Medical Image Processing

Morphological Operations

Main thresholding methods

- Introduction to the mathematical morphology in IP
- Combined operations
- Some examples and applications

Introduction to mathimatical morphology in IP

- Some basic set operations on binary images
  1. Set translation:

$$A_z = \{b \mid b = a + z, a \epsilon A\} = \{(a_x+z_x, a_y+z_y) \mid (a_x, a_y) \epsilon A\}, z=(z_x, z_y)$$

  2. Set reflection

$$A_z = \{b \mid b = a + z, a \epsilon A\}$$

Introduction to mathimatical morphology in IP

- Some basic set operations...
  3. Erosion

  - Structuring element: an element containing a set of pixels of interest with a shape and an origin.
  - Suppose that B is the structuring element set and A is the original image. Erosion presented by $\mathrm{A} \ominus B$ simply is a pixel set in A such that translated B fits fully inside A.
  - Mathematically represented by:

$$\mathrm{A} \ominus B = \{z | B_z \subseteq A\}$$

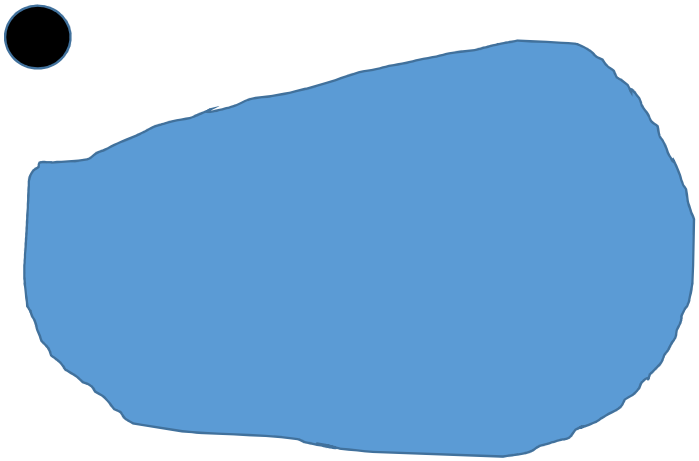
Introduction to mathimatical morphology in IP

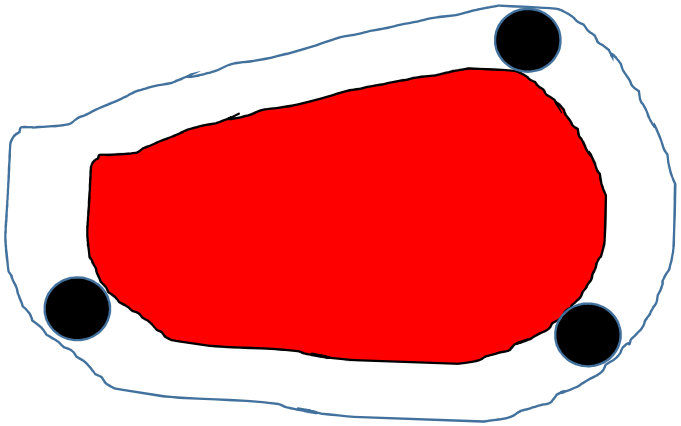
- Some basic set operations
  3. Erosion (cont'd) :

an example: the result is in red

B:

A:





Introduction to mathimatical morphology in IP

- Some basic set operations...
  4. Dilation

  - Opposite if the erosion operation
  - To increase the objects in the image
  - Suppose that B is the structuring element set and A is the original image. Erosion presented by $A \oplus B$ simply is a pixel set in A such that shifted translated B has any ovelap with A.
  - Mathematically represented by:

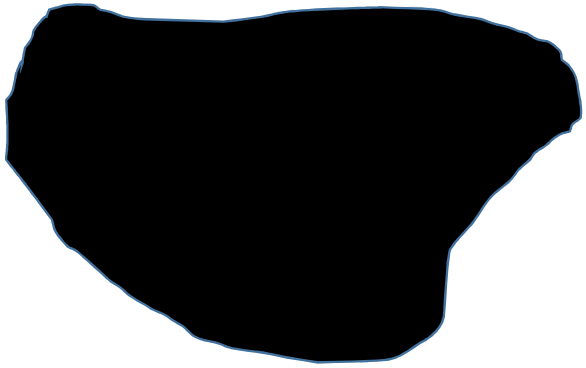
$$A \oplus B = \{z | \widehat{B_z} \cap A \subseteq A\}$$

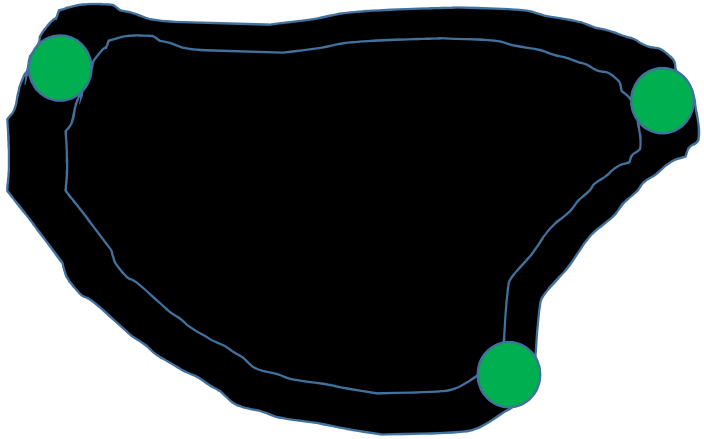
Introduction to mathimatical morphology in IP

- Some basic set operations...
  4. Dilation (cont'd): an example; the result after dilation is in black as below.

B:

A:





Introduction to mathimatical morphology in IP

Some properties:

1. Can be extended easly to the grayscale images
2. Very useful applications appear in image segmentation
3. More applications will appear by combination of the basic operations

Combined operations

Operations:

1. **Opening:** Erosion + Dilation

- Let B be the structuring element
- Let A be the original set

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

Combined operations

Operations:

2. **Closing:** Dilation + Erosion

- Let B be the structuring element
- Let A be the original set

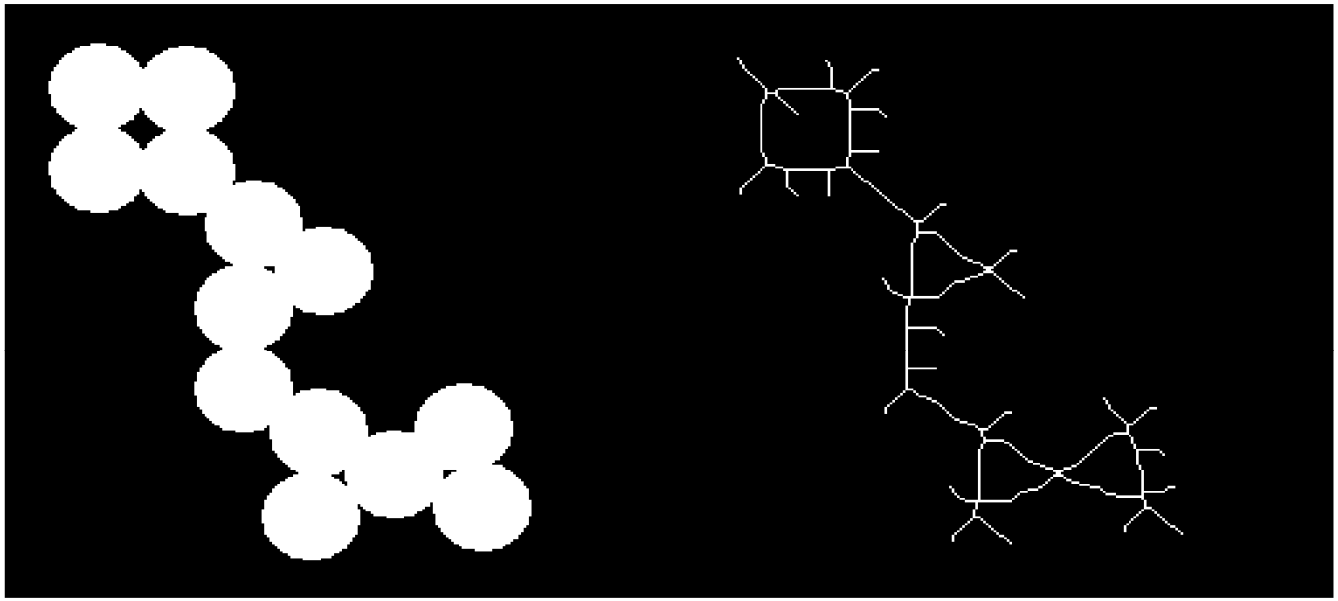
$$A \cdot B = (A \oplus B) \ominus B$$

Combined operations (not limited to)

3. Extracting the outline of the foreground
4. Extracting the skeleton of the foreground
5. Removing spur pixels from the image
6. Thickening the objects of the image

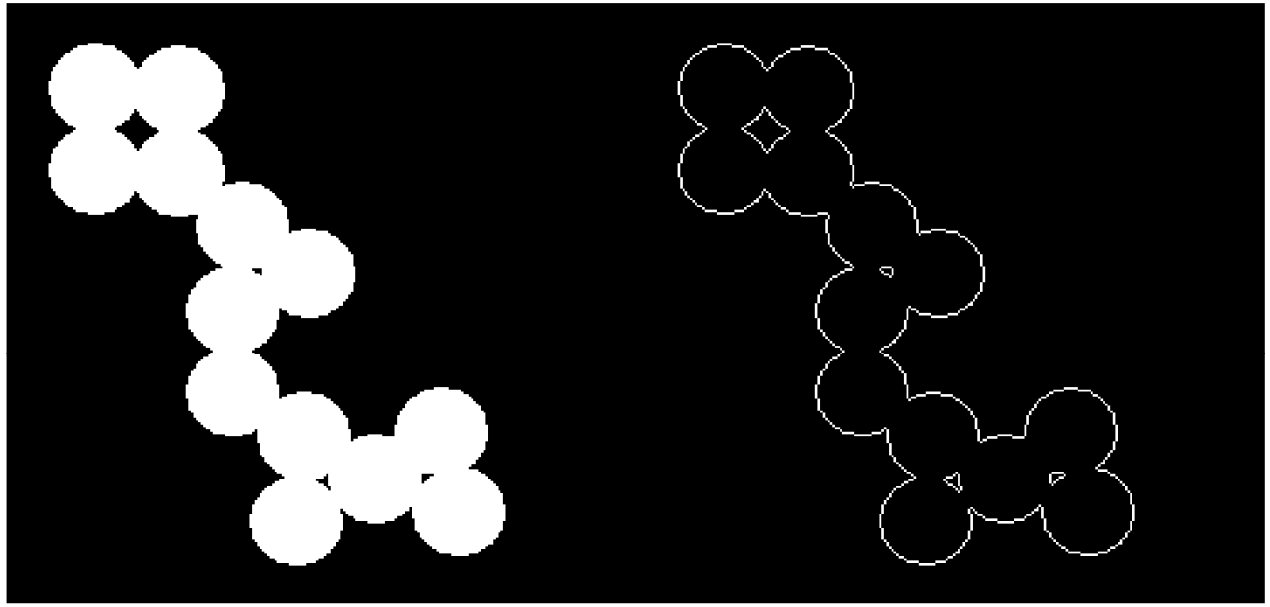
Combined operations (examples)

Extracting the skleton of the image (original image in right):



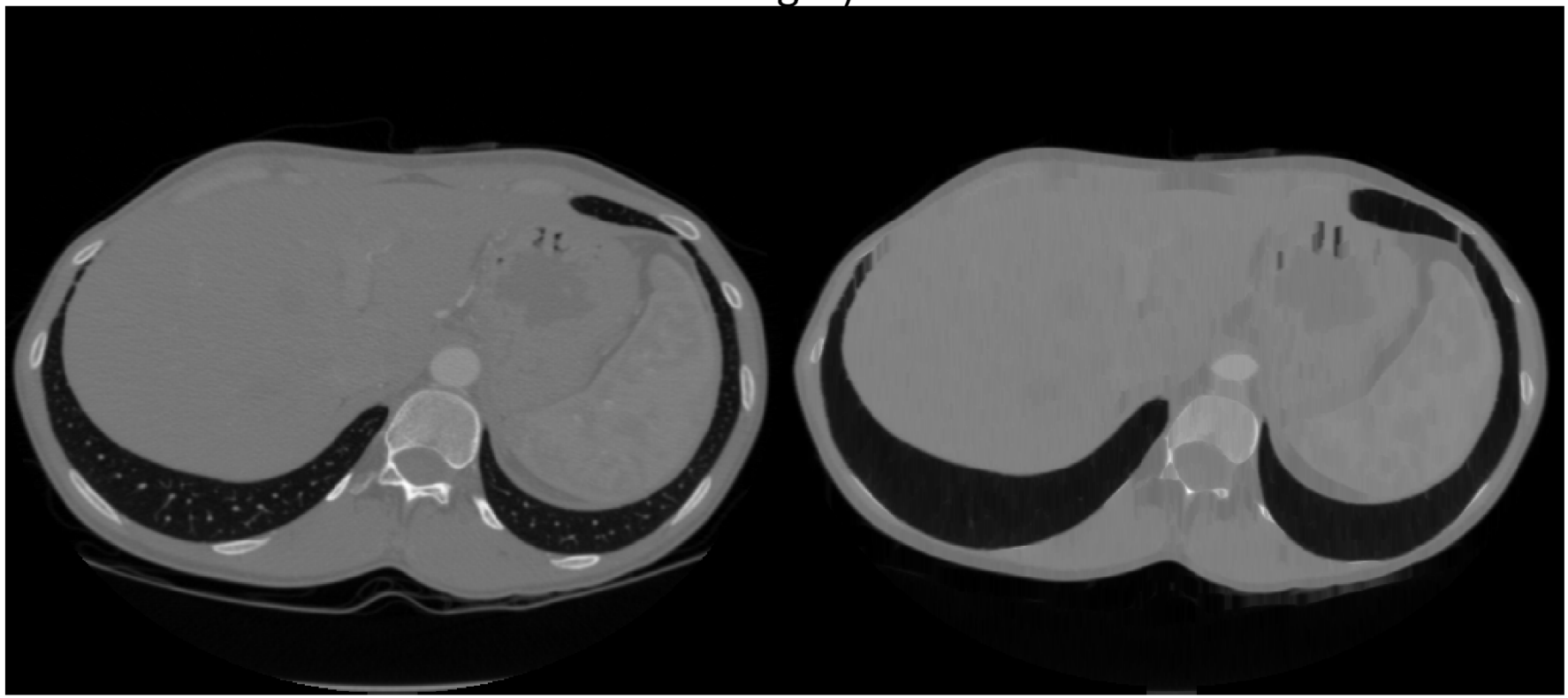
Combined operations (examples)

Extracting the outline of the objects in image (original image in right):



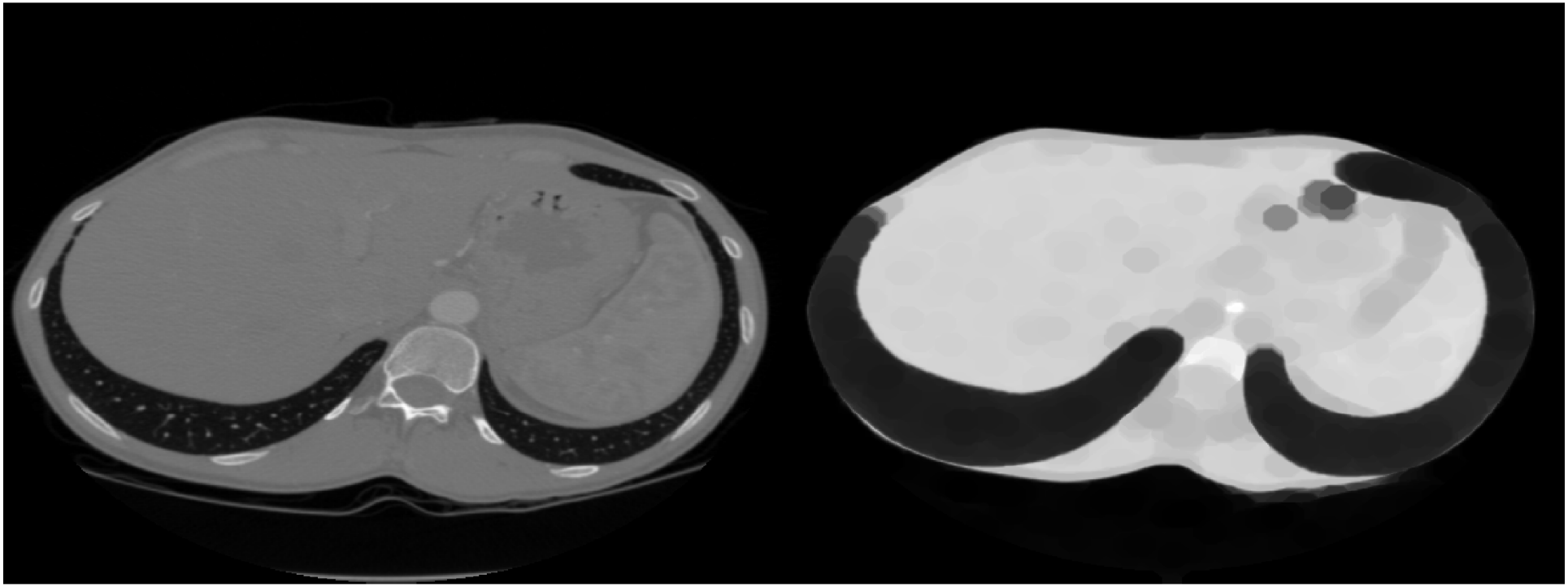
Combined operations (examples)

Erosion with respect to the structuring element in shape of line (original image in right):



Combined operations (examples)

- Erosion with a circle with radius 11 (original image in right):



Some Applications

- Hole and region filling
- Binary and watershed segmentation
- Noise removal from a noisy image
- Enhancing the segmentation tasks