

Contents

Goals for this Book.....	1
Free Resources for this Book	3
Fundamental Concepts.....	5
Descriptive vs. Inferential Statistics	6
Population Parameters vs. Sample Statistics.....	8
Random Sampling Error	9
Parametric versus Nonparametric Analyses.....	9
Hypothesis Testing.....	10
Null Hypothesis.....	11
Alternative Hypothesis.....	11
Effect.....	12
Significance Level (Alpha)	12
P-values	13
Statistical Significance.....	14
Confidence intervals (CIs)	14
Significance Levels In-Depth.....	14
How Hypothesis Tests Work.....	18
How Confidence Intervals Work	27

Review and Next Steps	33
T-Test Uses, Assumptions, and Analyses	35
1-Sample t-Tests	36
2-Sample t-Tests	40
Paired t-Tests	45
Why Not Accept the Null Hypothesis?	49
Interpreting Failures to Reject the Null	52
Using Confidence Intervals to Compare Means	53
Review and Next Steps	59
Test Statistics and Their Sampling Distributions	61
How 1-Sample t-Tests Calculate t-Values	62
How Two-Sample T-tests Calculate T-Values	65
t-Distributions and Statistical Significance	67
t-Distributions and Sample Size	71
Z-tests versus t-tests	72
Review and Next Steps	75
Interpreting P-values	77
It's All About the Null Hypothesis	78
Defining P-values	79
P-values Are <i>NOT</i> an Error Rate	80
What Is the True Error Rate?	81
Why Are P-values Misinterpreted So Frequently?	83

P-values and the Reproducibility of Experiments.....	85
The Good Side of High P-values	89
Practical vs. Statistical Significance	94
Practical Tips to Avoid Being Fooled	98
Review and Next Steps	103
Types of Errors and Statistical Power.....	105
Fire Alarm Analogy	106
Type I Errors: False Positives.....	107
Type II Errors: False Negatives.....	109
Type II Errors and Statistical Power.....	110
Graphing Type I and Type II Errors.....	110
Is One Error Worse Than the Other?	112
Power and Sample Size Analysis.....	113
Low Power Tests Exaggerate Effect Sizes.....	123
Review and Next Steps	135
One-Tailed and Two-Tailed Hypothesis Tests.....	137
Critical Regions.....	138
Two-Tailed Tests.....	139
One-Tailed Tests.....	141
When Can I Use One-Tailed Tests?.....	145
One-Tailed Tests Can Be the Only Option.....	146

Effects can Occur in Only One Direction	148
Only Need to Detect Effects in One Direction.....	149
Alternative: Two-Tails with a Higher Alpha	153
Review and Next Steps	156
Sample Size Considerations	159
Degrees of Freedom.....	159
Central Limit Theorem.....	168
Review and Next Steps.....	179
Data Types and Hypothesis Tests.....	181
Continuous Data.....	182
Binary Data	185
Count Data	187
Categorical Data	188
Ordinal Data.....	190
Review and Next Steps.....	191
ANOVA Compares More Than Two Groups.....	193
One-Way ANOVA	193
How F-tests work in ANOVA	197
Using Post Hoc Tests with ANOVA.....	205
What is the Experiment-wise Error Rate?.....	208
Tukey's Method.....	211
Post Hoc Tests and the Statistical Power Tradeoff...	214

Dunnett's Compares Treatments to a Control	216
Hsu's MCB to Find the Best.....	217
Recap of Using Multiple Comparison Methods.....	219
Two-Way ANOVA.....	220
Two-Way ANOVA without Interaction.....	222
Two-Way ANOVA with Interaction	225
Interaction Effects in Depth.....	227
Review and Next Steps	228
Continuous Data: Variability, Correlations, Distributions & Outliers.....	231
Testing Variability	232
One-Sample Variance Test	233
Two-Sample Variances Test.....	236
Variances Testing Methods	238
Test of Pearson's Correlation.....	239
Testing the Distribution of Your Continuous Data...	242
Using Distribution Tests	244
Normality Test.....	245
Goodness-of-Fit Tests for Other Distributions	247
Using Probability Plots.....	248
Three-Parameter Distributions.....	249
My Other Books	257

Parameter Values for Our Distribution.....	250
Caution: What These Tests Do NOT Tell You!	252
Outliers.....	254
Guidelines for Removing Outliers.....	259
Five Ways to Find Outliers	260
Finding Outliers with Hypothesis Tests	268
My Philosophy about Finding Outliers	270
Statistical Analyses that Can Handle Outliers.....	271
Review and Next Steps.....	272
Binary Data and Testing Proportions.....	273
One-Sample Proportion Test	275
How the Proportion Test Works.....	277
Two-Sample Proportions Test	278
Binomial Exact Test vs. Normal Approximation	281
Mythbusters Example: Are Yawns Contagious?.....	283
2 Proportions Example: Flu Shot Effectiveness	288
Distributions for Binary Data.....	293
Review and Next Steps	296
Count Data and Rates of Occurrence.....	299
One-Sample Poisson Rate Test	301
Two-Sample Poisson Rate Test.....	303

Poisson Exact Test vs. Normal Approximation.....	305
Goodness-of-Fit for a Poisson Distribution	306
Review and Next Steps	309
Categorical Variables	311
Chi-Square Test of Independence	311
How the Chi-square Test Works	318
Bonus Analysis!	324
Categorical Variables and Discrete Distributions	326
Review and Next Steps	330
Alternative Methods.....	331
Nonparametric Tests vs. Parametric Tests	332
Analyzing Likert Scale Data.....	337
Example of the Mann-Whitney Median Test	340
Bootstrapping Method	342
Wrapping Up	350
Hypothesis Tests by Data Types	355
Continuous Data	355
Binary Data.....	356
Count Data	356
Categorical Data.....	356
Ordinal and Ranked Data.....	356
My Other Books	357

Introduction to Statistics: An Intuitive Guide.....	357
Regression Analysis: An Intuitive Guide	358
Thinking Analytically: A Guide for Making Data-Driven Decisions.....	359
References	361
Recommended Citation for This Book.....	361
Index	363
About the Author.....	367