ECON 381 PROJECT

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1. Axial coordinate system is the most suitable option for the coordinate system in the pointed hexagonal grid. In axial coordinates, two axes (q,r) are used; q is the horizontal and r is the diagonal axis. There are adventages to using this system. The following formula is used to find the distances between hexagons:

(abs(q1-q2) + abs(r1-r2) + abs(q1+r1-q2-r2)) / 2 = distance

Base coordinate distances are added to define neighbors.

Their intersection is determined by determining whether the cells fall within the specified ranges.

2. A HashMap/Dictionary would be most suited for storing the complete map since it can effectively hold sparse grids.

Permits O(1) lookup time to determine whether a cell is present at specified coordinates.

Additional cell information, such as if a tower is present, can be readily stored. A coordinate pair (q,r) might serve as the key, and cel information could serve as the value.

3. The store areas detemined by sensor data: Regarding circles: it would be ideal to use a hash set of coordinates.

A. Effective for evaluating membership

B. Intersection operations are simple to execute. For rings, there is no discernible difference between storing rings and circles in a hash set.

C. Both require efficient set operations to locate intersections and O(1) search for coordinate checking.

4. The Java application is:

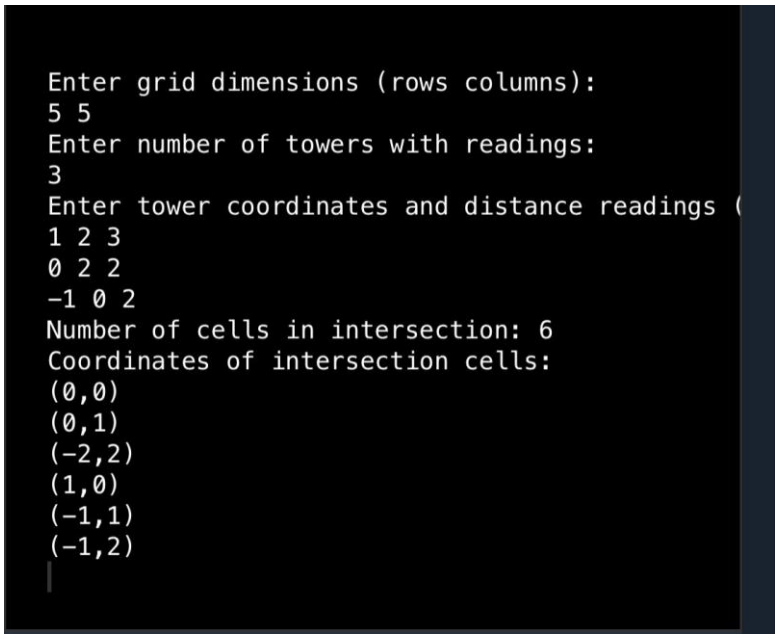
```
import java.util.*;


class Coord {
  final int q, r;


  public Coord(int q, int r) {
    this.q = q;
    this.r = r;
  }


  @Override
  public boolean equals(Object o) {
```

```
        if (this == o) return true;
        if (!(o instanceof Coord)) return false;
        Coord coord = (Coord) o;
        return q == coord.q && r == coord.r;
    }

    @Override
    public int hashCode() {
        return Objects.hash(q, r);
    }

    @Override
    public String toString() {
        return "(" + q + "," + r + ")";
    }
}

public class HexGridSystem {
    private final Map<Coord, Boolean> grid = new HashMap<>();

    public int distance(Coord a, Coord b) {
        return (Math.abs(a.q - b.q) + Math.abs(a.r - b.r) + Math.abs(a.q + a.r - b.q - b.r)) / 2;
    }

    public Set<Coord> getRange(Coord center, int d) {
        Set<Coord> results = new HashSet<>();
        for (int dq = -d; dq <= d; dq++) {
            for (int dr = Math.max(-d, -dq-d); dr <= Math.min(d, -dq+d); dr++) {
                results.add(new Coord(center.q + dq, center.r + dr));
            }
        }
```

```
        return results;
    }

    public Set<Coord> getRing(Coord center, int d) {
        Set<Coord> results = new HashSet<>();
        Coord cube = new Coord(center.q, center.r);
        if (d == 0) {
            results.add(cube);
        } else {
            int q = center.q + d;
            int r = center.r;
            int[][] directions = {{-1,0}, {-1,1}, {0,1}, {1,0}, {1,-1}, {0,-1}};
            for (int dir = 0; dir < 6; dir++) {
                for (int j = 0; j < d; j++) {
                    results.add(new Coord(q, r));
                    q += directions[dir][0];
                    r += directions[dir][1];
                }
            }
        }
        return results;
    }

    public Set<Coord> findIntersection(List<Map.Entry<Coord, Integer>> readings, boolean
exactDistance) {
        if (readings.isEmpty()) return new HashSet<>();
        Set<Coord> intersection = exactDistance ? getRing(readings.get(0).getKey(),
readings.get(0).getValue()) : getRange(readings.get(0).getKey(), readings.get(0).getValue());
        for (int i = 1; i < readings.size(); i++) {
            Set<Coord> currentRegion = exactDistance ? getRing(readings.get(i).getKey(),
readings.get(i).getValue()) : getRange(readings.get(i).getKey(), readings.get(i).getValue());
            intersection.retainAll(currentRegion);
```

```
    }
    return intersection;
}

public static void main(String[] args) {
    Scanner scanner = new Scanner(System.in);
    HexGridSystem system = new HexGridSystem();

    System.out.println("Enter grid dimensions (rows columns):");
    int rows = scanner.nextInt();
    int cols = scanner.nextInt();

    System.out.println("Enter number of towers with readings:");
    int numTowers = scanner.nextInt();

    List<Map.Entry<Coord, Integer>> readings = new ArrayList<>();
    System.out.println("Enter tower coordinates and distance readings (q r d):");
    for (int i = 0; i < numTowers; i++) {
        int q = scanner.nextInt();
        int r = scanner.nextInt();
        int d = scanner.nextInt();
        readings.add(new AbstractMap.SimpleEntry<>(new Coord(q, r), d));
    }

    Set<Coord> intersection = system.findIntersection(readings, false);

    System.out.println("Number of cells in intersection: " + intersection.size());
    System.out.println("Coordinates of intersection cells:");
    for (Coord coord : intersection) {
        System.out.println(coord);
    }
```

```
  }
}
```



5. Program inputs:

Grid size: 8x8

Number of towers:2

Locations and detection distances of towers:

Tower 1: (2,2) distance 2

Tower 2: (4,1) distance 2

Program outcomes:

Number of cells in the intersection zone: 4

Coordinates of cells in the intersection zone:

(3,1)

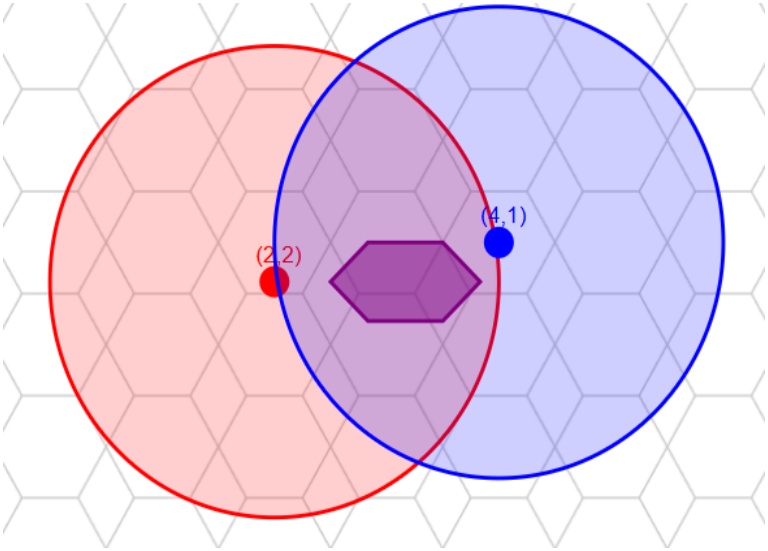
(3,2)

(4,1)

(4,2)

The program calculates the detection zone for each tower, then find the intersection of these regions. At the end, shows results.

Distance calculation: (|q1-q2| + |r1-r2| + |q1+r1-q2-r2|) / 2



Red: Tower 1

Blue: Tower 2

Purple: Intersection zone