

**DESIGN AND ANALYSIS OF
ALGORITHMS
LAB ASSIGNMENT**

Chain Matrix Multiplication and Its Time Complexity

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CSE

❖ Source Code:

```
#include<stdio.h>
#include<stdlib.h>
int minimum_cost(int matrix[20], int t){
    int x, small;
    if(t == 1)
        return matrix[0];
    else{
        small = matrix[0];
        for(x = 1; x < t; x++){
            if(matrix[x] < small)
                small = matrix[x];
        }
        return small;
    }
}
int main(){
    int t, i, l, j, k, limit,f;
    int matrix[30], multiplier[10][15]={0}, columns[15], rows[15], temp[15];
    printf("\nEnter Total Number of Matrices:\t");
    scanf("%d", &limit);
    for(i = 0; i < limit; i++){
        printf("\nEnter Number of Rows of Matrix %d:\t", i + 1);
        scanf("%d", &rows[i]);
        printf("Enter Number of Columns of Matrix %d:\t", i + 1);
        scanf("%d", &columns[i]);
    }
    printf("\n\n\n");
    for(i = 0; i < limit; i++)
        temp[i]=rows[i];

        temp[i] = columns[i - 1];
    for(l = 2; l <= limit; l++){
        for(j = 1, i = 1; j <= limit; j++, i++){
            t = 0;
            for(k = i; k < j; k++){
                matrix[t] = (multiplier[i][k] + multiplier[k + 1][j]) + (temp[i - 1] *
temp[k] * temp[j]);
                t++;
            }
            multiplier[i][j] = minimum_cost(matrix, t);
        }
    }
    printf("\nMinimum Scalar Multiplications:\t%d\n", multiplier[1][limit]);
    return 0;
}
```

❖ Output:

➤ 5:

```
C:\Users\gaura\Desktop\Chain.exe

Enter Total Number of Matrices: 5

Enter Number of Rows of Matrix 1:      2
Enter Number of Columns of Matrix 1:    2

Enter Number of Rows of Matrix 2:      2
Enter Number of Columns of Matrix 2:    5

Enter Number of Rows of Matrix 3:      5
Enter Number of Columns of Matrix 3:    7

Enter Number of Rows of Matrix 4:      7
Enter Number of Columns of Matrix 4:    3

Enter Number of Rows of Matrix 5:      3
Enter Number of Columns of Matrix 5:    6

Minimum Scalar Multiplications: 160

Process returned 0 (0x0)   execution time : 214.131 s
Press any key to continue.
```

➤ 10:

```
Select C:\Users\gaura\Desktop\Chain.exe

Enter Total Number of Matrices: 10

Enter Number of Rows of Matrix 1:      2
Enter Number of Columns of Matrix 1:    2

Enter Number of Rows of Matrix 2:      2
Enter Number of Columns of Matrix 2:    5

Enter Number of Rows of Matrix 3:      5
Enter Number of Columns of Matrix 3:    7

Enter Number of Rows of Matrix 4:      7
Enter Number of Columns of Matrix 4:    3

Enter Number of Rows of Matrix 5:      3
Enter Number of Columns of Matrix 5:    6

Enter Number of Rows of Matrix 6:      6
Enter Number of Columns of Matrix 6:    7

Enter Number of Rows of Matrix 7:      7
Enter Number of Columns of Matrix 7:    5

Enter Number of Rows of Matrix 8:      5
Enter Number of Columns of Matrix 8:    8

Enter Number of Rows of Matrix 9:      8
Enter Number of Columns of Matrix 9:    9

Enter Number of Rows of Matrix 10:     9
Enter Number of Columns of Matrix 10:   6

Minimum Scalar Multiplications: 1991919010

Process returned 0 (0x0)   execution time : 55.013 s
Press any key to continue.
```

➤ 15:

```
C:\Users\gaura\Desktop\Chain.exe

Enter Total Number of Matrices: 15

Enter Number of Rows of Matrix 1:      2
Enter Number of Columns of Matrix 1:    3

Enter Number of Rows of Matrix 2:      3
Enter Number of Columns of Matrix 2:    2

Enter Number of Rows of Matrix 3:      2
Enter Number of Columns of Matrix 3:    4

Enter Number of Rows of Matrix 4:      4
Enter Number of Columns of Matrix 4:    3

Enter Number of Rows of Matrix 5:      3
Enter Number of Columns of Matrix 5:    1

Enter Number of Rows of Matrix 6:      1
Enter Number of Columns of Matrix 6:    4

Enter Number of Rows of Matrix 7:      4
Enter Number of Columns of Matrix 7:    2

Enter Number of Rows of Matrix 8:      2
Enter Number of Columns of Matrix 8:    3

Enter Number of Rows of Matrix 9:      3
Enter Number of Columns of Matrix 9:    2

Enter Number of Rows of Matrix 10:     2
Enter Number of Columns of Matrix 10:   4

Enter Number of Rows of Matrix 11:     4
Enter Number of Columns of Matrix 11:   2

Enter Number of Rows of Matrix 12:     2
Enter Number of Columns of Matrix 12:   3

Enter Number of Rows of Matrix 13:     3
Enter Number of Columns of Matrix 13:   5

Enter Number of Rows of Matrix 14:     5
Enter Number of Columns of Matrix 14:   2

Enter Number of Rows of Matrix 15:     2
Enter Number of Columns of Matrix 15:   5


Minimum Scalar Multiplications: 119

Process returned 0 (0x0)   execution time : 50.151 s
Press any key to continue.
```

❖ Time Complexity:

* Time Complexity:

$M[1,4]$ time $k=1$ to $n-1$

- $C^*(n-1)$
- $2^* C^*(n-2)$
- $3^* C^*(n-3)$

0	x_1	x_4	x_6
0	0	x_2	x_5
0	0	0	x_6
0	0	0	0

4x4

$n \times n$

\vdots
 $\vdots (n-1)^* C^*(n-(n-1))$ where C is some constant

$$\begin{aligned} \Rightarrow T(n) &= C(n-1) + 2C(n-2) + \dots + (n-1)C(n-(n-1)) \\ &= C [1(n-1) + 2(n-2) + \dots + (n-1)(n-(n-1))] \\ &= C \sum_{i=1}^{n-1} i \cdot (n-i) \end{aligned}$$

$$\approx n \sum_{i=1}^{n-1} i - \sum_{i=1}^{n-1} i^2$$

$$= \frac{3n \cdot (n-1)(n)}{2 \times 3} - \frac{(n-1)(n)(2n-1)}{6}$$

$$\approx 3n^2(n-1) - 2n^2 - n(n-1)$$

$$\approx 3n^3 - 3n^2 - 2n^3 - n^2 + 2n^2 + n$$

$$= n^3 - 2n^2 + n$$

$$\approx n^3$$

$$\Rightarrow \boxed{T(n) = O(n^3)}$$