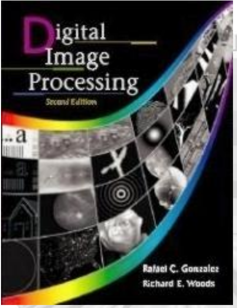
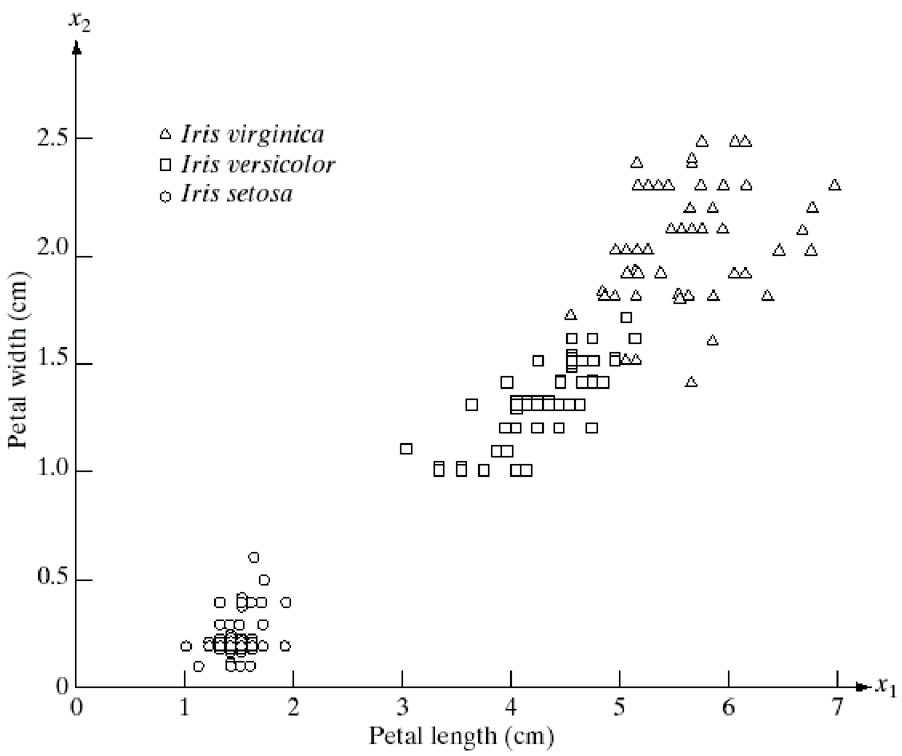
Object and Pattern Recognition/Machine Learning

Lecture 9

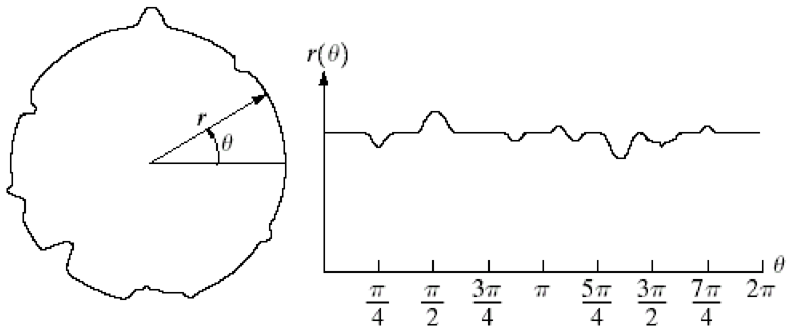


Object Recognition

FIGURE 12.1 Three types of iris flowers described by two measurements.



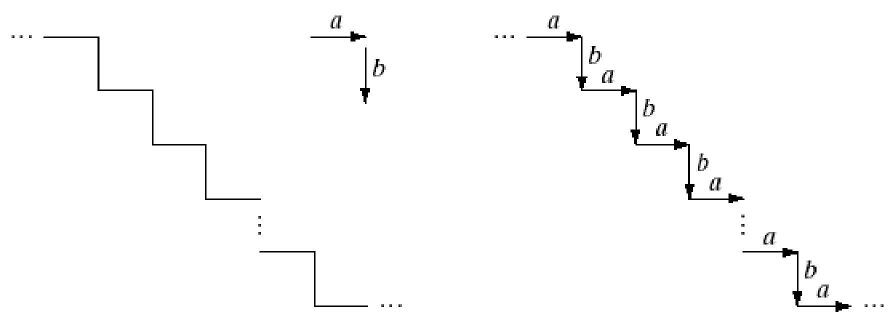
Object Recognition



a b

FIGURE 12.2 A noisy object and its corresponding signature.

Object Recognition



a b

FIGURE 12.3 (a) Staircase structure. (b) Structure coded in terms of the primitives *a* and *b* to yield the string description . . . *ababab* . . . .

Object Recognition

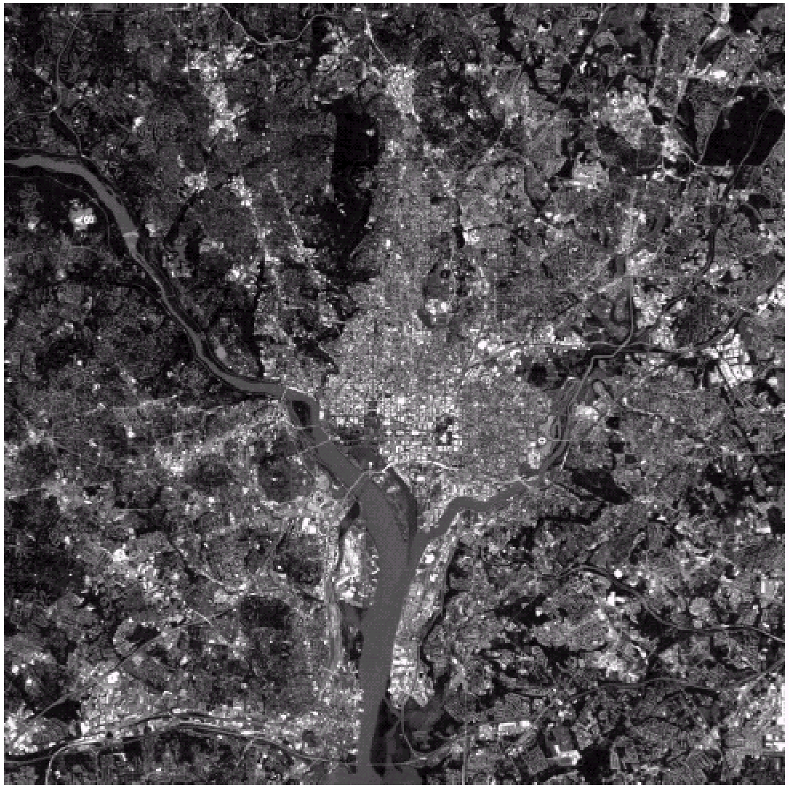


FIGURE 12.4 Satellite image of a heavily built downtown area (Washington, D.C.) and surrounding residential areas. (Courtesy of NASA.)

Object Recognition

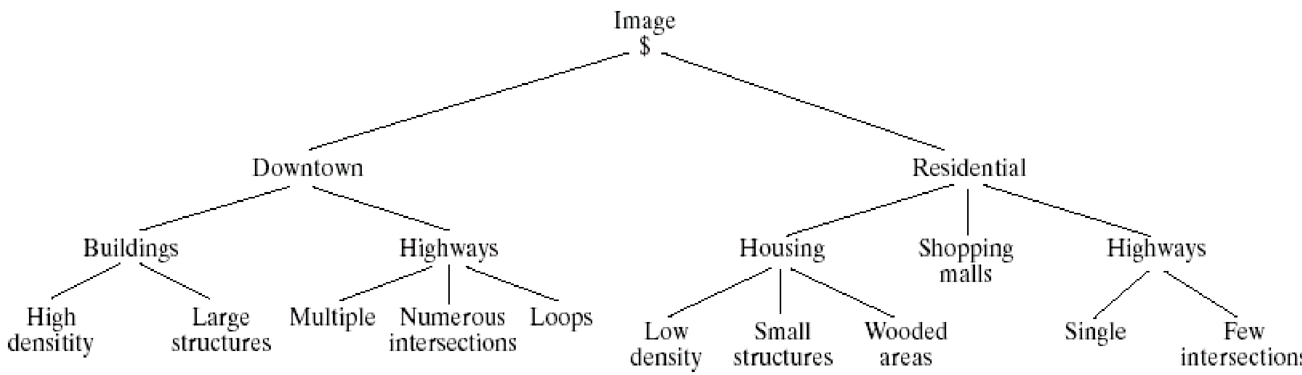


FIGURE 12.5 A tree description of the image in Fig. 12.4.

Object Recognition

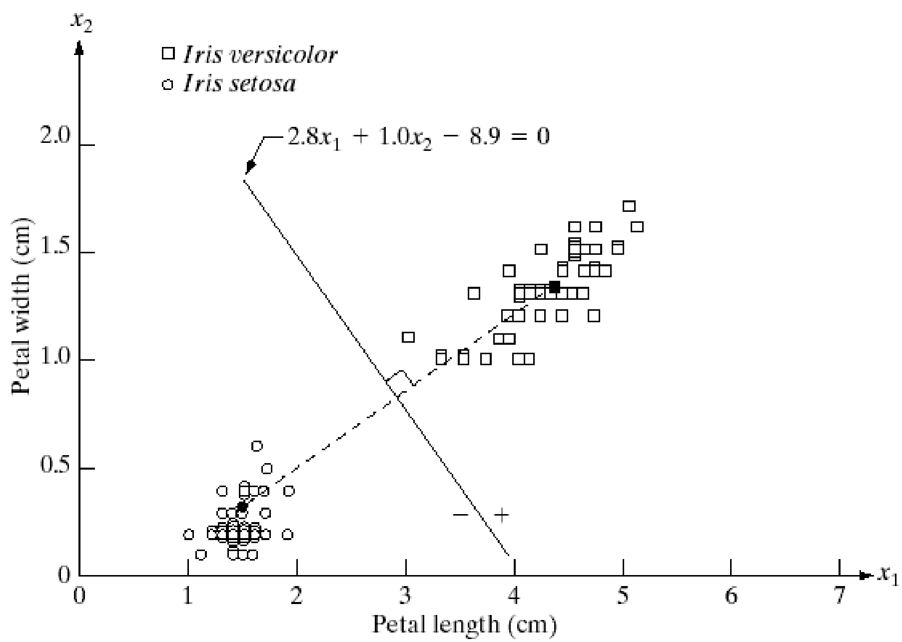
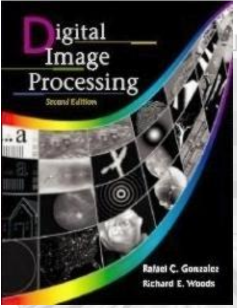


FIGURE 12.6 Decision boundary of minimum distance classifier for the classes of *Iris versicolor* and *Iris setosa*. The dark dot and square are the means.



Object Recognition

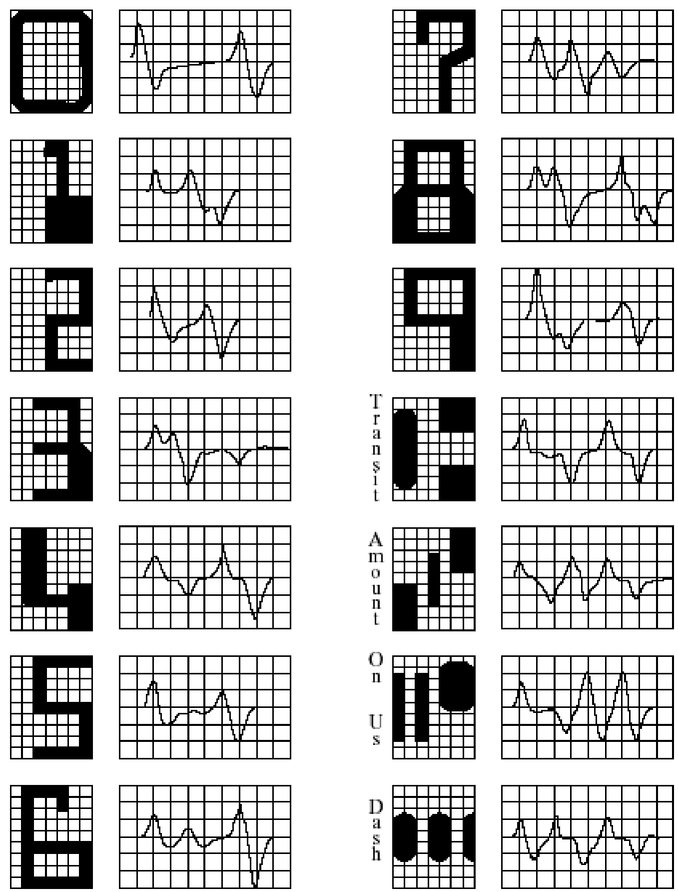


FIGURE 12.7 American Bankers Association E-13B font character set and corresponding waveforms.

Object Recognition

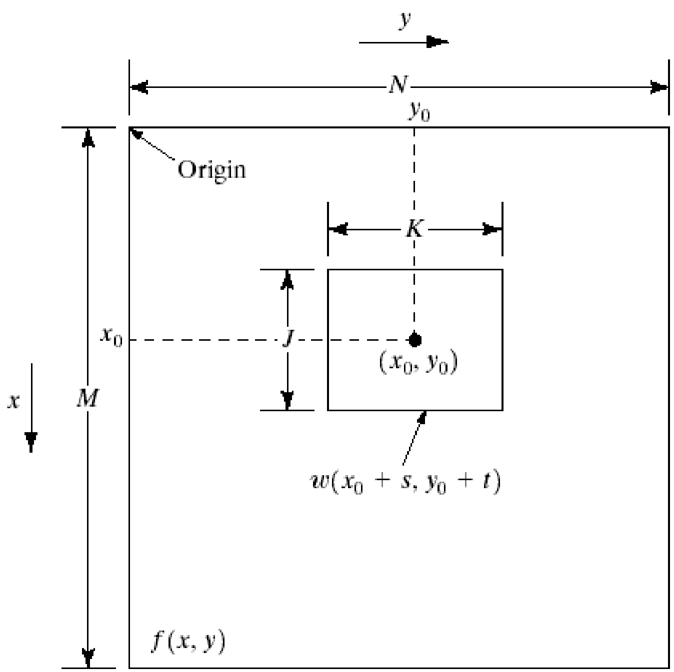
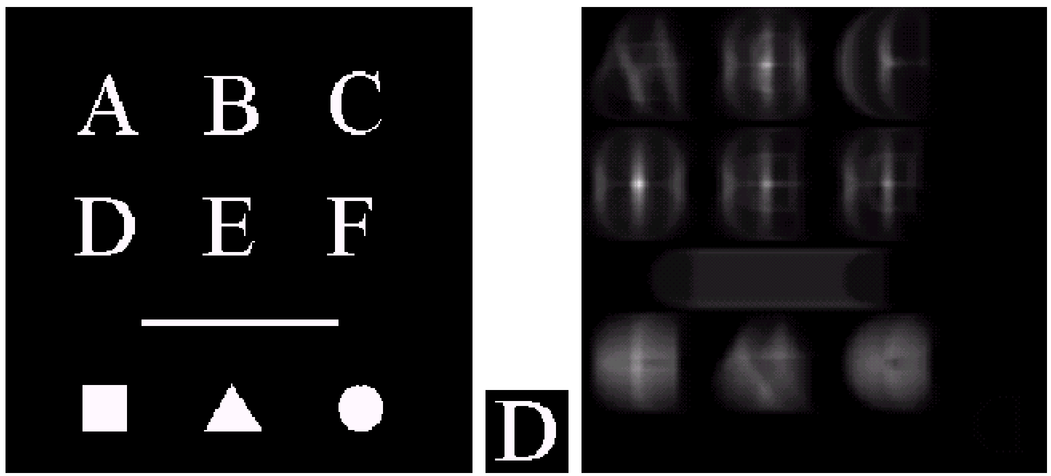


FIGURE 12.8 Arrangement for obtaining the correlation of f and w at point (x_0, y_0).

Object Recognition

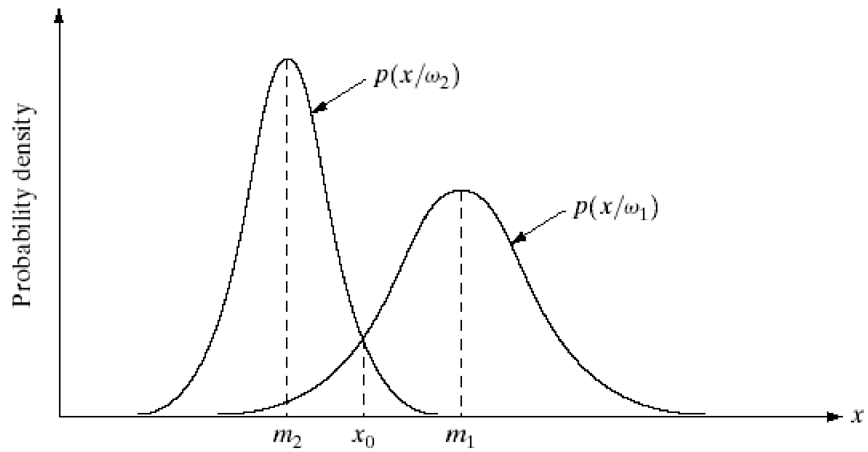


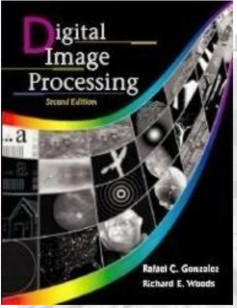
a b c

FIGURE 12.9 (a) Image. (b) Subimage. (c) Correlation coefficient of (a) and (b). Note that the highest (brighter) point in (c) occurs when subimage (b) is coincident with the letter "D" in (a).

Object Recognition

FIGURE 12.10 Probability density functions for two 1-D pattern classes. The point x_0 shown is the decision boundary if the two classes are equally likely to occur.





Object Recognition

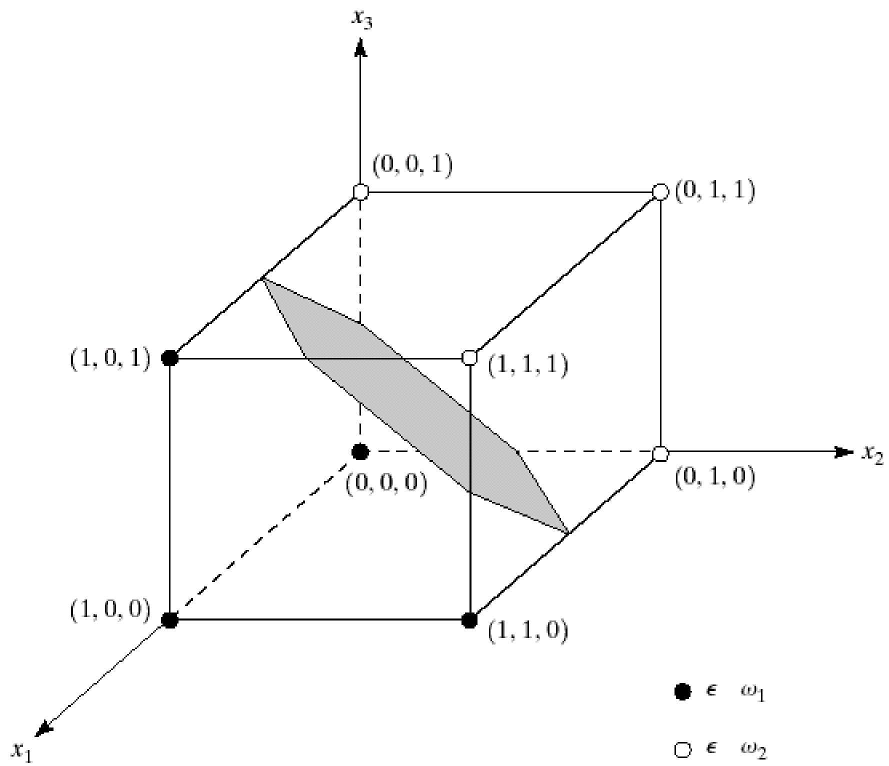
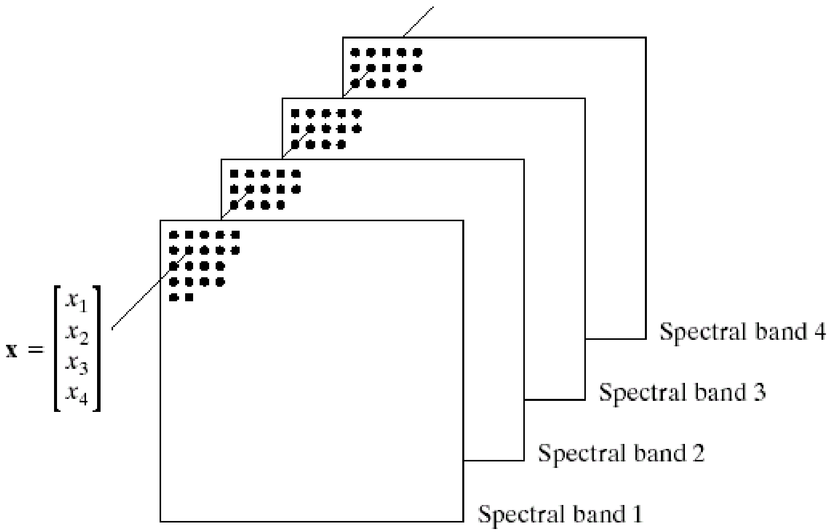
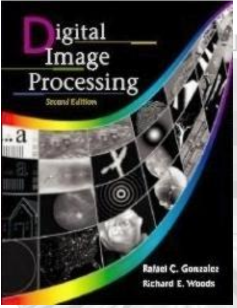


FIGURE 12.11 Two simple pattern classes and their Bayes decision boundary (shown shaded).

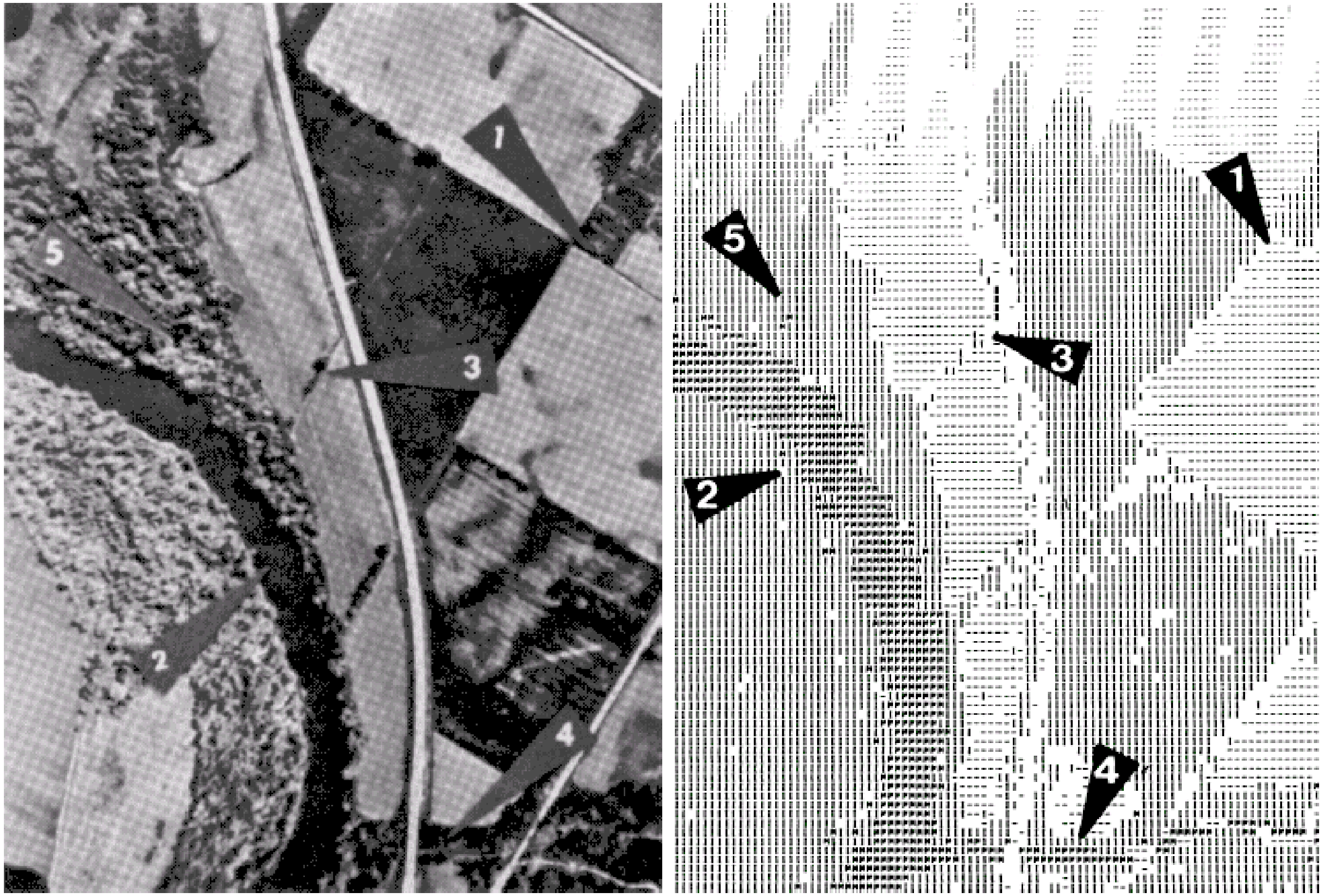
Object Recognition

FIGURE 12.12 Formation of a pattern vector from registered pixels of four digital images generated by a multispectral scanner.





Object Recognition



a b

FIGURE 12.13 (a) Multispectral image. (b) Printout of machine classification results using a Bayes classifier. (Courtesy of the Laboratory for Applications of Remote Sensing, Purdue University.)

Object Recognition

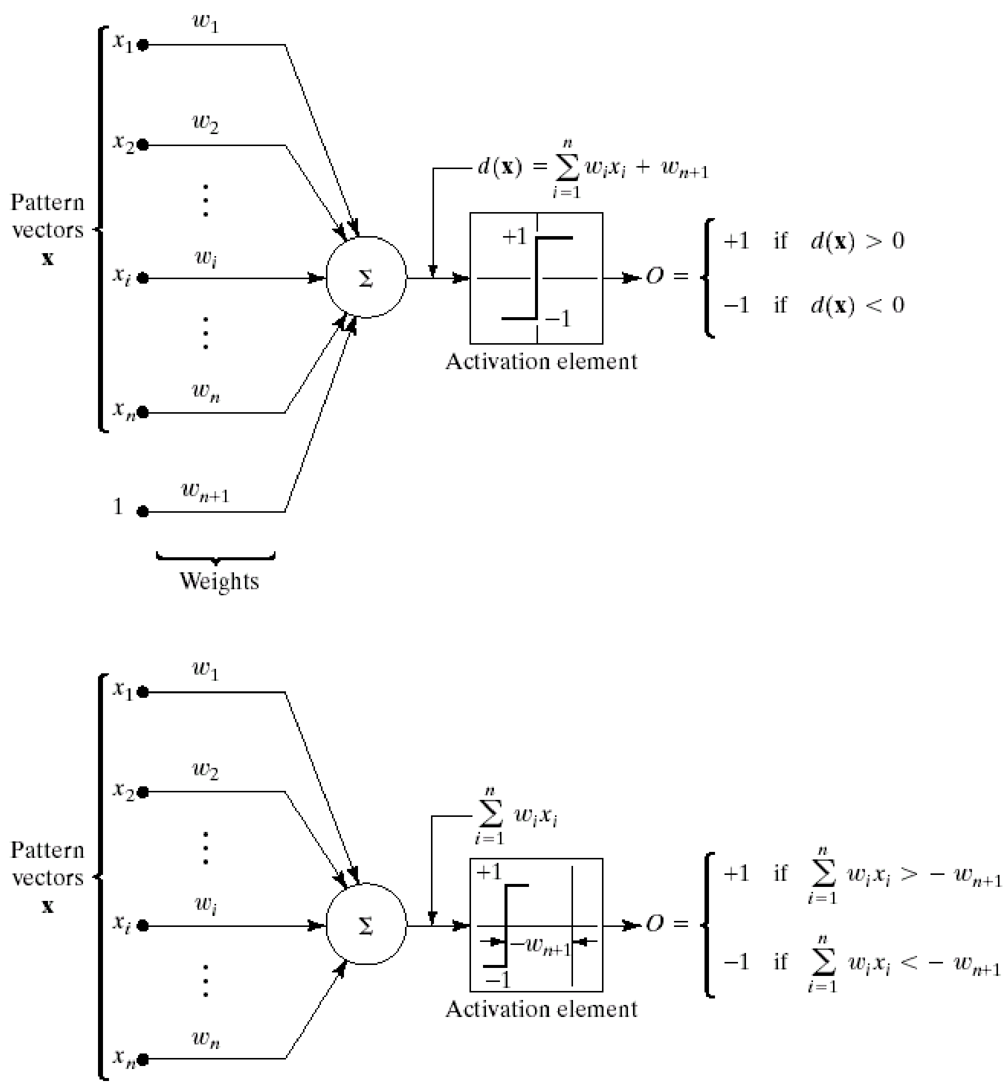
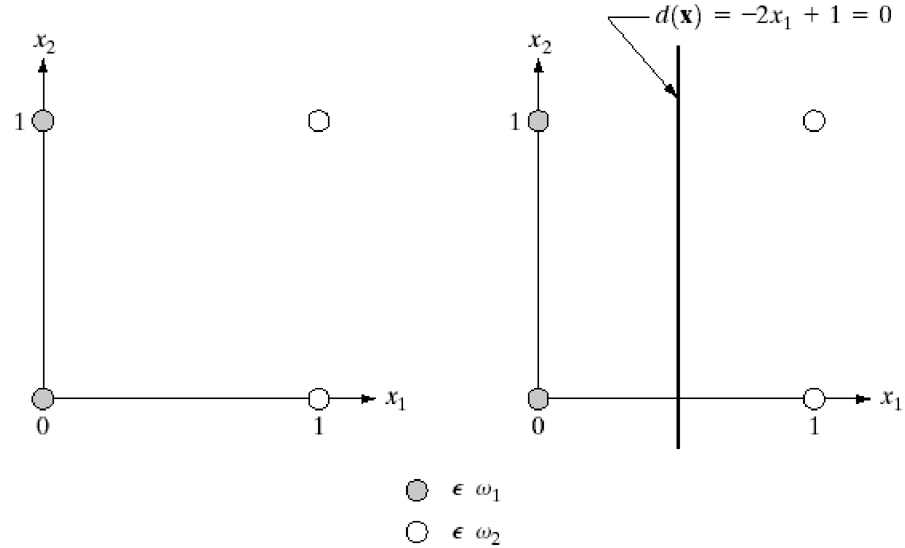


FIGURE 12.14 Two equivalent representations of the perceptron model for two pattern classes.

Object Recognition



a b

FIGURE 12.15
(a) Patterns belonging to two classes.
(b) Decision boundary determined by training.

Object Recognition

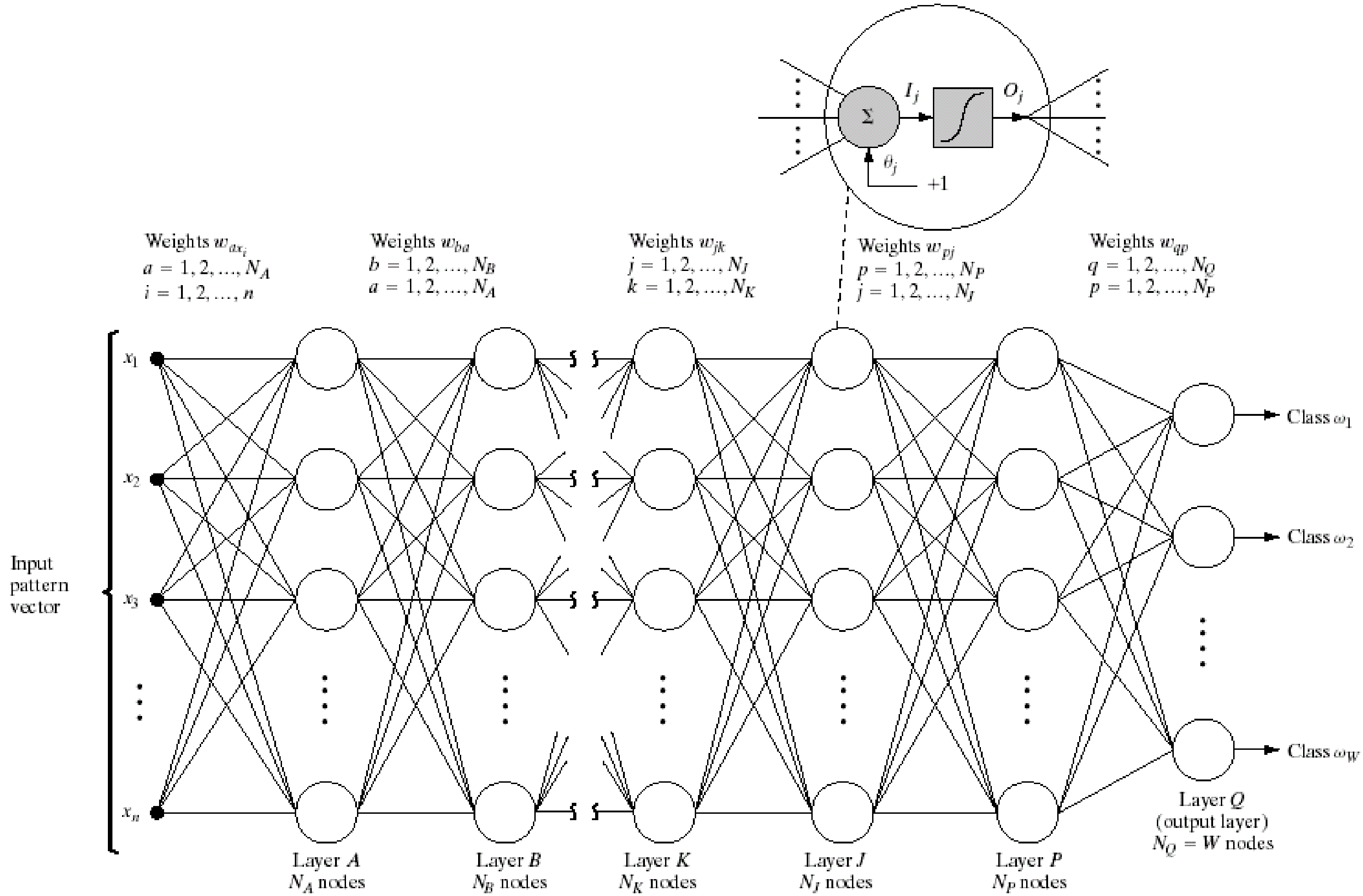
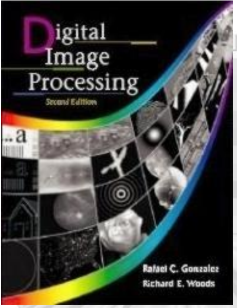


FIGURE 12.16 Multilayer feedforward neural network model. The blowup shows the basic structure of each neuron element throughout the network. The offset, θ_j, is treated as just another weight.



Object Recognition

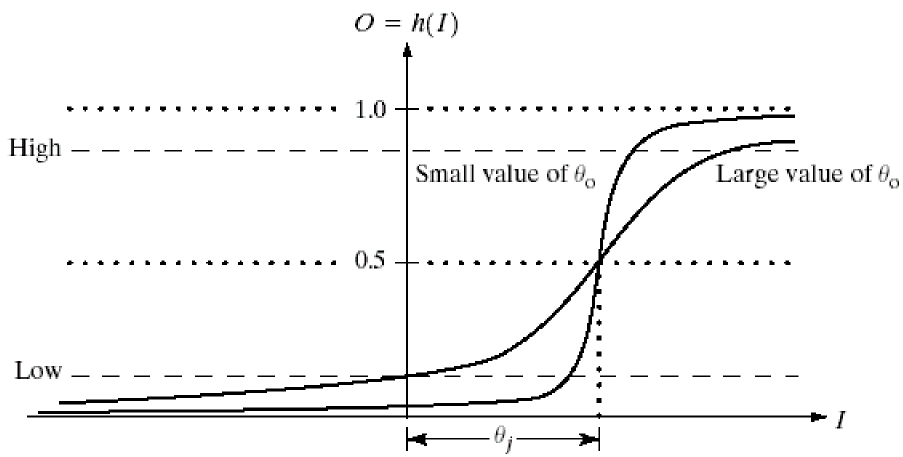
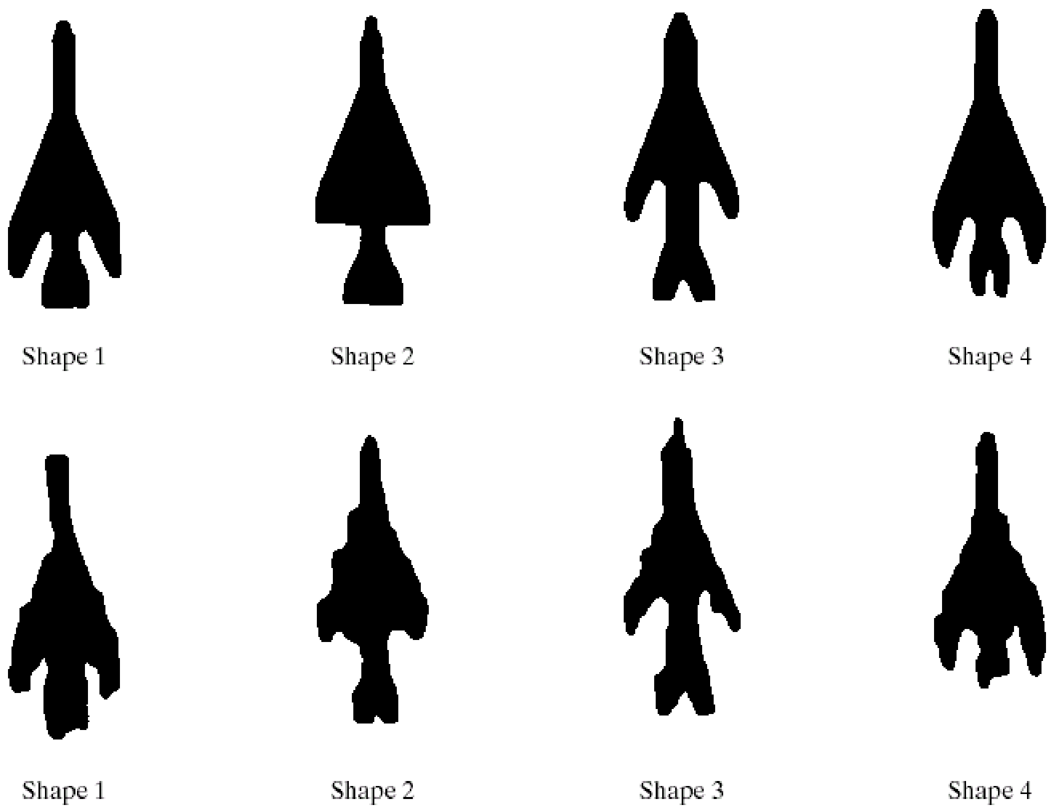


FIGURE 12.17 The sigmoidal activation function of Eq. (12.2-47).

Object Recognition

a
b

FIGURE 12.18 (a) Reference shapes and (b) typical noisy shapes used in training the neural network of Fig. 12.19. (Courtesy of Dr. Lalit Gupta, ECE Department, Southern Illinois University.)



Object Recognition

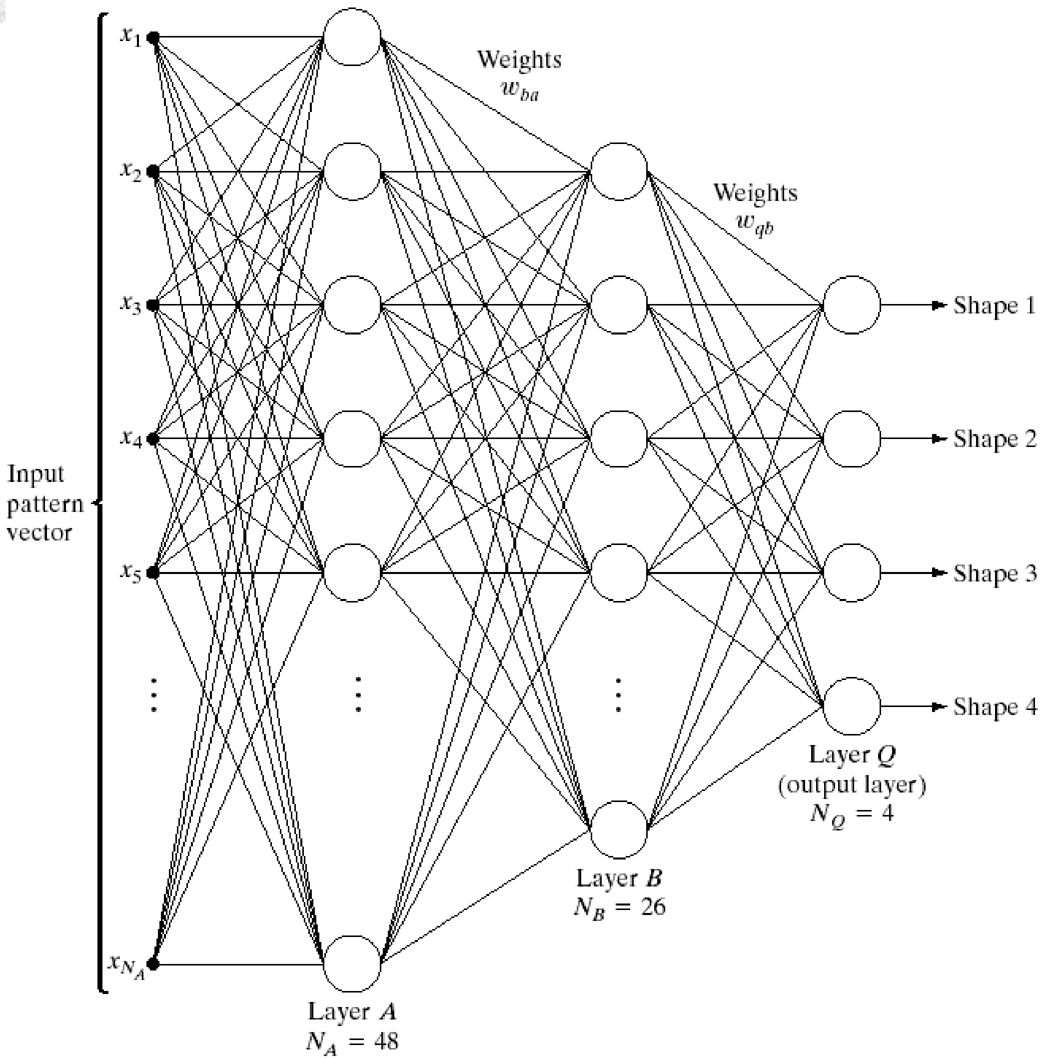


FIGURE 12.19 Three-layer neural network used to recognize the shapes in Fig. 12.18. (Courtesy of Dr. Lalit Gupta, ECE Department, Southern Illinois University.)

Object Recognition

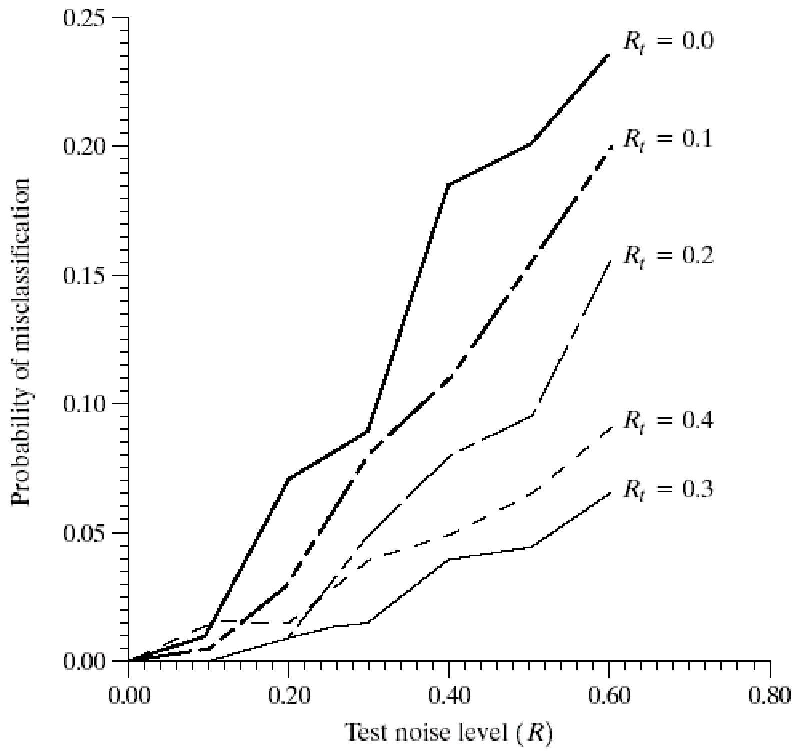


FIGURE 12.20 Performance of the neural network as a function of noise level. (Courtesy of Dr. Lalit Gupta, ECE Department, Southern Illinois University.)

Object Recognition

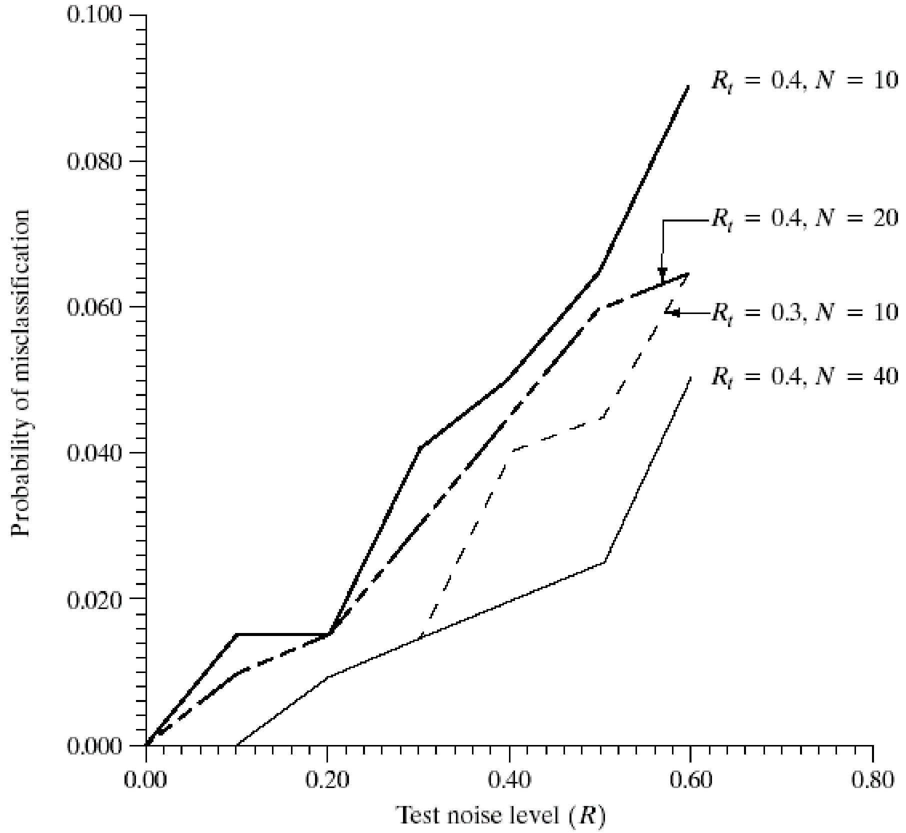
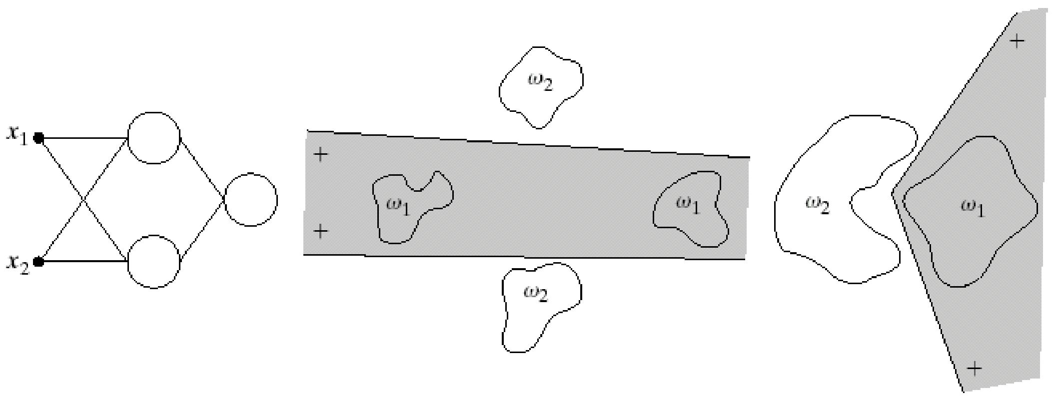


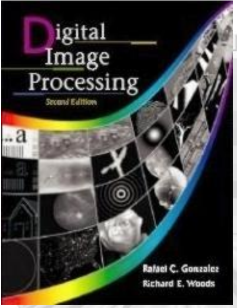
FIGURE 12.21 Improvement in performance for $R_t = 0.4$ by increasing the number of training patterns (the curve for $R_t = 0.3$ is shown for reference). (Courtesy of Dr. Lalit Gupta, ECE Department, Southern Illinois University.)

Object Recognition



a b c

FIGURE 12.22 (a) A two-input, two-layer, feedforward neural network. (b) and (c) Examples of decision boundaries that can be implemented with this network.



Object Recognition

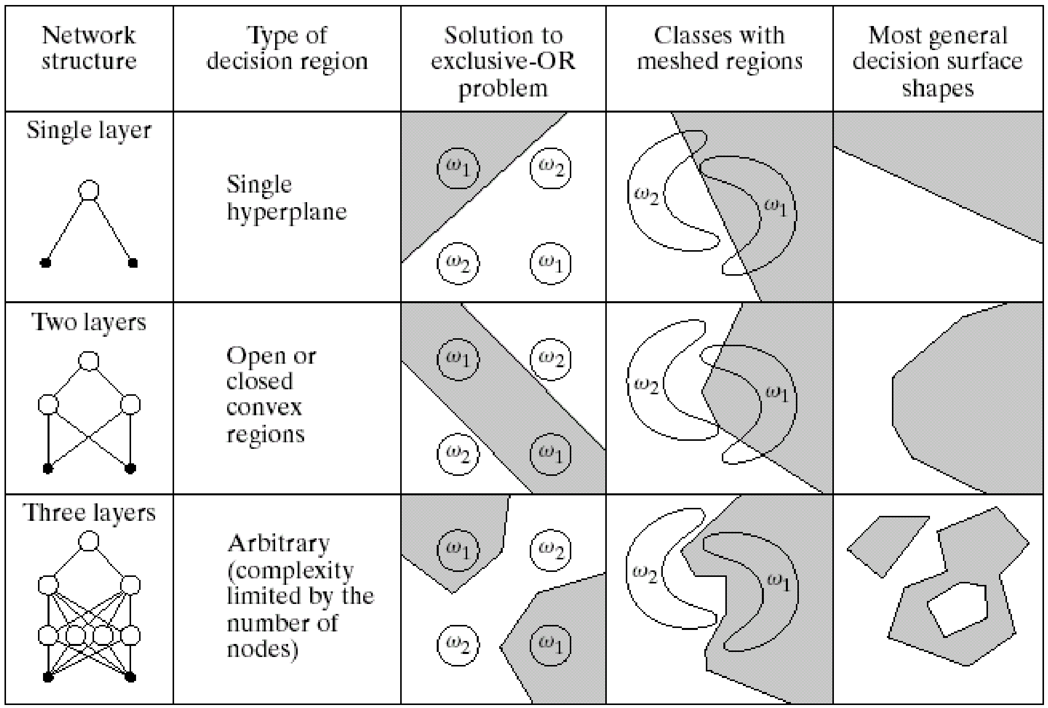
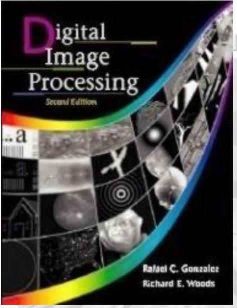
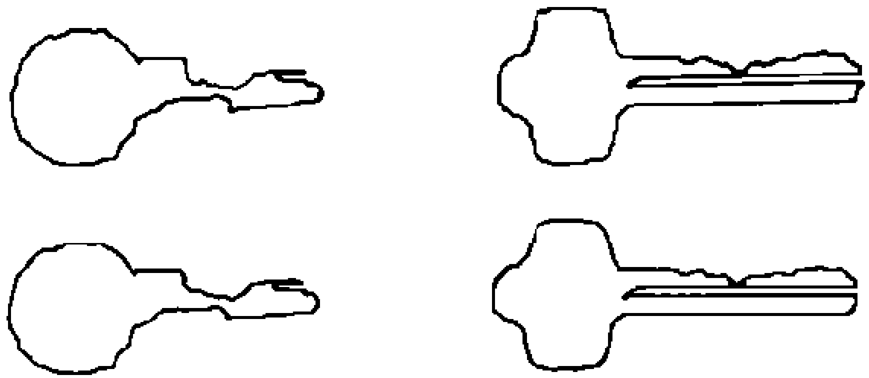


FIGURE 12.23 Types of decision regions that can be formed by single- and multilayer feed-forward networks with one and two layers of hidden units and two inputs. (Lippman)



Object Recognition



R	1.a	1.b	1.c	1.d	1.e	1.f
1.a	∞					
1.b	16.0	∞				
1.c	9.6	26.3	∞			
1.d	5.1	8.1	10.3	∞		
1.e	4.7	7.2	10.3	14.2	∞	
1.f	4.7	7.2	10.3	8.4	23.7	∞

R	2.a	2.b	2.c	2.d	2.e	2.f
2.a	∞					
2.b	33.5	∞				
2.c	4.8	5.8	∞			
2.d	3.6	4.2	19.3	∞		
2.e	2.8	3.3	9.2	18.3	∞	
2.f	2.6	3.0	7.7	13.5	27.0	∞

R	1.a	1.b	1.c	1.d	1.e	1.f
2.a	1.24	1.50	1.32	1.47	1.55	1.48
2.b	1.18	1.43	1.32	1.47	1.55	1.48
2.c	1.02	1.18	1.19	1.32	1.39	1.48
2.d	1.02	1.18	1.19	1.32	1.29	1.40
2.e	0.93	1.07	1.08	1.19	1.24	1.25
2.f	0.89	1.02	1.02	1.24	1.22	1.18

a b
c d
e f
g

FIGURE 12.25 (a) and (b) Sample boundaries of two different object classes; (c) and (d) their corresponding polygonal approximations; (e)–(g) tabulations of *R*. (Sze and Yang.)

Image Restoration

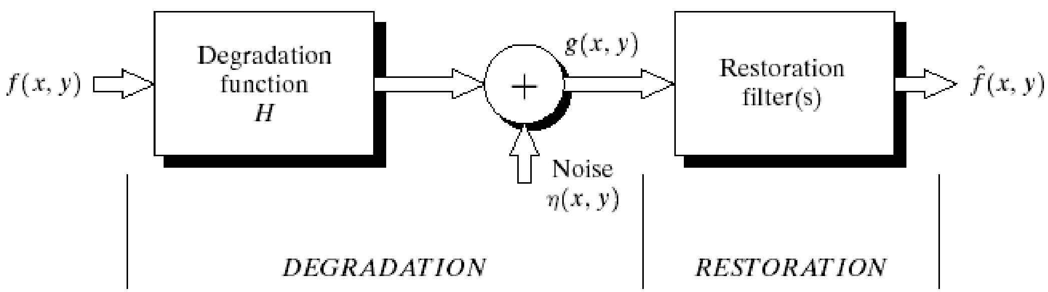
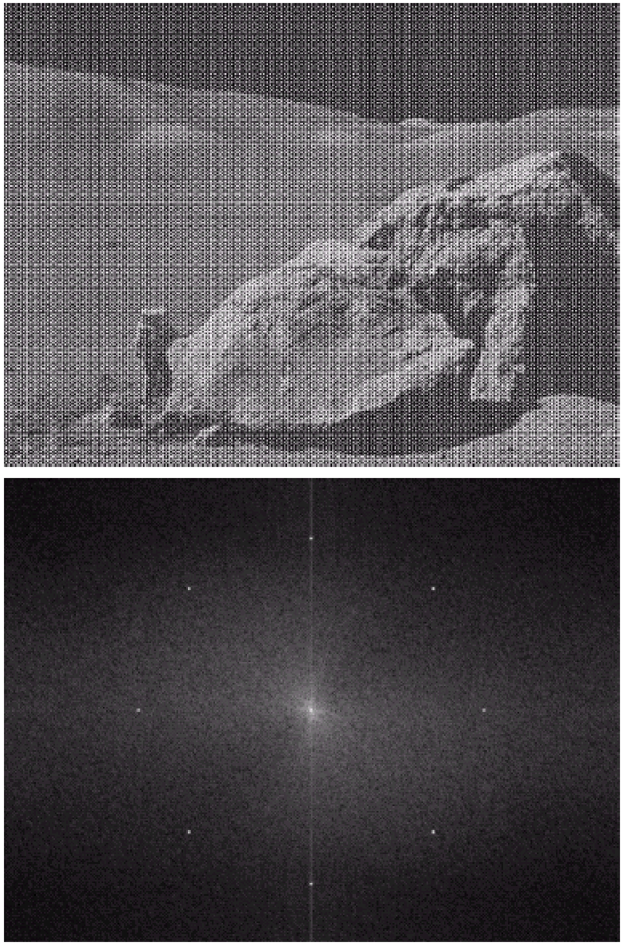


FIGURE 5.1 A model of the image degradation/restoration process.

Image Restoration

a b
c d

FIGURE 5.25 Illustration of the atmospheric turbulence model. (a) Negligible turbulence. (b) Severe turbulence, $k = 0.0025$. (c) Mild turbulence, $k = 0.001$. (d) Low turbulence, $k = 0.00025$. (Original image courtesy of NASA.)

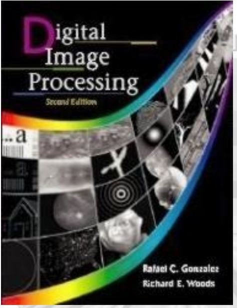


a
b

FIGURE 5.5
(a) Image corrupted by sinusoidal noise. (b) Spectrum (each pair of conjugate impulses corresponds to one sine wave). (Original image courtesy of NASA.)

Color

Extension to 3D and Color


Digital
Image
Processing
Second Edition
Rafael C. Gonzalez
Richard E. Woods

Thank you!