**CSCI 381 – Computer Vision (JAVA)  
Program: Project 4.1: Morphology**

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**Due Date:**

**Soft copy: 3/12/2019 Tuesday before midnight**

**Hard copy: 3/14/2019 Thursday in class**

step -1: make sure all inputted arguments are valid

step 0:

* Step 0.1:
  + imageInFile 🡨 arg[0]
  + structElementInFile 🡨 arg[1]
  + dilationResultOutFile 🡨 arg[2]
  + erosionResultOutFile 🡨 arg[3]
  + openingResultOutFile 🡨 arg[4]
  + closingResultOutFile 🡨 arg[5]
* Step 0.2:
  + Load image from imageInFile
  + Load structuring element from structElementInFile

Step 1: Frame image

Step 2: Print Loaded Image and Structuring Element

* Step 2.1: console 🡨 framedImage
* Step 2.2: console 🡨 structElement

Step 3: Dilation

* Step 3.1: Dilate the image
* Step 3.2: console 🡨 dilatedImage
* Step 3.3: Unframe the dilatedImgae
* Step 3.4: dilationResultOutfile 🡨 unframed dilatedImage

Step 4: Erosion

* Step 4.1: Erode the image
* Step 4.2: console 🡨 erodedImage
* Step 4.3: Unframe the erodedImgae
* Step 4.4: erosionResultOutfile 🡨 unframed erodedImage

Step 5: Openeing

* Step 5.1: Perform opening the image
* Step 5.2: console 🡨 openedImage
* Step 5.3: Unframe the openedImgae
* Step 5.4: openingResultOutfile 🡨 unframed openedImage

Step 6: Closing

* Step 6.1: Close the image
* Step 6.2: console 🡨 closedImage
* Step 6.3: Unframe the closedImgae
* Step 6.4: closingResultOutfile 🡨 unframed closedImage

Step ~7: Close all open streams (occurs on the method level everytime prettyPring is called.)

**Code: MorphologyMain.java**

import java.io.\*;

import java.util.\*;

public class MorphologyMain {

public static void main(String args[]){

File imageInFile, structElementInFile;

File dilationResultOutFile, erosionResultOutFile;

File openingResultOutFile, closingResultOutFile;

final String ARG\_ERROR\_STRING = "Improper arguements. Correct syntax is: \n>> ... <input1.txt> <input2.txt> <output1.txt> <output2.txt> <output3.txt> <output4.txt>"

+ " \n\twhere: \n\tinput1.txt is a grey-scale image with header \n\tinput2.txt is a Structuring Element with a double header \n\toutput1.txt is a file to "

+ " print the result of the a Dilation to \n\toutput2.txt is a file to print the result of the Erosion.\n\toutput3.txt is a file to print the result of the Opening."

+ "\n\toutput4.txt is a file to print the result of the Closing.";

//STEP -1: Check for bad arguements

if(args.length != 6) {

System.out.println(ARG\_ERROR\_STRING);

System.exit(0);

}//if

for(String s: args) {

if(!s.endsWith("txt")) {

System.out.println(s + " is not a valid arguement. Must be a .txt file.");

System.exit(0);

}//if

}//for

try{

//Step 0

imageInFile = new File(args[0]);

structElementInFile = new File(args[1]);

dilationResultOutFile = new File(args[2]);

erosionResultOutFile = new File(args[3]);

openingResultOutFile = new File(args[4]);

closingResultOutFile = new File(args[5]);

Image img = new Image(imageInFile);

StructuringElement structuringElement = new StructuringElement(structElementInFile);

//Step 1

Image framedImage = img.frame(structuringElement);

//Step 2

framedImage.prettyprint(true);

structuringElement.prettyprint(true);

//Step 3

Image dilatedImage = Morpher.dilation(framedImage, structuringElement);

dilatedImage.prettyprint(true);

dilatedImage = dilatedImage.unframe(structuringElement);

dilatedImage.prettyprint(dilationResultOutFile, true);

//Step 4

Image erodedImage = Morpher.erosion(framedImage, structuringElement);

erodedImage.prettyprint(true);

erodedImage = erodedImage.unframe(structuringElement);

erodedImage.prettyprint(erosionResultOutFile, true);

//Step 5

Image openedImage = Morpher.opening(framedImage, structuringElement);

openedImage.prettyprint(true);

openedImage = openedImage.unframe(structuringElement);

openedImage.prettyprint(openingResultOutFile, true);

//Step 6

Image closedImage = Morpher.closing(framedImage, structuringElement);

closedImage.prettyprint(true);

closedImage = closedImage.unframe(structuringElement);

closedImage.prettyprint(closingResultOutFile, true);

} catch(FileNotFoundException fnf){

fnf.printStackTrace();

System.exit(0);

} catch(IllegalArgumentException iae){

iae.printStackTrace();

System.exit(0);

}

}//main

}//class

**Code: Image.java**

import java.io.\*;

import java.util.\*;

public class Image {

int numRows; //number of rows based on header

int numCols; //number of cols based on header

int minVal; //lowest value based on header

int maxVal; //largest value based on header

int[][] imgAry; //actual image data

boolean isFramed; //is this a framed image?

public Image(){

}//null contructor

public Image(int numRows, int numCols, int minVal, int maxVal){

this.numRows = numRows;

this.numCols = numCols;

this.minVal = minVal;

this.maxVal = maxVal;

initWithZeros();

}//constructor w header

public Image(File imageFile) throws FileNotFoundException{

Scanner inStream = new Scanner(new FileReader(imageFile));

//get header values

this.numRows = inStream.nextInt();

this.numCols = inStream.nextInt();

this.minVal = inStream.nextInt();

this.maxVal = inStream.nextInt();

initWithZeros();

//get all image data

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

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

imgAry[i][j] = inStream.nextInt();

}//for

}//for

inStream.close();

//set as unframed image

isFramed = false;

}//constrcutor from file

/\*\*

\* Initializs imgAry with a 2D array of zeros.

\*/

public void initWithZeros(){

imgAry = new int[numRows][numCols];

for(int r = 0; r < numRows; r++){

for(int c = 0; c < numCols; c++){

imgAry[r][c] = 0;

}//for

}//for

}//initWithZeroes

/\*\*

\* @param imgAry the imgAry to set

\*/

public void copyImage(Image image) {

this.numCols = image.getNumCols();

this.numRows = image.getNumRows();

this.minVal = image.getMinVal();

this.maxVal = image.getMaxVal();

this.isFramed = image.isFramed();

this.imgAry = new int[this.numRows][this.numCols];

int[][] copyAry = image.getImgAry();

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

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

this.imgAry[i][j] = copyAry[i][j];

}//for

}//fpr

}//copyImage

/\*\*

\* Creates a frame around this image based of the origin of the structuring element

\* @param structuringElement

\* @return a copy of this image framed, null if the image is already framed

\*/

public Image frame(StructuringElement structuringElement){

Image framedImage = null;

if(this.isFramed) return framedImage;

//get all frame dims

int[] frameDims = structuringElement.computeFrame();

int top = frameDims[0];

int bottom = frameDims[1];

int left = frameDims[2];

int right = frameDims[3];

//get new imgAry, new row count, new col count

int newNumRows = this.numRows + top + bottom;

int newNumCols = this.numCols + left + right;

int[][] newImgAry = new int[newNumRows][newNumCols];

//copy this.imgAry into the framed newImgAry

for(int r = top; r < newNumRows - bottom; r++){

for(int c = left; c < newNumCols - right; c++){

newImgAry[r][c] = this.imgAry[r - top][c - left];

}//for

}//for

//create new framedImage to return

framedImage = new Image(newNumRows, newNumCols, this.minVal, this.maxVal);

framedImage.setImgAry(newImgAry);

framedImage.setFramed(true);

return framedImage;

}//frame()

/\*\*

\* Unframe an image and return the unframed image

\* @return

\*/

public Image unframe(StructuringElement structuringElement){

if(!this.isFramed) return this;

Image unframedImage = new Image();

//find unframe image dims

int[] frameDims = structuringElement.computeFrame();

int top = frameDims[0];

int bottom = frameDims[1];

int left = frameDims[2];

int right = frameDims[3];

int newNumRows = this.numRows - top - bottom;

int newNumCols = this.numCols - left - right;

int[][] newImgAry = new int[newNumRows][newNumCols];

//copy this.imgAry into the framed newImgAry

for(int r = 0; r < newNumRows; r++){

for(int c = 0; c < newNumCols; c++){

newImgAry[r][c] = this.imgAry[r + top][c + left];

}//for

}//for

unframedImage.setNumCols(newNumCols);

unframedImage.setNumRows(newNumRows);

unframedImage.setImgAry(newImgAry);

unframedImage.setFramed(false);

return unframedImage;

}//unframe

/\*\*

\* Prints the image to the console

\*/

public void prettyprint(boolean doBinary){

//header

System.out.println("\n"+ numRows + " " + numCols + " " + minVal + " " + maxVal);

//imgAry print -> if doBinary then print 0's else replace 0's with space

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

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

if(this.imgAry[i][j] == 1)

System.out.print("1");

else{

if(doBinary) System.out.print("0");

else System.out.print(" ");

}//if-else

}//for

System.out.println();

}//for

System.out.println("\n");

}//prettyprint to console

/\*\*

\* Prints the image to an outputfile

\* @param outputFile the file to send the image

\* @throws FileNotFoundException

\*/

public void prettyprint(File outputFile, boolean doBinary) throws FileNotFoundException{

PrintWriter outputstream = new PrintWriter(outputFile);

outputstream.println(numRows + " " + numCols + " " + minVal + " " + maxVal);

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

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

if(this.imgAry[i][j] == 1)

outputstream.print("1");

else{

if(doBinary) outputstream.print("0");

else outputstream.print(" ");

}//if-else

}//for

outputstream.println();

}//for

outputstream.close();

}//preetyprint to outputFile

/\*\*

\* @return the numRows

\*/

public int getNumRows() {

return numRows;

}//getNumRows

/\*\*

\* @param numRows the numRows to set

\*/

public void setNumRows(int numRows) {

this.numRows = numRows;

}

/\*\*

\* @return the numCols

\*/

public int getNumCols() {

return numCols;

}

/\*\*

\* @param numCols the numCols to set

\*/

public void setNumCols(int numCols) {

this.numCols = numCols;

}

/\*\*

\* @return the minVal

\*/

public int getMinVal() {

return minVal;

}

/\*\*

\* @param minVal the minVal to set

\*/

public void setMinVal(int minVal) {

this.minVal = minVal;

}

/\*\*

\* @return the maxVal

\*/

public int getMaxVal() {

return maxVal;

}

/\*\*

\* @param maxVal the maxVal to set

\*/

public void setMaxVal(int maxVal) {

this.maxVal = maxVal;

}

/\*\*

\* @return the imgAry

\*/

public int[][] getImgAry() {

return imgAry;

}

/\*\*

\* @param imgAry the imgAry to set

\*/

public void setImgAry(int[][] imgAry) {

this.imgAry = new int[this.numRows][this.numCols];

for(int i = 0; i < imgAry.length; i++){

for(int j = 0; j < imgAry[i].length;j++){

this.imgAry[i][j] = imgAry[i][j];

}

}

}

/\*\*

\* @return the isFramed

\*/

public boolean isFramed() {

return isFramed;

}

/\*\*

\* @param isFramed the isFramed to set

\*/

public void setFramed(boolean isFramed) {

this.isFramed = isFramed;

}

}//class

**Code: StructuringElement.java**

import java.io.\*;

import java.util.\*;

public class StructuringElement{

int numRows;

int numCols;

int minVal;

int maxVal;

int originX;

int originY;

int[][] structImgArray;

public StructuringElement(){

}//null constructor

public StructuringElement(int numRows, int numCols, int minVal, int maxVal, int originX, int originY){

this.numRows = numRows;

this.numCols = numCols;

this.minVal = minVal;

this.maxVal = maxVal;

this.originX = originX;

this.originY = originY;

initZeroArray();

}//value contructor

public StructuringElement(File structFile) throws FileNotFoundException{

Scanner inStream = new Scanner(new FileReader(structFile));

//get header values

this.numRows = inStream.nextInt();

this.numCols = inStream.nextInt();

this.minVal = inStream.nextInt();

this.maxVal = inStream.nextInt();

this.originX = inStream.nextInt();

this.originY = inStream.nextInt();

this.structImgArray = new int[numRows][numCols];

//get all image data

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

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

structImgArray[i][j] = inStream.nextInt();

//System.out.println("round ("+ i+","+j+")= "+ structImgArray[i][j]);

}//for

}//for

inStream.close();

}//main constructor

public void initZeroArray(){

for(int r = 0; r < this.numRows; r++){

for(int c = 0; c < numCols; c++){

structImgArray[r][c] = 0;

}//for

}//for

}//initZeroArray

public void prettyprint(boolean doBinary){

//headers

System.out.println("\n" + numRows + " " + numCols + " " + minVal + " " + maxVal);

System.out.println(originX + " " + originY);

//structElement print -> if doBinary then print 0's else replace 0's with space

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

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

if(structImgArray[i][j] == 1)

System.out.print("1");

else{

if(doBinary) System.out.print("0");

else System.out.print(" ");

}//if-else

}//for

System.out.println();

}//for

System.out.println("\n");

}//prettyPrint

/\*\*

\* Computes the framing dimesntions based on a given structuring element.

\* @return int[4] = [topFrameDim, bottomFrameDim, leftFrameDim, rightFrameDim]

\*/

public int[] computeFrame(){

int[] dims = new int[4];

//find distance from origin to all sides, and add said dims to dims[]

dims[0] = this.originY;

dims[1] = (this.numRows - 1) - this.originY;

dims[2] = this.originX;

dims[3] = (this.numCols - 1) - this.originX;

return dims;

}//computeFrame

/\*\*

\* @return the numRows

\*/

public int getNumRows() {

return numRows;

}

/\*\*

\* @return the numCols

\*/

public int getNumCols() {

return numCols;

}

/\*\*

\* @return the minVal

\*/

public int getMinVal() {

return minVal;

}

/\*\*

\* @return the maxVal

\*/

public int getMaxVal() {

return maxVal;

}

/\*\*

\* @return the originX

\*/

public int getOriginX() {

return originX;

}

/\*\*

\* @return the originY

\*/

public int getOriginY() {

return originY;

}

/\*\*

\* @return the structImgArray

\*/

public int[][] getStructImgArray() {

return structImgArray;

}

}//class

**Code: Morpher.java**

import java.io.\*;

import java.util.\*;

public abstract class Morpher {

/\*\*

\* Dilates a framed image using a specified structuring element. Assumes the image is framed

\* using the specified structElement.

\* @param originalImage the image to dilate

\* @param structElement the structuring element to use

\*/

public static Image dilation(Image originalImage, StructuringElement structElement) throws IllegalArgumentException{

//make sure the image inputted is a framed image

if(!originalImage.isFramed()){

throw new IllegalArgumentException("Inputted Image must be framed.");

}//if

//copy original image

Image morphedImage = new Image();

morphedImage.copyImage(originalImage);

int[] frameDims = structElement.computeFrame();

int top = frameDims[0];

int bottom = frameDims[1];

int left = frameDims[2];

int right = frameDims[3];

int originVal = structElement.structImgArray[structElement.getOriginX()][structElement.getOriginY()];

int[][] oImg = originalImage.getImgAry();

//the actual dilation ASSUMES FRAMED IMAGE

for(int r = top; r < originalImage.getNumRows() - bottom; r++){

for(int c = left; c < originalImage.getNumCols() - right; c++){

//if the origin matches the current pixel, then dilate

if(oImg[r][c] == originVal){

//dilate using each element of the structElement

for(int i = 0; i < structElement.getNumRows(); i++){

for(int j = 0; j < structElement.getNumCols(); j++){

int x = r+i-top;

int y = c+j-right;

if(structElement.structImgArray[i][j] == 1)

morphedImage.imgAry[x][y] = 1;

}//for j

}//for i

}//if

}//for c

}//for r

return morphedImage;

}//dilation

/\*\*

\* Erodes a framed image using a specified structuring element. Assumes the image is framed

\* using the specified structElement.

\* @param originalImage the image to erode

\* @param structElement the structuring element to use

\*/

public static Image erosion(Image originalImage, StructuringElement structElement){

//make sure the image inputted is a framed image

if(!originalImage.isFramed()){

throw new IllegalArgumentException("Inputted Image must be framed.");

}//if

//copy original image

Image morphedImage = new Image();

morphedImage.copyImage(originalImage);

int[] frameDims = structElement.computeFrame();

int top = frameDims[0];

int bottom = frameDims[1];

int left = frameDims[2];

int right = frameDims[3];

int[][] newImgAry = new int[morphedImage.getNumRows()][morphedImage.getNumCols()];

for(int i = 0; i < morphedImage.getNumRows(); i++){

for(int j = 0; j < morphedImage.getNumCols(); j++){

newImgAry[i][j] = morphedImage.imgAry[i][j];

}

}

//the actual erosion ASSUMES FRAMED IMAGE

for(int r = top; r < originalImage.getNumRows() - bottom; r++){

for(int c = left; c < originalImage.getNumCols() - right; c++){

//if the structElement can "stand" at r,c then do nothing, otherwise wipe to zeros

boolean matches = true; int hit=0;

for(int i = 0; i < structElement.getNumRows(); i++){

for(int j = 0; j < structElement.getNumCols(); j++){

int x = r-top+i;

int y = c-left+j;

//if structElem at this index is 1 but diesnt natch, set mayeches=false

if(!(structElement.structImgArray[i][j] == originalImage.imgAry[x][y]) && (structElement.structImgArray[i][j] == 1)){

matches = false;

}//if

}//for j

}//for i

//if there is no match here, wipe to zero

if(!matches) newImgAry[r][c] = 0;

}//for

}//for

morphedImage.setImgAry(newImgAry);

return morphedImage;

}//erosion

public static Image opening(Image originalImage, StructuringElement structElement){

//copy origional image

Image morphedImage = new Image();

morphedImage.copyImage(originalImage);

//run an erosion and then dialtion

morphedImage = erosion(morphedImage, structElement);

morphedImage = dilation(morphedImage, structElement);

return morphedImage;

}//opening

public static Image closing(Image originalImage, StructuringElement structElement){

//copy origional image

Image morphedImage = new Image();

morphedImage.copyImage(originalImage);

//run a dilation then erosion

morphedImage = dilation(morphedImage, structElement);

morphedImage = erosion(morphedImage, structElement);

return morphedImage;

}//closing

}//class

**Output: Dilation Results**

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**Output: Erosion Results**

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**Output: Opening Results**

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**Output: Closing Result**

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