School of Computer Science and Applied Mathematics
UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

APPM4058A & COMS7238A: Digital Image Processing
Exercise 5

2019-3-6

1 Problems

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Table 1: A binary image.

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Table 2: Structuring element. $()^1$ indicates the origin.

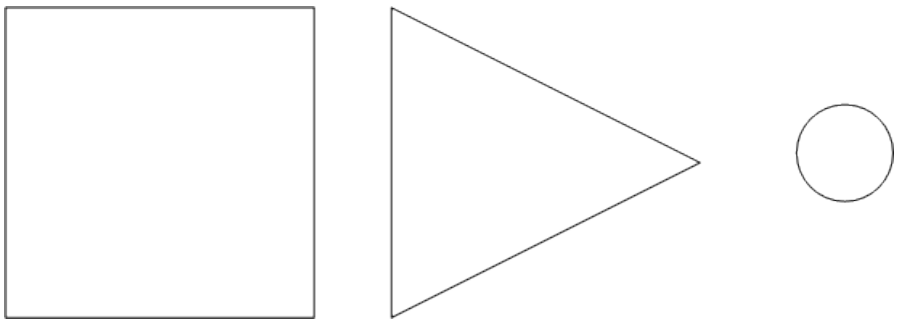


Figure 1: A binary image and a circle structuring element.

1. Find the opening and closing of the shapes given in Table 1, Figures 1 and 2 by the corresponding structuring elements. Note that the origins of the structuring elements in Figures 1 and 2 are in the center.
2. Find the opening and closing of the shapes in Figure 3. What would you expect their skeletons to look like?
3. Prove directly (by choosing an element in one side and showing that it's in the other) that
   (a) $A \ominus B \ominus B = A \ominus 2B$, where $2B = B \oplus B$.
   (b) Let A be a shape and B a structuring element. Suppose $A \oplus B$ is closed with regard to B. Prove that $A \bullet B = A \bullet 2B$.
   (c) Show that $(A \ominus B) \bullet B = (A \circ B) \ominus B$.
   (d) Deduce that $A \ominus B$ is closed with regard to B.
   (e) Consider the operator $*$ is defined by $A * B = (A \bullet B) \circ B$. Show that $*$ is idempotent, i.e., $A * B * B = A * B$.

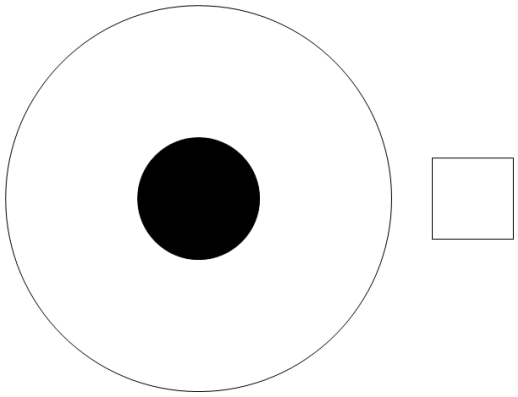


Figure 2: The image is a disc of diameter 5cm with an 1cm diameter hole cut out in the middle. The structuring element is a square of side 1cm.

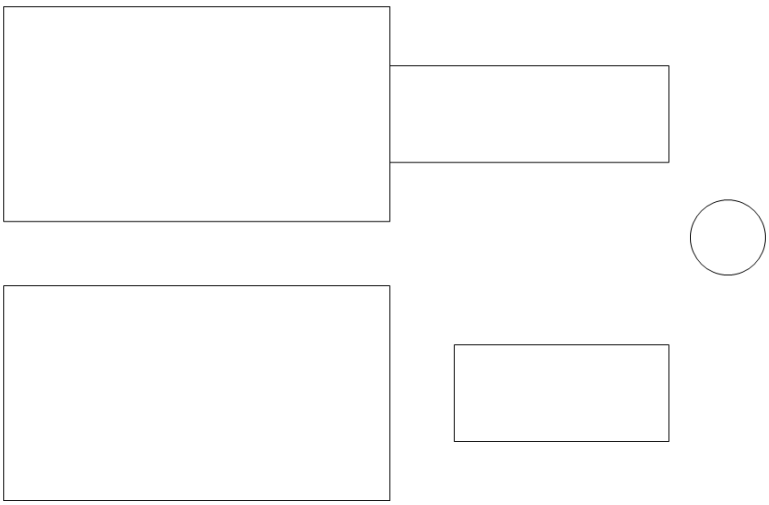


Figure 3:

4. In the following, clearly indicate with a cross symbol, x, the dilation, erosion, opening, closing and boundary respectively of the given discrete images by the given structuring element.

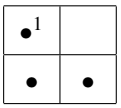
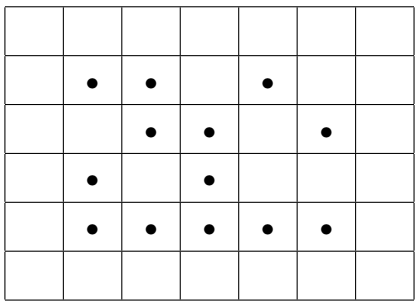
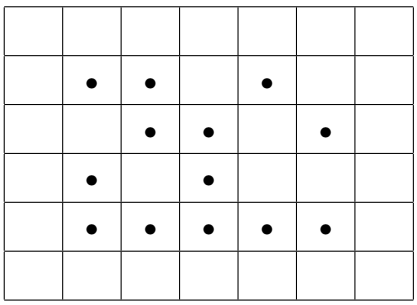


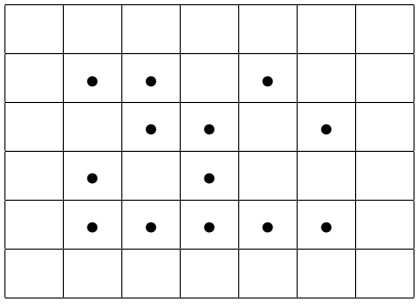
Table 3: Structuring element.



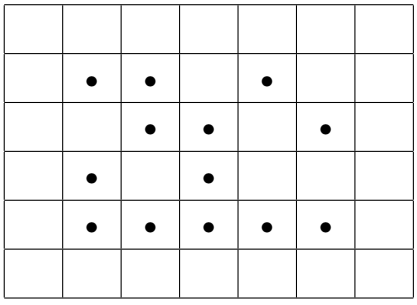
Original image



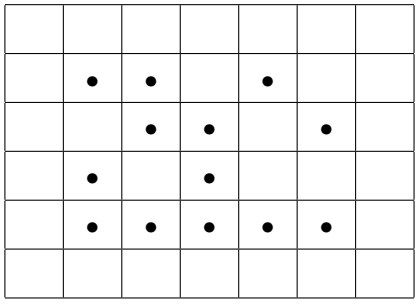
Dilation



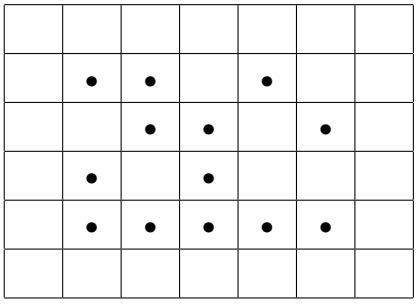
Erosion



Opening



Closing



Boundary

2 Lab exercises

1. Given image ‘left’, apply appropriate morphological operators to eliminate the smaller squares.
2. Given image ‘wirebond-mask’, how would you extract the large square in the middle?
3. Apply opening and closing to image ‘phantom’ using different structuring elements and analyze the difference.
4. Extract the boundary of image ‘lincoln’ using morphological operators.
5. Extract the skeleton of image ‘leg_bone’.