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Subject : AAC

Expt no : 3

Aim : Write a program to implement and Analysis Matrix Chain Multiplication & Cutting Edge Problem

Aim:

Write a program to implement and Analysis Matrix Chain Multiplication & Cutting Rod Problem.

Objectives:

- Finding how the matrices are multiplied together with minimize scalar multiplication operation.
- Finding the cost to multiply matrices.
- Finding shortest path from source node to every other node.

Methodology:

- Matrix Chain Multiplication :

  The matrix-chain multiplication problem can be stated as : given a chain A1 , A2 , … ,An of n matrices, where for i = 1, 2, ..., n, matrix Ai has dimension pi-1 × pi , fully parenthesize the product A1 A2 An in a way that minimizes the number of scalar multiplications.

  Note that in the matrix-chain multiplication problem, we are not actually multiplying matrices. Our goal is only to determine an order for multiplying matrices that has the lowest cost. Equation to find minimum cost parenthesizing the matrix multiplication is :

$$m[i, j] = \begin{cases} 0 & \text{if } i = j, \\ \min\limits_{i \le k < j} \{m[i, k] + m[k+1, j] + p_{i-1} p_k p_j\} & \text{if } i < j. \end{cases}$$

- Cutting Rod Problem :

  Cutting rod problem can be stated as : Given a rod of length n and an array of prices that contains prices of all pieces of size smaller than n. Determine the maximum value obtainable by cutting up the rod and selling the pieces.

  The idea is very simple, we are given an array of prices where rod of length is I has a value price[i-1]. One by one , we are partition the given rod of length n into two parts of lengths I and n-i. We recur for rod of length n-1 but dont divide rod of length I any further. Finally, we take maximum of all values. This yields the below recursive relation :

$$\text{rodCut}(n) = \max\{ \text{price}[i-1] + \text{rodCut}(n-i) \} \quad \text{where } 1 <= i <= n$$

Time Complexity:

Matrix Chain Multiplication: O(n^3) where n is no of matrices.

Cutting Rod Problem: O(n^2) where n is length of rod.

Matrix Chain Multiplication :

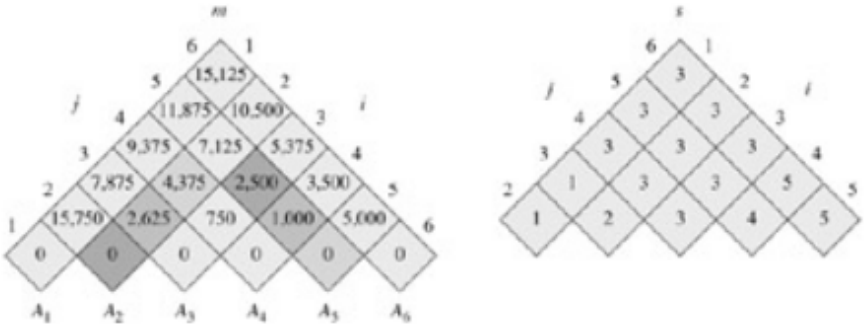
Input:

A1	30 × 35
A2	35 × 15
A3	15 × 5
A4	5 × 10
A5	10 × 20
A6	20 × 25

Output:

Cost = 15125

Order = (A1(A2 A3))((A4 A5)A6)



Implementation :

```
saeem@saeem-Inspiron-3558:~/Desktop/college/aac/expt3$ python3 matrix2.py
Matrices:  ['A1', 'A2', 'A3', 'A4', 'A5', 'A6']
P:  [30, 35, 15, 5, 10, 20, 25]
i j      m                                  s
1 2      15750                              1
2 3      2625                               2
3 4      750                                3
4 5      1000                               4
5 6      5000                               5
1 3      7875                               1
2 4      4375                               3
3 5      2500                               3
4 6      3500                               5
1 4      9375                               3
2 5      7125                               3
3 6      5375                               3
1 5      11875                              3
2 6      10500                              3
1 6      15125                              3

Cost = 15125
Order = (A1(A2 A3))((A4 A5)A6)
```

Cutting-Edge problem :

Input:

Rod length (n) = 4

price = [1,5,8,9,10,17,17,20]

Output:

Cut	Profit
4	9
1, 3	(1 + 8) = 9
2, 2	(5 + 5) = 10
3, 1	(8 + 1) = 9
1, 1, 2	(1 + 1 + 5) = 7
1, 2, 1	(1 + 5 + 1) = 7
2, 1, 1	(5 + 1 + 1) = 7
1, 1, 1, 1	(1 + 1 + 1 + 1) = 4

Implementation:

```
saeem@saeem-Inspiron-3558:~/Desktop/college/aac/expt3$ python cutting.py
enter the length of rod 4
Insert price of pieces of rod in incresing order1,5,8,9,10,17,17,20
('Maximum Obtainable Value is ', 10)
```

Conclusion:

Here we can conclude that it is very effective to find sequence of matrix to be multiply that save large no of scalar multiplication. Time complexity of matrix chain multiplication is proportional to no of matrices to be multiply. There are many solution of cutting rod problem but the most optimal solution is using dynamic programming and time complexity of this is depend on length of the rod.