Solution Review: Problem Challenge 1

Permutation in a String (hard)

Given a string and a pattern, find out if the **string contains any permutation of the pattern**.

Permutation is defined as the re-arranging of the characters of the string. For example, “abc” has the following six permutations:

1. abc
2. acb
3. bac
4. bca
5. cab
6. cba

If a string has ‘n’ distinct characters it will have $n!$ permutations.

Example 1:

```
Input: String="oidbcaf", Pattern="abc"
Output: true
Explanation: The string contains "bca" which is a permutation of the given pattern.
```

Example 2:

```
Input: String="odicf", Pattern="dc"
Output: false
Explanation: No permutation of the pattern is present in the given string as a substring.
```

Example 3:

```
Input: String="bcdxabcdy", Pattern="bcdyabcdx"
Output: true
Explanation: Both the string and the pattern are a permutation of each other.
```

Example 4:

```
Input: String="aaacb", Pattern="abc"
Output: true
Explanation: The string contains "acb" which is a permutation of the given pattern.
```

Solution

This problem follows the **Sliding Window** pattern and we can use a similar sliding window strategy as discussed in Longest Substring with K Distinct Characters. We can use a **HashMap** to remember the frequencies of all characters in the given pattern. Our goal will be to match all the characters from this **HashMap** with a sliding window in the given string. Here are the steps of our algorithm:

1. Create a **HashMap** to calculate the frequencies of all characters in the pattern.
2. Iterate through the string, adding one character at a time in the sliding window.
3. If the character being added matches a character in the **HashMap**, decrement its frequency in the map. If the character frequency becomes zero, we got a complete match.
4. If at any time, the number of characters matched is equal to the number of distinct characters in the pattern (i.e., total characters in the **HashMap**), we have gotten our required permutation.
5. If the window size is greater than the length of the pattern, shrink the window to make it equal to the size of the pattern. At the same time, if the character going out was part of the pattern, put it back in the frequency **HashMap**.

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 StringPermutation {
 public:
  static bool findPermutation(const string &str, const string &pattern) {
    int windowStart = 0, matched = 0;
    unordered_map<char, int> charFrequencyMap;
    for (auto chr : pattern) {
      charFrequencyMap[chr]++;
    }

    // our goal is to match all the characters from the 'charFrequencyMap' with the current window
    // try to extend the range [windowStart, windowEnd]
    for (int windowEnd = 0; windowEnd < str.length(); windowEnd++) {
      char rightChar = str[windowEnd];
      if (charFrequencyMap.find(rightChar) != charFrequencyMap.end()) {
        // decrement the frequency of the matched character
        charFrequencyMap[rightChar]--;
        if (charFrequencyMap[rightChar] == 0) {  // character is completely matched
          matched++;
        }
      }

      if (matched == (int)charFrequencyMap.size()) {
        return true;
      }

      if (windowEnd >= pattern.length() - 1) {  // shrink the window
        char leftChar = str[windowStart++];
        if (charFrequencyMap.find(leftChar) != charFrequencyMap.end()) {
          if (charFrequencyMap[leftChar] == 0) {
            matched--;  // before putting the character back, decrement the matched count
          }
          // put the character back for matching
          charFrequencyMap[leftChar]++;
        }
      }
    }

    return false;
  }
};

int main(int argc, char *argv[]) {
  cout << "Permutation exist: " << StringPermutation::findPermutation("oidbcaf", "abc") << endl;
  cout << "Permutation exist: " << StringPermutation::findPermutation("odicf", "dc") << endl;
  cout << "Permutation exist: " << StringPermutation::findPermutation("bcdxabcdy", "bcdyabcdx") << endl;
  cout << "Permutation exist: " << StringPermutation::findPermutation("aaacb", "abc") << endl;
}

```

Output 1.223s

```
Permutation exist: 1
Permutation exist: 0
```

```
Permutation exist: 1
Permutation exist: 1
```

Time Complexity

The time complexity of the above algorithm will be $O(N + M)$ where 'N' and 'M' are the number of characters in the input string and the pattern respectively.

Space Complexity

The space complexity of the algorithm is $O(M)$ since in the worst case, the whole pattern can have distinct characters which will go into the **HashMap**.