

L9 27 Feb, Component List

1) Download Moodle / Week 7 / Pgm8_ComponentList.nb

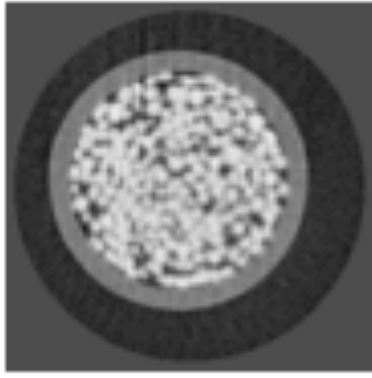
Objective of Pgm8:

Goal: Export an Excel spreadsheet with a component analysis.

- 1) write functions to calculate: (a) a list, (b) a distance
- 2) use For and Table loops
- 3) use Append and ConstantArray
- 4) use TableForm and TableHeadings
- 5) use Norm to calculate the length of a vector (any dimension)
- 6) use Ordering and Reverse
- 7) use Flatten[Position[list, p_? (# > test value &)]]
- 8) use Intersection
- 9) export a spreadsheet

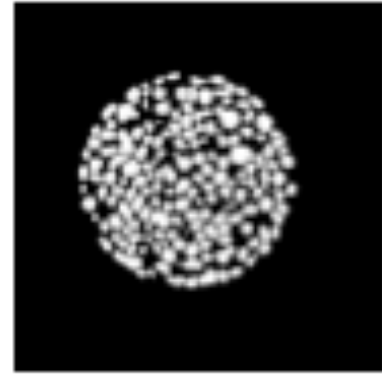
- **Step 1: Define the variables “imageSlice” and “imageBinarySeparated”. These are in image format**

```
In[1]:= imageSlice =
```



```
;
```

```
imageBinarySeparated =
```



```
;
```

```
In[3]:= {ImageQ[imageSlice], ImageQ[imageBinarySeparated]}
```

```
Out[3]= {True, True}
```

■ Step 2: Convert images to variables dataSlice, dataBinarySeparated, and dataComponents

```

In[4]:= dataSlice = ImageData[imageSlice, "Bit16"];
         {Dimensions[dataSlice], Min[dataSlice], Mean[Flatten[dataSlice]] // N, Max[dataSlice], ImageQ[dataSlice]}
         ListDensityPlot[dataSlice, PlotRange -> {All, All, {20 000, 65 000}}]

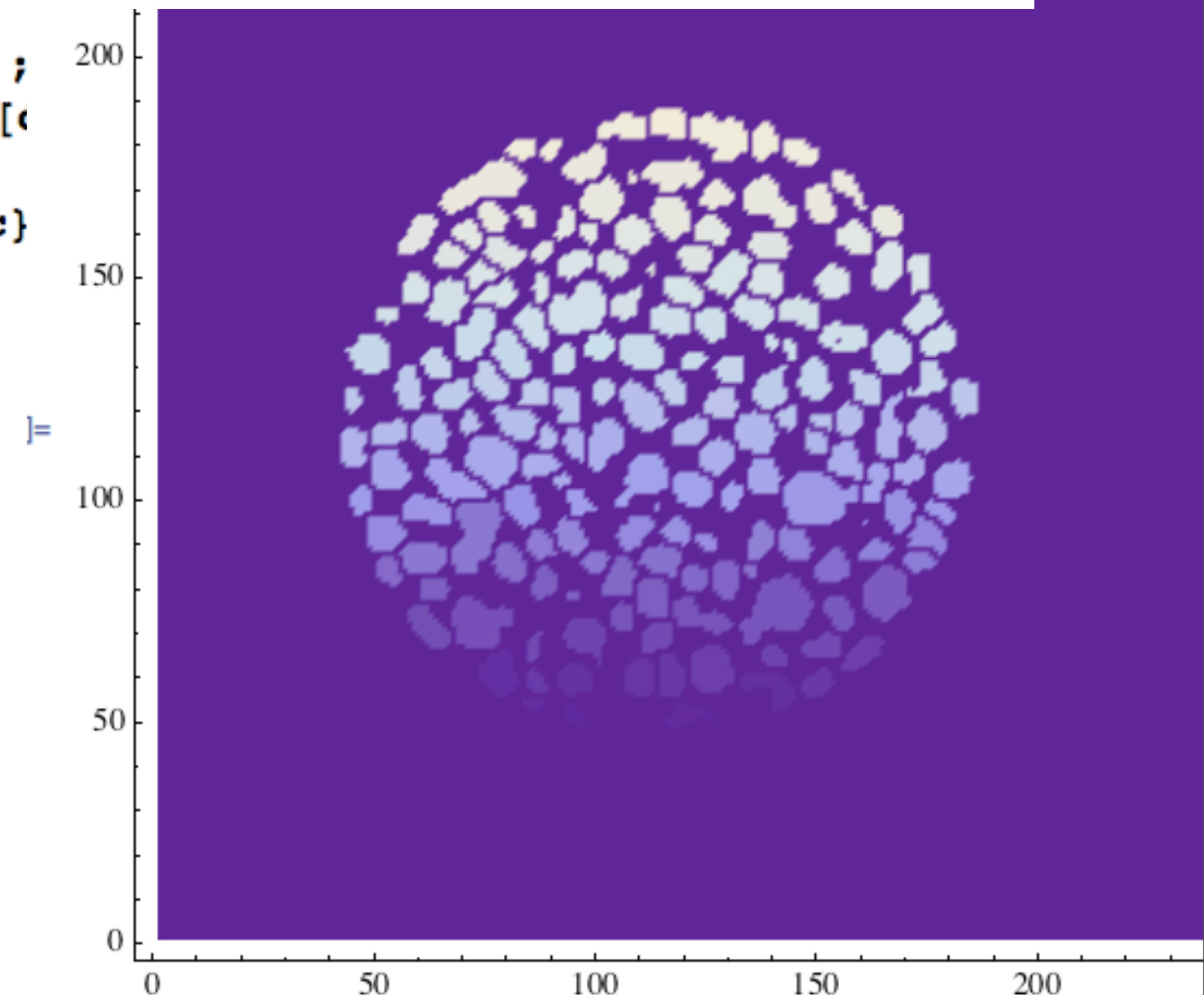
Out[5]= {{243, 243}, 0, 22 557.6, 65 535, False}

In[7]:= dataBinarySeparated = ImageData[imageBinarySeparated, "Bit"];
         {Dimensions[dataBinarySeparated], Min[dataBinarySeparated], Mean[Flatten[dataBinarySeparated]] // N,
         Max[dataBinarySeparated], ImageQ[dataBinarySeparated]}
         ListDensityPlot[dataBinarySeparated, PlotRange -> {All, All, Automatic}]

Out[8]= {{243, 243}, 0, 0.138258, 1, False}

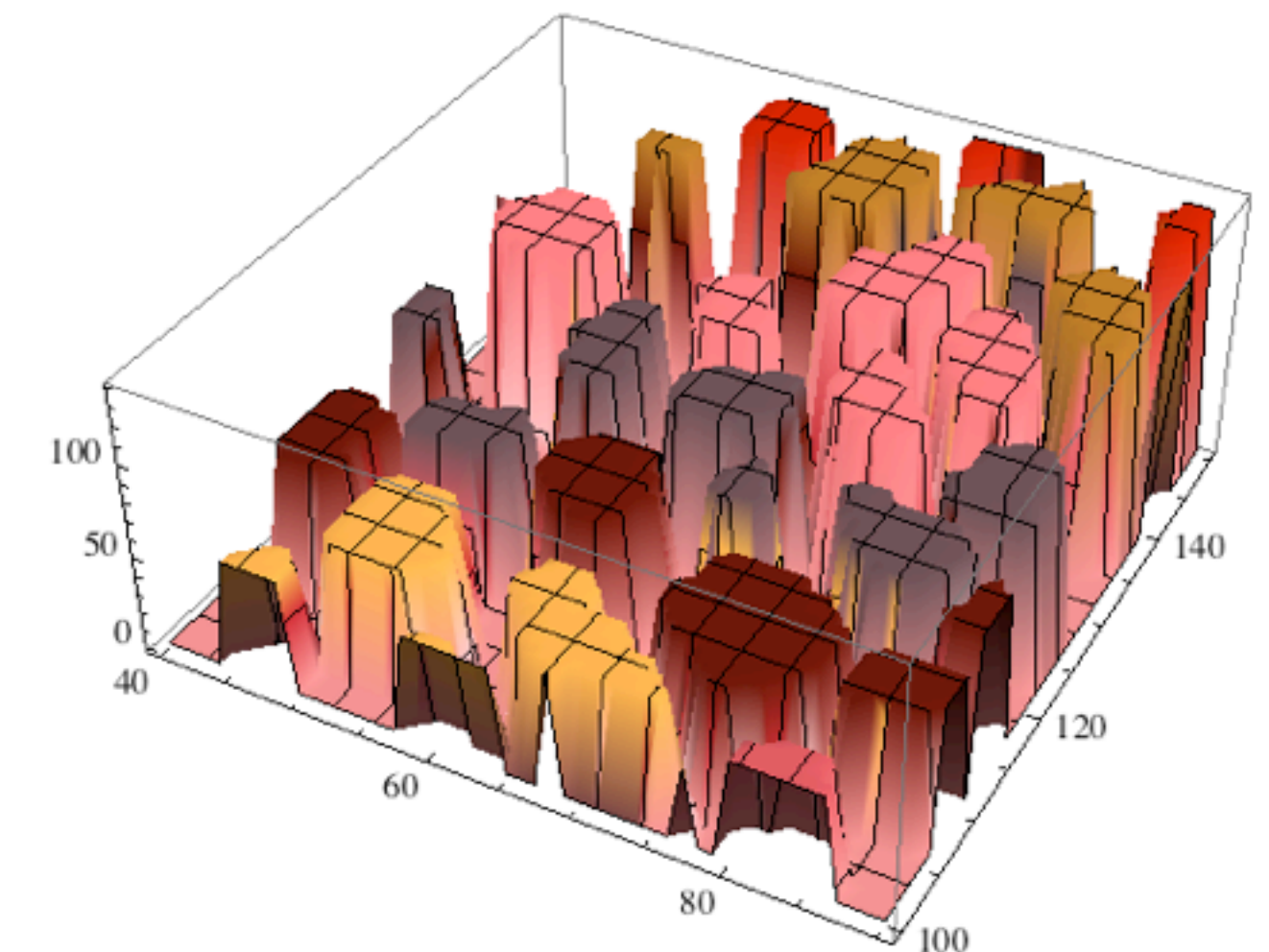
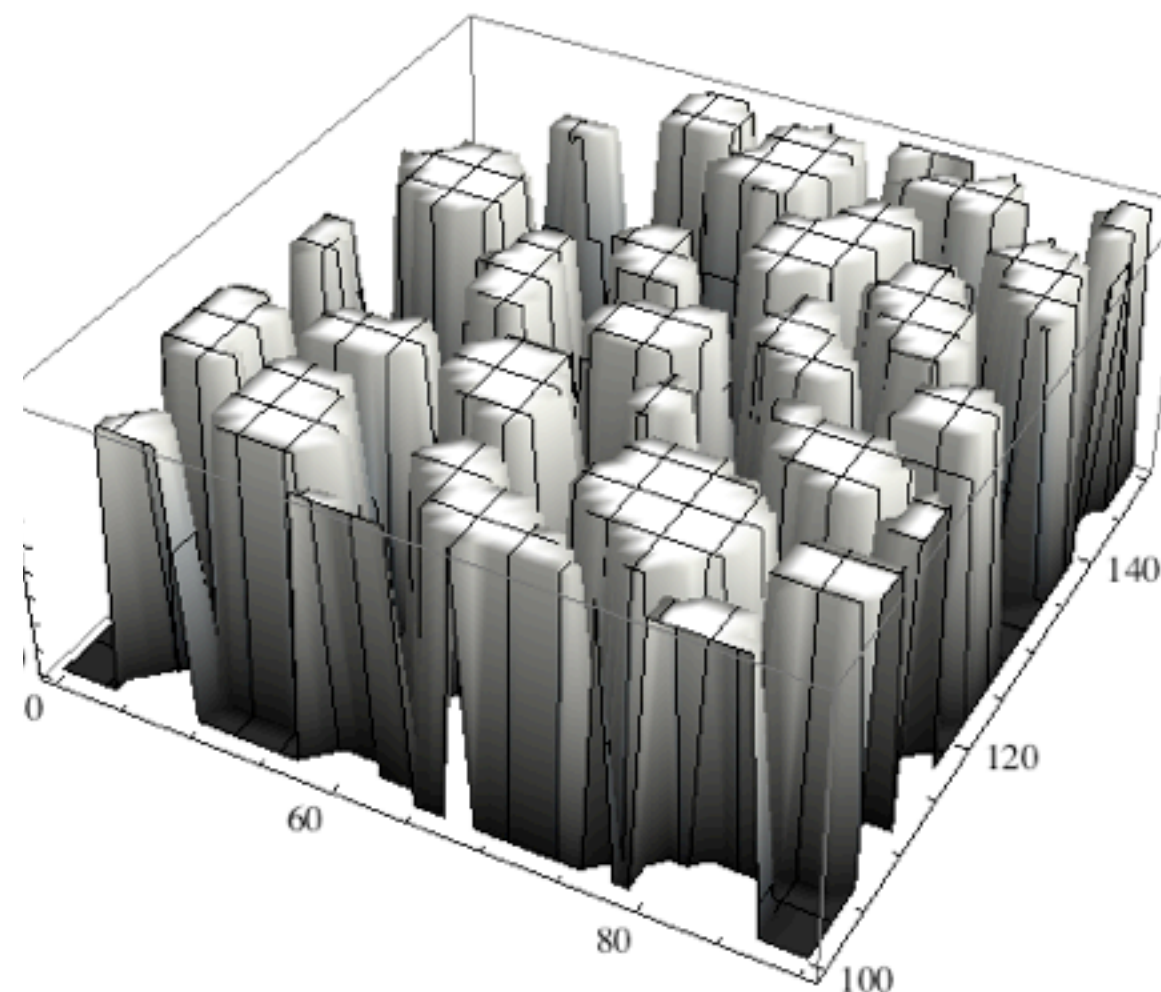
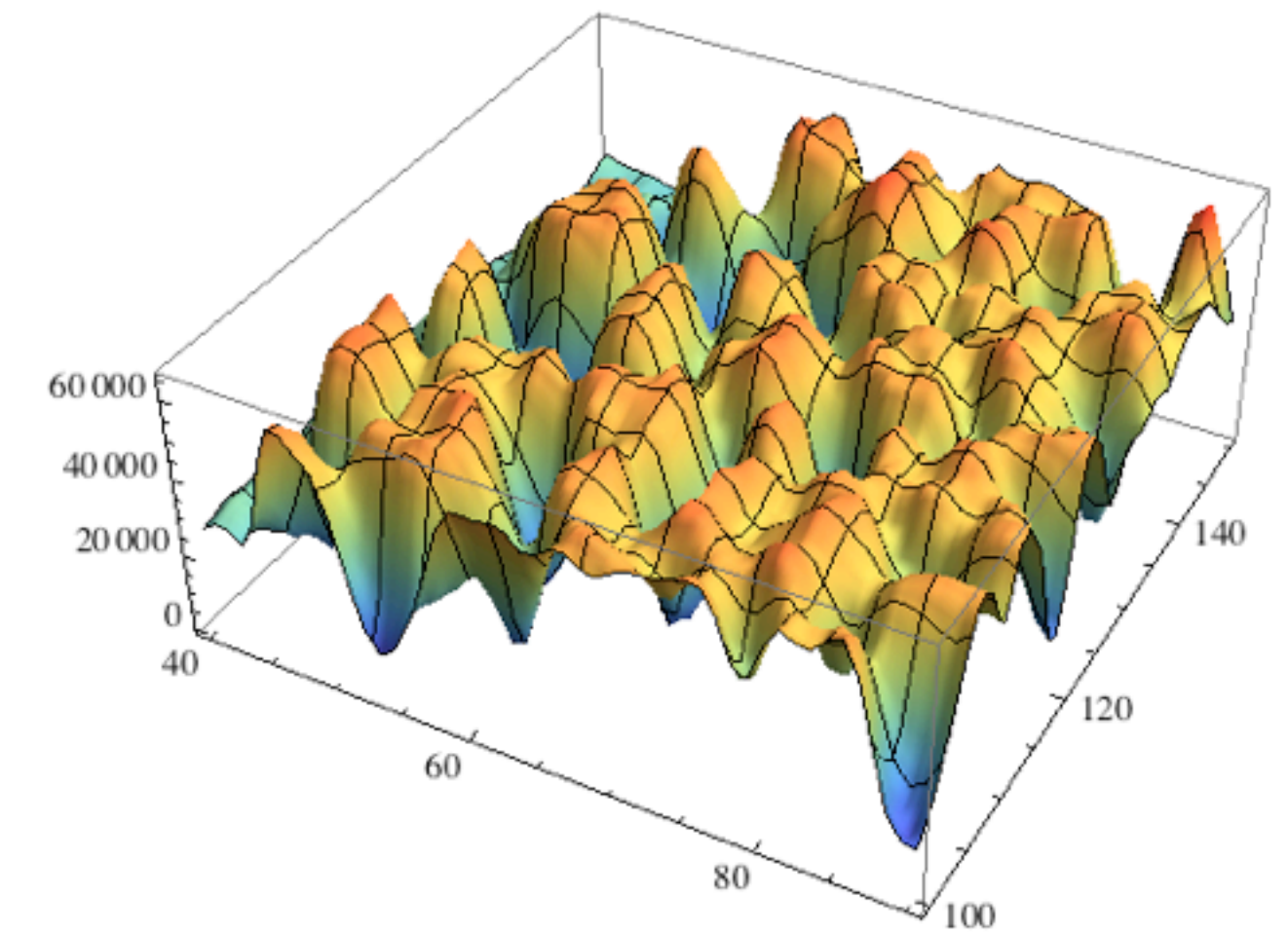
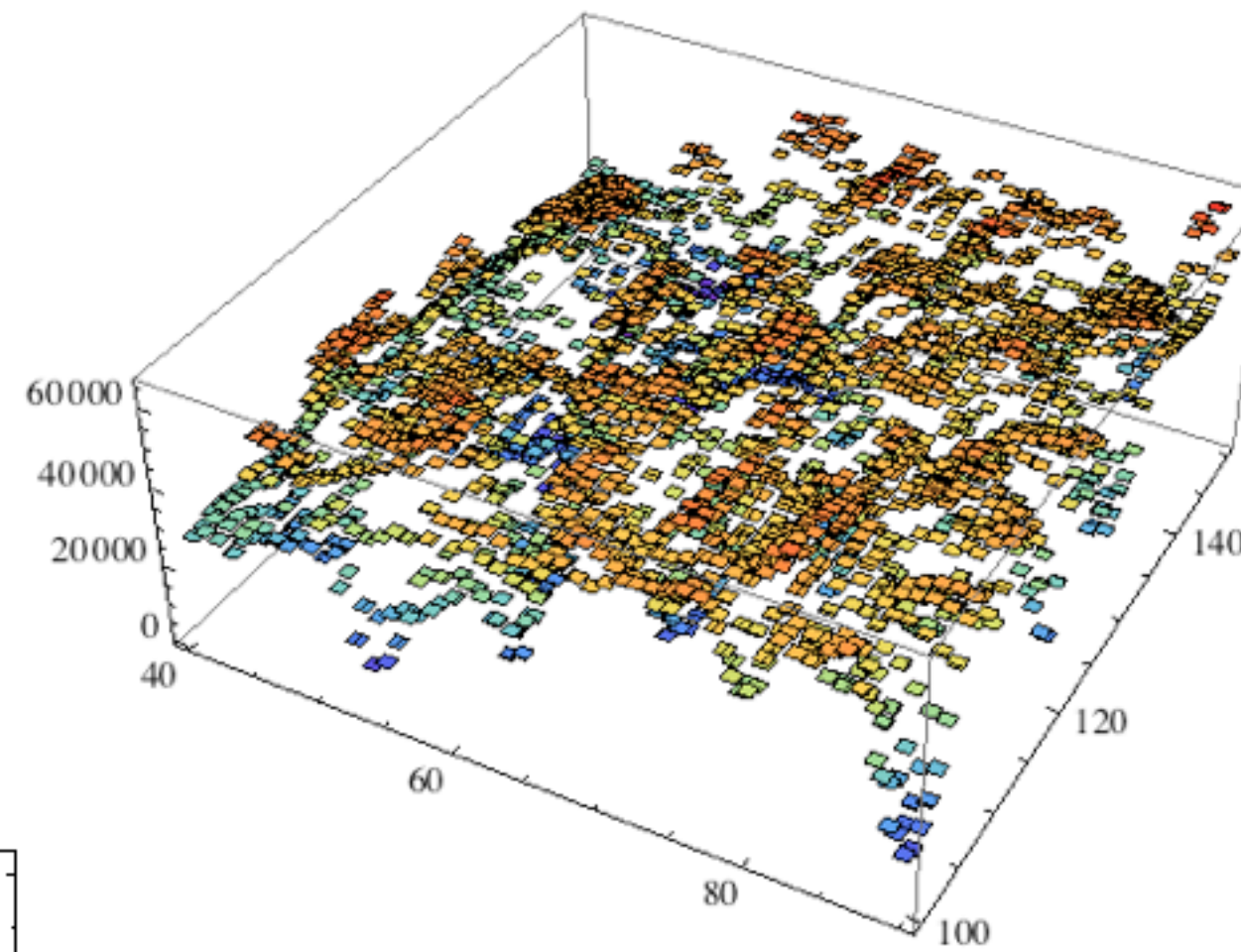
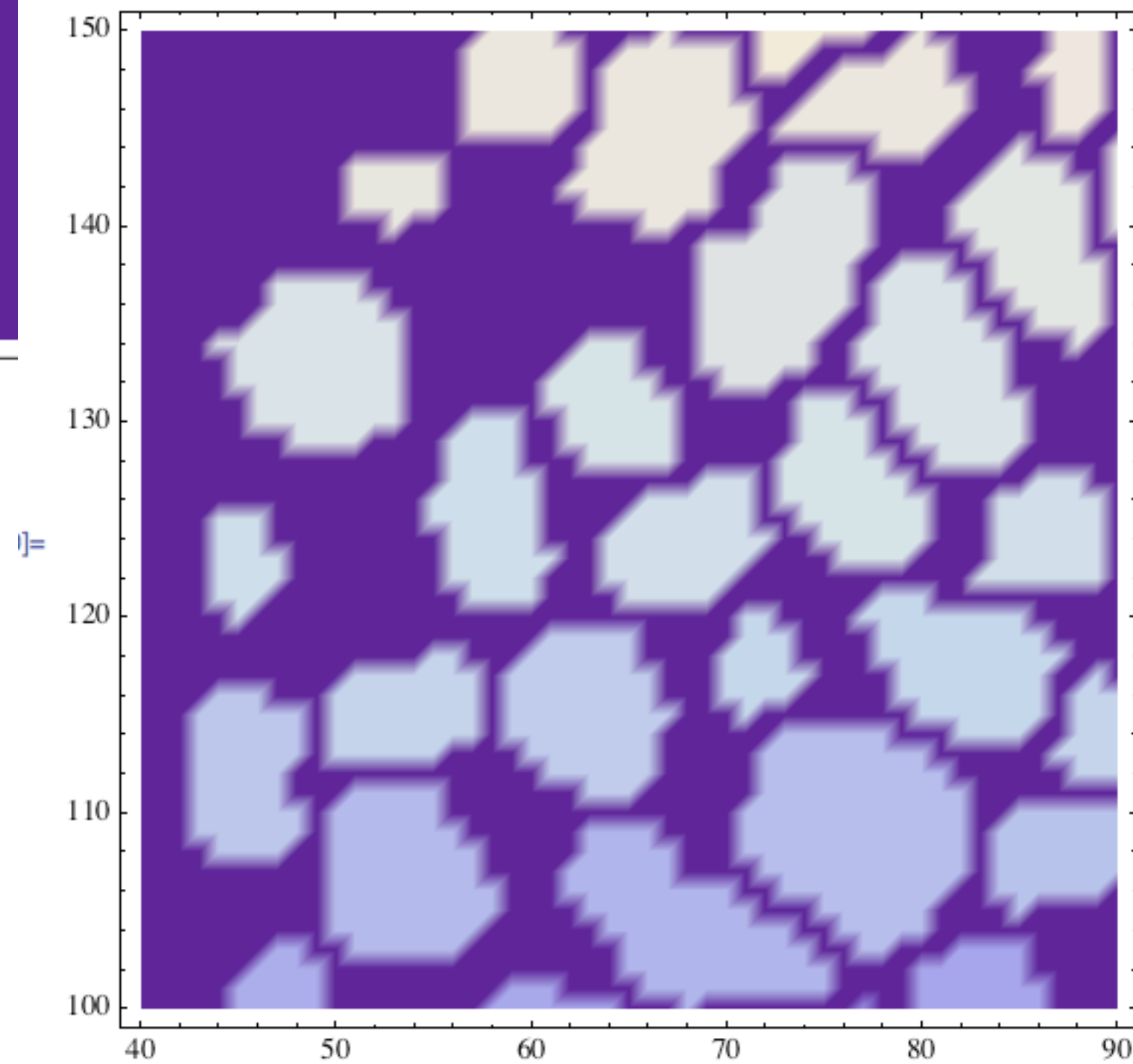
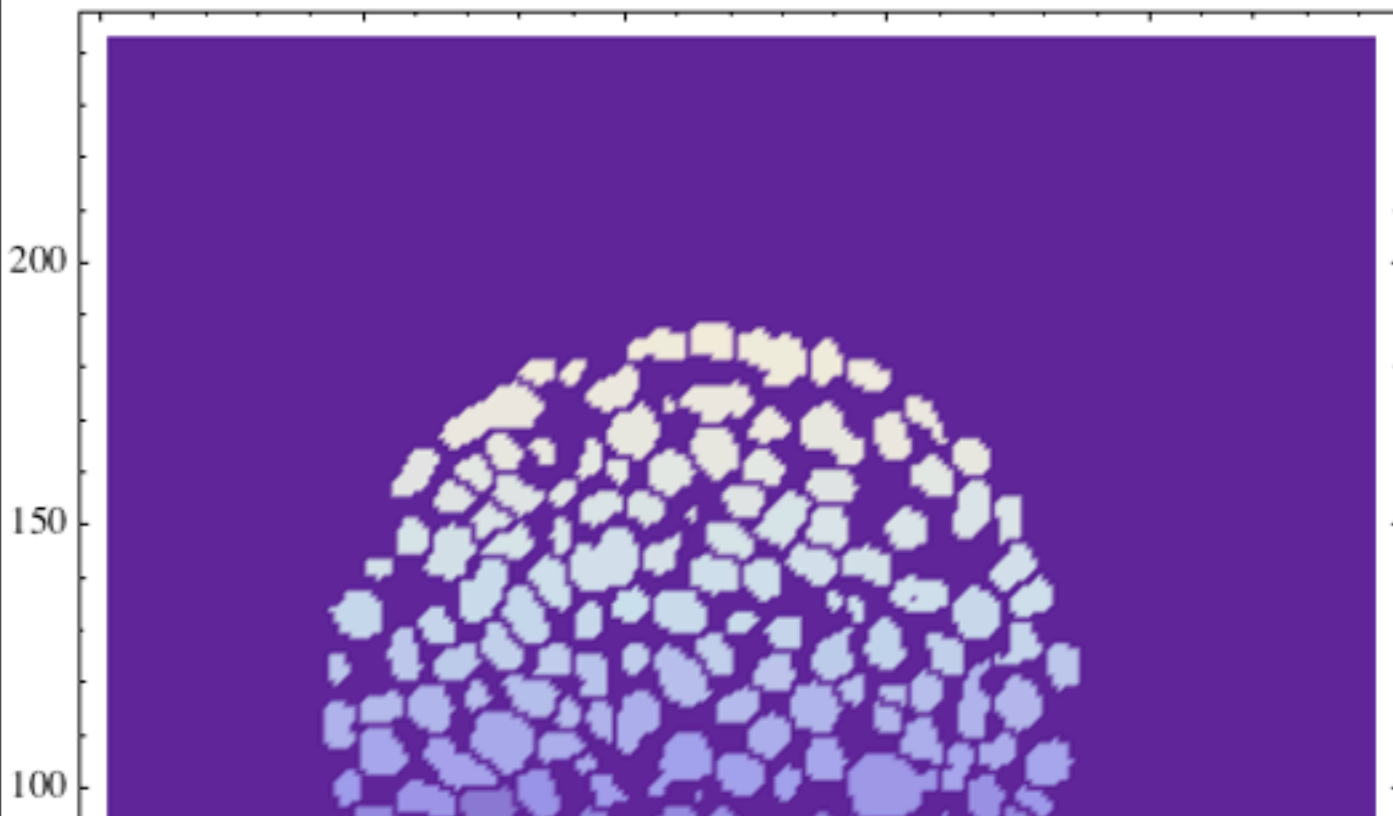
In[9]:= dataComponents = MorphologicalComponents[imageBinarySeparated];
         {Dimensions[dataComponents], Min[dataComponents], Mean[Flatten[dataComponents]] // N,
         Max[dataComponents], ImageQ[dataComponents]}
         ListDensityPlot[dataComponents, PlotRange -> {All, All, Automatic}]

Out[10]= {{243, 243}, 0, 11.9233, 175, False}
```



■ Step 3: Compare the three data sets with a 3D plot over a small range of rows and columns

```
[250]:= gComponents2D = ListDensityPlot[dataComponents[[100 ;; 150, 40 ;; 90]], PlotRange -> {All, All, Automatic},  
DataRange -> {{40, 90}, {100, 150}}]
```



■ Step 4: Apply ComponentAnalysis on the variable dataComponents for some typical measurements

```
56]:= listAreas = ComponentMeasurements[dataComponents, "Area"];

14]:= listAreas[[1 ;; 10]]

[14]= {1 → 34.25, 2 → 47.25, 3 → 25.625, 4 → 47.5, 5 → 80., 6 → 15.625, 7 → 74.125, 8 → 53.375, 9 → 58.625, 10 → 56.375}

15]:= listCentroids = ComponentMeasurements[dataComponents, "Centroid"];
listCentroids[[1 ;; 10]]

[16]= {1 → {104.063, 195.094}, 2 → {133.9, 192.611}, 3 → {94.8333, 192.083}, 4 → {120.409, 191.977}, 5 → {139.22, 185.807},
6 → {85.3571, 189.214}, 7 → {77.9085, 182.627}, 8 → {95.0294, 183.912}, 9 → {109.625, 183.554}, 10 → {116.708, 183.198}}

17]:= listEquivalentDiskRadius = ComponentMeasurements[dataComponents, "EquivalentDiskRadius"];
listEquivalentDiskRadius[[1 ;; 10]]

[18]= {1 → 3.19154, 2 → 3.7847, 3 → 2.76395, 4 → 3.74241, 5 → 4.88603, 6 → 2.111, 7 → 4.75395, 8 → 4.02912, 9 → 4.22201, 10 → 4.10736}

19]:= listEllipseLength = ComponentMeasurements[dataComponents, "Length"];
listEllipseLength[[1 ;; 10]]

[20]= {1 → 9.25701, 2 → 9.89713, 3 → 6.93269, 4 → 11.9999,
5 → 14.6584, 6 → 5.49985, 7 → 10.6894, 8 → 8.36107, 9 → 9.49568, 10 → 10.8637}

21]:= listEllipseWidth = ComponentMeasurements[dataComponents, "Width"];
listEllipseWidth[[1 ;; 10]]

[22]= {1 → 4.48382, 2 → 6.07366, 3 → 4.40254, 4 → 5.48113,
5 → 8.05137, 6 → 3.39817, 7 → 8.72709, 8 → 7.80605, 9 → 7.50955, 10 → 6.33512}

23]:= listEllipseElongation = ComponentMeasurements[dataComponents, "Elongation"];
listEllipseElongation[[1 ;; 10]]

[24]= {1 → 0.51563, 2 → 0.386321, 3 → 0.364959, 4 → 0.543237,
5 → 0.450735, 6 → 0.382135, 7 → 0.183577, 8 → 0.0663817, 9 → 0.209161, 10 → 0.416857}
```

■ Step 5: Build up the i-th line of a report

```
i[25]:= index = 3;  
      listAreas[[index]]  
      listAreas[[index, 2]]
```

```
it[26]= 3 → 25.625
```

```
it[27]= 25.625
```

```
i[28]:= listCentroids[[index]]  
      listCentroids[[index, 2]]  
      listCentroids[[index, 2, 1]]  
      listCentroids[[index, 2, 2]]
```

```
it[28]= 3 → {94.8333, 192.083}
```

```
it[29]= {94.8333, 192.083}
```

```
it[30]= 94.8333
```

```
it[31]= 192.083
```

index, x, y, area, radius, length, width, elongation

```
i[32]:= {index, listCentroids[[index, 2, 1]], listCentroids[[index, 2, 2]], listAreas[[index, 2]],  
      listEquivalentDiskRadius[[index, 2]], listEllipseLength[[index, 2]], listEllipseWidth[[index, 2]],  
      listEllipseElongation[[index, 2]]}
```

```
it[32]= {3, 94.8333, 192.083, 25.625, 2.76395, 6.93269, 4.40254, 0.364959}
```

■ Step 6: Make a function out of the previous expression

```
In[33]:= funcExtractDataAndFormat[index_] := Module[{  
    {index, listCentroids[[index, 2, 1]], listCentroids[[index, 2, 2]], listAreas[[index, 2]],  
    listEquivalentDiskRadius[[index, 2]], listEllipseLength[[index, 2]], listEllipseWidth[[index, 2]],  
    listEllipseElongation[[index, 2]]}  
];
```

```
In[34]:= funcExtractDataAndFormat[3]
```

```
Out[34]= {3, 94.8333, 192.083, 25.625, 2.76395, 6.93269, 4.40254, 0.364959}
```

■ Step 7: Build listReport with For loop and Append. Display listReport with TableForm

```

i[35]:= listReport = {};
For[index = 1, index ≤ 10, index++,
  listReport = Append[listReport, funcExtractDataAndFormat[index] ];
]
listReport
TableForm[listReport, TableHeadings → {None, {"i", "x", "y", "area", "radius", "length", "width", "elocation"}}]

```

```

i[37]= {{1, 104.063, 195.094, 34.25, 3.19154, 9.25701, 4.48382, 0.51563},
{2, 133.9, 192.611, 47.25, 3.7847, 9.89713, 6.07366, 0.386321},
{3, 94.8333, 192.083, 25.625, 2.76395, 6.93269, 4.40254, 0.364959},
{4, 120.409, 191.977, 47.5, 3.74241, 11.9999, 5.48113, 0.543237},
{5, 139.22, 185.807, 80., 4.88603, 14.6584, 8.05137, 0.450735},
{6, 85.3571, 189.214, 15.625, 2.111, 5.49985, 3.39817, 0.382135},
{7, 77.9085, 182.627, 74.125, 4.75395, 10.6894, 8.72709, 0.183577},
{8, 95.0294, 183.912, 53.375, 4.02912, 8.36107, 7.80605, 0.0663817},
{9, 109.625, 183.554, 58.625, 4.22201, 9.49568, 7.50955, 0.209161},
{10, 116.708, 183.198, 56.375, 4.10736, 10.8637, 6.33512, 0.416857}}

```

8)//TableForm=

i	x	y	area	radius	length	width	elocation
1	104.063	195.094	34.25	3.19154	9.25701	4.48382	0.51563
2	133.9	192.611	47.25	3.7847	9.89713	6.07366	0.386321
3	94.8333	192.083	25.625	2.76395	6.93269	4.40254	0.364959
4	120.409	191.977	47.5	3.74241	11.9999	5.48113	0.543237
5	139.22	185.807	80.	4.88603	14.6584	8.05137	0.450735
6	85.3571	189.214	15.625	2.111	5.49985	3.39817	0.382135
7	77.9085	182.627	74.125	4.75395	10.6894	8.72709	0.183577
8	95.0294	183.912	53.375	4.02912	8.36107	7.80605	0.0663817
9	109.625	183.554	58.625	4.22201	9.49568	7.50955	0.209161
10	116.708	183.198	56.375	4.10736	10.8637	6.33512	0.416857

■ Step 8: Build listReport with Table. Display listReport with TableForm

```
listReport = Table[funcExtractDataAndFormat[index], {index, 10} ];  
TableForm[listReport, TableHeadings → {None, {"i", "x", "y", "area", "radius", "length", "width", "elocation"}}]
```

i	x	y	area	radius	length	width	elocation
1	104.063	195.094	34.25	3.19154	9.25701	4.48382	0.51563
2	133.9	192.611	47.25	3.7847	9.89713	6.07366	0.386321
3	94.8333	192.083	25.625	2.76395	6.93269	4.40254	0.364959
4	120.409	191.977	47.5	3.74241	11.9999	5.48113	0.543237
5	139.22	185.807	80.	4.88603	14.6584	8.05137	0.450735
6	85.3571	189.214	15.625	2.111	5.49985	3.39817	0.382135
7	77.9085	182.627	74.125	4.75395	10.6894	8.72709	0.183577
8	95.0294	183.912	53.375	4.02912	8.36107	7.80605	0.0663817
9	109.625	183.554	58.625	4.22201	9.49568	7.50955	0.209161
10	116.708	183.198	56.375	4.10736	10.8637	6.33512	0.416857

■ Step 9: Build listReport with For loop and predefined array. Display listReport with TableForm

```
in[133]:= Length[listAreas]
out[133]= 175

in[134]:= listReport = ConstantArray[0, {Length[listAreas], 8}];
For[index = 1, index <= Length[listAreas], index++,
  listReport[[index, All]] = {index, listCentroids[[index, 2, 1]], listCentroids[[index, 2, 2]], listAreas[[index, 2]],
    listEquivalentDiskRadius[[index, 2]], listEllipseLength[[index, 2]], listEllipseWidth[[index, 2]],
    listEllipseElongation[[index, 2]]};
]
TableForm[listReport, TableHeadings -> {None, {"i", "x", "y", "area", "radius", "length", "width", "elongation"}}]
```

136]//TableForm=

i	x	y	area	radius	length	width	elongation
1	104.063	195.094	34.25	3.19154	9.25701	4.48382	0.51563
2	133.9	192.611	47.25	3.7847	9.89713	6.07366	0.386321
3	94.8333	192.083	25.625	2.76395	6.93269	4.40254	0.364959
4	120.409	191.977	47.5	3.74241	11.9999	5.48113	0.543237
5	139.22	185.807	80.	4.88603	14.6584	8.05137	0.450735
6	85.3571	189.214	15.625	2.111	5.49985	3.39817	0.382135
7	77.9085	182.627	74.125	4.75395	10.6894	8.72709	0.183577
8	95.0294	183.912	53.375	4.02912	8.36107	7.80605	0.0663817
9	109.625	183.554	58.625	4.22201	9.49568	7.50955	0.209161
10	116.708	183.198	56.375	4.10736	10.8637	6.33512	0.416857
11	149.797	184.797	39.125	3.43183	8.30294	5.73424	0.309372
12	86.2143	184.5	22.375	2.58544	6.5107	4.15415	0.36195
13	125.744	181.622	93.625	5.35237	11.282	10.192	0.0966171
14	159.989	178.011	49.5	3.86789	11.4701	5.25193	0.542119

■ Step 10: Export as excel spreadsheet

```
In[39]:= Export[NotebookDirectory[] <> "listReport.xls", listReport]
```

```
Out[39]= /Users/les/Documents/Class/4581_Spr12/wk7/listReport.xls
```



■ Step 11: Just one more thing: Include grain-to-center distance (part 1 of 2)

```
i[105]:= x = listCentroids[ [All, 2, 1] ];  
        y = listCentroids[ [All, 2, 2] ];  
        centerOfAllGrains = {Mean[x], Mean[y]}  
  
it[107]= {113.152, 125.805}  
  
i[129]:= funcCalculateCenterOfAllGrains[listCentroids_] := Module[{x, y},  
        x = listCentroids[ [All, 2, 1] ];  
        y = listCentroids[ [All, 2, 2] ];  
        {Mean[x], Mean[y] } ];  
  
        centerOfAllGrains = funcCalculateCenterOfAllGrains[listCentroids]  
  
it[130]= {113.152, 125.805}  
  
i[112]:= index = 3;  
        x = listCentroids[ [index, 2, 1] ];  
        y = listCentroids[ [index, 2, 2] ];  
        vectorCenterToGrain = {x, y} - centerOfAllGrains  
        grainToCenterDistance = Norm[vectorCenterToGrain]  
  
it[115]= {-18.3191, 66.2788}  
  
it[116]= 68.7638  
  
i[131]:= funcGrainToCenterDistance[index_, listCentroids_, centerOfAllGrains_] := Module[{x, y, vectorCenterToGrain},  
        x = listCentroids[ [index, 2, 1] ];  
        y = listCentroids[ [index, 2, 2] ];  
        vectorCenterToGrain = {x, y} - centerOfAllGrains;  
        Norm[vectorCenterToGrain] ];  
  
        funcGrainToCenterDistance[3, listCentroids, centerOfAllGrains]  
  
it[132]= 68.7638
```

■ Step 12: Just one more thing: Include grain-to-center distance (part 2 of 2)

```
n[164]:= listReport = ConstantArray[0, {Length[listAreas], 9}];
centerOfAllGrains = funcCalculateCenterOfAllGrains[listCentroids];
For[index = 1, index ≤ Length[listAreas], index++,
  listReport[[index, All]] =
    {index, listCentroids[[index, 2, 1]], listCentroids[[index, 2, 2]],
    funcGrainToCenterDistance[index, listCentroids, centerOfAllGrains],
    listAreas[[index, 2]],
    listEquivalentDiskRadius[[index, 2]], listEllipseLength[[index, 2]], listEllipseWidth[[index, 2]],
    listEllipseElongation[[index, 2]]}
]
TableForm[listReport,
  TableHeadings → {None, {"i", "x", "y", "distance to center", "area", "radius", "length", "width", "elocation"}}]
```

[167]//TableForm=

i	x	y	distance to center	area	radius	length	width	elocation
1	104.063	195.094	69.8829	34.25	3.19154	9.25701	4.48382	0.51563
2	133.9	192.611	69.9541	47.25	3.7847	9.89713	6.07366	0.386321
3	94.8333	192.083	68.7638	25.625	2.76395	6.93269	4.40254	0.364959
4	120.409	191.977	66.5694	47.5	3.74241	11.9999	5.48113	0.543237
5	139.22	185.807	65.4199	80.	4.88603	14.6584	8.05137	0.450735
6	85.3571	189.214	69.2342	15.625	2.111	5.49985	3.39817	0.382135
7	77.9085	182.627	66.8648	74.125	4.75395	10.6894	8.72709	0.183577
8	95.0294	183.912	60.8678	53.375	4.02912	8.36107	7.80605	0.0663817
9	109.625	183.554	57.8566	58.625	4.22201	9.49568	7.50955	0.209161
10	116.708	183.198	57.5035	56.375	4.10736	10.8637	6.33512	0.416857
11	149.797	184.797	69.4477	39.125	3.43183	8.30294	5.73424	0.309372
12	86.2143	184.5	64.5819	22.375	2.58544	6.5107	4.15415	0.36195
13	125.744	181.622	57.2203	93.625	5.35237	11.282	10.192	0.0966171
14	159.989	178.011	70.1368	49.5	3.86789	11.4701	5.25193	0.542119
15	97.4	174.3	50.9897	73.375	4.72035	10.7722	8.78726	0.184268

■ Step 13: Just one more thing (again): Sort list by area

```
[258]:= TableForm[listReport[[1 ;; 10]],  
  TableHeadings → {None, {"i", "x", "y", "distance to center", "area", "radius", "length", "width", "elongation"}}]
```

58]//TableForm=

i	x	y	distance to center	area	radius	length	width	elongation
1	104.063	195.094	69.8829	34.25	3.19154	9.25701	4.48382	0.51563
2	133.9	192.611	69.9541	47.25	3.7847	9.89713	6.07366	0.386321
3	94.8333	192.083	68.7638	25.625	2.76395	6.93269	4.40254	0.364959
4	120.409	191.977	66.5694	47.5	3.74241	11.9999	5.48113	0.543237
5	139.22	185.807	65.4199	80.	4.88603	14.6584	8.05137	0.450735
6	85.3571	189.214	69.2342	15.625	2.111	5.49985	3.39817	0.382135
7	77.9085	182.627	66.8648	74.125	4.75395	10.6894	8.72709	0.183577
8	95.0294	183.912	60.8678	53.375	4.02912	8.36107	7.80605	0.0663817
9	109.625	183.554	57.8566	58.625	4.22201	9.49568	7.50955	0.209161
10	116.708	183.198	57.5035	56.375	4.10736	10.8637	6.33512	0.416857

```
[168]:= listAreasSorted = listReport[All, 5];  
listAreasSorted[[1 ;; 20]]
```

```
[169]= {34.25, 47.25, 25.625, 47.5, 80., 15.625, 74.125, 53.375, 58.625,  
  56.375, 39.125, 22.375, 93.625, 49.5, 73.375, 26.5, 19.75, 42.875, 43.5, 65.}
```

```
[259]:= indexOrdering = Ordering[listAreasSorted];  
listAreasSorted[[indexOrdering]][[1 ;; 20]]
```

```
[260]= {1., 2.25, 4.25, 5.625, 6.75, 8.875, 10.125, 11., 13.25,  
  15.625, 16.5, 17.375, 17.625, 17.75, 18.375, 19.25, 19.375, 19.75, 20., 20.75}
```

```
[261]:= indexOrdering = Reverse[Ordering[listAreasSorted]];  
listAreasSorted[[indexOrdering]][[1 ;; 20]]
```

```
[262]= {163.75, 158.125, 136.375, 128.375, 124.625, 121.25, 109.125, 105.75,  
  102.25, 93.625, 90.5, 87.5, 84.5, 80.25, 80., 78.875, 78., 75.875, 74.375, 74.125}
```

```
[177]:= listReportSorted = listReport[[indexOrdering, All]];  
TableForm[listReportSorted[[1 ;; 20]],  
  TableHeadings → {None, {"i", "x", "y", "distance to center", "area", "radius", "length", "width", "elongation"}}]
```

78]//TableForm=

i	x	y	distance to center	area	radius	length	width	elongation
24	140.804	167.93	50.3903	163.75	7.09175	18.3847	12.0018	0.347185
56	149.526	143.18	40.3106	158.125	6.97864	16.6342	12.1914	0.267087
...	...	...	...	...	...	...	...	...

■ Step 14: Just one more thing (and again): Select the large, elongated grains

```
[263]:= TableForm[listReportSorted[[1 ;; 10]],  
  TableHeadings → {None, {"i", "x", "y", "distance to center", "area", "radius", "length", "width", "elocation"}}]
```

263]//TableForm=

i	x	y	distance to center	area	radius	length	width	elocation
24	140.804	167.93	50.3903	163.75	7.09175	18.3847	12.0018	0.347185
56	149.526	143.18	40.3106	158.125	6.97864	16.6342	12.1914	0.267087
40	72.5076	151.202	47.9275	136.375	6.45744	18.6592	9.78405	0.475645
163	74.5081	72.5323	65.8128	128.375	6.28255	21.6669	8.03706	0.629062
21	73.2917	171.258	60.456	124.625	6.18039	13.965	11.7707	0.157125
124	95.7308	100.415	30.7924	121.25	6.10264	14.6365	10.5337	0.280316
70	76.1952	134.424	37.949	109.125	5.78122	12.5797	10.7553	0.145033
26	165.245	164.412	64.8395	105.75	5.69804	12.5339	10.4643	0.165122
172	127.816	61.3367	66.1145	102.25	5.58519	14.3705	9.28198	0.354095
13	125.744	181.622	57.2203	93.625	5.35237	11.282	10.192	0.0966171

```
[264]:= listAreasLarge = listReportSorted[[All, 5]];  
listAreasLarge[[1 ;; 20]]  
thresholdLarge = 80;  
indexAreasLarge = Flatten[Position[listAreasLarge, p_? (# >= thresholdLarge &)]]
```

```
t[265]= {163.75, 158.125, 136.375, 128.375, 124.625, 121.25, 109.125, 105.75,  
  102.25, 93.625, 90.5, 87.5, 84.5, 80.25, 80., 78.875, 78., 75.875, 74.375, 74.125}
```

```
t[267]= {1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15}
```

```
[243]:= listElongated = listReportSorted[[All, 9]];  
listElongated[[1 ;; 20]]  
thresholdElongated = 0.4;  
indexElongated = Flatten[Position[listElongated, p_? (# >= thresholdElongated &)]]
```

```
t[244]= {0.347185, 0.267087, 0.475645, 0.629062, 0.157125, 0.280316, 0.145033, 0.165122, 0.354095, 0.0966171,  
  0.419272, 0.355598, 0.388115, 0.452602, 0.450735, 0.547356, 0.488147, 0.0950835, 0.0852551, 0.183577}
```

```
t[246]= {3, 4, 11, 14, 15, 16, 17, 29, 31, 34, 35, 37, 42, 44, 48, 52, 53, 57, 58, 71, 77,  
  79, 87, 102, 103, 107, 108, 109, 114, 123, 128, 136, 141, 143, 148, 152, 158, 167, 172, 174}
```

```
[247]:= indexBothLargeAndElongated = Intersection[indexAreasLarge, indexElongated]
```

```
t[247]= {3, 4, 11, 14, 15, 16, 17, 29, 31, 34, 35, 37, 42, 44, 48, 52, 53, 57, 58, 71}
```