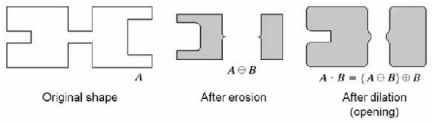
Compound Operations

- More interesting morphological operations can be performed by performing combinations of erosions and dilations.
- The most widely used of these compound operations are:
  1. Opening
  2. Closing

Opening

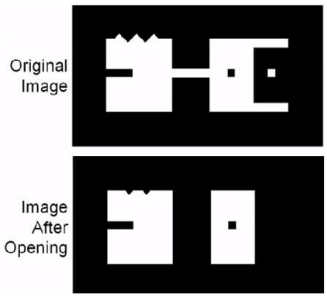
- Opening of image ***t*** by structuring element ***s*** denoted by
- **t ∘ s** is simply an erosion followed by a dilation

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



- Note a disc shaped structuring element is used

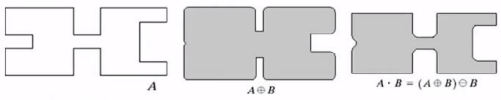
Opening- Example



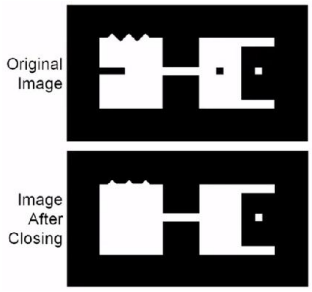
Closing

- Closing of an image ***t*** by structuring element ***s*** denoted by ***t.s*** is simply dilation followed by erosion

$$t \cdot s = (t \oplus s) \ominus s$$



Note a disc shaped structuring element is used



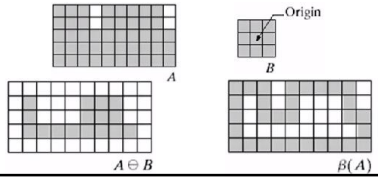
Boundary Extraction
Region Filling

- Some more interesting morphological algorithms include
  - Boundary extraction
  - Region filling
  - Extraction of connected components
  - Thinning/thickening
  - Skeletonisation

Boundary Extraction

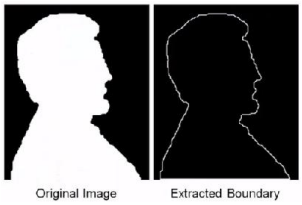
- Extracting the boundary (or outline) of an object is often extremely useful. The boundary can be given simply as

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



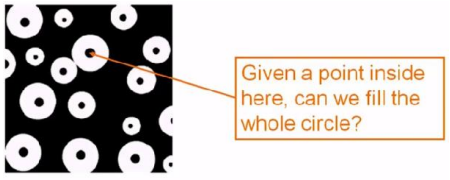
Boundary Extraction

- A simple image and the result of performing boundary extraction using a square 3x3 structuring element



Region Filling

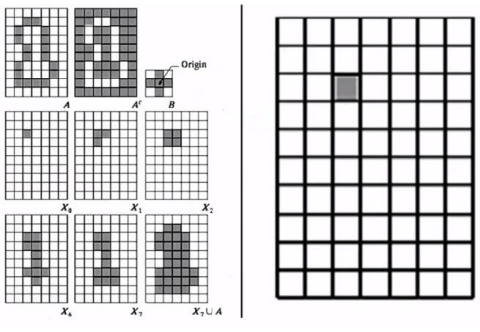
- Given a pixel inside a boundary, region filling attempts to fill that boundary with object pixels



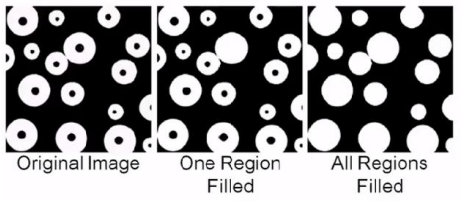
Region Filling

- The key equation for region filling is
- Whe $X_k = (X_{k-1} \oplus B) \cap A^c \quad k = 1,2,3.....$
  - X_o is simply the starting point inside the boundary
  - B is a simple structuring
  - A^c is the complement of A
- This equation is applied repeatedly until X_K is equal to X_{K-1} .
- Finally the result is unioned with the original boundary.

Region Filling



Region Filling



Reading

- Chapter 9 :

THANK YOU