Contents

Author ix

1 Who is this book for? 1
1.1 The big picture . . . 1
1.2 Software . . . 3
1.3 Documentation . . . 4
1.4 Data . . . 5

I Interpretation 7

2 Models and meaning 9
2.1 Why fit a model? . . . 9
2.2 What is your estimand? . . . 13
2.3 Making sense of parameter estimates . . . 15

3 Conceptual framework 17
3.1 Quantity . . . 18
3.2 Predictors . . . 23
3.3 Aggregation . . . 29
3.4 Uncertainty . . . 30
3.5 Test . . . 31
3.6 Summary . . . 32

II Quantities and tests 37

4 Hypothesis and equivalence tests 39
4.1 Null hypothesis . . . 42
4.2 Equivalence . . . 47
4.3 Summary . . . 50

5 Predictions 52
5.1 Quantity . . . 53
5.2 Predictors . . . 56
5.3 Aggregation . . . 62

5.4 Uncertainty 65
5.5 Test 66
5.6 Visualization 70
5.7 Summary 76

6 Counterfactual comparisons **79**
6.1 Quantity 80
6.2 Predictors 85
6.3 Aggregation 93
6.4 Uncertainty 98
6.5 Test 98
6.6 Visualization 100
6.7 Summary 102

7 Slopes **105**
7.1 Quantity 106
7.2 Predictors 112
7.3 Aggregation 114
7.4 Uncertainty 115
7.5 Test 116
7.6 Visualization 117
7.7 Summary 119

III Case studies **123**

8 Causal inference with G-computation **125**
8.1 Treatment effects: ATE, ATT, ATU 126
8.2 Conditional treatment effects: CATE 134

9 Experiments **136**
9.1 Regression adjustment 136
9.2 Factorial experiments 138

10 Interactions and polynomials **143**
10.1 Multiplicative interactions 144
10.2 Polynomial regression 162

11 Categorical and ordinal outcomes **167**
11.1 Predictions 169
11.2 Counterfactual comparisons 173

12 Multilevel regression with poststratification **175**
12.1 Multilevel models 176
12.2 Frequentist 177

12.3 Bayesian 179
12.4 Poststratification 186

13 Machine learning **190**
13.1 `tidymodels` and `mlr3` 190
13.2 Predictions 192
13.3 Counterfactual comparisons 195

14 Uncertainty **197**
14.1 Delta method 197
14.2 Bootstrap 206
14.3 Simulation 208
14.4 Conformal prediction 210

IV Back matter **219**

Appendix I: Online content **221**

Appendix II: Python **222**
1. Who is this book for? 222
3. Conceptual framework 223
4. Hypothesis and equivalence tests 224
5. Predictions 225
6. Counterfactual comparisons 228
7. Slopes 232
8. Causal inference with G-computation 234
9. Experiments 235
10. Interactions and polynomials 236
13. Machine learning 238
Roadmap 240

Bibliography **241**

Index **251**