**Formulation of the problem:**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **1**  (0,0) | **1** | **1** | **2** | **1** | **1** | **1** | **2** | **3**  (8,0) |
| **2** | **1** | **1** | **1** | **3** | **3** | **1** | **1** | **2** |
| **1** | **1** | **2** | **2** | **5** | **2** | **2** | **1** | **1** |
| **1** | **2** | **2** | **3** | **4** | **5** | **3** | **2** | **1** |
| **Robot**  (0,4) | **2** | **2** | **3** | **4** | **6** | **3** | **2** | **Dest**  (8,4) |
| **1** | **1** | **5** | **4** | **3** | **3** | **5** | **1** | **1** |
| **3** | **1** | **2** | **1** | **3** | **1** | **3** | **2** | **2** |
| **1** | **1** | **1** | **1** | **2** | **1** | **2** | **1** | **1** |
| **1**  (0,8) | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1**  (8,8) |

Above is a Cartesian graph that is a 2D planar representation of a geographical terrain. There is a Robot “Robot” at co-ordinate (0,4), who has to reach the destination “Dest” at co-ordinate (8,4). It needs to reach the destination with **minimum number of walks (or steps, or hops).**

The blue numbers in each unit cell represents the amount of energy the Robot would consume in that cell. For instances, a value of 1 means the Robot would consume 1 Joule if it traverses that cell, a value of 2 would mean that the Robot would consume 2 Joules, and so on.

Robot “Robot” starts from location (0,4) with a certain amount of initial energy = 18 Joules. It needs to reach the destination traversing through a path of cells, where each cell consumes certain amount of Robot’s energy. As soon as Robot’s energy becomes zero in a cell, it gets stuck there and cannot proceed forward. So, there will be some paths which will become unreachable.

The objective of this problem is to find the shortest reachable path from “Robot” (0,4) to “Dest” (8,4) considering that Robot starts with 18 joules of energy and consumes energy in each cell along that path, in the amount as shown in the Cartesian Graph. Please note that the path that consumes minimum energy is not a solution for this problem. When there are multiple shortest paths, the program must return the shortest path which consumes least amount of energy.

Legal moves for the robot (up, down, left, right). Illegal move (diagonal).

Write a C++ code (preferred), or a programming language of your choice:

* Please choose object-oriented way of representing data.
* Please build a data structure that initializes the above Cartesian graph.
* Please write a traversal function that computes the optimal path.
* Please write a summary on the choice of data structure, way of representing graph, and the asymptotic computational order of traversal.

**Program Interface**

Your program should read the cartesian graph (txt file) and show the optimal trajectory of the path. The input text file would have comma separated values of energy with each row in one line. The starting point of the robot will be marked with **R** and end-point will be marked with **D**. Your program should take the name of the text file and the initial energy of the robot as command line input arguments.

Sample content of text file is shown below.

1, 1, 1, 2, 1, 1, 1, 2, 3

2, 1, 1, 1, 3, 3, 1, 1, 2

1, 1, 2, 2, 5, 2, 2, 1, 1

1, 2, 2, 3, 4, 5, 3, 2, 1

R, 2, 2, 3, 4, 6, 3, 2, D

1, 1, 5, 4, 3, 3, 5, 1, 1

3, 1, 2, 1, 3, 1, 3, 2, 2

1, 1, 1, 1, 2, 1, 2, 1, 1

1, 1, 1, 1, 1, 1, 1, 1, 1

Advanced questions:

1. What is the cost of time-space complexity?
2. What optimizations/algorithms would you choose to reduce the time-space complexity?
3. Describe the data structures and classes you have used in implementing the solution.