5

STATISTICAL METHODS

The only useful function of a statistician is to make predictions, and thus to provide a basis for action.
William Edwards Deming

The remaining chapters of this book describe various learning algorithms for estimating predictive models from data. This chapter describes statistical methods for classification and regression tasks, introduced earlier in Chapter 2. Biologically inspired neural network methods for the same learning tasks are presented in Chapter 6. Each field has adopted its own terminology, even though the technical issues that arise in most applications are very similar. Our discussion of learning methods covers:

- original motivation behind these techniques, which may be different from predictive learning;
- field-specific terminology;
- interpretation of these methods under a common predictive learning framework;
- important technical issues, such as nonlinear optimization and complexity control.

The discussion of statistical methods in Section 5.1 starts with methodological assumptions, followed by description of two basic statistical methods: linear regression and logistic regression. These methods yield linear models, and they are often used by statisticians to motivate more complex (nonlinear) models. Section 5.2 describes general issues for estimating nonlinear models and presents taxonomy of nonlinear methods, aka adaptive methods. This taxonomy is useful for understanding statistical methods, and also for neural network methods presented in Chapter 6. The remaining sections 5.3 – 5.5 describe several popular nonlinear statistical methods. Section 5.6 describes methods for estimating univariate functions, called signals or waveforms, developed in signal processing.

Statistical methods are often used for predictive modeling and they may be algorithmically very similar to machine learning methods. However, they are motivated by the goal of estimating a probabilistic model. An important distinction between probabilistic (or generative) and predictive (or risk-minimization) modeling approaches was explained in Chapter 4. This distinction is important for understanding statistical methods, as discussed in the summary Section 5.7.

Predictive Learning
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