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利用MATLAB快速實現多種影像處理演算法

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Application Engineer

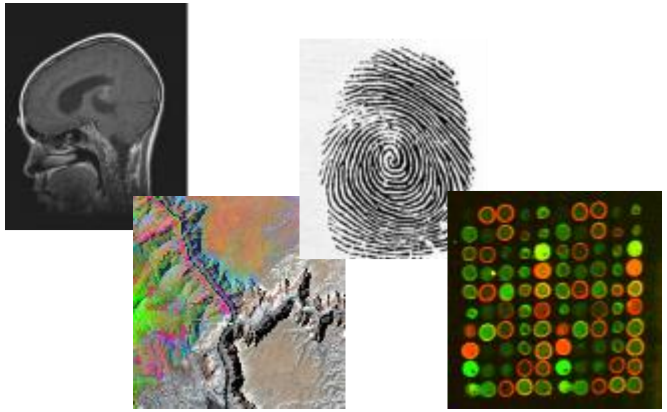
MathWorks
Accelerating the pace of engineering and science

Why should you use MATLAB for image processing ?

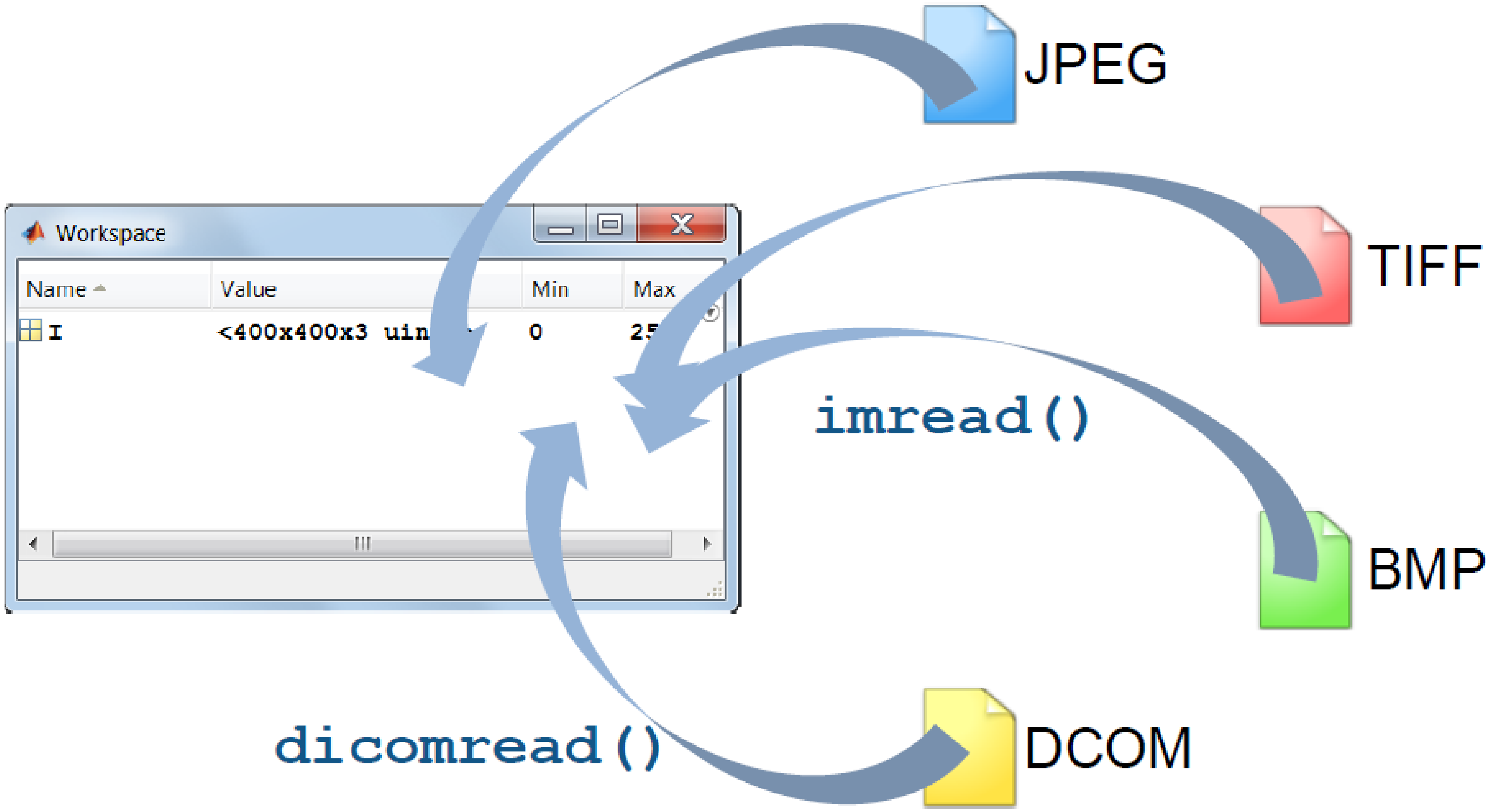
Outline

- Images in MATLAB
- Image Enhancement
- Edge and Line Detection
- Segmentation & Feature Extraction

Images in MATLAB



Supported Image Files



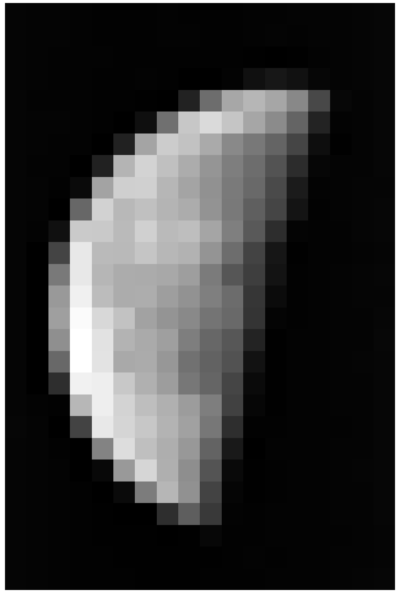
Basic Knowledge of Image

- Uint8:

0 ~ 255

- Resolution

537*358



27*18

Basic Knowledge of Image

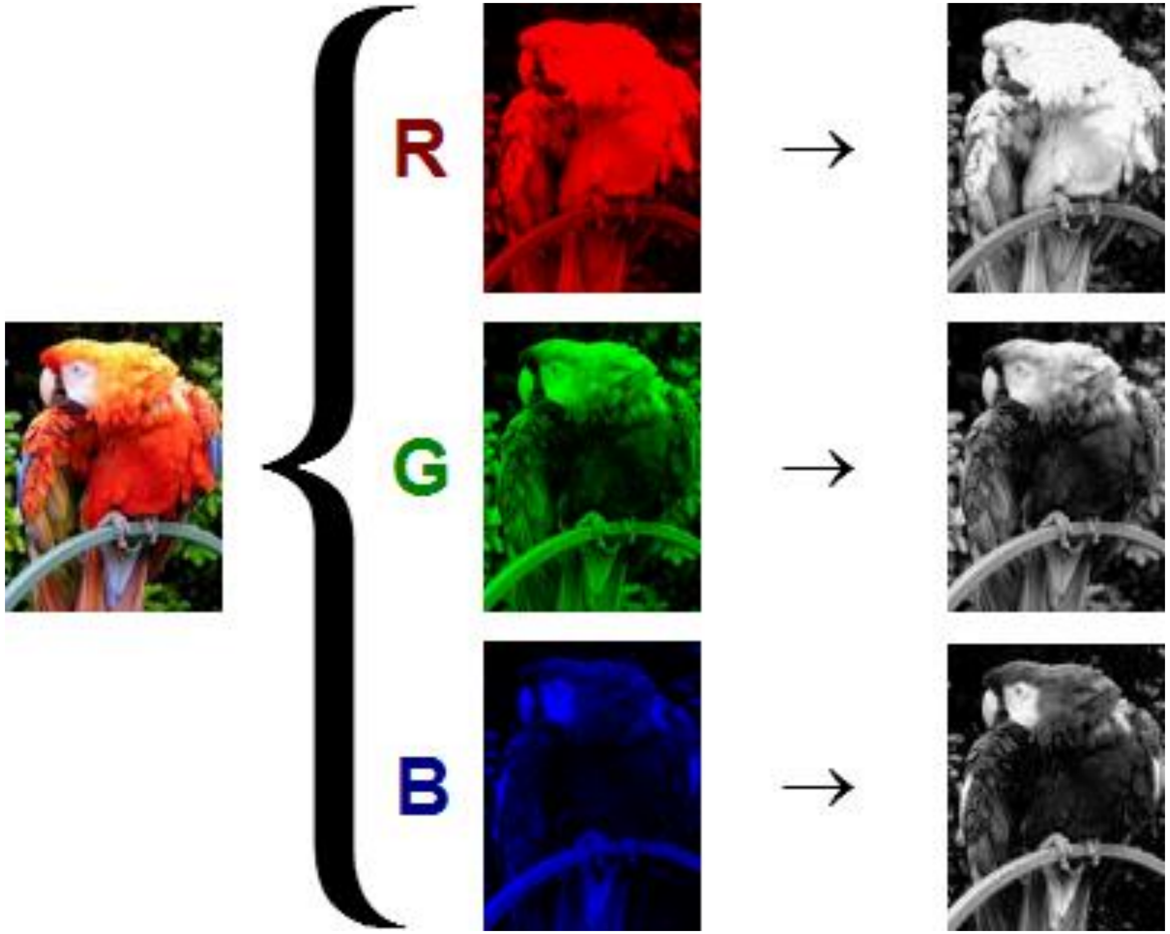
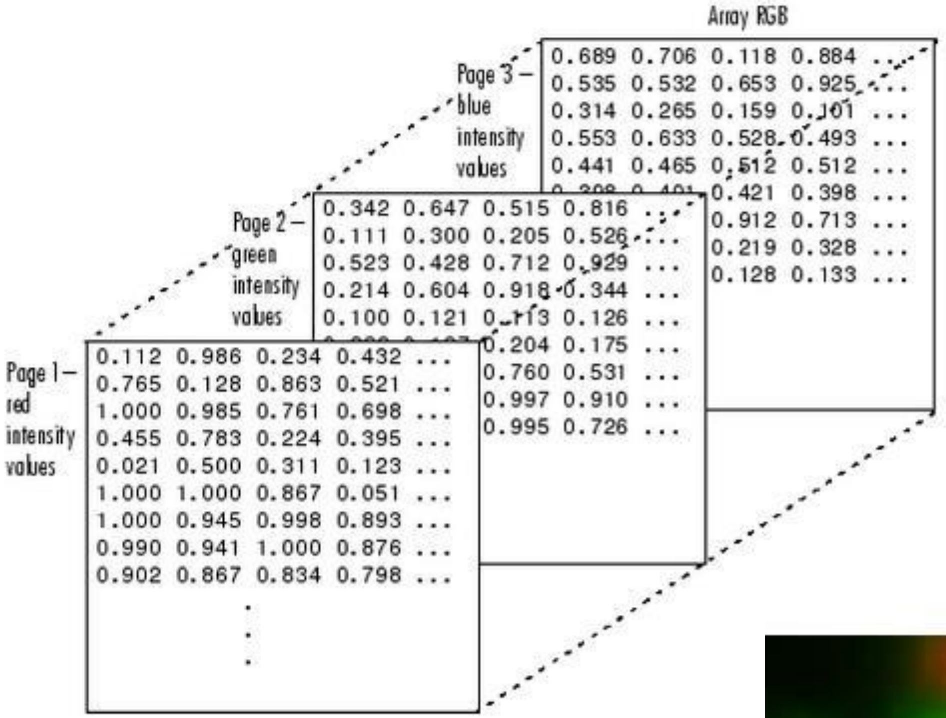
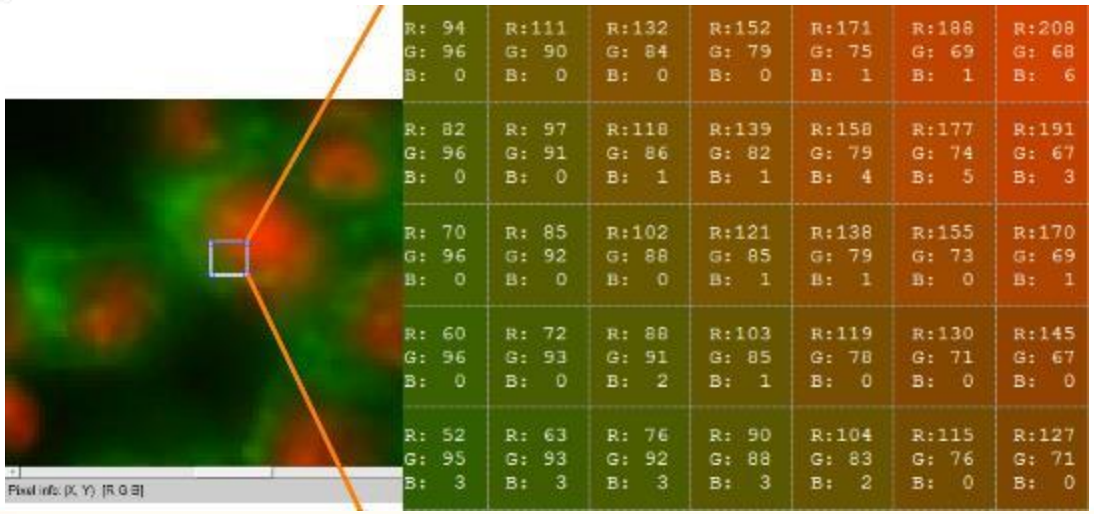


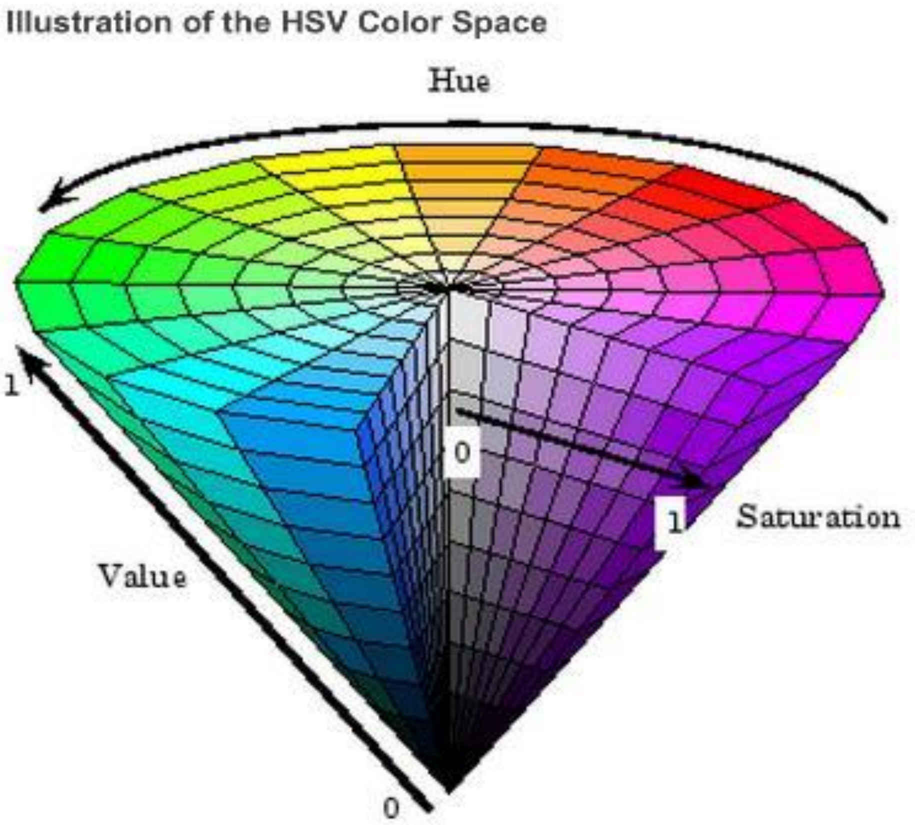
Image is Formed by Matrix



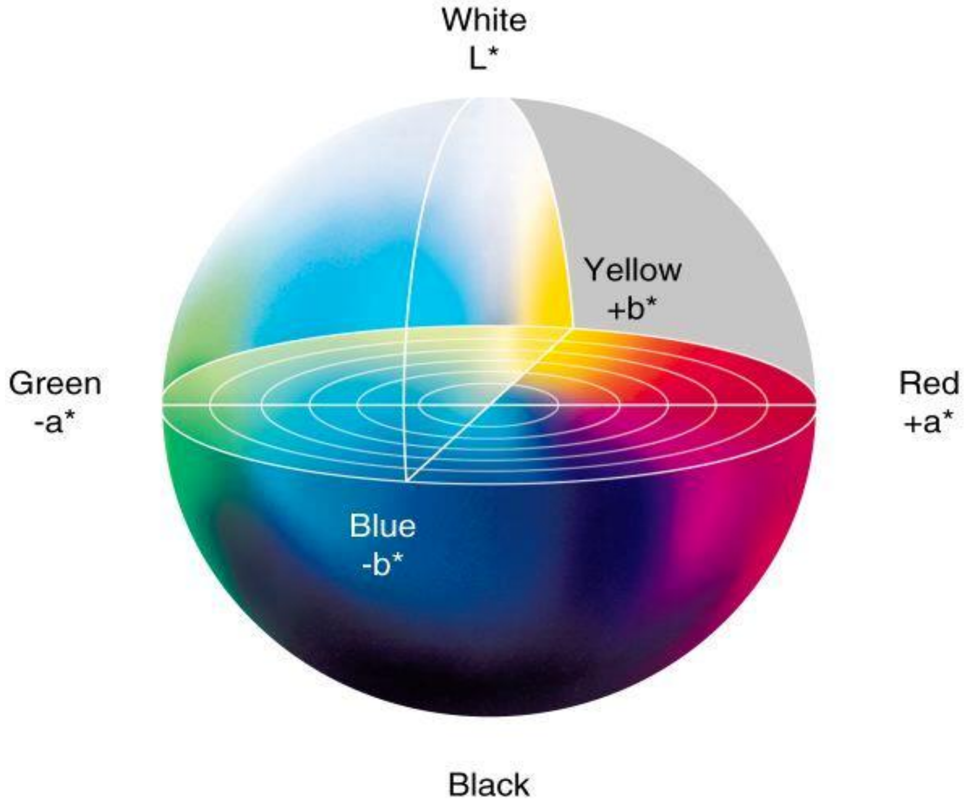


Other Color Spaces for Presenting a True Color Image

HSV



L*a*b*



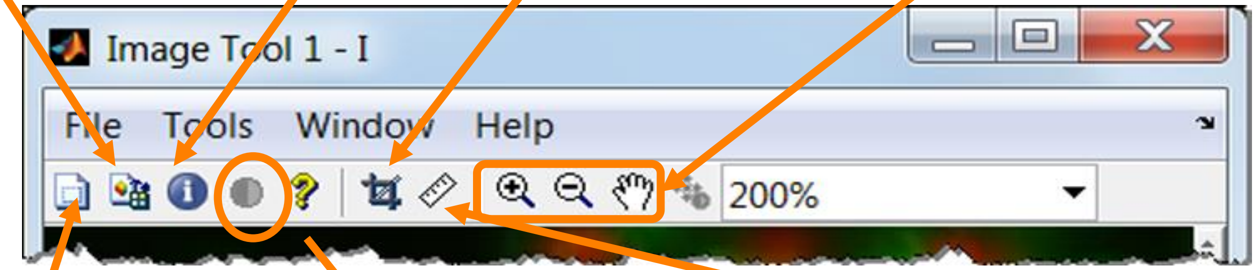
Exploring images using Image Viewer APP

Display Image information

Inspect Pixel Values

Crop Image

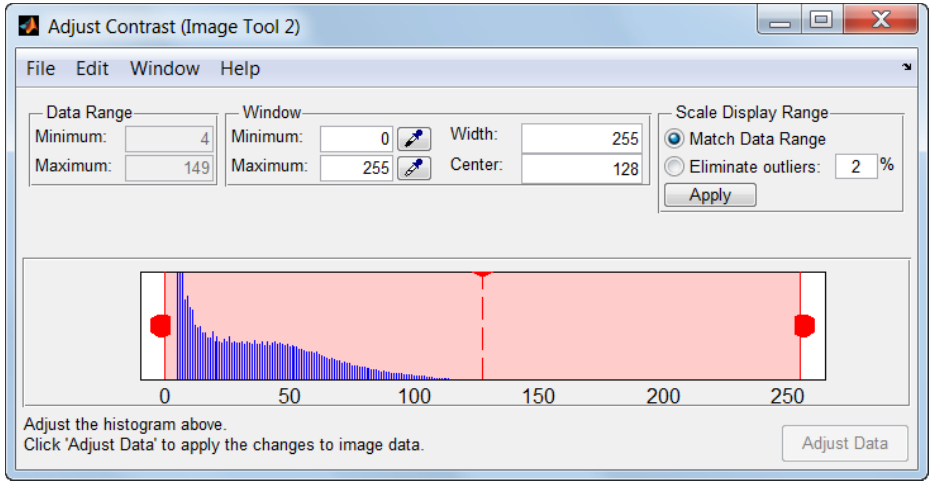
Zoom and Pan



Measure Distance

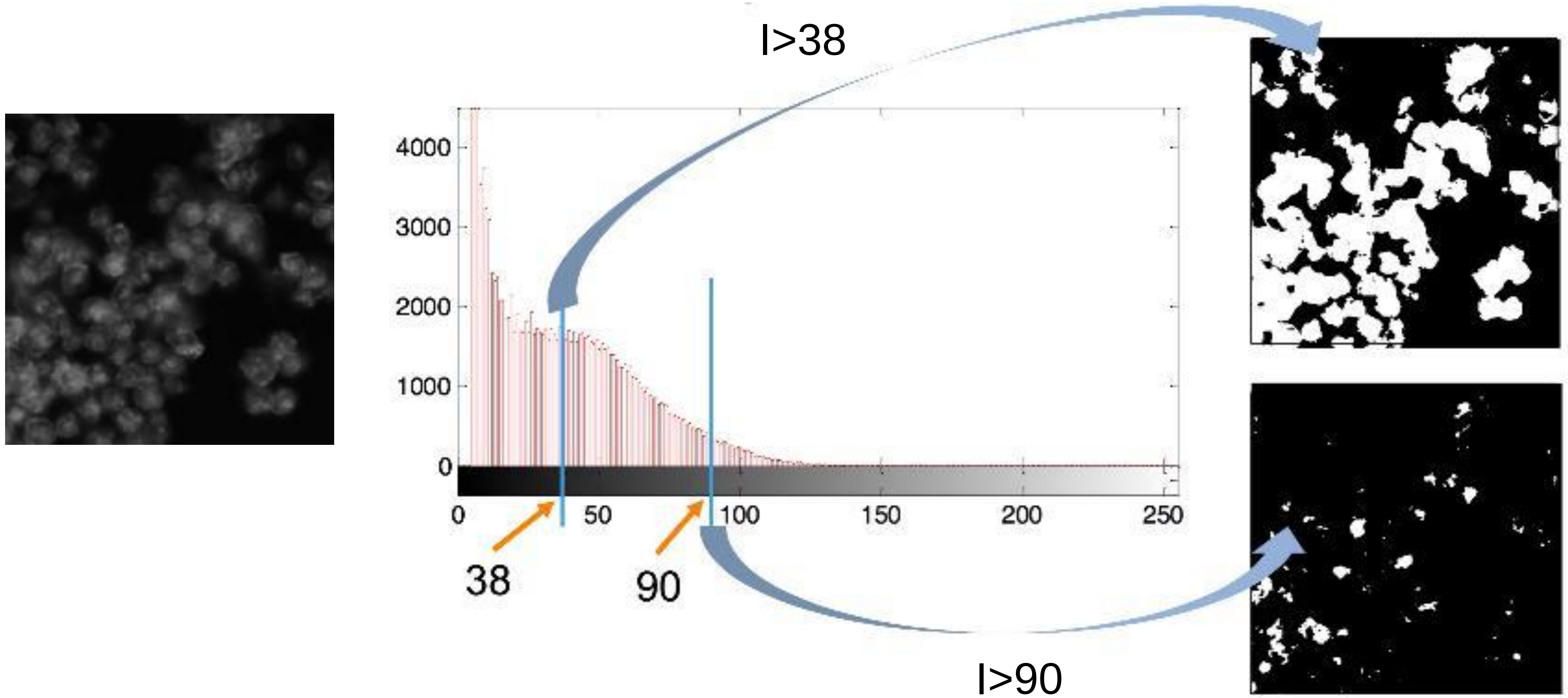
Navigate Image Using Overview

Contrast adjustment

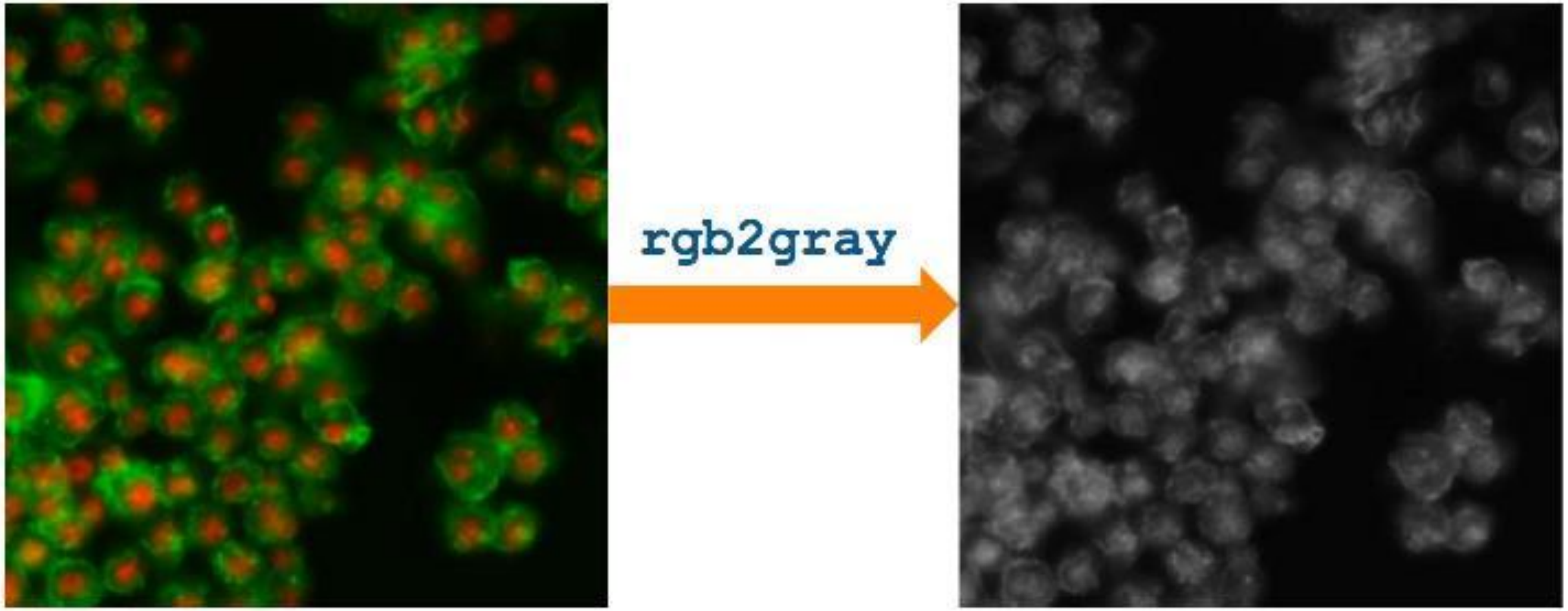


Converting to Binary Image by Thresholding

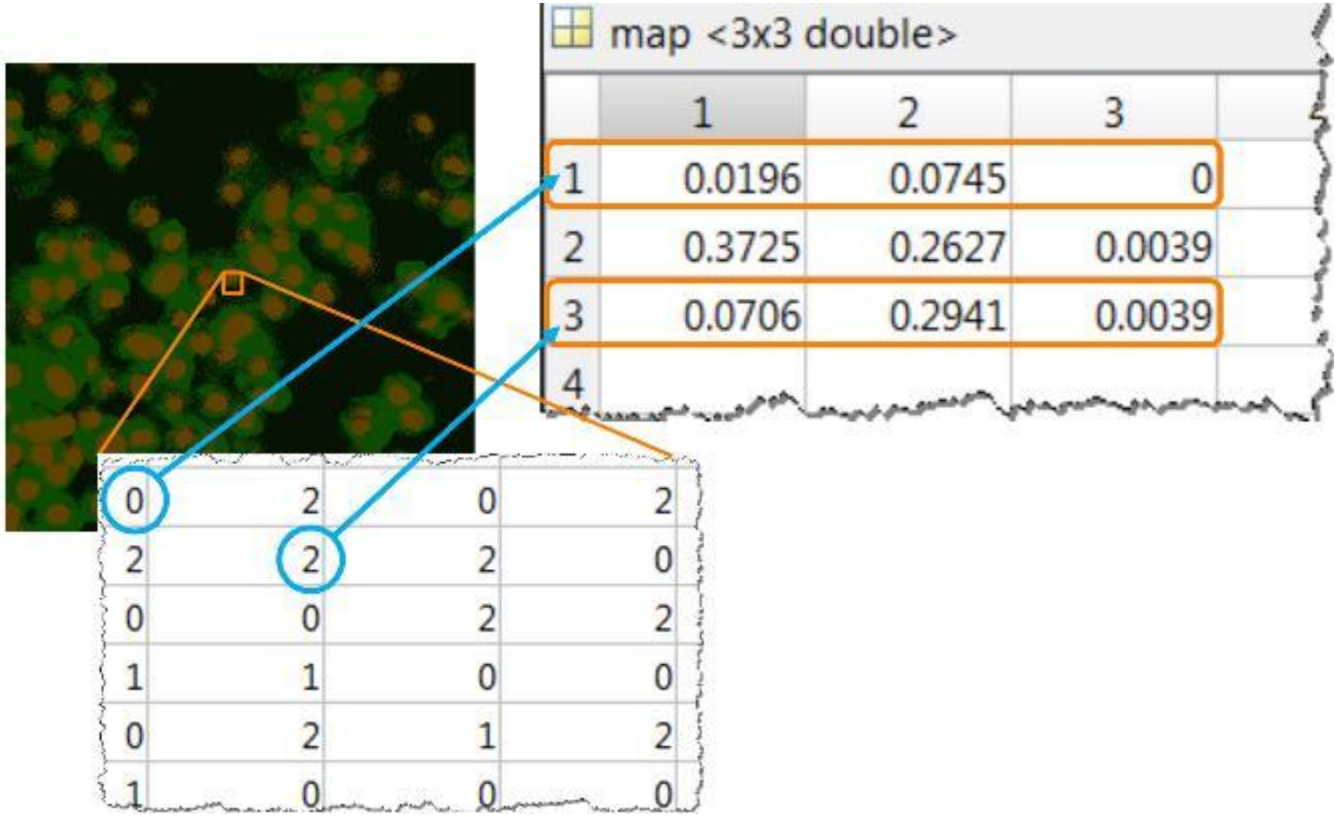
- just black or white



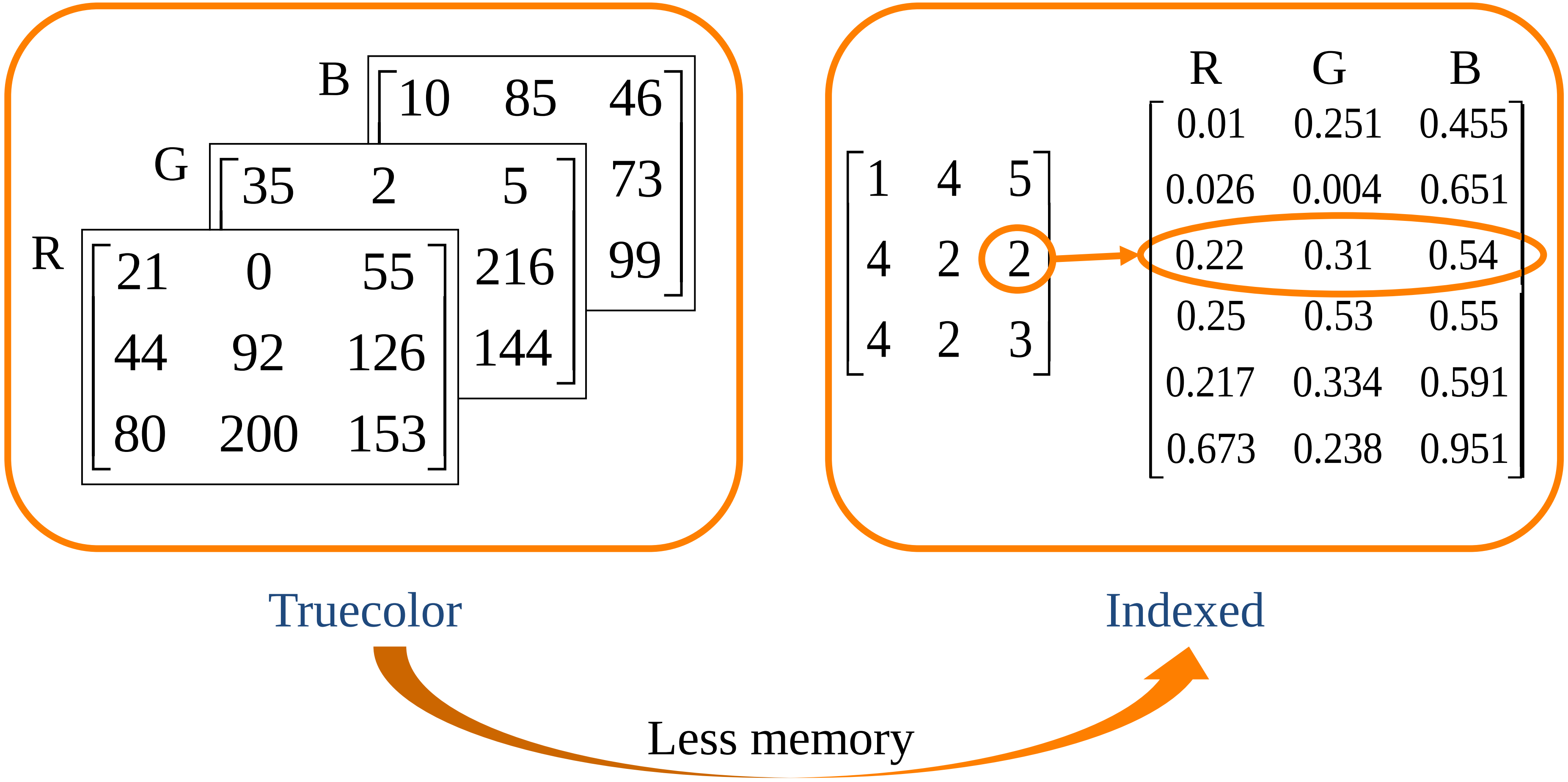
Grayscale (Intensity) Image



Indexed Images



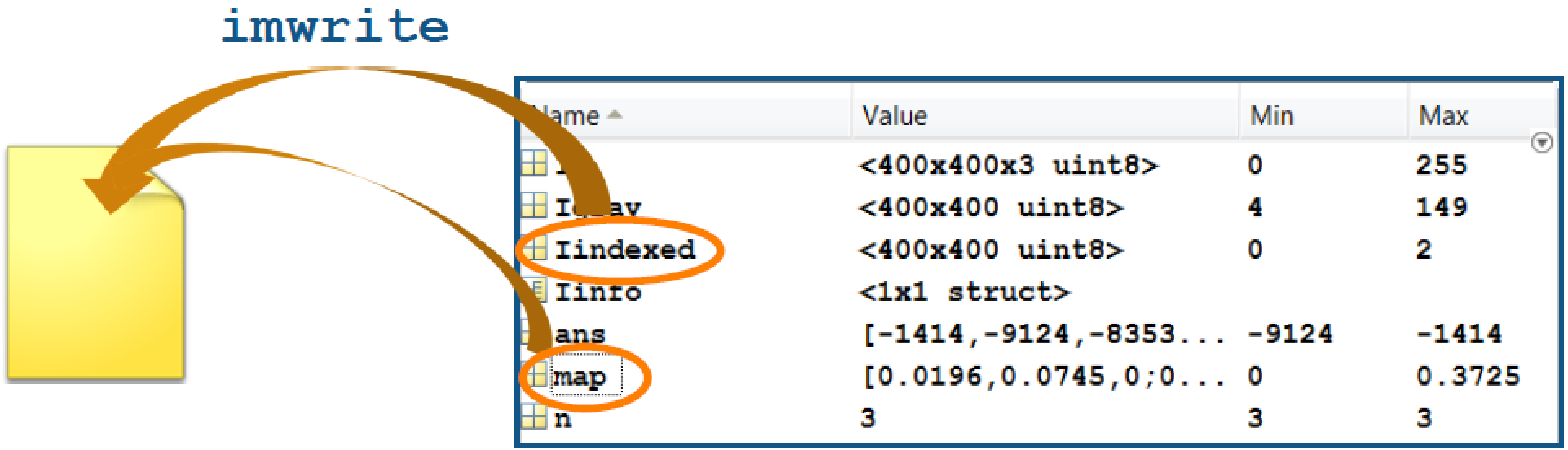
The Advantages of Indexed Images



Images Type Summary

Binary	Matrix of 0s and 1s	$\begin{bmatrix}1&0&1\\0&1&1\\0&0&1\end{bmatrix}$
Grayscale	Matrix of integers or floating-point numbers	$\begin{bmatrix}21&0&55\\44&92&126\\80&200&153\end{bmatrix}$
Indexed	Matrix of numbers with integer values that point to a colormap entry	$\begin{bmatrix}1&4&5\\4&2&2\\4&2&3\end{bmatrix} \rightarrow \begin{array}{ccc}R&G&B\\ \hline 0.01&0.251&0.455\\0.026&0.004&0.651\\0.22&0.31&0.54\\0.25&0.53&0.55\\0.217&0.334&0.591\\0.673&0.238&0.951\end{array}$
Truecolor	3-D array of numbers of size *m*-by-*n*-by-3	B $\begin{bmatrix}10&85&46\\&&73\\&&99\end{bmatrix}$ G $\begin{bmatrix}35&2&5\\&&216\\&&144\end{bmatrix}$ R $\begin{bmatrix}21&0&55\\44&92&126\\80&200&153\end{bmatrix}$

Exporting Images



Name	Value	Min	Max
I	<400x400x3 uint8>	0	255
Igray	<400x400 uint8>	4	149
Iindexed	<400x400 uint8>	0	2
Iinfo	<1x1 struct>		
ans	[-1414,-9124,-8353...	-9124	-1414
map	[0.0196,0.0745,0;0...	0	0.3725
n	3	3	3

Image Enhancement

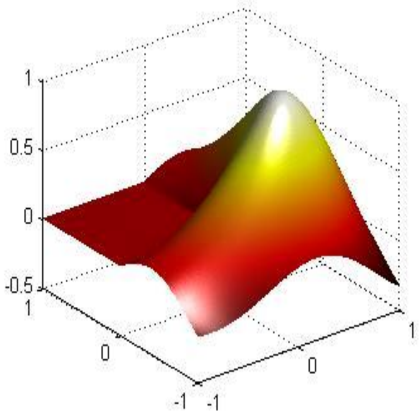
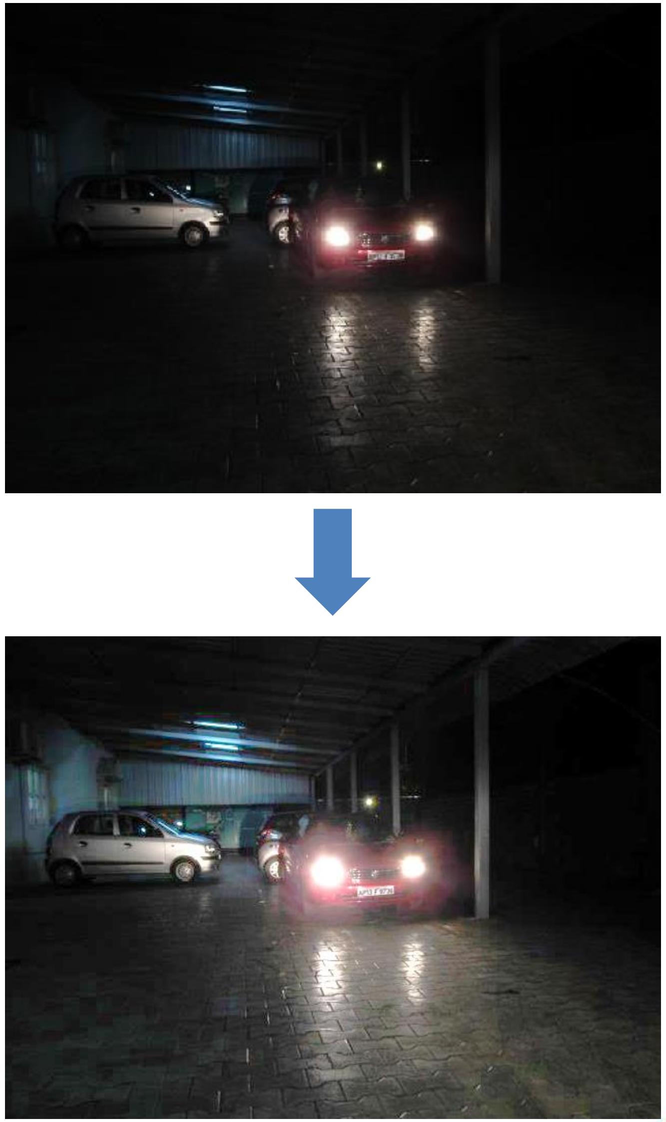
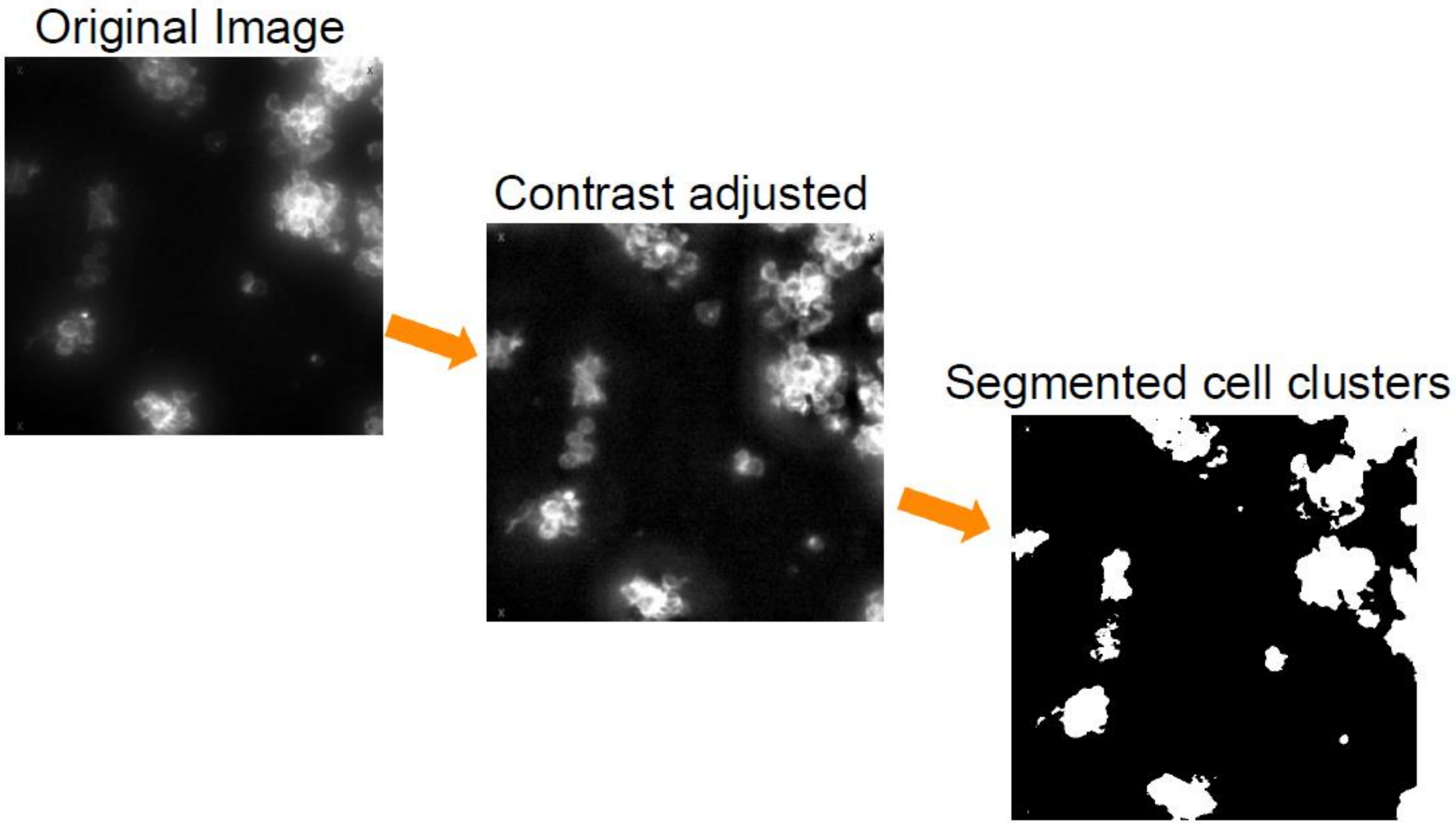


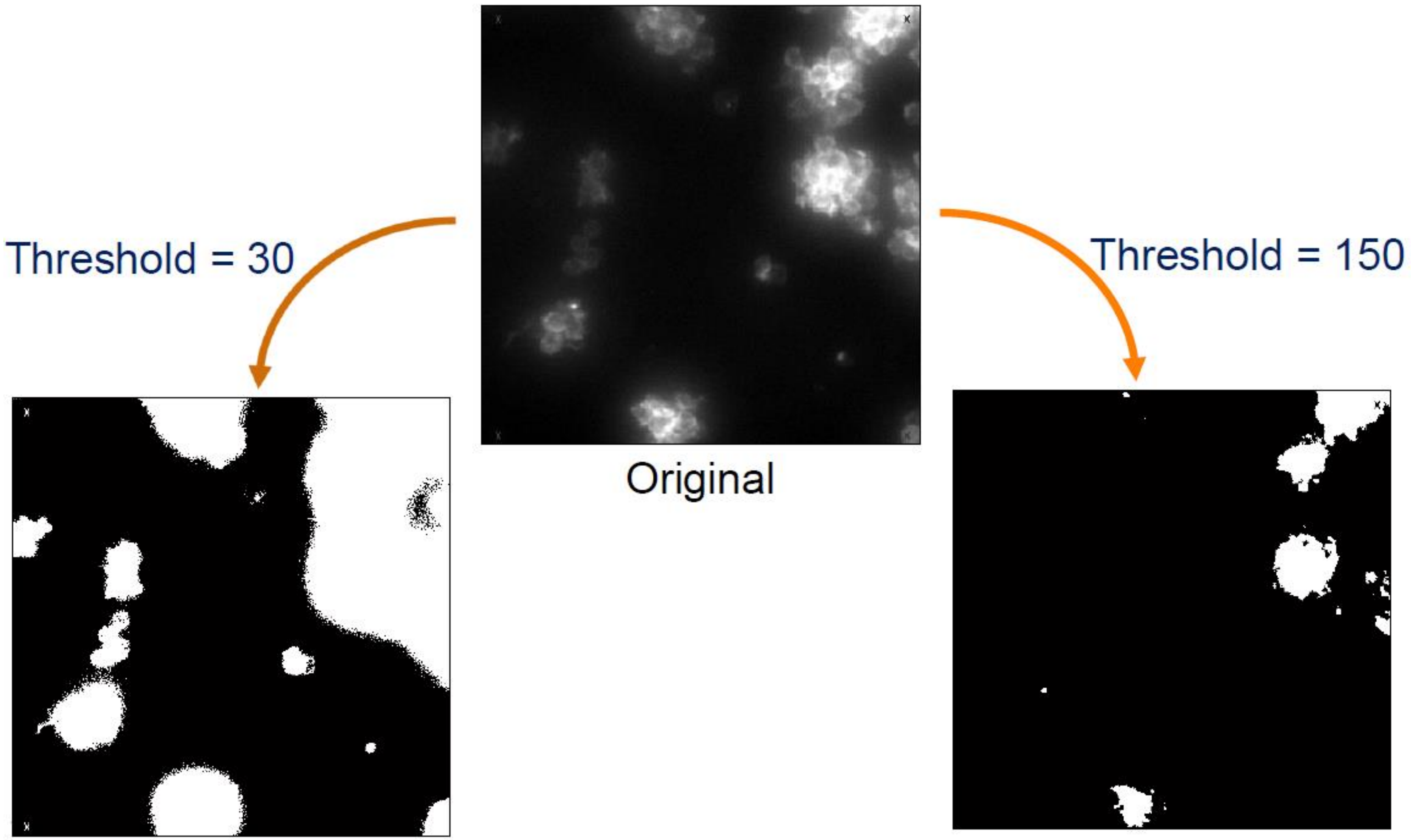
Image Enhancement



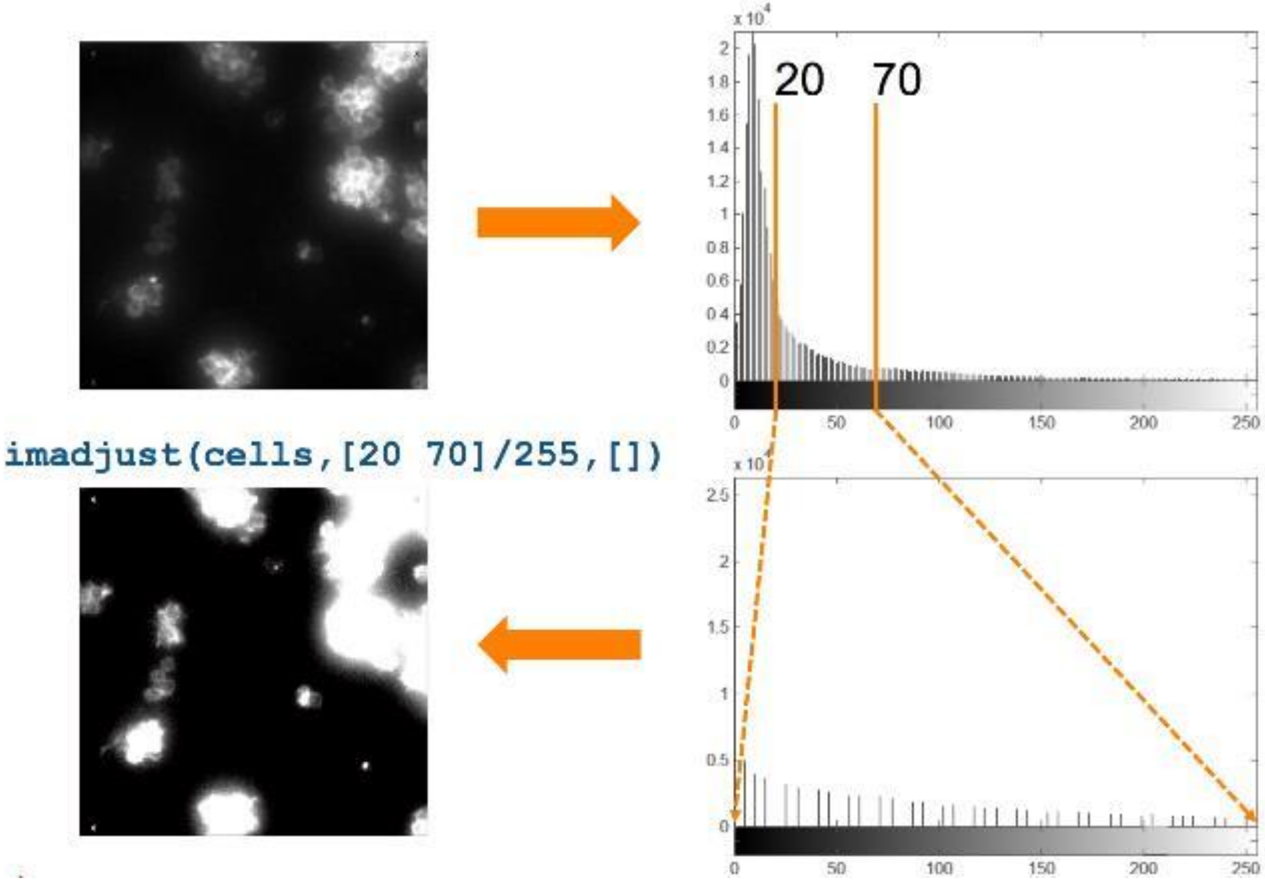
Course Example: Segmenting Cell Clusters



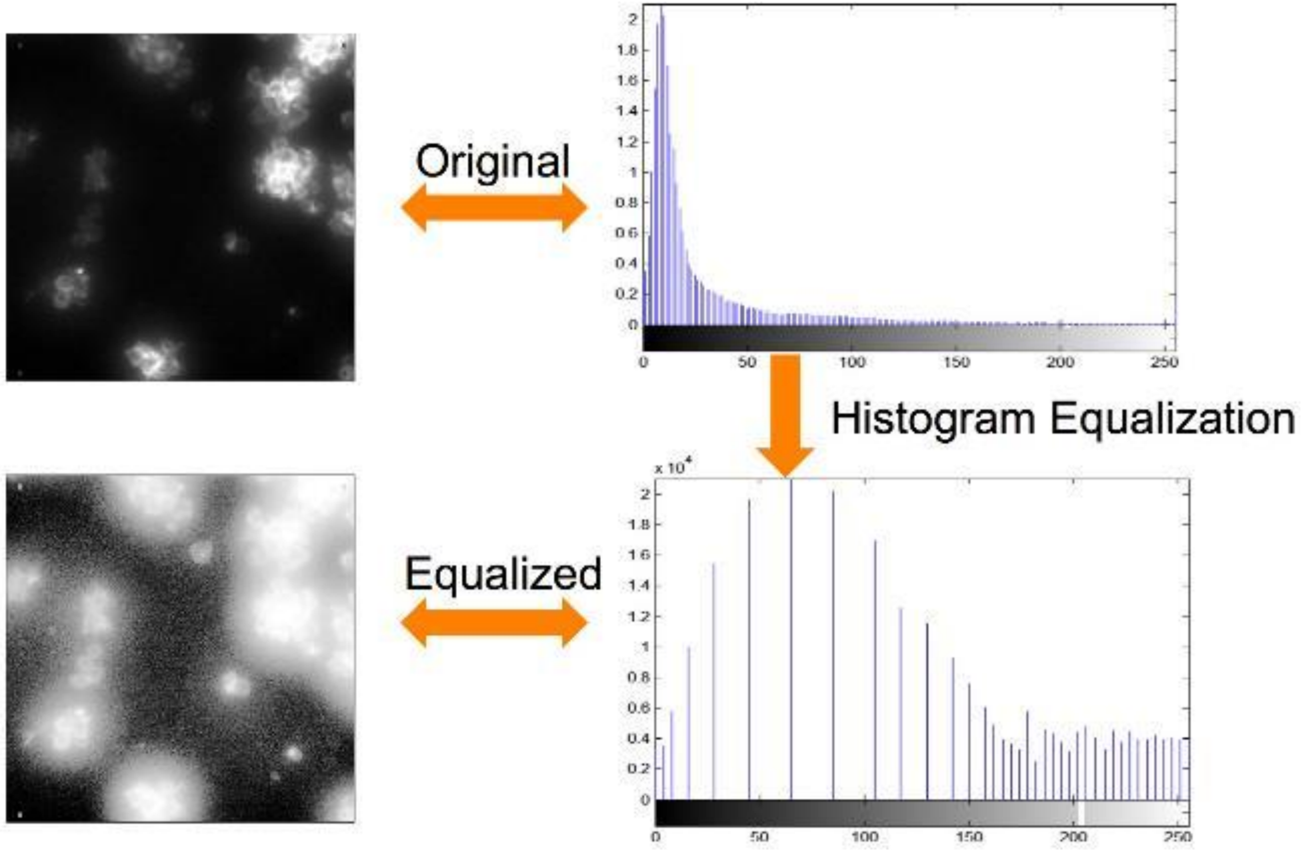
The Problem with Poor Contrast



Histogram Adjustment

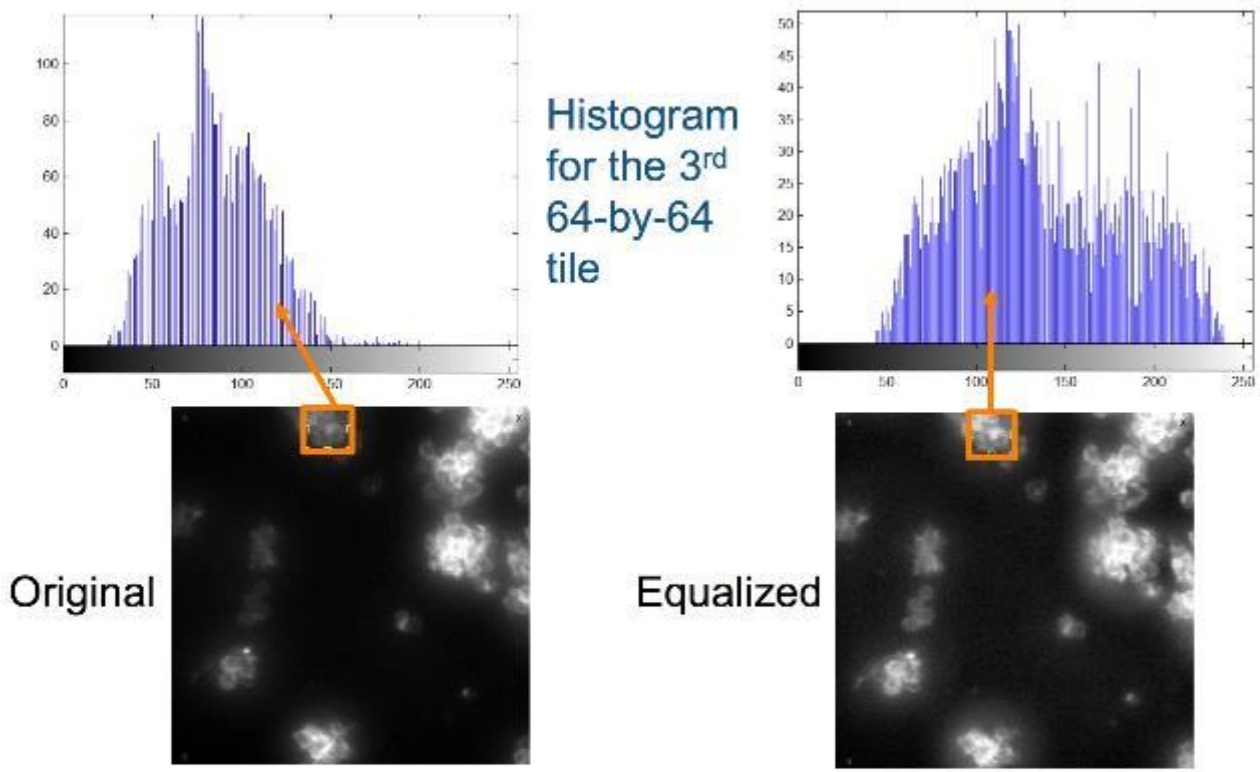


Histogram Equalization



Adaptive Histogram Equalization

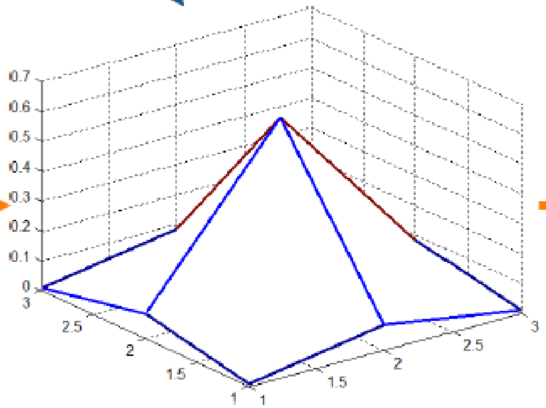
- Suitable for improving the local contrast



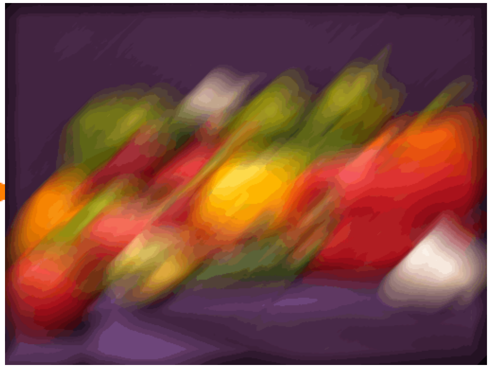
Linear Filtering

Create spatial filter (`fspecial`) → **Filter the image (`imfilter`)**

Input image



Filter kernel



Output image

Computing Linear Filter Output

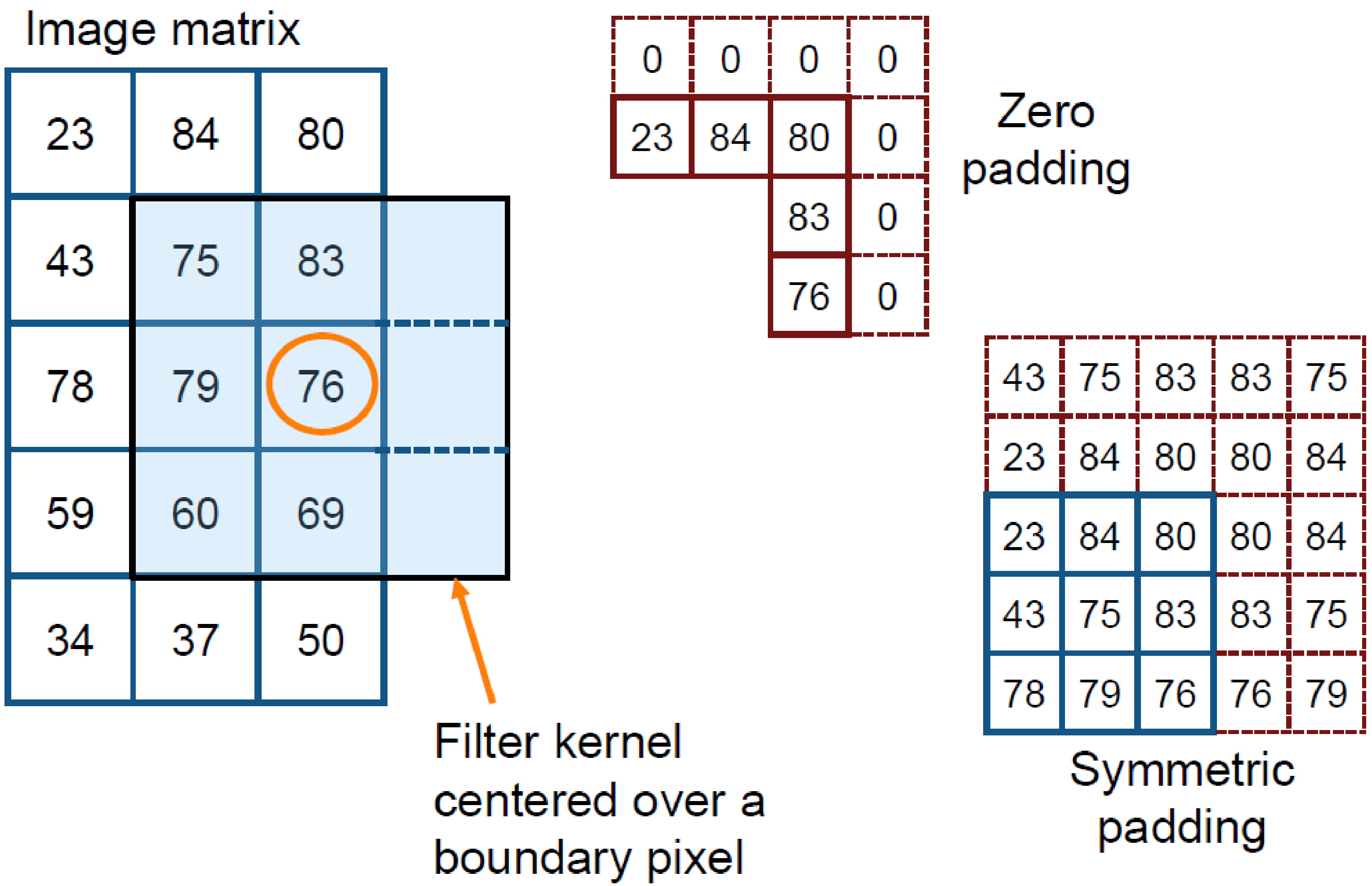
$$1\times8+8\times1+15\times6+7\times3+14\times5+16\times7+19\times4+20\times9+22\times2=609$$

Filter kernel

$$\begin{bmatrix} 8 & 1 & 6 \\ 3 & 5 & 7 \\ 4 & 9 & 2 \end{bmatrix}$$

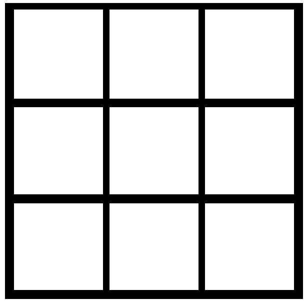
17	24	1*8	8*1	15*6
23	5	7*3	14*5	16*7
4	6	19*4	20*9	22*2
10	12	19	21	3
11	18	25	2	9

Linear Filtering at Image Boundary



Nonlinear Filtering

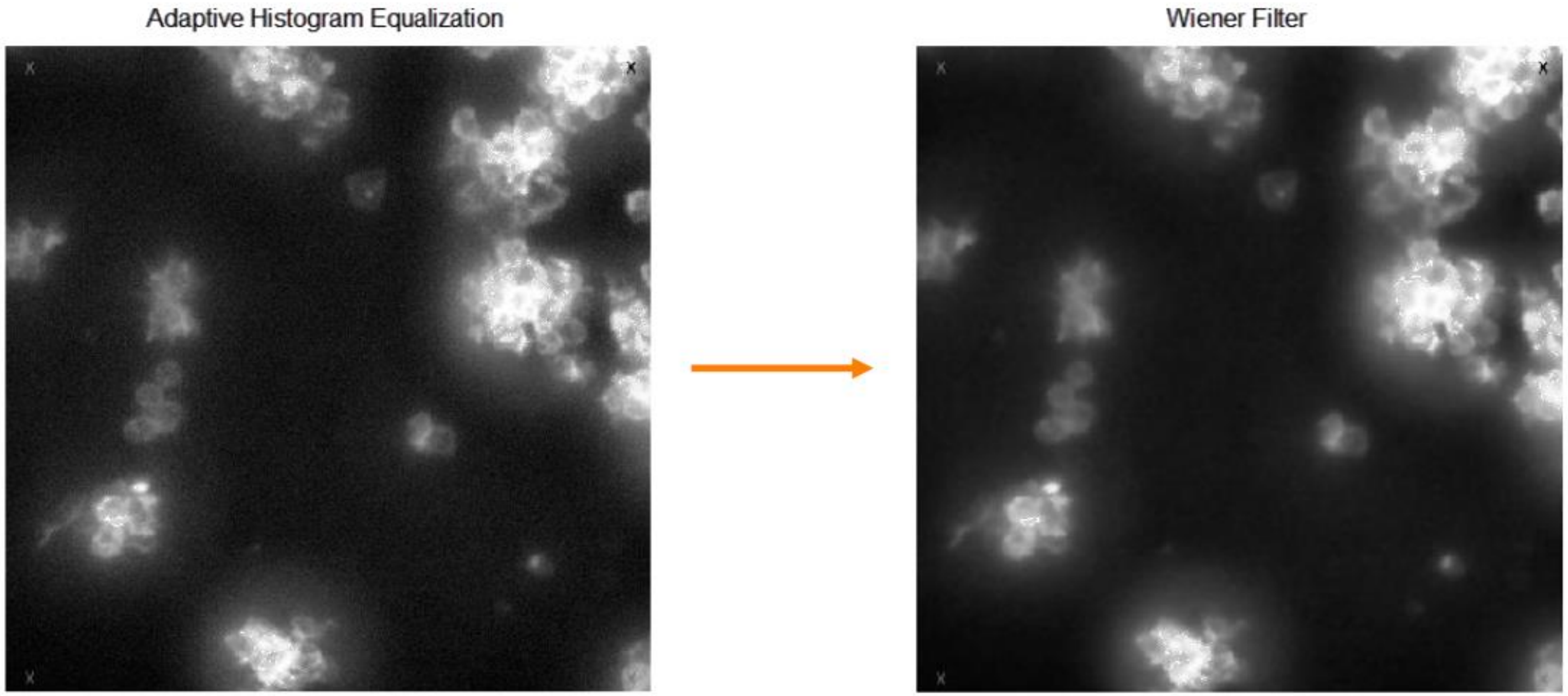
Assign median value: 1,7,8,14,15,16,19,20,22



neighborhood

17	24	1	8	15
23	5	7	14	16
4	6	19	20	22
10	12	19	21	3
11	18	25	2	9

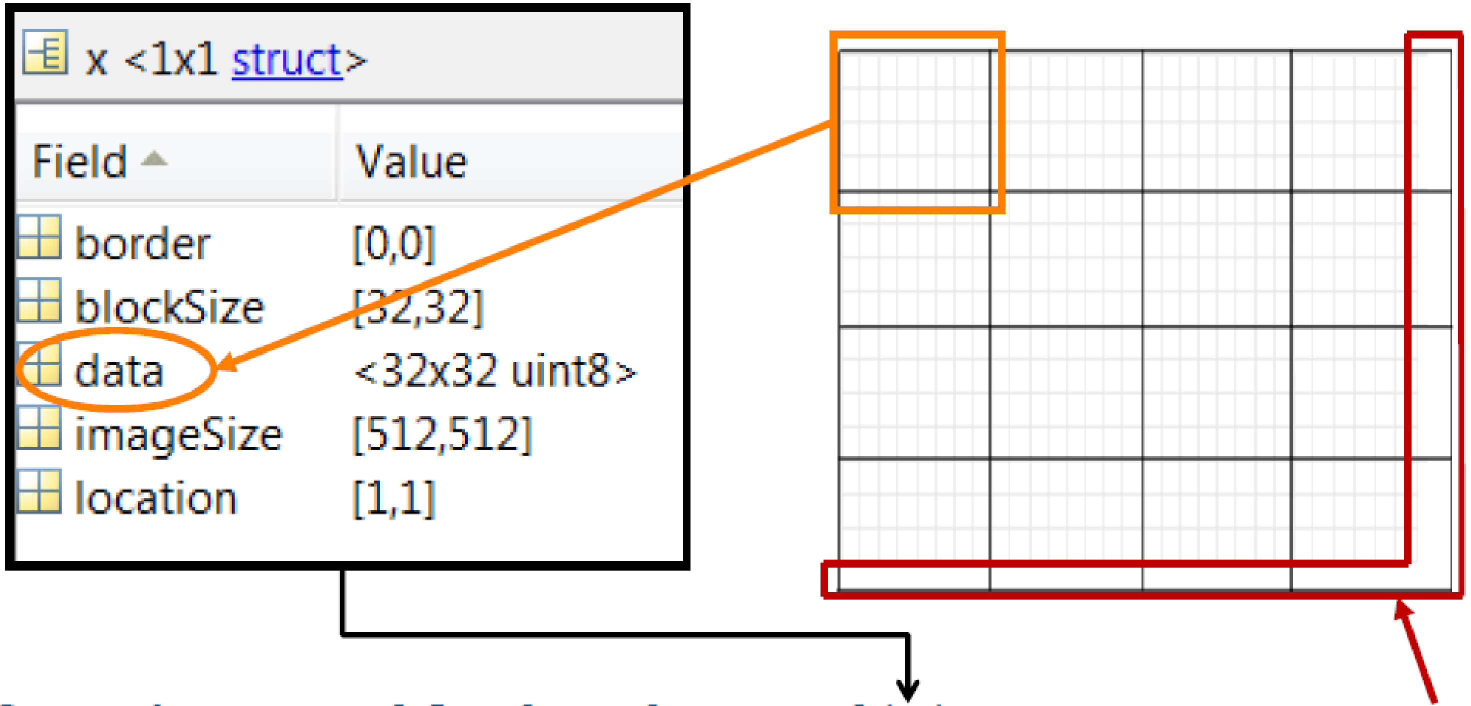
Adaptive Filtering




```
>> wiener2(cellAdaptHist,[5 5]);
```

Handling Inhomogeneous Background by Block Processing

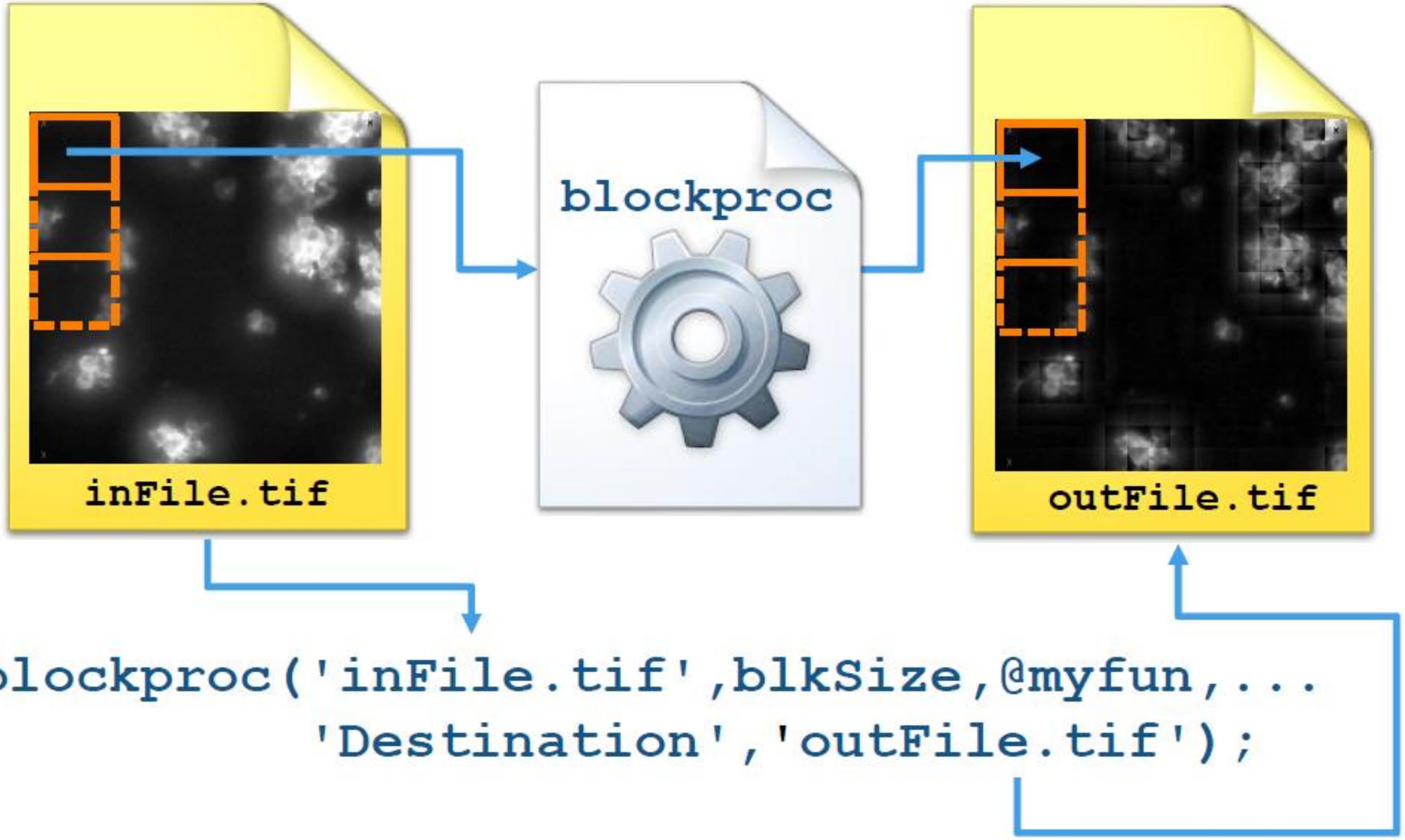
```
B = blockproc(A, [m n], @blockBackground)
```




```
function y = blockBackground(x)
block = x.data;
  .
  .
```

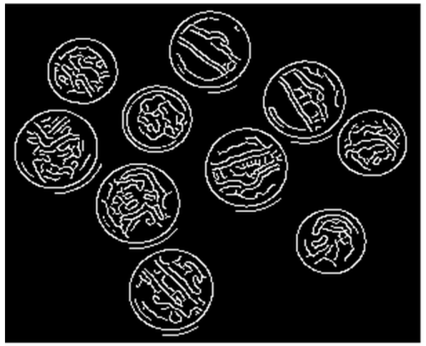
Padding as selected

Block Processing of Large Images

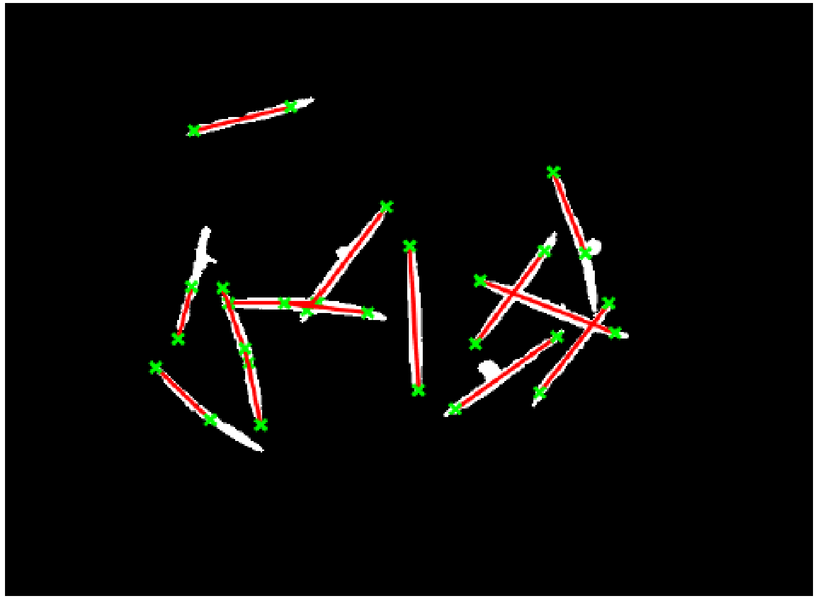


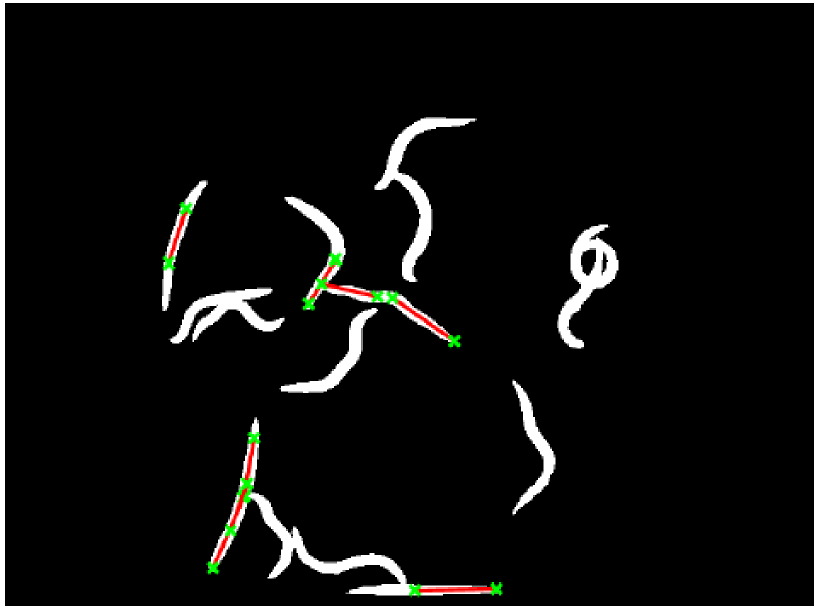

```
blockproc('inFile.tif',blkSize,@myfun,...
              'Destination','outFile.tif');
```

Edge and Line Detection



Course Example: Identifying Dead Worms



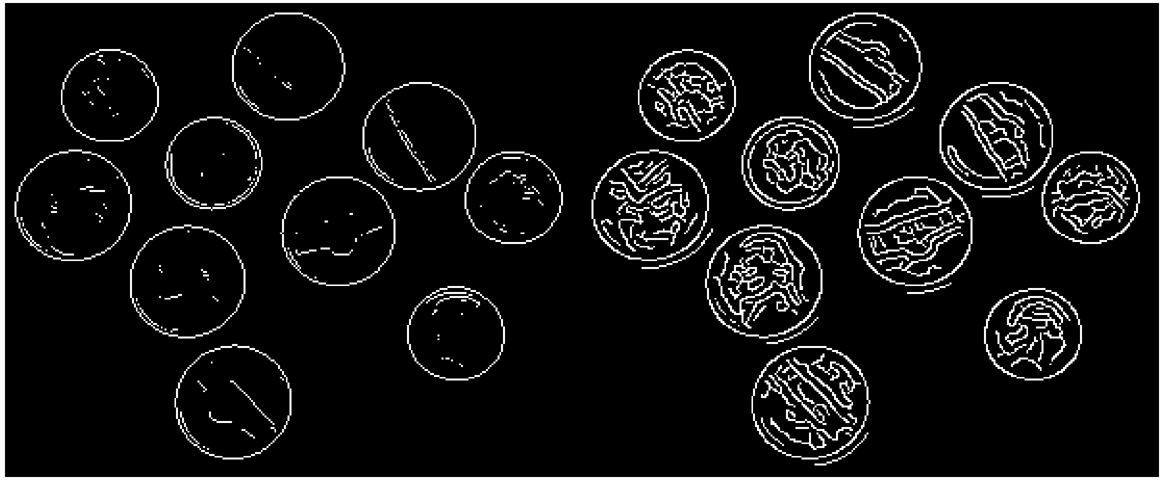


Edge Detection

- Edges are often associated with the boundaries of objects in a scene.
- Applicable Method: Sobel, Prewitt, LoG, Canny, …

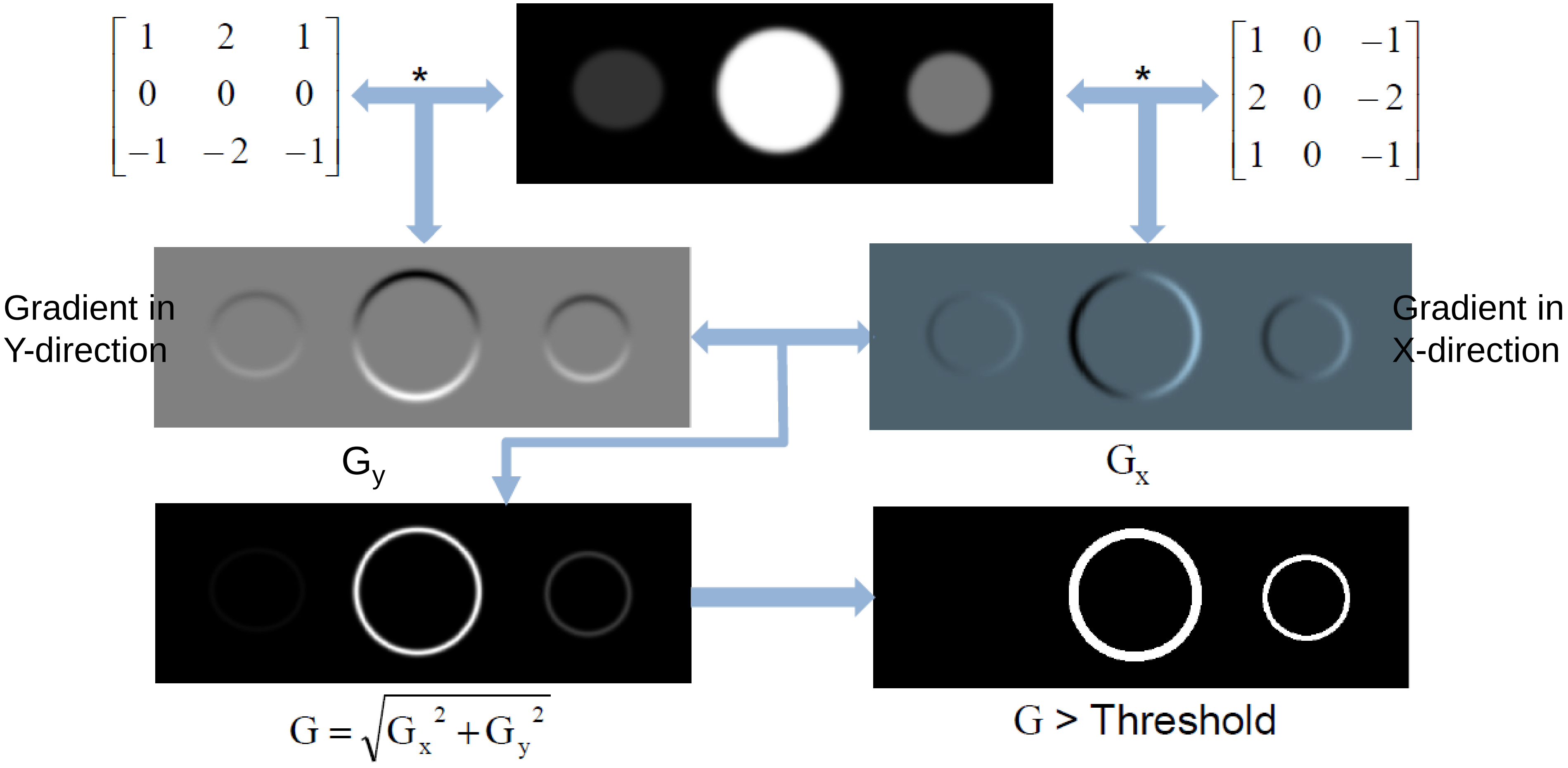
Sobel Filter

Canny Filter

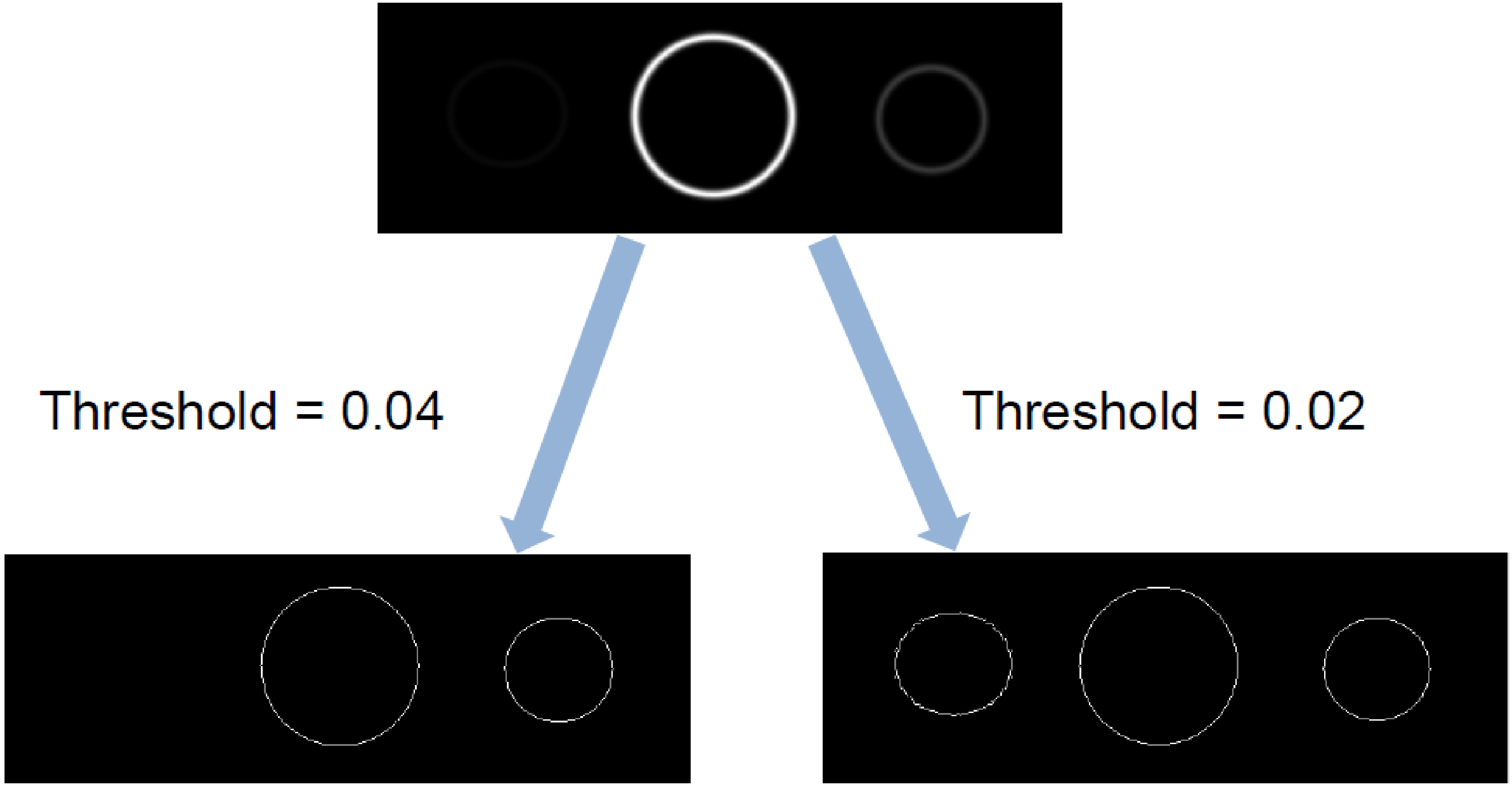


```
>> BW = edge(I, 'sobel');
```

Edge Detection with the Sobel Method

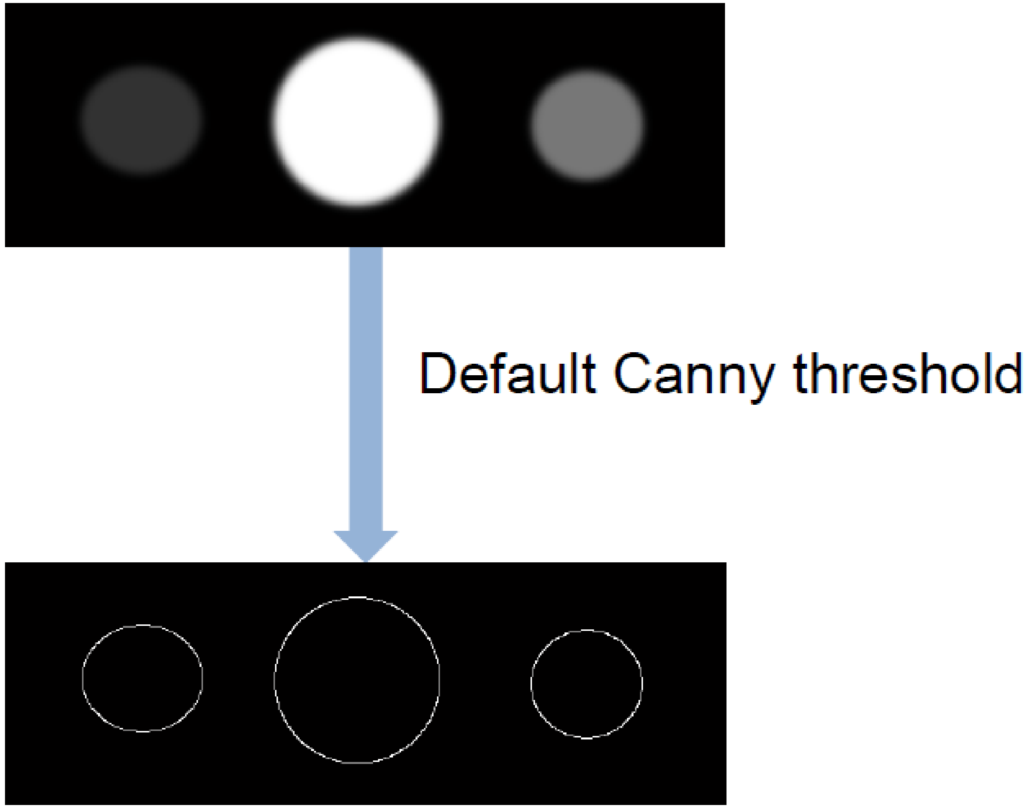


Choosing the Right Threshold

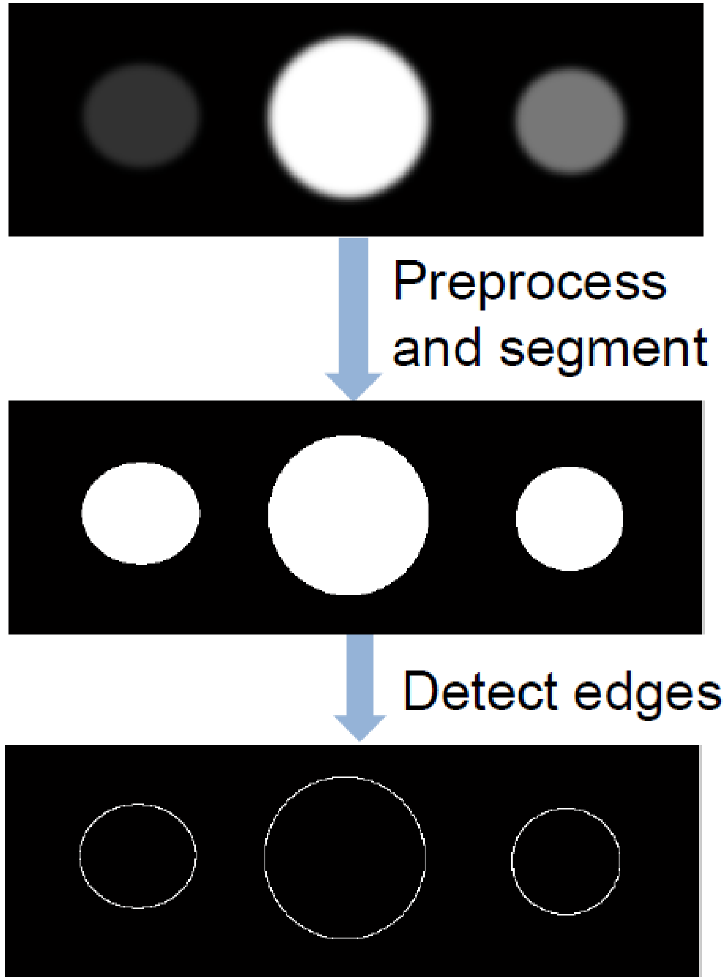


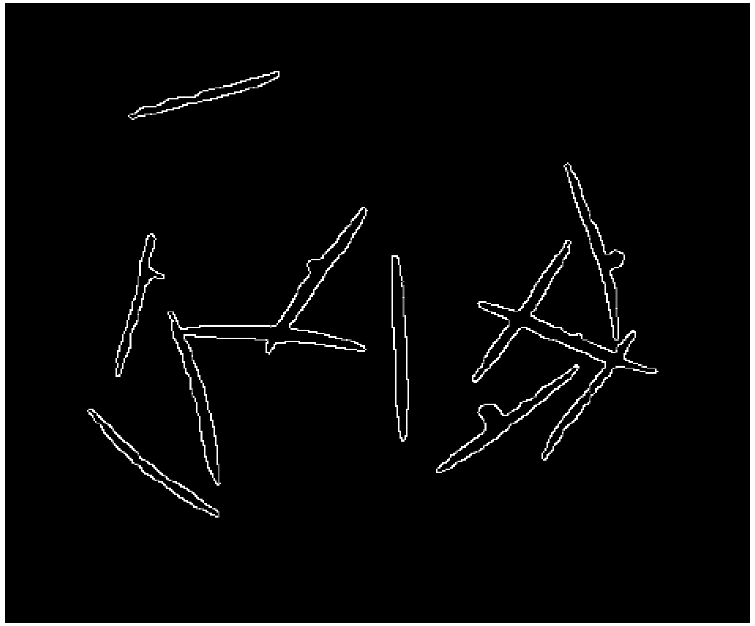
Edge Detection with the Canny Method

- Canny is better at detecting weaker edges.



Edge Detection on Binary Images





Tracing Object Boundaries

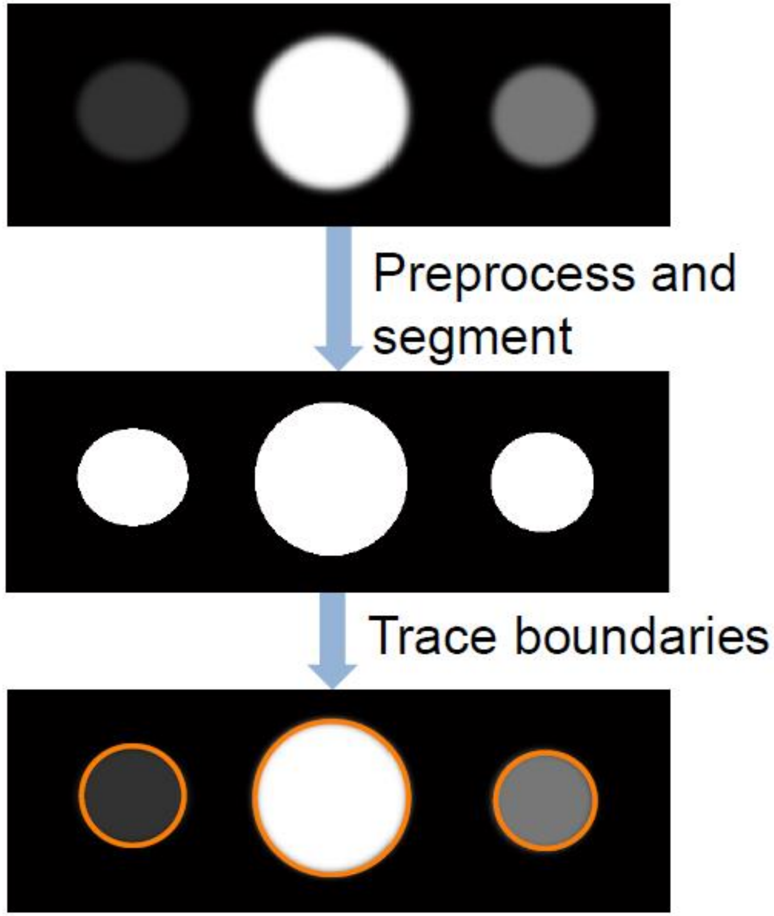
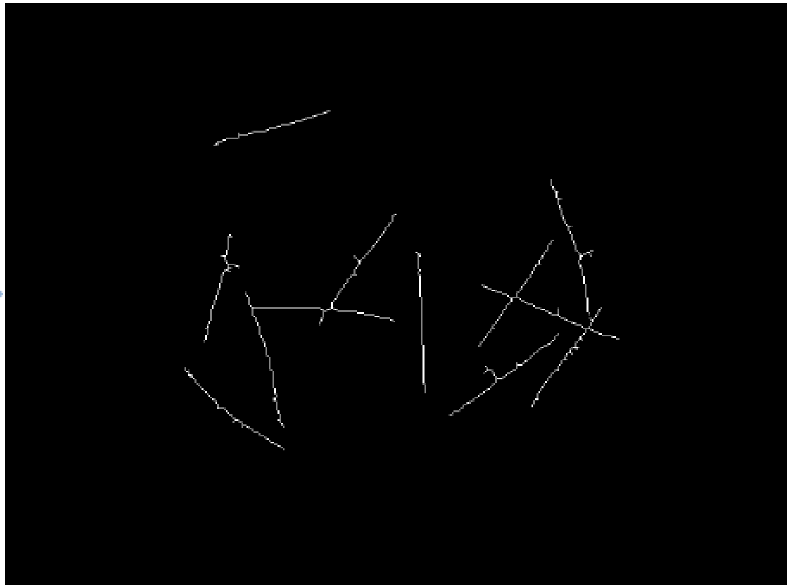
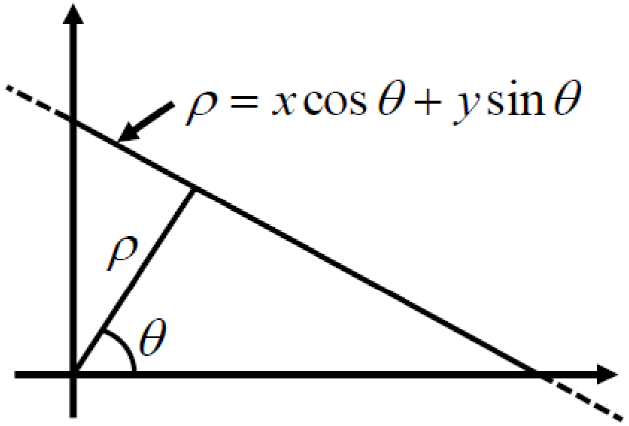


Image Skeletonization



Standard Hough Transform



$$(x, y) \Leftrightarrow (\theta, \rho)$$

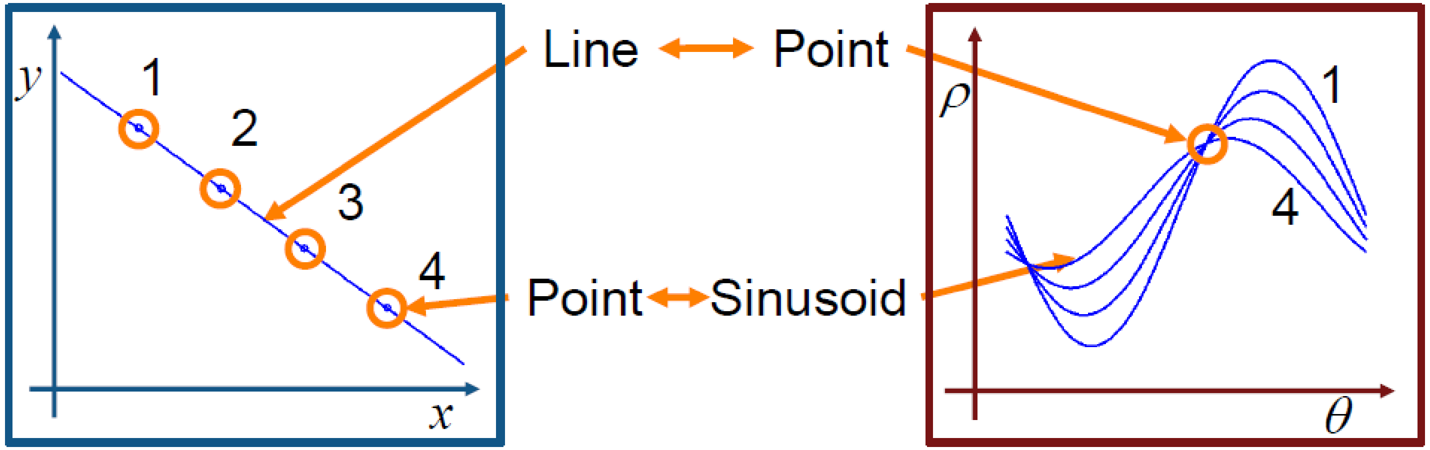


Image plane Parameter plane

Extracting Line Segments Using Hough Transform

Create Hough transform matrix (`hough`)

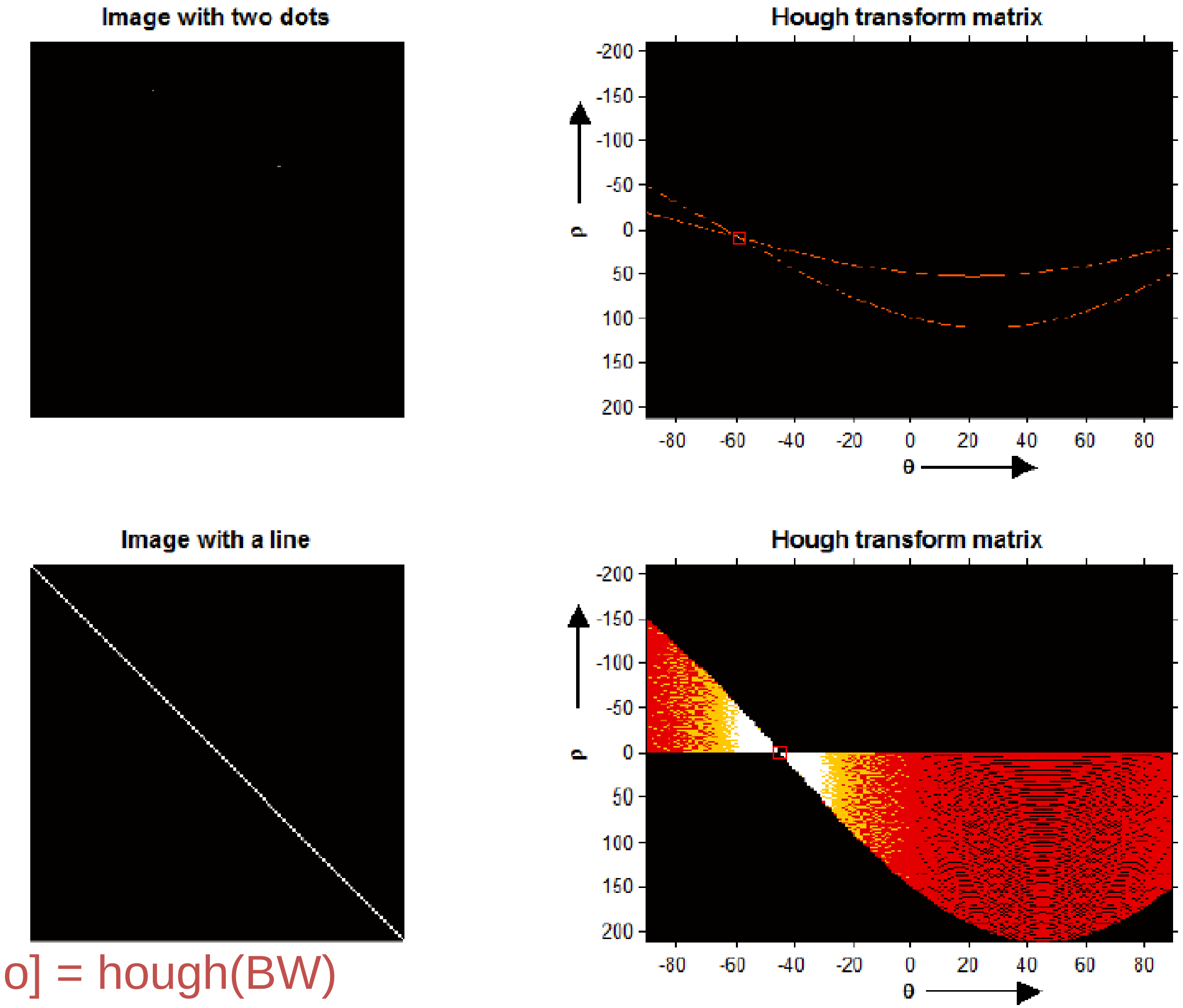
↓

Locate peaks in the Hough transform matrix (`houghpeaks`)

↓

Extract line segments corresponding to peaks in the Hough transform matrix (`houghlines`)

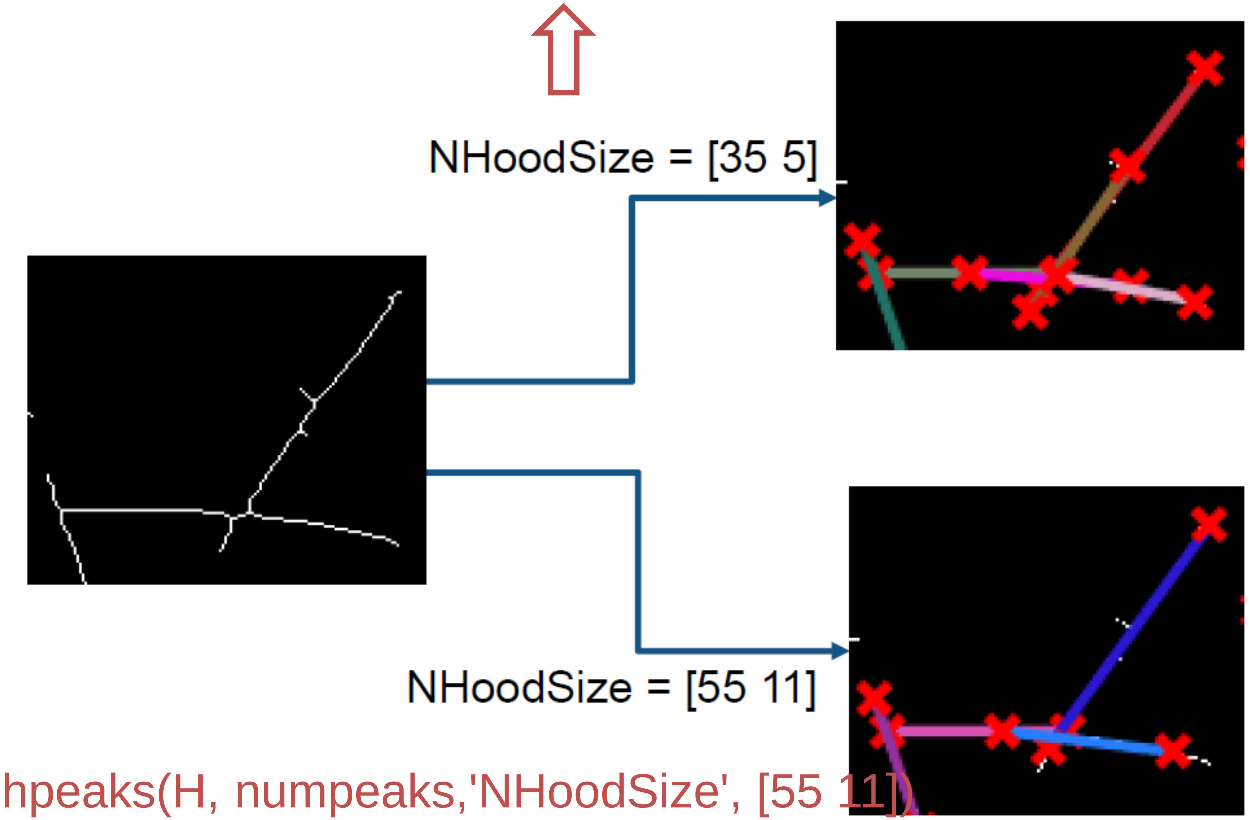
Creating the Hough Transform Matrix



>> [H, theta, rho] = hough(BW)

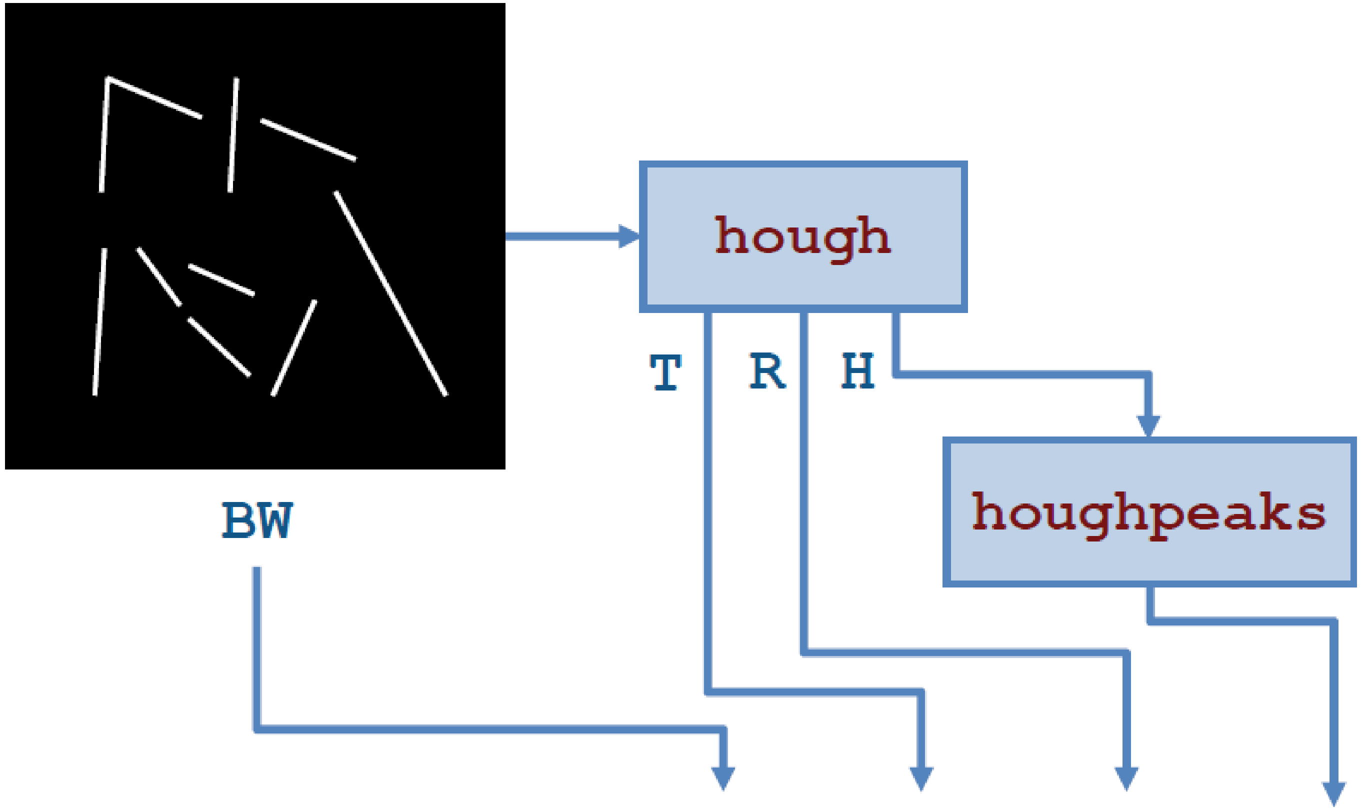
Locating Peaks in the Hough Transform Matrix

Size of suppression neighborhood:
neighborhood around each peak that is set to zero after the peak is identified.




```
>> peaks = houghpeaks(H, numpeaks,'NHoodSize', [55 11])
```

Extracting Line Segments




```
lines = houghlines(BW, theta, rho, peaks)
```

Classifying Worms Images

These worms are dead

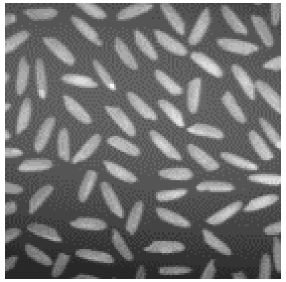
median length = 69.34

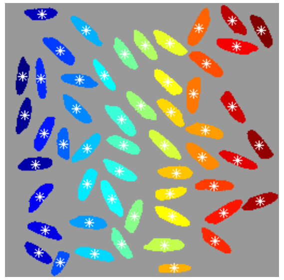
These worms are alive

median length = 46.57

median length > 58 → dead

Segmentation & Feature Extraction

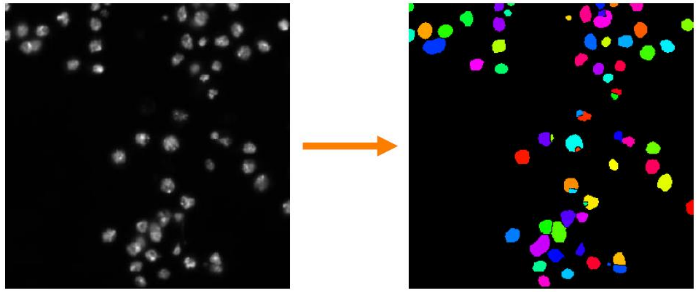




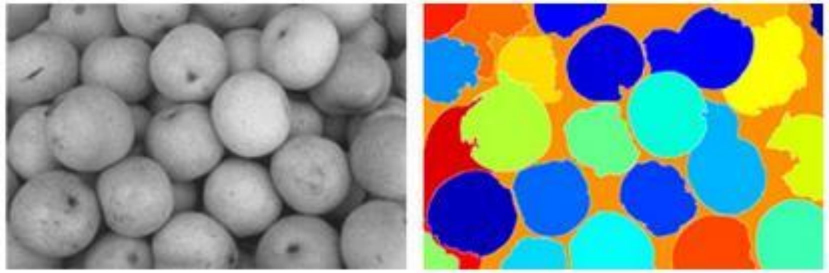
Segmentation

– Divide image into objects and background

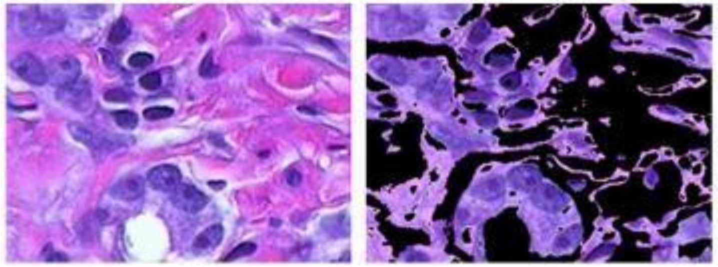
- Thresholding method



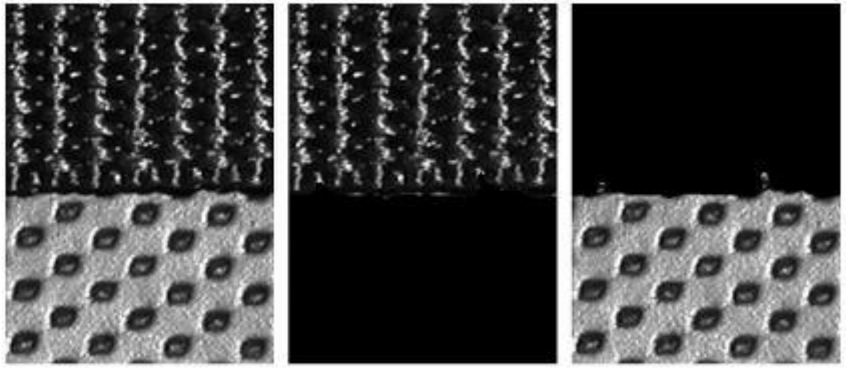
- Transform methods



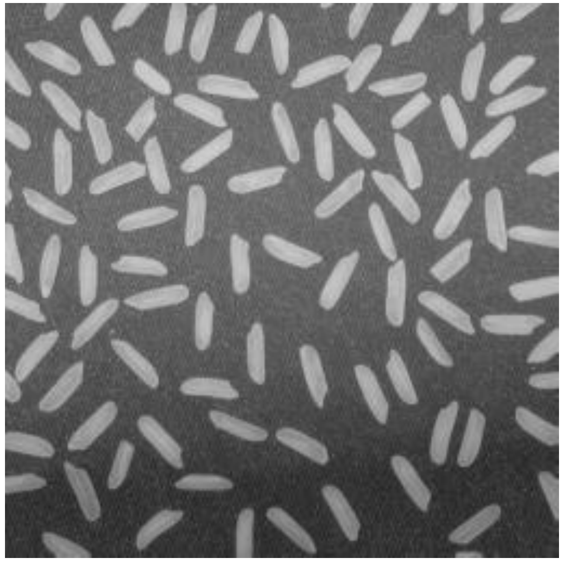
- Color-based method

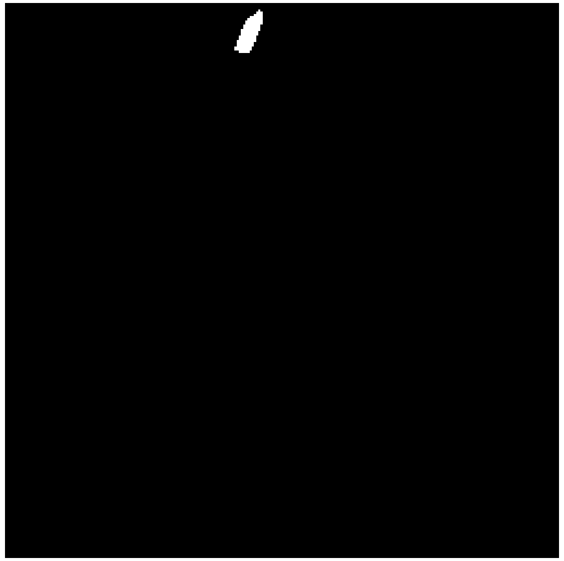


- Texture methods

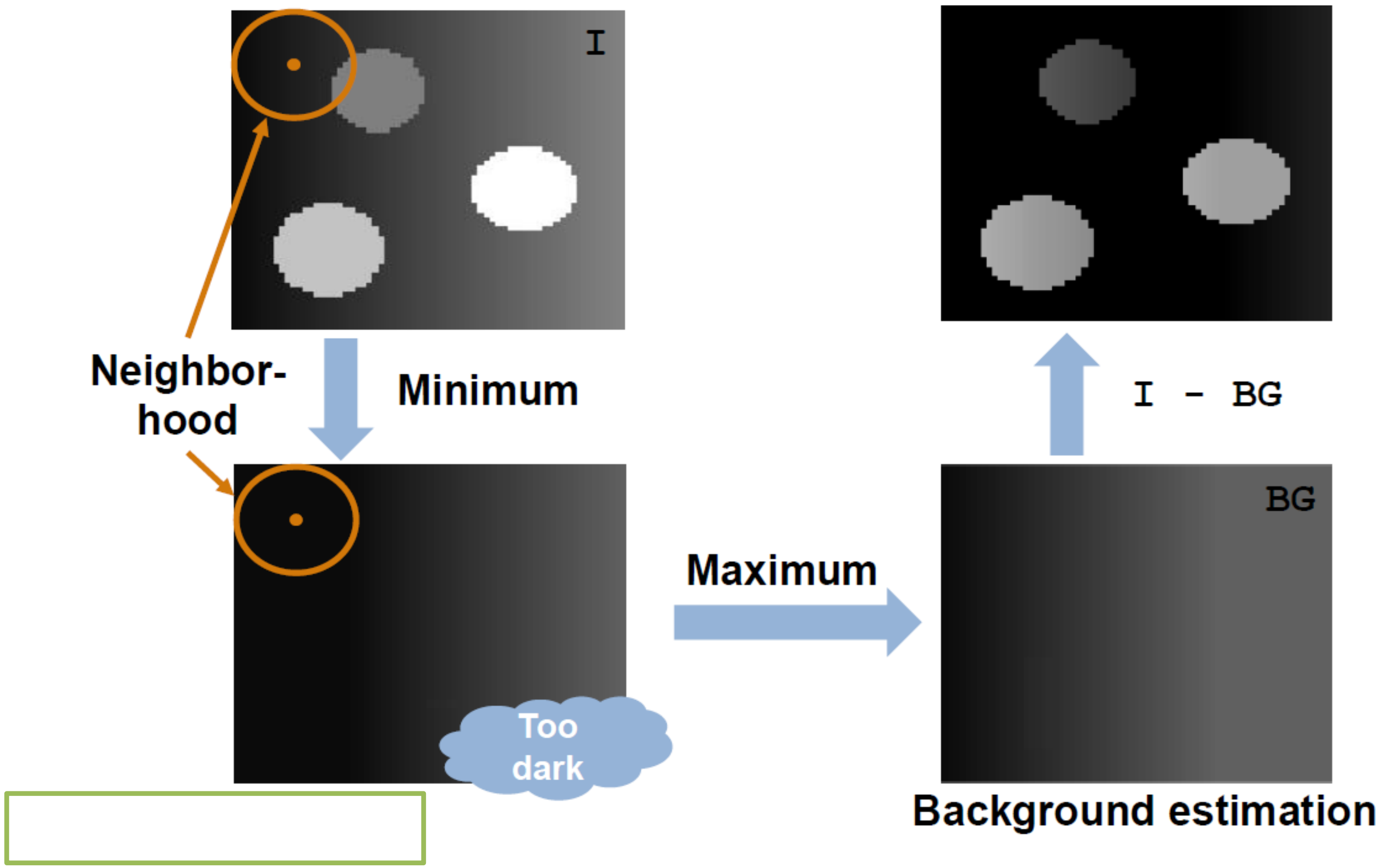


Course Example: Find the Smallest Complete Grain





Handling Inhomogeneous Background



Applying Morphological Operators

Assign minimum value `imerode`: 7, 8, 14, 16, 20

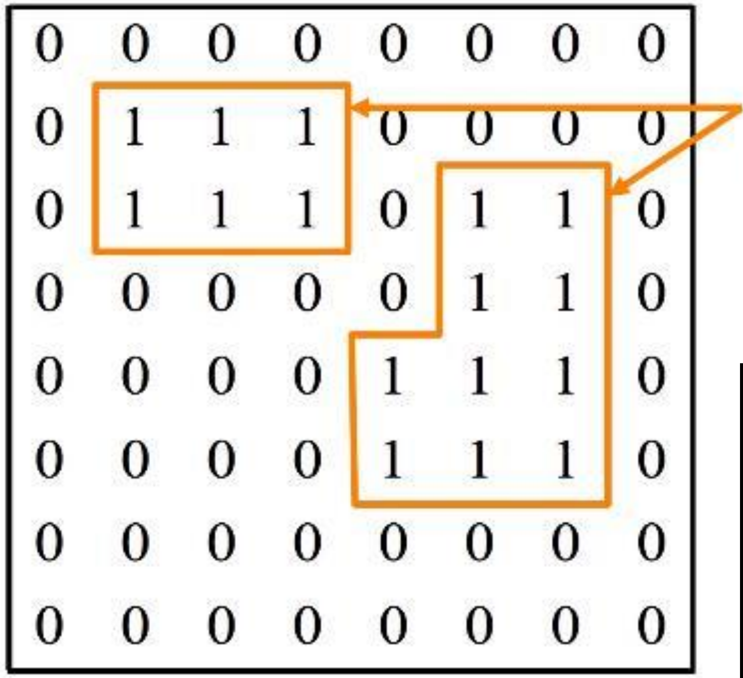
Assign maximum value `imdilate`: 7, 8, 14, 16, 20

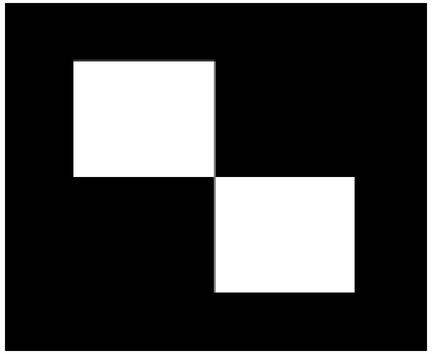
0	1	0
1	1	1
0	1	0

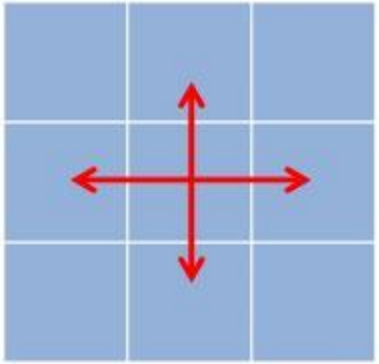
Structuring element
`strel`

17	24	1	8	15
23	5	7	14	16
4	6	19	20	22
10	12	19	21	3
11	18	25	2	9

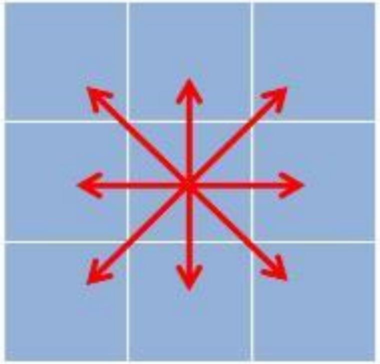
Finding Objects in a Binary Image







4 connected



8 connected

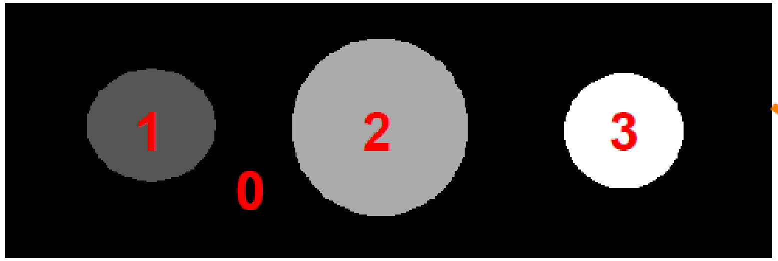
```
>> CC = bwconncomp(BW, conn)
```

Visualizing Connected Components

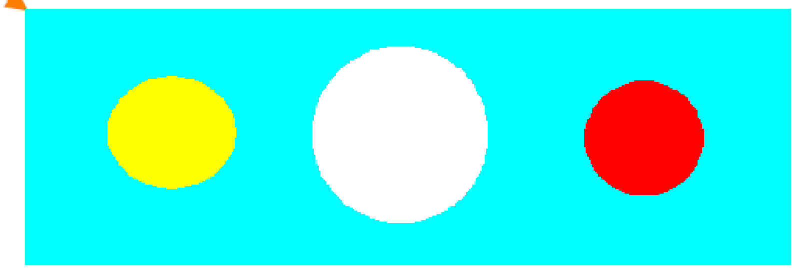
1x1 struct with 4 fields

Field	Value	Min	Max
Connectivity	8	8	8
ImageSize	[200 600]	200	600
NumObjects	3	3	3
PixelIdxList	*1x3 cell*		

`labelmatrix`

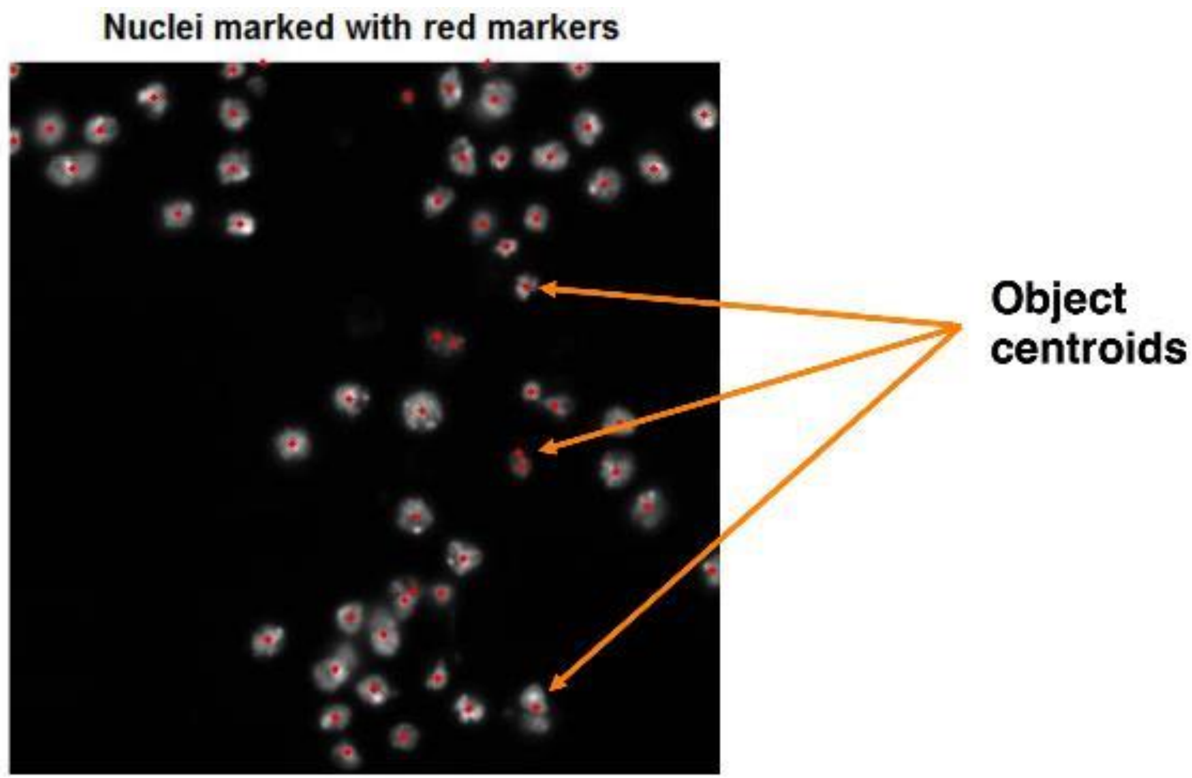


`label2rgb`



Measuring Shape Properties

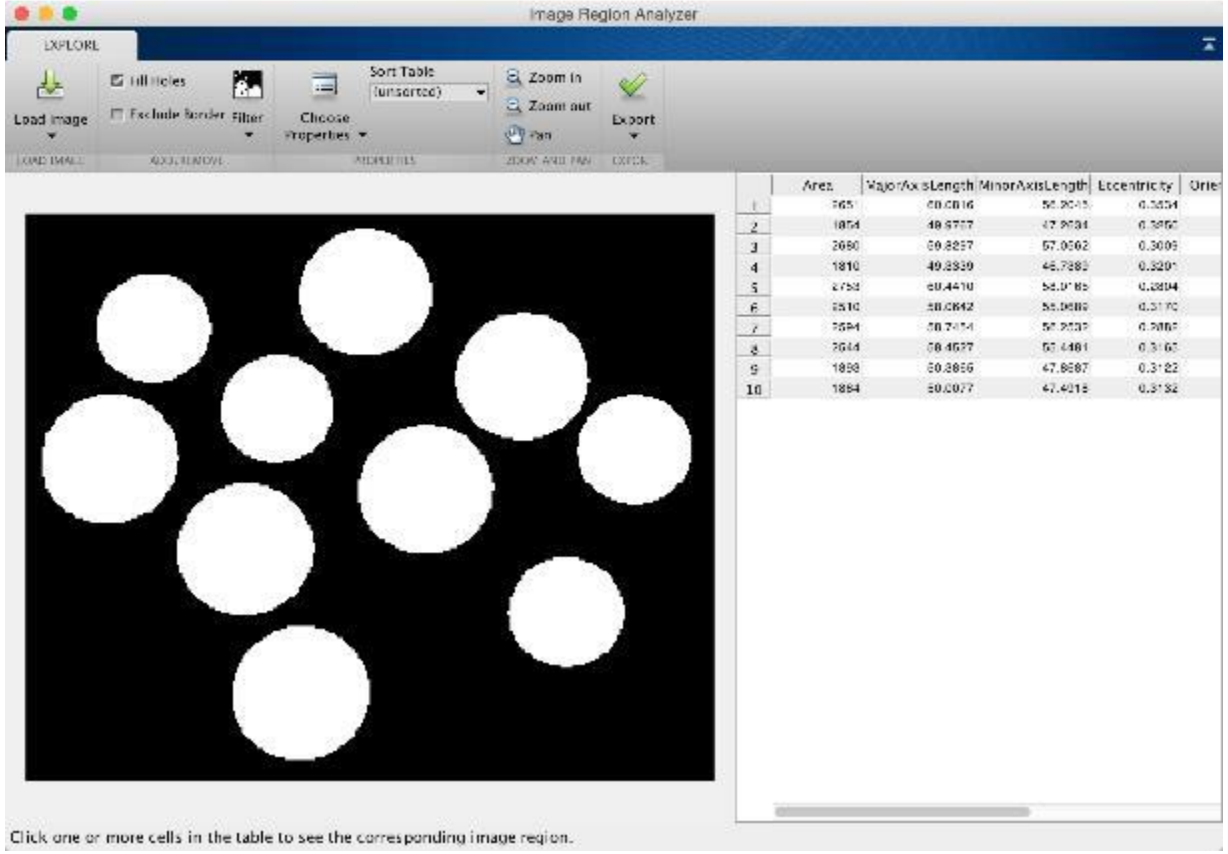
- Area, Centroid, Bounding box,…



>> STATS = regionprops(A, properties)

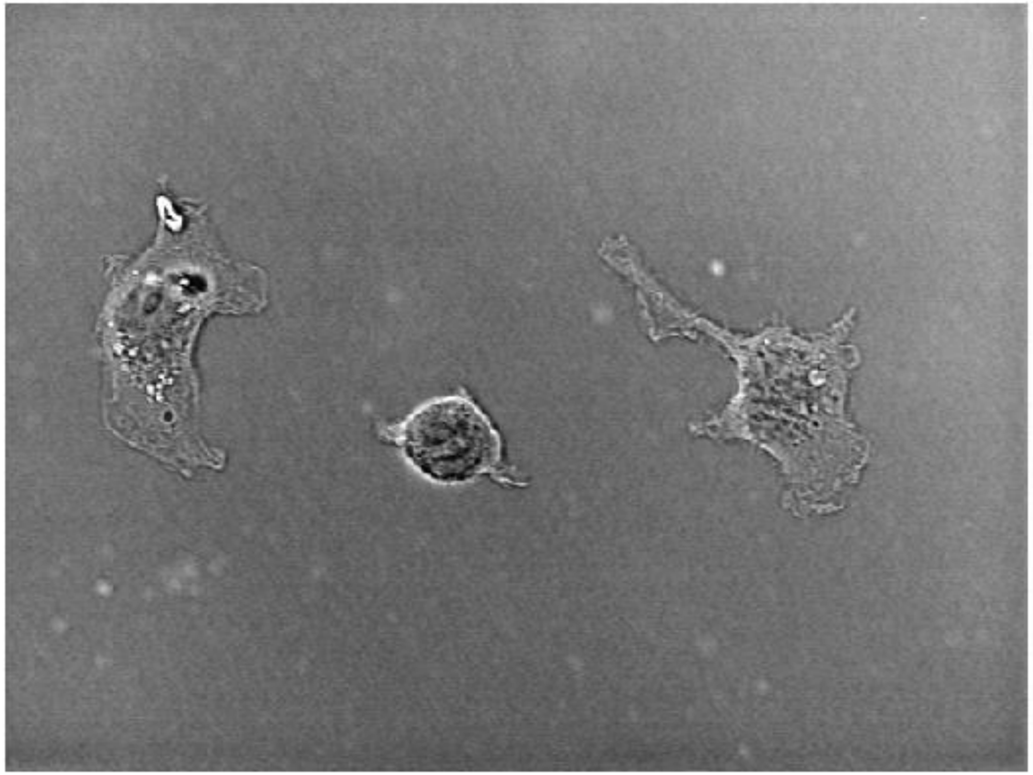
Image Region Analyzer APP

- App for analyzing the properties of each foreground object
- Only consider measurable properties, such as Area, Axis length, etc.



Texture Segmentation

- Textures described using subjective terms like **smooth, rough or silky** could be described by the spatial variation in pixel intensities in the image.



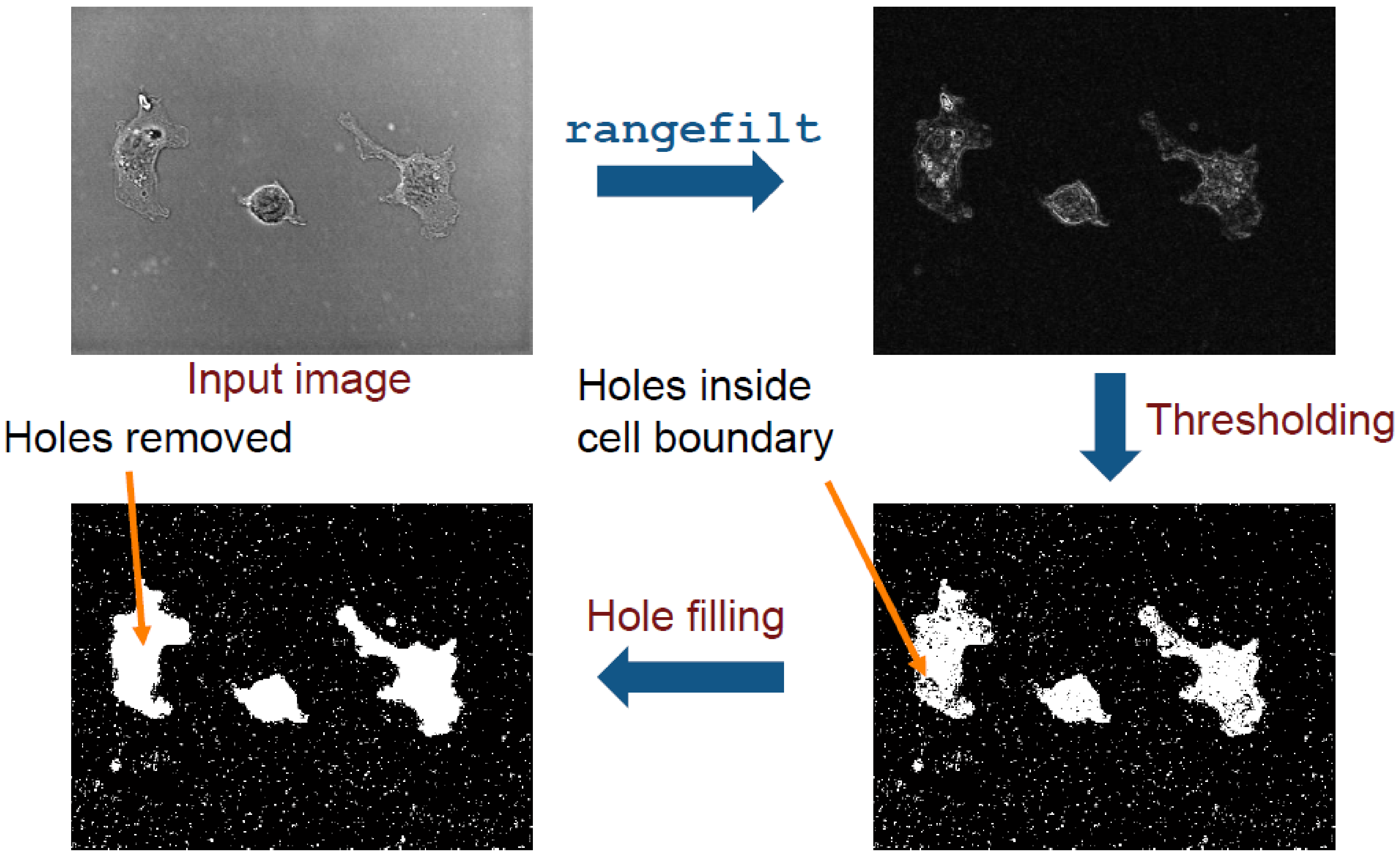
Using Range and Standard Deviation

$$\begin{bmatrix} 17 & 24 & 1 & 8 & 15 \\ 23 & 5 & 7 & 14 & 16 \\ 4 & 6 & 13 & 20 & 22 \\ 10 & 12 & 19 & 21 & 3 \\ 11 & 18 & 25 & 2 & 9 \end{bmatrix} \rightarrow \begin{bmatrix} 19 & 23 & 23 & 15 & 8 \\ 20 & 23 & 23 & 21 & 14 \\ 19 & 19 & 16 & 19 & 19 \\ 14 & 21 & 23 & 23 & 20 \\ 8 & 15 & 23 & 23 & 19 \end{bmatrix}$$

A B

`B = rangefilt(A)`

Thresholding and Filling Image Regions



Removing Smaller Objects