Brief Contents

PART I Exploring Data 1

Exploring Data: Variables and Distributions

CHAPTER 1 Picturing Distributions with Graphs 3

CHAPTER 2 Describing Distributions with Numbers 37

CHAPTER 3 The Normal Distributions 64

Exploring Data: Relationships

CHAPTER 4 Scatterplots and Correlation 90

CHAPTER 5 Regression 115

CHAPTER 6 Two-Way Tables* 149

CHAPTER 7 Exploring Data: Part I Review 167

PART II From Exploration to Inference 186

Producing Data

CHAPTER 8 Producing Data: Sampling 189

CHAPTER 9 Producing Data: Experiments 213

COMMENTARY: Data Ethics* 235

Probability and Sampling Distributions

CHAPTER 10 Introducing Probability 246

CHAPTER 11 Sampling Distributions 271

CHAPTER 12 General Rules of Probability* 302

CHAPTER 13 Binomial Distributions* 326

Introducing Inference

CHAPTER 14 Confidence Intervals: The Basics 343

CHAPTER 15 Tests of Significance: The Basics 362

CHAPTER 16 Inference in Practice 387

CHAPTER 17 From Exploration to Inference: Part II Review 412

PART III Inference about Variables 430

Quantitative Response Variable

CHAPTER 18 Inference about a Population Mean 433

CHAPTER 19 Two-Sample Problems 460

Categorical Response Variable

CHAPTER 20 Inference about a Population Proportion 491

CHAPTER 21 Comparing Two Proportions 512

CHAPTER 22 Inference about Variables: Part III Review 530

PART IV Inference about Relationships 544

CHAPTER 23 Two Categorical Variables: The Chi-Square Test 547

CHAPTER 24 Inference for Regression 581

CHAPTER 25 One-Way Analysis of Variance: Comparing Several Means 620

PART V Optional Companion Chapters (available on the *BPS* CD and online)

CHAPTER 26 Nonparametric Tests 26-1

CHAPTER 27 Statistical Process Control 27-1

CHAPTER 28 Multiple Regression 28-1

CHAPTER 29 Two-Way Analysis of Variance (available online only) 29-1

*Starred material is optional.

Contents

To the Instructor: About This Book xi
To the Student: Statistical Thinking xxvii

PART I Exploring Data 1

CHAPTER 1 Picturing Distributions with Graphs 3

Individuals and variables 3
Categorical variables: pie charts and bar graphs 6
Quantitative variables: histograms 10
Interpreting histograms 14
Quantitative variables: stemplots 19
Time plots 22

CHAPTER 2 Describing Distributions with Numbers 37

Measuring center: the mean 38
Measuring center: the median 39
Comparing the mean and the median 40
Measuring spread: the quartiles 41
The five-number summary and boxplots 43
Spotting suspected outliers* 45
Measuring spread: the standard deviation 47
Choosing measures of center and spread 50
Using technology 51
Organizing a statistical problem 53

CHAPTER 3 The Normal Distributions 64

Density curves 64
Describing density curves 67
Normal distributions 70
The 68–95–99.7 rule 71
The standard Normal distribution 74
Finding Normal proportions 76
Using the standard Normal table* 78
Finding a value given a proportion 81

CHAPTER 4 Scatterplots and Correlation 90

Explanatory and response variables 90
Displaying relationships: scatterplots 92
Interpreting scatterplots 94
Adding categorical variables to scatterplots 97
Measuring linear association: correlation 99
Facts about correlation 101

CHAPTER 5 Regression 115

Regression lines 115
The least-squares regression line 118
Using technology 120
Facts about least-squares regression 123
Residuals 126
Influential observations 129
Cautions about correlation and regression 132
Association does not imply causation 134

CHAPTER 6 Two-Way Tables* 149

Marginal distributions 150
Conditional distributions 153
Simpson's paradox 158

CHAPTER 7 Exploring Data: Part I Review 167

Part I summary 169
Review exercises 172
Supplementary exercises 180
EESEE case studies 184

PART II From Exploration to Inference 186

CHAPTER 8 Producing Data: Sampling 189

Observation versus experiment 189
Sampling 192
How to sample badly 194

*Starred material is optional.

Simple random samples 196
Other sampling designs 200
Cautions about sample surveys 201
Inference about the population 204

CHAPTER 9 Producing Data: Experiments 213

Experiments 213
How to experiment badly 215
Randomized comparative experiments 217
The logic of randomized comparative experiments 220
Cautions about experimentation 222
Matched pairs and other block designs 224

Commentary: Data Ethics* 235
Institutional review boards 236
Informed consent 237
Confidentiality 237
Clinical trials 238
Behavioral and social science experiments 240

CHAPTER 10 Introducing Probability 246

The idea of probability 247
Probability models 250
Probability rules 252
Discrete probability models 255
Continuous probability models 257
Random variables 260
Personal probability* 261

CHAPTER 11 Sampling Distributions 271

Parameters and statistics 271
Statistical estimation and the law of large numbers 273
Sampling distributions 275
The sampling distribution of $\bar{x}$ 278
The central limit theorem 280
Statistical process control* 286
$\bar{x}$ charts* 287
Thinking about process control* 292

CHAPTER 12 General Rules of Probability* 302

Independence and the multiplication rule 303
The general addition rule 307
Conditional probability 309
The general multiplication rule 311
Independence 312
Tree diagrams 314

CHAPTER 13 Binomial Distributions* 326

The binomial setting and binomial distributions 326
Binomial distributions in statistical sampling 327
Binomial probabilities 328
Using technology 331
Binomial mean and standard deviation 332
The Normal approximation to binomial distributions 334

CHAPTER 14 Confidence Intervals: The Basics 343

Estimating with confidence 344
Confidence intervals for the mean μ 349
How confidence intervals behave 353
Choosing the sample size 355

CHAPTER 15 Tests of Significance: The Basics 362

The reasoning of tests of significance 363
Stating hypotheses 365
Test statistics 367
P-values 368
Statistical significance 371
Tests for a population mean 372
Using tables of critical values* 376
Tests from confidence intervals 379

CHAPTER 16 Inference in Practice 387

Where did the data come from? 388
Cautions about the z procedures 389
Cautions about confidence intervals 391
Cautions about significance tests 392
The power of a test* 396
Type I and Type II errors* 399

CHAPTER 17 From Exploration to Inference: Part II Review 412

Part II summary 414
Review exercises 417
Supplementary exercises 424
Optional exercises 426
EESEE case studies 429

PART III Inference about Variables 430

CHAPTER 18 Inference about a Population Mean 433

Conditions for inference 433
The *t* distributions 435
The one-sample *t* confidence interval 437
The one-sample *t* test 439
Using technology 441
Matched pairs *t* procedures 444
Robustness of *t* procedures 447

CHAPTER 19 Two-Sample Problems 460

Two-sample problems 460
Comparing two population means 462
Two-sample *t* procedures 464
Examples of the two-sample *t* procedures 466
Using technology 470
Robustness again 473
Details of the *t* approximation* 473
Avoid the pooled two-sample *t* procedures* 476
Avoid inference about standard deviations* 476
The *F* test for comparing two standard deviations* 477

CHAPTER 20 Inference about a Population Proportion 491

The sample proportion $\hat{p}$ 492
The sampling distribution of $\hat{p}$ 492
Large-sample confidence intervals for a proportion 496
Accurate confidence intervals for a proportion 499
Choosing the sample size 502
Significance tests for a proportion 504

CHAPTER 21 Comparing Two Proportions 512

Two-sample problems: proportions 512
The sampling distribution of a difference between proportions 513
Large-sample confidence intervals for comparing proportions 514
Using technology 516
Accurate confidence intervals for comparing proportions 517
Significance tests for comparing proportions 520

CHAPTER 22 Inference about Variables: Part III Review 530

Part III summary 532
Review exercises 533
Supplementary exercises 539
EESEE case studies 543

PART IV Inference about Relationships 544

CHAPTER 23 Two Categorical Variables: The Chi-Square Test 547

Two-way tables 547
The problem of multiple comparisons 550
Expected counts in two-way tables 552
The chi-square test 554
Using technology 555
Cell counts required for the chi-square test 559
Uses of the chi-square test 560
The chi-square distributions 563
The chi-square test and the *z* test* 565
The chi-square test for goodness of fit* 566

CHAPTER 24 Inference for Regression 581

Conditions for regression inference 583
Estimating the parameters 584
Using technology 587
Testing the hypothesis of no linear relationship 591
Testing lack of correlation 592
Confidence intervals for the regression slope 594
Inference about prediction 596
Checking the conditions for inference 600

CHAPTER 25 One-Way Analysis of Variance: Comparing Several Means 620

Comparing several means 622
The analysis of variance *F* test 623
Using technology 625

The idea of analysis of variance 630
Conditions for ANOVA 632
F distributions and degrees of freedom 637
Some details of ANOVA: the two-sample case* 639
Some details of ANOVA* 641

Statistical Thinking Revisited 657

Notes and Data Sources 660

Tables 683
Table A Standard Normal probabilities 684
Table B Random digits 686
Table C *t* distribution critical values 687
Table D *F* distribution critical values 688
Table E Chi-square distribution critical values 692
Table F Critical values of the correlation *r* 693

Answers to Selected Exercises 694

Index 721

PART V
Optional Companion Chapters (on the *BPS* CD and online)

CHAPTER 26 Nonparametric Tests 26-1
Comparing two samples: the Wilcoxon rank sum test 26-3
The Normal approximation for W 26-7
Using technology 26-9
What hypotheses does Wilcoxon test? 26-11
Dealing with ties in rank tests 26-12
Matched pairs: the Wilcoxon signed rank test 26-17
The Normal approximation for W^+ 26-20
Dealing with ties in the signed rank test 26-22
Comparing several samples: the Kruskal-Wallis test 26-25
Hypotheses and conditions for the Kruskal-Wallis test 26-26
The Kruskal-Wallis test statistic 26-27

CHAPTER 27 Statistical Process Control 27-1
Processes 27-2
Describing processes 27-2
The idea of statistical process control 27-6
$\bar{x}$ charts for process monitoring 27-8
s charts for process monitoring 27-14
Using control charts 27-21
Setting up control charts 27-24
Comments on statistical control 27-30
Don't confuse control with capability! 27-33
Control charts for sample proportions 27-35
Control limits for *p* charts 27-36

CHAPTER 28 Multiple Regression 28-1
Parallel regression lines 28-2
Estimating parameters 28-6
Using technology 28-11
Inference for multiple regression 28-15
Interaction 28-26
The multiple linear regression model 28-32
The woes of regression coefficients 28-38
A case study for multiple regression 28-42
Inference for regression parameters 28-54
Checking the conditions for inference 28-59

CHAPTER 29 Two-Way Analysis of Variance (available online only)
Extending the one-way ANOVA model
Two-way ANOVA models
Using technology
Inference for two-way ANOVA
Inference for a randomized block design
Multiple comparisons
Contrasts
Conditions for two-way ANOVA