Übungsaufgaben IV, SBV1

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4 Übungsaufgaben IV

4.1 Region Growing

a) Manuelles Image Growing

Der Algorithmus zu dieser Übung wurde aus der Vorlesung übernommen. Es waren lediglisch N4 und N8 Nachbarpixelregionen zu unterscheiden. Diese wurden einfach durch Variable der Funktion mitgegeben und in einer *if* Abfrage abgefragt.
Figure 1 und Figure 2 vergleichen die zu unersuchenden Nachbarschaftspixel.

Regionsvergleich

x/y	-1	0	1
-1	0	x	0
0	x	0	x
1	0	x	0

Table 1: N4 Region

x/y	-1	0	1
-1	x	x	x
0	x	0	x
1	x	x	x

Table 2: N8 Region

Listing 1: RegionGrowing-Algorithmus.

```
      ; columns
1
2  import java.awt.Point;
3  import java.awt.Rectangle;
4  import java.util.Stack;
5
6  import ij.*;
7  import ij.gui.GenericDialog;
8  import ij.gui.PointRoi;
9  import ij.plugin.filter.PlugInFilter;
10 import ij.process.*;
11
12 public class RegionGrowing_ implements PlugInFilter {
13
14         ImagePlus imp1;
15
16         public int setup(String arg, ImagePlus imp) {
17                 if (arg.equals("about")) {
18                         showAbout();
19                         return DONE;
20                 }
21
22                 imp1 = imp;
23                 return DOES_8G + DOES_STACKS + SUPPORTS_MASKING + ROI_REQUIRED;
24         } // setup
25
26         public static int[][] performRegionGrowing(int[][] inImgArr, int width, int height, int lowerThresh, int upperThresh
               ↪ , int seedX, int seedY, String region) {
27                 // constants
28                 int BG_VAL = 0;
29                 int FG_VAL = 255;
30                 int UNPROCESSED_VAL = -1;
31
32                 int[][] returnArr = new int[width][height];
33
34                 for( int x= 0; x < width; x++) {
35                         for (int y = 0; y < height; y++) {
36                                 returnArr[x][y] = UNPROCESSED_VAL;
37                         }
38                 }
39
40                 Stack<Point> processingStack = new Stack<Point>();
41
42                 //first check if seed point is valid
```

```
43 |                 int seedVal = inImgArr[seedX][seedY];
44 |                 if(seedVal >= lowerThresh && seedVal <= upperThresh) {
45 |                         processingStack.push(new Point(seedX, seedY));
46 |                         returnArr[seedX][seedY] = FG_VAL;
47 |                 }
48 |
49 |                 while(!processingStack.empty()) {
50 |                         Point nextPos = processingStack.pop();
51 |
52 |                         //check all children in N4
53 |                         for( int xOffset= -1; xOffset <= 1; xOffset++) {
54 |                                 for (int yOffset = -1; yOffset <= 1; yOffset++) {
55 |                                         int nbX = nextPos.x + xOffset;
56 |                                         int nbY = nextPos.y + yOffset;
57 |
58 |                                         // check if N4 region
59 |                                         boolean isRegion = false;
60 |                                         if(region.equals("N4") && (xOffset*yOffset == 0 && xOffset+yOffset != 0)) isRegion =
                                                ↪  true;
61 |                                         if(region.equals("N8") && (xOffset != 0 || yOffset != 0)) isRegion = true;
62 |
63 |
64 |                                         if(isRegion) {
65 |
66 |                                                 // check if valid range ==> position within image boundaries
67 |                                                 if(nbX >= 0 && nbY >= 0 && nbX < width && nbY < height) {
68 |
69 |                                                         int nbVal = inImgArr[nbX][nbY];
70 |
71 |                                                         //if current pixel was not processed yet (check if pixel is
                                                                ↪ unprocessed and if vlaue in threshold range)
72 |                                                         if(returnArr[nbX][nbY] == UNPROCESSED_VAL) {
73 |
74 |                                                                 //if range valid
75 |                                                                 if(nbVal >= lowerThresh && nbVal <= upperThresh) {
76 |                                                                         returnArr[nbX][nbY] = FG_VAL;
                                                                                ↪          //set current pixel to foreground
77 |                                                                         processingStack.push(new Point(nbX,nbY));        //
                                                                                ↪ push current pixel to the stack
78 |                                                                 }
79 |                                                                 else {
80 |                                                                         returnArr[nbX][nbY] = BG_VAL;
81 |                                                                 }
82 |                                                         }
83 |                                                 }
```

```
                                        } // if N4 region
                                }//for yOffset
                        }// for xOffset

                } //while

                System.out.println(processingStack.size());

                //cleanup - all values still unprocessed - get assigned the background value BG_VAL
                for( int x = 0; x < width; x++) {
                        for (int y = 0; y< height; y++) {
                                if(returnArr[x][y] == UNPROCESSED_VAL) {
                                        returnArr[x][y] = BG_VAL;
                                }
                        }
                }


                return returnArr;
        } //performRegionGrowing


        public void run(ImageProcessor ip) {
                byte[] pixels = (byte[]) ip.getPixels();
                int width = ip.getWidth();
                int height = ip.getHeight();

                int[][] inDataArrInt = ImageJUtility.convertFrom1DByteArr(pixels, width, height);

                //request seed point
                PointRoi pr = (PointRoi)imp1.getRoi();
                Rectangle rect = pr.getBounds();
                int xStart = pr.getXCoordinates()[0] + rect.x;
                int yStart = pr.getXCoordinates()[0] + rect.y;

                System.out.println("xStart : " + xStart +  ", yStart : " + yStart);

                // user input - default
                int lowerThresh = 100;
                int upperThresh = 255;
                // user dialog
                GenericDialog gd = new GenericDialog("thresh_params");
                gd.addSlider("lower_thresh", 0, 255, lowerThresh);
                gd.addSlider("upper_thresh", 0, 255, upperThresh);
                gd.showDialog();
```

```
129 |
130 |                 if (!gd.wasCanceled()) {
131 |                         lowerThresh = (int) gd.getNextNumber();
132 |                         upperThresh = (int) gd.getNextNumber();
133 |                 }
134 |
135 |                 //finally calling function
136 |                 int[][] resultImg = performRegionGrowing(inDataArrInt, width, height, lowerThresh, upperThresh, xStart,
    |                     ↪ yStart,"N4");
137 |
138 |
139 |                 ImageJUtility.showNewImage(resultImg, width, height, "region_coin_result");
140 |
141 |         } // run
142 |
143 |         void showAbout() {
144 |                 IJ.showMessage("About_Template_...", "this_is_a_PluginFilter_template\n");
145 |         } // showAbout
146 |
147 | } // class FilterTemplate_
```

b) Image Growing mit Labeling

Für die Implmentierung wurde der Code aus Aufgabe a) kopiert und erweitert. Muss das gesamte Bild untersucht werden um alle Objekte zu finden. Wird ein passendes Pixel gefunden, wird der Region-Growing Algorithmus herangezogen. Mittels der Fordergrundfarbe werden die Objekte eingeteilt und unterschieden.

Listing 2: RegionGrowing-Algorithmus

```
      ; columns
1
2  import java.awt.Point;
3  import java.awt.Rectangle;
4  import java.util.Stack;
5
6  import ij.*;
7  import ij.gui.GenericDialog;
8  import ij.gui.PointRoi;
9  import ij.plugin.filter.PlugInFilter;
10 import ij.process.*;
11
12 public class AutoRegionGrowing_ implements PlugInFilter {
13
14    public int setup(String arg, ImagePlus imp) {
15                  if (arg.equals("about"))
16                          {showAbout(); return DONE;}
17                  return DOES_8G+DOES_STACKS+SUPPORTS_MASKING;
18          } //setup
19
20
8 21         public static int[][] performRegionGrowing(int[][] inImgArr, int width, int height, int lowerThresh, int upperThresh
                ↪ , String region) {
22                  // constants
23                  int BG_VAL = 0;
24                  int FG_VAL = 255;
25                  int UNPROCESSED_VAL = -1;
26
27                  int[][] returnArr = new int[width][height];
28
29
30                  // prepare -> set every pixel to unprocessed state
31                  for( int x= 0; x < width; x++) {
32                          for (int y = 0; y < height; y++) {
33                                  returnArr[x][y] = UNPROCESSED_VAL;
34                          }
35                  }
36
37                  Stack<Point> processingStack = new Stack<Point>();
38
39                  // for whole image
40                  for ( int x = 0; x < width; x++) {
41                          for ( int y = 0; y < height; y++) {
42
```

```
43                  //first check if seed point is valid
44                  int seedVal = inImgArr[x][y];
45                  if(seedVal >= lowerThresh && seedVal <= upperThresh && returnArr[x][y] == UNPROCESSED_VAL) {
46                          processingStack.push(new Point(x, y));
47                          FG_VAL = FG_VAL -20;
48                          System.out.println("next foreground will be: " + FG_VAL);
49                          //returnArr[x][y] = FG_VAL;
50                  }
51
52
53                  while(!processingStack.empty()) {
54                          Point nextPos = processingStack.pop();
55
56                          //check all children in N4
57                          for( int xOffset= -1; xOffset <= 1; xOffset++) {
58                                  for (int yOffset = -1; yOffset <= 1; yOffset++) {
59                                          int nbX = nextPos.x + xOffset;
60                                          int nbY = nextPos.y + yOffset;
61
62                                          // check if N4 region
63                                          boolean isRegion = false;
64                                          if(region.equals("N4") && (xOffset*yOffset == 0 && xOffset+yOffset
                                                ↪ != 0)) isRegion = true;
65                                          if(region.equals("N8") && (xOffset != 0 || yOffset != 0)) isRegion =
                                                ↪  true;
66
67                                          if(isRegion) {
68
69                                                  // check if valid range ==> position within image boundaries
70                                                  if(nbX >= 0 && nbY >= 0 && nbX < width && nbY < height) {
71
72                                                          int nbVal = inImgArr[nbX][nbY];
73
74                                                          //if current pixel was not processed yet (check if
                                                                ↪ pixel is unprocessed and if vlaue in
                                                                ↪ threshold range)
75                                                          if(returnArr[nbX][nbY] == UNPROCESSED_VAL) {
76
77                                                                  //if range valid
78                                                                  if(nbVal >= lowerThresh && nbVal <=
                                                                        ↪ upperThresh) {
79                                                                          returnArr[nbX][nbY] = FG_VAL;
                                                                                ↪                       //set
                                                                                ↪  current pixel to foreground
80                                                                          processingStack.push(new Point(nbX,
                                                                                ↪ nbY));        // push current
```

```
                                                                                        ↪ pixel to the stack
                                                                        }
                                                                        else {
                                                                                returnArr[nbX][nbY] = BG_VAL;
                                                                        }
                                                                }
                                                        }
                                                } // if N4 region
                                        }//for yOffset
                                }// for xOffset

                        } //while processed all pixels of growing region



                } // for hight -> y
        } //ffor width -> x


        System.out.println(processingStack.size());


        //cleanup - all values still unprocessed - get assigned the background value BG_VAL
        for( int x = 0; x < width; x++) {
                for (int y = 0; y< height; y++) {
                        if(returnArr[x][y] == UNPROCESSED_VAL) {
                                returnArr[x][y] = BG_VAL;
                        }
                }
        }


        return returnArr;
} //performRegionGrowing


public void run(ImageProcessor ip) {
        byte[] pixels = (byte[]) ip.getPixels();
        int width = ip.getWidth();
        int height = ip.getHeight();

        int[][] inDataArrInt = ImageJUtility.convertFrom1DByteArr(pixels, width, height);

        // user input - default
        int lowerThresh = 100;
```

```
                int upperThresh = 255;
                // user dialog
                GenericDialog gd = new GenericDialog("thresh_params");
                gd.addSlider("lower_thresh", 0, 255, lowerThresh);
                gd.addSlider("upper_thresh", 0, 255, upperThresh);
                gd.showDialog();

                if (!gd.wasCanceled()) {
                        lowerThresh = (int) gd.getNextNumber();
                        upperThresh = (int) gd.getNextNumber();
                }

                //finally calling function
                int[][] resultImg = performRegionGrowing(inDataArrInt, width, height, lowerThresh, upperThresh,"N8");


                ImageJUtility.showNewImage(resultImg, width, height, "region_coin_result");

        } // run

        void showAbout() {
                IJ.showMessage("About_Template_...", "this_is_a_PluginFilter_template\n");
        } // showAbout

} // class FilterTemplate_
```

4.2 Optimaler Threshold

Der zum Start benötigte initiale Threshold wird anhand eines User Inputs definiert. Wird kein Input angegeben wird als Default-Wert 127 gesetzt (255/2), somit startet die Berechnung mittig vom Histogramm.
Um mit der Berechnung des optimalen Threshold starten zu können wurden zwei Konstanten FG_VAL und BG_VAL definiert, die die jeweils kleinste und höchste Intensität enthalten. Bei jeder Iteration wird geprüft, ob der aktuelle Wert des Eingangsbildes über oder unter dem Threshold Wert. Liegt der Wert darunter, wird dieser in der sumThresh01 Variable aufsummiert und der Counter erhöht. Ist der Wert darüber, passiert dasselbe nur mit anderen Variablen.
Die aufsummierten Werte der zwei Bereiche werden nun benötigt um nach durlaufen des Eingangsbildes den Durchschnitt zu berechnen. Der vorübergehende Threshold wird aus den beiden meanThresh01, meanThresh02 berechnet. Nun wird geprüft, ob das Delta das sich zwischen dem vorübergehenden und initialen Threshold ergibt, über der definierten Konvergenz (DELTA_VAL), in diesem Fall 0.01, liegt. Wenn ja, wird ein erneuter Schleifendurchlauf gestartet. Wenn die Werte gleich sind, wird die Schleife abgebrochen und das berechnete Ausgangsbild ausgegeben.

initialer Threshold	Eingangs- bild	Optimal Threshold	Threshold Bild
60		117.81	
127		120.53	

Table 3: Optimal Threshold Testbilder

Listing 3: Optimal Threshold Algorithmus

```
    ; columns
1
2  import ij.*;
3  import ij.gui.GenericDialog;
4  import ij.plugin.filter.PlugInFilter;
5  import ij.process.*;
6
7  public class OptimalThreshold_ implements PlugInFilter {
8
9          public int setup(String arg, ImagePlus imp) {
10                 if (arg.equals("about")) {
11                         showAbout();
12                         return DONE;
13                 }
14                 return DOES_8G + DOES_STACKS + SUPPORTS_MASKING;
15         } // setup
16
17         public int[][] performOptimalThresh(int[][] inImg, int width, int height, int
               ↪ BG_VAL, int FG_VAL,
```

```
                double initialThresh, double DELTA_VAL) {
        int[][] resultImg = new int[width][height];
        double sumThresh01 = 0;
        double sumThresh02 = 0;
        int countThresh01 = 0;
        int countThresh02 = 0;
        double meanThresh01 = 0;
        double meanThresh02 = 0;
        double intermediateThresh = 0;

        int loopCount = 0;

        // calculate intermediate threshold value and check

        while (true) {
                for (int x = 0; x < width; x++) {
                        for (int y = 0; y < height; y++) {
                                int currVal = inImg[x][y];

                                if (currVal < initialThresh) {
                                        sumThresh01 += currVal;
                                        countThresh01++;

                                } else {

                                        sumThresh02 += currVal;
                                        countThresh02++;
                                }

                        }

                }

                // calculate mean
                meanThresh01 = (sumThresh01 / countThresh01);
                meanThresh02 = (sumThresh02 / countThresh02);

                //calculate intermediate threshold
                intermediateThresh = (meanThresh01 + meanThresh02) / 2;
                loopCount++;
                System.out.println("intermediate thresh=" + intermediateThresh + "; Iteration=" + loopCount);

                if (Math.abs((initialThresh - intermediateThresh)) > DELTA_VAL) {
                        initialThresh = intermediateThresh;
                } else {
                        break;
                }

        }

        // calculate result image
        for (int x = 0; x < width; x++) {
                for (int y = 0; y < height; y++) {
                        int currVal = inImg[x][y];

                        if (currVal < initialThresh) {
                                resultImg[x][y] = BG_VAL;

                        } else {
                                resultImg[x][y] = FG_VAL;
                        }
```

```
80                          }
81
82                  }
83
84                  return resultImg;
85          }
86
87          public void run(ImageProcessor ip) {
88                  byte[] pixels = (byte[]) ip.getPixels();
89                  int width = ip.getWidth();
90                  int height = ip.getHeight();
91
92                  // user input
93                  double initialThresh = 255 / 2;
94
95                  // constants
96                  int BG_VAL = 0;
97                  int FG_VAL = 255;
98                  double DELTA_VAL = 0.01;
99
100                 GenericDialog gd = new GenericDialog("thresh params");
101                 gd.addNumericField("Initial Threshold Value: ", initialThresh, 0);
102                 gd.showDialog();
103
104                 if (!gd.wasCanceled()) {
105                         initialThresh = (int) gd.getNextNumber();
106                 }
107
108                 System.out.println("initial Threshold Value = " + initialThresh);
109
110                 int[][] inDataArrInt = ImageJUtility.convertFrom1DByteArr(pixels, width,
                        ↪  height);
111                 int[][] resultImg = performOptimalThresh(inDataArrInt, width, height,
                        ↪ BG_VAL, FG_VAL, initialThresh, DELTA_VAL);
112
113                 // inDataArrInt = ImageJUtility.convertFrom1DByteArr(pixels, width,
                        ↪ height);
114
115                 ImageJUtility.showNewImage(resultImg, width, height, "threshold image");
116
117         } // run
118
119         void showAbout() {
120                 IJ.showMessage("About Template ...", "this is a PluginFilter template\n"
                        ↪ );
121         } // showAbout
122
123 } // class FilterTemplate
```

a) Adaptiver optimar Threshold

Um den Filter des Optimal Threshold auch bei Bildern gut einsetzen zu können, die unterschiedliche Intensitätsverteilung pro Sektor haben, wurde der Adaptive Threshold-Filter implementiert.

Dieser verwendet die Funktionalität des Optimal Threshold wendet diese jedoch auf Sektoren mit einer Größe von 100x100 Pixel an. Die Sektoren werden aus dem Bild herausgeschnitten, der Optimal Threshold berechnet

und zwischengespeichert. Abschließend werden Sie zu einem Bild zusammen gesetzt und ausgegeben.

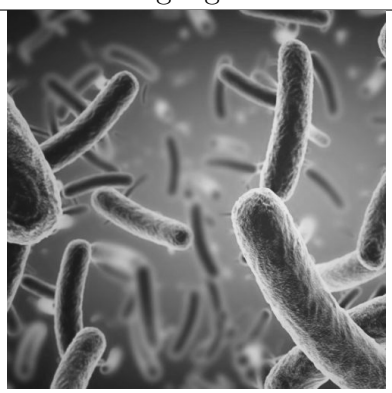
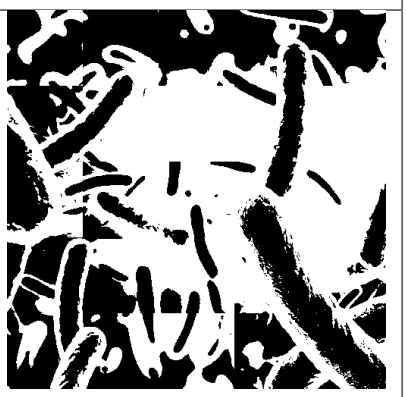
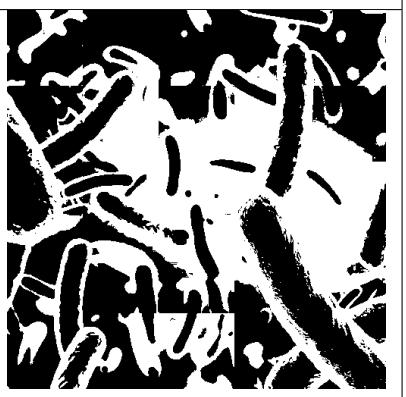
initialer Threshold Wert	Eingangsbild	Threshold Bild
60		
127		

Table 4: Adaptive Threshold Testbilder

Listing 4: Adaptive Threshold Algorithmus

```
      ; columns
1  |                                                                                                    |
2  |import java.awt.Rectangle;                                                                          |
3  |                                                                                                    |
4  |import ij.*;                                                                                        |
5  |import ij.gui.GenericDialog;                                                                        |
6  |import ij.plugin.filter.PlugInFilter;                                                               |
7  |import ij.process.*;                                                                                |
8  |                                                                                                    |
9  |public class AdaptiveThreshold_ implements PlugInFilter {                                          |
10 |                                                                                                    |
11 |        public int setup(String arg, ImagePlus imp) {                                              |
12 |                if (arg.equals("about")) {                                                          |
13 |                        showAbout();                                                                |
```

```
                return DONE;
            }
            return DOES_8G + DOES_STACKS + SUPPORTS_MASKING;
        } // setup

        public void run(ImageProcessor ip) {
            byte[] pixels = (byte[]) ip.getPixels();
            int width = ip.getWidth();
            int height = ip.getHeight();

            // user input
            double initialThresh = 255 / 2;

            // constants
            int BG_VAL = 0;
            int FG_VAL = 255;
            double DELTA_VAL = 0.01;
            int maskSize = 100;

            GenericDialog gd = new GenericDialog("thresh params");
            gd.addNumericField("Initial Threshold Value: ", initialThresh, 0);
            gd.showDialog();

            if (!gd.wasCanceled()) {
                initialThresh = (int) gd.getNextNumber();
            }

            //System.out.println("initial Threshold Value = " + initialThresh);

            int[][] inDataArrInt = ImageJUtility.convertFrom1DByteArr(pixels, width,
                ↪ height);
            double[][] inDataArrDouble = ImageJUtility.convertToDoubleArr2D(
                ↪ inDataArrInt, width, height);
            double[][] resultImg = new double[width][height];

            int xCount = (width / maskSize);
            int yCount = (height / maskSize);

            int xPos = 0;
            for (int x = 0; x < xCount; x++) {
                int yPos = 0;
                for (int y = 0; y < yCount; y++) {
                    int rWidth = maskSize;
                    int rHeight = maskSize;
                    if(xPos+rWidth > width) {
                        rWidth-=width % maskSize;
                    }
                    if(yPos+rHeight > height) {
                        rHeight-=height % maskSize;
                    }
                    Rectangle r = new Rectangle(xPos, yPos, maskSize,
                        ↪ maskSize);

                    double[][] mask = ImageJUtility.cropImage(
                        ↪ inDataArrDouble, rWidth, rHeight, r);
                    double[][] tempResult = performOptimalThresh(mask,
                        ↪ rWidth, rHeight, BG_VAL, FG_VAL, initialThresh,
                        ↪ DELTA_VAL);


                    for (int u = 0; u < rWidth; u++) {
                        for (int v = 0; v < rHeight; v++) {
                            int uPos = xPos + u;
                            int vPos = yPos + v;
```

```
                                        resultImg[uPos][vPos] = tempResult[u][v
                                            ↪ ];
                                }
                        }
                        yPos += maskSize;
                }
                xPos += maskSize;
        }

        //double[][] resultImg = performOptimalThresh(inDataArrDouble, width,
            ↪ height, BG_VAL, FG_VAL, initialThresh, DELTA_VAL);

        // inDataArrInt = ImageJUtility.convertFrom1DByteArr(pixels, width,
            ↪ height);

        ImageJUtility.showNewImage(resultImg, width, height, "threshold_image");

    } // run




    public double[][] performOptimalThresh(double[][] inImg, int width, int height,
        ↪ int BG_VAL, int FG_VAL,
                    double initialThresh, double DELTA_VAL) {
        double[][] resultImg = new double[width][height];
        double sumThresh01 = 0;
        double sumThresh02 = 0;
        int countThresh01 = 0;
        int countThresh02 = 0;
        double meanThresh01 = 0;
        double meanThresh02 = 0;
        double intermediateThresh = 0;

        int loopCount = 0;

        // calculate intermediate threshold value and check

        while (true) {
                for (int x = 0; x < width; x++) {
                        for (int y = 0; y < height; y++) {
                                double currVal = inImg[x][y];

                                if (currVal < initialThresh) {
                                        sumThresh01 += currVal;
                                        countThresh01++;

                                } else {

                                        sumThresh02 += currVal;
                                        countThresh02++;
                                }

                        }

                }

                // calculate mean
                meanThresh01 = (sumThresh01 / countThresh01);
                meanThresh02 = (sumThresh02 / countThresh02);

                // calculate intermediate threshold
                intermediateThresh = (meanThresh01 + meanThresh02) / 2;
                loopCount++;
```

```
132                         //System.out.println("intermediate thresh= " +
                                ↪ intermediateThresh + "; Iteration= " + loopCount);
133
134                         if (Math.abs((initialThresh - intermediateThresh)) > DELTA_VAL)
                                ↪ {
135                             initialThresh = intermediateThresh;
136                         } else {
137                             break;
138                         }
139
140                 }
141
142                 // calculate result image
143                 for (int x = 0; x < width; x++) {
144                         for (int y = 0; y < height; y++) {
145                             double currVal = inImg[x][y];
146
147                             if (currVal < initialThresh) {
148                                 resultImg[x][y] = BG_VAL;
149
150                             } else {
151                                 resultImg[x][y] = FG_VAL;
152                             }
153
154                         }
155
156                 }
157
158                 return resultImg;
159         }
160
161
162
163         void showAbout() {
164                 IJ.showMessage("About_Template_...", "this_is_a_PluginFilter_template\n"
                        ↪ );
165         } // showAbout
166
167 } // class FilterTemplate_
```