Maze Traversal

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Outline


Outline

Maze

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

- 0: path; 1: barriers.

Maze ▷ a path from the upper-left corner to the lower-right corner?

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

- 0: path; 1: barriers.

Moves

NW ↖ [i-1][j-1]	N ↑ [i-1][j]	NE ↗ [i-1][j+1]
W ← [i][j-1]	X [i][j]	E → [i][j+1]
SW ↙ [i+1][j-1]	S ↓ [i-1][j]	SE ↘ [i+1][j+1]

```
typedef struct {
    short int vert; // vertical direction
    short int horiz; // horizontal direction
} offsets;
offsets move[8];
```

Moves (2/2)

name	dir	move[dir].vert	move[dir].horiz
N ↑	0	−1	0
NE ↗	1	−1	1
E →	2	0	1
SE ↘	3	1	1
S ↓	4	1	0
SW ↙	5	1	−1
W ←	6	0	−1
NW ↖	7	−1	−1

- `next_row = row + move[dir].vert;`
- `next_col = col + move[dir].horiz;`

Outline

Initial Attempt for Maze Traversal

- A two-dimensional array `mark` for recording the maze positions that are already checked.
- Use a stack to save current path and direction.
- Return and try another path if we take a hopeless path.
- The stack size: $m \times n$ (# of positions).

```
#define MAX_STACK_SIZE 100

typedef struct {
    short int row; // can be of other types...
    short int col;
    short int dir;
} element;

element stack a[MAX_STACK_SIZE];
```

An algorithm using a stack

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

name	dir	.vert	.horiz
N	0	-1	0
NE	1	-1	1
E	2	0	1
SE	3	1	1
S	4	1	0
SW	5	1	-1
W	6	0	-1
NW	7	-1	-1

row							
col							
dir							

An algorithm using a stack

1	1	1	1	1	1	1
1	0	1	1	1	0	1
1	1	**0**	0	0	1	1
1	1	1	0	1	1	1
1	0	0	1	0	1	1
1	1	1	1	1	0	1
1	1	1	1	1	1	1

name	dir	.vert	.horiz
N	0	-1	0
NE	1	-1	1
E	2	0	1
SE	3	1	1
S	4	1	0
SW	5	1	-1
W	6	0	-1
NW	7	-1	-1

row	1						
col	1						
dir	3						

An algorithm using a stack

1	1	1	1	1	1	1
1	0	1	1	1	0	1
1	1	0	**0**	0	1	1
1	1	1	0	1	1	1
1	0	0	1	0	1	1
1	1	1	1	1	0	1
1	1	1	1	1	1	1

name	dir	.vert	.horiz
N	0	-1	0
NE	1	-1	1
E	2	0	1
SE	3	1	1
S	4	1	0
SW	5	1	-1
W	6	0	-1
NW	7	-1	-1

row	1	2					
col	1	2					
dir	3	2					

An algorithm using a stack

1	1	1	1	1	1	1
1	0	1	1	1	0	1
1	1	0	0	**0**	1	1
1	1	1	0	1	1	1
1	0	0	1	0	1	1
1	1	1	1	1	0	1
1	1	1	1	1	1	1

name	dir	.vert	.horiz
N	0	-1	0
NE	1	-1	1
E	2	0	1
SE	3	1	1
S	4	1	0
SW	5	1	-1
W	6	0	-1
NW	7	-1	-1

row	1	2	2				
col	1	2	3				
dir	3	2	2				

An algorithm using a stack

1	1	1	1	1	1	1
1	0	1	1	1	**0**	1
1	1	0	0	0	1	1
1	1	1	0	1	1	1
1	0	0	1	0	1	1
1	1	1	1	1	0	1
1	1	1	1	1	1	1

name	dir	.vert	.horiz
N	0	-1	0
NE	1	-1	1
E	2	0	1
SE	3	1	1
S	4	1	0
SW	5	1	-1
W	6	0	-1
NW	7	-1	-1

row	1	2	2	2			
col	1	2	3	4			
dir	3	2	2	1			

An algorithm using a stack

1	1	1	1	1	1	1
1	0	1	1	1	0	1
1	1	0	0	**0**	1	1
1	1	1	0	1	1	1
1	0	0	1	0	1	1
1	1	1	1	1	0	1
1	1	1	1	1	1	1

name	dir	.vert	.horiz
N	0	-1	0
NE	1	-1	1
E	2	0	1
SE	3	1	1
S	4	1	0
SW	5	1	-1
W	6	0	-1
NW	7	-1	-1

row	1	2	2				
col	1	2	3				
dir	3	2	2				

An algorithm using a stack

1	1	1	1	1	1	1
1	0	1	1	1	0	1
1	1	0	0	0	1	1
1	1	1	**0**	1	1	1
1	0	0	1	0	1	1
1	1	1	1	1	0	1
1	1	1	1	1	1	1

name	dir	.vert	.horiz
N	0	-1	0
NE	1	-1	1
E	2	0	1
SE	3	1	1
S	4	1	0
SW	5	1	-1
W	6	0	-1
NW	7	-1	-1

row	1	2	2	2			
col	1	2	3	4			
dir	3	2	2	5			

An algorithm using a stack

1	1	1	1	1	1	1
1	0	1	1	1	0	1
1	1	0	0	0	1	1
1	1	1	0	1	1	1
1	0	0	1	**0**	1	1
1	1	1	1	1	0	1
1	1	1	1	1	1	1

name	dir	.vert	.horiz
N	0	-1	0
NE	1	-1	1
E	2	0	1
SE	3	1	1
S	4	1	0
SW	5	1	-1
W	6	0	-1
NW	7	-1	-1

row	1	2	2	2	3		
col	1	2	3	4	3		
dir	3	2	2	5	3		

An algorithm using a stack

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

name	dir	.vert	.horiz
N	0	-1	0
NE	1	-1	1
E	2	0	1
SE	3	1	1
S	4	1	0
SW	5	1	-1
W	6	0	-1
NW	7	-1	-1

row	1	2	2	2	3	4
col	1	2	3	4	3	4
dir	3	2	2	5	3	3

path()

```
void path() { /* output a path through the maze if such a path exists */
    int i, row, col, next_row, next_col, dir, found = false;
    element position;
    mark[1][1] = 1; top =0; stack[0].row = 1; stack[0].col = 1; stack[0].dir = 0;
    while (top > -1 && !found) {
        position = pop(&top);
        row = position.row; col = position.col; dir  = position.dir;
        while (dir < 8 && !found) { /*move in direction dir  */
            next_row = row + move[dir].vert;
            next_col = col + move[dir].horiz;
            if (next_row == EXIT_ROW && next_col == EXIT_COL)
                found = true;
            else if (maze[next_row][next_col] == 0 && mark[next_row][next_col]==0) {
                mark[next_row][next_col] = 1;
                position.row = row; position.col = col; position.dir = ++dir;
                push(&top, position);
                row = next_row; col = next_col; dir = 0;
            } else ++dir;
        }
    }
    if (found) {
        printf("The path is :\n"); printf("row col\n");
        for (i = 0; i <= top; i++)
            printf("%2d%5d", stack[i].row, stack[i].col);
        printf("%2d%5d\n", row, col);
        printf("%2d%5d\n", EXIT_ROW, EXIT_COL);
    } else printf("The maze does not have a path\n");
}
```

A Recursive Example

- An example of maze traversal by recursion.


A Recursive Example

- An example of maze traversal by recursion.
  - Recall: System Stack.

A Recursive Example

- An example of maze traversal by recursion.
  - Recall: System Stack.
- **Exercise:** Try to modify it to consider 8 directions.

Discussions