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AI Practical

EXPEIMENT 2

AIM: Identify and analyze Uninformed Search Algorithm to solve the problem.

1. BFS
2. DFS
3. BFID

THEORY:

Uninformed search is a class of general-purpose search algorithms which operates in brute force-way. Uninformed search algorithms do not have additional information about state or search space other than how to traverse the tree, so it is also called blind search.

BFS:

BFS algorithm starts searching from the root node of the tree and expands all successor node at the current level before moving to nodes of next level.

The breadth-first search algorithm is an example of a general-graph search algorithm.

Breadth-first search implemented using FIFO queue data structure.

Time Complexity T(b) : $1+b^2+b^3+.......+ b^s = O(b^s)$
Where, s= depth of shallowest solution; b is a node at every state.

Space Complexity: $O(b^d)$.

Completeness: BFS is complete, which means if the shallowest goal node is at some finite depth, then BFS will find a solution.

Optimality: BFS is optimal if path cost is a non-decreasing function of the depth of the node.

Advantages:

- BFS is comlete.
- If there are more than one solutions for a given problem, then BFS will provide the minimal solution requiring the least number of steps.

Disadvantages:

- It requires lots of memory since each level of the tree must be saved into memory to expand the next level.
- BFS needs lots of time if the solution is far away from the root node.

DFS:

Depth-first search is a recursive algorithm for traversing a tree or graph data structure.

It is called the depth-first search because it starts from the root node and follows each path to its greatest depth node before moving to the next path.

DFS uses a stack data structure for its implementation.

Completeness: DFS search algorithm is complete within finite state space as it will expand every node within a limited search tree.

Time Complexity T(n) = $1+ n^2+ n^3 +.........+ n^d = O(n^d)$
where, m= maximum depth of any node and this can be much larger than d (Shallowest solution depth)

Space Complexity: O(nd) => DFS algorithm needs to store only single path from the root node, hence space complexity of DFS is equivalent to the size of the fringe set (=n).

Optimal: DFS search algorithm is non-optimal, as it may generate a large number of steps or high cost to reach to the goal node.

Advantage:

- DFS requires very less memory as it only needs to store a stack of the nodes on the path from root node to the current node.

Disadvantage:

- There is the possibility that many states keep re-occurring, and there is no guarantee of finding the solution.
- DFS algorithm goes for deep down searching and sometime it may go to the infinite loop

DFID

The iterative deepening algorithm is a combination of DFS and BFS algorithms. DFID search algorithm finds out the best depth limit and does it by gradually increasing the limit until a goal is found.

It performs depth-first search up to a certain "depth limit", and it keeps increasing the depth limit after each iteration until the goal node is found.

This search algorithm combines the benefits of Breadth-first search's fast search and depth-first search's memory efficiency.

The iterative search algorithm is useful uninformed search when search space is large, and depth of goal node is unknown.

Completeness: Generates a complete solution if the branching factor is finite.

Space Complexity: O(d).
Time Complexity: O(b^d)
Where, b is the branching factor and d is the current depth.

Optimal: DFID algorithm is optimal if path cost is a non- decreasing function of the depth of the node.

Advantages:

- It combines the benefits of BFS and DFS search algorithm in terms of fast search and memory efficiency.

Disadvantages:

- The main drawback of DFID is that it repeats all the work of the previous phase.

CODE:

1) BFS & DFS

```
#include <conio.h>
#include<stdio.h>
#include<ctype.h>
#include <stdbool.h>
#define MAX 20

int a[MAX][MAX], visited[MAX], dfs_list[MAX], k = 0, queue[MAX], front = 0,
rear = -1, goal[MAX], goal_pending;

bool isGoal(int s, int len) {

  for (int i = 0; i < len; i++) {
    if (s == goal[i]) {
      return true;
    }
  }

  return false;

}

void dfs(int s, int n, int goal_num) {

  visited[s] = 1; // checked its entry
  //dfs_list[k++] =s ;

  if (isGoal(s, goal_num)) {
    printf(" [%d] \t", s);
    goal_pending--;
  } else {
    printf(" %d \t", s);
  }

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

    if (a[s][i] == 1 && visited[i] == 0) {
      //passing the current node as parent to traverse in depth.
      dfs(i, n, goal_num);

    }
  }
```

```
}

void bfs(int s, int n, int goal_num) {

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

    if (a[s][i] == 1 && visited[i] == 0) {
      //adding all the unvisited childs
      queue[++rear] = i;
      visited[i] = 1; //make it visited

      //  if(i == goal){
      if (isGoal(i, goal_num)) {
        printf(" [%d] ", i);
        goal_pending--;
      } else {
        printf(" %d ", i);

      }
    }

  }

  if (front <= rear) {
    bfs(queue[++front], n, goal_num);
  }

}


void main() {

  int n, s, key = -1;

  printf("\n Enter the number of Vertices  : ");
  scanf("%d", & n);

  printf("\n Enter the Matrix  of Vertices  : \n");
  for (int i = 0; i < n; i++) {
    for (int j = 0; j < n; j++) {
      scanf("%d", & a[i][j]);

    }

  }
```

```
printf("\n The Adjacency Matrix  : \n\n");

for (int i = 0; i < n; i++) {
  for (int j = 0; j < n; j++) {
    printf("%d \t", a[i][j]);
  }

  printf("\n");

}

do {

  // Clearing
  for (int j = 0; j < MAX; j++) {
    visited[j] = 0;
    queue[j] = 0;
    goal[j] = 0;

  }

  front = 0;
  rear = -1;

  printf("\n \n ***** MAIN MENU ***** \n");
  printf("\n  1)BFS ");
  printf("\n  2)DFS");
  printf("\n -1)Exit ");
  printf("\n \n Enter your Choice : ");
  scanf("%d", & key);

  switch (key) {

  case 1: {

    printf("\n ***** BFS *****");
    printf("\n\n Enter Goal Vertex(s) :");
    printf("\n To exit -1 ");

    int k = 0;
    printf("\n\n Enter Goal %d :", k + 1);
    scanf("%d", & goal[k]);
    while (goal[k] != -1) {
      printf(" Enter Goal %d :", k + 2);
    scanf("%d", & goal[++k]);
  }

  int num_goals = k;
  goal_pending = k;

  //Select your Start vertex.
  printf("\n Select your Start Vertex : ");
  scanf("%d", & s);
  queue[++rear] = s;
  visited[queue[front]] = 1; //make it visited

  printf("\n *****BFS TRAVERSAL*****\n\n");

  if (isGoal(s, num_goals)) {
    printf(" [%d] ", s);
  } else {
    printf(" %d ", s);
  }

  bfs(s, n, num_goals);
  if (goal_pending > 0) {
    printf("\n No. of Goal Nodes still pending : %d", goal_pending);
  } else {
    printf("\n All Goal Nodes reached!!");
  }
  printf("\n\n*********");

  printf("\n");
  break;

}


case 2: {

  printf("\n ***** DFS *****");

  printf("\n\n Enter Goal Vertex(s) :");
  printf("\n To exit -1 ");

  int k = 0;
  printf("\n\n Enter Goal %d :", k + 1);
  scanf("%d", & goal[k]);
  while (goal[k] != -1) {
    printf(" Enter Goal %d :", k + 2);
```

```
        scanf("%d", & goal[++k]);
      }

      int num_goals = k;
      goal_pending = k;

      //Select your Start vertex.
      printf("\n \n Select your Start Vertex : ");
      scanf("%d", & s);

      printf("\n *****DFS TRAVERSAL*****\n\n");
      dfs(s, n, num_goals);

      if (goal_pending > 0) {
        printf("\n No. of Goal Nodes still pending : %d", goal_pending);
      } else {
        printf("\n All Goal Nodes reached!!");
      }
      printf("\n\n*********\n");

      break;

    }

    case -1: {
      printf("\n \n***** END ***** \n");
      break;
    }

    default: {
      printf("\n INVALID KEY!! ");
      break;
    }

    }

  } while (key != -1);

}
```

2) DFID

```
#include <conio.h>
#include<stdio.h>
#include<ctype.h>
#include <stdbool.h>

#define MAX 20

int a[MAX][MAX], visited[MAX], dfs_list[MAX], k = 0, queue[MAX], front = 0,
rear = -1  ,goal[MAX], goal_pending ;

int MAX_DEPTH ;

bool isGoal(int s , int len){

    for(int i = 0 ; i<len ; i++){
        if(s == goal[i]){
            return true;
        }
    }

    return false ;

}


void dfs(int s , int n,  int goal_num , int depth ,int limit) {

        visited[s] = 1; // checked its entry
        int d= depth ;

       // if(s == isGoal(s ,goal_num)){
        //     printf(" [%c] \t",(char)(s+65));
        //     goal_pending-- ;
        // }else{
        //     printf(" %c \t", (char)(s+65));
```

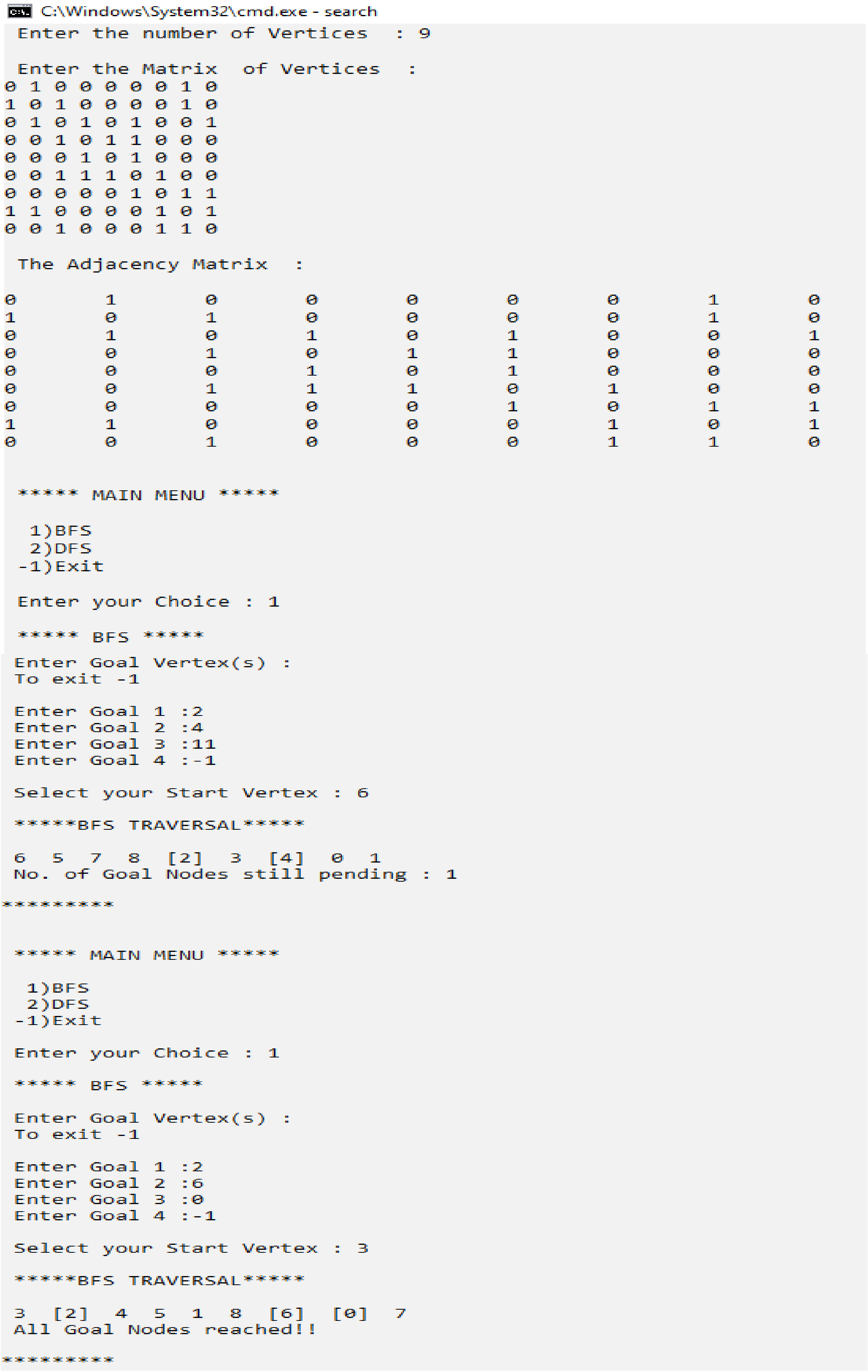
```
         if(isGoal(s ,goal_num)){
            printf(" [%d] ", s);
            goal_pending-- ;
        }else{
            printf(" %d ", s);
        }



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

            if(depth<=limit){
                if (a[s][i] == 1 && visited[i] == 0) {
                //passing the current node as parent to traverse in depth.
                dfs(i, n, goal_num , ++d , limit);

                }
            }

        }



}

bool isGoalPending(){

    if(goal_pending >0){
        return true ;
    }else{
        return false;
    }
}

void DFID(int s, int n, int num_goal){

    printf("\n Level %d :  %d" , 0 , s) ;
    printf("\n %d goal(s) found ", (num_goal- goal_pending)) ;
    printf("\n %d goal(s) pending ", goal_pending) ;

    for(int i=0; i<=MAX_DEPTH ; i++){
```

```
  // Clearing
    for (int j = 0; j < MAX ; j++) {
    visited[j] = 0;
    queue[j] = 0;

    }
  // Restoring total goal before next loop
    goal_pending = num_goal ;
    int depth=0 ;

    if(isGoalPending()){
      // Next Level
      printf("\n\n Level %d : " , i+1) ;
      dfs(s, n , num_goal , depth, i) ;
      printf("\n %d goal(s) found ", (num_goal- goal_pending)) ;
      printf("\n %d goal(s) pending ", goal_pending) ;

    }else{

      printf("\n All goals reached!! ") ;
      break ;

  }
}


void main() {
 int n, s,g, key = -1;

 printf("\n Enter the number of Vertices  : ");
 scanf("%d", &n);

 printf("\n Enter the Matrix  of Vertices  : \n");
 for (int i = 0; i < n; i++) {
  for (int j = 0; j < n; j++) {
   scanf("%d", & a[i][j]);

  }

 }
```

```
    // Clearing
    for (int j = 0; j < MAX ; j++) {
      visited[j] = 0;
      queue[j] = 0;
      goal[j] = 0 ;

    }

    printf("\n Enter the MAX DEPTH : ") ;
    scanf("%d", &MAX_DEPTH) ;
    printf("\n Enter the Start Node : ") ;
    scanf("%d", &s) ;



    printf("\n\n Enter Goal Vertex(s) :");
    printf("\n To exit -1 ");

        int k =0 ;
        printf("\n\n Enter Goal %d :", k+1);
        scanf("%d", &goal[k]);
        while(goal[k] != -1){
        printf(" Enter Goal %d :", k+2);
          scanf("%d", &goal[++k]);
        }

        int num_goal = k ;
        goal_pending = k ;

    printf("\n ***** DFID***** \n");
    DFID(s, n, num_goal) ;


}
```

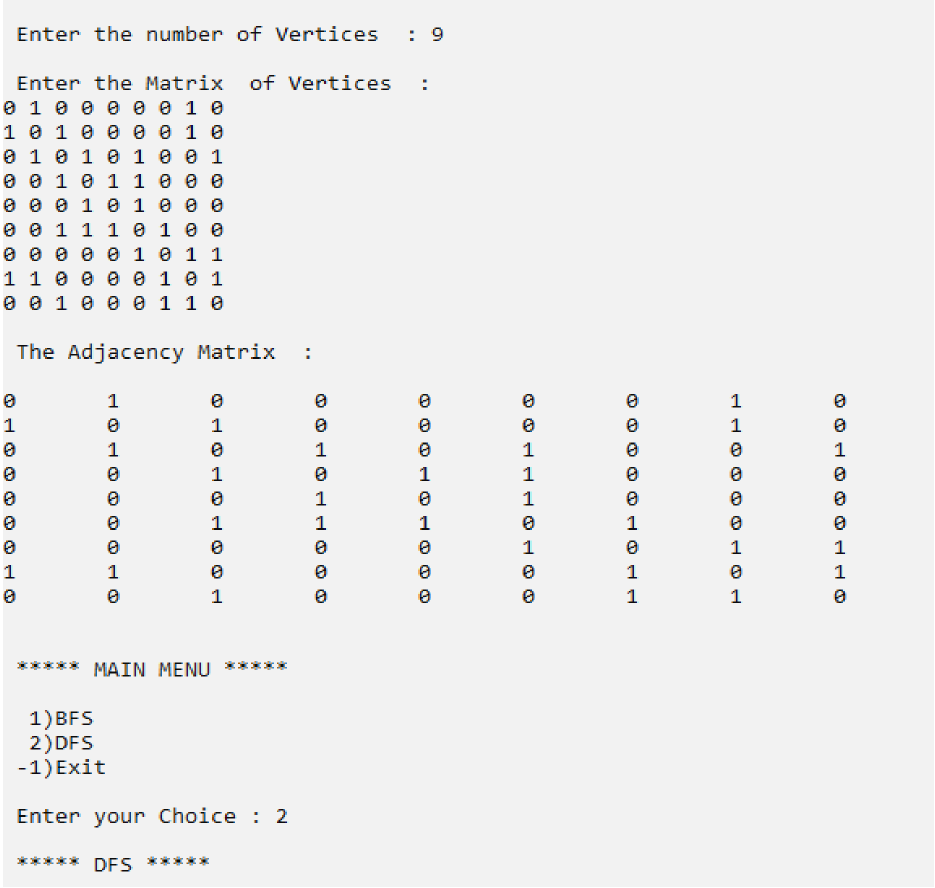
OUTPUT

1) BFS

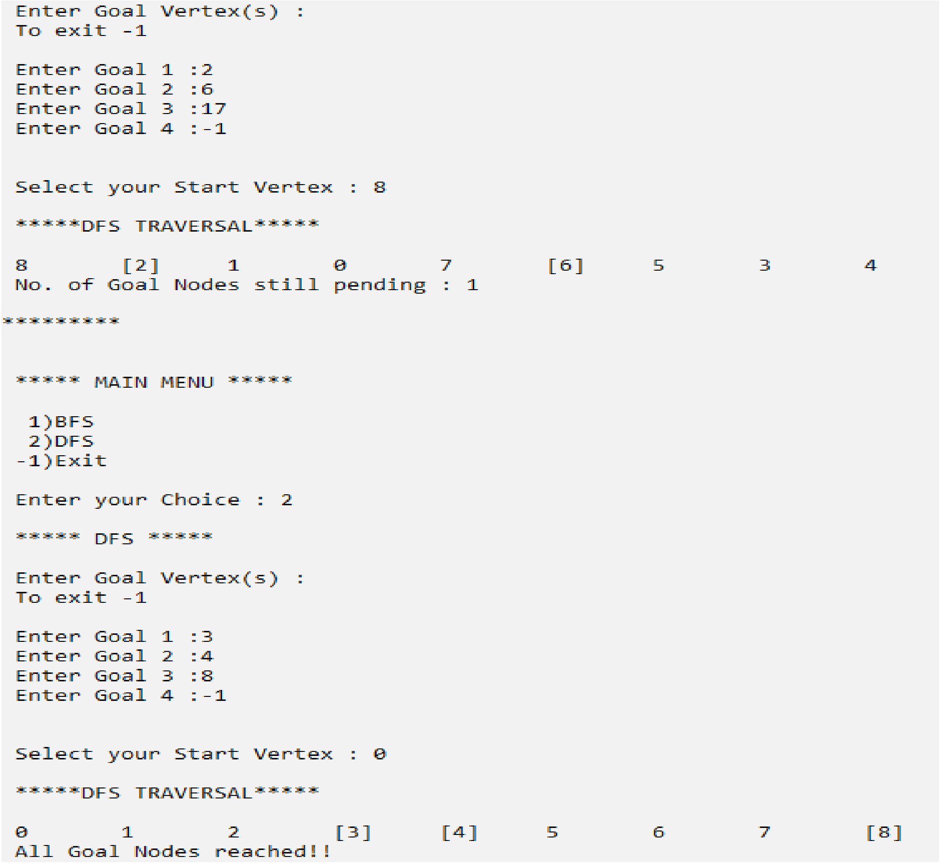


```
 Enter the number of Vertices  : 9

 Enter the Matrix  of Vertices  :
0 1 0 0 0 0 0 1 0
1 0 1 0 0 0 0 1 0
0 1 0 1 0 1 0 0 1
0 0 1 0 1 1 0 0 0
0 0 0 1 0 1 0 0 0
0 0 1 1 1 0 1 0 0
0 0 0 0 0 1 0 1 1
1 1 0 0 0 0 1 0 1
0 0 1 0 0 0 1 1 0

 The Adjacency Matrix  :

0       1       0       0       0       0       0       1       0
1       0       1       0       0       0       0       1       0
0       1       0       1       0       1       0       0       1
0       0       1       0       1       1       0       0       0
0       0       0       1       0       1       0       0       0
0       0       1       1       1       0       1       0       0
0       0       0       0       0       1       0       1       1
1       1       0       0       0       0       1       0       1
0       0       1       0       0       0       1       1       0


 ***** MAIN MENU *****

  1)BFS
  2)DFS
 -1)Exit

 Enter your Choice : 1

 ***** BFS *****
 Enter Goal Vertex(s) :
 To exit -1

 Enter Goal 1 :2
 Enter Goal 2 :4
 Enter Goal 3 :11
 Enter Goal 4 :-1

 Select your Start Vertex : 6

 *****BFS TRAVERSAL*****

 6  5  7  8  [2]  3  [4]  0  1
 No. of Goal Nodes still pending : 1

*********


 ***** MAIN MENU *****

  1)BFS
  2)DFS
 -1)Exit

 Enter your Choice : 1

 ***** BFS *****

 Enter Goal Vertex(s) :
 To exit -1

 Enter Goal 1 :2
 Enter Goal 2 :6
 Enter Goal 3 :0
 Enter Goal 4 :-1

 Select your Start Vertex : 3

 *****BFS TRAVERSAL*****

 3  [2]  4  5  1  8  [6]  [0]  7
 All Goal Nodes reached!!

*********
```

2) DFS

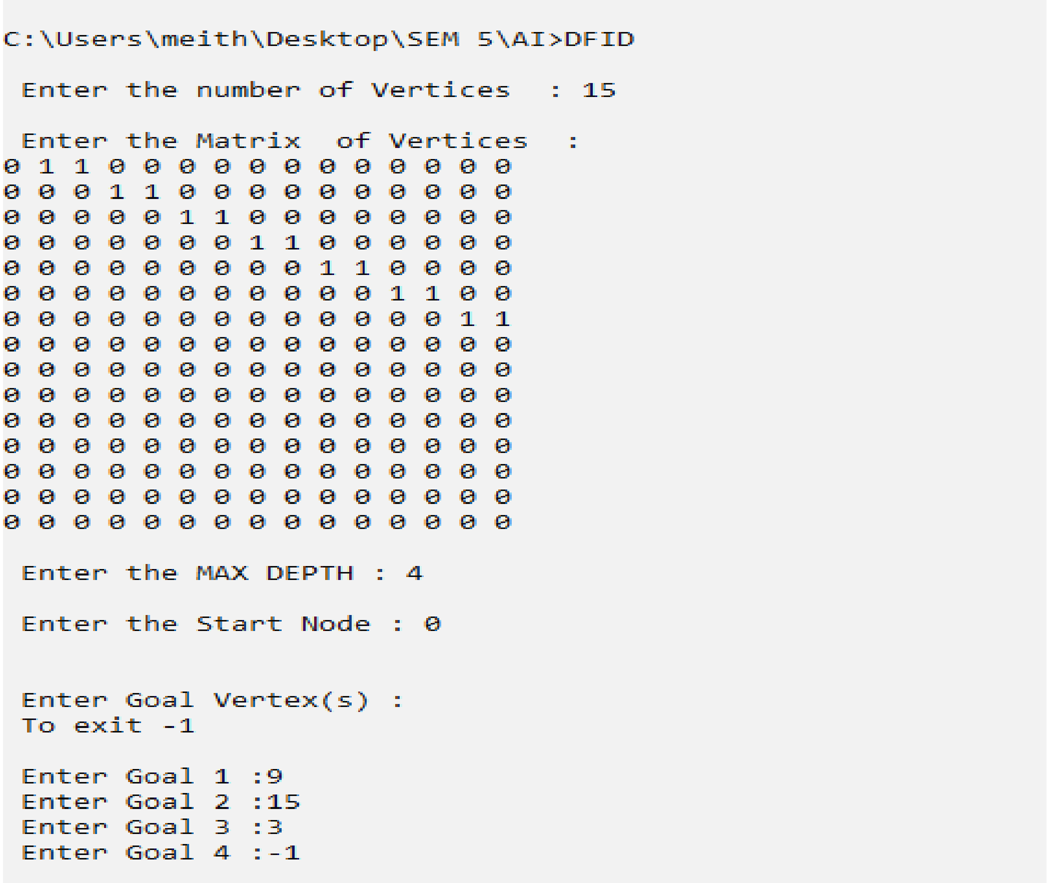


```
 Enter the number of Vertices  : 9

 Enter the Matrix  of Vertices  :
0 1 0 0 0 0 0 1 0
1 0 1 0 0 0 0 1 0
0 1 0 1 0 1 0 0 1
0 0 1 0 1 1 0 0 0
0 0 0 1 0 1 0 0 0
0 0 1 1 1 0 1 0 0
0 0 0 0 0 1 0 1 1
1 1 0 0 0 0 1 0 1
0 0 1 0 0 0 1 1 0

 The Adjacency Matrix  :

0       1       0       0       0       0       0       1       0
1       0       1       0       0       0       0       1       0
0       1       0       1       0       1       0       0       1
0       0       1       0       1       1       0       0       0
0       0       0       1       0       1       0       0       0
0       0       1       1       1       0       1       0       0
0       0       0       0       0       1       0       1       1
1       1       0       0       0       0       1       0       1
0       0       1       0       0       0       1       1       0


 ***** MAIN MENU *****

  1)BFS
  2)DFS
 -1)Exit

 Enter your Choice : 2

 ***** DFS *****
```

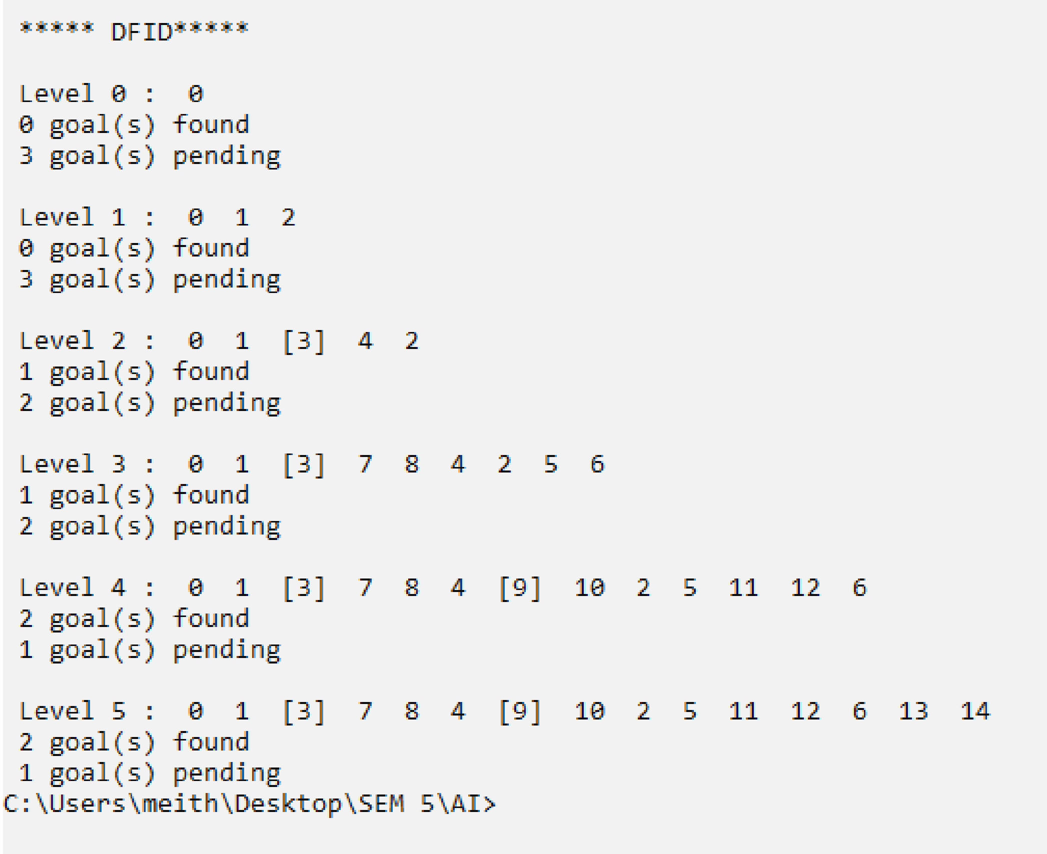


```
 Enter Goal Vertex(s) :
 To exit -1

 Enter Goal 1 :2
 Enter Goal 2 :6
 Enter Goal 3 :17
 Enter Goal 4 :-1


 Select your Start Vertex : 8

 *****DFS TRAVERSAL*****

 8       [2]      1       0       7       [6]     5       3       4
 No. of Goal Nodes still pending : 1

*********


 ***** MAIN MENU *****

  1)BFS
  2)DFS
 -1)Exit

 Enter your Choice : 2

 ***** DFS *****

 Enter Goal Vertex(s) :
 To exit -1

 Enter Goal 1 :3
 Enter Goal 2 :4
 Enter Goal 3 :8
 Enter Goal 4 :-1


 Select your Start Vertex : 0

 *****DFS TRAVERSAL*****

 0       1       2       [3]     [4]     5       6       7       [8]
 All Goal Nodes reached!!
```

3) DFID



```
C:\Users\meith\Desktop\SEM 5\AI>DFID

 Enter the number of Vertices  : 15

 Enter the Matrix  of Vertices  :
0 1 1 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 1 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 1 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 1 1 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 1 1 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 1 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 1 1
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

 Enter the MAX DEPTH : 4

 Enter the Start Node : 0


 Enter Goal Vertex(s) :
 To exit -1

 Enter Goal 1 :9
 Enter Goal 2 :15
 Enter Goal 3 :3
 Enter Goal 4 :-1
```



```
***** DFID*****

Level 0 :  0
0 goal(s) found
3 goal(s) pending

Level 1 :  0  1  2
0 goal(s) found
3 goal(s) pending

Level 2 :  0  1  [3]  4  2
1 goal(s) found
2 goal(s) pending

Level 3 :  0  1  [3]  7  8  4  2  5  6
1 goal(s) found
2 goal(s) pending

Level 4 :  0  1  [3]  7  8  4  [9]  10  2  5  11  12  6
2 goal(s) found
1 goal(s) pending

Level 5 :  0  1  [3]  7  8  4  [9]  10  2  5  11  12  6  13  14
2 goal(s) found
1 goal(s) pending
C:\Users\meith\Desktop\SEM 5\AI>
```

CONCLUSION: In this experiment I implemented 3 differnet Uninformed Search Algorithms viz, BFS, DFS and DFID. BFS gives a complete solution but has too large space and time complexities. DFS on the other hand, requires less memory space and than BFS, but it is not complete. There's a possiblity that the states may be re-curring thus not possibility of a solution. Finally, DFID is a combination of BFS and DFS that mutually provides the pros of both the algorithms.