

Longest Palindromic Substring

To solve the longest palindromic substring problem, the most efficient and intuitive approach is the Expand Around Center technique.

Key Idea: A palindrome mirrors around its center. So for each index in the string, try to expand outward to check if the substring is a palindrome.

There are $2n-1$ centers to consider (because each character can be a center and the gap between every two characters can also be a center for even-length palindromes).

Strategy: Expand Around Center:

1. Iterate through each character in the string.
2. For each index i :
 - Expand around center i (odd length palindrome)
 - Expand around center i and $i+1$ (even length palindrome)
3. Track the longest palindrome seen so far.

Helper Function: Write a function to expand from center:

```
int left = i, right = i;  
while (left >= 0 && right < s.length() && s[left] == s[right]) {  
    left--;  
    right++;  
}
```

Return the bounds of the longest substring found from this center.

Example: For $s = "babad"$:

- Center at 1 (char 'a') → expands to "bab"
 - Center between 1 and 2 → expands to "ab"
- Return either "bab" or "aba"

Time Complexity: $O(n^2)$ time (In center, each expands up to n)
 $O(1)$ space