String

In C++, a string is a dynamic sequence of characters. std::string simplifies manipulation with built-in functions, offering efficiency and safety.

Using namespace std; use it to avoid making use of std:: library again and again

String initialization in c++

Dynamic way:

```
string n;

getline(cin,n);

cout<<n;
```

Static way :

```
char str[10]= {'C', '+', '+', '\0'};
```

The \0 is the null character in C and C++. It serves as the string terminator, indicating the end of a string. When used in a character array, it marks the end of the string data.

String operations

Use <string> header to work with below operations in c++

strcpy: Copy string data.

strcat: Concatenate two strings.

strlen: Get string length.

strcmp: Compare two strings.

strchr: Locate character in string.

NOTE :[In string Index start from 0 , Length start from 1]

Example : khadeer length is 7 , Index of r is 6

Libraries and Operations

<iostream>

Basic Input/Output: std::cin, std::cout

String Output: std::cout << "Hello";

<string>

String Declaration: string myString = "Hello";

String Concatenation: myString = myString + " World";

String Length: myString.length()

<cstring>

String Copying: strcpy(str1, str2);

String Concatenation: strcat(dest, source);

String Length: strlen(str):

<sstream>

istringstream (Input String Stream):

Purpose: Used for reading from strings.

Example:

```
#include <iostream>
#include <sstream
using namespace std;
int main()
{
   string str = "123";
   int numericVar;
   istringstream iss(str);
   iss >> numericVar;
   cout << "Original String: " << str << endl;
   cout << "Converted Numeric Value: " <<numericVar << endl;
   return 0;
}
```

Output : int: 123, Float: 45.6, String: hello

std::ostringstream (Output String Stream):

Purpose: Used for writing to strings.

Example:

```
#include <iostream>
```

```
#include <sstream>
int main()
{
    std::ostringstream oss;
    int intValue = 123;
    float floatValue = 45.6;
    std::string stringValue = "hello";
    oss << "Int: " << intValue << ", Float: " << floatValue << ", String: " << stringValue;
    std::string outputStr = oss.str();
    std::cout << "Concatenated String: " << outputStr << std::endl;
    return 0;
}
```

OUTPUT :

```
Concatenated String: Int: 123, Float: 45.6, String: hello
```

std::stringstream (Input/Output String Stream):

Purpose: Supports both reading and writing operations on strings.

Example:

```
#include <iostream>
#include <sstream>
using namespace std;
int main() {
    stringstream ss;
    int intValue = 123;
    float floatValue = 45.6;
    string stringValue = "hello";
    ss << "Int: " << intValue << ", Float: " << floatValue << ", String: " << stringValue;
    int newIntValue;
    float newFloatValue;
    string newStringValue;
```

```
  ss >> newIntValue >> newFloatValue >> newStringValue;

  cout << "Read values - Int: " << newIntValue << ", Float: " << newFloatValue << ", String: " <<
newStringValue << endl;

  return 0;

}
```

BASIC ALL PROGRAMS ON STRINGS IN C++

1) https://leetcode.com/problems/add-strings/

DESCRIPTION: This C++ code implements the "Two Sum" problem using a hash map to efficiently find pairs of numbers that sum up to the target value. Here's a breakdown of the code:

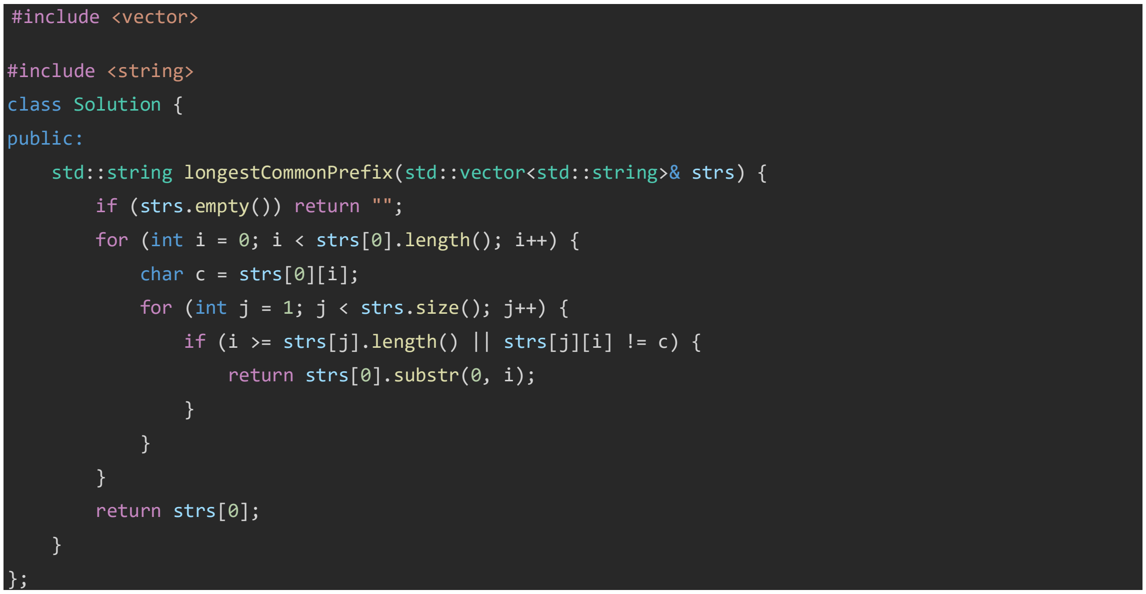
1. **Initialization:**
   - Create an unordered map `num_map` to store elements of the input array `nums`, where the keys are the array elements, and the values are their corresponding indices.
2. **Main Loop:**
   - Use a for loop to iterate through each element of the array `nums`.
   - Inside the loop:
     - Calculate the complement, which is the difference between the target value and the current element (`complement = target - nums[i]`).
     - Check if the complement is present in the `num_map`. If it is, a pair of indices with the desired sum is found. Return the indices as a vector `{num_map[complement], i}`.
     - If the complement is not in the map, add the current element and its index to the `num_map`.
3. **Result:**
   - If no such pair is found, return an empty vector `{}`.

CODE:

```
class Solution {

public:
    vector<int> twoSum(vector<int>& nums, int target) {
        unordered_map<int, int> num_map;
        for (int i = 0; i < nums.size(); i++) {
            int complement = target - nums[i];
            if (num_map.find(complement) != num_map.end()) {
                return {num_map[complement], i};
            }
            num_map[nums[i]] = i;
        }
        return {};
    }
};
```

2) https://leetcode.com/problems/longest-common-prefix/

1. **Check Empty Input:**
   - o If the input vector `strs` is empty, return an empty string as there is no common prefix.
2. **Prefix Comparison Loop:**
   - o Iterate through each character position `i` of the first string in the array (`strs[0]`).
   - o For each character position, compare the character `c` from the first string with the corresponding characters in the rest of the strings (`strs[j]`) starting from the second string.
   - o If any of the following conditions are met:
     - ▪ The index `i` is beyond the length of the current string `strs[j]`.
     - ▪ The character at position `i` in the current string `strs[j]` is different from the character `c`.
   - o Return the substring of the first string (`strs[0]`) up to the index `i`. This substring is the longest common prefix found so far.
3. **Result:**
   - o If the loop completes without returning, the entire first string (`strs[0]`) is the longest common prefix among all strings in the array.

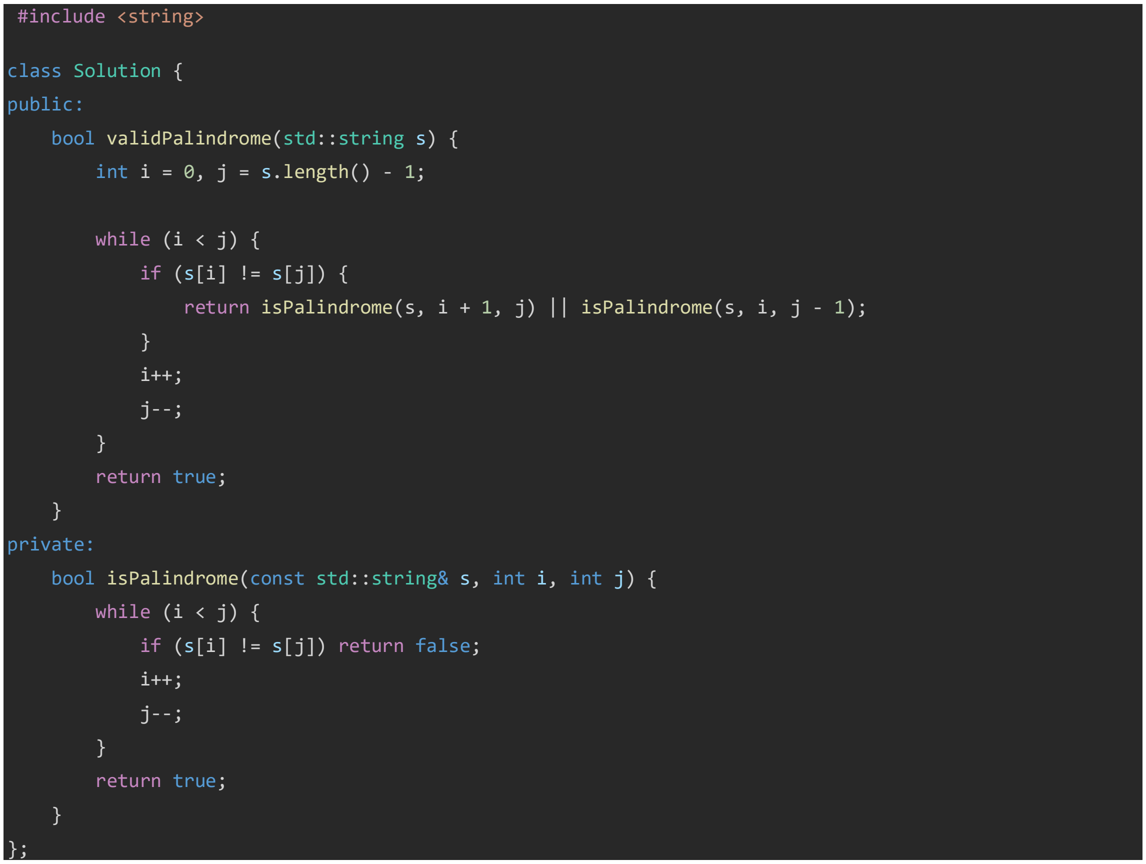


```
#include <vector>

#include <string>
class Solution {
public:
    std::string longestCommonPrefix(std::vector<std::string>& strs) {
        if (strs.empty()) return "";
        for (int i = 0; i < strs[0].length(); i++) {
            char c = strs[0][i];
            for (int j = 1; j < strs.size(); j++) {
                if (i >= strs[j].length() || strs[j][i] != c) {
                    return strs[0].substr(0, i);
                }
            }
        }
        return strs[0];
    }
};
```

3) https://leetcode.com/problems/valid-palindrome-ii/

1. **Initialization:**
   - o Initialize two pointers `i` and `j` to the beginning and end of the string `s`.
   - o Use a while loop that continues as long as `i` is less than `j`.
2. **Palindrome Check Loop:**
   - o Inside the loop, compare characters at positions `i` and `j` in the string `s`.
   - o If the characters are not equal, return the result of two palindrome checks:

        - Check if the substring from `i + 1` to `j` is a palindrome.
        - Check if the substring from `i` to `j - 1` is a palindrome.
    - If both checks fail, return `false`.
3. **Move Pointers:**
    - If characters at positions `i` and `j` are equal, increment `i` and decrement `j`.
4. **Result:**
    - If the loop completes without returning `false`, the string is a valid palindrome after at most one deletion.
5. **Helper Function `isPalindrome`:**
    - A helper function to check if a given substring is a palindrome. It uses two pointers (`i` and `j`) to compare characters from the start and end of the substring, returning `true` if it's a palindrome and `false` otherwise.



```
 #include <string>

class Solution {
public:
    bool validPalindrome(std::string s) {
        int i = 0, j = s.length() - 1;

        while (i < j) {
            if (s[i] != s[j]) {
                return isPalindrome(s, i + 1, j) || isPalindrome(s, i, j - 1);
            }
            i++;
            j--;
        }
        return true;
    }
private:
    bool isPalindrome(const std::string& s, int i, int j) {
        while (i < j) {
            if (s[i] != s[j]) return false;
            i++;
            j--;
        }
        return true;
    }
};
```

4) https://leetcode.com/problems/roman-to-integer/

1. **Roman Values Map:**
    - Initialize an unordered map `roman_values` to store the integer values corresponding to each Roman numeral character.
2. **Initialization:**
    - Initialize `result` to store the final integer value and `i` as a pointer to iterate through the string `s`.
3. **Conversion Loop:**
    - Use a while loop that continues as long as `i` is less than the length of the string `s`.

    - Inside the loop:
        - Check if the current character at position `i` is a valid Roman numeral character.
        - If there is a next character (`i + 1 < s.length()`) and the value of the current character is less than the value of the next character:
            - Add the difference between the values of the next and current characters to the result.
            - Increment `i` by 2 to skip the next character.
        - Otherwise, add the value of the current character to the result and increment `i` by 1.

4. **Result:**
    - After the loop, the variable `result` contains the integer value corresponding to the input Roman numeral string.

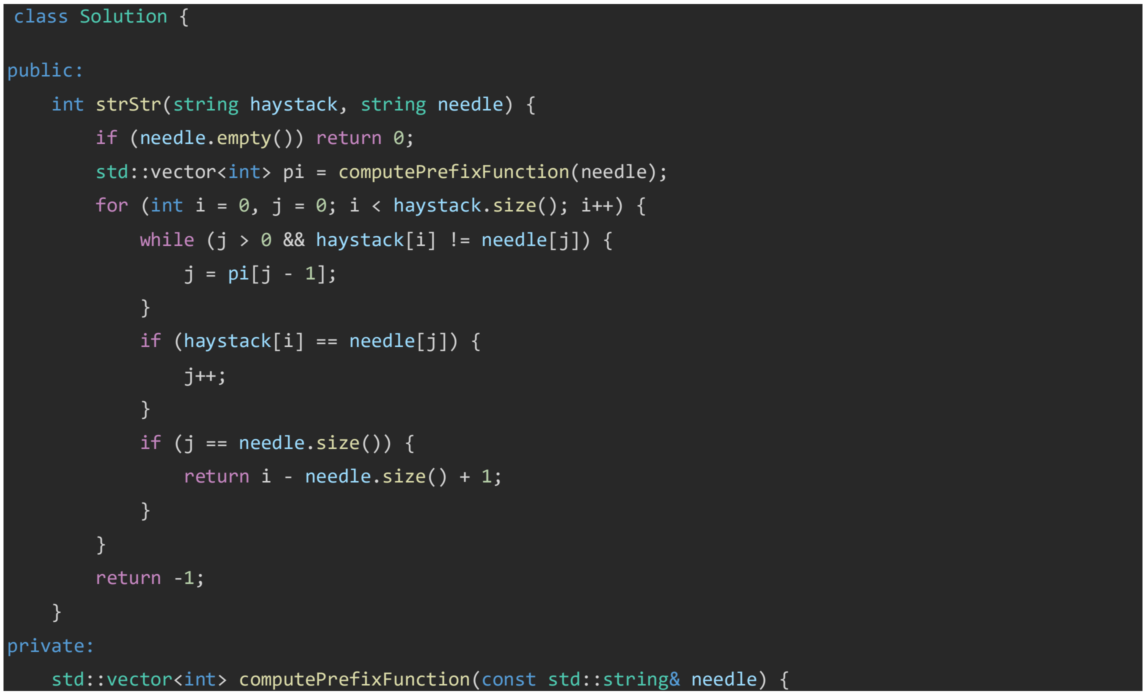
```
 #include <unordered_map>

#include <string>
class Solution {
public:
    int romanToInt(std::string s) {
        std::unordered_map<char, int> roman_values = {
            {'I', 1},
            {'V', 5},
            {'X', 10},
            {'L', 50},
            {'C', 100},
            {'D', 500},
            {'M', 1000}
        };
        int result = 0, i = 0;
        while (i < s.length()) {
            if (i + 1 < s.length() && roman_values[s[i]] < roman_values[s[i + 1]])
{
                result += roman_values[s[i + 1]] - roman_values[s[i]];
                i += 2;
            } else {
                result += roman_values[s[i]];
                i++;
            }
        }
        return result;
    }
};
```

5) https://leetcode.com/problems/implement-strstr/

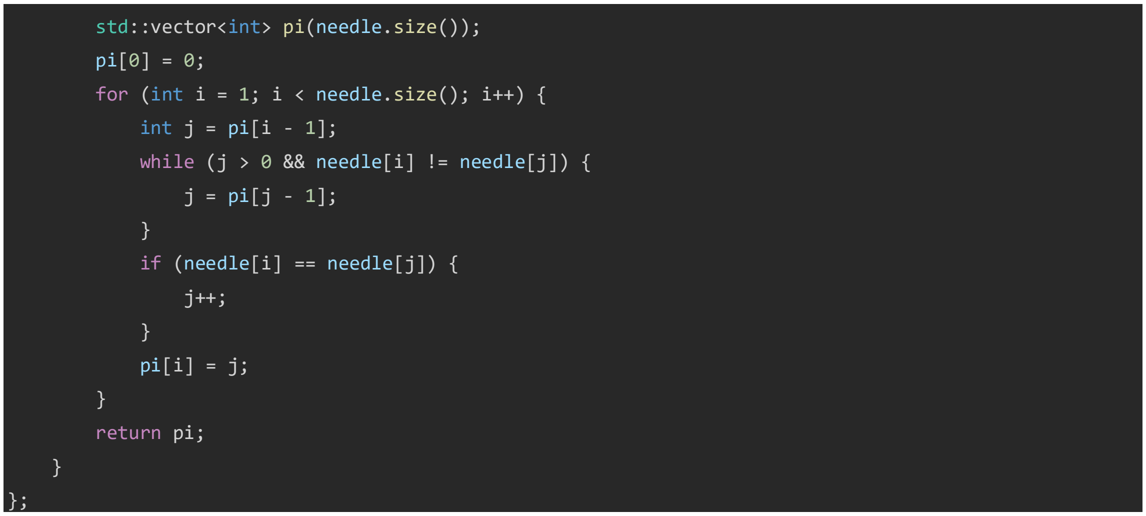
This C++ code is an implementation of the Knuth-Morris-Pratt (KMP) algorithm to find the index of the first occurrence of a substring (needle) within a string (haystack).

Here's an explanation of how the algorithm works:

1. **Check Empty Needle:**
   - If the needle is an empty string, return 0, as an empty needle is considered to be present at the beginning of any string.
2. **Compute Prefix Function:**
   - Call the `computePrefixFunction` function to compute the prefix function (pi) for the needle. The prefix function helps in efficiently skipping unnecessary comparisons.
3. **Main Loop:**
   - Use a for loop to iterate through each character of the haystack.
   - Inside the loop:
     - While the current characters in the haystack and needle do not match and `j` is greater than 0, update `j` using the prefix function (failure function).
     - If the characters match, increment `j`.
     - If `j` becomes equal to the length of the needle, a match is found. Return the starting index of the match in the haystack (`i - needle.size() + 1`).
4. **Compute Prefix Function Function:**
   - The `computePrefixFunction` function calculates the prefix function (pi) for the needle using a while loop and updates the pi array accordingly.
5. **Result:**
   - If no match is found, return -1.



```
 class Solution {

public:
    int strStr(string haystack, string needle) {
        if (needle.empty()) return 0;
        std::vector<int> pi = computePrefixFunction(needle);
        for (int i = 0, j = 0; i < haystack.size(); i++) {
            while (j > 0 && haystack[i] != needle[j]) {
                j = pi[j - 1];
            }
            if (haystack[i] == needle[j]) {
                j++;
            }
            if (j == needle.size()) {
                return i - needle.size() + 1;
            }
        }
        return -1;
    }
private:
    std::vector<int> computePrefixFunction(const std::string& needle) {
```



```
        std::vector<int> pi(needle.size());
        pi[0] = 0;
        for (int i = 1; i < needle.size(); i++) {
            int j = pi[i - 1];
            while (j > 0 && needle[i] != needle[j]) {
                j = pi[j - 1];
            }
            if (needle[i] == needle[j]) {
                j++;
            }
            pi[i] = j;
        }
        return pi;
    }
};
```