

Morphological operations

Image Processing & Analysis for Life Scientists

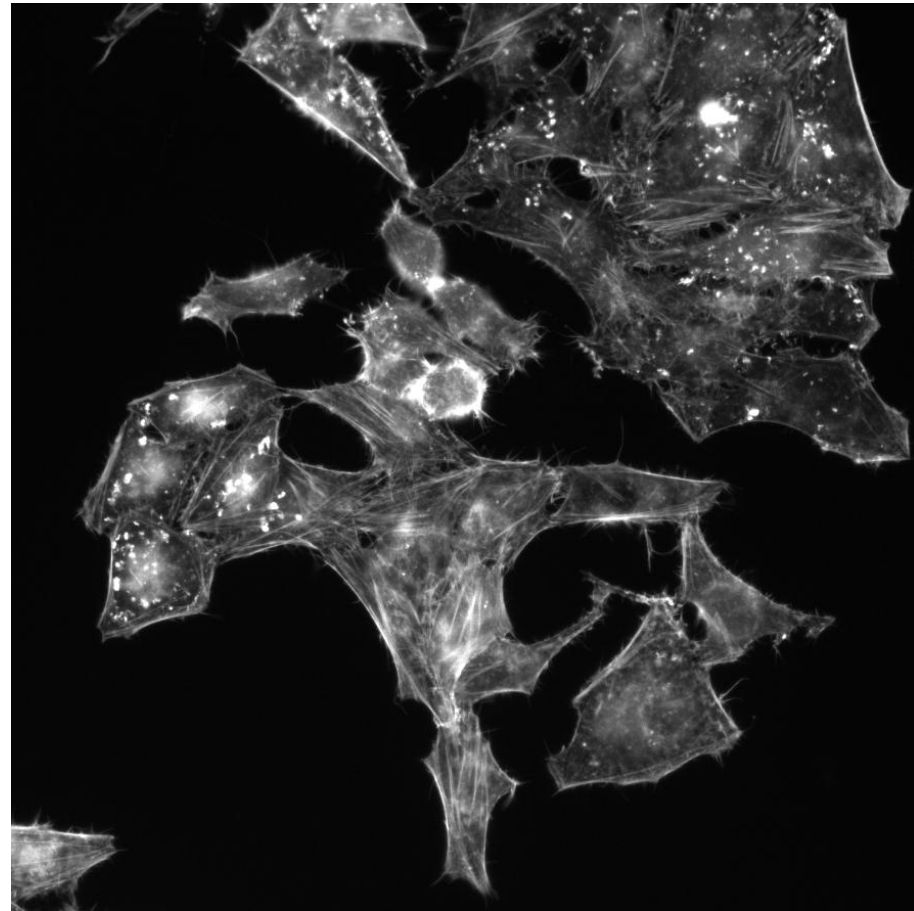
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- Morphological Operations
- Usage in Image Analysis

Motivation

Thresholding

Morphological
operations



Input image



Binary image



Binary image

- Morphological Operations
- Usage in Image Analysis

Morphological Filter

	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0

Input

1	1	1
1	1	1
1	1	1

Filter

Output

Morphological Filter

	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0

Input

1	1	1
1	1	1
1	1	1

Filter

0						

Output

Morphological Filter

0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
1	1	1	1	1	1	1
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

Input

1	1	1
1	1	1
1	1	1

Filter

0	0	0	0	0	0	0

Output

Morphological Filter

	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Input

1	1	1
1	1	1
1	1	1

Filter

0	0	0	0	0	0	0
0						

Output

Morphological Filter

0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
1	1	1	1	1	1	1
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

Input

1	1	1
1	1	1
1	1	1

Filter

0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

Output

Morphological Filter

0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
1	1	1	1	1	1	1
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

Input

1	1	1
1	1	1
1	1	1

Filter

0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

Output

Morphological Filter

	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0	0	0	0	0	0	0

Input

1	1	1
1	1	1
1	1	1

Filter

0	0	0	0	0	0	0
0	0	0	0	0	0	0
1	1	0	0	0	0	0
1	1					
1	1					

Output

Morphological Filter

0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
1	1	1	1	1	1	1
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

Input

1	1	1
1	1	1
1	1	1

Filter

0	0	0	0	0	0	0
0	0	0	0	0	0	0
1	1	1	1	1	1	1
1	1	1	1	1	1	1
1	1	1	1	1	1	1

Output

Morphological Filter

0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
1	1	1	1	1	1	1
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

Input

1	1	1
1	1	1
1	1	1

Filter

0	0	0	0	0	0	0
0	0	0	0	0	0	0
1	1	1	1	1	1	1
1	1	1	1	1	1	1
1	1	1	1	1	1	1

Output

Morphological Filter

0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
1	1	1	1	1	1	1
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

Input

1	1	1
1	1	1
1	1	1

Filter

0	0	0	0	0	0	0
0	0	0	0	0	0	0
1	1	1	1	1	1	1
1	1	1	1	1	1	1
1	1	1	1	1	1	1

Output

Morphological Filter

0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
1	1	1	1	1	1	1
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

Input

1	1	1
1	1	1
1	1	1

Filter

0	0	0	0	0	0	0
0	0	0	0	0	0	0
1	1	1	1	1	1	1
1	1	1	1	1	1	1
1	1	1	1	1	1	1
0						

Output

Morphological Filter

0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
1	1	1	1	1	1	1
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

Input

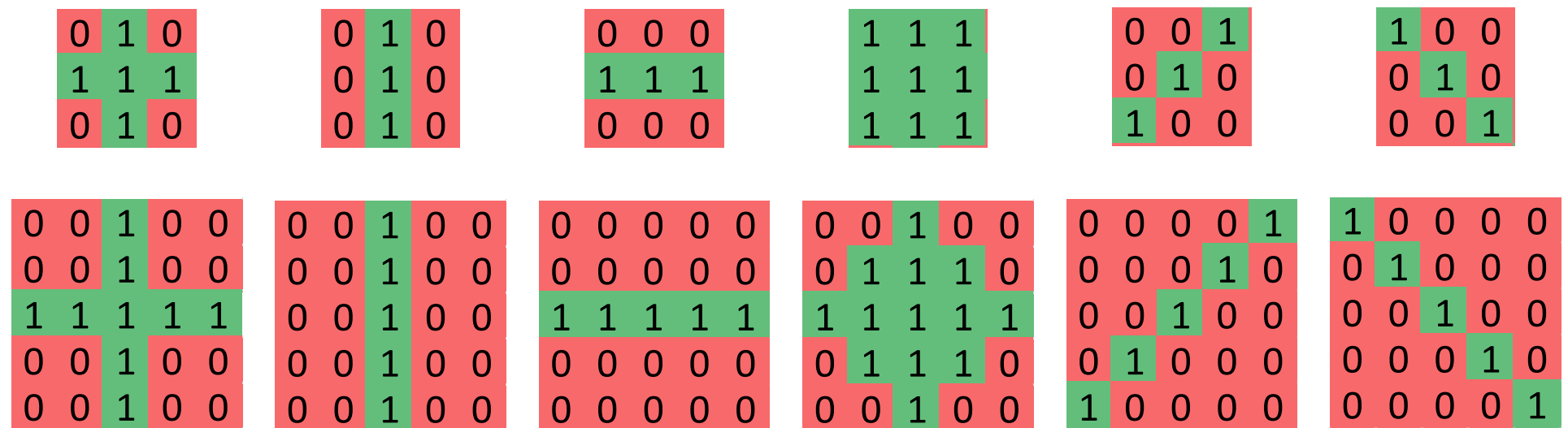
1	1	1
1	1	1
1	1	1

Filter

0	0	0	0	0	0	0
0	0	0	0	0	0	0
1	1	1	1	1	1	1
1	1	1	1	1	1	1
1	1	1	1	1	1	1
0	0	0	0	0	0	0
0	0	0	0	0	0	0

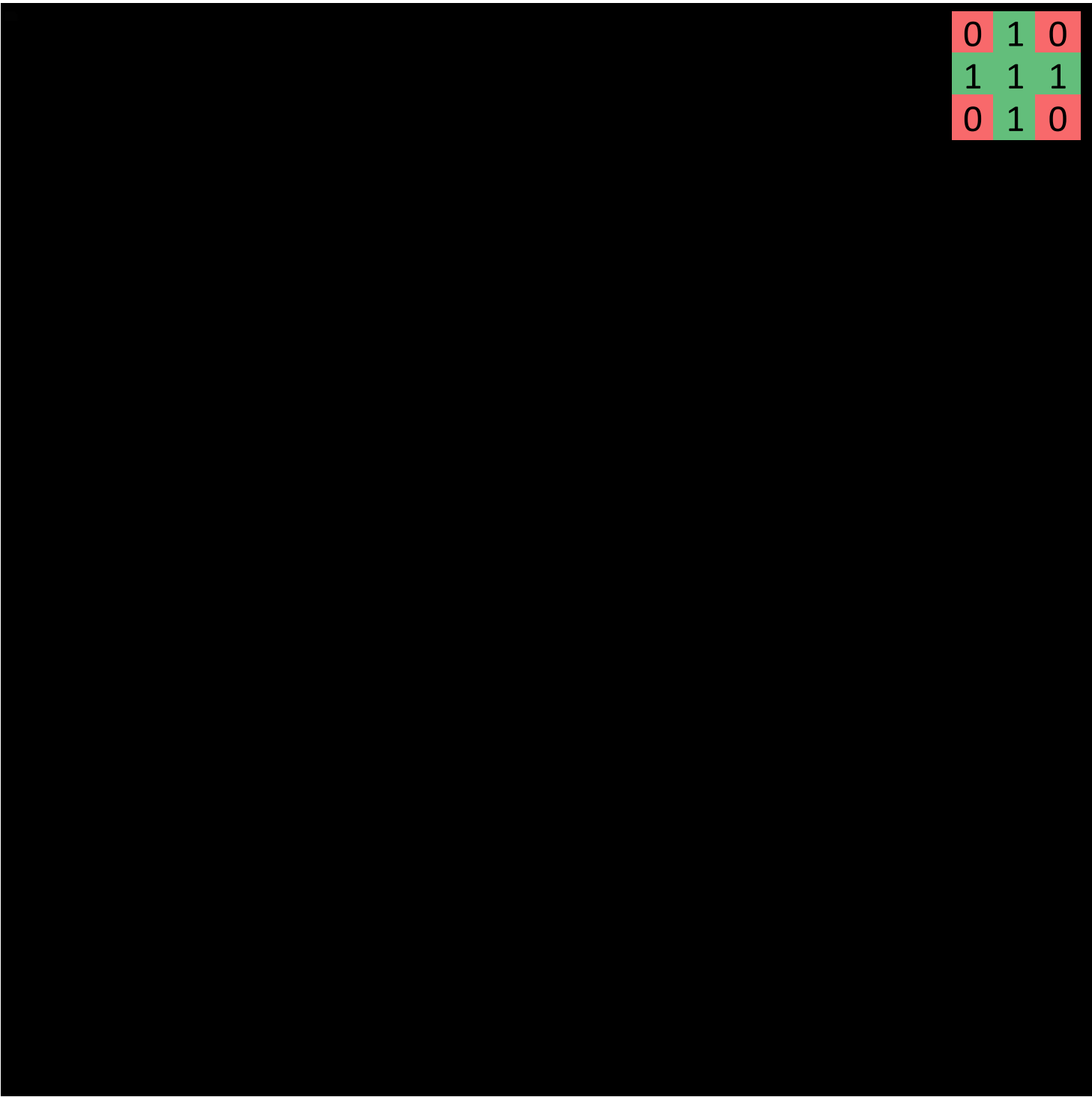
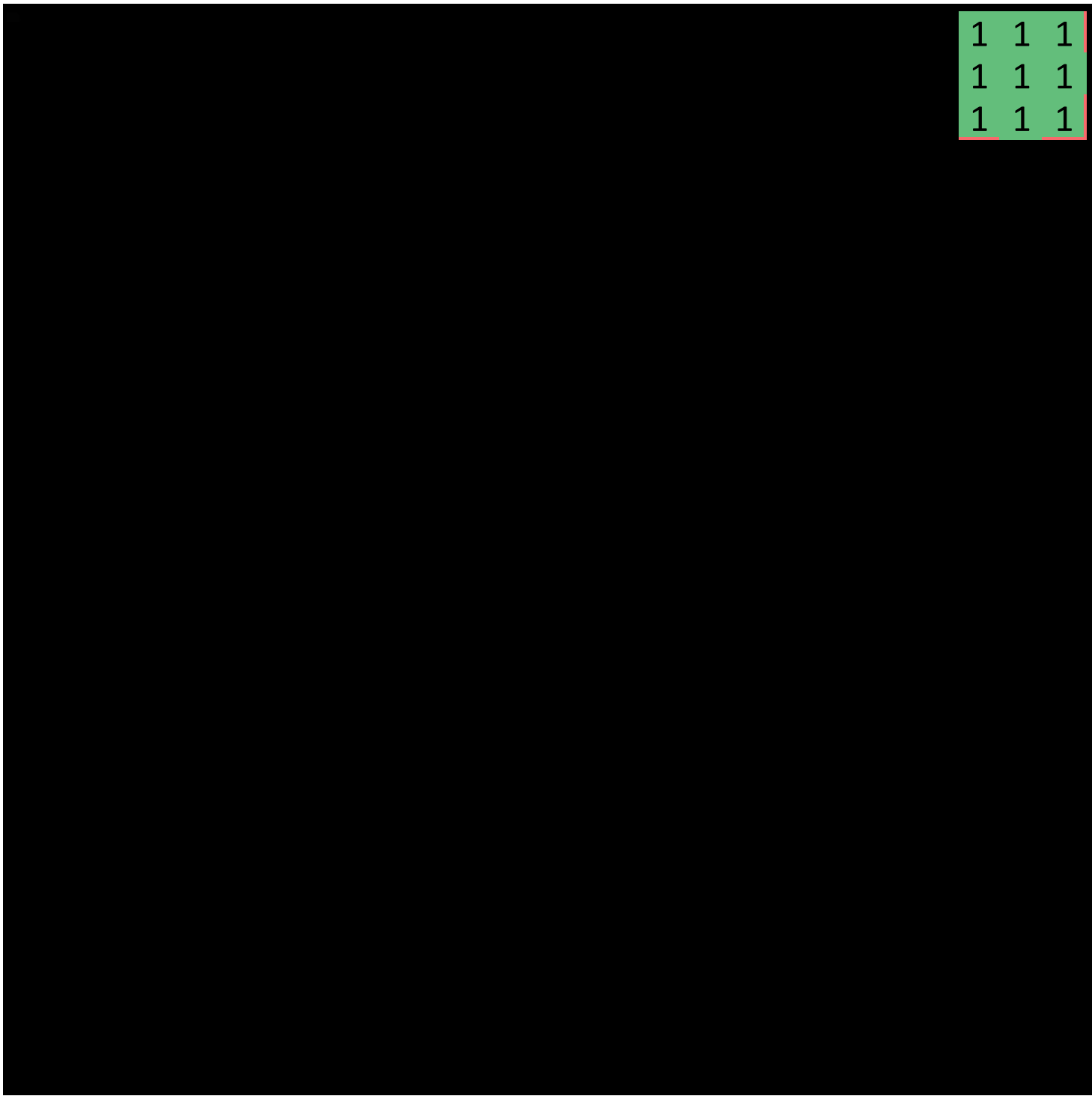
Output

- A type of non-linear filtering
 - Kernels of different shapes

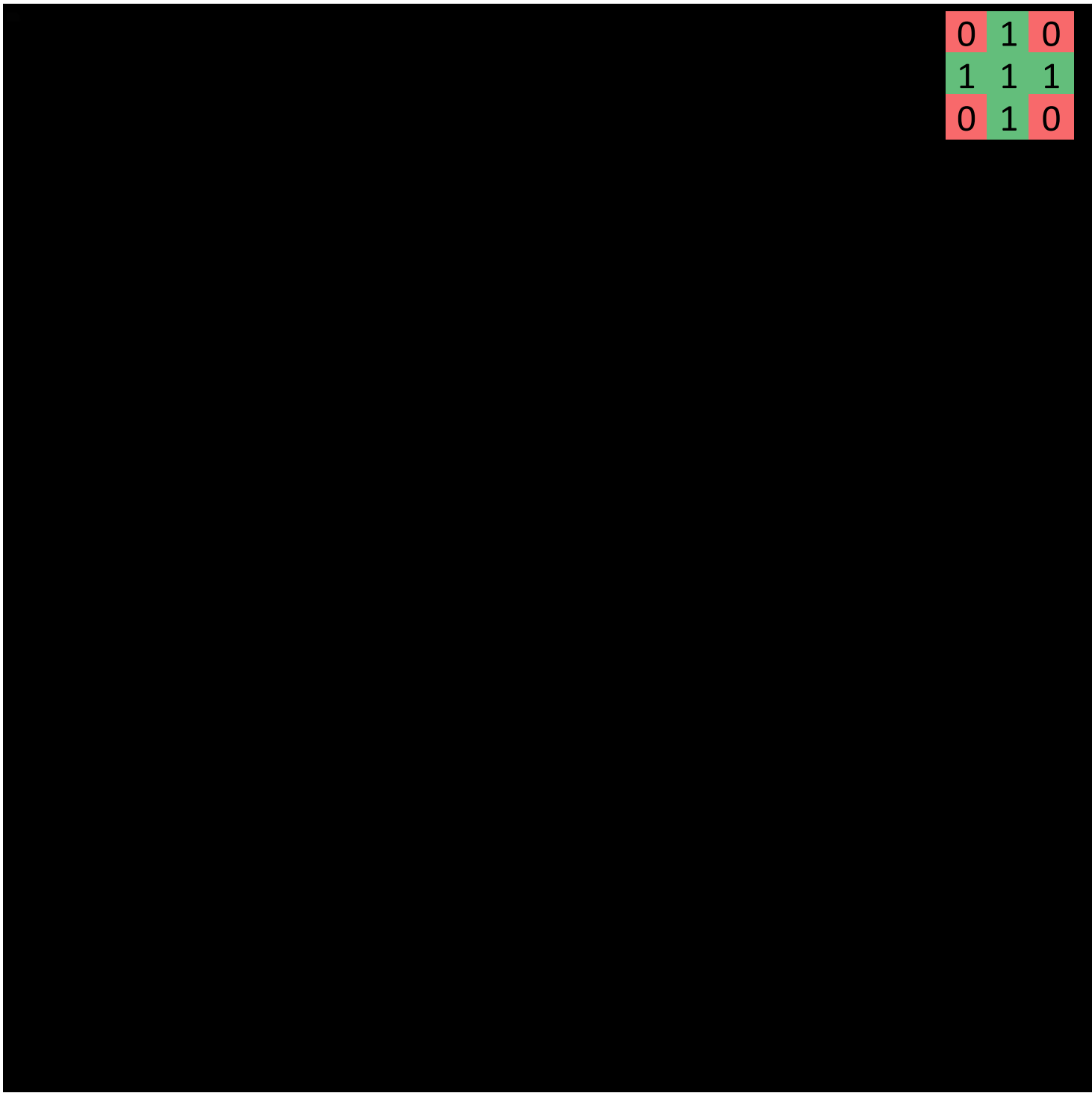
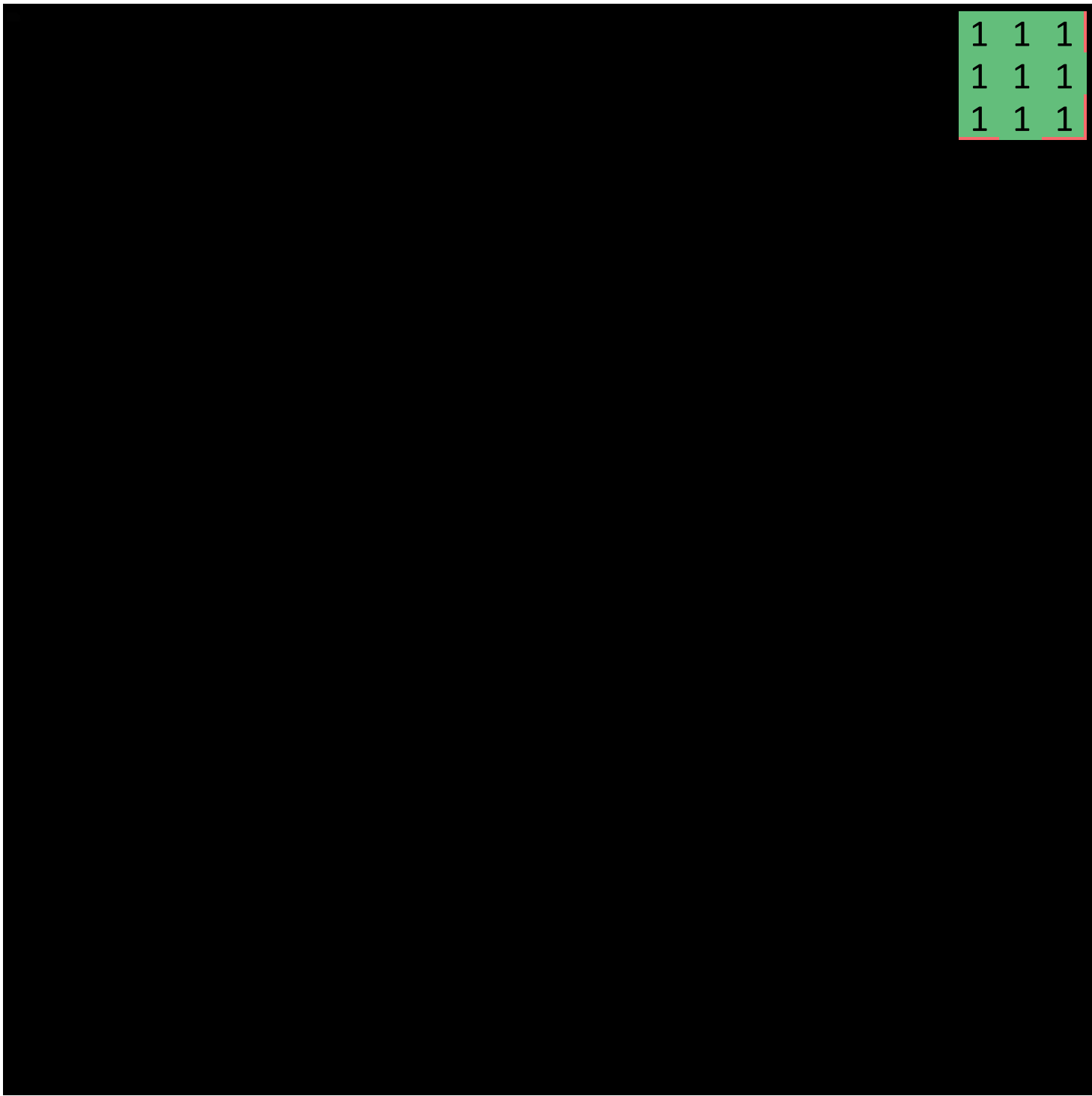


- Where neighbors are affected by simple rules
 - Eg. “If the center pixel is white, make all pixels surrounding it white too”
(or according to the kernel’s shape)

Dilation



Erosion

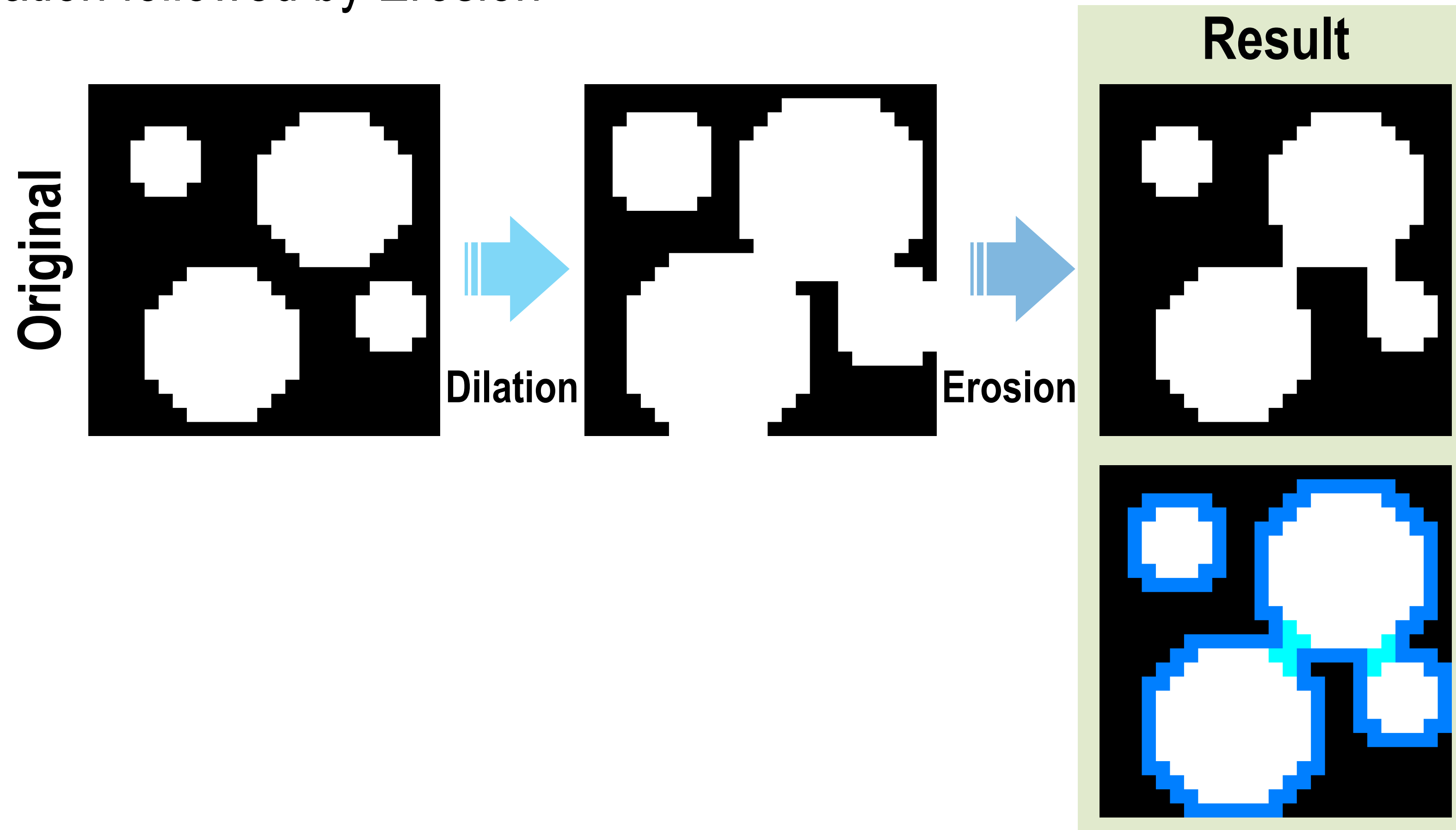


Morphological Filtering

- Erosion
- Dilation

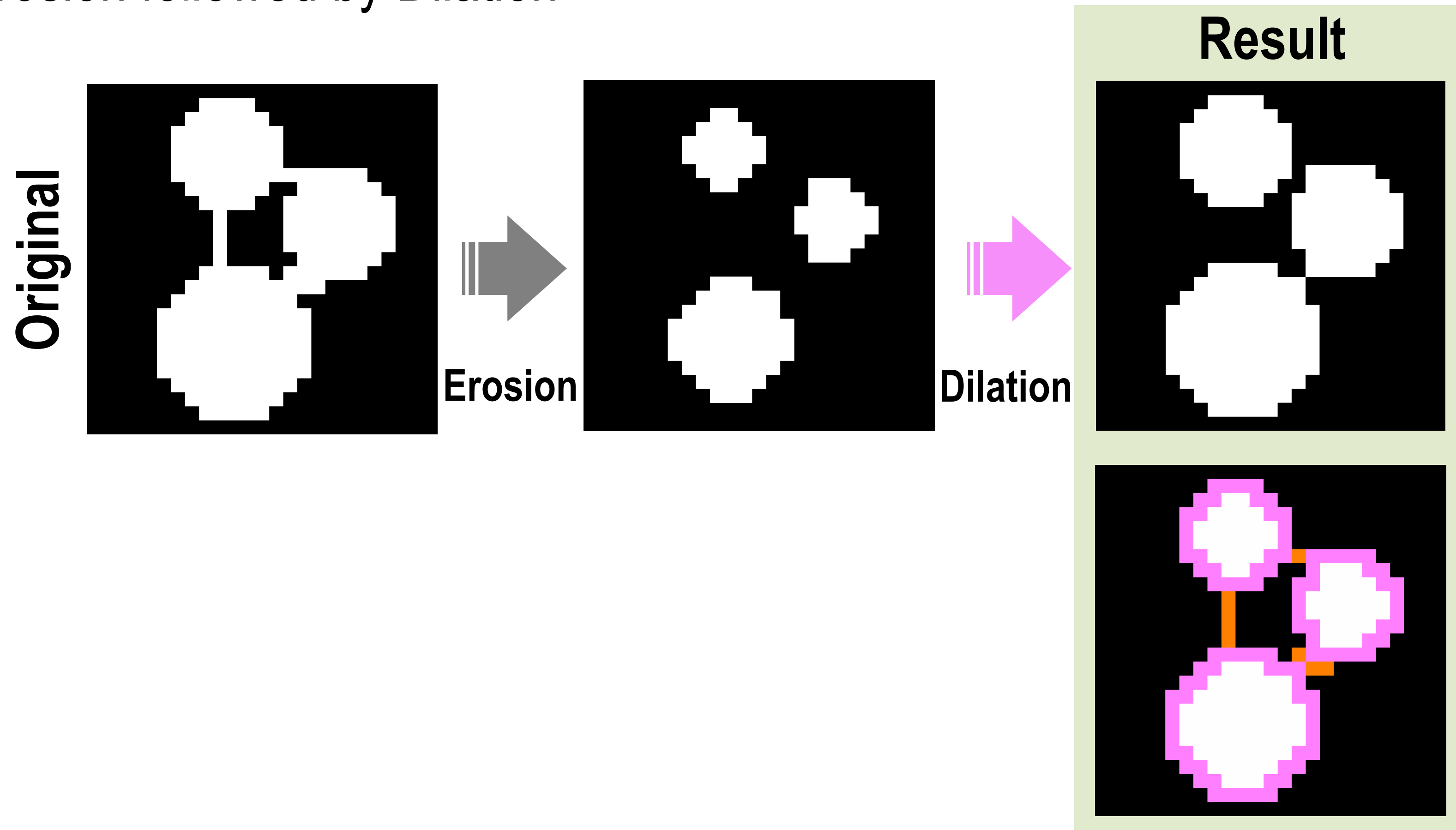
Morphological Filtering

Closing: Dilation followed by Erosion



Morphological Filtering

Opening: Erosion followed by Dilation

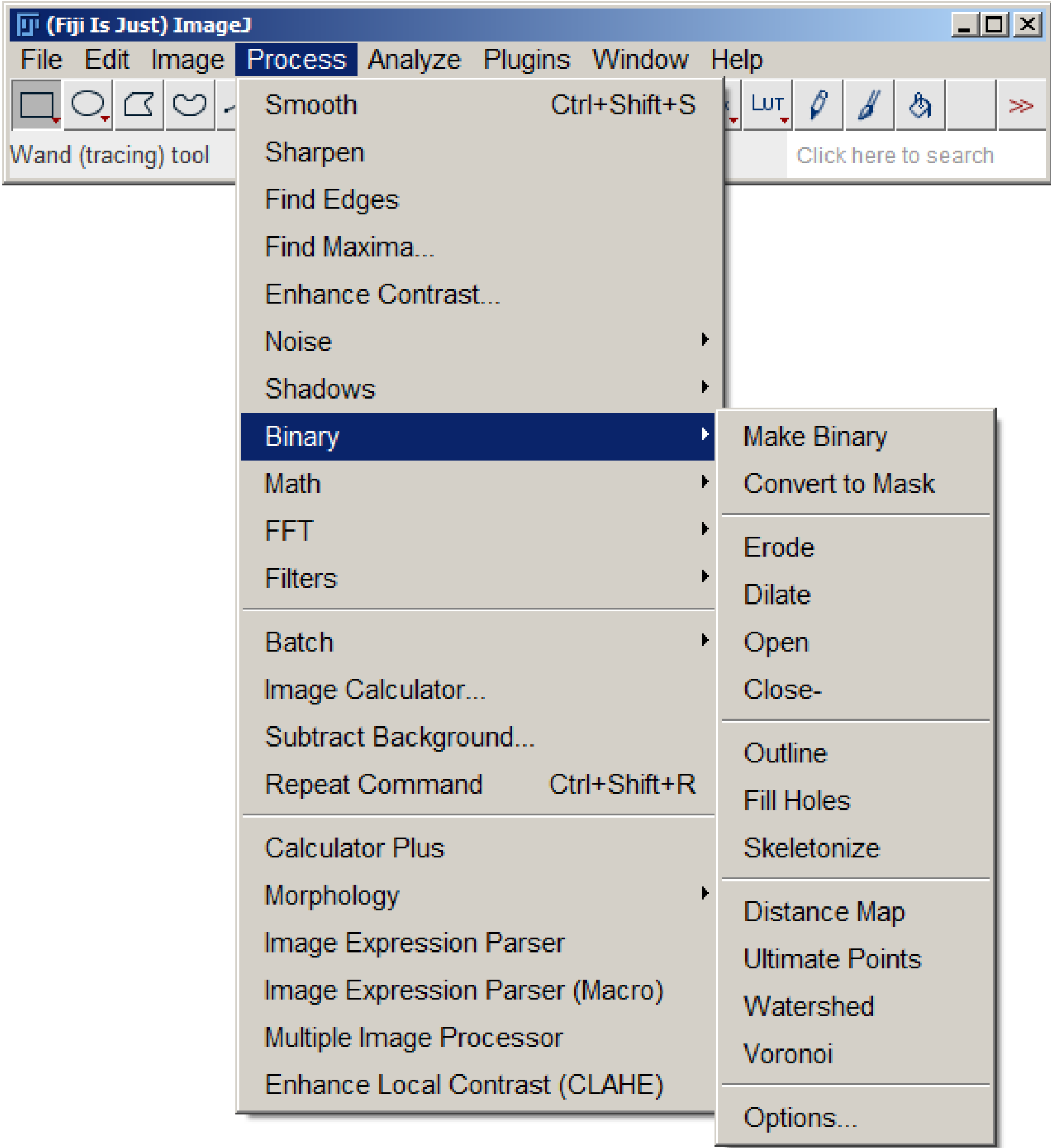


Morphological Filtering

- Erosion
- Dilation

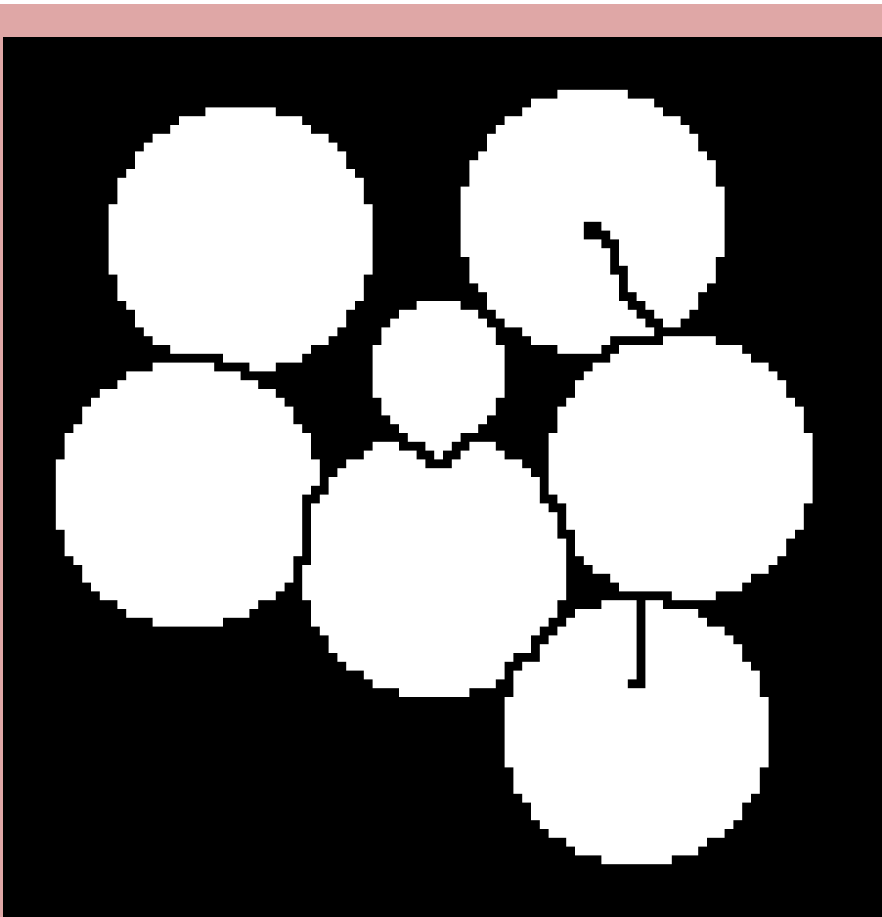
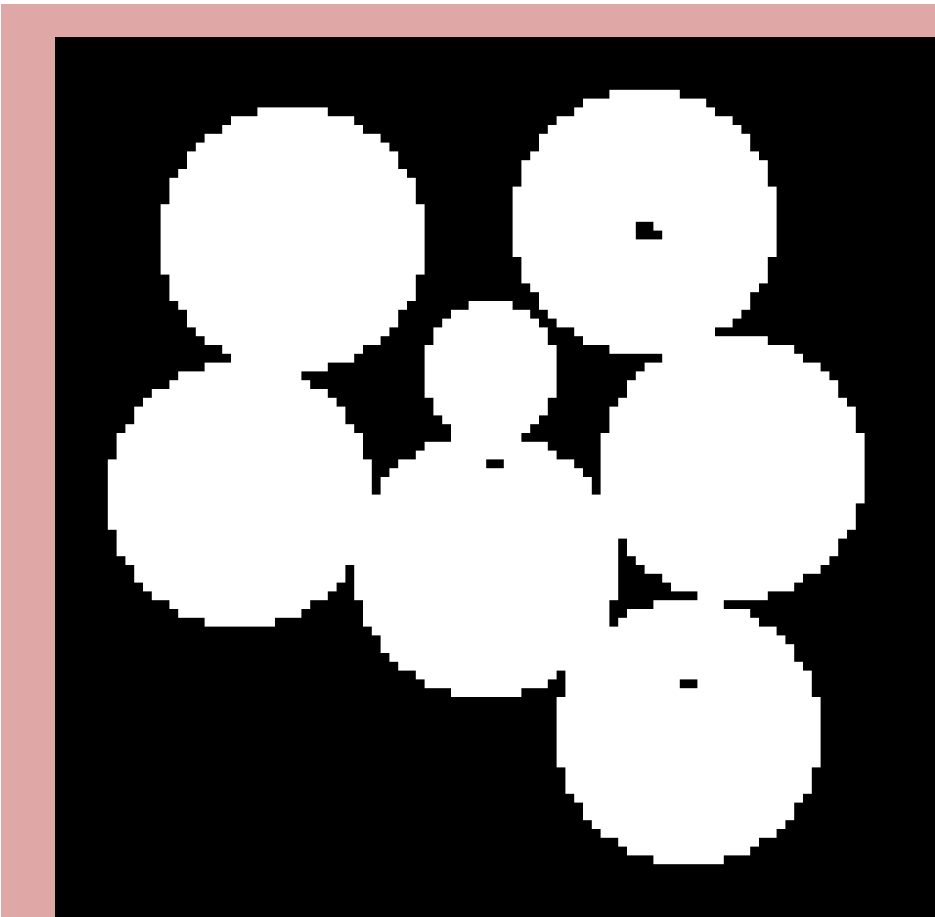
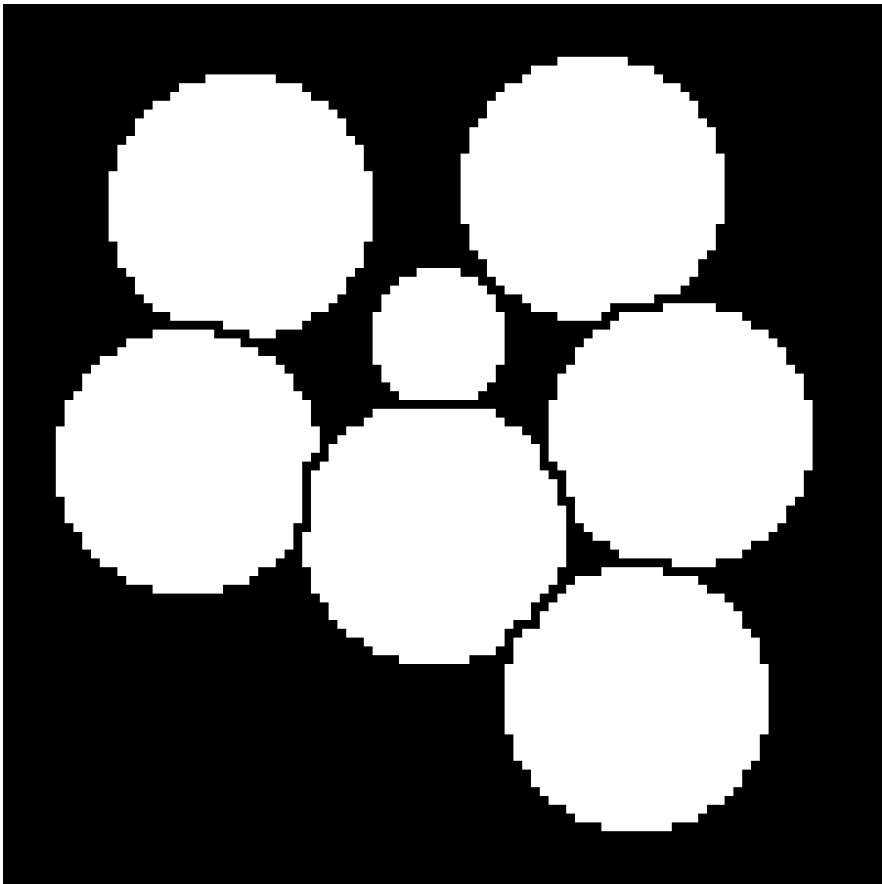
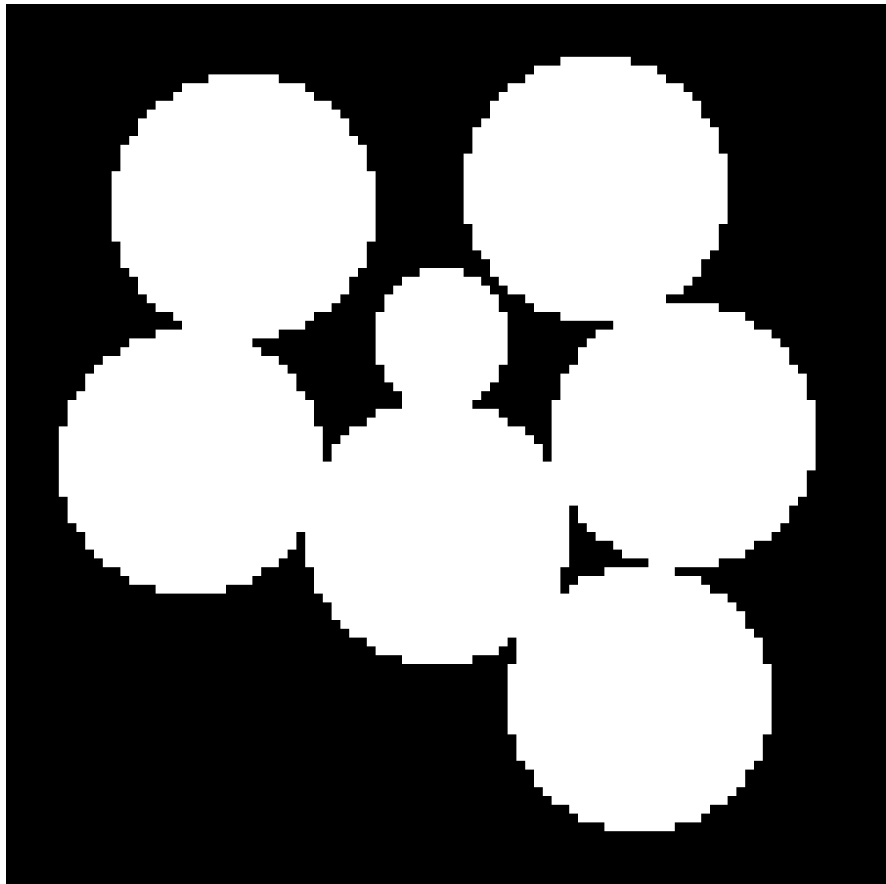
- Closing
 - Erosion+Dilation
- Opening
 - Dilation+Erosion

Binary-Based Operations

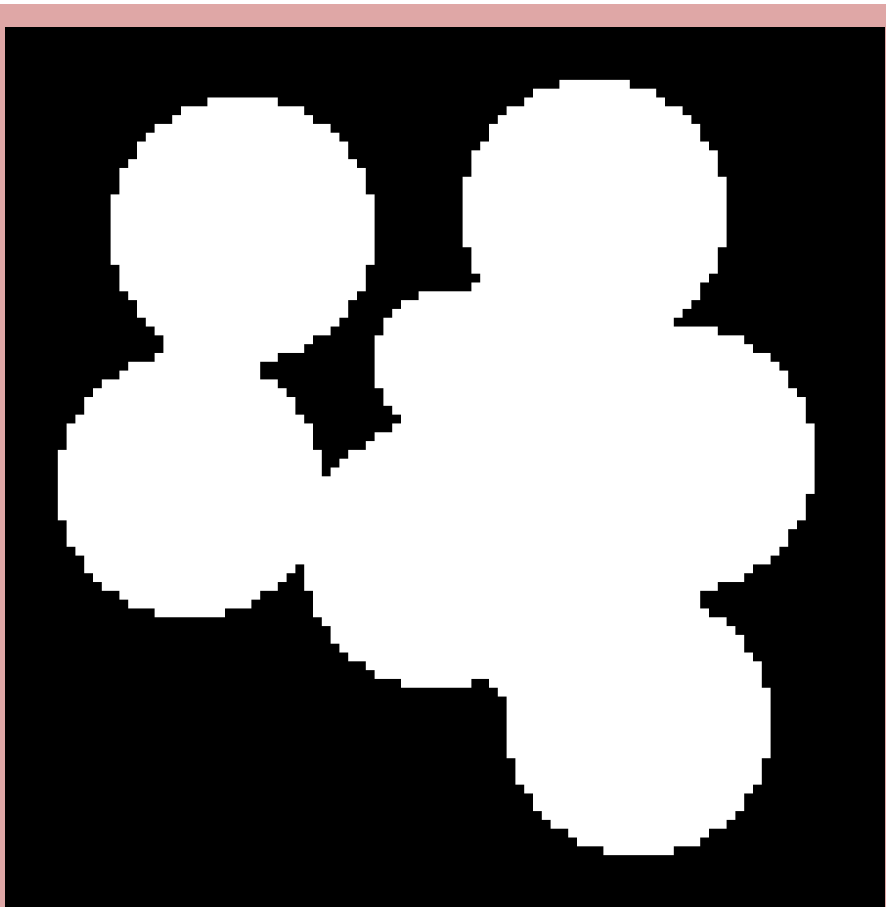
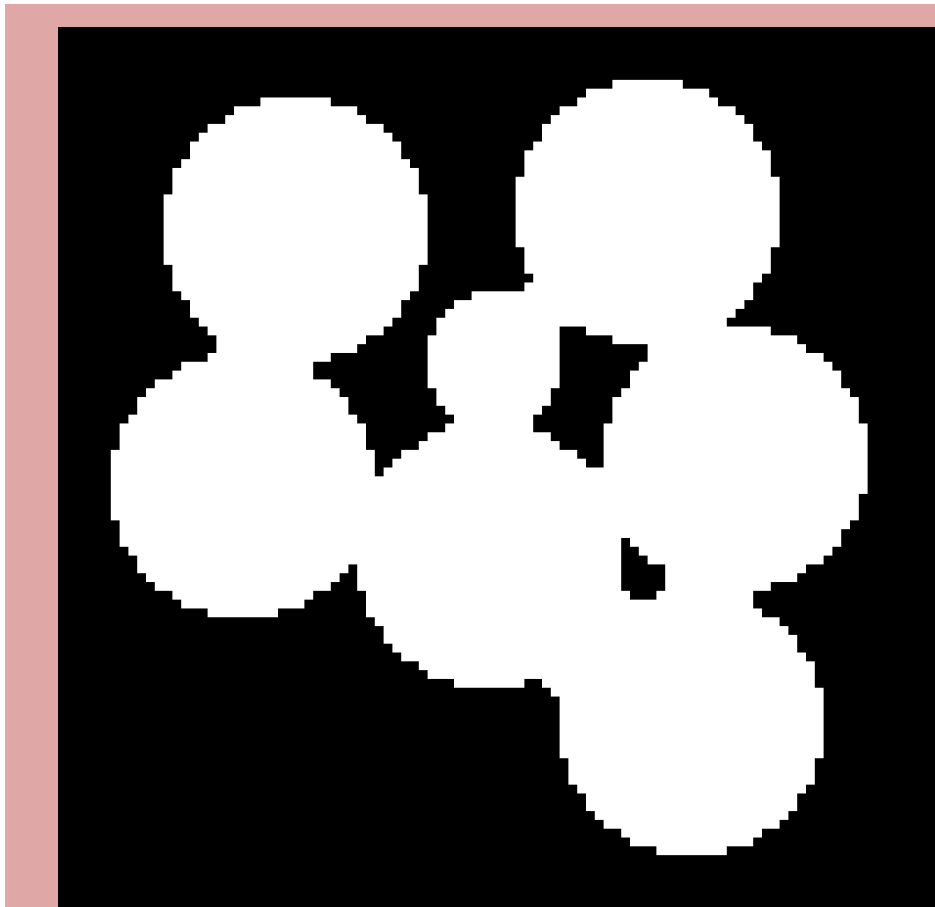
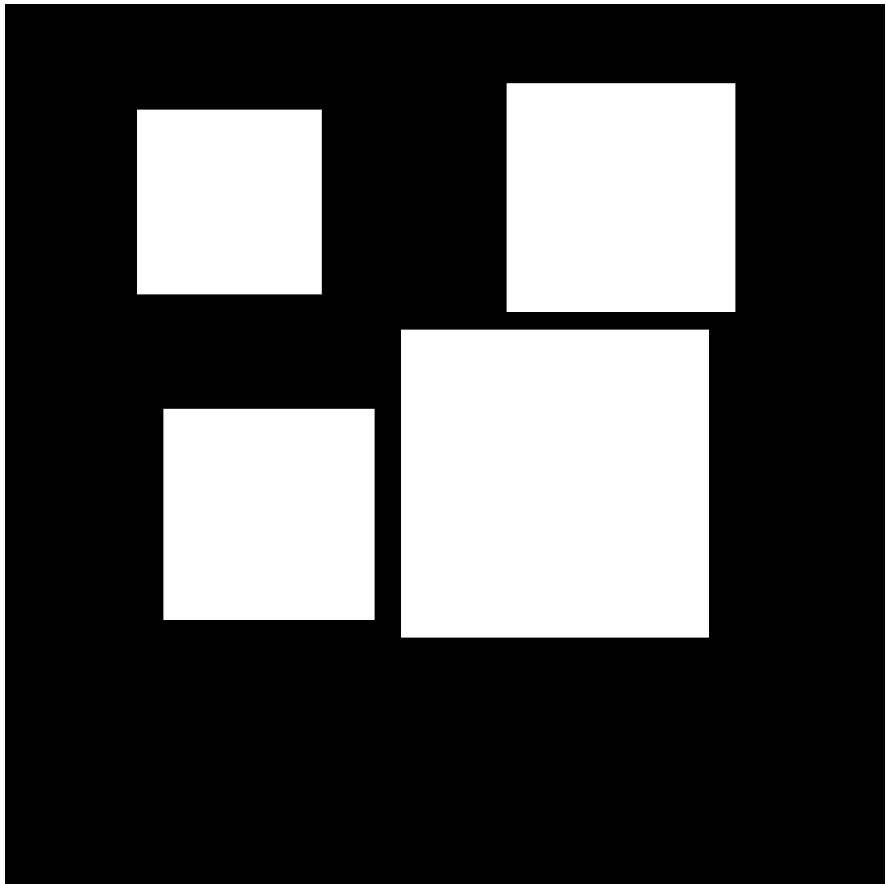
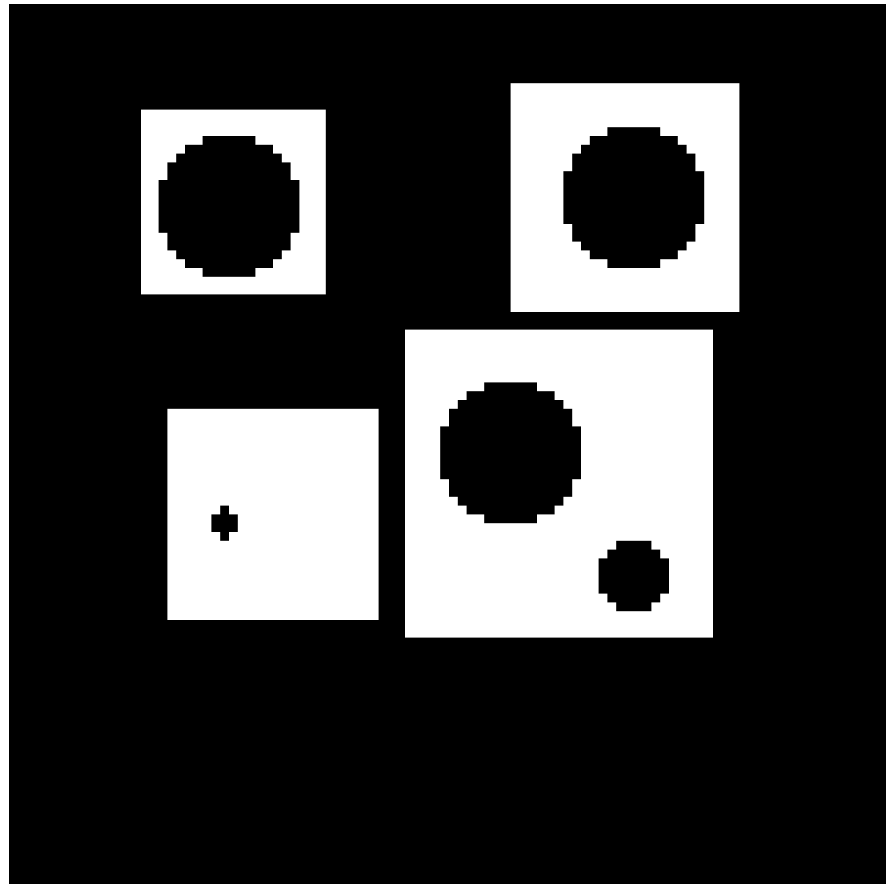


- Watershed
- Fill Holes
- Skeletonization
- Voronoi
- Distance Map

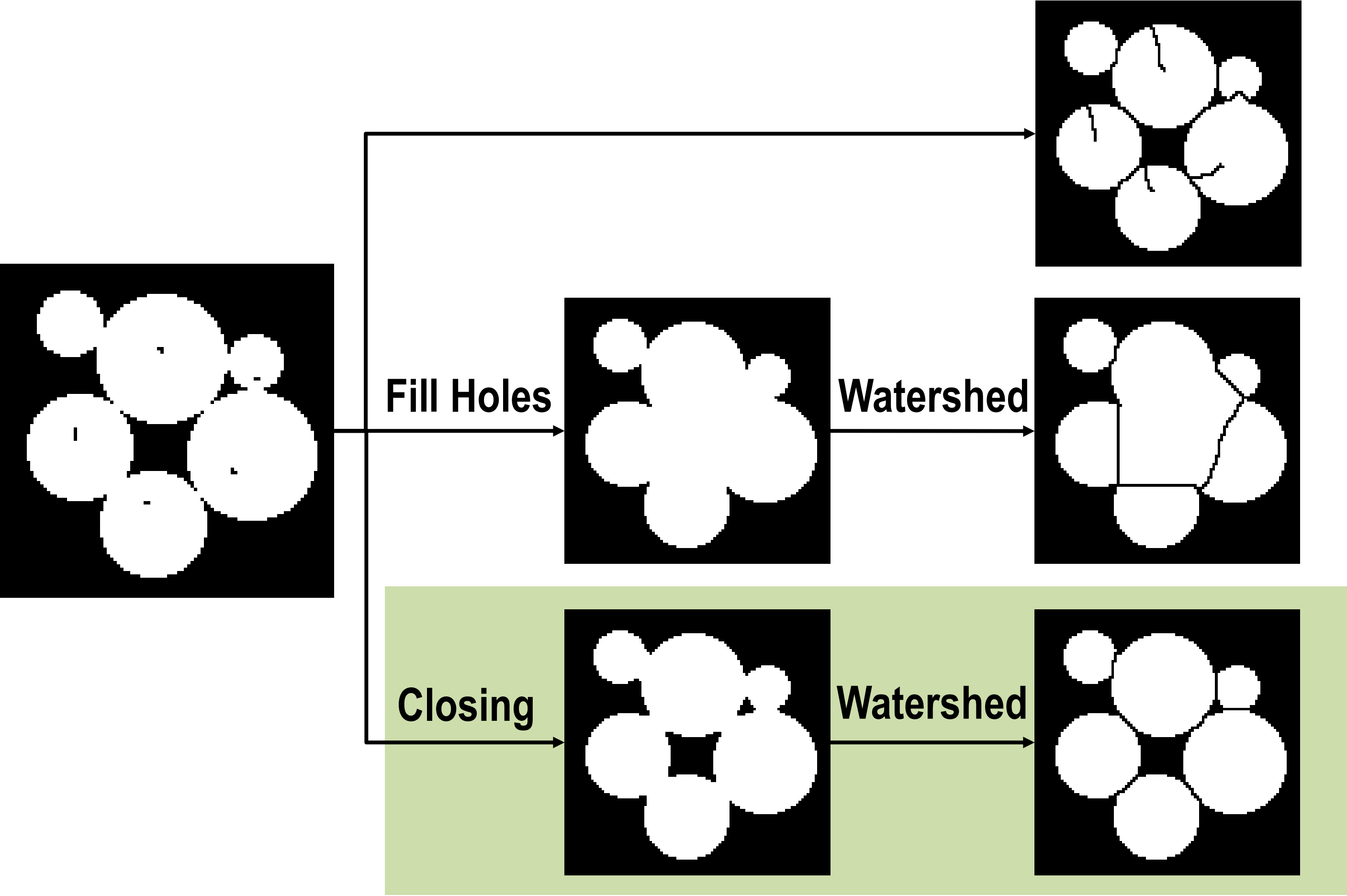
Watershed



Fill Holes

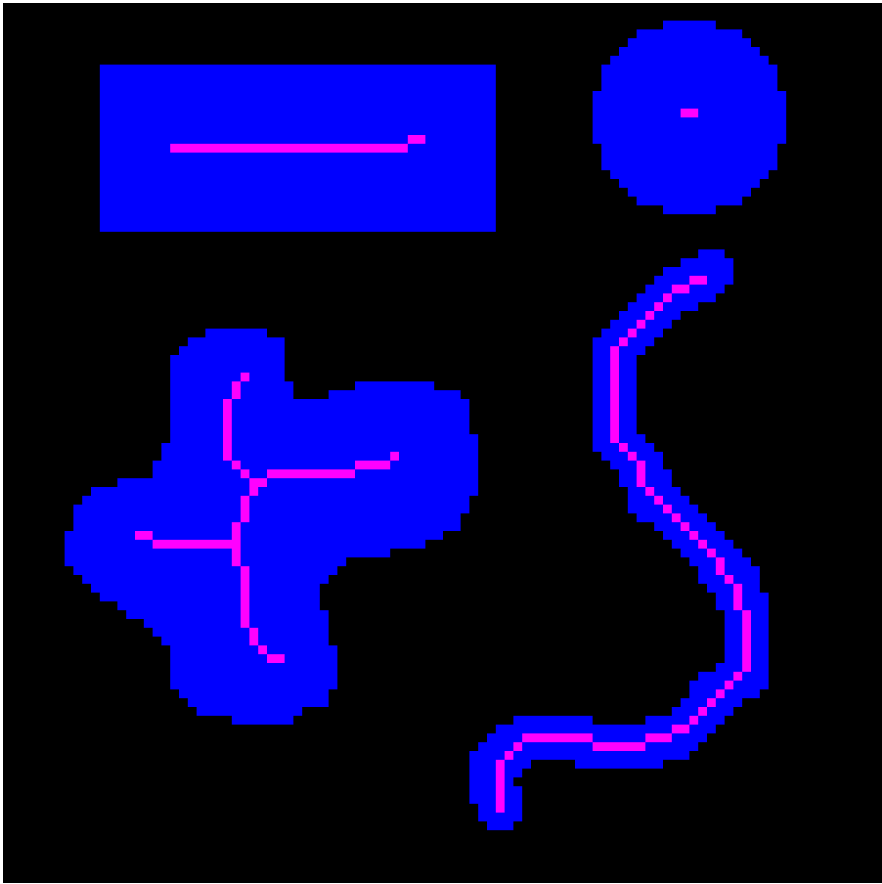
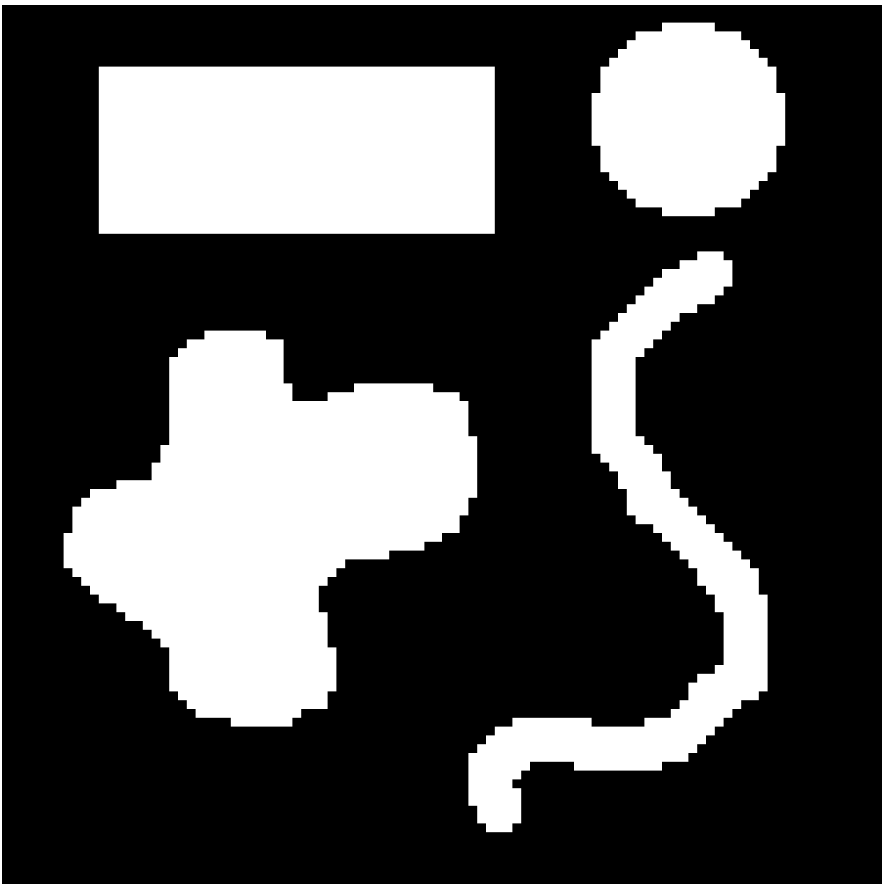


Combined Operations

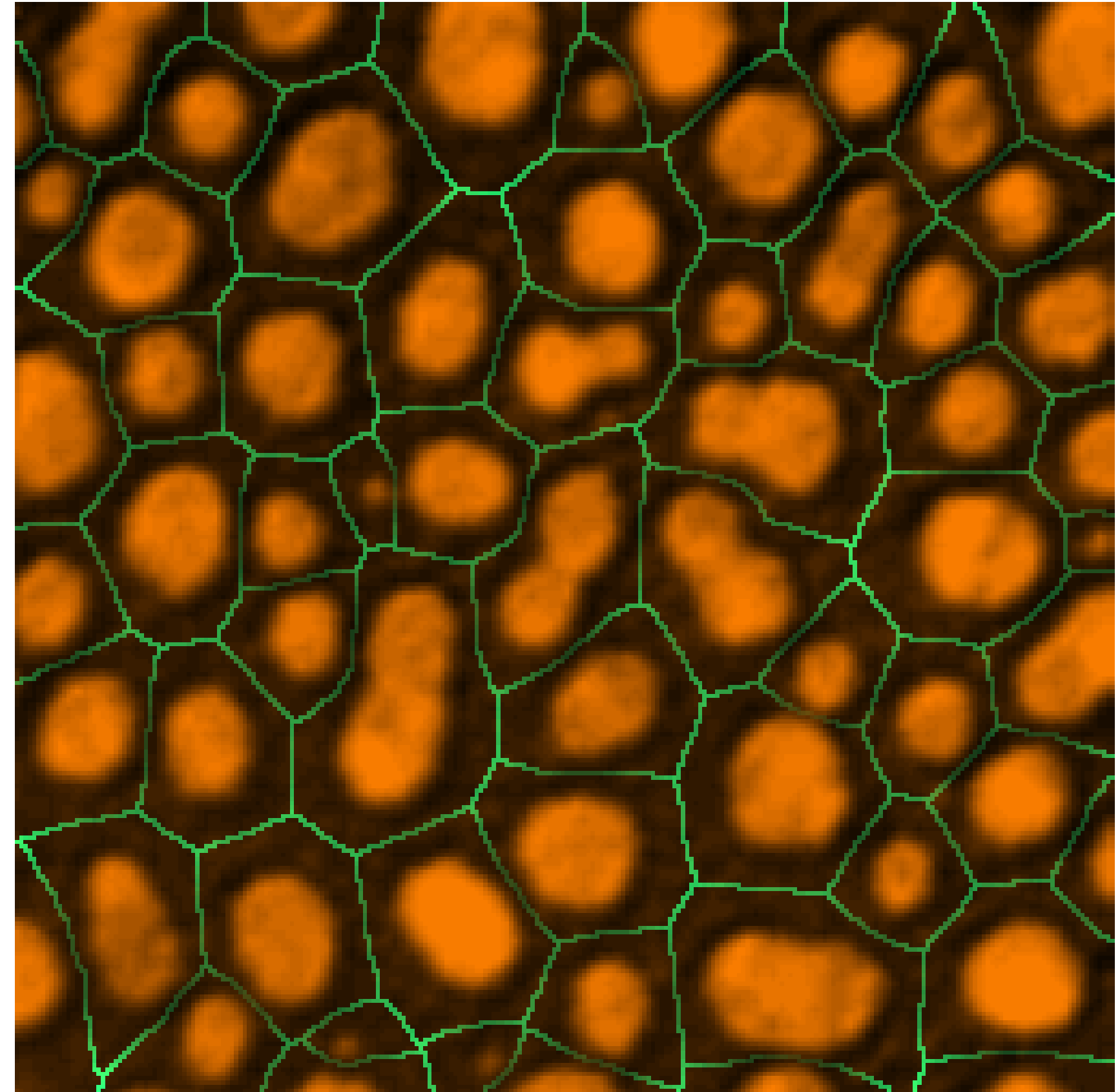


Watershed
Alone

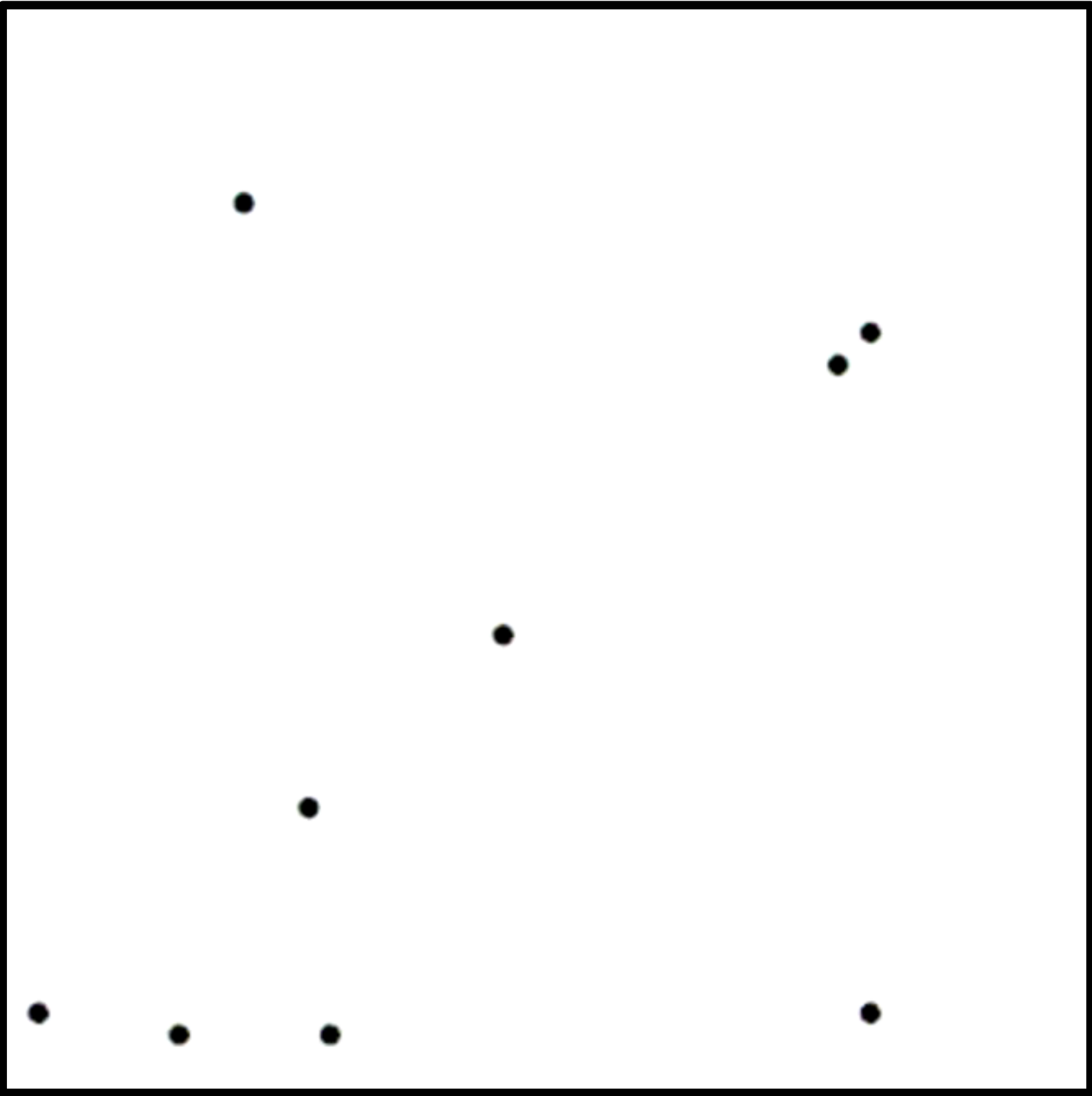
Skeletonization



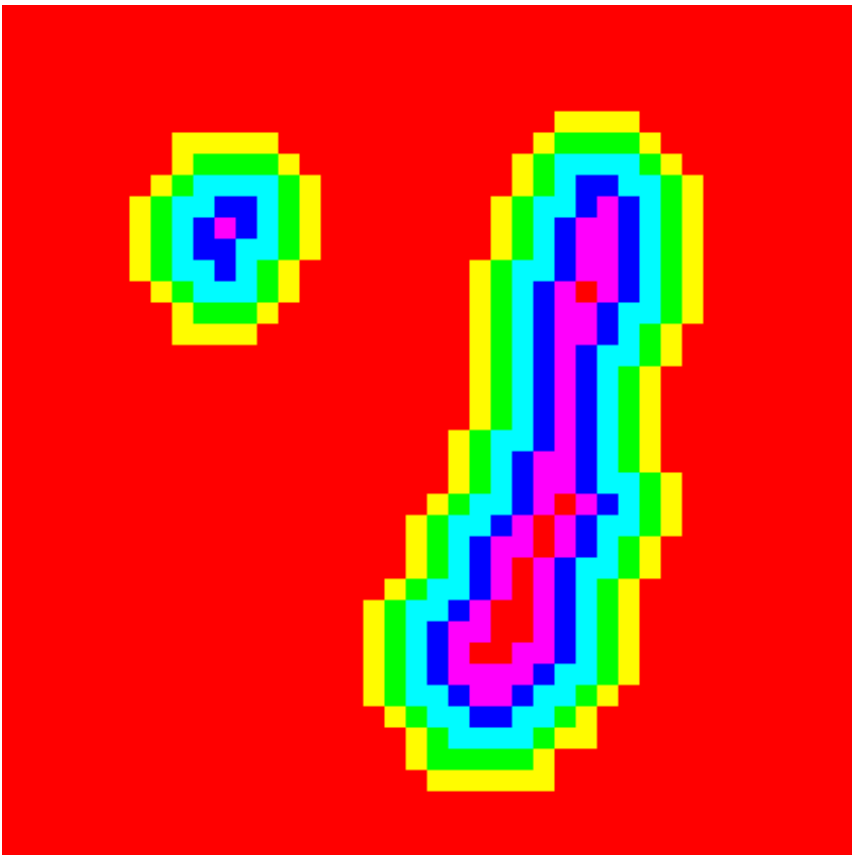
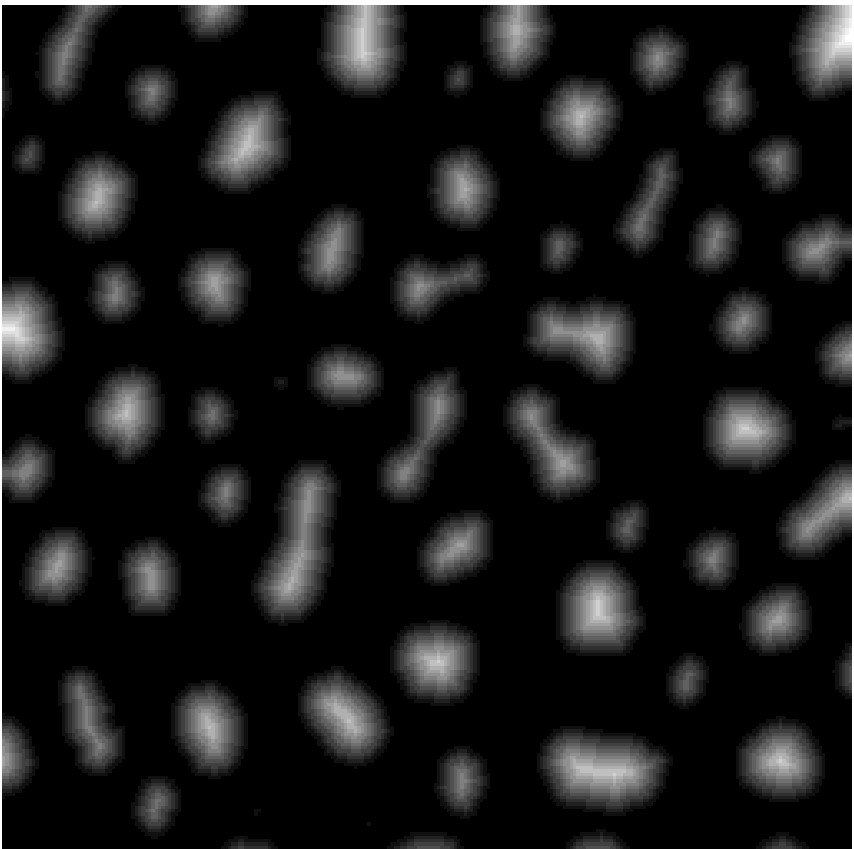
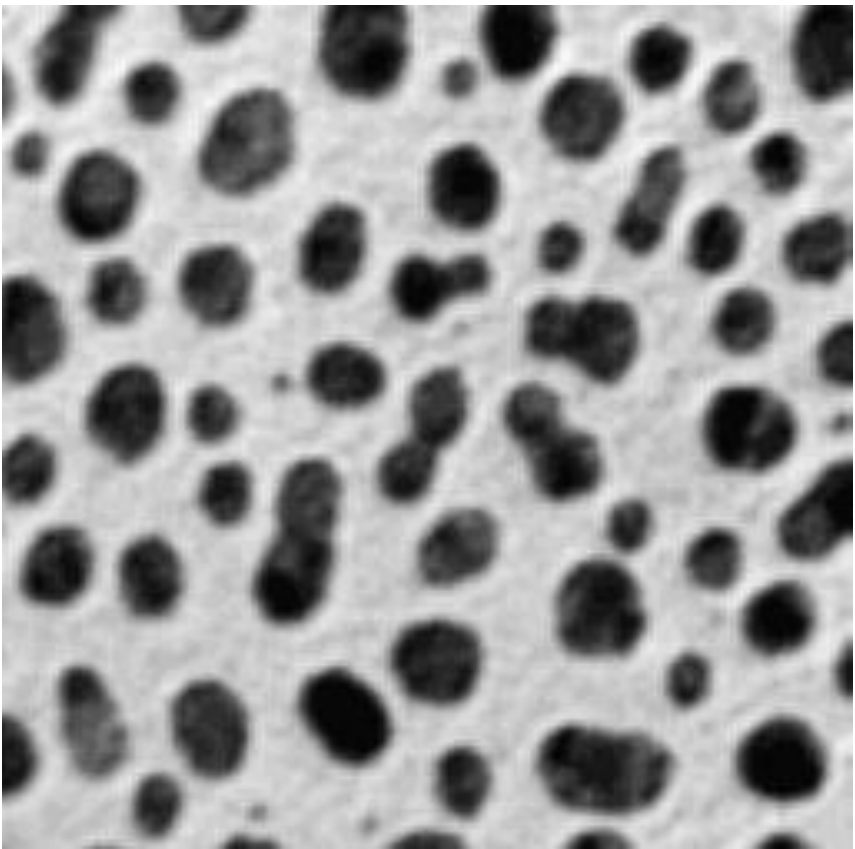
Voronoi



Voronoi



Distance Map

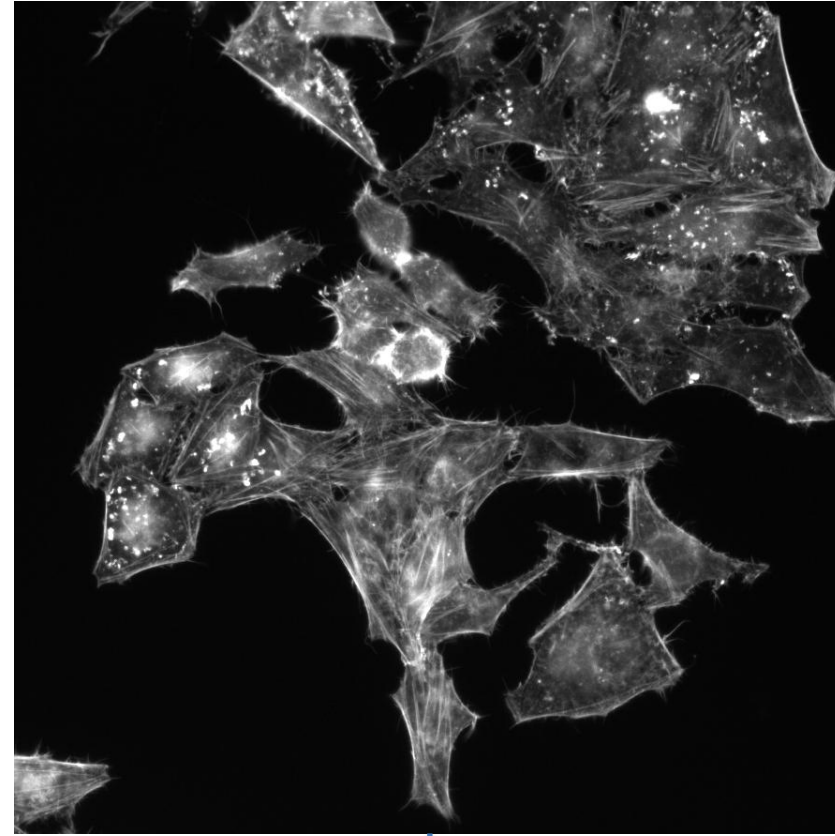


0px

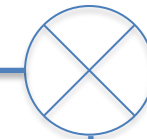
7px

Summary

Input image



Binary image



- Erosion
- Dilation

- Closing
 - Erosion+Dilation
- Opening
 - Dilation+Erosion

- Watershed
- Fill Holes
- Skeletonization
- Voronoi
- Distance Map