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Corner Detection Algorithm Steps:

Step 0: $Q \leftarrow 0$

$P \leftarrow K$

$R \leftarrow 2 * K$

Step 1: $\text{index} \leftarrow P$

Step 2: $\text{curvature} \leftarrow \text{computeCurvature}(Q, P, R)$

Step 3: $\text{PtAry}[\text{index}] \rightarrow \text{curvature} \leftarrow \text{curvature}$

Step 4: $\text{outFile3} \leftarrow \text{print } Q, P, R, \text{index}, x, y, \text{curvature of PtAry}[\text{index}]$ // for debugging to see the curvature.

Step 5: Increment Q, P, R by 1 // each need to mod with numPts

Step 6: repeat step 2 to step until $P == K-1$

Algorithm for calculating the curvature:

Step 1: Get the coordinates for p, q and r.

Step 2: Find the difference in slope (curvature) formed by line joining p and q with line joining q and r.

Step 3: Handle the possible divide by zero errors by checking if either line has the same x-coordinates or 'r'. We can do it by increasing or decreasing the value of r by 0.1.

Step 4: Use the formula to calculate curvature.

$$(c1 - c2) / (r1 - r2) - (c2 - c3) / (r2 - r3)$$

Source Code:

```
#include <iostream>
#include <fstream>
#include <string>
#include <cstdint>
using namespace std;

class BoundaryPt
{
public:
    int x, y;
    double curvature;
    int localMax;
    int corner; // 1 means it is not a corner or 9 means it is a corner
};

class Image
{
public:
    int numRows;
    int numCols;
    int minVal;
    int maxVal;
    int newMin;
    int newMax;
    int **imgAry; // a 2D array for display, initially set to 0

    Image(ifstream &inFile)
    {
        inFile >> numRows >> numCols >> minVal >> maxVal;
        imgAry = new int *[numRows];
        for (int i = 0; i < numRows; i++)
        {
            imgAry[i] = new int[numCols]();
        }
    }

    void reformatPrettyPrint(ofstream &outFile)
    {
        outFile << numRows << " " << numCols << " " << newMin << " " << newMax << endl;
        for (int i = 0; i < numRows; i++)
        {
            for (int j = 0; j < numCols; j++)
            {
                if (imgAry[i][j] > 0)
                {
                    outFile << imgAry[i][j] << " ";
                }
            }
        }
    }
};
```

```

        }
        else
        {
            outFile << ". ";
        }
    }
    outFile << endl;
}

~Image()
{
    for (int i = 0; i < numRows; i++)
    {
        delete[] imgAry[i];
    }
}
};

class kCurvature
{
public:
    int K;
    int numPts;           //number of boundary Points
    int Q;                //an index of the array, initially set to 0
    int P;                //an index of the array, initially set to K
    int R;                //an index of the array, initially set to 2*K
    BoundaryPt *PtAry;    // an 1D array of boundaryPt class size is numPts,
    // need to dynamically allocate.
    // use mod function to compute the curvature for the beginning of
    // the K points without extending the tail of the array,
    int label;

    void init(ifstream &inFile, string inputFileName)
    {
        countPts(inFile);
        //initializing boundaryPts array
        PtAry = new BoundaryPt[numPts];

        inFile.close();
        inFile.open(inputFileName);
        int a;
        //skipping image header and label
        inFile >> a >> a >> a >> a >> label;

        //Storing each points in the array
        for (int i = 0; i < numPts; i++)
        {
            int x, y;
            inFile >> x >> y;

```

```

        storePt(x, y, i);
    }
}

void cornerDetection(ofstream &debugFile)
{
    Q = 0;
    P = K;
    R = 2 * K;
    cout << "K" << K << endl;
    cout << "Number of Pts: " << numPts << endl;
    for (int i = 0; i < numPts; i++)
    {
        double curvature = computeCurvature(Q, P, R);
        PtAry[P].curvature = curvature;
        P = (P + 1) % numPts;
        Q = (Q + 1) % numPts;
        R = (R + 1) % numPts;
    }
}

void countPts(istream &inFile)
{
    int x, y;
    int count = 0;
    while (inFile >> x && inFile >> y)
    {
        count++;
    }
    numPts = count;
}

void storePt(int x, int y, int index)
{
    PtAry[index].x = x;
    PtAry[index].y = y;
}

double computeCurvature(int q, int p, int r)
{
    cout << "Q: " << Q << " P: " << P << " R: " << R << " ";
    cout << "P has " << PtAry[p].x << " " << PtAry[p].y << " ";
    double r1 = (double)PtAry[q].x;
    double c1 = (double)PtAry[q].y;
    double r2 = (double)PtAry[p].x;
    double c2 = (double)PtAry[p].y;
    double r3 = (double)PtAry[r].x;
    double c3 = (double)PtAry[r].y;

```

```

        cout << "r1 c1 r2 c2 r3 c3: " << r1 << " " << c1 << " " << r2 << " " << c2 << " "
<< r3 << " " << c3 << " ";

    //Math error cases
    if (r1 == r2)
    {
        r2 = r2 + 0.1;
        cout << " Math Error";
    }
    if (r2 == r3)
    {
        r2 = r2 + 0.1;
        cout << " Maths error";
    }

    double curvature = (c1 - c2) / (r1 - r2) - (c2 - c3) / (r2 - r3);

    cout << " Curvature: " << curvature << endl;
    return curvature;
}

void computeLocalMaxima()
{
    // P(i) is a local maxima if in its 1 X 5 neighborhood if the curvature
    // of p(i) is >= the curvatures of
    // its linear neighbors: p(i-2), p(i-1), p(i+1), p(i+2)
    // returns 1 if yes, returns 0 if not.
    for (int i = 2; i < numPts + 2; i++)
    {
        double neighbour1 = PtAry[(i - 2) % numPts].curvature;
        double neighbour2 = PtAry[(i - 1) % numPts].curvature;
        double neighbour3 = PtAry[(i + 1) % numPts].curvature;
        double neighbour4 = PtAry[(i + 2) % numPts].curvature;

        int index = i % numPts;
        double p = PtAry[index].curvature;
        if (p >= neighbour1 && p >= neighbour2 && p >= neighbour3 && p >= neighbour4)
        {
            PtAry[index].localMax = 1;
        }
        else
        {
            PtAry[index].localMax = 0;
        }
    }
}

void markCorner()
{

```

```
    const int t = 1; //t is threshold value of change in curvature. We ignore change in curvature that is smaller than t.
```

```
    //Corner pixel has maximum change in curvature
```

```
    for (int i = K; i < numPts + K; i++)
    {
        int pCurvature = PtAry[i % numPts].curvature;
        int qCurvature = PtAry[(i - 1) % numPts].curvature;
        int rCurvature = PtAry[(i + 1) % numPts].curvature;

        if (abs(pCurvature - qCurvature) >= t && abs(pCurvature - rCurvature) >= t)
        {
            PtAry[i % numPts].corner = 9;
        }
        else
        {
            PtAry[i % numPts].corner = 1;
        }
    }
}
```

```
void display(Image &img)
```

```
{
    img.newMax = 0;
    for (int i = 0; i < numPts; i++)
    {
        int x = PtAry[i].x;
        int y = PtAry[i].y;
        img.imgAry[x][y] = PtAry[i].corner;

        //Updating newMax
        if (PtAry[i].corner > img.newMax)
        {
            img.newMax = PtAry[i].corner;
        }
    }
}
```

```
void printBoundary(ofstream &outFile)
```

```
{
    outFile << numPts << endl;
    for (int i = 0; i < numPts; i++)
    {
        outFile << PtAry[i].x << " " << PtAry[i].y
            << " " << PtAry[i].corner << endl;
    }
}
```

```
void printPtAry(ofstream &outFile) // For debugging, print the content of the entire PtAry to outFile3
```

```

{
    for (int i = 0; i < numPts; i++)
    {
        outFile << "r: " << PtAry[i].x << " c: " << PtAry[i].y << " "
            << " Curvature: " << PtAry[i].curvature << " Corner: " <<
PtAry[i].corner << endl;
    }
}

~kCurvature()
{
    delete[] PtAry;
}
};

int main(int argc, const char *argv[])
{
    // READ
    string inputName = argv[1];
    ifstream input;
    input.open(inputName);

    //WRITES
    string outFile1Name = argv[2],
        outFile2Name = argv[3], outFile3Name = argv[4];
    ofstream outFile1, outFile2, outFile3;
    outFile1.open(outFile1Name);
    outFile2.open(outFile2Name);
    outFile3.open(outFile3Name);

    //Input for K
    int K;
    cout << "Enter the value of K: ";
    cin >> K;

    //Checking if IO operations succeeds
    if (input.is_open())
    {
        if (outFile1.is_open() && outFile2.is_open() && outFile3.is_open())
        {
            Image img(input);
            int label;
            input >> label;
            kCurvature k;
            k.K = K;
            k.init(input, inputName);
            outFile3 << endl
                << "Before applying k curvature corner detection algorithm:" << endl;
            k.printPtAry(outFile3);
            k.cornerDetection(outFile3);

```

```

        outFile3 << endl
            << "After applying k curvature corner detection algorithm:" << endl;
        k.printPtAry(outFile3);
        k.computeLocalMaxima();
        k.markCorner();
        outFile3 << endl
            << "After marking corners:" << endl;
        k.printPtAry(outFile3);
        outFile1 << img.numRows << " " << img.numCols << " " << img.minVal << " " <<
img.maxVal << endl;
        outFile1 << k.label << endl;
        k.printBoundary(outFile1);
        k.display(img);
        img.reformatPrettyPrint(outFile2);
    }
    else
    {
        cout << "ERROR: Some output files is missing or couldnt be opened." << endl;
    }
}
else
{
    cout << "ERROR: The input file with following name does not exists or there was
problem reading it: " << inputName << endl;
}

    input.close();
    outFile1.close();
    outFile2.close();
    outFile3.close();
    return 0;
};

```


Outputs

Data_A:

Result of K-Curvature of the object boundary points

```
30 40 0 1
1
96
6 6 9
7 6 1
8 6 1
9 6 1
10 6 1
11 6 1
12 6 1
13 6 1
14 6 1
15 6 1
16 6 1
17 6 1
18 6 1
19 6 1
20 6 1
21 6 1
22 6 1
23 6 1
24 6 1
25 6 9
25 7 1
25 8 1
25 9 1
25 10 1
25 11 1
25 12 1
25 13 1
25 14 1
25 15 1
25 16 1
25 17 1
25 18 1
25 19 1
25 20 1
25 21 1
25 22 1
25 23 1
25 24 1
25 25 1
25 26 1
25 27 1
25 28 1
25 29 1
25 30 1
25 31 1
25 32 1
25 33 1
25 34 1
25 35 9
24 35 1
23 35 1
22 35 1
21 35 1
20 35 1
19 35 1
18 35 1
17 35 1
16 35 1
15 35 1
14 35 1
13 35 1
12 35 1
```

11	35	1
10	35	1
9	35	1
8	35	1
7	35	1
6	35	9
6	34	1
6	33	1
6	32	1
6	31	1
6	30	1
6	29	1
6	28	1
6	27	1
6	26	1
6	25	1
6	24	1
6	23	1
6	22	1
6	21	1
6	20	1
6	19	1
6	18	1
6	17	1
6	16	1
6	15	1
6	14	1
6	13	1
6	12	1
6	11	1
6	10	1
6	9	1
6	8	1
6	7	1

Pretty Print of the K-curvature corner detection

[illegible]

Debug File

Before applying k curvature corner detection algorithm:

```
r: 6 c: 6 Curvature: 0 Corner: 0
r: 7 c: 6 Curvature: 0 Corner: 0
r: 8 c: 6 Curvature: 0 Corner: 0
r: 9 c: 6 Curvature: 0 Corner: 0
r: 10 c: 6 Curvature: 0 Corner: 0
r: 11 c: 6 Curvature: 0 Corner: 0
r: 12 c: 6 Curvature: 0 Corner: 0
r: 13 c: 6 Curvature: 0 Corner: 0
r: 14 c: 6 Curvature: 0 Corner: 0
r: 15 c: 6 Curvature: 0 Corner: 0
r: 16 c: 6 Curvature: 0 Corner: 0
r: 17 c: 6 Curvature: 0 Corner: 0
r: 18 c: 6 Curvature: 0 Corner: 0
r: 19 c: 6 Curvature: 0 Corner: 0
r: 20 c: 6 Curvature: 0 Corner: 0
r: 21 c: 6 Curvature: 0 Corner: 0
r: 22 c: 6 Curvature: 0 Corner: 0
r: 23 c: 6 Curvature: 0 Corner: 0
r: 24 c: 6 Curvature: 0 Corner: 0
r: 25 c: 6 Curvature: 0 Corner: 0
r: 25 c: 7 Curvature: 0 Corner: 0
r: 25 c: 8 Curvature: 0 Corner: 0
r: 25 c: 9 Curvature: 0 Corner: 0
r: 25 c: 10 Curvature: 0 Corner: 0
r: 25 c: 11 Curvature: 0 Corner: 0
r: 25 c: 12 Curvature: 0 Corner: 0
r: 25 c: 13 Curvature: 0 Corner: 0
r: 25 c: 14 Curvature: 0 Corner: 0
r: 25 c: 15 Curvature: 0 Corner: 0
r: 25 c: 16 Curvature: 0 Corner: 0
r: 25 c: 17 Curvature: 0 Corner: 0
r: 25 c: 18 Curvature: 0 Corner: 0
r: 25 c: 19 Curvature: 0 Corner: 0
r: 25 c: 20 Curvature: 0 Corner: 0
r: 25 c: 21 Curvature: 0 Corner: 0
r: 25 c: 22 Curvature: 0 Corner: 0
r: 25 c: 23 Curvature: 0 Corner: 0
r: 25 c: 24 Curvature: 0 Corner: 0
r: 25 c: 25 Curvature: 0 Corner: 0
r: 25 c: 26 Curvature: 0 Corner: 0
r: 25 c: 27 Curvature: 0 Corner: 0
r: 25 c: 28 Curvature: 0 Corner: 0
r: 25 c: 29 Curvature: 0 Corner: 0
r: 25 c: 30 Curvature: 0 Corner: 0
r: 25 c: 31 Curvature: 0 Corner: 0
r: 25 c: 32 Curvature: 0 Corner: 0
r: 25 c: 33 Curvature: 0 Corner: 0
r: 25 c: 34 Curvature: 0 Corner: 0
r: 25 c: 35 Curvature: 0 Corner: 0
r: 24 c: 35 Curvature: 0 Corner: 0
r: 23 c: 35 Curvature: 0 Corner: 0
r: 22 c: 35 Curvature: 0 Corner: 0
r: 21 c: 35 Curvature: 0 Corner: 0
r: 20 c: 35 Curvature: 0 Corner: 0
r: 19 c: 35 Curvature: 0 Corner: 0
r: 18 c: 35 Curvature: 0 Corner: 0
r: 17 c: 35 Curvature: 0 Corner: 0
r: 16 c: 35 Curvature: 0 Corner: 0
r: 15 c: 35 Curvature: 0 Corner: 0
r: 14 c: 35 Curvature: 0 Corner: 0
r: 13 c: 35 Curvature: 0 Corner: 0
r: 12 c: 35 Curvature: 0 Corner: 0
r: 11 c: 35 Curvature: 0 Corner: 0
r: 10 c: 35 Curvature: 0 Corner: 0
r: 9 c: 35 Curvature: 0 Corner: 0
r: 8 c: 35 Curvature: 0 Corner: 0
r: 7 c: 35 Curvature: 0 Corner: 0
r: 6 c: 35 Curvature: 0 Corner: 0
r: 6 c: 34 Curvature: 0 Corner: 0
r: 6 c: 33 Curvature: 0 Corner: 0
```

```
r: 6 c: 32 Curvature: 0 Corner: 0
r: 6 c: 31 Curvature: 0 Corner: 0
r: 6 c: 30 Curvature: 0 Corner: 0
r: 6 c: 29 Curvature: 0 Corner: 0
r: 6 c: 28 Curvature: 0 Corner: 0
r: 6 c: 27 Curvature: 0 Corner: 0
r: 6 c: 26 Curvature: 0 Corner: 0
r: 6 c: 25 Curvature: 0 Corner: 0
r: 6 c: 24 Curvature: 0 Corner: 0
r: 6 c: 23 Curvature: 0 Corner: 0
r: 6 c: 22 Curvature: 0 Corner: 0
r: 6 c: 21 Curvature: 0 Corner: 0
r: 6 c: 20 Curvature: 0 Corner: 0
r: 6 c: 19 Curvature: 0 Corner: 0
r: 6 c: 18 Curvature: 0 Corner: 0
r: 6 c: 17 Curvature: 0 Corner: 0
r: 6 c: 16 Curvature: 0 Corner: 0
r: 6 c: 15 Curvature: 0 Corner: 0
r: 6 c: 14 Curvature: 0 Corner: 0
r: 6 c: 13 Curvature: 0 Corner: 0
r: 6 c: 12 Curvature: 0 Corner: 0
r: 6 c: 11 Curvature: 0 Corner: 0
r: 6 c: 10 Curvature: 0 Corner: 0
r: 6 c: 9 Curvature: 0 Corner: 0
r: 6 c: 8 Curvature: 0 Corner: 0
r: 6 c: 7 Curvature: 0 Corner: 0
```

After applying k curvature corner detection algorithm:

```
r: 6 c: 6 Curvature: -10 Corner: 0
r: 7 c: 6 Curvature: 0 Corner: 0
r: 8 c: 6 Curvature: 0 Corner: 0
r: 9 c: 6 Curvature: 0 Corner: 0
r: 10 c: 6 Curvature: 0 Corner: 0
r: 11 c: 6 Curvature: 0 Corner: 0
r: 12 c: 6 Curvature: 0 Corner: 0
r: 13 c: 6 Curvature: 0 Corner: 0
r: 14 c: 6 Curvature: 0 Corner: 0
r: 15 c: 6 Curvature: 0 Corner: 0
r: 16 c: 6 Curvature: 0 Corner: 0
r: 17 c: 6 Curvature: 0 Corner: 0
r: 18 c: 6 Curvature: 0 Corner: 0
r: 19 c: 6 Curvature: 0 Corner: 0
r: 20 c: 6 Curvature: 0 Corner: 0
r: 21 c: 6 Curvature: 0 Corner: 0
r: 22 c: 6 Curvature: 0 Corner: 0
r: 23 c: 6 Curvature: 0 Corner: 0
r: 24 c: 6 Curvature: 0 Corner: 0
r: 25 c: 6 Curvature: 10 Corner: 0
r: 25 c: 7 Curvature: 20 Corner: 0
r: 25 c: 8 Curvature: 20 Corner: 0
r: 25 c: 9 Curvature: 20 Corner: 0
r: 25 c: 10 Curvature: 20 Corner: 0
r: 25 c: 11 Curvature: 20 Corner: 0
r: 25 c: 12 Curvature: 20 Corner: 0
r: 25 c: 13 Curvature: 20 Corner: 0
r: 25 c: 14 Curvature: 20 Corner: 0
r: 25 c: 15 Curvature: 20 Corner: 0
r: 25 c: 16 Curvature: 20 Corner: 0
r: 25 c: 17 Curvature: 20 Corner: 0
r: 25 c: 18 Curvature: 20 Corner: 0
r: 25 c: 19 Curvature: 20 Corner: 0
r: 25 c: 20 Curvature: 20 Corner: 0
r: 25 c: 21 Curvature: 20 Corner: 0
r: 25 c: 22 Curvature: 20 Corner: 0
r: 25 c: 23 Curvature: 20 Corner: 0
r: 25 c: 24 Curvature: 20 Corner: 0
r: 25 c: 25 Curvature: 20 Corner: 0
r: 25 c: 26 Curvature: 20 Corner: 0
r: 25 c: 27 Curvature: 20 Corner: 0
r: 25 c: 28 Curvature: 20 Corner: 0
r: 25 c: 29 Curvature: 20 Corner: 0
r: 25 c: 30 Curvature: 20 Corner: 0
r: 25 c: 31 Curvature: 20 Corner: 0
r: 25 c: 32 Curvature: 20 Corner: 0
r: 25 c: 33 Curvature: 20 Corner: 0
r: 25 c: 34 Curvature: 20 Corner: 0
```

```

r: 25 c: 35 Curvature: 10 Corner: 0
r: 24 c: 35 Curvature: 0 Corner: 0
r: 23 c: 35 Curvature: 0 Corner: 0
r: 22 c: 35 Curvature: 0 Corner: 0
r: 21 c: 35 Curvature: 0 Corner: 0
r: 20 c: 35 Curvature: 0 Corner: 0
r: 19 c: 35 Curvature: 0 Corner: 0
r: 18 c: 35 Curvature: 0 Corner: 0
r: 17 c: 35 Curvature: 0 Corner: 0
r: 16 c: 35 Curvature: 0 Corner: 0
r: 15 c: 35 Curvature: 0 Corner: 0
r: 14 c: 35 Curvature: 0 Corner: 0
r: 13 c: 35 Curvature: 0 Corner: 0
r: 12 c: 35 Curvature: 0 Corner: 0
r: 11 c: 35 Curvature: 0 Corner: 0
r: 10 c: 35 Curvature: 0 Corner: 0
r: 9 c: 35 Curvature: 0 Corner: 0
r: 8 c: 35 Curvature: 0 Corner: 0
r: 7 c: 35 Curvature: 0 Corner: 0
r: 6 c: 35 Curvature: -10 Corner: 0
r: 6 c: 34 Curvature: -20 Corner: 0
r: 6 c: 33 Curvature: -20 Corner: 0
r: 6 c: 32 Curvature: -20 Corner: 0
r: 6 c: 31 Curvature: -20 Corner: 0
r: 6 c: 30 Curvature: -20 Corner: 0
r: 6 c: 29 Curvature: -20 Corner: 0
r: 6 c: 28 Curvature: -20 Corner: 0
r: 6 c: 27 Curvature: -20 Corner: 0
r: 6 c: 26 Curvature: -20 Corner: 0
r: 6 c: 25 Curvature: -20 Corner: 0
r: 6 c: 24 Curvature: -20 Corner: 0
r: 6 c: 23 Curvature: -20 Corner: 0
r: 6 c: 22 Curvature: -20 Corner: 0
r: 6 c: 21 Curvature: -20 Corner: 0
r: 6 c: 20 Curvature: -20 Corner: 0
r: 6 c: 19 Curvature: -20 Corner: 0
r: 6 c: 18 Curvature: -20 Corner: 0
r: 6 c: 17 Curvature: -20 Corner: 0
r: 6 c: 16 Curvature: -20 Corner: 0
r: 6 c: 15 Curvature: -20 Corner: 0
r: 6 c: 14 Curvature: -20 Corner: 0
r: 6 c: 13 Curvature: -20 Corner: 0
r: 6 c: 12 Curvature: -20 Corner: 0
r: 6 c: 11 Curvature: -20 Corner: 0
r: 6 c: 10 Curvature: -20 Corner: 0
r: 6 c: 9 Curvature: -20 Corner: 0
r: 6 c: 8 Curvature: -20 Corner: 0
r: 6 c: 7 Curvature: -20 Corner: 0

```

After marking corners:

```

r: 6 c: 6 Curvature: -10 Corner: 9
r: 7 c: 6 Curvature: 0 Corner: 1
r: 8 c: 6 Curvature: 0 Corner: 1
r: 9 c: 6 Curvature: 0 Corner: 1
r: 10 c: 6 Curvature: 0 Corner: 1
r: 11 c: 6 Curvature: 0 Corner: 1
r: 12 c: 6 Curvature: 0 Corner: 1
r: 13 c: 6 Curvature: 0 Corner: 1
r: 14 c: 6 Curvature: 0 Corner: 1
r: 15 c: 6 Curvature: 0 Corner: 1
r: 16 c: 6 Curvature: 0 Corner: 1
r: 17 c: 6 Curvature: 0 Corner: 1
r: 18 c: 6 Curvature: 0 Corner: 1
r: 19 c: 6 Curvature: 0 Corner: 1
r: 20 c: 6 Curvature: 0 Corner: 1
r: 21 c: 6 Curvature: 0 Corner: 1
r: 22 c: 6 Curvature: 0 Corner: 1
r: 23 c: 6 Curvature: 0 Corner: 1
r: 24 c: 6 Curvature: 0 Corner: 1
r: 25 c: 6 Curvature: 10 Corner: 9
r: 25 c: 7 Curvature: 20 Corner: 1
r: 25 c: 8 Curvature: 20 Corner: 1
r: 25 c: 9 Curvature: 20 Corner: 1
r: 25 c: 10 Curvature: 20 Corner: 1
r: 25 c: 11 Curvature: 20 Corner: 1
r: 25 c: 12 Curvature: 20 Corner: 1

```

[illegible]

Data_B:

Result of K-Curvature of the object boundary points

```
31 41 0 1
1
56
1 20 9
2 19 1
3 18 1
4 17 1
5 16 1
6 15 1
7 14 1
8 13 1
9 12 1
10 11 1
11 10 1
12 9 1
13 8 1
14 7 1
15 6 9
16 7 1
17 8 1
18 9 1
19 10 1
20 11 1
21 12 1
22 13 1
23 14 1
24 15 1
25 16 1
26 17 1
27 18 1
28 19 1
29 20 9
28 21 1
27 22 1
26 23 1
25 24 1
24 25 1
23 26 1
22 27 1
21 28 1
20 29 1
19 30 1
18 31 1
17 32 1
16 33 1
15 34 9
14 33 1
13 32 1
12 31 1
11 30 1
10 29 1
9 28 1
8 27 1
7 26 1
6 25 1
5 24 1
4 23 1
3 22 1
2 21 1
```

[illegible]

Before applying k curvature corner detection algorithm:

r: 1	c: 20	Curvature: 0	Corner: 0
r: 2	c: 19	Curvature: 0	Corner: 0
r: 3	c: 18	Curvature: 0	Corner: 0
r: 4	c: 17	Curvature: 0	Corner: 0
r: 5	c: 16	Curvature: 0	Corner: 0
r: 6	c: 15	Curvature: 0	Corner: 0
r: 7	c: 14	Curvature: 0	Corner: 0
r: 8	c: 13	Curvature: 0	Corner: 0
r: 9	c: 12	Curvature: 0	Corner: 0
r: 10	c: 11	Curvature: 0	Corner: 0
r: 11	c: 10	Curvature: 0	Corner: 0
r: 12	c: 9	Curvature: 0	Corner: 0
r: 13	c: 8	Curvature: 0	Corner: 0
r: 14	c: 7	Curvature: 0	Corner: 0
r: 15	c: 6	Curvature: 0	Corner: 0
r: 16	c: 7	Curvature: 0	Corner: 0
r: 17	c: 8	Curvature: 0	Corner: 0
r: 18	c: 9	Curvature: 0	Corner: 0
r: 19	c: 10	Curvature: 0	Corner: 0
r: 20	c: 11	Curvature: 0	Corner: 0
r: 21	c: 12	Curvature: 0	Corner: 0
r: 22	c: 13	Curvature: 0	Corner: 0
r: 23	c: 14	Curvature: 0	Corner: 0
r: 24	c: 15	Curvature: 0	Corner: 0
r: 25	c: 16	Curvature: 0	Corner: 0
r: 26	c: 17	Curvature: 0	Corner: 0
r: 27	c: 18	Curvature: 0	Corner: 0
r: 28	c: 19	Curvature: 0	Corner: 0
r: 29	c: 20	Curvature: 0	Corner: 0
r: 28	c: 21	Curvature: 0	Corner: 0
r: 27	c: 22	Curvature: 0	Corner: 0


```

r: 26 c: 23 Curvature: 0 Corner: 0
r: 25 c: 24 Curvature: 0 Corner: 0
r: 24 c: 25 Curvature: 0 Corner: 0
r: 23 c: 26 Curvature: 0 Corner: 0
r: 22 c: 27 Curvature: 0 Corner: 0
r: 21 c: 28 Curvature: 0 Corner: 0
r: 20 c: 29 Curvature: 0 Corner: 0
r: 19 c: 30 Curvature: 0 Corner: 0
r: 18 c: 31 Curvature: 0 Corner: 0
r: 17 c: 32 Curvature: 0 Corner: 0
r: 16 c: 33 Curvature: 0 Corner: 0
r: 15 c: 34 Curvature: 0 Corner: 0
r: 14 c: 33 Curvature: 0 Corner: 0
r: 13 c: 32 Curvature: 0 Corner: 0
r: 12 c: 31 Curvature: 0 Corner: 0
r: 11 c: 30 Curvature: 0 Corner: 0
r: 10 c: 29 Curvature: 0 Corner: 0
r: 9 c: 28 Curvature: 0 Corner: 0
r: 8 c: 27 Curvature: 0 Corner: 0
r: 7 c: 26 Curvature: 0 Corner: 0
r: 6 c: 25 Curvature: 0 Corner: 0
r: 5 c: 24 Curvature: 0 Corner: 0
r: 4 c: 23 Curvature: 0 Corner: 0
r: 3 c: 22 Curvature: 0 Corner: 0
r: 2 c: 21 Curvature: 0 Corner: 0

```

After applying k curvature corner detection algorithm:

```

r: 1 c: 20 Curvature: 2 Corner: 0
r: 2 c: 19 Curvature: 0 Corner: 0
r: 3 c: 18 Curvature: 0 Corner: 0
r: 4 c: 17 Curvature: 0 Corner: 0
r: 5 c: 16 Curvature: 0 Corner: 0
r: 6 c: 15 Curvature: 0 Corner: 0
r: 7 c: 14 Curvature: 0 Corner: 0
r: 8 c: 13 Curvature: 0 Corner: 0
r: 9 c: 12 Curvature: 0 Corner: 0
r: 10 c: 11 Curvature: 0 Corner: 0
r: 11 c: 10 Curvature: 0 Corner: 0
r: 12 c: 9 Curvature: 0 Corner: 0
r: 13 c: 8 Curvature: 0 Corner: 0
r: 14 c: 7 Curvature: 0 Corner: 0
r: 15 c: 6 Curvature: -2 Corner: 0
r: 16 c: 7 Curvature: 0 Corner: 0
r: 17 c: 8 Curvature: 0 Corner: 0
r: 18 c: 9 Curvature: 0 Corner: 0
r: 19 c: 10 Curvature: 0 Corner: 0
r: 20 c: 11 Curvature: 0 Corner: 0
r: 21 c: 12 Curvature: 0 Corner: 0
r: 22 c: 13 Curvature: 0 Corner: 0
r: 23 c: 14 Curvature: 0 Corner: 0
r: 24 c: 15 Curvature: 0 Corner: 0
r: 25 c: 16 Curvature: 0 Corner: 0
r: 26 c: 17 Curvature: 0 Corner: 0
r: 27 c: 18 Curvature: 0 Corner: 0
r: 28 c: 19 Curvature: 0 Corner: 0
r: 29 c: 20 Curvature: 2 Corner: 0
r: 28 c: 21 Curvature: 0 Corner: 0
r: 27 c: 22 Curvature: 0 Corner: 0
r: 26 c: 23 Curvature: 0 Corner: 0
r: 25 c: 24 Curvature: 0 Corner: 0
r: 24 c: 25 Curvature: 0 Corner: 0
r: 23 c: 26 Curvature: 0 Corner: 0
r: 22 c: 27 Curvature: 0 Corner: 0
r: 21 c: 28 Curvature: 0 Corner: 0
r: 20 c: 29 Curvature: 0 Corner: 0
r: 19 c: 30 Curvature: 0 Corner: 0
r: 18 c: 31 Curvature: 0 Corner: 0
r: 17 c: 32 Curvature: 0 Corner: 0
r: 16 c: 33 Curvature: 0 Corner: 0
r: 15 c: 34 Curvature: -2 Corner: 0
r: 14 c: 33 Curvature: 0 Corner: 0
r: 13 c: 32 Curvature: 0 Corner: 0
r: 12 c: 31 Curvature: 0 Corner: 0
r: 11 c: 30 Curvature: 0 Corner: 0
r: 10 c: 29 Curvature: 0 Corner: 0
r: 9 c: 28 Curvature: 0 Corner: 0

```

r: 8 c: 27 Curvature: 0 Corner: 0
r: 7 c: 26 Curvature: 0 Corner: 0
r: 6 c: 25 Curvature: 0 Corner: 0
r: 5 c: 24 Curvature: 0 Corner: 0
r: 4 c: 23 Curvature: 0 Corner: 0
r: 3 c: 22 Curvature: 0 Corner: 0
r: 2 c: 21 Curvature: 0 Corner: 0

After marking corners:

r: 1 c: 20 Curvature: 2 Corner: 9
r: 2 c: 19 Curvature: 0 Corner: 1
r: 3 c: 18 Curvature: 0 Corner: 1
r: 4 c: 17 Curvature: 0 Corner: 1
r: 5 c: 16 Curvature: 0 Corner: 1
r: 6 c: 15 Curvature: 0 Corner: 1
r: 7 c: 14 Curvature: 0 Corner: 1
r: 8 c: 13 Curvature: 0 Corner: 1
r: 9 c: 12 Curvature: 0 Corner: 1
r: 10 c: 11 Curvature: 0 Corner: 1
r: 11 c: 10 Curvature: 0 Corner: 1
r: 12 c: 9 Curvature: 0 Corner: 1
r: 13 c: 8 Curvature: 0 Corner: 1
r: 14 c: 7 Curvature: 0 Corner: 1
r: 15 c: 6 Curvature: -2 Corner: 9
r: 16 c: 7 Curvature: 0 Corner: 1
r: 17 c: 8 Curvature: 0 Corner: 1
r: 18 c: 9 Curvature: 0 Corner: 1
r: 19 c: 10 Curvature: 0 Corner: 1
r: 20 c: 11 Curvature: 0 Corner: 1
r: 21 c: 12 Curvature: 0 Corner: 1
r: 22 c: 13 Curvature: 0 Corner: 1
r: 23 c: 14 Curvature: 0 Corner: 1
r: 24 c: 15 Curvature: 0 Corner: 1
r: 25 c: 16 Curvature: 0 Corner: 1
r: 26 c: 17 Curvature: 0 Corner: 1
r: 27 c: 18 Curvature: 0 Corner: 1
r: 28 c: 19 Curvature: 0 Corner: 1
r: 29 c: 20 Curvature: 2 Corner: 9
r: 28 c: 21 Curvature: 0 Corner: 1
r: 27 c: 22 Curvature: 0 Corner: 1
r: 26 c: 23 Curvature: 0 Corner: 1
r: 25 c: 24 Curvature: 0 Corner: 1
r: 24 c: 25 Curvature: 0 Corner: 1
r: 23 c: 26 Curvature: 0 Corner: 1
r: 22 c: 27 Curvature: 0 Corner: 1
r: 21 c: 28 Curvature: 0 Corner: 1
r: 20 c: 29 Curvature: 0 Corner: 1
r: 19 c: 30 Curvature: 0 Corner: 1
r: 18 c: 31 Curvature: 0 Corner: 1
r: 17 c: 32 Curvature: 0 Corner: 1
r: 16 c: 33 Curvature: 0 Corner: 1
r: 15 c: 34 Curvature: -2 Corner: 9
r: 14 c: 33 Curvature: 0 Corner: 1
r: 13 c: 32 Curvature: 0 Corner: 1
r: 12 c: 31 Curvature: 0 Corner: 1
r: 11 c: 30 Curvature: 0 Corner: 1
r: 10 c: 29 Curvature: 0 Corner: 1
r: 9 c: 28 Curvature: 0 Corner: 1
r: 8 c: 27 Curvature: 0 Corner: 1
r: 7 c: 26 Curvature: 0 Corner: 1
r: 6 c: 25 Curvature: 0 Corner: 1
r: 5 c: 24 Curvature: 0 Corner: 1
r: 4 c: 23 Curvature: 0 Corner: 1
r: 3 c: 22 Curvature: 0 Corner: 1
r: 2 c: 21 Curvature: 0 Corner: 1

Data_C:

Result of K-Curvature of the object boundary points

```
40 40 0 1
1
108
5 5 9
6 5 1
7 5 1
8 5 1
9 5 1
10 5 1
11 5 1
12 5 1
13 5 1
14 5 1
15 5 9
16 6 1
17 7 1
18 8 1
19 9 1
20 10 9
21 9 1
22 8 1
23 7 1
24 6 1
25 5 9
26 5 1
27 5 1
28 5 1
29 5 1
30 5 1
31 5 1
32 5 1
33 5 1
34 5 1
35 5 9
35 6 1
35 7 1
35 8 1
35 9 1
35 10 1
35 11 1
35 12 1
35 13 1
35 14 1
35 15 1
35 16 1
35 17 1
35 18 1
35 19 1
35 20 1
35 21 1
35 22 1
35 23 1
35 24 1
35 25 1
35 26 1
35 27 1
35 28 1
35 29 9
34 29 1
33 29 1
32 29 1
31 29 1
30 29 1
29 29 1
28 29 1
27 29 1
26 29 1
25 29 9
24 30 1
23 31 1
22 32 1
21 33 1
20 34 9
19 33 1
18 32 1
17 31 1
16 30 1
15 29 9
14 29 1
13 29 1
12 29 1
```

11	29	1
10	29	1
9	29	1
8	29	1
7	29	1
6	29	1
5	29	9
5	28	1
5	27	1
5	26	1
5	25	1
5	24	1
5	23	1
5	22	1
5	21	1
5	20	1
5	19	1
5	18	1
5	17	1
5	16	1
5	15	1
5	14	1
5	13	1
5	12	1
5	11	1
5	10	1
5	9	1
5	8	1
5	7	1
5	6	1

Pretty Print of the K-curvature corner detection

40 40 0 9

[illegible]

Debug File

Before applying k curvature corner detection algorithm:

```
r: 5 c: 5 Curvature: 0 Corner: 0
r: 6 c: 5 Curvature: 0 Corner: 0
r: 7 c: 5 Curvature: 0 Corner: 0
r: 8 c: 5 Curvature: 0 Corner: 0
r: 9 c: 5 Curvature: 0 Corner: 0
r: 10 c: 5 Curvature: 0 Corner: 0
r: 11 c: 5 Curvature: 0 Corner: 0
r: 12 c: 5 Curvature: 0 Corner: 0
r: 13 c: 5 Curvature: 0 Corner: 0
r: 14 c: 5 Curvature: 0 Corner: 0
r: 15 c: 5 Curvature: 0 Corner: 0
r: 16 c: 6 Curvature: 0 Corner: 0
r: 17 c: 7 Curvature: 0 Corner: 0
r: 18 c: 8 Curvature: 0 Corner: 0
r: 19 c: 9 Curvature: 0 Corner: 0
r: 20 c: 10 Curvature: 0 Corner: 0
r: 21 c: 9 Curvature: 0 Corner: 0
r: 22 c: 8 Curvature: 0 Corner: 0
r: 23 c: 7 Curvature: 0 Corner: 0
r: 24 c: 6 Curvature: 0 Corner: 0
r: 25 c: 5 Curvature: 0 Corner: 0
r: 26 c: 5 Curvature: 0 Corner: 0
r: 27 c: 5 Curvature: 0 Corner: 0
r: 28 c: 5 Curvature: 0 Corner: 0
r: 29 c: 5 Curvature: 0 Corner: 0
r: 30 c: 5 Curvature: 0 Corner: 0
r: 31 c: 5 Curvature: 0 Corner: 0
r: 32 c: 5 Curvature: 0 Corner: 0
r: 33 c: 5 Curvature: 0 Corner: 0
r: 34 c: 5 Curvature: 0 Corner: 0
r: 35 c: 5 Curvature: 0 Corner: 0
r: 35 c: 6 Curvature: 0 Corner: 0
r: 35 c: 7 Curvature: 0 Corner: 0
r: 35 c: 8 Curvature: 0 Corner: 0
r: 35 c: 9 Curvature: 0 Corner: 0
r: 35 c: 10 Curvature: 0 Corner: 0
r: 35 c: 11 Curvature: 0 Corner: 0
r: 35 c: 12 Curvature: 0 Corner: 0
r: 35 c: 13 Curvature: 0 Corner: 0
r: 35 c: 14 Curvature: 0 Corner: 0
r: 35 c: 15 Curvature: 0 Corner: 0
r: 35 c: 16 Curvature: 0 Corner: 0
r: 35 c: 17 Curvature: 0 Corner: 0
r: 35 c: 18 Curvature: 0 Corner: 0
r: 35 c: 19 Curvature: 0 Corner: 0
r: 35 c: 20 Curvature: 0 Corner: 0
r: 35 c: 21 Curvature: 0 Corner: 0
r: 35 c: 22 Curvature: 0 Corner: 0
r: 35 c: 23 Curvature: 0 Corner: 0
r: 35 c: 24 Curvature: 0 Corner: 0
r: 35 c: 25 Curvature: 0 Corner: 0
r: 35 c: 26 Curvature: 0 Corner: 0
r: 35 c: 27 Curvature: 0 Corner: 0
r: 35 c: 28 Curvature: 0 Corner: 0
r: 35 c: 29 Curvature: 0 Corner: 0
r: 34 c: 29 Curvature: 0 Corner: 0
r: 33 c: 29 Curvature: 0 Corner: 0
r: 32 c: 29 Curvature: 0 Corner: 0
r: 31 c: 29 Curvature: 0 Corner: 0
r: 30 c: 29 Curvature: 0 Corner: 0
r: 29 c: 29 Curvature: 0 Corner: 0
r: 28 c: 29 Curvature: 0 Corner: 0
r: 27 c: 29 Curvature: 0 Corner: 0
r: 26 c: 29 Curvature: 0 Corner: 0
r: 25 c: 29 Curvature: 0 Corner: 0
r: 24 c: 30 Curvature: 0 Corner: 0
r: 23 c: 31 Curvature: 0 Corner: 0
r: 22 c: 32 Curvature: 0 Corner: 0
r: 21 c: 33 Curvature: 0 Corner: 0
r: 20 c: 34 Curvature: 0 Corner: 0
```

```

r: 19 c: 33 Curvature: 0 Corner: 0
r: 18 c: 32 Curvature: 0 Corner: 0
r: 17 c: 31 Curvature: 0 Corner: 0
r: 16 c: 30 Curvature: 0 Corner: 0
r: 15 c: 29 Curvature: 0 Corner: 0
r: 14 c: 29 Curvature: 0 Corner: 0
r: 13 c: 29 Curvature: 0 Corner: 0
r: 12 c: 29 Curvature: 0 Corner: 0
r: 11 c: 29 Curvature: 0 Corner: 0
r: 10 c: 29 Curvature: 0 Corner: 0
r: 9 c: 29 Curvature: 0 Corner: 0
r: 8 c: 29 Curvature: 0 Corner: 0
r: 7 c: 29 Curvature: 0 Corner: 0
r: 6 c: 29 Curvature: 0 Corner: 0
r: 5 c: 29 Curvature: 0 Corner: 0
r: 5 c: 28 Curvature: 0 Corner: 0
r: 5 c: 27 Curvature: 0 Corner: 0
r: 5 c: 26 Curvature: 0 Corner: 0
r: 5 c: 25 Curvature: 0 Corner: 0
r: 5 c: 24 Curvature: 0 Corner: 0
r: 5 c: 23 Curvature: 0 Corner: 0
r: 5 c: 22 Curvature: 0 Corner: 0
r: 5 c: 21 Curvature: 0 Corner: 0
r: 5 c: 20 Curvature: 0 Corner: 0
r: 5 c: 19 Curvature: 0 Corner: 0
r: 5 c: 18 Curvature: 0 Corner: 0
r: 5 c: 17 Curvature: 0 Corner: 0
r: 5 c: 16 Curvature: 0 Corner: 0
r: 5 c: 15 Curvature: 0 Corner: 0
r: 5 c: 14 Curvature: 0 Corner: 0
r: 5 c: 13 Curvature: 0 Corner: 0
r: 5 c: 12 Curvature: 0 Corner: 0
r: 5 c: 11 Curvature: 0 Corner: 0
r: 5 c: 10 Curvature: 0 Corner: 0
r: 5 c: 9 Curvature: 0 Corner: 0
r: 5 c: 8 Curvature: 0 Corner: 0
r: 5 c: 7 Curvature: 0 Corner: 0
r: 5 c: 6 Curvature: 0 Corner: 0

```

After applying k curvature corner detection algorithm:

```

r: 5 c: 5 Curvature: -10 Corner: 0
r: 6 c: 5 Curvature: 0 Corner: 0
r: 7 c: 5 Curvature: 0 Corner: 0
r: 8 c: 5 Curvature: 0 Corner: 0
r: 9 c: 5 Curvature: 0 Corner: 0
r: 10 c: 5 Curvature: 0 Corner: 0
r: 11 c: 5 Curvature: 0 Corner: 0
r: 12 c: 5 Curvature: 0 Corner: 0
r: 13 c: 5 Curvature: 0 Corner: 0
r: 14 c: 5 Curvature: 0 Corner: 0
r: 15 c: 5 Curvature: -1 Corner: 0
r: 16 c: 6 Curvature: 0 Corner: 0
r: 17 c: 7 Curvature: 0 Corner: 0
r: 18 c: 8 Curvature: 0 Corner: 0
r: 19 c: 9 Curvature: 0 Corner: 0
r: 20 c: 10 Curvature: 2 Corner: 0
r: 21 c: 9 Curvature: 0 Corner: 0
r: 22 c: 8 Curvature: 0 Corner: 0
r: 23 c: 7 Curvature: 0 Corner: 0
r: 24 c: 6 Curvature: 0 Corner: 0
r: 25 c: 5 Curvature: -1 Corner: 0
r: 26 c: 5 Curvature: 0 Corner: 0
r: 27 c: 5 Curvature: 0 Corner: 0
r: 28 c: 5 Curvature: 0 Corner: 0
r: 29 c: 5 Curvature: 0 Corner: 0
r: 30 c: 5 Curvature: 0 Corner: 0
r: 31 c: 5 Curvature: 0 Corner: 0
r: 32 c: 5 Curvature: 0 Corner: 0
r: 33 c: 5 Curvature: 0 Corner: 0
r: 34 c: 5 Curvature: 0 Corner: 0
r: 35 c: 5 Curvature: 10 Corner: 0
r: 35 c: 6 Curvature: 20 Corner: 0
r: 35 c: 7 Curvature: 20 Corner: 0
r: 35 c: 8 Curvature: 20 Corner: 0
r: 35 c: 9 Curvature: 20 Corner: 0
r: 35 c: 10 Curvature: 20 Corner: 0

```

```

r: 35 c: 11 Curvature: 20 Corner: 0
r: 35 c: 12 Curvature: 20 Corner: 0
r: 35 c: 13 Curvature: 20 Corner: 0
r: 35 c: 14 Curvature: 20 Corner: 0
r: 35 c: 15 Curvature: 20 Corner: 0
r: 35 c: 16 Curvature: 20 Corner: 0
r: 35 c: 17 Curvature: 20 Corner: 0
r: 35 c: 18 Curvature: 20 Corner: 0
r: 35 c: 19 Curvature: 20 Corner: 0
r: 35 c: 20 Curvature: 20 Corner: 0
r: 35 c: 21 Curvature: 20 Corner: 0
r: 35 c: 22 Curvature: 20 Corner: 0
r: 35 c: 23 Curvature: 20 Corner: 0
r: 35 c: 24 Curvature: 20 Corner: 0
r: 35 c: 25 Curvature: 20 Corner: 0
r: 35 c: 26 Curvature: 20 Corner: 0
r: 35 c: 27 Curvature: 20 Corner: 0
r: 35 c: 28 Curvature: 20 Corner: 0
r: 35 c: 29 Curvature: 10 Corner: 0
r: 34 c: 29 Curvature: 0 Corner: 0
r: 33 c: 29 Curvature: 0 Corner: 0
r: 32 c: 29 Curvature: 0 Corner: 0
r: 31 c: 29 Curvature: 0 Corner: 0
r: 30 c: 29 Curvature: 0 Corner: 0
r: 29 c: 29 Curvature: 0 Corner: 0
r: 28 c: 29 Curvature: 0 Corner: 0
r: 27 c: 29 Curvature: 0 Corner: 0
r: 26 c: 29 Curvature: 0 Corner: 0
r: 25 c: 29 Curvature: 1 Corner: 0
r: 24 c: 30 Curvature: 0 Corner: 0
r: 23 c: 31 Curvature: 0 Corner: 0
r: 22 c: 32 Curvature: 0 Corner: 0
r: 21 c: 33 Curvature: 0 Corner: 0
r: 20 c: 34 Curvature: -2 Corner: 0
r: 19 c: 33 Curvature: 0 Corner: 0
r: 18 c: 32 Curvature: 0 Corner: 0
r: 17 c: 31 Curvature: 0 Corner: 0
r: 16 c: 30 Curvature: 0 Corner: 0
r: 15 c: 29 Curvature: 1 Corner: 0
r: 14 c: 29 Curvature: 0 Corner: 0
r: 13 c: 29 Curvature: 0 Corner: 0
r: 12 c: 29 Curvature: 0 Corner: 0
r: 11 c: 29 Curvature: 0 Corner: 0
r: 10 c: 29 Curvature: 0 Corner: 0
r: 9 c: 29 Curvature: 0 Corner: 0
r: 8 c: 29 Curvature: 0 Corner: 0
r: 7 c: 29 Curvature: 0 Corner: 0
r: 6 c: 29 Curvature: 0 Corner: 0
r: 5 c: 29 Curvature: -10 Corner: 0
r: 5 c: 28 Curvature: -20 Corner: 0
r: 5 c: 27 Curvature: -20 Corner: 0
r: 5 c: 26 Curvature: -20 Corner: 0
r: 5 c: 25 Curvature: -20 Corner: 0
r: 5 c: 24 Curvature: -20 Corner: 0
r: 5 c: 23 Curvature: -20 Corner: 0
r: 5 c: 22 Curvature: -20 Corner: 0
r: 5 c: 21 Curvature: -20 Corner: 0
r: 5 c: 20 Curvature: -20 Corner: 0
r: 5 c: 19 Curvature: -20 Corner: 0
r: 5 c: 18 Curvature: -20 Corner: 0
r: 5 c: 17 Curvature: -20 Corner: 0
r: 5 c: 16 Curvature: -20 Corner: 0
r: 5 c: 15 Curvature: -20 Corner: 0
r: 5 c: 14 Curvature: -20 Corner: 0
r: 5 c: 13 Curvature: -20 Corner: 0
r: 5 c: 12 Curvature: -20 Corner: 0
r: 5 c: 11 Curvature: -20 Corner: 0
r: 5 c: 10 Curvature: -20 Corner: 0
r: 5 c: 9 Curvature: -20 Corner: 0
r: 5 c: 8 Curvature: -20 Corner: 0
r: 5 c: 7 Curvature: -20 Corner: 0
r: 5 c: 6 Curvature: -20 Corner: 0

```

After marking corners:

```

r: 5 c: 5 Curvature: -10 Corner: 9
r: 6 c: 5 Curvature: 0 Corner: 1

```

r: 7 c: 5 Curvature: 0 Corner: 1
r: 8 c: 5 Curvature: 0 Corner: 1
r: 9 c: 5 Curvature: 0 Corner: 1
r: 10 c: 5 Curvature: 0 Corner: 1
r: 11 c: 5 Curvature: 0 Corner: 1
r: 12 c: 5 Curvature: 0 Corner: 1
r: 13 c: 5 Curvature: 0 Corner: 1
r: 14 c: 5 Curvature: 0 Corner: 1
r: 15 c: 5 Curvature: -1 Corner: 9
r: 16 c: 6 Curvature: 0 Corner: 1
r: 17 c: 7 Curvature: 0 Corner: 1
r: 18 c: 8 Curvature: 0 Corner: 1
r: 19 c: 9 Curvature: 0 Corner: 1
r: 20 c: 10 Curvature: 2 Corner: 9
r: 21 c: 9 Curvature: 0 Corner: 1
r: 22 c: 8 Curvature: 0 Corner: 1
r: 23 c: 7 Curvature: 0 Corner: 1
r: 24 c: 6 Curvature: 0 Corner: 1
r: 25 c: 5 Curvature: -1 Corner: 9
r: 26 c: 5 Curvature: 0 Corner: 1
r: 27 c: 5 Curvature: 0 Corner: 1
r: 28 c: 5 Curvature: 0 Corner: 1
r: 29 c: 5 Curvature: 0 Corner: 1
r: 30 c: 5 Curvature: 0 Corner: 1
r: 31 c: 5 Curvature: 0 Corner: 1
r: 32 c: 5 Curvature: 0 Corner: 1
r: 33 c: 5 Curvature: 0 Corner: 1
r: 34 c: 5 Curvature: 0 Corner: 1
r: 35 c: 5 Curvature: 10 Corner: 9
r: 35 c: 6 Curvature: 20 Corner: 1
r: 35 c: 7 Curvature: 20 Corner: 1
r: 35 c: 8 Curvature: 20 Corner: 1
r: 35 c: 9 Curvature: 20 Corner: 1
r: 35 c: 10 Curvature: 20 Corner: 1
r: 35 c: 11 Curvature: 20 Corner: 1
r: 35 c: 12 Curvature: 20 Corner: 1
r: 35 c: 13 Curvature: 20 Corner: 1
r: 35 c: 14 Curvature: 20 Corner: 1
r: 35 c: 15 Curvature: 20 Corner: 1
r: 35 c: 16 Curvature: 20 Corner: 1
r: 35 c: 17 Curvature: 20 Corner: 1
r: 35 c: 18 Curvature: 20 Corner: 1
r: 35 c: 19 Curvature: 20 Corner: 1
r: 35 c: 20 Curvature: 20 Corner: 1
r: 35 c: 21 Curvature: 20 Corner: 1
r: 35 c: 22 Curvature: 20 Corner: 1
r: 35 c: 23 Curvature: 20 Corner: 1
r: 35 c: 24 Curvature: 20 Corner: 1
r: 35 c: 25 Curvature: 20 Corner: 1
r: 35 c: 26 Curvature: 20 Corner: 1
r: 35 c: 27 Curvature: 20 Corner: 1
r: 35 c: 28 Curvature: 20 Corner: 1
r: 35 c: 29 Curvature: 10 Corner: 9
r: 34 c: 29 Curvature: 0 Corner: 1
r: 33 c: 29 Curvature: 0 Corner: 1
r: 32 c: 29 Curvature: 0 Corner: 1
r: 31 c: 29 Curvature: 0 Corner: 1
r: 30 c: 29 Curvature: 0 Corner: 1
r: 29 c: 29 Curvature: 0 Corner: 1
r: 28 c: 29 Curvature: 0 Corner: 1
r: 27 c: 29 Curvature: 0 Corner: 1
r: 26 c: 29 Curvature: 0 Corner: 1
r: 25 c: 29 Curvature: 1 Corner: 9
r: 24 c: 30 Curvature: 0 Corner: 1
r: 23 c: 31 Curvature: 0 Corner: 1
r: 22 c: 32 Curvature: 0 Corner: 1
r: 21 c: 33 Curvature: 0 Corner: 1
r: 20 c: 34 Curvature: -2 Corner: 9
r: 19 c: 33 Curvature: 0 Corner: 1
r: 18 c: 32 Curvature: 0 Corner: 1
r: 17 c: 31 Curvature: 0 Corner: 1
r: 16 c: 30 Curvature: 0 Corner: 1
r: 15 c: 29 Curvature: 1 Corner: 9
r: 14 c: 29 Curvature: 0 Corner: 1
r: 13 c: 29 Curvature: 0 Corner: 1
r: 12 c: 29 Curvature: 0 Corner: 1

r: 11 c: 29 Curvature: 0 Corner: 1
r: 10 c: 29 Curvature: 0 Corner: 1
r: 9 c: 29 Curvature: 0 Corner: 1
r: 8 c: 29 Curvature: 0 Corner: 1
r: 7 c: 29 Curvature: 0 Corner: 1
r: 6 c: 29 Curvature: 0 Corner: 1
r: 5 c: 29 Curvature: -10 Corner: 9
r: 5 c: 28 Curvature: -20 Corner: 1
r: 5 c: 27 Curvature: -20 Corner: 1
r: 5 c: 26 Curvature: -20 Corner: 1
r: 5 c: 25 Curvature: -20 Corner: 1
r: 5 c: 24 Curvature: -20 Corner: 1
r: 5 c: 23 Curvature: -20 Corner: 1
r: 5 c: 22 Curvature: -20 Corner: 1
r: 5 c: 21 Curvature: -20 Corner: 1
r: 5 c: 20 Curvature: -20 Corner: 1
r: 5 c: 19 Curvature: -20 Corner: 1
r: 5 c: 18 Curvature: -20 Corner: 1
r: 5 c: 17 Curvature: -20 Corner: 1
r: 5 c: 16 Curvature: -20 Corner: 1
r: 5 c: 15 Curvature: -20 Corner: 1
r: 5 c: 14 Curvature: -20 Corner: 1
r: 5 c: 13 Curvature: -20 Corner: 1
r: 5 c: 12 Curvature: -20 Corner: 1
r: 5 c: 11 Curvature: -20 Corner: 1
r: 5 c: 10 Curvature: -20 Corner: 1
r: 5 c: 9 Curvature: -20 Corner: 1
r: 5 c: 8 Curvature: -20 Corner: 1
r: 5 c: 7 Curvature: -20 Corner: 1
r: 5 c: 6 Curvature: -20 Corner: 1

Data_D:

Result of K-Curvature of the object boundary points

```
40 40 0 1
1
76
5 15 9
6 14 1
7 13 1
8 12 1
9 11 1
10 10 1
11 9 1
12 8 1
13 7 1
14 6 1
15 5 9
16 5 1
17 5 1
18 5 1
19 5 1
20 5 1
21 5 1
22 5 1
23 5 1
24 5 9
25 6 1
26 7 1
27 8 1
28 9 1
29 10 1
30 11 1
31 12 1
32 13 1
33 14 1
34 15 9
34 16 1
34 17 1
34 18 1
34 19 1
34 20 1
34 21 1
34 22 1
34 23 1
34 24 9
33 25 1
32 26 1
31 27 1
30 28 1
29 29 1
28 30 1
27 31 1
26 32 1
25 33 1
24 34 9
23 34 1
22 34 1
21 34 1
20 34 1
19 34 1
18 34 1
17 34 1
16 34 1
15 34 9
14 33 1
13 32 1
12 31 1
11 30 1
10 29 1
9 28 1
8 27 1
7 26 1
6 25 1
```

5	24	9
5	23	1
5	22	1
5	21	1
5	20	1
5	19	1
5	18	1
5	17	1
5	16	1

Pretty Print of the K-curvature corner detection

[illegible]

Debug File

Before applying k curvature corner detection algorithm:

```
r: 5 c: 15 Curvature: 0 Corner: 0
r: 6 c: 14 Curvature: 0 Corner: 0
r: 7 c: 13 Curvature: 0 Corner: 0
r: 8 c: 12 Curvature: 0 Corner: 0
r: 9 c: 11 Curvature: 0 Corner: 0
r: 10 c: 10 Curvature: 0 Corner: 0
r: 11 c: 9 Curvature: 0 Corner: 0
r: 12 c: 8 Curvature: 0 Corner: 0
r: 13 c: 7 Curvature: 0 Corner: 0
r: 14 c: 6 Curvature: 0 Corner: 0
r: 15 c: 5 Curvature: 0 Corner: 0
r: 16 c: 5 Curvature: 0 Corner: 0
r: 17 c: 5 Curvature: 0 Corner: 0
r: 18 c: 5 Curvature: 0 Corner: 0
r: 19 c: 5 Curvature: 0 Corner: 0
r: 20 c: 5 Curvature: 0 Corner: 0
r: 21 c: 5 Curvature: 0 Corner: 0
r: 22 c: 5 Curvature: 0 Corner: 0
r: 23 c: 5 Curvature: 0 Corner: 0
r: 24 c: 5 Curvature: 0 Corner: 0
r: 25 c: 6 Curvature: 0 Corner: 0
r: 26 c: 7 Curvature: 0 Corner: 0
r: 27 c: 8 Curvature: 0 Corner: 0
r: 28 c: 9 Curvature: 0 Corner: 0
r: 29 c: 10 Curvature: 0 Corner: 0
r: 30 c: 11 Curvature: 0 Corner: 0
r: 31 c: 12 Curvature: 0 Corner: 0
r: 32 c: 13 Curvature: 0 Corner: 0
r: 33 c: 14 Curvature: 0 Corner: 0
r: 34 c: 15 Curvature: 0 Corner: 0
r: 34 c: 16 Curvature: 0 Corner: 0
r: 34 c: 17 Curvature: 0 Corner: 0
r: 34 c: 18 Curvature: 0 Corner: 0
r: 34 c: 19 Curvature: 0 Corner: 0
r: 34 c: 20 Curvature: 0 Corner: 0
r: 34 c: 21 Curvature: 0 Corner: 0
r: 34 c: 22 Curvature: 0 Corner: 0
r: 34 c: 23 Curvature: 0 Corner: 0
r: 34 c: 24 Curvature: 0 Corner: 0
r: 33 c: 25 Curvature: 0 Corner: 0
r: 32 c: 26 Curvature: 0 Corner: 0
r: 31 c: 27 Curvature: 0 Corner: 0
r: 30 c: 28 Curvature: 0 Corner: 0
r: 29 c: 29 Curvature: 0 Corner: 0
r: 28 c: 30 Curvature: 0 Corner: 0
r: 27 c: 31 Curvature: 0 Corner: 0
r: 26 c: 32 Curvature: 0 Corner: 0
r: 25 c: 33 Curvature: 0 Corner: 0
r: 24 c: 34 Curvature: 0 Corner: 0
r: 23 c: 34 Curvature: 0 Corner: 0
r: 22 c: 34 Curvature: 0 Corner: 0
r: 21 c: 34 Curvature: 0 Corner: 0
r: 20 c: 34 Curvature: 0 Corner: 0
r: 19 c: 34 Curvature: 0 Corner: 0
r: 18 c: 34 Curvature: 0 Corner: 0
r: 17 c: 34 Curvature: 0 Corner: 0
r: 16 c: 34 Curvature: 0 Corner: 0
r: 15 c: 34 Curvature: 0 Corner: 0
r: 14 c: 33 Curvature: 0 Corner: 0
r: 13 c: 32 Curvature: 0 Corner: 0
r: 12 c: 31 Curvature: 0 Corner: 0
r: 11 c: 30 Curvature: 0 Corner: 0
r: 10 c: 29 Curvature: 0 Corner: 0
r: 9 c: 28 Curvature: 0 Corner: 0
r: 8 c: 27 Curvature: 0 Corner: 0
r: 7 c: 26 Curvature: 0 Corner: 0
r: 6 c: 25 Curvature: 0 Corner: 0
r: 5 c: 24 Curvature: 0 Corner: 0
r: 5 c: 23 Curvature: 0 Corner: 0
r: 5 c: 22 Curvature: 0 Corner: 0
r: 5 c: 21 Curvature: 0 Corner: 0
r: 5 c: 20 Curvature: 0 Corner: 0
```

r: 5 c: 19 Curvature: 0 Corner: 0
r: 5 c: 18 Curvature: 0 Corner: 0
r: 5 c: 17 Curvature: 0 Corner: 0
r: 5 c: 16 Curvature: 0 Corner: 0

After applying k curvature corner detection algorithm:

r: 5 c: 15 Curvature: -8.88889 Corner: 0
r: 6 c: 14 Curvature: 0 Corner: 0
r: 7 c: 13 Curvature: 0 Corner: 0
r: 8 c: 12 Curvature: 0 Corner: 0
r: 9 c: 11 Curvature: 0 Corner: 0
r: 10 c: 10 Curvature: 0 Corner: 0
r: 11 c: 9 Curvature: 0 Corner: 0
r: 12 c: 8 Curvature: 0 Corner: 0
r: 13 c: 7 Curvature: 0 Corner: 0
r: 14 c: 6 Curvature: 0 Corner: 0
r: 15 c: 5 Curvature: -1 Corner: 0
r: 16 c: 5 Curvature: 0 Corner: 0
r: 17 c: 5 Curvature: 0 Corner: 0
r: 18 c: 5 Curvature: 0 Corner: 0
r: 19 c: 5 Curvature: 0 Corner: 0
r: 20 c: 5 Curvature: 0 Corner: 0
r: 21 c: 5 Curvature: 0 Corner: 0
r: 22 c: 5 Curvature: 0 Corner: 0
r: 23 c: 5 Curvature: 0 Corner: 0
r: 24 c: 5 Curvature: -1 Corner: 0
r: 25 c: 6 Curvature: 0 Corner: 0
r: 26 c: 7 Curvature: 0 Corner: 0
r: 27 c: 8 Curvature: 0 Corner: 0
r: 28 c: 9 Curvature: 0 Corner: 0
r: 29 c: 10 Curvature: 0 Corner: 0
r: 30 c: 11 Curvature: 0 Corner: 0
r: 31 c: 12 Curvature: 0 Corner: 0
r: 32 c: 13 Curvature: 0 Corner: 0
r: 33 c: 14 Curvature: 0 Corner: 0
r: 34 c: 15 Curvature: 10.9091 Corner: 0
r: 34 c: 16 Curvature: 20 Corner: 0
r: 34 c: 17 Curvature: 20 Corner: 0
r: 34 c: 18 Curvature: 20 Corner: 0
r: 34 c: 19 Curvature: 20 Corner: 0
r: 34 c: 20 Curvature: 20 Corner: 0
r: 34 c: 21 Curvature: 20 Corner: 0
r: 34 c: 22 Curvature: 20 Corner: 0
r: 34 c: 23 Curvature: 20 Corner: 0
r: 34 c: 24 Curvature: 10.9091 Corner: 0
r: 33 c: 25 Curvature: 0 Corner: 0
r: 32 c: 26 Curvature: 0 Corner: 0
r: 31 c: 27 Curvature: 0 Corner: 0
r: 30 c: 28 Curvature: 0 Corner: 0
r: 29 c: 29 Curvature: 0 Corner: 0
r: 28 c: 30 Curvature: 0 Corner: 0
r: 27 c: 31 Curvature: 0 Corner: 0
r: 26 c: 32 Curvature: 0 Corner: 0
r: 25 c: 33 Curvature: 0 Corner: 0
r: 24 c: 34 Curvature: -1 Corner: 0
r: 23 c: 34 Curvature: 0 Corner: 0
r: 22 c: 34 Curvature: 0 Corner: 0
r: 21 c: 34 Curvature: 0 Corner: 0
r: 20 c: 34 Curvature: 0 Corner: 0
r: 19 c: 34 Curvature: 0 Corner: 0
r: 18 c: 34 Curvature: 0 Corner: 0
r: 17 c: 34 Curvature: 0 Corner: 0
r: 16 c: 34 Curvature: 0 Corner: 0
r: 15 c: 34 Curvature: -1 Corner: 0
r: 14 c: 33 Curvature: 0 Corner: 0
r: 13 c: 32 Curvature: 0 Corner: 0
r: 12 c: 31 Curvature: 0 Corner: 0
r: 11 c: 30 Curvature: 0 Corner: 0
r: 10 c: 29 Curvature: 0 Corner: 0
r: 9 c: 28 Curvature: 0 Corner: 0
r: 8 c: 27 Curvature: 0 Corner: 0
r: 7 c: 26 Curvature: 0 Corner: 0
r: 6 c: 25 Curvature: 0 Corner: 0
r: 5 c: 24 Curvature: -8.88889 Corner: 0
r: 5 c: 23 Curvature: -20 Corner: 0
r: 5 c: 22 Curvature: -20 Corner: 0

r: 5 c: 21 Curvature: -20 Corner: 0
r: 5 c: 20 Curvature: -20 Corner: 0
r: 5 c: 19 Curvature: -20 Corner: 0
r: 5 c: 18 Curvature: -20 Corner: 0
r: 5 c: 17 Curvature: -20 Corner: 0
r: 5 c: 16 Curvature: -20 Corner: 0

After marking corners:

r: 5 c: 15 Curvature: -8.88889 Corner: 9
r: 6 c: 14 Curvature: 0 Corner: 1
r: 7 c: 13 Curvature: 0 Corner: 1
r: 8 c: 12 Curvature: 0 Corner: 1
r: 9 c: 11 Curvature: 0 Corner: 1
r: 10 c: 10 Curvature: 0 Corner: 1
r: 11 c: 9 Curvature: 0 Corner: 1
r: 12 c: 8 Curvature: 0 Corner: 1
r: 13 c: 7 Curvature: 0 Corner: 1
r: 14 c: 6 Curvature: 0 Corner: 1
r: 15 c: 5 Curvature: -1 Corner: 9
r: 16 c: 5 Curvature: 0 Corner: 1
r: 17 c: 5 Curvature: 0 Corner: 1
r: 18 c: 5 Curvature: 0 Corner: 1
r: 19 c: 5 Curvature: 0 Corner: 1
r: 20 c: 5 Curvature: 0 Corner: 1
r: 21 c: 5 Curvature: 0 Corner: 1
r: 22 c: 5 Curvature: 0 Corner: 1
r: 23 c: 5 Curvature: 0 Corner: 1
r: 24 c: 5 Curvature: -1 Corner: 9
r: 25 c: 6 Curvature: 0 Corner: 1
r: 26 c: 7 Curvature: 0 Corner: 1
r: 27 c: 8 Curvature: 0 Corner: 1
r: 28 c: 9 Curvature: 0 Corner: 1
r: 29 c: 10 Curvature: 0 Corner: 1
r: 30 c: 11 Curvature: 0 Corner: 1
r: 31 c: 12 Curvature: 0 Corner: 1
r: 32 c: 13 Curvature: 0 Corner: 1
r: 33 c: 14 Curvature: 0 Corner: 1
r: 34 c: 15 Curvature: 10.9091 Corner: 9
r: 34 c: 16 Curvature: 20 Corner: 1
r: 34 c: 17 Curvature: 20 Corner: 1
r: 34 c: 18 Curvature: 20 Corner: 1
r: 34 c: 19 Curvature: 20 Corner: 1
r: 34 c: 20 Curvature: 20 Corner: 1
r: 34 c: 21 Curvature: 20 Corner: 1
r: 34 c: 22 Curvature: 20 Corner: 1
r: 34 c: 23 Curvature: 20 Corner: 1
r: 34 c: 24 Curvature: 10.9091 Corner: 9
r: 33 c: 25 Curvature: 0 Corner: 1
r: 32 c: 26 Curvature: 0 Corner: 1
r: 31 c: 27 Curvature: 0 Corner: 1
r: 30 c: 28 Curvature: 0 Corner: 1
r: 29 c: 29 Curvature: 0 Corner: 1
r: 28 c: 30 Curvature: 0 Corner: 1
r: 27 c: 31 Curvature: 0 Corner: 1
r: 26 c: 32 Curvature: 0 Corner: 1
r: 25 c: 33 Curvature: 0 Corner: 1
r: 24 c: 34 Curvature: -1 Corner: 9
r: 23 c: 34 Curvature: 0 Corner: 1
r: 22 c: 34 Curvature: 0 Corner: 1
r: 21 c: 34 Curvature: 0 Corner: 1
r: 20 c: 34 Curvature: 0 Corner: 1
r: 19 c: 34 Curvature: 0 Corner: 1
r: 18 c: 34 Curvature: 0 Corner: 1
r: 17 c: 34 Curvature: 0 Corner: 1
r: 16 c: 34 Curvature: 0 Corner: 1
r: 15 c: 34 Curvature: -1 Corner: 9
r: 14 c: 33 Curvature: 0 Corner: 1
r: 13 c: 32 Curvature: 0 Corner: 1
r: 12 c: 31 Curvature: 0 Corner: 1
r: 11 c: 30 Curvature: 0 Corner: 1
r: 10 c: 29 Curvature: 0 Corner: 1
r: 9 c: 28 Curvature: 0 Corner: 1
r: 8 c: 27 Curvature: 0 Corner: 1
r: 7 c: 26 Curvature: 0 Corner: 1
r: 6 c: 25 Curvature: 0 Corner: 1
r: 5 c: 24 Curvature: -8.88889 Corner: 9

r: 5 c: 23 Curvature: -20 Corner: 1
r: 5 c: 22 Curvature: -20 Corner: 1
r: 5 c: 21 Curvature: -20 Corner: 1
r: 5 c: 20 Curvature: -20 Corner: 1
r: 5 c: 19 Curvature: -20 Corner: 1
r: 5 c: 18 Curvature: -20 Corner: 1
r: 5 c: 17 Curvature: -20 Corner: 1
r: 5 c: 16 Curvature: -20 Corner: 1