

Contents

1	INTRODUCTION	1
1	What Is Statistics?	3
2	Statistics in Our Everyday Life	3
3	Statistics in Aid of Scientific Inquiry	5
4	Two Basic Concepts—Population and Sample	8
5	The Purposeful Collection of Data	14
6	Statistics in Context	15
7	Objectives of Statistics	17
8	Using Statistics Wisely	18
9	Key Ideas	18
10	Review Exercises	19
2	ORGANIZATION AND DESCRIPTION OF DATA	21
1	Introduction	23
2	Main Types of Data	23
3	Describing Data by Tables and Graphs	24
3.1	Categorical Data	24
3.2	Discrete Data	28
3.3	Data on a Continuous Variable	29
4	Measures of Center	40
5	Measures of Variation	48
6	Checking the Stability of the Observations over Time	60
7	More on Graphics	64
8	Statistics in Context	66
9	Using Statistics Wisely	68
10	Key Ideas and Formulas	68
11	Technology	70
12	Review Exercises	73

1	Introduction	83
2	Summarization of Bivariate Categorical Data	83
3	A Designed Experiment for Making a Comparison	88
4	Scatter Diagram of Bivariate Measurement Data	90
5	The Correlation Coefficient—A Measure of Linear Relation	93
6	Prediction of One Variable from Another (Linear Regression)	104
7	Using Statistics Wisely	109
8	Key Ideas and Formulas	109
9	Technology	110
10	Review Exercises	111

4 PROBABILITY

115

1	Introduction	117
2	Probability of an Event	118
3	Methods of Assigning Probability	124
3.1	Equally Likely Elementary Outcomes — The Uniform Probability Model	124
3.2	Probability As the Long-Run Relative Frequency	126
4	Event Relations and Two Laws of Probability	132
5	Conditional Probability and Independence	141
6	Bayes' Theorem	140
7	Random Sampling from a Finite Population	155
8	Using Statistics Wisely	162
9	Key Ideas and Formulas	162
10	Technology	164
11	Review Exercises	165

5 PROBABILITY DISTRIBUTIONS

171

1	Introduction	173
2	Random Variables	173
3	Probability Distribution of a Discrete Random Variable	176
4	Expectation (Mean) and Standard Deviation of a Probability Distribution	185
5	Successes and Failures—Bernoulli Trials	193
6	The Binomial Distribution	198
7	The Binomial Distribution in Context	208
8	Using Statistics Wisely	211
9	Key Ideas and Formulas	212
10	Technology	213
11	Review Exercises	215

- 1 Probability Model for a Continuous Random Variable 223
- 2 The Normal Distribution—Its General Features 230
- 3 The Standard Normal Distribution 233
- 4 Probability Calculations with Normal Distributions 238
- 5 The Normal Approximation to the Binomial 242
- *6 Checking the Plausibility of a Normal Model 248
- *7 Transforming Observations to Attain Near Normality 251
- 8 Using Statistics Wisely 254
- 9 Key Ideas and Formulas 255
- 10 Technology 256
- 11 Review Exercises 257

7 VARIATION IN REPEATED SAMPLES— SAMPLING DISTRIBUTIONS

263

- 1 Introduction 265
- 2 The Sampling Distribution of a Statistic 266
- 3 Distribution of the Sample Mean and the Central Limit Theorem 273
- 4 Statistics in Context 285
- 5 Using Statistics Wisely 289
- 6 Key Ideas and Formulas 289
- 7 Review Exercises 290
- 8 Class Projects 292
- 9 Computer Project 293

8 DRAWING INFERENCES FROM LARGE SAMPLES

295

- 1 Introduction 297
- 2 Point Estimation of a Population Mean 299
- 3 Confidence Interval for a Population Mean 305
- 4 Testing Hypotheses about a Population Mean 314
- 5 Inferences about a Population Proportion 329
- 6 Using Statistics Wisely 337
- 7 Key Ideas and Formulas 338
- 8 Technology 340
- 9 Review Exercises 343

1	Introduction	351		
2	Student's t Distribution	351		
3	Inferences about μ —Small Sample Size	355		
3.1	Confidence Interval for μ	355		
3.2	Hypotheses Tests for μ	358		
4	Relationship between Tests and Confidence Intervals	363		
5	Inferences about the Standard Deviation (The Chi-Square Distribution)	366		
6	Robustness of Inference Procedures	371		
7	Using Statistics Wisely	372		
8	Key Ideas and Formulas	373		
9	Technology	375		
10	Review Exercises	376		

10 COMPARING TWO TREATMENTS 381

1	Introduction	383		
2	Independent Random Samples from Two Populations	386		
3	Large Samples Inference about Difference of Two Means	388		
4	Inferences from Small Samples: Normal Populations with Equal Variances	394		
5	Inferences from Small Samples: Normal Populations with Unequal Variances	400		
5.1	A Conservative t Test	400		
5.2	An Approximate t Test—Satterthwaite Correction	402		
6	Randomization and Its Role in Inference	407		
7	Matched Pairs Comparisons	409		
7.1	Inferences from a Large Number of Matched Pairs	412		
7.2	Inferences from a Small Number of Matched Pairs	413		
7.3	Randomization with Matched Pairs	416		
8	Choosing between Independent Samples and a Matched Pairs Sample	418		
9	Comparing Two Population Proportions	420		
10	Using Statistics Wisely	426		
11	Key Ideas and Formulas	427		
12	Technology	431		
13	Review Exercises	434		

11 REGRESSION ANALYSIS—I 439
Simple Linear Regression

1	Introduction	441		
2	Regression with a Single Predictor	443		

3	A Straight-Line Regression Model	446
4	The Method of Least Squares	448
5	The Sampling Variability of the Least Squares Estimators— Tools for Inference	456
6	Important Inference Problems	458
	6.1. Inference Concerning the Slope β_1	458
	6.2. Inference about the Intercept β_0	460
	6.3. Estimation of the Mean Response for a Specified x Value	460
	6.4. Prediction of a Single Response for a Specified x Value	463
7	The Strength of a Linear Relation	471
8	Remarks about the Straight Line Model Assumptions	476
9	Using Statistics Wisely	476
10	Key Ideas and Formulas	477
11	Technology	480
12	Review Exercises	481

12 REGRESSION ANALYSIS—II

Multiple Linear Regression and Other Topics 485

1	Introduction	487
2	Nonlinear Relations and Linearizing Transformations	487
3	Multiple Linear Regression	491
4	Residual Plots to Check the Adequacy of a Statistical Model	503
5	Using Statistics Wisely	507
6	Key Ideas and Formulas	507
7	Technology	508
8	Review Exercises	509

13 ANALYSIS OF CATEGORICAL DATA 513

1	Introduction	515
2	Pearson's χ^2 Test for Goodness of Fit	518
3	Contingency Table with One Margin Fixed (Test of Homogeneity)	522
4	Contingency Table with Neither Margin Fixed (Test of Independence)	531
5	Using Statistics Wisely	537
6	Key Ideas and Formulas	537
7	Technology	539
8	Review Exercises	540

14 ANALYSIS OF VARIANCE (ANOVA) 543

1	Introduction	545
2	Comparison of Several Treatments— The Completely Randomized Design	545

3	Population Model and Inferences for a Completely Randomized Design	553
4	Simultaneous Confidence Intervals	557
5	Graphical Diagnostics and Displays to Supplement ANOVA	561
6	Randomized Block Experiments for Comparing k Treatments	563
7	Using Statistics Wisely	571
8	Key Ideas and Formulas	572
9	Technology	573
10	Review Exercises	574

15 NONPARAMETRIC INFERENCE

577

1	Introduction	579
2	The Wilcoxon Rank-Sum Test for Comparing Two Treatments	579
3	Matched Pairs Comparisons	590
4	Measure of Correlation Based on Ranks	599
5	Concluding Remarks	603
6	Using Statistics Wisely	604
7	Key Ideas and Formulas	604
8	Technology	605
9	Review Exercises	605

APPENDIX A1	SUMMATION NOTATION	609
APPENDIX A2	RULES FOR COUNTING	614
APPENDIX A3	EXPECTATION AND STANDARD DEVIATION—PROPERTIES	617
APPENDIX A4	THE EXPECTED VALUE AND STANDARD DEVIATION OF X	622