Name :	Swati Kundu
Section :	A4-B3
Roll No :	48

Practical 5

Aim: Implement a dynamic algorithm for Longest Common Subsequence (LCS) to find the length and LCS for DNA sequences.

Problem Statement:

(i) DNA sequences can be viewed as strings of A, C, G, and T characters, which represent nucleotides. Finding the similarities between two DNA sequences are an important computation performed in bioinformatics.

[Note that a subsequence might not include consecutive elements of the original sequence.]

TASK 1: Find the similarity between the given X and Y sequence.

X=AGCCCTAAGGGCTACCTAGCTT

Y= GACAGCCTACAAGCGTTAGCTTG

Output: Cost matrix with all costs and direction, final cost of LCS and the LCS.

Length of LCS=16

TASK-2: Find the longest repeating subsequence (LRS). Consider it as a variation of the longest common subsequence (LCS) problem.

Let the given string be S. You need to find the LRS within S. To use the LCS framework, you effectively compare S with itself. So, consider string1 = S and string2 = S.

Example:

AABCBDC

LRS= ABC or ABD

LeetCode Assesment:

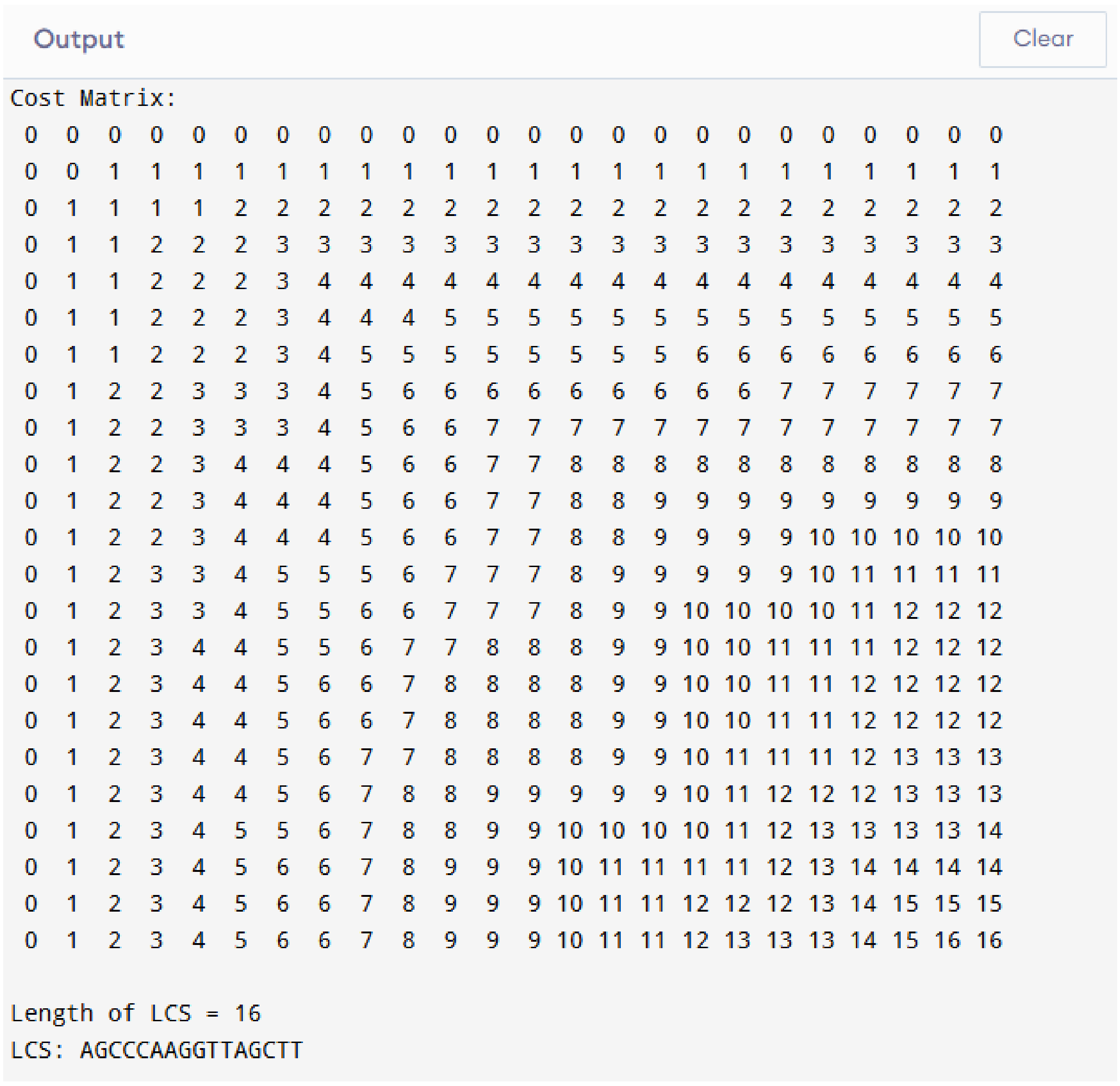
https://leetcode.com/problems/longest-common-subsequence/description/

Task 1 Code :

```c
#include <stdio.h>
#include <string.h>

#define MAX 100


void LCS_Length(char X[], char Y[], int m, int n, int c[MAX][MAX], char
b[MAX][MAX]) {
    for (int i = 0; i <= m; i++)
        c[i][0] = 0;
    for (int j = 0; j <= n; j++)
        c[0][j] = 0;

    for (int i = 1; i <= m; i++) {
        for (int j = 1; j <= n; j++) {
            if (X[i - 1] == Y[j - 1]) {
                c[i][j] = c[i - 1][j - 1] + 1;
                b[i][j] = '\\'; // diagonal
            } else if (c[i - 1][j] >= c[i][j - 1]) {
                c[i][j] = c[i - 1][j];
                b[i][j] = '^'; // up
            } else {
                c[i][j] = c[i][j - 1];
                b[i][j] = '<'; // left
            }
        }
    }
}


void Print_LCS(char b[MAX][MAX], char X[], int i, int j) {
    if (i == 0 || j == 0)
        return;
    if (b[i][j] == '\\') {
        Print_LCS(b, X, i - 1, j - 1);
        printf("%c", X[i - 1]);
    } else if (b[i][j] == '^') {
        Print_LCS(b, X, i - 1, j);
    } else {
        Print_LCS(b, X, i, j - 1);
    }
}
```

```c
int main() {
    char X[] = "AGCCCTAAGGGCTACCTAGCTT";
    char Y[] = "GACAGCCTACAAGCGTTAGCTTG";

    int m = strlen(X);
    int n = strlen(Y);

    int c[MAX][MAX];
    char b[MAX][MAX];


    LCS_Length(X, Y, m, n, c, b);

    printf("Cost Matrix:\n");
    for (int i = 0; i <= m; i++) {
        for (int j = 0; j <= n; j++) {
            printf("%2d ", c[i][j]);
        }
        printf("\n");
    }


    printf("\nLength of LCS = %d\n", c[m][n]);


    printf("LCS: ");
    Print_LCS(b, X, m, n);
    printf("\n");

    return 0;
}
```

Output :

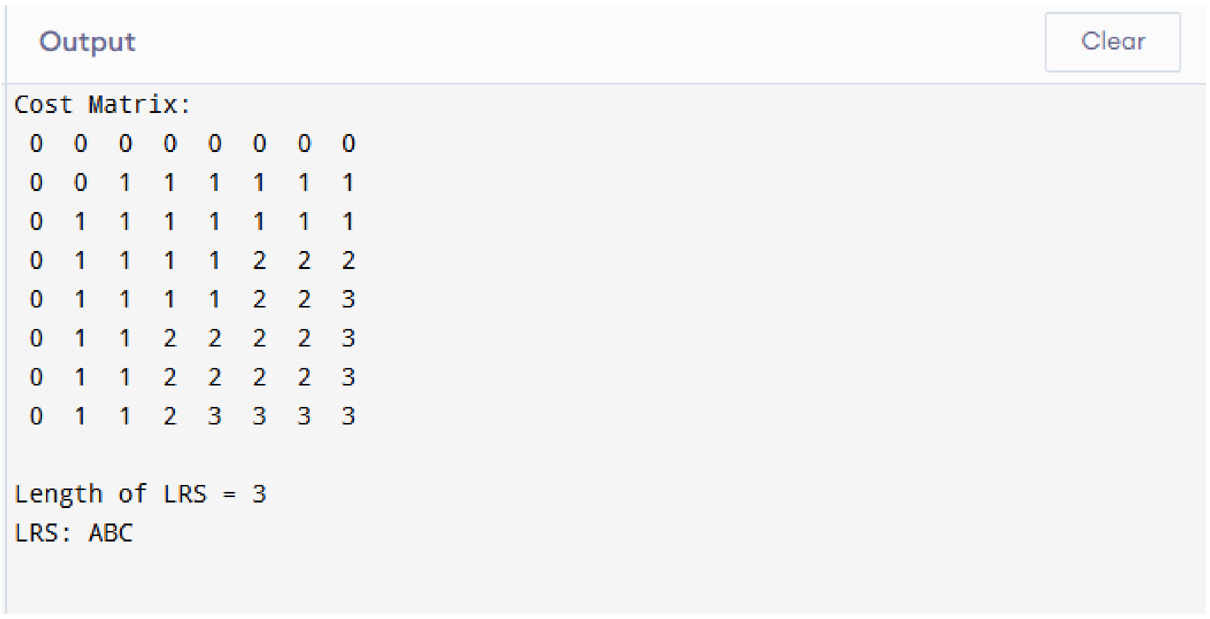


```
Cost Matrix:
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
  0  1  1  1  1  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
  0  1  1  2  2  2  3  3  3  3  3  3  3  3  3  3  3  3  3  3  3  3  3  3
  0  1  1  2  2  2  3  4  4  4  4  4  4  4  4  4  4  4  4  4  4  4  4  4
  0  1  1  2  2  2  3  4  4  4  5  5  5  5  5  5  5  5  5  5  5  5  5  5
  0  1  1  2  2  2  3  4  5  5  5  5  5  5  5  5  6  6  6  6  6  6  6  6
  0  1  2  2  3  3  3  4  5  6  6  6  6  6  6  6  6  6  7  7  7  7  7  7
  0  1  2  2  3  3  3  4  5  6  6  7  7  7  7  7  7  7  7  7  7  7  7  7
  0  1  2  2  3  4  4  4  5  6  6  7  7  8  8  8  8  8  8  8  8  8  8  8
  0  1  2  2  3  4  4  4  5  6  6  7  7  8  8  9  9  9  9  9  9  9  9  9
  0  1  2  2  3  4  4  4  5  6  6  7  7  8  8  9  9  9  9 10 10 10 10 10
  0  1  2  3  3  4  5  5  5  6  7  7  7  8  9  9  9  9  9 10 11 11 11 11
  0  1  2  3  3  4  5  5  6  6  7  7  7  8  9  9 10 10 10 10 11 12 12 12
  0  1  2  3  4  4  5  5  6  7  7  8  8  8  9  9 10 10 11 11 11 12 12 12
  0  1  2  3  4  4  5  6  6  7  8  8  8  8  9  9 10 10 11 11 12 12 12 12
  0  1  2  3  4  4  5  6  6  7  8  8  8  8  9  9 10 10 11 11 12 12 12 12
  0  1  2  3  4  4  5  6  7  7  8  8  8  8  9  9 10 11 11 11 12 13 13 13
  0  1  2  3  4  4  5  6  7  8  8  9  9  9  9  9 10 11 12 12 12 13 13 13
  0  1  2  3  4  5  5  6  7  8  8  9  9 10 10 10 10 11 12 13 13 13 13 14
  0  1  2  3  4  5  6  6  7  8  9  9  9 10 11 11 11 11 12 13 14 14 14 14
  0  1  2  3  4  5  6  6  7  8  9  9  9 10 11 11 12 12 12 13 14 15 15 15
  0  1  2  3  4  5  6  6  7  8  9  9  9 10 11 11 12 13 13 13 14 15 16 16

Length of LCS = 16
LCS: AGCCCAAGGTTAGCTT
```

Task 2 Code :

```c
#include <stdio.h>
#include <string.h>

#define MAX 100

void LRS_Length(char S[], int n, int c[MAX][MAX], char b[MAX][MAX]) {
    for (int i = 0; i <= n; i++)
        c[i][0] = c[0][i] = 0;

    for (int i = 1; i <= n; i++) {
        for (int j = 1; j <= n; j++) {
            if (S[i - 1] == S[j - 1] && i != j) {
                c[i][j] = c[i - 1][j - 1] + 1;
                b[i][j] = '\\'; // diagonal
            } else if (c[i - 1][j] >= c[i][j - 1]) {
                c[i][j] = c[i - 1][j];
                b[i][j] = '^'; // up
            } else {
                c[i][j] = c[i][j - 1];
                b[i][j] = '<'; // left
            }
        }
    }
}

void Print_LRS(char b[MAX][MAX], char S[], int i, int j) {
    if (i == 0 || j == 0)
        return;
    if (b[i][j] == '\\') {
        Print_LRS(b, S, i - 1, j - 1);
        printf("%c", S[i - 1]);
    } else if (b[i][j] == '^') {
        Print_LRS(b, S, i - 1, j);
    } else {
        Print_LRS(b, S, i, j - 1);
    }
}

int main() {
    char S[] = "AABCBDC";
    int n = strlen(S);

    int c[MAX][MAX];
    char b[MAX][MAX];

    LRS_Length(S, n, c, b);

    printf("Cost Matrix:\n");
    for (int i = 0; i <= n; i++) {
        for (int j = 0; j <= n; j++) {
            printf("%2d ", c[i][j]);
        }
        printf("\n");
    }

    // Final cost of LRS
    printf("\nLength of LRS = %d\n", c[n][n]);

    printf("LRS: ");
    Print_LRS(b, S, n, n);
    printf("\n");
    return 0;
}
```

Output :

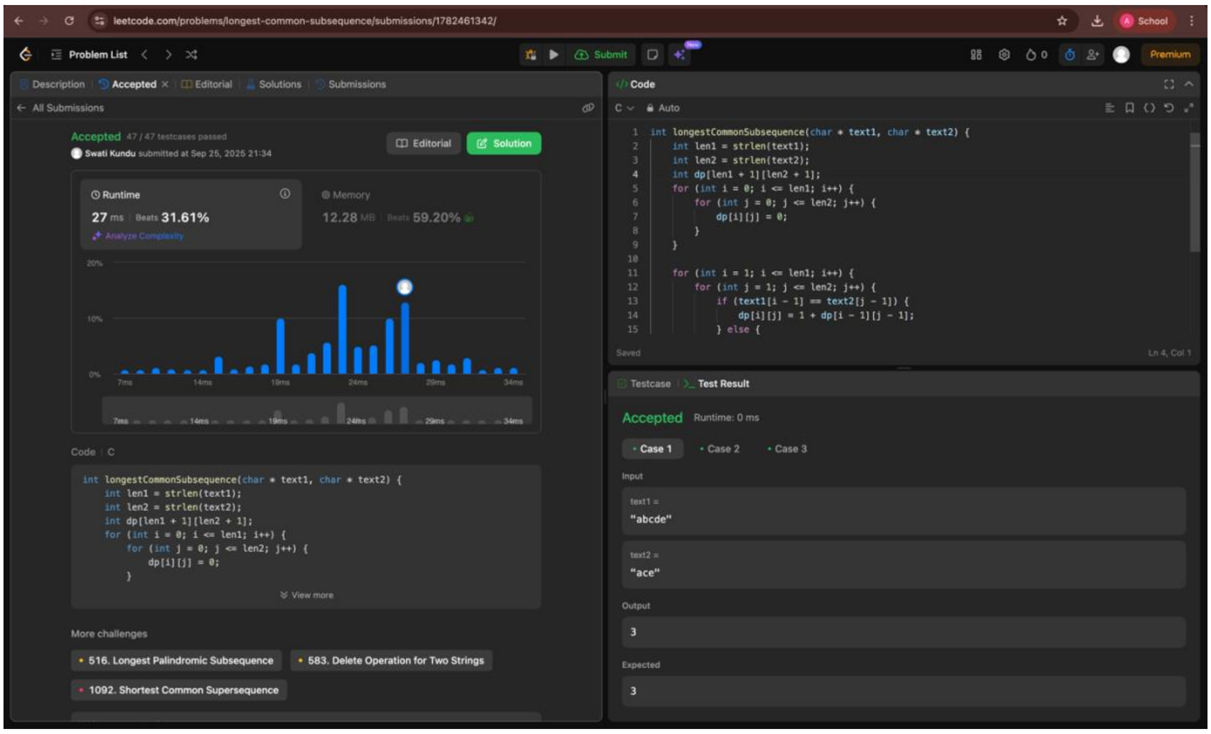


```
Cost Matrix:
  0   0   0   0   0   0   0   0
  0   0   1   1   1   1   1   1
  0   1   1   1   1   1   1   1
  0   1   1   1   1   2   2   2
  0   1   1   1   1   2   2   3
  0   1   1   2   2   2   2   3
  0   1   1   2   2   2   2   3
  0   1   1   2   3   3   3   3

Length of LRS = 3
LRS: ABC
```

Leetcode task :

```
int longestCommonSubsequence(char * text1, char * text2) {
    int len1 = strlen(text1);
    int len2 = strlen(text2);

    // Create DP table
    int dp[len1 + 1][len2 + 1];

    // Initialize DP table
    for (int i = 0; i <= len1; i++) {
        for (int j = 0; j <= len2; j++) {
            dp[i][j] = 0;
        }
    }
    // Fill the DP table
    for (int i = 1; i <= len1; i++) {
        for (int j = 1; j <= len2; j++) {
            if (text1[i - 1] == text2[j - 1]) {
                dp[i][j] = 1 + dp[i - 1][j - 1];
            } else {
                dp[i][j] = (dp[i - 1][j] > dp[i][j - 1]) ? dp[i - 1][j] : dp[i][j - 1];
            }
        }
    }

    return dp[len1][len2];
}
```

Output:



Accepted 47 / 47 testcases passed
Swati Kundu submitted at Sep 25, 2025 21:34

Runtime
27 ms | Beats 31.61%

Memory
12.28 MB | Beats 59.20%

Code | C

```
int longestCommonSubsequence(char * text1, char * text2) {
    int len1 = strlen(text1);
    int len2 = strlen(text2);
    int dp[len1 + 1][len2 + 1];
    for (int i = 0; i <= len1; i++) {
        for (int j = 0; j <= len2; j++) {
            dp[i][j] = 0;
        }
```

More challenges
- 516. Longest Palindromic Subsequence
- 583. Delete Operation for Two Strings
- 1092. Shortest Common Supersequence

```
int longestCommonSubsequence(char * text1, char * text2) {
    int len1 = strlen(text1);
    int len2 = strlen(text2);
    int dp[len1 + 1][len2 + 1];
    for (int i = 0; i <= len1; i++) {
        for (int j = 0; j <= len2; j++) {
            dp[i][j] = 0;
        }
    }

    for (int i = 1; i <= len1; i++) {
        for (int j = 1; j <= len2; j++) {
            if (text1[i - 1] == text2[j - 1]) {
                dp[i][j] = 1 + dp[i - 1][j - 1];
            } else {
```

Accepted Runtime: 0 ms

Case 1 | Case 2 | Case 3

Input

text1 =
"abcde"

text2 =
"ace"

Output

3

Expected

3