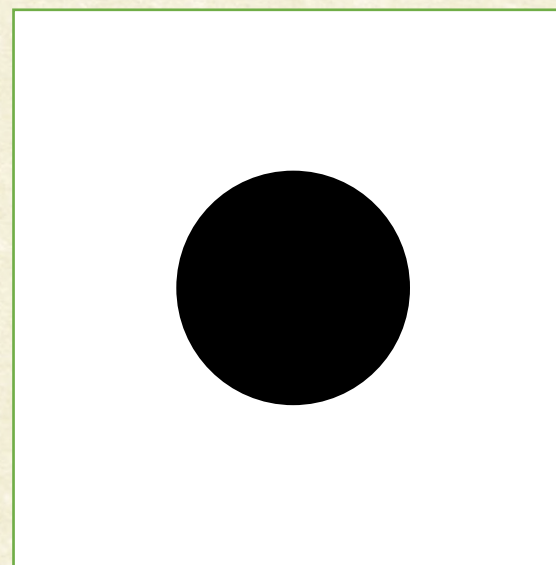
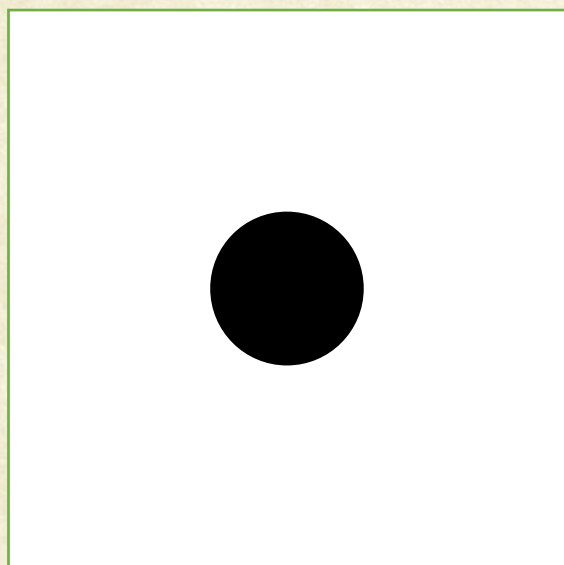




CS7.404: Digital Image Processing

Monsoon 2023: Morphological Image Processing 2

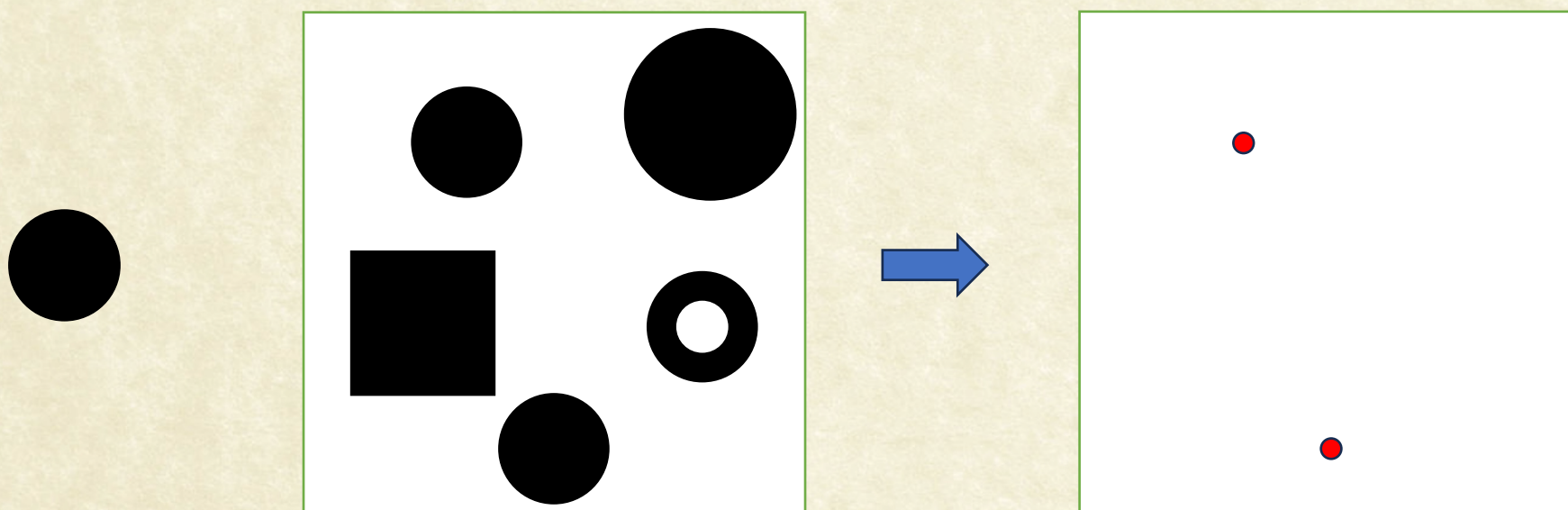


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CS7.404: Digital Image Processing

Monsoon 2023: Hit or Miss Transform (HMT)



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HMT: Finding Exact Matches

- Goal:
 - Detect objects of a particular shape in the image (exact matches)
- Approach:
 - Find locations in the image where:
 1. The shape (B_1) fits inside the foreground
 2. The boundary of the shape (B_2) fits in the background
 - Take the intersection of the two to find object locations

- Definition:

$$\begin{aligned} I \circledast B_{1,2} &= \{z | (B_1)_z \subseteq A \text{ and } (B_2)_z \subseteq A^c\} \\ &= (A \ominus B_1) \cap (A^c \ominus B_2) \end{aligned}$$



HMT Example

Row1: Original Image and its complement

Row 2:

- The structuring elements
- Hits with B_1 .

• Row 3:

- Hits with B_2 .
- Intersection of the hits

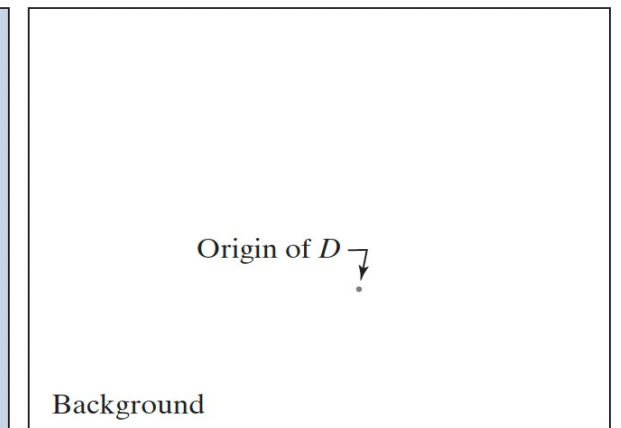
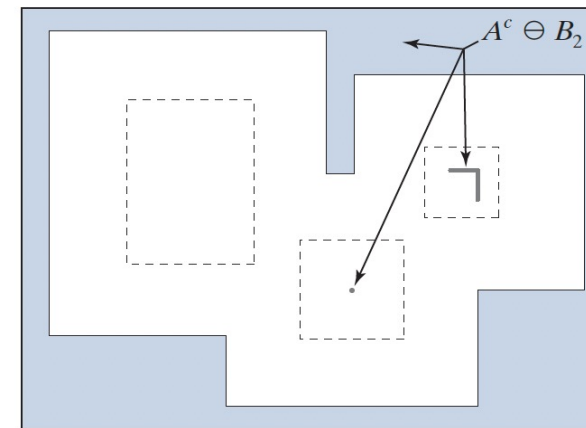
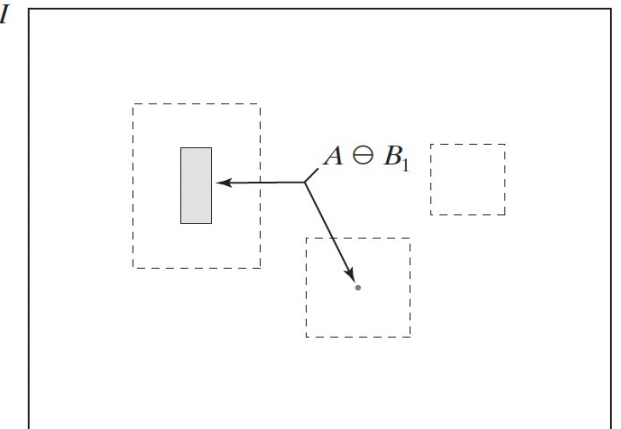
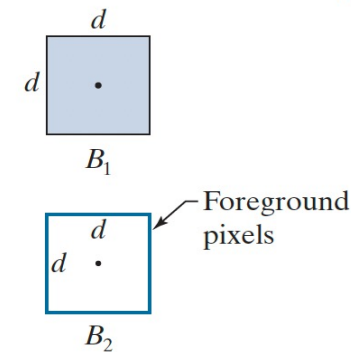
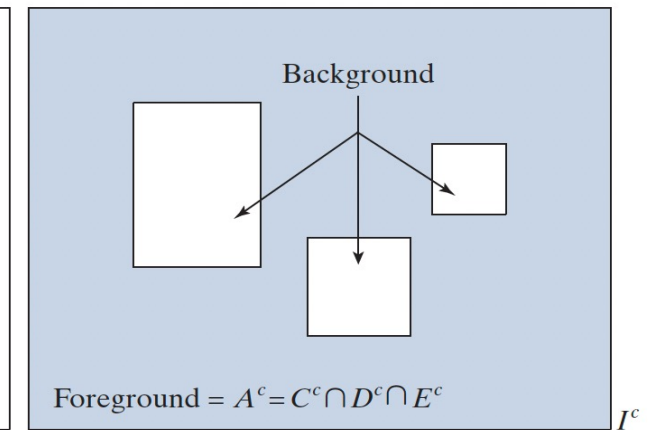
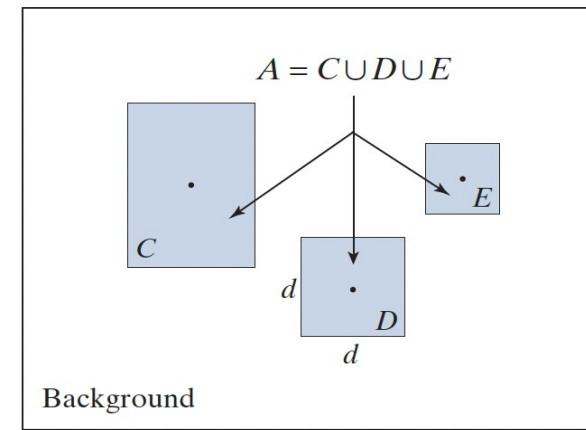
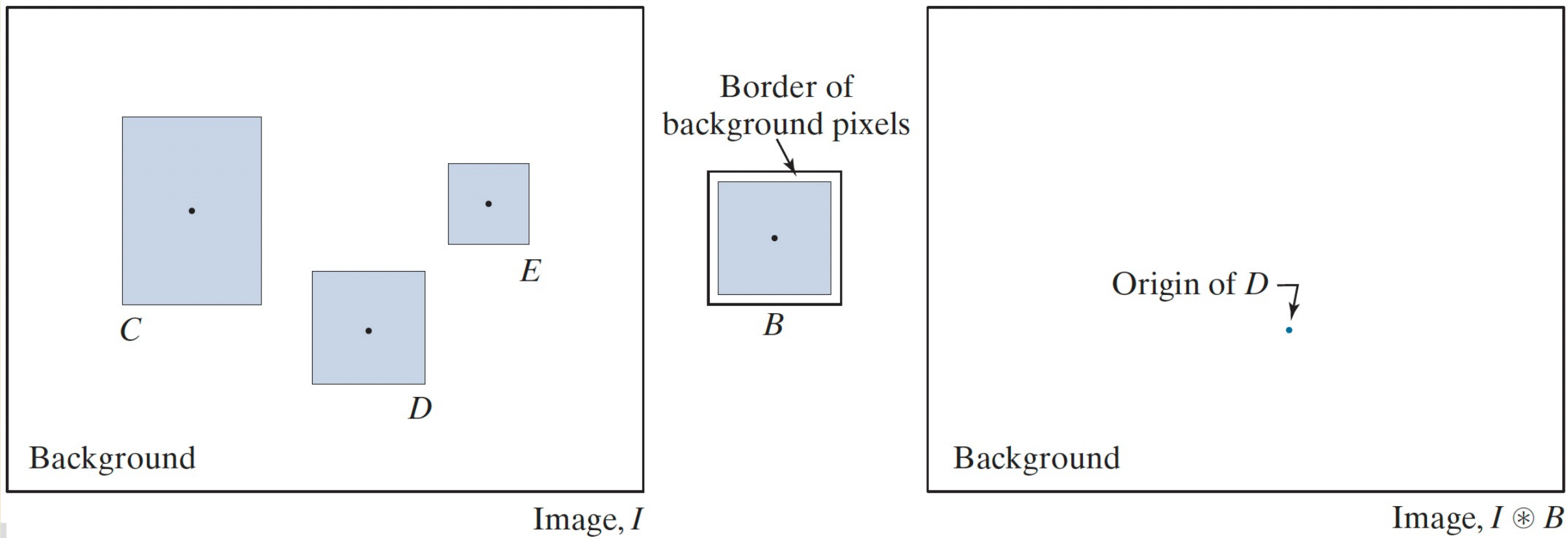


Image: $I \circledast B_{1,2} = A \ominus B_1 \cap A^c \ominus B_2$



HMT with single structuring element



- We match backgrounds as well

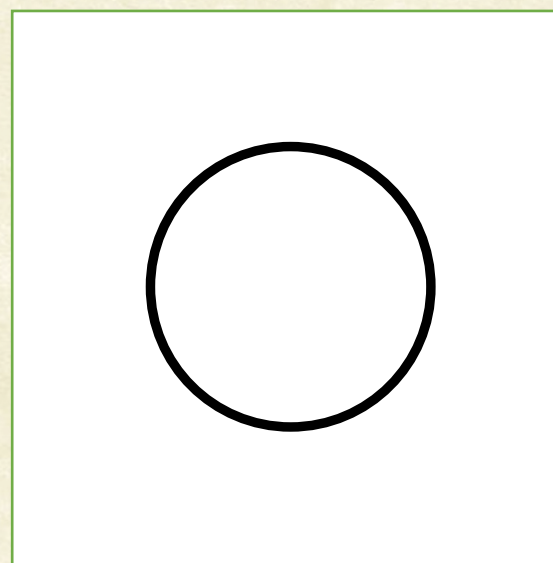
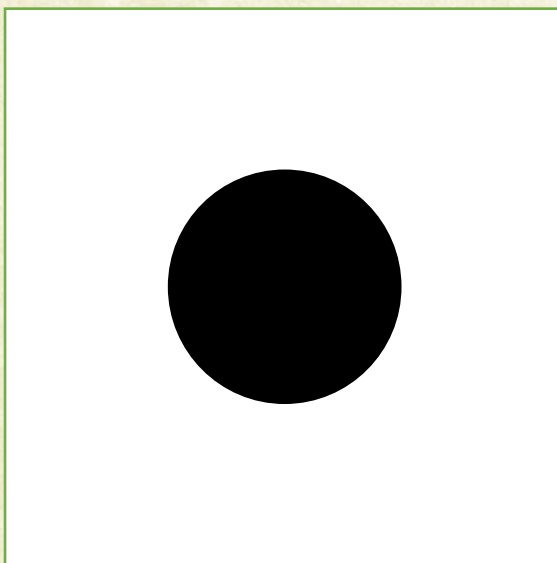


Questions?



CS7.404: Digital Image Processing

Monsoon 2023: **Boundary Detection**

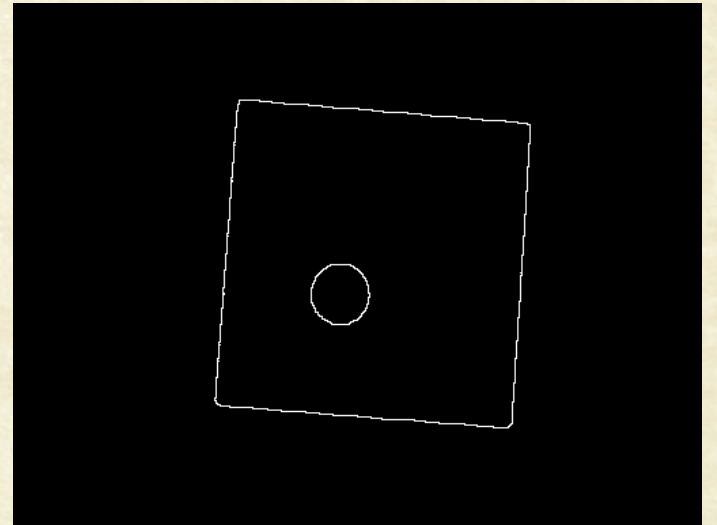
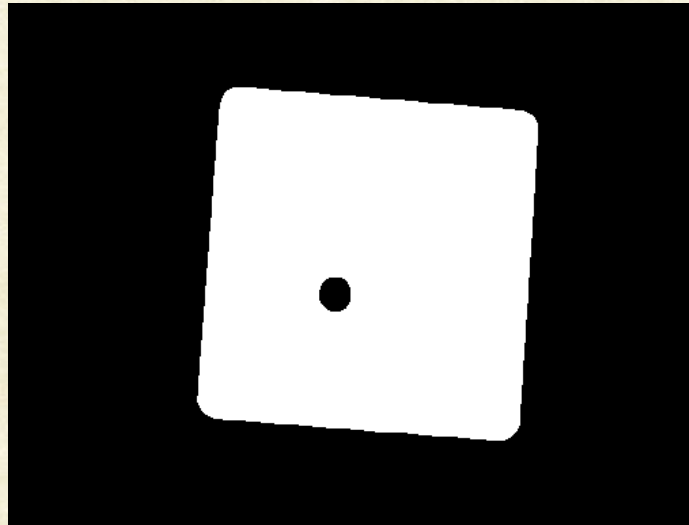
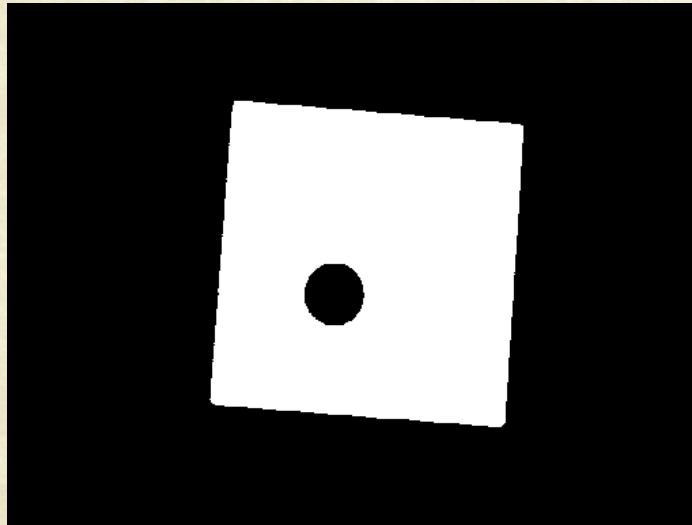


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Boundary Detection

1. Dilate input image
2. Subtract input image from dilated image
3. Boundaries remain!





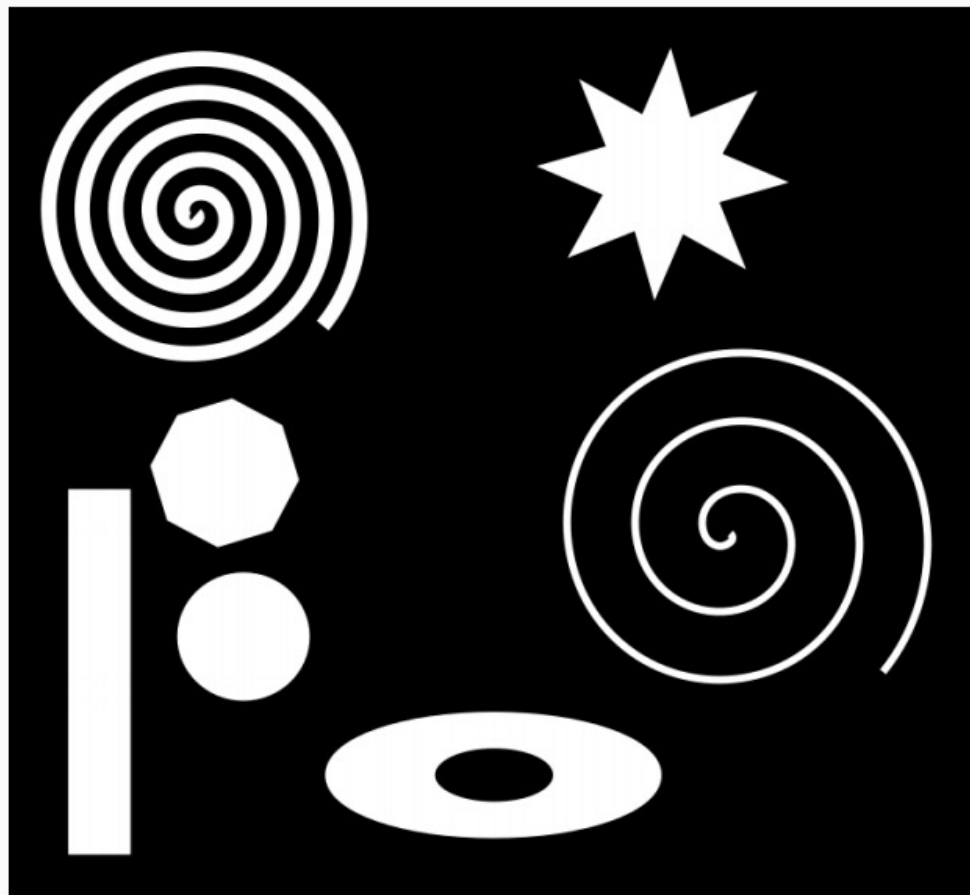
Can use erosion also ..



Fig 3: (a) Original Image (linkon.tif) (B) After erosion operation (C) Boundary Extraction with the help of Erosion.



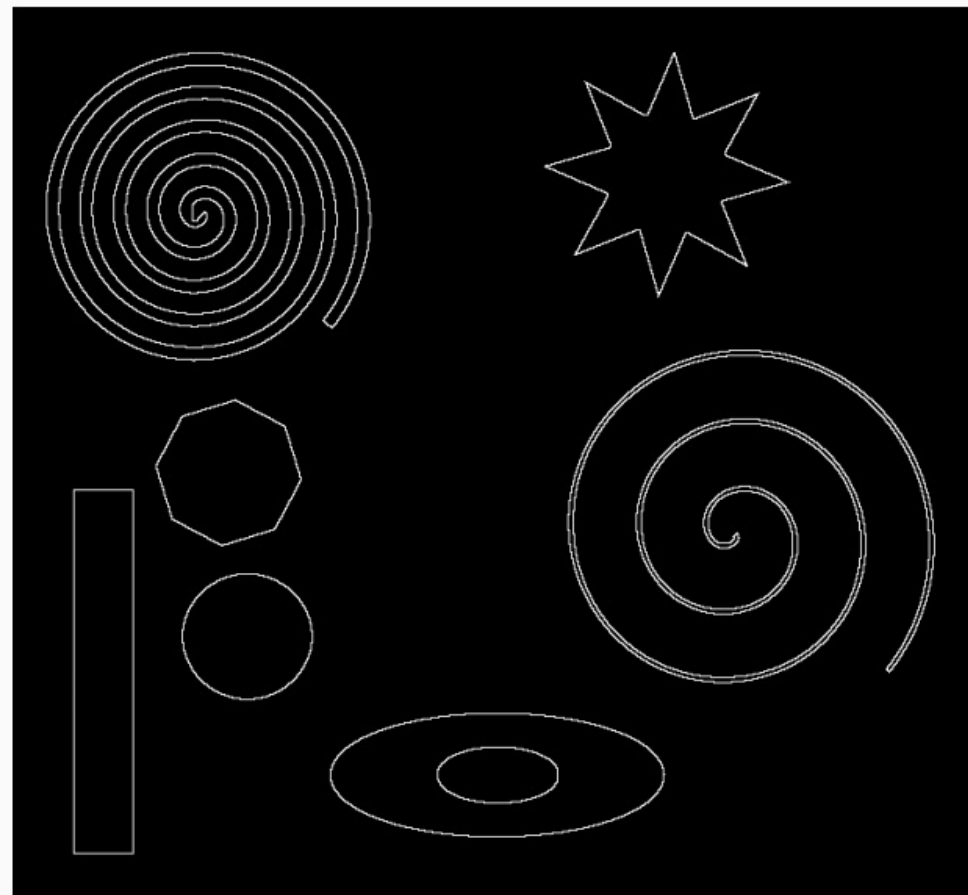
Boundary Detection: Effect of STREL



(a) f

1	1	1
1	1	1
1	1	1

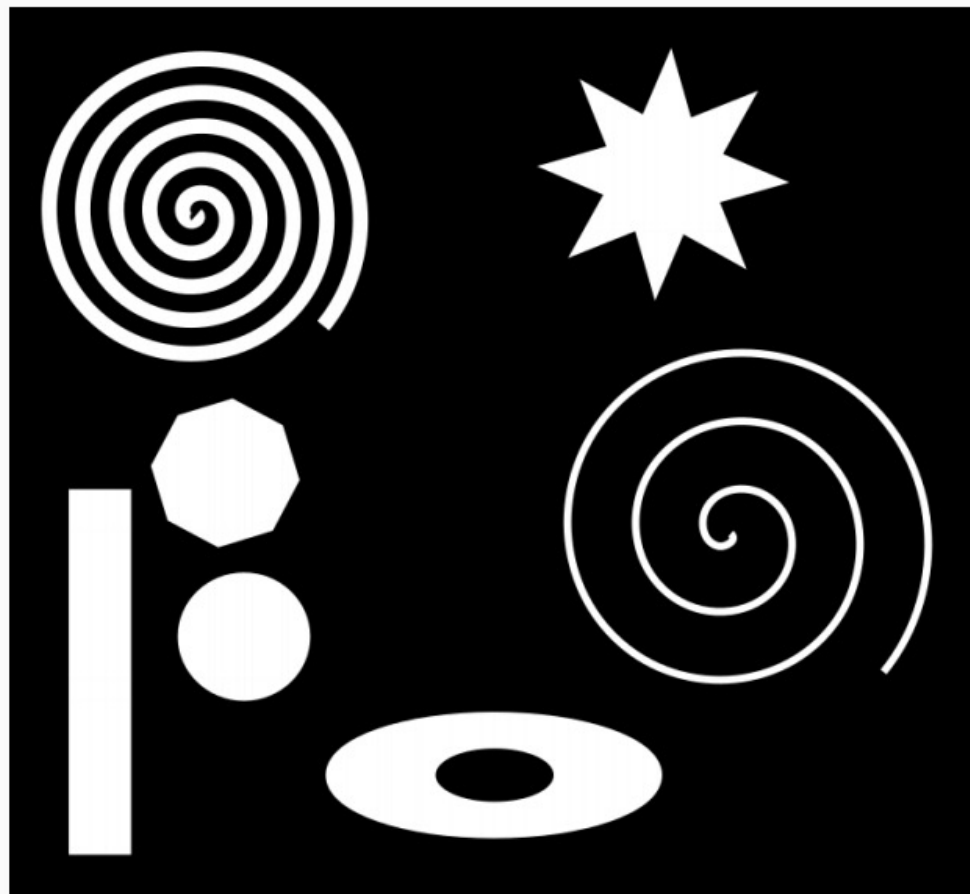
(b) s



(c) $f - (f \ominus s)$



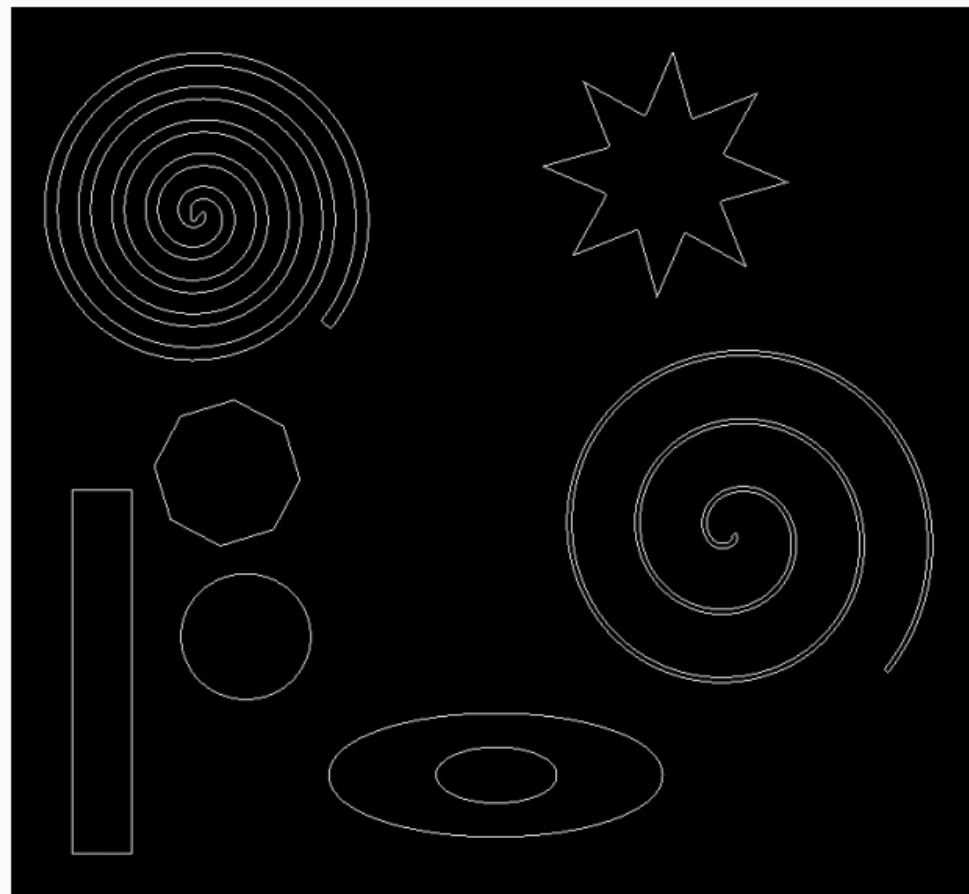
Boundary Detection: Effect of STREL



(a) f

0	1	0
1	1	1
0	1	0

(b) s



(c) $f - (f \ominus s)$

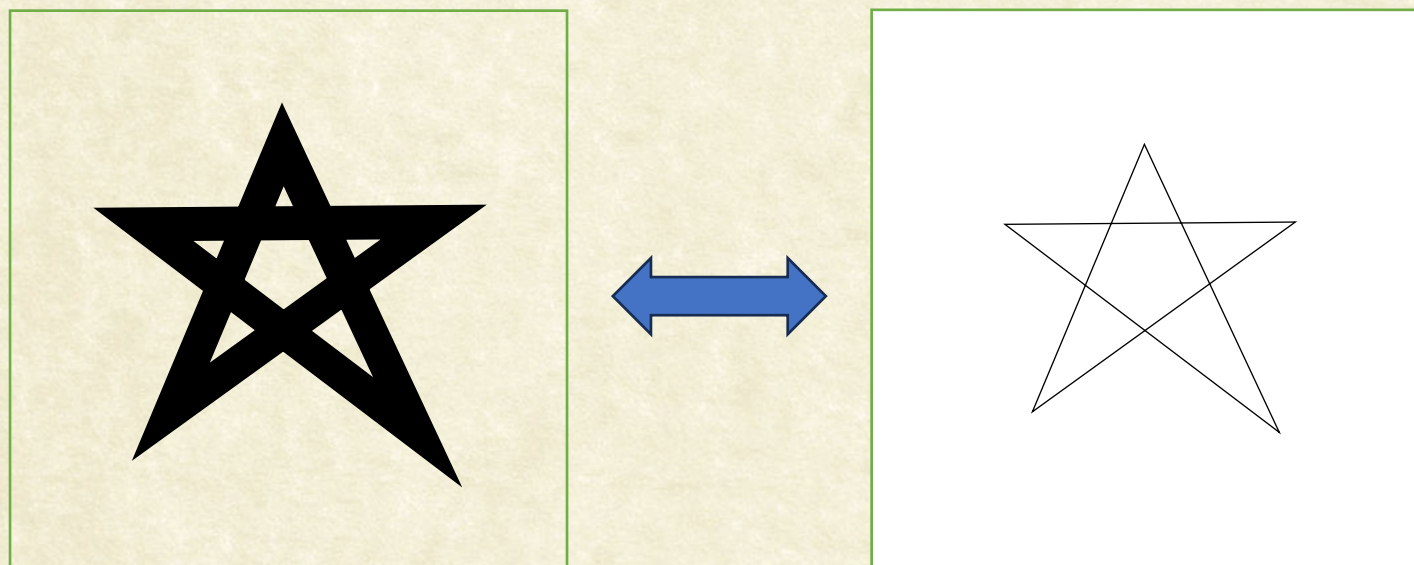


Questions?



CS7.404: Digital Image Processing

Monsoon 2023: Thinning and Thickening



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Thinning

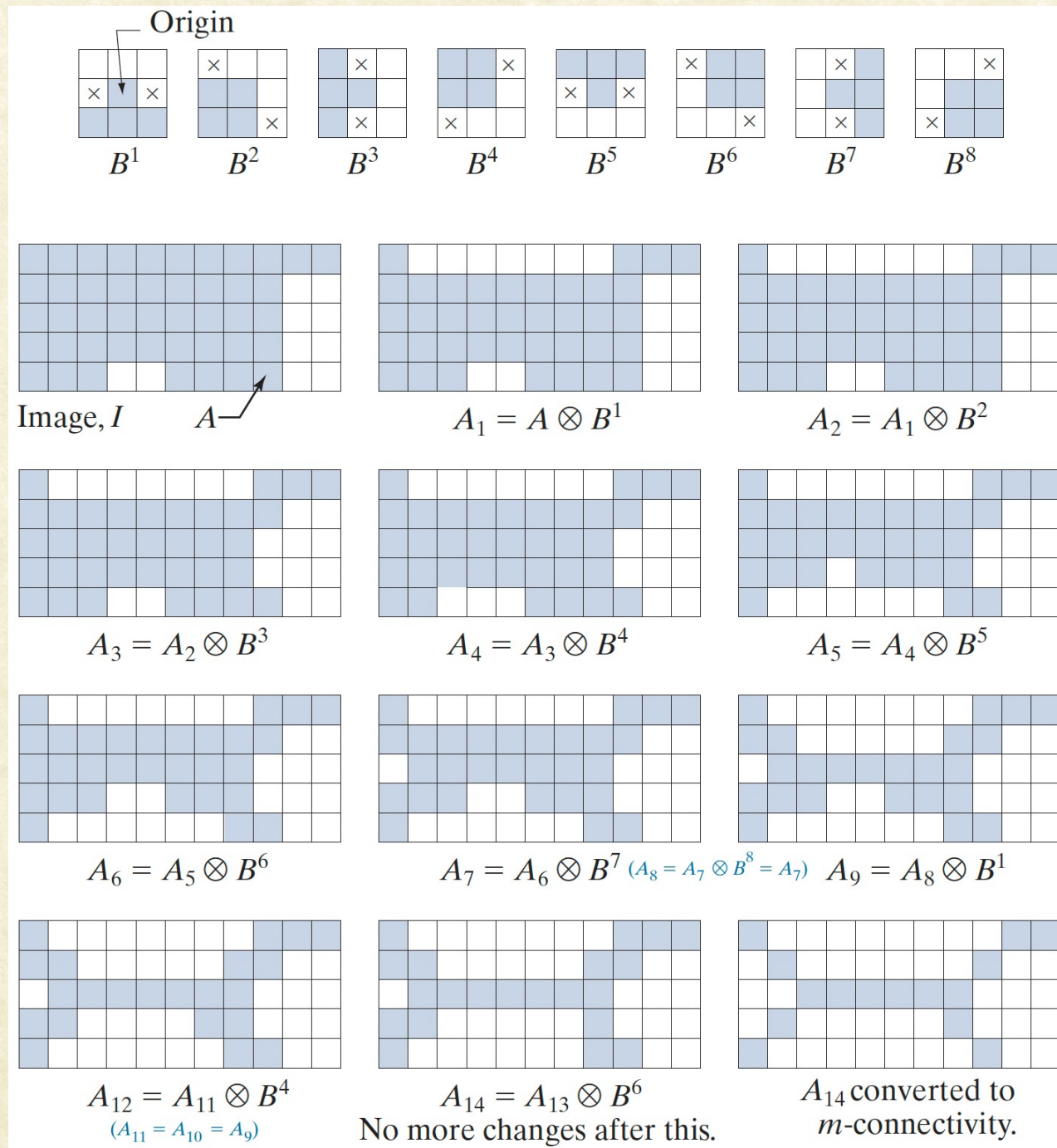
- In terms of HMT:

$$A \otimes B = A - (A * B) \\ = A \cap (A * B)^c$$

- Repeat with a set of specific structuring elements

$$A \otimes \{B\} = \left(\left(\dots \left((A \otimes B^1) \otimes B^2 \right) \dots \right) \otimes B^n \right)$$

until no more changes

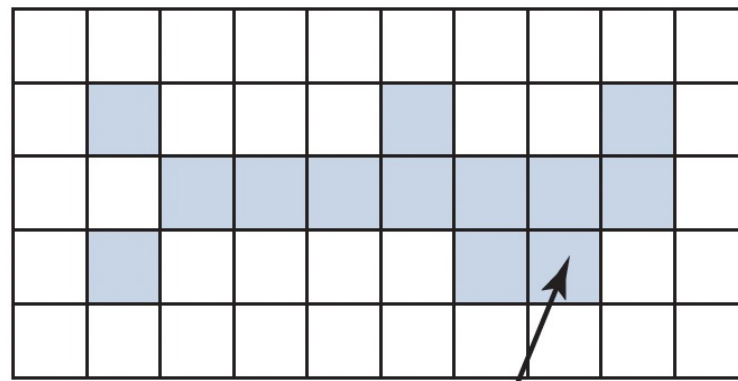




Thickening

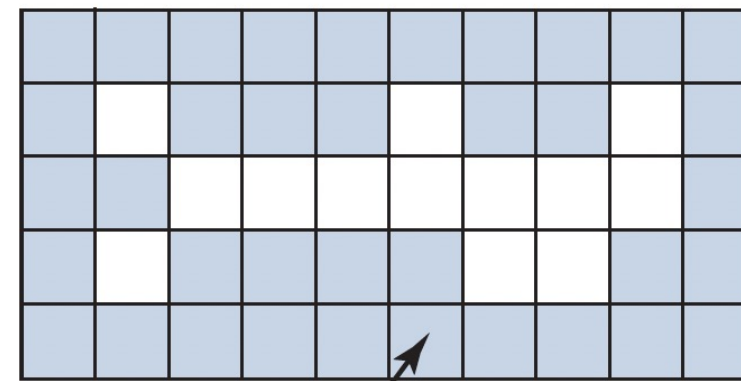
- Dual of Thinning

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

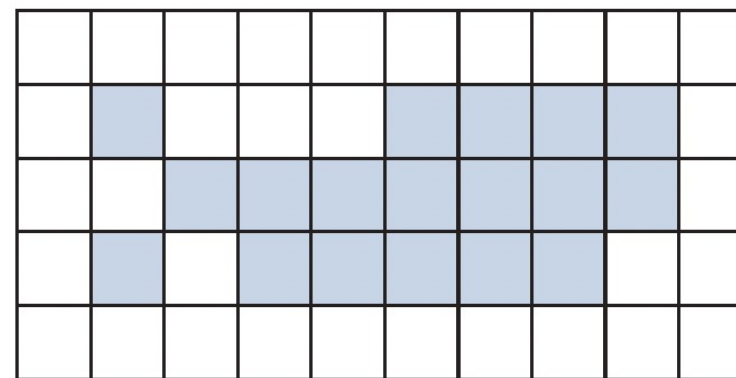
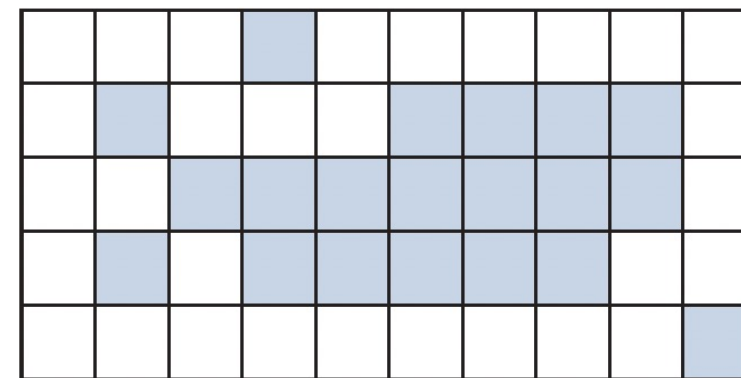
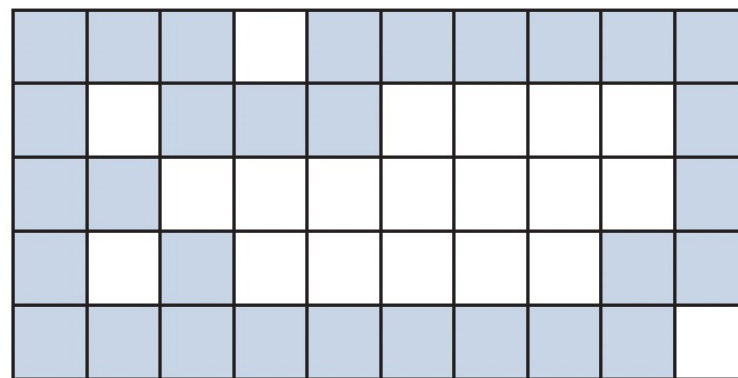


Image, I

A



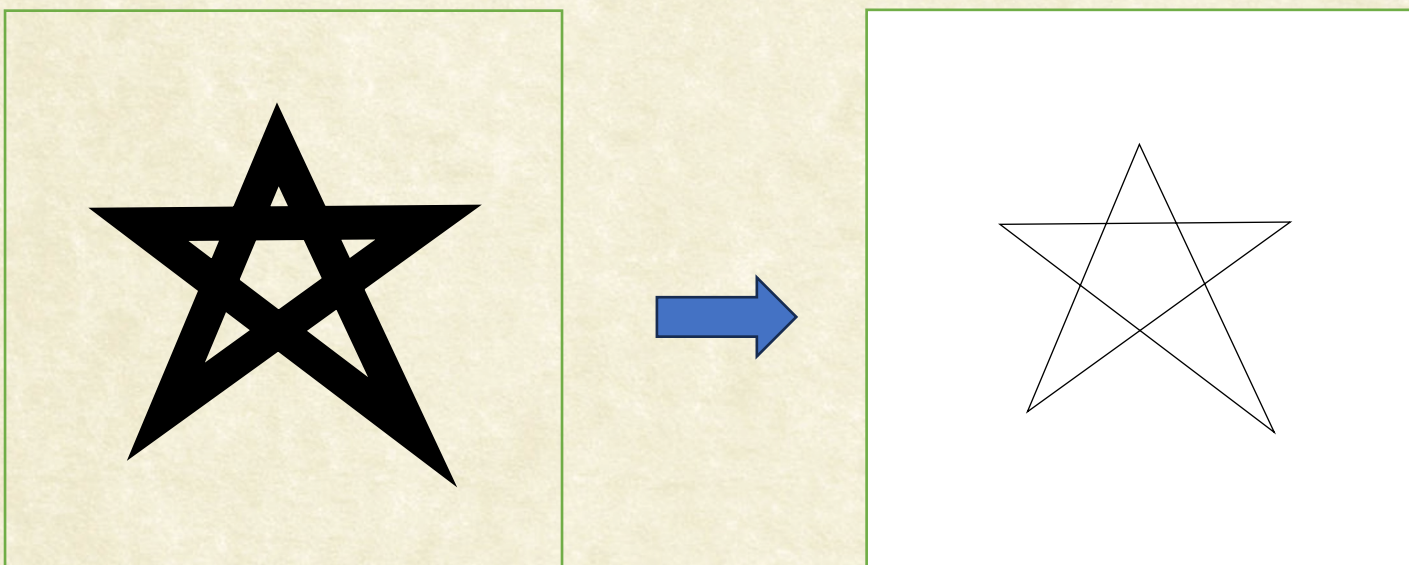
A^c





CS7.404: Digital Image Processing

Monsoon 2023: Skeletonization

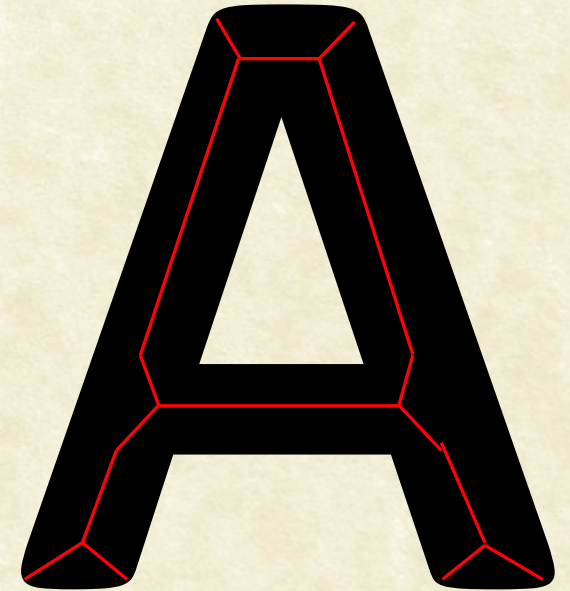


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The Skeleton

- The skeleton of a shape is defined as the set of all points in the shape that are equidistant from the two nearest boundary points.
 - Burning the boundary
- The skeleton of a shape is the locus of the center of maximum disks of the shape





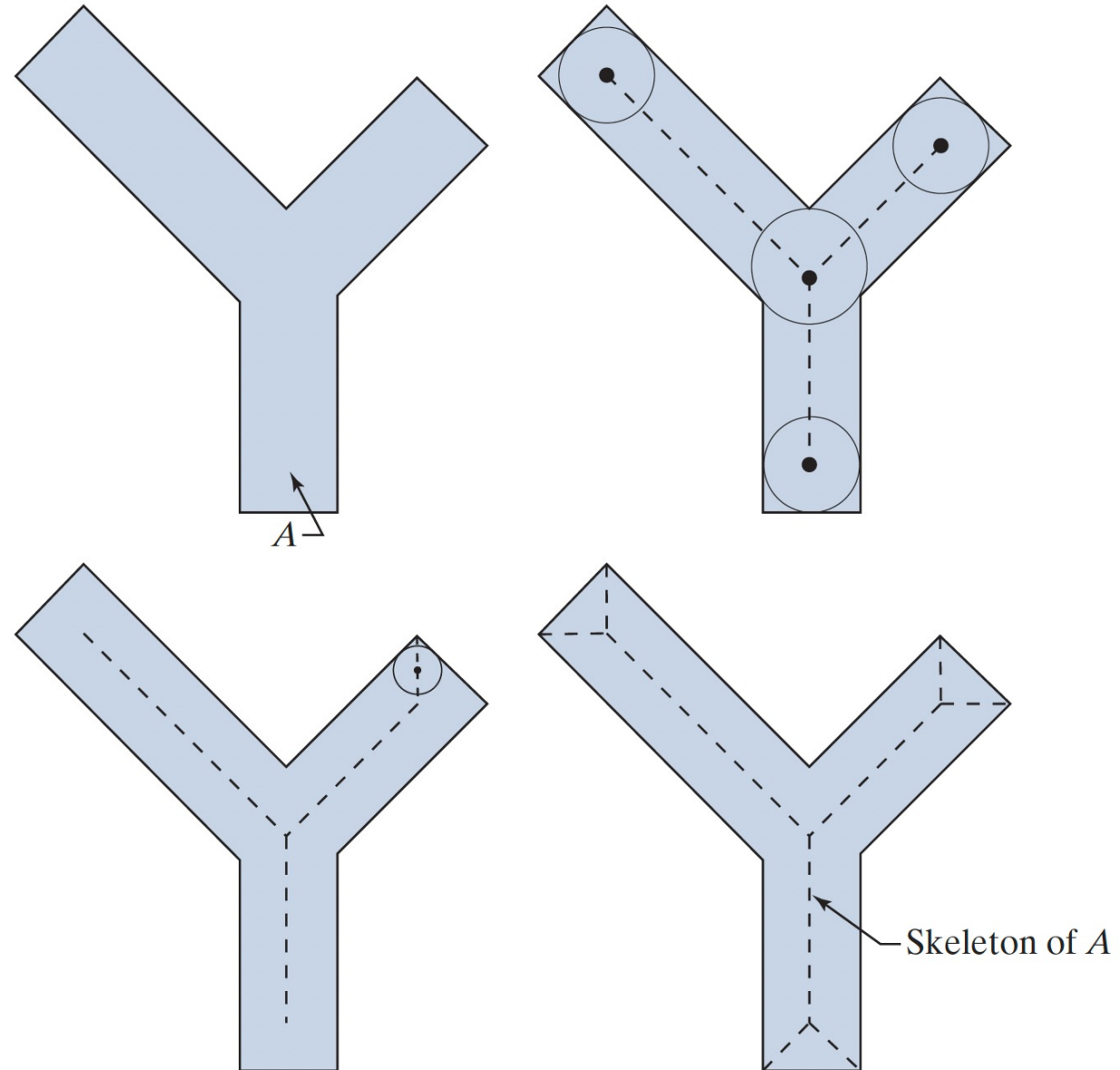
Skeleton as Maximum Disks

- Maximum Disks
 - A disc d that fits in A , such that no larger disk exists that fits inside A and contains d .
 - A maximum disk will touch the boundary of A at two or more points

- Definition:

$$S(A) = \bigcup_{k=0}^K S_k(A)$$

$$S_k(A) = (A \ominus kB) - (A \ominus kB) \circ B$$





Other Morphological Algorithms

- Hole Filling
- Connected Component Extraction
- Convex Hull



Questions?