Computer Vision

CSC-455

Today's Lecture

Some Post Segmentation Operations using Morphological Operations

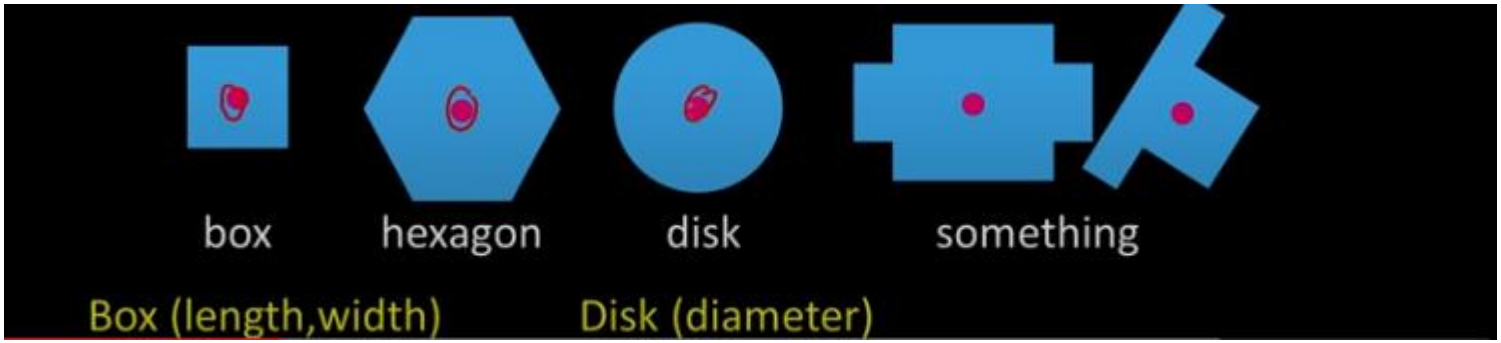
Morphological Operations

Morphological Operations. **Morphology** is a broad set of image processing **operations** that process images based on shapes. In a **morphological operation**, each pixel in the image is adjusted based on the value of other pixels in its neighborhood

Structuring Element

A shape mask used in the morphological operations

- Any shape ,size that is digitally representable
- With a defined origin



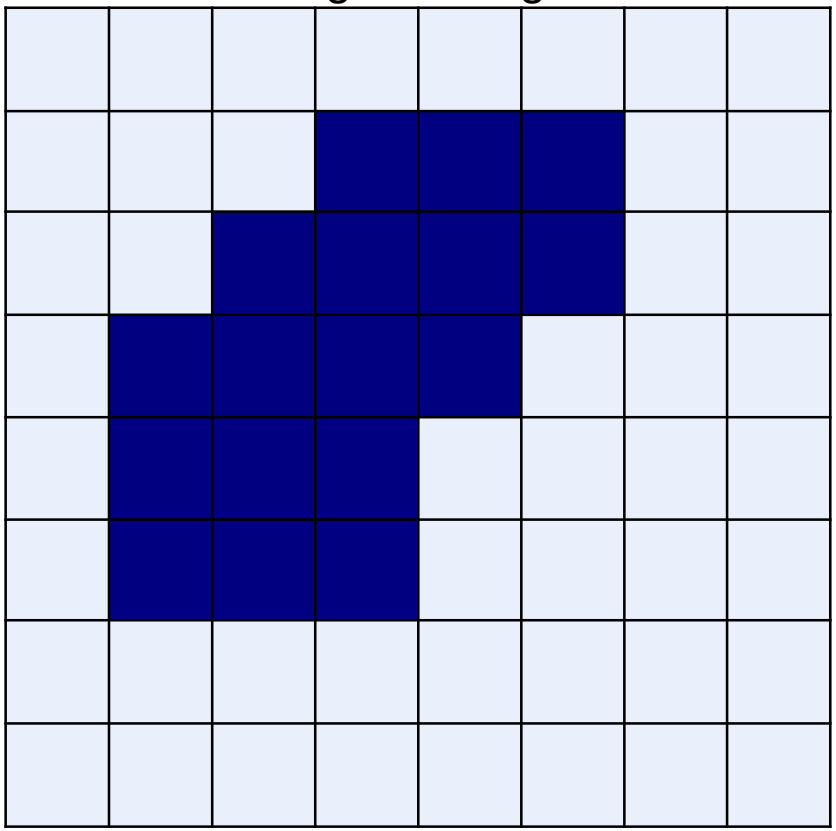
Morphology: Quick Example

Image after segmentation

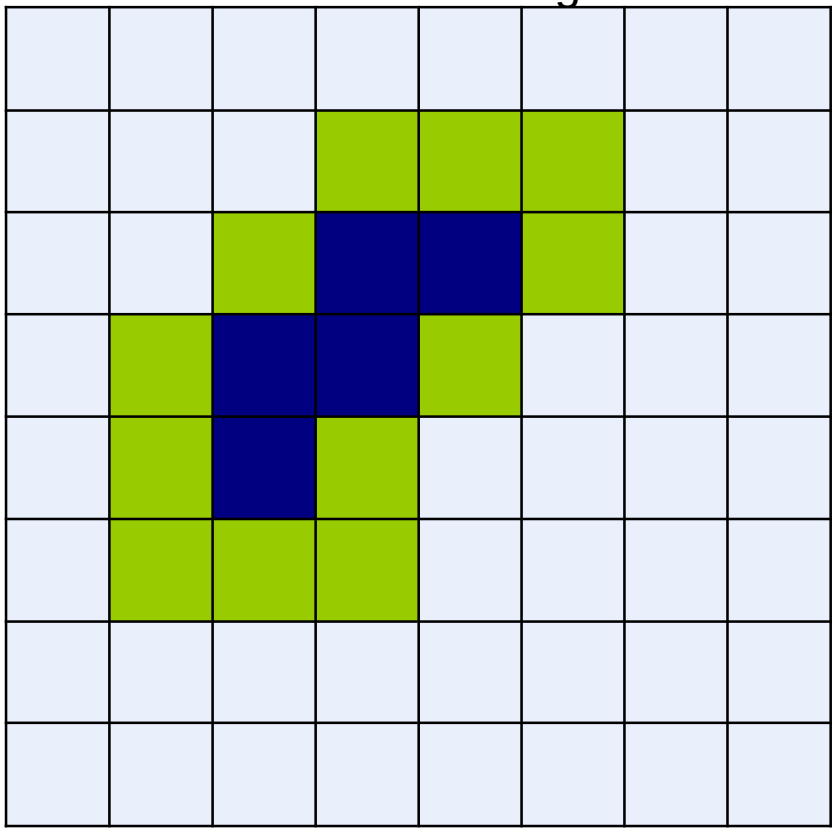
Image after segmentation and morphological processing

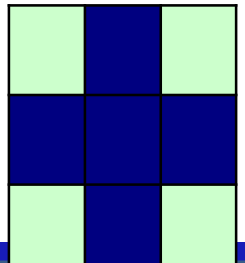
Erosion: Example

Original Image



Processed Image





Structuring Element

Erosion

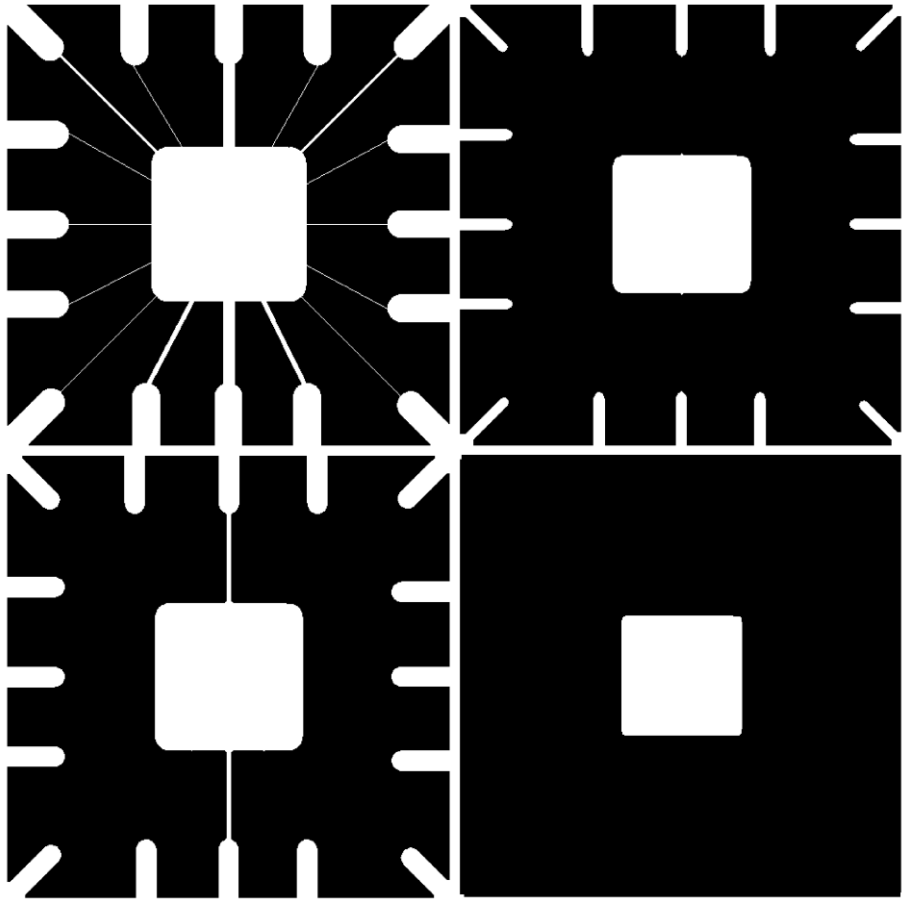
- Effects
  - Shrinks the size of foreground (1-valued) objects
  - Smoothes object boundaries
  - Removes small objects

- Rule for Erosion

  In a binary image, if any of the pixel (in the neighborhood defined by structuring element) is 0, then output is 0

$$g(x,y) = \begin{cases} 1 \text{ if } s \text{ fits } f \\ 0 \text{ otherwise} \end{cases}$$

Erosion: Example 1



Original image

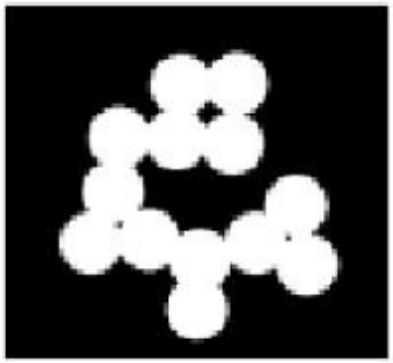
After erosion with a disc of radius 10

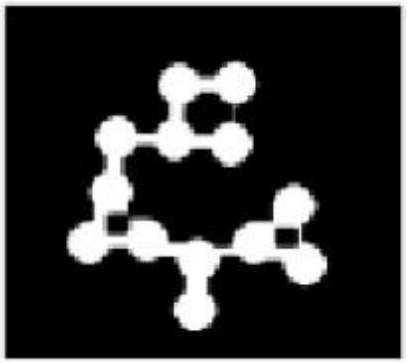
After erosion with a disc of radius 5

After erosion with a disc of radius 20

Erosion: Example 2

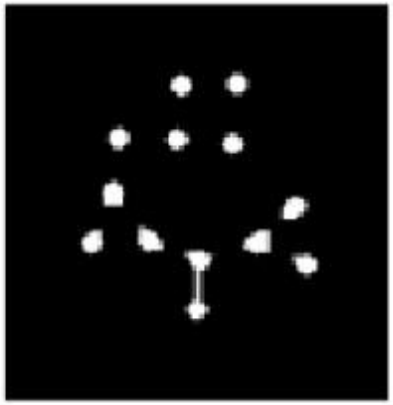
Original binary image *circles*

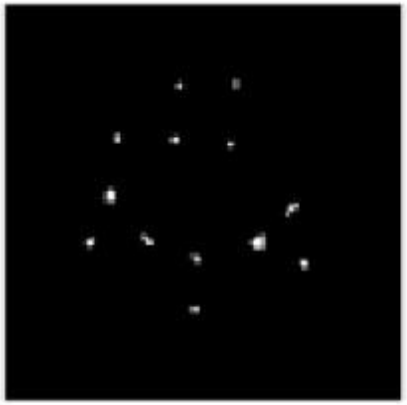




Erosion by 11x11 structuring element

Erosion by 21x21 structuring element



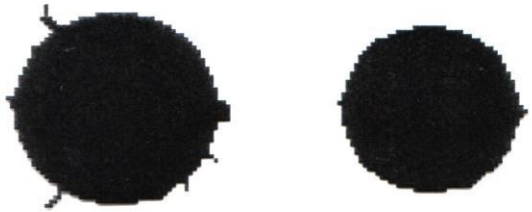


Erosion by 27x27 structuring element

Erosion

Erosion can split apart joined objects

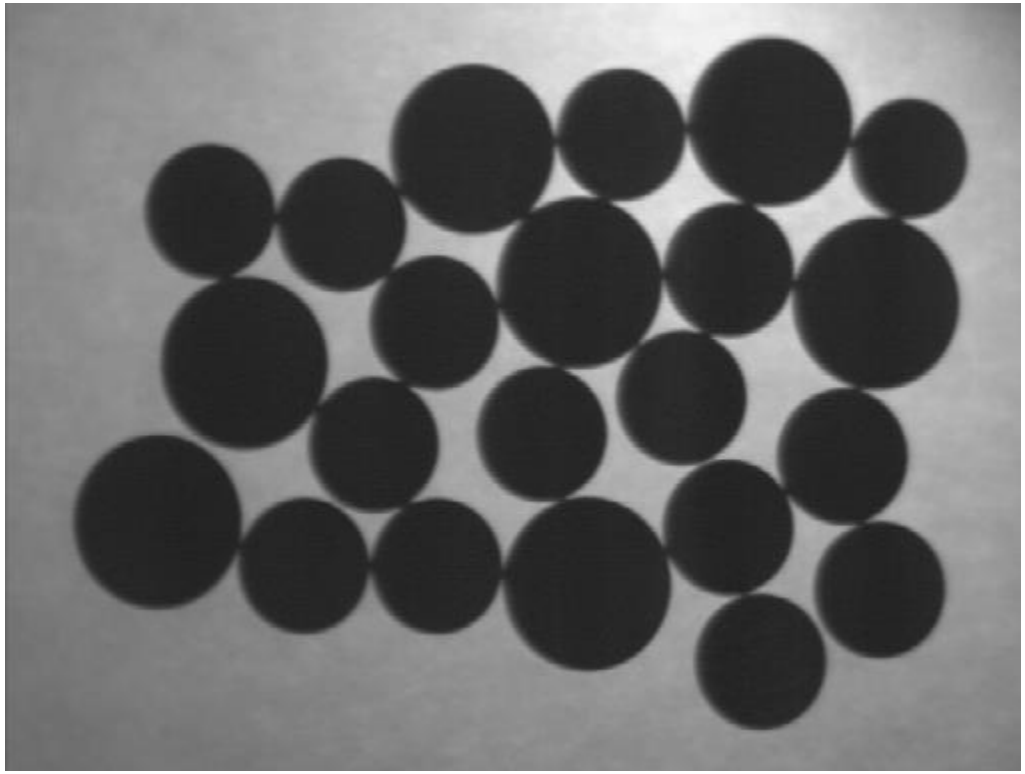
Erosion can strip away extrusions



Watch out: Erosion shrinks objects

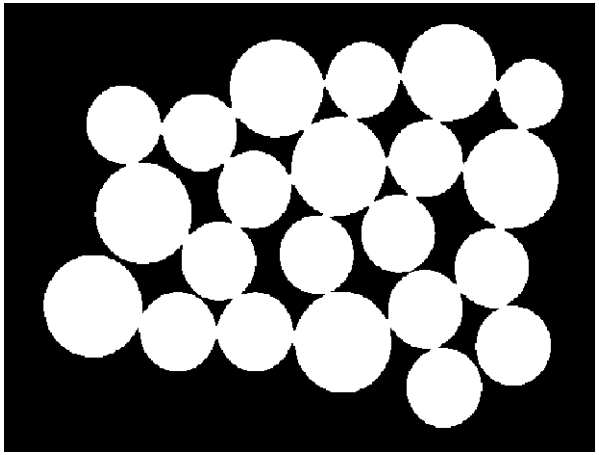
Exercise

Count the number of coins in the given image

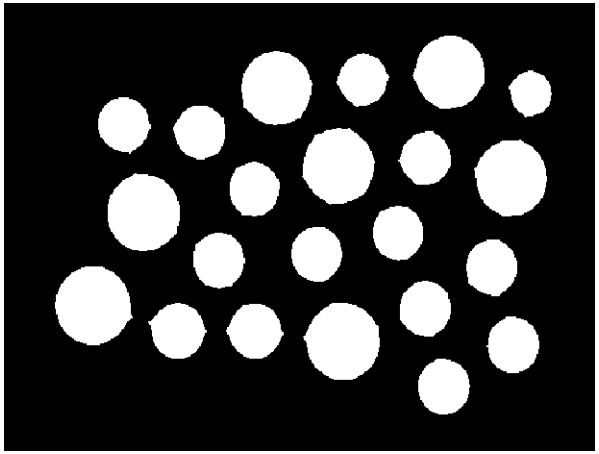


Exercise: Solution

Binarize the image



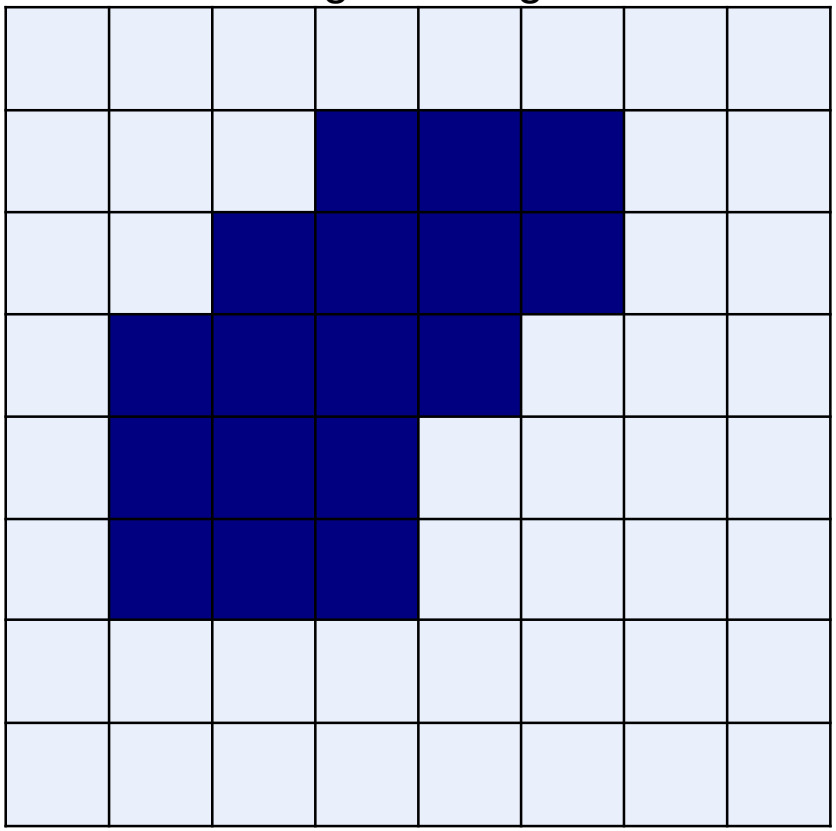
Perform Erosion



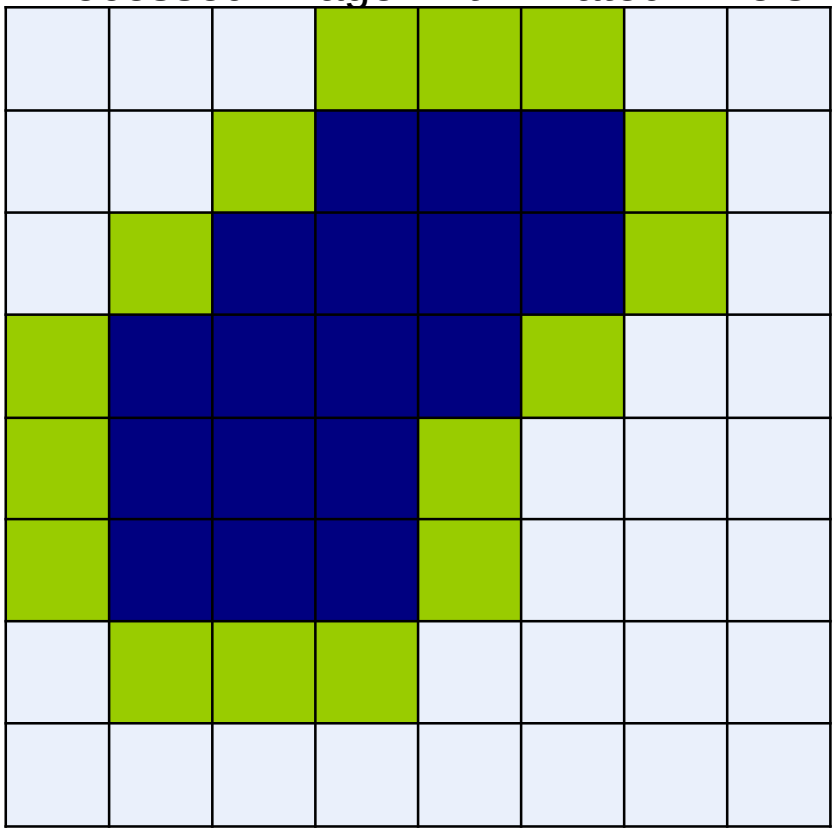
Use connected component labeling to count the number of coins

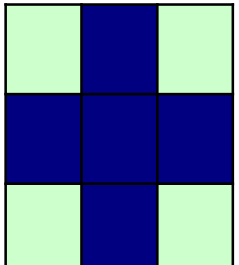
Dilation: Example

Original Image



Processed Image With Dilated Pixels





Structuring Element

Dilation

- Effects
  - Expands the size of foreground(1-valued) objects
  - Smoothes object boundaries
  - Closes holes and gaps

- Rule for Dilation

  In a binary image, if any of the pixel (in the neighborhood defined by structuring element) is 1, then output is 1

$$g(x,y) = \begin{cases} 1 \text{ if } s \text{ hits } f \\ 0 \text{ otherwise} \end{cases}$$

Dilation: Example 1

Original image

Dilation by 3*3 square structuring element

Dilation by 5*5 square structuring element

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

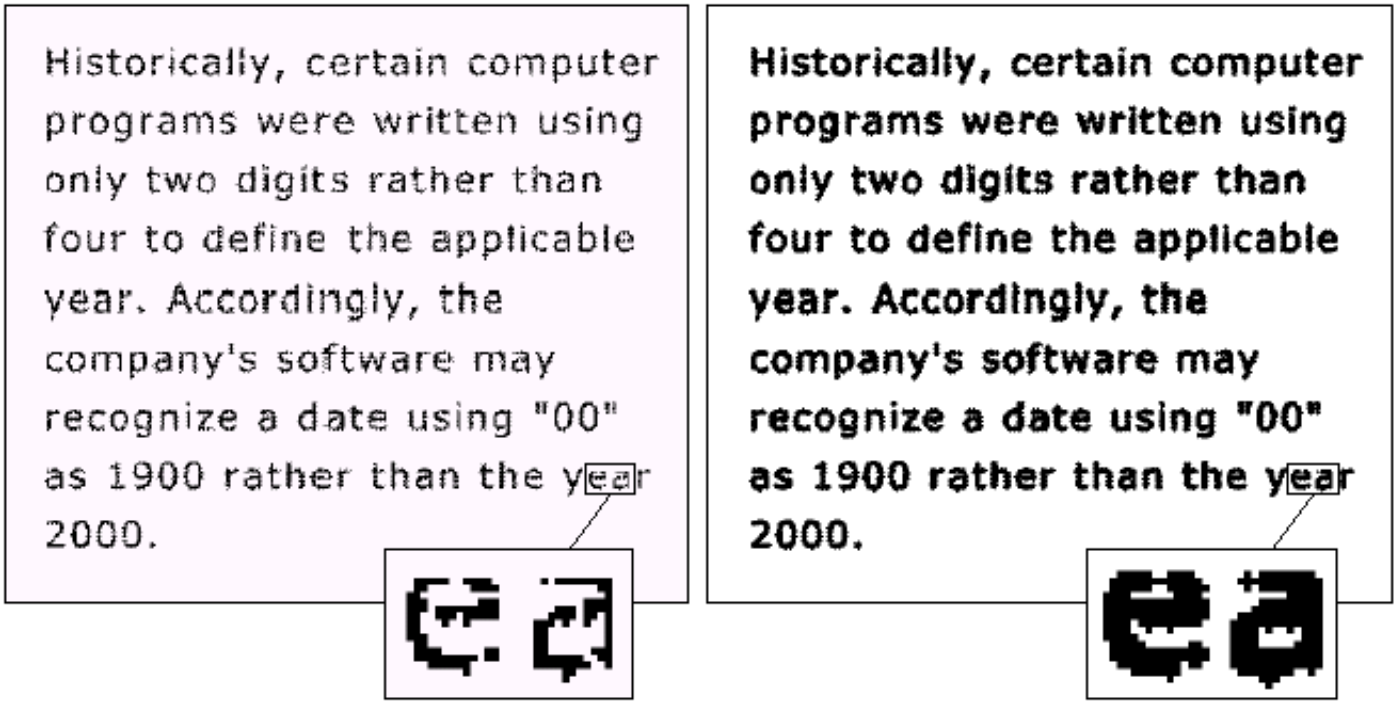
Dilation: Example 2

Original (178x178)

dilation with
3x3 structuring element

dilation with
7x7 structuring element

Dilation: Example 3



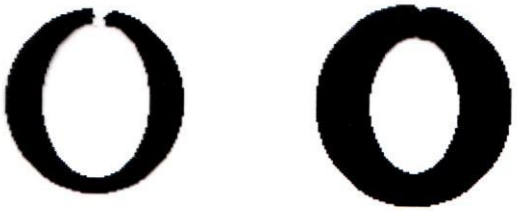
a c
b

FIGURE 9.5
(a) Sample text of poor resolution with broken characters (magnified view). (b) Structuring element. (c) Dilation of (a) by (b). Broken segments were joined.

0	1	0
1	1	1
0	1	0

Dilation

Dilation can repair breaks



Dilation can repair intrusions

Watch out: Dilation enlarges objects

Example

Segment A

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

Image Segment

0	1	0
1	1	1
0	1	0

Structuring Element

Segment B

Erosion A -B

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

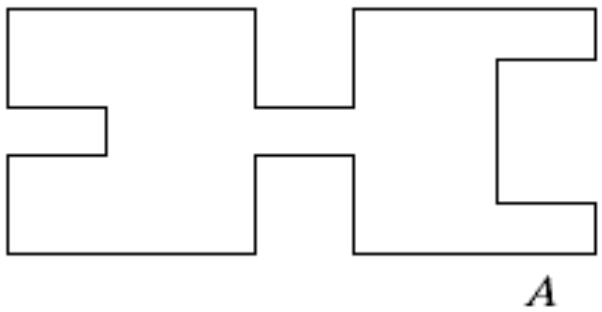
Dilation A +B

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

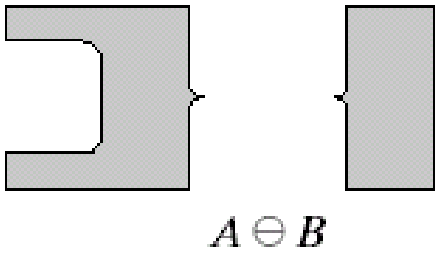
Opening

The opening of image *f* by structuring element *s*, denoted by $f \circ s$ is simply an erosion followed by a dilation

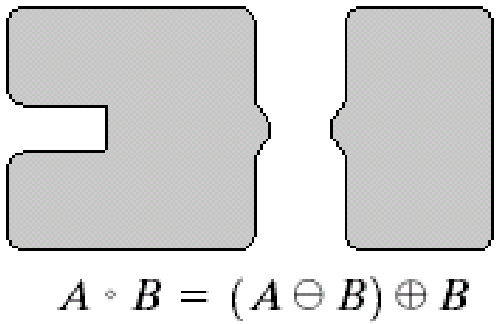
$$f \circ s = (f \ominus s) \oplus s$$



Original shape



After erosion



After dilation (opening)

Opening: Example

Original Image

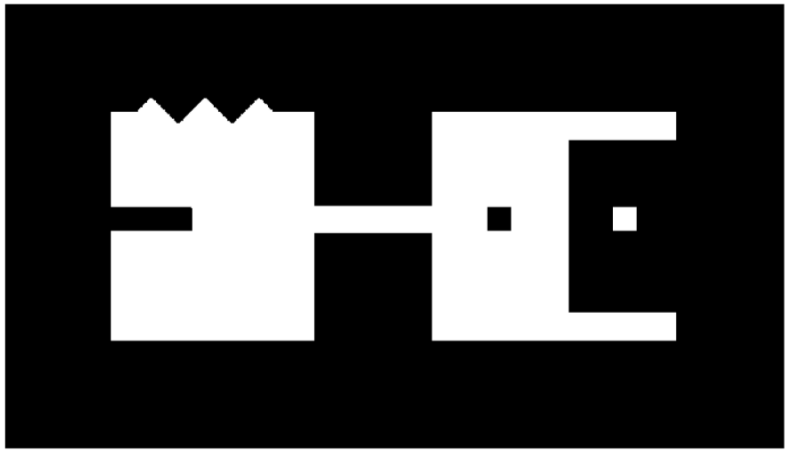
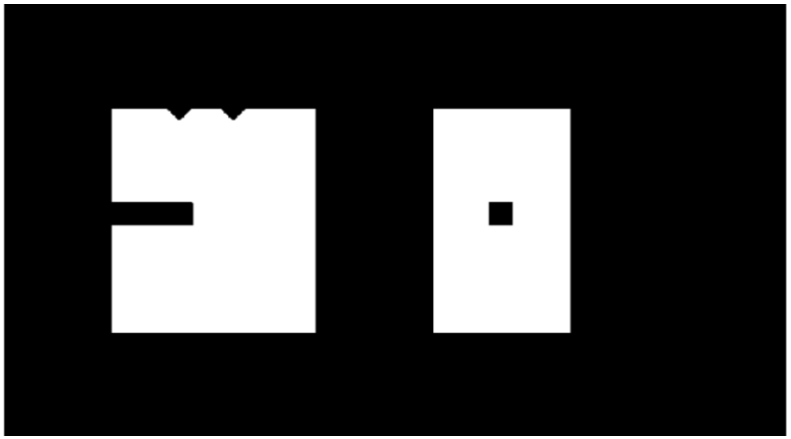


Image After Opening



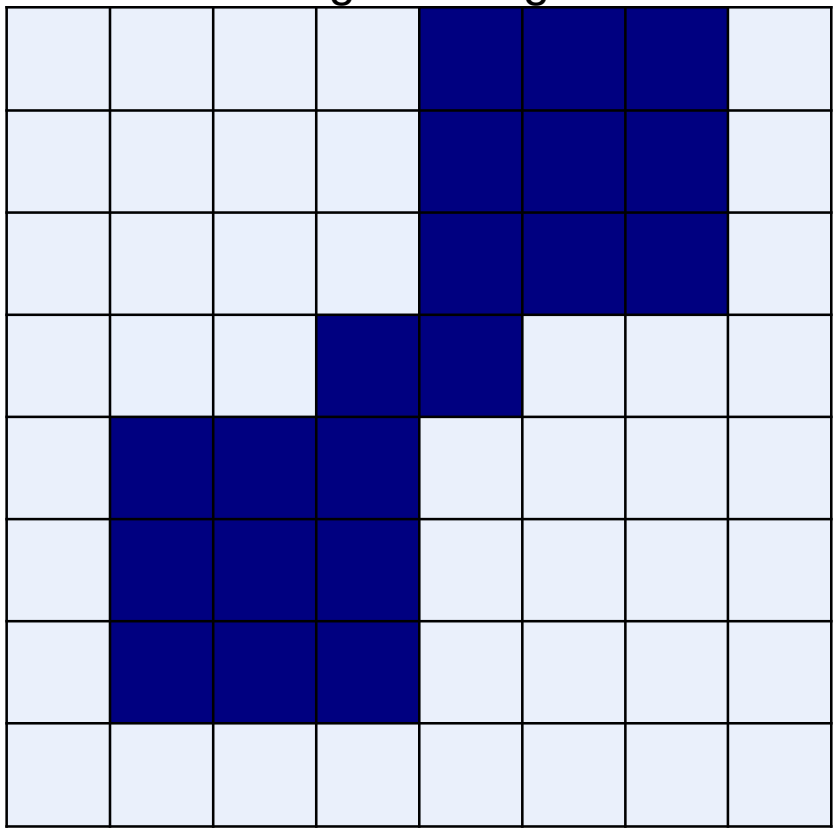
Opening

Breaks narrow joints

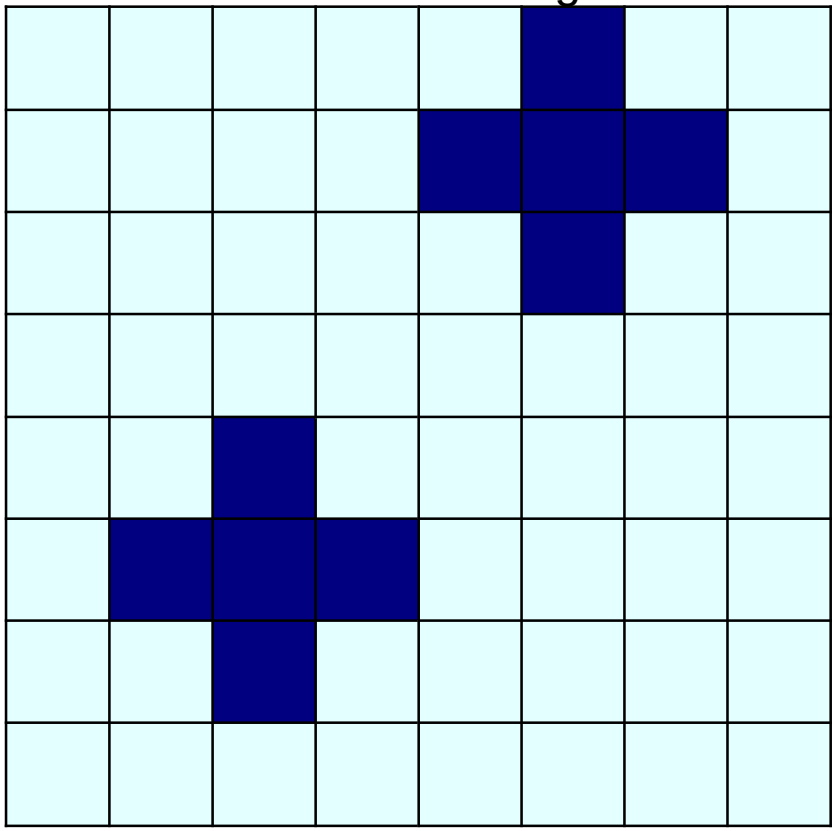
Removes ‘Salt’ noise

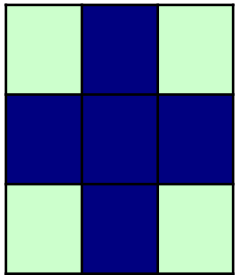
Opening: Example

Original Image



Processed Image



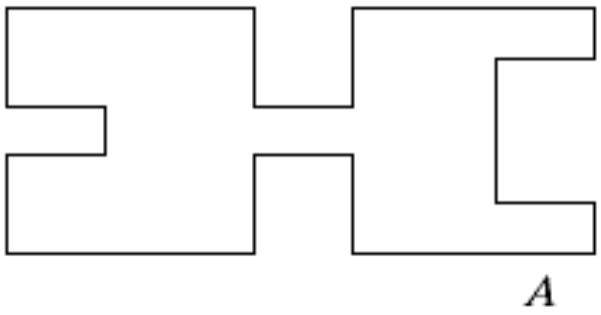


Structuring Element

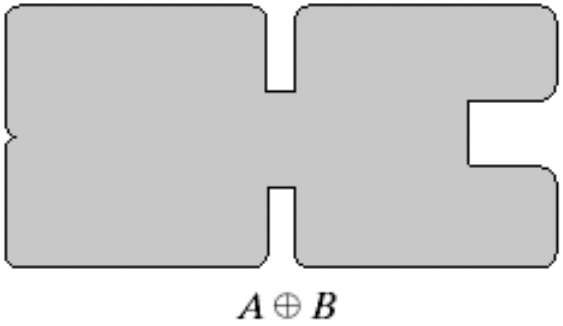
Closing

The closing of image *f* by structuring element *s*, denoted by $f \bullet s$ is simply a dilation followed by an erosion

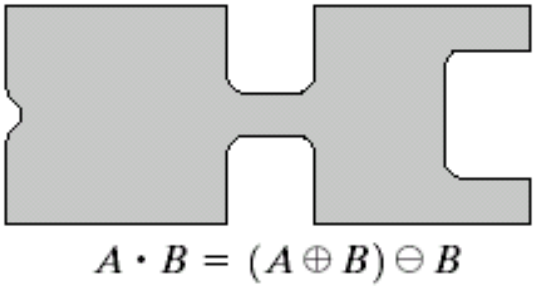
$$f \bullet s = (f \oplus s) \ominus s$$



Original shape



After dilation



After erosion (closing)

Closing: Example

Original Image

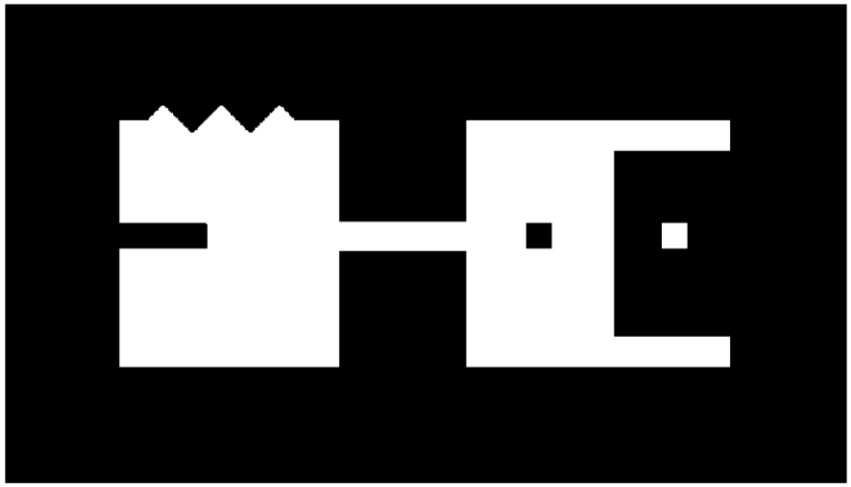
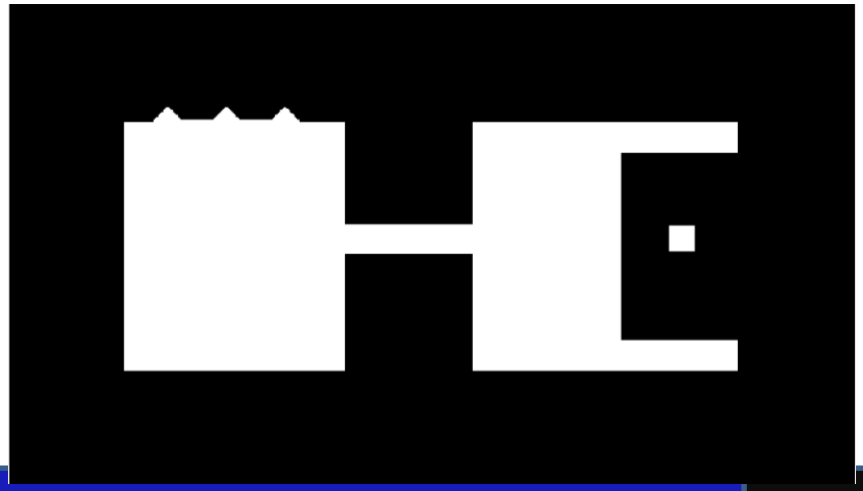


Image After Closing

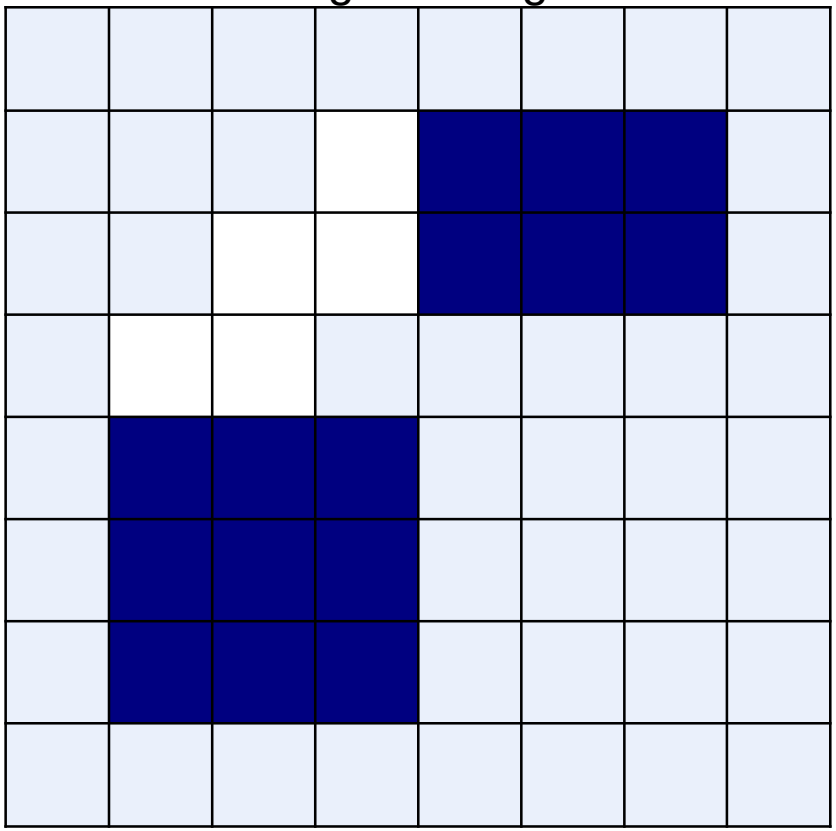


Closing

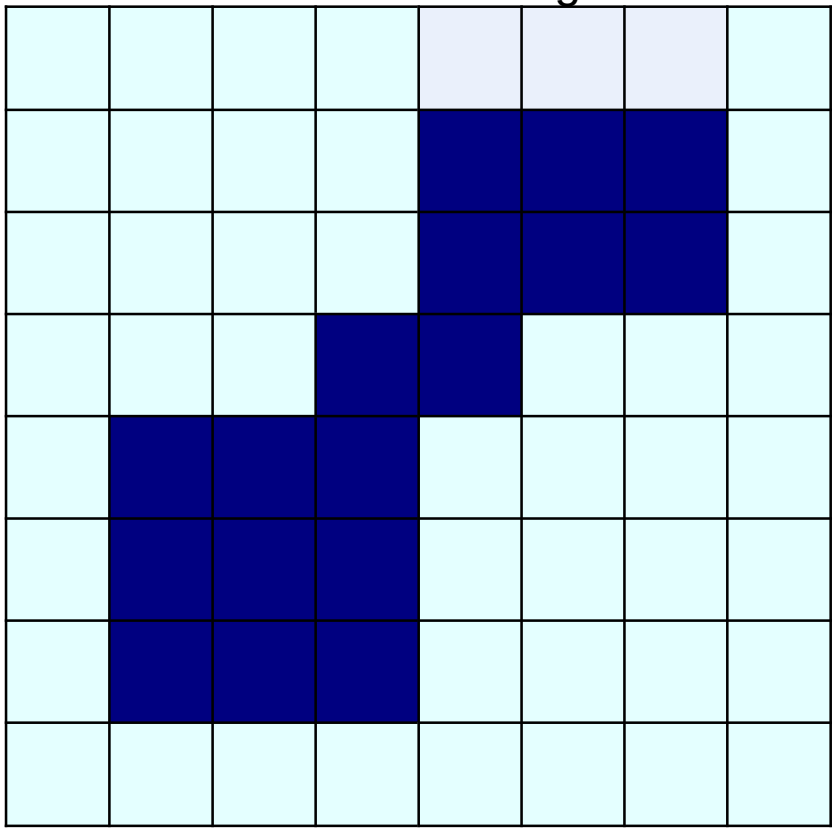
- Eliminates small holes
- Fills gaps
- Removes ‘Pepper’ noise

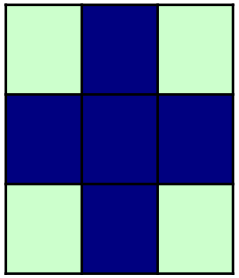
Closing: Example

Original Image



Processed Image





Structuring Element

References

- Some Slide material has been taken from Dr M. Usman Akram Computer Vision Lectures
- CSCI 1430: Introduction to Computer Vision by James Tompkin
- Statistical Pattern Recognition: A Review – A.K Jain et al., PAMI (22) 2000
- Pattern Recognition and Analysis Course – A.K. Jain, MSU
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- Digital Image Processing", Rafael C. Gonzalez & Richard E. Woods, Addison-Wesley, 2002
- Machine Vision: Automated Visual Inspection and Robot Vision", David Vernon, Prentice Hall, 1991
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- http://www.cs.cmu.edu/~16385/s18/