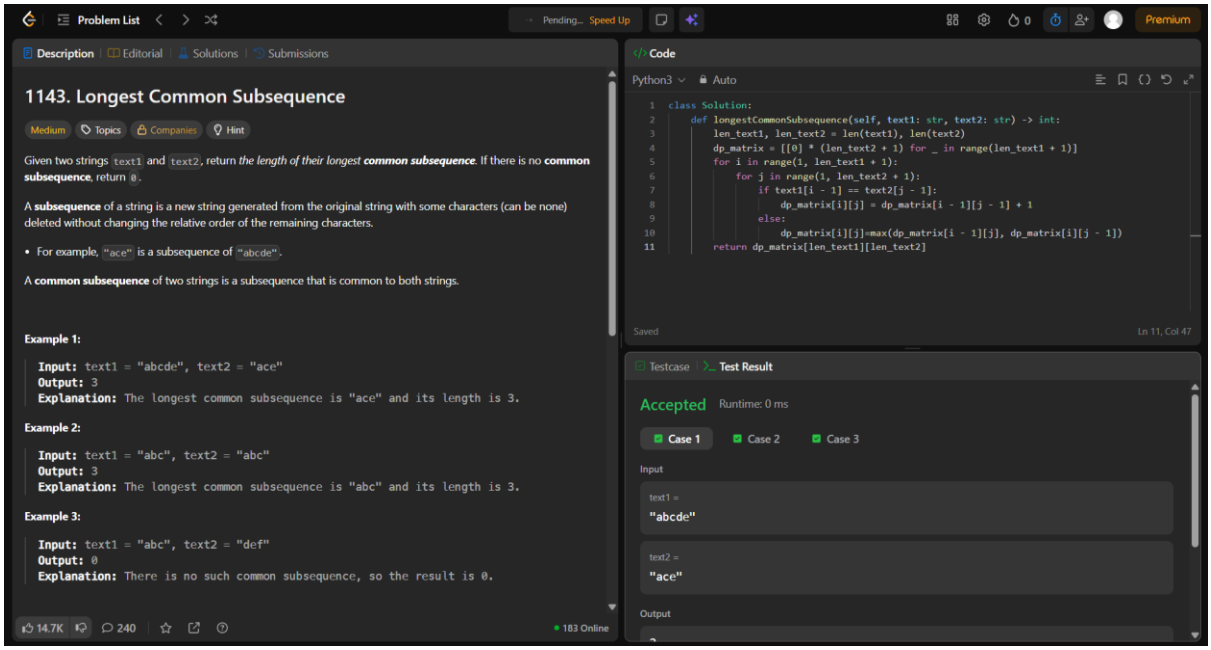
Name-Shiva Nema

Section-A3-B3

Rollno.-40

DAA LAB-PRACTICAL 5




```
[1]: from typing import List, Tuple

def lcs_table(X: str, Y: str) -> Tuple[List[List[int]], List[List[str]]]:
    m, n = len(X), len(Y)
    dp = [[0] * (n + 1) for _ in range(m + 1)]
    direction = [['·'] * (n + 1) for _ in range(m + 1)]
    for i in range(1, m + 1):
        for j in range(1, n + 1):
            if X[i - 1] == Y[j - 1]:
                dp[i][j] = dp[i - 1][j - 1] + 1
                direction[i][j] = '↖'
            else:
                if dp[i - 1][j] >= dp[i][j - 1]:
                    dp[i][j] = dp[i - 1][j]
                    direction[i][j] = '↑'
                else:
                    dp[i][j] = dp[i][j - 1]
                    direction[i][j] = '←'
    return dp, direction

def lcs_backtrack(X: str, Y: str, dp: List[List[int]]) -> str:
    i, j = len(X), len(Y)
    lcs_chars: List[str] = []
    while i > 0 and j > 0:
        if X[i - 1] == Y[j - 1]:
            lcs_chars.append(X[i - 1])
            i -= 1
            j -= 1
        else:
            if dp[i - 1][j] >= dp[i][j - 1]:
                i -= 1
            else:
                j -= 1
    return ''.join(reversed(lcs_chars))

def print_cost_matrix_with_directions(X: str, Y: str, dp: List[List[int]], direction: List[List[str]]) -> None:
    m, n = len(X), len(Y)
    header = ["    "]
    header += [f"   {ch} " for ch in (' ' + Y)]
```

```
    header += [f"   {ch} " for ch in (' ' + Y)]
    print(''.join(header))
    for i in range(m + 1):
        row_label = ' ' if i == 0 else X[i - 1]
        line = [f" {row_label}  "]
        for j in range(n + 1):
            arrow = direction[i][j]
            cell = f"{dp[i][j]}{arrow if not (i == 0 or j == 0) else '·'}"
            line.append(f"{cell:>4} ")
        print(''.join(line))

def lcs(X: str, Y: str) -> Tuple[int, str, List[List[int]], List[List[str]]]:
    dp, direction = lcs_table(X, Y)
    seq = lcs_backtrack(X, Y, dp)
    return dp[-1][-1], seq, dp, direction

if __name__ == "__main__":
    X = "AGCCCTAAGGGCTACCTAGCTT"
    Y = "GACAGCCTACAAGCGTTAGCTTG"
    length, seq, dp, direction = lcs(X, Y)
    print("LCS Cost Matrix with Directions:")
    print_cost_matrix_with_directions(X, Y, dp, direction)
    print()
    print(f"Final LCS Length: {length}")
    print(f"LCS: {seq}")
```

```
LCS Cost Matrix with Directions:
          G    A    C    A    G    C    C    T    A    C    A    A    G    C    G    T    T    A    G    C    T    T    G
     0·   0·   0·   0·   0·   0·   0·   0·   0·   0·   0·   0·   0·   0·   0·   0·   0·   0·   0·   0·   0·   0·   0·   0·
 A   0·   0↑   1↖   1←   1↖   1←   1←   1←   1←   1↖   1←   1↖   1↖   1←   1←   1←   1←   1←   1↖   1←   1←   1←   1←   1←
 G   0·   1↖   1↑   1↑   1↑   2↖   2←   2←   2←   2←   2←   2←   2←   2↖   2←   2↖   2←   2←   2←   2↖   2←   2←   2←   2↖
 C   0·   1↑   1↑   2↖   2←   2↑   3↖   3↖   3←   3←   3↖   3←   3←   3←   3↖   3←   3←   3←   3←   3←   3↖   3←   3←   3←
 C   0·   1↑   1↑   2↖   2↑   2↑   3↖   4↖   4←   4←   4↖   4←   4←   4←   4↖   4←   4←   4←   4←   4←   4↖   4←   4←   4←
 C   0·   1↑   1↑   2↖   2↑   2↑   3↖   4↖   4↑   4↑   5↖   5←   5←   5←   5↖   5←   5←   5←   5←   5←   5↖   5←   5←   5←
 T   0·   1↑   1↑   2↑   2↑   2↑   3↑   4↑   5↖   5←   5↑   5↑   5↑   5↑   5↑   5↑   6↖   6↖   6←   6←   6←   6↖   6↖   6←
 A   0·   1↑   2↖   2↑   3↖   3←   3↑   4↑   5↑   6↖   6←   6↖   6↖   6←   6←   6←   6↑   6↑   7↖   7←   7←   7←   7←   7←
 A   0·   1↑   2↖   2↑   3↖   3↑   3↑   4↑   5↑   6↖   6↑   7↖   7↖   7←   7←   7←   7←   7←   7↖   7↑   7↑   7↑   7↑   7↑
 G   0·   1↖   2↑   2↑   3↑   4↖   4←   4↑   5↑   6↑   6↑   7↑   7↑   8↖   8←   8↖   8←   8←   8←   8↖   8←   8←   8←   8↖
 G   0·   1↖   2↑   2↑   3↑   4↖   4↑   4↑   5↑   6↑   6↑   7↑   7↑   8↖   8↑   9↖   9←   9←   9←   9↖   9←   9←   9←   9↖
 G   0·   1↖   2↑   2↑   3↑   4↖   4↑   4↑   5↑   6↑   6↑   7↑   7↑   8↖   8↑   9↖   9↑   9↑   9↑   10↖  10←  10←  10←  10↖
 C   0·   1↑   2↑   3↖   3↑   4↑   5↖   5↖   5↑   6↑   7↖   7↑   7↑   8↑   9↖   9↑   9↑   9↑   9↑   10↑  11↖  11←  11←  11←
 T   0·   1↑   2↑   3↑   3↑   4↑   5↑   5↑   6↖   6↑   7↑   7↑   7↑   8↑   9↑   9↑   10↖  10↖  10←  10↑  11↑  12↖  12↖  12←
 A   0·   1↑   2↖   3↑   4↖   4↑   5↑   5↑   6↑   7↖   7↑   8↖   8↖   8↑   9↑   9↑   10↑  10↑  11↖  11←  11↑  12↑  12↑  12↑
 C   0·   1↑   2↑   3↖   4↑   4↑   5↖   6↖   6↑   7↑   8↖   8↑   8↑   8↑   9↖   9↑   10↑  10↑  11↑  11↑  12↖  12↑  12↑  12↑
 C   0·   1↑   2↑   3↖   4↑   4↑   5↖   6↖   6↑   7↑   8↖   8↑   8↑   8↑   9↖   9↑   10↑  10↑  11↑  11↑  12↖  12↑  12↑  12↑
 T   0·   1↑   2↑   3↑   4↑   4↑   5↑   6↑   7↖   7↑   8↑   8↑   8↑   8↑   9↑   9↑   10↖  11↖  11↑  11↑  12↑  13↖  13↖  13←
 A   0·   1↑   2↖   3↑   4↖   4↑   5↑   6↑   7↑   8↖   8↑   9↖   9↖   9←   9↑   9↑   10↑  11↑  12↖  12←  12↑  13↑  13↑  13↑
 G   0·   1↖   2↑   3↑   4↑   5↖   5↑   6↑   7↑   8↑   8↑   9↑   9↑   10↖  10←  10↖  10↑  11↑  12↑  13↖  13←  13↑  13↑  14↖
 C   0·   1↑   2↑   3↖   4↑   5↑   6↖   6↖   7↑   8↑   9↖   9↑   9↑   10↑  11↖  11←  11←  11↑  12↑  13↑  14↖  14←  14←  14↑
 T   0·   1↑   2↑   3↑   4↑   5↑   6↑   6↑   7↖   8↑   9↑   9↑   9↑   10↑  11↑  11↑  12↖  12↖  12↑  13↑  14↑  15↖  15↖  15←
 T   0·   1↑   2↑   3↑   4↑   5↑   6↑   6↑   7↖   8↑   9↑   9↑   9↑   10↑  11↑  11↑  12↖  13↖  13←  13↑  14↑  15↖  16↖  16←

Final LCS Length: 16
LCS: AGCCCAAGGTTAGCTT
```

[2]:

```python
from typing import List, Tuple

def lrs_table(S: str) -> List[List[int]]:
    n = len(S)
    dp = [[0] * (n + 1) for _ in range(n + 1)]
    for i in range(1, n + 1):
        for j in range(1, n + 1):
            if S[i - 1] == S[j - 1] and i != j:
                dp[i][j] = 1 + dp[i - 1][j - 1]
            else:
                dp[i][j] = max(dp[i - 1][j], dp[i][j - 1])
    return dp

def lrs_backtrack(S: str, dp: List[List[int]]) -> str:
    i, j = len(S), len(S)
    out: List[str] = []
    while i > 0 and j > 0:
        if S[i - 1] == S[j - 1] and i != j:
            out.append(S[i - 1])
            i -= 1
            j -= 1
        else:
            if dp[i - 1][j] >= dp[i][j - 1]:
                i -= 1
            else:
                j -= 1
    return ''.join(reversed(out))

def lrs(S: str) -> Tuple[int, str, List[List[int]]]:
    dp = lrs_table(S)
    seq = lrs_backtrack(S, dp)
    return dp[-1][-1], seq, dp

def print_matrix(S: str, dp: List[List[int]]) -> None:
    n = len(S)
    header = ["    "] + [f"   {ch} " for ch in (' ' + S)]
    print(''.join(header))
    for i in range(n + 1):
        row_label = ' ' if i == 0 else S[i - 1]
```

```python
def lrs(S: str) -> Tuple[int, str, List[List[int]]]:
    dp = lrs_table(S)
    seq = lrs_backtrack(S, dp)
    return dp[-1][-1], seq, dp

def print_matrix(S: str, dp: List[List[int]]) -> None:
    n = len(S)
    header = ["    "] + [f"   {ch} " for ch in (' ' + S)]
    print(''.join(header))
    for i in range(n + 1):
        row_label = ' ' if i == 0 else S[i - 1]
        line = [f" {row_label}  "]
        for j in range(n + 1):
            line.append(f"{dp[i][j]:>4} ")
        print(''.join(line))

if __name__ == "__main__":
    S = "AABEBCDD"
    length, seq, dp = lrs(S)
    print("LRS DP Matrix (values):")
    print_matrix(S, dp)
    print()
    print(f"Final LRS Length: {length}")
    print(f"LRS: {seq}")
```

```
LRS DP Matrix (values):
            A    A    B    E    B    C    D    D
       0    0    0    0    0    0    0    0    0
 A     0    0    1    1    1    1    1    1    1
 A     0    1    1    1    1    1    1    1    1
 B     0    1    1    1    1    2    2    2    2
 E     0    1    1    1    1    2    2    2    2
 B     0    1    1    2    2    2    2    2    2
 C     0    1    1    2    2    2    2    2    2
 D     0    1    1    2    2    2    2    2    3
 D     0    1    1    2    2    2    2    3    3

Final LRS Length: 3
LRS: ABD
```