3-Balanced String

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pseudocode representation of the (non-recursive) algorithm:

```
algorithm longest_balanced_substring(s) \\ for get longest balanced substring
  n <- length(s)
  max_length <- 0
  for i <- 0 to n-2 do
    for j <- i+2 to n do
      substr <- s[i:j]  // Extract the substring }
   if is_balanced(substr) and length(substr) > max_length then
        max_length <- length(substr)  // Update the maximum length
   return max_length
 algorithm is_balanced(substr) \\ for check if string is balanced or not
  count <- [0, 0]
  for i <- 0 to length(substr)-1 do{
    if substr[i] == substr[0] then
      count[0]++
    else
      count[1]++
if (count[0] == count[1]) then return 1
return 0
```

Analysis of this algorithm:

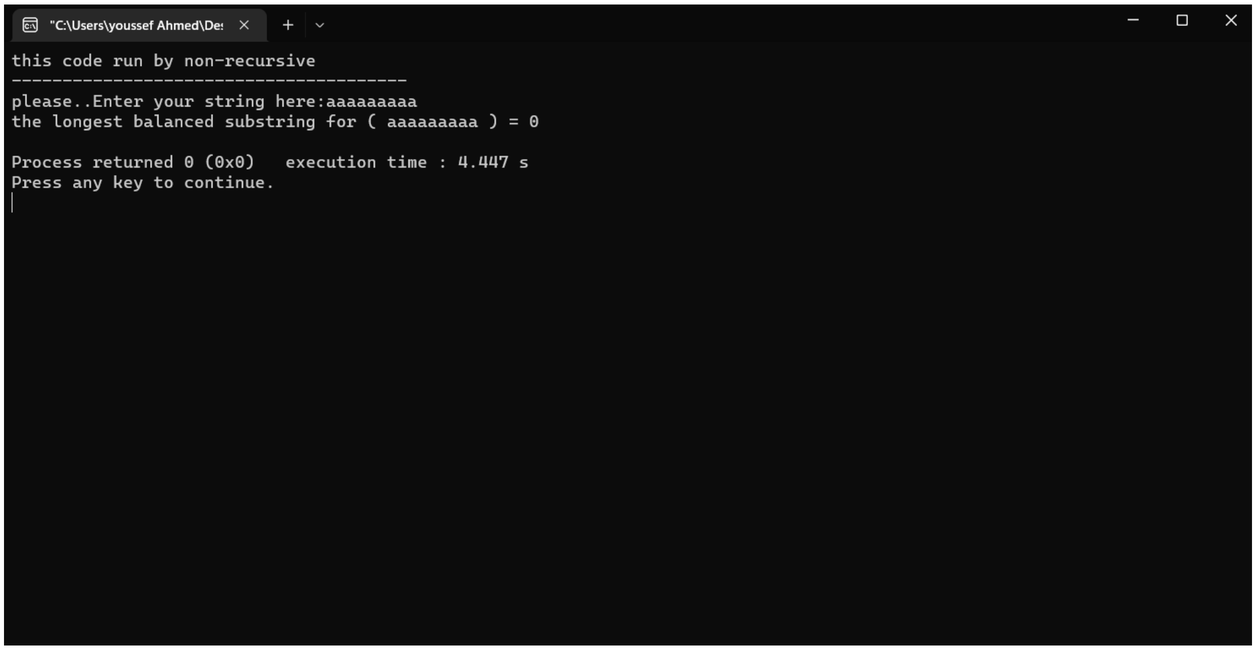
The outer loop of the **longest_balanced_substring** algorithm iterates over all possible starting indices **i** in the input string, from 0 to **n-2**. This takes O(n) time.

The inner loop iterates over all possible ending indices **j** in the input string, starting from **i+2** and going up to **n**. This also takes O(n) time.

For each pair of indices **(i, j)**, the algorithm extracts a substring using **strncpy**, which takes O(j-i) time. This is the time required to copy the characters from the input string to the **substr** array. Since there are at most O(n^2) pairs of indices **(i, j)** to consider, the total time taken for all substring extractions is O(n^3).

Finally, the **is_balanced** algorithm is called on each extracted substring, which takes O(k) time, where **k** is the length of the substring. Since the total length of all extracted substrings is O(n^3), the total time taken by **is_balanced** is O(n^3) as well.

Adding up these time complexities, we get a total time complexity of O(n^3) for the entire algorithm.



```
this code run by non-recursive
---------------------------------------
please..Enter your string here:aaaaaaaaa
the longest balanced substring for ( aaaaaaaaa ) = 0

Process returned 0 (0x0)   execution time : 4.447 s
Press any key to continue.
```

pseudocode representation of the (Recursive) algorithm:

```
 algorithm longest_balanced_substring(s)

RETURN longest_balanced_substring (s, 0,length(s) - 1)


algorithm longest_balanced_substring_helper(s, start, end)

   IF end - start + 1 < 2 THEN

      RETURN 0

   freq [26] <- {0}

   FOR i <- start to end    Do

      freq[s[i] - 'a'] <- freq[s[i] - 'a'] + 1

   IF is_balanced(freq) THEN

      RETURN end - start + 1

   len1 <-longest_balanced_substring _helper (s, start, end - 1)

   len2<- longest_balanced_substring_helper (s, start + 1, end)

   IF len1 > len2 THEN

      RETURN len1

ELSE

      RETURN len2


algorithm is_balanced(freq)

  count <- 0

   diff_chars <- 0

   FOR i <- 0 to 25   Do

      IF freq[i] > 0 THEN

         diff_chars <- diff_chars + 1
```

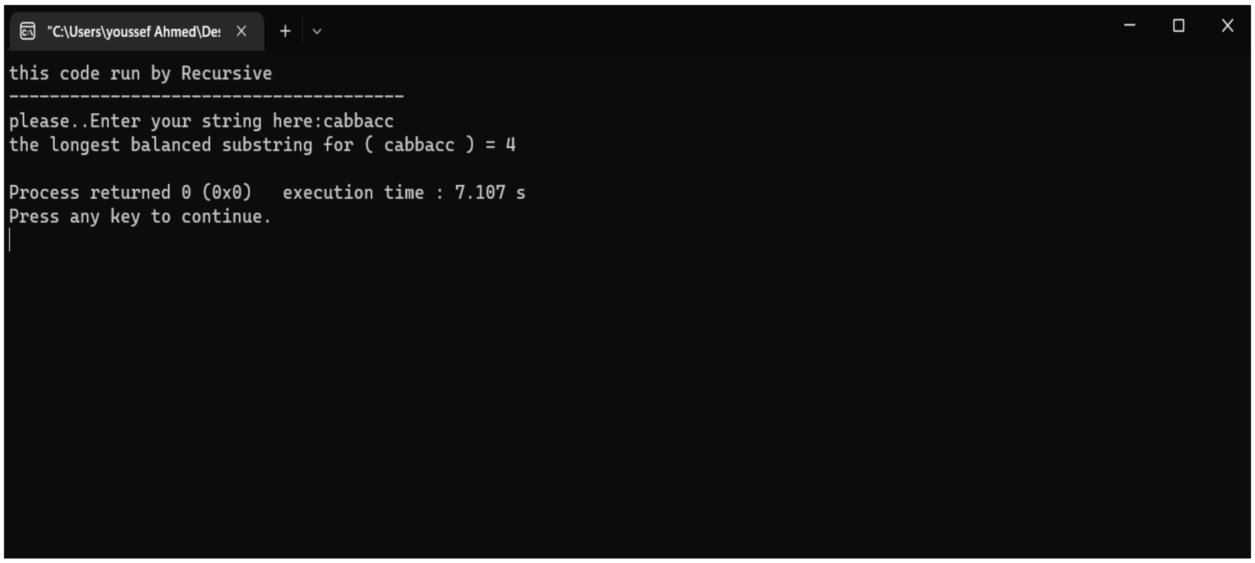
```
        IF freq[i] <- freq[0] AND freq[i] > 0 THEN
            count <- count + 1
    IF diff_chars == 2 AND count == 2 THEN
        RETURN 1
    ELSE
        RETURN 0
```

Analysis of this algorithm:

The time complexity of the **longest_balanced_substring** algorithm is O(n log n) because it uses a divide-and-conquer approach that involves recursively dividing the input string into two halves and then combining the results of these subproblems.

At each level of recursion, the algorithm splits the input string into two substrings of length n/2, where n is the length of the original input string. The algorithm then recursively calls itself on each of these substrings, which results in a binary tree of recursive calls with a height of log n.

At each level of recursion, the algorithm computes the frequency of each character in the substring and checks if it is balanced using the **is_balanced** function, which takes O(n) time in the worst case, where n is the length of the substring. Therefore, the total time complexity of the algorithm is the product of the number of levels in the recursive tree and the time complexity of each level, which is O(log n * n) = O(n log n).



```
this code run by Recursive
---------------------------------------
please..Enter your string here:cabbacc
the longest balanced substring for ( cabbacc ) = 4

Process returned 0 (0x0)   execution time : 7.107 s
Press any key to continue.
```

	Recursive algorithm	*Non-Recursive algorithm*
Complexity	O(n log n)	O(n^3)
Understanding	more challenging to follow because of the recursion.	simpler and easier to understand

- The recursive algorithm has a lower time complexity than the non-recursive algorithm because the time complexity of the non-recursive is O(n^3) and the recursive is O(n log n). , so it is more efficient in terms of time complexity.