# Morphological Operation

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# Definition

✓ **모폴로지 연산** : 영상 내에 존재하는 특정 객체의 형태를 변형 시키는 용도로 사용됨. (노이즈 제거, 특징 추출에 사용)

$$a = (a_x, a_y)$$

$$a \in A \quad a \notin A$$

- Translation

$$(A)_b = \{c \mid c = a + b, \text{ for } a \in A\}$$

- Reflection

$$\hat{B} = \{x \mid x = -b, \text{ for } b \in B\}$$

- Complement

$$A^c = \{x \mid x \notin A\}$$

- Difference

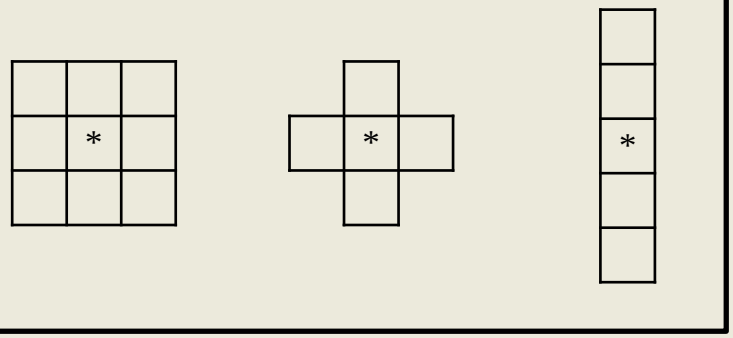
$$\begin{aligned} A - B &= \{x \mid x \in A, x \notin B\} \\ &= A \cap B^c \end{aligned}$$

# Binary

## ✓ Erosion

$$A \ominus B = \{x \mid (B)_x \subset A\}$$

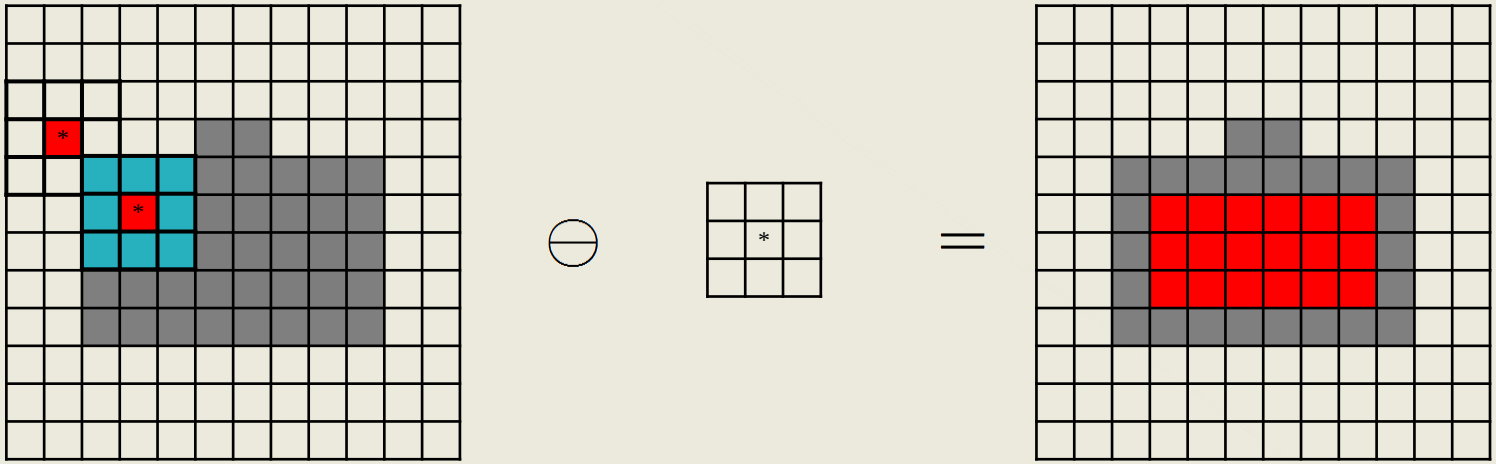
<B : Structuring element>



# Binary

## ✓ Erosion

$$A \ominus B = \{x \mid (B)_x \subset A\}$$



# Binary

## ✓ Erosion

Origin

Erosion

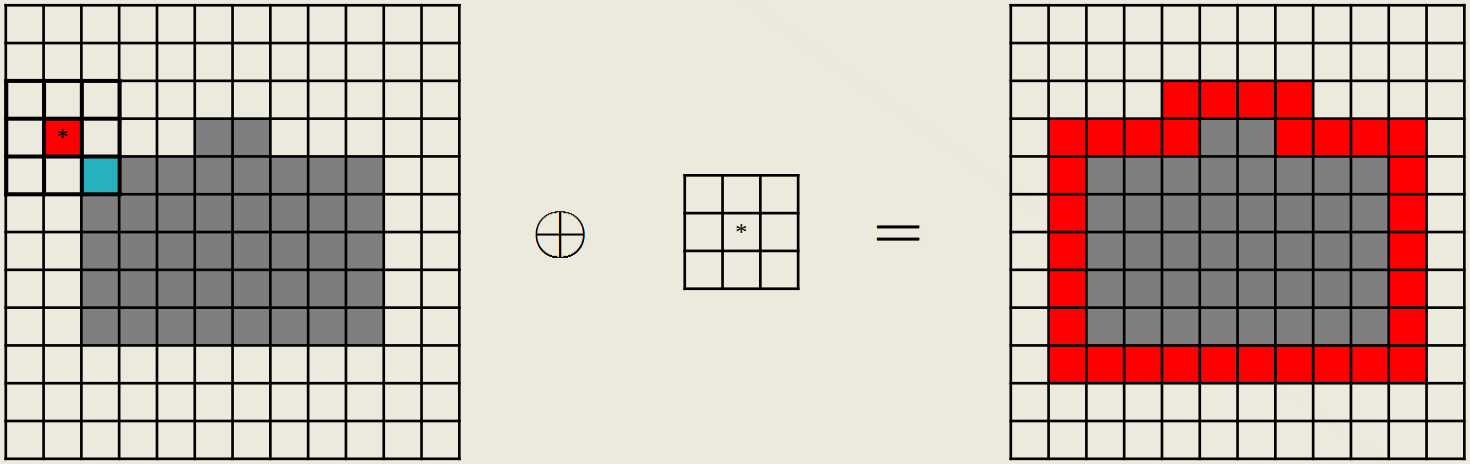

Origin


Erosion

# Binary

## ✓ Dilation

$$A \oplus B = \left\{ x \,|\, (\hat{B}) \cap A \neq \phi \right\}$$
$$= \left\{ [(\hat{B})_x \cap A] \subseteq A \right\}$$

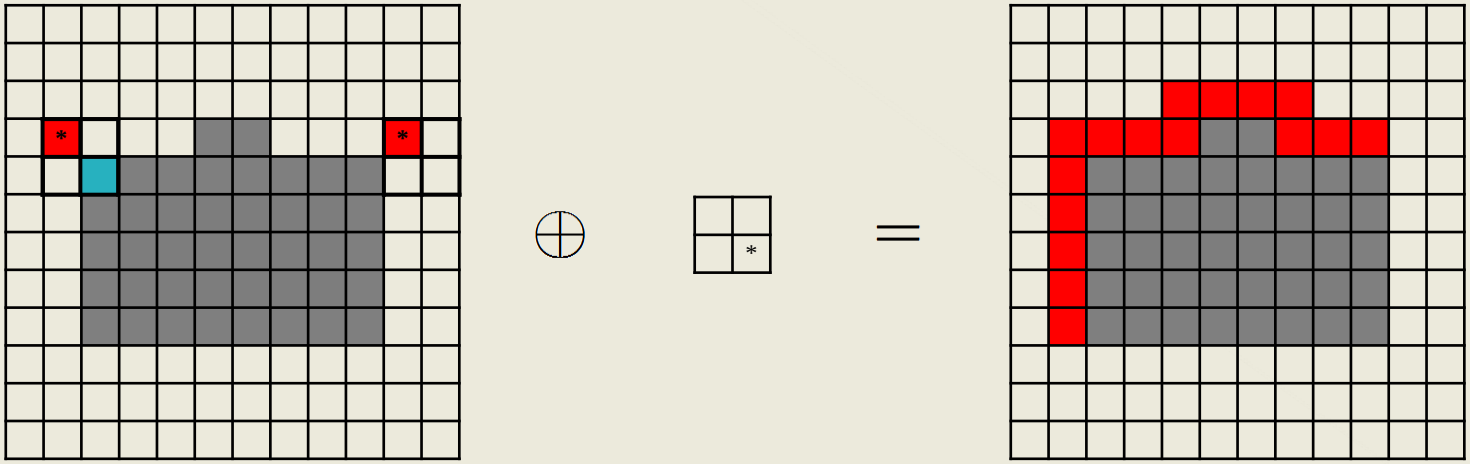


# Binary

## ✓ Dilation

$B$ : 

$\hat{B}$ : 



# Binary

## ✓ Dilation

Origin

Dilation


Origin


Dilation

# Binary

- **Relationship**

$$(A \ominus B)^c = A^c \oplus \hat{B}$$

- **Contour**

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

# Binary

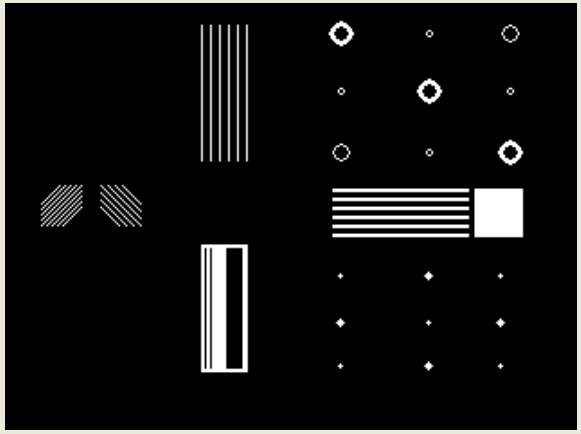
- ✓ **Opening & Closing**

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

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

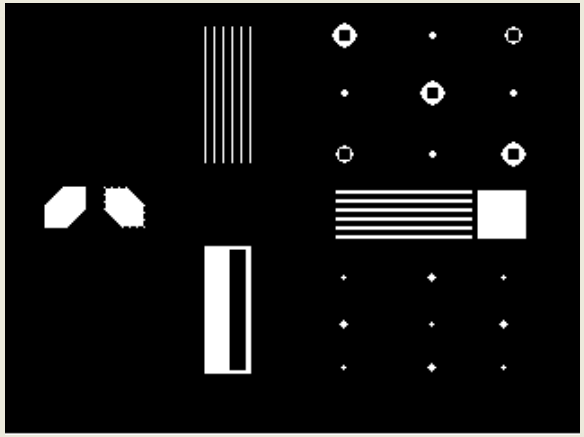
# Binary

## ✓ Opening & Closing



->Origin

Opening



Closing

# Gray-scale

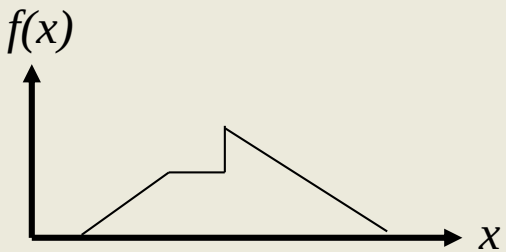
## ✓ Erosion & Dilation

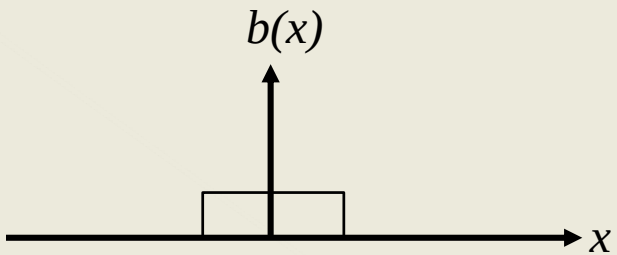
$$(f \ominus b)(x) = \min_{z-x \subseteq D_f,\, z \subseteq D_b} \{f(z-x) - b(z)\}$$

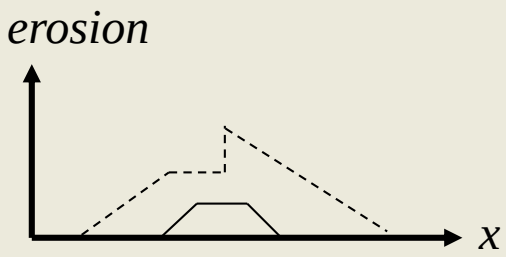
$$(f \oplus b)(x) = \max_{z-x \subseteq D_f,\, z \subseteq D_b} \{f(z-x) + b(z)\}$$

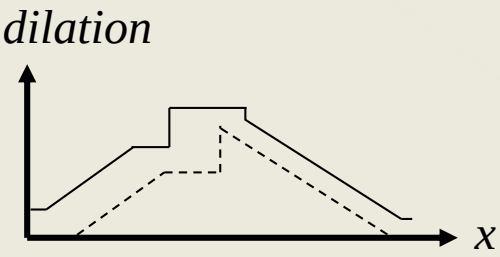
*(b : Structuring function)*

| | | |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 0 | 0 |
| 0 | 0 | 0 |



# Gray-scale

- ✓ **Opening & Closing**

$$f \circ b = (f \ominus b) \oplus b$$

$$f \bullet b = (f \oplus b) \ominus b$$

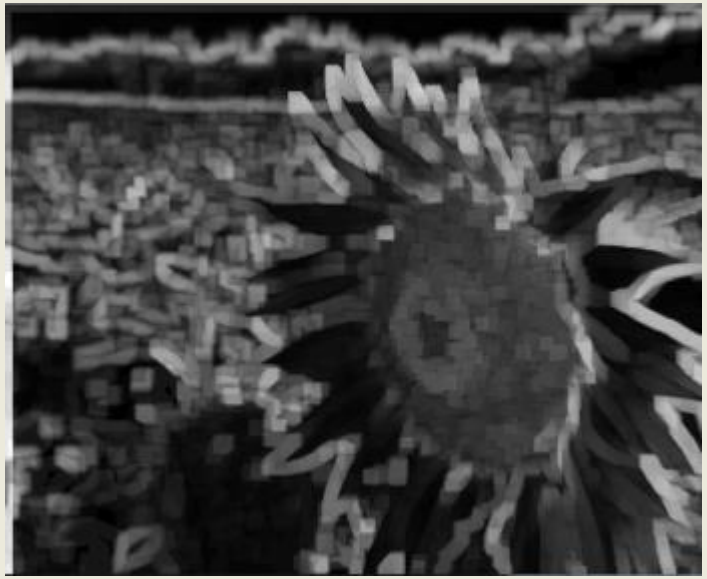
# Application

- **Contour (Origin – Erosion)**

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

- **Gradient (Dilation – Erosion)**

Origin



Gradient

# Application

- ✓ **Top-hat(Origin - Opening) & Black-hat(Closing - Origin)**


->Origin

Top-hat

Black-hat

# Application

## ✓ RGB Color

1) RGB to Gray
2) Morphological Operation
3) Gray to RGB

- RGB Average: (R+G+B)/3

- Y value of YUV: Y = R * 0.299 + G *0.587 + B *0.114
(U : 0.492*(B-Y), V : 0.877*(R-Y)

- R: Y + 1.140*V , G: Y-0.395*U-0.581*V, B: Y+2.032*U

# Q & A