PART

GENERATIVE APPROACH TO STATISTICAL PATTERN RECOGNITION

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The objective of pattern recognition is to classify a given pattern $\boldsymbol{x}$ to one of the pre-specified classes, y. For example, in hand-written digit recognition, pattern $\boldsymbol{x}$ is an image of hand-written digit and class y corresponds to the number the image represents. The number of classes is 10 (i.e., from “0” to “9”). Among various approaches, statistical pattern recognition tries to learn a classifier based on statistical properties of training samples. In Part 3, an approach to statistical pattern recognition based on estimation of the data-generating probability distribution.

After the problem of pattern recognition based on generative model estimation is formulated in Chapter 11, various statistical estimators are introduced. These methods are categorizes as either *parametric* or *non-parametric* and either *frequentist* or *Bayesian*.

First, a standard parametric frequentist method called *maximum likelihood estimation* is introduced in Chapter 12, its theoretical properties are investigated in Chapter 13, the issue of model selection is discussed in Chapter 14, and the algorithm for Gaussian mixture models called the *expectation–maximization algorithm* is introduced in Chapter 15. Then, non-parametric frequentist methods called *kernel density estimation* and *nearest neighbor density estimation* are introduced in Chapter 16.

The basic ideas of the parametric Bayesian approach is introduced in Chapter 17, its analytic approximation methods are discussed in Chapter 18, and its numerical approximation methods are introduced in Chapter 19. Then practical Bayesian inference algorithms for *Gaussian mixture models* and *topic models* are introduced in Chapter 20, which also includes a non-parametric Bayesian approach.