Contents

List of examples  page xvii

Preface  xix

1 Why? 1
1.1 What is multilevel regression modeling? 1
1.2 Some examples from our own research 3
1.3 Motivations for multilevel modeling 6
1.4 Distinctive features of this book 8
1.5 Computing 9

2 Concepts and methods from basic probability and statistics 13
2.1 Probability distributions 13
2.2 Statistical inference 16
2.3 Classical confidence intervals 18
2.4 Classical hypothesis testing 20
2.5 Problems with statistical significance 22
2.6 55,000 residents desperately need your help! 23
2.7 Bibliographic note 26
2.8 Exercises 26

Part 1A: Single-level regression 29

3 Linear regression: the basics 31
3.1 One predictor 31
3.2 Multiple predictors 32
3.3 Interactions 34
3.4 Statistical inference 37
3.5 Graphical displays of data and fitted model 42
3.6 Assumptions and diagnostics 45
3.7 Prediction and validation 47
3.8 Bibliographic note 49
3.9 Exercises 49

4 Linear regression: before and after fitting the model 53
4.1 Linear transformations 53
4.2 Centering and standardizing, especially for models with interactions 55
4.3 Correlation and “regression to the mean” 57
4.4 Logarithmic transformations 59
4.5 Other transformations 65
4.6 Building regression models for prediction 68
4.7 Fitting a series of regressions 73
## 4.8 Bibliographic note
4.9 Exercises

### 5 Logistic regression
5.1 Logistic regression with a single predictor
5.2 Interpreting the logistic regression coefficients
5.3 Latent-data formulation
5.4 Building a logistic regression model: wells in Bangladesh
5.5 Logistic regression with interactions
5.6 Evaluating, checking, and comparing fitted logistic regressions
5.7 Average predictive comparisons on the probability scale
5.8 Identifiability and separation
5.9 Bibliographic note
5.10 Exercises

### 6 Generalized linear models
6.1 Introduction
6.2 Poisson regression, exposure, and overdispersion
6.3 Logistic-binomial model
6.4 Probit regression: normally distributed latent data
6.5 Multinomial regression
6.6 Robust regression using the$t$ model
6.7 Building more complex generalized linear models
6.8 Constructive choice models
6.9 Bibliographic note
6.10 Exercises

### Part 1B: Working with regression inferences

### 7 Simulation of probability models and statistical inferences
7.1 Simulation of probability models
7.2 Summarizing linear regressions using simulation: an informal Bayesian approach
7.3 Simulation for nonlinear predictions: congressional elections
7.4 Predictive simulation for generalized linear models
7.5 Bibliographic note
7.6 Exercises

### 8 Simulation for checking statistical procedures and model fits
8.1 Fake-data simulation
8.2 Example: using fake-data simulation to understand residual plots
8.3 Simulating from the fitted model and comparing to actual data
8.4 Using predictive simulation to check the fit of a time-series model
8.5 Bibliographic note
8.6 Exercises

### 9 Causal inference using regression on the treatment variable
9.1 Causal inference and predictive comparisons
9.2 The fundamental problem of causal inference
9.3 Randomized experiments
9.4 Treatment interactions and poststratification