Name: Jingshi Liu

Section: Image Processing

Project: **Midterm Q1 - Concavity Threshold**

Due Date: Oct 19th

Source Code:

```
import java.io.FileReader;
import java.io.FileWriter;
import java.io.IOException;
import java.util.Arrays;
import java.util.Scanner;


class ConcavityThreshold{
    int numRows, numCols, minVal, maxVal;
    int x1, x2, y1, y2;
    double m, b;
    int[] histogramArray;
    int maxHeight;
    char[][] histGraph;
    int bestThrVal;

    ConcavityThreshold(Scanner inFile1, Scanner inFile2){
        numRows = inFile1.nextInt();
        numCols = inFile1.nextInt();
        minVal = inFile1.nextInt();
        maxVal = inFile1.nextInt();
        x1 = inFile2.nextInt();
        y1 = inFile2.nextInt();
        x2 = inFile2.nextInt();
        y2 = inFile2.nextInt();
        histogramArray = new int[maxVal+1];
        maxHeight = loadHist(inFile1);
        histGraph = new char[maxVal+1][maxHeight+10];
        for(char[] hist: histGraph){
            Arrays.fill(hist, ' ');
        }
        plotHistGraph();
    }

    public int loadHist(Scanner inFile){
        int maxHeight = 0, grayScaleVal, grayScaleHeight;
        while(inFile.hasNext()){
            grayScaleVal = inFile.nextInt();
            grayScaleHeight = inFile.nextInt();

            this.histogramArray[grayScaleVal] = grayScaleHeight;
            maxHeight = Math.max(maxHeight, grayScaleHeight);
        }
        this.maxHeight = maxHeight;
        return maxHeight;
    }

    public void displayHistogram(FileWriter outFile) throws IOException {
        outFile.write(numRows + ' ' + numCols + ' ' + minVal + ' ' + maxVal + '\n');
        for (int i = 0; i < this.histogramArray.length; i++) {
            outFile.write(i + " (" + this.histogramArray[i] + "):" );
            for (int j = 0; j < this.histogramArray[i]; j++) {
                outFile.write('+');
            }
            outFile.write('\n');
        }
    }
```

```
void plotHistGraph(){
    for (int i = 0; i < maxVal + 1; i++) {
        histGraph[i][histogramArray[i]] = '*';
    }
}

void lineEQ(){
    m = (double)(y2 - y1) / (double)(x2 - x1);
    b = (double)y1 - (m * (double)x1 );
}

int deepestConcavity(){
    int max = 0, bestThrVal = x1;
    int y, gap;
    for (int x = x1; x <= x2; x++) {
        y = (int)(m * x + b);
        histGraph[x][y] = '+';
        gap = Math.abs(histogramArray[x] - y);
        if (gap > max){
            max = gap;
            bestThrVal = x;
        }
    }
    return bestThrVal;
}

public void printHistGraph(FileWriter outFile) throws IOException {
    outFile.write("Histogram Graph\n");
    for (int i = 0; i < histGraph.length; i++) {
        for (int j = 0; j < histGraph[i].length; j++) {
            outFile.write(histGraph[i][j]);
        }
        outFile.write('\n');
    }
    }
}

public class LiuJ_Q1_Java {
    public static void main(String[] args) throws IOException {
        Scanner inFile1 = new Scanner(new FileReader(args[0]));
        Scanner inFile2 = new Scanner(new FileReader(args[1]));
        FileWriter outFile = new FileWriter(args[2]);

        ConcavityThreshold concavityThreshold = new ConcavityThreshold(inFile1, inFile2);
        outFile.write("Histogram\n");
        concavityThreshold.displayHistogram(outFile);
        outFile.write("\n\n");

        concavityThreshold.lineEQ();
        int bestThrVal = concavityThreshold.deepestConcavity();
        outFile.write("The bestThrVal is: " + bestThrVal + "\n\n");

        outFile.write("Histogram with line between peaks\n");
        concavityThreshold.printHistGraph(outFile);

        inFile2.close();
        inFile1.close();
        outFile.close();

    }
}
```

Program Output

Output for Set 1

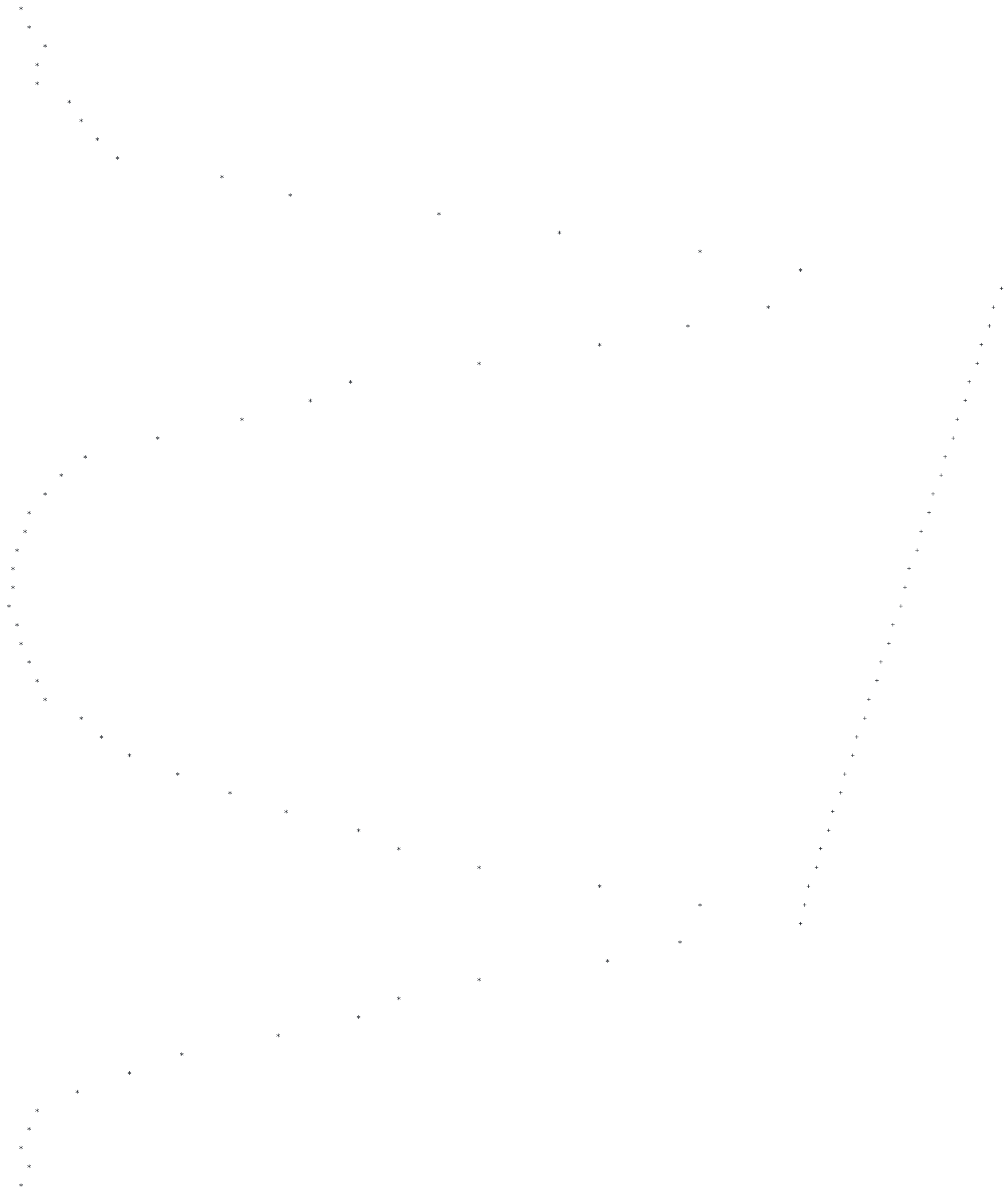
```
Histogram
```

```
ĩ0 (6):++++++
1 (8):++++++++
2 (12):++++++++++++
3 (10):++++++++++
4 (10):++++++++++
5 (18):++++++++++++++++++
6 (21):+++++++++++++++++++++
7 (25):+++++++++++++++++++++++++
8 (30):++++++++++++++++++++++++++++++
9 (56):++++++++++++++++++++++++++++++++++++++++++++++++++++++++
10 (73):+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
11 (110):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
12 (140):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
13 (175):+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
14 (200):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
15 (250):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
16 (192):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
17 (172):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
18 (150):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
19 (120):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
20 (88):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
21 (78):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
22 (61):+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
23 (40):++++++++++++++++++++++++++++++++++++++++
24 (22):++++++++++++++++++++++
25 (16):++++++++++++++++
26 (12):++++++++++++
27 (8):++++++++
28 (7):+++++++
29 (5):+++++
30 (4):++++
31 (4):++++
32 (3):+++
33 (5):+++++
34 (6):++++++
35 (8):++++++++
36 (10):++++++++++
37 (12):++++++++++++
38 (21):+++++++++++++++++++++
39 (26):++++++++++++++++++++++++++
40 (33):+++++++++++++++++++++++++++++++++
41 (45):+++++++++++++++++++++++++++++++++++++++++++++
42 (58):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
43 (72):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
44 (90):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
45 (100):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
46 (120):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
47 (150):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
48 (175):+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
49 (200):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
50 (170):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
51 (152):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
52 (120):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
53 (100):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
54 (90):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
55 (70):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
56 (46):++++++++++++++++++++++++++++++++++++++++++++++
57 (33):+++++++++++++++++++++++++++++++++
58 (20):++++++++++++++++++++
59 (10):++++++++++
60 (8):++++++++
61 (6):++++++
62 (8):++++++++
63 (6):++++++
```

```
The bestThrVal is: 27
```

Histogram with line between peaks

Histogram Graph



Output for Set 2

Histogram

```
i0 (0):
1 (0):
2 (0):
3 (0):
4 (4):++++
5 (5):+++++
6 (7):+++++++
7 (9):+++++++++
8 (11):+++++++++++
9 (10):++++++++++
10 (12):++++++++++++
11 (15):+++++++++++++++
12 (16):++++++++++++++++
13 (14):++++++++++++++
14 (15):+++++++++++++++
15 (22):++++++++++++++++++++++
16 (20):++++++++++++++++++++
17 (18):++++++++++++++++++
18 (28):++++++++++++++++++++++++++++
19 (38):++++++++++++++++++++++++++++++++++++++
20 (44):++++++++++++++++++++++++++++++++++++++++++++
21 (56):++++++++++++++++++++++++++++++++++++++++++++++++++++++++
22 (70):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
23 (90):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
24 (110):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
25 (120):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
26 (140):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
27 (155):+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
28 (170):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
29 (210):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
30 (220):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
31 (189):+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
32 (150):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
33 (120):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
34 (110):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
35 (90):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
36 (77):+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
37 (50):++++++++++++++++++++++++++++++++++++++++++++++++++
38 (28):++++++++++++++++++++++++++++
39 (12):++++++++++++
40 (10):++++++++++
41 (9):+++++++++
42 (9):+++++++++
43 (5):+++++
44 (3):+++
45 (6):++++++
46 (10):++++++++++
47 (30):++++++++++++++++++++++++++++++
48 (70):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
49 (100):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
50 (120):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
51 (145):+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
52 (188):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
53 (214):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
54 (196):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
55 (160):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
56 (138):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
57 (97):+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
58 (76):++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
59 (33):+++++++++++++++++++++++++++++++++
60 (20):++++++++++++++++++++
61 (2):++
```

The bestThrVal is: 44

Histogram with line between peaks

Histogram Graph