Segmentação e Morfologia de Imagens

Prof. Vinícius de Oliveira

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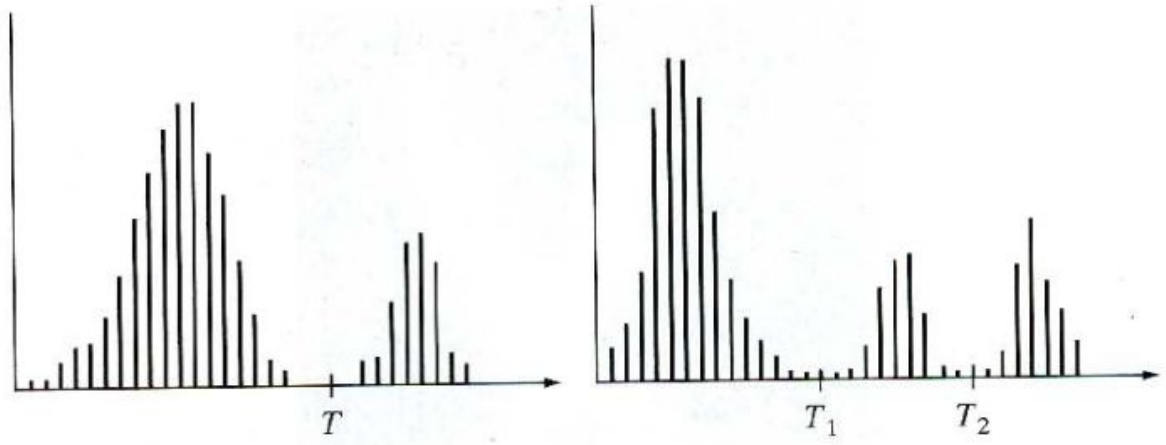
Segmentação de Imagens

- Em visão computacional, **segmentação** se refere ao processo de dividir uma **imagem** digital em múltiplas regiões (conjunto de pixels) ou objetos, com o objetivo de simplificar e/ou mudar a representação de uma **imagem** para facilitar a sua análise.

Limiarização

- É a classificação de pixels de acordo com a especificação de 1 ou mais limiares (*thresholds*).



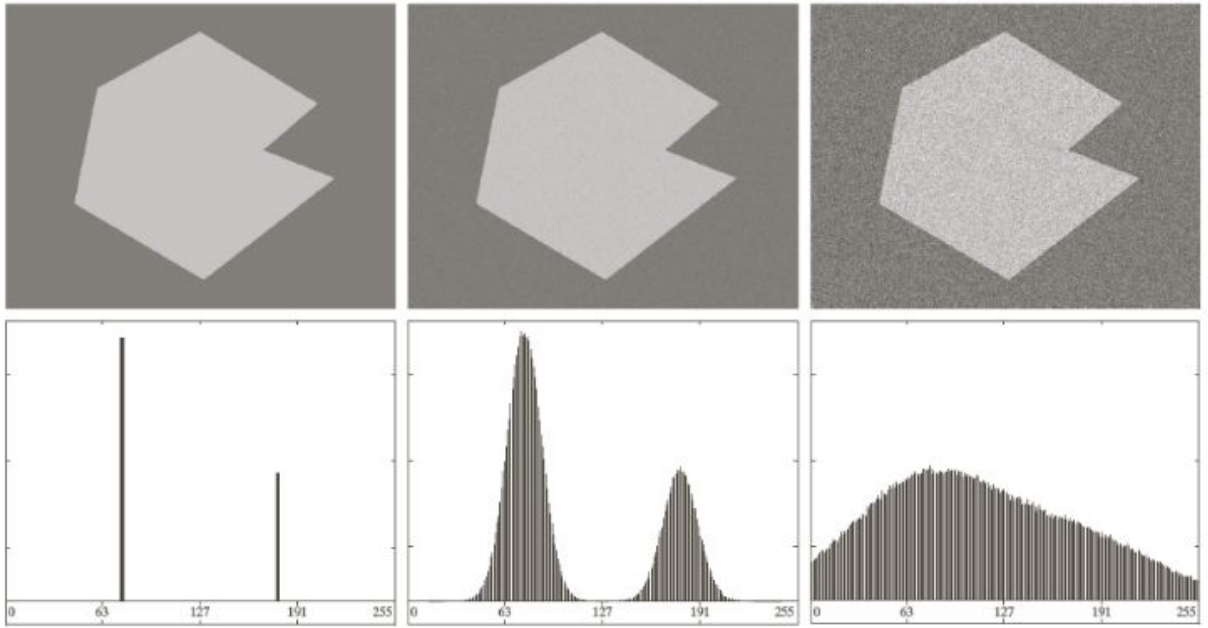
Limiarização

- Local ou global;
- Multi-níveis;
- Dinâmica ou adaptativa;

$$T = T[x, y, p(x, y), f(x, y)]$$

$$g(x, y) = \begin{cases} 1 & \text{se } f(x, y) > T, \\ 0 & \text{se } f(x, y) \leq T. \end{cases}$$

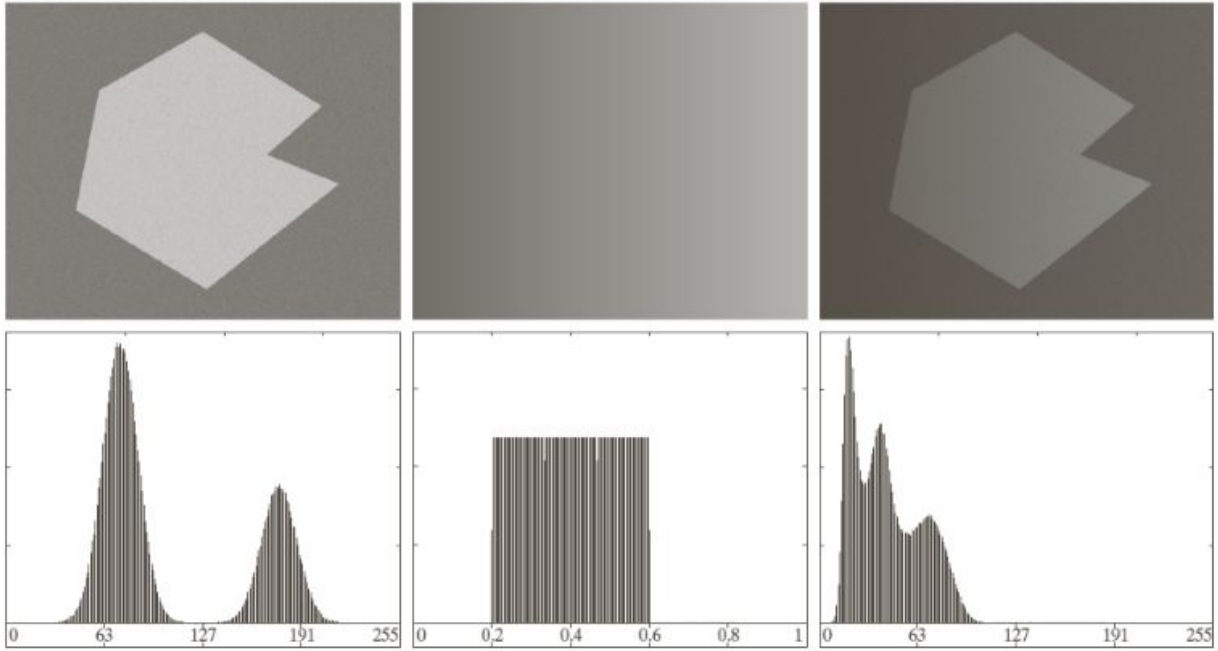
Limiarização



a b c
d e f

FIGURE 10.36 (a) Noiseless 8-bit image. (b) Image with additive Gaussian noise of mean 0 and standard deviation of 10 intensity levels. (c) Image with additive Gaussian noise of mean 0 and standard deviation of 50 intensity levels. (d)–(f) Corresponding histograms.

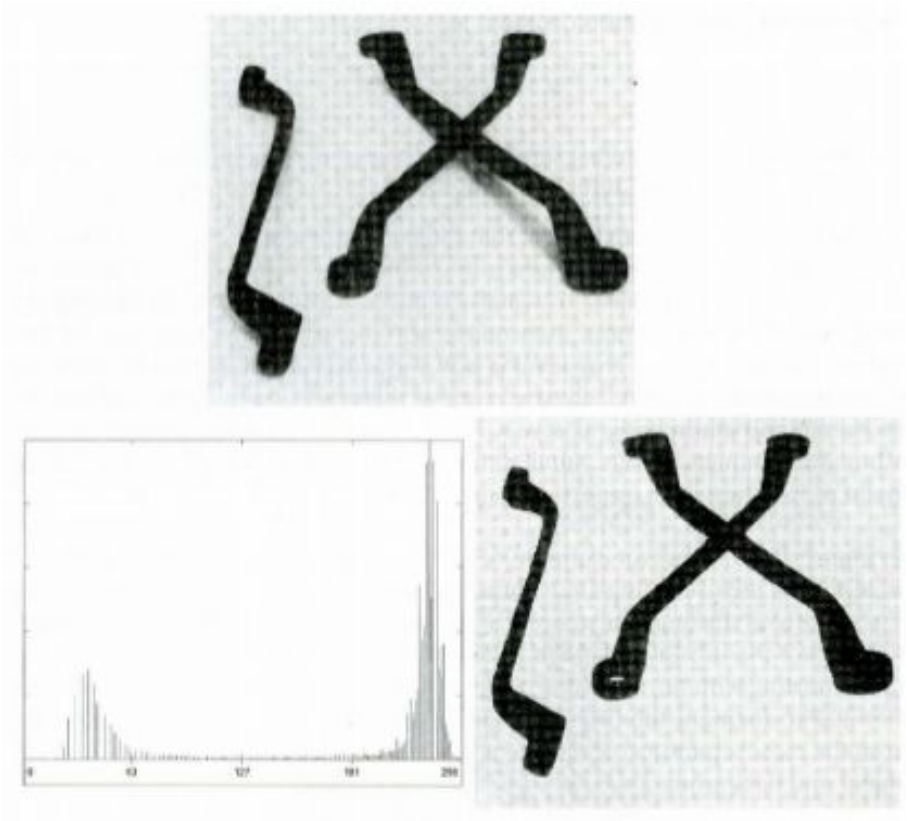
Limiarização



a b c
d e f

FIGURE 10.37 (a) Noisy image. (b) Intensity ramp in the range [0.2, 0.6]. (c) Product of (a) and (b). (d)–(f) Corresponding histograms.

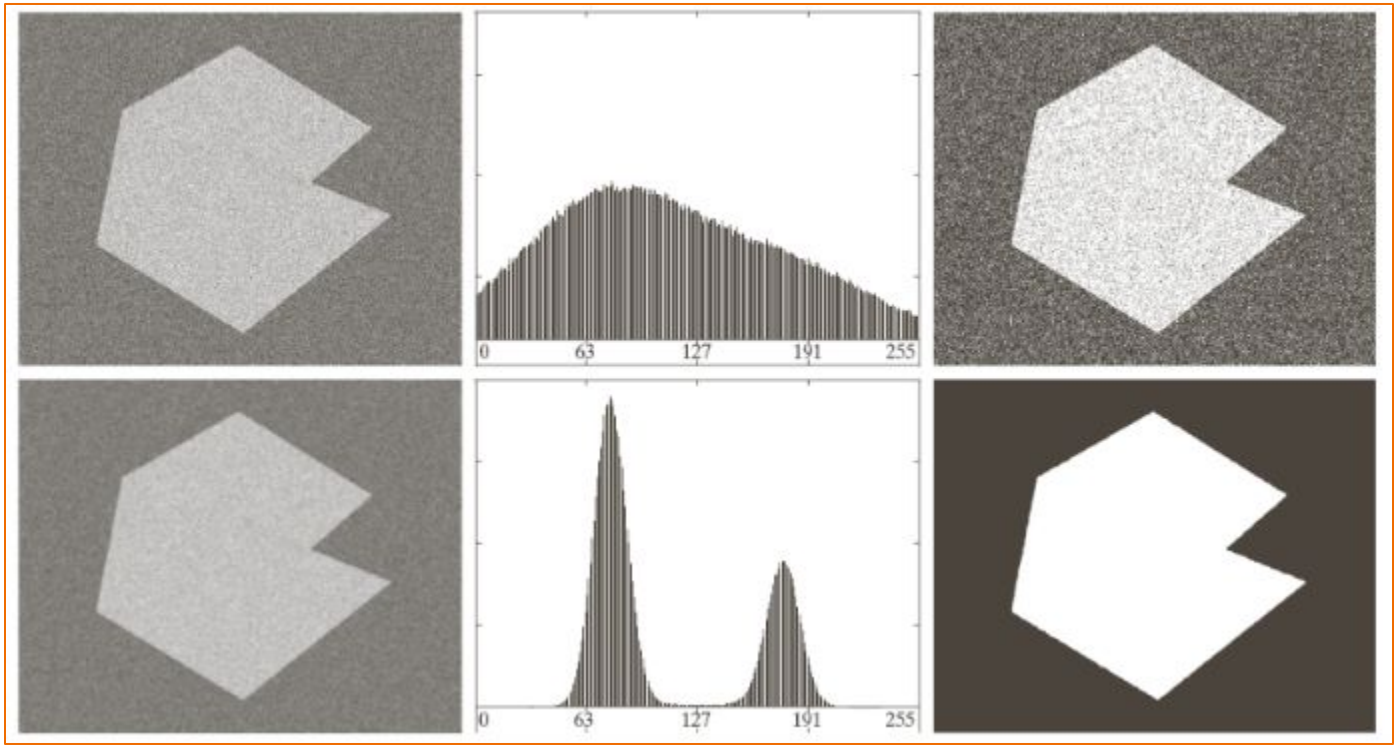
Limiarização



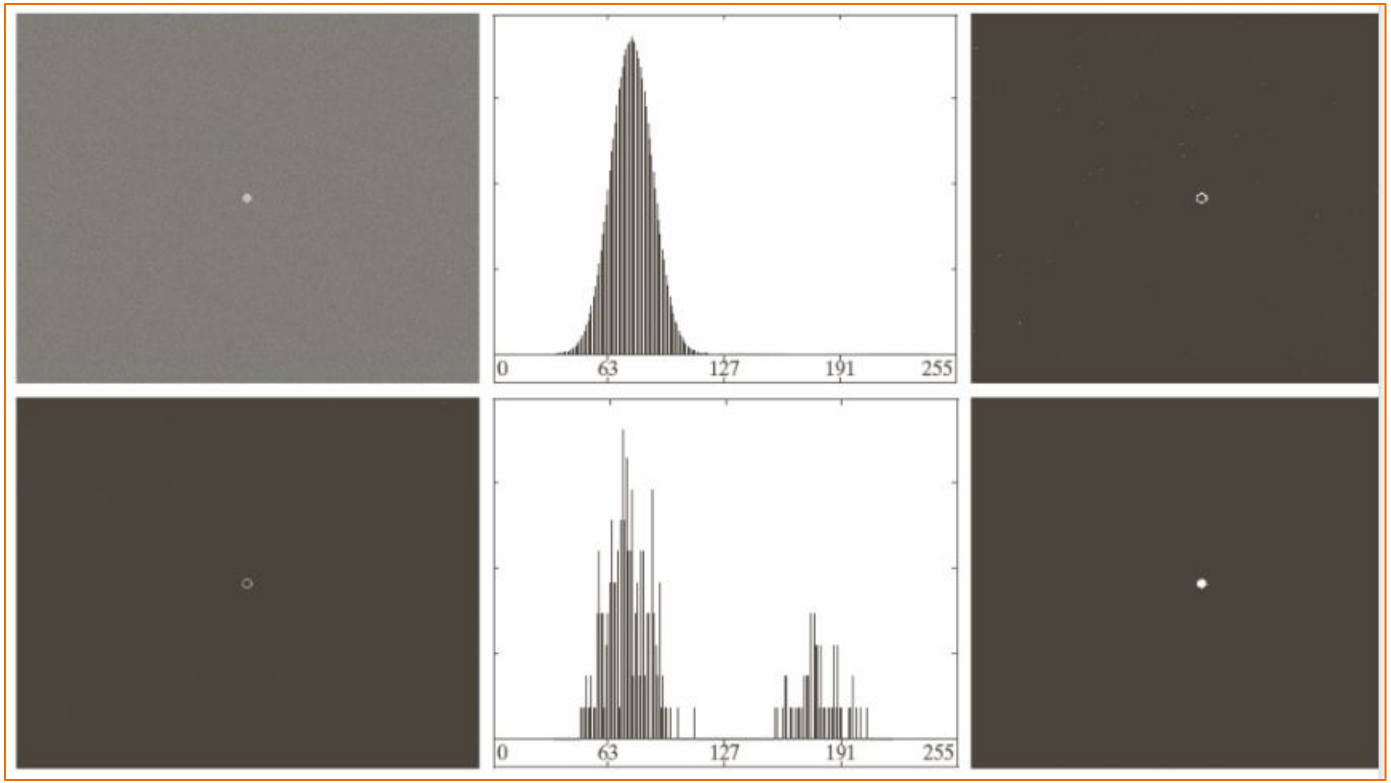
Segmentação com Limiarização

- Algoritmo Iterativo:
  1. Escolha o valor de T inicial;
  2. Segmente a imagem utilizando T (nela G_1 consiste de pixels com níveis > T e G_2 consiste de pixels de níveis ≤ T);
  3. Calcule a média dos níveis dos pixels em G_1 (m_1) e G_2 (m_2);
  4. Calcule o novo limiar $T = (m_1+m_2)/2$;
  5. Repita os passos 2-4 até que a diferença de T entre sucessivas iterações seja menor que um parâmetro pré-determinado;

Efeito do Ruído



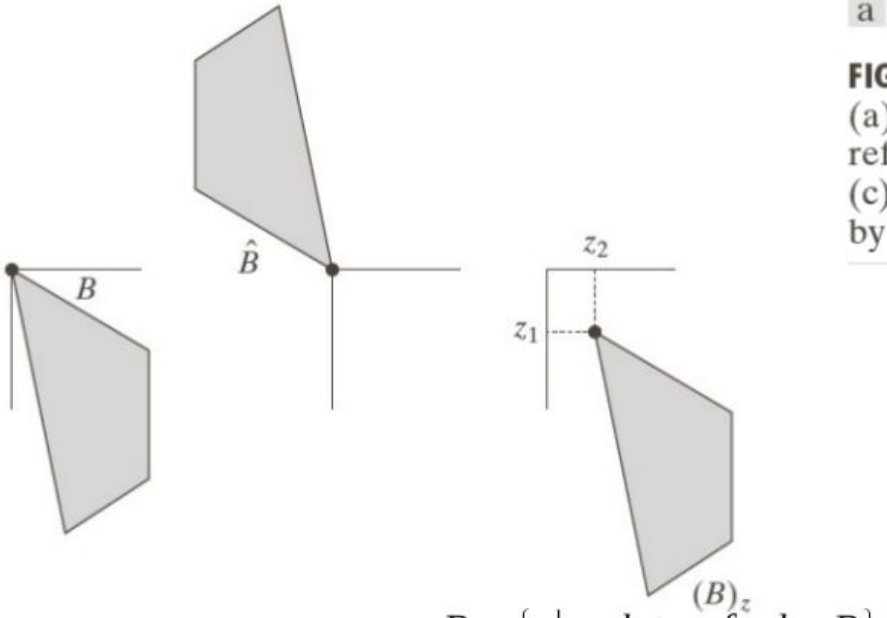
Efeito do Ruído



Morfologia de Imagens

Teoria dos Conjuntos

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

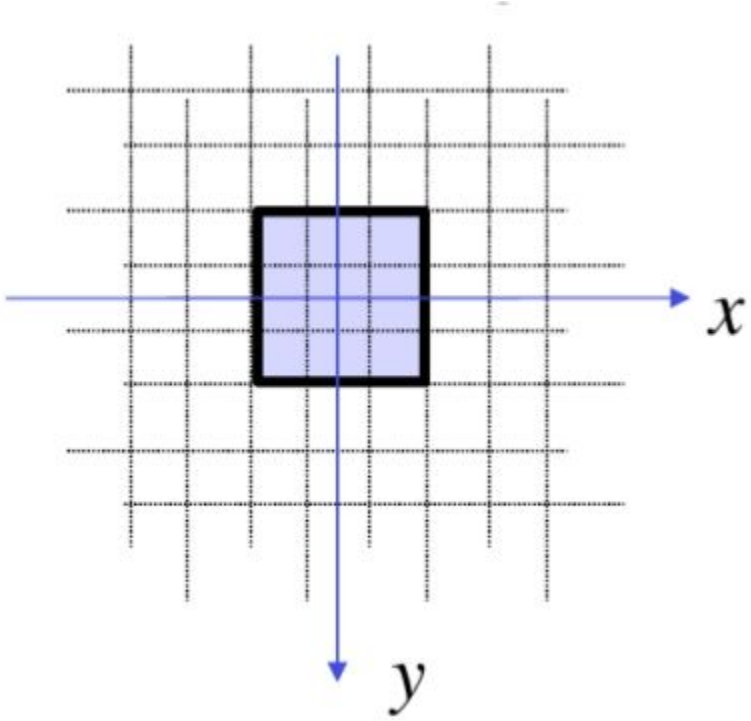


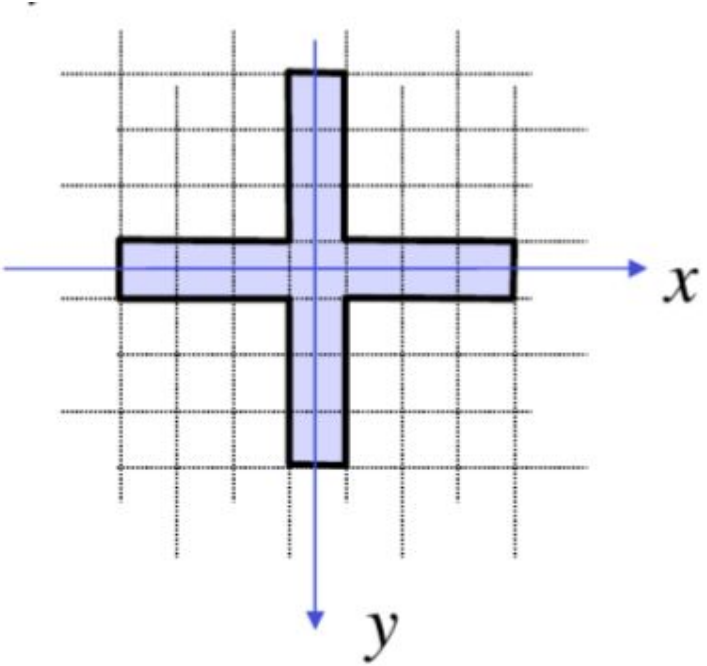
a b c

FIGURE 9.1
(a) A set, (b) its reflection, and (c) its translation by z.

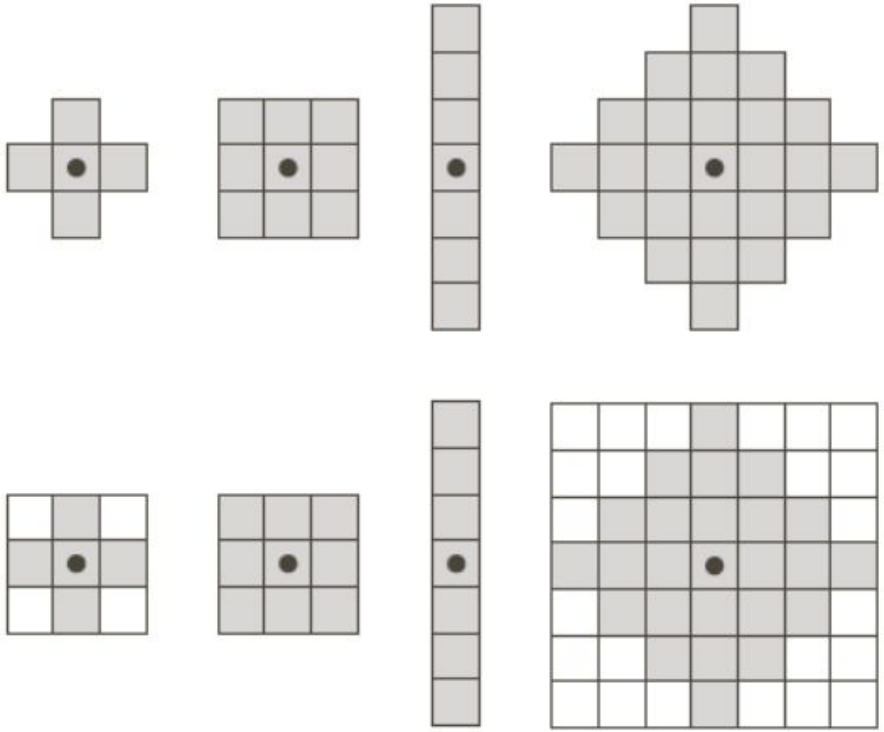
$$B_z = \{c \mid c = b + z, \text{for } b \in B\}$$

Elementos estruturantes:

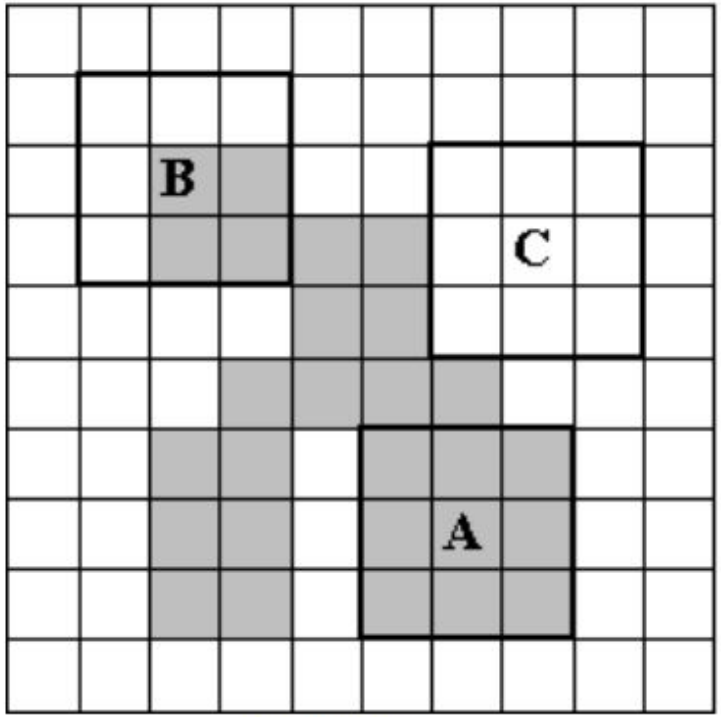




Elementos estruturantes:

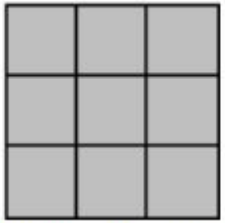


Elementos estruturantes:



Binary Image

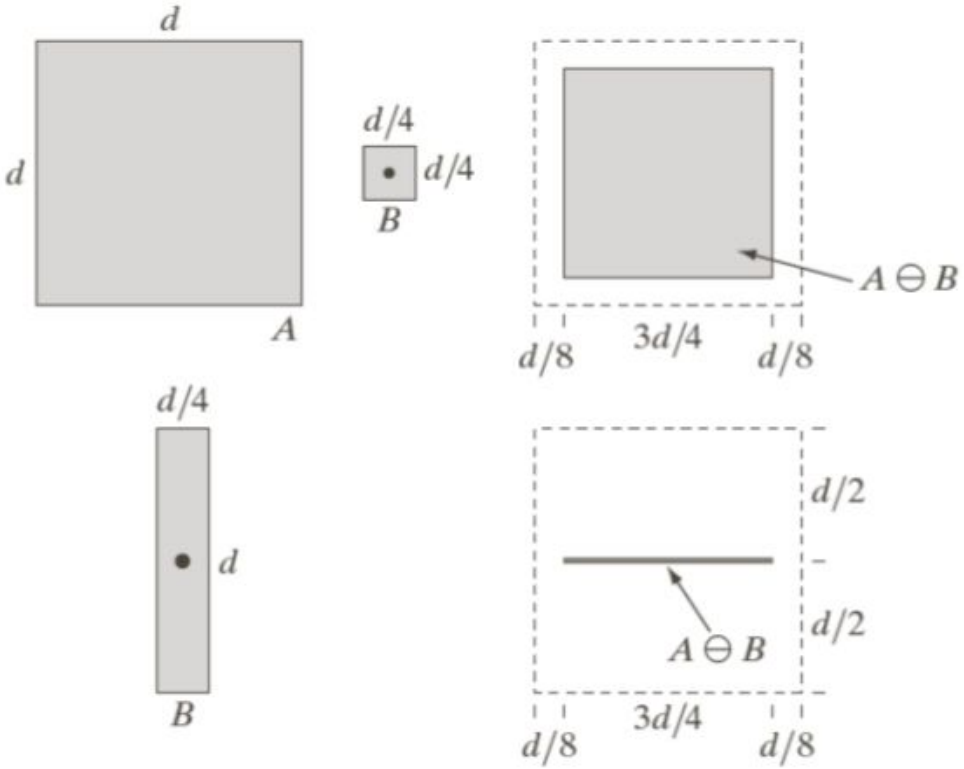
- Elemento se encaixa (fits) na imagem em A;
- Elemento toca (hits) na imagem em B;
- Nem se encaixa, nem toca na imagem em C;
- É como se fosse uma convolução binária;



Structuring Element

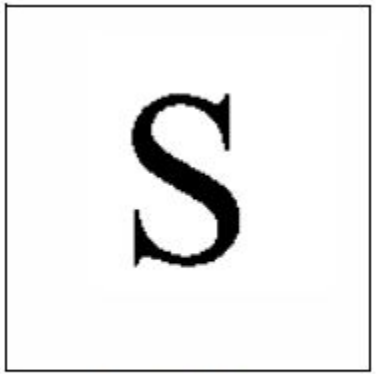
Erosão:

$$A \ominus B = \{z \mid (B)_z \subseteq A\}.$$

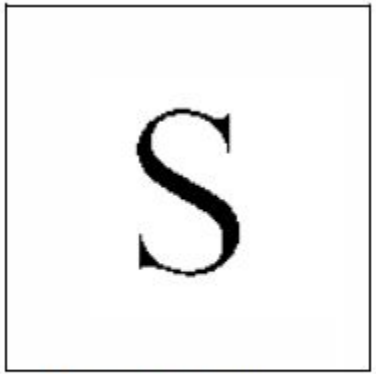


Erosão:

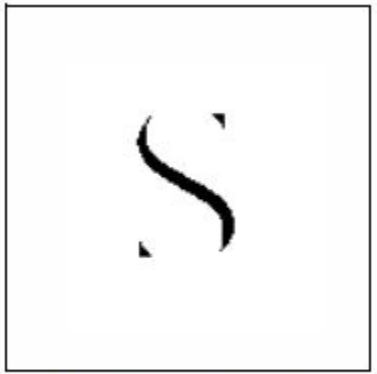
```
import cv2
import numpy as np

img = cv2.imread('j.png',0)
kernel = np.ones((5,5),np.uint8)
erosion = cv2.erode(img,kernel,iterations = 1)
```



(a) Binary Image



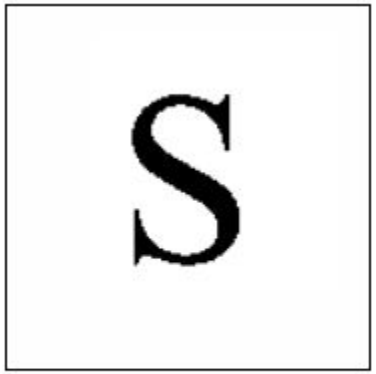
(b) Erosion by 3×3 square structuring element



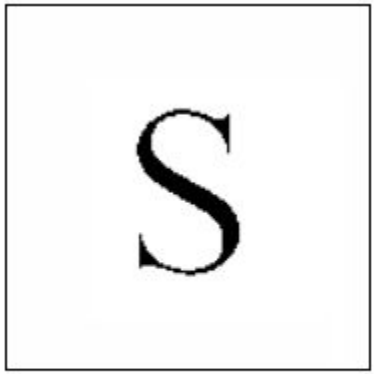
(c) Erosion by 5×5 square structuring element

Erosão para detecção de bordas:

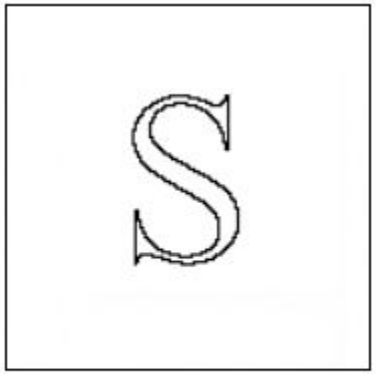
- boundaries = image - erosion(image, se);
- image → imagem original;
- se → elemento estruturante;



(a) Binary Image



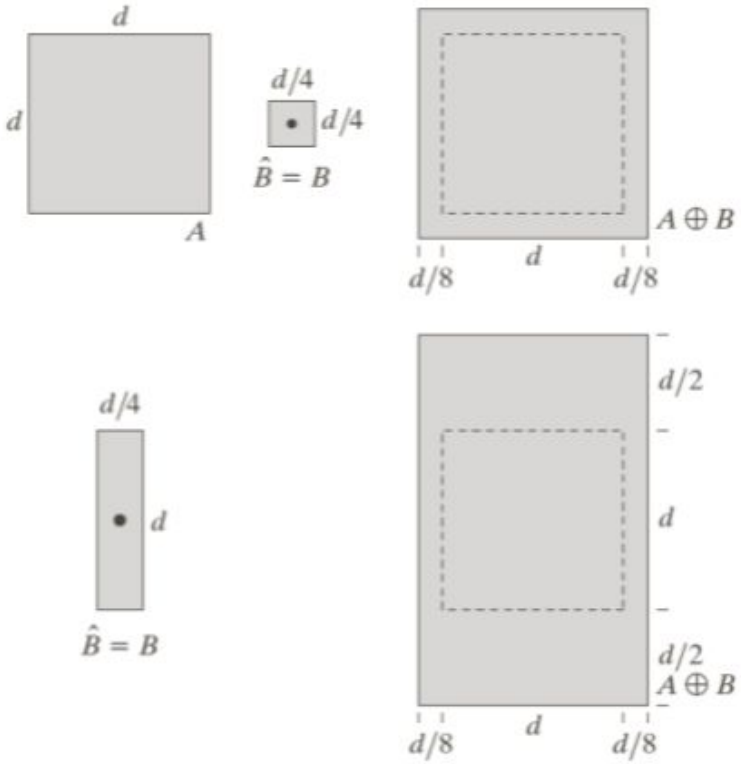
(b) Erosion by 3×3 square structuring element



(c) Difference between the original and eroded image

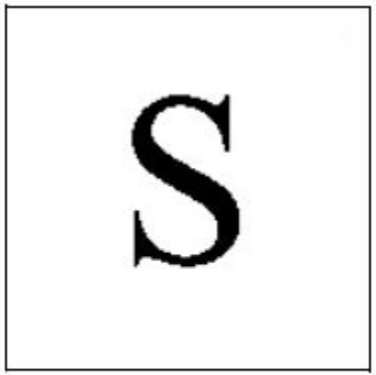
Dilatação:

$$A \oplus B = \{z | (\hat{B})_z \cap A \neq \varnothing\}.$$

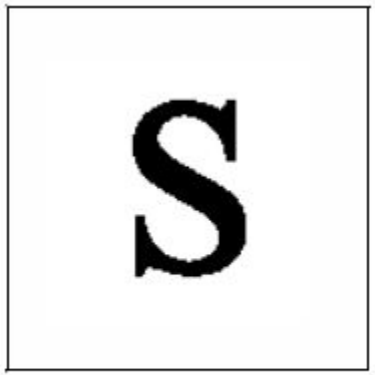


Dilatação:

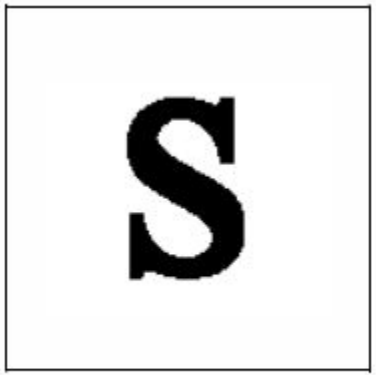
```
dilation = cv2.dilate(img,kernel,iterations = 1)
```



(a) Binary Image



(b) Dilation by 3×3 square structuring element



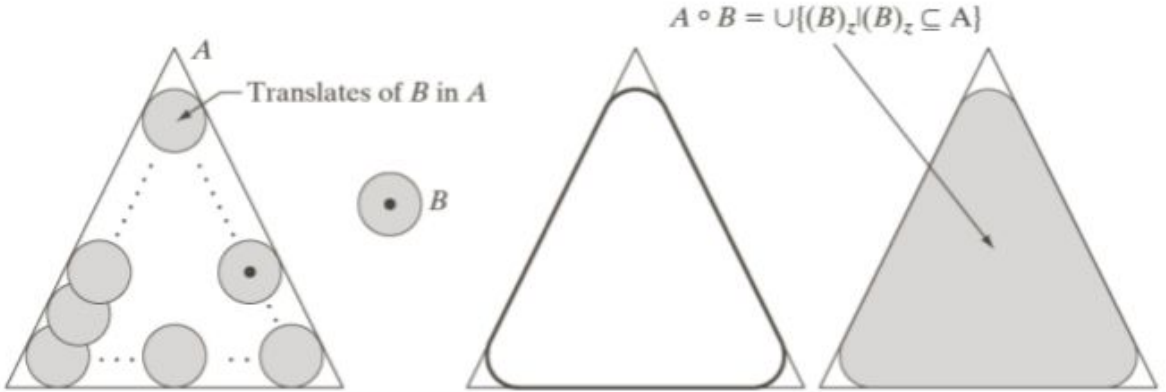
(c) Dilation by 5×5 square structuring element

Abertura (Opening):

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

$$A \circ B = \cup\{(B)_z | (B)_z \subseteq A\}$$

Opening = erosão + dilatação

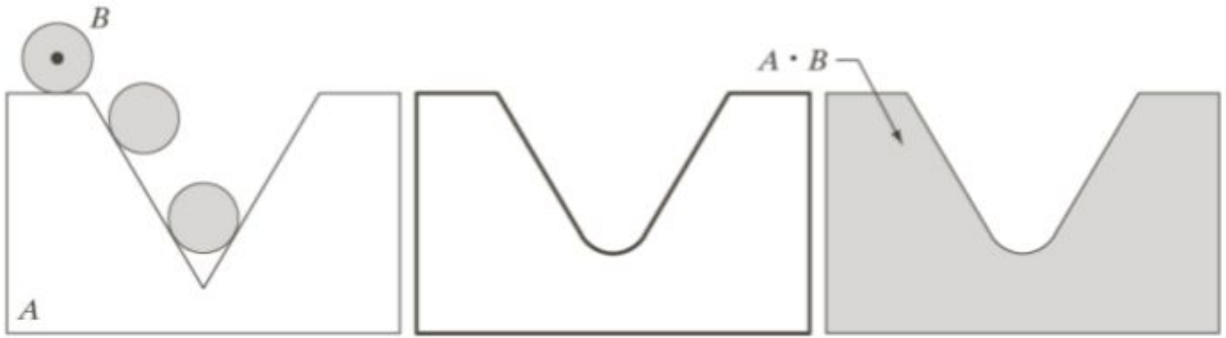


Abertura suaviza as bordas, elimando extremidades proeminentes

Fechamento (Closing):

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

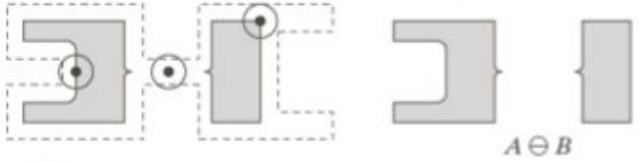
closing = dilatação + erosão



Fechamento suaviza as bordas, deixando extremidades ou áreas finas

original

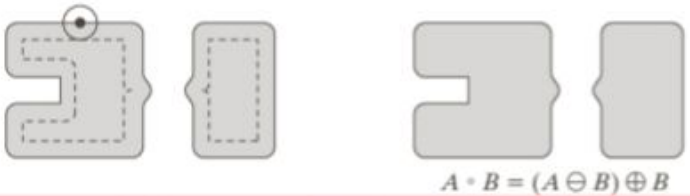
A



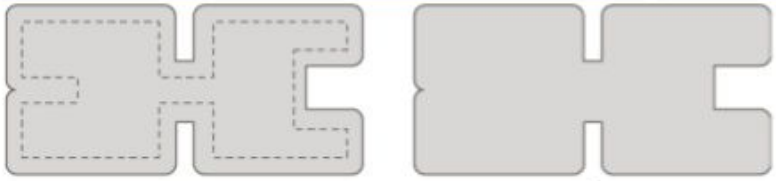
$A \ominus B$

Abertura

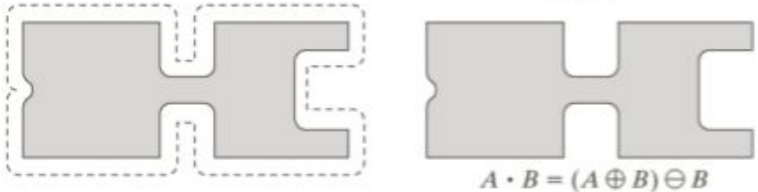
$$A \circ B = (A \ominus B) \oplus B.$$



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



$A \oplus B$



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

Fechamento

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

Imagem ruidosa

A

$A \ominus B$

erosão

1	1	1
1	1	1
1	1	1

B

elemento estruturante

erosão

Erosão+ dilatação= abertura

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

abertura

$(A \circ B) \oplus B$

$[(A \circ B) \oplus B] \ominus B = (A \circ B) \bullet B$

abertura+ fechamento

abertura+ dilatação

Fim!

Referências

[1] GONZALEZ, Rafael C.; WOODS, Richard E. Image processing. Digital image processing, v. 2, p. 1, 2007.

[2] Al Bovik, Handbook of Image and Video Processing, Academic Press.