

CONTENTS

Preface	ix
About the Companion Website	xiii
1 Introduction	1
1.1 Categorical Response Data	1
1.2 Probability Distributions for Categorical Data	3
1.3 Statistical Inference for a Proportion	5
1.4 Statistical Inference for Discrete Data	10
1.5 Bayesian Inference for Proportions *	13
1.6 Using R Software for Statistical Inference about Proportions *	17
Exercises	21
2 Analyzing Contingency Tables	25
2.1 Probability Structure for Contingency Tables	26
2.2 Comparing Proportions in 2×2 Contingency Tables	29
2.3 The Odds Ratio	31
2.4 Chi-Squared Tests of Independence	36
2.5 Testing Independence for Ordinal Variables	42
2.6 Exact Frequentist and Bayesian Inference *	46
2.7 Association in Three-Way Tables	52
Exercises	56

3	Generalized Linear Models	65
3.1	Components of a Generalized Linear Model	66
3.2	Generalized Linear Models for Binary Data	68
3.3	Generalized Linear Models for Counts and Rates	72
3.4	Statistical Inference and Model Checking	76
3.5	Fitting Generalized Linear Models	82
	Exercises	84
4	Logistic Regression	89
4.1	The Logistic Regression Model	89
4.2	Statistical Inference for Logistic Regression	94
4.3	Logistic Regression with Categorical Predictors	98
4.4	Multiple Logistic Regression	102
4.5	Summarizing Effects in Logistic Regression	107
4.6	Summarizing Predictive Power: Classification Tables, ROC Curves, and Multiple Correlation	110
	Exercises	113
5	Building and Applying Logistic Regression Models	123
5.1	Strategies in Model Selection	123
5.2	Model Checking	130
5.3	Infinite Estimates in Logistic Regression	136
5.4	Bayesian Inference, Penalized Likelihood, and Conditional Likelihood for Logistic Regression *	140
5.5	Alternative Link Functions: Linear Probability and Probit Models *	145
5.6	Sample Size and Power for Logistic Regression *	150
	Exercises	151
6	Multicategory Logit Models	159
6.1	Baseline-Category Logit Models for Nominal Responses	159
6.2	Cumulative Logit Models for Ordinal Responses	167
6.3	Cumulative Link Models: Model Checking and Extensions *	176
6.4	Paired-Category Logit Modeling of Ordinal Responses *	184
	Exercises	187
7	Loglinear Models for Contingency Tables and Counts	193
7.1	Loglinear Models for Counts in Contingency Tables	194
7.2	Statistical Inference for Loglinear Models	200
7.3	The Loglinear – Logistic Model Connection	207

7.4	Independence Graphs and Collapsibility	210
7.5	Modeling Ordinal Associations in Contingency Tables	214
7.6	Loglinear Modeling of Count Response Variables *	217
	Exercises	221
8	Models for Matched Pairs	227
8.1	Comparing Dependent Proportions for Binary Matched Pairs	228
8.2	Marginal Models and Subject-Specific Models for Matched Pairs	230
8.3	Comparing Proportions for Nominal Matched-Pairs Responses	235
8.4	Comparing Proportions for Ordinal Matched-Pairs Responses	239
8.5	Analyzing Rater Agreement *	243
8.6	Bradley-Terry Model for Paired Preferences *	247
	Exercises	249
9	Marginal Modeling of Correlated, Clustered Responses	253
9.1	Marginal Models Versus Subject-Specific Models	254
9.2	Marginal Modeling: The Generalized Estimating Equations (GEE) Approach	255
9.3	Marginal Modeling for Clustered Multinomial Responses	260
9.4	Transitional Modeling, Given the Past	263
9.5	Dealing with Missing Data *	266
	Exercises	268
10	Random Effects: Generalized Linear Mixed Models	273
10.1	Random Effects Modeling of Clustered Categorical Data	273
10.2	Examples: Random Effects Models for Binary Data	278
10.3	Extensions to Multinomial Responses and Multiple Random Effect Terms	284
10.4	Multilevel (Hierarchical) Models	288
10.5	Latent Class Models *	291
	Exercises	295
11	Classification and Smoothing *	299
11.1	Classification: Linear Discriminant Analysis	300
11.2	Classification: Tree-Based Prediction	302
11.3	Cluster Analysis for Categorical Responses	306
11.4	Smoothing: Generalized Additive Models	310
11.5	Regularization for High-Dimensional Categorical Data (Large p)	313
	Exercises	321

12 A Historical Tour of Categorical Data Analysis *	325
Appendix: Software for Categorical Data Analysis	331
A.1 R for Categorical Data Analysis	331
A.2 SAS for Categorical Data Analysis	332
A.3 Stata for Categorical Data Analysis	342
A.4 SPSS for Categorical Data Analysis	346
Brief Solutions to Odd-Numbered Exercises	349
Bibliography	363
Examples Index	365
Subject Index	369