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Branch - CBA Batch - 51
AAD Practical 10

Institute of Computer Technology
B. Tech Computer Science and Engineering

Sub: Algorithm Analysis and Design

Practical 10

Problem : Given a sequence of matrices, we want to find the most efficient way to multiply these matrices together to obtain the minimum number of multiplications. The problem is not actually to perform the multiplication of the matrices but to obtain the minimum number of multiplications. We have many options because matrix multiplication is an associative operation, meaning that the order in which we multiply do not matter. The optimal order depends only on the dimensions of the matrices. The brute-force algorithm is to consider all possible orders and take the minimum. This is a very inefficient method.

Implement the minimum multiplication algorithm using dynamic programming and determine where to place parentheses to minimize the number of multiplications.

Find an optimal parenthesization of a matrix chain product whose sequence of dimensions are (5, 10, 3, 12, 5, 50, 6).

Input:

```
Enter total matrices: 4
Enter no. of rows in matrix 1: 5
Enter no. of rows in matrix 2: 4
Enter no. of rows in matrix 3: 6
Enter no. of rows in matrix 4: 2
Enter no. of columns in matrix 4: 7
```

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Output:

```
The number of scalar multiplications needed: 158
Optimal parenthesization: ((A[1](A[2]A[3]))A[4])
```

Code :

```
import YSL_io


def mcm(dmsns):
n = len(dmsns) - 1
dp = [[0] * n for _ in range(n)]
parenthesization = [[0] * n for _ in range(n)]


for chain_length in range(2, n + 1):
for i in range(n - chain_length + 1):
j = i + chain_length - 1
dp[i][j] = float('inf')
for k in range(i, j):
cost = dp[i][k] + dp[k + 1][j] + dmsns[i] * dmsns[k + 1] * dmsns[j + 1]
if cost < dp[i][j]:
dp[i][j] = cost
parenthesization[i][j] = k
print('\nDP Matrix : \n')
for i in range(n):
for j in range(n):
```

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```
print(dp[i][j], end="\t\t")
print()

return dp[0][n - 1], optimal_parenthesization(parenthesization, 0, n - 1)



def optimal_parenthesization(parenthesization, i, j):
if i == j:
return f'A[{i + 1}]'
else:
k = parenthesization[i][j]
left = optimal_parenthesization(parenthesization, i, k)
right = optimal_parenthesization(parenthesization, k + 1, j)
return f'({left}{right})'



n = int(YSL_io.inputGRN("\n\tEnter total matrices : "))
print()
dmsns = [0] * (n + 1)
for i in range(n):
dmsns[i] = int(YSL_io.inputCYN(f"\tEnter no. of rows in matrix {i+1}: "))
dmsns[n] = int(YSL_io.inputCYN(f"\tEnter no. of columns in matrix {n}: "))

min_multiplications, parenthesization = mcm(dmsns)
```

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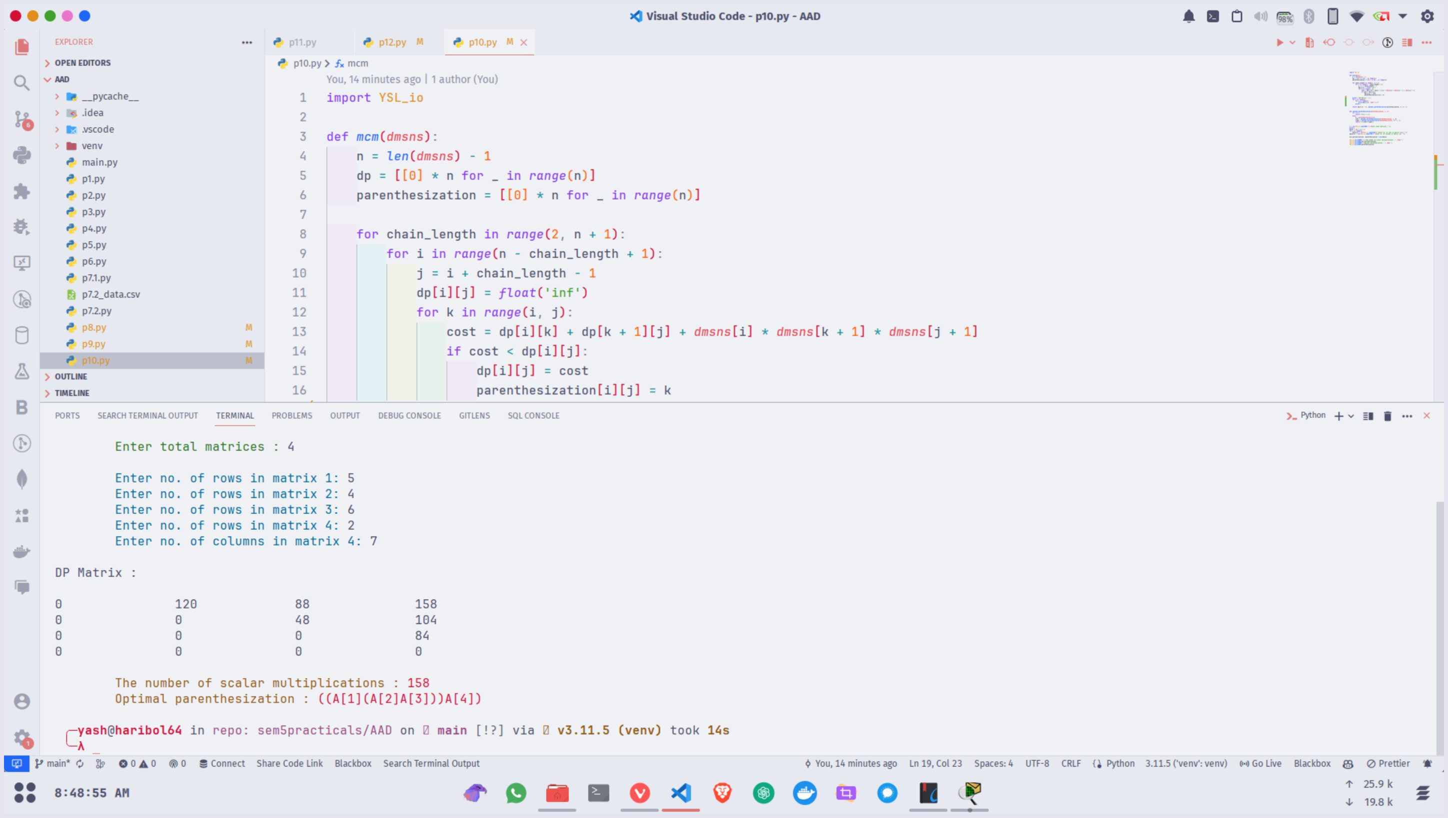
```python
YSL_io.printORNG("\n\tThe number of scalar multiplications : ", end='')
YSL_io.printRED(min_multiplications)
YSL_io.printORNG("\tOptimal parenthesization : ", end='')
YSL_io.printRED(parenthesization)
```

Screenshot :



```python
import YSL_io

def mcm(dmsns):
    n = len(dmsns) - 1
    dp = [[0] * n for _ in range(n)]
    parenthesization = [[0] * n for _ in range(n)]

    for chain_length in range(2, n + 1):
        for i in range(n - chain_length + 1):
            j = i + chain_length - 1
            dp[i][j] = float('inf')
            for k in range(i, j):
                cost = dp[i][k] + dp[k + 1][j] + dmsns[i] * dmsns[k + 1] * dmsns[j + 1]
                if cost < dp[i][j]:
                    dp[i][j] = cost
                    parenthesization[i][j] = k
```

```
        Enter total matrices : 4

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        Enter no. of rows in matrix 2: 4
        Enter no. of rows in matrix 3: 6
        Enter no. of rows in matrix 4: 2
        Enter no. of columns in matrix 4: 7

DP Matrix :

0               120             88              158
0               0               48              104
0               0               0               84
0               0               0               0

        The number of scalar multiplications : 158
        Optimal parenthesization : ((A[1](A[2]A[3]))A[4])

╭─yash@haribol64 in repo: sem5practicals/AAD on  main [!?] via  v3.11.5 (venv) took 14s
╰─λ _
```