



Department of Computer Science and Engineering (Data Science)

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Experiment 8 (Dynamic Programming)

Aim: Implementation of Longest Common Subsequence (LCS).

Theory:

The longest common subsequence (LCS) is defined as the longest subsequence that is common to all the given sequences, provided that the elements of the subsequence are not required to occupy consecutive positions within the original sequences.

If S_1 and S_2 are the two given sequences then, Z is the common subsequence of S_1 and S_2 if Z is a subsequence of both S_1 and S_2 . Furthermore, Z must be a strictly increasing sequence of the indices of both S_1 and S_2 .

In a strictly increasing sequence, the indices of the elements chosen from the original sequences must be in ascending order in Z .

If: $S_1 = \{B, C, D, A, A, C, D\}$

Then, $\{A, D, B\}$ cannot be a subsequence of S_1 as the order of the elements is not the same (ie. not strictly increasing sequence).

Example:



Figure 1. The first sequence



Figure 2. Second Sequence

The following steps are followed for finding the longest common subsequence.

1. Create a table of dimension $n+1*m+1$ where n and m are the lengths of X and Y respectively. The first row and the first column are filled with zeros.

| | | C | B | D | A |
|---|--|---|---|---|---|
| | | 0 | 0 | 0 | 0 |
| A | | 0 | | | |
| C | | 0 | | | |
| A | | 0 | | | |
| D | | 0 | | | |
| B | | 0 | | | |

Figure 3. Initialise a table



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- Fill each cell of the table using the following logic.
- If the character corresponding to the current row and current column are matching, then fill the current cell by adding one to the diagonal element. Point an arrow to the diagonal cell.
- Else take the maximum value from the previous column and previous row element for filling the current cell. Point an arrow to the cell with maximum value. If they are equal, point to any of them.

| | C | B | D | A |
|---|---|---|---|---|
| A | 0 | 0 | 0 | 0 |
| C | 0 | 0 | 0 | 0 |
| A | 0 | 0 | 0 | 1 |
| D | 0 | | | |
| B | 0 | | | |

Figure 4.Fill the values

- Step 2 is repeated until the table is filled.

| | C | B | D | A |
|---|---|---|---|---|
| A | 0 | 0 | 0 | 0 |
| C | 0 | 1 | 1 | 1 |
| A | 0 | 1 | 1 | 2 |
| D | 0 | 1 | 2 | 2 |
| B | 0 | 1 | 2 | 2 |

Figure 5.Fill all the values

- The value in the last row and the last column is the length of the longest common subsequence.



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| | | C | B | D | A |
|---|--|---|---|---|---|
| | | 0 | 0 | 0 | 0 |
| A | | 0 | 0 | 0 | 1 |
| C | | 0 | 1 | 1 | 1 |
| A | | 0 | 1 | 1 | 2 |
| D | | 0 | 1 | 2 | 2 |
| B | | 0 | 1 | 2 | 2 |

Figure 6. The bottom right corner is the length of the LCS

- In order to find the longest common subsequence, start from the last element and follow the direction of the arrow. The elements corresponding to () symbol form the longest common subsequence.

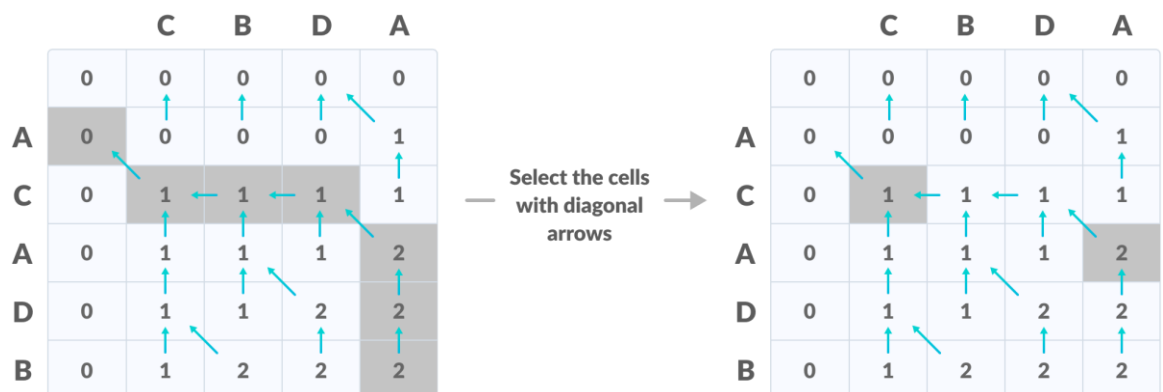


Figure 7. Create a path according to the arrows

Thus, the longest common subsequence is CA.

Pseudocode:

X and Y be two given sequences
 Initialize a table LCS of dimension X.length * Y.length
 X.label = X
 Y.label = Y
 LCS[0][] = 0
 LCS[][0] = 0
 Start from LCS[1][1]
 Compare X[i] and Y[j]



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If $X[i] = Y[j]$

$LCS[i][j] = 1 + LCS[i-1, j-1]$

Point an arrow to $LCS[i][j]$

Else

$LCS[i][j] = \max(LCS[i-1][j], LCS[i][j-1])$

Point an arrow to $\max(LCS[i-1][j], LCS[i][j-1])$

Lab Assignment to Complete:

Consider the two following sequences, X and Y:

X: ABCBDAB

Y: BDCABA