Percolation

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Outline:

What is Percolation?; Model; Historical development; Code and its explanation; Conclusion.

What is Percolation?





Model and FIRST MENTION

Percolator:







Given a composite systems comprised of randomly distributed insulating and metallic materials: what fraction of the materials need to be metallic so that the composite system is an electrical conductor?





The plots below show the site vacancy probability p versus the percolation probability for 20-by-20 random grid (left) and 100-by-100 random grid (right)



To model a percolation system, create a data type Percolation with the following API:

public class Percolation {
 public Percolation(int N)
 public void open(int i, int j)
 public boolean isOpen(int i, int j)
 public boolean isFull(int i, int j)
 public boolean percolates()



Code

public class Percolation {
 private static final int TOP = 0;
 private final boolean[][] opened;
 private final int size;
 private final int bottom;
 private int openSites;
 private final WeightedQuickUnionUF qf;

```
public Percolation(int n) {
    if (n <= 0) {
        throw new IllegalArgumentException();
    }
    size = n;
    bottom = size * size + 1;
    qf = new WeightedQuickUnionUF(size * size + 2);
    opened = new boolean[size][size];
    openSites = 0;
}</pre>
```

```
public void open(int row, int col) {
    checkException(row, col);
    opened[row - 1][col - 1] = true; // Open the box
    ++openSites;
```

```
f (row > 1 && isOpen(row - 1, col)) {
    qf.union(getQuickFindIndex(row, col), getQuickFindIndex(row - 1, col));
    }
    if (row < size && isOpen(row + 1, col)) {
        qf.union(getQuickFindIndex(row, col), getQuickFindIndex(row + 1, col));
    }
    if (col > 1 && isOpen(row, col - 1)) {
        qf.union(getQuickFindIndex(row, col), getQuickFindIndex(row, col - 1));
    }
    if (col < size && isOpen(row, col + 1)) {
        qf.union(getQuickFindIndex(row, col), getQuickFindIndex(row, col + 1));
    }
}</pre>
```



public boolean isFull(int row, int col) {
 if ((row > 0 && row <= size) && (col > 0 && col <= size)) {
 return qf.find(TOP) == qf.find(getQuickFindIndex(row, col));
 } else throw new IllegalArgumentException();
}</pre>

```
import edu.princeton.cs.algs4.StdOut;
import edu.princeton.cs.algs4.StdRandom;
import edu.princeton.cs.algs4.StdStats;
public class PercolationStats {
    private static final double CONFIDENCE_95 = 1.96;
    private final int experimentsCount;
```

```
private final double[] fractions;
```

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```
public PercolationStats(int n, int t) {
    if (n <= 0 || t <= 0) {
        throw new IllegalArgumentException("Given N <= 0 || T <= 0");</pre>
    }
    experimentsCount = t;
    fractions = new double[experimentsCount];
    for (int expNum = 0; expNum < experimentsCount; expNum++) {</pre>
        Percolation pr = new Percolation(n);
        int openedSites = 0;
        while (!pr.percolates()) {
            int i = StdRandom.uniform(1, n + 1);
            int j = StdRandom.uniform(1, n + 1);
            if (!pr.is0pen(i, j)) {
                pr.open(i, j);
                openedSites++;
        double fraction = (double) openedSites / (n * n);
        fractions[expNum] = fraction;
```

```
public double mean() {
    return StdStats.mean(fractions);
}
public double stddev() {
    return StdStats.stddev(fractions);
}

public double confidenceLo() {
    return mean() - ((CONFIDENCE_95 * stddev()) / Math.sqrt(experimentsCount));
}

public double confidenceHi() {
    return mean() + ((CONFIDENCE_95 * stddev()) / Math.sqrt(experimentsCount));
}
```



OUTPUT:

110	1.	mean	=	8.592431749999998
	± 10: 21 ±	stddev	=	8.010149171394127389
		95% confidence interval		8.5904425124867508, 0.5944289875932488
		Process finished with exit code 0		



The methods and tools that we used in the process of implementing the problem allow us to solve various other issues. In our example, a widely used computing technique known as Monte Carlo simulation to study a natural model known as percolation.