BINARY MORPHOLOGICAL OPERATIONS

- Dilation Operation
- Erosion Operation
- **Opening and Closing Operations**
- Hit or Miss Transformation

Opening and Closing Operations

- They are Based on Dilation and Erosion Operation.

Opening Operation

- The opening of a binary image A by the structuring element E is denoted by $A \circ E$ and is defined as

$$\boxed{A \circ E = (A \Theta E) \oplus E}$$ -------------------(1)

- Opening smoothens the contour of an object, breaks narrow isthmuses and eliminates thin protrusions in images.

$$A \circ E = (A \Theta E) \oplus E$$

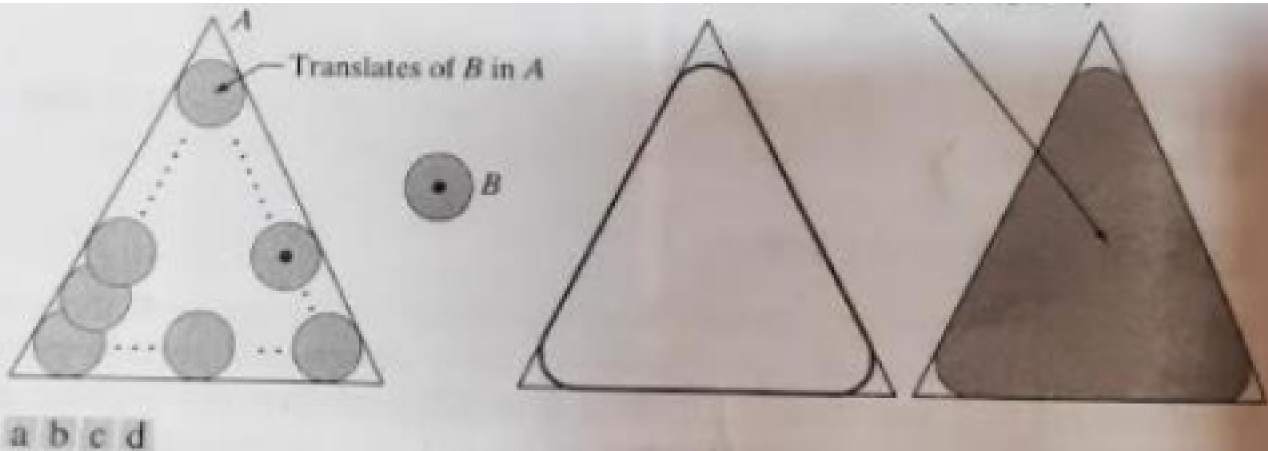


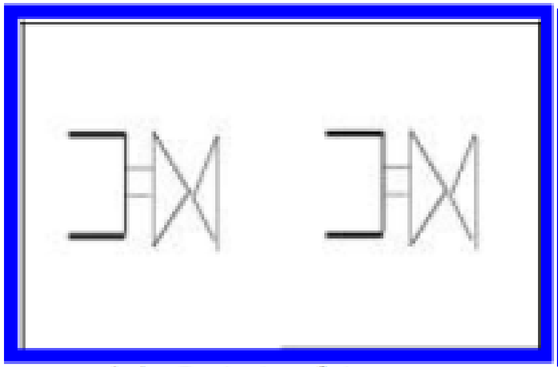
FIGURE 9.8 (a) Structuring element B "rolling" along the inner boundary of A (the dot indicates the origin of B). (b) Structuring element. (c) The heavy line is the outer boundary of the opening. (d) Complete opening (shaded). We did not shade A in (a) for clarity.

The opening operation satisfies the following properties:

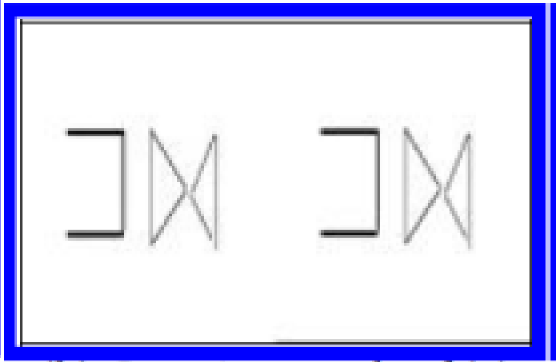
(i) $A \circ B$ is a subset (subimage) of A.

(ii) If C is a subset of D, then $C \circ B$ is a subset of $D \circ B$.

(iii) $(A \circ B) \circ B = A \circ B$.



(a) Original image



(b) Opening result of (a)

- Consider the folling image A and structuring element E Perform Opening Operation.

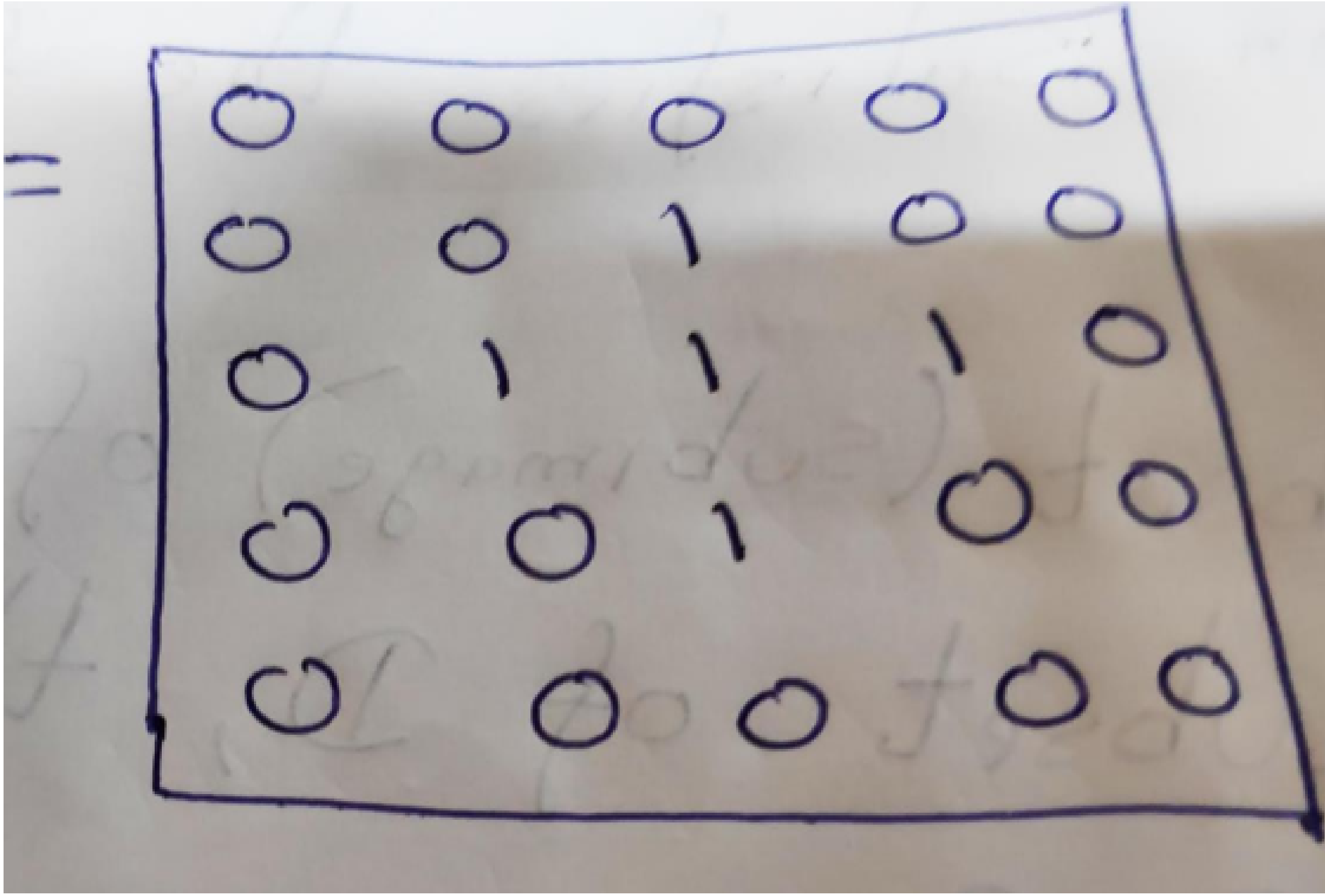
$$\begin{matrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 1 & 0 \\ 0 & 1 & 1 & 1 & 0 \\ 0 & 1 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{matrix} \qquad \begin{matrix} 0 & 1 & 0 \\ 1 & 1 & 1 \\ 0 & 1 & 0 \end{matrix}$$

A $\qquad\qquad$ E

Soln

$$A \circ E = (A \ominus E) \oplus E.$$

$$= \begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix} \oplus \begin{pmatrix} 0 & 1 & 0 \\ 1 & 1 & 1 \\ 0 & 1 & 0 \end{pmatrix}.$$



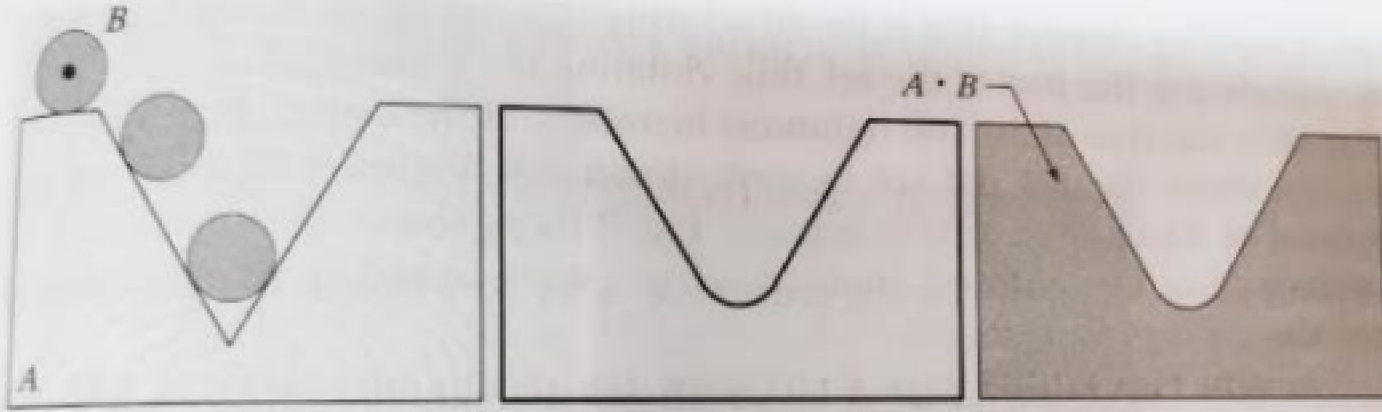
<u>Closing Operation</u>

- The closing of A by the structuring element E is denoted by A • E and is defined as

$$\boxed{A \bullet E = (A \oplus E) \Theta E}$$

-------------------(2)

- Closing tends to smooth sections of contours, it also fuses narrow breaks and long thin gulfs, eliminates small holes and fills gaps in the contour.

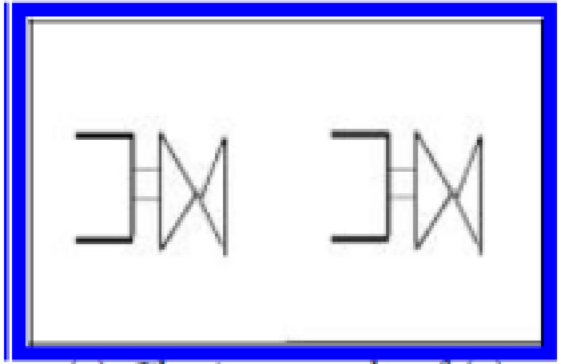


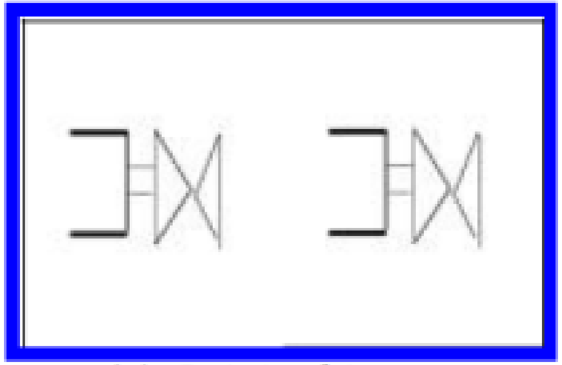
a b c

FIGURE 9.9 (a) Structuring element B "rolling" on the outer boundary of set A. (b) The heavy line is the outer boundary of the closing. (c) Complete closing (shaded). We did not shade A in (a) for clarity.

Similarly, the closing operation satisfies the following properties:

(i) A is a subset (subimage) of $A \bullet B$.
(ii) If C is a subset of D, then $C \bullet B$ is a subset of $D \bullet B$.
(iii) $(A \bullet B) \bullet B = A \bullet B$.


(c) Closing result of (a)


(a) Original image

- Consider the folling image A and structuring element E Perform Closing Operation.

0	0	0	0	0
0	1	1	1	0
0	1	1	1	0
0	1	1	1	0
0	0	0	0	0

A

0	1	0
1	1	1
0	1	0

E

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

$$= \begin{pmatrix} 0 & 1 & 1 & 1 & 0 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 0 & 1 & 1 & 1 & 0 \end{pmatrix} \ominus \begin{pmatrix} 0 & 1 & 0 \\ 1 & 1 & 1 \\ 0 & 1 & 0 \end{pmatrix}$$

$$= \begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 1 & 0 \\ 0 & 1 & 1 & 1 & 0 \\ 0 & 1 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$