anaCircles

December 24, 2015

1 Image Analysis of Touching Circles

This is a simple particle analysis of touching circles from an image by John Russ. The analysis was adapted from a pythonvision tutorial and converted to work with python 3.51 (Anaconda 2.41) and and to mainly use skimage.

The image came from Reindeer Graphics.

Note that since the skimage regionprops supplies the bounding box, we can just eliminate the features touching the borders.

1.1 First, import the packages we need

I like to put this all up front and include any notebook magic that is helpful.

```
In [1]: %matplotlib inline
        import math
        import matplotlib.pyplot as plt
        import numpy as np
        import scipy.ndimage as nd
        import warnings

        import skimage.exposure as expo
        import skimage.feature as fea        # peak_local_max
        import skimage.filters as fil        # rank, moved from .filter
        import skimage.io as io
        import skimage.measure as mea        # regionprops
        import skimage.morphology as mor     # watershed, disk
```

1.2 Define functions to plot our images and gray level histograms

```
In [2]: def plotOneImage(dat, label, sFont=12, size=(10,10), colormap=plt.cm.gray):
            """plotOneImage(dat, label, sizeFont=12, size=(10,10), colormap=plt.cm.gray)
            Use matplotlib to plot the image
            Input:
            dat       - a numpy array with the data
            label     - a title
            sFont     - the size of the font, default 12
            size      - a tuple, default (10,10) with the figure size
            colormap - a pyplot color map, default plt.cm.gray
            Return:
            a matplotlib figure"""
            fig, axes = plt.subplots(ncols=1, nrows=1, figsize=size)
            ax0 = axes
            ax0.imshow(dat, cmap=colormap, interpolation='nearest')
```

```
        ax0.set_title(label, fontsize=sFont)
        ax0.axis('off')
        fig.show()
        return(fig)

    def plotGrayLevelHistogram(im, label, sFont=12, size=(10,10), bins=256):
        """Use matplotlib to plot the gray level histogram of an image"""
        fig, axes = plt.subplots(ncols=1, nrows=1, figsize=size)
        ax0 = axes
        his = im.flatten()
        plt.hist(his, bins)
        plt.show()
        ax0.set_xlabel('gray level', fontsize=sFont)
        ax0.set_ylabel('count', fontsize=sFont)
        sTitle = label + ' - gray level histogram'
        ax0.set_title(sTitle, fontsize=sizeFont)
        fig.show()
        return(fig)
```

1.3 Define some file names and read in our image

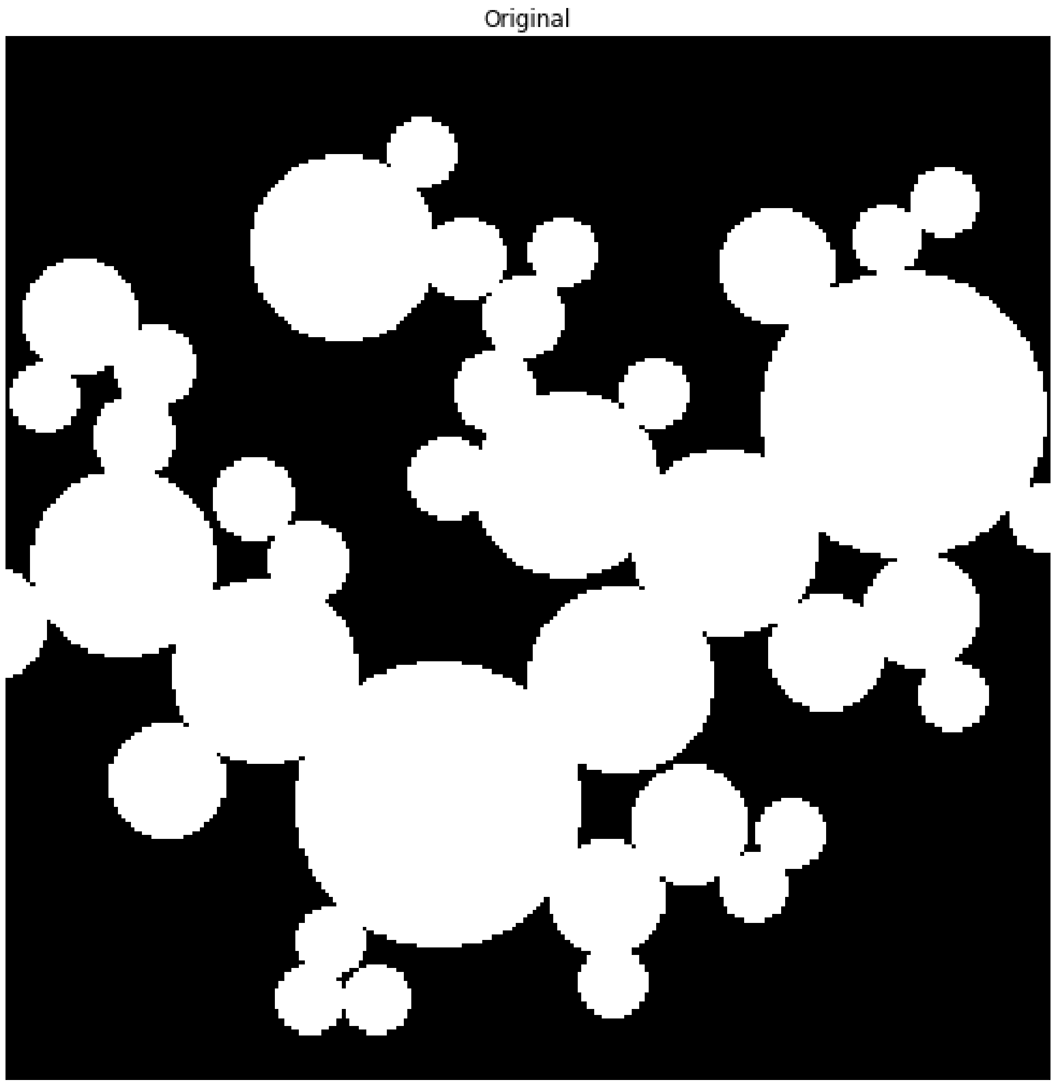
```
In [3]: warnings.filterwarnings('ignore')
        fOut = 'features.csv'
        fImg = './circles.png'
        sizeFont = 12

        im = io.imread(fImg)
        print(im.dtype)
        print(im.shape)
        imgRows = im.shape[0]
        imgCols = im.shape[1]
```

```
uint8
(252, 252)
```

1.4 Examine the input image

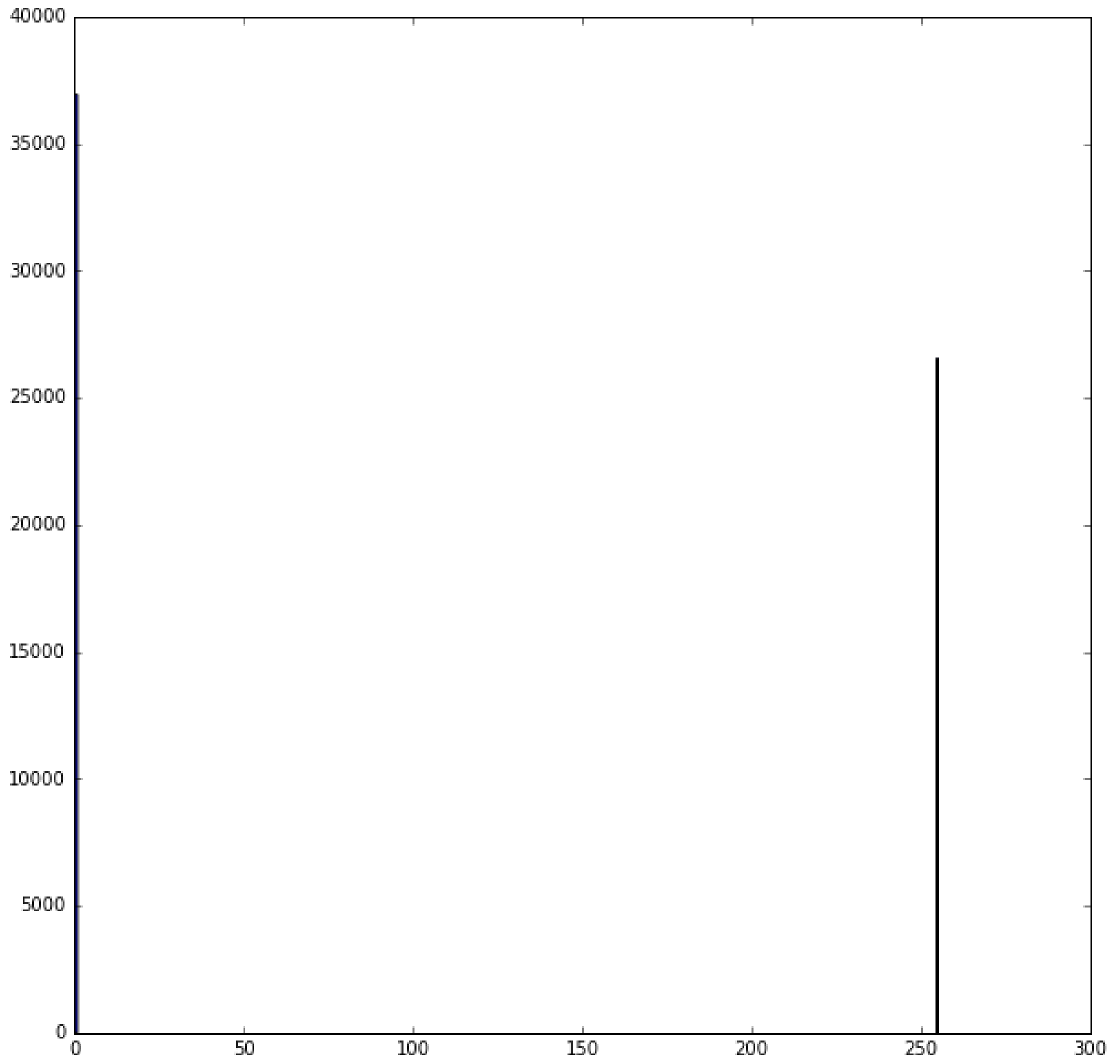
```
In [4]: figOri = plotOneImage(im, "Original", sFont=sizeFont, colormap=plt.cm.gray)
        figOri.show()
```



1.5 Compute and display the histogram

This will not be surprisng for binary image...

In [5]:
```
diaHistFig = plotGrayLevelHistogram(im, "Original", sFont=12, bins=256)
diaHistFig.show()
```

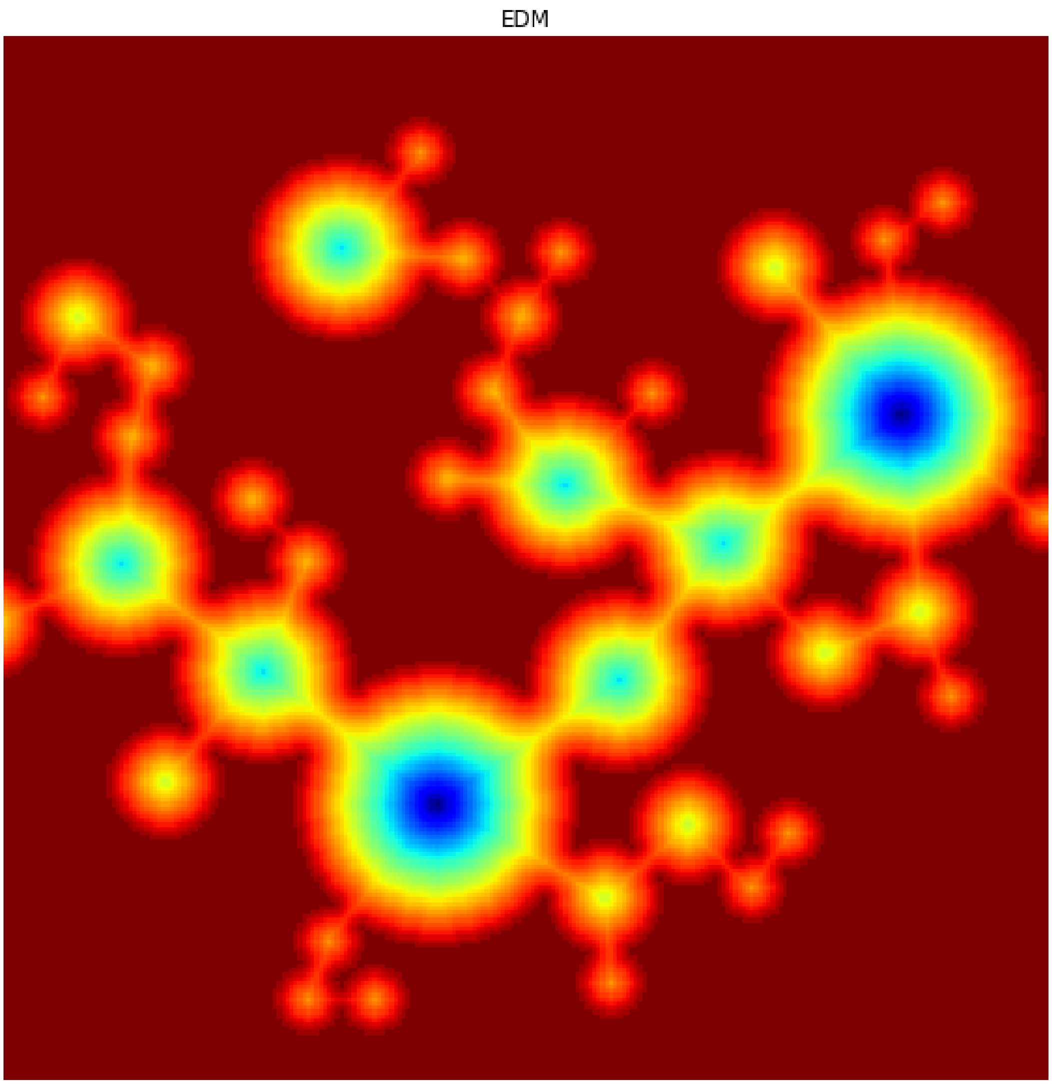


1.6 Set a gray level threshold

```
In [6]: thr = im > 0.5
```

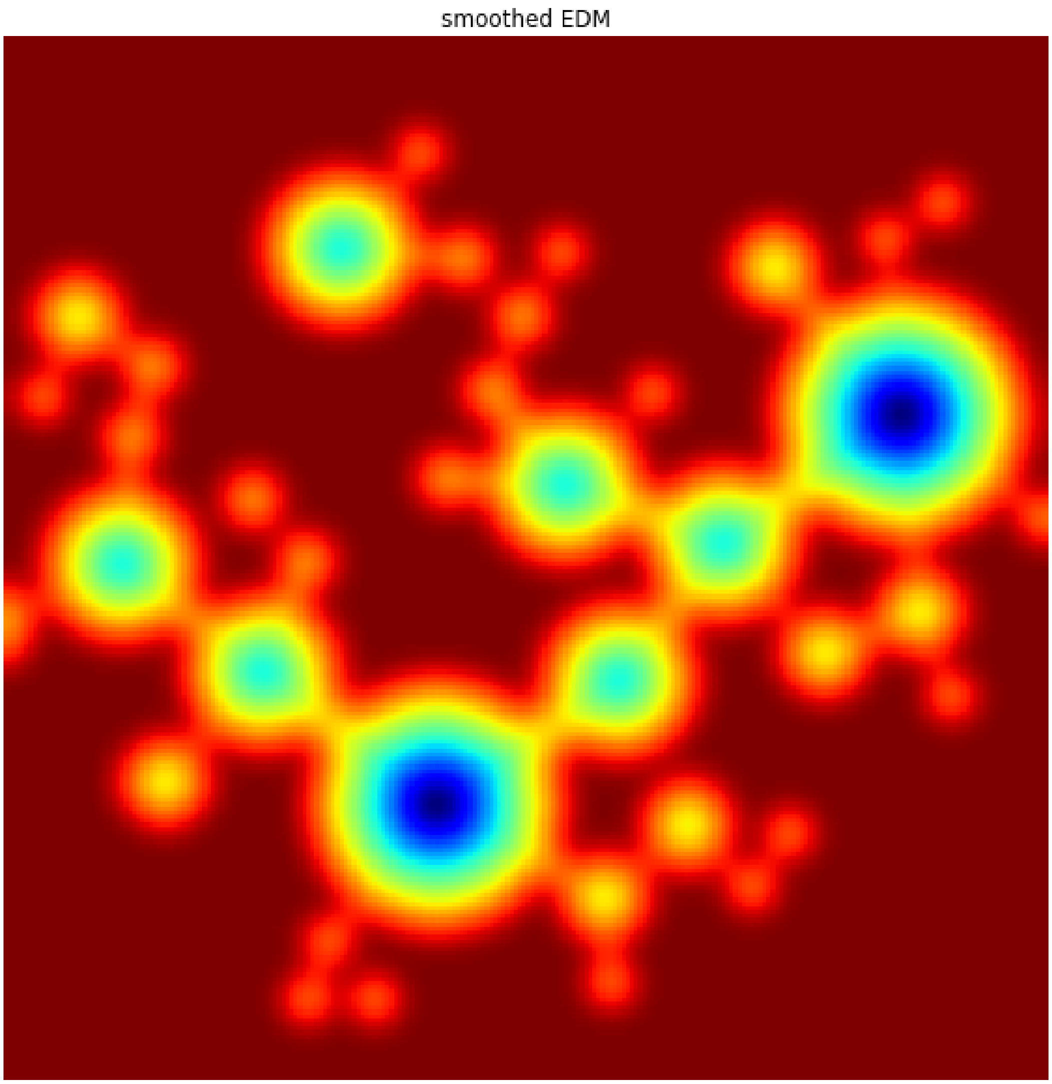
1.7 Compute the Euclidean Distance Transform

```
In [7]: dis = nd.distance_transform_edt(thr).astype(np.float32)
        disFig = plotOneImage(-dis, "EDM", sFont=12, colormap=plt.cm.jet)
        disFig.show()
```



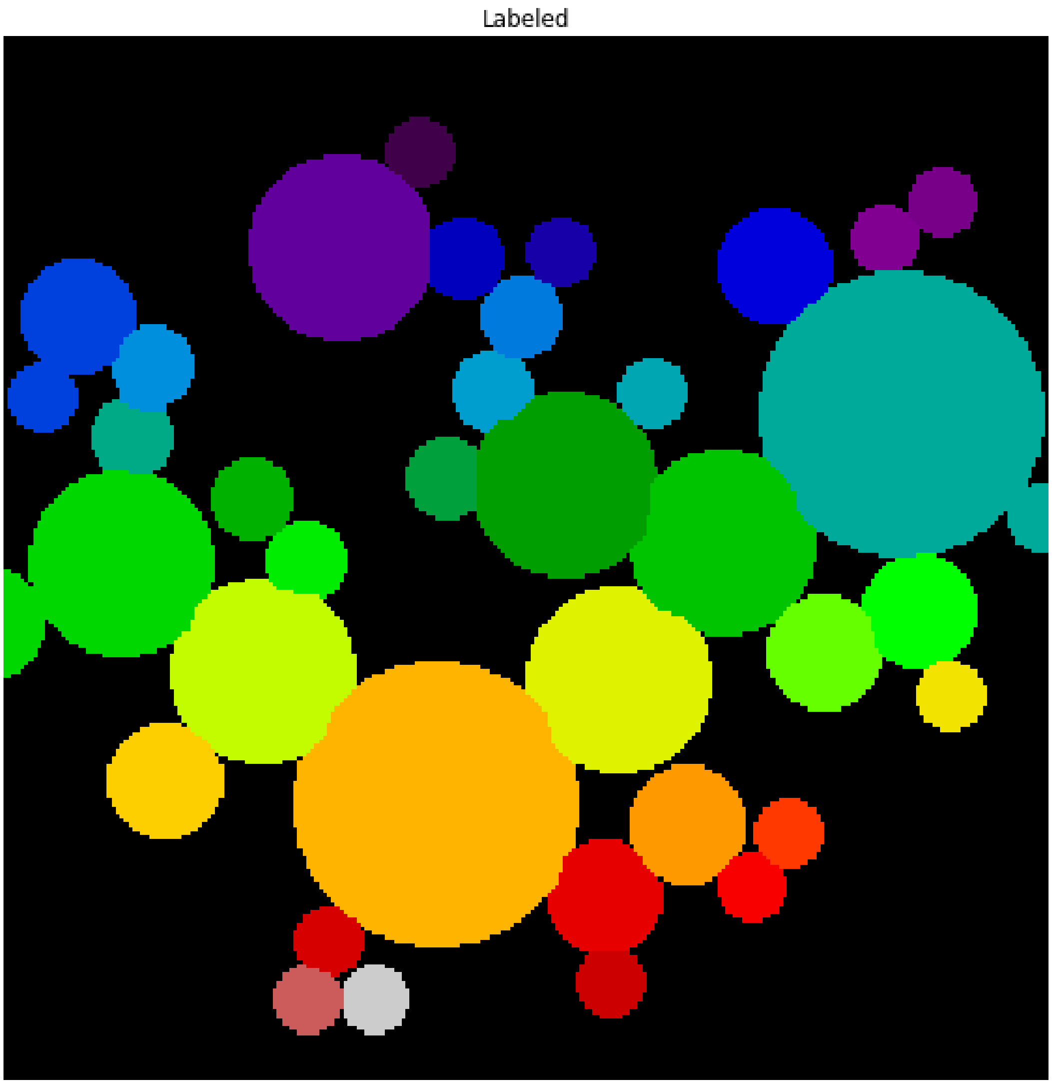
1.8 Smooth the Euclidean Distance Transform

In [8]:
```
blur = nd.gaussian_filter(dis,3)
blurFig = plotOneImage(-blur, "smoothed EDM", sFont=12, colormap=plt.cm.jet)
blurFig.show()
```



1.9 Find the local maxima and do a Watershed separation

```
In [9]: lMax = fea.peak_local_max(blur, indices=False, footprint=np.ones((3, 3)), labels=im)
        mrk = nd.label(lMax)[0]
        lab = mor.watershed(-dis, mrk, mask=thr)
        labFig = plotOneImage(lab, "Labeled", sFont=12, colormap=plt.cm.spectral)
        labFig.show()
```



1.10 Compute the properties

```
In [10]: props = mea.regionprops(lab, cache=True)
         l = len(props)
```

1.11 Write out the diameters

```
In [11]: f = open(fOut,'w')
         line = "label, ecd, minor.ax.len, major.ax.len, ar, solidity"
         print(line)
         f.write(line+'\n')
         for i in range(l):
             # check the labeled regions for border touching
             theBox = props[i].bbox
             if(theBox[0] > 0):
```

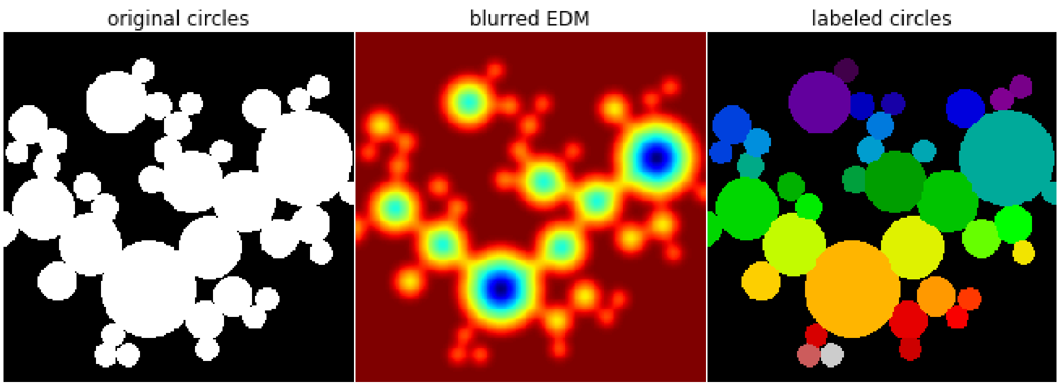
```
                if(theBox[1] > 0):
                    if(theBox[2] < imgRows):
                        if(theBox[3] < imgCols):
                            ecd = 2.0 * math.sqrt(props[i].area/math.pi)
                            ar = props[i].major_axis_length / props[i].minor_axis_length
                            line = "%g, %g," % (i+1, ecd)
                            line += "%g," % props[i].minor_axis_length
                            line += "%g," % props[i].major_axis_length
                            line += "%g, %g" % (ar, props[i].solidity)
                            print(line)
                            f.write(line+'\n')
        f.close()
```

```
label, ecd, minor.ax.len, major.ax.len, ar, solidity
1, 16.8125,16.6139,17.0332,1.02523, 0.961039
2, 16.9257,16.8622,16.9883,1.00748, 0.965665
3, 16.7366,16.3471,17.1547,1.0494, 0.986547
4, 44.9373,44.7138,45.1699,1.0102, 0.988778
5, 16.9257,16.9244,16.9244,1, 0.965665
6, 19.5441,18.7784,20.4522,1.08913, 0.980392
7, 27.8003,27.456,28.1852,1.02656, 0.983793
8, 32.4495,25.1815,45.7574,1.81711, 0.894054
9, 20.0585,19.8194,20.2924,1.02386, 0.981366
10, 20.2166,19.1939,21.3642,1.11308, 0.955357
11, 19.1492,18.1811,20.3699,1.12039, 0.96
12, 16.888,16.8092,16.9621,1.0091, 0.965517
14, 18.8138,17.1206,20.9961,1.22636, 0.952055
15, 19.0826,17.823,20.6408,1.1581, 0.979452
16, 44.4959,43.795,45.296,1.03427, 0.980454
17, 20.0902,20.0227,20.1511,1.00641, 0.972393
18, 43.8474,42.868,45.167,1.05363, 0.966091
20, 19.3805,18.564,20.3528,1.09636, 0.970395
21, 27.5703,27.422,27.7985,1.01373, 0.970732
22, 27.7315,27.2704,28.2511,1.03596, 0.980519
23, 44.1512,43.7414,44.7699,1.02351, 0.970215
24, 44.3383,43.2965,45.5844,1.05284, 0.975363
25, 17.0007,16.8549,17.1466,1.01731, 0.970085
26, 27.9829,27.9359,28.0237,1.00314, 0.987159
27, 68.4788,68.0149,69.0357,1.01501, 0.981087
28, 28.5013,28.0389,28.9785,1.03351, 0.98609
29, 16.888,16.8092,16.9621,1.0091, 0.965517
30, 16.8125,16.615,17.0325,1.02513, 0.982301
31, 27.2685,27.1959,27.5292,1.01226, 0.976589
32, 16.5837,16.0485,17.1834,1.07071, 0.96
33, 16.7746,16.4721,17.1176,1.03919, 0.977876
34, 16.6985,16.3352,17.0985,1.04673, 0.973333
35, 16.6985,16.3479,17.0653,1.04388, 0.977679
```

1.12 Plot the three key images

```
In [12]: fig, axes = plt.subplots(ncols=3, figsize=(9, 3))
         ax0, ax1, ax2 = axes
         ax0.imshow(im, cmap=plt.cm.gray, interpolation='nearest')
         ax0.set_title('original circles')
         ax1.imshow(-blur, cmap=plt.cm.jet, interpolation='nearest')
```

```
ax1.set_title('blurred EDM')
ax2.imshow(lab, cmap=plt.cm.spectral, interpolation='nearest')
ax2.set_title('labeled circles')
for ax in axes:
  ax.axis('off')
plt.subplots_adjust(hspace=0.01, wspace=0.01, top=1, bottom=0, left=0, right=1)
plt.show()
```




```
In [13]: %reload_ext load_style
         %load_style ../themes/tutorial.css
```

<IPython.core.display.HTML object>