1

a

Dilation adds pixels to the boundaries of objects in an image, while erosion removes pixels in the same area. The structure of pixels added/removed each iteration is contained within a "structuring element", which controls how the pixels should be evaluated in terms of size and shape.

The structuring element is of a given shape and with a reference pixel. When the reference pixel overlaps with a positive pixel value, the rest of the structuring element will be applied at that position.

Dilation expands the connected sets of 1s, meaning it will fill holes, gaps, and gulfs, as well as expand shapes. Erosion removes disconnected sets of 1s, meaning it will smooth objects and boundaries, and can be used to shrink objects.

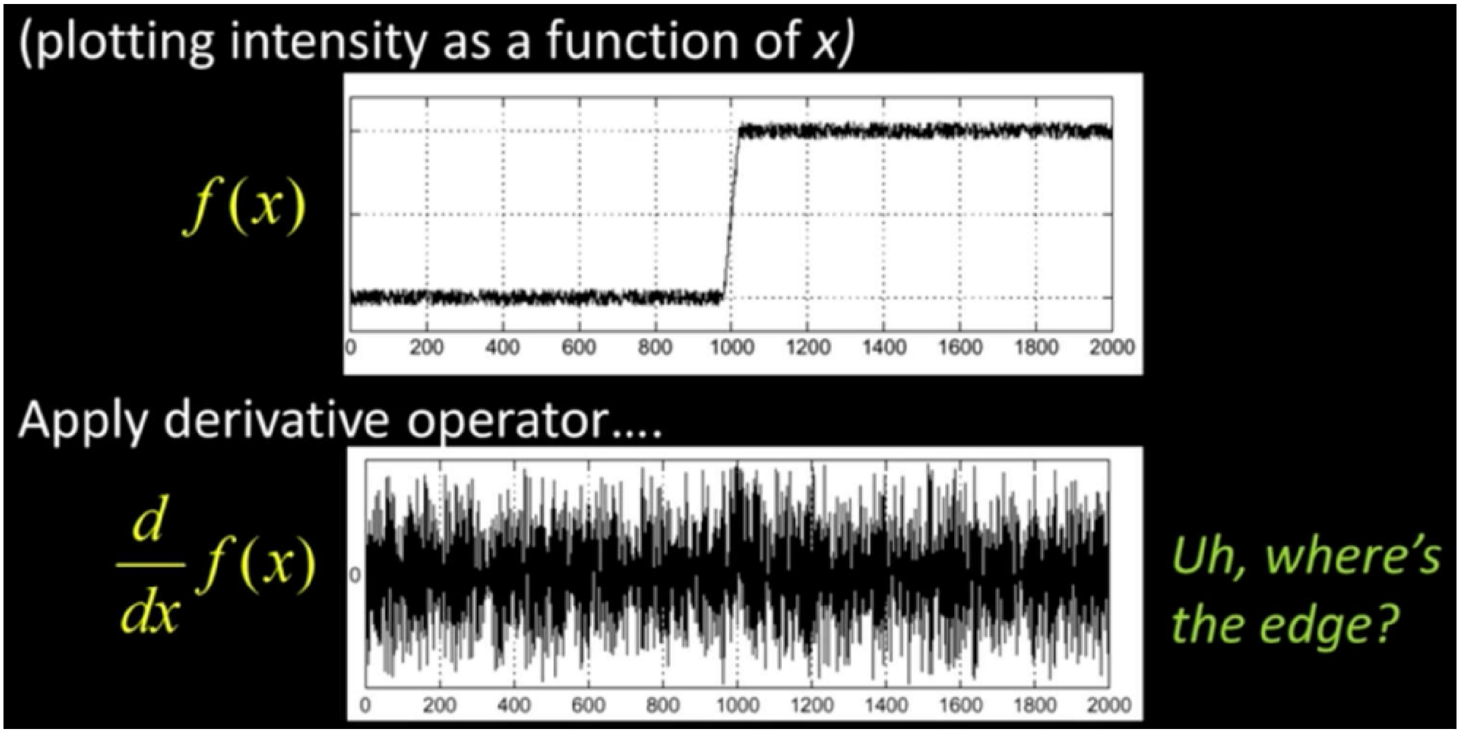
Closing involves dilation followed by erosion, while opening involves erosion followed by dilation. The opening and closing operations have the advantage of retaining the original object size, while still achieving the results of the first respective operation (opening achieves the effects of erosion, while closing achieves the affects of dilation).

When either opening or closing is applied multiple times in a row, the same operation has no effect. Example where 'x' is either the opening or closing function.

(AxB)xB=AxB

b

Smoothing an image before edge detection can be beneficial as it smoothes out the edges, meaning they become easier to recognize by the edge detection by reducing noise. Smoothing can be done by replacing each pixel with the average of its neighbors. As a result, it smooths out the derivative of the pixel intensities, which allows the edge detection to work since it now will be able to separate the low derivative from the high derivative where the actual edge is.



c

Hysteris thresholding works by defining two intensity levels - "high" and "low". This is used by evaluating potential edges as actual edges if their intensity is higher than "high", but discarded if it's lower than "low". The ones in between are only kept if they are connected to an edge with intensity above "high".

d

Two threshold values work better since it allows for a higher granularity of intensity evaluation like described in c). This leads to a better edge detection result.

e

Before:

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

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

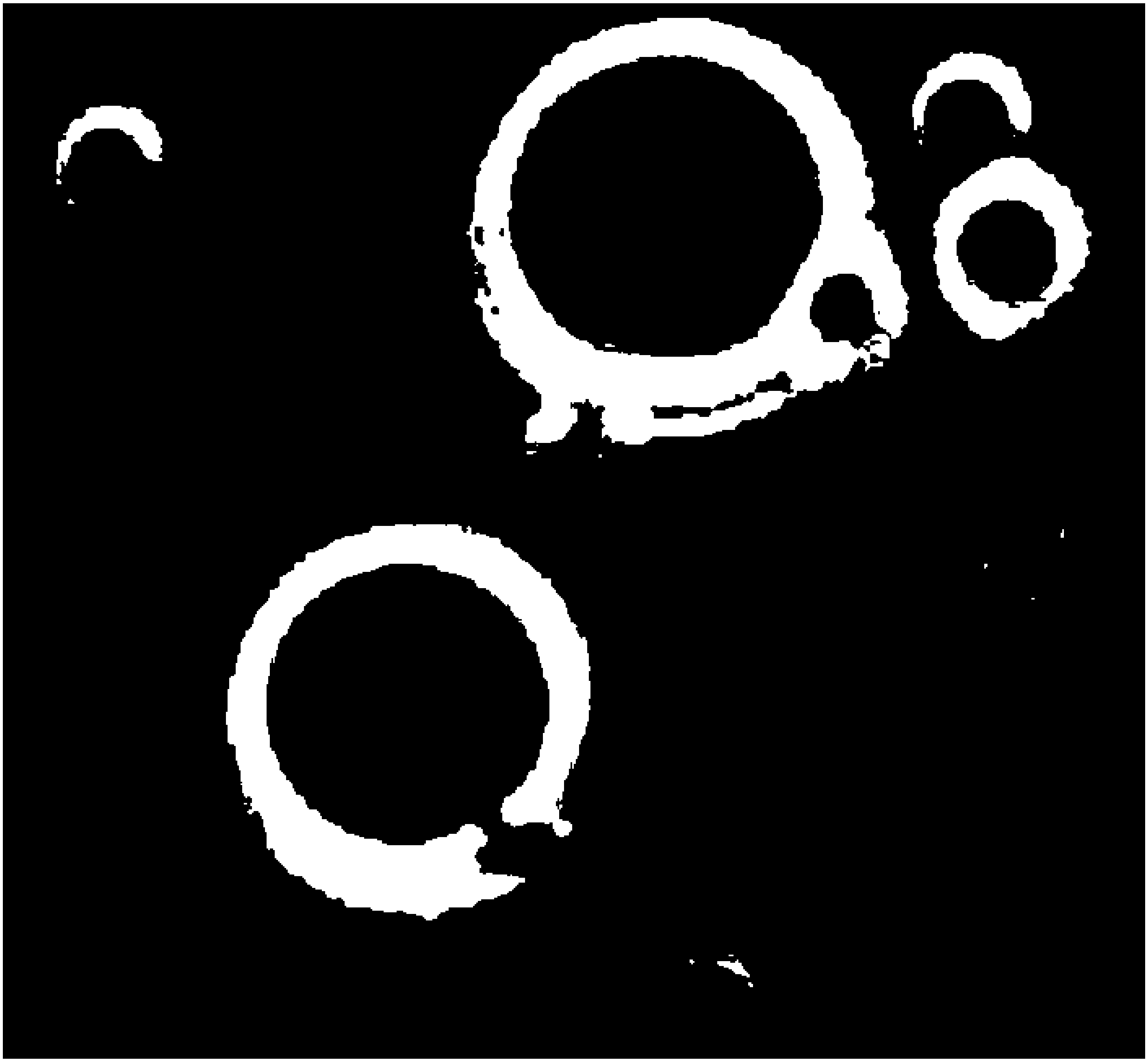
After:

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

2

a

polymercell segmented:



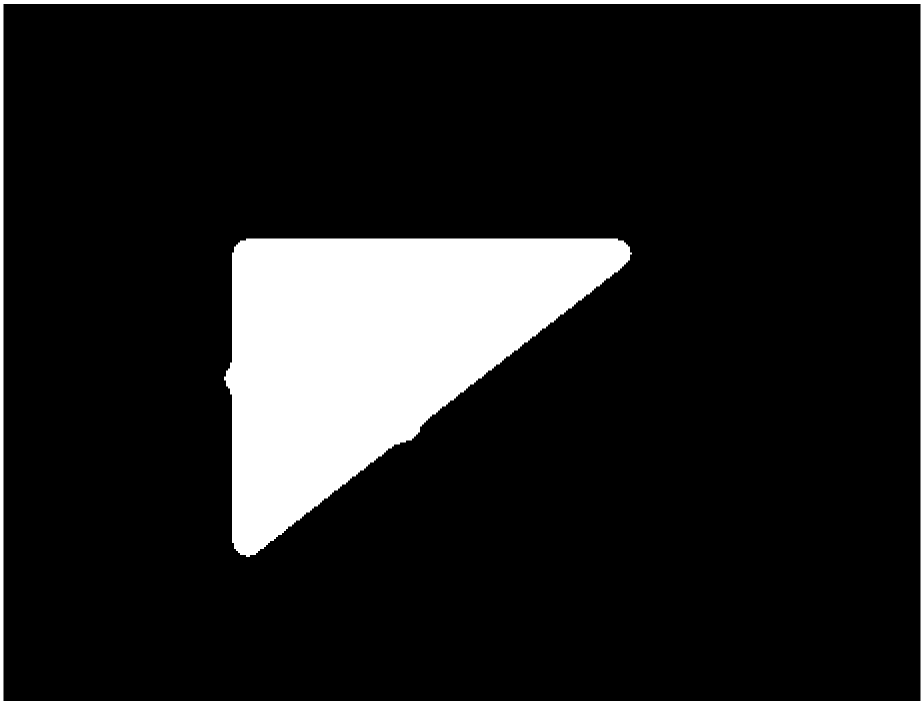
thumbprint segmented:

b

3

a

I removed the noise by first applying binary opening, followed by binary closing. Opening will remove pixels, causing the noise around to disappear, and then the closing operation will fill in the missing parts of the objects. Both of these operations also retain the original shape of the object (see 1a). A series of erosion followed by dilation could also be used instead of the opening function, and vice versa for the closing function. The structuring element used is simply a disk with a radius that was iteratively found to give the best results with value 7.



b

c

d