Table 6.1 TYPICAL DATA REQUIRED IN URBAN PLANNING APPLICATIONS

Data Items
• total population by place of residence
• population by age-sex groups by place of residence
• population by family size groups by place of residence
• population by annual family income groups by place of residence
• population by industry groups by place of residence
• population by occupational groups by place of residence
• total labor force by place of residence
• total employment by place of work
• employment by industry groups by place of work
• employment by occupational groups by place of work
• employment by income groups by place of work
• total annual retail sales by place of sale
• annual retail sales by retailing groups by place of sale
• total value of manufactured products by place of manufacture
• value of manufactured products by industry groups by place of manufacture
• total government expenditures by place of agency
• capital and operating government expenditures
• government expenditures, capital and operating, by agency
• total person trips by place of destination
• total person trips by land-use groups by place of destination
• total market value of land by small area
• market value of land by land-use groups by small area
• total market value of land and buildings by small area
• market value of land and buildings by structural-type groups by small area
• total housing units by small area
• housing units by type of structure by small area
• housing units by density class by small area
• housing units by condition of structure by small area
• housing units by age of structure by small area
• total floor area by small area
• floor area by land-use groups by small area
• land area by land-use groups by small area
• accessibility to region by small area
• distance (time or cost) to all parts of the region or to the center of the region by small area

Figure 6.1 PROXIMAL MAP OF DEVELOPABLE RESIDENTIAL LAND IN YORK, PENNSYLVANIA

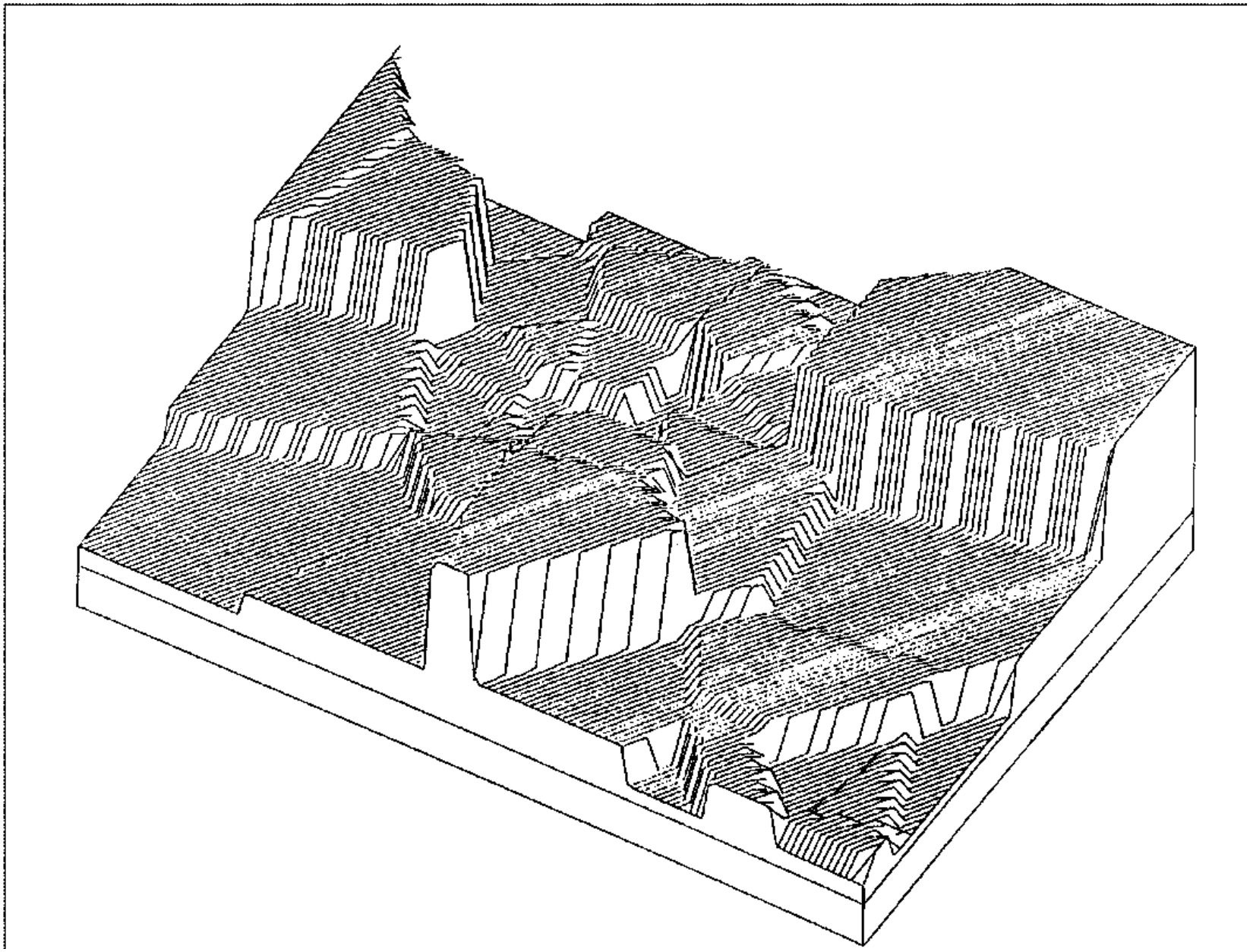


Figure 6.2 CONTOUR MAP OF POPULATION IN YORK, PENNSYLVANIA

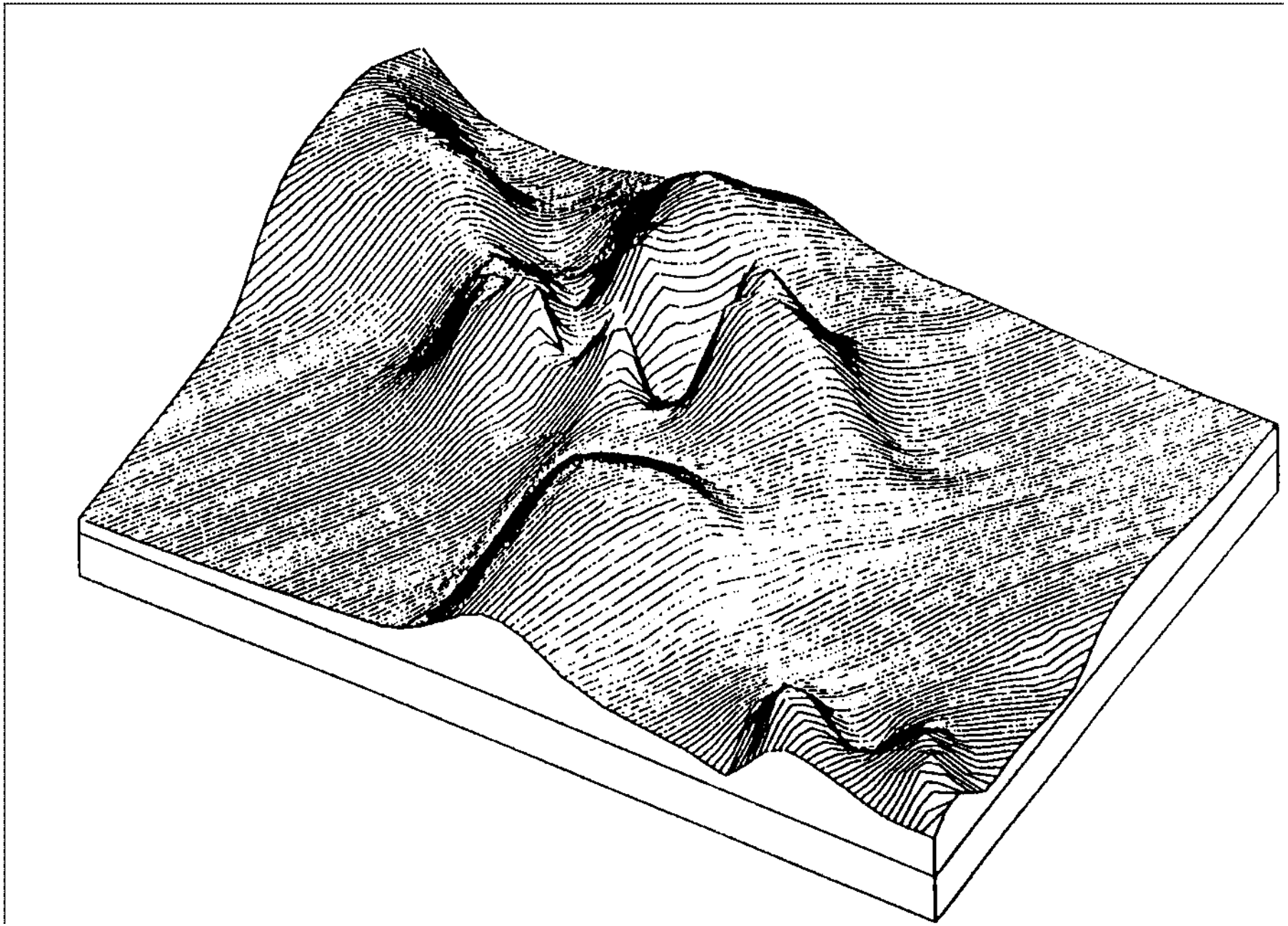
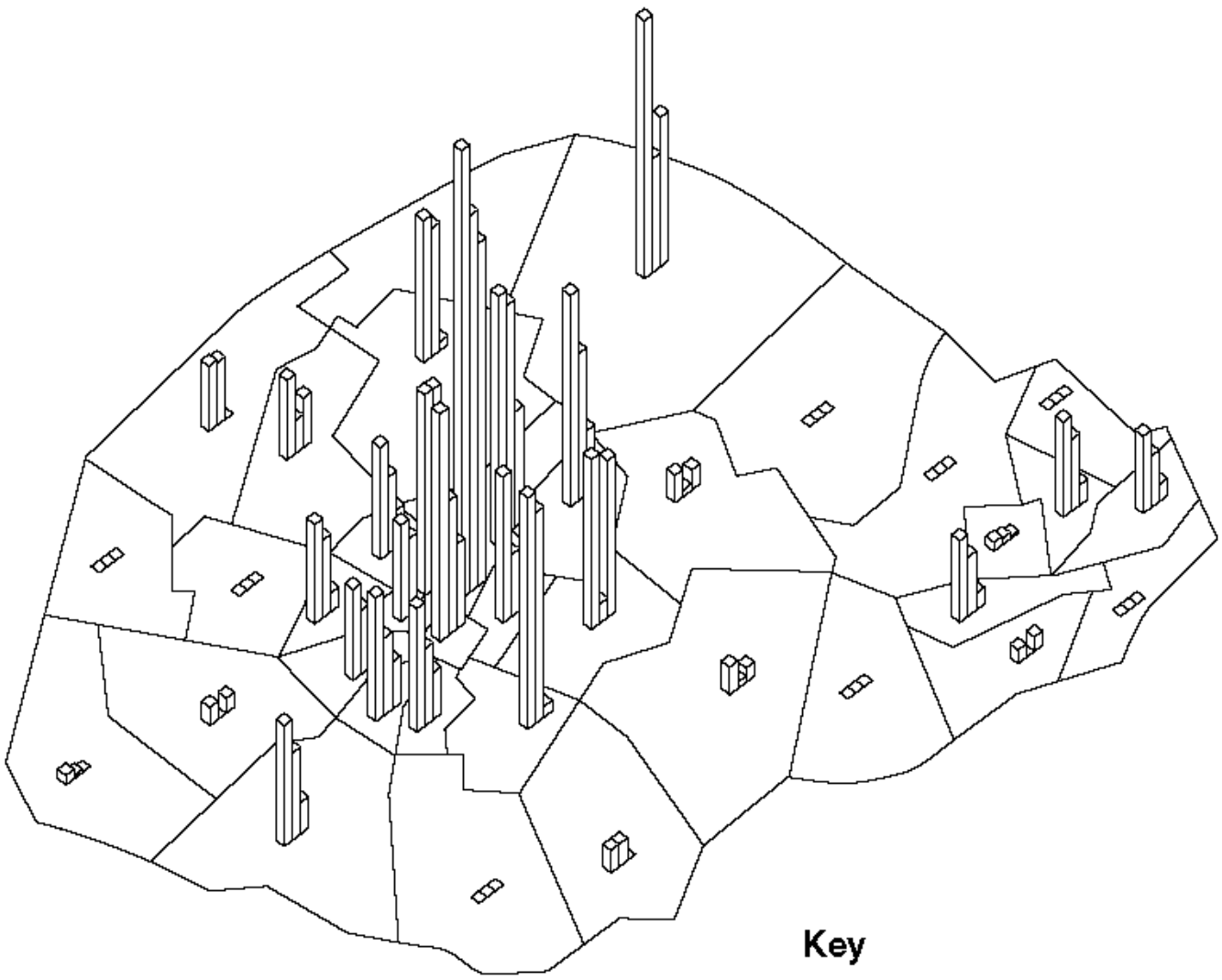


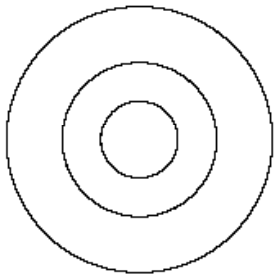
Figure 6.3 BASE-YEAR ZONAL EMPLOYMENT, YORK, PENNSYLVANIA



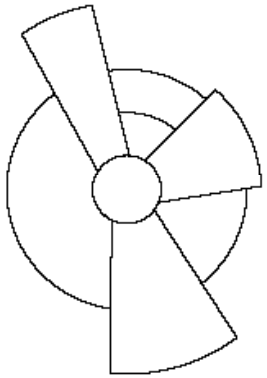
Key

Left-most bar – Total employment
Middle bar – Basic employment
Right-most bar – Nonbasic employment

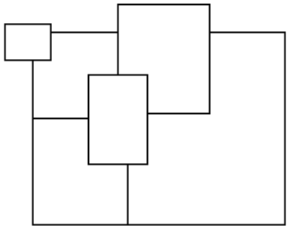
Figure 6.4 CONCENTRIC ZONE, SECTOR, AND MULTI-NUCLEI STRUCTURES OF A CITY



(a) Concentric zone structure

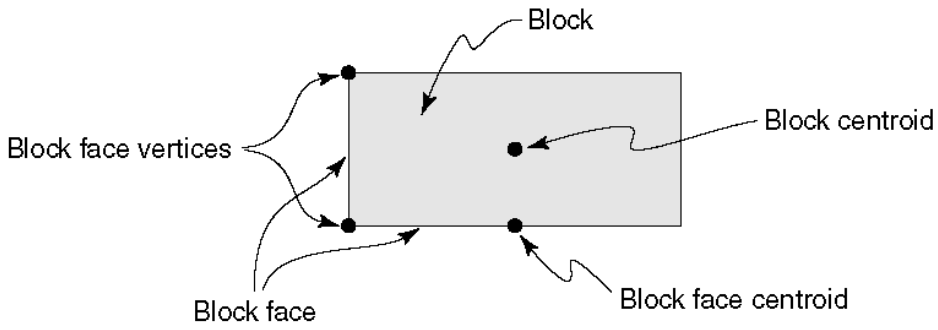


(b) Sector-structure

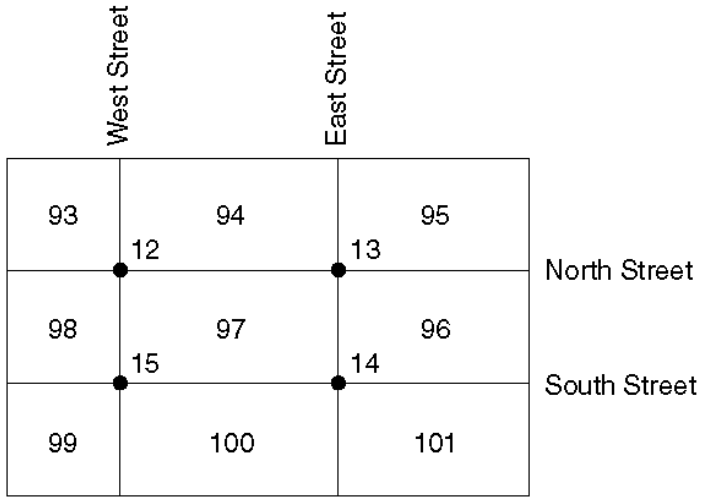


(c) Multi-nuclei structure

Figure 6.5 ILLUSTRATING THE DIME FILES



(a) Alternative ways of coding data at city block level.



Segment name	Nodes		Block number		Address			
					Left		Right	
	From	To	Left	Right	Low	High	Low	High
North Street	12	13	94	97	133	229	134	230

(b) Form of segment records in a DIME file.

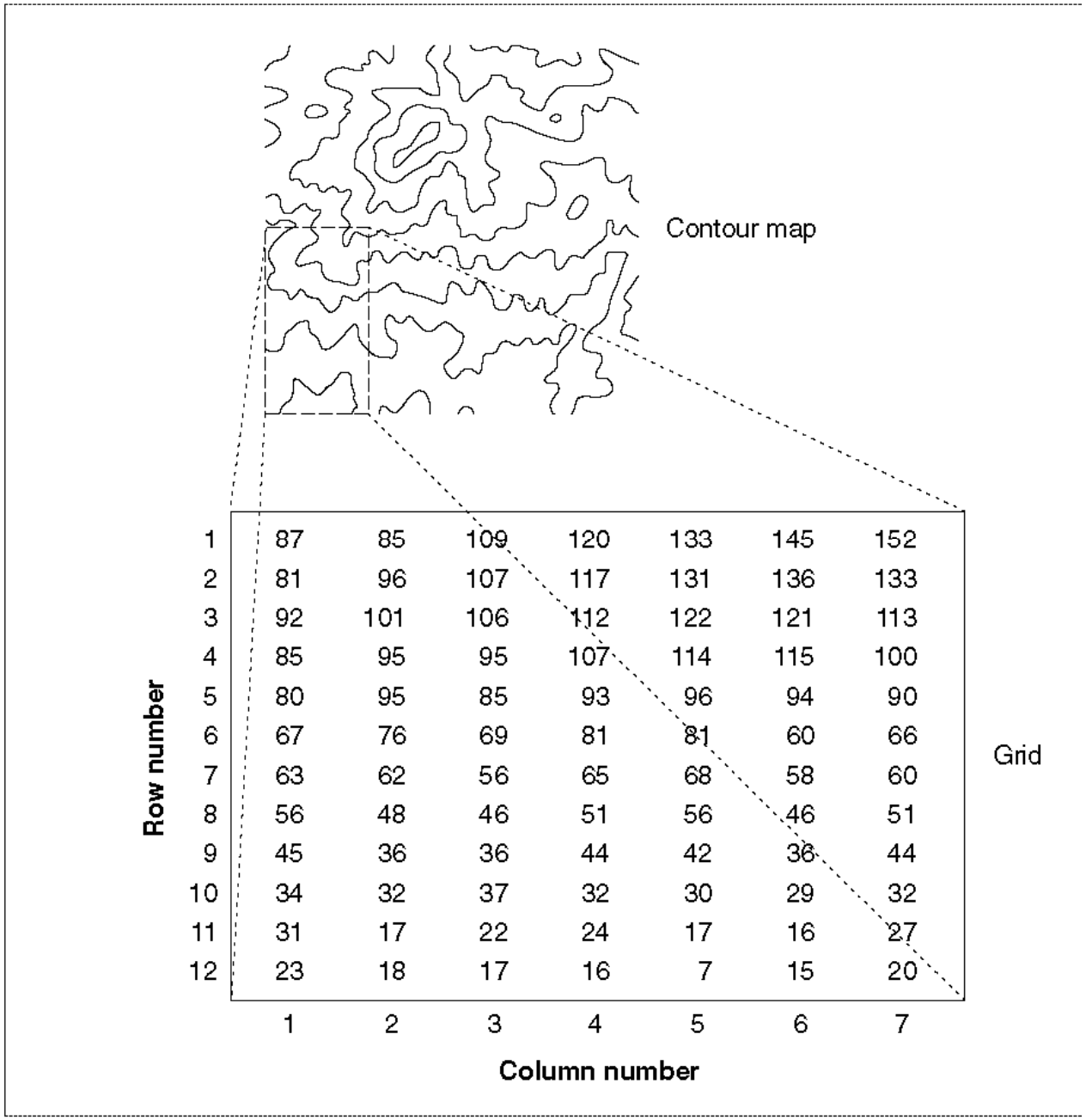
SOURCE: Hutchinson (1974). Reprinted with permission.

Table 6.2 DIGITAL DATA AVAILABLE FROM THE UNITED STATES GOVERNMENT

Data Type	Data Source
Topography:	
Digital elevation model	U.S. Geological Survey (National Mapping Division)
Digital terrain data	Defense Mapping Agency
Land use and land cover:	U.S. Geological Survey (National Mapping Division)
Ownership and political boundaries	
Transportation	Note: Department of Energy also has transportation data
Hydrography	
Socioeconomic and demographic data:	U.S. Department of Commerce (Census Bureau)
Census tract boundaries	
Demographic data	
Socioeconomic data	
Soils	U.S. Department of Agriculture (Soil Conservation Service)
Wetlands	U.S. Fish and Wildlife Service
Remotely sensed data	National Aeronautics and Space Administration
	National Oceanic and Atmospheric Administration

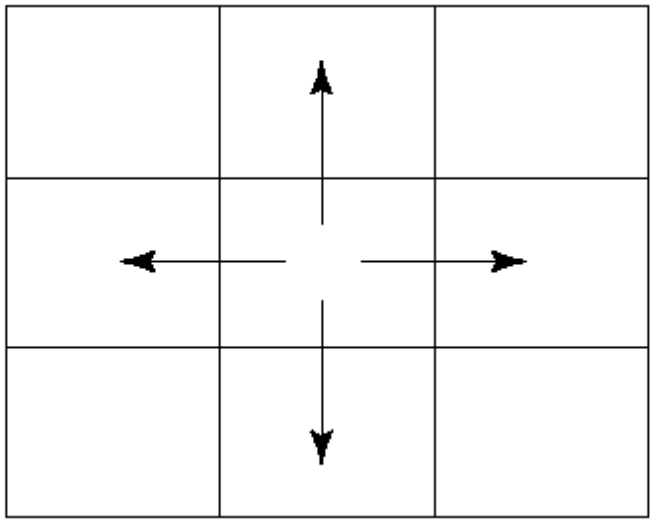
SOURCE: Star and Estes (1990). Reprinted with permission.

Figure 6.6 RASTER DATA STRUCTURE EXAMPLE

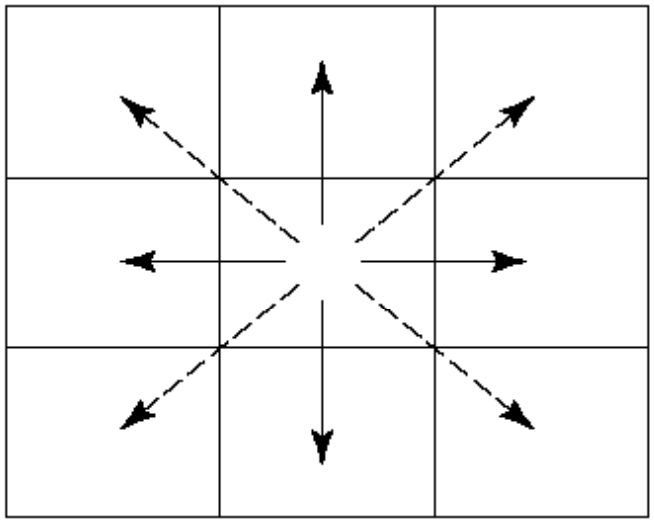


SOURCE: Star and Estes (1990). Reprinted with permission.

Figure 6.7 DEFINITION OF SPATIAL NEIGHBORHOOD



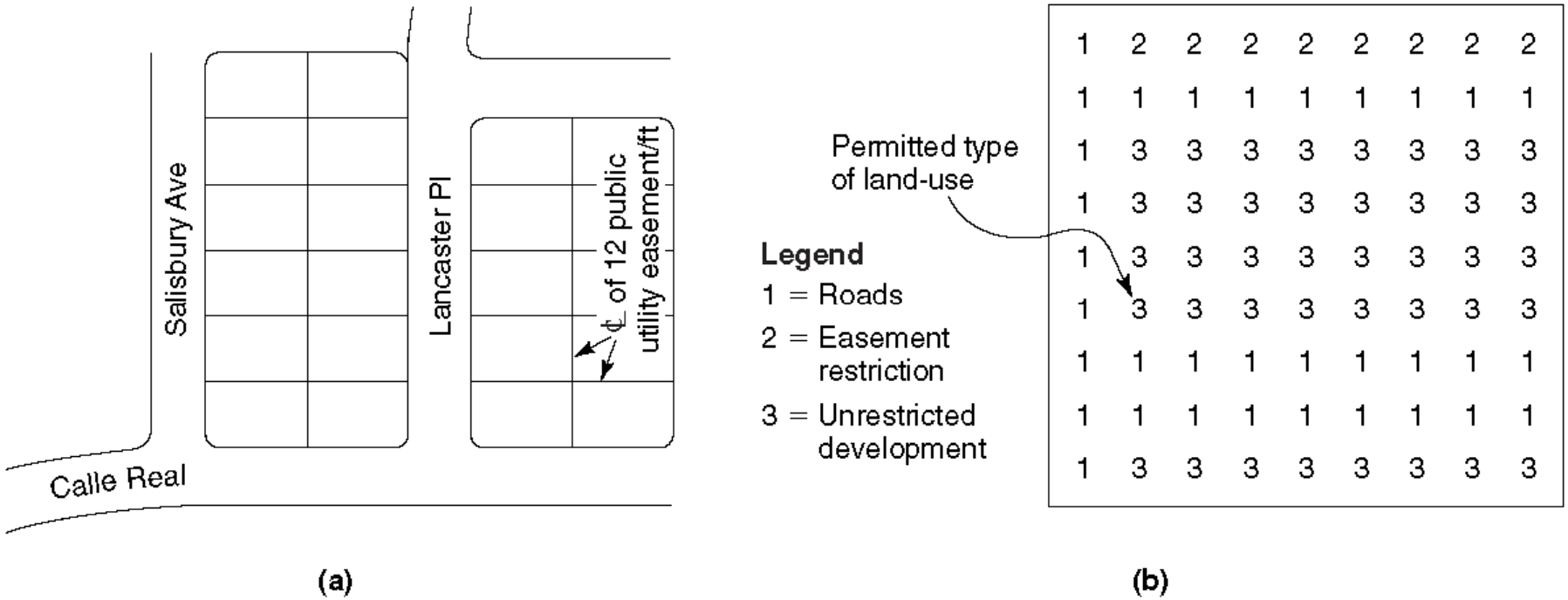
4-connected
(1st-order neighbors)



8-connected
(1st-order and 2nd-order neighbors)

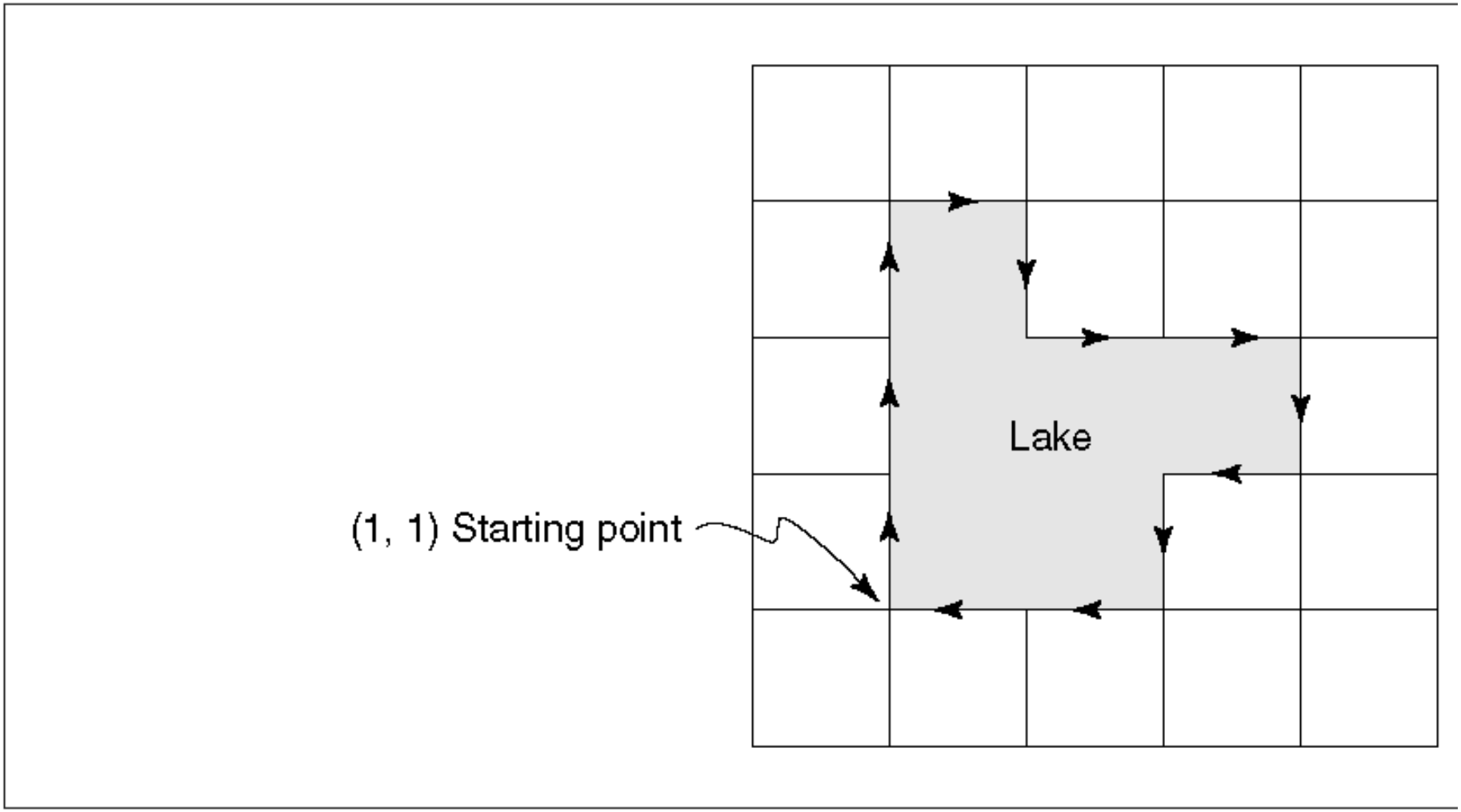
SOURCE: Star and Estes (1990). Reprinted with permission.

Figure 6.8 A SUBDIVISION MAP AND ITS RASTER REPRESENTATION



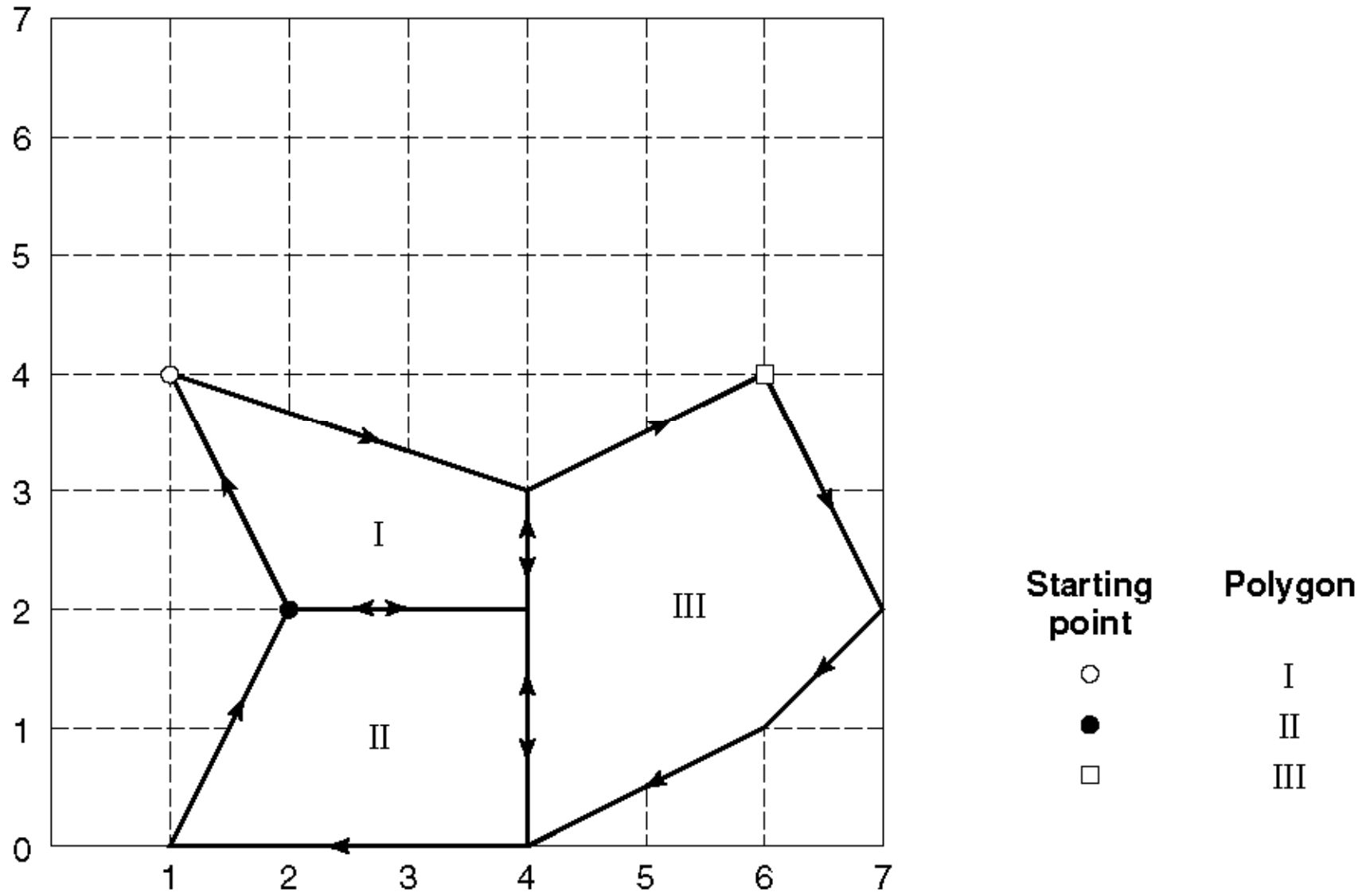
SOURCE: Star and Estes (1990). Reprinted with permission.

Figure 6.9 A CHAIN CODE REPRESENTATION



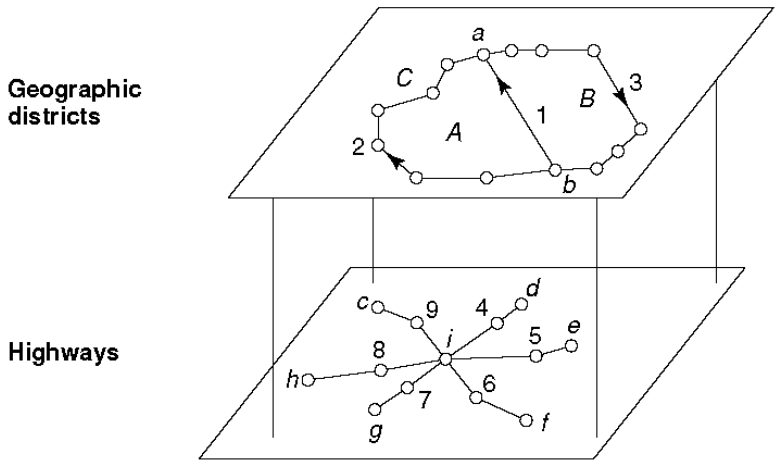
SOURCE: Star and Estes (1990). Reprinted with permission.

Figure 6.10 EXAMPLE OF A WHOLE POLYGON STRUCTURE



SOURCE: Star and Estes (1990). Reprinted with permission.

Figure 6.11 CHAIN AND POLYGON DATA RECORDS FOR GIS



Geographic districts – Polygons

Area ID	Ring (chain list)*
A	−1, 2
B	3, 1

Geographic district – boundary chains

Boundary chain ID	From node	To node	Left area ID	Right area ID	*x-y* coordinate
1	*b*	*a*	*A*	*B*	$x_1y_1 \ldots x_ny_n$
2	*b*	*a*	*C*	*A*	$x_1y_1 \ldots x_ny_n$
3	*a*	*b*	*C*	*B*	$x_1y_1 \ldots x_ny_n$

Highway network chains

Network chain ID	From node	To node	*x-y* coordinates
4	*i*	*d*	$x_1y_1 \ldots x_ny_n$
5	*i*	*e*	$x_1y_1 \ldots x_ny_n$
6	*i*	*f*	$x_1y_1 \ldots x_ny_n$
7	*i*	*g*	$x_1y_1 \ldots x_ny_n$
8	*i*	*h*	$x_1y_1 \ldots x_ny_n$
9	*i*	*c*	$x_1y_1 \ldots x_ny_n$

*Negative entries indicate reverse order

SOURCE: Nyerges and Dueker (1988). Reprinted with permission.

Figure 6.12 LOCATIONAL DATA LINKED TO ATTRIBUTE DATA

Highway-network chains

Network chain ID	From node	To node	Coordinates
4	i	d	$x_1y_1 \ldots x_ny_n$
5	i	e	$x_1y_1 \ldots x_ny_n$
6	i	f	$x_1y_1 \ldots x_ny_n$
7	i	g	$x_1y_1 \ldots x_ny_n$
8	i	h	$x_1y_1 \ldots x_ny_n$
9	i	e	$x_1y_1 \ldots x_ny_n$

Locational data

Highway-network data

Chain ID (control section ID)	Travel time (min.)	Traffic volume (veh./day)	Other attributes
4	15	5,000	…
5	20	10,000	…
6	17	4,000	…
7	14	6,000	…
8	22	11,000	…
9	18	3,000	…

Attribute data

Figure 6.14
Formation of
an IBIS database

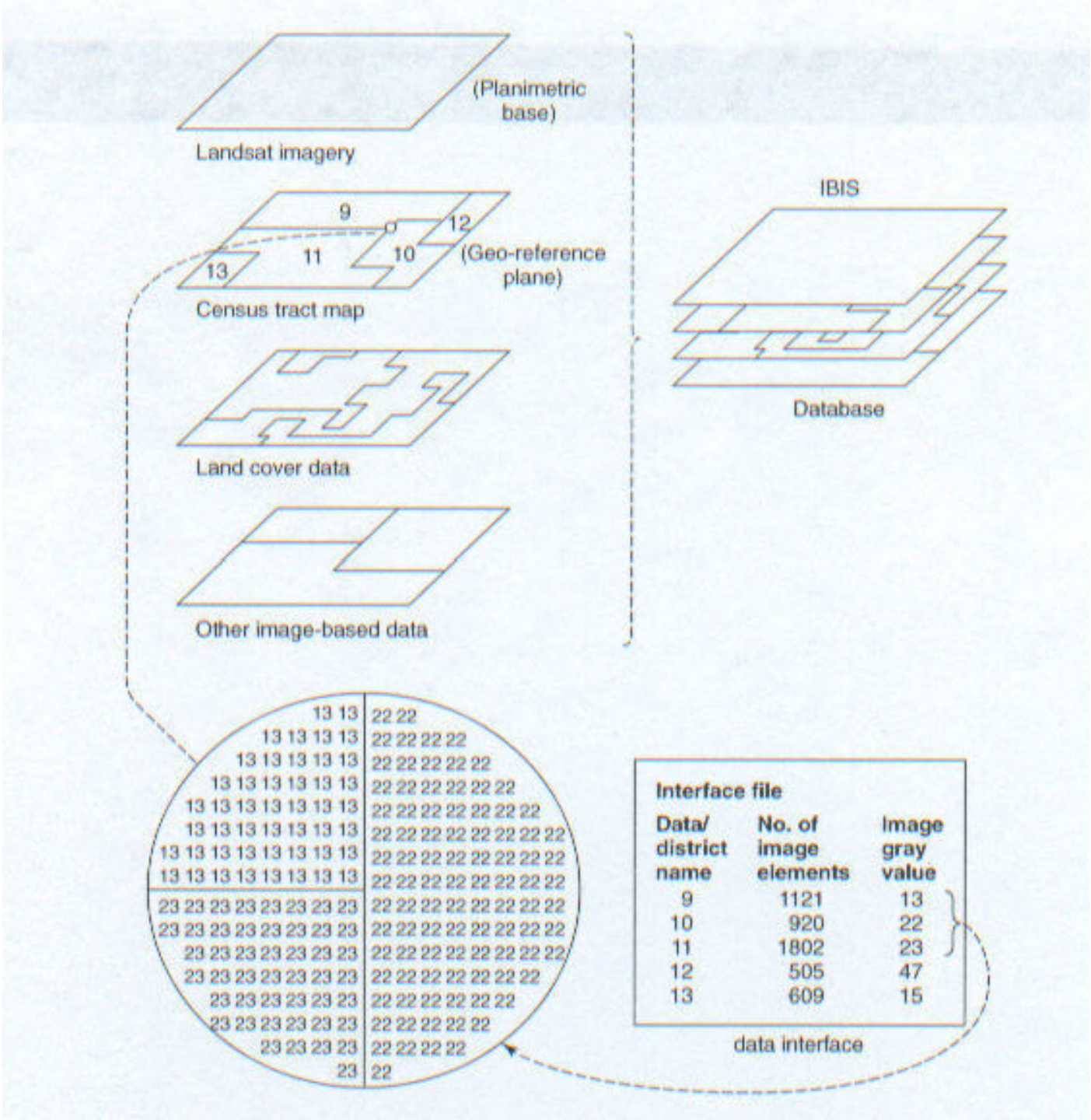
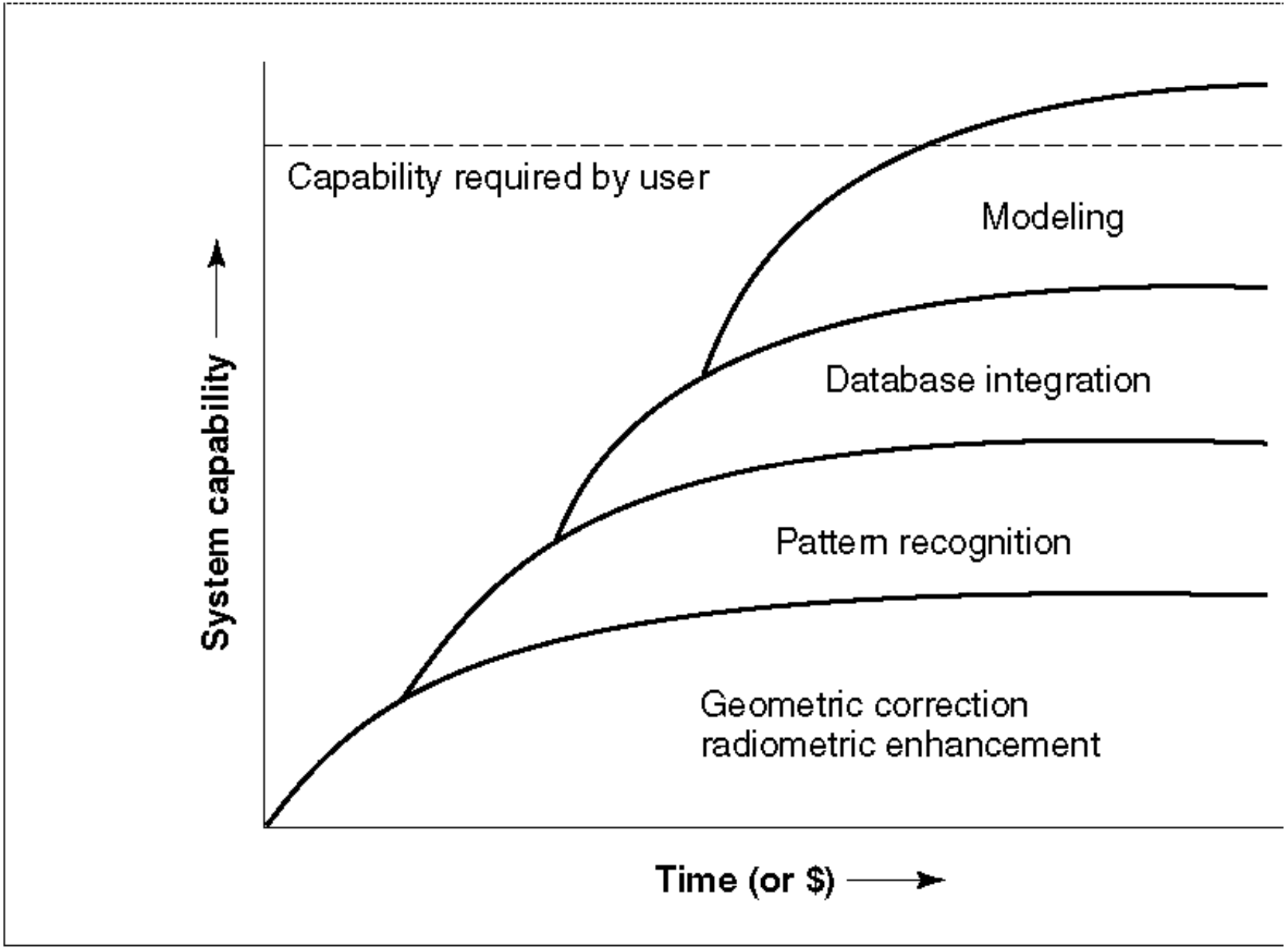
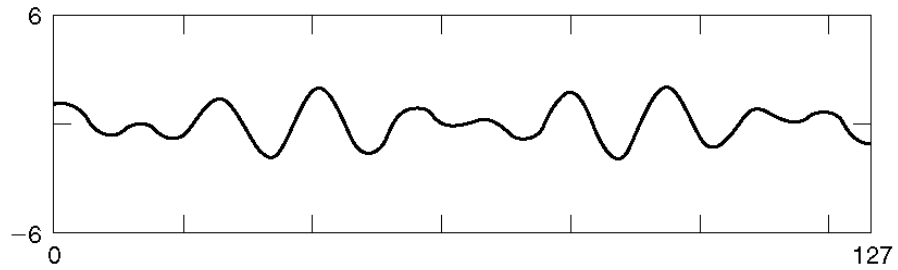


Figure 6.14 IMAGE PROCESSING DEVELOPMENT

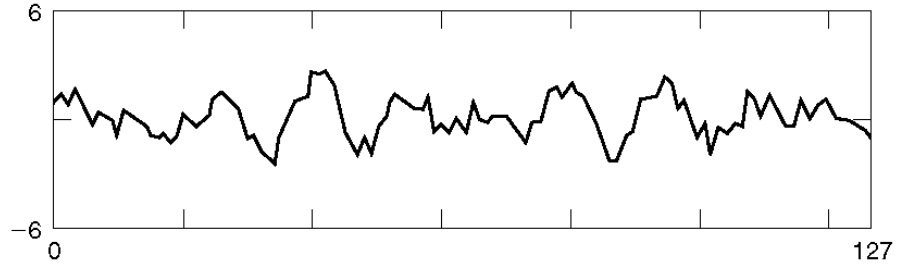


SOURCE: Marble and Peuquet (1988). Reprinted with permission.

Figure **6.15** FILTERING A NOISY SIGNAL WITH FOURIER TRANSFORM

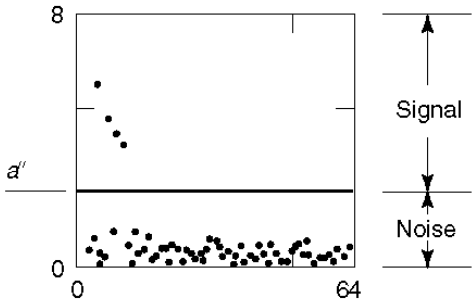


Add some noise:



Take its discrete fourier transform:

$a'' = 2.5$ …define threshold for spectral noise rejection.



Filter and take the inverse transform:

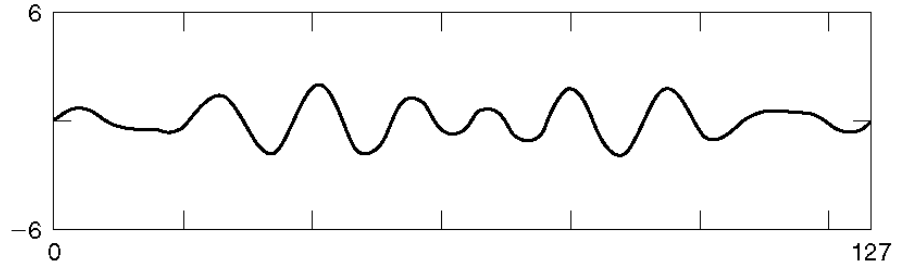


Figure 6.16 DISCRETE FOURIER TRANSFORM EXAMPLE

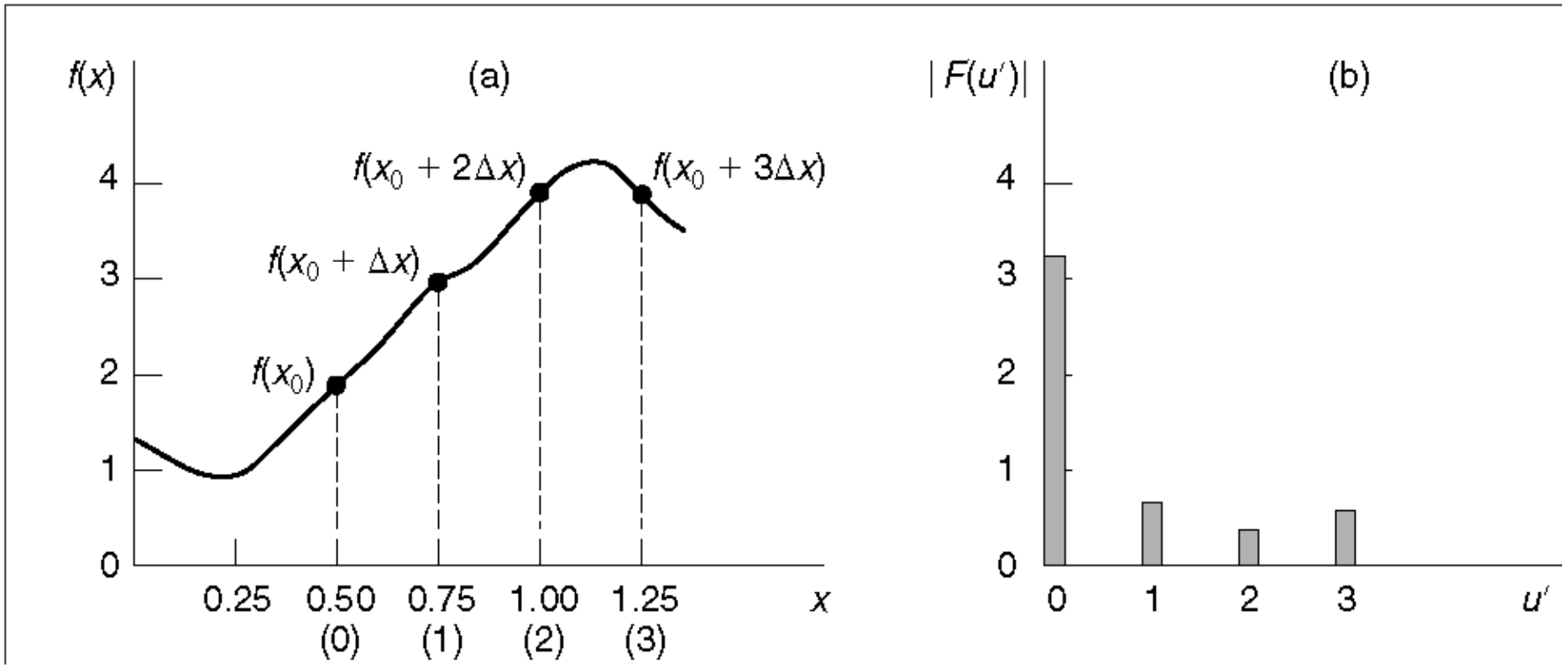
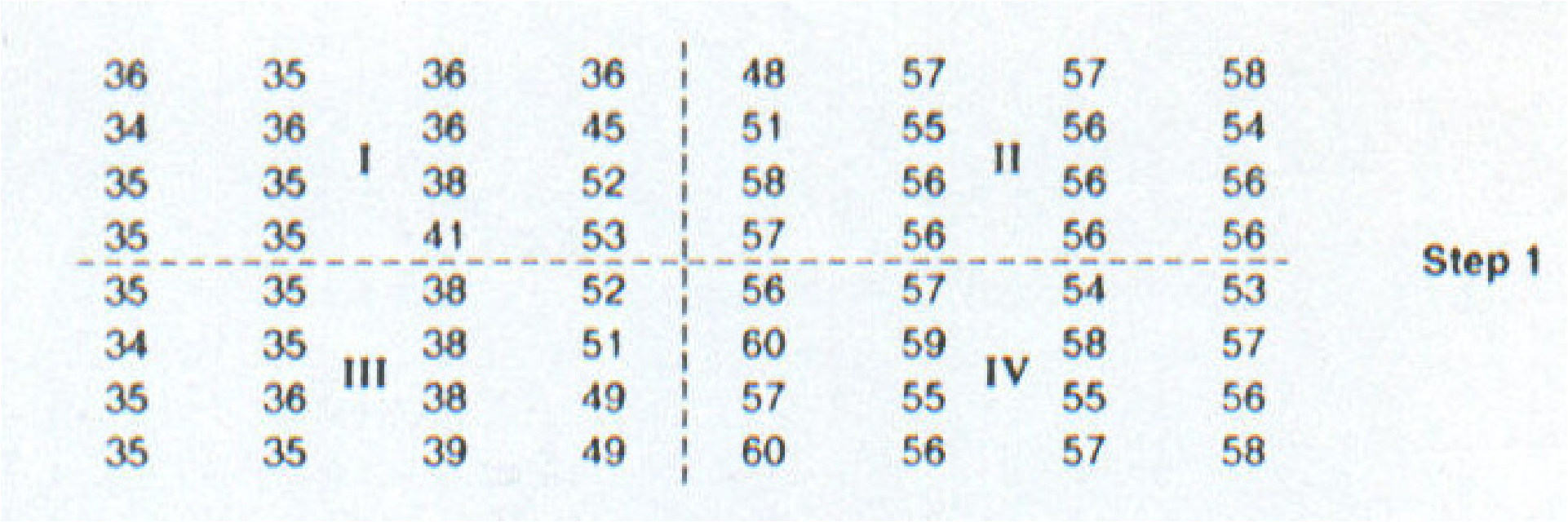
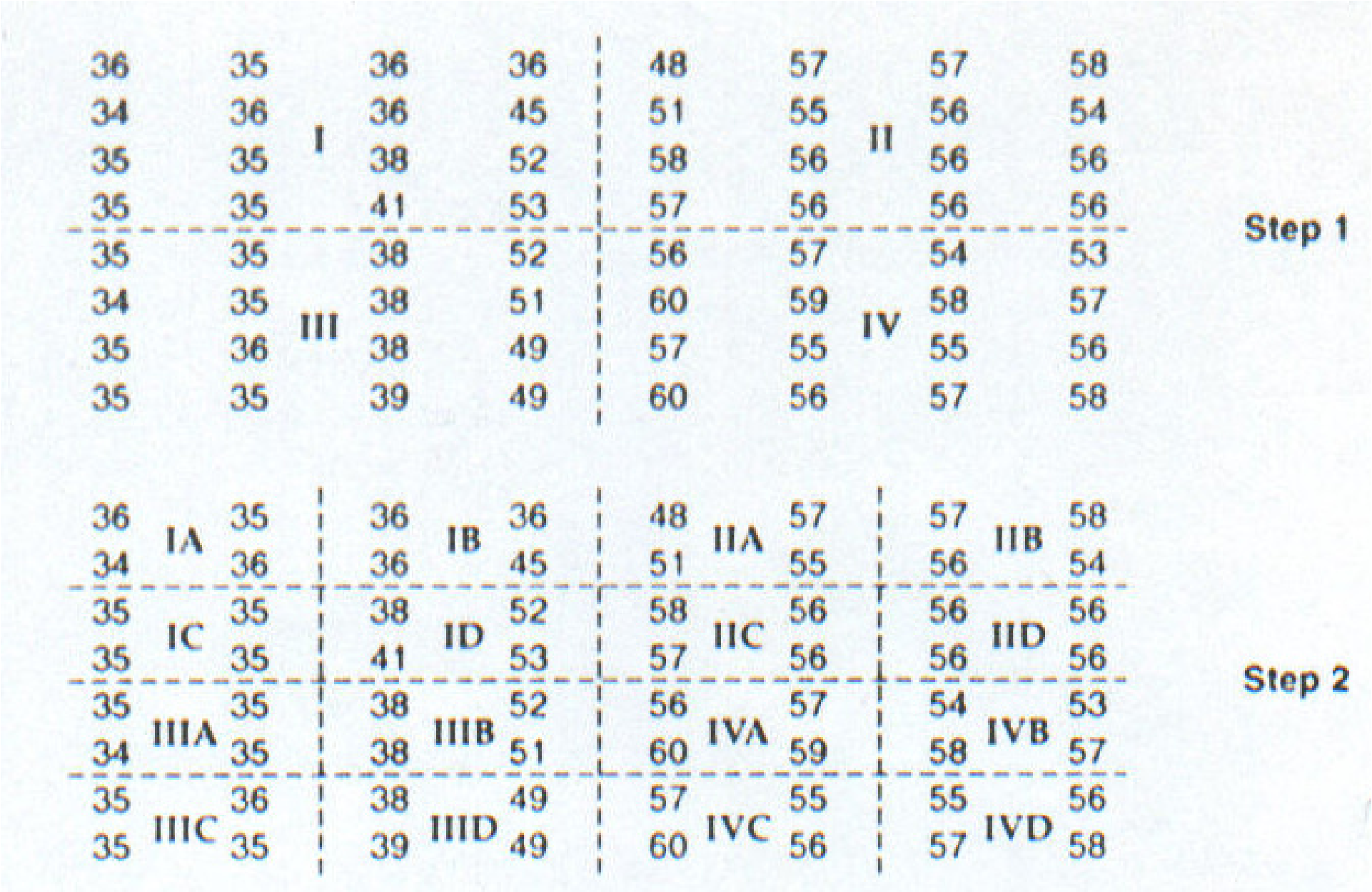


Figure 6.17 DISAGGREGATION AND AGGREGATION OF DIGITAL IMAGE

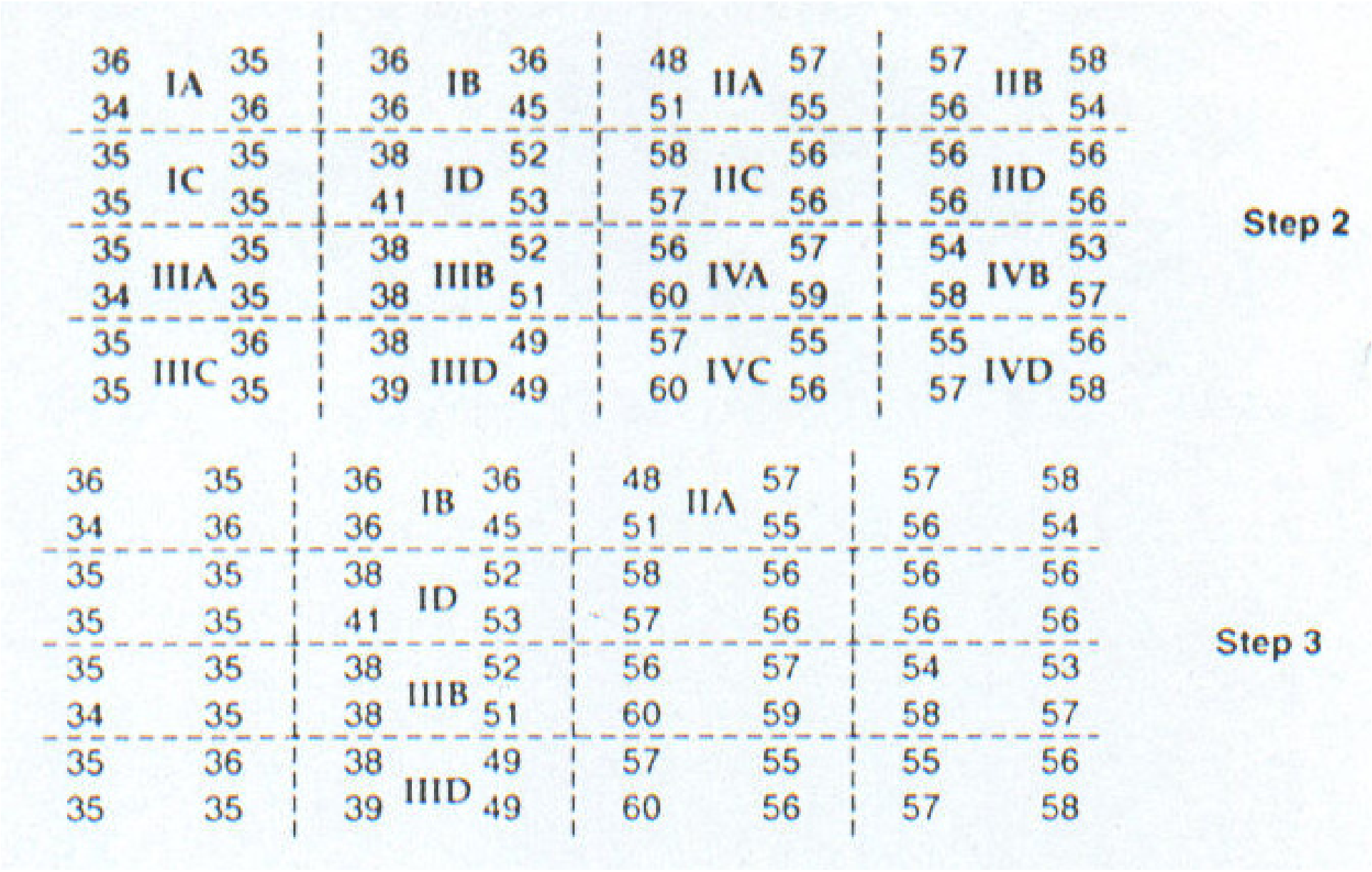
Steps 1


36 35 36 36
34 36 36 45
35 35 38 52
35 35 41 53
I
48 57 57 58
51 55 56 54
58 56 56 56
57 56 56 56
II
35 35 38 52
34 35 38 51
35 36 38 49
35 35 39 49
III
56 57 54 53
60 59 58 57
57 55 55 56
60 56 57 58
IV
Step 1

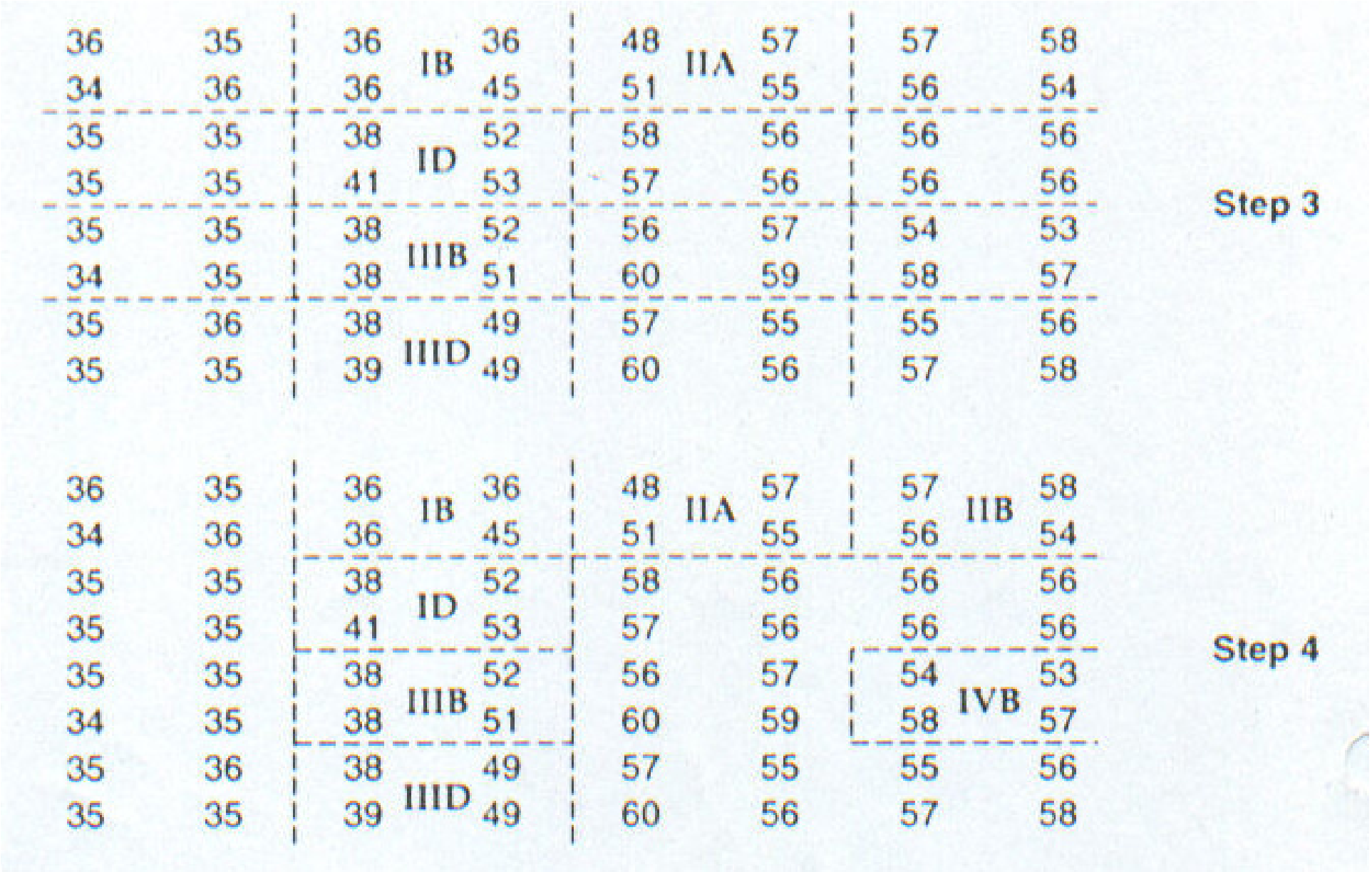
Step 2


36 35 36 36 48 57 57 58
34 36 I 36 45 51 55 II 56 54
35 35 38 52 58 56 56 56
35 35 41 53 57 56 56 56
Step 1
35 35 38 52 56 57 54 53
34 35 III 38 51 60 59 IV 58 57
35 36 38 49 57 55 55 56
35 35 39 49 60 56 57 58
36 IA 35 36 IB 36 48 IIA 57 57 IIB 58
34 36 36 45 51 55 56 54
35 IC 35 38 ID 52 58 IIC 56 56 IID 56
35 35 41 53 57 56 56 56
Step 2
35 35 38 52 56 57 54 53
34 IIIA 35 38 IIIB 51 60 IVA 59 58 IVB 57
35 36 38 49 57 55 55 56
35 IIIC 35 39 IIID 49 60 IVC 56 57 IVD 58

Step 3


36 35
34 36
IA
36 36
36 45
IB
48 57
51 55
IIA
57 58
56 54
IIB
35 35
35 35
IC
38 52
41 53
ID
58 56
57 56
IIC
56 56
56 56
IID
35 35
34 35
IIIA
38 52
38 51
IIIB
56 57
60 59
IVA
54 53
58 57
IVB
35 36
35 35
IIIC
38 49
39 49
IIID
57 55
60 56
IVC
55 56
57 58
IVD
Step 2
36 35
34 36
IB
36 36
36 45
48 57
51 55
IIA
57 58
56 54
35 35
35 35
ID
38 52
41 53
58 56
57 56
56 56
56 56
35 35
34 35
IIIB
38 52
38 51
56 57
60 59
54 53
58 57
35 36
35 35
IIID
38 49
39 49
57 55
60 56
55 56
57 58
Step 3

Step 4


36 35 36 IB 36 48 IIA 57 57 58
34 36 36 45 51 55 56 54
35 35 38 ID 52 58 56 56 56
35 35 41 53 57 56 56 56
35 35 38 IIIB 52 56 57 54 53
34 35 38 51 60 59 58 57
35 36 38 IIID 49 57 55 55 56
35 35 39 49 60 56 57 58
Step 3
36 35 36 IB 36 48 IIA 57 57 IIB 58
34 36 36 45 51 55 56 54
35 35 38 ID 52 58 56 56 56
35 35 41 53 57 56 56 56
35 35 38 IIIB 52 56 57 54 IVB 53
34 35 38 51 60 59 58 57
35 36 38 IIID 49 57 55 55 56
35 35 39 49 60 56 57 58
Step 4

Summary

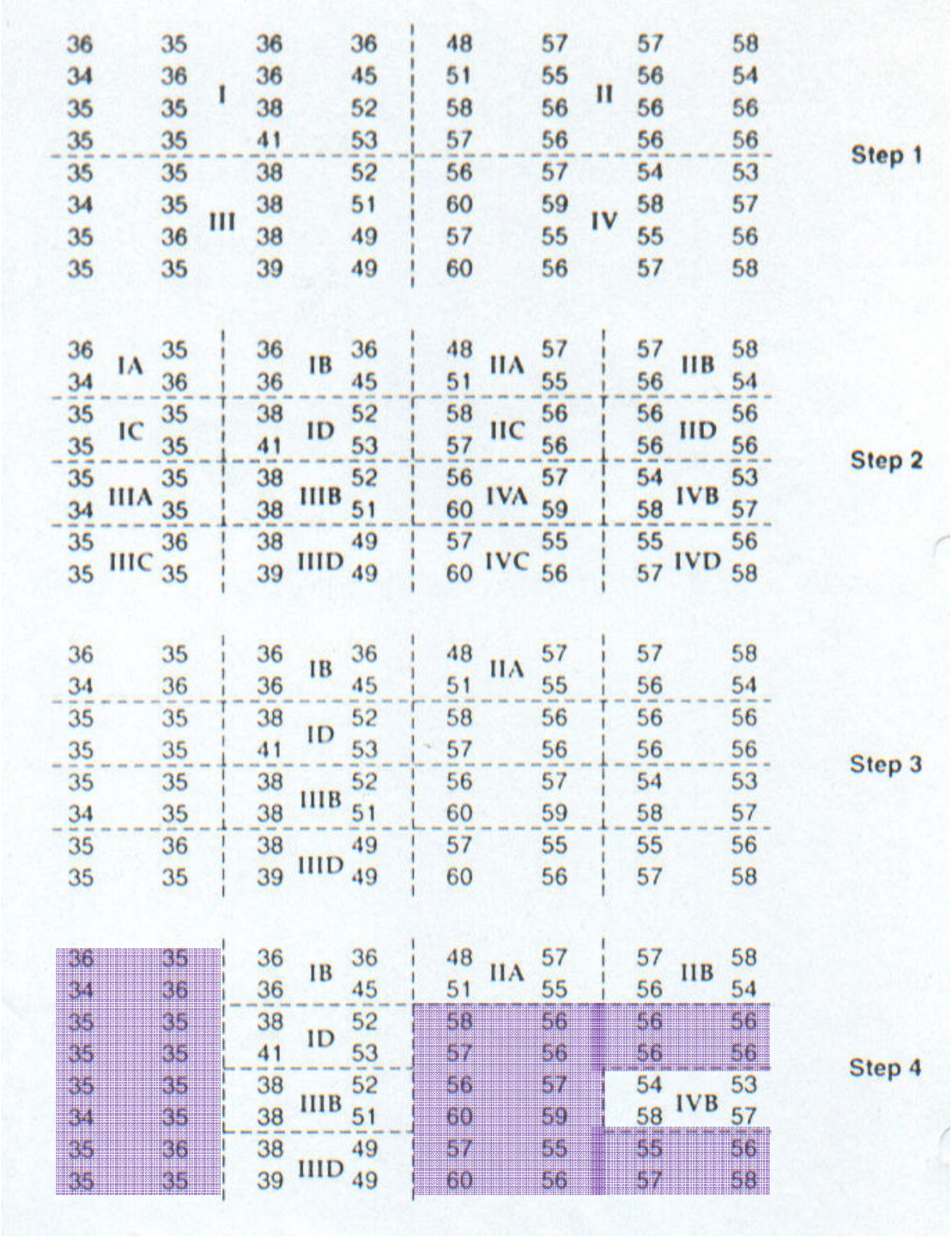
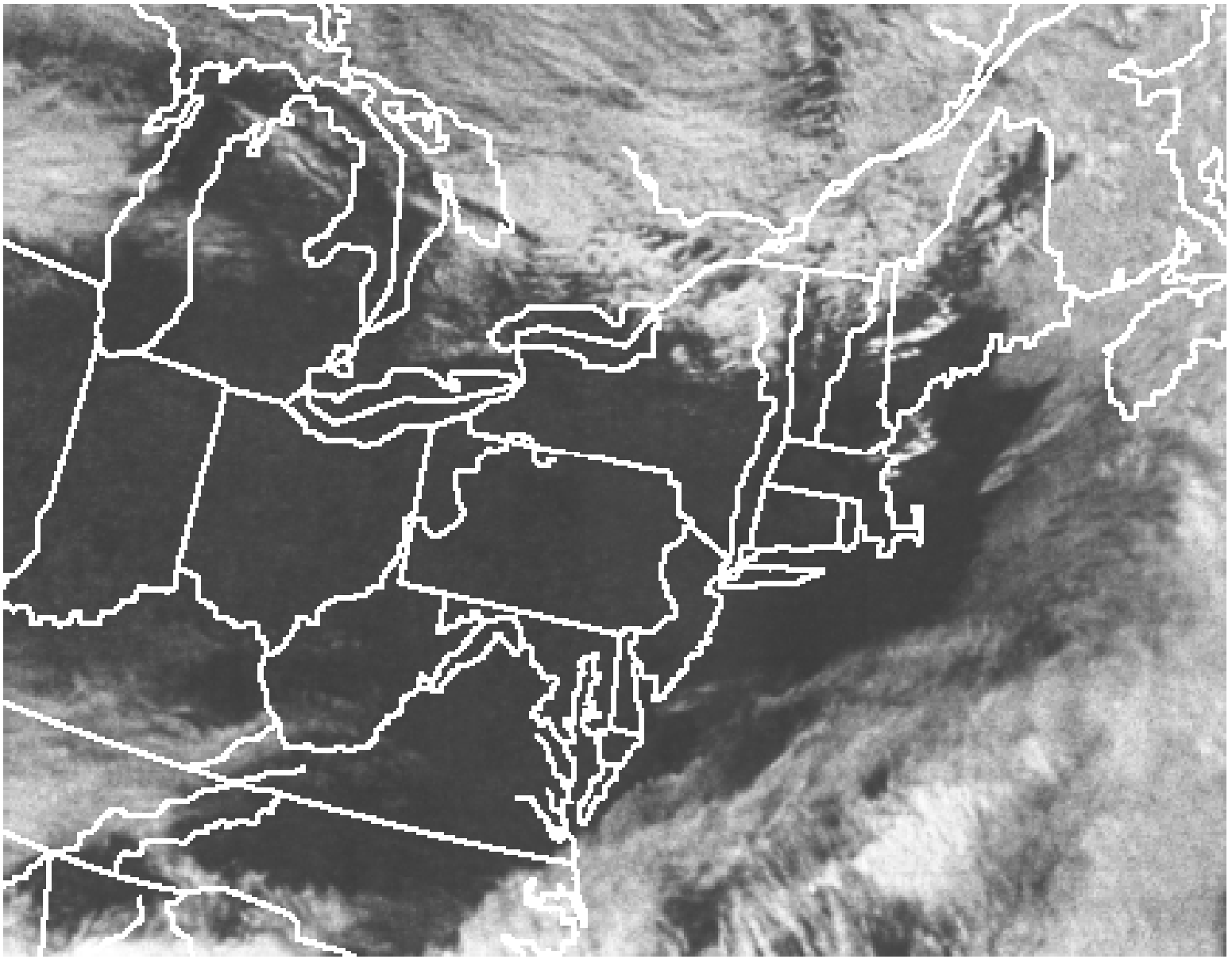
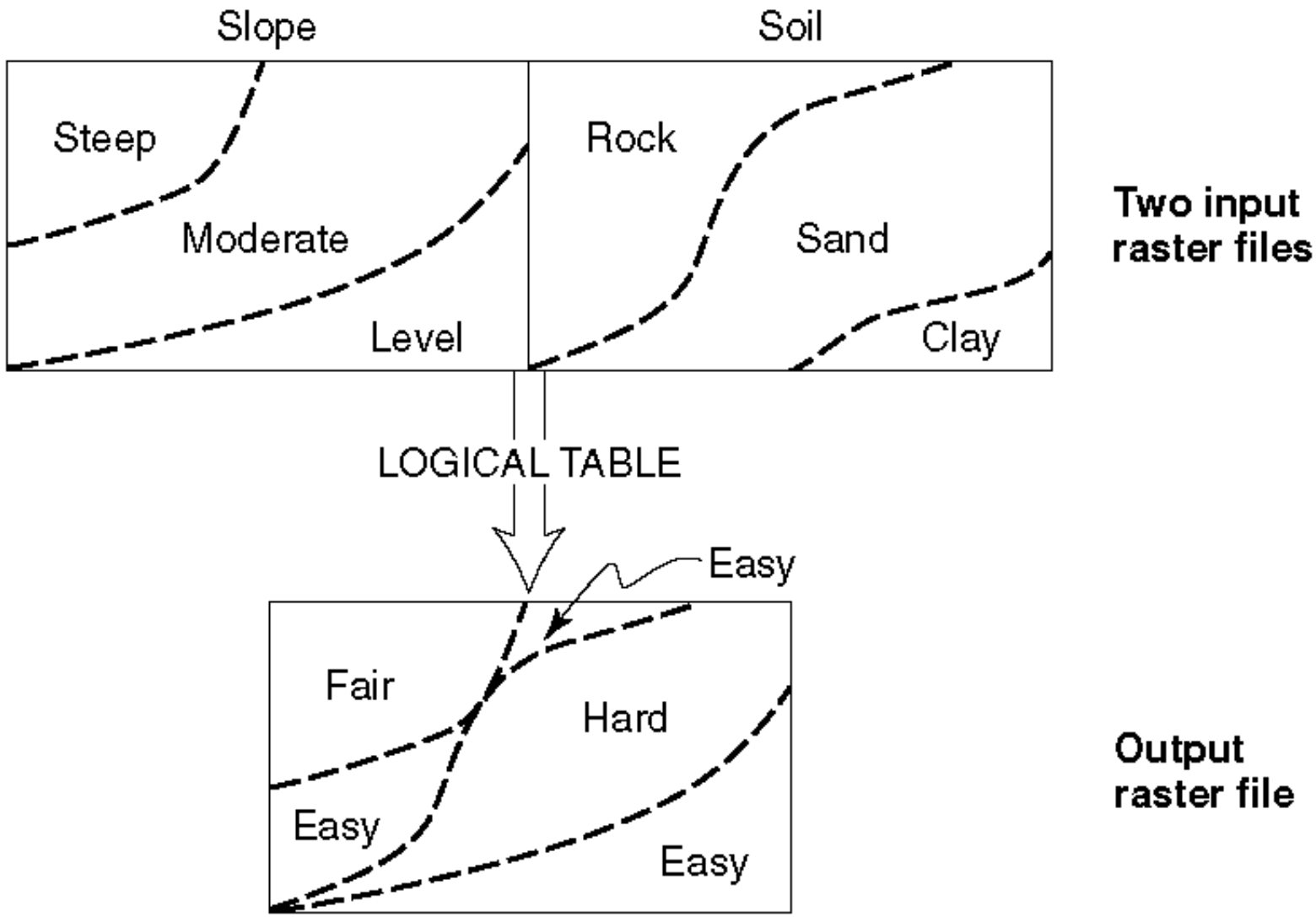

I
II
III
IV
IA
IB
IIA
IIB
IC
ID
IIC
IID
IIIA
IIIB
IVA
IVB
IIIC
IIID
IVC
IVD
Step 1
Step 2
Step 3
Step 4

Figure 6.18 OVERLAY OF JURISDICTIONAL AND NATURAL BOUNDARIES ON WEATHER INFORMATION



SOURCE: Courtesy of T.S. Kelso. Reprinted with permission.

Figure **6.19** A TRAFFICABILITY EXAMPLE OF DATA MERGING



SOURCE: Star and Estes (1990). Reprinted with permission.

Table 6.3 INPUT DATA LAYER REGARDING TRAFFICABILITY

		Soil type		
		Rock	**Sand**	**Clay**
Slope	**Level**	Easy	Easy	Easy
	Moderate	Easy	Hard	Fair
	Steep	Fair	Hard	Hard

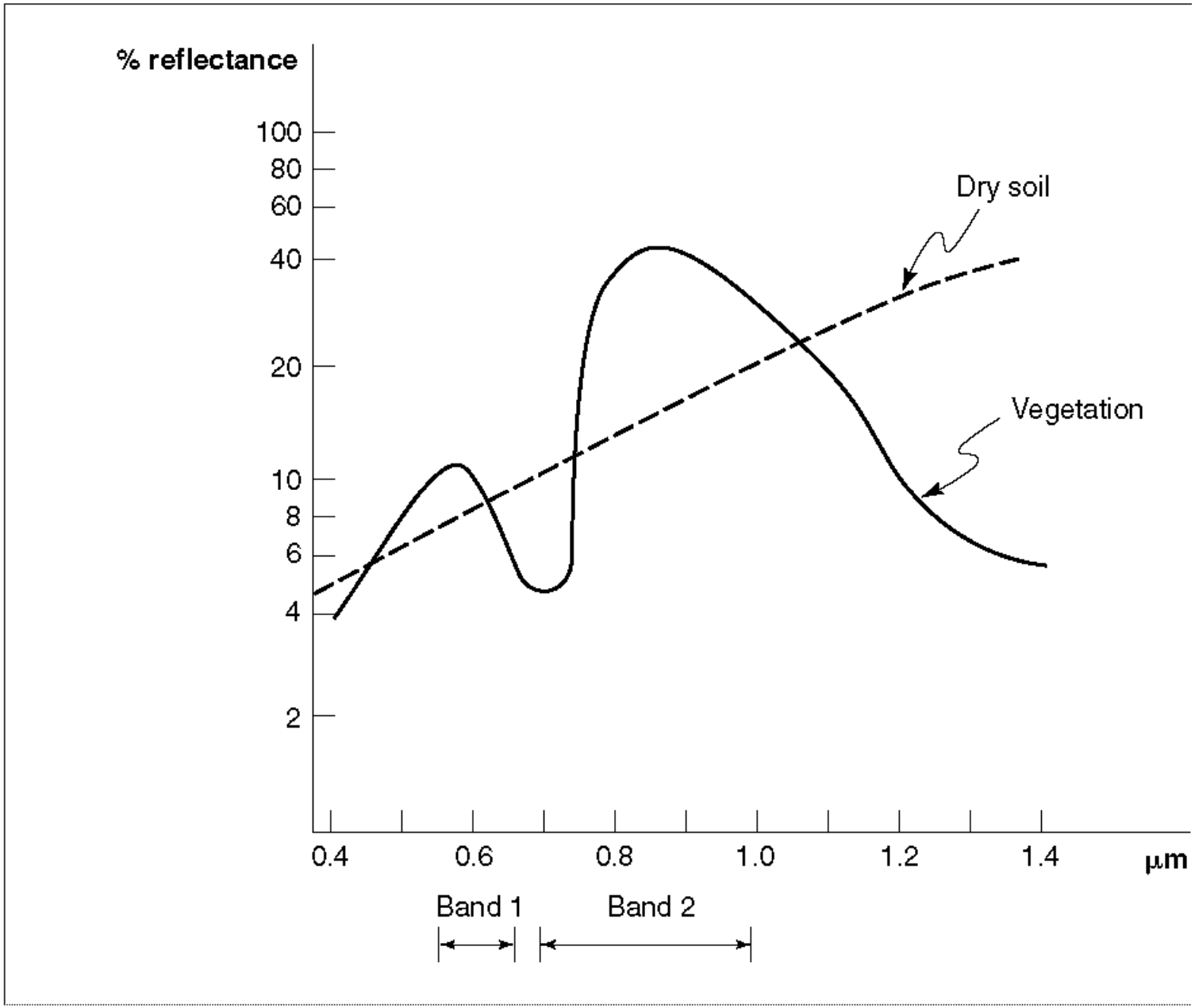
SOURCE: Star and Estes (1990). Reprinted with permission.

Table 6.4 REMOTE SENSING CHARACTERISTICS OF THE ADVANCED VERY HIGH RESOLUTION RADIOMETER

Band	Wavelength, μm	Remarks
1	0.55–0.68	Red: for daytime clouds and vegetation
2	0.73–1.10	Reflected IR: for shorelines and vegetation
3	3.55–3.93	Thermal IR: for hot targets such as fires and volcanoes
4	10.50–11.50	Thermal IR: for sea temperatures and for daytime and nighttime clouds
5	11.50–12.50	Thermal IR: recorded only on NOAA 7 satellites & beyond

SOURCE: Sabins (1987). Reprinted with permission.

Figure 6.21 REFLECTANCE SPECTRA OF VEGETATION AND DRY SOIL



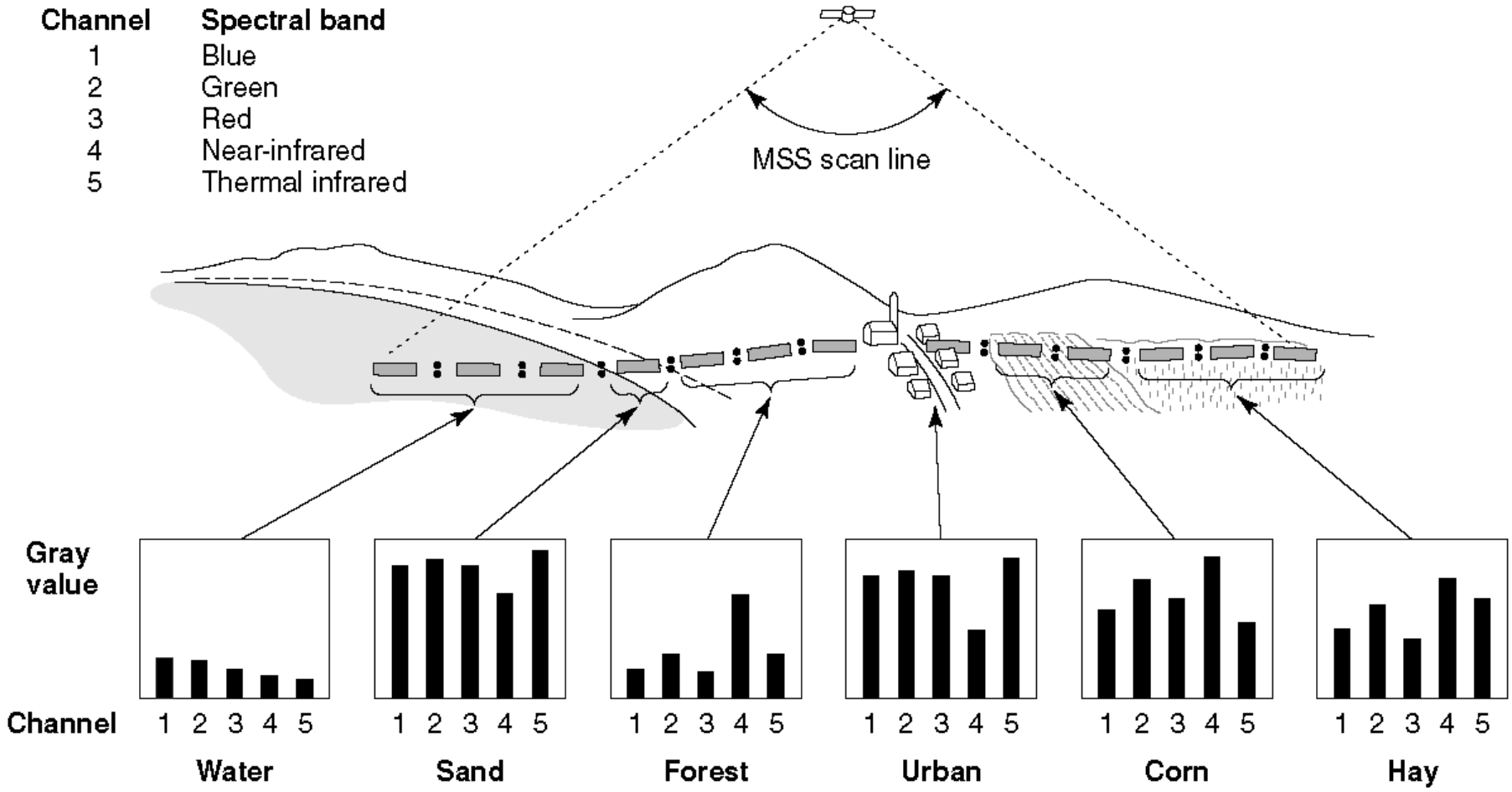
SOURCE: Sabins (1987). Reprinted with permission.

Table 6.5 MULTILEVEL CLASSIFICATION OF IMAGES

Level	System	Image Scale
I	Landsat MSS images	1:250,000 and smaller
II	Landsat TM images and high-altitude aerial photographs	1:80,000 and smaller
III	Medium altitude aerial photographs	1:20,000 to 1:80,000
IV	Low altitude aerial photographs	Larger than 1:20,000

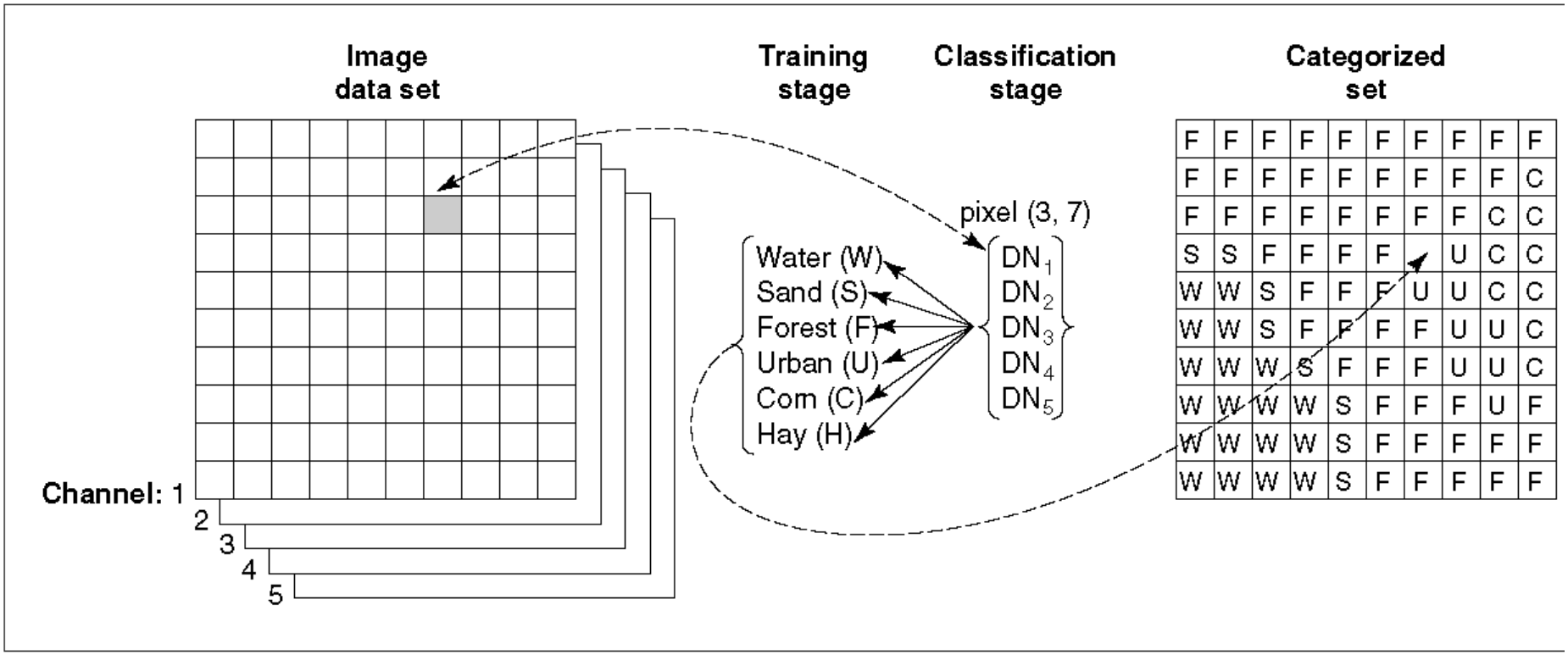
SOURCE: Anderson et al. (1976). Reprinted with permission.

Figure 6.21 MEASUREMENTS MADE ALONG ONE SCAN LINE



SOURCE: Lillesand and Kiefer (1987). Reprinted with permission.

Figure **6.22** BASIC STEPS IN SUPERVISED CLASSIFICATION



SOURCE: Lillesand and Kiefer (1987). Reprinted with permission.

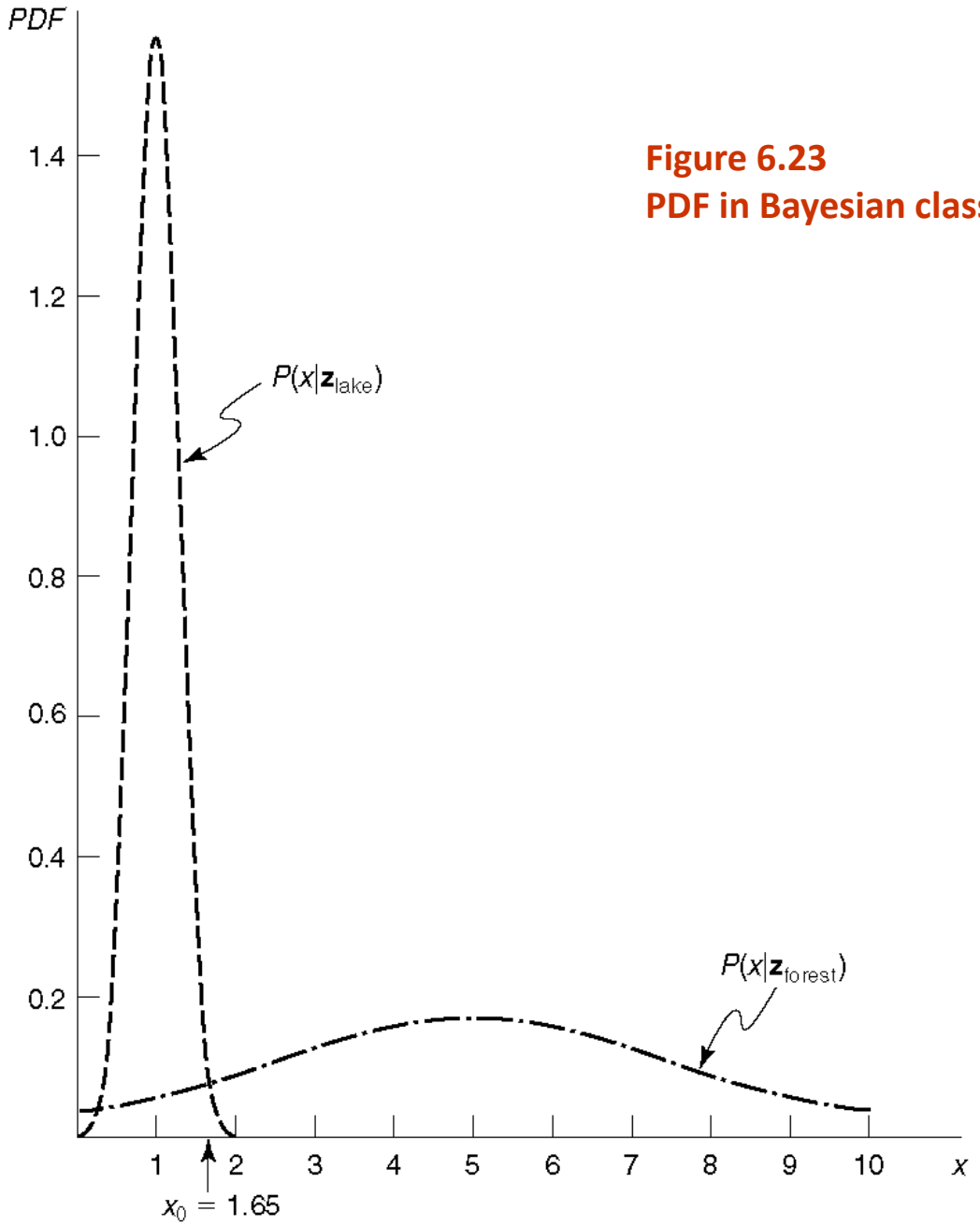
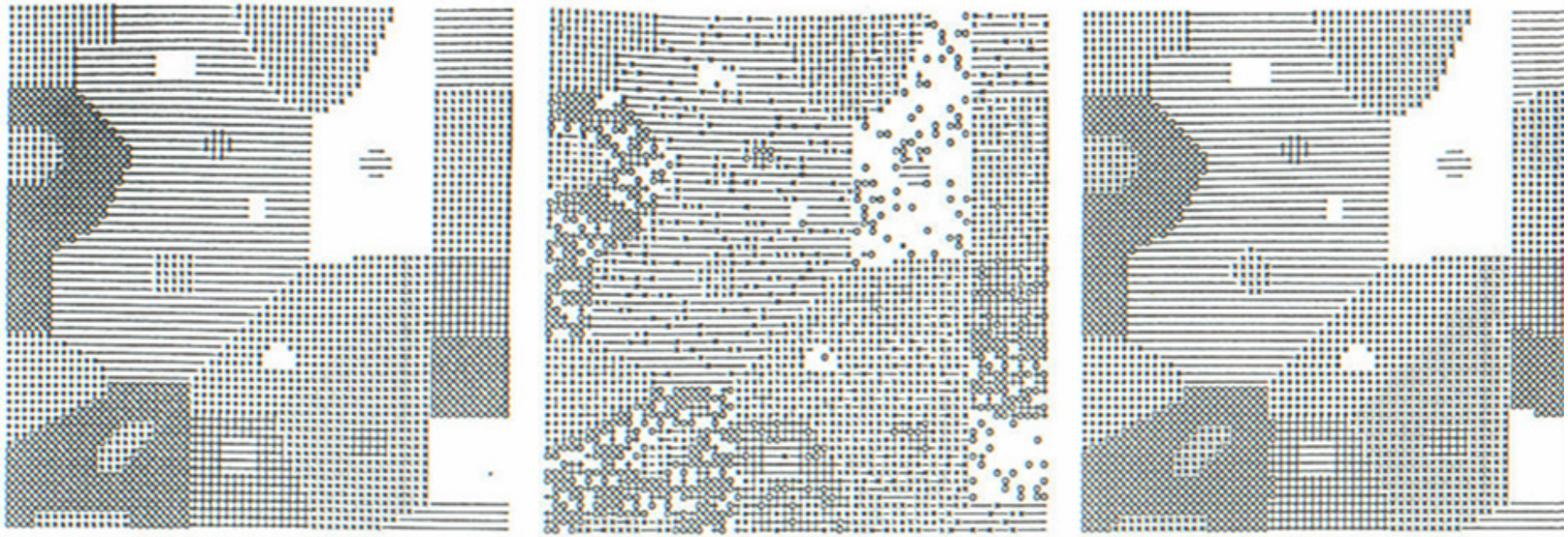


Figure 6.23
PDF in Bayesian classifier

Figure 6.24 Contextual vs. non-contextual image classification

(a) (b) (c)



Legend

(a) True color scene

(b) Non-contextual classification

(c) Contextual classification

Figure 6.25 A NONINFERIOR SOLUTION SHOWING A SINGLE SUBREGION

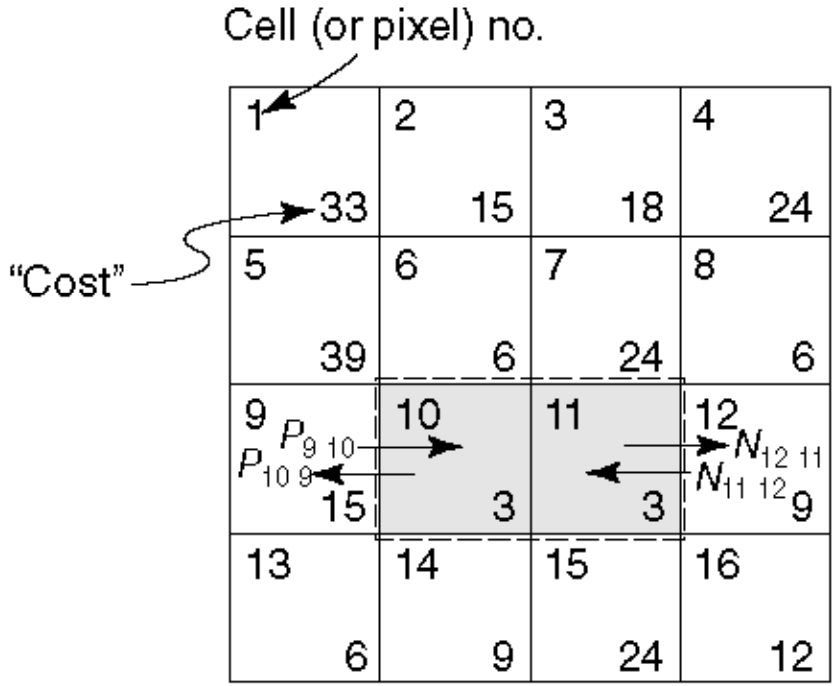


Figure 6.26(a) Multicriteria-optimization model formulation

```
. . OBJECTIVE MINIMIZE
1 ( 33 [ [ x1] ] + 15 [ [ x2] ] + 18 [ [ x3] ] + 24 [ [ x4] ] +
39 [ [ x5] ] + 6 [ [ x6] ] + 24 [ [ x7] ] + 6 [ [ x8] ] +
15 [ [ x9] ] + 3 [ [ x10] ] + 3 [ [ x11] ] + 9 [ [ x12] ] +
6 [ [ x13] ] + 9 [ [ x14] ] + 24 [ [ x15] ] + 12 [ [ x16] ] )
```

Figure 6.26(b) Multicriteria-optimization model formulation

```
. . OBJECTIVE MINIMIZE
1 ( 33 [ [ x1] ] + 15 [ [ x2] ] + 18 [ [ x3] ] + 24 [ [ x4] ] +
39 [ [ x5] ] + 6 [ [ x6] ] + 24 [ [ x7] ] + 6 [ [ x8] ] +
15 [ [ x9] ] + 3 [ [ x10] ] + 3 [ [ x11] ] + 9 [ [ x12] ] +
6 [ [ x13] ] + 9 [ [ x14] ] + 24 [ [ x15] ] + 12 [ [ x16] ] )
CONSTRAINTS
*constraint for sum (Xj) = M
x1 + x2 + x3 + x4 + x5 + x6 + x7 + x8 + x9 + x10 + x11 + x12 +
x13 + x14 + x15 + x16 = 2
```

Figure 6.26(c) Multicriteria-optimization model formulation

```
. . OBJECTIVE MINIMIZE
1 ( 33 [ [ x1] ] + 15 [ [ x2] ] + 18 [ [ x3] ] + 24 [ [ x4] ] +
39 [ [ x5] ] + 6 [ [ x6] ] + 24 [ [ x7] ] + 6 [ [ x8] ] +
15 [ [ x9] ] + 3 [ [ x10] ] + 3 [ [ x11] ] + 9 [ [ x12] ] +
6 [ [ x13] ] + 9 [ [ x14] ] + 24 [ [ x15] ] + 12 [ [ x16] ] )
CONSTRAINTS
*constraint for sum (Xj) = M
x1 + x2 + x3 + x4 + x5 + x6 + x7 + x8 + x9 + x10 + x11 + x12 +
x13 + x14 + x15 + x16 = 2
*constraint for Xi - Xj - Pij + Nij = 0
x1 - x2 - p12 + n12 = 0
x1 - x5 - p15 + n15 = 0
x2 - x1 - p21 + n21 = 0
x2 - x3 - p23 + n23 = 0
x2 - x6 - p26 + n26 = 0
x3 - x2 - p32 + n32 = 0
```

Figure 6.26(d) Multicriteria-optimization model formulation

*constraint for sum ($P_i + N_i$) = L

p12 + n12 + p15 + n15 +
p21 + n21 + p23 + n23 + p26 + n26 +
p32 + n32 + p34 + n34 + p37 + n37 +
p43 + n43 + p48 + n48 +
p51 + n51 + p56 + n56 + p59 + n59 +
p62 + n62 + p65 + n65 + p67 + n67 + p610 + n610 +
p73 + n73 + p76 + n76 + p78 + n78 + p711 + n711 +
p84 + n84 + p87 + n87 + p812 + n812 +
p95 + n95 + p910 + n910 + p913 + n913 +
p106 + n106 + p109 + n109 + p1011 + n1011 + p1014 + n1014 +
p117 + n117 + p1110 + n1110 + p1112 + n1112 + p1115 + n1115 +
p128 + n128 + p1211 + n1211 + p1216 + n1216 +
p139 + n139 + p1314 + n1314 +
p1410 + n1410 + p1413 + n1413 + p1415 + n1415 +
p1511 + n1511 + p1514 + n1514 + p1516 + n1516 +
p1612 + n1612 + p1615 + n1615 = 12

Figure 6.27 Multiple subregion noninferior solutions

File[1]	M_1	L_1	Cost	Cells	M_2	L_2	Cost	Cells	Total Cost
S2_1_1	1	4	1	8	1	4	1	9	2

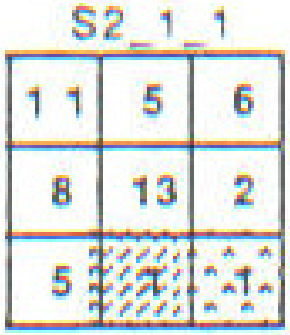
[1]Take the first entry under this column, S2 stands for 2 subregions, 1 stands for an area of 1 pixel for subregion 1 and the last 1, stands for an area of 1 pixel for subregion 2 also.

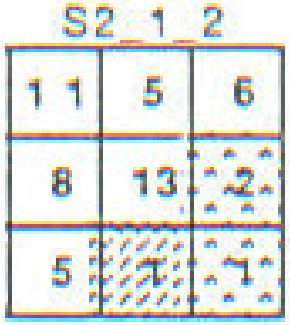
Figure 6.27A Multiple subregion noninferior solutions

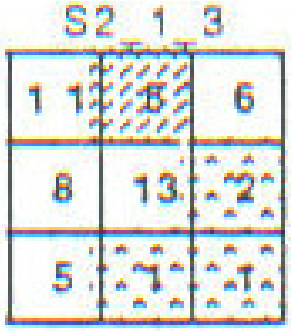
File[1]	M_1	L_1	Cost	Cells	M_2	L_2	Cost	Cells	Total Cost
S2_1_1	1	4	1	8	1	4	1	9	2
S2_1_2	1	4	1	8	2	6	3	6, 9	4
S2_1_3	1	4	5	2	3	8	4	6, 8, 9	9
S2_1_4a	1	4	5	2	4	8	17	5, 6, 8, 9	22
S2_1_4b	1	4	5	2	4	10	9	6, 7, 8, 9	14

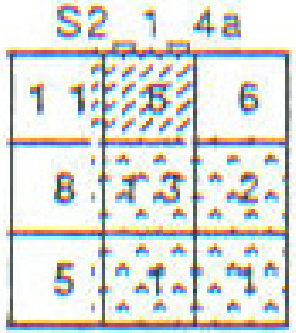
[1]Take the first entry under this column, S2 stands for 2 subregions, 1 stands for an area of 1 pixel for subregion 1 and the last 1, stands for an area of 1 pixel for subregion 2 also. The a and b entries specify two different variations on the boundary of the subregion in generating noninferior solutions.

Figure 6.28 Multiple subregion allocation results









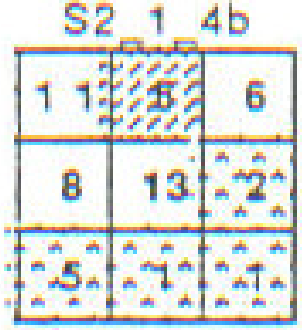
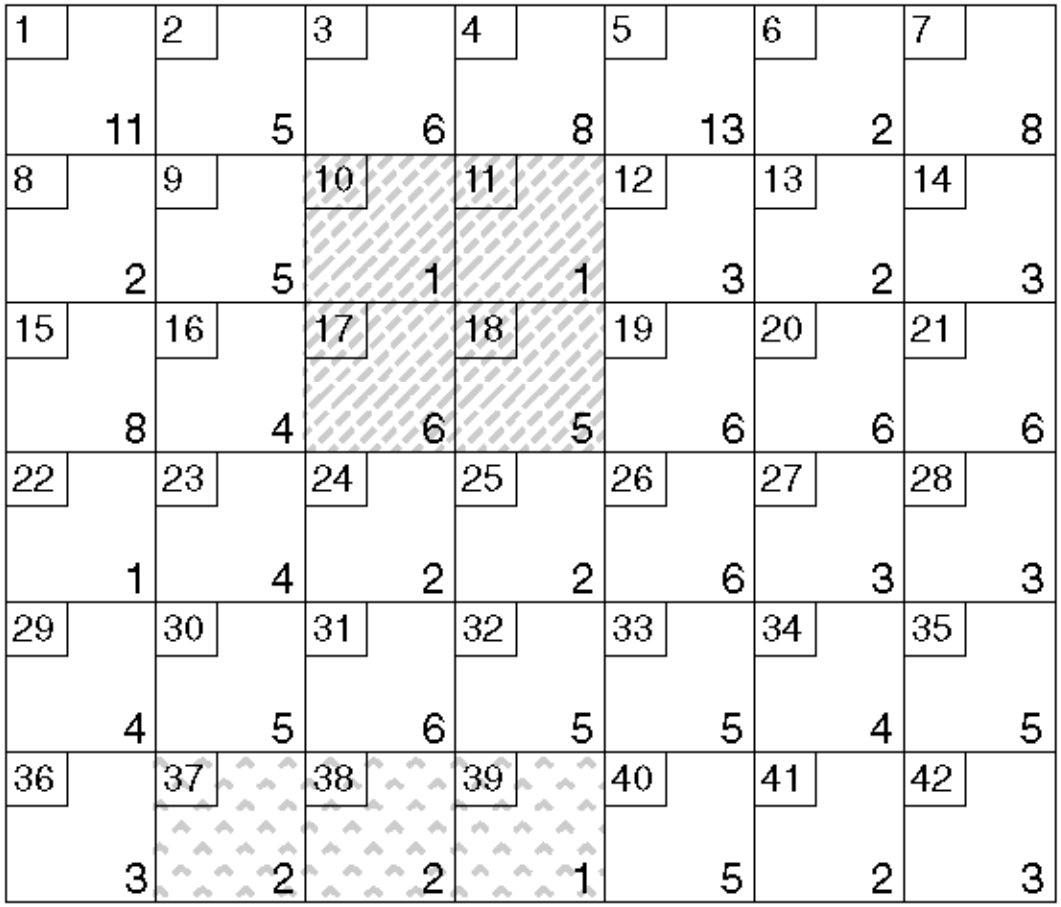


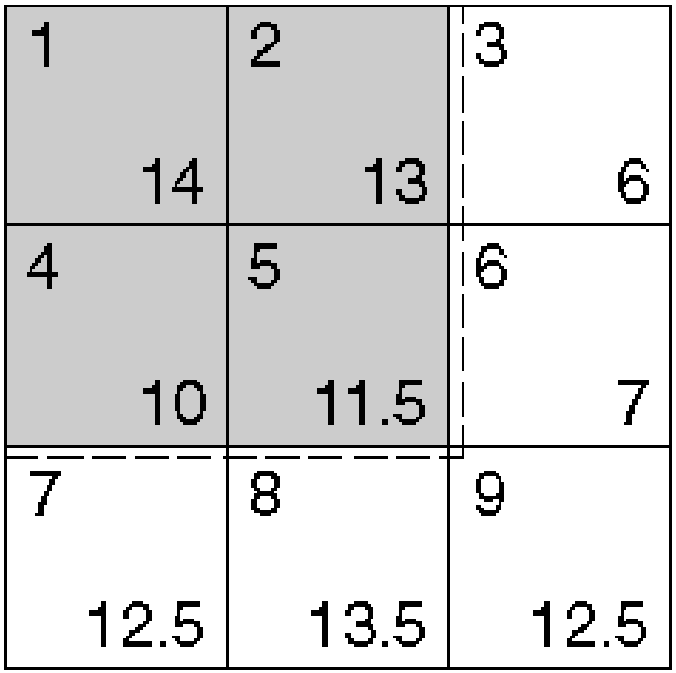
Figure 6.29 MULTIPLE SUBREGION MODEL WITH SHAPE SPECIFICATIONS



Total cost = 18

Subregion	Cost
	5
	13

Figure 6.30 DISTRICTING FOR DEMAND EQUITY



SOURCE: Ahituv and Berman (1988). Reprinted with permission.

Figure 6.31 A split subregion at the border

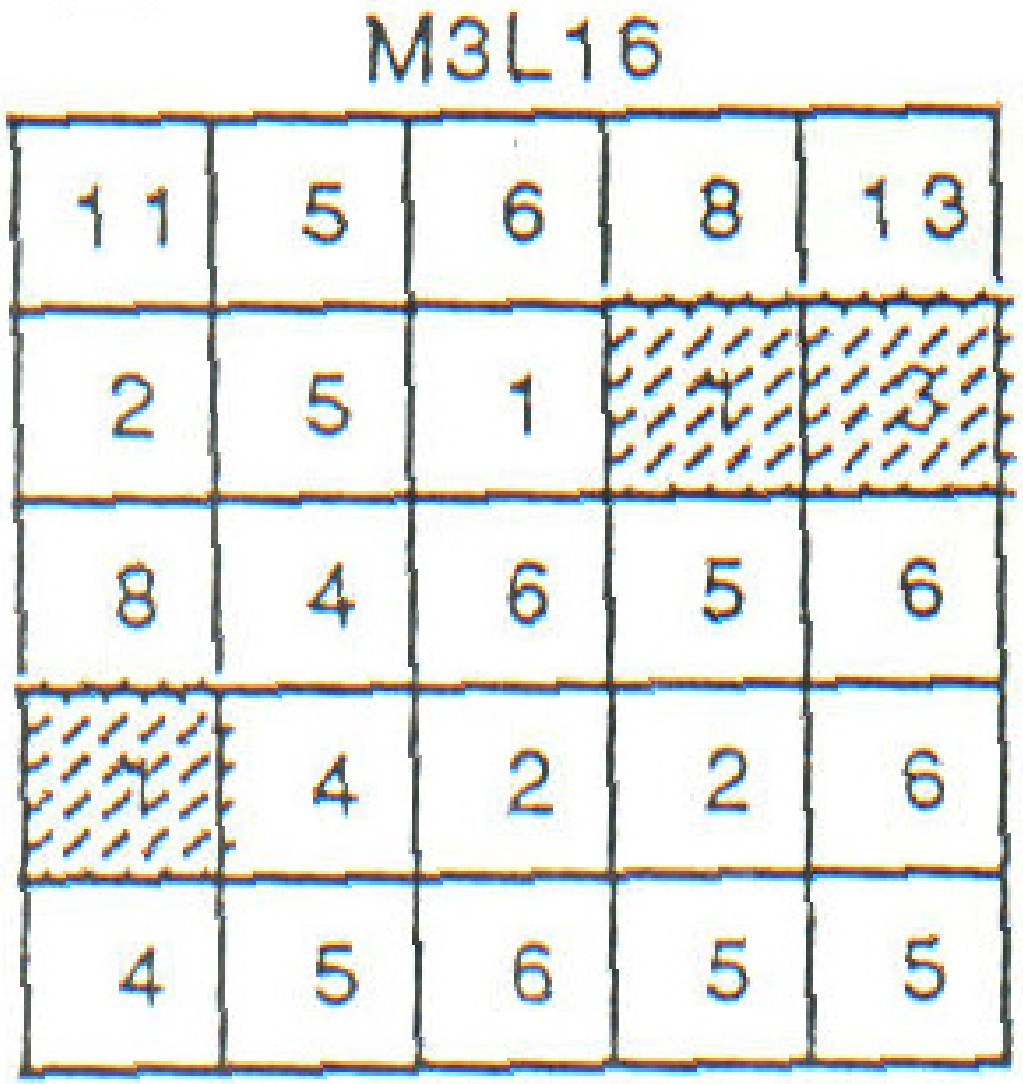
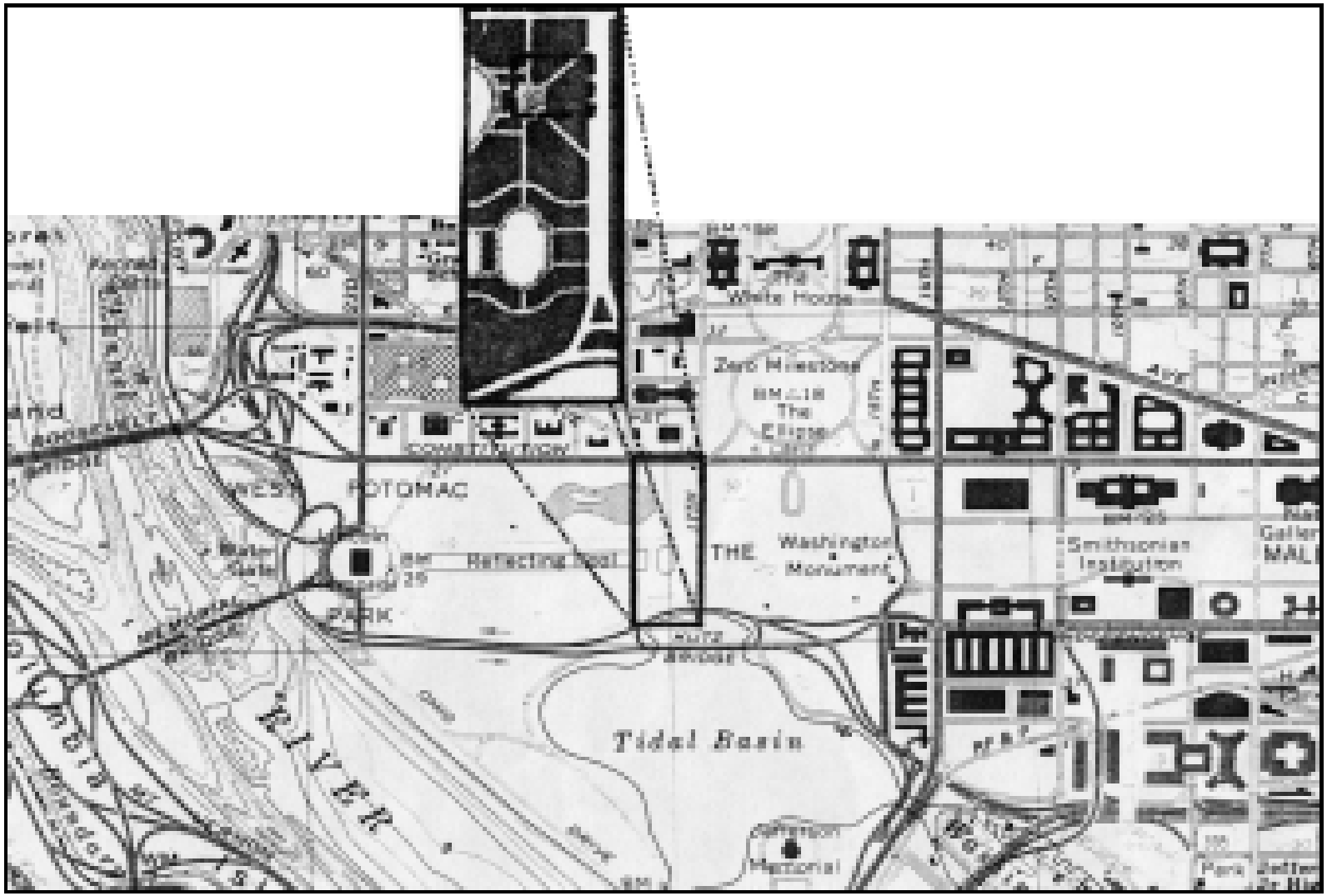


Figure 6.32 PORTION OF WASHINGTON D.C. MALL UNDER ANALYSIS



Note: ▭ represents an area for further analysis in the 'Spatial-Temporal Information' chapter in Chan (2005)

SOURCE: U.S. Geological Survey (1983). Reprinted with permission.

Figure 6.33 SPOT sub-image gray values

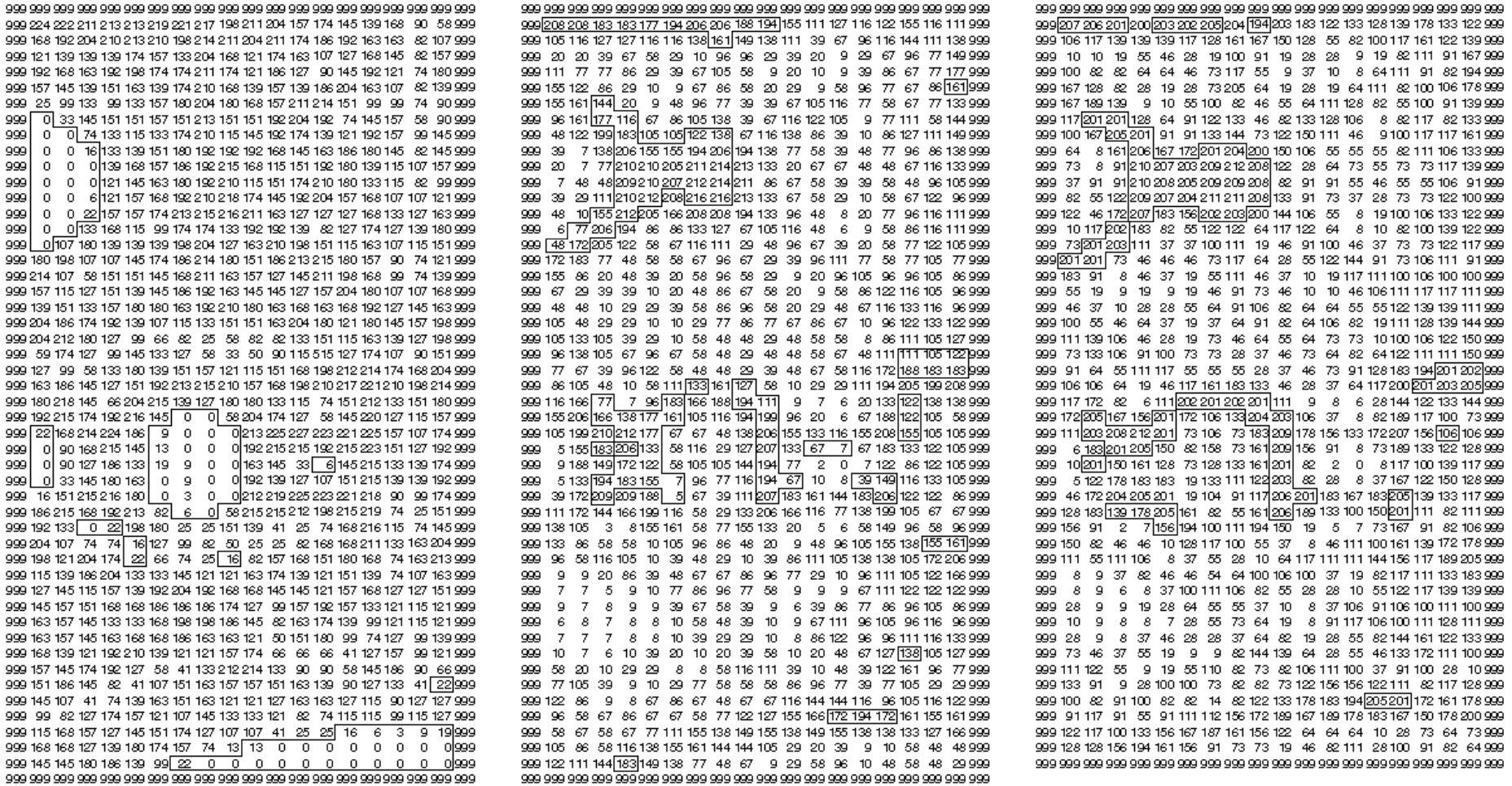
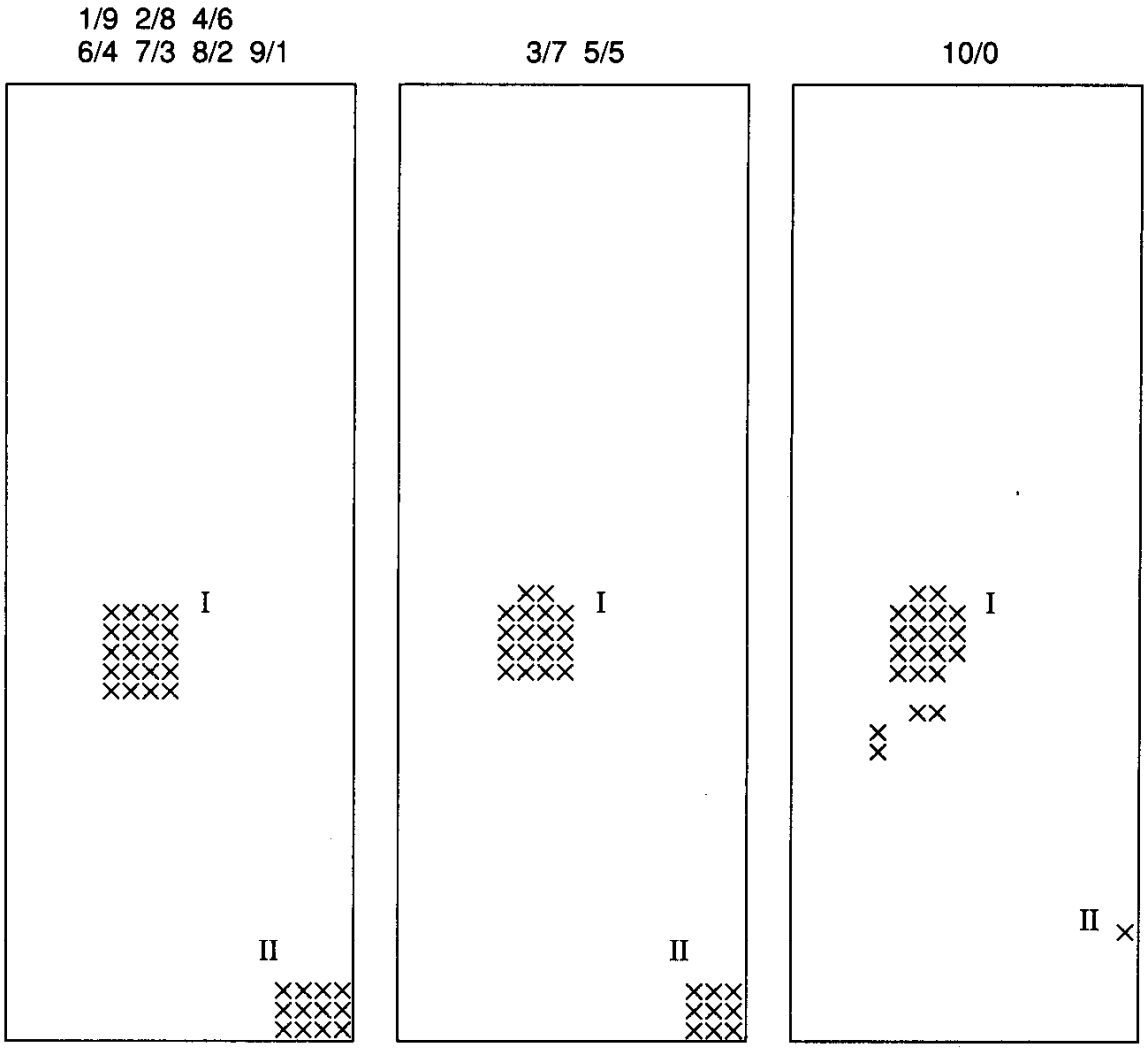


Table 6.6 CLASSIFICATION OF WATER IN CHANNEL 1

Gray value	Pixel count		Classification accuracy (%)
	Water areas	Total	
0	57	58	98
3	2	2	100
6	3	4	75
9	4	4	100
13	2	2	100
16	3	5	60
19	2	2	100
22	3	6	50

SOURCE: Amrine (1992). Reprinted with permission.

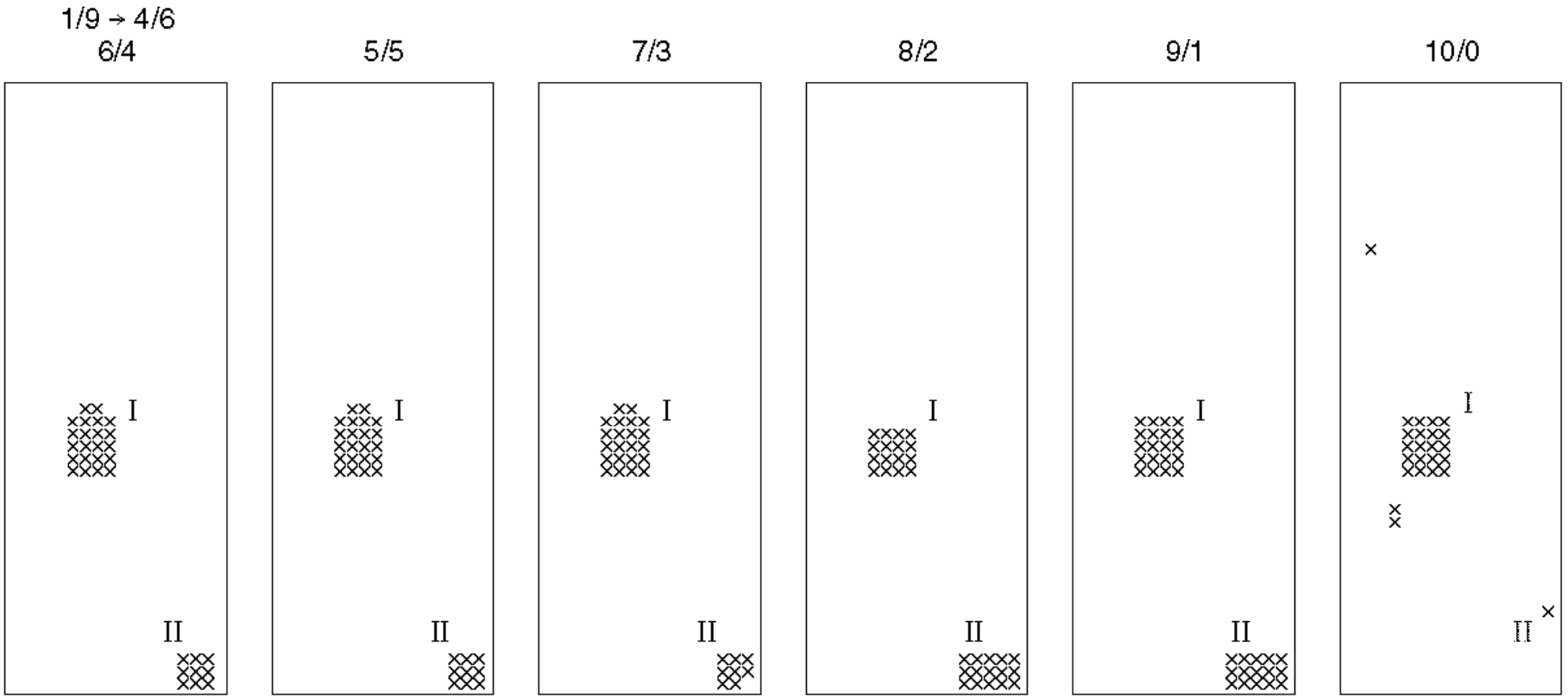
Figure 6.34 Runs for area ≥ 24 & border length ≤ 64



Legend

A/B = Weight on channel-1 pixels/weight on channel-3 pixels
Subregion I = Reflecting Pool
Subregion II = Tidal Basin

Figure **6.35** RESULTS OF RUNS FOR AREA ≥ 26 AND BORDER LENGTH ≤ 64



Legend

A/*B* = Weight on channel-1 pixels/weight on channel-3 pixels
Subregion I = Reflecting Pool
Subregion II = Tidal Basin