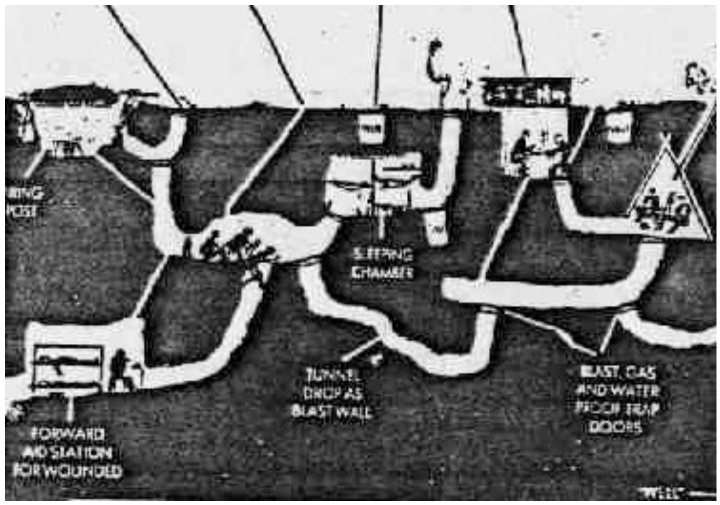
Assignment

TUNNEL PROBLEM

1. Introduction



A tunnel, an underground network, was the location of several military campaigns during a war. The tunnels were used by the guerrillas as hiding spots during combat, as well as serving as communication and supply routes, hospitals, food, weapon caches and living quarters for numerous guerrilla fighters.

The story is that, after finishing the tunnel, they wanted to put some observation stations in it. These stations must be placed at the intersection of routes, or at the end of a route. A *diagram of the tunnel* was created. The guerrillas at stations must know the *shortest path* from their stations to the exit position in case discovered by the enemy.

Now, suppose that you were the General of military. How can you solve the above problems?

2. Requirement

In this assignment, we provide you a tunnel structure in a maze form. You are required to do 2 following tasks:

1. Creating the diagram of the tunnel. (*diagram* problem)
2. Finding the shortest path from a certain station to an exit position. (*shortest path* problem)

The detail is given in the next pages.

3. Converting a Maze to a Graph

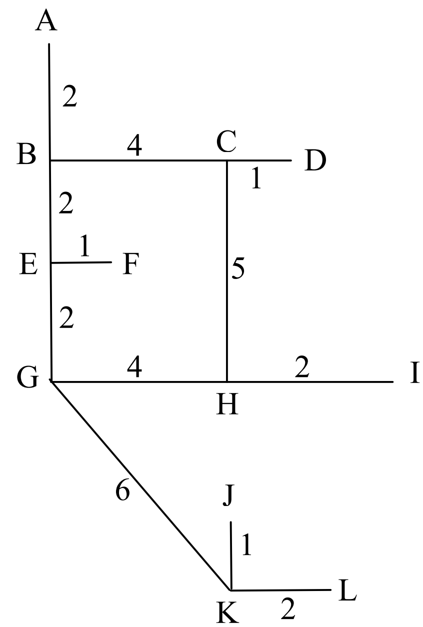
You can consider the tunnel as a maze represented by a matrix of '#' and '**.**', with "#" and "**.**"are corresponding to wall and blank. A maze cannot contain a square of blanks, such as the following grid

```
####
#..#
#..#
####
```

To solve the above problems, you must first convert the maze to a weighted graph, then apply your knowledge about graph algorithms to find the solutions. The vertices of the graph are correspondingly observation stations in the tunnel. The weight w(u, v) of the edge (u, v) is the blank-based distance between u and v.

Here is a simple maze and its corresponding weighted graph.

```
#.######
#.######
#......#
#.###.##
#..##.##
#.###.##
#.......
#.######
#.##.###
#......#
########
```



Also, the shortest path from B to I is B-E-G-H-I.

Identification of vertices of the graph can be determined based on its 2-dimensional positions in the maze. Conventionally, position (0,0) is the uppermost left corner. Column numbers increase to the right and row numbers increase as you move down. In the above maze sample, position of the vertex C is (2, 5). Given r and c are correspondingly the number of rows and columns of the maze, VertexID of vertices can be determined as follow:

VertexID (V) = position (i, j) = i * c + j

For example: VertexID (C) = position (2, 5) = 2 * 8 + 5 = 21

VertexID (B) = position (2, 1) = 2 * 8 + 1 = 17

VertexID (I) = position(6, 7) = 6 * 8 + 7 = 55

4. Input File

Two files: `maze_input.txt` and `graph_input.txt`.

The first, `maze_input.txt`, represents for a tunnel. It is used as input file for the *diagram* problem. It includes the number of rows and columns of the maze, the content of the maze, and the locations of the starting position and exit position for the shortest path problem. Here is what a sample maze file looks like:

```
11
8
#.######
#.######
#......#
#.###.##
#..#..##
#.##.###
#.......
#.######
#.##.###
#......#
########
17
55
```

the number of rows

the number of columns

content of the maze

Position of a station. Here, it is vertex B whose ID is
17 = 2 * 8 + 1 = (2, 1)

Exit position. Here, it is vertex I whose ID is
55 = 6 * 8 + 7 = (6, 7)

The second, `graph_input.txt`, is used as input file for the *shortest path* problem. If you solve the diagram problem correctly, content of `graph_input.txt` is the same as content of output file `diagram.txt` given below.

5. Output File

Results of your program are 2 output files: **`diagram.txt`**, and **`shortest_path.txt`**. Your output file names must be exactly like that.

In the file of **`diagram.txt`**, you must show the weighted graph in an adjacency-list format. Each adjacent edge has an attached weight. Here is the sample file for the above maze.

```
1(17,2)
17(1,2)(21,4)(33,2)
21(17,4)(22,1)(52,5)
22(21,1)
33(17,2)(34,1)(49,2)
34(33,1)
49(33,2)(52,3)(76,6)
52(21,5)(49,3)(55,3)
55(52,3)
68(76,1)
76(49,6)(68,1)(78,2)
78(76,2)
```

Finally, the shortest path from B to I (B-E-G-H-I) in the graph can be showed as follows, with `10` is the total cost of the path.

17-33-49-52-55

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