CONTENTS

Acknowledgments · xi

PART 1. CONCEPTS

- What Is Data Mining? 3 The Goals of This Book 6 Software and Hardware for Data Mining 7 Basic Terminology 8
- 2. Contrasts with the Conventional Statistical Approach 13 Predictive Power in Conventional Statistical Modeling 13 Hypothesis Testing in the Conventional Approach 15 Heteroscedasticity as a Threat to Validity in Conventional Modeling 17 The Challenge of Complex and Nonrandom Samples 20 Bootstrapping and Permutation Tests 20 Nonlinearity in Conventional Predictive Models 24 Statistical Interactions in Conventional Models 25 Conclusion 27
- Some General Strategies Used in Data Mining 30 Cross-Validation 30 Overfitting 32 Boosting 35

Calibrating 38 Measuring Fit: The Confusion Matrix and ROC Curves 39 Identifying Statistical Interactions and Effect Heterogeneity in Data Mining 43 Bagging and Random Forests 45 The Limits of Prediction 48 Big Data Is Never Big Enough 50

4. Important Stages in a Data Mining Project 53
 When to Sample Big Data 53
 Building a Rich Array of Features 54
 Feature Selection 56
 Feature Extraction 56
 Constructing a Model 58

PART 2. WORKED EXAMPLES

- Preparing Training and Test Datasets
 63 The Logic of Cross-Validation
 63 Cross-Validation Methods: An Overview
 65
- 6. Variable Selection Tools 72
 Stepwise Regression 73
 The LASSO 79
 VIF Regression 86
- 7. Creating New Variables Using Binning and Trees
 93
 Discretizing a Continuous Predictor
 95
 Continuous Outcomes and Continuous Predictors
 100
 Binning Categorical Predictors
 105
 Using Partition Trees to Study Interactions
 108
- Extracting Variables 116
 Principal Component Analysis 116
 Independent Component Analysis 125
- 9. Classifiers 133
 K-Nearest Neighbors 134
 Naive Bayes 142
 Support Vector Machines 147
 Optimizing Prediction across Multiple Classifiers 156
- Classification Trees 162
 Partition Trees 162
 Boosted Trees and Random Forests 172

- 11. Neural Networks · 185
- 12. Clustering 196
 Hierarchical Clustering 199
 K-Means Clustering 203
 Normal Mixtures 208
 Self-Organized Maps 212
- 13. Latent Class Analysis and Mixture Models 216
 Latent Class Analysis 216
 Latent Class Regression 221
 Mixture Models 223

.

14. Association Rules · 227

Conclusion 235 Bibliography 239 Notes 245 Index 247