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Algorithm Steps for Draw Boxes given a property file and an image with labeled components:

1. Index ←1
2. minRow ← CCProperty[Index].minR + 1
3. minCol ← CCProperty[Index].minC + 1
4. maxRow ← CCProperty[Index].maxR + 1
5. maxCol ← CCProperty[Index].maxC + 1
6. label ← CCProperty[Index].label
7. Assign all pixels on minRow from minCol to maxCol ←label
8. Assign all pixel on maxRow from minCol to maxCol ← label
9. Assign all pixels on minCol from minRow to maxRow ← label
10. Assign all pixels on maxCol from minRow to maxRow ← label
11. Index++
12. Repeat steps 2 to 11 while index <= trueNumCC

Main.cpp

```
#include <iostream>
#include <fstream>
#include <string>

using namespace std;

struct Property{
    int label, numpixels, minR, minC, maxR, maxC;
};

class CClabel{
    public:
    //variables
    int numRows, numCols, minVal, maxVal;
    int newMin, newMax, newLabel, trueNumCC;
    int **zeroFramedAry;
    int* nonZeroNeighborAry;
    int* EQAry;
    Property* CCProperty;

    //constructor + destructor
    CClabel(int * params, ifstream &inp);
    ~CClabel();

    //functions
    void zero2D();
    void minus1D();
    void loadImage(ifstream &inp);
    void imgReformat(ofstream &outp);
    void connect8Pass1();
    void connect8Pass2();
    void connect4Pass1();
    void connect4Pass2();
    void connectPass3();
    void drawBoxes();
    void updateEQ(int* inp, int* eq, int count, int min);
    int manageEQAry();
    void printCCProperty(ofstream &outp);
    void printEQAry(ofstream &outp);
    void printImg(ofstream &outp);
};

int main(int argc, char** argv){
```

```
    //pull command line args
    ifstream image(argv[1]);
    int connectedness = atoi(argv[2]);
    ofstream RFPrettyPrintFile(argv[3]), labelFile(argv[4]),
propertyFile(argv[5]);

    //read in the header info from the image
    int params[4];
    for(int i = 0; i < 4; ++i){
        image >> params[i];
    }
    RFPrettyPrintFile << argv[1] << " - First Pass of Connected Components ";
    CClabel cclabel(params, image);
    if(connectedness == 4){
        RFPrettyPrintFile << "with 4-connected:\n";
        cclabel.connect4Pass1();
        cclabel.imgReformat(RFPrettyPrintFile);
        cclabel.printEQAry(RFPrettyPrintFile);
        RFPrettyPrintFile << argv[1] << " - Second Pass of Connected Components
with 4-connected:\n";
        cclabel.connect4Pass2();
    }
    else{
        RFPrettyPrintFile << argv[1] << " - with 8-connected:\n";
        cclabel.connect8Pass1();
        cclabel.imgReformat(RFPrettyPrintFile);
        cclabel.printEQAry(RFPrettyPrintFile);
        RFPrettyPrintFile << argv[1] << " - Second Pass of Connected Components
with 8-connected:\n";
        cclabel.connect8Pass2();
    }
    cclabel.imgReformat(RFPrettyPrintFile);
    cclabel.printEQAry(RFPrettyPrintFile);
    cclabel.trueNumCC = cclabel.manageEQAry();
    RFPrettyPrintFile << argv[1] << " - updating equality table labels:\n";
    cclabel.printEQAry(RFPrettyPrintFile);
    cclabel.connectPass3();
    RFPrettyPrintFile << argv[1] << " - Third Pass of Connect Components:\n";
    cclabel.imgReformat(RFPrettyPrintFile);
    cclabel.printEQAry(RFPrettyPrintFile);
    labelFile << to_string(cclabel.numRows) + " " + to_string(cclabel.numCols) +
" " + to_string(cclabel.newMin) + " " + to_string(cclabel.newMax) + "\n";
    cclabel.printImg(labelFile);
    cclabel.printCCProperty(propertyFile);
```

```
    cclabel.drawBoxes();
    cclabel.imgReformat(RFPrettyPrintFile);
    RFPrettyPrintFile << "True Number of Connected Components: " +
to_string(cclabel.trueNumCC) + "\n";

    //close all files
    image.close();
    RFPrettyPrintFile.close();
    labelFile.close();
    propertyFile.close();

    return 0;
}


CClabel::CClabel(int* params, ifstream &inp){

    numRows = params[0];
    numCols = params[1];
    minVal = params[2];
    maxVal = params[3];
    int rows = numRows + 2, cols = numCols + 2;
    zeroFramedAry = new int*[rows];
    for(int i = 0; i < rows; ++i){
        zeroFramedAry[i] = new int[cols];
    }

    EQAry = new int[(numRows*numCols)/4 + 1];
    nonZeroNeighborAry = new int[5];

    //set EQarray to store all -1's
    minus1D();
    EQAry[0] = 0;

    //make all indices of zeroFramedArray 0
    zero2D();

    //load image into zeroFramedArray
    loadImage(inp);

    newLabel = 0;

}
```

```
CClabel::~CClabel(){
    int rows = numRows + 2;
    for(int i = 0; i < rows; ++i){
        delete[] zeroFramedAry[i];
    }
    delete[] zeroFramedAry;
    delete[] EQAry;
    delete[] nonZeroNeighborAry;

}


void CClabel::zero2D(){
    int rows = numRows + 2, cols = numCols + 2;
    for(int i = 0; i < rows; ++i){
        for(int j = 0; j < cols; ++j){
            zeroFramedAry[i][j] = 0;
        }
    }
}


void CClabel::minus1D(){
    int len = numRows * numCols;
    len /= 4;
    for(int i = 0; i < len; ++i){
        EQAry[i] = -1;
    }
}


void CClabel::loadImage(ifstream &inp){
    for(int i = 1; i <= numRows; ++i){
        for(int j = 1; j<= numCols; ++j){
            inp >> zeroFramedAry[i][j];
        }
    }
}


void CClabel::imgReformat(ofstream &outp){
    int width = to_string(newLabel).length();
    for(int i = 1; i <= numRows; ++i){
        for(int j = 1; j<= numCols; ++j){
            if(zeroFramedAry[i][j] < 1){
                outp << ". ";
```

```
            }
            else{
                outp << to_string(zeroFramedAry[i][j]) << " ";
            }
            for(int ww = to_string(zeroFramedAry[i][j]).length(); ww < width;
++ww){
                outp << " ";
            }
        }
        outp << " \n";
    }
    outp << "\n\n";
}


void CClabel::connect8Pass1(){
    int **p = zeroFramedAry, min = 99999, max = 0;
    for(int i = 1; i <= numRows; ++i){
        for(int j = 1; j<= numCols; ++j){
            if(p[i][j] > 0){
                max = 0;
                min = 99999;
                nonZeroNeighborAry[0] = p[i-1][j-1];
                nonZeroNeighborAry[1] = p[i-1][j];
                nonZeroNeighborAry[2] = p[i-1][j+1];
                nonZeroNeighborAry[3] = p[i][j-1];

                for(int k = 0; k < 4; ++k) max |= nonZeroNeighborAry[k];

                //case 1
                if(max == 0){
                    newLabel++;
                    EQAry[newLabel] = newLabel;
                    p[i][j] = newLabel;
                }
                else{
                    max = 0;
                    for(int k = 0; k < 4 ; ++k){
                        if(nonZeroNeighborAry[k] != 0){
                            max = EQAry[nonZeroNeighborAry[k]] > max ?
EQAry[nonZeroNeighborAry[k]] : max;
                            min = EQAry[nonZeroNeighborAry[k]] < min ?
EQAry[nonZeroNeighborAry[k]] : min;
                        }
                    }
```

```
                    //case 2
                    if(min == max){
                        p[i][j] = max;
                    }
                    //case 3
                    else{
                        p[i][j] = min;
                        updateEQ(nonZeroNeighborAry, EQAry, 4, min);
                    }
                }
            }
        }
    }
}


void CClabel::connect8Pass2(){
    int **p = zeroFramedAry, min = 99999, max = 0;
    for(int i = numRows; i > 0; --i){
        for(int j = numCols; j > 0; --j){
            if(p[i][j] > 0){
                max = 0;
                min = 99999;
                nonZeroNeighborAry[0] = p[i+1][j-1];
                nonZeroNeighborAry[1] = p[i+1][j];
                nonZeroNeighborAry[2] = p[i+1][j+1];
                nonZeroNeighborAry[3] = p[i][j+1];
                nonZeroNeighborAry[4] = p[i][j];


                for(int k = 0; k < 4; ++k) max |= nonZeroNeighborAry[k];

                //case 1 if max == 0 do nothing
                if(max != 0){
                    max = 0;
                    for(int k = 0; k < 5 ; ++k){
                        if(nonZeroNeighborAry[k] != 0){
                            max = EQAry[nonZeroNeighborAry[k]] > max ?
EQAry[nonZeroNeighborAry[k]] : max;
                            min = EQAry[nonZeroNeighborAry[k]] < min ?
EQAry[nonZeroNeighborAry[k]] : min;
                        }
                    }
                    //case 2 - if they are all the same do nothing
                    if(max != min){
```

```
                        //case 3
                        EQAry[p[i][j]] = min;
                        p[i][j] = min;
                        updateEQ(nonZeroNeighborAry, EQAry, 5, min);
                    }
                }
            }
            p[i][j] = EQAry[p[i][j]];
        }
    }
}


void CClabel::connect4Pass1(){
    int** p = zeroFramedAry, max = 0;
    for(int i = 1; i <= numRows; ++i){
        for(int j = 1; j<= numCols; ++j){
            if(p[i][j] > 0){
                nonZeroNeighborAry[0] = p[i-1][j];
                nonZeroNeighborAry[1] = p[i][j-1];

                max =  nonZeroNeighborAry[0] | nonZeroNeighborAry[1];

                //case 1
                if(max == 0){
                    newLabel++;
                    EQAry[newLabel] = newLabel;
                    p[i][j] = newLabel;
                }
                else{
                    //case 2
                    if(nonZeroNeighborAry[0] == nonZeroNeighborAry[1]){
                        p[i][j] = nonZeroNeighborAry[0];
                    }
                    else if(nonZeroNeighborAry[0] == 0 || nonZeroNeighborAry[1]
== 0){
                        p[i][j] = nonZeroNeighborAry[0] + nonZeroNeighborAry[1];
                    }
                    //case 3
                    else{
                        p[i][j] = EQAry[nonZeroNeighborAry[0]] <
EQAry[nonZeroNeighborAry[1]] ? EQAry[nonZeroNeighborAry[0]] :
EQAry[nonZeroNeighborAry[1]];
                        updateEQ(nonZeroNeighborAry, EQAry, 2, p[i][j]);
```

```
                    }
                }
            }
        }
    }
}


void CClabel::connect4Pass2(){
    int **p = zeroFramedAry, min = 99999, max = 0;
    for(int i = numRows; i > 0; --i){
        for(int j = numCols; j > 0; --j){
            if(p[i][j] > 0){
                min = 99999;
                nonZeroNeighborAry[0] = p[i+1][j];
                nonZeroNeighborAry[1] = p[i][j+1];
                nonZeroNeighborAry[2] = p[i][j];



                max =  nonZeroNeighborAry[0] | nonZeroNeighborAry[1];

                //case 1 if max == 0 do nothing
                if(max != 0){
                    max = 0;
                    for(int k = 0; k < 3 ; ++k){
                        if(nonZeroNeighborAry[k] != 0){
                            max = EQAry[nonZeroNeighborAry[k]] > max ?
EQAry[nonZeroNeighborAry[k]] : max;
                            min = EQAry[nonZeroNeighborAry[k]] < min ?
EQAry[nonZeroNeighborAry[k]] : min;
                        }
                    }
                    //case 2 - if they are all the same do nothing
                    if(max != min){
                        //case 3
                        EQAry[p[i][j]] = min;
                        p[i][j] = min;
                        updateEQ(nonZeroNeighborAry, EQAry, 3, min);
                    }
                }
            }
            p[i][j] = EQAry[p[i][j]];
        }
    }
```

```
}


void CClabel::connectPass3(){
    CCProperty = new Property[trueNumCC+1];
    for(int i = 0; i <= trueNumCC; ++i){
        CCProperty[i].label = i;
        CCProperty[i].numpixels = 0;
        CCProperty[i].minR = 99999;
        CCProperty[i].minC = 99999;
        CCProperty[i].maxR = 0;
        CCProperty[i].maxC= 0;
    }
    int** p = zeroFramedAry;
    for(int i = 1; i <= numRows; i++) {
        for(int j = 1; j <= numCols; ++j){
            if(p[i][j] > 0){
                p[i][j] = EQAry[p[i][j]];

                CCProperty[p[i][j]].numpixels++;
                CCProperty[p[i][j]].minR = i < CCProperty[p[i][j]].minR ? i :
CCProperty[p[i][j]].minR;
                CCProperty[p[i][j]].minC = j < CCProperty[p[i][j]].minC ? j :
CCProperty[p[i][j]].minC;
                CCProperty[p[i][j]].maxR = i > CCProperty[p[i][j]].maxR ? i :
CCProperty[p[i][j]].maxR;
                CCProperty[p[i][j]].maxC = j > CCProperty[p[i][j]].maxC ? j :
CCProperty[p[i][j]].maxC;
            }
        }
    }

}


void CClabel::drawBoxes(){
    int sr, sc, er, ec, label;
    for(int i = 1; i <= trueNumCC; ++i){

        //only draw if you are not overwriting an existing pixel
        for(int j = CCProperty[i].minC; j <= CCProperty[i].maxC; ++j){
            if(zeroFramedAry[CCProperty[i].minR][j] < 1){
                zeroFramedAry[CCProperty[i].minR][j] = CCProperty[i].label;
            }
            if(zeroFramedAry[CCProperty[i].maxR][j] < 1){
```

```
                zeroFramedAry[CCProperty[i].maxR][j] = CCProperty[i].label;
            }
        }
        for(int j = CCProperty[i].minR; j <= CCProperty[i].maxR; ++j){
            if(zeroFramedAry[j][CCProperty[i].minC] < 1){
                zeroFramedAry[j][CCProperty[i].minC] = CCProperty[i].label;
            }
            if(zeroFramedAry[j][CCProperty[i].maxC] < 1){
                zeroFramedAry[j][CCProperty[i].maxC] = CCProperty[i].label;
            }
        }

    }

}


void CClabel::updateEQ(int* inp, int* eq, int count, int min){
    for(int m = 0; m < count; ++m){
        if(inp[m] > 0) eq[inp[m]] = min;
    }
}


int CClabel::manageEQAry(){

    int label = 0, index = 1;
    while(index <= newLabel){
        if(EQAry[index] != index) EQAry[index] = EQAry[EQAry[index]];
        else{
            label++;
            EQAry[index] = label;
        }
        index++;
    }
    return label;
}


void CClabel::printCCProperty(ofstream &outp){
    outp << numRows << " " << numCols << " " << minVal << " " << maxVal << "\n";
    outp << trueNumCC << "\n";
    for(int i = 1; i <= trueNumCC; ++i){
        outp << CCProperty[i].label << "\n";
        outp << CCProperty[i].numpixels << "\n";
```

```
        //subtract frame from locatiion
        outp << CCProperty[i].minR - 1 << " " << CCProperty[i].minC - 1 << "\n";
        outp << CCProperty[i].maxR - 1 << " " << CCProperty[i].maxC - 1 << "\n";
    }
    outp << "\n\n";

}


void CClabel::printEQAry(ofstream &outp){
    outp << "Equality Array:\n";
    int width = to_string(newLabel).length();
    for(int i = 0; i <= newLabel; ++i){
        outp << "| " << i << " ";
        for(int j = to_string(i).length(); j < width; ++j){
            outp << " ";
        }
    }
    outp << "|\n";
    for(int i = 0; i <= newLabel; ++i){
        outp << "| " << EQAry[i] << " ";
        for(int j = to_string(EQAry[i]).length(); j < width; ++j){
            outp << " ";
        }
    }
    outp << "|\n\n";
}

void CClabel::printImg(ofstream &outp){
    outp << numRows << " " << numCols << " " << minVal << " " << maxVal << "\n";
    int** p = zeroFramedAry;
    int width = to_string(newLabel).length();
    for(int i = 1; i <= numRows; ++i){
        for(int j = 1; j <= numCols; ++j){
            outp << p[i][j] << " ";
            for(int ww = to_string(p[i][j]).length(); ww < width; ++ww){
                outp << " ";
            }
        }
        outp << "\n";
    }
    outp << "\n\n";
}
```

OUTPUT

```
Full output for rfprettyprint14.txt:
data1.txt - First Pass of Connected Components with 4-connected:
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
. . . . . 1 1 1 1 1 1 1 1 1 1 . . . . . . . . . . . . . . . 2 . . . .
. . . . . 1 1 1 1 1 1 1 1 1 1 . . . . . . . . . . 3 3 3 . . 2 2 . . .
. . . . . . . . . 1 1 . . . . . . . . . . . . . 4 3 3 3 3 . 2 . . . .
. . . . . . . . . 1 1 . . . . . . . . . . . . 5 3 . . . 3 3 . . . . .
. . . . . . . . . 1 1 . . . . . . . . . . . 6 3 . . . . . 3 3 . . . .
. . . . . . . . . 1 1 . . . . . . . . . . . 6 3 . . . . . 3 3 . . . .
. . . . . 7 . . . 1 1 . . . . . . . . . . . 6 3 . . . . 8 3 3 . . . .
. . . . . . 9 . . 1 1 . . . . . . . . . . . . 3 3 . . . 8 3 . . . . .
. . . . . . . 10 . 1 1 . . . . . . . . . . . . . 3 3 3 3 3 . . . . . .
. . . . . . . . 11 1 1 1 . . . . . . . . . . . . . 3 3 3 . . . . . . .
. . . . . . . . 11 1 1 1 1 . . . . . . . . . . . . . . . . . . . . . .
. . . . . . . . . . . 1 . . . . . . . . . . . . . . . . . . . . . . .
. . . . . . . . . . 12 . . . . . . . . 13 13 13 . . . . . . . . . . . . .
. . . . . . . . . 14 . . . . . . . . 15 13 13 13 13 . . . . . . . . . . . .
. . . . . . . . 16 . . . . . . . . 17 13 13 . 13 13 13 . . . . . . . 18 18 . .
. . . . . . . 19 . . . . . . . . 20 13 . . . . . 13 13 . . . . . . 18 18 . .
. . . . . . 21 . . . . . . . . . 20 13 . . . . . 13 13 . . . . . . . . . .
. . . 22 22 22 . . . 23 23 . . . . . 20 13 . . . . . 13 13 . . . . . . 24 24 . .
. . . 22 22 . . . 25 23 . . . . . . 20 13 . . . . . 13 13 . . . . . . 24 24 . .
. . . 22 22 . . 26 23 . . . 27 . . . 20 13 . . . . . 13 13 . . . . . . 24 24 . .
. . . 22 22 . 28 23 . . . . . 29 . . 20 13 13 13 13 13 13 13 13 . . . . . . 24 24 . .
. . . 22 22 . 28 23 . . . . . 29 . . 20 13 13 13 13 13 13 13 13 . . . . . . 24 24 . .
. . . 22 22 22 22 . . . . . . 29 . . 20 13 . . . . . 13 13 . . . . . . 24 24 . .
. . . 22 22 . 22 22 . . . . . . 30 . 20 13 . . . . . 13 13 . . . . . . 24 24 . .
. . . 22 22 . . . . 31 . . . . 30 . 20 13 . . . . . 13 13 . . . . . . 24 24 . .
. . . 22 22 . . . 32 31 . . . . 30 . 20 13 . . . . . 13 13 . . 33 33 . 34 24 24 . .
. . . 22 22 . . . 32 31 . . . . 30 . 20 13 . . . . . 13 13 . . . 33 33 . 24 24 . .
. . . 22 22 . . . 32 31 . . . . 30 . . . . . . . . 13 . . . . 33 33 33 24 . . .
. . . 22 22 . . . . 31 31 . . 35 . 36 . . . . . . . . 37 . . . . 33 33 24 24 . .


Equality Array:
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 |
| 0 | 1 | 2 | 3 | 3 | 3 | 3 | 7 | 3 | 9 | 10 | 1 | 12 | 13 | 14 | 13 | 16 | 13 | 18 | 19 | 13 | 21 | 22 | 23 | 24 | 23 | 23 | 27 | 22 | 29 | 30 | 31 | 31 | 24 | 24 | 35 | 36 | 37 |

data1.txt - Second Pass of Connected Components with 4-connected:
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
. . . . . 1 1 1 1 1 1 1 1 1 1 . . . . . . . . . . . . . . . 2 . . . .
. . . . . 1 1 1 1 1 1 1 1 1 1 . . . . . . . . . . 3 3 3 . . 2 2 . . .
. . . . . . . . . 1 1 . . . . . . . . . . . . . 3 3 3 3 3 . 2 . . . .
. . . . . . . . . 1 1 . . . . . . . . . . . . 3 3 . . . 3 3 . . . . .
. . . . . . . . . 1 1 . . . . . . . . . . . 3 3 . . . . . 3 3 . . . .
. . . . . . . . . 1 1 . . . . . . . . . . . 3 3 . . . . . 3 3 . . . .
. . . . . 7 . . . 1 1 . . . . . . . . . . . 3 3 . . . . 3 3 3 . . . .
. . . . . . 9 . . 1 1 . . . . . . . . . . . . 3 3 . . . 3 3 . . . . .
. . . . . . . 10 . 1 1 . . . . . . . . . . . . . 3 3 3 3 3 . . . . . .
. . . . . . . . 1 1 1 1 . . . . . . . . . . . . . 3 3 3 . . . . . . .
. . . . . . . . 1 1 1 1 1 . . . . . . . . . . . . . . . . . . . . . .
. . . . . . . . . . . 1 . . . . . . . . . . . . . . . . . . . . . . .
. . . . . . . . . . 12 . . . . . . . . 13 13 13 . . . . . . . . . . . . .
. . . . . . . . . 14 . . . . . . . . 13 13 13 13 13 . . . . . . . . . . . .
. . . . . . . . 16 . . . . . . . . 13 13 13 . 13 13 13 . . . . . . . 18 18 . .
. . . . . . . 19 . . . . . . . . 13 13 . . . . . 13 13 . . . . . . 18 18 . .
. . . . . . 21 . . . . . . . . . 13 13 . . . . . 13 13 . . . . . . . . . .
. . . 22 22 22 . . . 22 22 . . . . . 13 13 . . . . . 13 13 . . . . . . 24 24 . .
. . . 22 22 . . . 22 22 . . . . . . 13 13 . . . . . 13 13 . . . . . . 24 24 . .
. . . 22 22 . . 22 22 . . . 27 . . . 13 13 . . . . . 13 13 . . . . . . 24 24 . .
. . . 22 22 . 22 22 . . . . . 29 . . 13 13 13 13 13 13 13 13 13 . . . . . . 24 24 . .
. . . 22 22 . 22 23 . . . . . 29 . . 13 13 13 13 13 13 13 13 13 . . . . . . 24 24 . .
. . . 22 22 22 22 . . . . . . 29 . . 13 13 . . . . . 13 13 . . . . . . 24 24 . .
. . . 22 22 . 22 22 . . . . . . 30 . 13 13 . . . . . 13 13 . . . . . . 24 24 . .
. . . 22 22 . . . . 31 . . . . 30 . 13 13 . . . . . 13 13 . . . . . . 24 24 . .
. . . 22 22 . . . 31 31 . . . . 30 . 13 13 . . . . . 13 13 . . 24 24 . 24 24 24 . .
. . . 22 22 . . . 31 31 . . . . 30 . 13 13 . . . . . 13 13 . . . 24 24 . 24 24 . .
. . . 22 22 . . . 31 31 . . . . 30 . . . . . . . . 13 . . . . 24 24 24 24 . . .
. . . 22 22 . . . . 31 31 . . 35 . 36 . . . . . . . . 37 . . . . 24 24 24 24 . .


Equality Array:
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 |
| 0 | 1 | 2 | 3 | 3 | 3 | 3 | 7 | 3 | 9 | 10 | 1 | 12 | 13 | 14 | 13 | 16 | 13 | 18 | 19 | 13 | 21 | 22 | 22 | 24 | 22 | 22 | 27 | 22 | 29 | 30 | 31 | 31 | 24 | 24 | 35 | 36 | 37 |

data1.txt - updating equality table labels:
Equality Array:
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 |
| 0 | 1 | 2 | 3 | 3 | 3 | 3 | 4 | 3 | 5 | 6 | 1 | 7 | 8 | 9 | 8 | 10 | 8 | 11 | 12 | 8 | 13 | 14 | 14 | 15 | 14 | 14 | 16 | 14 | 17 | 18 | 19 | 19 | 15 | 15 | 20 | 21 | 22 |

data1.txt - Third Pass of Connect Components:
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
. . . . . 1 1 1 1 1 1 1 1 1 1 . . . . . . . . . . . . . . . 2 . . . .
. . . . . 1 1 1 1 1 1 1 1 1 1 . . . . . . . . . . 3 3 3 . . 2 2 . . .
. . . . . . . . . 1 1 . . . . . . . . . . . . . 3 3 3 3 3 . 2 . . . .
. . . . . . . . . 1 1 . . . . . . . . . . . . 3 3 . . . 3 3 . . . . .
. . . . . . . . . 1 1 . . . . . . . . . . . 3 3 . . . . . 3 3 . . . .
. . . . . . . . . 1 1 . . . . . . . . . . . 3 3 . . . . . 3 3 . . . .
. . . . . 4 . . . 1 1 . . . . . . . . . . . 3 3 . . . . 3 3 3 . . . .
. . . . . . 5 . . 1 1 . . . . . . . . . . . . 3 3 . . . 3 3 . . . . .
. . . . . . . 6 . 1 1 . . . . . . . . . . . . . 3 3 3 3 3 . . . . . .
. . . . . . . . 1 1 1 1 . . . . . . . . . . . . . 3 3 3 . . . . . . .
. . . . . . . . 1 1 1 1 1 . . . . . . . . . . . . . . . . . . . . . .
. . . . . . . . . . . 1 . . . . . . . . . . . . . . . . . . . . . . .
. . . . . . . . . . 7 . . . . . . . . 8 8 8 . . . . . . . . . . . . .
. . . . . . . . . 9 . . . . . . . . 8 8 8 8 8 . . . . . . . . . . . .
. . . . . . . . 10 . . . . . . . . 8 8 8 . 8 8 8 . . . . . . . 11 11 . .
. . . . . . . 12 . . . . . . . . 8 8 . . . . . 8 8 . . . . . . 11 11 . .
. . . . . . 13 . . . . . . . . . 8 8 . . . . . 8 8 . . . . . . . . . .
. . . 14 14 14 . . . 14 14 . . . . . 8 8 . . . . . 8 8 . . . . . . 15 15 . .
. . . 14 14 . . . 14 14 . . . . . . 8 8 . . . . . 8 8 . . . . . . 15 15 . .
. . . 14 14 . . 14 14 . . . 16 . . . 8 8 . . . . . 8 8 . . . . . . 15 15 . .
. . . 14 14 . 14 14 . . . . . 17 . . 8 8 8 8 8 8 8 8 8 . . . . . . 15 15 . .
. . . 14 14 . 14 14 . . . . . 17 . . 8 8 8 8 8 8 8 8 8 . . . . . . 15 15 . .
. . . 14 14 14 14 . . . . . . 17 . . 8 8 . . . . . 8 8 . . . . . . 15 15 . .
. . . 14 14 . 14 14 . . . . . . 18 . 8 8 . . . . . 8 8 . . . . . . 15 15 . .
. . . 14 14 . . . . 19 . . . . 18 . 8 8 . . . . . 8 8 . . . . . . 15 15 . .
. . . 14 14 . . . 19 19 . . . . 18 . 8 8 . . . . . 8 8 . . 15 15 . 15 15 15 . .
. . . 14 14 . . . 19 19 . . . . 18 . 8 8 . . . . . 8 8 . . . 15 15 . 15 15 . .
. . . 14 14 . . . 19 19 . . . . 18 . . . . . . . . 8 . . . . 15 15 15 15 . . .
. . . 14 14 . . . . 19 19 . . 20 . 21 . . . . . . . . 22 . . . . 15 15 15 15 . .


Equality Array:
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 |
| 0 | 1 | 2 | 3 | 3 | 3 | 3 | 4 | 3 | 5 | 6 | 1 | 7 | 8 | 9 | 8 | 10 | 8 | 11 | 12 | 8 | 13 | 14 | 14 | 15 | 14 | 14 | 16 | 14 | 17 | 18 | 19 | 19 | 15 | 15 | 20 | 21 | 22 |
```

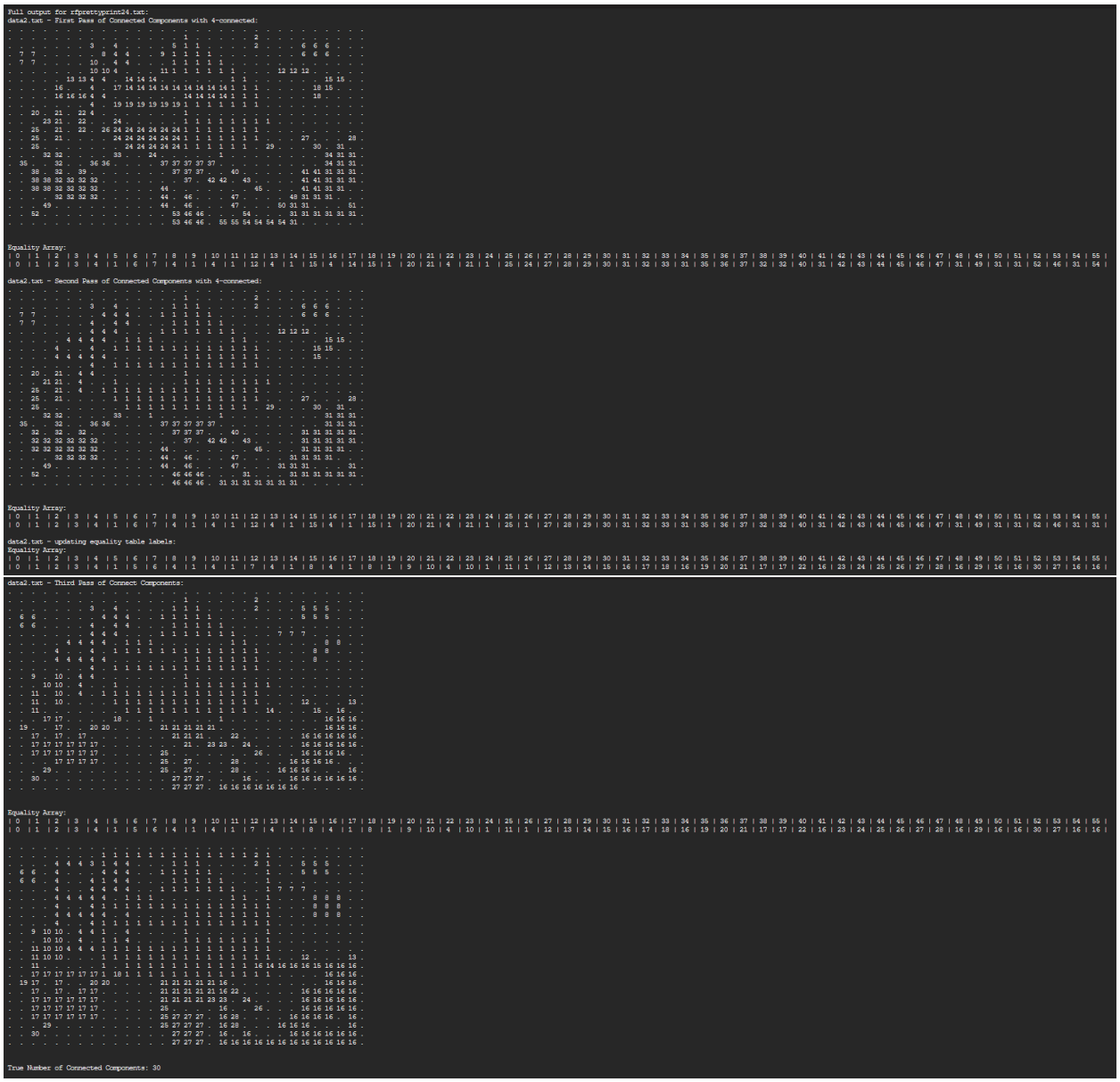
```
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
. . . . . 1 1 1 1 1 1 1 1 1 1 . . . . . . . . . . . . . . . 2 2 . . .
. . . . . 1 1 1 1 1 1 1 1 1 1 . . . . . . . 3 3 3 3 3 3 3 3 2 2 . . .
. . . . . 1 . . . 1 1 . . . 1 . . . . . . . 3 . 3 3 3 3 3 . 2 2 . . .
. . . . . 1 . . . 1 1 . . . 1 . . . . . . . 3 3 3 . . . 3 3 3 . . . .
. . . . . 1 . . . 1 1 . . . 1 . . . . . . . 3 3 . . . . . 3 3 . . . .
. . . . . 1 . . . 1 1 . . . 1 . . . . . . . 3 3 . . . . . 3 3 . . . .
. . . . . 4 . . . 1 1 . . . 1 . . . . . . . 3 3 . . . . 3 3 3 . . . .
. . . . . 1 5 . . 1 1 . . . 1 . . . . . . . 3 3 3 . . . 3 3 3 . . . .
. . . . . 1 . 6 . 1 1 . . . 1 . . . . . . . 3 . 3 3 3 3 3 . 3 . . . .
. . . . . 1 . . 1 1 1 1 . . 1 . . . . . . . 3 3 3 3 3 3 3 3 3 . . . .
. . . . . 1 . . 1 1 1 1 1 . 1 . . . . . . . . . . . . . . . . . . . .
. . . . . 1 1 1 1 1 1 1 1 1 1 . . . . . . . . . . . . . . . . . . . .
. . . . . . . . . . 7 . . . . . 8 8 8 8 8 8 8 8 8 . . . . . . . . . .
. . . . . . . . . 9 . . . . . . 8 . 8 8 8 8 8 . 8 . . . . . . . . . .
. . . . . . . . 10 . . . . . . . 8 8 8 8 . 8 8 8 8 . . . . . . 11 11 . .
. . . . . . . 12 . . . . . . . . 8 8 . . . . . 8 8 . . . . . . 11 11 . .
. . . . . . 13 . . . . . . . . . 8 8 . . . . . 8 8 . . . . . . . . . .
. . . 14 14 14 14 14 14 14 14 . . . . . 8 8 . . . . . 8 8 . . 15 15 15 15 15 15 . .
. . . 14 14 . . . 14 14 14 . . . . . 8 8 . . . . . 8 8 . . 15 . . . 15 15 . .
. . . 14 14 . . 14 14 . 14 . 16 . . . 8 8 . . . . . 8 8 . . 15 . . . 15 15 . .
. . . 14 14 . 14 14 . . 14 . . 17 . . 8 8 8 8 8 8 8 8 8 . . 15 . . . 15 15 . .
. . . 14 14 . 14 14 . . 14 . . 17 . . 8 8 8 8 8 8 8 8 8 . . 15 . . . 15 15 . .
. . . 14 14 14 14 . . . 14 . . 17 . . 8 8 . . . . . 8 8 . . 15 . . . 15 15 . .
. . . 14 14 . 14 14 . . 14 . . . 18 . 8 8 . . . . . 8 8 . . 15 . . . 15 15 . .
. . . 14 14 . . . 19 19 14 . . . 18 . 8 8 . . . . . 8 8 . . 15 . . . 15 15 . .
. . . 14 14 . . . 19 19 14 . . . 18 . 8 8 . . . . . 8 8 . . 15 15 . 15 15 15 . .
. . . 14 14 . . . 19 19 14 . . . 18 . 8 8 . . . . . 8 8 . . 15 15 15 . 15 15 . .
. . . 14 14 . . . 19 19 14 . . . 18 . 8 8 8 8 8 8 8 8 8 . . 15 15 15 15 15 15 . .
. . . 14 14 14 14 14 14 19 19 . . 20 . 21 . . . . . . . . 22 . . 15 15 15 15 15 15 . .


True Number of Connected Components: 22
```

```
Label Print-out for rfprettyprint14.txt:
30 35 40 0
30 35 0 1
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  1  1  1  1  1  1  1  1  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  2  0  0  0  0
0  0  0  0  0  1  1  1  1  1  1  1  1  1  1  0  0  0  0  0  0  0  0  0  0  0  0  3  3  3  0  0  2  2  0  0  0
0  0  0  0  0  0  0  0  0  0  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  3  3  3  3  3  0  2  0  0  0  0
0  0  0  0  0  0  0  0  0  0  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  3  3  0  0  0  3  3  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  3  3  0  0  0  0  0  3  3  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  3  3  0  0  0  0  0  3  3  0  0  0  0  0
0  0  0  0  0  4  0  0  0  0  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  3  3  0  0  0  0  0  3  3  3  0  0  0  0
0  0  0  0  0  0  5  0  0  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  3  3  0  0  0  3  3  0  0  0  0  0  0  0
0  0  0  0  0  0  0  6  0  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  3  3  3  3  3  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  1  1  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  3  3  3  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  1  1  1  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  7  0  0  0  0  0  0  0  0  8  8  8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  9  0  0  0  0  0  0  0  0  8  8  8  8  8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  10 0  0  0  0  0  0  0  0  8  8  8  0  8  8  8  0  0  0  0  0  0  0  11 11 0  0
0  0  0  0  0  0  0  0  12 0  0  0  0  0  0  0  0  8  8  0  0  0  0  0  8  8  0  0  0  0  0  0  11 11 0  0
0  0  0  0  0  0  13 0  0  0  0  0  0  0  0  0  8  8  0  0  0  0  0  8  8  0  0  0  0  0  0  0  0  0  0  0
0  0  0  14 14 14 0  0  0  14 14 0  0  0  0  0  0  8  8  0  0  0  0  0  8  8  0  0  0  0  0  0  15 15 0  0
0  0  0  14 14 0  0  0  14 14 0  0  0  0  0  0  8  8  0  0  0  0  0  8  8  0  0  0  0  0  0  15 15 0  0
0  0  0  14 14 0  0  14 14 0  0  0  16 0  0  0  8  8  0  0  0  0  0  8  8  0  0  0  0  0  0  15 15 0  0
0  0  0  14 14 0  14 14 0  0  0  0  0  17 0  0  8  8  8  8  8  8  8  8  0  0  0  0  0  0  15 15 0  0
0  0  0  14 14 0  14 14 0  0  0  0  0  17 0  0  8  8  8  8  8  8  8  8  0  0  0  0  0  0  15 15 0  0
0  0  0  14 14 14 14 0  0  0  0  0  0  17 0  0  8  8  0  0  0  0  0  8  8  0  0  0  0  0  0  15 15 0  0
0  0  0  14 14 0  14 14 0  0  0  0  0  0  18 0  8  8  0  0  0  0  0  8  8  0  0  0  0  0  0  15 15 0  0
0  0  0  14 14 0  0  0  0  19 0  0  0  0  18 0  8  8  0  0  0  0  0  8  8  0  0  0  0  0  0  15 15 0  0
0  0  0  14 14 0  0  0  19 19 0  0  0  0  18 0  8  8  0  0  0  0  0  8  8  0  0  15 15 0  15 15 15 0  0
0  0  0  14 14 0  0  0  19 19 0  0  0  0  18 0  8  8  0  0  0  0  0  8  8  0  0  0  15 15 0  15 15 0  0
0  0  0  14 14 0  0  0  19 19 0  0  0  0  18 0  0  0  0  0  0  0  0  8  0  0  0  0  15 15 15 15 0  0  0
0  0  0  14 14 0  0  0  0  19 19 0  0  20 0  21 0  0  0  0  0  0  0  0  22 0  0  0  0  15 15 15 15 0  0


Property File Print-out for rfprettyprint14.txt:
30 35 0 1
22
1
44
1 5
12 14
2
4
1 30
3 31
3
37
2 22
10 30
4
1
7 5
7 5
5
1
8 6
8 6
6
1
9 7
9 7
7
1
13 10
13 10
```

```
8
73
13 16
28 24
9
1
14 9
14 9
10
1
15 8
15 8
11
4
15 31
16 32
12
1
16 7
16 7
13
1
17 6
17 6
14
39
18 3
29 10
15
33
18 27
29 32
16
1
20 12
20 12
17
3
21 13
23 13
18
5
24 14
28 14
19
9
25 8
29 10
20
1
29 13
29 13
21
1
29 15
29 15
22
1
29 24
29 24
```


Full output for rfprettyprint24.txt:
data2.txt - First Pass of Connected Components with 4-connected:
Equality Array:
data2.txt - Second Pass of Connected Components with 4-connected:
Equality Array:
data2.txt - updating equality table labels:
Equality Array:
data2.txt - Third Pass of Connect Components:
Equality Array:
True Number of Connected Components: 30

```
Label Print-out for rfprettyprint24.txt:
24 31 40 0
24 31 0 1
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  2  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  3  0  4  0  0  0  0  0  1  1  1  0  0  0  0  2  0  0  0  5  5  5  0  0  0  0
0  6  6  0  0  0  0  0  4  4  4  0  0  1  1  1  1  1  0  0  0  0  0  0  0  0  5  5  5  0  0  0  0
0  6  6  0  0  0  0  4  0  4  4  0  0  0  1  1  1  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  4  4  4  0  0  0  1  1  1  1  1  1  1  0  0  0  7  7  7  0  0  0  0  0
0  0  0  0  0  0  4  4  4  4  0  1  1  1  0  0  0  0  0  0  1  1  0  0  0  0  0  0  0  8  8  0  0  0
0  0  0  0  4  0  0  4  0  1  1  1  1  1  1  1  1  1  1  1  1  1  0  0  0  0  8  8  0  0  0
0  0  0  0  4  4  4  4  4  0  0  0  0  0  0  1  1  1  1  1  1  1  0  0  0  0  8  0  0  0  0
0  0  0  0  0  0  0  4  0  1  1  1  1  1  1  1  1  1  1  1  1  1  0  0  0  0  0  0  0  0  0
0  0  9  0  10 0  4  4  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  10 10 0  4  0  0  1  0  0  0  0  0  1  1  1  1  1  1  1  1  0  0  0  0  0  0  0  0
0  0  11 0  10 0  4  0  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  0  0  0  0  0  0  0  0
0  0  11 0  10 0  0  0  0  1  1  1  1  1  1  1  1  1  1  1  1  1  1  0  0  0  12 0  0  0  13 0
0  0  11 0  0  0  0  0  0  0  1  1  1  1  1  1  1  1  1  1  1  1  0  14 0  0  0  15 0  16 0  0
0  0  0  17 17 0  0  0  0  18 0  0  1  0  0  0  0  0  1  0  0  0  0  0  0  0  0  16 16 16 0
0  19 0  0  17 0  0  20 20 0  0  0  0  21 21 21 21 21 0  0  0  0  0  0  0  0  0  16 16 16 0
0  0  17 0  17 0  17 0  0  0  0  0  0  0  21 21 21 0  0  22 0  0  0  0  0  16 16 16 16 16 0
0  0  17 17 17 17 17 17 0  0  0  0  0  0  0  0  21 0  23 23 0  24 0  0  0  0  0  16 16 16 16 16 0
0  0  17 17 17 17 17 17 0  0  0  0  0  0  25 0  0  0  0  0  0  0  26 0  0  0  16 16 16 16 0  0
0  0  0  0  17 17 17 17 0  0  0  0  0  0  25 0  27 0  0  0  28 0  0  0  0  16 16 16 16 0  0  0
0  0  0  29 0  0  0  0  0  0  0  0  0  0  25 0  27 0  0  0  28 0  0  0  16 16 16 0  0  0  16 0
0  0  30 0  0  0  0  0  0  0  0  0  0  0  0  27 27 27 0  0  0  16 0  0  0  16 16 16 16 16 16 0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  27 27 27 0  16 16 16 16 16 16 16 0  0  0  0  0  0  0


Property File Print-out for rfprettyprint24.txt:
24 31 0 1
30
1
109
1 8
15 22
2
2
1 21
2 21
3
1
2 7
2 7
4
26
2 4
12 10
5
6
2 25
3 27
6
4
3 1
4 2
7
3
5 23
5 25
8
5
6 26
8 28
```

```
9
1
10 2
10 2
10
5
10 3
13 4
11
3
12 2
14 2
12
1
13 25
13 25
13
1
13 29
13 29
14
1
14 22
14 22
15
1
14 26
14 26
16
43
14 18
23 29
17
22
15 2
20 7
18
1
15 9
15 9
19
1
16 1
16 1
20
2
16 7
16 8
21
9
16 13
18 17
22
1
17 19
17 19
23
2
18 17
18 18
24
1
18 20
18 20
```

```
25
3
19 13
21 13
26
1
19 21
19 21
27
8
20 14
23 16
28
2
20 19
21 19
29
1
21 3
21 3
30
1
22 2
22 2



Full output for rfprettyprint18.txt:
data1.txt - First Pass of Connected Components data1.txt - with 8-connected:
.  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .
.  .  .  .  .  .  1  1  1  1  1  1  1  1  1  1  .  .  .  .  .  .  .  .  .  .  .  .  .  .  2  .  .  .  .
.  .  .  .  .  .  1  1  1  1  1  1  1  1  1  1  .  .  .  .  .  .  .  .  .  3  3  3  .  .  2  2  .  .  .
.  .  .  .  .  .  .  .  .  1  1  .  .  .  .  .  .  .  .  .  .  .  .  .  3  3  3  3  3  .  2  .  .  .  .
.  .  .  .  .  .  .  .  .  1  1  .  .  .  .  .  .  .  .  .  .  .  .  3  3  .  .  .  3  2  .  .  .  .  .
.  .  .  .  .  .  .  .  .  1  1  .  .  .  .  .  .  .  .  .  .  .  2  2  .  .  .  .  .  2  2  .  .  .  .
.  .  .  .  .  .  .  .  .  1  1  .  .  .  .  .  .  .  .  .  .  .  2  2  .  .  .  .  .  2  2  .  .  .  .
.  .  .  .  .  4  .  .  .  1  1  .  .  .  .  .  .  .  .  .  .  .  2  2  .  .  .  .  2  2  2  .  .  .  .
.  .  .  .  .  .  4  .  .  1  1  .  .  .  .  .  .  .  .  .  .  .  .  2  2  .  .  .  2  2  .  .  .  .  .
.  .  .  .  .  .  .  4  .  1  1  .  .  .  .  .  .  .  .  .  .  .  .  .  2  2  2  2  2  .  .  .  .  .  .
.  .  .  .  .  .  .  .  1  1  1  1  .  .  .  .  .  .  .  .  .  .  .  .  .  2  2  2  .  .  .  .  .  .  .
.  .  .  .  .  .  .  .  1  1  1  1  1  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .
.  .  .  .  .  .  .  .  .  .  .  1  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .
.  .  .  .  .  .  .  .  .  .  1  .  .  .  .  .  .  .  .  5  5  5  .  .  .  .  .  .  .  .  .  .  .  .  .
.  .  .  .  .  .  .  .  .  1  .  .  .  .  .  .  .  .  5  5  5  5  5  .  .  .  .  .  .  .  .  .  .  .  .
.  .  .  .  .  .  .  .  1  .  .  .  .  .  .  .  .  5  5  5  .  5  5  5  .  .  .  .  .  .  .  6  6  .  .
.  .  .  .  .  .  .  1  .  .  .  .  .  .  .  .  5  5  .  .  .  .  .  5  5  .  .  .  .  .  .  6  6  .  .
.  .  .  .  .  .  1  .  .  .  .  .  .  .  .  .  5  5  .  .  .  .  .  5  5  .  .  .  .  .  .  .  .  .  .
.  .  .  7  7  1  .  .  .  8  8  .  .  .  .  .  5  5  .  .  .  .  .  5  5  .  .  .  .  .  .  9  9  .  .
.  .  .  1  1  .  .  .  8  8  .  .  .  .  .  .  5  5  .  .  .  .  .  5  5  .  .  .  .  .  .  9  9  .  .
.  .  .  1  1  .  .  8  8  .  .  .  10 .  .  .  5  5  .  .  .  .  .  5  5  .  .  .  .  .  .  9  9  .  .
.  .  .  1  1  .  8  8  .  .  .  .  .  10 .  .  5  5  5  5  5  5  5  5  5  .  .  .  .  .  .  9  9  .  .
.  .  .  1  1  .  8  8  .  .  .  .  .  10 .  .  5  5  5  5  5  5  5  5  5  .  .  .  .  .  .  9  9  .  .
.  .  .  1  1  1  1  .  .  .  .  .  .  10 .  .  5  5  .  .  .  .  .  5  5  .  .  .  .  .  .  9  9  .  .
.  .  .  1  1  .  1  1  .  .  .  .  .  .  10 .  5  5  .  .  .  .  .  5  5  .  .  .  .  .  .  9  9  .  .
.  .  .  1  1  .  .  .  .  11 .  .  .  .  10 .  5  5  .  .  .  .  .  5  5  .  .  .  .  .  .  9  9  .  .
.  .  .  1  1  .  .  .  11 11 .  .  .  .  10 .  5  5  .  .  .  .  .  5  5  .  .  12 12 .  9  9  9  .  .
.  .  .  1  1  .  .  .  11 11 .  .  .  .  10 .  5  5  .  .  .  .  .  5  5  .  .  .  12 9  .  9  9  .  .
.  .  .  1  1  .  .  .  11 11 .  .  .  .  10 .  .  .  .  .  .  .  .  5  .  .  .  .  9  9  9  9  .  .  .
.  .  .  1  1  .  .  .  .  11 11 .  .  10 .  10 .  .  .  .  .  .  .  .  5  .  .  .  .  9  9  9  9  .  .


Equality Array:
| 0  | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 |
| 0  | 1  | 2  | 2  | 1  | 5  | 6  | 1  | 1  | 9  | 10 | 11 | 9  |
```

```
data1.txt - Second Pass of Connected Components with 8-connected:
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
. . . . . 1 1 1 1 1 1 1 1 1 1 . . . . . . . . . . . . . . . 2 . . . .
. . . . . 1 1 1 1 1 1 1 1 1 1 . . . . . . . . . . 2 2 2 . . 2 2 . . .
. . . . . . . . . 1 1 . . . . . . . . . . . . . 2 2 2 2 2 . 2 . . . .
. . . . . . . . . 1 1 . . . . . . . . . . . . 2 2 . . . 2 2 . . . . .
. . . . . . . . . 1 1 . . . . . . . . . . . 2 2 . . . . . 2 2 . . . .
. . . . . . . . . 1 1 . . . . . . . . . . . 2 2 . . . . . 2 2 . . . .
. . . . . 1 . . . 1 1 . . . . . . . . . . . 2 2 . . . . 2 2 2 . . . .
. . . . . . 1 . . 1 1 . . . . . . . . . . . . 2 2 . . . 2 2 . . . . .
. . . . . . . 1 . 1 1 . . . . . . . . . . . . . 2 2 2 2 2 . . . . . .
. . . . . . . . 1 1 1 1 . . . . . . . . . . . . . 2 2 2 . . . . . . .
. . . . . . . . 1 1 1 1 1 . . . . . . . . . . . . . . . . . . . . . .
. . . . . . . . . . . 1 . . . . . . . . . . . . . . . . . . . . . . .
. . . . . . . . . . 1 . . . . . . . . 5 5 5 . . . . . . . . . . . . .
. . . . . . . . . 1 . . . . . . . . 5 5 5 5 5 . . . . . . . . . . . .
. . . . . . . . 1 . . . . . . . . 5 5 5 . 5 5 5 . . . . . . . 6 6 . .
. . . . . . . 1 . . . . . . . . 5 5 . . . . . 5 5 . . . . . . 6 6 . .
. . . . . . 1 . . . . . . . . . 5 5 . . . . . 5 5 . . . . . . . . . .
. . . 1 1 1 . . . 1 1 . . . . . 5 5 . . . . . 5 5 . . . . . . 9 9 . .
. . . 1 1 . . . 1 1 . . . . . . 5 5 . . . . . 5 5 . . . . . . 9 9 . .
. . . 1 1 . . 1 1 . . . 10 . . . 5 5 . . . . . 5 5 . . . . . . 9 9 . .
. . . 1 1 . 1 1 . . . . . 10 . . 5 5 5 5 5 5 5 5 5 . . . . . . 9 9 . .
. . . 1 1 . 1 1 . . . . . 10 . . 5 5 5 5 5 5 5 5 5 . . . . . . 9 9 . .
. . . 1 1 1 1 . . . . . . 10 . . 5 5 . . . . . 5 5 . . . . . . 9 9 . .
. . . 1 1 . 1 1 . . . . . . 10 . 5 5 . . . . . 5 5 . . . . . . 9 9 . .
. . . 1 1 . . . . 11 . . . . 10 . 5 5 . . . . . 5 5 . . . . . . 9 9 . .
. . . 1 1 . . . 11 11 . . . . 10 . 5 5 . . . . . 5 5 . . 9 9 . 9 9 9 . .
. . . 1 1 . . . 11 11 . . . . 10 . 5 5 . . . . . 5 5 . . . 9 9 . 9 9 . .
. . . 1 1 . . . 11 11 . . . . 10 . . . . . . . . 5 . . . . 9 9 9 9 . . .
. . . 1 1 . . . . 11 11 . . 10 . 10 . . . . . . . . 5 . . . . 9 9 9 9 . .


Equality Array:
| 0  | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 |
| 0  | 1  | 2  | 2  | 1  | 5  | 6  | 1  | 1  | 9  | 10 | 11 | 9  |

data1.txt - updating equality table labels:
Equality Array:
| 0  | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 |
| 0  | 1  | 2  | 2  | 1  | 3  | 4  | 1  | 1  | 5  | 6  | 7  | 5  |
```

```
data1.txt - updating equality table labels:
Equality Array:
| 0  | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 |
| 0  | 1  | 2  | 2  | 1  | 3  | 4  | 1  | 1  | 5  | 6  | 7  | 5  |

data1.txt - Third Pass of Connect Components:
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
. . . . . 1 1 1 1 1 1 1 1 1 1 . . . . . . . . . . . . . . . 2 . . . .
. . . . . 1 1 1 1 1 1 1 1 1 1 . . . . . . . . . . 2 2 2 . . 2 2 . . .
. . . . . . . . . 1 1 . . . . . . . . . . . . . 2 2 2 2 2 . 2 . . . .
. . . . . . . . . 1 1 . . . . . . . . . . . . 2 2 . . . 2 2 . . . . .
. . . . . . . . . 1 1 . . . . . . . . . . . 2 2 . . . . . 2 2 . . . .
. . . . . . . . . 1 1 . . . . . . . . . . . 2 2 . . . . . 2 2 . . . .
. . . . . 1 . . . 1 1 . . . . . . . . . . . 2 2 . . . . 2 2 2 . . . .
. . . . . . 1 . . 1 1 . . . . . . . . . . . . 2 2 . . . 2 2 . . . . .
. . . . . . . 1 . 1 1 . . . . . . . . . . . . . 2 2 2 2 2 . . . . . .
. . . . . . . . 1 1 1 1 . . . . . . . . . . . . . 2 2 2 . . . . . . .
. . . . . . . . 1 1 1 1 1 . . . . . . . . . . . . . . . . . . . . . .
. . . . . . . . . . . 1 . . . . . . . . . . . . . . . . . . . . . . .
. . . . . . . . . . 1 . . . . . . . . 3 3 3 . . . . . . . . . . . . .
. . . . . . . . . 1 . . . . . . . . 3 3 3 3 3 . . . . . . . . . . . .
. . . . . . . . 1 . . . . . . . . 3 3 3 . 3 3 3 . . . . . . . 4 4 . .
. . . . . . . 1 . . . . . . . . 3 3 . . . . . 3 3 . . . . . . 4 4 . .
. . . . . . 1 . . . . . . . . . 3 3 . . . . . 3 3 . . . . . . . . . .
. . . 1 1 1 . . . 1 1 . . . . . 3 3 . . . . . 3 3 . . . . . . 5 5 . .
. . . 1 1 . . . 1 1 . . . . . . 3 3 . . . . . 3 3 . . . . . . 5 5 . .
. . . 1 1 . . 1 1 . . . 6 . . . 3 3 . . . . . 3 3 . . . . . . 5 5 . .
. . . 1 1 . 1 1 . . . . . 6 . . 3 3 3 3 3 3 3 3 3 . . . . . . 5 5 . .
. . . 1 1 . 1 1 . . . . . 6 . . 3 3 3 3 3 3 3 3 3 . . . . . . 5 5 . .
. . . 1 1 1 1 . . . . . . 6 . . 3 3 . . . . . 3 3 . . . . . . 5 5 . .
. . . 1 1 . 1 1 . . . . . . 6 . 3 3 . . . . . 3 3 . . . . . . 5 5 . .
. . . 1 1 . . . . 7 . . . . 6 . 3 3 . . . . . 3 3 . . . . . . 5 5 . .
. . . 1 1 . . . 7 7 . . . . 6 . 3 3 . . . . . 3 3 . . 5 5 . 5 5 5 . .
. . . 1 1 . . . 7 7 . . . . 6 . 3 3 . . . . . 3 3 . . . 5 5 . 5 5 . .
. . . 1 1 . . . 7 7 . . . . 6 . . . . . . . . 3 . . . . 5 5 5 5 . . .
. . . 1 1 . . . . 7 7 . . 6 . 6 . . . . . . . . 3 . . . . 5 5 5 5 . .


Equality Array:
| 0  | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 |
| 0  | 1  | 2  | 2  | 1  | 3  | 4  | 1  | 1  | 5  | 6  | 7  | 5  |
```

```
.  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .
.  .  .  1  1  1  1  1  1  1  1  1  1  1  1  .  .  .  .  .  .  .  2  2  2  2  2  2  2  2  2  2  .  .  .
.  .  .  1  .  1  1  1  1  1  1  1  1  1  1  .  .  .  .  .  .  .  2  .  .  2  2  2  .  .  2  2  .  .  .
.  .  .  1  .  .  .  .  .  1  1  .  .  .  1  .  .  .  .  .  .  .  2  .  2  2  2  2  2  .  2  2  .  .  .
.  .  .  1  .  .  .  .  .  1  1  .  .  .  1  .  .  .  .  .  .  .  2  2  2  .  .  .  2  2  .  2  .  .  .
.  .  .  1  .  .  .  .  .  1  1  .  .  .  1  .  .  .  .  .  .  .  2  2  .  .  .  .  .  2  2  2  .  .  .
.  .  .  1  .  .  .  .  .  1  1  .  .  .  1  .  .  .  .  .  .  .  2  2  .  .  .  .  .  2  2  2  .  .  .
.  .  .  1  .  1  .  .  .  1  1  .  .  .  1  .  .  .  .  .  .  .  2  2  .  .  .  .  2  2  2  2  .  .  .
.  .  .  1  .  .  1  .  .  1  1  .  .  .  1  .  .  .  .  .  .  .  2  2  2  .  .  .  2  2  .  2  .  .  .
.  .  .  1  .  .  .  1  .  1  1  .  .  .  1  .  .  .  .  .  .  .  2  .  2  2  2  2  2  .  .  2  .  .  .
.  .  .  1  .  .  .  .  1  1  1  1  .  .  1  .  .  .  .  .  .  .  2  2  2  2  2  2  2  2  2  2  .  .  .
.  .  .  1  .  .  .  .  1  1  1  1  1  .  1  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .
.  .  .  1  .  .  .  .  .  .  .  1  .  .  1  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .
.  .  .  1  .  .  .  .  .  .  1  .  .  .  1  .  3  3  3  3  3  3  3  3  3  .  .  .  .  .  .  .  .  .  .
.  .  .  1  .  .  .  .  .  1  .  .  .  .  1  .  3  .  3  3  3  3  3  .  3  .  .  .  .  .  .  .  .  .  .
.  .  .  1  .  .  .  .  1  .  .  .  .  .  1  .  3  3  3  3  .  3  3  3  3  .  .  .  .  .  .  4  4  .  .
.  .  .  1  .  .  .  1  .  .  .  .  .  .  1  .  3  3  .  .  .  .  .  3  3  .  .  .  .  .  .  4  4  .  .
.  .  .  1  .  .  1  .  .  .  .  .  .  .  1  .  3  3  .  .  .  .  .  3  3  .  .  .  .  .  .  .  .  .  .
.  .  .  1  1  1  .  .  .  1  1  .  .  .  1  .  3  3  .  .  .  .  .  3  3  .  .  5  5  5  5  5  5  .  .
.  .  .  1  1  .  .  .  1  1  .  .  .  .  1  .  3  3  .  .  .  .  .  3  3  .  .  5  .  .  .  5  5  .  .
.  .  .  1  1  .  .  1  1  .  .  .  6  6  1  6  3  3  .  .  .  .  .  3  3  .  .  5  .  .  .  5  5  .  .
.  .  .  1  1  .  1  1  .  .  .  .  6  6  1  6  3  3  3  3  3  3  3  3  3  .  .  5  .  .  .  5  5  .  .
.  .  .  1  1  .  1  1  .  .  .  .  6  6  1  6  3  3  3  3  3  3  3  3  3  .  .  5  .  .  .  5  5  .  .
.  .  .  1  1  1  1  .  .  .  .  .  6  6  1  6  3  3  .  .  .  .  .  3  3  .  .  5  .  .  .  5  5  .  .
.  .  .  1  1  .  1  1  .  .  .  .  6  .  6  6  3  3  .  .  .  .  .  3  3  .  .  5  .  .  .  5  5  .  .
.  .  .  1  1  .  .  .  7  7  7  .  6  .  6  6  3  3  .  .  .  .  .  3  3  .  .  5  .  .  .  5  5  .  .
.  .  .  1  1  .  .  .  7  7  7  .  6  .  6  6  3  3  .  .  .  .  .  3  3  .  .  5  5  .  5  5  5  .  .
.  .  .  1  1  .  .  .  7  7  7  .  6  .  6  6  3  3  .  .  .  .  .  3  3  .  .  5  5  5  .  5  5  .  .
.  .  .  1  1  .  .  .  7  7  7  .  6  .  6  6  3  .  .  .  .  .  .  3  3  .  .  5  5  5  5  5  5  .  .
.  .  .  1  1  1  1  1  1  7  7  1  1  6  1  6  3  3  3  3  3  3  3  3  3  .  .  5  5  5  5  5  5  .  .


True Number of Connected Components: 7
```

```
Label Print-out for rfprettyprint18.txt:
30 35 40 0
30 35 0 1
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  1  1  1  1  1  1  1  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  2  0  0  0  0
0  0  0  0  0  1  1  1  1  1  1  1  1  1  0  0  0  0  0  0  0  0  0  0  0  2  2  2  0  0  2  2  0  0  0
0  0  0  0  0  0  0  0  0  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  2  2  2  2  2  0  2  0  0  0  0
0  0  0  0  0  0  0  0  0  1  1  0  0  0  0  0  0  0  0  0  0  0  0  2  2  0  0  0  2  2  0  0  0  0  0
0  0  0  0  0  0  0  0  0  1  1  0  0  0  0  0  0  0  0  0  0  0  2  2  0  0  0  0  0  2  2  0  0  0  0
0  0  0  0  0  0  0  0  0  1  1  0  0  0  0  0  0  0  0  0  0  0  2  2  0  0  0  0  0  2  2  0  0  0  0
0  0  0  0  0  1  0  0  0  1  1  0  0  0  0  0  0  0  0  0  0  0  2  2  0  0  0  0  2  2  2  0  0  0  0
0  0  0  0  0  0  1  0  0  1  1  0  0  0  0  0  0  0  0  0  0  0  0  2  2  0  0  0  2  2  0  0  0  0  0
0  0  0  0  0  0  0  1  0  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  2  2  2  2  2  0  0  0  0  0  0
0  0  0  0  0  0  0  0  1  1  1  1  1  0  0  0  0  0  0  0  0  0  0  0  0  2  2  2  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  3  3  3  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  3  3  3  3  3  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  3  3  3  0  3  3  3  0  0  0  0  0  0  0  4  4  0  0
0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  3  3  0  0  0  0  0  3  3  0  0  0  0  0  0  4  4  0  0
0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  3  3  0  0  0  0  0  0  3  3  0  0  0  0  0  0  0  0  0  0
0  0  0  1  1  1  0  0  0  1  1  0  0  0  0  0  3  3  0  0  0  0  0  3  3  0  0  0  0  0  0  5  5  0  0
0  0  0  1  1  0  0  0  1  1  0  0  0  0  0  0  3  3  0  0  0  0  0  3  3  0  0  0  0  0  0  5  5  0  0
0  0  0  1  1  0  0  1  1  0  0  0  6  0  0  0  3  3  0  0  0  0  0  3  3  0  0  0  0  0  0  5  5  0  0
0  0  0  1  1  0  1  1  0  0  0  0  0  6  0  0  3  3  3  3  3  3  3  3  3  0  0  0  0  0  0  5  5  0  0
0  0  0  1  1  0  1  1  0  0  0  0  0  6  0  0  3  3  3  3  3  3  3  3  3  0  0  0  0  0  0  5  5  0  0
0  0  0  1  1  1  1  0  0  0  0  0  0  6  0  0  3  3  0  0  0  0  0  3  3  0  0  0  0  0  0  5  5  0  0
0  0  0  1  1  0  1  1  0  0  0  0  0  0  6  0  3  3  0  0  0  0  0  3  3  0  0  0  0  0  0  5  5  0  0
0  0  0  1  1  0  0  0  0  7  0  0  0  0  6  0  3  3  0  0  0  0  0  3  3  0  0  0  0  0  0  5  5  0  0
0  0  0  1  1  0  0  0  7  7  0  0  0  0  6  0  3  3  0  0  0  0  0  3  3  0  0  5  5  0  5  5  5  0  0
0  0  0  1  1  0  0  0  7  7  0  0  0  0  6  0  3  3  0  0  0  0  0  3  3  0  0  0  5  5  0  5  5  0  0
0  0  0  1  1  0  0  0  7  7  0  0  0  0  6  0  0  0  0  0  0  0  0  3  0  0  0  0  5  5  5  5  0  0  0
0  0  0  1  1  0  0  0  0  7  7  0  0  6  0  6  0  0  0  0  0  0  0  0  3  0  0  0  0  5  5  5  5  0  0


Property File Print-out for rfprettyprint18.txt:
30 35 0 1
7
1
91
1 3
29 14
2
41
1 22
10 31
3
74
13 16
29 24
4
4
15 31
16 32
5
33
18 27
29 32
6
11
20 12
29 15
```

```
7
9
25 8
29 10



Full output for rfprettyprint28.txt:
data2.txt - First Pass of Connected Components data2.txt - with 8-connected:
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
. . . . . . . . . . . . . . . 1 . . . . . 2 . . . . . . . . .
. . . . . . . 3 . 4 . . . . 1 1 1 . . . . 2 . . . 5 5 5 . . .
. 6 6 . . . . . 3 3 3 . . 1 1 1 1 1 . . . . . . . 5 5 5 . . .
. 6 6 . . . . 3 . 3 3 . . . 1 1 1 1 1 . . . . . . . . . . . .
. . . . . . . 3 3 3 . . . 1 1 1 1 1 1 1 . . . 7 7 7 . . . . .
. . . . . 8 3 3 3 . 3 3 1 . . . . . . 1 1 . . . . . . 9 9 . .
. . . . 3 . . 1 . 1 1 1 1 1 1 1 1 1 1 1 1 1 . . . . 9 9 . . .
. . . . 1 1 1 1 1 . . . . . . 1 1 1 1 1 1 1 . . . . 9 . . . .
. . . . . . . 1 . 1 1 1 1 1 1 1 1 1 1 1 1 1 . . . . . . . . .
. . 10 . 11 . 1 1 . . . . . . . 1 . . . . . . . . . . . . . . .
. . . 10 10 . 1 . . 12 . . . . . 1 1 1 1 1 1 1 1 . . . . . . . .
. . 10 . 10 . 1 . 12 12 12 12 12 12 1 1 1 1 1 1 1 1 . . . . . . . . .
. . 10 . 10 . . . . 1 1 1 1 1 1 1 1 1 1 1 1 1 . . . 13 . . . 14 .
. . 10 . . . . . . . 1 1 1 1 1 1 1 1 1 1 1 . 1 . . . 13 . 14 . .
. . . 10 10 . . . . 1 . . 1 . . . . . 1 . . . . . . . . 13 13 13 .
. 15 . . 10 . . 16 1 . . . . 1 1 1 1 1 . . . . . . . . . 13 13 13 .
. . 15 . 10 . 1 . . . . . . . 1 1 1 . . 17 . . . . . 18 13 13 13 13 .
. . 15 10 10 1 1 1 . . . . . . . 1 . 1 1 . 1 . . . . 13 13 13 13 13 .
. . 1 1 1 1 1 1 . . . . . 19 . . . . . . . 1 . . . 13 13 13 13 . .
. . . . 1 1 1 1 . . . . . 19 . 20 . . . 21 . . . . 13 13 13 13 . . .
. . . 1 . . . . . . . . . 19 . 20 . . . 21 . . . 13 13 13 . . . 22 .
. . 1 . . . . . . . . . . . 19 19 19 . . . 21 . . . 13 13 13 13 13 13 .
. . . . . . . . . . . . . . 19 19 19 . 23 21 21 21 21 13 13 . . . . . .


Equality Array:
| 0  | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| 0  | 1  | 2  | 1  | 3  | 5  | 6  | 7  | 3  | 9  | 1  | 10 | 1  | 13 | 13 | 1  | 1  | 1  | 13 | 19 | 19 | 13 | 13 | 21 |

data2.txt - Second Pass of Connected Components with 8-connected:
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
. . . . . . . . . . . . . . . 1 . . . . . 2 . . . . . . . . .
. . . . . . . 1 . 1 . . . . 1 1 1 . . . . 2 . . . 5 5 5 . . .
. 6 6 . . . . . 1 1 1 . . 1 1 1 1 1 . . . . . . . 5 5 5 . . .
. 6 6 . . . . 1 . 1 1 . . . 1 1 1 1 1 . . . . . . . . . . . .
. . . . . . . 1 1 1 . . . 1 1 1 1 1 1 1 . . . 7 7 7 . . . . .
. . . . . 1 1 1 1 . 1 1 1 . . . . . . 1 1 . . . . . . 9 9 . .
. . . . 1 . . 1 . 1 1 1 1 1 1 1 1 1 1 1 1 1 . . . . 9 9 . . .
. . . . 1 1 1 1 1 . . . . . . 1 1 1 1 1 1 1 . . . . 9 . . . .
. . . . . . . 1 . 1 1 1 1 1 1 1 1 1 1 1 1 1 . . . . . . . . .
. . 1 . 1 . 1 1 . . . . . . . 1 . . . . . . . . . . . . . . .
. . . 1 1 . 1 . . 1 . . . . . 1 1 1 1 1 1 1 1 . . . . . . . .
. . 1 . 1 . 1 . 1 1 1 1 1 1 1 1 1 1 1 1 1 1 . . . . . . . . .
. . 1 . 1 . . . . 1 1 1 1 1 1 1 1 1 1 1 1 1 . . . 13 . . . 13 .
. . 1 . . . . . . . 1 1 1 1 1 1 1 1 1 1 1 . 1 . . . 13 . 13 . .
. . . 1 1 . . . . 1 . . 1 . . . . . 1 . . . . . . . . 13 13 13 .
. 1 . . 1 . . 1 1 . . . . 1 1 1 1 1 . . . . . . . . . 13 13 13 .
. . 1 . 1 . 1 . . . . . . . 1 1 1 . . 1 . . . . . 13 13 13 13 13 .
. . 1 1 1 1 1 1 . . . . . . . 1 . 1 1 . 1 . . . . 13 13 13 13 13 .
. . 1 1 1 1 1 1 . . . . . 19 . . . . . . . 1 . . . 13 13 13 13 . .
. . . . 1 1 1 1 . . . . . 19 . 19 . . . 13 . . . . 13 13 13 13 . . .
. . . 1 . . . . . . . . . 19 . 19 . . . 13 . . . 13 13 13 . . . 13 .
. . 1 . . . . . . . . . . . 19 19 19 . . . 13 . . . 13 13 13 13 13 13 .
. . . . . . . . . . . . . . 19 19 19 . 13 13 13 13 13 13 13 . . . . . .
```

```
Equality Array:
| 0  | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| 0  | 1  | 2  | 1  | 1  | 5  | 6  | 7  | 1  | 9  | 1  | 1  | 1  | 13 | 13 | 1  | 1  | 1  | 13 | 19 | 19 | 13 | 13 | 13 |

data2.txt - updating equality table labels:
Equality Array:
| 0  | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| 0  | 1  | 2  | 1  | 1  | 3  | 4  | 5  | 1  | 6  | 1  | 1  | 1  | 7  | 7  | 1  | 1  | 1  | 7  | 8  | 8  | 7  | 7  | 7  |

data2.txt - Third Pass of Connect Components:
.  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .
.  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  1  .  .  .  .  .  .  2  .  .  .  .  .  .
.  .  .  .  .  .  .  1  .  1  .  .  .  .  .  1  1  1  .  .  .  .  .  2  .  .  .  3  3  3  .  .  .
.  4  4  .  .  .  .  .  1  1  1  .  .  1  1  1  1  1  .  .  .  .  .  .  .  .  3  3  3  .  .  .
.  4  4  .  .  .  .  .  1  .  1  1  .  .  .  1  1  1  1  1  1  .  .  .  .  .  .  .  .  .  .  .
.  .  .  .  .  .  .  .  1  1  1  .  .  .  1  1  1  1  1  1  1  .  .  .  5  5  5  .  .  .  .  .
.  .  .  .  .  .  1  1  1  1  1  .  1  1  1  .  .  .  .  .  .  1  1  .  .  .  .  .  .  6  6  .  .
.  .  .  .  .  1  .  .  1  .  1  1  1  1  1  1  1  1  1  1  1  1  1  1  .  .  .  .  .  6  6  .  .
.  .  .  .  .  1  1  1  1  1  1  .  .  .  .  .  .  .  1  1  1  1  1  1  1  .  .  .  .  .  6  .  .  .  .
.  .  .  .  .  .  .  .  1  .  1  1  1  1  1  1  1  1  1  1  1  1  1  1  .  .  .  .  .  .  .  .  .  .
.  .  1  .  1  .  1  1  .  .  .  .  .  .  .  1  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .
.  .  .  1  1  .  1  .  .  1  .  .  .  .  .  .  1  1  1  1  1  1  1  1  .  .  .  .  .  .  .  .
.  .  1  .  1  .  1  .  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  .  .  .  .  .  .  .  .
.  .  1  .  1  .  .  .  .  .  1  1  1  1  1  1  1  1  1  1  1  1  1  1  .  .  .  7  .  .  .  7  .
.  .  1  .  .  .  .  .  .  .  .  1  1  1  1  1  1  1  1  1  1  1  1  1  .  1  .  .  .  7  .  7  .  .
.  .  .  1  1  .  .  .  .  .  1  .  .  1  .  .  .  .  .  .  1  .  .  .  .  .  .  .  .  7  7  7  .
.  1  .  .  1  .  .  1  1  .  .  .  .  1  1  1  1  1  1  .  .  .  .  .  .  .  .  .  .  7  7  7  .
.  .  1  .  1  .  1  .  .  .  .  .  .  .  .  1  1  1  .  .  1  .  .  .  .  .  7  7  7  7  7  .
.  .  1  1  1  1  1  1  .  .  .  .  .  .  .  .  1  .  1  1  .  1  .  .  .  .  .  7  7  7  7  7  .
.  .  1  1  1  1  1  1  1  .  .  .  .  .  .  8  .  .  .  .  .  .  .  1  .  .  .  7  7  7  7  .  .
.  .  .  .  .  1  1  1  1  .  .  .  .  .  .  8  .  8  .  .  .  .  7  .  .  .  .  7  7  7  7  .  .  .
.  .  .  .  1  .  .  .  .  .  .  .  .  .  .  8  .  8  .  .  .  .  7  .  .  .  7  7  7  .  .  .  7  .
.  .  1  .  .  .  .  .  .  .  .  .  .  .  .  .  8  8  8  .  .  .  7  .  .  .  7  7  7  7  7  7  .
.  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  8  8  8  .  7  7  7  7  7  7  7  .  .  .  .  .  .


Equality Array:
| 0  | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| 0  | 1  | 2  | 1  | 1  | 3  | 4  | 5  | 1  | 6  | 1  | 1  | 1  | 7  | 7  | 1  | 1  | 1  | 7  | 8  | 8  | 7  | 7  | 7  |

.  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .
.  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  2  1  .  .  .  .  .  .  .  .
.  1  .  .  .  .  .  .  1  .  1  .  .  .  .  1  1  1  .  .  .  .  .  2  1  .  .  3  3  3  .  .  .
.  4  4  .  .  .  .  .  .  1  1  1  .  .  1  1  1  1  1  .  .  .  .  .  1  .  .  3  3  3  .  .  .
.  4  4  .  .  .  .  .  1  .  1  1  .  .  .  1  1  1  1  1  1  .  .  .  1  .  .  .  .  .  .  .  .
.  1  .  .  .  .  .  .  1  1  1  .  .  .  1  1  1  1  1  1  1  .  .  1  5  5  5  .  .  .  .  .
.  1  .  .  .  1  1  1  1  1  .  1  1  1  .  .  .  .  .  .  .  1  1  .  .  .  6  6  6  .  .
.  1  .  .  1  .  .  1  .  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  .  .  .  6  6  6  .  .
.  1  .  .  1  1  1  1  1  .  .  .  .  .  .  .  1  1  1  1  1  1  1  1  .  .  .  6  6  6  .  .
.  1  .  .  .  .  .  .  1  .  1  1  1  1  1  1  1  1  1  1  1  1  1  1  .  .  .  .  .  .  .  .
.  1  1  .  1  .  1  1  .  .  .  .  .  .  .  .  1  .  .  .  .  .  .  .  1  .  .  .  .  .  .  .  .
.  1  .  1  1  .  1  .  .  1  .  .  .  .  .  .  1  1  1  1  1  1  1  1  1  .  .  .  .  .  .  .  .
.  1  1  .  1  .  1  .  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  .  .  .  .  .  .  .  .
.  1  1  .  1  .  .  .  .  .  1  1  1  1  1  1  1  1  1  1  1  1  1  1  7  7  7  7  7  7  7  .
.  1  1  .  .  .  .  .  .  .  .  1  1  1  1  1  1  1  1  1  1  1  1  1  .  1  .  .  .  7  .  7  7  .
.  1  .  1  1  .  .  .  .  .  1  .  .  1  .  .  .  .  .  .  1  .  .  .  1  .  .  .  .  7  7  7  .
.  1  .  .  1  .  .  1  1  .  .  .  .  1  1  1  1  1  1  7  .  .  .  1  .  .  .  .  7  7  7  .
.  1  1  .  1  .  1  .  .  .  .  .  .  .  1  1  1  .  7  1  .  .  1  .  .  7  7  7  7  7  .
.  1  1  1  1  1  1  1  .  .  .  .  .  .  .  1  .  1  1  .  1  .  1  .  .  7  7  7  7  7  .
.  1  1  1  1  1  1  1  1  .  .  .  .  .  8  8  8  8  .  7  .  .  1  1  .  .  7  7  7  7  7  .
.  1  .  .  1  1  1  1  .  .  .  .  .  .  8  .  8  8  .  7  7  .  .  1  .  7  7  7  .  .  7  .
.  1  .  1  .  .  .  .  .  .  .  .  .  .  8  .  8  8  .  7  7  .  .  1  7  7  7  .  .  .  7  .
.  1  1  1  1  1  1  1  1  1  1  1  1  1  1  8  8  8  8  1  1  1  7  1  1  .  7  7  7  7  7  7  .
.  .  .  .  .  .  .  .  .  .  .  .  .  .  .  8  8  8  8  .  7  7  7  7  7  7  7  7  7  7  7  .
```

```
True Number of Connected Components: 8

Label Print-out for rfprettyprint28.txt:
24 31 40 0
24 31 0 1
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  2  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  1  0  1  0  0  0  0  1  1  1  0  0  0  0  2  0  0  0  3  3  3  0  0  0
0  4  4  0  0  0  0  0  1  1  1  0  0  1  1  1  1  1  0  0  0  0  0  0  0  3  3  3  0  0  0
0  4  4  0  0  0  0  1  0  1  1  0  0  0  1  1  1  1  1  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  1  1  1  0  0  0  0  1  1  1  1  1  1  0  0  0  5  5  5  0  0  0  0  0
0  0  0  0  0  1  1  1  1  0  1  1  1  0  0  0  0  0  0  1  1  0  0  0  0  0  0  6  6  0  0
0  0  0  0  1  0  0  1  0  1  1  1  1  1  1  1  1  1  1  1  1  1  0  0  0  0  6  6  0  0  0
0  0  0  0  1  1  1  1  1  0  0  0  0  0  0  1  1  1  1  1  1  1  0  0  0  0  6  0  0  0  0
0  0  0  0  0  0  0  0  1  0  1  1  1  1  1  1  1  1  1  1  1  1  0  0  0  0  0  0  0  0  0
0  0  1  0  1  0  1  1  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  1  1  0  1  0  0  1  0  0  0  0  0  1  1  1  1  1  1  1  1  0  0  0  0  0  0  0  0
0  0  1  0  1  0  1  0  1  1  1  1  1  1  1  1  1  1  1  1  1  1  0  0  0  0  0  0  0  0  0
0  0  1  0  1  0  0  0  0  1  1  1  1  1  1  1  1  1  1  1  1  1  0  0  0  7  0  0  0  7  0
0  0  1  0  0  0  0  0  0  0  1  1  1  1  1  1  1  1  1  1  1  0  1  0  0  0  7  0  7  0  0
0  0  0  1  1  0  0  0  0  1  0  0  1  0  0  0  0  0  1  0  0  0  0  0  0  0  0  7  7  7  0
0  1  0  0  1  0  0  1  1  0  0  0  0  1  1  1  1  1  0  0  0  0  0  0  0  0  0  7  7  7  0
0  0  1  0  1  0  1  0  0  0  0  0  0  0  1  1  1  0  0  1  0  0  0  0  0  0  7  7  7  7  0
0  0  1  1  1  1  1  1  0  0  0  0  0  0  0  1  0  1  1  0  1  0  0  0  0  7  7  7  7  7  0
0  0  1  1  1  1  1  1  0  0  0  0  0  8  0  0  0  0  0  0  0  1  0  0  0  7  7  7  7  0  0
0  0  0  0  1  1  1  1  0  0  0  0  0  8  0  8  0  0  0  7  0  0  0  0  7  7  7  7  0  0  0
0  0  0  1  0  0  0  0  0  0  0  0  0  8  0  8  0  0  0  7  0  0  0  7  7  7  0  0  0  7  0
0  0  1  0  0  0  0  0  0  0  0  0  0  0  8  8  8  0  0  0  7  0  0  0  7  7  7  7  7  7  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  8  8  8  0  7  7  7  7  7  7  7  0  0  0  0  0  0


Property File Print-out for rfprettyprint28.txt:
24 31 0 1
8
1
188
1 1
22 22
2
2
1 21
2 21
3
6
2 25
3 27
4
4
3 1
4 2
5
3
5 23
5 25
6
5
6 26
8 28
7
48
13 18
23 29
25 25
8
11
19 13
23 16
```