constraint);
40         int right_sum = maxSubArraySumUtil(arr, mid + 1, right, constraint);
41         int cross_sum = maxCrossingSum(arr, left, mid, right, constraint);
42         return max(max(left_sum, right_sum), cross_sum);
43     }
44     Tabnine | Edit | Test | Explain | Document
45     int maxSubArraySum(int arr[], int n, int constraint) {
46         if (n == 0) return 0;
47         return maxSubArraySumUtil(arr, 0, n - 1, constraint);
48     }

```

File Edit Selection View Go Run Terminal Help

PRAC4.c > main()

```

47 int main() {
48     int arr1[] = {1, 2, 3, 4};
49     int constraint1 = 5;
50     int n1 = sizeof(arr1) / sizeof(arr1[0]);
51     printf("Test 1: Max sum = %d\n", maxSubArraySum(arr1, n1, constraint1));
52
53     int arr2[] = {2, 2, 2, 2};
54     int constraint2 = 4;
55     int n2 = sizeof(arr2) / sizeof(arr2[0]);
56     printf("Test 2: Max sum = %d\n", maxSubArraySum(arr2, n2, constraint2));
57
58     int arr3[] = {1, 2, 2, 3};
59     int constraint3 = 5;
60     int n3 = sizeof(arr3) / sizeof(arr3[0]);
61     printf("Test 3: Max sum = %d\n", maxSubArraySum(arr3, n3, constraint3));
62
63     int arr4[] = {6, 7, 8};
64     int constraint4 = 5;
65     int n4 = sizeof(arr4) / sizeof(arr4[0]);
66     printf("Test 4: Max sum = %d\n", maxSubArraySum(arr4, n4, constraint4));
67
68     int arr5[] = {1, 1, 1};
69     int constraint5 = 5;
70     int n5 = sizeof(arr5) / sizeof(arr5[0]);
71     printf("Test 5: Max sum = %d\n", maxSubArraySum(arr5, n5, constraint5));
72
73     int arr6[] = {1, 1, 1, 1, 1};
74     int constraint6 = 4;
75     int n6 = sizeof(arr6) / sizeof(arr6[0]);
76     printf("Test 6: Max sum = %d\n", maxSubArraySum(arr6, n6, constraint6));
77
78     int arr7[] = {4, 2, 3, 1};
79     int constraint7 = 5;
80     int n7 = sizeof(arr7) / sizeof(arr7[0]);
81     printf("Test 7: Max sum = %d\n", maxSubArraySum(arr7, n7, constraint7));
82
83     int arr8[] = {};
84     int constraint8 = 10;
85     int n8 = sizeof(arr8) / sizeof(arr8[0]);
86     printf("Test 8: Max sum = %d\n", maxSubArraySum(arr8, n8, constraint8));
87
88     int arr9[] = {1, 2, 3};
89     int constraint9 = 8;
90     int n9 = sizeof(arr9) / sizeof(arr9[0]);
91     printf("Test 9: Max sum = %d\n", maxSubArraySum(arr9, n9, constraint9));
92
93     int arr10[100000];
94     for (int i = 0; i < 100000; i++) arr10[i] = i + 1;
95     int constraint10 = 1000000000;
96     int n10 = sizeof(arr10) / sizeof(arr10[0]);
97     printf("Test 10: Max sum = %d\n", maxSubArraySum(arr10, n10, constraint10));
98
99     return 0;
100 }
```

File Explorer: DAA PRAC 04, .vscode, PRAC41.c, PRAC42.c

CHAT: Welcome to Copilot, Let's get started, Add context (#), extensions (@), corr, Build Workspace, Show Config, Review AI output carefully before use.

Bottom status bar: Line 53 Col 1 Spaces 4 UFT-8 CRLF ⌘ C ⌘ V Go Live BLACKBOX Agent Open Website

OUTPUT :

DAA Lab Section A6, Section A4 > Online C Compiler - Programiz

https://www.programiz.com/c-programming/online-compiler/

Programiz C Online Compiler

Turn your knowledge into new customers

Google Ads

Programiz PRO

main.c

```

69 int constraint5 = 5;
70 int n5 = sizeof(arr5) / sizeof(arr5[0]);
71 printf("Test 5: Max sum = %d\n", maxSubArraySum(arr5, n5,
    constraint5));
72
73 int arr6[] = {1, 1, 1, 1, 1};
74 int constraint6 = 4;
75 int n6 = sizeof(arr6) / sizeof(arr6[0]);
76 printf("Test 6: Max sum = %d\n", maxSubArraySum(arr6, n6,
    constraint6));
77
78 int arr7[] = {4, 2, 3, 1};
79 int constraint7 = 5;
80 int n7 = sizeof(arr7) / sizeof(arr7[0]);
81 printf("Test 7: Max sum = %d\n", maxSubArraySum(arr7, n7,
    constraint7));
82
83 int arr8[] = {};
84 int constraint8 = 10;
85 int n8 = sizeof(arr8) / sizeof(arr8[0]);
86 printf("Test 8: Max sum = %d\n", maxSubArraySum(arr8, n8,
    constraint8));
87
88 int arr9[] = {1, 2, 3};
89 int constraint9 = 8;
90 int n9 = sizeof(arr9) / sizeof(arr9[0]);
91 printf("Test 9: Max sum = %d\n", maxSubArraySum(arr9, n9,
    constraint9));
92
93 int arr10[100000];
94 for (int i = 0; i < 100000; i++) arr10[i] = i + 1;
95 int constraint10 = 1000000000;
96 int n10 = sizeof(arr10) / sizeof(arr10[0]);
97 printf("Test 10: Max sum = %d\n", maxSubArraySum(arr10, n10,
    constraint10));
98
99 return 0;
100 }
```

Output:

```

/tmp/JmHq0Aaltf/main.c: In function 'main':
/tmp/JmHq0Aaltf/main.c:86:5: warning: 'maxSubArraySum' accessing 4 bytes in
region of size 0 [-Wstringop-overflow=]
86 |     printf("Test 8: Max sum = %d\n", maxSubArraySum(arr8, n8,
|     constraint8));
|     ^
=====
/tmp/JmHq0Aaltf/main.c:86:5: note: referencing argument 1 of type 'int[0]'
/tmp/JmHq0Aaltf/main.c:43:5: note: in a call to function "maxSubArraySum"
43 | int maxSubArraySum(int arr[], int n, int constraint) {
|     ^
=====
Test 1: Max sum = 4
Test 2: Max sum = 4
Test 3: Max sum = 5
Test 4: Max sum = 0
Test 5: Max sum = 5
Test 6: Max sum = 3
Test 7: Max sum = 4
Test 8: Max sum = 0
Test 9: Max sum = 0
Test 10: Max sum = 999984681

==== Code Execution Successful ====

```

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