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Batch:	CSE(DS)D1
Exp:	05
Aim:	To implement dynamic programming- Matrix chain multiplication.

PROBLEM STATEMENT: The aim of this experiment is two-fold. First, it finds the efficient way of multiplying a sequence of k matrices (called Matrix Chain Multiplication) using Dynamic Programming. The chain of multiplication M1 x M2 x M3 x M4 x...x Mk may be computed in $(2N)!/((N + 1)!\ N!)$ = $(2N\ N)\ /(N + 1)$ ways due to associative property where NN = $kk - 1$ of matrix multiplication.

Algorithms/Theory: Given a sequence of matrices, find the most efficient way to multiply these matrices together. The problem is not actually to perform the multiplications, but merely to decide in which order to perform the multiplications. We have many options to multiply a chain of matrices because matrix multiplication is associative. In other words, no matter how we parenthesize the product, the result will be the same. For example, if we had four matrices A, B, C, and D, we would have: (ABC)D = (AB)(CD) = A(BCD) = ...

However, the order in which we parenthesize the product affects the number of simple arithmetic operations needed to compute the product, or the efficiency.

For example, suppose A is a 10 × 30 matrix, B is a 30 × 5 matrix, and C is a 5 × 60 matrix. Then,

(AB)C = (10×30×5) + (10×5×60) = 1500 + 3000 = 4500 operations

A(BC) = (30×5×60) + (10×30×60) = 9000 + 18000 = 27000 operations.

Clearly the first parenthesization requires less number of operations.

Code:-

```
#include<stdio.h>

#include<time.h>

#include<stdlib.h>


 int mat[100][100], s[100][100], count = 0;


int

MCM (int p[], int i, int j)

{
```

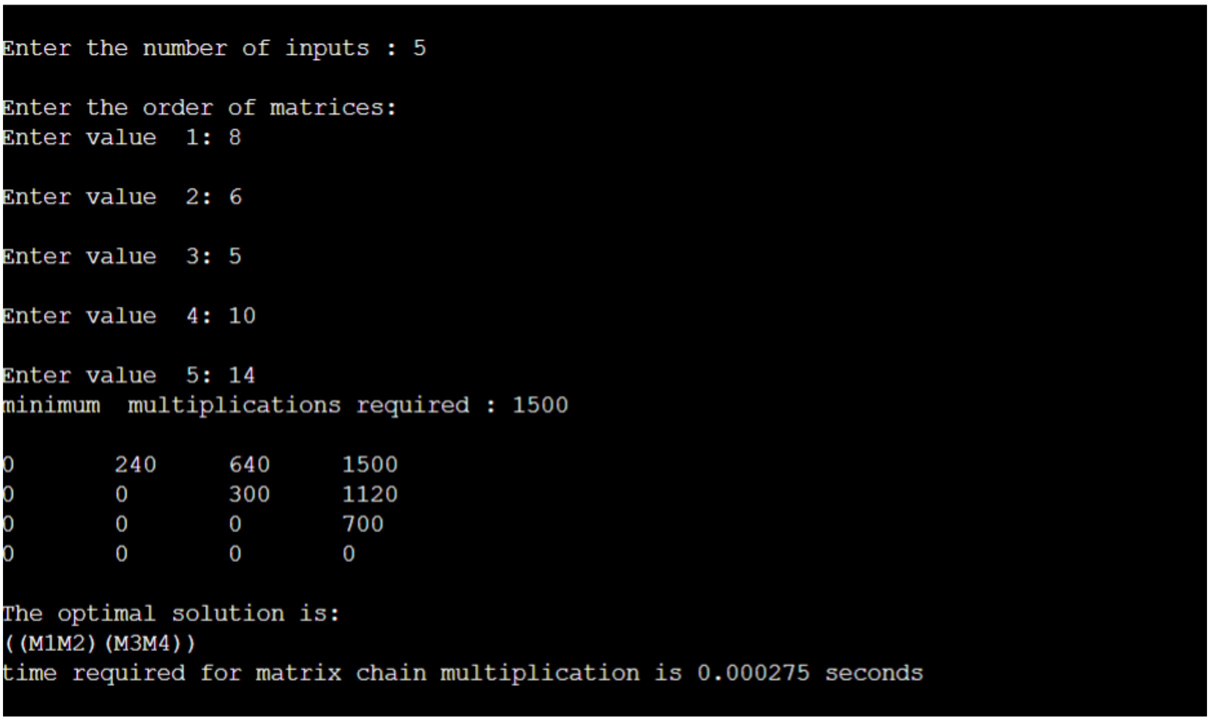
```
if (i == j)
    {

mat[i][j] = 0;

return 0;

}

mat[i][j] = 30000;

for (int k = i; k < j; k++)
    {

count = MCM (p, i, k) + MCM (p, k + 1, j) + p[i - 1] * p[k] * p[j];

if (count < mat[i][j])
         {

mat[i][j] = count;

s[i][j] = k;
```

```
}

}

return mat[i][j];

}



void
POP (int i, int j)
{

if (i == j)

printf ("M%d", i);

  else
    {

printf ("(");
POP (i, s[i][j]);

POP (s[i][j] + 1, j);

printf (")");

}

}


void
main ()
{

int num;

clock_t start, end;

printf ("\nEnter the number of inputs you want to give: ");
```

```
scanf ("%d", &num);

int p[num];

printf ("\nEnter the order of matrices: ");

start = clock ();

for (int i = 0; i < num; i++)
   {

printf ("\nEnter value for place %d: ", i + 1);

scanf ("%d", &p[i]);

}
printf ("The minimum number of multiplications required are: %d\n\n",
             MCM (p, 1, num - 1));

end = clock ();
```

```
for (int i = 1; i < num; i++)
   {

for (int j = 1; j < num; j++)
       {

printf ("%d\t", mat[i][j]);

}
printf ("\n");

}
printf ("\nThe optimal solution is: \n");

POP (1, num - 1);

printf ("\nThe time required for matrix chain multiplication is
%f seconds", ((double) end - start) / CLOCKS_PER_SEC);

}
```

Output:-



```
Enter the number of inputs : 5

Enter the order of matrices:
Enter value  1: 8

Enter value  2: 6

Enter value  3: 5

Enter value  4: 10

Enter value  5: 14
minimum  multiplications required : 1500

0       240     640     1500
0       0       300     1120
0       0       0       700
0       0       0       0

The optimal solution is:
((M1M2)(M3M4))
time required for matrix chain multiplication is 0.000275 seconds
```

Conclusion:-From this Experiment, I have learned Matrix Chain Multiplication that how it used to find the minimum cost in Dynamic Programming.