SSN College of Engineering Department of Computer Science and Engineering UCS2312 – Data Structures Lab II Year CSE - B Section (III Semester) Academic Year 2022-23

Staff Incharge: Dr.H. Shahul Hamead

Exercise-7: Exercises on BFS, DFS, Shortest Path

Aim:

To implement C program in Data structures using the concept of BFS, DFS, Shortest Path (Single source and all-pair)

BFS

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BFS (& graph, o, visited) 12 Jan (2)	D F3 C

```
#include <stdio.h>
#include <stdlib.h>
#define MAX VERTICES 100
typedef struct Graph {
 int numVertices;
 int adjacencyMatrix[MAX VERTICES][MAX VERTICES];
} Graph;
typedef struct Queue {
  int items[MAX VERTICES];
 int front, rear;
} Queue;
void enqueue(Queue* queue, int item) {
  queue->items[queue->rear] = item;
 queue->rear = (queue->rear + 1) % MAX VERTICES;
}
int dequeue(Queue* queue) {
  int item = queue->items[queue->front];
 queue->front = (queue->front + 1) % MAX_VERTICES;
  return item;
int isEmpty(Queue* queue) {
  return queue->front == queue->rear;
void BFS(Graph* graph, int startVertex, int visited[]) {
  Queue queue;
 queue.front = queue.rear = 0;
  enqueue(&queue, startVertex);
  visited[startVertex] = 1;
 while (!isEmpty(&queue)) {
    int currentVertex = dequeue(&queue);
    printf("%d ", currentVertex);
```

```
for (int i = 0; i < graph->numVertices; i++) {
      if (graph->adjacencyMatrix[currentVertex][i] && !visited[i]) {
        enqueue(&queue, i);
        visited[i] = 1;
      }
  }
int main(void) {
  Graph graph;
  graph.numVertices = 4;
  // Assume that the graph is an adjacency matrix representation
  // and the graph is as follows:
  // 1 0 0 1
  graph.adjacencyMatrix[0][1] = 1;
  graph.adjacencyMatrix[0][2] = 1;
  graph.adjacencyMatrix[1][0] = 1;
  graph.adjacencyMatrix[1][3] = 1;
  graph.adjacencyMatrix[2][0] = 1;
  graph.adjacencyMatrix[2][3] = 1;
  graph.adjacencyMatrix[3][1] = 1;
  graph.adjacencyMatrix[3][2] = 1;
  // Initialize the visited array
  int visited[MAX VERTICES];
  for (int i = 0; i < graph.numVertices; i++) {</pre>
    visited[i] = 0;
  }
  printf("BFS: ");
  BFS(&graph, 0, visited);
  return 0;
```

Output:

Windows PowerShell
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Install the latest PowerShell for new features and improvements! https://aka.ms/PSWindows

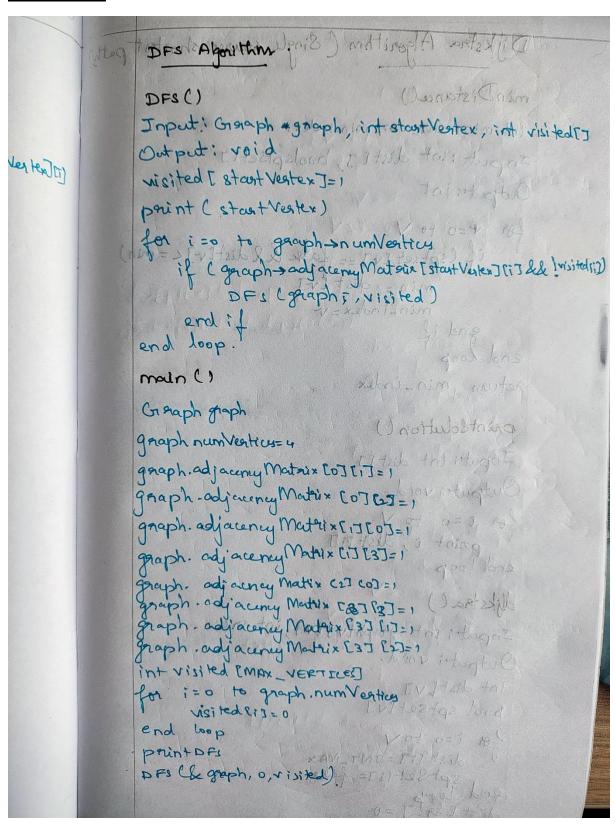
PS C:\Rohith\Backup\Desktop\SEM 3\Data Structures in C\Assignment-7> gcc BFS.c -o run

PS C:\Rohith\Backup\Desktop\SEM 3\Data Structures in C\Assignment-7> ./run

BFS: 0 1 2 3

PS C:\Rohith\Backup\Desktop\SEM 3\Data Structures in C\Assignment-7>

DFS



```
#include <stdio.h>
#include <stdlib.h>
#define MAX VERTICES 100
typedef struct Graph {
  int numVertices;
 int adjacencyMatrix[MAX VERTICES][MAX VERTICES];
} Graph;
void DFS(Graph* graph, int startVertex, int visited[]) {
  visited[startVertex] = 1;
  printf("%d ", startVertex);
  for (int i = 0; i < graph->numVertices; i++) {
    if (graph->adjacencyMatrix[startVertex][i] && !visited[i]) {
      DFS(graph, i, visited);
    }
  }
int main(void) {
 Graph graph;
 graph.numVertices = 4;
  // Assume that the graph is an adjacency matrix representation
  // and the graph is as follows:
  graph.adjacencyMatrix[0][1] = 1;
  graph.adjacencyMatrix[0][2] = 1;
  graph.adjacencyMatrix[1][0] = 1;
  graph.adjacencyMatrix[1][3] = 1;
  graph.adjacencyMatrix[2][0] = 1;
  graph.adjacencyMatrix[2][3] = 1;
  graph.adjacencyMatrix[3][1] = 1;
```

```
graph.adjacencyMatrix[3][2] = 1;

// Initialize the visited array
int visited[MAX_VERTICES];
for (int i = 0; i < graph.numVertices; i++) {
    visited[i] = 0;
}

printf("DFS: ");
DFS(&graph, 0, visited);

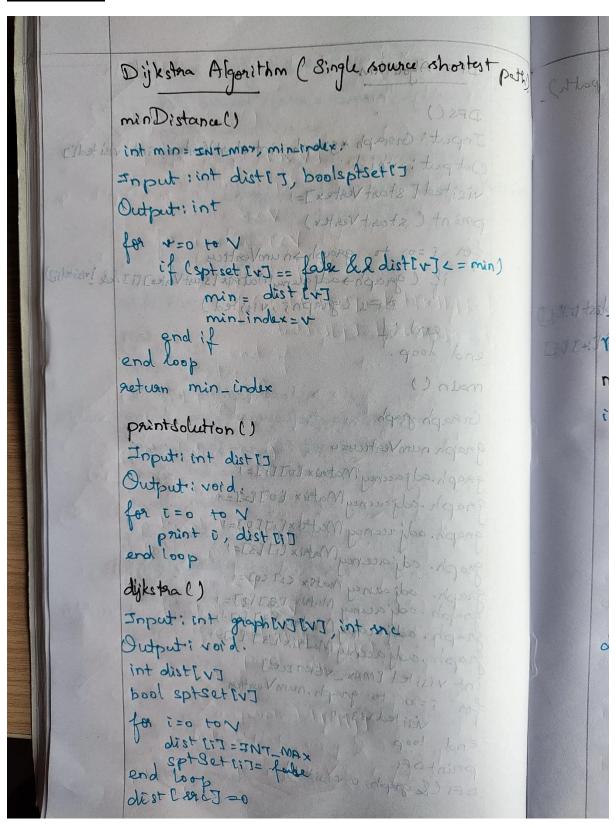
return 0;
}</pre>
```

Output:

```
PS C:\Rohith\Backup\Desktop\SEM 3\Data Structures in C\Assignment-7> gcc DFS.c -o run PS C:\Rohith\Backup\Desktop\SEM 3\Data Structures in C\Assignment-7> ./run DFS: 0 1 3 2
PS C:\Rohith\Backup\Desktop\SEM 3\Data Structures in C\Assignment-7>
```

Shortest Path

<u>Dijkstra algorithm (Single source shortest path)</u>



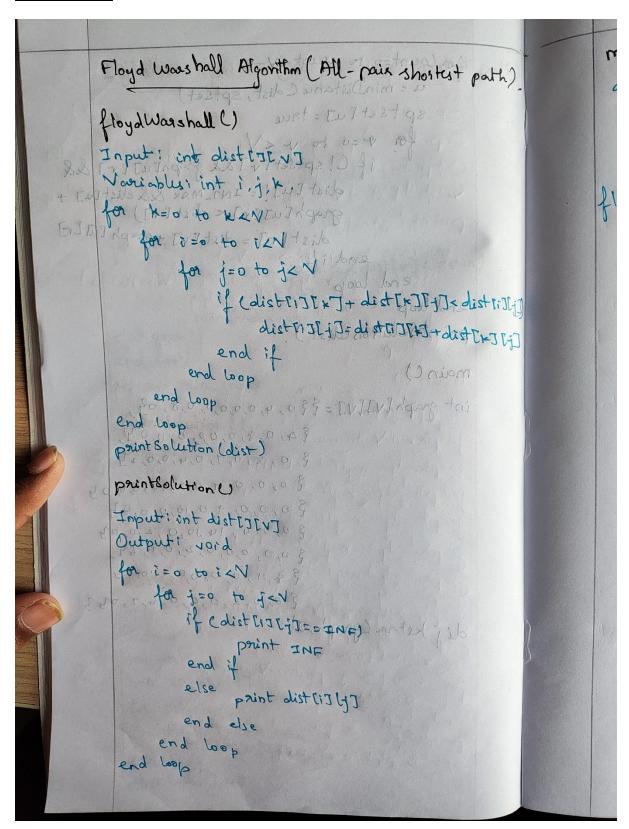
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	end il
	end loop
	end loop 12/1/21/0)
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	main ()
	int graph[V][V] = 220, 4,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
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	20,0,0,9,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
	20,0,4,14,10,0,2,0,03
	28,11,0,0,0,0,1,0,43
	80,0,2,0,0,6,7,03,3
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```
#include <limits.h>
#include <stdbool.h>
#include <stdio.h>
// Number of vertices in the graph
#define V 9
// A utility function to find the vertex with minimum
// distance value, from the set of vertices not yet included
// in shortest path tree
int minDistance(int dist[], bool sptSet[])
    // Initialize min value
    int min = INT MAX, min index;
    for (int v = 0; v < V; v++)
        if (sptSet[v] == false && dist[v] <= min)</pre>
            min = dist[v], min index = v;
    return min index;
// A utility function to print the constructed distance
// array
void printSolution(int dist[])
{
    printf("Vertex \t\t Distance from Source\n");
   for (int i = 0; i < V; i++)
        printf("%d \t\t\t \t \%d\n", i, dist[i]);
// Function that implements Dijkstra's single source
// shortest path algorithm for a graph represented using
// adjacency matrix representation
void dijkstra(int graph[V][V], int src)
    int dist[V]; // The output array. dist[i] will hold the
                 // shortest
    // distance from src to i
```

```
bool sptSet[V]; // sptSet[i] will be true if vertex i is
                   // included in shortest
   // path tree or shortest distance from src to i is
   // finalized
   // Initialize all distances as INFINITE and stpSet[] as
   // false
   for (int i = 0; i < V; i++)
       dist[i] = INT MAX, sptSet[i] = false;
   // Distance of source vertex from itself is always 0
   dist[src] = 0;
   // Find shortest path for all vertices
   for (int count = 0; count < V - 1; count++) {</pre>
       // Pick the minimum distance vertex from the set of
       // vertices not yet processed. u is always equal to
       // src in the first iteration.
       int u = minDistance(dist, sptSet);
       // Mark the picked vertex as processed
       sptSet[u] = true;
       // Update dist value of the adjacent vertices of the
       // picked vertex.
       for (int v = 0; v < V; v++)
           // Update dist[v] only if is not in sptSet,
           // there is an edge from u to v, and total
           // weight of path from src to v through u is
           // smaller than current value of dist[v]
           if (!sptSet[v] && graph[u][v]
               && dist[u] != INT MAX
               && dist[u] + graph[u][v] < dist[v])
               dist[v] = dist[u] + graph[u][v];
   }
   // print the constructed distance array
   printSolution(dist);
// driver's code
```

Output:

Floyd Warshell Algorithm (All-pair shortest path)



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	8 INF, INF, INF, 039;
	floyd Warshall (graph)
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```
#include <stdio.h>
// Number of vertices in the graph
#define V 4
/* Define Infinite as a large enough
 value. This value will be used
 for vertices not connected to each other */
#define INF 99999
// A function to print the solution matrix
void printSolution(int dist[][V]);
// Solves the all-pairs shortest path
// problem using Floyd Warshall algorithm
void floydWarshall(int dist[][V])
  int i, j, k;
    /* Add all vertices one by one to
      the set of intermediate vertices.
      ---> Before start of an iteration, we
      have shortest distances between all
      pairs of vertices such that the shortest
      distances consider only the
      vertices in set {0, 1, 2, .. k-1} as
      intermediate vertices.
      ----> After the end of an iteration,
      vertex no. k is added to the set of
      intermediate vertices and the set
      becomes {0, 1, 2, .. k} */
    for (k = 0; k < V; k++) {
        // Pick all vertices as source one by one
        for (i = 0; i < V; i++) {
            // Pick all vertices as destination for the
            // above picked source
            for (j = 0; j < V; j++) {
                // If vertex k is on the shortest path from
                // i to j, then update the value of
                // dist[i][i]
```

```
if (dist[i][k] + dist[k][j] < dist[i][j])</pre>
                    dist[i][j] = dist[i][k] + dist[k][j];
            }
       }
    // Print the shortest distance matrix
    printSolution(dist);
/* A utility function to print solution */
void printSolution(int dist[][V])
    printf(
        "The following matrix shows the shortest distances"
        " between every pair of vertices \n");
    for (int i = 0; i < V; i++) {
        for (int j = 0; j < V; j++) {
            if (dist[i][j] == INF)
                printf("%7s", "INF");
            else
                printf("%7d", dist[i][j]);
        printf("\n");
    }
// driver's code
int main()
    /* Let us create the following weighted graph
       (0)---->(3)
      5 l
    int graph[V][V] = { { 0, 5, INF, 10 },
                        { INF, 0, 3, INF },
                        { INF, INF, 0, 1 },
```

```
{ INF, INF, INF, 0 } };

// Function call
floydWarshall(graph);
return 0;
}
```

Output:

```
PS C:\Rohith\Backup\Desktop\SEM 3\Data Structures in C\Assignment-7> gcc Floyd_Warshall.c -o run PS C:\Rohith\Backup\Desktop\SEM 3\Data Structures in C\Assignment-7> ./run The following matrix shows the shortest distances between every pair of vertices

0 5 8 9

INF 0 3 4

INF INF 0 1

INF INF SINF 0 1

INF INF SINF O 1

INF INF SINF O 3\Data Structures in C\Assignment-7>
```

Result:

Hence C program using BFS, DFS and Shortest Path in data structure has been implemented to perform various operations.