DESIGN OF ANALYSIS OF ALGORITHM

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LAB ASSIGNMENT: -

LAB 1: Implement the insertion inside iterative and recursive Binary search tree and compare their performance.

-: ASSIGNMENT_1.C

```
#include <stdio.h>
#include <stdlib.h>
#include <time.h>
// Structure for a BST node
struct Node {
    int data;
    struct Node* left;
    struct Node* right;
};
// Create a new node
struct Node* createNode(int data) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    newNode->data = data;
    newNode->left = NULL;
    newNode->right = NULL;
    return newNode;
}
// Iterative BST insertion
```

```c
struct Node* iterativeInsert(struct Node* root, int data) {
   struct Node* newNode = createNode(data);
   if (root == NULL) return newNode;

   struct Node* parent = NULL;
   struct Node* current = root;
   while (current != NULL) {
      parent = current;
      if (data < current->data)
         current = current->left;
      else if (data > current->data)
         current = current->right;
      else
         return root; // No duplicates
   }
   if (data < parent->data)
      parent->left = newNode;
   else
      parent->right = newNode;
   return root;
}
// Recursive BST insertion
struct Node* recursiveInsert(struct Node* root, int data) {
   if (root == NULL) return createNode(data);
   if (data < root->data)
      root->left = recursiveInsert(root->left, data);
   else if (data > root->data)
      root->right = recursiveInsert(root->right, data);
   return root;
}
// Utility function to print BST in-order (for verification)
void inorderTraversal(struct Node* root) {
```

```
    if (root != NULL) {
        inorderTraversal(root->left);
        printf("%d ", root->data);
        inorderTraversal(root->right);
    } }
// Time comparison function for both insertions
void compareInsertionTimes(int arrays[5][10], int sizes[5]) {
    for (int i = 0; i < 5; i++) {
        printf("\n--- Array %d ---\n", i + 1);
        struct Node* root1 = NULL; // For iterative insertions
        struct Node* root2 = NULL; // For recursive insertions
      // Measure time for iterative insertion
        clock_t startIter = clock();
        for (int j = 0; j < sizes[i]; j++) {
            root1 = iterativeInsert(root1, arrays[i][j]);
        }
        clock_t endIter = clock();
        double timeIter = ((double)(endIter - startIter)) / CLOCKS_PER_SEC;
    // Measure time for recursive insertion
        clock_t startRecur = clock();
        for (int j = 0; j < sizes[i]; j++) {
            root2 = recursiveInsert(root2, arrays[i][j]);
        }
        clock_t endRecur = clock();
        double timeRecur = ((double)(endRecur - startRecur)) / CLOCKS_PER_SEC;
        printf("Iterative Insertion Time: %f seconds\n", timeIter);
        printf("Recursive Insertion Time: %f seconds\n", timeRecur);
       // Optional: Print BST (for verification)
        printf("In-order traversal (Iterative): ");
        inorderTraversal(root1);
        printf("\nIn-order traversal (Recursive): ");
        inorderTraversal(root2);
```

```c
        printf("\n");
    } }
// Driver function
int main() {
    // Define five sample arrays
    int arrays[5][10] = {
        {50, 30, 20, 40, 70, 60, 80},  // 7 elements
        {10, 20, 30, 40, 50, 60, 70, 80, 90}, // 9 elements
        {25, 15, 50, 10, 22, 35, 70, 40, 80}, // 9 elements
        {100, 90, 80, 70, 60}, // 5 elements
        {5, 25, 15, 35, 20, 30, 10}  // 7 elements
    };
    // Define the size of each array
    int sizes[5] = {7, 9, 9, 5, 7};
    // Compare insertion times
    compareInsertionTimes(arrays, sizes);
    return 0;
}
```

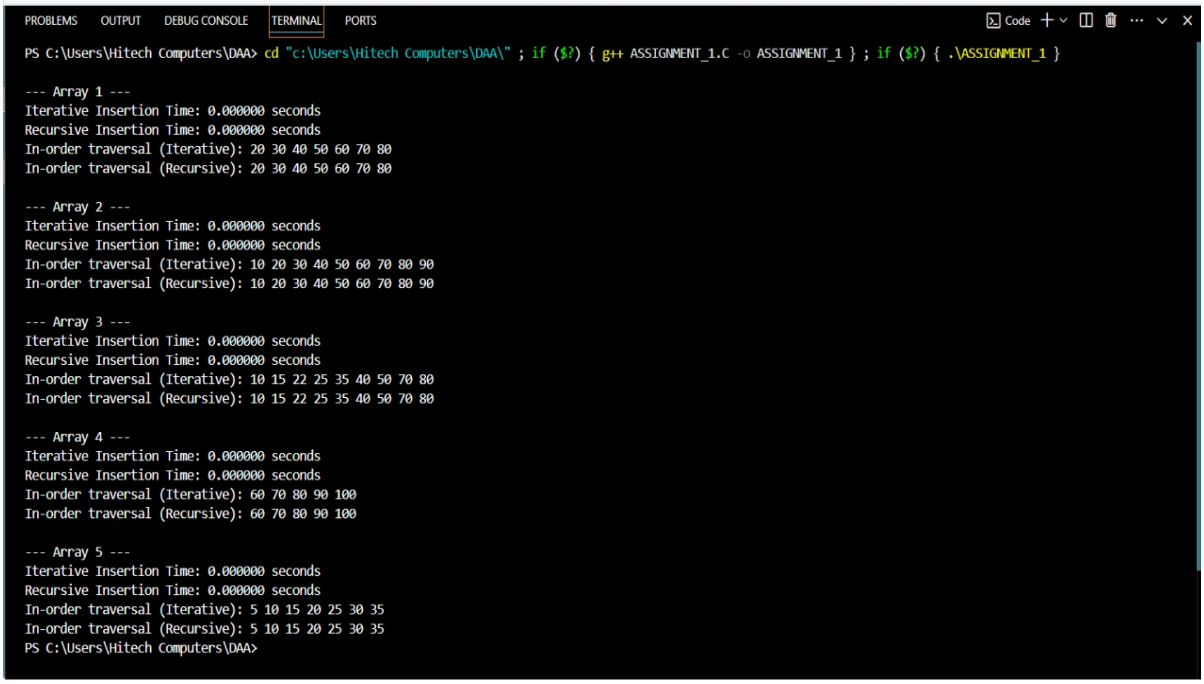
-: CREATE AN EMPTY (ASSIGNMENT_1.exe) FILE.

-: ASSIGNMENT_1.py

```python
 # -*- coding: utf-8 -*-
"""graph1.py
Automatically generated by Colab.
Original file is located at
    https://colab.research.google.com/drive/1BZtdoC6NETTa08-m6Ykv-4Nbsz90yUL4
"""
import matplotlib.pyplot as plt
# Updated data for Array Size, Iterative Time, and Recursive Time
array_size = [5000, 10000, 50000, 100000, 1000000]
iterative_time = [0.000000, 0.001000, 0.006000, 0.012000, 0.110000]
recursive_time = [0.000000, 0.001000, 0.008000, 0.014000, 0.140000]
# Create the plot
```

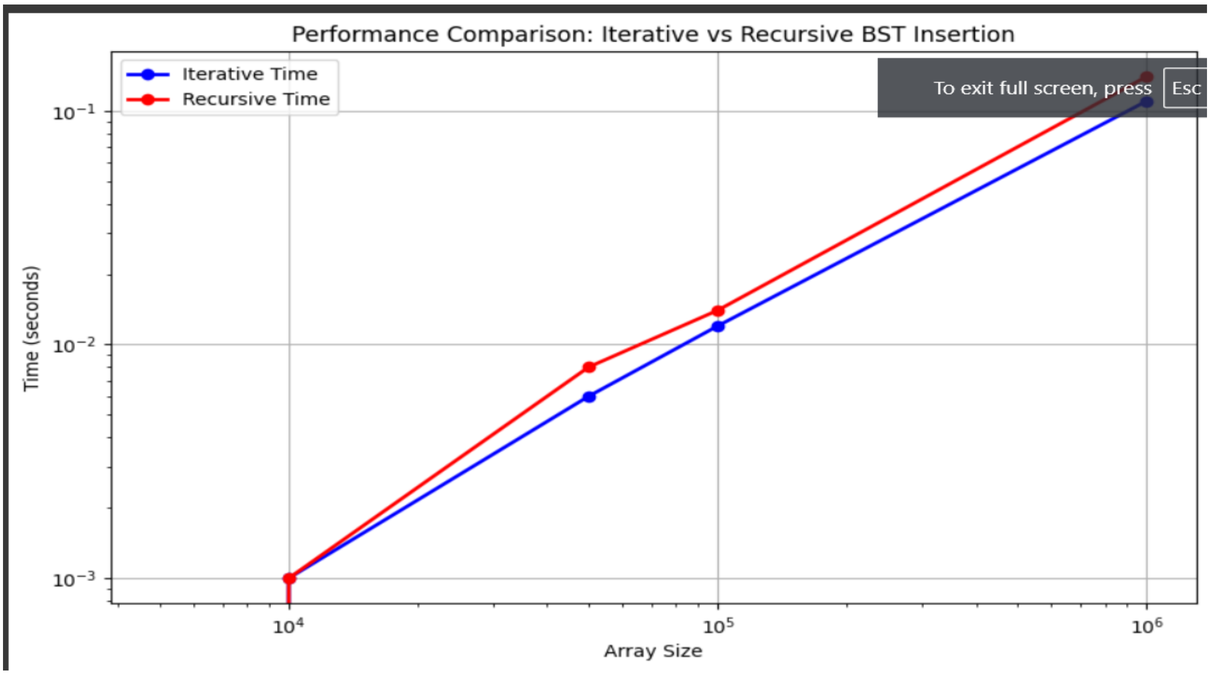
```
plt.figure(figsize=(10, 6))

# Plot the Iterative Time vs Array Size

plt.plot(array_size, iterative_time, label='Iterative Time', marker='o', color='blue',
linestyle='-', linewidth=2)

# Plot the Recursive Time vs Array Size

plt.plot(array_size, recursive_time, label='Recursive Time', marker='o', color='red',
linestyle='-', linewidth=2)

# Add labels and title

plt.xlabel('Array Size')

plt.ylabel('Time (seconds)')

plt.title('Performance Comparison: Iterative vs Recursive BST Insertion')

# Set logarithmic scale for both axes for better visualization

plt.xscale('log')

plt.yscale('log')

# Add a legend

plt.legend()

# Add grid for better readability

plt.grid(True)

# Display the plot

plt.show()
```

-: ASSIGNMENT_1_OUTPUT.png



```
PROBLEMS   OUTPUT   DEBUG CONSOLE   TERMINAL   PORTS
PS C:\Users\Hitech Computers\DAA> cd "c:\Users\Hitech Computers\DAA\" ; if ($?) { g++ ASSIGNMENT_1.C -o ASSIGNMENT_1 } ; if ($?) { .\ASSIGNMENT_1 }

--- Array 1 ---
Iterative Insertion Time: 0.000000 seconds
Recursive Insertion Time: 0.000000 seconds
In-order traversal (Iterative): 20 30 40 50 60 70 80
In-order traversal (Recursive): 20 30 40 50 60 70 80

--- Array 2 ---
Iterative Insertion Time: 0.000000 seconds
Recursive Insertion Time: 0.000000 seconds
In-order traversal (Iterative): 10 20 30 40 50 60 70 80 90
In-order traversal (Recursive): 10 20 30 40 50 60 70 80 90

--- Array 3 ---
Iterative Insertion Time: 0.000000 seconds
Recursive Insertion Time: 0.000000 seconds
In-order traversal (Iterative): 10 15 22 25 35 40 50 70 80
In-order traversal (Recursive): 10 15 22 25 35 40 50 70 80

--- Array 4 ---
Iterative Insertion Time: 0.000000 seconds
Recursive Insertion Time: 0.000000 seconds
In-order traversal (Iterative): 60 70 80 90 100
In-order traversal (Recursive): 60 70 80 90 100

--- Array 5 ---
Iterative Insertion Time: 0.000000 seconds
Recursive Insertion Time: 0.000000 seconds
In-order traversal (Iterative): 5 10 15 20 25 30 35
In-order traversal (Recursive): 5 10 15 20 25 30 35
PS C:\Users\Hitech Computers\DAA>
```

-: GRAPH_1_OUTPUT.png



-: CREATE AN EMPTY (TEMP) FILE.

Lab 2: Implement divide and conquer based merge sort and quick sort algorithms and compare their performance for the same set of elements.

-: ASSIGNMENT_2.C

```
#include <stdio.h>

#include <stdlib.h>

#include <time.h>

#include <string.h>

// Merge function for merge sort

void merge(int arr[], int left, int mid, int right) {

  int i, j, k;

  int n1 = mid - left + 1;

  int n2 = right - mid;

   int L[n1], R[n2];

  for (i = 0; i < n1; i++)

    L[i] = arr[left + i];

  for (j = 0; j < n2; j++)

    R[j] = arr[mid + 1 + j];
```

```
    i = 0;
    j = 0;
    k = left;
   while (i < n1 && j < n2) {
        if (L[i] <= R[j]) {
            arr[k] = L[i];
            i++;
        } else {
            arr[k] = R[j];
            j++;
        }
        k++;                    }
   while (i < n1) {
        arr[k] = L[i];
        i++;
        k++;
    }
  while (j < n2) {
        arr[k] = R[j];
        j++;
        k++;
    } }
// Merge Sort function
void mergeSort(int arr[], int left, int right) {
    if (left < right) {
        int mid = left + (right - left) / 2;
        mergeSort(arr, left, mid);
        mergeSort(arr, mid + 1, right);
        merge(arr, left, mid, right);
    } }
// Function to swap two elements
void swap(int* a, int* b) {
```

```
    int t = *a;
    *a = *b;
    *b = t;                                  }
// Partition function for quick sort
int partition(int arr[], int low, int high) {
    int pivot = arr[high];
    int i = (low - 1);
    for (int j = low; j <= high - 1; j++) {
        if (arr[j] < pivot) {
            i++;
            swap(&arr[i], &arr[j]);
        } }
    swap(&arr[i + 1], &arr[high]);
    return (i + 1);          }
// Quick Sort function
void quickSort(int arr[], int low, int high) {
    if (low < high) {
        int pi = partition(arr, low, high);
        quickSort(arr, low, pi - 1);
        quickSort(arr, pi + 1, high);
    } }
// Function to generate random array
void generateRandomArray(int arr[], int n) {
    for (int i = 0; i < n; i++) {
        arr[i] = rand() % 10000;  // Random numbers between 0 and 9999
    } }
// Function to measure sorting time
double measureSortingTime(void (*sortFunction)(int[], int, int), int arr[], int n) {
    clock_t start, end;
    double cpu_time_used;
    int* arrCopy = (int*)malloc(n * sizeof(int));
    memcpy(arrCopy, arr, n * sizeof(int));
```

```
   start = clock();
   sortFunction(arrCopy, 0, n - 1);
   end = clock();
   cpu_time_used = ((double) (end - start)) / CLOCKS_PER_SEC;
   free(arrCopy);
   return cpu_time_used;                              }
  int main() {
   srand(time(NULL));
   int sizes[] = {1000, 5000, 10000, 50000, 100000}
  [int num_sets = sizeof(sizes) / sizeof(sizes[0]);
   printf("Set\tSize\tMerge Sort Time\tQuick Sort Time\n");
   for (int i = 0; i < num_sets; i++) {
       int n = sizes[i];
       int* arr = (int*)malloc(n * sizeof(int));
         generateRandomArray(arr, n)
       double mergeSortTime = measureSortingTime(mergeSort, arr, n);
       double quickSortTime = measureSortingTime(quickSort, arr, n);
       printf("%d\t%d\t%.6f\t\t%.6f\n", i+1, n, mergeSortTime, quickSortTime);
       free(arr);
   }
      return 0;
}
```

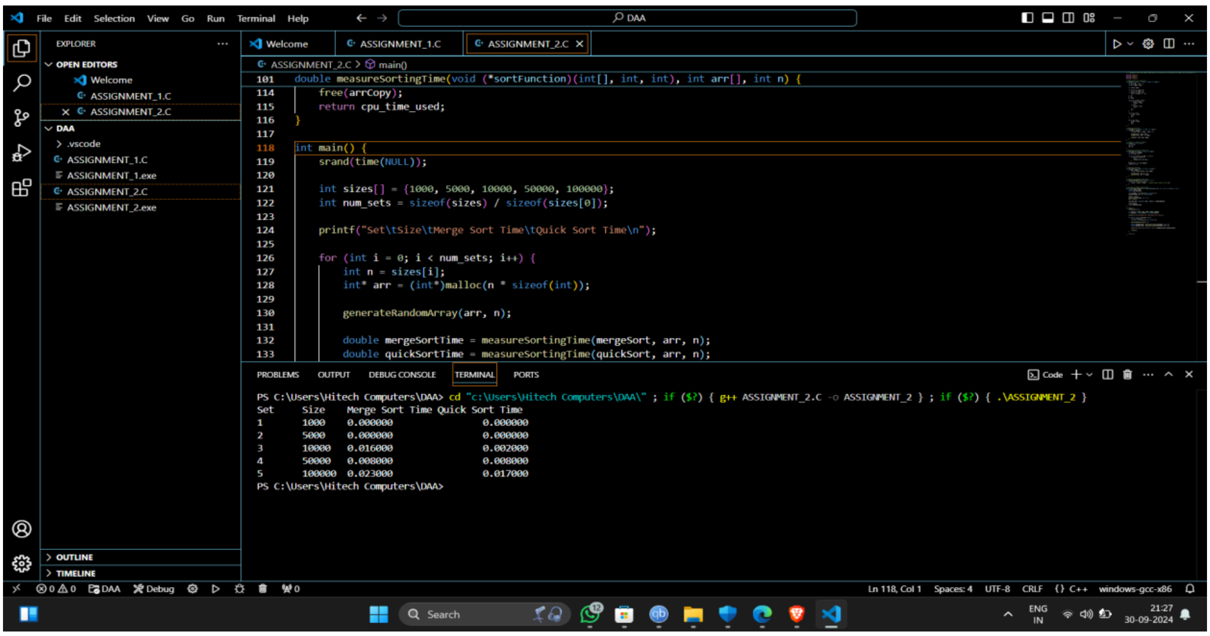
-: CREATE AN EMPTY (ASSIGNMENT_2.exe) FILE.

-: ASSIGNMENT_2.py

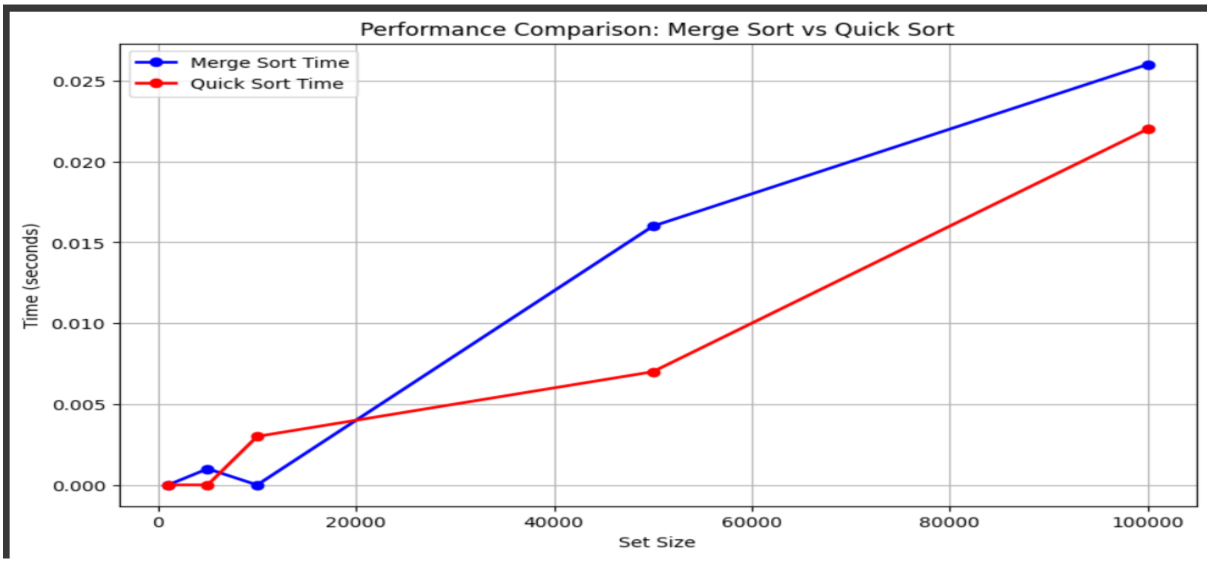
```
# -*- coding: utf-8 -*-
"""graph1.py
Automatically generated by Colab.
Original file is located at
   https://colab.research.google.com/drive/1BZtdoC6NETTa08-m6Ykv-4Nbsz90yUL4
"""
import matplotlib.pyplot as plt
# Data for Set Size, Merge Sort Time, and Quick Sort Time
```

```
set_size = [1000, 5000, 10000, 50000, 100000]

merge_sort_time = [0.000000, 0.001000, 0.000000, 0.016000, 0.026000]

quick_sort_time = [0.000000, 0.000000, 0.003000, 0.007000, 0.022000]

# Create the plot

plt.figure(figsize=(10, 6))

# Plot the Merge Sort Time vs Set Size

plt.plot(set_size, merge_sort_time, label='Merge Sort Time', marker='o', color='blue', linestyle='-', linewidth=2)

# Plot the Quick Sort Time vs Set Size

plt.plot(set_size, quick_sort_time, label='Quick Sort Time', marker='o', color='red', linestyle='-', linewidth=2)

# Add labels and title

plt.xlabel('Set Size')

plt.ylabel('Time (seconds)')

plt.title('Performance Comparison: Merge Sort vs Quick Sort')

# Add a legend

plt.legend()

# Add grid for better readability

plt.grid(True)

# Display the plot

plt.show()
```

-: ASSIGNMENT_2_OUTPUT.png



-: GRAPH_2_OUTPUT.png



-: CREATE AN EMPTY (TEMP) FILE.

LAB 3 : Compare the performance of Strassen method of matrix multiplication with traditional way of matrix multiplication.

-: <u>ASSIGNMENT_3.C</u>

```
#include <stdio.h>
#include <stdlib.h>
#include <time.h>
// Function to allocate memory for a matrix
int** allocateMatrix(int n) {
    int** matrix = (int**)malloc(n * sizeof(int*));
    for (int i = 0; i < n; i++) {
        matrix[i] = (int*)malloc(n * sizeof(int));
    }
    return matrix;
}
// Function to free memory of a matrix
void freeMatrix(int** matrix, int n) {
    for (int i = 0; i < n; i++) {
        free(matrix[i]);
```

```
    }
    free(matrix);                       }
// Function to add two matrices
void addMatrix(int** A, int** B, int** C, int n) {
    for (int i = 0; i < n; i++) {
        for (int j = 0; j < n; j++) {
            C[i][j] = A[i][j] + B[i][j];
        } } }
  // Function to subtract two matrices
void subtractMatrix(int** A, int** B, int** C, int n) {
    for (int i = 0; i < n; i++) {
        for (int j = 0; j < n; j++) {
            C[i][j] = A[i][j] - B[i][j];
        } } }
    // Traditional matrix multiplication
void traditionalMultiply(int** A, int** B, int** C, int n) {
    for (int i = 0; i < n; i++) {
        for (int j = 0; j < n; j++) {
            C[i][j] = 0;
            for (int k = 0; k < n; k++) {
                C[i][j] += A[i][k] * B[k][j];
            } } }
    // Strassen's matrix multiplication
void strassenMultiply(int** A, int** B, int** C, int n) {
    if (n <= 64) {  // Base case: use traditional method for small matrices
        traditionalMultiply(A, B, C, n);
        return;
    }
    int newSize = n / 2;
    int** A11 = allocateMatrix(newSize);
    int** A12 = allocateMatrix(newSize);
    int** A21 = allocateMatrix(newSize);
```

```
int** A22 = allocateMatrix(newSize);
int** B11 = allocateMatrix(newSize);
int** B12 = allocateMatrix(newSize);
int** B21 = allocateMatrix(newSize);
int** B22 = allocateMatrix(newSize);
int** P1 = allocateMatrix(newSize);
int** P2 = allocateMatrix(newSize);
int** P3 = allocateMatrix(newSize);
int** P4 = allocateMatrix(newSize);
int** P5 = allocateMatrix(newSize);
int** P6 = allocateMatrix(newSize);
int** P7 = allocateMatrix(newSize);
int** C11 = allocateMatrix(newSize);
int** C12 = allocateMatrix(newSize);
int** C21 = allocateMatrix(newSize);
int** C22 = allocateMatrix(newSize);
int** tempA = allocateMatrix(newSize);
int** tempB = allocateMatrix(newSize);
// Dividing matrices into 4 sub-matrices
for (int i = 0; i < newSize; i++) {
    for (int j = 0; j < newSize; j++) {
        A11[i][j] = A[i][j];
        A12[i][j] = A[i][j + newSize];
        A21[i][j] = A[i + newSize][j];
        A22[i][j] = A[i + newSize][j + newSize];
        B11[i][j] = B[i][j];
        B12[i][j] = B[i][j + newSize];
        B21[i][j] = B[i + newSize][j];
        B22[i][j] = B[i + newSize][j + newSize];
    } }
     // Calculate P1 to P7
addMatrix(A11, A22, tempA, newSize);
```

```
 addMatrix(B11, B22, tempB, newSize);
 strassenMultiply(tempA, tempB, P1, newSize);  // P1 = (A11 + A22) * (B11 + B22)
 addMatrix(A21, A22, tempA, newSize);
 strassenMultiply(tempA, B11, P2, newSize);  // P2 = (A21 + A22) * B11
 subtractMatrix(B12, B22, tempB, newSize);
 strassenMultiply(A11, tempB, P3, newSize);  // P3 = A11 * (B12 - B22)
 subtractMatrix(B21, B11, tempB, newSize);
 strassenMultiply(A22, tempB, P4, newSize);  // P4 = A22 * (B21 - B11)
 addMatrix(A11, A12, tempA, newSize);
 strassenMultiply(tempA, B22, P5, newSize);  // P5 = (A11 + A12) * B22
 subtractMatrix(A21, A11, tempA, newSize);
 addMatrix(B11, B12, tempB, newSize);
 strassenMultiply(tempA, tempB, P6, newSize);  // P6 = (A21 - A11) * (B11 + B12)
 subtractMatrix(A12, A22, tempA, newSize);
 addMatrix(B21, B22, tempB, newSize);
 strassenMultiply(tempA, tempB, P7, newSize);  // P7 = (A12 - A22) * (B21 + B22)
// Calculate C11, C12, C21, C22
 addMatrix(P1, P4, tempA, newSize);
 subtractMatrix(tempA, P5, tempB, newSize);
 addMatrix(tempB, P7, C11, newSize);  // C11 = P1 + P4 - P5 + P7
 addMatrix(P3, P5, C12, newSize);  // C12 = P3 + P5
 addMatrix(P2, P4, C21, newSize);  // C21 = P2 + P4
 addMatrix(P1, P3, tempA, newSize);
 subtractMatrix(tempA, P2, tempB, newSize);
 addMatrix(tempB, P6, C22, newSize);  // C22 = P1 + P3 - P2 + P6
// Grouping into C
 for (int i = 0; i < newSize; i++) {
    for (int j = 0; j < newSize; j++) {
       C[i][j] = C11[i][j];
       C[i][j + newSize] = C12[i][j];
       C[i + newSize][j] = C21[i][j];
       C[i + newSize][j + newSize] = C22[i][j];
```

```
        } }
    // Free allocated memory
    freeMatrix(A11, newSize); freeMatrix(A12, newSize);
    freeMatrix(A21, newSize); freeMatrix(A22, newSize);
    freeMatrix(B11, newSize); freeMatrix(B12, newSize);
    freeMatrix(B21, newSize); freeMatrix(B22, newSize);
    freeMatrix(P1, newSize); freeMatrix(P2, newSize);
    freeMatrix(P3, newSize); freeMatrix(P4, newSize);
    freeMatrix(P5, newSize); freeMatrix(P6, newSize);
    freeMatrix(P7, newSize);
    freeMatrix(C11, newSize); freeMatrix(C12, newSize);
    freeMatrix(C21, newSize); freeMatrix(C22, newSize);
    freeMatrix(tempA, newSize); freeMatrix(tempB, newSize);
}
// Function to measure execution time
double measureExecutionTime(void (*multiplyFunc)(int**, int**, int**, int), int** A, int** B,
int** C, int n) {
    clock_t start, end;
    double cpu_time_used;
    start = clock();
    multiplyFunc(A, B, C, n);
    end = clock();
    cpu_time_used = ((double) (end - start)) / CLOCKS_PER_SEC;
    return cpu_time_used;
}
int main() {
    srand(time(NULL));
    int sizes[] = {64, 128, 256, 512, 1024, 2048};
    int num_sizes = sizeof(sizes) / sizeof(sizes[0]);
    printf("Matrix Size\tTraditional Time\tStrassen Time\n");
    for (int i = 0; i < num_sizes; i++) {
        int n = sizes[i];
        int** A = allocateMatrix(n);
```

```c
    int** B = allocateMatrix(n);
    int** C = allocateMatrix(n);
  // Initialize matrices A and B with random values
    for (int j = 0; j < n; j++) {
      for (int k = 0; k < n; k++) {
        A[j][k] = rand() % 10;
        B[j][k] = rand() % 10;
      } }
    double traditionalTime = measureExecutionTime(traditionalMultiply, A, B, C, n);
    double strassenTime = measureExecutionTime(strassenMultiply, A, B, C, n);
    printf("%d x %d\t%.6f\t\t%.6f\n", n, n, traditionalTime, strassenTime);
    freeMatrix(A, n);
    freeMatrix(B, n);
    freeMatrix(C, n);
  }
 return 0;
  }
```

-: CREATE AN EMPTY (ASSIGNMENT_3.exe) FILE.

-: ASSIGNMENT_3.py

```python
# -*- coding: utf-8 -*-
"""graph1.py
Automatically generated by Colab.
Original file is located at
  https://colab.research.google.com/drive/1BZtdoC6NETTa08-m6Ykv-4Nbsz90yUL4
"""
import matplotlib.pyplot as plt
# Data for Matrix Size, Traditional Time, and Strassen Time
matrix_size = ['64x64', '128x128', '256x256', '512x512', '1024x1024', '2048x2048']
traditional_time = [0.000000, 0.013000, 0.106000, 0.822000, 7.965000, 93.234000]
strassen_time = [0.000000, 0.013000, 0.086000, 0.610000, 4.240000, 29.705000]
# Create the plot
plt.figure(figsize=(10, 6))
```

Plot the Traditional Time vs Matrix Size

plt.plot(matrix_size, traditional_time, label='Traditional Time', marker='o', color='blue', linestyle='-', linewidth=2)

Plot the Strassen Time vs Matrix Size

plt.plot(matrix_size, strassen_time, label='Strassen Time', marker='o', color='red', linestyle='-', linewidth=2)

Add labels and title

plt.xlabel('Matrix Size')

plt.ylabel('Time (seconds)')

plt.title('Performance Comparison: Traditional vs Strassen Matrix Multiplication')

Add a legend

plt.legend()

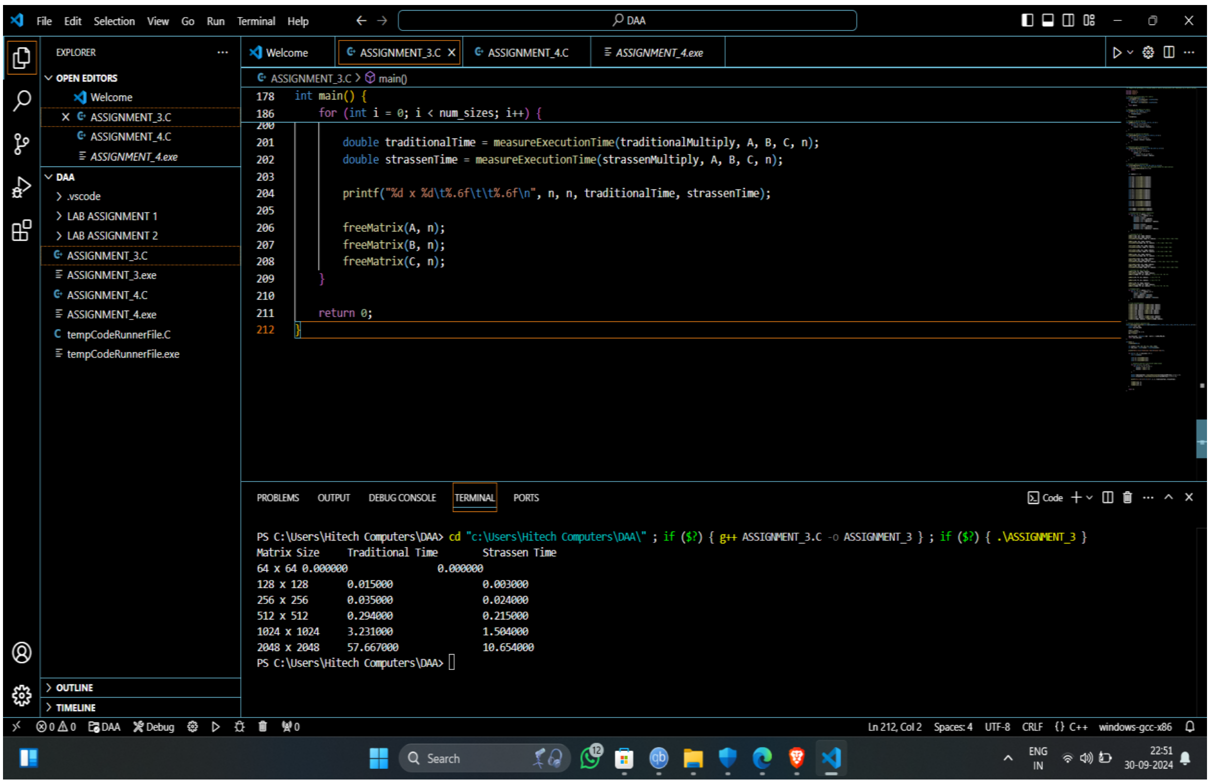
Add grid for better readability

plt.grid(True)

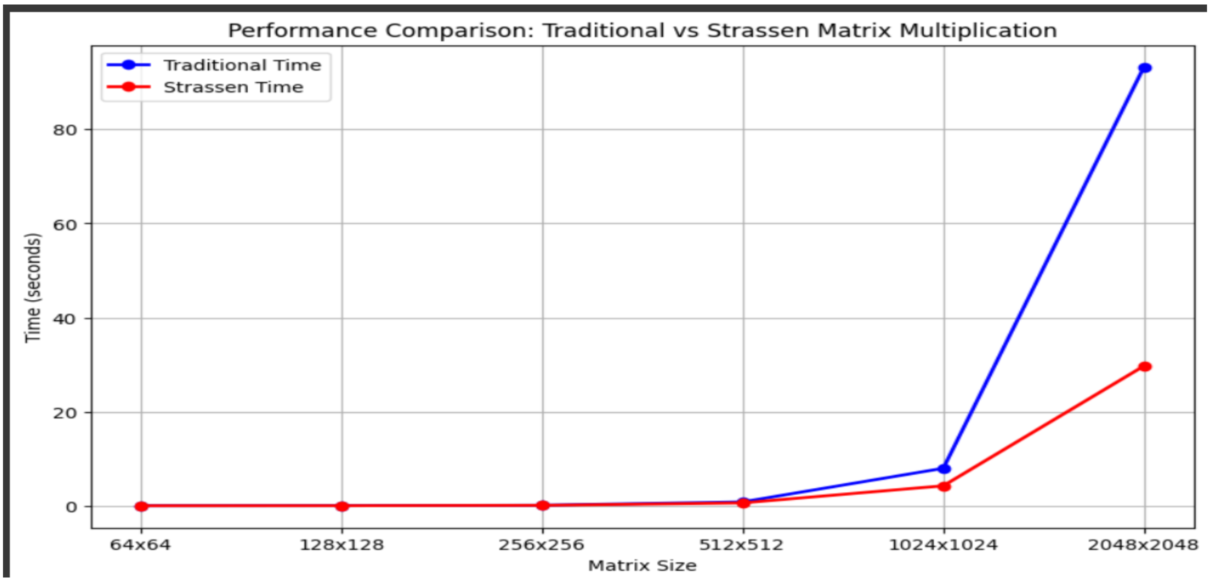
Display the plot

plt.show()

-: ASSIGNMENT_3_OUTPUT.png



-: GRAPH_3_OUTPUT.png



-: CREATE AN EMPTY (TEMP) FILE.

LAB 4: Implement the activity selection problem to get a clear understanding of greedy approach.

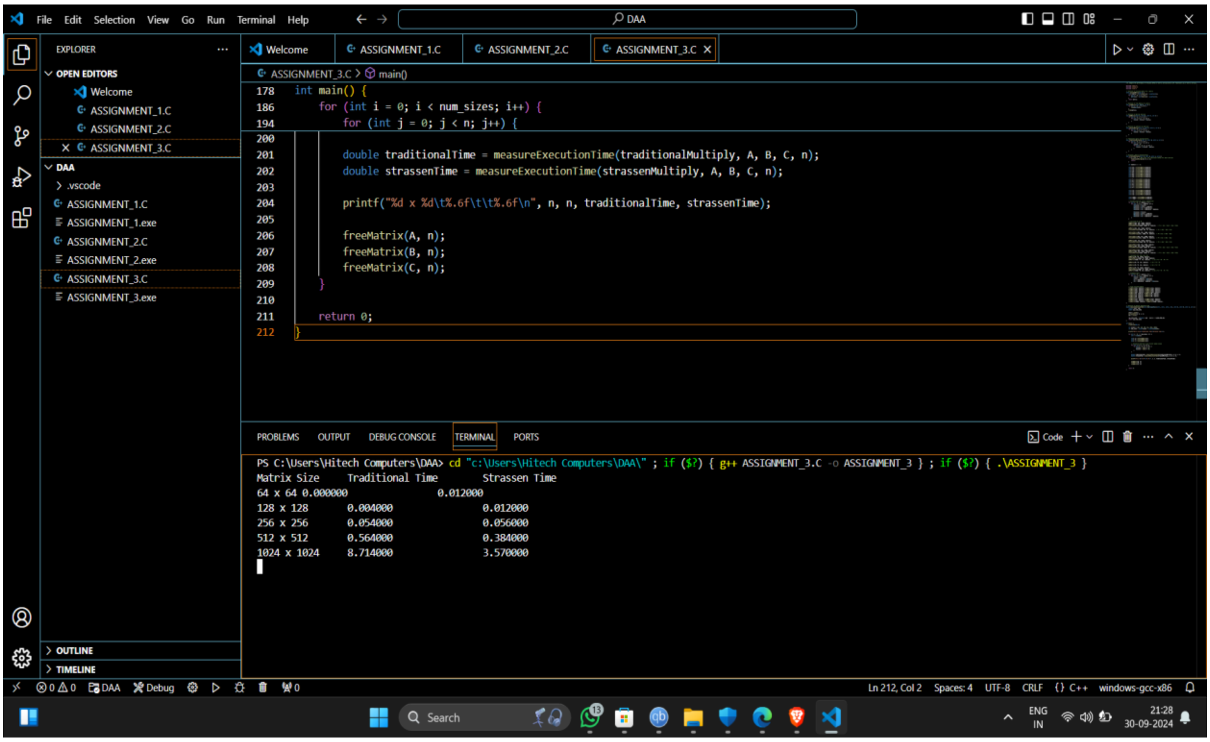
:- ASSIGNMENT_4.C

```
#include <stdio.h>
// Function to print the maximum number of activities that can be done
void activitySelection(int start[], int end[], int n) {
   int i, j;
   printf("Selected activities are:\n");
   // The first activity is always selected
   i = 0;
   printf("Activity %d (Start: %d, End: %d)\n", i+1, start[i], end[i]);
   // Consider rest of the activities
   for (j = 1; j < n; j++) {
      // If this activity has a start time greater than or equal to the
      // end time of the previously selected activity, select it
      if (start[j] >= end[i]) {
         printf("Activity %d (Start: %d, End: %d)\n", j+1, start[j], end[j]);
         i = j;  // Update i to the current activity
      } } }
int main() {
```

```
    // Example set of activities with their start and end times
    int start[] = {1, 3, 0, 5, 8, 5};
    int end[] = {2, 4, 6, 7, 9, 9};
    int n = sizeof(start) / sizeof(start[0]);
    activitySelection(start, end, n);
    return 0;
}
```

:- CREATE AN EMPTY (ASSIGNMENT_4.exe) FILE.

:- ASSIGNMENT_4_OUTPUT.png



:- CREATE AN EMPTY (TEMP) FILE.

LAB 5: Get a detailed insight of dynamic programming approach by the implementation of Matrix Chain Multiplication problem and see the impact of parenthesis positioning on time requirements for matrix multiplication.

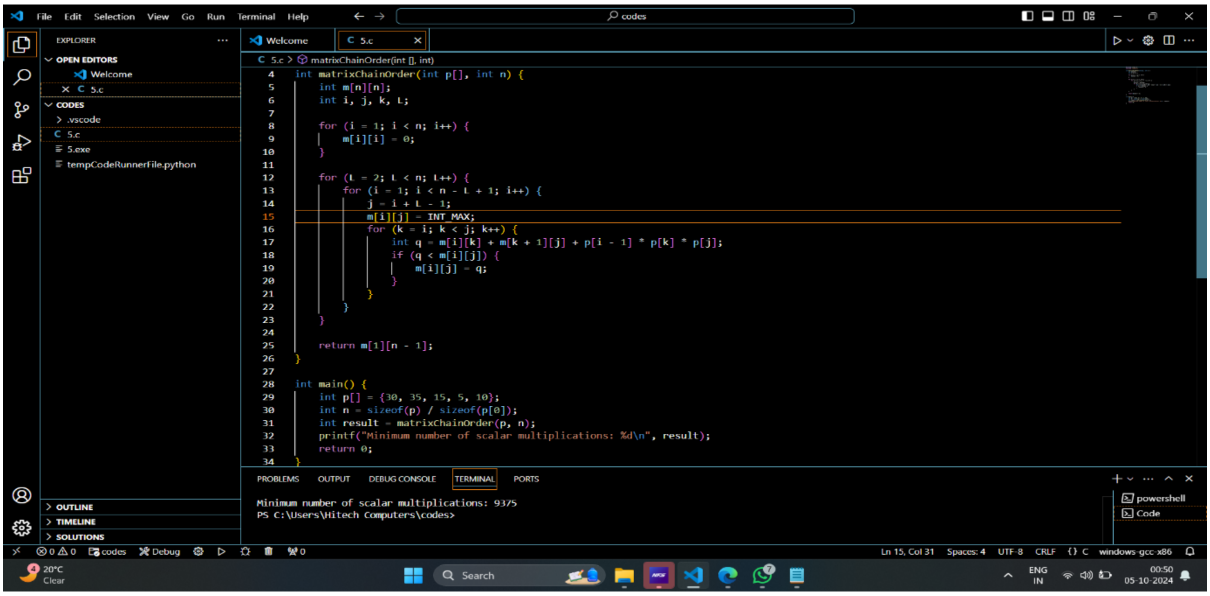
:- ASSIGNMENT_5.c

```
#include <stdio.h>
#include <limits.h>
int matrixChainOrder(int p[], int n) {
    int m[n][n];
```

```
    int i, j, k, L;
    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; k++) {
                int 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 p[] = {30, 35, 15, 5, 10};
    int n = sizeof(p) / sizeof(p[0]);
    int result = matrixChainOrder(p, n);
    printf("Minimum number of scalar multiplications: %d\n", result);
    return 0;
}
```

:- CREATE AN EMPTY (ASSIGNMENT_5.exe) FILE.

:- ASSIGNMENT_5_OUTPUT.png



:- CREATE AN EMPTY (TEMP) FILE.

LAB 6: Compare the performance of Dijkstra and Bellman ford algorithm for the single source shortest path problem.

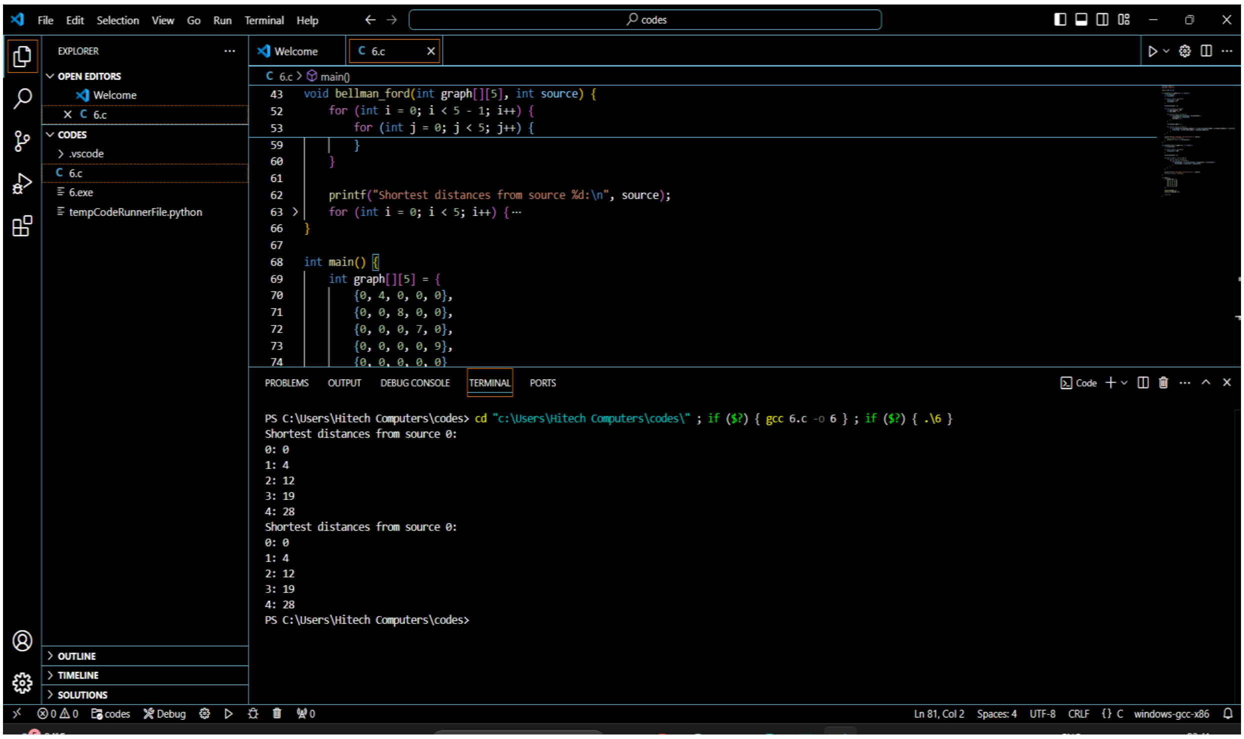
:- ASSIGNMENT_6.c

```
 #include <stdio.h>
#include <limits.h>
#define INF INT_MAX
void dijkstra(int graph[][5], int source) {
  int distance[5];
  int visited[5];
  for (int i = 0; i < 5; i++) {
    distance[i] = INF;
    visited[i] = 0;
  }
  distance[source] = 0;
  for (int i = 0; i < 5; i++) {
    int min_distance = INF;
    int min_index = -1;
    for (int j = 0; j < 5; j++) {
      if (!visited[j] && distance[j] < min_distance) {
        min_distance = distance[j];
        min_index = j;
      } }
    visited[min_index] = 1;
    for (int j = 0; j < 5; j++) {
      if (!visited[j] && graph[min_index][j] != 0 && distance[min_index] +
graph[min_index][j] < distance[j]) {
        distance[j] = distance[min_index] + graph[min_index][j];
      } }
 printf("Shortest distances from source %d:\n", source);
  for (int i = 0; i < 5; i++) {
    printf("%d: %d\n", i, distance[i]);
```

```
  } }
void bellman_ford(int graph[][5], int source) {
  int distance[5];
  for (int i = 0; i < 5; i++) {
    distance[i] = INF;
   }
  distance[source] = 0;
  for (int i = 0; i < 5 - 1; i++) {
    for (int j = 0; j < 5; j++) {
      for (int k = 0; k < 5; k++) {
        if (graph[j][k] != 0 && distance[j] + graph[j][k] < distance[k]) {
          distance[k] = distance[j] + graph[j][k];        } }
  printf("Shortest distances from source %d:\n", source);
  for (int i = 0; i < 5; i++) {
    printf("%d: %d\n", i, distance[i]);
  } }
int main() {
  int graph[][5] = {
    {0, 4, 0, 0, 0},
    {0, 0, 8, 0, 0},
    {0, 0, 0, 7, 0},
    {0, 0, 0, 0, 9},
    {0, 0, 0, 0, 0}
   };
  dijkstra(graph, 0);
  bellman_ford(graph, 0);
  return 0;
}
```

:- CREATE AN EMPTY (ASSIGNMENT_6.exe) FILE.

:- ASSIGNMENT_6_OUTPUT.png



:- CREATE AN EMPTY (TEMP) FILE.

LAB 7: Through 0/1 Knapsack problem, analyse the greedy and dynamic programming approach for the same dataset.

:- ASSIGNMENT_7.c

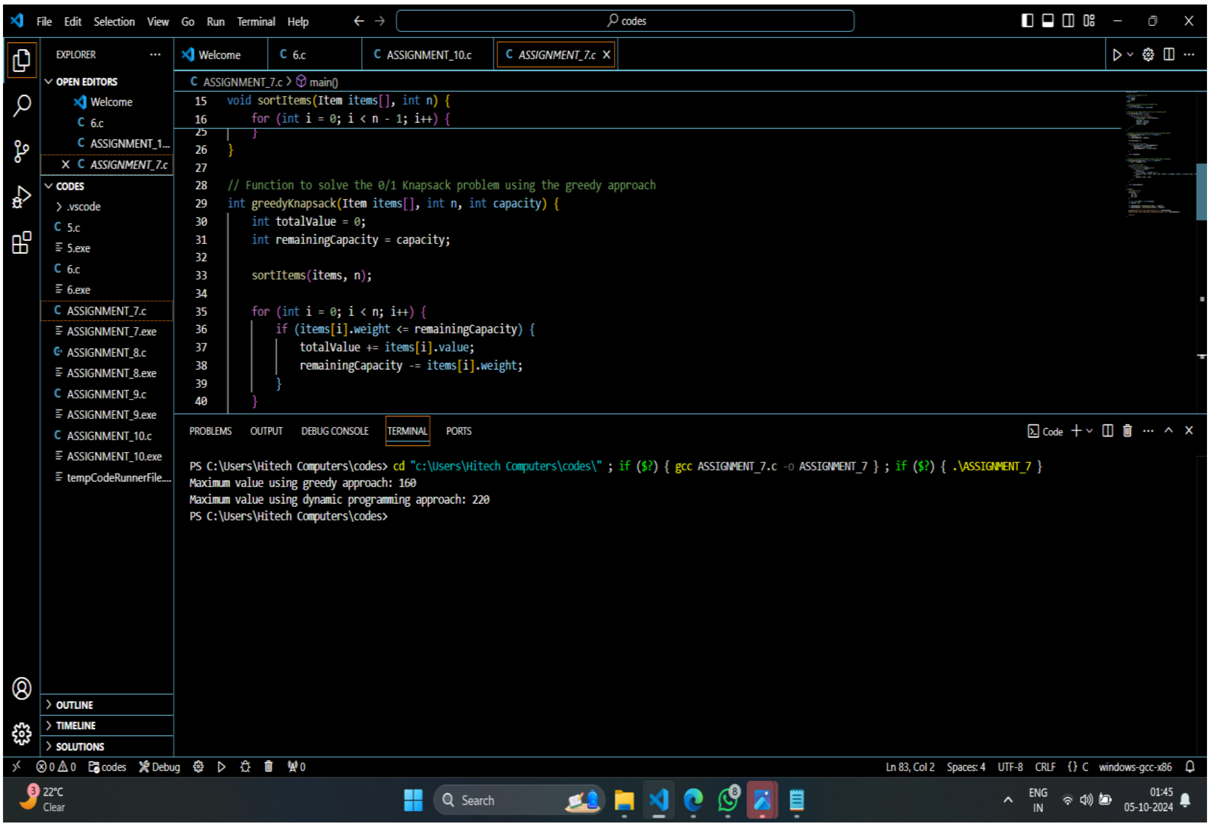
```
#include <stdio.h>
// Structure to represent an item
typedef struct {
    int weight;
    int value;
} Item;
// Function to calculate the value-to-weight ratio
float ratio(Item item) {
    return (float)item.value / item.weight;
}
// Function to sort items based on the ratio in descending order
void sortItems(Item items[], int n) {
    for (int i = 0; i < n - 1; i++) {
        for (int j = i + 1; j < n; j++) {
            if (ratio(items[i]) < ratio(items[j])) {
```

```
            // Swap items
            Item temp = items[i];
            items[i] = items[j];
            items[j] = temp;
         } } } }
// Function to solve the 0/1 Knapsack problem using the greedy approach
int greedyKnapsack(Item items[], int n, int capacity) {
   int totalValue = 0;
   int remainingCapacity = capacity;
   sortItems(items, n);
    for (int i = 0; i < n; i++) {
      if (items[i].weight <= remainingCapacity) {
         totalValue += items[i].value;
         remainingCapacity -= items[i].weight;
      } }
   return totalValue;
 }
// Function to solve the 0/1 Knapsack problem using dynamic programming
int dynamicKnapsack(Item items[], int n, int capacity) {
   int dp[n + 1][capacity + 1];
   // Initialize the table
   for (int i = 0; i <= n; i++) {
      for (int j = 0; j <= capacity; j++) {
         if (i == 0 || j == 0) {
            dp[i][j] = 0;
         } else if (items[i - 1].weight <= j) {
            dp[i][j] = (dp[i - 1][j] > dp[i - 1][j - items[i - 1].weight] + items[i - 1].value) ? dp[i -
1][j] : dp[i - 1][j - items[i - 1].weight] + items[i - 1].value;
         } else {
            dp[i][j] = dp[i - 1][j];
         } } }
   return dp[n][capacity];                    }
int main() {
```

```
    // Define the items
    Item items[] = {
        {10, 60},
        {20, 100},
        {30, 120}
    };
    int n = sizeof(items) / sizeof(items[0]);
    int capacity = 50;
    int maxValueGreedy = greedyKnapsack(items, n, capacity);
    int maxValueDynamic = dynamicKnapsack(items, n, capacity);
    printf("Maximum value using greedy approach: %d\n", maxValueGreedy);
    printf("Maximum value using dynamic programming approach: %d\n",
maxValueDynamic);
    return 0;
}
```

:- CREATE AN EMPTY (ASSIGNMENT_7.exe) FILE.

:- ASSIGNMENT_7_OUTPUT.png



:- CREATE AN EMPTY (TEMP) FILE.

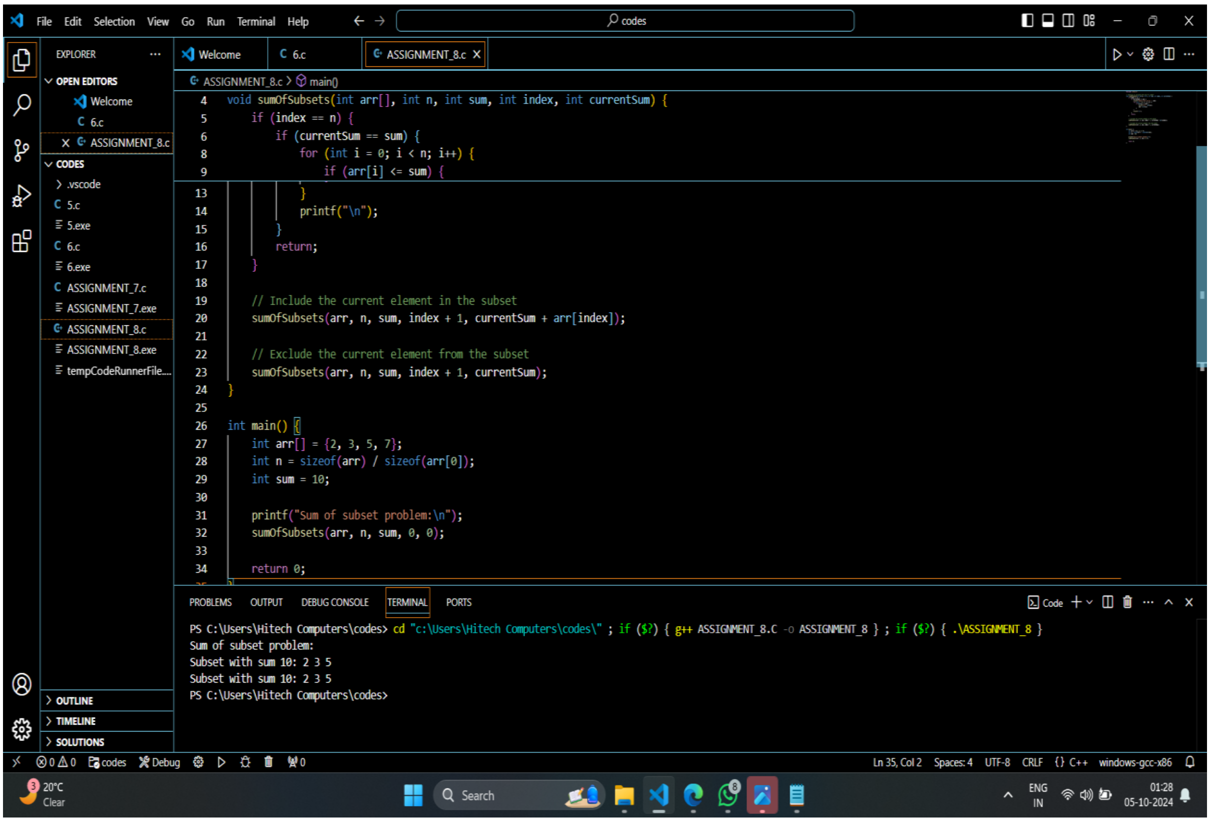
LAB 8: Implement the sum of subset.

:- ASSIGNMENT_8.c

```
#include <stdio.h>
// Function to calculate the sum of a subset
void sumOfSubsets(int arr[], int n, int sum, int index, int currentSum) {
    if (index == n) {
        if (currentSum == sum) {
            printf("Subset with sum %d: ", sum);
            for (int i = 0; i < n; i++) {
                if (arr[i] <= sum) {
                    printf("%d ", arr[i]);
                    sum -= arr[i];
                } }
            printf("\n");
        }
        return;
 }
    // Include the current element in the subset
    sumOfSubsets(arr, n, sum, index + 1, currentSum + arr[index]);
    // Exclude the current element from the subset
    sumOfSubsets(arr, n, sum, index + 1, currentSum);
}
int main() {
    int arr[] = {2, 3, 5, 7};
    int n = sizeof(arr) / sizeof(arr[0]);
    int sum = 10;
    printf("Sum of subset problem:\n");
    sumOfSubsets(arr, n, sum, 0, 0);
    return 0;
}
```

:- CREATE AN EMPTY (ASSIGNMENT_8.exe) FILE.

:- ASSIGNMENT_8_OUTPUT.png



:- CREATE AN EMPTY (TEMP) FILE.

LAB 9: Compare the Backtracking and Branch & Bound Approach by the implementation of 0/1 Knapsack problem. Also compare the performance with dynamic programming approach.

:- ASSIGNMENT_9.c

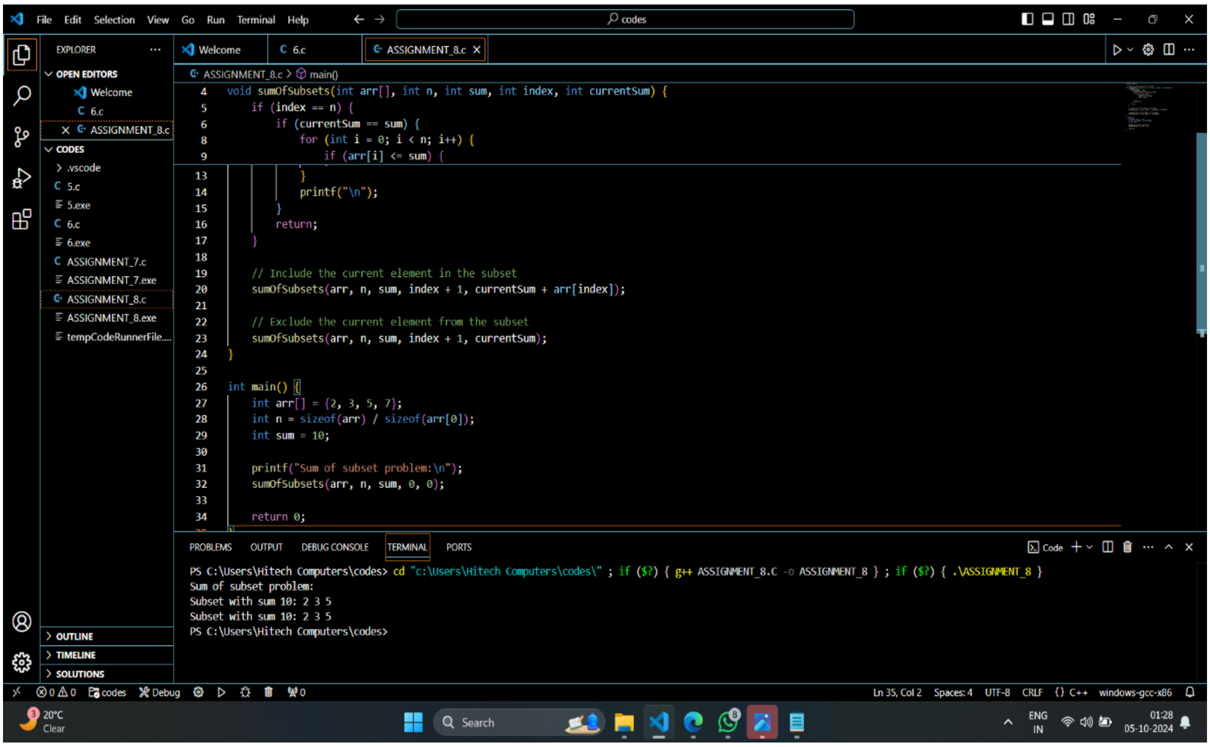
```
#include <stdio.h>

// Structure to represent an item

typedef struct {

    int weight;

    int value;

} Item;

// Function to implement backtracking approach

void backtrackKnapsack(Item items[], int n, int capacity, int i, int totalValue, int
totalWeight) {

    if (i == n) {
```

```
        if (totalWeight <= capacity) {
            printf("Backtracking Approach: Total value = %d\n", totalValue);
        }
        return;
    }
    // Include the current item in the knapsack
    if (totalWeight + items[i].weight <= capacity) {
        backtrackKnapsack(items, n, capacity, i + 1, totalValue + items[i].value, totalWeight + items[i].weight);
    }
    // Exclude the current item from the knapsack
    backtrackKnapsack(items, n, capacity, i + 1, totalValue, totalWeight);
}
// Function to implement branch and bound approach
void branchAndBoundKnapsack(Item items[], int n, int capacity, int i, int totalValue, int totalWeight, int upperBound) {
    if (i == n) {
        if (totalWeight <= capacity) {
            printf("Branch and Bound Approach: Total value = %d\n", totalValue);
        }
        return;
    }
    // Calculate the upper bound
    int newUpperBound = upperBound - items[i].value;
    // Include the current item in the knapsack
    if (totalWeight + items[i].weight <= capacity) {
        branchAndBoundKnapsack(items, n, capacity, i + 1, totalValue + items[i].value, totalWeight + items[i].weight, newUpperBound);
    }
    // Exclude the current item from the knapsack
    branchAndBoundKnapsack(items, n, capacity, i + 1, totalValue, totalWeight, upperBound);
}
// Function to implement dynamic programming approach
int dynamicKnapsack(Item items[], int n, int capacity) {
```

```
    int dp[n + 1][capacity + 1];
    // Initialize the table
    for (int i = 0; i <= n; i++) {
        for (int j = 0; j <= capacity; j++) {
            if (i == 0 || j == 0) {
                dp[i][j] = 0;
            } else if (items[i - 1].weight <= j) {
                dp[i][j] = (dp[i - 1][j] > dp[i - 1][j - items[i - 1].weight] + items[i - 1].value) ? dp[i - 1][j] : dp[i - 1][j - items[i - 1].weight] + items[i - 1].value;
            } else {
                dp[i][j] = dp[i - 1][j];
            } } }
    return dp[n][capacity];                                   }
int main() {
    // Define the items
    Item items[] = {
        {10, 60},
        {20, 100},
        {30, 120}
    };
    int n = sizeof(items) / sizeof(items[0]);
    int capacity = 50;
    printf("Backtracking Approach:\n");
    backtrackKnapsack(items, n, capacity, 0, 0, 0);
    printf("\nBranch and Bound Approach:\n");
    branchAndBoundKnapsack(items, n, capacity, 0, 0, 0, 1000);
    printf("\nDynamic Programming Approach:\n");
    int maxValue = dynamicKnapsack(items, n, capacity);
    printf("Total value = %d\n", maxValue);
    return 0;
}
```

:- CREATE AN EMPTY (ASSIGNMENT_8.exe) FILE.

:- ASSIGNMENT_8_OUTPUT.png



:- CREATE AN EMPTY (TEMP) FILE.

LAB 10: Compare the performance of Rabin-Karp, Knuth-Morris-Pratt and naive string□matching algorithms.

:- ASSIGNMENT_10.c

```
#include <stdio.h>

#include <string.h>

#include <time.h>


#define d 256 // Number of characters in the input alphabet

#define q 101 // A prime number

// Naive String Matching Algorithm

void naiveStringMatch(char *text, char *pattern) {

    int n = strlen(text);

    int m = strlen(pattern);

    for (int i = 0; i <= n - m; i++) {

        int j;

        for (j = 0; j < m; j++) {

            if (text[i + j] != pattern[j]) {
```

```
            break;
          } }
        if (j == m) {
          printf("Naive: Pattern found at index %d\n", i);
        } } }
// Rabin-Karp Algorithm
void rabinKarp(char *text, char *pattern) {
    int n = strlen(text);
    int m = strlen(pattern);
    int p = 0; // hash value for pattern
    int t = 0; // hash value for text
    int h = 1;
    // Calculate the value of h
    for (int i = 0; i < m - 1; i++)
        h = (h * d) % q;
    // Calculate hash value for pattern and first window of text
    for (int i = 0; i < m; i++) {
        p = (d * p + pattern[i]) % q;
        t = (d * t + text[i]) % q;
}
    // Slide the pattern over text
    for (int i = 0; i <= n - m; i++) {
        if (p == t) {
            int j;
            for (j = 0; j < m; j++) {
                if (text[i + j] != pattern[j])
                    break;
 }
            if (j == m) {
                printf("Rabin-Karp: Pattern found at index %d\n", i);
            } }
        // Calculate hash value for next window of text
```

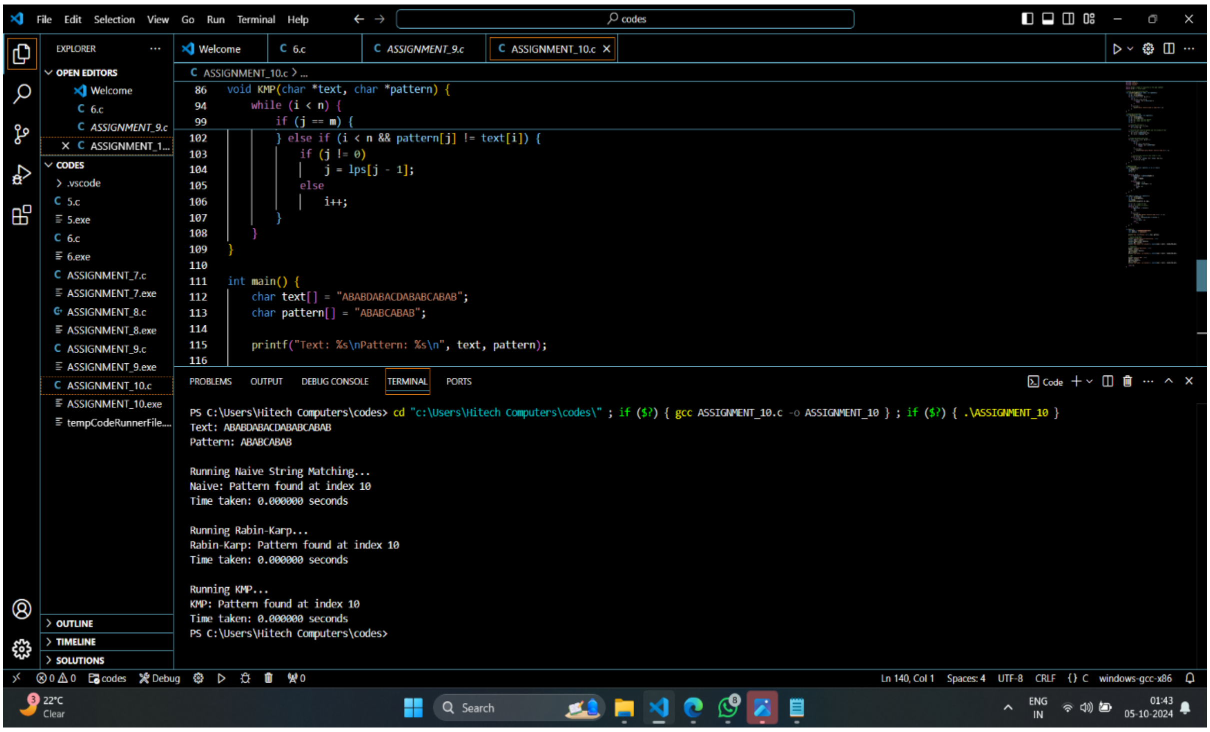
```
        if (i < n - m) {
            t = (d * (t - text[i] * h) + text[i + m]) % q;
            if (t < 0) t += q;
        } } }
// KMP Algorithm
void computeLPSArray(char *pattern, int m, int *lps) {
    int length = 0;
    lps[0] = 0;
    int i = 1;
    while (i < m) {
        if (pattern[i] == pattern[length]) {
            length++;
            lps[i] = length;
            i++;
        } else {
            if (length != 0) {
                length = lps[length - 1];
            } else {
                lps[i] = 0;
                i++;
            } } }
void KMP(char *text, char *pattern) {
    int n = strlen(text);
    int m = strlen(pattern);
    int lps[m];
    computeLPSArray(pattern, m, lps);
    int i = 0; // index for text
    int j = 0; // index for pattern
    while (i < n) {
        if (pattern[j] == text[i]) {
            i++;
            j++;            }
```

```
        if (j == m) {
            printf("KMP: Pattern found at index %d\n", i - j);
            j = lps[j - 1];
        } else if (i < n && pattern[j] != text[i]) {
            if (j != 0)
                j = lps[j - 1];
            else
                i++;
        } } }
int main() {
    char text[] = "ABABDABACDABABCABAB";
    char pattern[] = "ABABCABAB";
    printf("Text: %s\nPattern: %s\n", text, pattern);
    // Naive String Match
    printf("\nRunning Naive String Matching...\n");
    clock_t start = clock();
    naiveStringMatch(text, pattern);
    clock_t end = clock();
    printf("Time taken: %.6f seconds\n", (double)(end - start) / CLOCKS_PER_SEC);
    // Rabin-Karp
    printf("\nRunning Rabin-Karp...\n");
    start = clock();
    rabinKarp(text, pattern);
    end = clock();
    printf("Time taken: %.6f seconds\n", (double)(end - start) / CLOCKS_PER_SEC);
    // KMP
    printf("\nRunning KMP...\n");
    start = clock();
    KMP(text, pattern);
    end = clock();
    printf("Time taken: %.6f seconds\n", (double)(end - start) / CLOCKS_PER_SEC);
    return 0;
```

}

:- CREATE AN EMPTY (ASSIGNMENT_10.exe) FILE.

:- ASSIGNMENT_10_OUTPUT.png



:- CREATE AN EMPTY (TEMP) FILE.

Thank You!

GitHub id :- https://github.com/subratjain101