Chapter 11 Representation & Description

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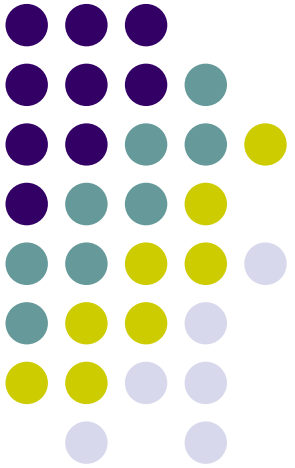
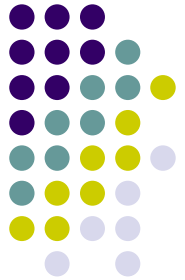
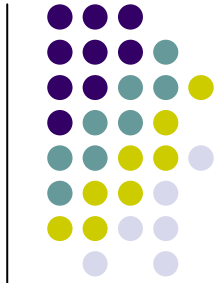
Tianjin University





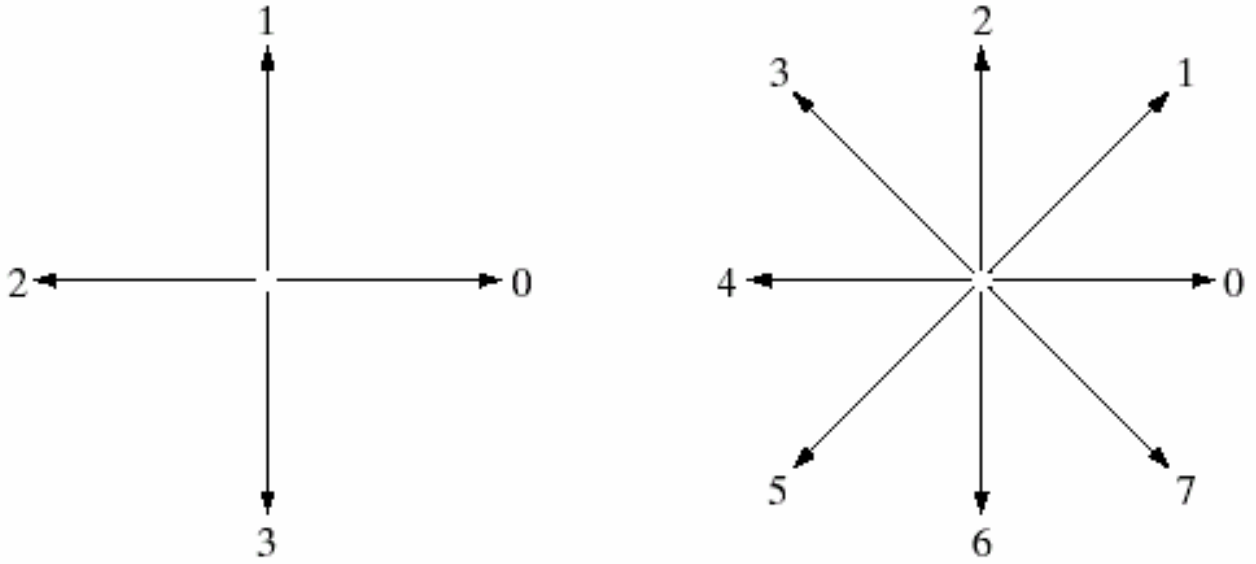
- Representation
- Boundary Descriptors
- Regional Descriptors

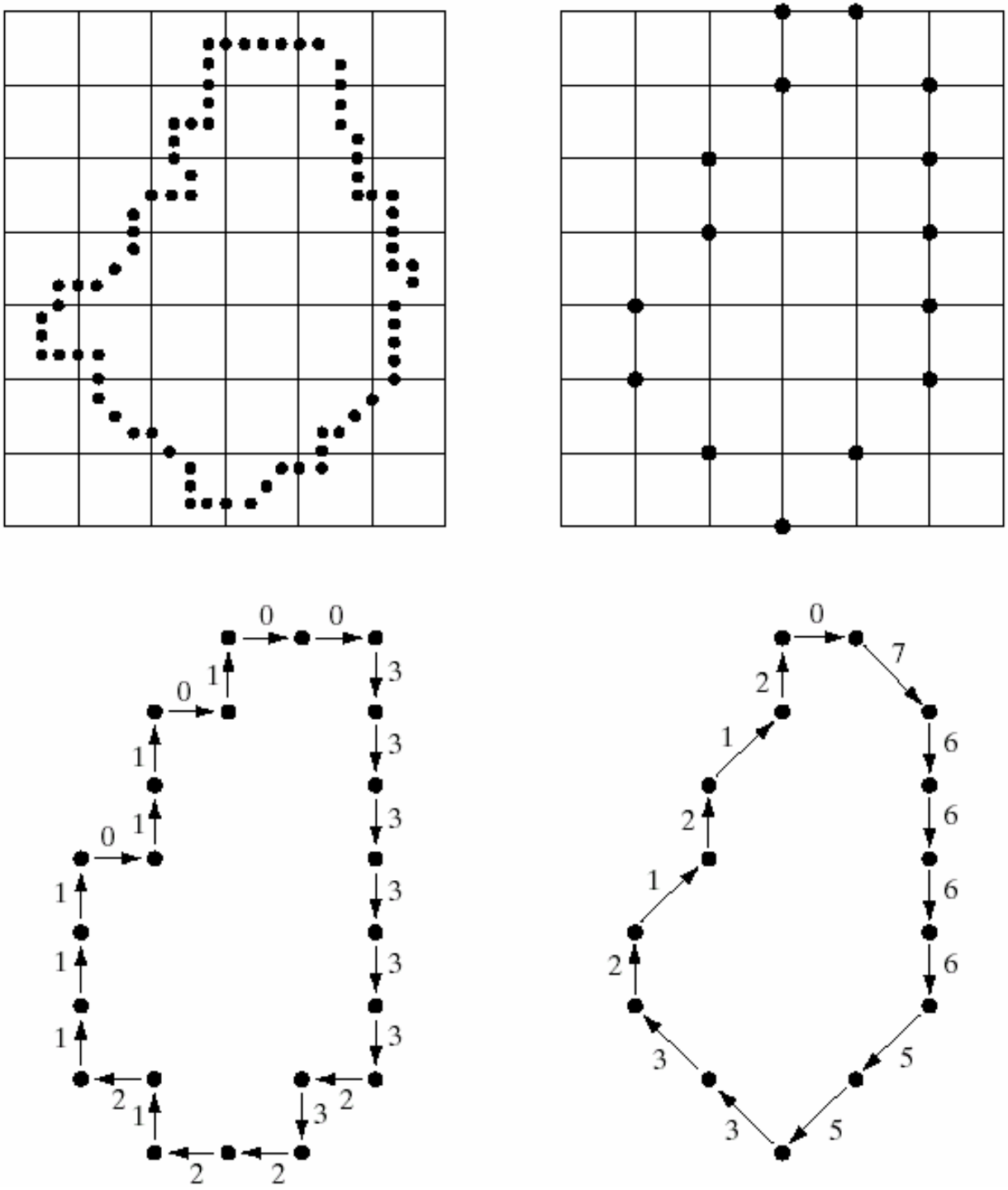
Chain Codes



a b

FIGURE 11.1
Direction numbers for (a) 4-directional chain code, and (b) 8-directional chain code.

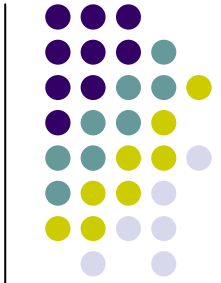




a b
c d

FIGURE 11.2
(a) Digital boundary with resampling grid superimposed. (b) Result of resampling. (c) 4-directional chain code. (d) 8-directional chain code.

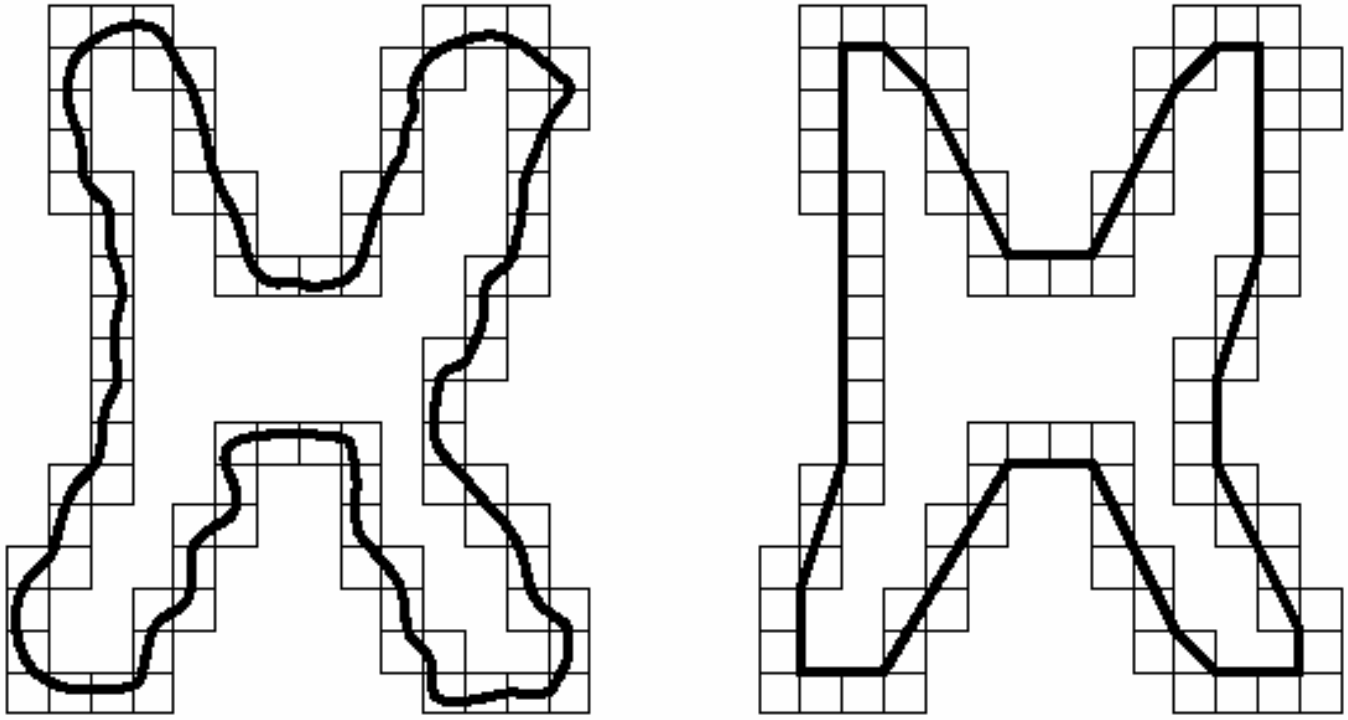
Polygonal Approximations

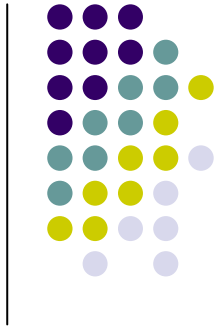


Minimum perimeter polygons

a b

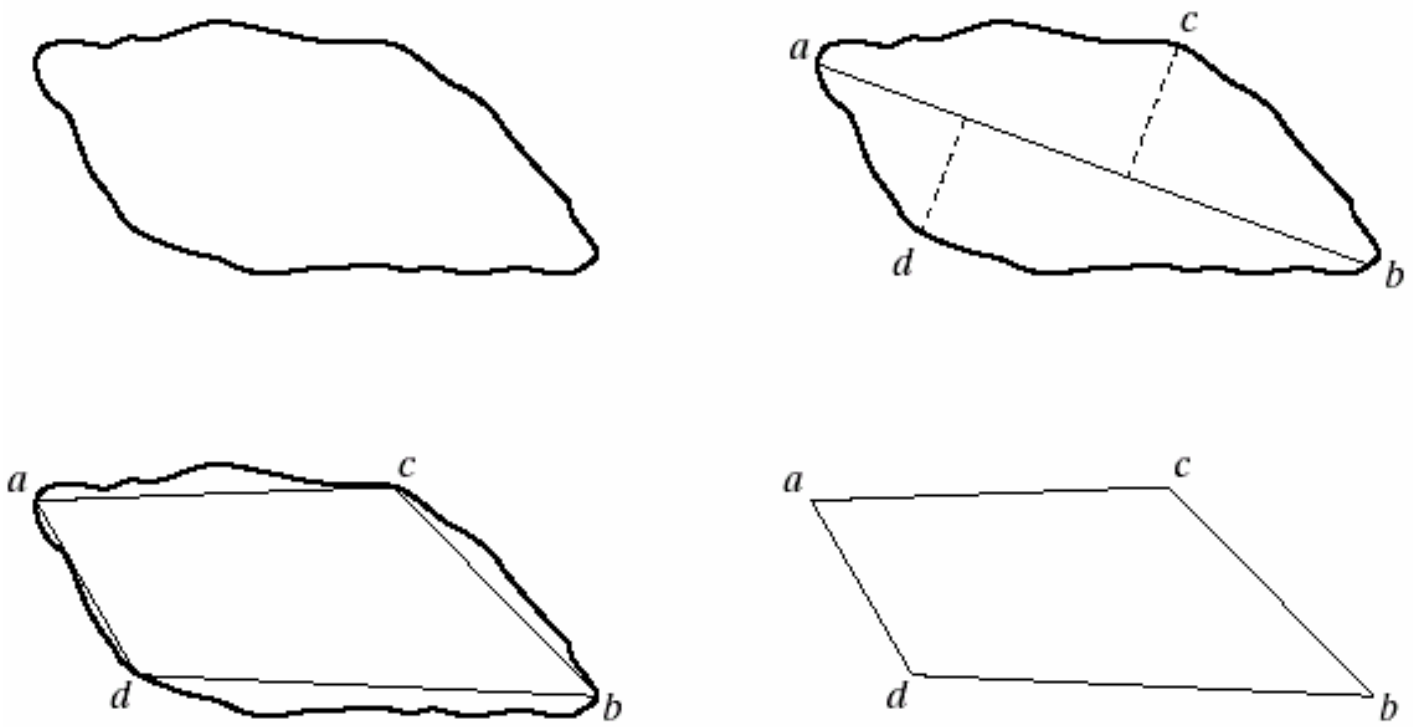
FIGURE 11.3
(a) Object boundary enclosed by cells. (b) Minimum perimeter polygon.





- Merging techniques

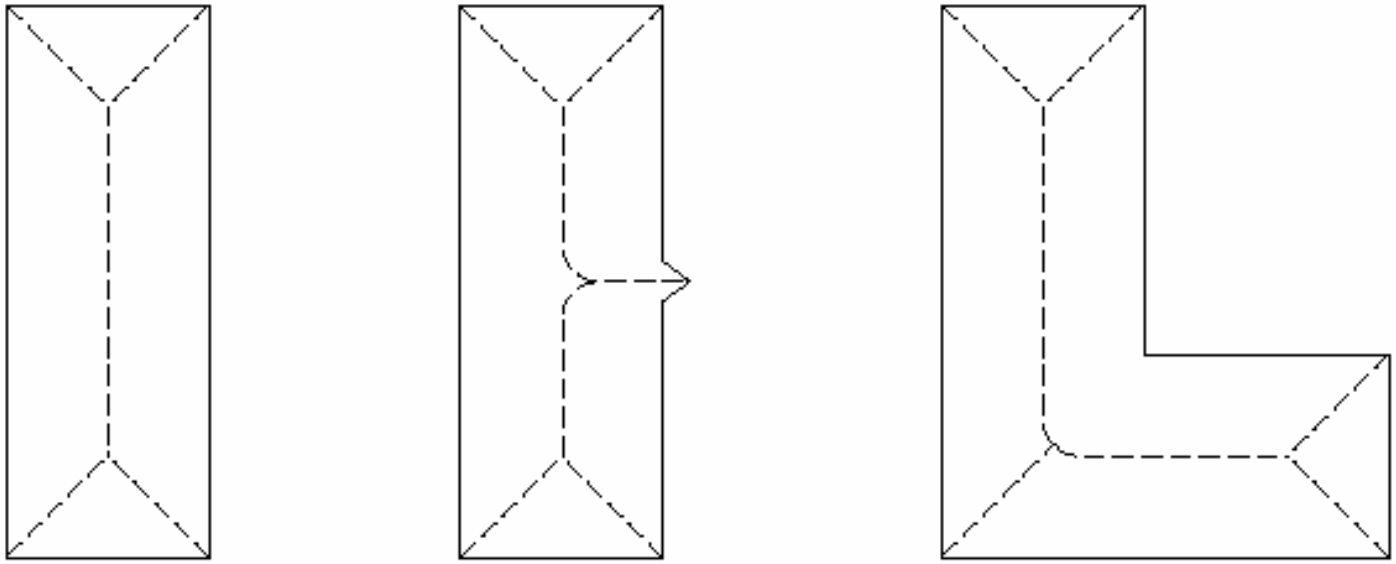
- Splitting techniques



a b
c d

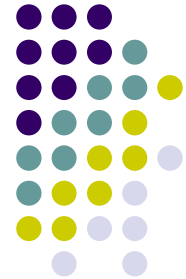
FIGURE 11.4
(a) Original boundary. (b) Boundary divided into segments based on extreme points. (c) Joining of vertices. (d) Resulting polygon.

Skeletons



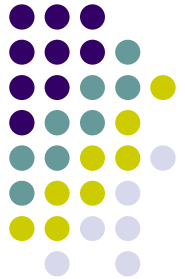
a b c

FIGURE 11.7
Medial axes (dashed) of three simple regions.



p_9	p_2	p_3
p_8	p_1	p_4
p_7	p_6	p_5

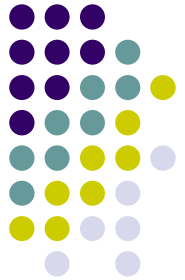
FIGURE 11.8
Neighborhood arrangement used by the thinning algorithm.



- Step 1 flags a contour point p1 for deletion if the following conditions are satisfied:
  (a) $2<=N(P_1)<=6$
  (b) $T(P_1)=1$
  (c) $p_2*p_4*p_6=0$
  (d) $p_4*p_6*p_8=0$
- $N(p_1)$ is the number of nonzero neighbors of p1; that is

$$N(p_1)=p_2+p_3+\ldots+p_8+p_9$$

- $T(p_1)$ is the number of 0-1 transitions in the ordered sequence $p_2, p_3,\ldots,p_8,p_9,p_2$.



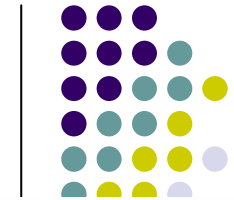
- Step 2 flags a contour point p_1 for deletion if the following conditions are satisfied:

  (a) $2<=N(p_1)<=6$

  (b) $T(p_1)=1$

  (c) $p_2*p_4*p_8=0$

  (d) $p_2*p_6*p_8=0$



0	0	1
1	p_1	0
1	0	1

FIGURE 11.9
Illustration of conditions (a) and (b) in Eq. (11.1-1). In this case $N(p_1) = 4$ and $T(p_1) = 3$.

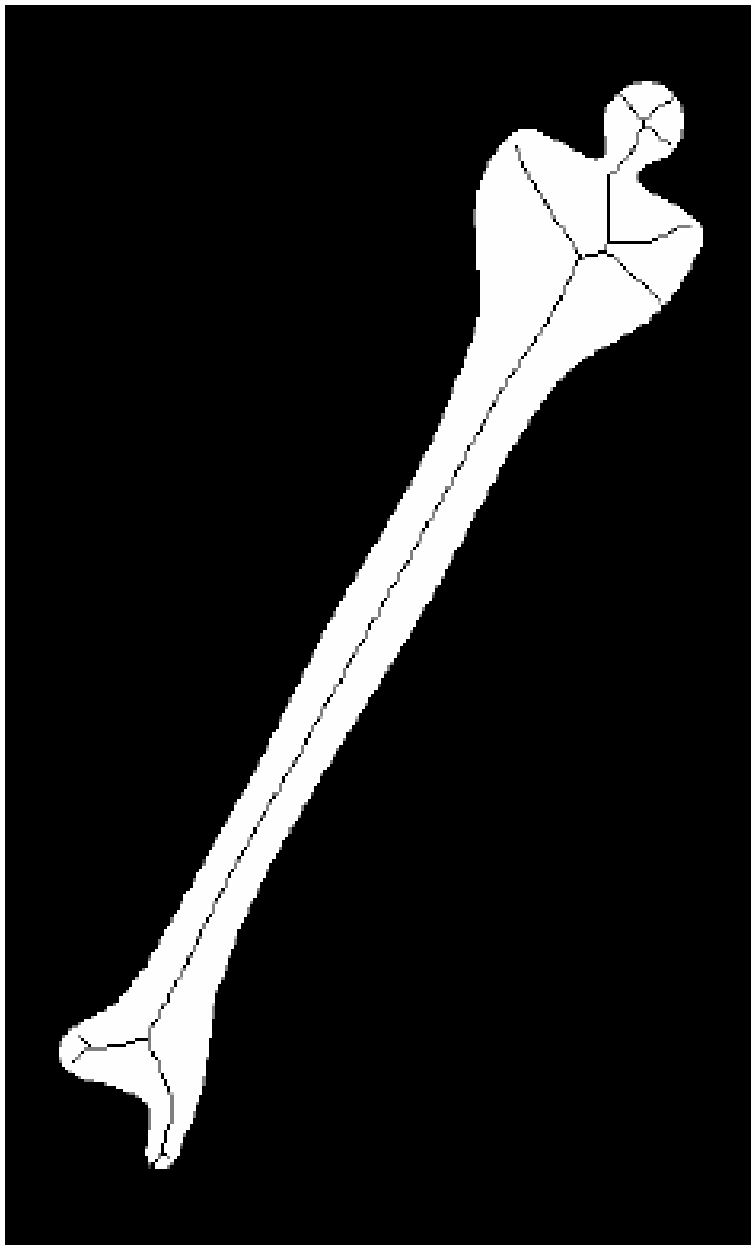
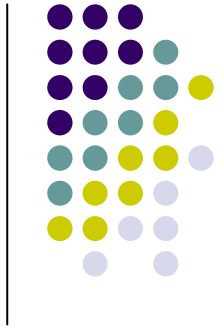


FIGURE 11.10
Human leg bone and skeleton of the region shown superimposed.



- Representation
- Boundary Descriptors
- Regional Descriptors

Shape Numbers

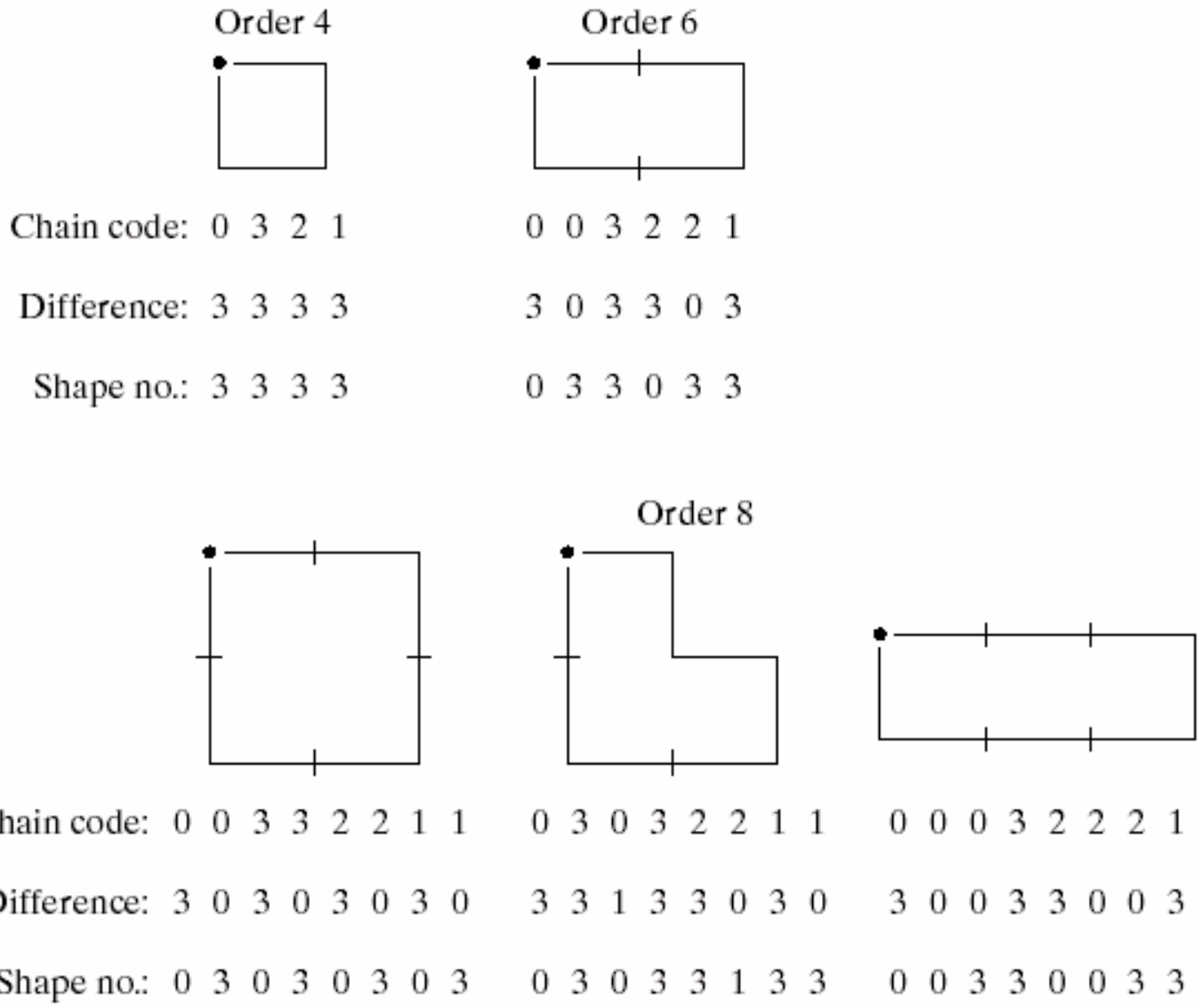
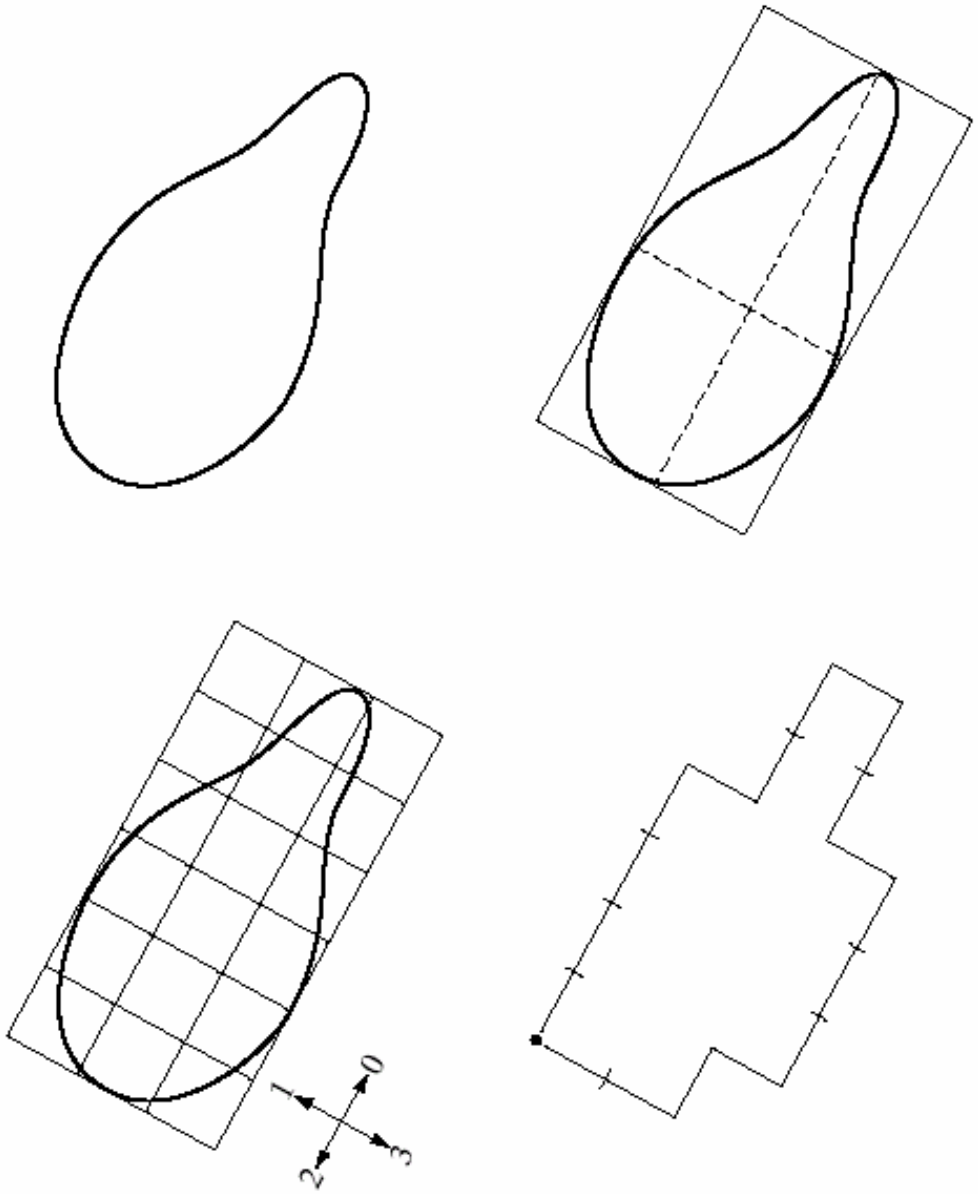


FIGURE 11.11 All shapes of order 4, 6, and 8. The directions are from Fig. 11.1(a), and the dot indicates the starting point.



a b
c d

FIGURE 11.12
Steps in the generation of a shape number.

Chain code:	0	0	0	0	3	0	0	3	2	2	3	2	2	2	1	2	1	1
Difference:	3	0	0	0	3	1	0	3	3	0	1	3	0	0	3	1	3	0
Shape no.:	0	0	0	3	1	0	3	3	0	1	3	0	0	3	1	3	0	3

Statistical Moments

$$\mu_n(v) = \sum_{i=0}^{A-1} (v_i - m)^n \, p(v_i)$$

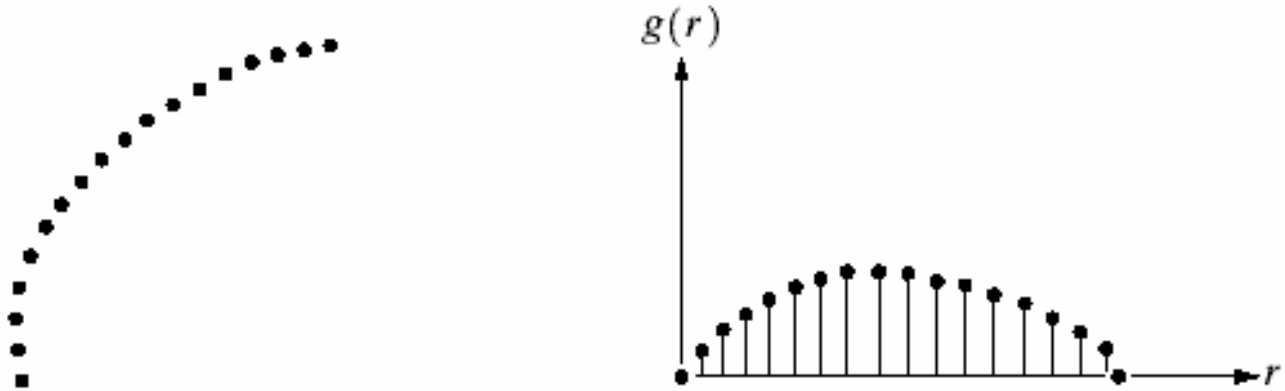
where $$m = \sum_{i=0}^{A-1} v_i \, p(v_i)$$

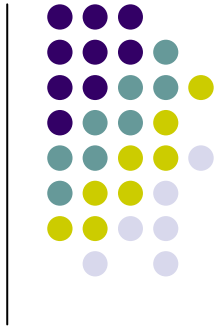
$$\mu_n(r) = \sum_{i=0}^{K-1} (r_i - m)^n \, g(r_i)$$

where $$m = \sum_{i=0}^{K-1} r_i \, g(r_i)$$

a b

FIGURE 11.15
(a) Boundary segment.
(b) Representation as a 1-D function.





- Representation
- Boundary Descriptors
- Regional Descriptors

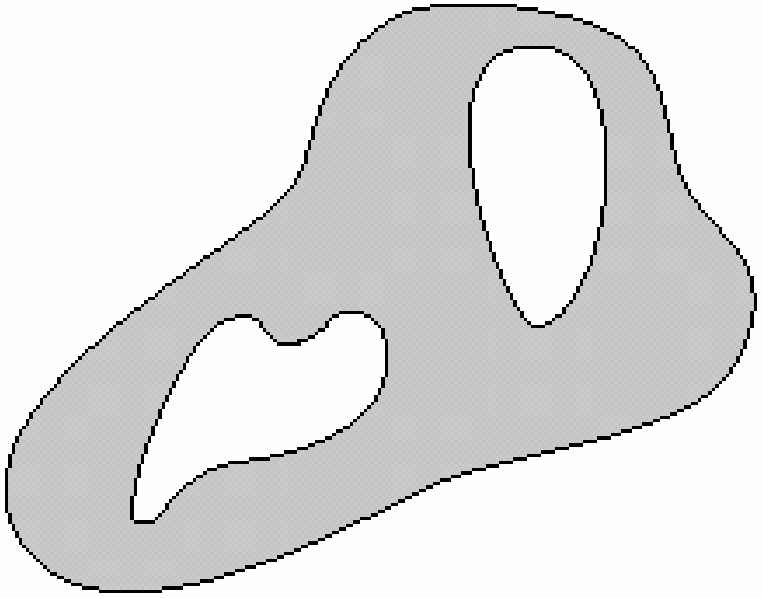


FIGURE 11.17 A region with two holes.

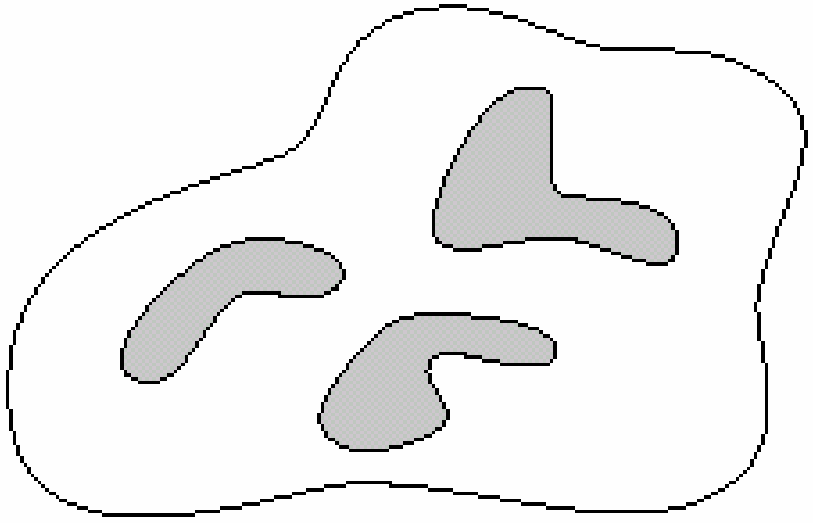
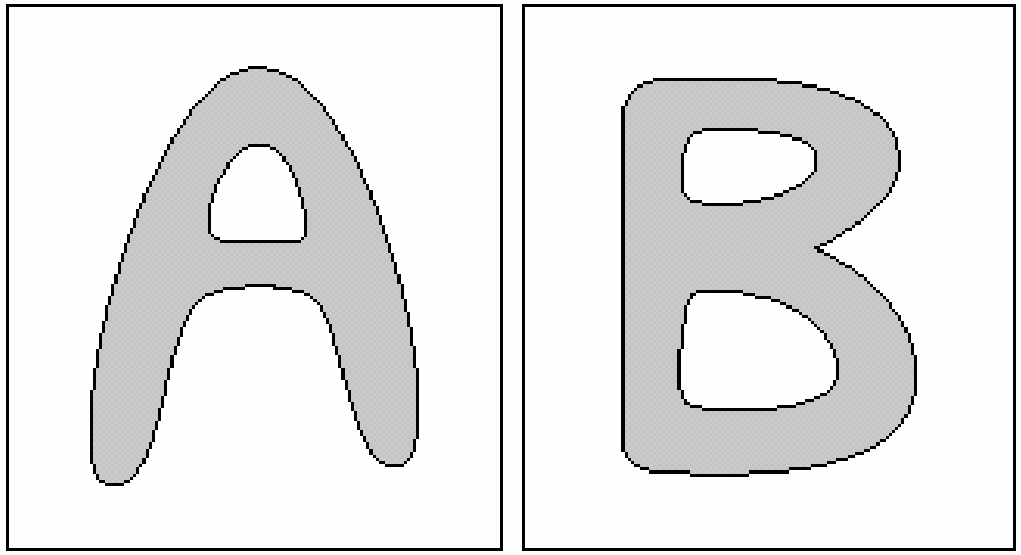


FIGURE 11.18 A region with three connected components.



a b

FIGURE 11.19 Regions with Euler number equal to 0 and −1, respectively.

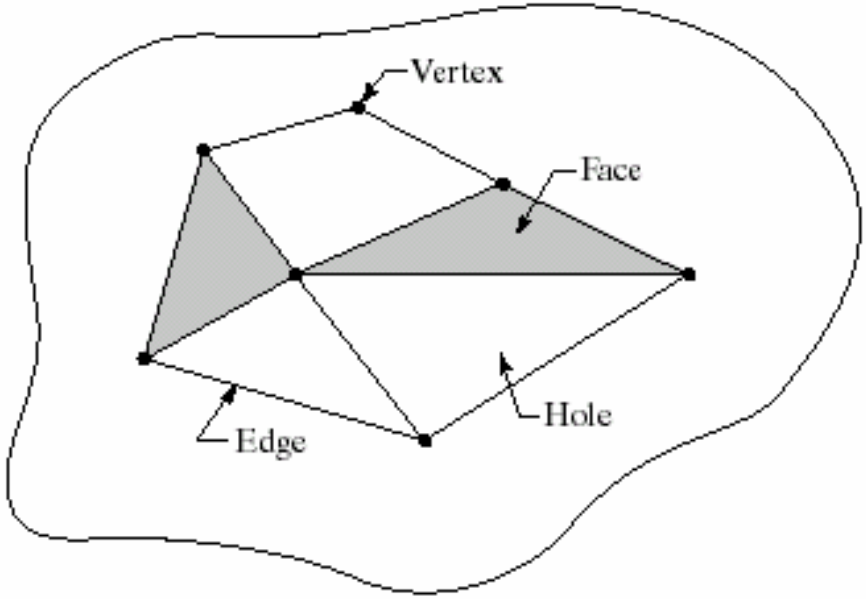
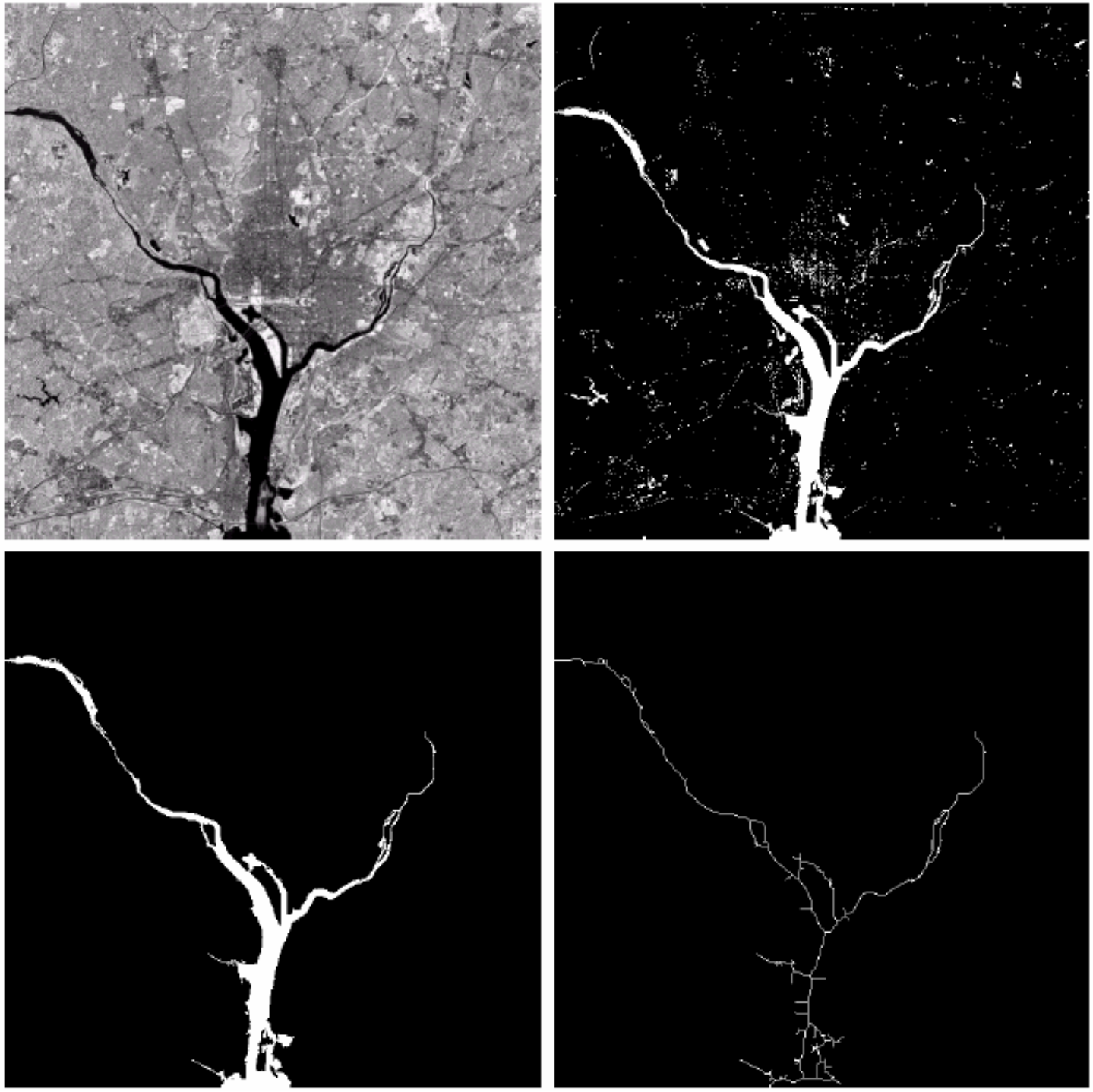


FIGURE 11.20 A region containing a polygonal network.

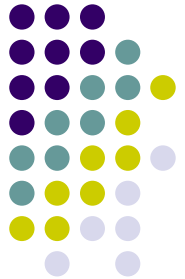


a b
c d

FIGURE 11.21
(a) Infrared image of the Washington, D.C. area. (b) Thresholded image. (c) The largest connected component of (b). Skeleton of (c).

Texture

Texture



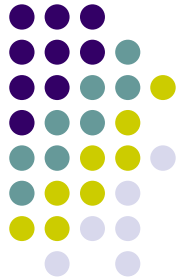
- The nth moment of z about the mean is

$$\mu_n(z) = \sum_{i=0}^{L-1} (z_i - m)^n \, p(z_i)$$

where m is the mean value of z:

$$m = \sum_{i=0}^{L-1} z_i \, p(z_i)$$

- Second moment: of particular importance in texture description. It is a measure of gray-level contrast that can be used to establish descriptors of relative smoothness.
- The third moment is a measure of the skewness of the histogram;
- The fourth moment is a measure of its relative flatness.



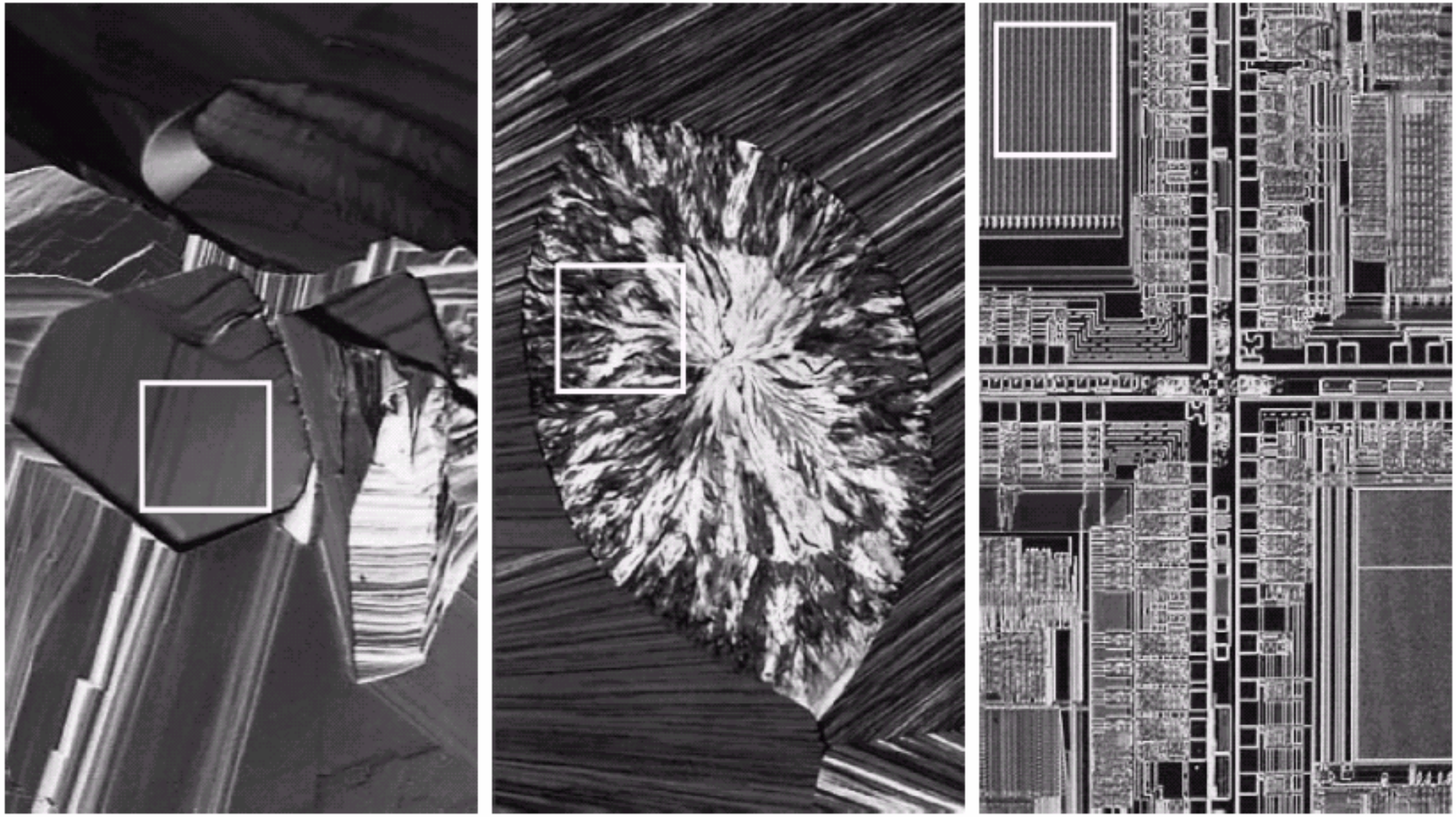
- A measure of “uniformity”

$$U = \sum_{i=0}^{L-1} p^2(z_i)$$

- An average entropy measure

$$e = -\sum_{i=0}^{L-1} p(z_i)\log_2 p(z_i)$$

Measure U is maximum for an image in which all gray levels are equal. Entropy is a measure of variability and is 0 for a constant image.



a b c

FIGURE 11.22 The white squares mark, from left to right, smooth, coarse, and regular textures. These are optical microscope images of a superconductor, human cholesterol, and a microprocessor. (Courtesy of Dr. Michael W. Davidson, Florida State University.)

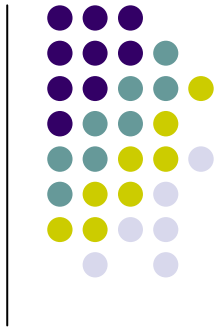


TABLE 11.2
Texture measures for the subimages shown in Fig. 11.22.

Texture	Mean	Standard deviation	R (normalized)	Third moment	Uniformity	Entropy
Smooth	82.64	11.79	0.002	−0.105	0.026	5.434
Coarse	143.56	74.63	0.079	−0.151	0.005	7.783
Regular	99.72	33.73	0.017	0.750	0.013	6.674