APPLICATIONS OF MATLAB IN ENGINEERING

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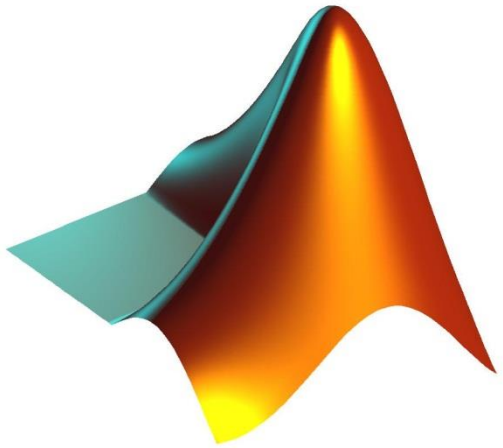
Today:

- Introduction to digital image



Problem Setup

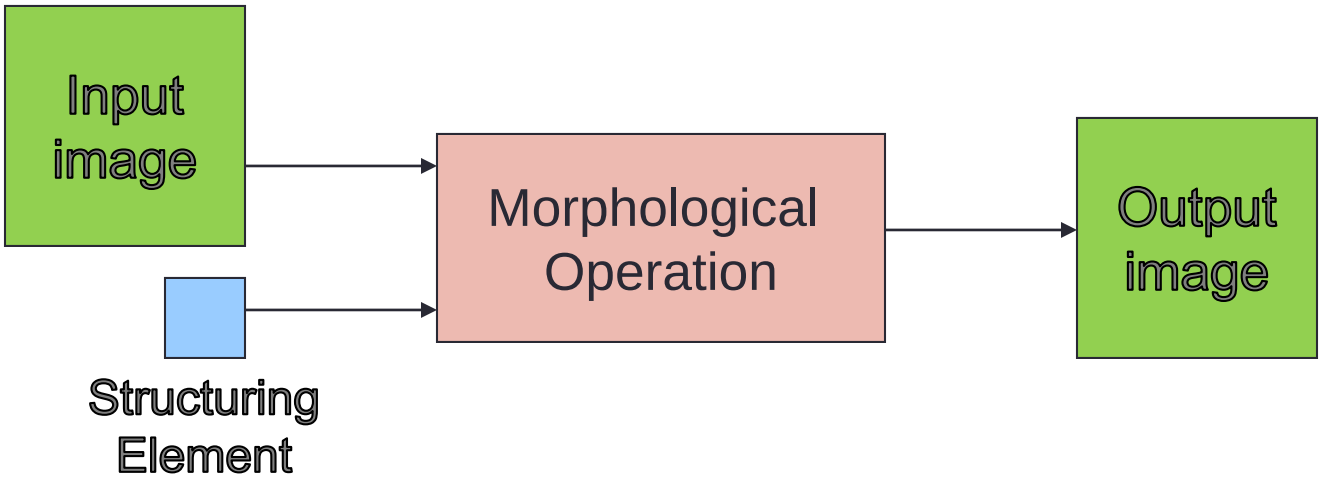
- Improve the quality of binary image (e.g., fingerprint)
- What are your strategies?

Morphology

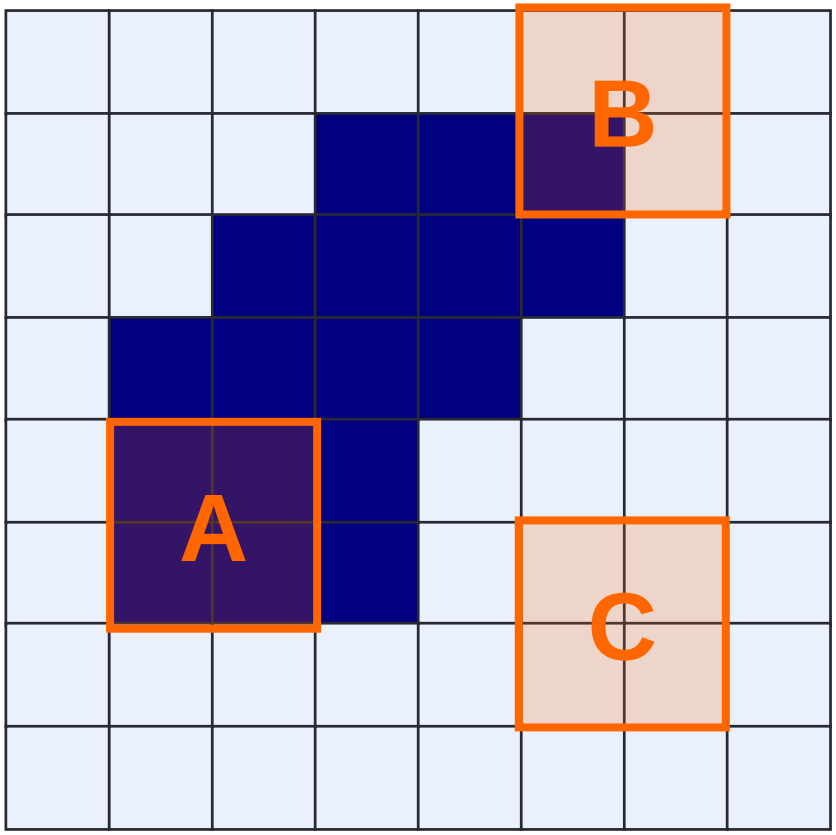
- Techniques that deal with the shape of features in an image
- Also called “morphological” image processing
- Typically applied to remove imperfections

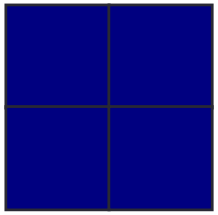
Morphology Operations

- Inputs
  - A binary image
  - A “structuring element” image
- Going through the input image to find the regions that “fit” or “hit” the structure elements



Structuring Elements, Fit, and Hit



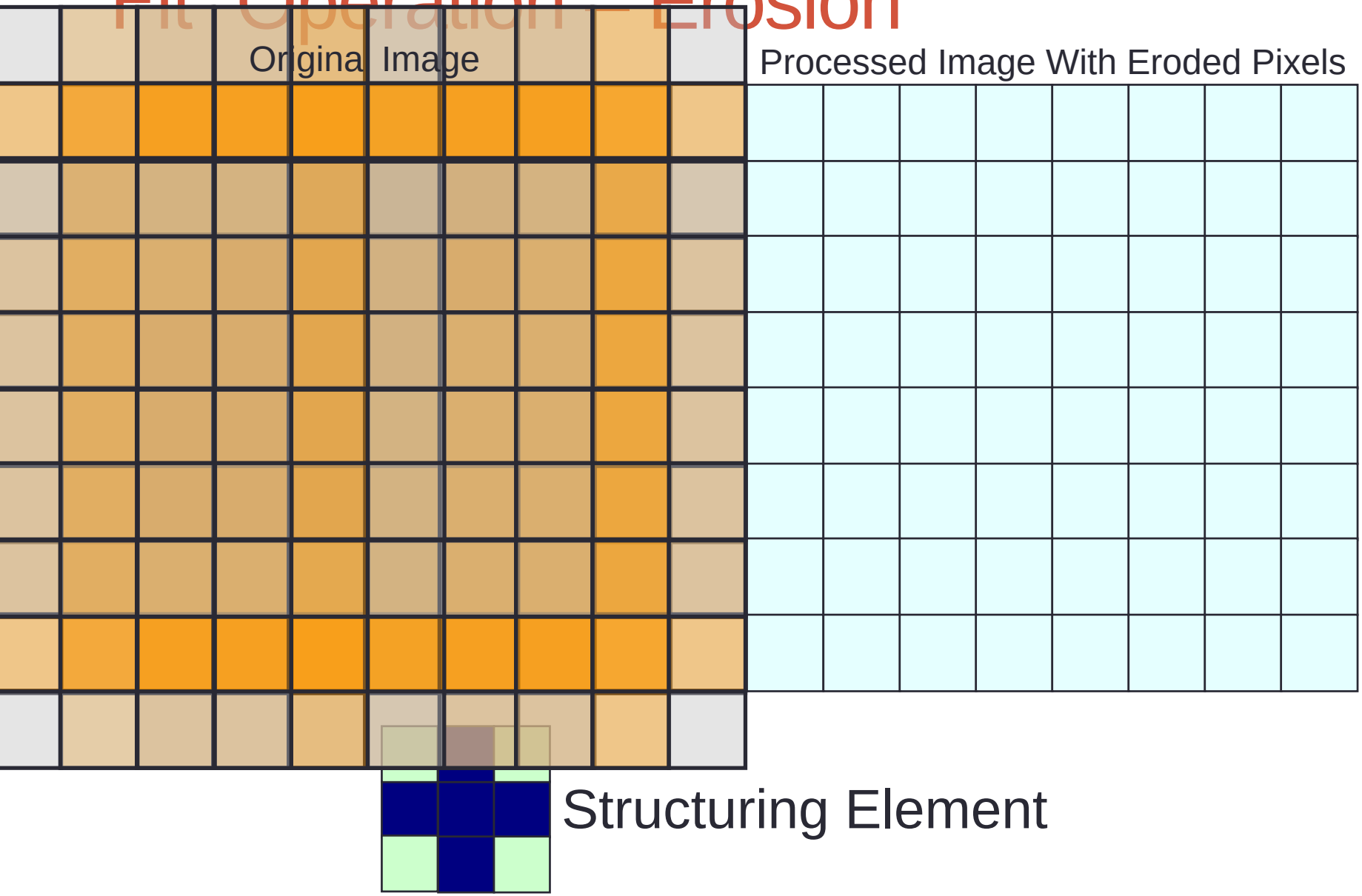


Structuring Element

Fit: All on pixels in the structuring element cover on pixels in the image

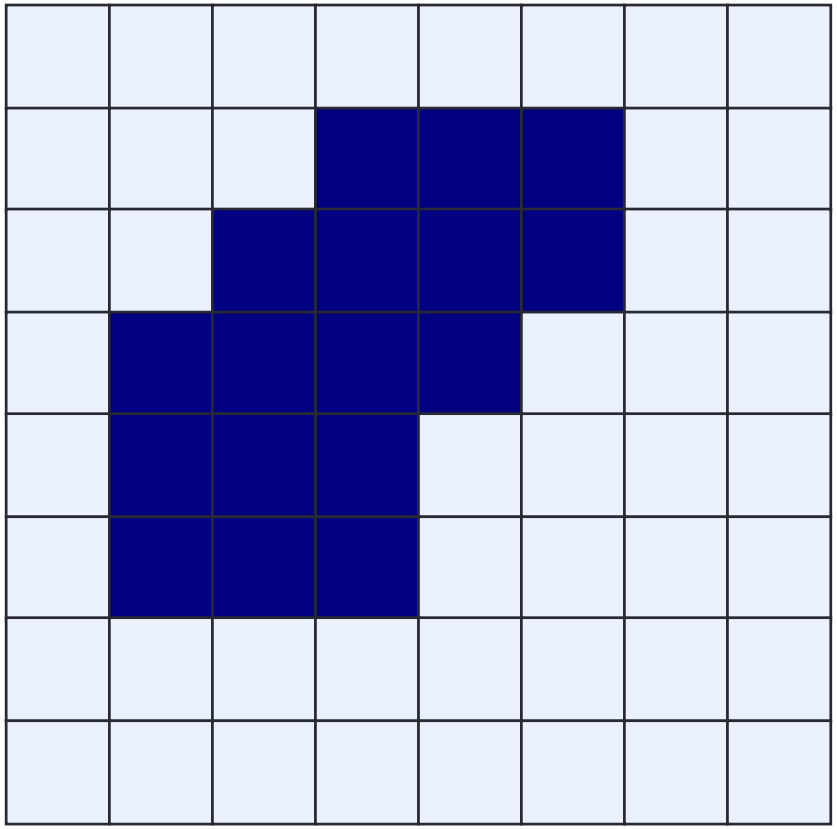
Hit: Any on pixel in the structuring element covers an on pixel in the image

“Fit” Operation – Erosion

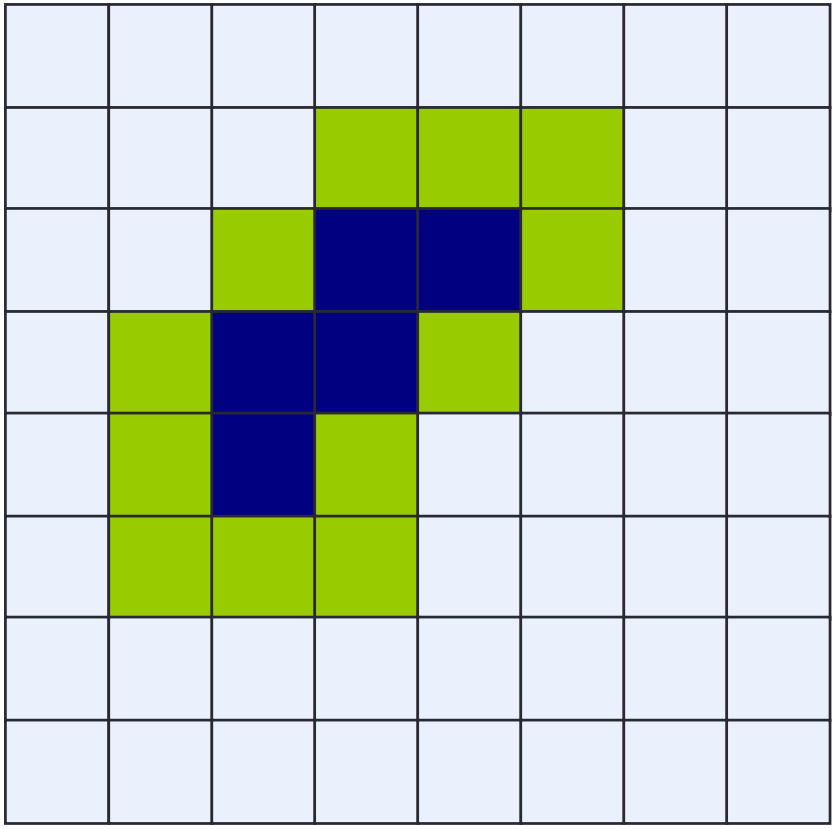


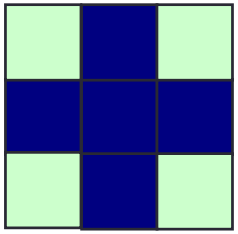
“Fit” Operation – Erosion

Original Image



Processed Image

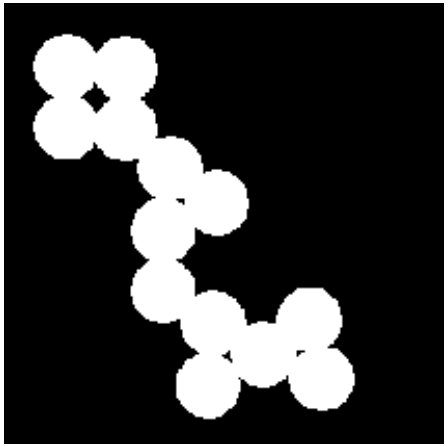


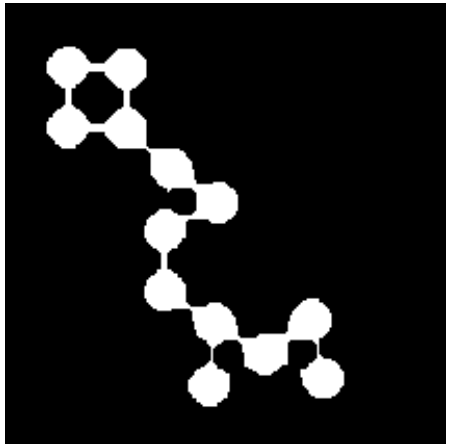


Structuring Element

imerode()

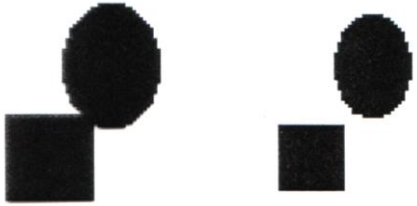
```
originalBW = imread('circles.png');
subplot( 1, 3, 1); imshow(originalBW);
se = strel('disk', 7);
erodedBW = imerode(originalBW, se);
subplot( 1, 3, 2); imshow(erodedBW);
se = strel('disk', 11);
erodedBW = imerode(originalBW, se);
subplot( 1, 3, 3); imshow(erodedBW);
```

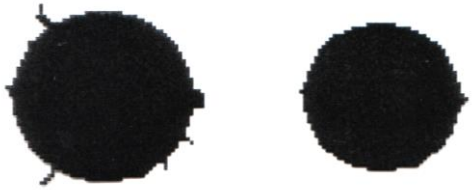




Effects of Erosion

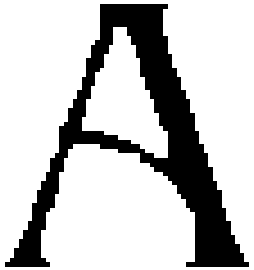
- Splitting joined objects and stripping extrusions



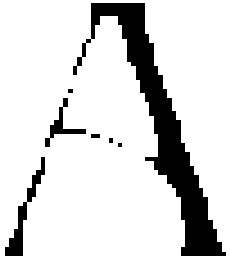


- Erosion example

Original image



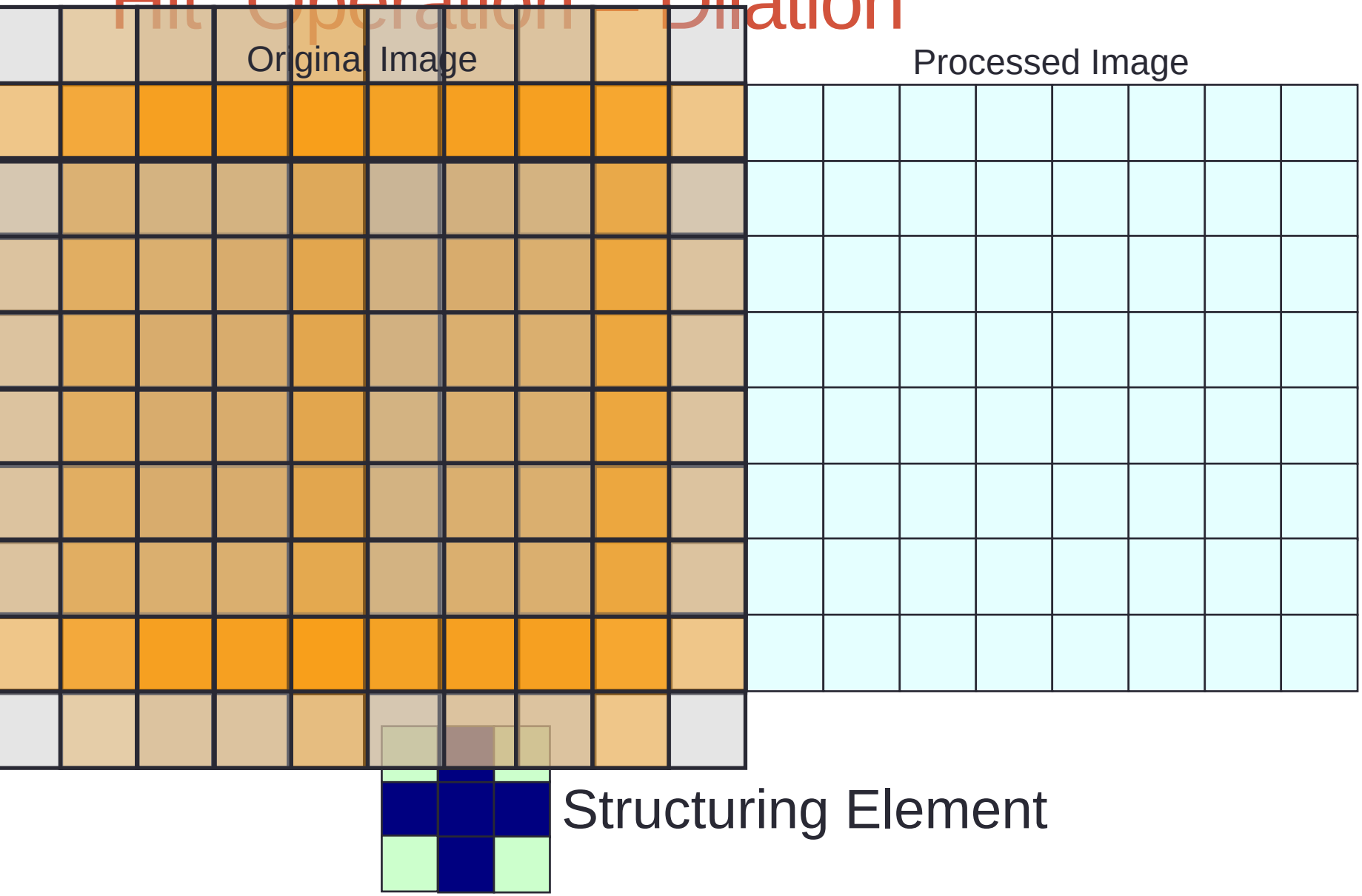
Erosion by 3×3 square structuring element



Erosion by 5×5 square structuring element

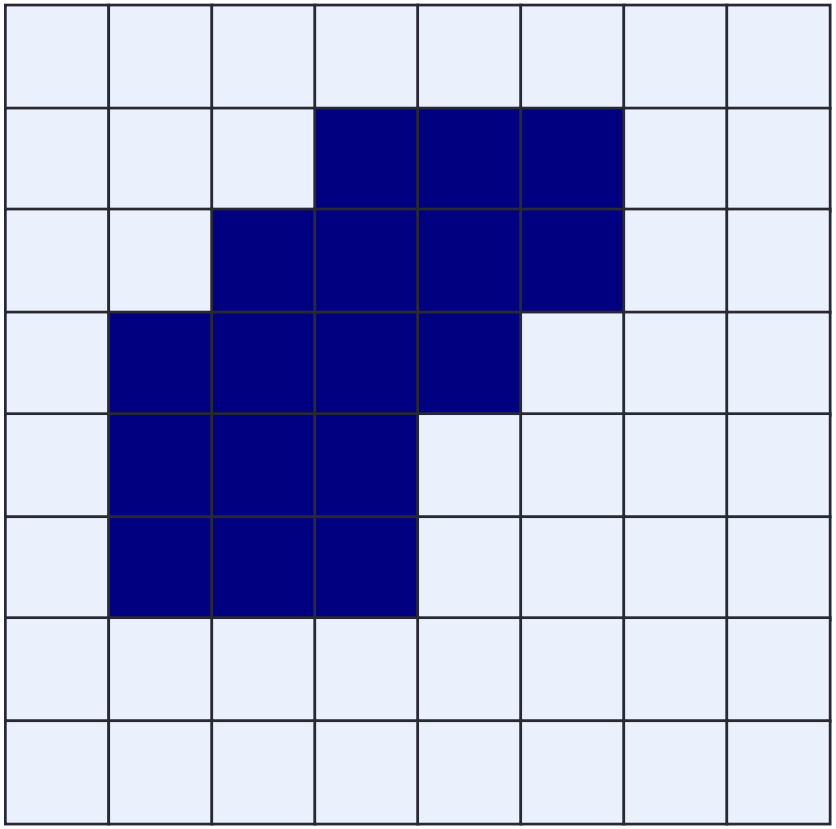
Note: In these examples a 1 refers to a black pixel!

“Hit” Operation – Dilation

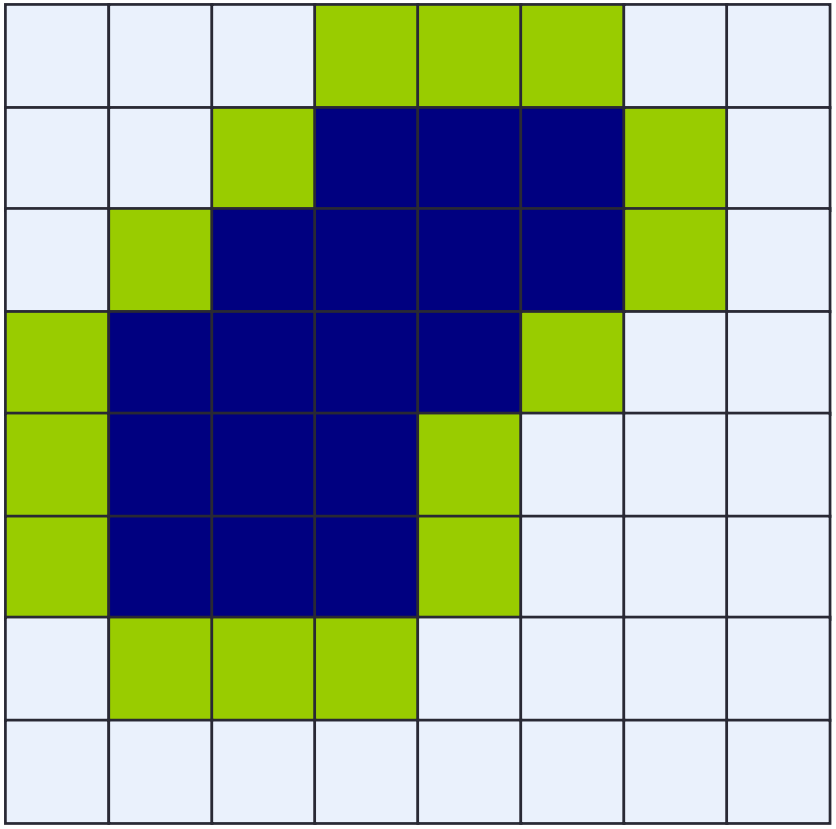


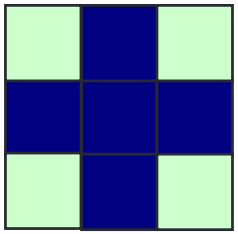
“Hit” Operation – Dilation

Original Image



Processed Image With Dilated Pixels

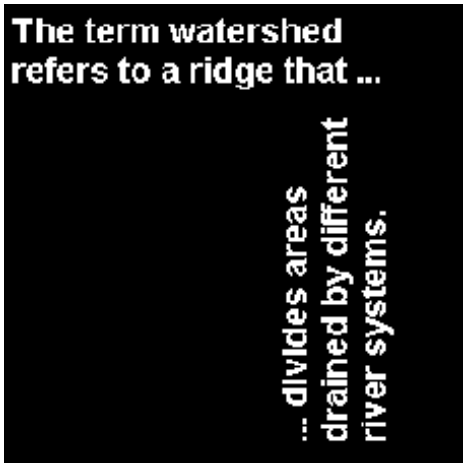




Structuring Element

imdilate()

```
bw = imread('text.png');
subplot( 1, 3, 1); imshow(bw);
se = strel('line', 11, 90);
dilatedBW = imdilate(bw, se);
subplot( 1, 3, 2); imshow(dilatedBW);
se = strel('line', 11, 0);
dilatedBW = imdilate(bw, se);
subplot( 1, 3, 3); imshow(dilatedBW);
```



Effects of Dilation

- Repairing breaks and intrusions

- Erosion example

Original image

Dilation by 3×3 square structuring element

Dilation by 5×5 square structuring element

Structuring Element

- Can be any size and make any shape
- Check `strel()`

Flat Structuring Elements	
'arbitrary'	'pair'
'diamond'	'periodicline'
'disk'	'rectangle'
'line'	'square'
'octagon'	

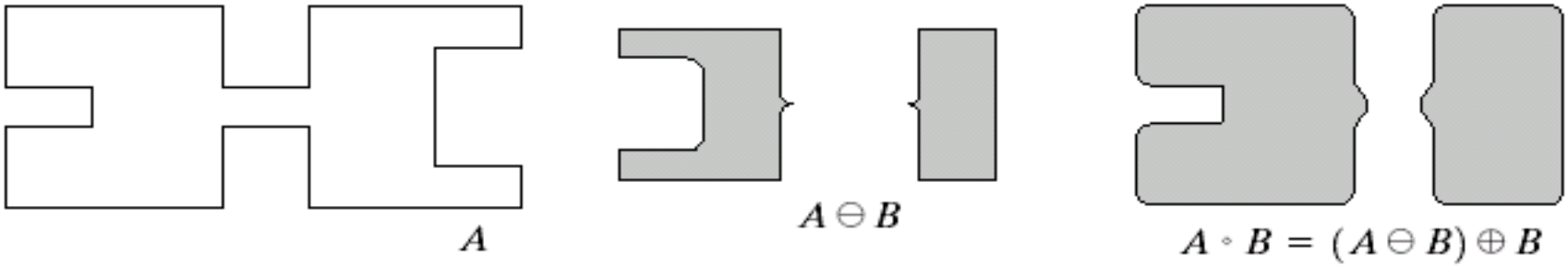
0	1	0
1	**1**	1
0	1	0

1	1	1
1	**1**	1
1	1	1

0	0	1	0	0
0	1	1	1	0
1	1	**1**	1	1
0	1	1	1	0
0	0	1	0	0

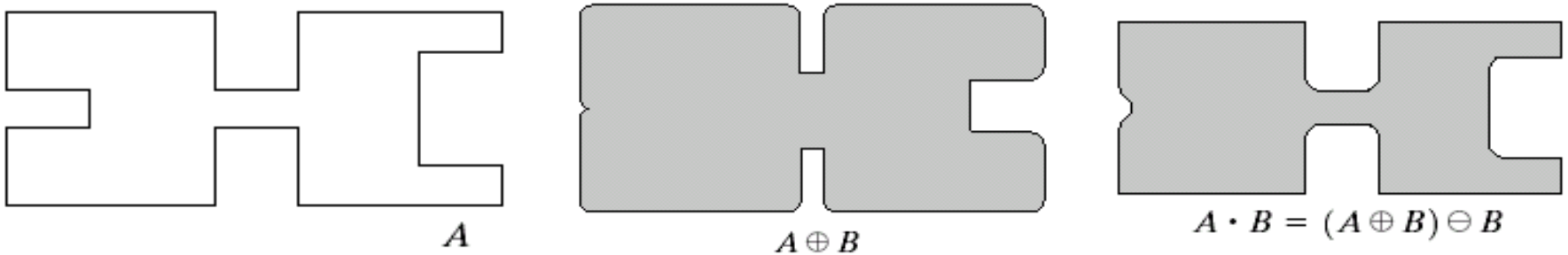
Compound Operations – Opening and Closing

- Opening: erosion → dilation



Original shape | After erosion | After dilation

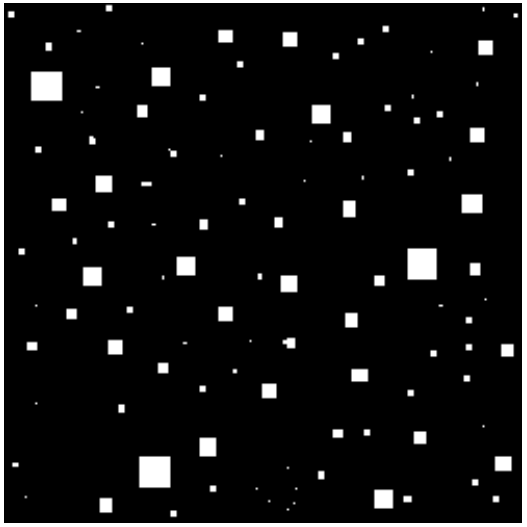
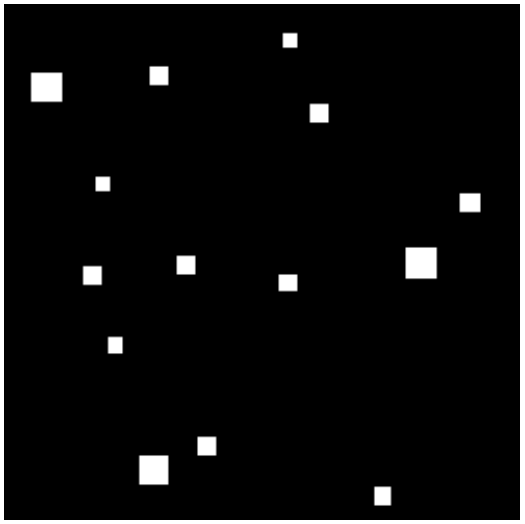
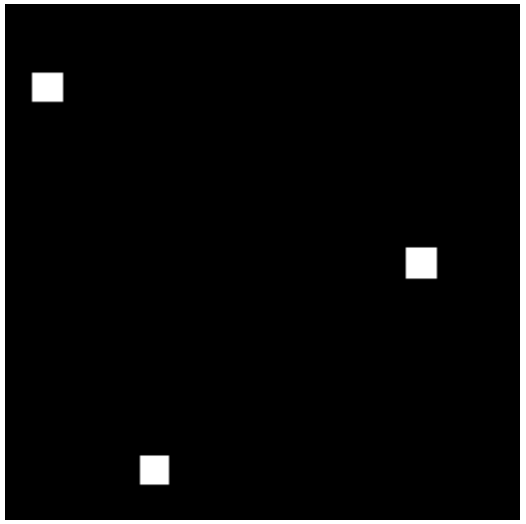
- Closing: dilation → erosion



Original shape | After dilation | After erosion

Elimination of Small Objects Using Opening

```
I = imread('07Squares_example.tif');
subplot( 1, 3, 1); imshow(I);
J = imopen( I, strel('square', 10));
subplot( 1, 3, 2); imshow(J);
K = imopen( I, strel('square', 18));
subplot( 1, 3, 3); imshow(K);
```

Fingerprint Example

```
I = imread('07FP_example.jpg');
subplot( 1, 2, 1); imshow(I);
J = imopen( I, strel('square',3));
K = imclose( J, strel('square',3));
subplot( 1, 2, 2); imshow(K);
```

End of Class