Lecture 10: Object Descriptors

- Our progress in the analysis process

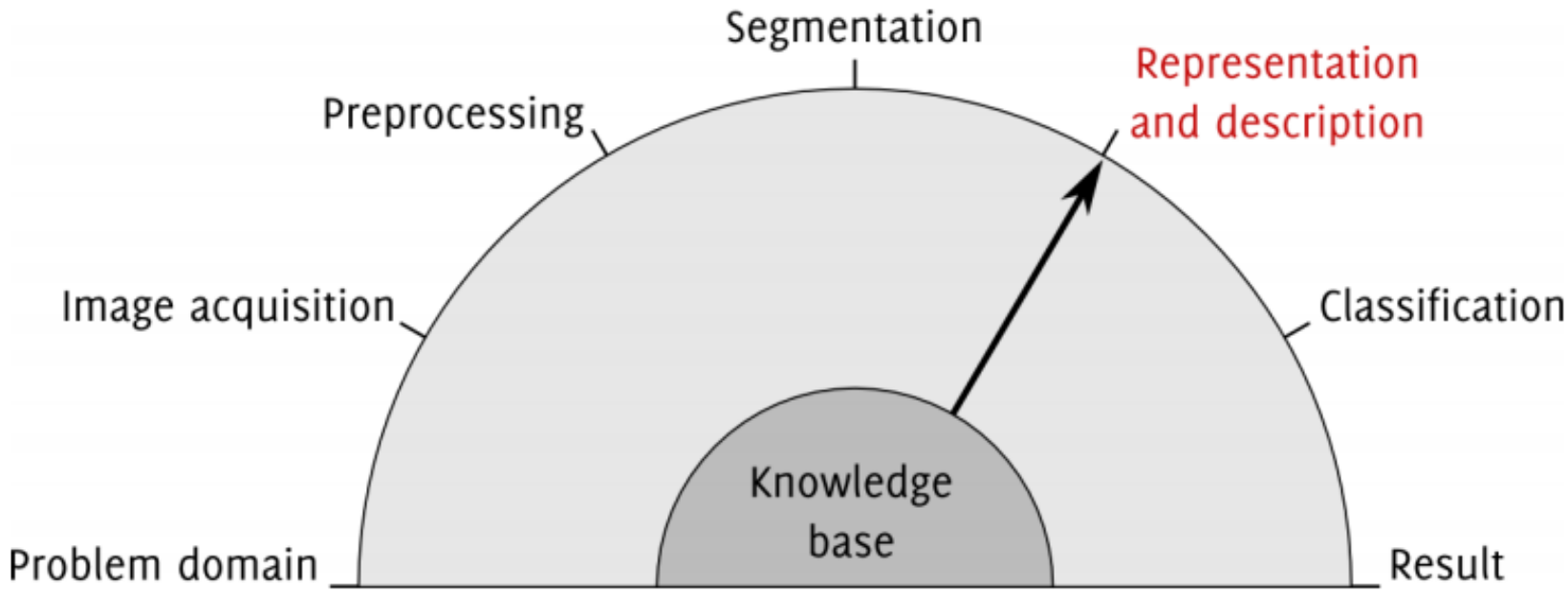
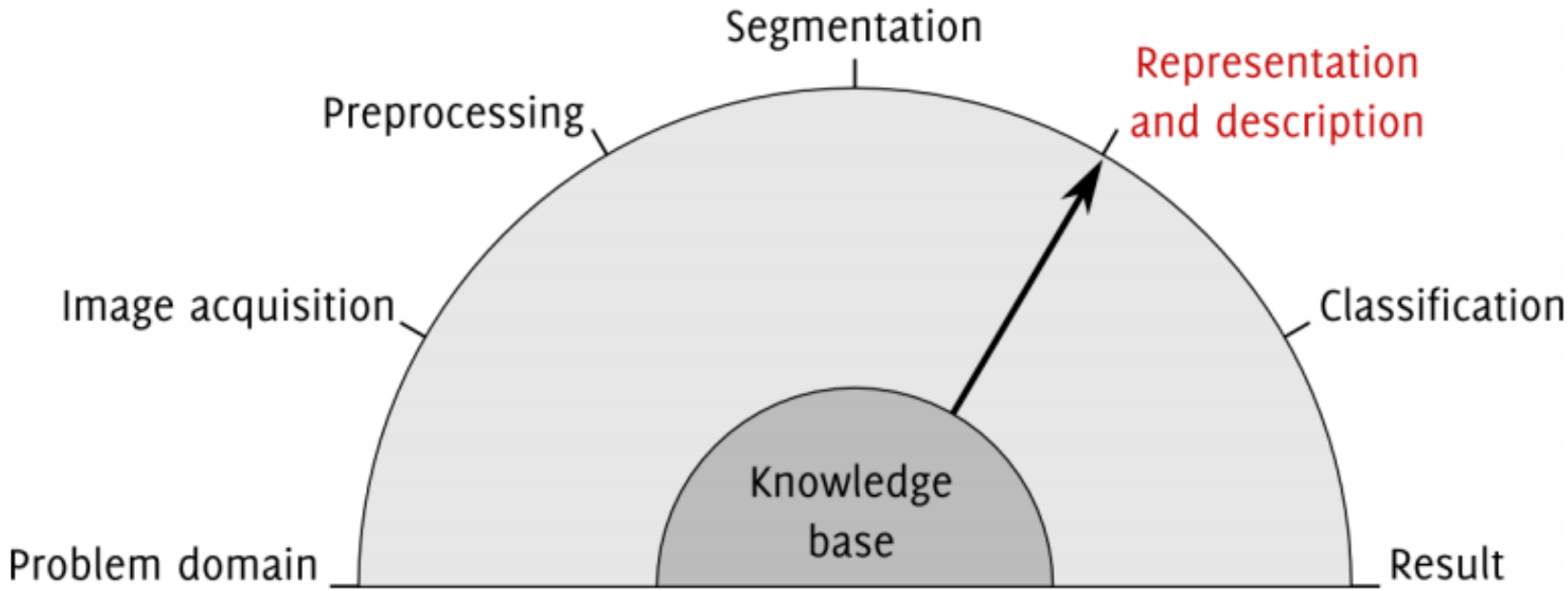


Image analysis

- Our progress in the analysis process



NỘI DUNG

1. Region Identification
2. Representation and Description

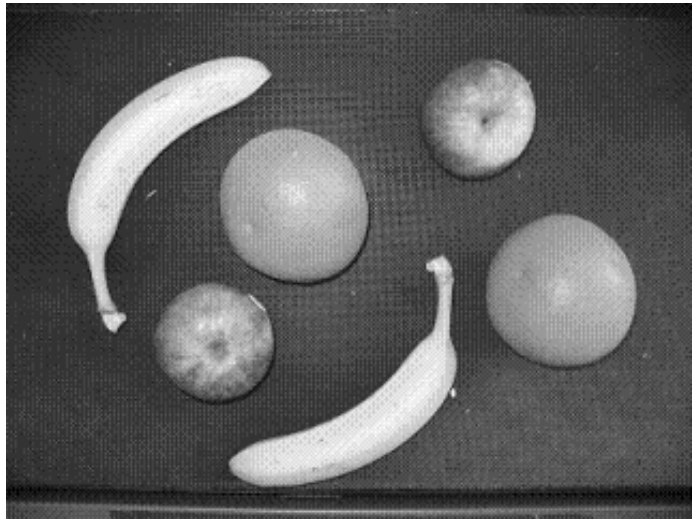
1. Region Identification

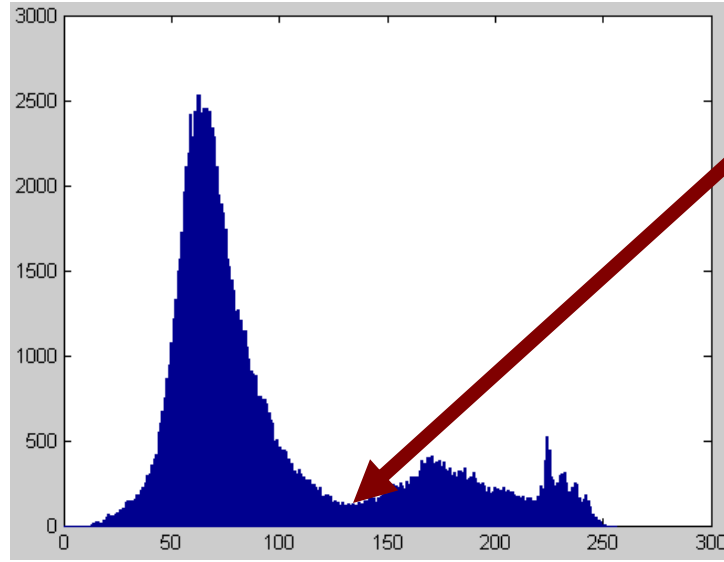
- Xác định vùng gồm 2 giai đoạn:

  (1) Xác định từng vùng, với đường biên tương ứng (border tracing - tìm biên)

  (2) Gán nhãn cho mỗi vùng (region labeling)

Thresholding





Valley separates light from dark

How to find it?

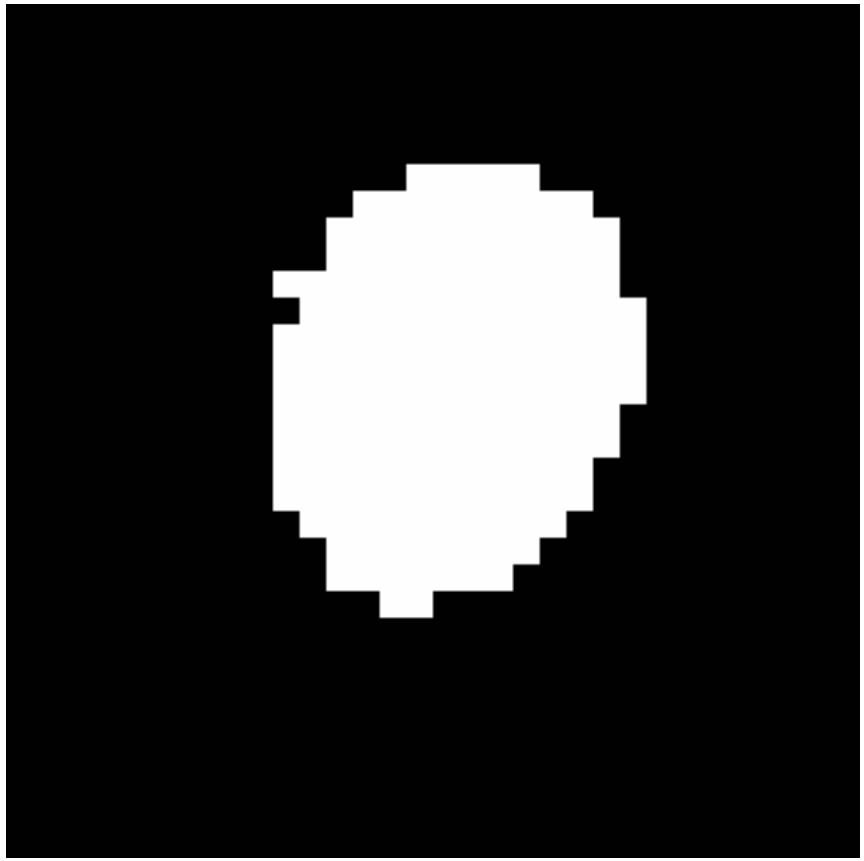
Thresholding Example

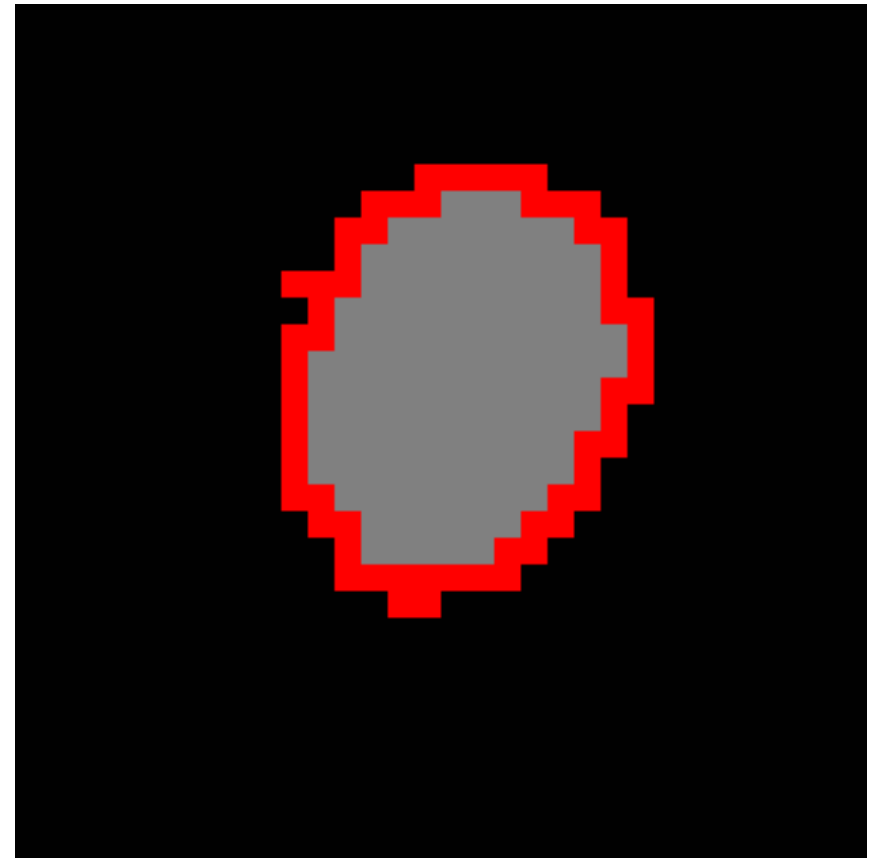
original gray tone image

binary thresholded image

Border Tracing – tìm biên

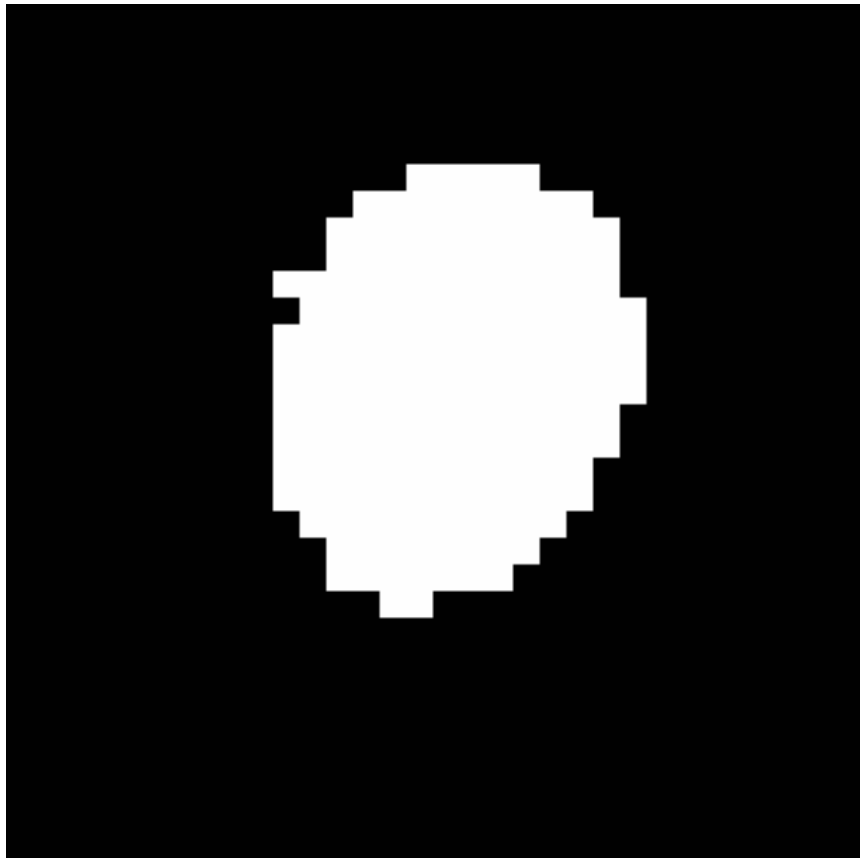
- Mỗi vùng có một đường biên bên trong. . .

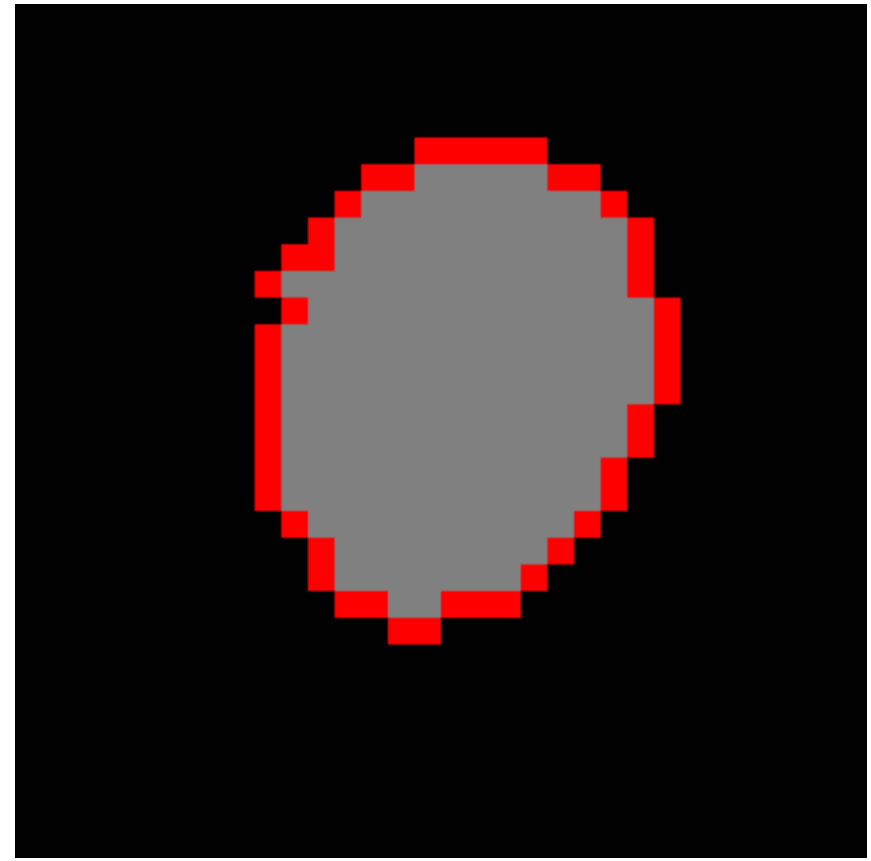




Border Tracing

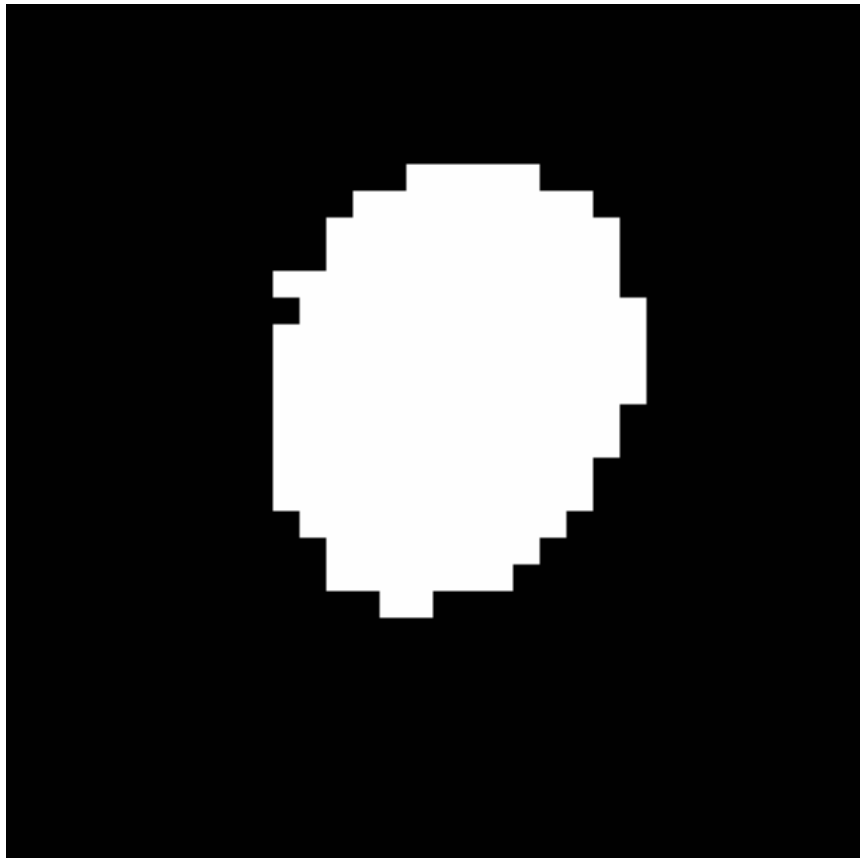
- và một biên bên ngoài.

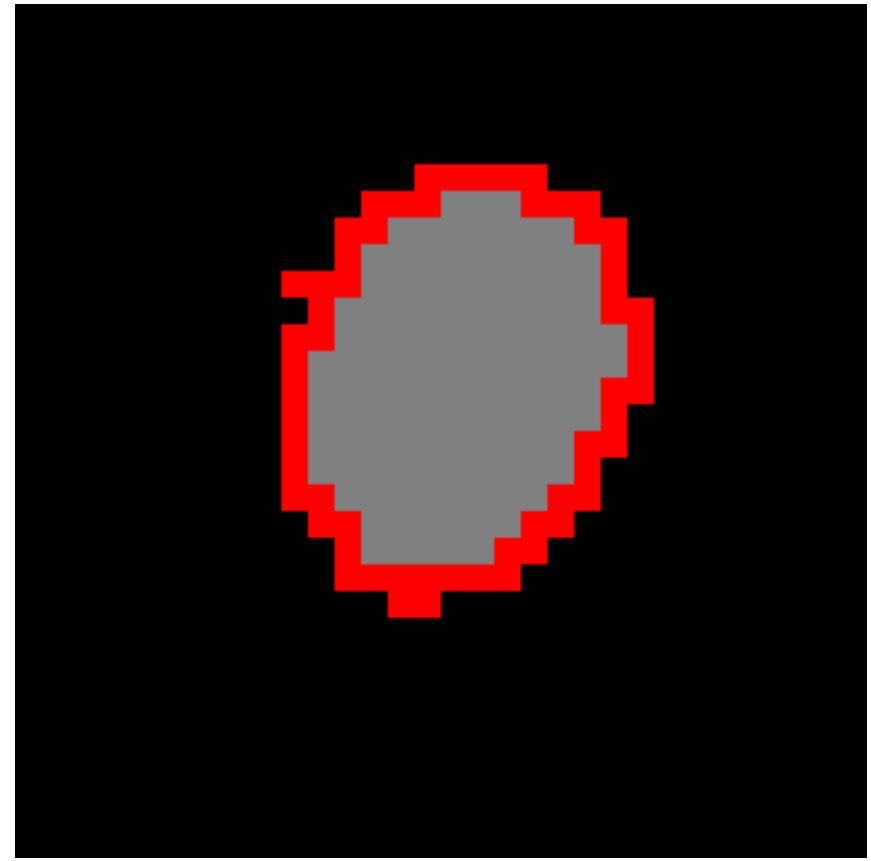




Border Tracing

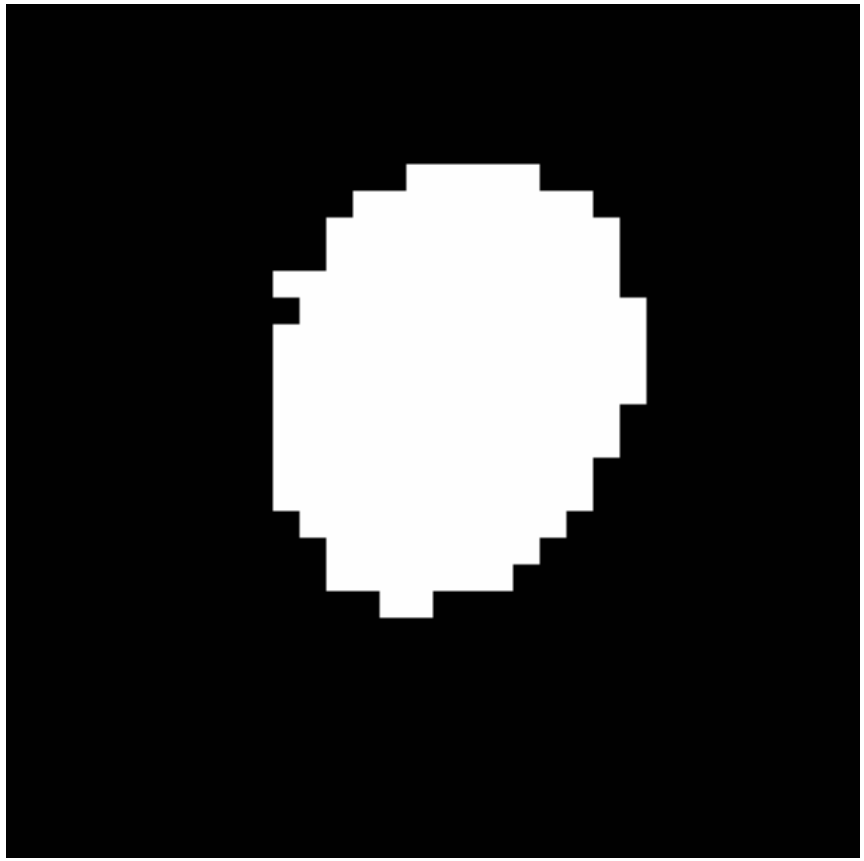
- Biên trong có thể là 4-connected . . .

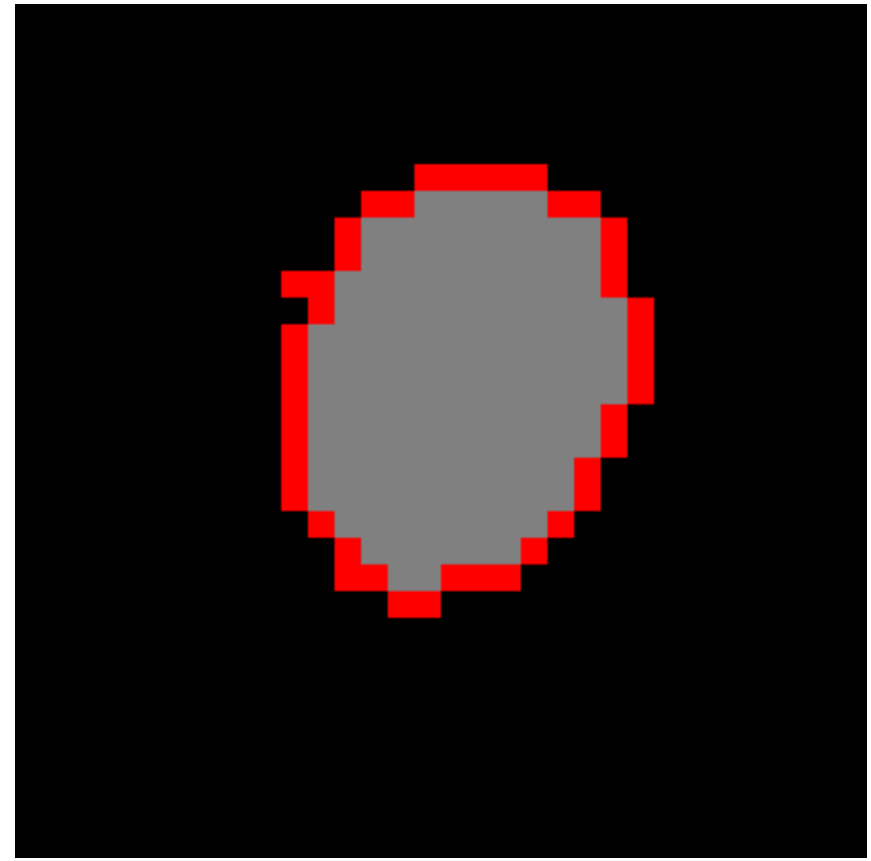




Border Tracing

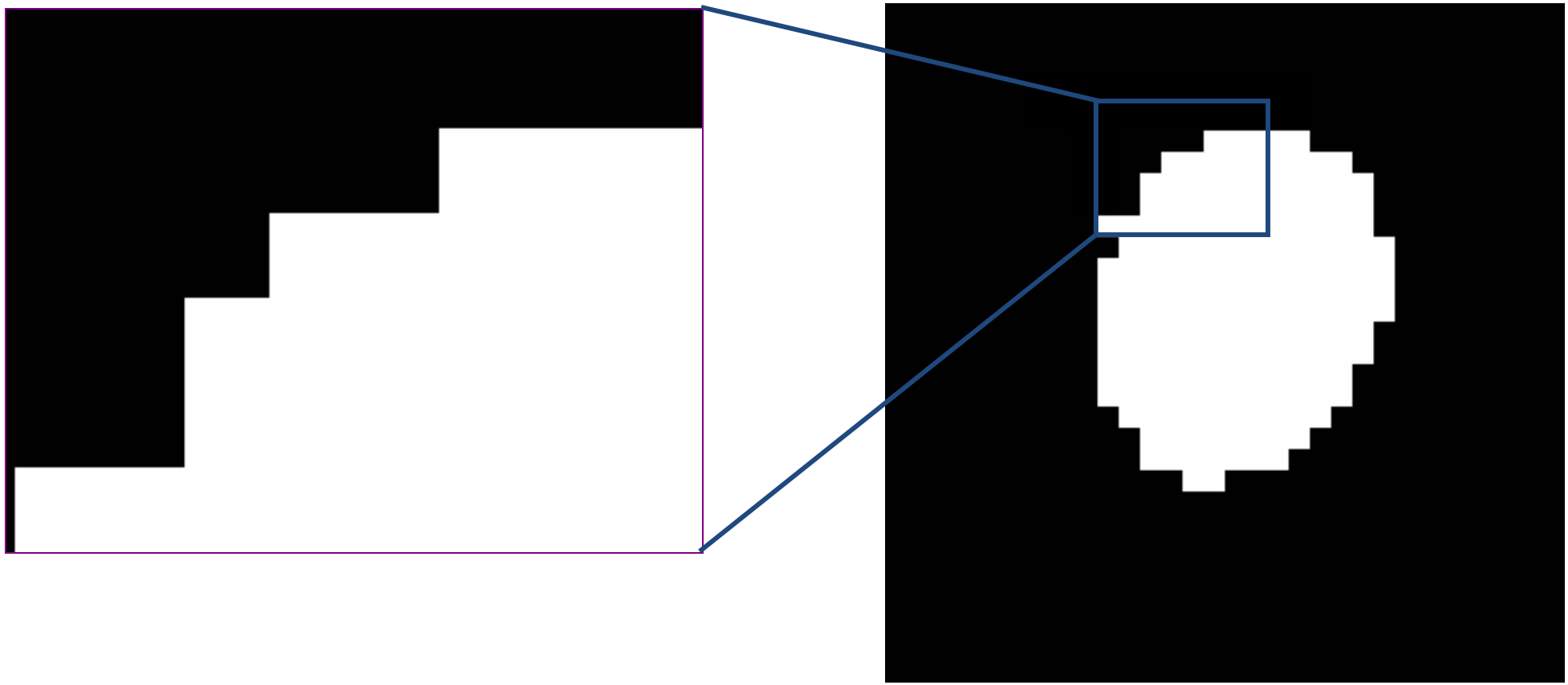
- hoặc 8-connected.



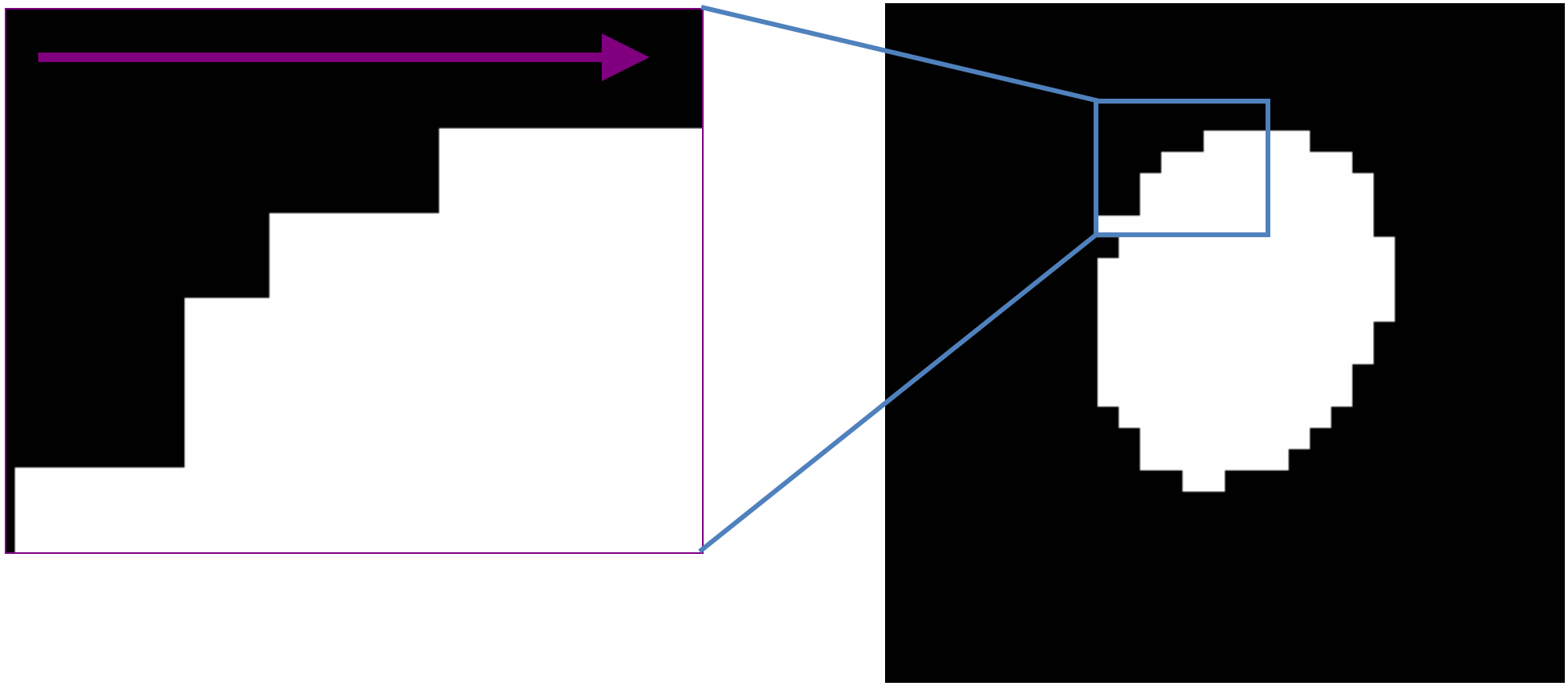


Border Tracing

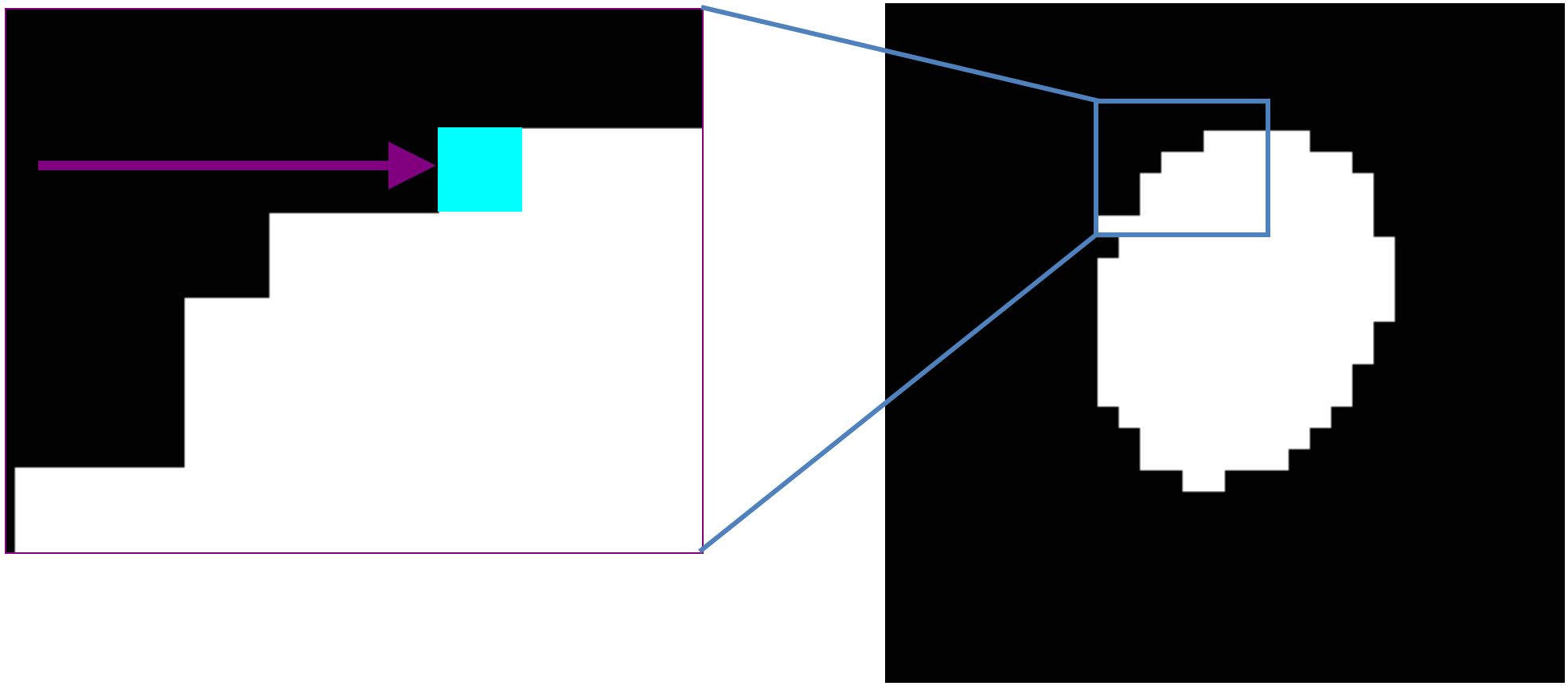
- Cách thức thực hiện? Xét biên trong với 4-connected.



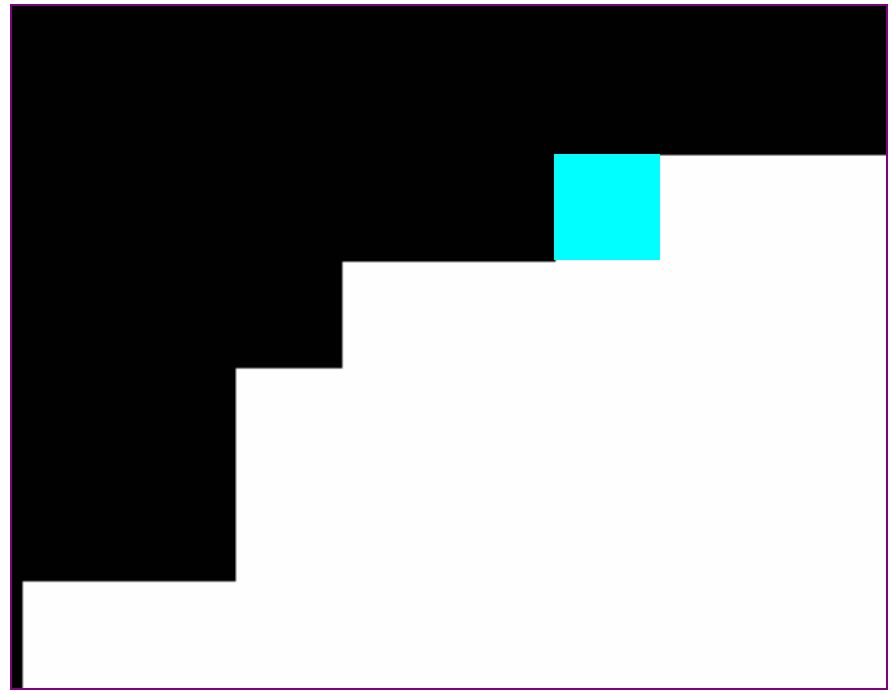
Border Tracing

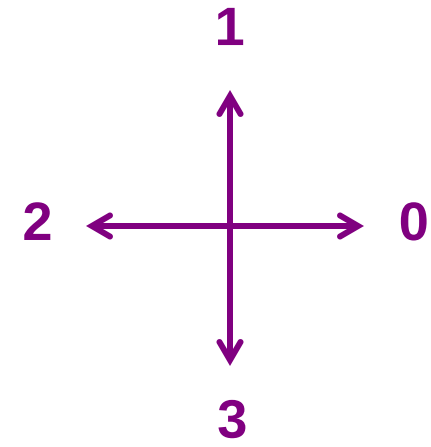


Border Tracing

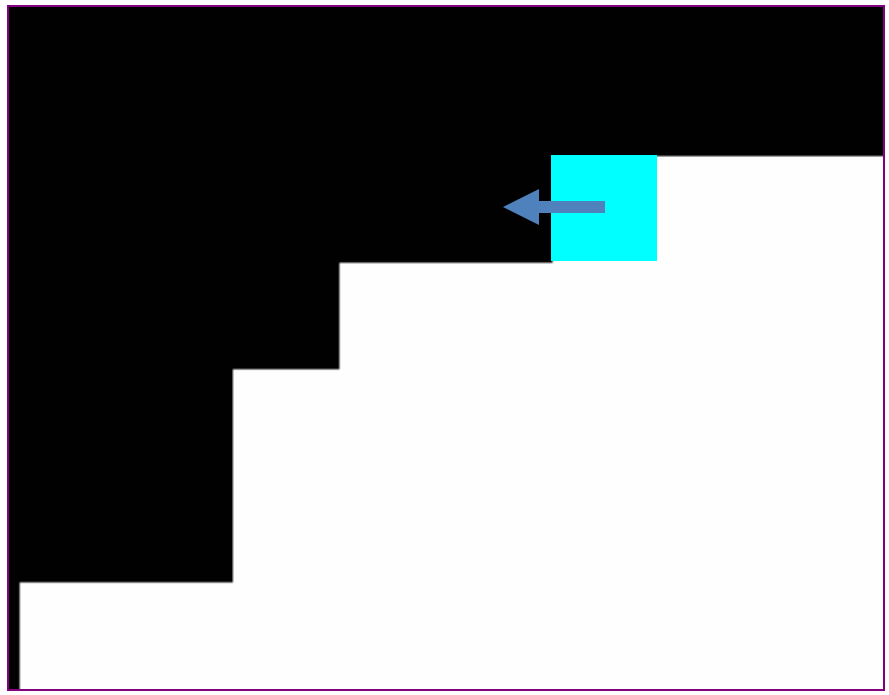


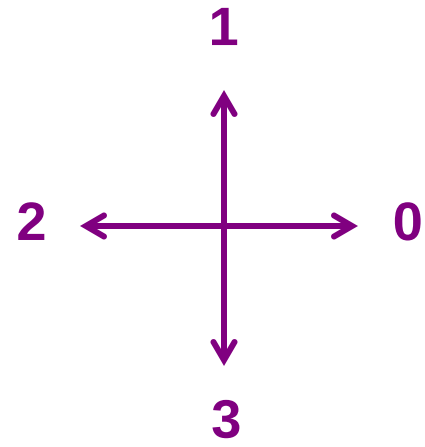
Border Tracing





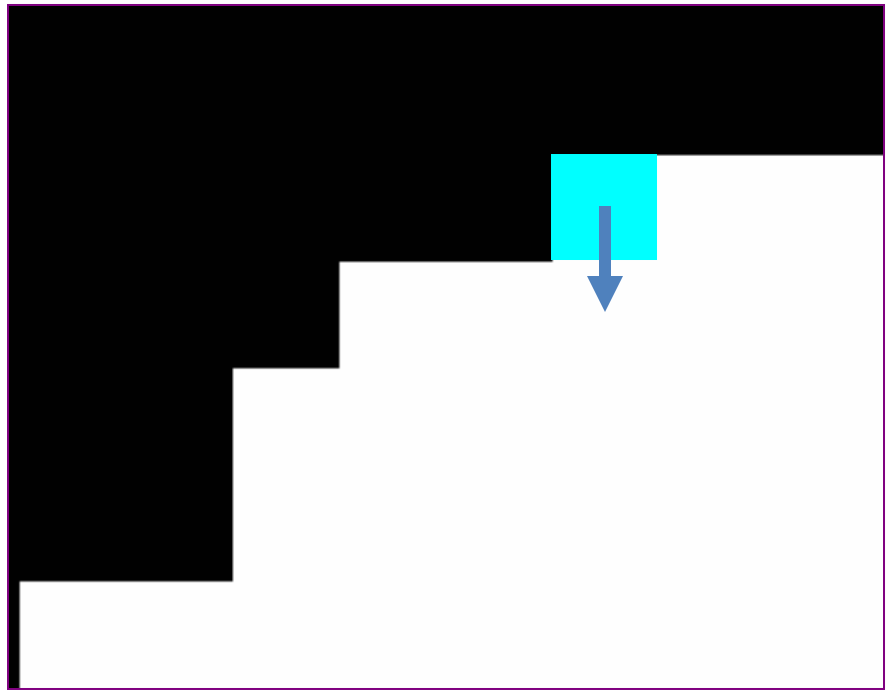
Border Tracing

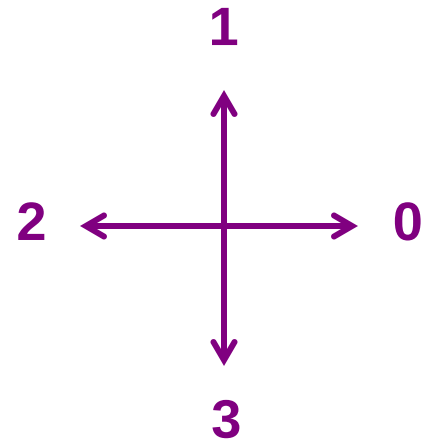




Bắt đầu tìm theo hướng $(d + 3) \bmod 4$, với d là hướng của điểm biên trước (khởi tạo $d = 3$)

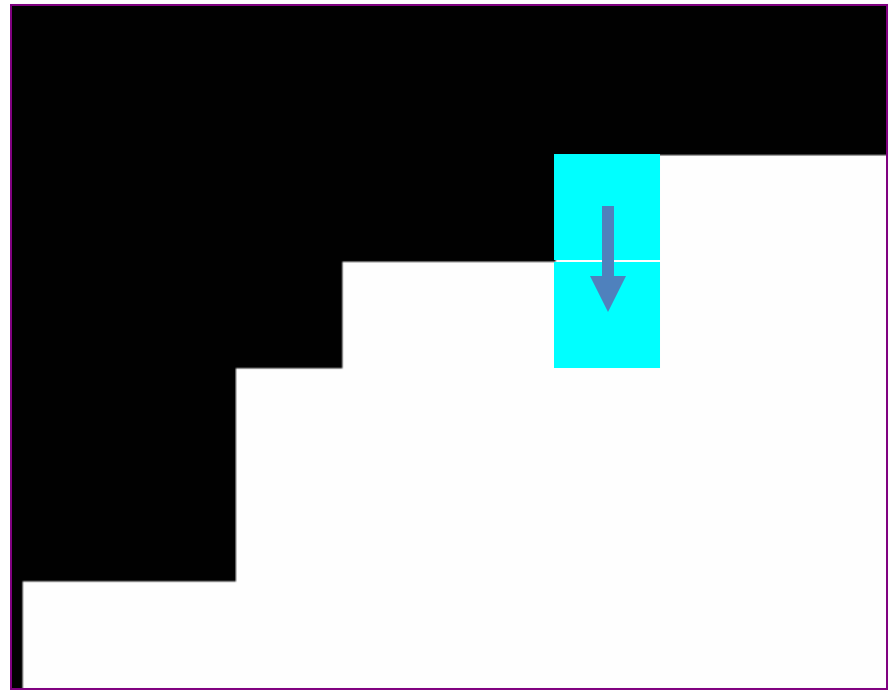
Border Tracing

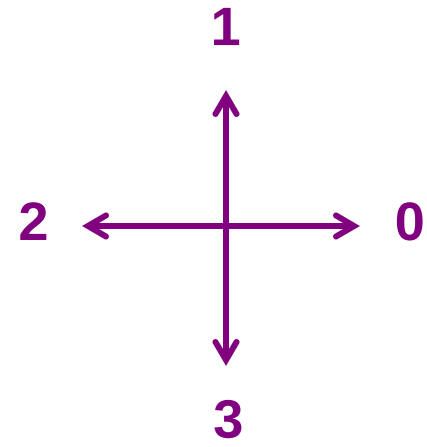




- Tiếp tục tìm theo hướng ngược chiều kim đồng hồ. . .

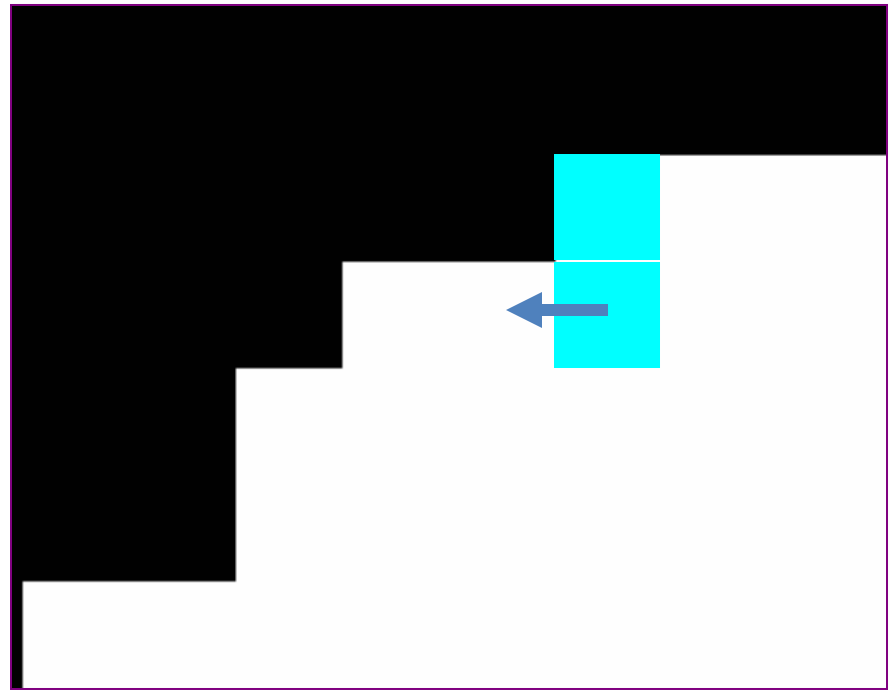
Border Tracing

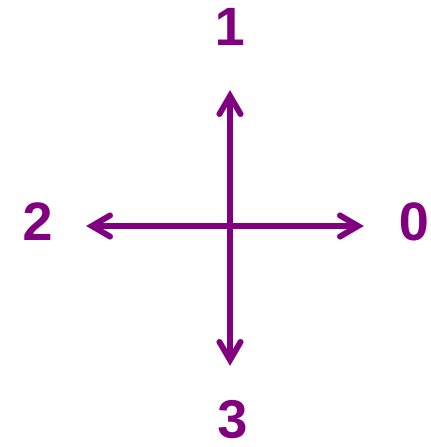




và xác định điểm biên tiếp theo tại $d = 3$

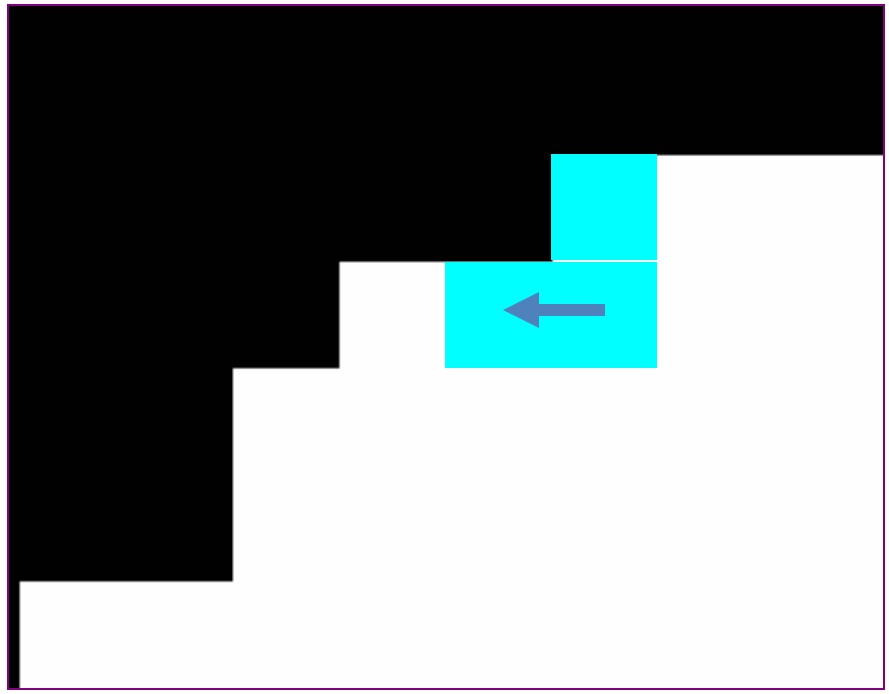
Border Tracing

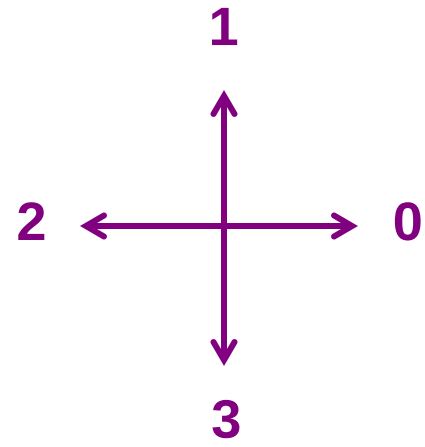




Tìm điểm biên tiếp theo theo hướng (3 + 3) mod 4 = 2

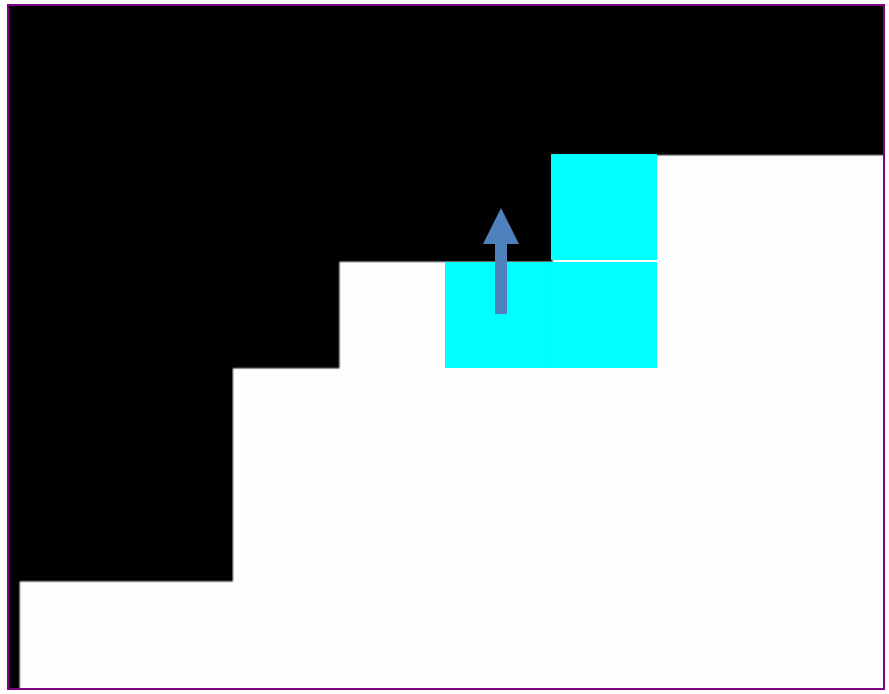
Border Tracing

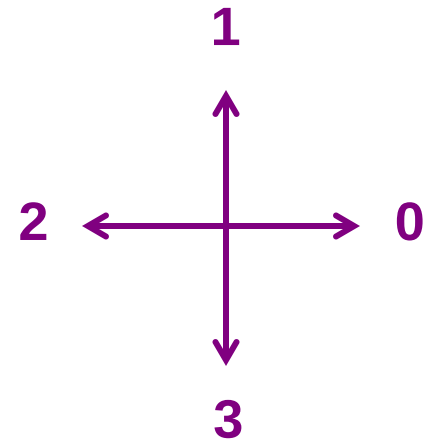




Xác định điểm biên tại $d = 2$

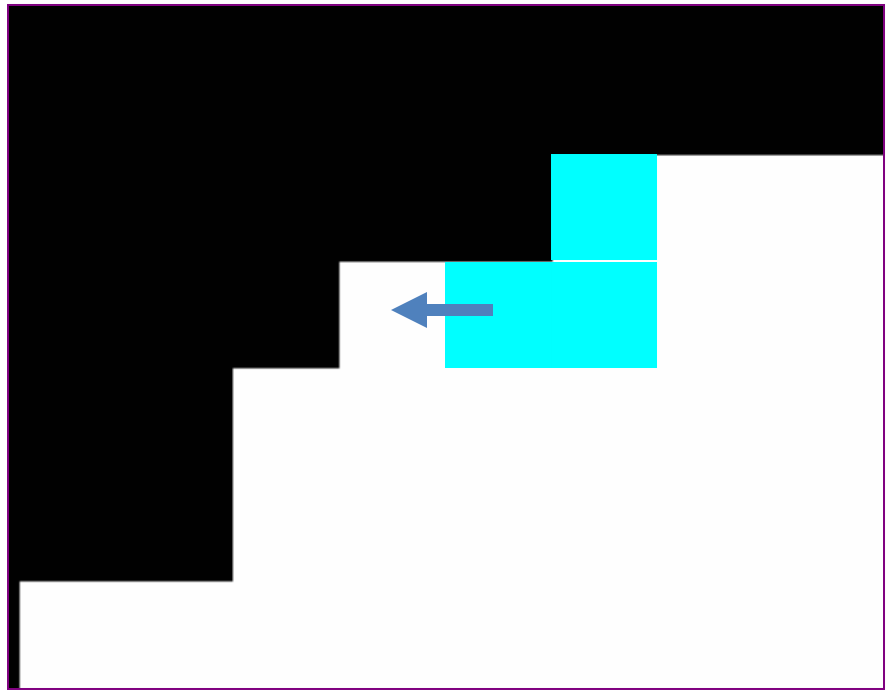
Border Tracing

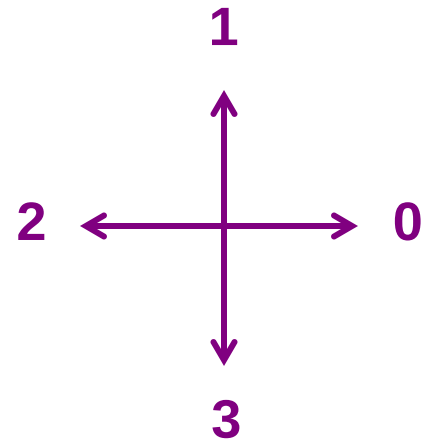




Tìm điểm biên tiếp theo theo hướng (2 + 3) mod 4 = 1

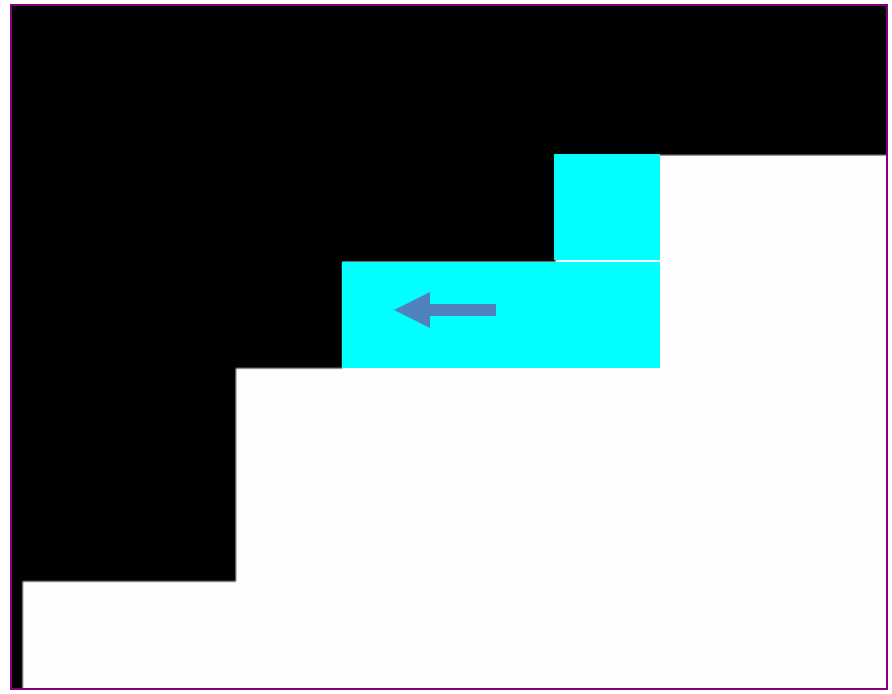
Border Tracing

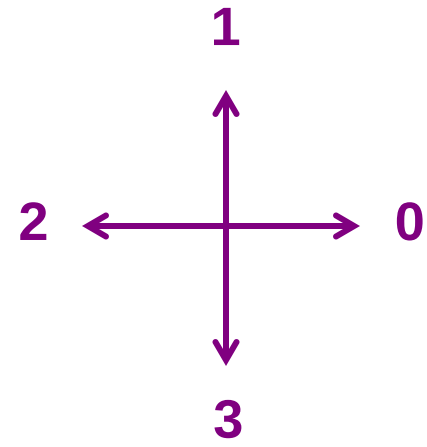




Tiếp tục tìm theo hướng ngược chiều kim đồng hồ. . .

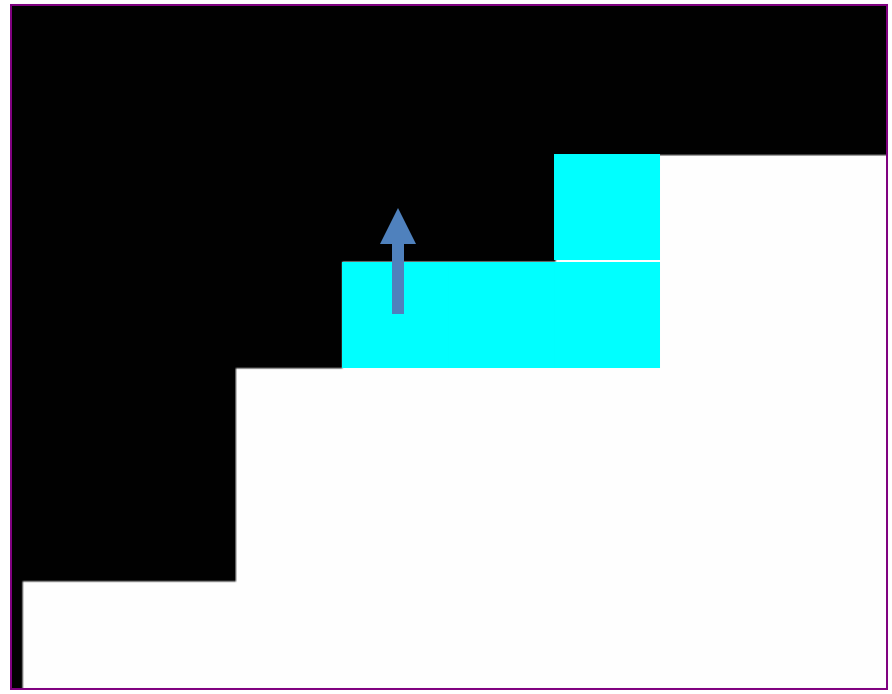
Border Tracing

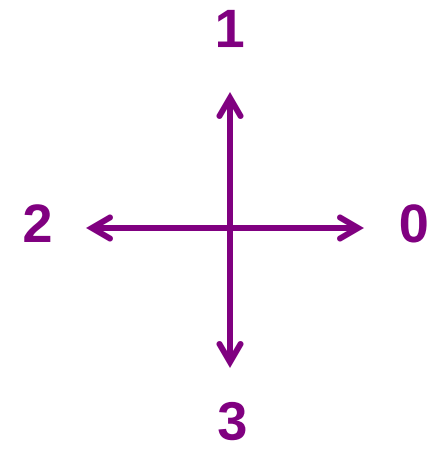




và xác định điểm biên tiếp theo tại $d = 2$

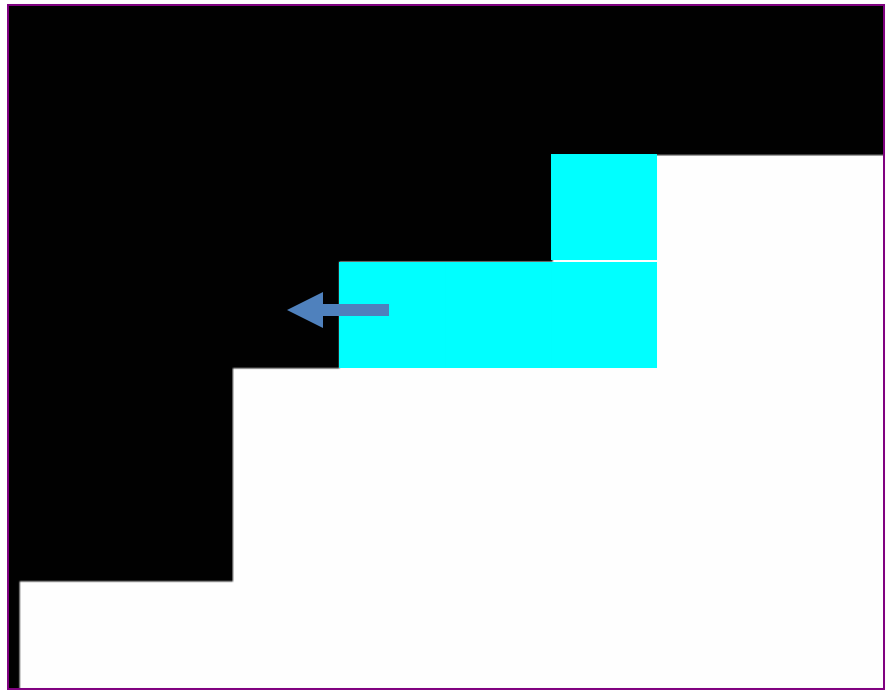
Border Tracing

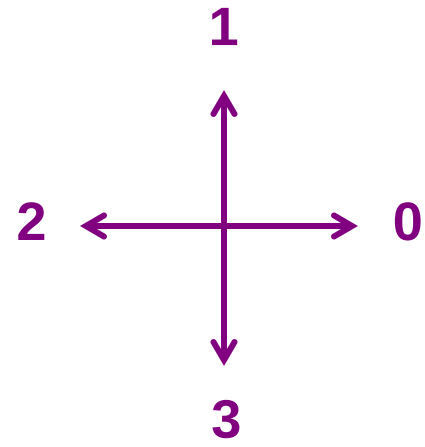




Tìm điểm biên tiếp theo theo hướng (2 + 3) mod 4 = 1

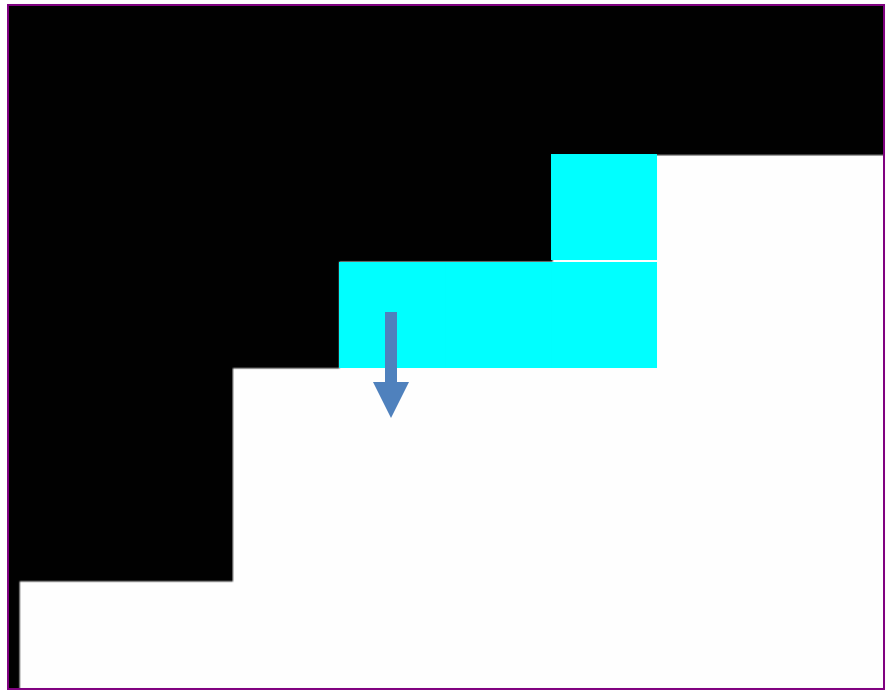
Border Tracing

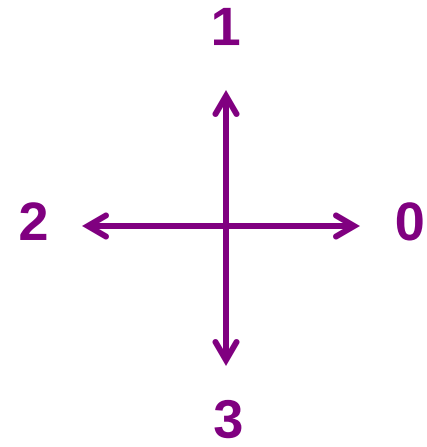




Tiếp tục tìm theo hướng ngược chiều kim đồng hồ. . .

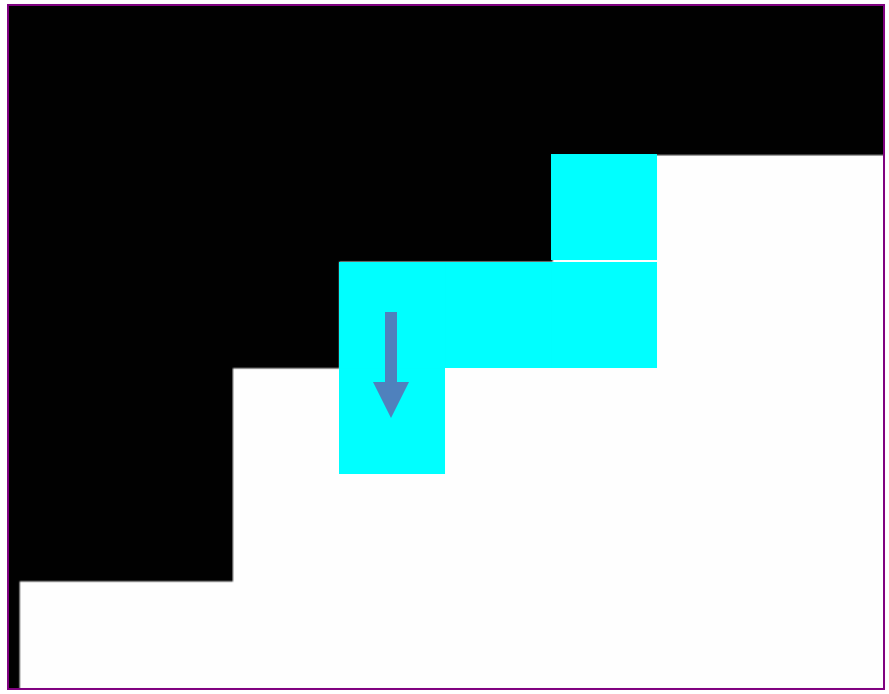
Border Tracing

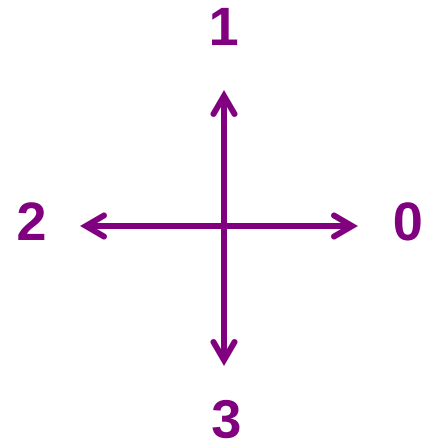




Tiếp tục tìm theo hướng ngược chiều kim đồng hồ. . .

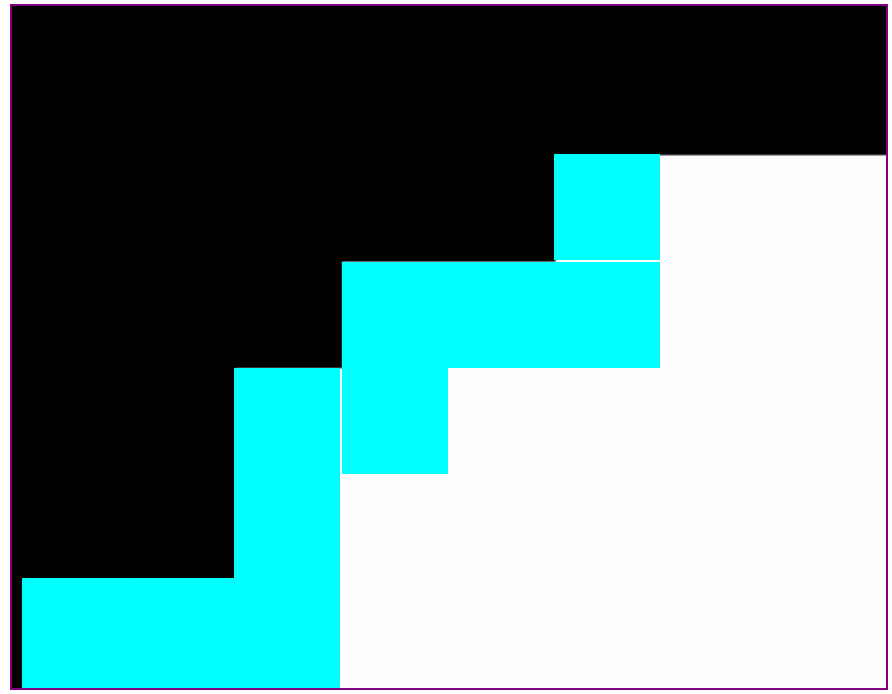
Border Tracing





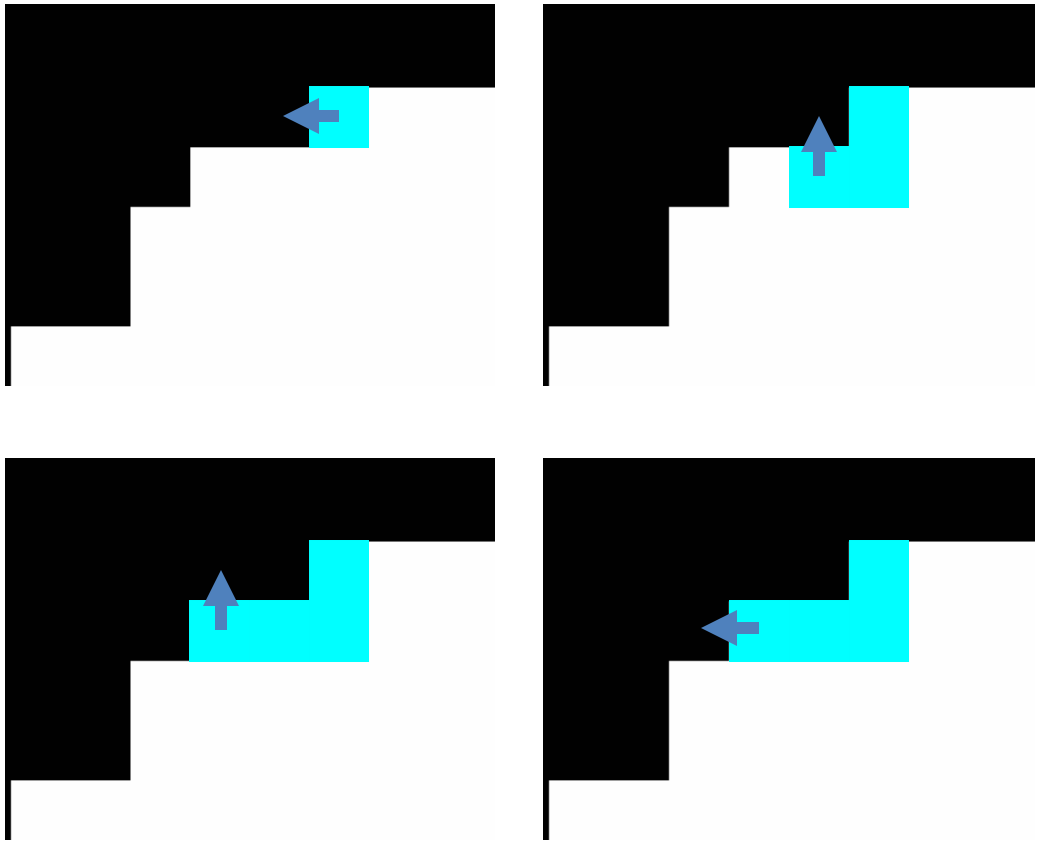
và xác định điểm biên tiếp theo tại $d = 3$

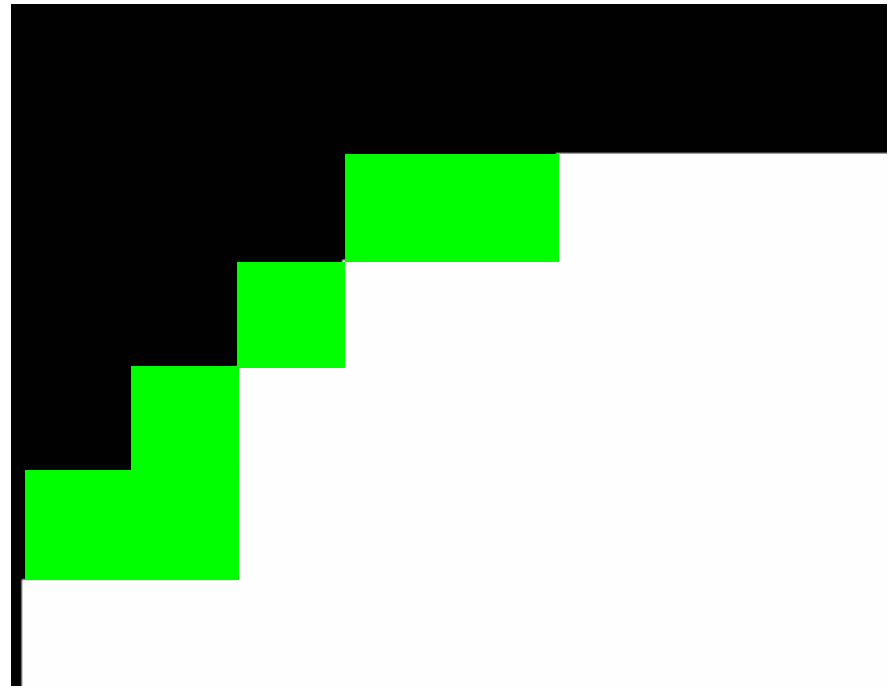
Border Tracing



Và cứ như vậy. . . .

Border Tracing





Các điểm biên ngoài vùng bao gồm các điểm nằm bên ngoài vùng đó đã được kiểm tra trong quá trình truy tìm biên bên trong.

Border Tracing

Algorithm 6.7: Inner boundary tracing

1. Search the image from top left until a pixel of a new region is found; this pixel P_0 then has the minimum column value of all pixels of that region having the minimum row value. Pixel P_0 is a starting pixel of the region border. Define a variable dir which stores the direction of the previous move along the border from the previous border element to the current border element. Assign
   (a) $dir = 3$ if the border is detected in 4-connectivity (Figure 6.14a),
   (b) $dir = 7$ if the border is detected in 8-connectivity (Figure 6.14b).
2. Search the 3×3 neighborhood of the current pixel in an anti-clockwise direction, beginning the neighborhood search in the pixel positioned in the direction
   (a) $(dir + 3) \bmod 4$ (Figure 6.14c),
   (b) $(dir + 7) \bmod 8$ if dir is *even* (Figure 6.14d),
   $(dir + 6) \bmod 8$ if dir is *odd* (Figure 6.14e).

   The first pixel found with the same value as the current pixel is a new boundary element P_n. Update the dir value.
3. If the current boundary element P_n is equal to the second border element P_1, and if the previous border element P_{n-1} is equal to P_0, stop. Otherwise repeat step 2.
4. The detected inner border is represented by pixels $P_0 \ldots P_{n-2}$.

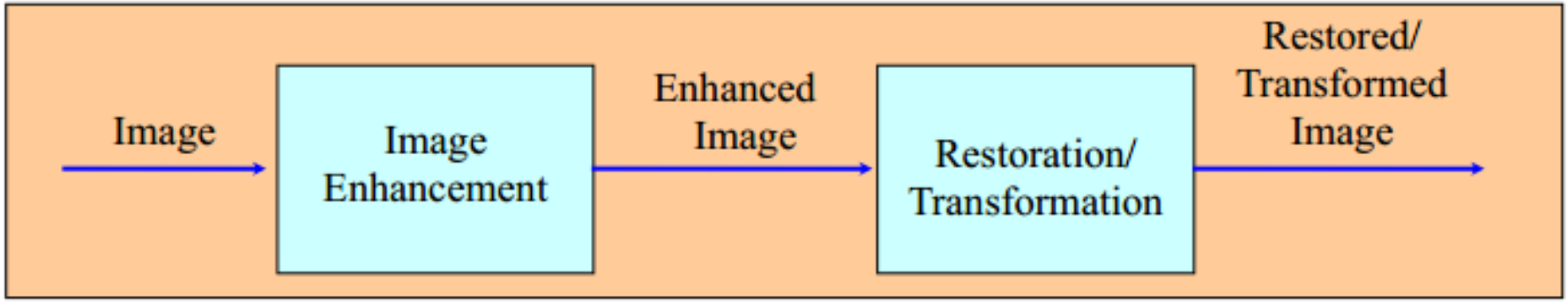
Border Tracing

Algorithm 6.8: Outer boundary tracing

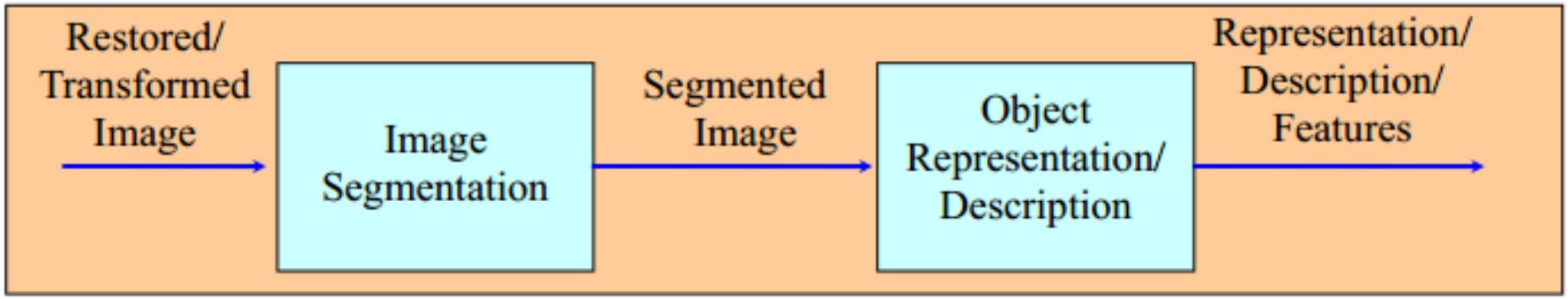
1. Trace the inner region boundary in 4-connectivity until done.
2. The outer boundary consists of all non-region pixels that were tested during the search process; if some pixels were tested more than once, they are listed more than once in the outer boundary list.

2. Representation and Description

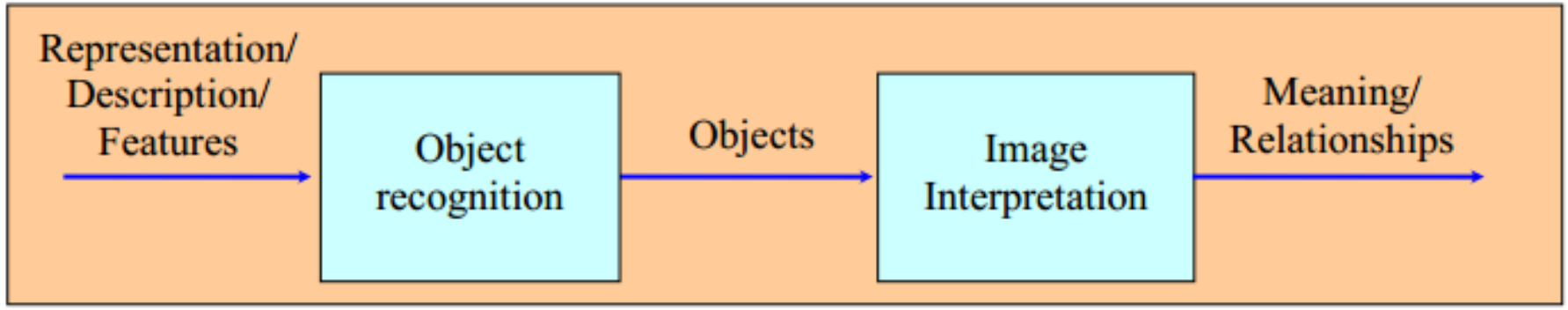
- Low-level image processing
  → Image enhancement, restoration, transformation…



- Mid-level image processing (image understanding)
  → Object representation, description



- High-level image processing (recognition and interpretation)
  → Object recognition, interpretation of object relationships

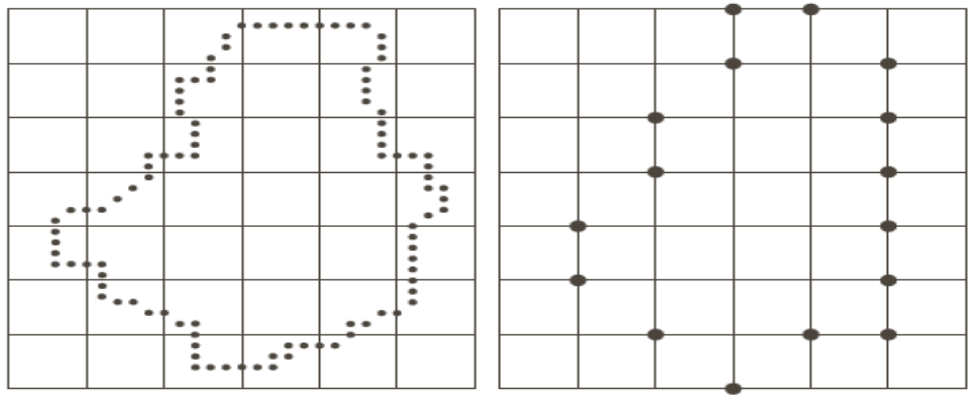


(a) Chain code

đường biên được đại diện bởi một chuỗi kết nối đoạn thẳng có chiều dài và hướng cụ thể

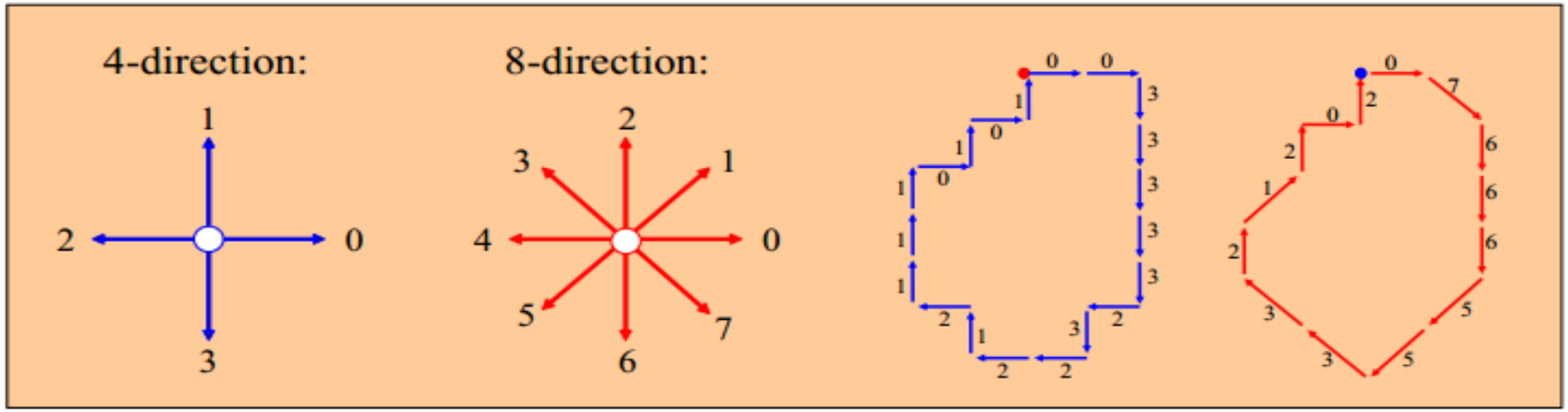
-> Chọn một lưới thích hợp để ước lượng các đối tượng

Chain Coding - Boundary representation



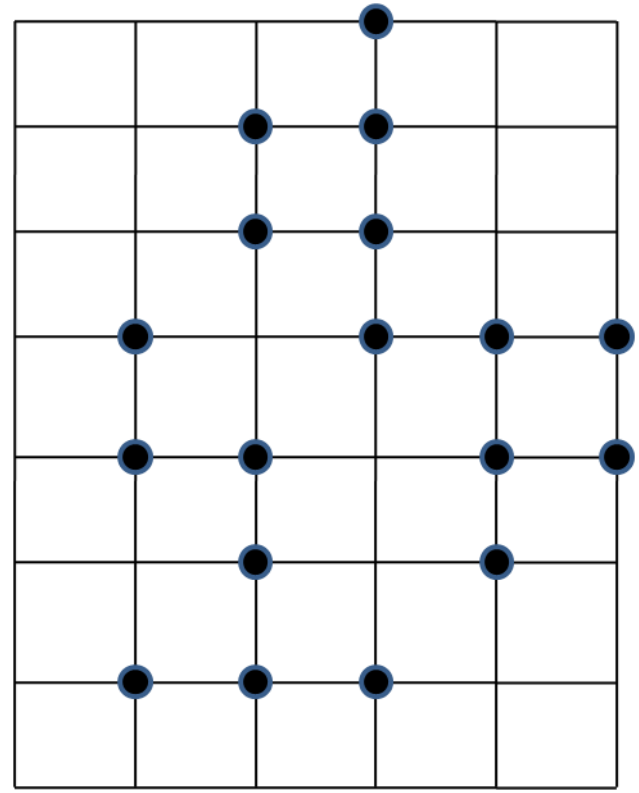
a b c

FIGURE 11.4
(a) Digital boundary with resampling grid superimposed. (b) Result of resampling. (c) 8-directional chain-coded boundary.



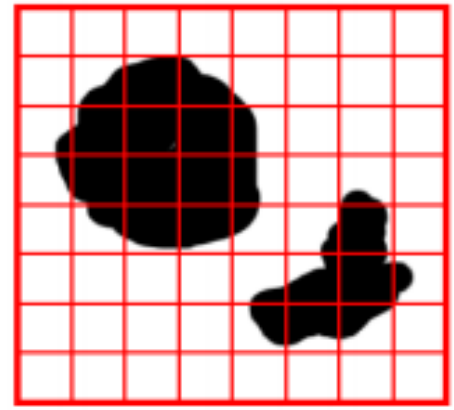
- Chain code (clockwise):
  → 4-direction: 00333332322121110101, 8-direction: 07666553321202

Example



Regional Descriptors

- Simple Region Descriptors
  - area



number of pixels

blue = 10
green = 4