Introduction to Image Processing

Lecture 6
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Guillaume Lemaître
guillaume.lemaitre@udg.edu

Université de Bourgogne

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2. Erosion & Dilation
   - Erosion
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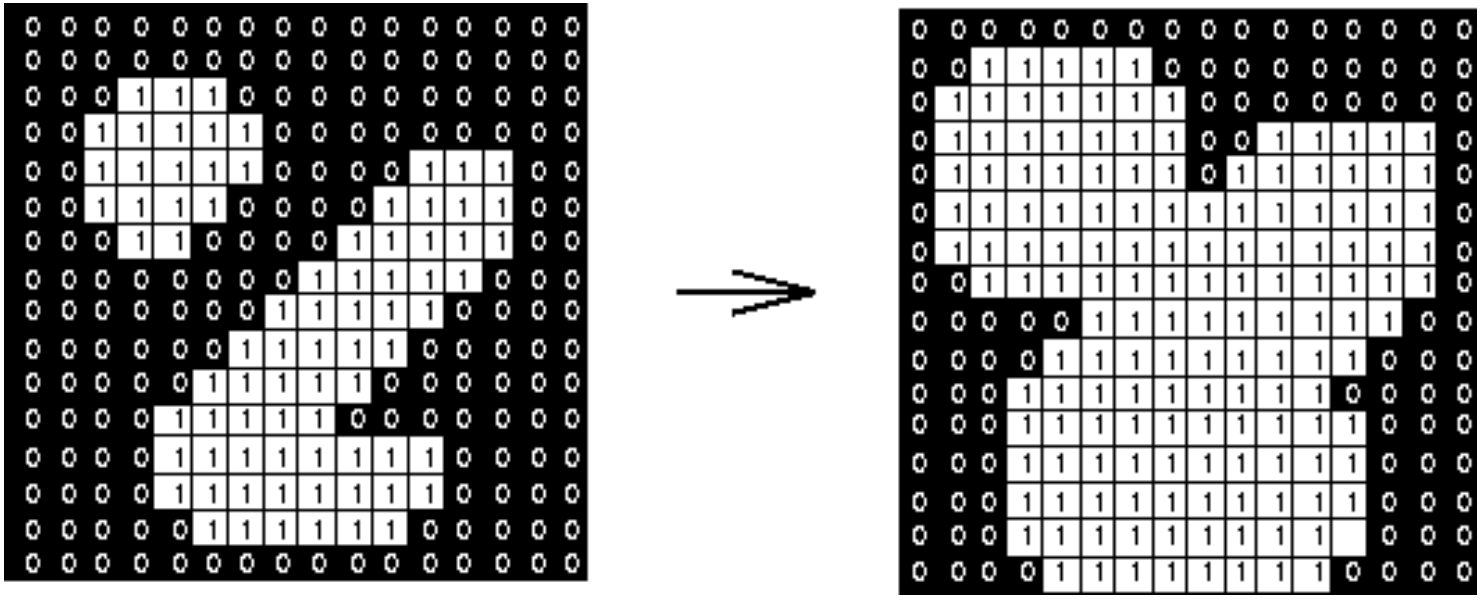
3. Opening & Closing
   - Opening
   - Closing
4. Hit-or-Miss Transformation
5. Basic Algorithms

Morphological Image Processing
Preliminaries

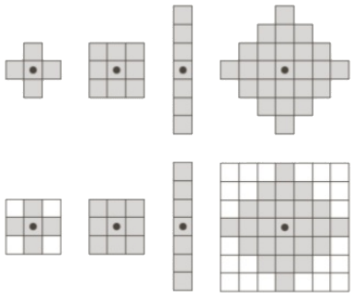
Problem statement



- Enhance binary images

Morphological Image Processing
Preliminaries

Structuring elements



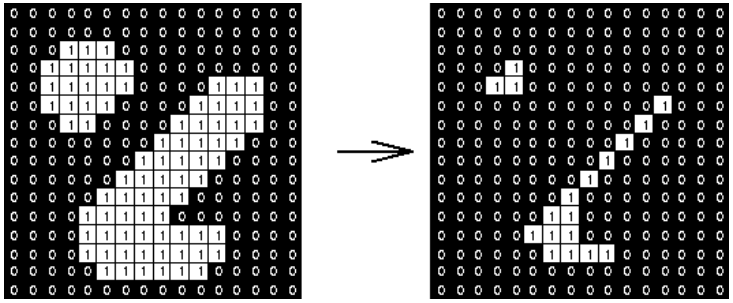
- Affect an label value to a given pixel inside a sub-region
- Consider only the shaded pixels

What types?

- Refer to `skimage.morphology` module
- ball, cube, diamond, disk, octagon, octahedron, square, star

Morphological Image Processing

Erosion

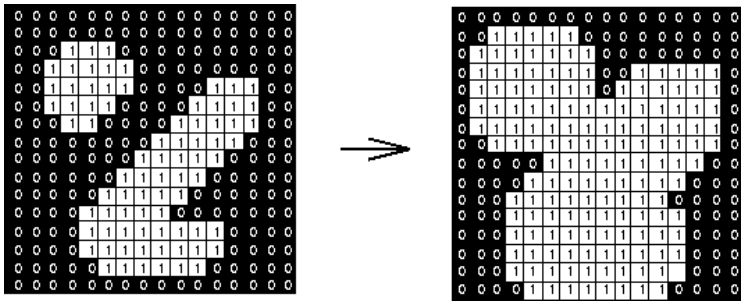


$$A \ominus B = \{z | (B)_z \subseteq A\}$$

- Shrink or thins objects

Morphological Image Processing

Dilation

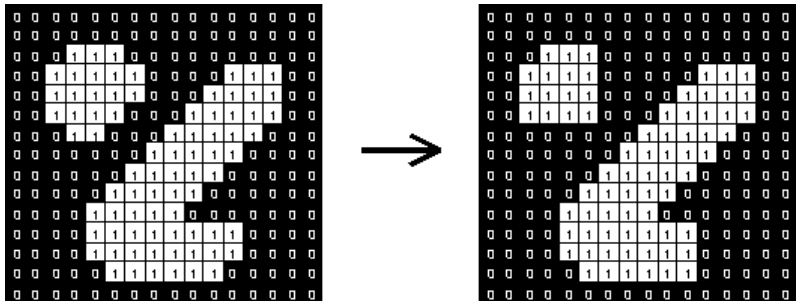


$$A \oplus B = \{z | (\hat{B})_z \cap A\}$$

- Grows or thickens objects

Morphological Image Processing

Opening

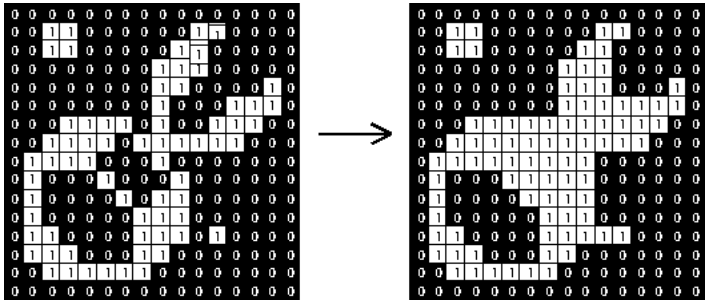


$$A \circ B = (A \ominus B) \oplus B$$

- Erosion followed by dilation
- Smoothes contour of objects
- Breaks narrow strip
- Eliminates protusions

Morphological Image Processing

Closing

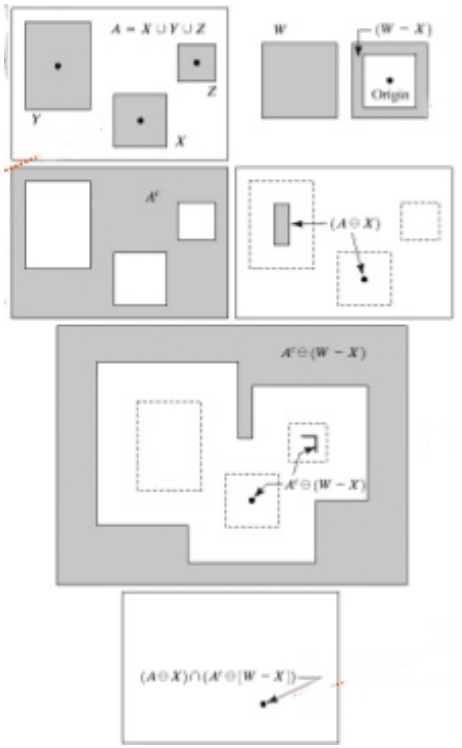


$$A \bullet B = (A \oplus B) \ominus B$$

- Dilation followed by erosion
- Smoothes section of contours
- Fuses narrow breaks
- Eliminate small holes
- Fill gaps in the contour

Morphological Image Processing

Hit-or-Miss Transformation



$$A \otimes B = (A \ominus X) \cap [A^c(W - X)]$$

Morphological Image Processing

Boundary Extraction

$$\beta(A) = A - (A \ominus B)$$

Hole Filling

$$X_k = (X_{k-1} \oplus B) \cap A^c \quad k = 1, 2, 3, \cdots$$

Extraction of Connected Components

$$X_k = (X_{k-1} \oplus B) \cap A \quad k = 1, 2, 3, \cdots$$

Morphological Image Processing

Convex Hule

$$X_k = (X_{k-1} \otimes B^i) \cap A^c \quad i = 1, 2, 3, 4 \quad k = 1, 2, 3, \cdots$$

Thinning

$$A \oslash B = A - (A \otimes B)$$

Thickening

$$A \odot B = A \cup (A \otimes B)$$