Recapitulation

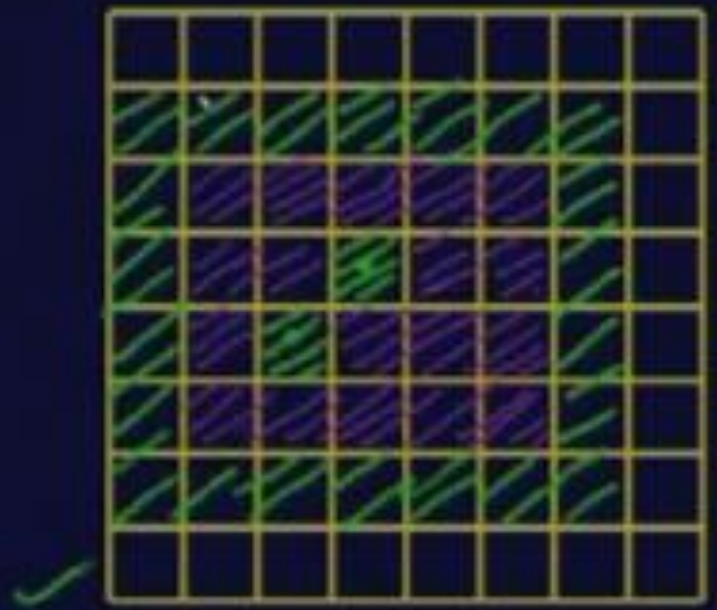
- What is Morphology?
- Review of some basic set operations
- Morphological image processing techniques
  - Dilation
  - Erosion
- Applications

Mathemetical Morphology

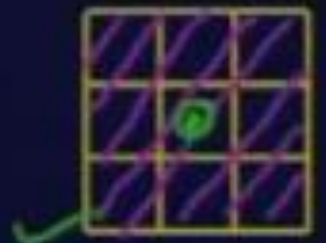
- On completion the students will learn and be able to implement

  - Erosion
  - Properties of dilation and erosion
  - Opening
  - Closing
  - Hit-or-Miss Transform

Dilation



X



B

Erosion

X B

$$X \ominus B = \{p \in Z^2 \mid p + b \in X \text{ for every } b \in B\}$$

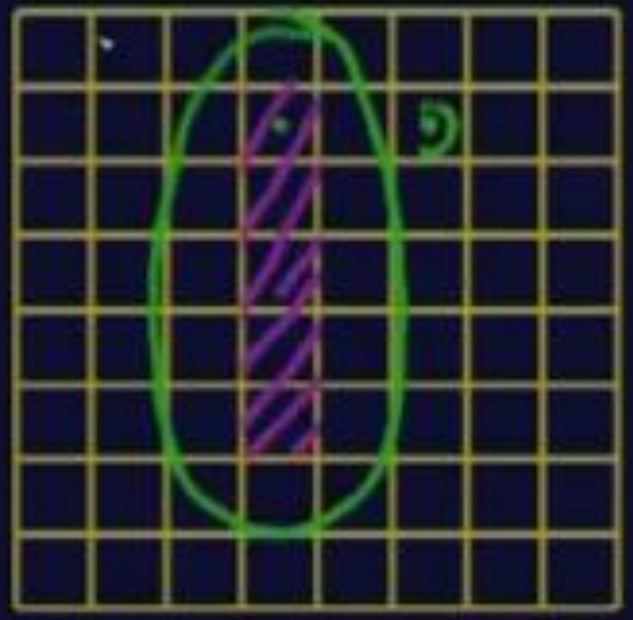
Erosion

X B

$$X \ominus B = \{p \in Z^2 \mid p + b \in X \text{ for every } b \in B\}$$

$$X \ominus B = \{x \mid (B)_x \subseteq X\}$$

Erosion



B

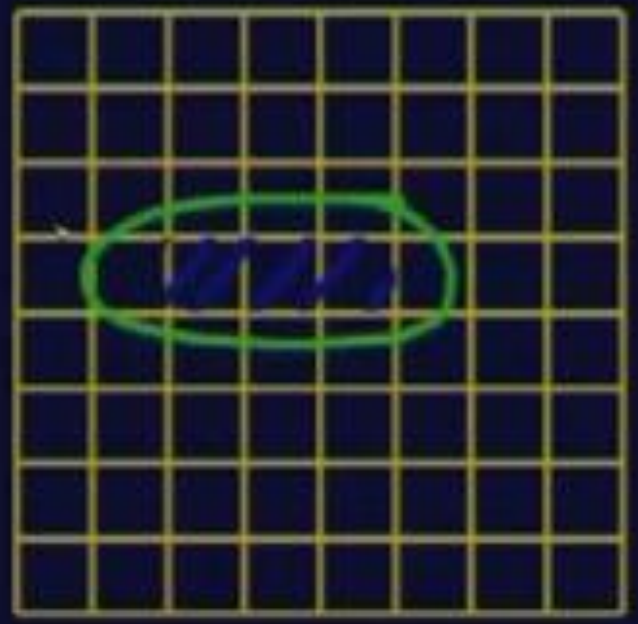
(-1, 0) (1, 0)

X

$X \ominus B$

$\{p \mid p+b \in X, \forall b \in B\}$

Erosion



B

X

Properties of Dilation

1. Commutative $\Rightarrow$

$$X \oplus B = B \oplus X$$

$$X \oplus B = \{x + b \mid x \in X, b \in B\}$$

$$B \oplus X = \{b + x \mid b \in B, x \in X\}$$

2. Associative

$$X \oplus (B \oplus D) = (X \oplus B) \oplus D$$

3. $X \oplus B = X_b$

2. Associative

$$X \oplus (B \oplus D) = (X \oplus B) \oplus D$$

3. $X \oplus B = \bigcup_{\forall b \in B} X_b$

2. Associative

$$X \oplus (B \oplus D) = (X \oplus B) \oplus D$$

3. $X \oplus B = \bigcup_{\forall b \in B} X_b$

4. Translation Invariance

$$X_h \oplus B = (X \oplus B)_h$$

5. Increasing Transform.

$X \subseteq Y$ then

$X \oplus B \subseteq Y \oplus B$

Properties of Erosion

1. $X \ominus B = \bigcap_{\forall b \in B} X_{-b}$

$(0,0) \in B \Rightarrow X \ominus B \subseteq X$

2. Translation

$X_h \ominus B = (X \ominus B)_h$

$X \ominus B_h = (X \ominus B)_{-h}$

3. Increasing Transform

if $X \subseteq Y$

$X \ominus B \subseteq Y \ominus B$

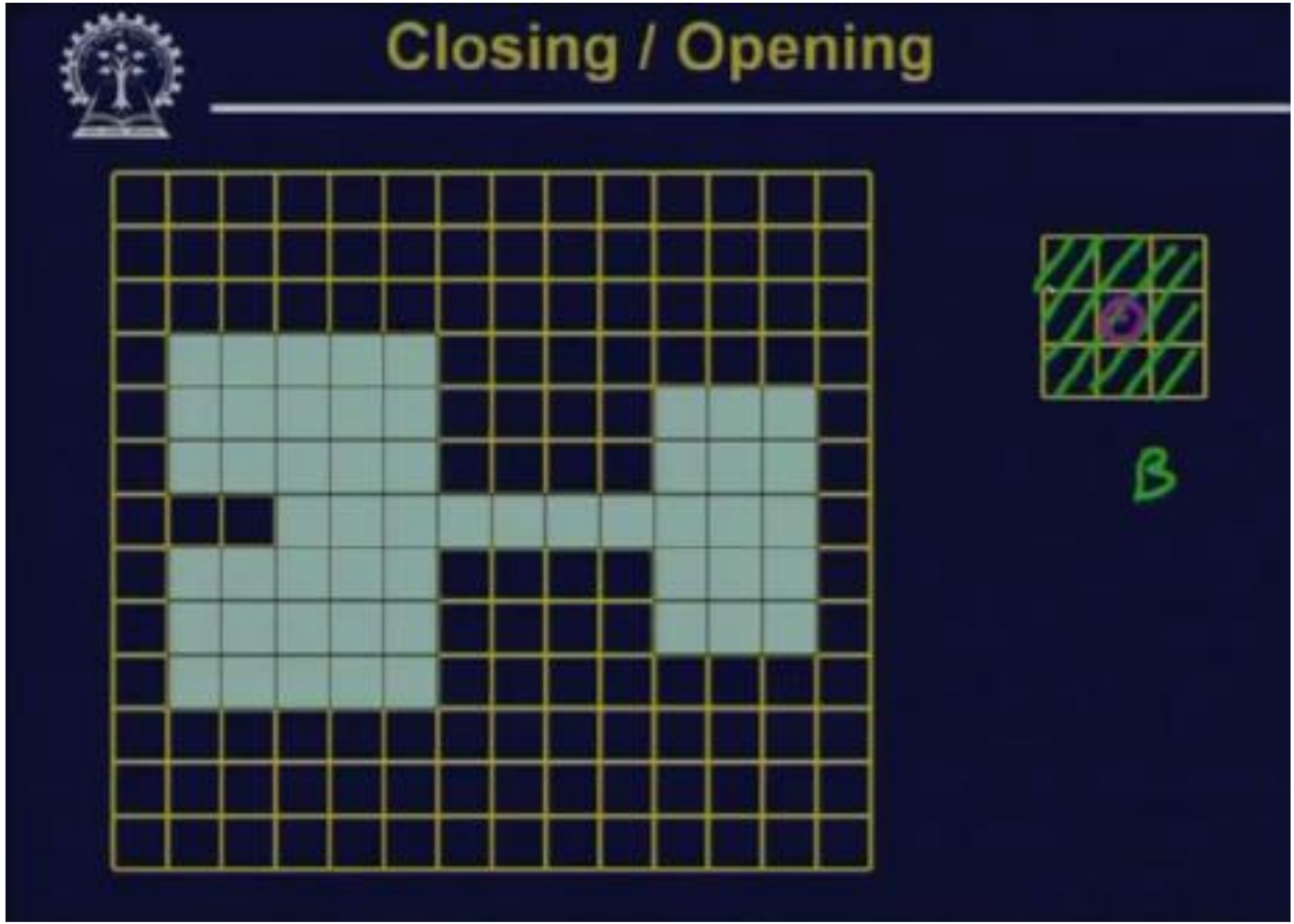
4. B & D $D \subseteq B$

$\Rightarrow X \ominus B \subseteq X \ominus D$

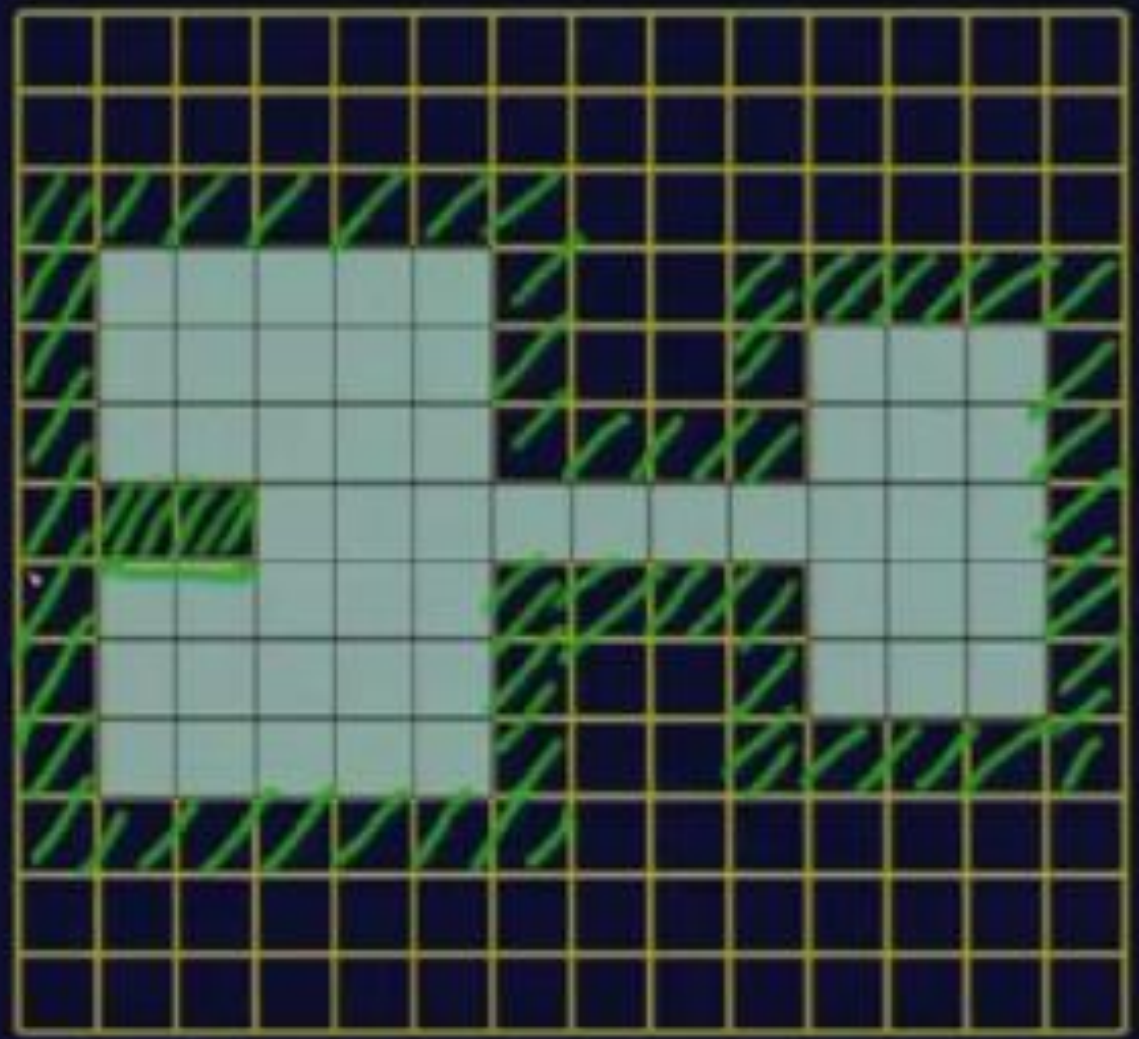
$$\left.\begin{aligned} x \oplus B &= B \oplus x \\ x \ominus B &\neq B \ominus x \end{aligned}\right\}$$

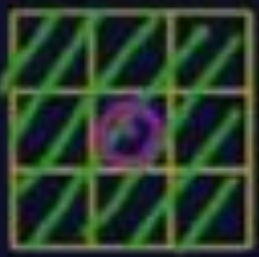
$$\begin{cases} x \oplus (B \oplus D) = (x \oplus B) \oplus D \\ x \ominus (B \ominus B) \neq (x \ominus B) \ominus D \end{cases}$$

Closing / Opening



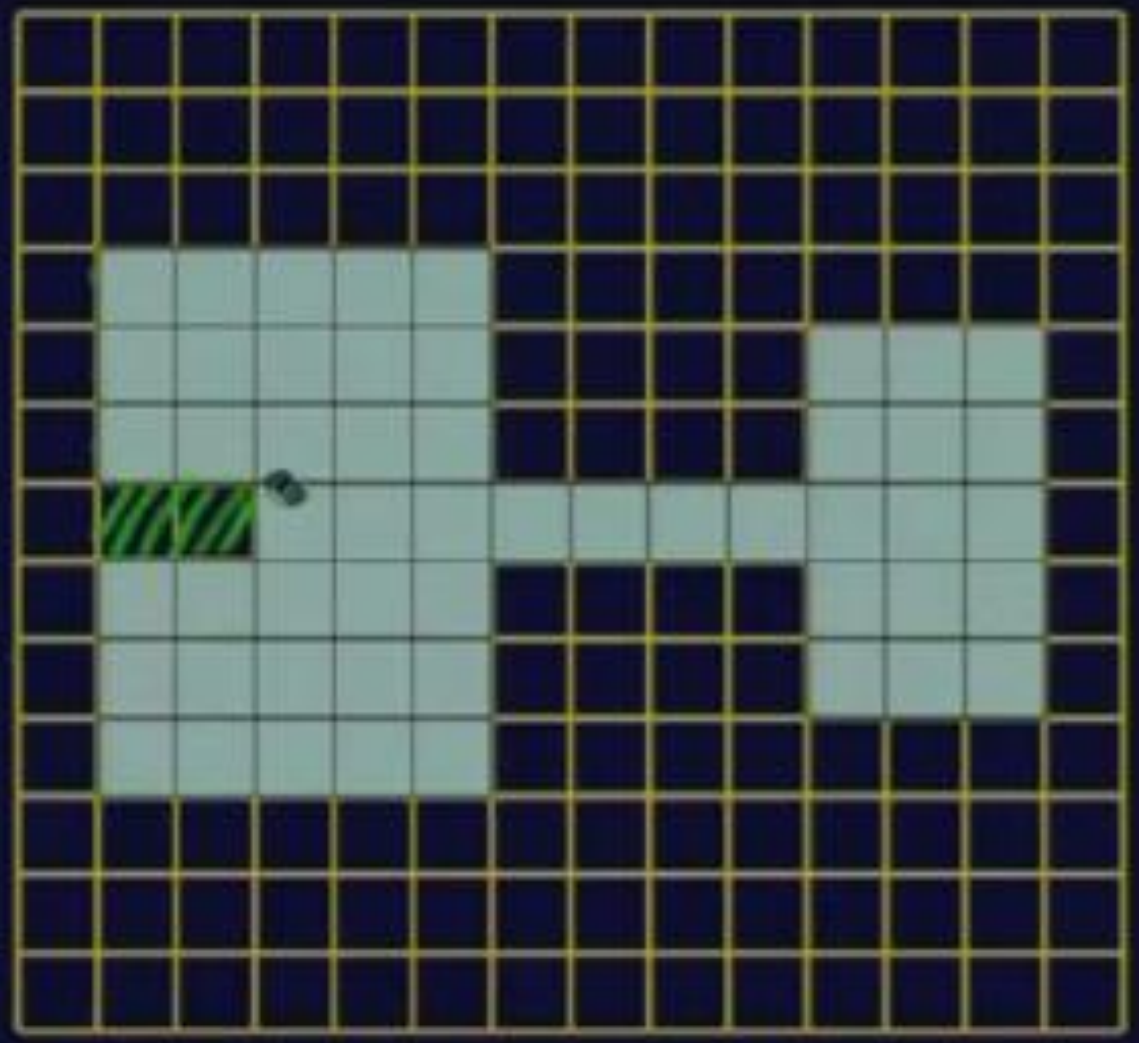
Closing / Opening

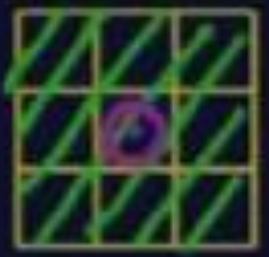




B

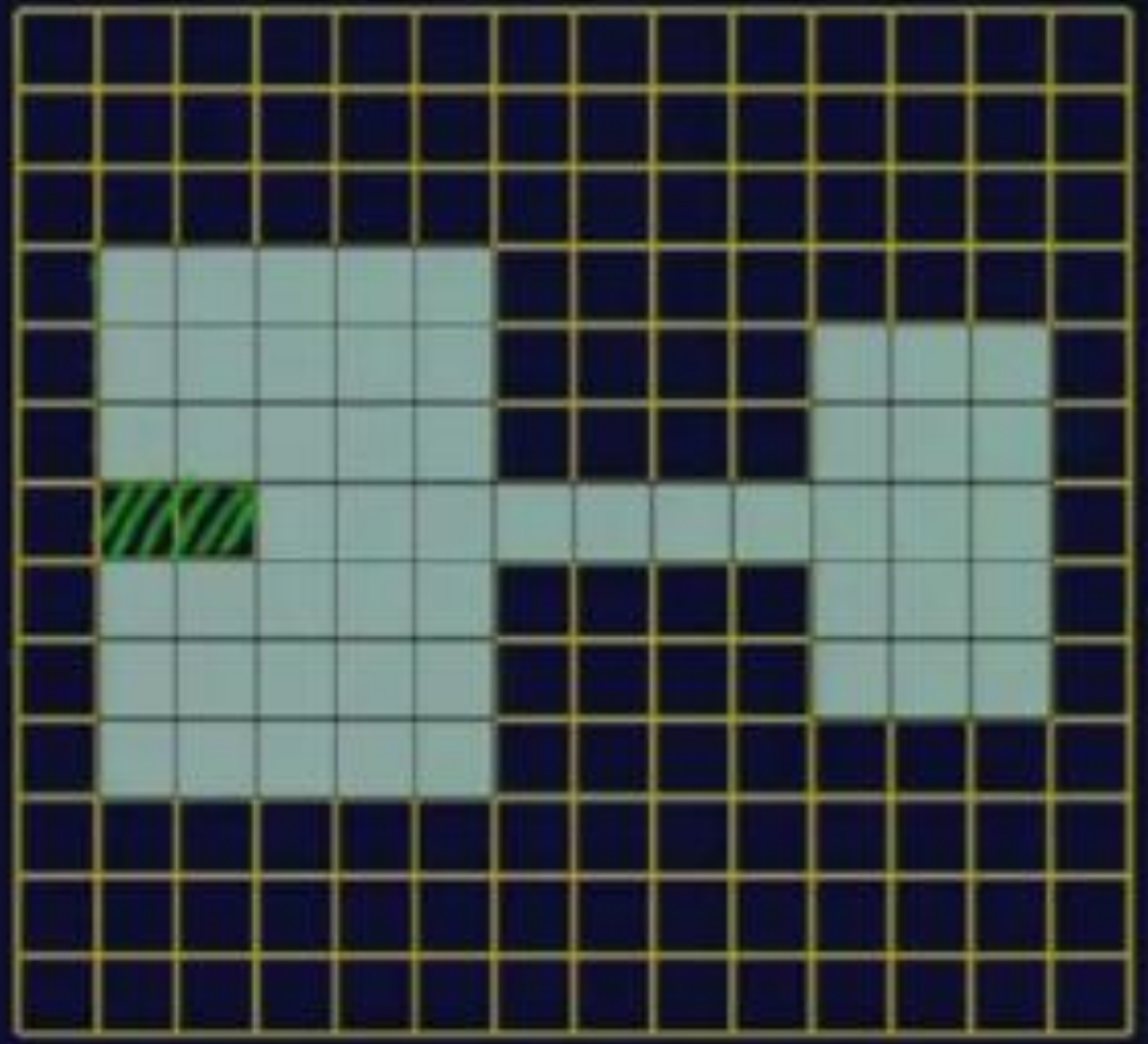
Closing / Opening

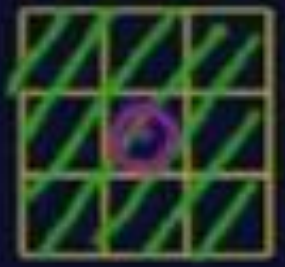




B

Closing / Opening

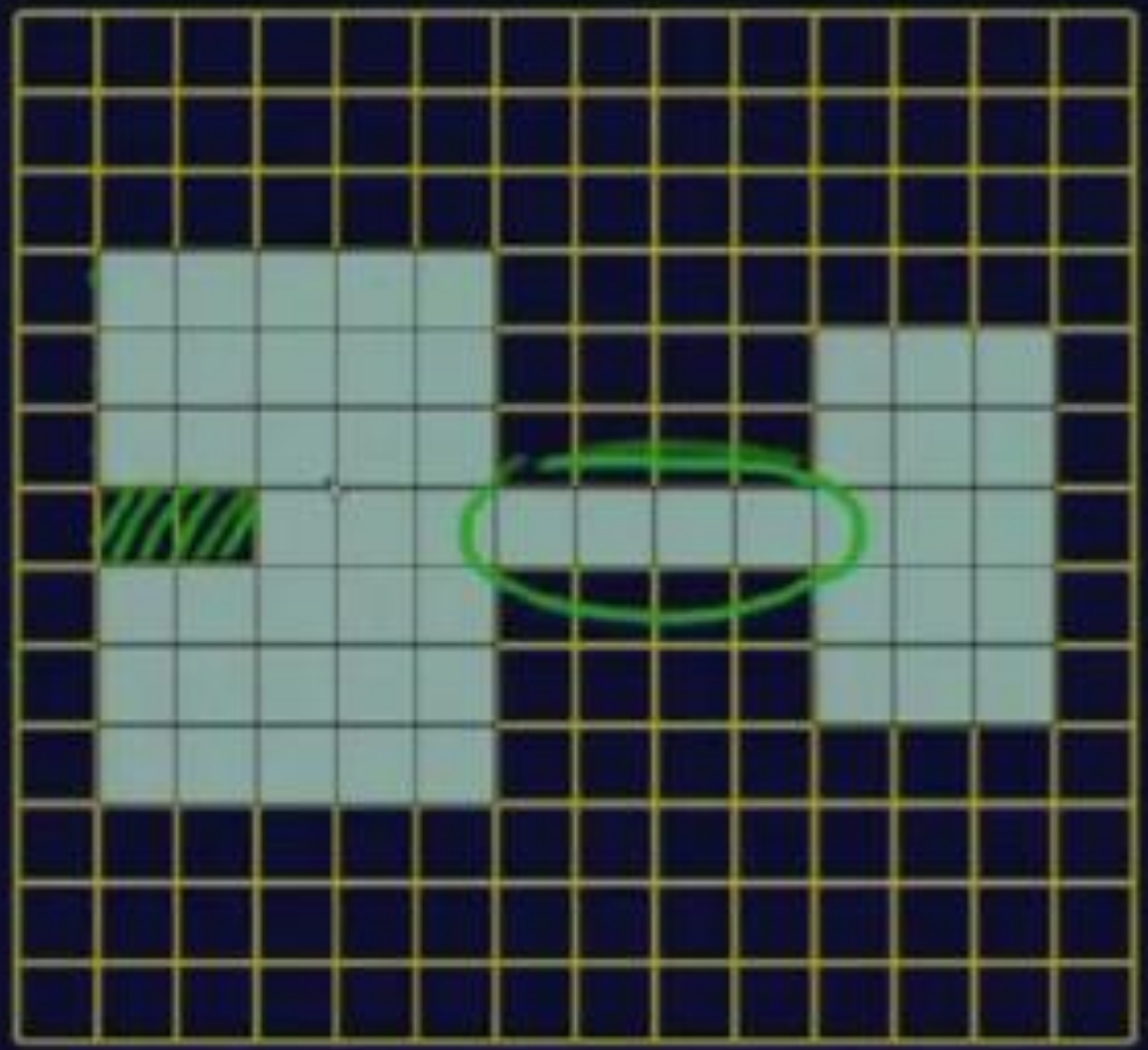




B

$X \cdot B = (X \oplus B) \ominus B$

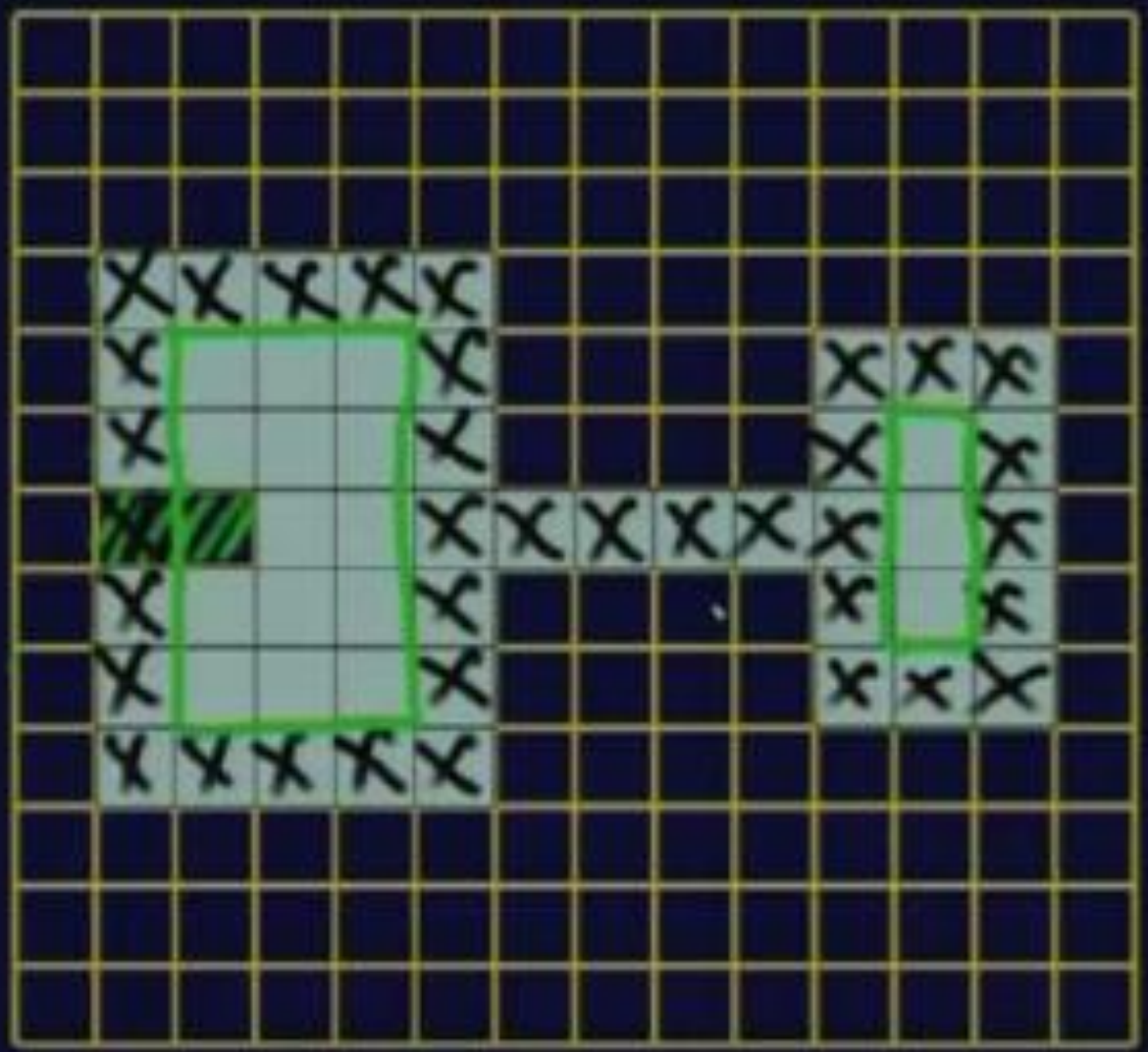
Closing / Opening

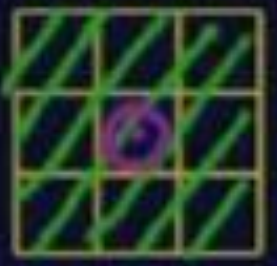


B

$X \cdot B \cdot (X \oplus B) \ominus B$

Closing / Opening

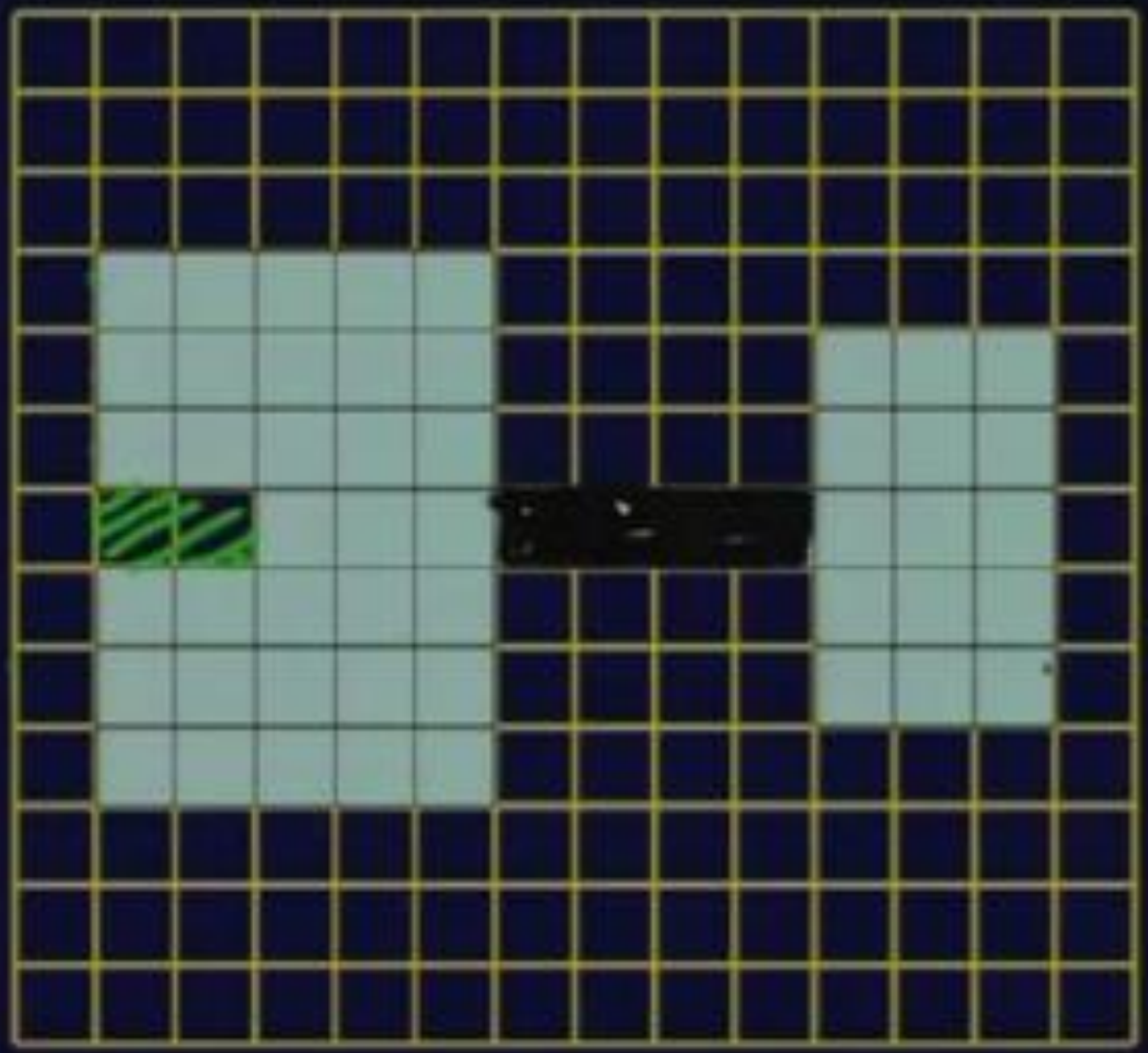


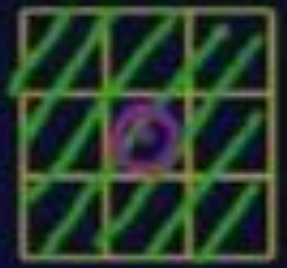


B

$X \cdot B \cdot (X \oplus B) \ominus B$

Closing / Opening

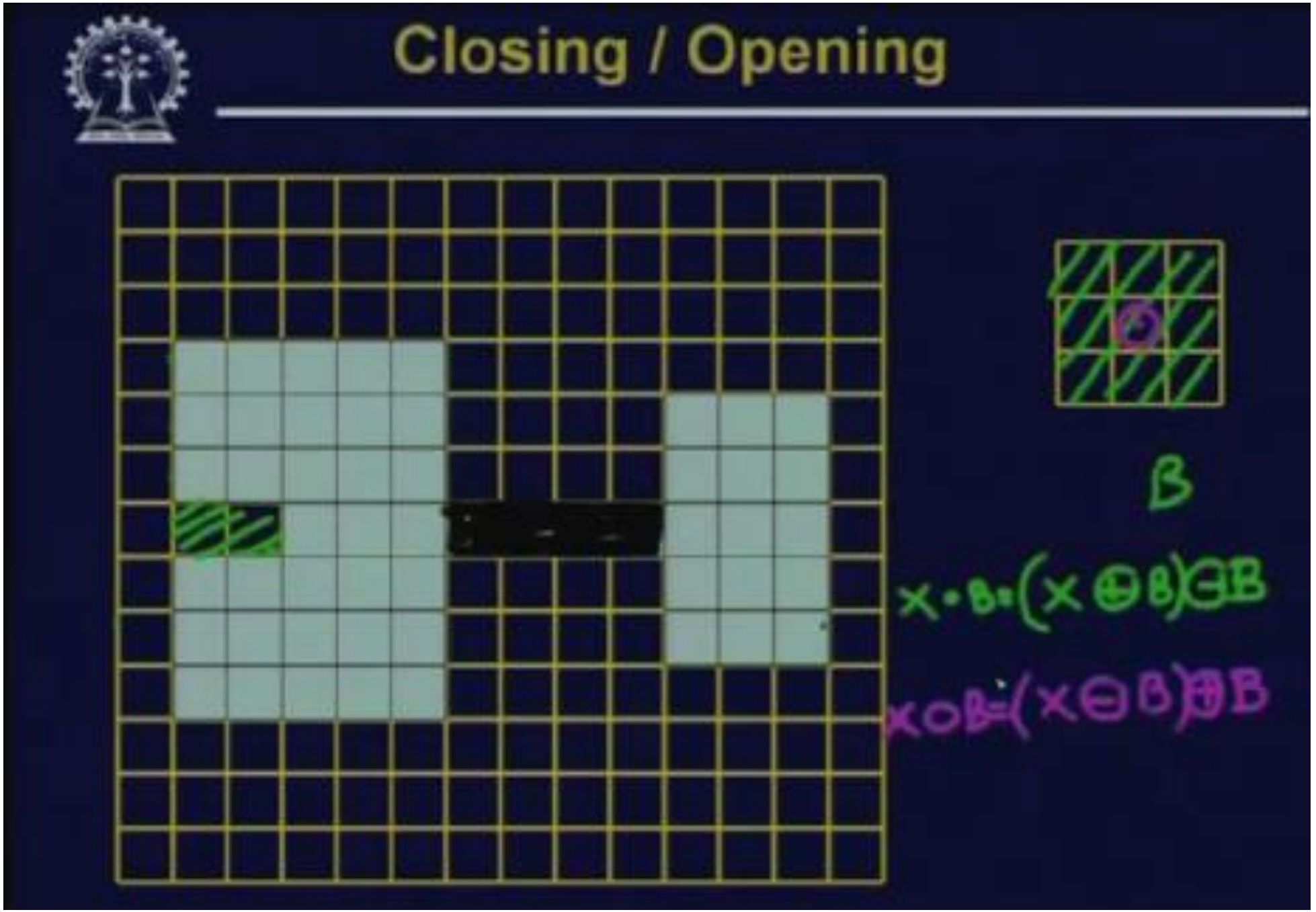




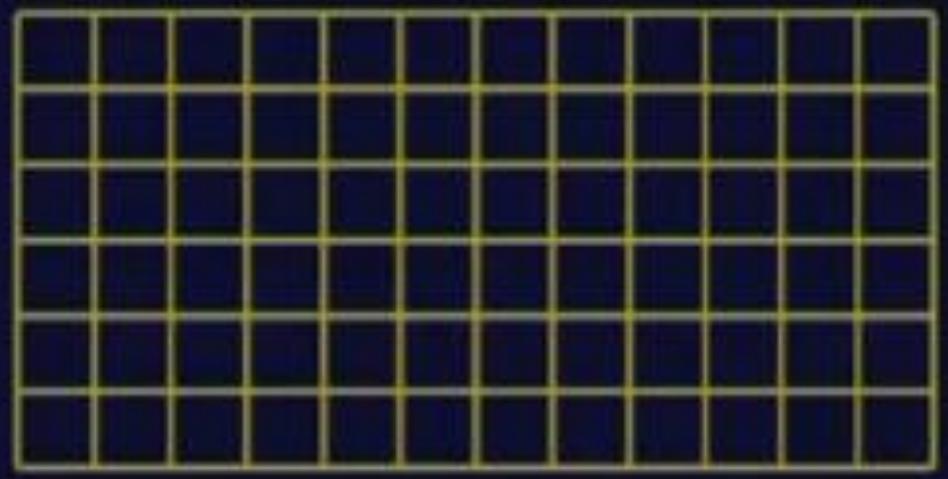
B

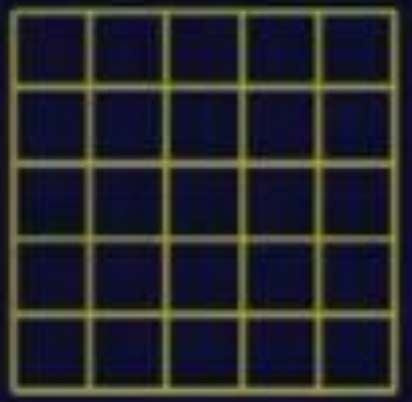
$X \cdot B = (X \oplus B) \ominus B$

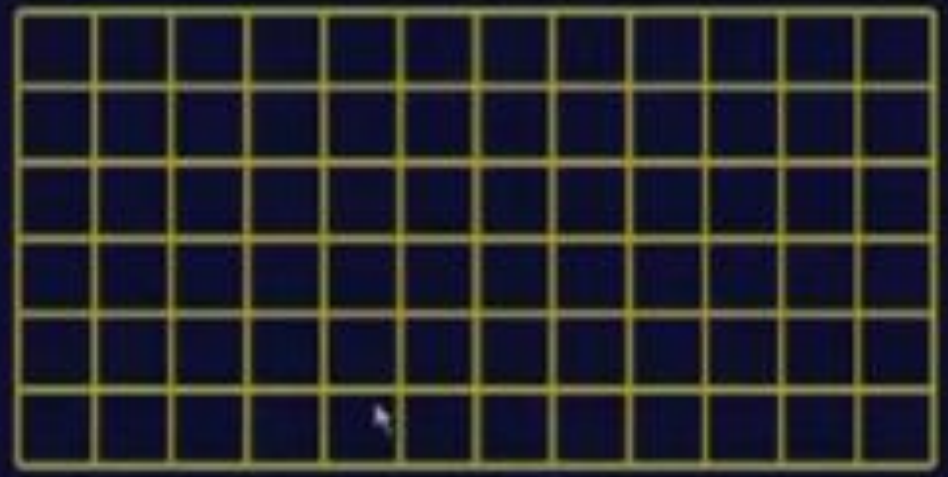
Closing / Opening



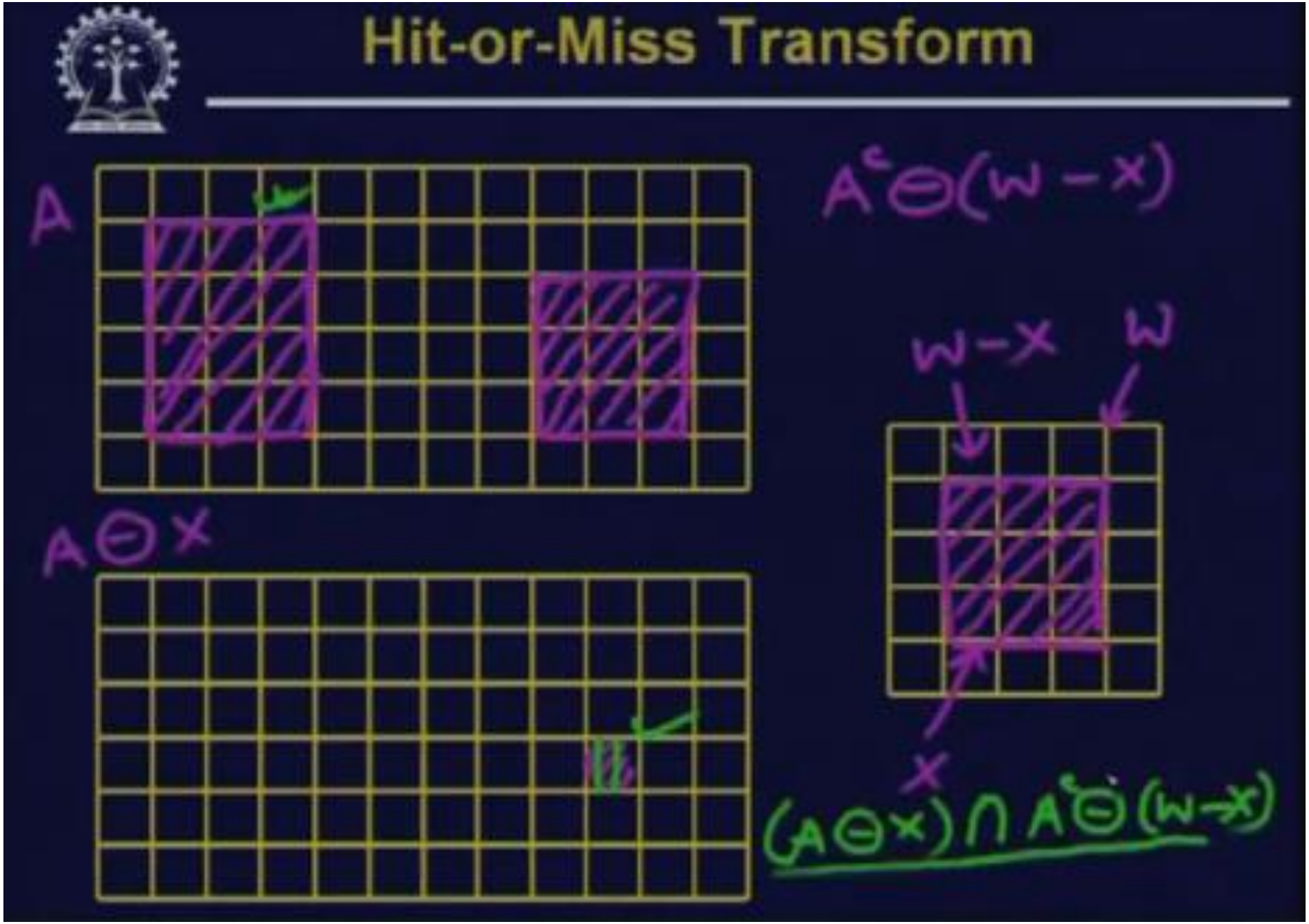
Hit-or-Miss Transform







Hit-or-Miss Transform



$$B = (B_1, B_2)$$

$$A \circledast B = (A \ominus B) \cap (A^c \ominus B_2)$$

Quiz Questions on Lecture 33 & 34

1. What is Morphology?
2. What are opening and closing operations?
3. Show that dilation operation is commutitave.
4. What are the translation properties of dilation and erosion operations?
5. What is meant by – dilation and erosion are increasing transformations?
6. Define Hit-or-Miss Transform.
7. What is the application of Hit-or-Miss Transform?