RBU, Nagpur
CSE III Sem
PRACTICAL NO. 5

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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 is an important computation performed in bioinformatics.

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

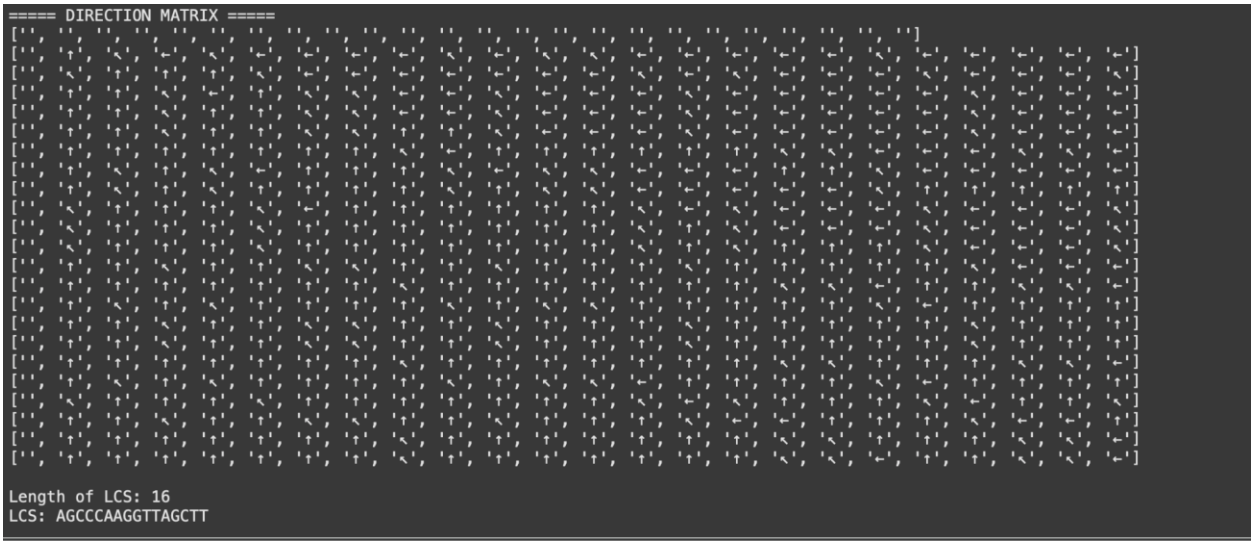
TASK 1: Find the similarity between the given X and Y sequences.
X=AGCCCTAAGGGCTACCTAGCTT
Y= GACAGCCTACAAGCGTTAGCTTG
Output: Cost matrix with all costs and direction, final cost of LCS, and the LCS.
Length of LCS=16
Code:

```
def lcs(X, Y):
    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] = "↖"
            elif 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] = "←"

    i, j = m, n
    lcs_str = ""
```

```
    while i > 0 and j > 0:
        if direction[i][j] == "↖":
            lcs_str = X[i - 1] + lcs_str
            i -= 1
            j -= 1
        elif direction[i][j] == "↑":
            i -= 1
        else:
            j -= 1

    print("===== COST MATRIX (DP Table) =====")
    for row in dp:
        print(row)

    print("\n===== DIRECTION MATRIX =====")
    for row in direction:
        print(row)

    print("\nLength of LCS:", dp[m][n])
    print("LCS:", lcs_str)


X = "AGCCCTAAGGGCTACCTAGCTT"
Y = "GACAGCCTACAAGCGTTAGCTTG"

print("===== TASK 1: DNA Sequence Similarity (LCS) =====")
lcs(X, Y)
```

Output:

```
===== TASK 1: DNA Sequence Similarity (LCS) =====
===== COST MATRIX (DP Table) =====
[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]
[0, 1, 1, 1, 1, 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]
[0, 1, 1, 2, 2, 2, 3, 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]
[0, 1, 1, 2, 2, 2, 3, 4, 5, 5, 5, 5, 5, 5, 5, 5, 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]
[0, 1, 2, 2, 3, 3, 3, 4, 5, 6, 6, 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]
[0, 1, 2, 2, 3, 4, 4, 4, 5, 6, 6, 7, 7, 8, 8, 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]

===== DIRECTION MATRIX =====
```



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

Code:

```
def longest_repeating_subsequence(S):
    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])

    i, j = n, n
    lrs = ""
    while i > 0 and j > 0:
        if dp[i][j] == dp[i - 1][j - 1] + 1 and S[i - 1] == S[j - 1] and i != j:
            lrs = S[i - 1] + lrs
            i -= 1
            j -= 1
        elif dp[i - 1][j] >= dp[i][j - 1]:
            i -= 1
        else:
            j -= 1

    print("===== COST MATRIX (DP Table) =====")
    for row in dp:
        print(row)

    print("\nLongest Repeating Subsequence (LRS):", lrs)
    print("Length of LRS:", dp[n][n])


S = "AABCBDC"
print("===== TASK 2: Longest Repeating Subsequence =====")
longest_repeating_subsequence(S)
```

Output:

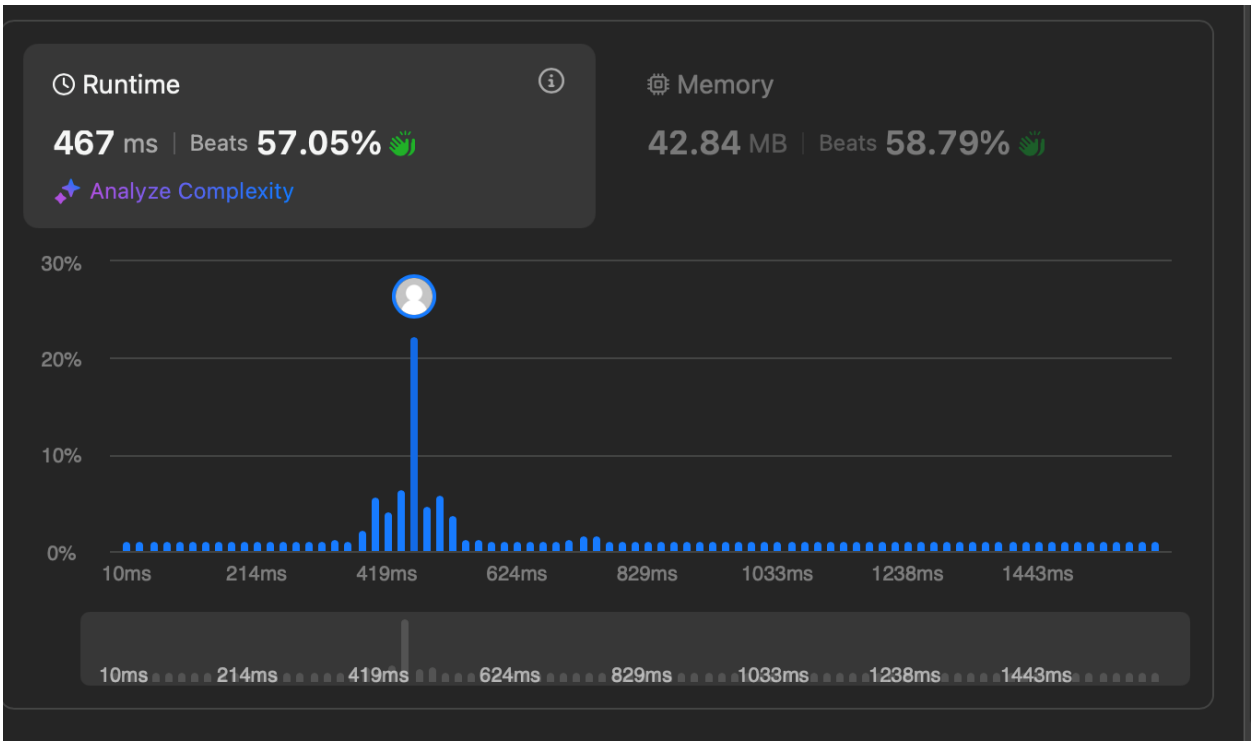
```
===== TASK 2: Longest Repeating Subsequence =====
===== COST MATRIX (DP Table) =====
[0, 0, 0, 0, 0, 0, 0, 0]
[0, 0, 1, 1, 1, 1, 1, 1]
[0, 1, 1, 1, 1, 1, 1, 1]
[0, 1, 1, 1, 1, 2, 2, 2]
[0, 1, 1, 1, 1, 2, 2, 3]
[0, 1, 1, 2, 2, 2, 2, 3]
[0, 1, 1, 2, 2, 2, 2, 3]
[0, 1, 1, 2, 3, 3, 3, 3]

Longest Repeating Subsequence (LRS): ABC
Length of LRS: 3
```

Leet Code Submission

Code:

```python
class Solution:
    def longestCommonSubsequence(self, text1: str, text2: str) -> int:
        m = len(text1)
        n = len(text2)
        dp = [[0] * (n + 1) for _ in range(m + 1)]
        for i in range(1, m + 1):
            for j in range(1, n + 1):
                if text1[i - 1] == text2[j - 1]:
                    dp[i][j] = dp[i - 1][j - 1] + 1
                else:
                    dp[i][j] = max(dp[i - 1][j], dp[i][j - 1])
        return dp[m][n]
```

Output/Screenshot:


Runtime
467 ms | Beats 57.05%
Analyze Complexity
Memory
42.84 MB | Beats 58.79%
30%
20%
10%
0%
10ms
214ms
419ms
624ms
829ms
1033ms
1238ms
1443ms
10ms
214ms
419ms
624ms
829ms
1033ms
1238ms
1443ms