Open4Tech Summer School

C++ STL Principles and Practice

Coding Test - July 2016

Victor Ciura - Technical Lead, Advanced Installer
Gabriel Diaconița - Senior Software Developer, Advanced Installer

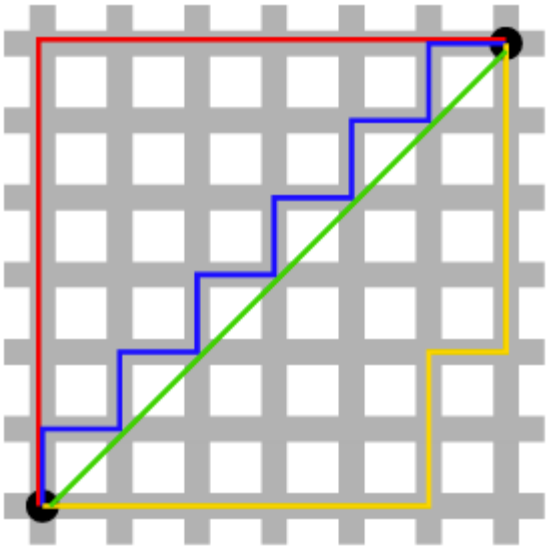
Intro

Manhattan Distance (Minkowski Geometry)
https://en.wikipedia.org/wiki/Taxicab_geometry

Taxicab geometry is a form of geometry in which the usual **distance** function of metric (Euclidean geometry) is replaced by a new metric in which the distance between two points is the **sum** of the absolute differences of their Cartesian coordinates.

The ***taxicab metric*** is also known as rectilinear distance, snake distance, city block distance, Manhattan distance or Manhattan length.

E.g.
In taxicab geometry, all rectilinear paths between the two points in the picture have the shortest length of **12**. In Euclidean geometry, the diagonal line has length $6\sqrt{2} \approx 8.49$, and is the unique shortest path.



```
// Manhattan distance between 2 points
int ManhattanDist(Point p1, Point p2)
{
  return abs(p1.x - p2.x) +
         abs(p1.y - p2.y);
}
```

Problem

Taxicab geometry is often used in fire-spread simulation with square-cell, grid-based city maps like Manhattan (New York).
Fire hydrants are installed at each street block (square-cell). Each fire hydrant is connected to an underground water pipe.

We need to determine if we have enough **redundancy** for water supply pipes (minimum of **2** hydrants that are supplied by the same main water pipe).

Write a program that analyzes the water grid and reports all main water pipes that have redundancy within a **maximum** safety (Manhattan) **distance** of **D** blocks.

12	44	11	19	67	23
31	45	12	88	61	44
23	11	90	55	17	19
56	31	76	71	12	67
90	44	19	23	11	43
89	18	17	33	72	14

Sample 6x6 city grid water hydrants.

Each hydrant is labeled by its water supply ***pipe ID*** (number).

Hydrants that are supplied by the same main water pipe will have the same ID.

ManhattanDistance.in

```
4                    ← Manhattan distance (D)
6 6                  ← city grid size
12 44 11 19 67 23
31 45 12 88 61 44
23 11 90 55 17 19
56 31 76 71 12 67
90 44 19 23 11 43
89 18 17 33 72 14
```

ManhattanDistance.out (IDs of water pipes that have redundancy)

```
11 : (0,2)(2,1)
12 : (0,0)(1,2);(1,2)(3,4)
19 : (0,3)(2,5)
31 : (1,0)(3,1)
44 : (0,1)(4,1)
67 : (0,4)(3,5)
90 : (2,2)(4,0)
```

← water pipe : coordinates of redundant hydrant pairs within specified Manhattan distance of each other