No-repeat Substring (hard)

Problem Statement

Given a string, find the **length of the longest substring** which has **no repeating characters**.

Example 1:

```
Input: String="aabccbb"
Output: 3
Explanation: The longest substring without any repeating characters is "abc".
```

Example 2:

```
Input: String="abbbb"
Output: 2
Explanation: The longest substring without any repeating characters is "ab".
```

Example 3:

```
Input: String="abccde"
Output: 3
Explanation: Longest substrings without any repeating characters are "abc" & "cde".
```

Try it yourself

Try solving this question here:

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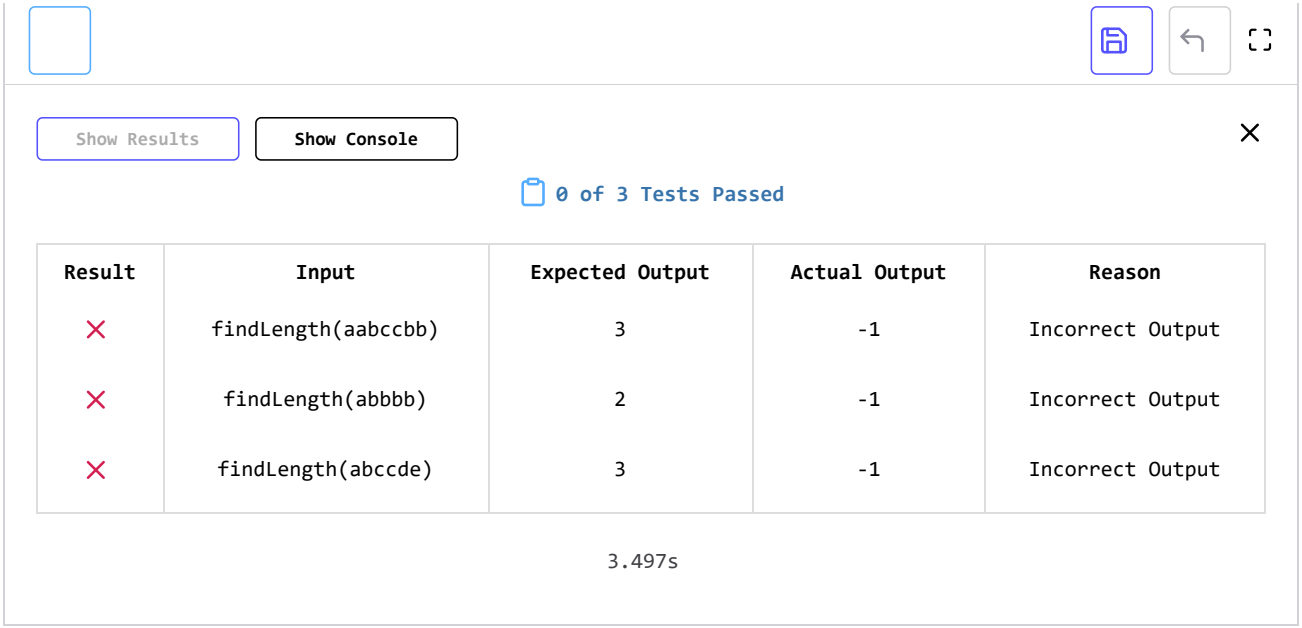
```
using namespace std;

#include <iostream>
#include <string>
#include <unordered_map>

class NoRepeatSubstring {
 public:
  static int findLength(const string& str) {
    int maxLength = 0;
    // TODO: Write your code here
    return maxLength;
  }
};

```



Solution

This problem follows the **Sliding Window** pattern and we can use a similar dynamic sliding window strategy as discussed in Longest Substring with K Distinct Characters. We can use a **HashMap** to remember the last index of each character we have processed. Whenever we get a repeating character we will shrink our sliding window to ensure that we always have distinct characters in the sliding window.

Code

Here is what our algorithm will look like:

Java | Python3 | C++ | JS

```cpp
using namespace std;

#include <iostream>
#include <string>
#include <unordered_map>

class NoRepeatSubstring {
 public:
  static int findLength(const string& str) {
    int windowStart = 0, maxLength = 0;
    unordered_map<char, int> charIndexMap;
    // try to extend the range [windowStart, windowEnd]
    for (int windowEnd = 0; windowEnd < str.length(); windowEnd++) {
      char rightChar = str[windowEnd];
      // if the map already contains the 'rightChar', shrink the window from the beginning so that
      // we have only one occurrence of 'rightChar'
      if (charIndexMap.find(rightChar) != charIndexMap.end()) {
        // this is tricky; in the current window, we will not have any 'rightChar' after its
        // previous index and if 'windowStart' is already ahead of the last index of 'rightChar',
        // we'll keep 'windowStart'
        windowStart = max(windowStart, charIndexMap[rightChar] + 1);
      }
      charIndexMap[rightChar] = windowEnd;  // insert the 'rightChar' into the map
      maxLength =
          max(maxLength, windowEnd - windowStart + 1);  // remember the maximum length so far
    }

    return maxLength;
  }
};

int main(int argc, char* argv[]) {
  cout << "Length of the longest substring: " << NoRepeatSubstring::findLength("aabccbb") << endl;
  cout << "Length of the longest substring: " << NoRepeatSubstring::findLength("abbbb") << endl;
  cout << "Length of the longest substring: " << NoRepeatSubstring::findLength("abccde") << endl;
}

```

Output 0.955s

```
Length of the longest substring: 3
Length of the longest substring: 2
Length of the longest substring: 3
```

Time Complexity

The time complexity of the above algorithm will be $O(N)$ where 'N' is the number of characters in the input string.

Space Complexity

The space complexity of the algorithm will be $O(K)$ where K is the number of distinct characters in the input string. This also means $K <= N$, because in the worst case, the whole string might not have any repeating character so the entire string will be added to the **HashMap**. Having said that, since we can expect a fixed set of characters in the input string (e.g., 26 for English letters), we can say that the algorithm runs in fixed space $O(1)$; in this case, we can use a fixed-size array instead of the **HashMap**.