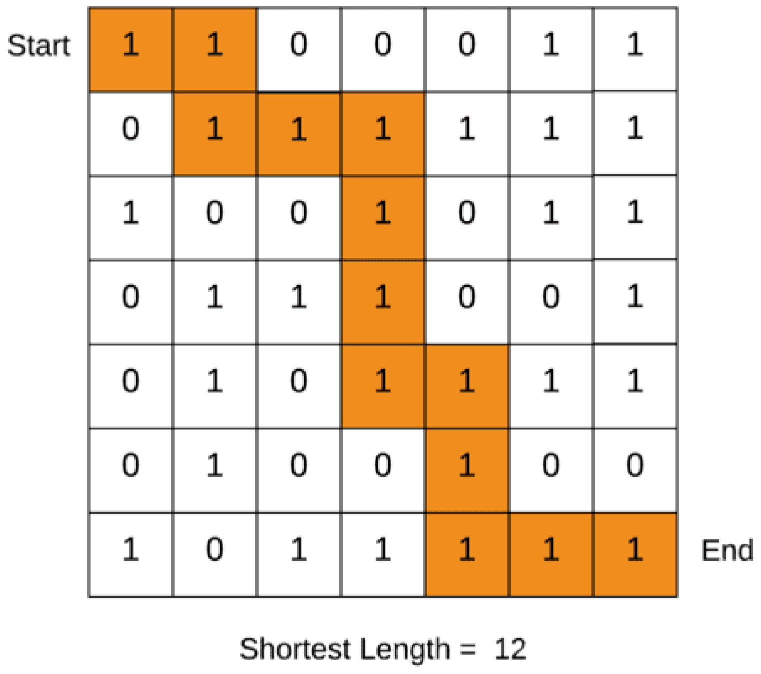
Shortest Path in Maze using Backtracking

[illegible]

Problem: Given a maze in the form of a binary rectangular matrix, we have to find the shortest path from the given source to the given destination. The path can only be created with the cells of 1.

It is important to note that only vertical and horizontal movements are allowed.



Search

Sharing Is Caring

Start Your Data Science Career

(https://datacamp.pxf.io/MXNbDP)

Advertisement

We can easily find the shortest path in the maze by using the backtracking algorithm.

The idea is to keep moving through a valid path until stuck, otherwise backtrack to the last traversed cell and explore other possible paths to the destination.

For each cell, the following 4 moves are possible:

- Up – (x, y-1)
- Down – (x, y+1)
- Right – (x+1, y)
- Left – (x-1, y)

We validate every move before undertaking it. If any move is not valid, we check for the next one.

For example, if the upper cell is zero, we test for the lower cell. If the lower cell also contains zero, we check for the right cell. If the right cell is also not valid, we go for the left cell if it is valid.

If non of the 4 moves are valid, we backtrack to the last visited cell to choose another cell (path) so that we can avoid the current cell which doesn't have any path to the destination.

On reaching the destination, we deliberately backtrack to explore other possible paths to the destination cell.

After exhausting all possibilities, we output the path with the minimum length.

Here is the recursive implementation of the solution using backtracking in C++, Java and Python:

Python

You May Also Like

1. Shortest Path in Unweighted Undirected Graph using DFS (https://pencilprogrammer.com/algorithms/shortest-path-in-unweighted-undirected-graph-using-dfs/)
2. Shortest Path in Unweighted Undirected Graph using BFS (https://pencilprogrammer.com/algorithms/shortest-path-in-unweighted-graph-using-bfs/)
3. Hamiltonian Cycle using Backtracking (https://pencilprogrammer.com/algorithms/hamiltonian-cycle-using-backtracking/)
4. Detect Cycle in a Directed Graph (https://pencilprogra

```
import sys

#Maze in binary representation
matrix =[ [ 1, 1, 0, 0, 0, 1, 1],
          [ 0, 1, 1, 1, 1, 1, 1],
          [ 1, 0, 0, 1, 0, 1, 1],
          [ 0, 1, 1, 1, 0, 0, 1],
          [ 0, 1, 0, 1, 1, 1, 1],
          [ 0, 1, 0, 0, 1, 0, 0],
          [ 1, 0, 1, 1, 1, 1, 1] ]

#2D Array mapping to mark visited cell
visited = [[0 for x in range(len(matrix[0]))] for y in rang

#Source and destination cell
start =(0,0)
end = (6,6)

#Initially storing the max possible integer as the shortest
shortLength = sys.maxsize
length=0
hasPath =False

#Function to initiate the search
def findPath():
    visit(start[0], start[1])

#Function to visit a cell and recursively make next move
def visit(x, y):
  global length, shortLength, visited, hasPath

  #Base Condition - Reached the destination cell
  if x==end[0]and y==end[1]:
    #Update hasPath to True (Maze has a solution)
    hasPath = True
    #Store the minimum of the path length
    shortLength = min(length, shortLength)
    #Backtrack to explore more possible paths
    return

  #Mark current cell as visited
  visited[x][y] = 1
  #Increment the current path length by 1
  length +=1

  #Check for next move:
  #1.Right
  if canVisit(x+1, y):
    visit(x+1, y)

  #2.Down
  if canVisit(x, y+1):
    visit(x, y+1)

  #3.Left
```

mmer.com/algorithms/detect-cycle-in-directed-graph/)

5. Dijkstra's Shortest Path Algorithm (https://pencilprogrammer.com/algorithms/dijkstra-shortest-path/)
6. Shortest Path in Weighted Directed Graph using Bellman-Ford Algorithm (https://pencilprogrammer.com/algorithms/shortest-path-using-bellman-ford-algorithm/)

```
  if canVisit(x-1, y):
    visit(x-1, y)

  #4.Up
  if canVisit(x, y-1):
    visit(x, y-1)

  #Backtrack by unvisiting the current cell and
  #decrementing the value of current path length
  visited[x][y] = 0
  length -= 1

#Function checks if (x,y) cell is valid cell or not
def canVisit(x, y):
  #check maze boundaries
  if x<0 or y<0 or x>=len(matrix[0]) or y>=len(matrix):
    return False
  #check 0 or already visited
  if matrix[x][y]==0 or visited[x][y]==1:
    return False
  return True

#Driver code
if __name__ == '__main__':
  findPath()

  #output only if any path to the destination was found
  if hasPath:
    print(f"Shortest Path Length: {shortLength}")
  else:
    print("No Path Possible")
```

C++

```cpp
#include <iostream>
#include <limits.h>

//Binary Representation of Maze
int matrix[7][7] =
  {
    { 1, 1, 0, 0, 0, 1, 1},
    { 0, 1, 1, 1, 1, 1, 1},
    { 1, 0, 0, 1, 0, 1, 1},
    { 0, 1, 1, 1, 0, 0, 1},
    { 0, 1, 0, 1, 1, 1, 1},
    { 0, 1, 0, 0, 1, 0, 0},
    { 1, 0, 1, 1, 1, 1, 1}
       };

//Maze Class
class Maze{
  public:
  int *start;
  int *end;
  int visited[7][7]= {0};
  int shortLength=INT_MAX;
  int length=0;
  bool hasPath = false;

  Maze(int start[], int end[]){
    this->start = start;
    this->end = end;
  }

  //Function to initiate search process
  void findPath(){
    visit(start[0], start[1]);
  }

  //Function to visit a cell and recursively make next move
  void visit(int x, int y){

    //Base Condition - Reached the destination cell
    if(x==end[0] && y==end[1]){
      //Update hasPath to True (Maze has a possible path)
      hasPath=true;
      //Store the minimum of the path length
      if(length<shortLength)
        shortLength=length;
      //return (Backtrack) to explore more possible paths
      return;
    }

    //Mark the current cell as visited
    visited[x][y] = 1;
    //Increment the current path length by 1
    length++;

    //Check for next move:
```

```
    //1.Right
    if(canVisit(x+1, y)){
      visit(x+1, y);
    }

    //2.Down
    if(canVisit(x, y+1)){
      visit(x, y+1);
    }

    //3.Left
    if(canVisit(x-1, y)){
      visit(x-1, y);
    }

    //4.Up
    if(canVisit(x, y-1)){
      visit(x, y-1);
    }

    //Backtrack by unvisiting the current cell and
    //decrementing the value of current path length
    visited[x][y] = 0;
    length--;
  }

  //Function checks if (x,y) is a vaid cell or not
  bool canVisit(int x, int y){
    //Number of Columns in Maze
    int m=sizeof(matrix[0])/sizeof(matrix[0][0]);
    //Number of rows in Maze
    int n=sizeof(matrix)/sizeof(matrix[0]);
    //Check Boundaries
    if(x<0 || y<0 || x>=m || y>=n)
      return false;
    //Check 0 or already visited
    if(matrix[x][y]==0 || visited[x][y]==1)
      return false;
    return true;
  }

};

//Driver Code
int main() {
  int start[] = {0, 0};
  int end[] = {6, 6};

  Maze maze(start, end);
  maze.findPath();

  //output if the maze has a solution
  if(maze.hasPath)
    std::cout << "Shortest Path Length: " << maze.shortLeng
  else
```

```
    std::cout << "No Path Possible";
}
```

Java

```
class Main {
  public static void main(String[] args) {
    //Matrix in Binary Format
    int matrix[][] =
               {
      { 1, 1, 0, 0, 0, 1, 1},
      { 0, 1, 1, 1, 1, 1, 1},
      { 1, 0, 0, 1, 0, 1, 1},
      { 0, 1, 1, 1, 0, 0, 1},
      { 0, 1, 0, 1, 1, 1, 1},
      { 0, 1, 0, 0, 1, 0, 0},
      { 1, 0, 1, 1, 1, 1, 1}
               };

    //Start and End cell
    int start[] = {0, 0};
    int end[] = {6, 6};

    //Driver code
    Maze maze = new Maze(matrix, start, end);
    maze.findPath();

    //Output the shortest length if the maze have any
    if(maze.hasPath)
      System.out.println("Shortest Path Length: "+maze.shor
    else
      System.out.println("No Path Possible");
  }
}

class Maze{
  int matrix[][];
  int visited[][];
  int shortLength=Integer.MAX_VALUE;
  int length=0;
  boolean hasPath = false;
  int start[];
  int end[];

  Maze(int matrix[][],int start[],int end[]){
    this.matrix = matrix;
    this.start =start;
    this.end=end;
    this.visited=new int[matrix.length][matrix.length];
  }

  //Function to initiate path search
  public void findPath(){
    visit(start[0], start[1]);
  }

  //Function to visit a cell and recursively move to next c
  private void visit(int x, int y){
    //Base condition - Reached destination cell
    if(x==end[0] && y==end[1]){
        hasPath=true;
        //Update lenght with the minimum length
        if(length<shortLength)
          shortLength=length;
        //Return to explore more paths
        return;
      }

      //Mark cell as visited
      visited[x][y] = 1;
      //Increment the length of the current path by 1
      length++;

      //Check and move to next cell:
      //1.Right
      if(canVisit(x+1, y)){
        visit(x+1, y);
      }

      //2.Down
      if(canVisit(x, y+1)){
        visit(x, y+1);
      }

      //3.Left
      if(canVisit(x-1, y)){
        visit(x-1, y);
      }

      //4.Up
      if(canVisit(x, y-1)){
        visit(x, y-1);
      }

      //Backtrack - Unvisit the cell
      visited[x][y] = 0;
      //Decrement the current length path by 1
      length--;
    }

    //Function check if (x,y) is a valid cell
    private boolean canVisit(int x, int y){
      //Check boundaries
      if(x<0 || y<0 || x>=matrix[0].length || y>=matrix.lengt
        return false;
      //Check for 0 and already visited cell
      if(matrix[x][y]==0 || visited[x][y]==1)
        return false;
      return true;
    }
  }
```

Output:

```
Shortest Path Length: 12
```

In the above program, the visit(int x, int y) is the recursive (https://pencilprogrammer.com/cpp-tutorials/recursion/) function implementing the backtracking algorithm.

The canVisit(int x, int y) function checks whether the current cell is valid or not. We use this function to validate the moves.

We are using the visited[][] array to avoid cyclic traversing of the path by marking the cell as visited.

We visit a cell of the maze matrix by updating the corresponding cell in the visited[][] matrix with the value of 1 i.e. visited[x][y]=1 .

Every time we mark a cell as visited we also increment the length of the current path. by 1 i.e. length++ .

We recursively traverse the next valid cell until we reach the destination cell.

On reaching the destination cell we update the minimum path length i.e. shortLength = min(shortLength, length) .

In the driver code of our program, we are initiating the search process and outputting the shortest path of the maze (if it has any).

The backtracking process of finding the shortest path in the maze is not efficient because it explores all possible paths to the destination, which may not be the final solution.

In this programming tutorial, we learned to find the shortest path in the binary maze using the backtracking algorithm in Python, C++, and Java Programming languages.

report this ad

Leave a Reply

Your comment here...

Name (required)

Email (required)

Website

☐ Save my name, email, and website in this browser for the next time I comment.

POST COMMENT