Name	Aryaman Agarwal
UID	2021700002
Class	CSE Data Science
Batch	A
Exp no.	4

Aim – To find the longest common subsequence of 2 strings by using the dynamic programming approach.

Theory-

The Longest Common Subsequence (LCS) is a classic problem in computer science that involves finding the longest subsequence common to two given sequences. In the book on Algorithms, the authors typically present several algorithms for solving the LCS problem, including the dynamic programming approach.

The dynamic programming approach involves constructing a matrix to store the lengths of the common subsequences of the two input sequences. The matrix is filled in a specific order using a recurrence relation that takes into account the previously computed values in the matrix.

Once the matrix is filled, the longest common subsequence can be reconstructed by backtracking through the matrix starting from the bottom right corner. This approach has a time complexity of O(nm), where n and m are the lengths of the input sequences.

Algorithm-

1. Define MAX_LENGTH constant to specify the maximum length of strings.
2. Define a function lcs that takes in two strings s1 and s2, their lengths m and n, a 2D array LCS and a character array result.
3. Initialize the first row and column of LCS with 0.
4. Loop through the remaining cells of LCS, filling in each cell using the dynamic programming approach:
   a. If s1[i-1] == s2[j-1], set LCS[i][j] = LCS[i-1][j-1] + 1.
   b. Otherwise, set LCS[i][j] = max(LCS[i-1][j], LCS[i][j-1]).
5. Set index to the value in the bottom-right cell of LCS and add a null terminator to the end of the result array.

6. Loop through LCS, tracing back through the cells used to compute the longest common subsequence:
   a. If s1[i-1] == s2[j-1], add s1[i-1] to the result array at index-1 and decrement index, i, and j by 1.
   b. Otherwise, if LCS[i-1][j] > LCS[i][j-1], decrement i by 1.
   c. Otherwise, decrement j by 1.
7. In main function:
   a. Declare character arrays s1, s2, and result, and a 2D integer array LCS with size MAX_LENGTH x MAX_LENGTH.
   b. Prompt the user to enter the two strings.
   c. Call the lcs function with s1, s2, their lengths m and n, LCS, and result.
   d. Print the length of the longest common subsequence and the longest common subsequence.
8. End of the program.

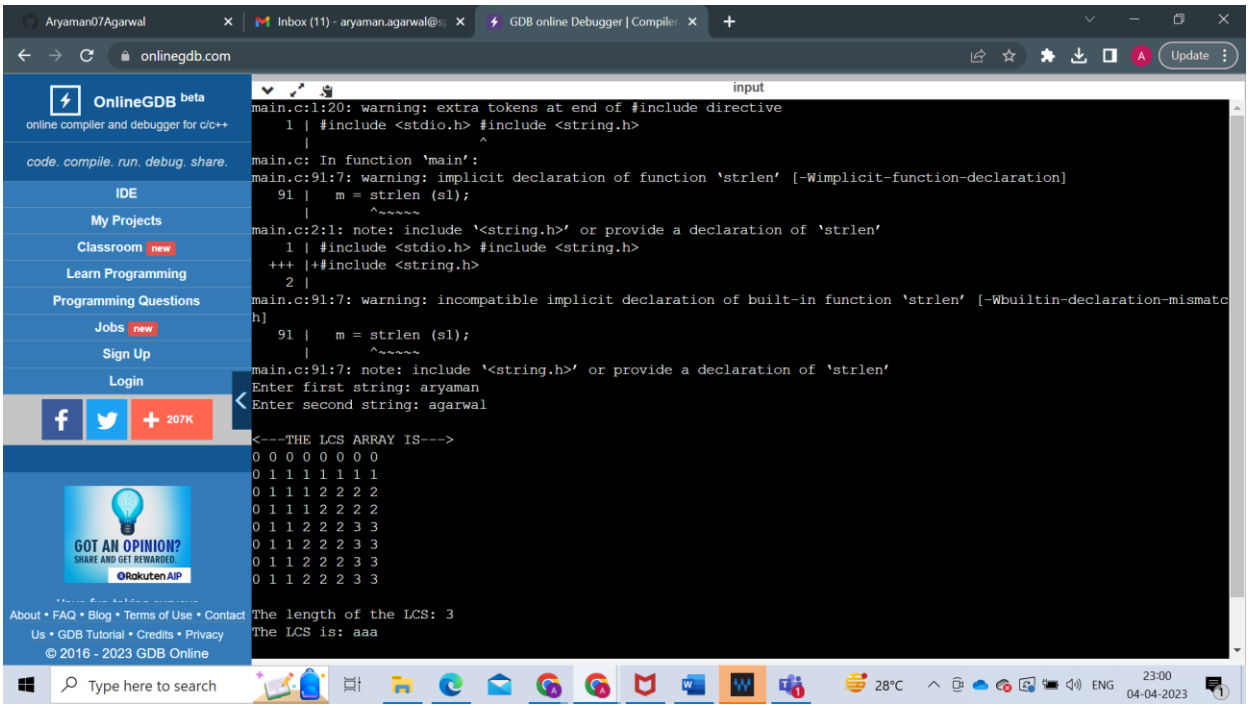
Code –

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

#define MAX_LENGTH 100

void
lcs (char *s1, char *s2, int m, int n, int LCS[][MAX_LENGTH], char *result)
{
  int i, j, index;

// Initialize first row and column with 0
  for (i = 0; i <= m; i++)
    {
      for (j = 0; j <= n; j++)
        {
          if (i == 0 || j == 0)
            {
              LCS[i][j] = 0;
            }
        }
    }

// Fill the remaining cells using dynamic programming
  for (i = 1; i <= m; i++)
    {
```

```
    for (j = 1; j <= n; j++)
      {
        if (s1[i - 1] == s2[j - 1])
          {
            LCS[i][j] = LCS[i - 1][j - 1] + 1;
          }
        else
          {
            LCS[i][j] = (LCS[i - 1][j] > LCS[i][j - 1]) ? LCS[i - 1][j] :
               LCS[i][j - 1];
          }
      }
  }

  printf ("\n<---THE LCS ARRAY IS--->\n");

  for (i = 0; i <= m; i++)
    {
      for (j = 0; j <= n; j++)
        {
          printf ("%d ", LCS[i][j]);
        }

      printf ("\n");
    }
  printf ("\n");

// Find the longest common subsequence
  index = LCS[m][n];
  result[index] = '\0';

  i = m;
  j = n;
  while (i > 0 && j > 0)
    {
      if (s1[i - 1] == s2[j - 1])
        {
          result[index - 1] = s1[i - 1];
          i--;
          j--;
          index--;
        }
      else if (LCS[i - 1][j] > LCS[i][j - 1])
        {
          i--;
        }
      else
```

```
        {
          j--;
        }
    }
}

int
main ()
{
  char s1[MAX_LENGTH], s2[MAX_LENGTH], result[MAX_LENGTH];
  int LCS[MAX_LENGTH][MAX_LENGTH];
  int m, n;

  printf ("Enter first string: ");
  scanf ("%s", s1);

  printf ("Enter second string: ");
  scanf ("%s", s2);

  m = strlen (s1);
  n = strlen (s2);

  lcs (s1, s2, m, n, LCS, result);

  printf ("The length of the LCS: %d\n", LCS[m][n]);
  printf ("The LCS is: %s\n", result);

  return 0;
}
```

Output –



Conclusion –

The time complexity of the code is O(mn) where m and n are the lengths of the two input strings. This is because we need to fill in an m x n matrix to compute the length of the longest common subsequence.

The space complexity of the code is O(mn) since we use a 2D array of size m x n to store the length of the longest common subsequence.

In this experiment, we used the dynamic programming approach to find the longest common subsequence of two strings.

We first learned about the algorithm and the two key equations used in the dynamic programming approach. We then implemented the algorithm in C language, and tested it on different strings to find their longest common subsequences.