Program to Find the Count of Distinct Substrings

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Industry Embedded Program

Lesson Plan

Subject/Course	**Competitive Coding**
Lesson Title	**Program to Find the Count of Distinct Substrings**

Lesson Objectives
Understand what substrings are and how to count them.
Learn how to find all distinct substrings in a given string.
Explore efficient methods using hashing or Trie.
Analyze time and space complexity of substring counting

Problem Statement:

Write a program to count the number of distinct substrings in a given string.

The program should:

1. Take a string as input.
2. Find all unique substrings.
3. Return the count of those distinct substrings.

Concept

What is a Substring?

- A **substring** is a continuous sequence of characters within a string.
  Example: For "abc", substrings are
  a, b, c, ab, bc, abc.
- Total substrings = *n × (n + 1) / 2* for a string of length *n*.
- But we only want **distinct substrings** (no duplicates).

Concept

⚙️ Approaches

1. **Brute Force:** Generate all substrings and use a set — O(n^2) substrings, O(n^3) time (inefficient).

1. **Trie-based Approach:**
   - Insert all suffixes of the string into a Trie.
   - Each new branch in the Trie represents a **new distinct substring**.
   - Count total Trie nodes = total distinct substrings + 1 (for empty string).

Algorithm/Logic

1. Initialize an empty HashSet.

2. Generate all substrings using two loops:

   - Outer loop for start index.

   - Inner loop for end index.

3. Add each substring to the HashSet.

4. The size of the HashSet gives the distinct substring count.

Visualization

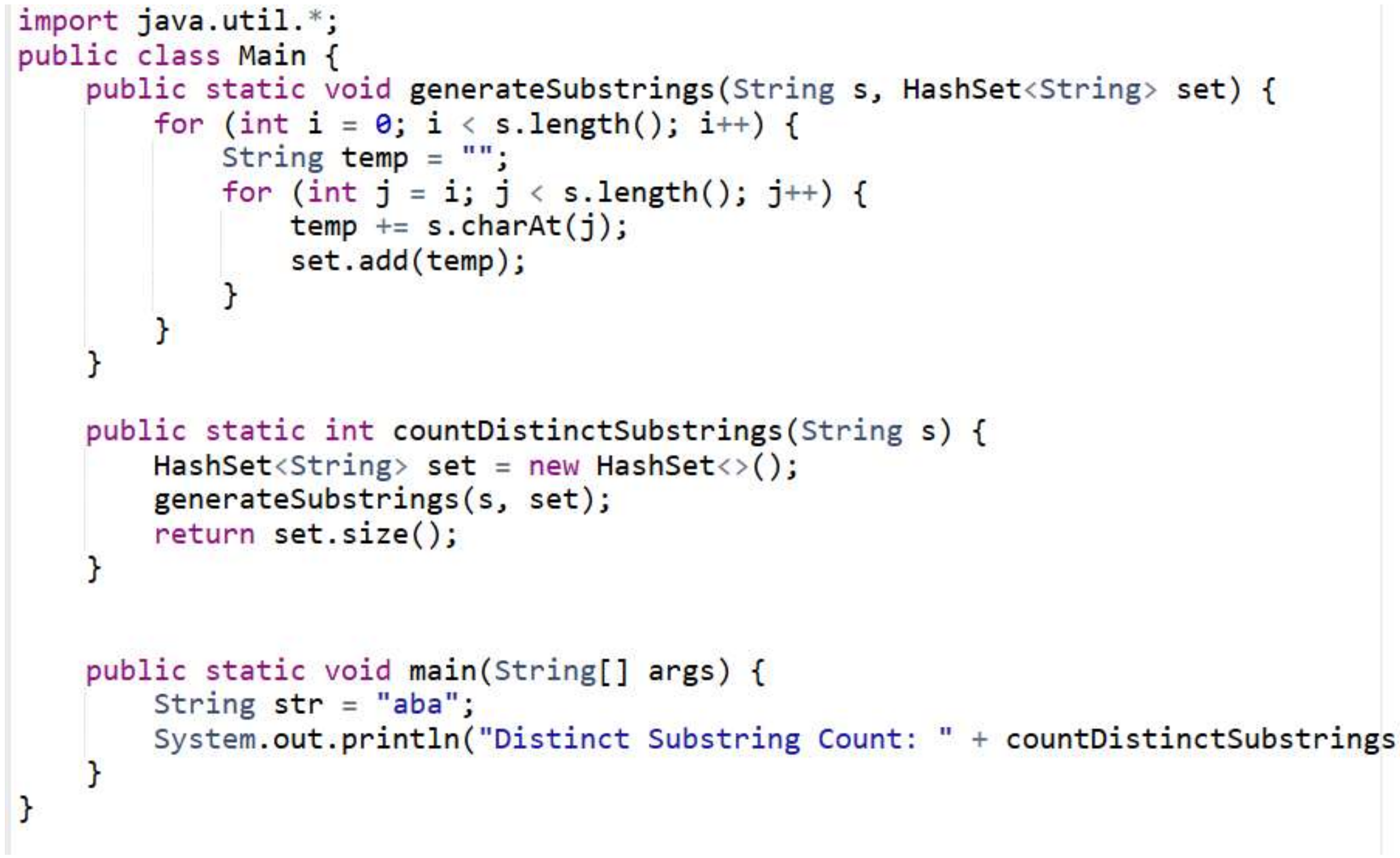
Example:
Input: "aba"

All substrings:
a, b, a, ab, ba, aba

Distinct substrings:
a, b, ab, ba, aba

Count = 5

Code Implementation

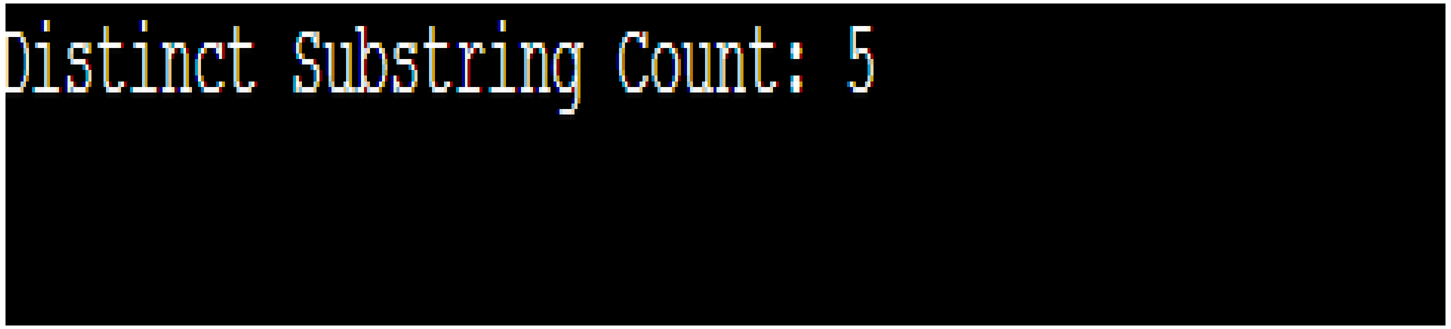


```java
import java.util.*;
public class Main {
    public static void generateSubstrings(String s, HashSet<String> set) {
        for (int i = 0; i < s.length(); i++) {
            String temp = "";
            for (int j = i; j < s.length(); j++) {
                temp += s.charAt(j);
                set.add(temp);
            }
        }
    }

    public static int countDistinctSubstrings(String s) {
        HashSet<String> set = new HashSet<>();
        generateSubstrings(s, set);
        return set.size();
    }


    public static void main(String[] args) {
        String str = "aba";
        System.out.println("Distinct Substring Count: " + countDistinctSubstrings(str));
    }
}
```

Output



```
Distinct Substring Count: 5
```

Example Walkthrough

1. Start = 0 → Substrings: a, ab, aba
2. Start = 1 → Substrings: b, ba
3. Start = 2 → Substrings: a
4. Unique ones stored in HashSet.
5. Final count = 5.

Time & Space Complexity

Time Complexity:

$O(n^2)$ – two nested loops for substring generation.

Space Complexity:

$O(n^2)$ – storing all substrings in the HashSet.

Summary

1. Substrings are continuous character sequences.
2. Use HashSet to remove duplicates automatically.
3. Total time complexity is $O(n^2)$.
4. Simple and effective approach for small strings.

Practice Questions:

1. Repeated Substring Pattern — LeetCode #459

🔗 https://leetcode.com/problems/repeated-substring-pattern/

Concept: Check if the given string can be formed by repeating a substring.

Why Practice: Related to substring structure and repetition detection.

Practice Questions:

2. Longest Substring Without Repeating Characters — LeetCode #3

🔗https://leetcode.com/problems/longest-substring-without-repeating-characters/

Concept: Sliding window and unique substring logic.

Why Practice: Reinforces unique substring concepts.

Practice Questions:

3. Count Unique Substrings – LeetCode #1698

🔗 https://leetcode.com/problems/number-of-distinct-substrings-in-a-string/

Concept:
Use Trie (Prefix Tree) or Suffix Array to count the number of distinct substrings efficiently.

Why Practice:
This problem is a **direct application** of the practical — it strengthens understanding of **Trie-based substring counting**, **suffix generation**, and **string manipulation**.

Thanks