School of Computer Science and Engineering (SCOPE)

Assessment – 2

Design and analysis of Algorithm (Lab Component)

MCSE502L

Course Name: Design and analysis of Algorithm (Lab Component)
Course Code: MCSE502L
Slot: L35+L36
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Assessment – 2

MCSE502L Design and analysis of Algorithm (Lab Component)

1. **Implement Matrix Chain Multiplication.**
2. **Implement Longest Common Subsequence.**
3. **Implement Subset-sum.**

1. Implement Matrix Chain Multiplication.

In the matrix chain multiplication problem, an array encoding the dimensions of the matrices [M 1, M 2,..., M n] has been provided. [M 1,M 2,...,M n] and we're trying to figure out how many multiplication steps are needed to multiply them.

Assume that we have three matrices, M 1, M 2, and M 3, with dimensions of 5 x 105, 10 x 8, and 8 x 58 correspondingly, and that we are interested in multiplying all of them for whatever reason. Two different multiplication orders are possible:

EXAMPLE:-

$M1\times(M2\times M3)$

- Steps required in M_2\times M_3$M2\times M3$ will be 10\times 8\times 510×8×5 == 400400.
- Dimensions of M_{23}$M23$ will be 10\times 510×5.
- Steps required in M_1\times M_{23}$M1\times M23$ will be 5\times 10 \times 55×10×5 == 250250.
- Total Steps == 400+250400+250 == 650650

(M1×M2)×M3

- Steps required in M_1\times M_2M1×M2 will be 5\times 10\times 85×10×8 == 400400.
- Dimensions of M_{12}M12 will be 5\times 85×8.
- Steps required in M_{12}\times M_{3}M12×M3 will be 5\times 8 \times 55×8×5 == 200200.
- Total Steps == 400+200400+200 == 600600

Algorithm:

- Iterate from **l = 2 to N-1** which denotes the length of the range:
  - Iterate from **i = 0 to N-1**:
    - Find the right end of the range (**j**) having **l** matrices.
    - Iterate from **k = i+1 to j** which denotes the point of partition.
      - Multiply the matrices in range (**i, k**) and (**k, j**).
      - This will create two matrices with dimensions **arr[i-1]*arr[k]** and **arr[k]*arr[j]**.
      - The number of multiplications to be performed to multiply these two matrices (say **X**) are **arr[i-1]*arr[k]*arr[j]**.
      - The total number of multiplications is **dp[i][k]+ dp[k+1][j] + X**.
- The value stored at **dp[1][N-1]** is the required answer.

Algorithm matrix Chain(S):

Algorithm matrixChain(S):

Input: sequence S of **n** matrices to be multiplied

Output: number of operations in an optimal parametrization of S

for i ← 1 **to n-1 do**

$\quad C_{i,i} \leftarrow 0$

for b ← 1 **to n-1 do**

$\quad$ **for i** ← 0 **to n-b-1 do**

$\quad\quad j \leftarrow i+b$

$\quad\quad C_{i,j} \leftarrow +\text{infinity}$

$\quad\quad$ **for k** ← i **to j-1 do**

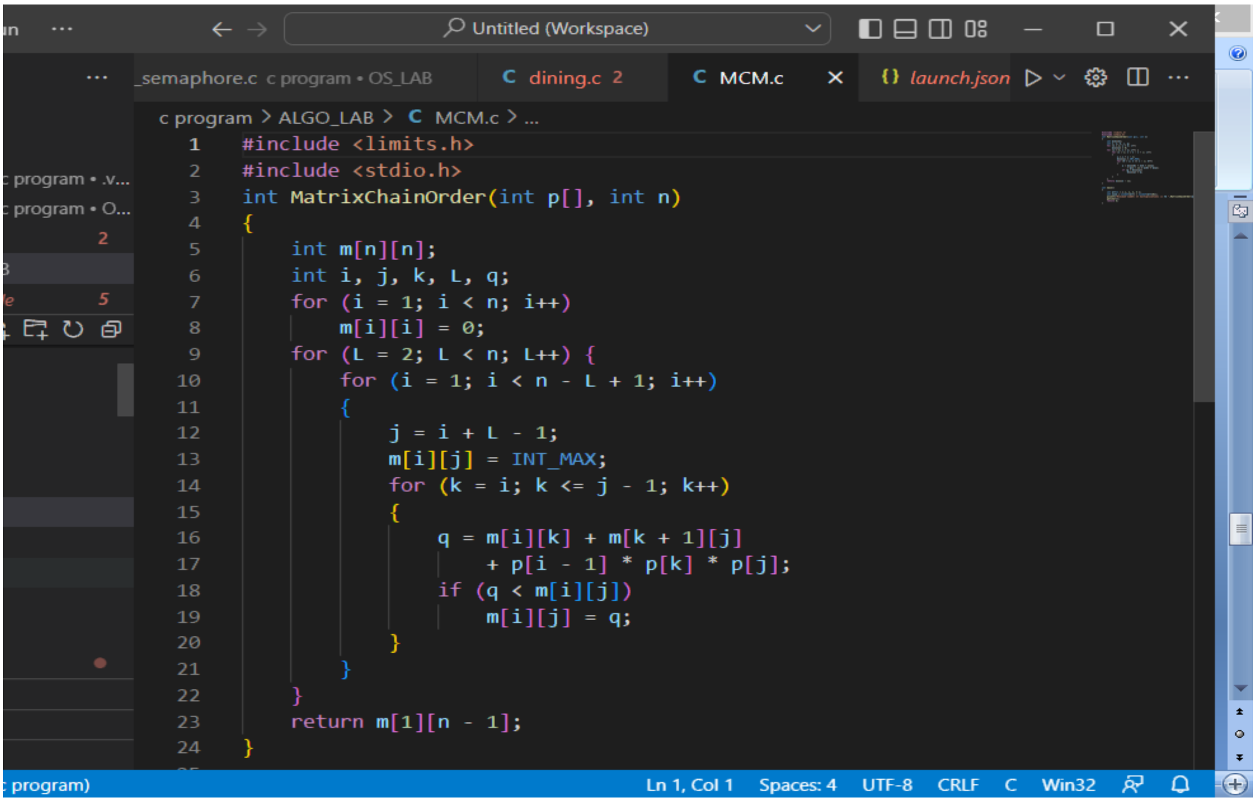
$\quad\quad\quad C_{i,j} \leftarrow \min\{C_{i,j}\ , C_{i,k} + C_{k+1,j} + d_i\, d_{k+1}\, d_{j+1}\}$

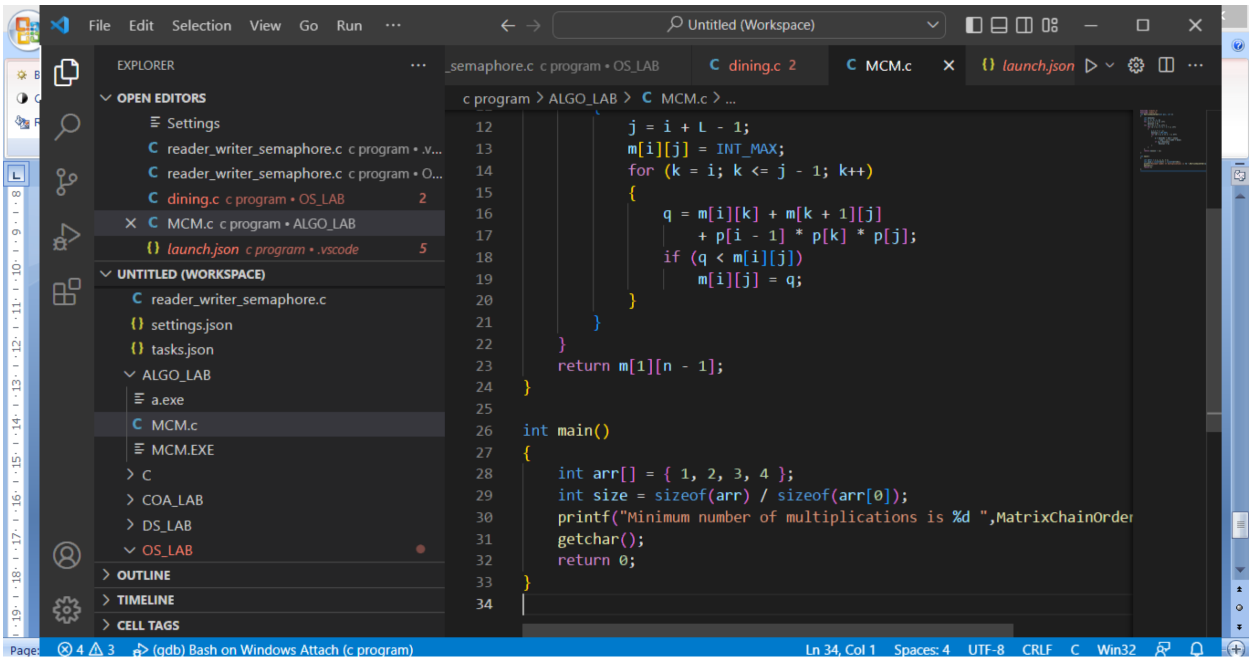
Complexity Analysis

Time Complexity: O(N^3)
Auxiliary Space: O(N^2)

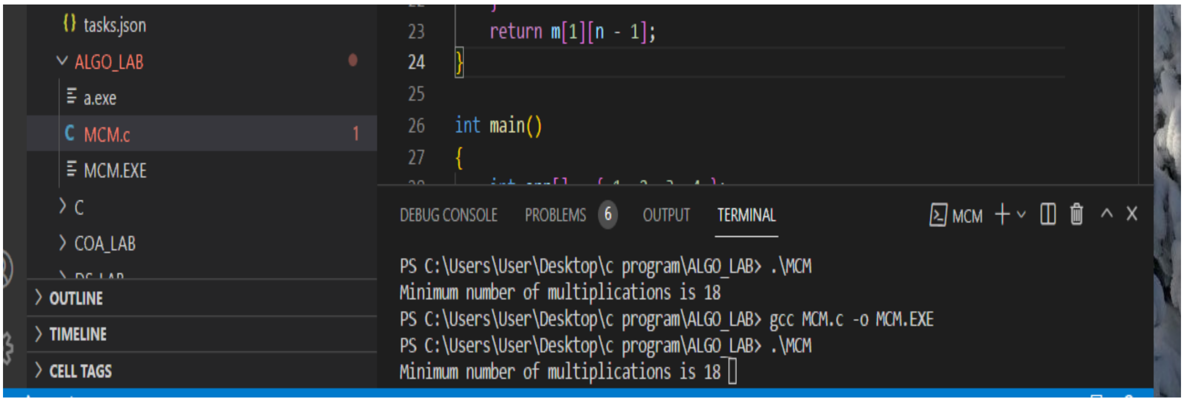
Program:

```
#include <limits.h>
#include <stdio.h>
int MatrixChainOrder(int p[], int n)
{
    int m[n][n];
    int i, j, k, L, q;
    for (i = 1; i < n; i++)
        m[i][i] = 0;
    for (L = 2; L < n; L++) {
        for (i = 1; i < n - L + 1; i++)
        {
            j = i + L - 1;
            m[i][j] = INT_MAX;
            for (k = i; k <= j - 1; k++)
            {
                q = m[i][k] + m[k + 1][j]
                    + p[i - 1] * p[k] * p[j];
                if (q < m[i][j])
                    m[i][j] = q;
            }
        }
    }
    return m[1][n - 1];
}

int main()
{
    int arr[] = { 1, 2, 3, 4 };
    int size = sizeof(arr) / sizeof(arr[0]);
    printf("Minimum number of multiplications is %d ",MatrixChainOrder(arr, size));
    getchar();
    return 0;
}
```


Untitled (Workspace)
semaphore.c c program • OS_LAB
dining.c 2
MCM.c
launch.json
c program > ALGO_LAB > MCM.c > ...
#include <limits.h>
#include <stdio.h>
int MatrixChainOrder(int p[], int n)
{
int m[n][n];
int i, j, k, L, q;
for (i = 1; i < n; i++)
m[i][i] = 0;
for (L = 2; L < n; L++) {
for (i = 1; i < n - L + 1; i++)
{
j = i + L - 1;
m[i][j] = INT_MAX;
for (k = i; k <= j - 1; k++)
{
q = m[i][k] + m[k + 1][j]
+ p[i - 1] * p[k] * p[j];
if (q < m[i][j])
m[i][j] = q;
}
}
}
return m[1][n - 1];
}
Ln 1, Col 1 Spaces: 4 UTF-8 CRLF C Win32


File Edit Selection View Go Run
Untitled (Workspace)
EXPLORER
OPEN EDITORS
Settings
reader_writer_semaphore.c
dining.c c program • OS_LAB
MCM.c c program • ALGO_LAB
launch.json c program • .vscode
UNTITLED (WORKSPACE)
settings.json
tasks.json
ALGO_LAB
a.exe
MCM.c
MCM.EXE
COA_LAB
DS_LAB
OS_LAB
OUTLINE
TIMELINE
CELL TAGS
j = i + L - 1;
m[i][j] = INT_MAX;
for (k = i; k <= j - 1; k++)
{
q = m[i][k] + m[k + 1][j]
+ p[i - 1] * p[k] * p[j];
if (q < m[i][j])
m[i][j] = q;
}
}
}
return m[1][n - 1];
}
int main()
{
int arr[] = { 1, 2, 3, 4 };
int size = sizeof(arr) / sizeof(arr[0]);
printf("Minimum number of multiplications is %d ",MatrixChainOrder
getchar();
return 0;
}
(gdb) Bash on Windows Attach (c program)
Ln 34, Col 1 Spaces: 4 UTF-8 CRLF C Win32

Output:-




```
D:\VIT\Design and Analysis of Algorithms\lab>matrix_chain_multiplication.exe
Minimum number of multiplications is 18
```

2. Implement Longest Common Subsequence.

- if |X| = m, |Y| = n, then there are 2^m subsequences of x; we must compare each with Y (n comparisons)
- So the running time of the brute-force algorithm is $O(n\ 2^m)$
- Notice that the LCS problem has *optimal substructure*: solutions of subproblems are parts of the final solution.
- Subproblems: “find LCS of pairs of *prefixes* of X and Y”

The longest common subsequence (LCS) is defined as the longest subsequence that is common to all the given sequences, provided that the elements of the subsequence are not required to occupy consecutive positions within the original sequences.

Example:

LCS for input Sequences “**ABCDGH**” and “**AEDFHR**” is “**ADH**” of length 3.
LCS for input Sequences “**AGGTAB**” and “**GXTXAYB**” is “**GTAB**” of length 4.

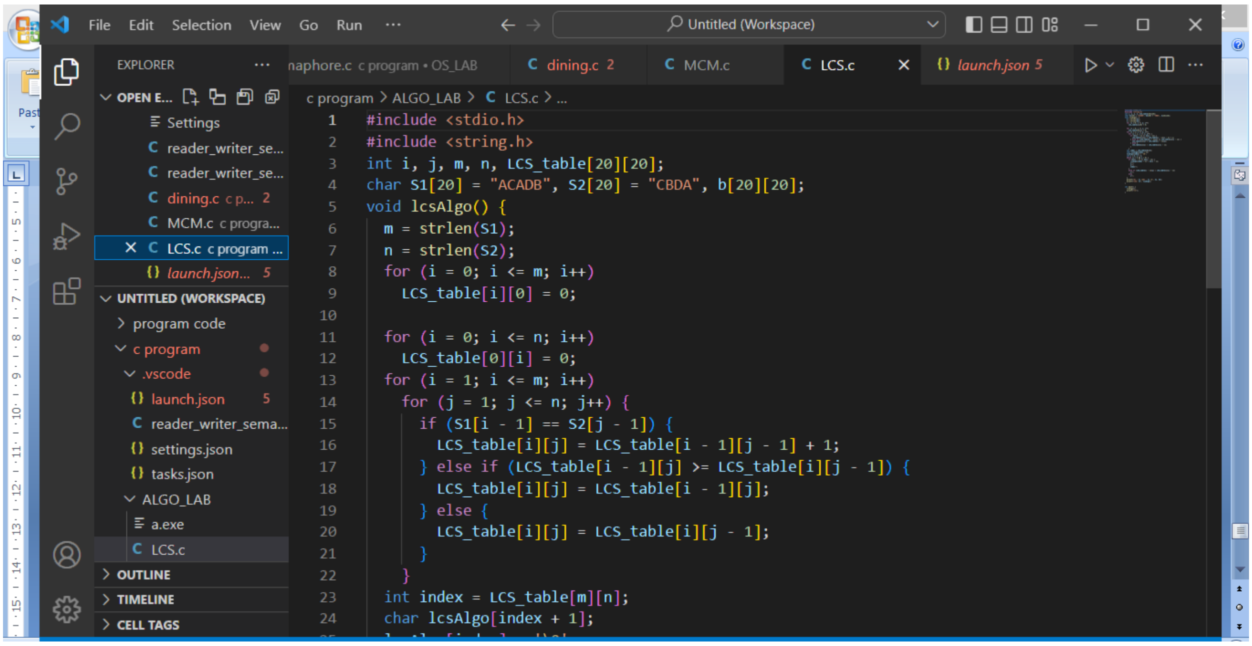
LCS Length Algorithm

```
LCS-Length(X, Y)
1. m = length(X)  // get the # of symbols in X
2. n  = length(Y) // get the # of symbols in Y
3. for i = 1 to m          c[i,0] = 0        // special case: Y0
4. for j = 1 to n          c[0,j] = 0        // special case: X0
5. for i = 1 to m                            // for all Xi
6.        for j = 1 to n                     // for all Yj
7.                 if ( Xi == Yj )
8.                          c[i,j] = c[i-1,j-1] + 1
9.                 else c[i,j] = max( c[i-1,j], c[i,j-1] )
10. return c
```

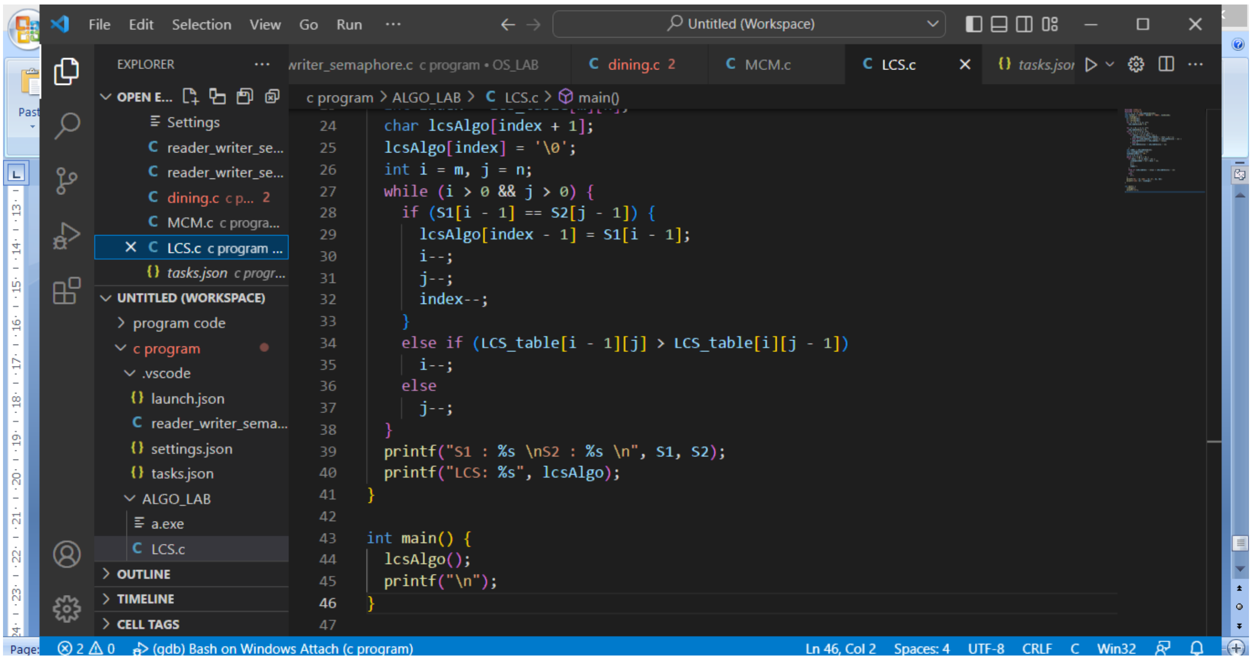
Time Complexity: O(mn)

Program :-

```
#include <stdio.h>
#include <string.h>
int i, j, m, n, LCS_table[20][20];
char S1[20] = "ACADB", S2[20] = "CBDA", b[20][20];
void lcsAlgo() {
  m = strlen(S1);
  n = strlen(S2);
  for (i = 0; i <= m; i++)
    LCS_table[i][0] = 0;

  for (i = 0; i <= n; i++)
    LCS_table[0][i] = 0;
  for (i = 1; i <= m; i++)
    for (j = 1; j <= n; j++) {
      if (S1[i - 1] == S2[j - 1]) {
        LCS_table[i][j] = LCS_table[i - 1][j - 1] + 1;
      } else if (LCS_table[i - 1][j] >= LCS_table[i][j - 1]) {
        LCS_table[i][j] = LCS_table[i - 1][j];
      } else {
        LCS_table[i][j] = LCS_table[i][j - 1];
      }
    }
  int index = LCS_table[m][n];
  char lcsAlgo[index + 1];
  lcsAlgo[index] = '\0';
  int i = m, j = n;
  while (i > 0 && j > 0) {
    if (S1[i - 1] == S2[j - 1]) {
      lcsAlgo[index - 1] = S1[i - 1];
      i--;
      j--;
      index--;
    }
    else if (LCS_table[i - 1][j] > LCS_table[i][j - 1])
      i--;
    else
      j--;
  }
  printf("S1 : %s \nS2 : %s \n", S1, S2);
  printf("LCS: %s", lcsAlgo);
}

int main() {
  lcsAlgo();
  printf("\n");
}
```



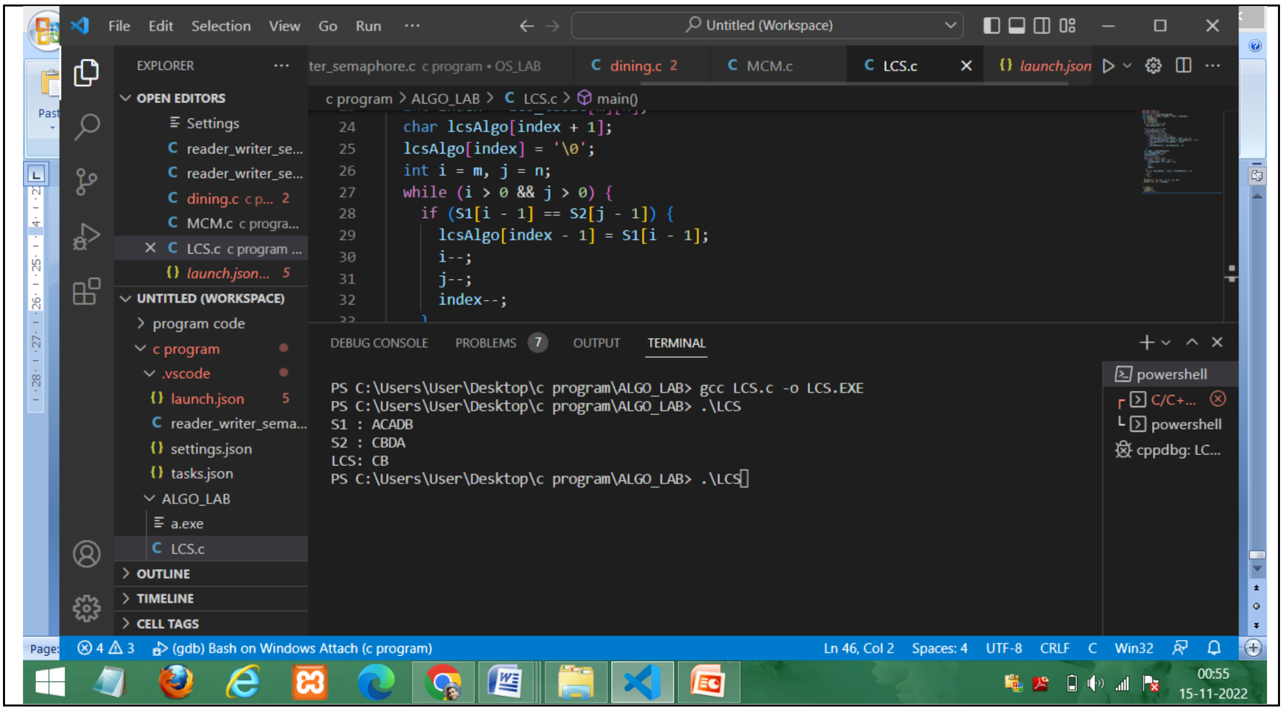
```c
#include <stdio.h>
#include <string.h>
int i, j, m, n, LCS_table[20][20];
char S1[20] = "ACADB", S2[20] = "CBDA", b[20][20];
void lcsAlgo() {
  m = strlen(S1);
  n = strlen(S2);
  for (i = 0; i <= m; i++)
    LCS_table[i][0] = 0;

  for (i = 0; i <= n; i++)
    LCS_table[0][i] = 0;
  for (i = 1; i <= m; i++)
    for (j = 1; j <= n; j++) {
      if (S1[i - 1] == S2[j - 1]) {
        LCS_table[i][j] = LCS_table[i - 1][j - 1] + 1;
      } else if (LCS_table[i - 1][j] >= LCS_table[i][j - 1]) {
        LCS_table[i][j] = LCS_table[i - 1][j];
      } else {
        LCS_table[i][j] = LCS_table[i][j - 1];
      }
    }
  int index = LCS_table[m][n];
  char lcsAlgo[index + 1];
```



```c
  char lcsAlgo[index + 1];
  lcsAlgo[index] = '\0';
  int i = m, j = n;
  while (i > 0 && j > 0) {
    if (S1[i - 1] == S2[j - 1]) {
      lcsAlgo[index - 1] = S1[i - 1];
      i--;
      j--;
      index--;
    }
    else if (LCS_table[i - 1][j] > LCS_table[i][j - 1])
      i--;
    else
      j--;
  }
  printf("S1 : %s \nS2 : %s \n", S1, S2);
  printf("LCS: %s", lcsAlgo);
}

int main() {
  lcsAlgo();
  printf("\n");
}
```

OUTPUT:-

```
PS C:\Users\User\Desktop\c program\ALGO_LAB> gcc LCS.c -o LCS.EXE
PS C:\Users\User\Desktop\c program\ALGO_LAB> .\LCS
S1 : ACADB
S2 : CBDA
LCS: CB
```



3. Implement Subset-sum.

Given a set of non-negative integers, and a value sum, determine if there is a subset of the given set with sum equal to given sum.

Example:

Suppose we are given *n*–distinct positive numbers *wi,i=1,2,…,n.*
Our objective is to find out all subsets of these numbers whose sum is *m*.
Consider an example:
(w1,w2,w3,w4)=(11,13,24,7)
m=31
Solution:
(w1,w2,w4)=(11,13,7)
(w3,w4)=(24,7)

Example:
Input: set[] = {3, 34, 4, 12, 5, 2}, sum = 9
Output: True
There is a subset (4, 5) with sum 9.

Input: set[] = {3, 34, 4, 12, 5, 2}, sum = 30
Output: False
There is no subset that add up to 30.

Algorithm:-

1.Sum of Subsets(S,k,r)

2.k=1,S=0

3.x[k]=1

4.If(S+w[k]=m)

5.then writex[1:k]

6.Else if(S+w[k]+w[k+1]□m)

7.then Sum of Subsets(S+w[k],k+1,r–w[k])

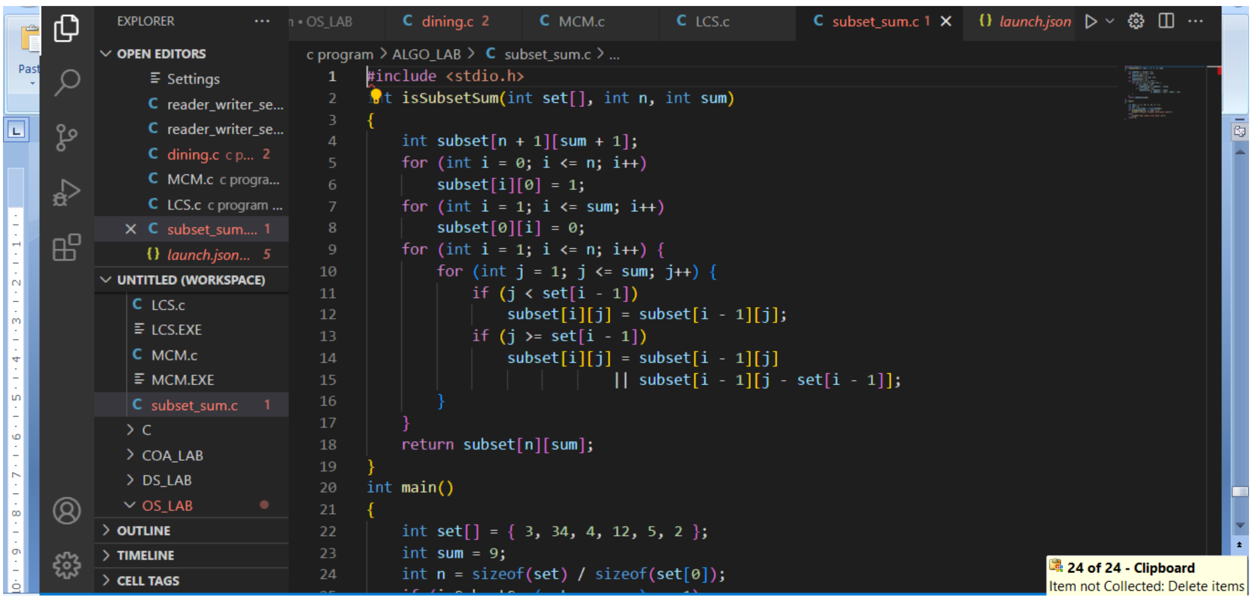
8.If(S+r–w[k]□m)and(S+w[k+1]□m)

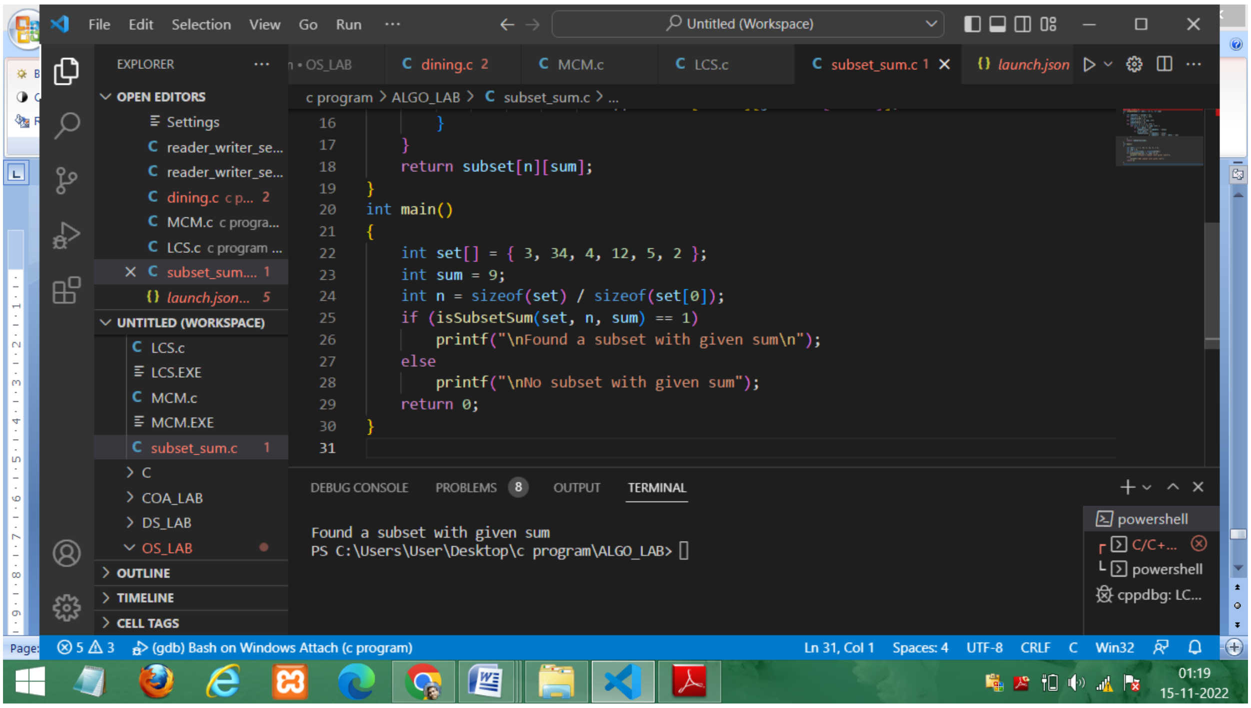
9.x[k]=0

10.Sum of Subsets(S,k+1,r–w[k])

Program:

```
#include <stdio.h>
int isSubsetSum(int set[], int n, int sum)
{
    int subset[n + 1][sum + 1];
    for (int i = 0; i <= n; i++)
        subset[i][0] = 1;
    for (int i = 1; i <= sum; i++)
        subset[0][i] = 0;
    for (int i = 1; i <= n; i++) {
        for (int j = 1; j <= sum; j++) {
            if (j < set[i - 1])
                subset[i][j] = subset[i - 1][j];
            if (j >= set[i - 1])
                subset[i][j] = subset[i - 1][j]
                               || subset[i - 1][j - set[i - 1]];
        }
    }
    return subset[n][sum];
}
int main()
{
    int set[] = { 3, 34, 4, 12, 5, 2 };
    int sum = 9;
    int n = sizeof(set) / sizeof(set[0]);
    if (isSubsetSum(set, n, sum) == 1)
        printf("Found a subset with given sum");
    else
        printf("No subset with given sum");
    return 0;
}
```





OUTPUT:-

PS C:\Users\User\Desktop\c program\ALGO_LAB> gcc subset_sum.c
PS C:\Users\User\Desktop\c program\ALGO_LAB> ./a.exe

Found a subset with given sum