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CSCI 381-26 Project 6: Connected-Component Language: C++

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**Part 1: Algorithm**

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I. main(...)

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step 0: inFile 🡨 open the input file

prettyPrintFile, labelFile, propertyFile 🡨 open from argc[]

numRows, numCols, minVal, maxVal 🡨 read from inFile

dynamically allocate zeroFramedAry.

step 1: zero2D (zeroFramedAry) // \*\* Initialized zeroFramedAry to zero.

step 2: loadImage(inFile, zeroFramedAry)

// read from input file and write to zeroFramedAry begin at(1,1)

step 3: Connectness 🡨 from argv[2]

step 4: newLabel 🡨 connectPass1 (Connectness, zeroFramedAry, NonZeroNeighborAry)

// see algorithm below

step 5: prettyPrint (prettyPrintFile) // Print zeroFramedAry to prettyPrintFile

printEQAry (newLable, prettyPrintFile)

// print the EQAry up to newLable with proper caption

step 6: connectPass2 (Connectness, zeroFramedAry, NonZeroNeighborAry)

step 7: prettyPrint (prettyPrintFile) // Print zeroFramedAry to prettyPrintFile

printEQAry (newLable, prettyPrintFile)

// print the EQAry up to newLable with proper caption

step 8: manageEQAry (EQAry, newLabel)

printEQAry (numCCLable, prettyPrintFile)

// print the EQAry up to newLabel with proper caption

step 9: connectPass3 (...) // See algorithm below

prettyPrint (prettyPrintFile) // Print zeroFramedAry to prettyPrintFile

printEQAry (numCCLable, prettyPrintFile)

// print the EQAry up to numCCLabel with proper caption

step 10: output numRows, numCols, newMin, newMax to labelFile

step 11: printImg (labelFile) // Output the result of pass3 from zeroFramedAry to //labelFile, begins at zeroFramedAry[1, 1] and ending at ??

step 12: printCCproperty (propertyFile) // print cc properties to propertyFile

step 13: drawBoxes(zeroFramedAry, CCproperty)

step 14: prettyPrint (prettyPrintFile) // Print zeroFramedAry to prettyPrintFile

step 15: close all files

**Part 2: Source code**

#include <iostream>

#include<fstream>

using namespace std;

class CCLabel{

public:

int numRows, numCols, minVal, maxVal, newMin = 9999, newMax = 0, newLabel = 0, trueNumCC, numNb = 5, Connectness;

int\* NonZeroNeighborAry;

int\* EQAry;

int\*\* zeroFramedAry;

struct Property{

public:

int label, numpixels, upperLftR, upperLftC, lowerRgtR, lowerRgtC;

};

Property\* CCproperty;

void set2DZero(int\*\* Ary){

for(int i = 0 ; i < numRows + 2 ; i++){

for(int j = 0 ; j < numCols + 2 ; j++){

Ary[i][j] = 0;

}

}

}

void loadImage(ifstream& file, int\*\* Ary){

for(int i = 1 ; i < numRows + 1 ; i++){

for(int j = 1 ; j < numCols + 1 ; j++){

file>>Ary[i][j];

}

}

}

int connectPass1(int connectness, int\*\* Ary, int\* nonZeroAry){

int newLabel = 0, nonZeroCount;

bool diffFlag;

for(int i = 1 ; i < numRows + 1 ; i++){

for(int j = 1 ; j < numCols + 1 ; j++){

if(Ary[i][j] > 0){

int minLabel = loadNonZeroPass1(Ary, Connectness, i, j, nonZeroAry, diffFlag, nonZeroCount);

if(minLabel == 0){

newLabel++;

Ary[i][j] = newLabel;

}

else if(minLabel > 0){

Ary[i][j] = minLabel;

if (diffFlag == true){

updateEQ(EQAry, nonZeroAry, minLabel, nonZeroCount);

}

}

}

}

}

return newLabel;

}

int loadNonZeroPass1(int\*\* Ary, int connnectness, int i, int j, int\* nonZeroAry,bool &diffFlag,int &nonZeroCount){

minus1D(nonZeroAry);

nonZeroCount = 0;

if(Ary[i-1][j] > 0){

nonZeroAry[nonZeroCount] = Ary[i-1][j];

nonZeroCount++;

}

if(Ary[i][j-1] > 0){

nonZeroAry [nonZeroCount] = Ary[i][j-1];

nonZeroCount++;

}

if(Connectness == 8){

if(Ary[i-1][j-1] > 0){

nonZeroAry[nonZeroCount] = Ary[i-1][j-1];

nonZeroCount++;

}

if(Ary[i-1][j+1] > 0){

nonZeroAry[nonZeroCount] = Ary[i-1][j+1];

nonZeroCount++;

}

}

if(nonZeroCount <= 0){

return 0;

}

int minLabel = nonZeroAry[0];

diffFlag = false;

int index = 1;

while(index < nonZeroCount){

if(minLabel != nonZeroAry[index]){

diffFlag = true;

}

if(minLabel > nonZeroAry[index]){

minLabel = nonZeroAry[index];

}

index++;

}

return minLabel;

}

void minus1D(int\* Ary){

for(int i = 0; i < numNb ; i++ ){

Ary[i] = -1;

}

}

void updateEQ(int\* Ary, int\* nonZeroAry, int minLabel, int nonZeroCount){

int index = 0;

while(index < nonZeroCount ){

EQAry[nonZeroAry[index]] = minLabel;

index++;

}

}

void prettyPrint(ofstream& file){

for(int i = 0 ; i < numRows + 2 ; i++){

for(int j = 0 ; j < numCols + 2 ; j++){

if(zeroFramedAry[i][j] > 0){

file<<zeroFramedAry[i][j]<<" ";

}

else{

file<<" ";

}

}

file<<endl;

}

}

void printEQAry(int i, ofstream& file){

int index = 0;

while(index <= i){

file<<EQAry[index]<<" ";

index++;

}

}

void connectPass2(int Connectness, int\*\* Ary, int\* nonZeroAry){

int nonZeroCount;

bool diffFlag;

for(int i = numRows ; i > 0 ; i--){

for(int j = numCols ; j > 0 ; j--){

if(Ary[i][j] > 0){

int minLabel = loadNonZeroPass2(Ary, Connectness, i, j, nonZeroAry, diffFlag, nonZeroCount);

if(minLabel != Ary[i][j]){

Ary[i][j] = minLabel;

}

if(diffFlag == true){

updateEQ(EQAry, nonZeroAry, minLabel, nonZeroCount);

}

}

}

}

}

int loadNonZeroPass2(int\*\* Ary, int Connectness, int i, int j, int\* nonZeroAry, bool &diffFlag, int &nonZeroCount){

minus1D(nonZeroAry);

nonZeroCount = 0;

nonZeroAry[nonZeroCount] = Ary[i][j];

nonZeroCount++;

if(Ary[i+1][j] > 0){

nonZeroAry[nonZeroCount] = Ary[i+1][j];

nonZeroCount++;

}

if(zeroFramedAry[i][j+1] > 0){

nonZeroAry[nonZeroCount] = Ary[i][j+1];

nonZeroCount++;

}

if(Connectness == 8){

if(Ary[i+1][j-1] > 0){

nonZeroAry[nonZeroCount] = Ary[i+1][j-1];

nonZeroCount++;

}

if(zeroFramedAry[i+1][j+1] > 0){

nonZeroAry[nonZeroCount] = Ary[i+1][j+1];

nonZeroCount++;

}

}

int minLabel = nonZeroAry[0];

diffFlag = false;

int index = 1;

while(index < nonZeroCount){

if(minLabel != nonZeroAry[index]){

diffFlag = true;

}

if(minLabel > nonZeroAry[index]){

minLabel = nonZeroAry[index];

}

index++;

}

return minLabel;

}

int manageEQAry(int\* EQAry, int newLabel){

int index = 1;

trueNumCC = 0;

while (index <= newLabel){

if(index != EQAry[index]){

EQAry[index]=EQAry[EQAry[index]];

}

else{

trueNumCC++;

EQAry[index] = trueNumCC;

}

index++;

}

return trueNumCC;

}

void connectPass3(int\* EQAry,int\*\* Ary){

for(int i = 1 ; i < numRows + 1 ; i++){

for(int j = 1 ; j < numCols + 1 ; j++){

if(Ary[i][j]>0){

Ary[i][j] = EQAry[Ary[i][j]];

CCproperty[Ary[i][j]].numpixels++;

if(CCproperty[Ary[i][j]].upperLftR == 0)

CCproperty[Ary[i][j]].upperLftR = i;

if(CCproperty[Ary[i][j]].lowerRgtR < i)

CCproperty[Ary[i][j]].lowerRgtR = i;

if(CCproperty[Ary[i][j]].upperLftC == 0)

CCproperty[Ary[i][j]].upperLftC = j;

if(CCproperty[Ary[i][j]].lowerRgtC < j)

CCproperty[Ary[i][j]].lowerRgtC = j;

}

if(newMin > Ary[i][j]){

newMin = Ary[i][j];

}

if(newMax < Ary[i][j]){

newMax = Ary[i][j];

}

}

}

}

void printImg(ofstream& file){

for(int r = 1; r < numRows + 1; r++){

for(int c =1; c < numCols + 1; c++){

file<<zeroFramedAry[r][c]<<" ";

}

file<<endl;

}

}

void printCCproperty(ofstream& file){

file<<numRows<<" "<<numCols<<" "<<newMin<<" "<<newMax<<endl;

file<<trueNumCC<<endl;

file<<"-- -- -- -- -- -- -- --"<<endl;

int index = 1;

while(index < trueNumCC + 1){

file<<index<<endl;

file<<CCproperty[index].numpixels<<endl;

file<<CCproperty[index].upperLftR<<" "<<CCproperty[index].upperLftC<<endl;

file<<CCproperty[index].lowerRgtR<<" "<<CCproperty[index].lowerRgtC<<endl;

file<<"-- -- -- -- -- -- -- --"<<endl;

index++;

}

}

void drawBoxes(int\*\* Ary,Property\* CCproperty){

int index =1;

while(index <= trueNumCC){

int minRow = CCproperty[index].upperLftR;

int maxRow = CCproperty[index].lowerRgtR;

int minCol = CCproperty[index].upperLftC;

int maxCol = CCproperty[index].lowerRgtC;

for (int i = minRow; i < maxRow + 1; i++) {

Ary[i][minCol] = index;

Ary[i][maxCol] = index;

}

for (int j = minCol; j < maxCol + 1; j++) {

Ary[minRow][j] = index;

Ary[maxRow][j] = index;

}

index++;

}

}

};

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

CCLabel l;

string inputName = argv[1];

ifstream inFile;

inFile.open( inputName );

string outputName1 = argv[3];

ofstream prettyPrintFile;

prettyPrintFile.open( outputName1 );

string outputName2 = argv[4];

ofstream labelFile;

labelFile.open( outputName2 );

string outputName3 = argv[5];

ofstream propertyFile;

propertyFile.open( outputName3 );

if(inFile.is\_open()){

if(prettyPrintFile.is\_open() && labelFile.is\_open() && propertyFile.is\_open() ){

inFile>>l.numRows>>l.numCols>>l.minVal>>l.maxVal;

l.zeroFramedAry = new int\* [l.numRows + 2];

for( int i = 0; i < l.numRows + 2; i++ ){

l.zeroFramedAry[i] = new int[l.numCols + 2];

}

l.set2DZero(l.zeroFramedAry);

l.loadImage(inFile, l.zeroFramedAry);

l.Connectness = stoi(argv[2]);

l.NonZeroNeighborAry = new int[l.numNb];

l.minus1D(l.NonZeroNeighborAry);

l.EQAry = new int[(l.numRows \* l.numCols) / 2];

for(int i = 0; i< ((l.numRows \* l.numCols) / 2) + 1; i++){

l.EQAry[i] = i;

}

l.newLabel = l.connectPass1(l.Connectness, l.zeroFramedAry,l.NonZeroNeighborAry);

l.prettyPrint(prettyPrintFile);

prettyPrintFile<<"EQAry up to newLable after pass 1: "<<endl;

l.printEQAry(l.newLabel, prettyPrintFile);

l.connectPass2(l.Connectness, l.zeroFramedAry, l.NonZeroNeighborAry);

l.prettyPrint(prettyPrintFile);

prettyPrintFile<<"EQAry up to newLable after pass 2: "<<endl;

l.printEQAry(l.newLabel, prettyPrintFile);

l.trueNumCC = l.manageEQAry(l.EQAry, l.newLabel);

l.CCproperty = new CCLabel::Property[l.trueNumCC + 1];

for (int i = 0; i < l.trueNumCC + 1; i++) {

l.CCproperty[i].label = 0;

l.CCproperty[i].lowerRgtR = 0;

l.CCproperty[i].lowerRgtC = 0;

l.CCproperty[i].numpixels = 0;

l.CCproperty[i].upperLftR = 0;

l.CCproperty[i].upperLftC = 0;

}

prettyPrintFile<<endl<<"EQAry up to newLable after manageEQAry: "<<endl;

l.printEQAry(l.newLabel, prettyPrintFile);

l.connectPass3(l.EQAry, l.zeroFramedAry);

l.prettyPrint(prettyPrintFile);

prettyPrintFile<<endl<<"EQAry up to newLable after pass3: "<<endl;

l.printEQAry(l.newLabel, prettyPrintFile);

labelFile<<l.numRows<<" "<<l.numCols<<" "<<l.newMin<<" "<<l.newMax<<endl;

l.printImg(labelFile);

l.printCCproperty(propertyFile);

l.drawBoxes(l.zeroFramedAry, l.CCproperty);

l.prettyPrint(prettyPrintFile);

inFile.close();

prettyPrintFile.close();

labelFile.close();

propertyFile.close();

}else{cout<<"Error!! Could NOT create output file"<<endl ;}

}else{cout<<"Error!! Could NOT open input file"<<endl;}

}

**Part 3: Output**

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 4 3 3

1 1 6 5 3 3

1 1 6 5 3 3

7 1 1 6 5 8 3 3

9 1 1 5 5 8 3

10 1 1 5 5 5 5 5

11 1 1 1 5 5 5

11 1 1 1 1

1

12 13 13 13

14 15 13 13 13 13

16 17 15 13 13 13 13 18 18

19 20 17 13 13 18 18

21 20 17 13 13

22 22 22 23 23 20 17 13 13 24 24

22 22 25 23 20 17 13 13 24 24

22 22 26 25 27 20 17 13 13 24 24

22 22 28 26 29 20 17 17 17 17 17 17 13 13 24 24

22 22 28 26 29 20 17 17 17 17 17 17 13 13 24 24

22 22 22 22 29 20 17 13 13 24 24

22 22 22 22 30 20 17 13 13 24 24

22 22 31 30 20 17 13 13 24 24

22 22 32 31 30 20 17 13 13 33 33 34 24 24

22 22 32 31 30 20 17 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

22 22 31 31 31 38 39 40 41 42

43 39 44 44 42

45 46 44 47

48 49 50 47

51 50

EQAry up to newLable after pass 1:

0 1 2 3 4 5 5 7 5 9 10 1 12 13 14 13 16 17 18 19 17 21 22 23 24 25 26 27 22 29 30 31 31 24 24 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 47 51

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 4 4 3 3

1 1 5 5 3 3

1 1 5 5 3 3

7 1 1 5 5 3 3 3

9 1 1 5 5 3 3

10 1 1 5 5 5 5 5

1 1 1 1 5 5 5

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 23 23 13 13 13 13 24 24

22 22 23 23 13 13 13 13 24 24

22 22 25 25 27 13 13 13 13 24 24

22 22 22 26 29 13 13 13 13 13 13 13 13 13 24 24

22 22 22 26 29 13 13 13 13 13 13 13 13 13 24 24

22 22 22 22 29 17 17 13 13 24 24

22 22 22 22 30 17 17 13 13 24 24

22 22 31 30 17 17 13 13 24 24

22 22 31 31 30 17 17 13 13 24 24 24 24 24

22 22 31 31 30 17 17 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

22 22 31 31 31 38 39 40 41 42

43 39 44 44 42

45 46 44 47

48 49 47 47

51 50

EQAry up to newLable after pass 2:

0 1 2 3 3 4 5 7 3 9 10 1 12 13 14 13 16 13 18 19 13 21 22 23 24 23 25 27 22 29 30 31 31 24 24 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 47 51

EQAry up to newLable after manageEQAry:

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

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 15 15 8 8 8 8 16 16

14 14 15 15 8 8 8 8 16 16

14 14 15 15 17 8 8 8 8 16 16

14 14 14 15 18 8 8 8 8 8 8 8 8 8 16 16

14 14 14 15 18 8 8 8 8 8 8 8 8 8 16 16

14 14 14 14 18 8 8 8 8 16 16

14 14 14 14 19 8 8 8 8 16 16

14 14 20 19 8 8 8 8 16 16

14 14 20 20 19 8 8 8 8 16 16 16 16 16

14 14 20 20 19 8 8 8 8 16 16 16 16

14 14 20 20 19 8 16 16 16 16

14 14 20 20 21 22 23 16 16 16 16

14 14 20 20 20 24 25 26 27 28

29 25 30 30 28

31 32 30 33

34 35 33 33

36 33

EQAry up to newLable after pass3:

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

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 3 2

1 1 1 1 3 3 3 3 3 3 3 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 15 15 15 15 8 8 8 8 16 16 16 16 16 16

14 14 15 15 15 15 8 8 8 8 16 16 16

14 14 15 15 15 17 8 8 8 8 16 16 16

14 14 14 15 15 18 8 8 8 8 8 8 8 8 8 16 16 16

14 14 14 15 15 15 15 18 8 8 8 8 8 8 8 8 8 16 16 16

14 14 14 14 14 18 8 8 8 8 16 16 16

14 14 14 14 19 8 8 8 8 16 16 16

14 14 14 20 20 20 20 20 19 8 8 8 8 16 16 16

14 14 14 20 20 20 19 8 8 8 8 16 16 16 16 16

14 14 14 20 20 20 19 8 8 8 8 16 16 16 16 16

14 14 14 20 20 20 19 8 8 8 8 8 8 8 8 8 16 16 16 16 16 16

14 14 14 20 20 20 20 21 22 23 16 16 16 16 16 16

14 14 14 14 14 20 20 20 20 20 24 25 26 27 28

29 25 30 30 28

31 32 30 30 33 33

34 35 33 33

36 33 33

- labelFile for 4-connectness

35 35 0 36

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 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 3 3 3 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 3 3 3 3 3 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 3 3 0 0 0 3 3 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 3 3 0 0 0 0 0 3 3 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 3 3 0 0 0 0 0 3 3 0 0 0 0

0 0 0 0 0 4 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 3 3 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 3 3 0 0 0 3 3 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 3 3 3 3 3 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 3 3 3 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 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 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 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 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 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 14 14 14 0 0 0 15 15 0 0 0 0 0 8 8 0 0 0 0 0 8 8 0 0 0 0 0 0 16 16 0 0

0 0 0 14 14 0 0 0 15 15 0 0 0 0 0 0 8 8 0 0 0 0 0 8 8 0 0 0 0 0 0 16 16 0 0

0 0 0 14 14 0 0 15 15 0 0 0 17 0 0 0 8 8 0 0 0 0 0 8 8 0 0 0 0 0 0 16 16 0 0

0 0 0 14 14 0 14 15 0 0 0 0 0 18 0 0 8 8 8 8 8 8 8 8 8 0 0 0 0 0 0 16 16 0 0

0 0 0 14 14 0 14 15 0 0 0 0 0 18 0 0 8 8 8 8 8 8 8 8 8 0 0 0 0 0 0 16 16 0 0

0 0 0 14 14 14 14 0 0 0 0 0 0 18 0 0 8 8 0 0 0 0 0 8 8 0 0 0 0 0 0 16 16 0 0

0 0 0 14 14 0 14 14 0 0 0 0 0 0 19 0 8 8 0 0 0 0 0 8 8 0 0 0 0 0 0 16 16 0 0

0 0 0 14 14 0 0 0 0 20 0 0 0 0 19 0 8 8 0 0 0 0 0 8 8 0 0 0 0 0 0 16 16 0 0

0 0 0 14 14 0 0 0 20 20 0 0 0 0 19 0 8 8 0 0 0 0 0 8 8 0 0 16 16 0 16 16 16 0 0

0 0 0 14 14 0 0 0 20 20 0 0 0 0 19 0 8 8 0 0 0 0 0 8 8 0 0 0 16 16 0 16 16 0 0

0 0 0 14 14 0 0 0 20 20 0 0 0 0 19 0 0 0 0 0 0 0 0 8 0 0 0 0 16 16 16 16 0 0 0

0 0 0 14 14 0 0 0 0 20 20 0 0 21 0 22 0 0 0 0 0 0 0 0 23 0 0 0 0 16 16 16 16 0 0

0 0 0 14 14 0 0 0 0 0 20 20 20 0 0 0 24 0 0 0 0 0 0 25 0 26 0 0 27 0 0 0 0 28 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 29 0 0 0 0 0 25 0 0 30 30 0 0 0 0 0 28 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 31 0 0 0 32 0 0 0 0 30 0 33 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 34 0 35 0 0 0 0 0 0 33 33 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 36 0 0 0 0 0 0 0 33 0 0 0 0 0 0

- propertyFile for 4-connectness

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| --- | --- | --- |
| 35 35 0 36  36  -- -- -- -- -- -- -- --  1  44  2 6  13 15  -- -- -- -- -- -- -- --  2  4  2 31  4 32  -- -- -- -- -- -- -- --  3  37  3 23  11 31  -- -- -- -- -- -- -- --  4  1  8 6  8 6  -- -- -- -- -- -- -- --  5  1  9 7  9 7  -- -- -- -- -- -- -- --  6  1  10 8  10 8  -- -- -- -- -- -- -- --  7  1  14 11  14 11  -- -- -- -- -- -- -- --  8  73  14 17  29 25  -- -- -- -- -- -- -- --  9  1  15 10  15 10  -- -- -- -- -- -- -- --  10  1  16 9  16 9  -- -- -- -- -- -- -- --  11  4  16 32  17 33  -- -- -- -- -- -- -- --  12  1  17 8  17 8  -- -- -- -- -- -- -- --  13  1  18 7  18 7 | -- -- -- -- -- -- -- --  14  33  19 4  31 8  -- -- -- -- -- -- -- --  15  8  19 8  23 11  -- -- -- -- -- -- -- --  16  33  19 28  30 33  -- -- -- -- -- -- -- --  17  1  21 13  21 13  -- -- -- -- -- -- -- --  18  3  22 14  24 14  -- -- -- -- -- -- -- --  19  5  25 15  29 15  -- -- -- -- -- -- -- --  20  12  26 9  31 13  -- -- -- -- -- -- -- --  21  1  30 14  30 14  -- -- -- -- -- -- -- --  22  1  30 16  30 16  -- -- -- -- -- -- -- --  23  1  30 25  30 25  -- -- -- -- -- -- -- --  24  1  31 17  31 17  -- -- -- -- -- -- -- --  25  2  31 24  32 24  -- -- -- -- -- -- -- -- | 26  1  31 26  31 26  -- -- -- -- -- -- -- --  27  1  31 29  31 29  -- -- -- -- -- -- -- --  28  2  31 34  32 34  -- -- -- -- -- -- -- --  29  1  32 18  32 18  -- -- -- -- -- -- -- --  30  3  32 27  33 28  -- -- -- -- -- -- -- --  31  1  33 19  33 19  -- -- -- -- -- -- -- --  32  1  33 23  33 23  -- -- -- -- -- -- -- --  33  4  33 29  35 30  -- -- -- -- -- -- -- --  34  1  34 20  34 20  -- -- -- -- -- -- -- --  35  1  34 22  34 22  -- -- -- -- -- -- -- --  36  1  35 21  35 21  -- -- -- -- -- -- -- -- |

- prettyPrintFile for 8-connectness

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1 1 1 1 1 1 1 1 1 1 3 3 3 2 2

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1 5 5 5

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1 5 5 5 5 5 5 6 6

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7 7 1 8 8 5 5 5 5 9 9

7 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

1 1 11 11 10 10 5 5 9 9

10 5 5 5 9

10 5 5 13

10 5 5 5

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EQAry up to newLable after pass 1:

0 1 2 2 1 5 6 1 1 5 5 10 9 5

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1 1 1 1 1 1 1 1 1 1 2 2 2 2 2

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1 1 1 1 5 5 5 5 5 5 5

1 1 10 5 5 5 5 5 5 5

1 1 10 10 5 5 5 5 5 5 5 5 5 5

1 1 10 10 5 5 5 5 5 5 5 5 9

1 1 10 10 5 5 5 5 5 9

1 1 10 10 10 5 5 5 9 9 9

1 1 10 10 10 5 5 5 5 9

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EQAry up to newLable after pass 2:

0 1 2 2 1 5 6 1 1 5 5 10 5 5

EQAry up to newLable after manageEQAry:

0 1 2 2 1 3 4 1 1 3 3 3 3 3

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

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EQAry up to newLable after pass3:

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| --- | --- |
| - labelFile for 8-connectness | - propertyFile for 8-connectness |
| 35 35 0 4  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 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 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 0 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 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 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 0 3 3 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 3 3 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 3 3 0 0  0 0 0 1 1 0 0 1 1 0 0 0 3 0 0 0 3 3 0 0 0 0 0 3 3 0 0 0 0 0 0 3 3 0 0  0 0 0 1 1 0 1 1 0 0 0 0 0 3 0 0 3 3 3 3 3 3 3 3 3 0 0 0 0 0 0 3 3 0 0  0 0 0 1 1 0 1 1 0 0 0 0 0 3 0 0 3 3 3 3 3 3 3 3 3 0 0 0 0 0 0 3 3 0 0  0 0 0 1 1 1 1 0 0 0 0 0 0 3 0 0 3 3 0 0 0 0 0 3 3 0 0 0 0 0 0 3 3 0 0  0 0 0 1 1 0 1 1 0 0 0 0 0 0 3 0 3 3 0 0 0 0 0 3 3 0 0 0 0 0 0 3 3 0 0  0 0 0 1 1 0 0 0 0 3 0 0 0 0 3 0 3 3 0 0 0 0 0 3 3 0 0 0 0 0 0 3 3 0 0  0 0 0 1 1 0 0 0 3 3 0 0 0 0 3 0 3 3 0 0 0 0 0 3 3 0 0 3 3 0 3 3 3 0 0  0 0 0 1 1 0 0 0 3 3 0 0 0 0 3 0 3 3 0 0 0 0 0 3 3 0 0 0 3 3 0 3 3 0 0  0 0 0 1 1 0 0 0 3 3 0 0 0 0 3 0 0 0 0 0 0 0 0 3 0 0 0 0 3 3 3 3 0 0 0  0 0 0 1 1 0 0 0 0 3 3 0 0 3 0 3 0 0 0 0 0 0 0 0 3 0 0 0 0 3 3 3 3 0 0  0 0 0 1 1 0 0 0 0 0 3 3 3 0 0 0 3 0 0 0 0 0 0 3 0 3 0 0 3 0 0 0 0 3 0  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 0 0 0 0 0 3 0 0 3 3 0 0 0 0 0 3 0  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 0 0 0 3 0 0 0 0 3 0 3 0 0 0 0 0  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 0 3 0 0 0 0 0 0 3 3 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 3 0 0 0 0 0 0 0 3 0 0 0 0 0 0 | 35 35 0 4  4  -- -- -- -- -- -- -- --  1  93  2 4  31 15  -- -- -- -- -- -- -- --  2  41  2 23  11 32  -- -- -- -- -- -- -- --  3  150  14 9  35 34  -- -- -- -- -- -- -- --  4  4  16 32  17 33  -- -- -- -- -- -- -- -- |