Morphological Image Processing

Image Processing

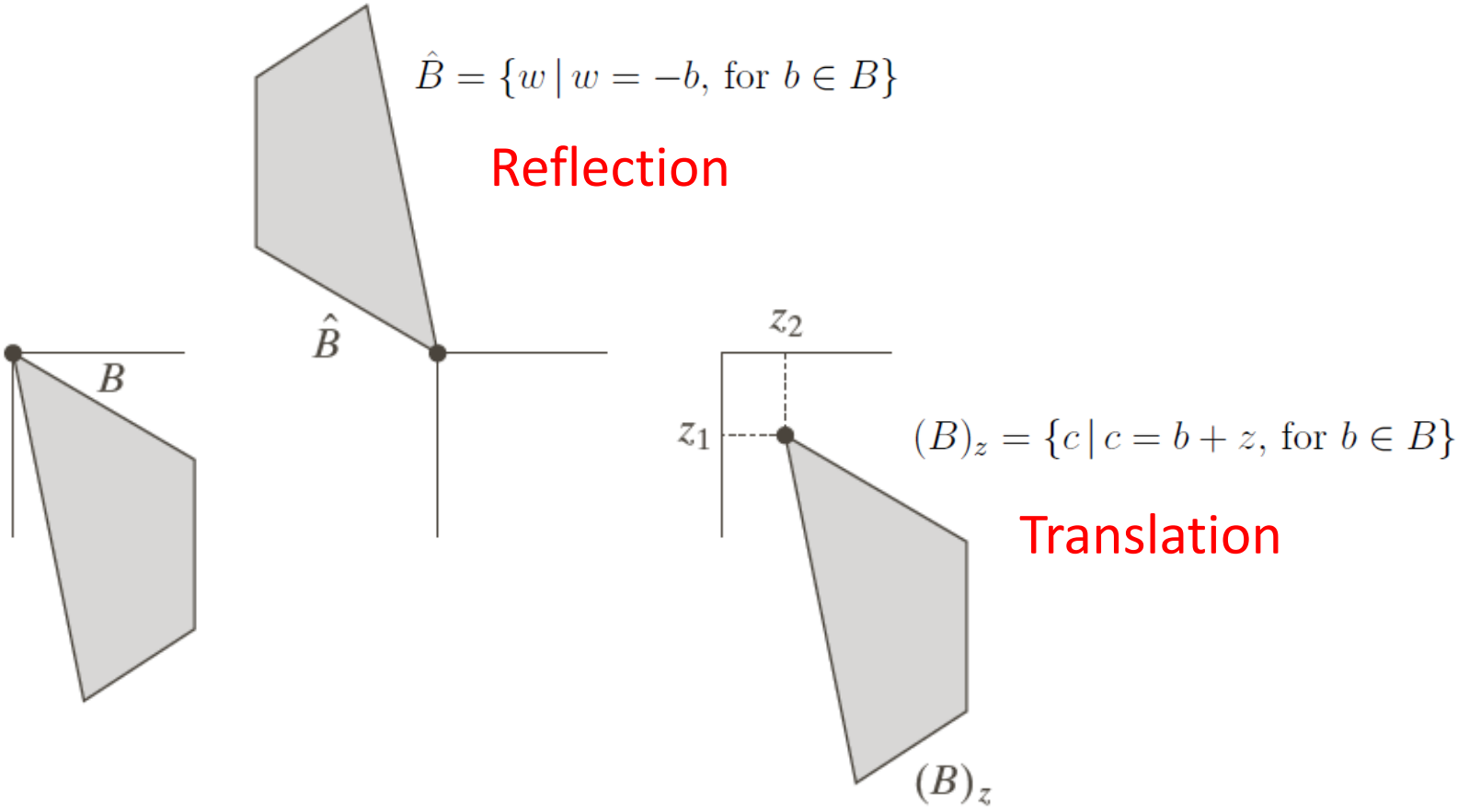
CSE 166

Lecture 15

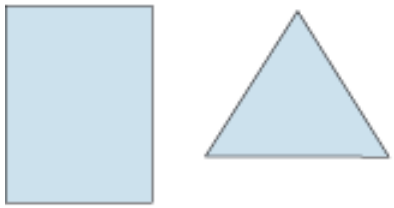
Announcements

- Assignment 4 is due today, 11:59 PM
- Reading
  - Chapter 9: Morphological image processing
    - Sections 9.1, 9.2, 9.3, and 9.5 (through subsection connected components)

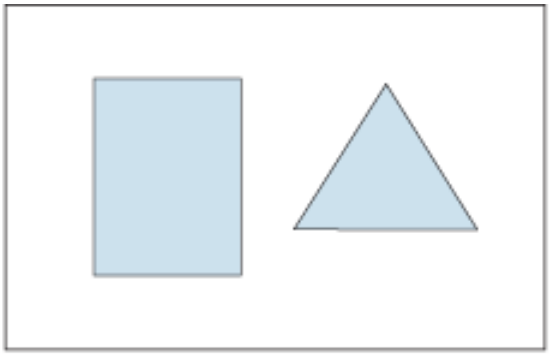
Reflection and translation



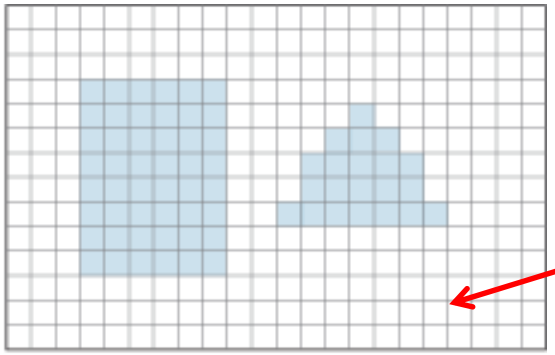
Sets of pixels: objects and structuring elements (SEs)



Objects representeed as sets



Objects represented as a graphical image



Digital image

Border of background pixels around objects

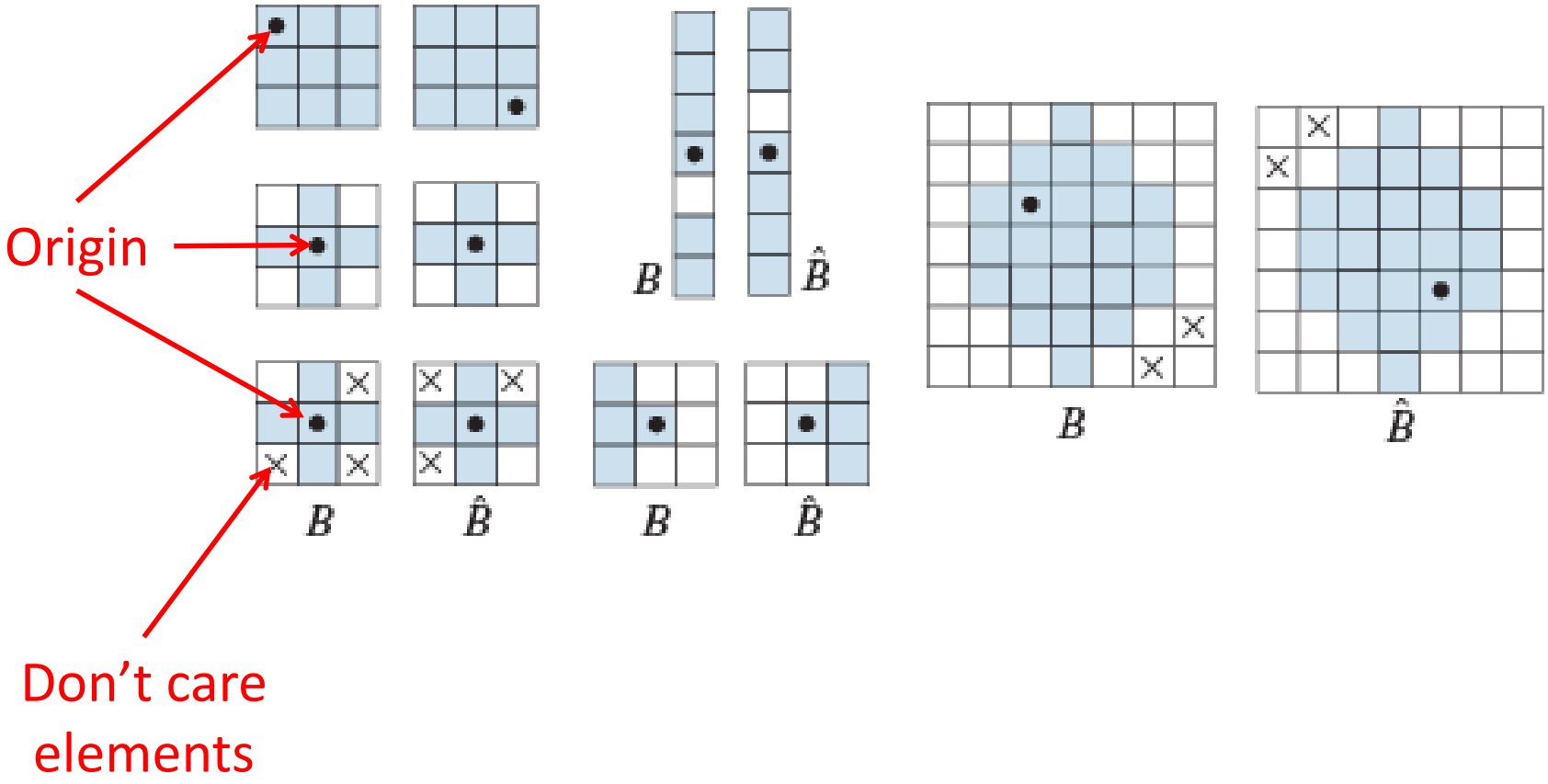
Structuring element represented as a set

Structuring element represented as a graphical image

Digital structuring element

Tight border around SE

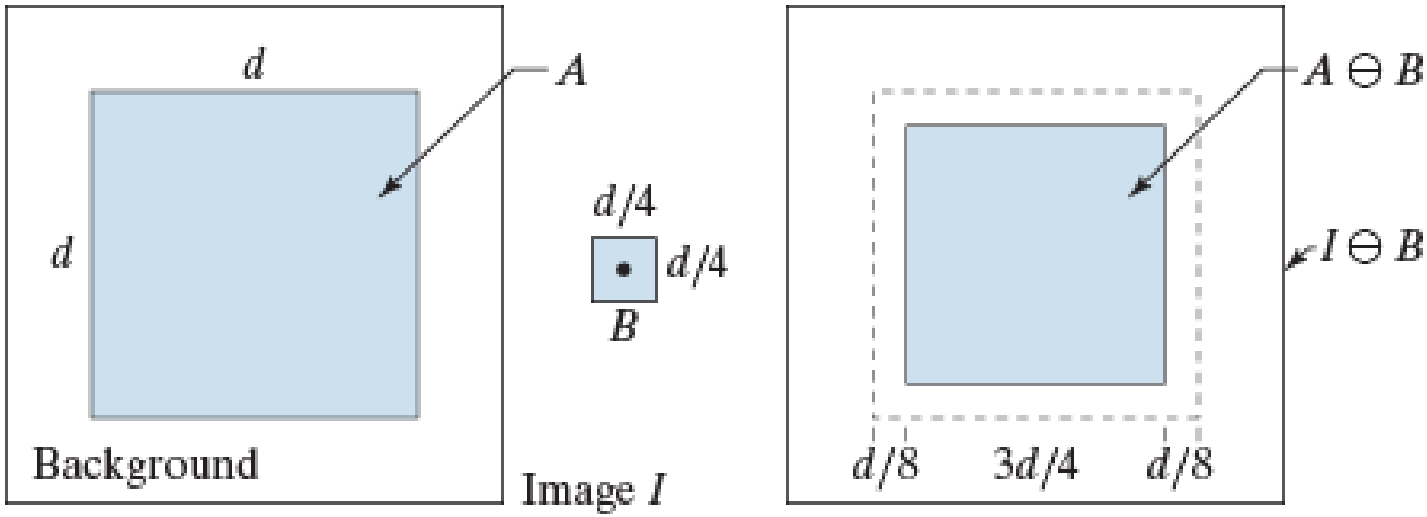
Reflection about the origin



Erosion

Example: square SE

$$A \ominus B = \{z \mid (B)_z \subseteq A\}$$



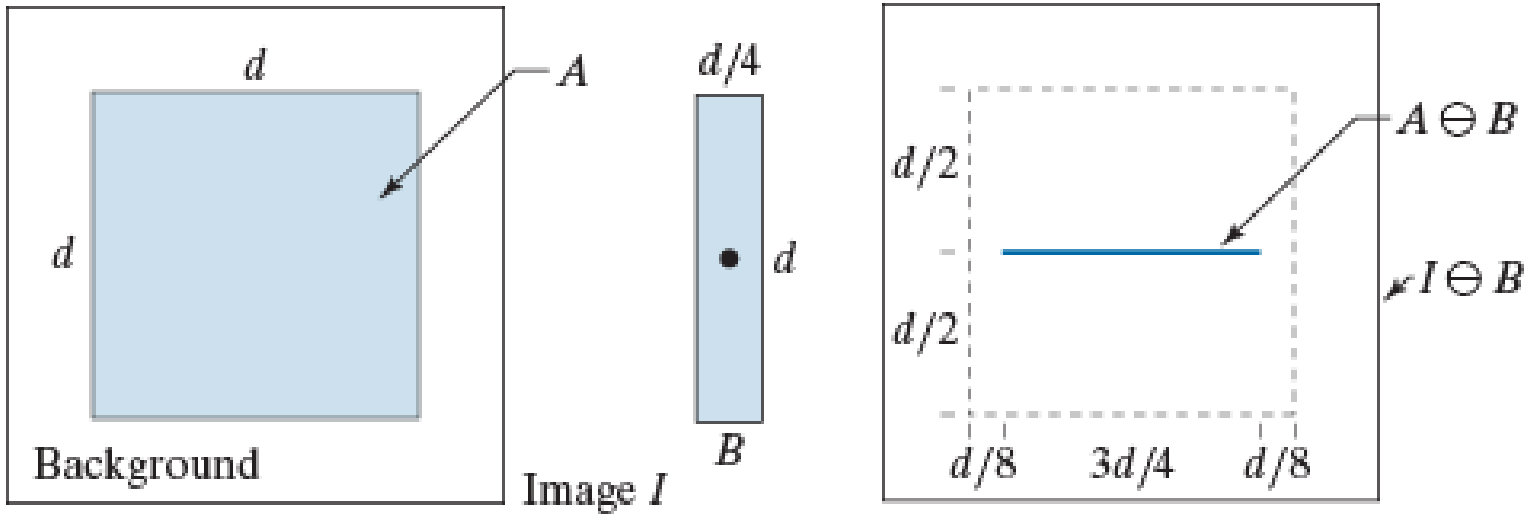
$$I \ominus B = \{z \mid (B)_z \subseteq A \text{ and } A \in I\} \cup \{A^c \mid A^c \subseteq I\}$$

Complement of A
(i.e., set of elements not in A)

Erosion

Example: elongated SE

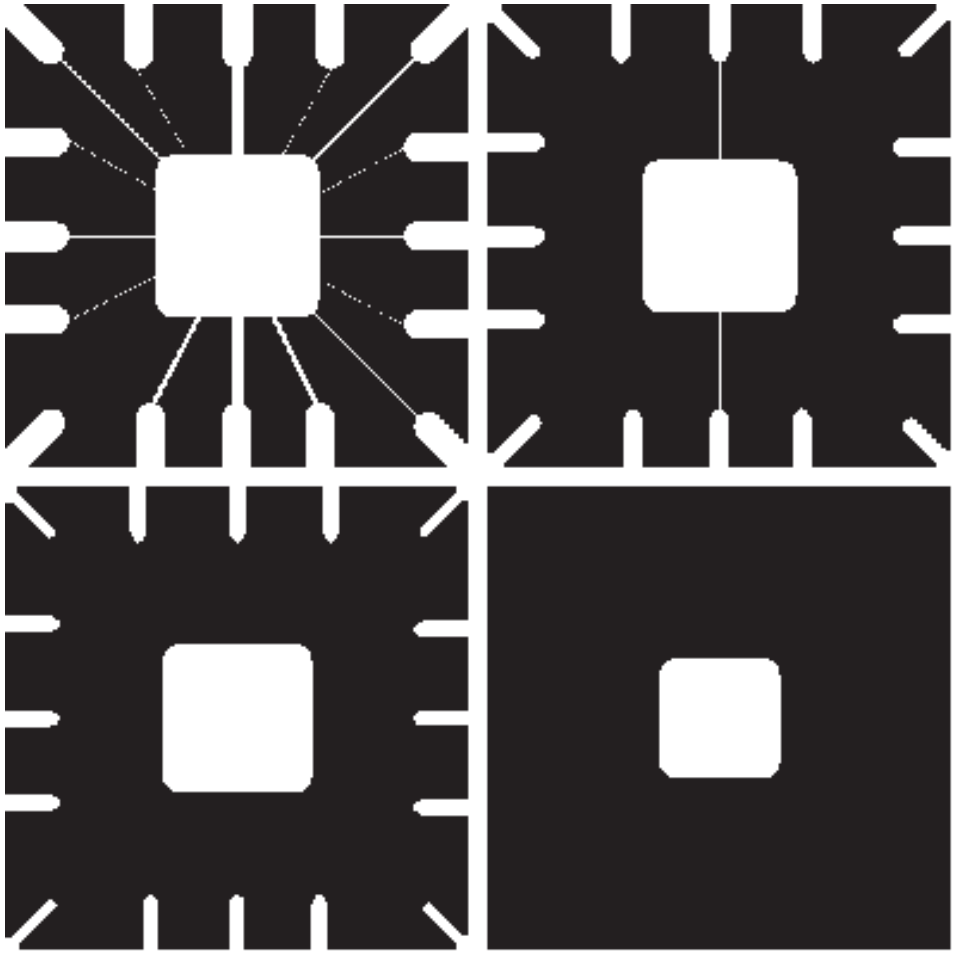
$$A \ominus B = \{z \mid (B)_z \subseteq A\}$$



$$I \ominus B = \{z \mid (B)_z \subseteq A \text{ and } A \in I\} \cup \{A^c \mid A^c \subseteq I\}$$

Erosion

Shrinks



11x11

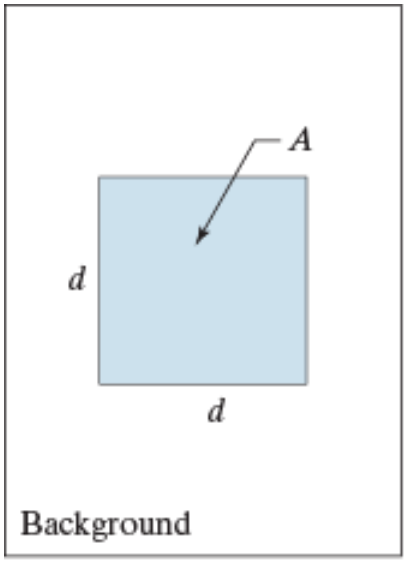
15x15

45x45

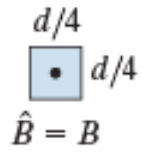
Dilation

$$A \oplus B = \{z \mid (\hat{B})_z \cap A \neq \varnothing\}$$

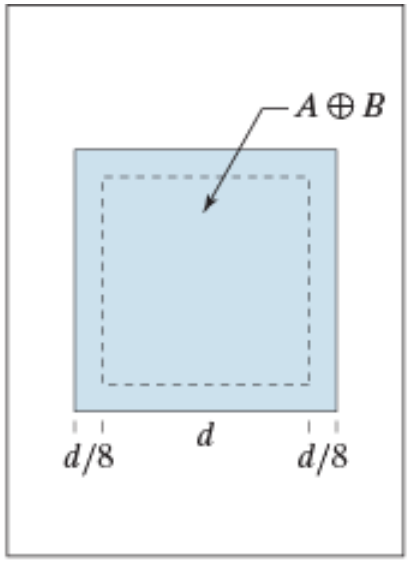
Examples



Image, I



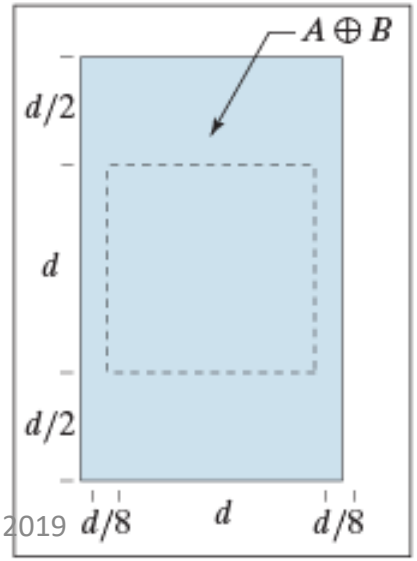
$\hat{B} = B$



$I \oplus B$

Square SE

$\hat{B} = B$

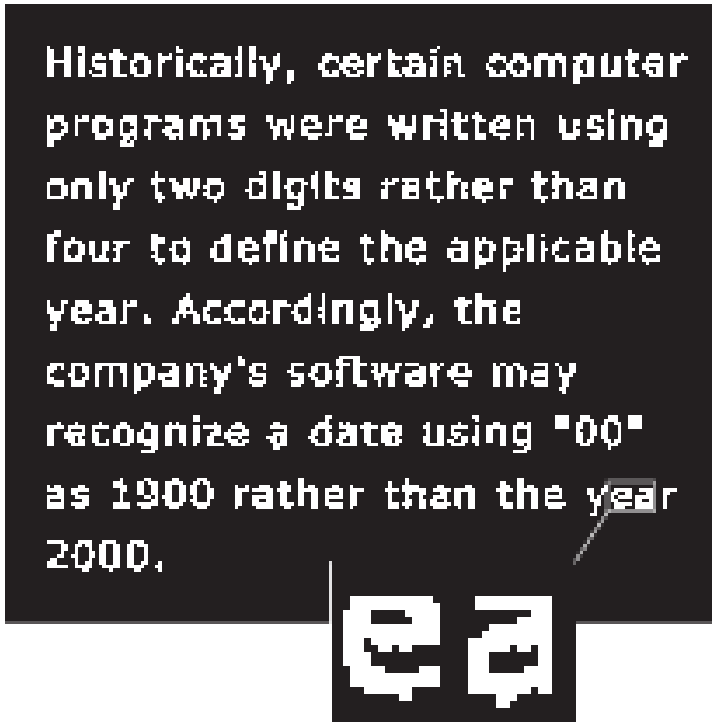


$I \oplus B$

Elongated SE

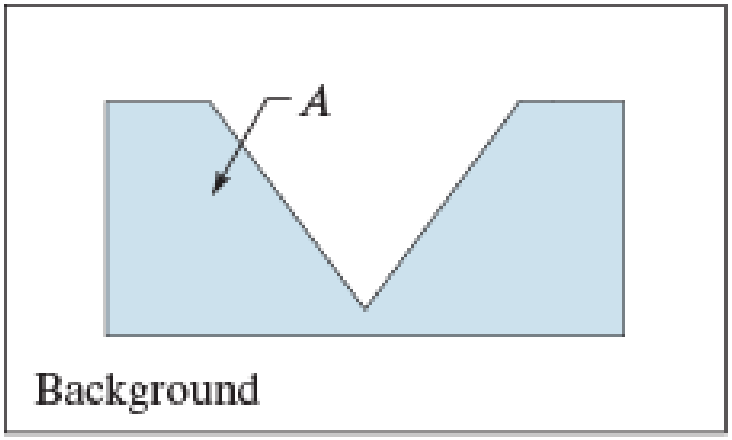
Dilation

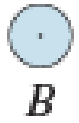
Expands



1	1	1
1	1	1
1	1	1

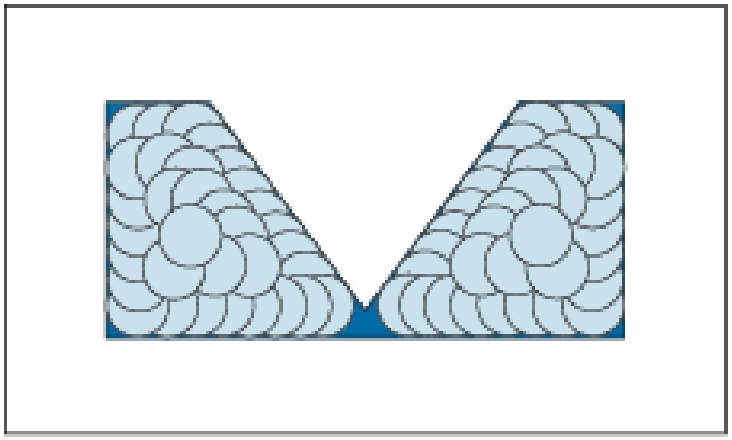
Opening

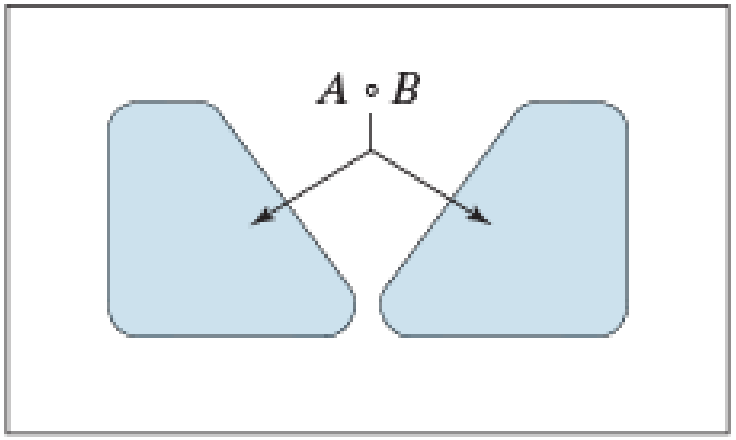




Image, I

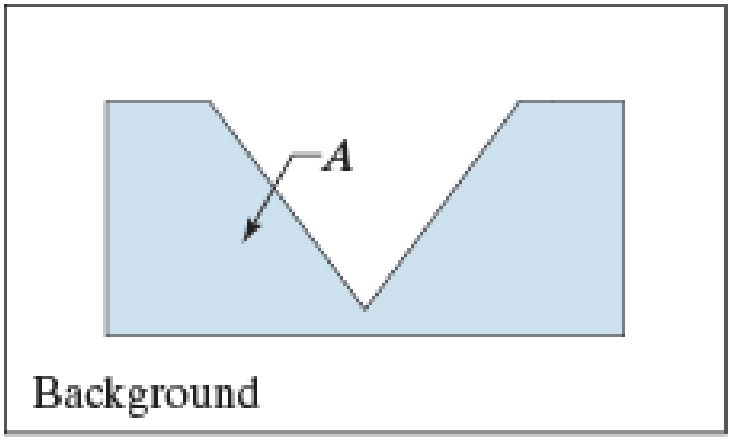
$$A \circ B = (A \ominus B) \oplus B$$

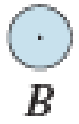




Structuring element rolls along **inner** boundary

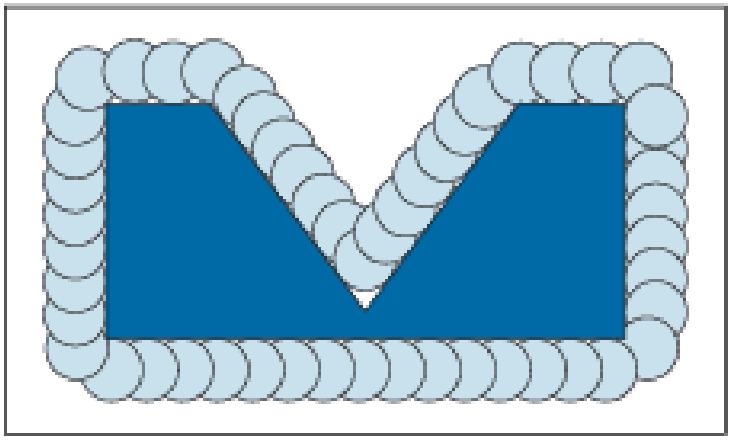
Closing

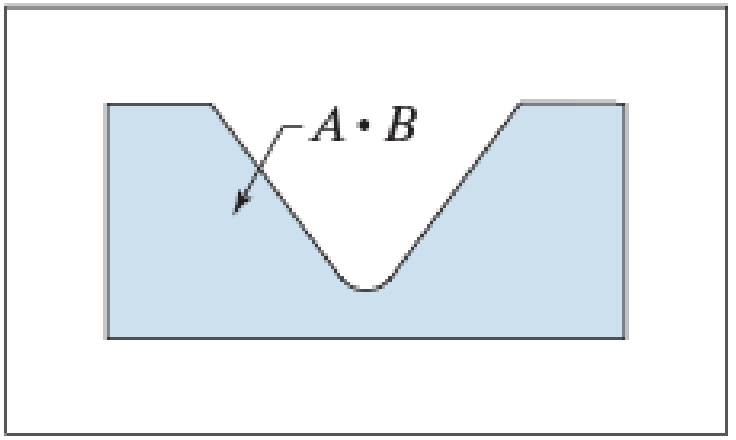




Image, I

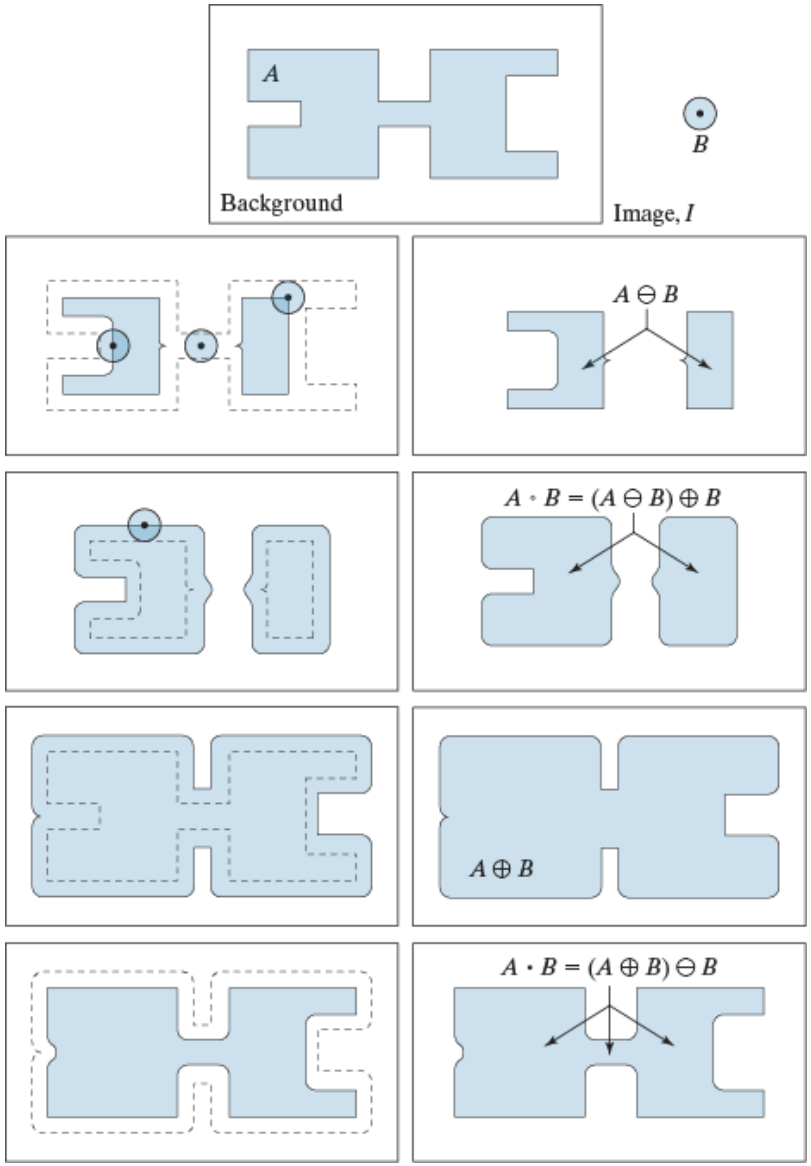
$$A \bullet B = (A \oplus B) \ominus B$$





Structuring element rolls along **outer** boundary

Opening and closing



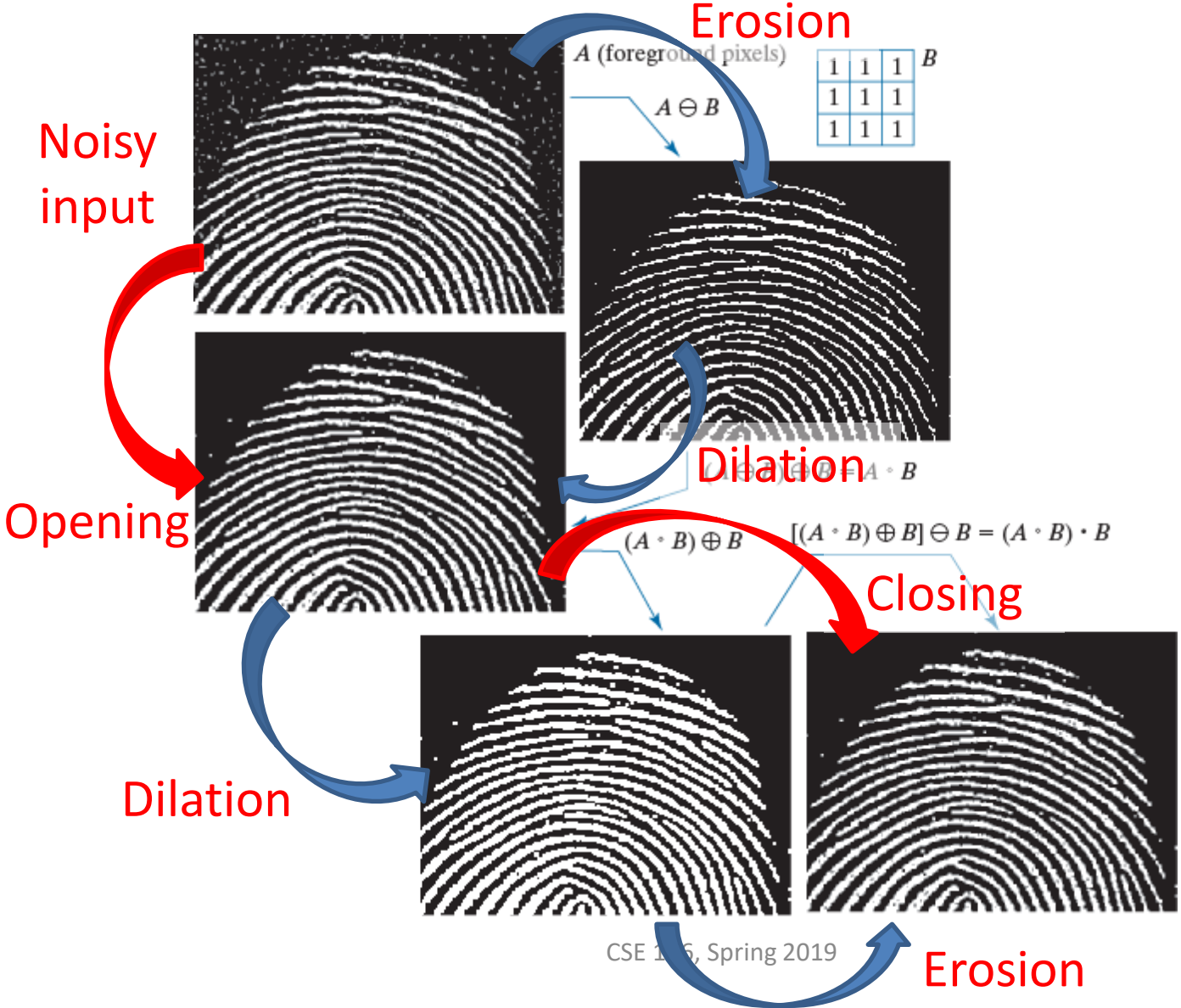
Erosion

Opening

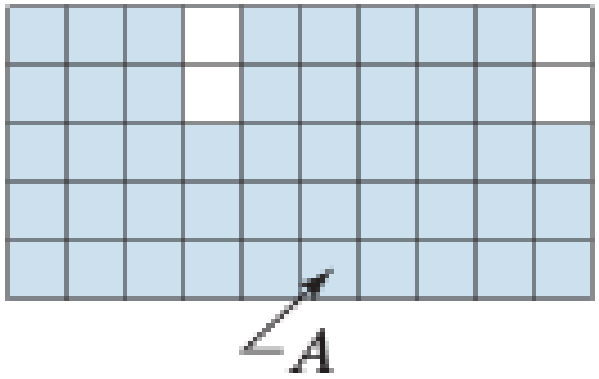
Dilation

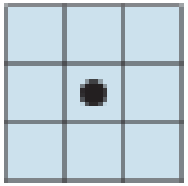
Closing

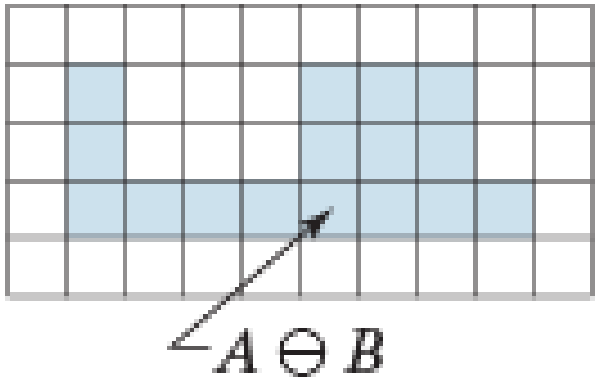
Morphological image processing



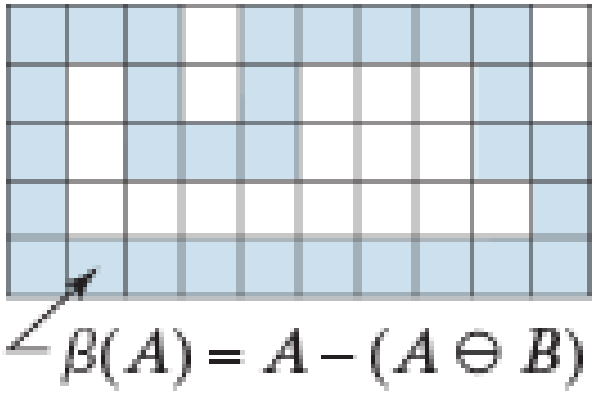
Boundary extraction





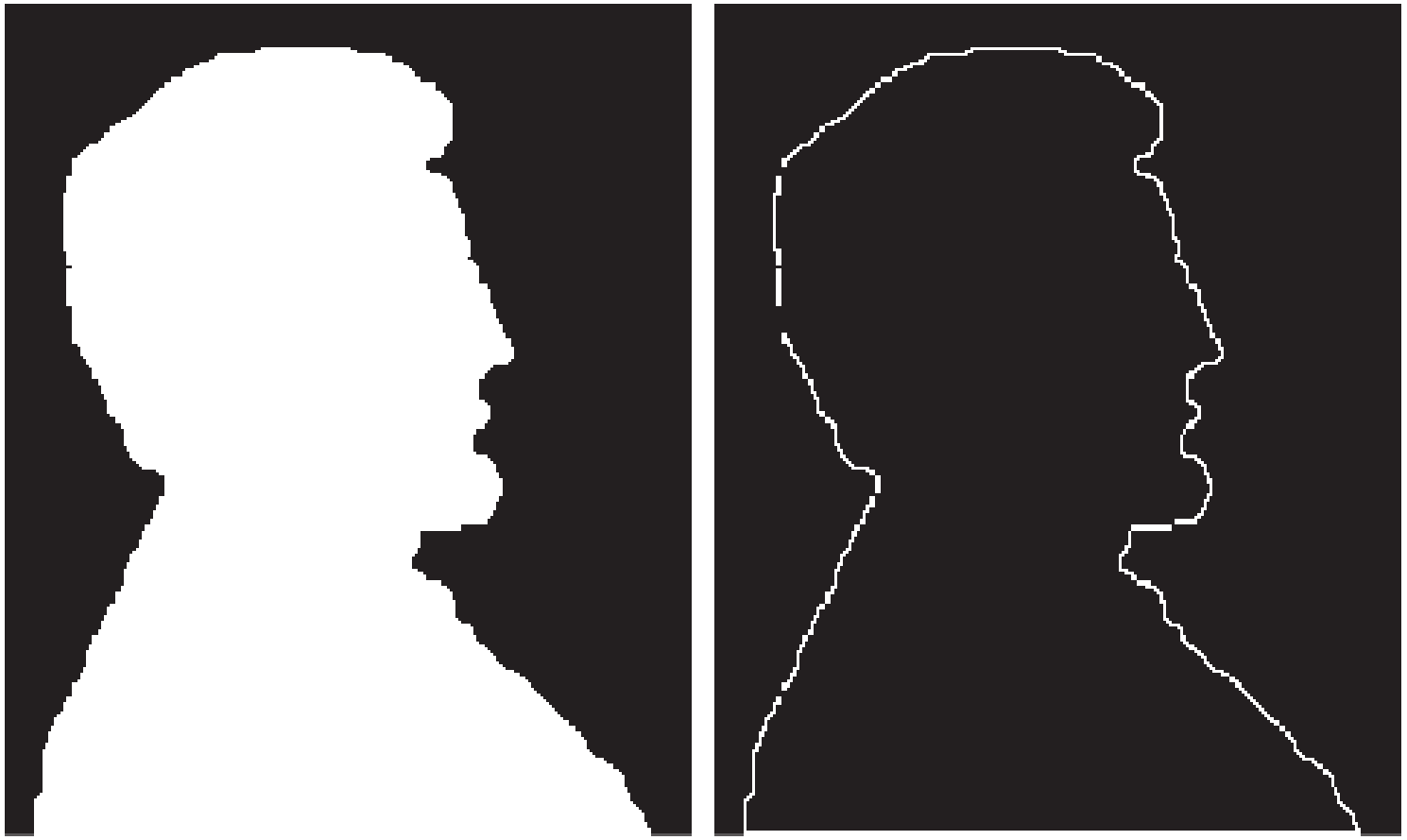


Erosion



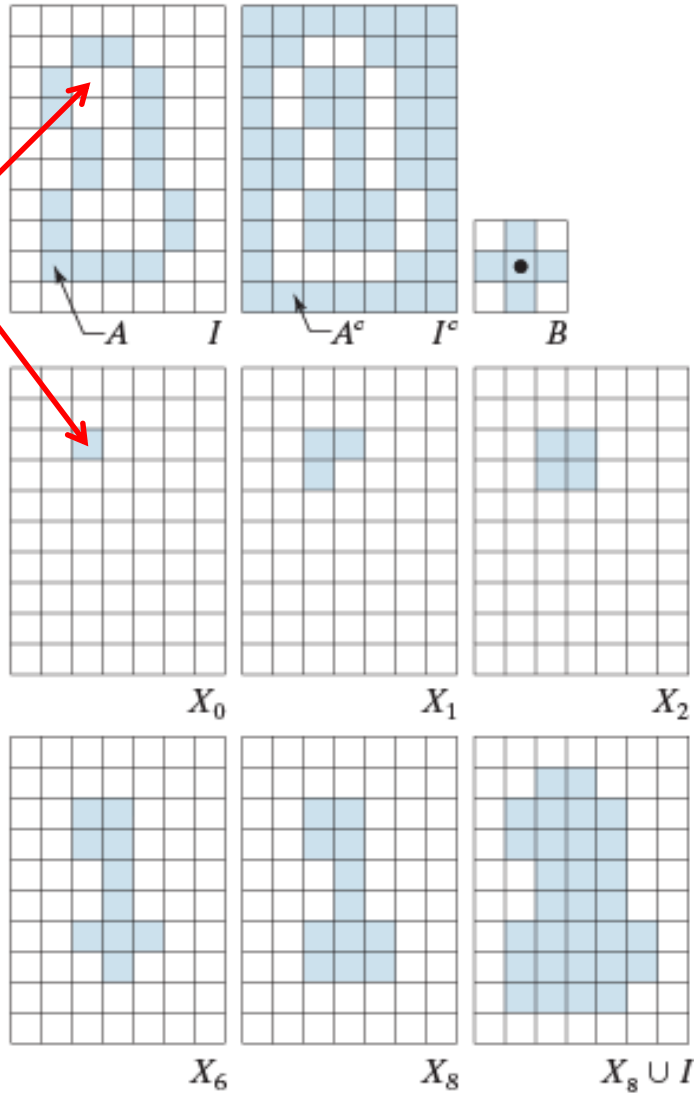
Set difference

Boundary extraction



Hole filling

Given point in hole

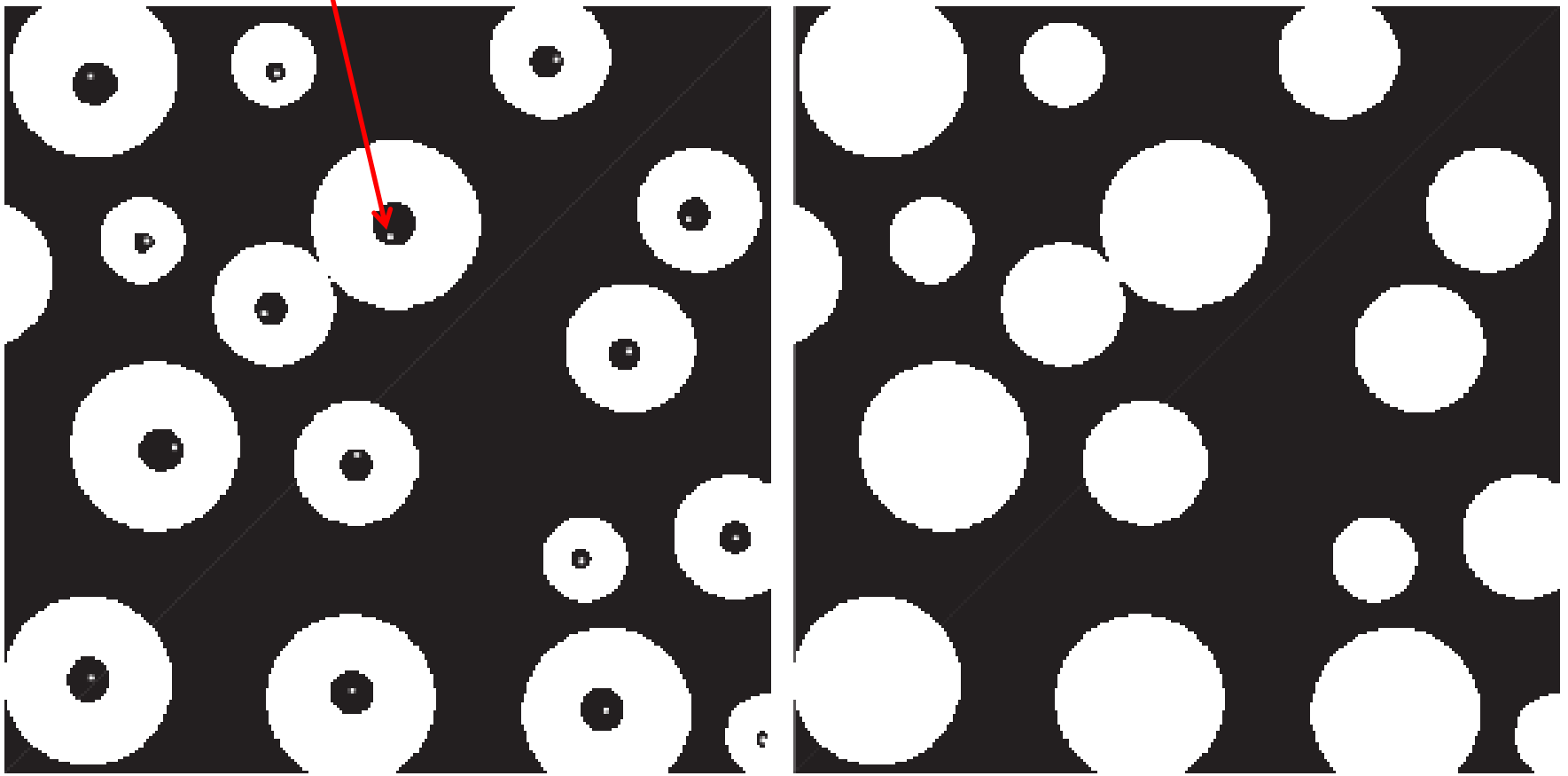


$$X_k = (X_{k-1} \oplus B) \cap A^c \quad k = 1, 2, \ldots$$

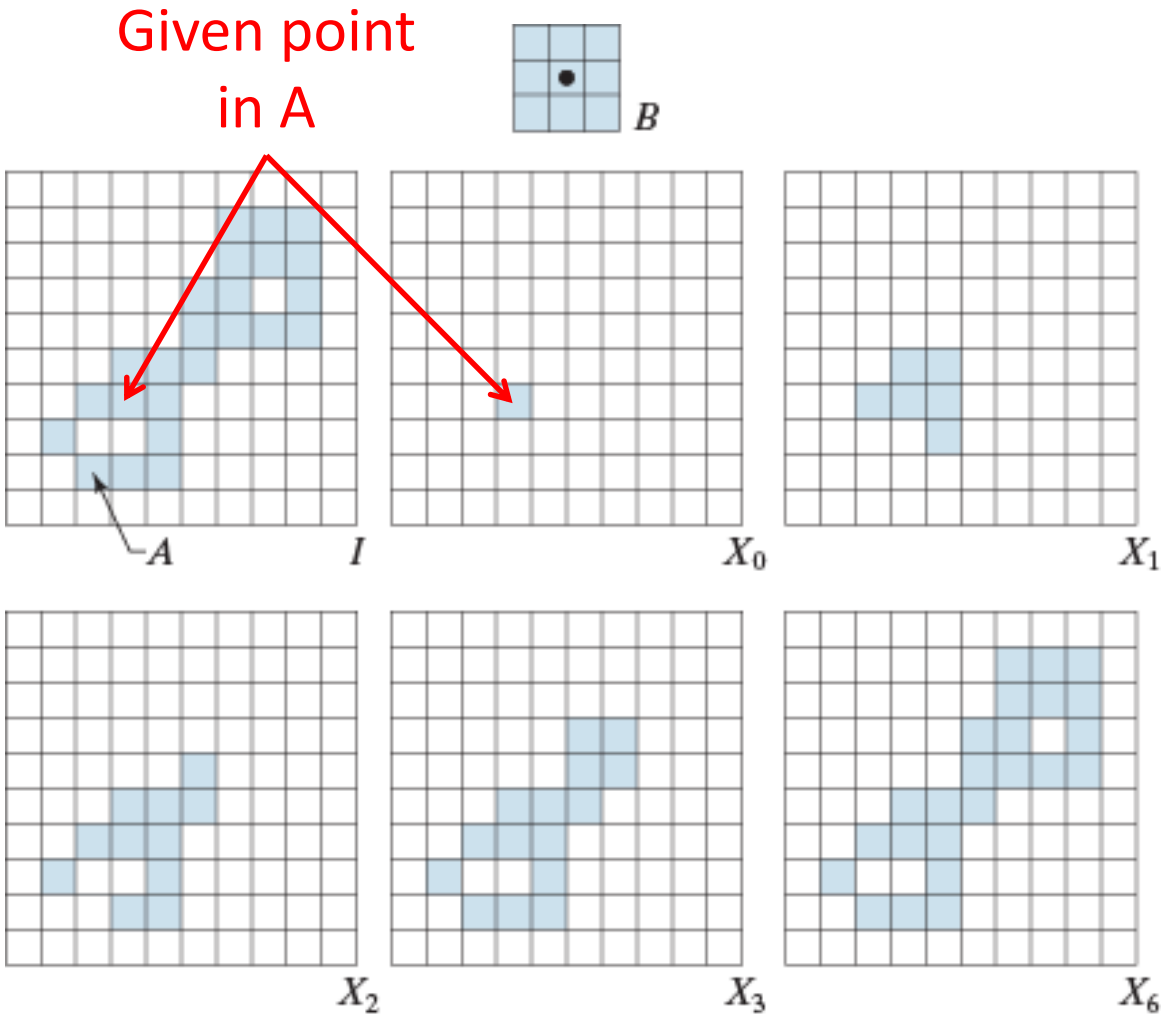
Hole filling

Given points in holes

All holes filled



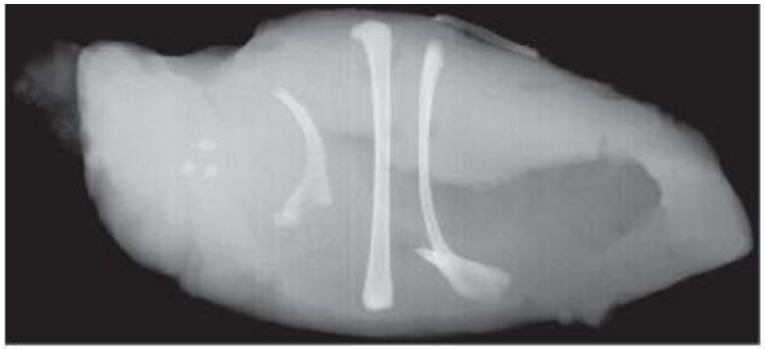
Connected components



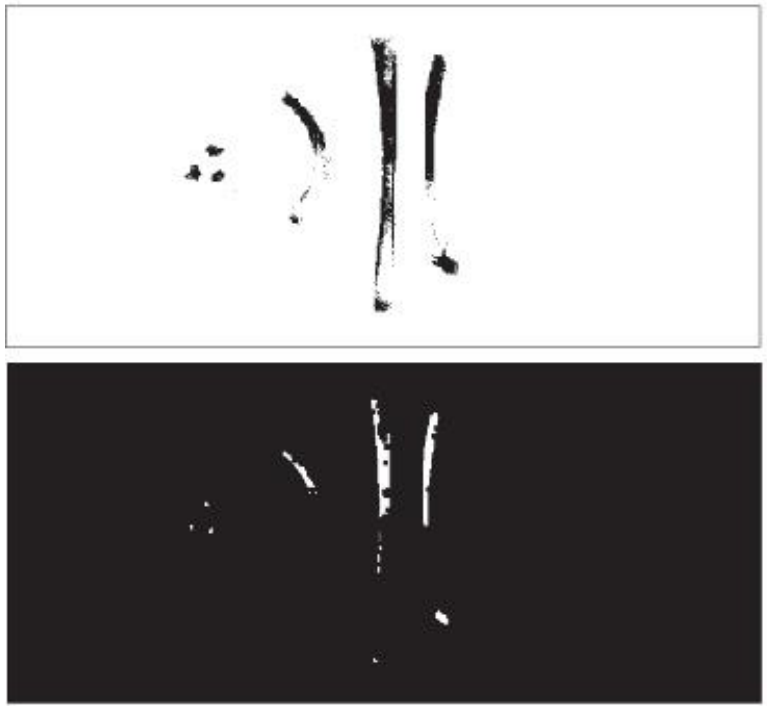
$$X_k = (X_{k-1} \oplus B) \cap A \quad k = 1, 2, \ldots$$

Connected components

X-ray image



Threshold (negative)



Connected component	No. of pixels in connected comp
01	11
02	9
03	9
04	39
05	133
06	1
07	1
08	743
09	7
10	11
11	11
12	9
13	9
14	674
15	85

15 connected components

Next Lecture

- Image segmentation
- Reading
  - Chapter 10: Image segmentation I: edge detection, thresholding, and region detection
    - Sections 10.1, 10.2, and 10.3