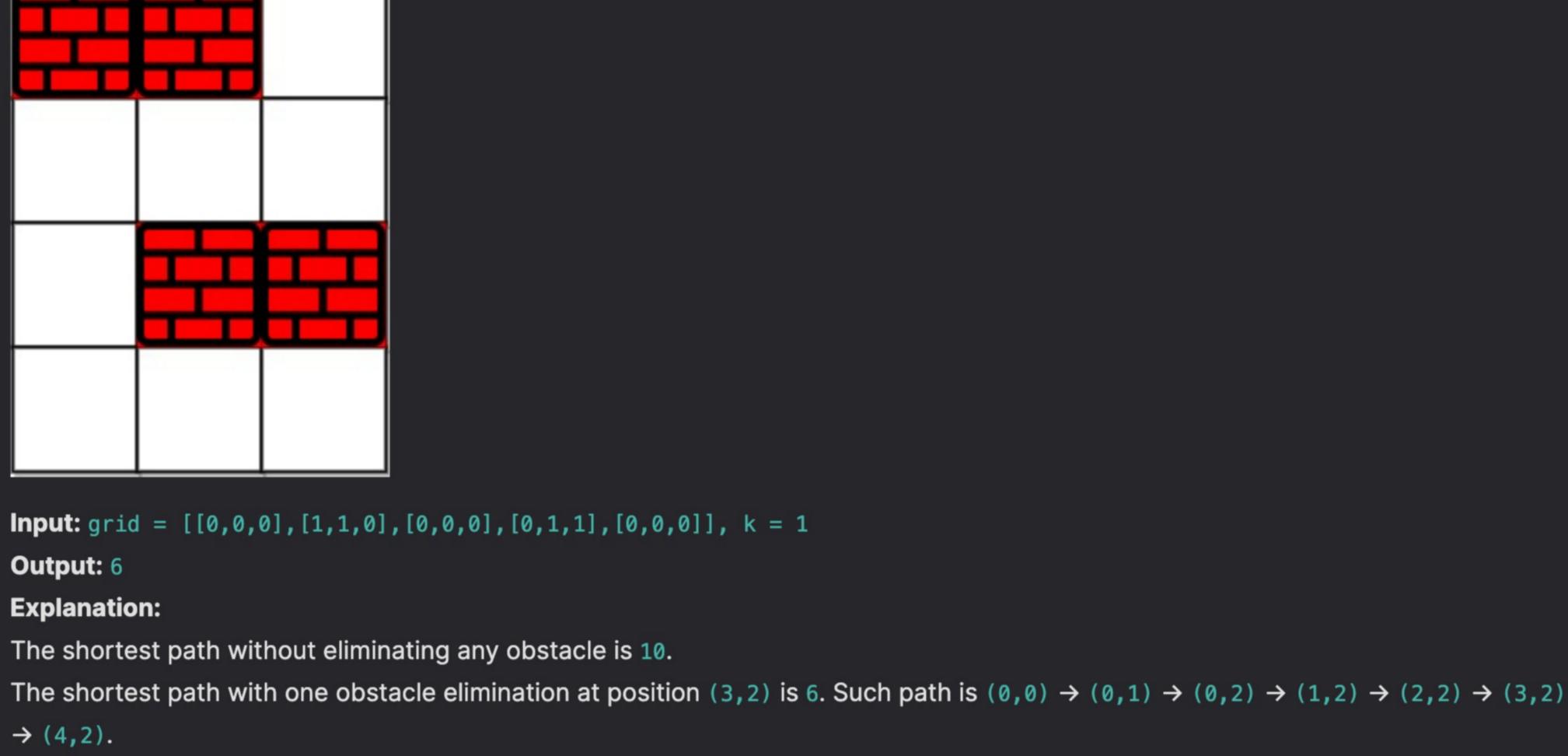
1293. Shortest Path in a Grid with Obstacles Elimination **Leetcode Link** You are given an m imes n integer matrix <code>grid</code> where each cell is either 0 (empty) or 1 (obstacle). In one step, you can move up, down,

left, or right to an empty cell. Return the minimum number of steps to walk from the upper left corner (0, 0) to the lower right corner (m - 1, n - 1) given that you can eliminate at most k obstacles. If no such walks exist, return -1.



Example 2:

Explanation: We need to eliminate at least two obstacles to find such a walk.

Input: grid = [[0,1,1],[1,1,1],[1,0,0]], k = 1 Output: -1

• m == grid.length • n == grid[i].length • 1 <= m, n <= 40 • 1 <= k <= m * n

• grid[i][j] is either 0 or 1.

• grid[0][0] == grid[m - 1][n - 1] == 0

Constraints:

Solution **Brute Force**

Then, on every possible elimination, we can run a BFS/flood fill algorithm on the new grid to find the length of the shortest path. Our

Instead of thinking of first removing obstacles and then finding the shortest path, we can find the shortest path and remove

To accomplish this, we'll introduce an additional state by adding a counter for the number of obstacles we removed so far in our

path. For any path, we can extend that path by moving up, left, down, or right. If the new cell we move into is blocked, we will remove

that obstacle and add 1 to our counter. However, since we can remove no more than $m{K}$ obstacles, we can't let our counter exceed

final answer will be the minimum of all of these lengths. However, this is way too inefficient and complicated.

Example

Full Solution

obstacles along the way when necessary.

K.

First, we might think to try all possible eliminations of at most k obstacles.

Let's look at our destination options if we started in the cell grid[2][1] with the obstacle counter at 0.

Change In

Obstacle Counter

+1

+0

+1

+0

We can also make the observation that each position/state (row, column, obstacle counter) can act as a node in a graph and each

Let's think of how different nodes exist in our graph. There are O(MN) cells in total, and in each cell, our current counter of

obstacles ranges from 0 to K, inclusive. This gives us O(K) options for our obstacle counter, yielding O(MNK) nodes. From each

node, we have a maximum of 4 other destinations we can visit (i.e. edges), which is equivalent to O(1). From all O(MNK) nodes,

Our graph has O(MNK) nodes and O(MNK) edges. A BFS with O(MNK) nodes and O(MNK) edges will have a final time

Our graph has O(MNK) nodes so a <code>BFS</code> will have a space complexity of O(MNK) as well.

bool vis[m][n][k + 1]; // keeps track of whether or not we visited a node

curY == n - 1) { // check if node is in bottom right corner

int newX = curX + deltaX[i]; // row of destination

int newY = curY + deltaY[i]; // column of destination

q.push({0, 0, 0}); // starting at upper left corner for BFS/floodfill

Change In

Row

-1

+0

+1

+0

we also obtain O(MNK) total edges.

complexity of O(MNK).

Space Complexity

C++ solution

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1 class Solution {

Time Complexity: O(MNK)

Space Complexity: O(MNK)

memset(dis, 0, sizeof(dis));

if (curX == m - 1 &&

queue<vector<int>> q;

vis[0][0][0] = true;

while (!q.empty()) {

q.pop();

memset(vis, false, sizeof(vis));

vector<int> cur = q.front();

for (int i = 0; i < 4; i++) {

int curX = cur[0]; // current row

int curY = cur[1]; // current column

return dis[curX][curY][curK];

int curK = cur[2]; // current obstacles removed

destination option can act as a directed edge in a graph.

Cell

grid[1][1]

grid[2][2]

grid[3][1]

grid[2][0]

Change In

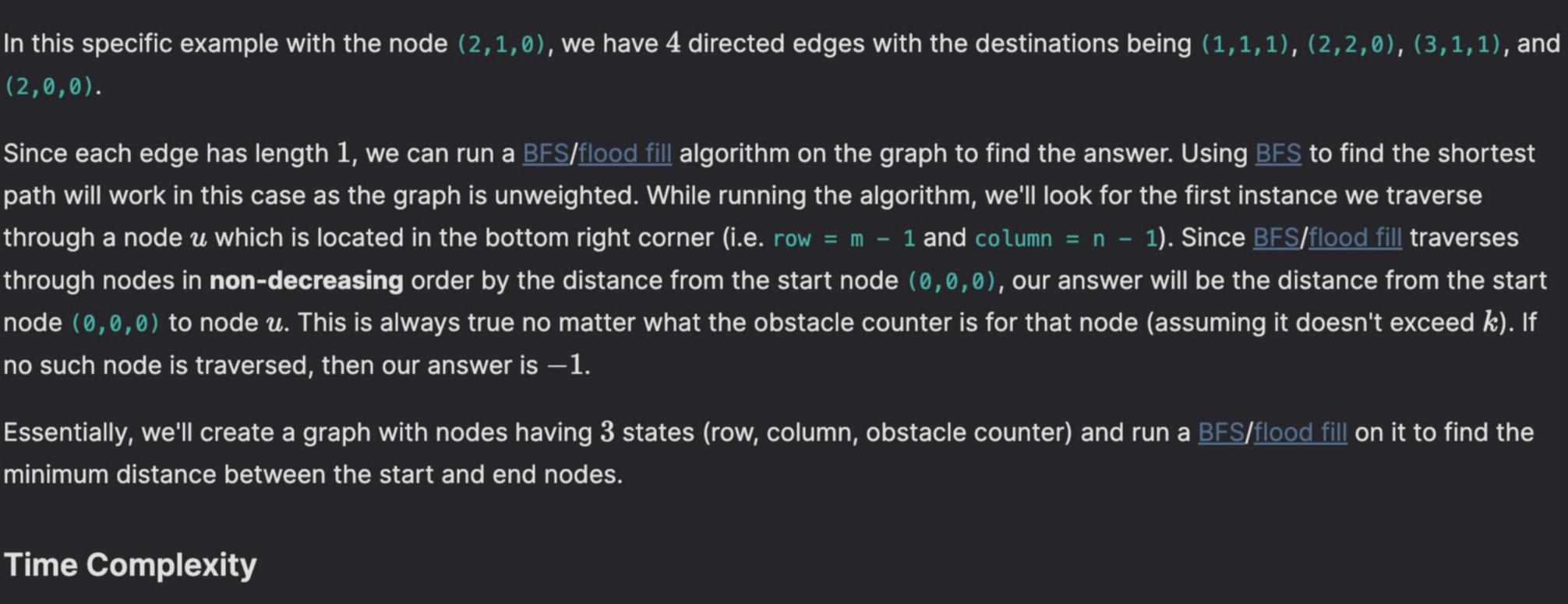
Column

+0

+1

+0

-1



public: int shortestPath(vector<vector<int>>& grid, int k) { int m = grid.size(); int n = grid[0].size(); // dimensions of the grid vector<int> deltaX = {-1, 0, 1, 0};

if (newX < 0 || newX >= m || newY < 0 ||</pre> 29 30 newY >= n) { // check if it's in boundary 31 continue; 32 33 int newK = curK; // obstacle count of destination if (grid[newX][newY] == 1) newK++; 34

dis[newX][newY][newK] = dis[curX][curY][curK] + 1; 41 vis[newX][newY][newK] = true; 42 43 q.push({newX, newY, newK}); 44 // process destination node 45 46 47 return -1; // no valid answer found 48 49 }; Java solution

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Python Solution

1 class Solution(object):

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*/

= [[0, 0, 0]]; // starting at up][0][0] = true;
<pre>(q.length > 0) { [curX, curY, curK] = q.shift(); curX refers to current row curY refers to current column curK refers to current obstacles (curX == m - 1 && curY == n - 1) / check if node is in bottom right eturn dis[curX][curY][curK];</pre>
<pre>(let i = 0; i < 4; i++) { et newX = curX + deltaX[i]; // re et newY = curY + deltaY[i]; // ce f (newX < 0 newX >= m newY // check if it's in boundary continue;</pre>
et newK = curK; // obstacle count f (grid[newX][newY] === 1) { newK++;

* @param {number[][]} grid

const m = grid.length;

let dis = new Array(m)

let vis = new Array(m)

.fill()

.fill()

let q

vis[0]

while

let

let deltaX = [-1, 0, 1, 0];

let deltaY = [0, 1, 0, -1];

var shortestPath = function (grid, k) {

// keeps track of distance of nodes

const n = grid[0].length; // dimensions of the grid

// keeps track of whether or not we visited a node

current obstacles removed

// nodes are in the form (row, column, obstacles removed so far)

.map((_) => new Array(n).fill().map((_) => new Array(k).fill(0)));

.map((_) => new Array(n).fill().map((_) => new Array(k).fill(false)));

// starting at upper left corner for BFS/floodfill

* @param {number} k

* @return {number}

// obstacle count of destination newY] === 1) { if (newK > k) { // surpassed obstacle removal limit continue; // check if node has been visited before continue; Got a question? Ask the Teaching Assistant anything you don't understand.

Example 1:

through a node u which is located in the bottom right corner (i.e. row = m - 1 and column = n - 1). Since BFS/flood fill traverses through nodes in non-decreasing order by the distance from the start node (0,0,0), our answer will be the distance from the start node (0,0,0) to node u. This is always true no matter what the obstacle counter is for that node (assuming it doesn't exceed k). If Essentially, we'll create a graph with nodes having 3 states (row, column, obstacle counter) and run a BFS/flood fill on it to find the

vector<int> deltaY = $\{0, 1, 0, -1\}$; // nodes are in the form (row, column, obstacles removed so far) 8 int dis[m][n][k + 1]; // keeps track of distance of nodes 9

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                    if (newK > k) { // surpassed obstacle removal limit
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                        continue;
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                    if (vis[newX][newY][newK]) { // check if node has been visited before
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                        continue;
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 1 class Solution {
        public int shortestPath(int[][] grid, int k) {
            int m = grid.length;
           int n = grid[0].length; // dimensions of the grid
            int[] deltaX = {-1, 0, 1, 0};
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           int[] deltaY = {0, 1, 0, -1};
           // nodes are in the form (row, column, obstacles removed so far)
            int[][][] dis = new int[m][n][k + 1]; // keeps track of distance of nodes
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            boolean[][][] vis =
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                new boolean[m][n][k + 1]; // keeps track of whether or not we visited a node
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            Queue<int[]> q = new LinkedList<int[]>();
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           int[] start = {0, 0, 0};
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            q.add(start); // starting at upper left corner for BFS/floodfill
           vis[0][0][0] = true;
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            while (!q.isEmpty()) {
               int[] cur = q.poll();
                int curX = cur[0]; // current row
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                int curY = cur[1]; // current column
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                int curK = cur[2]; // current obstacles removed
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                if (curX == m - 1)
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                    && curY == n - 1) { // check if node is in bottom right corner
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                    return dis[curX][curY][curK];
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                for (int i = 0; i < 4; i++) {
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                    int newX = curX + deltaX[i]; // row of destination
26
                    int newY = curY + deltaY[i]; // column of destination
27
                    if (newX < 0 || newX >= m || newY < 0</pre>
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                        || newY >= n) { // check if it's in boundary
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                        continue;
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int newK = curK; // obstacle count of destination

if (newK > k) { // surpassed obstacle removal limit

dis[newX][newY][newK] = dis[curX][curY][curK] + 1;

if (vis[newX][newY][newK]) { // check if node has been visited before

if (grid[newX][newY] == 1)

vis[newX][newY][newK] = true;

// process destination node

int[] destination = {newX, newY, newK};

newK++;

continue;

continue;

q.add(destination);

return -1; // no valid answer found

def shortestPath(self, grid, k):

:type grid: List[List[int]] :type k: int :rtype: int m = len(grid)n = len(grid[0])# dimensions of the grid deltaX = [-1, 0, 1, 0]deltaY = [0, 1, 0, -1]# nodes are in the form (row, column, obstacles removed so far) dis = [[[0 for x in range(k + 1)] for y in range(n)] for z in range(m)] # keeps track of distance of nodes vis = [[[False for col in range(k + 1)] for col in range(n)] for row in range(m)] # keeps track of whether or not we visited a node q = []q.append((0, 0, 0)) # starting at upper left corner for BFS/floodfill vis[0][0][0] = True while q: (curX, curY, curK) = q.pop(0)# curX refers to current row # curY refers to current column # curK refers to current obstacles removed if (curX == m - 1 and curY == n - 1): # check if node is in bottom right corner return dis[curX][curY][curK] for i in range(4): newX = curX + deltaX[i] # row of destination newY = curY + deltaY[i] # column of destination if (newX < 0 or newX >= m or newY < 0 or newY >= n): # check if it's in boundary continue newK = curK # obstacle count of destination if grid[newX][newY] == 1: newK += 1 if newK > k: # surpassed obstacle removal limit if vis[newX][newY][newK]: # check if node has been visited before continue dis[newX][newY][newK] = dis[curX][curY][curK] + 1 vis[newX][newY][newK] = True q.append((newX, newY, newK)) # process destination node return -1 # no valid answer found Javascript Solution

> && curY == n - 1) { e is in bottom right corner [curY][curK]; < 4; i++) { + deltaX[i]; // row of destination + deltaY[i]; // column of destination $newX >= m \mid \mid newY < 0 \mid \mid newY >= n) {$'s in boundary

45 if (vis[newX][newY][newK]) { 46 47 48 49 dis[newX][newY][newK] = dis[curX][curY][curK] + 1; 50 vis[newX][newY][newK] = true; 51 q.push([newX, newY, newK]); 53 // process destination node 54 55 56 return -1; // no valid answer found 57 };