
Contents

Preface to the Third Edition	v
Preface to the Second Edition	vii
Preface to the First Edition	ix
1 A Wide Range of Applications	1
1.1 Basic Concepts	1
1.1.1 Stochastic Phenomena	1
1.1.2 Distribution Functions	3
1.1.3 Hypotheses	3
1.2 Applications	5
1.3 Testing a Hypothesis	7
1.3.1 Five Steps to a Test	8
1.3.2 Analyze the Experiment	8
1.3.3 Choose a Test Statistic	8
1.3.4 Compute the Test Statistic	9
1.3.5 Determine the Frequency Distribution of the Test Statistic	9
1.3.6 Make a Decision	10
1.3.7 Variations on a Theme	10
1.4 A Brief History of Statistics in Decision-Making	10
1.5 Exercises	12
2 Optimal Procedures	13
2.1 Defining Optimal	13
2.1.1 Trustworthy	13
2.1.2 Two Types of Error	14
2.1.3 Losses and Risk	16
2.1.4 Significance Level and Power	17

	2.1.4.1	Power and the Magnitude of the Effect . . .	18
	2.1.4.2	Power and Sample Size	18
	2.1.4.3	Power and the Alternative	20
	2.1.5	Exact, Unbiased, Conservative	21
	2.1.6	Impartial	22
	2.1.7	Most Stringent Tests	23
2.2		Basic Assumptions	23
	2.2.1	Independent Observations	23
	2.2.2	Exchangeable Observations	24
2.3		Decision Theory	25
	2.3.1	Bayes' Risk	26
	2.3.2	Mini-Max	27
	2.3.3	Generalized Decisions	28
2.4		Exercises	29
3		Testing Hypotheses	33
3.1		Testing a Simple Hypothesis	33
3.2		One-Sample Tests for a Location Parameter	34
	3.2.1	A Permutation Test	34
	3.2.2	A Parametric Test	36
	3.2.3	Properties of the Parametric Test	37
	3.2.4	Student's t	38
	3.2.5	Properties of the Permutation Test	39
	3.2.6	Exact Significance Levels: A Digression	39
3.3		Confidence Intervals	40
	3.3.1	Confidence Intervals Based on Permutation Tests	41
	3.3.2	Confidence Intervals Based on Parametric Tests	42
	3.3.3	Confidence Intervals Based on the Bootstrap	43
	3.3.4	Parametric Bootstrap	45
	3.3.5	Better Confidence Intervals	46
3.4		Comparison Among the Test Procedures	46
3.5		One-Sample Tests for a Scale Parameter	48
	3.5.1	Semiparametric Tests	48
	3.5.2	Parametric Tests: Sufficiency	48
	3.5.3	Unbiased Tests	50
	3.5.4	Comparison Among the Test Procedures	50
3.6		Comparing the Location Parameters of Two Populations	51
	3.6.1	A UMPU Parametric Test: Student's t	51
	3.6.2	A UMPU Semiparametric Procedure	51
	3.6.3	An Example	54
	3.6.4	Comparison of the Tests: The Behrens–Fisher Problem	54

3.7	Comparing the Dispersions of Two Populations	57
3.7.1	The Parametric Approach	57
3.7.2	The Permutation Approach	58
3.7.3	The Bootstrap Approach	61
3.8	Bivariate Correlation	62
3.9	Which Test?	63
3.10	Exercises	63
4	Distributions	67
4.1	Properties of Independent Observations	67
4.2	Binomial Distribution	67
4.3	Poisson: Events Rare in Time and Space	68
4.3.1	Applying the Poisson	69
4.3.2	A Poisson Distribution of Poisson Distributions	70
4.3.3	Comparing Two Poissons	70
4.4	Time Between Events	71
4.5	The Uniform Distribution	71
4.6	The Exponential Family of Distributions	72
4.6.1	Proofs of the Properties	73
4.6.2	Normal Distribution	74
4.7	Which Distribution?	75
4.8	Exercises	75
5	Multiple Tests	79
5.1	Controlling the Overall Error Rate	79
5.1.1	Standardized Statistics	80
5.1.2	Paired Sample Tests	81
5.2	Combination of Independent Tests	81
5.2.1	Omnibus Statistics	82
5.2.2	Binomial Random Variables	82
5.2.3	Bayes' Factor	83
5.3	Exercises	84
6	Experimental Designs	85
6.1	Invariance	85
6.1.1	Some Examples	86
6.2	k -Sample Comparisons—Least-Squares Loss Function	87
6.2.1	Linear Hypotheses	87
6.2.2	Large and Small Sample Properties of the F -ratio Test	89
6.2.3	Discrete Data and Time-to-Event Data	90
6.3	k -Sample Comparisons—Other Loss Functions	91
6.3.1	F -ratio	91
6.3.2	Pitman Correlation	92

6.3.3	Effect of Ties	95
6.3.4	Cochran–Armitage Test	96
6.3.5	Linear Estimation	96
6.3.6	A Unifying Theory	97
6.4	Four Ways to Control Variation	97
6.4.1	Control the Environment	98
6.4.2	Block the Experiment	98
	6.4.2.1 Using Ranks	99
	6.4.2.2 Matched Pairs	100
6.4.3	Measure Factors That Cannot Be Controlled	101
	6.4.3.1 Eliminate the Functional Relationship	101
	6.4.3.2 Selecting Variables	102
	6.4.3.3 Restricted Randomization	102
6.4.4	Randomize	103
6.5	Latin Square	104
6.6	Very Large Samples	106
6.7	Sequential Analysis	107
6.7.1	A Vaccine Trial	107
6.7.2	Determining the Boundary Values	110
6.7.3	Power of a Sequential Analysis	110
6.7.4	Expected Sample Size	111
6.7.5	Curtailed Inspection	112
6.7.6	Restricted Sequential Sampling Schemes	112
6.8	Sequentially Adaptive Treatment Allocation	113
6.8.1	Group Sequential Trials	113
6.8.2	Determining the Sampling Ratio	113
6.8.3	Exact Random Allocation Tests	114
6.9	Exercises	115
7	Multifactor Designs	119
7.1	Multifactor Models	119
7.2	Analysis of Variance	120
7.3	Permutation Methods: Main Effects	124
	7.3.1 An Example	125
7.4	Permutation Methods: Interactions	126
7.5	Synchronized Rearrangements	127
	7.5.1 Exchangeable and Weakly Exchangeable Variables	128
	7.5.2 Two Factors	129
	7.5.3 Three or More Factors	132
	7.5.4 Similarities	133
	7.5.5 Test for Interaction	135
7.6	Unbalanced Designs	137
	7.6.1 Missing Combinations	138
	7.6.2 The Boot-Perm Test	139

7.7	Which Test Should You Use?	140
7.8	Exercises	140
8	Categorical Data	143
8.1	Fisher’s Exact Test	143
8.1.1	Hypergeometric Distribution	145
8.1.2	One-Tailed and Two-Tailed Tests	145
8.1.3	The Two-Tailed Test	146
8.1.4	Determining the p -Value	146
8.1.5	What is the Alternative?	148
8.1.6	Increasing the Power	148
8.1.7	Ongoing Controversy	149
8.2	Odds Ratio	150
8.2.1	Stratified 2×2 ’s	151
8.3	Exact Significance Levels	152
8.4	Unordered $r \times c$ Contingency Tables	154
8.4.1	Agreement Between Observers	156
8.4.2	What Should We Randomize?	157
8.4.3	Underlying Assumptions	158
8.4.4	Symmetric Contingency Tables	158
8.5	Ordered Contingency Tables	160
8.5.1	Ordered $2 \times c$ Tables	160
8.5.1.1	Alternative Hypotheses	161
8.5.1.2	Back-up Statistics	162
8.5.1.3	Directed Chi-Square	162
8.5.2	More Than Two Rows and Two Columns	163
8.5.2.1	Singly Ordered Tables	163
8.5.2.2	Doubly Ordered Tables	163
8.6	Covariates	164
8.6.1	Bross’ Method	164
8.6.2	Blocking	165
8.7	Exercises	166
9	Multivariate Analysis	169
9.1	Nonparametric Combination of Univariate Tests	169
9.2	Parametric Approach	171
9.2.1	Canonical Form	171
9.2.2	Hotelling’s T^2	172
9.2.3	Multivariate Analysis of Variance (MANOVA)	173
9.3	Permutation Methods	173
9.3.1	Which Test—Parametric or Permutation?	175
9.3.2	Interpreting the Results	176

9.4	Alternative Statistics	177
9.4.1	Maximum- t	177
9.4.2	Block Effects	177
9.4.3	Runs Test	178
9.4.4	Which Statistic?	180
9.5	Repeated Measures	181
9.5.1	An Example	181
9.5.2	Matched Pairs	182
9.5.3	Response Profiles	183
9.5.4	Missing Data	183
9.5.5	Bioequivalence	184
9.6	Exercises	185
10	Clustering in Time and Space	189
10.1	The Generalized Quadratic Form	189
10.1.1	Mantel's U	189
10.1.2	An Example	189
10.2	Applications	190
10.2.1	The MRPP Statistic	190
10.2.2	The BW Statistic of Cliff and Ord [1973]	191
10.2.3	Equivalences	192
10.2.4	Extensions	192
10.2.5	Another Dimension	192
10.3	Alternate Approaches	193
10.3.1	Quadrant Density	193
10.3.2	Nearest-Neighbor Analysis	193
10.3.3	Comparing Two Spatial Distributions	193
10.4	Exercises	194
11	Coping with Disaster	195
11.1	Missing Data	195
11.2	Covariates After the Fact	197
11.2.1	Observational Studies	197
11.3	Outliers	198
11.3.1	Original Data	199
11.3.2	Ranks	199
11.3.3	Scores	200
11.3.4	Robust Transformations	201
11.3.5	Use an L_1 Test	201
11.3.6	Censoring	201
11.3.7	Discarding	202
11.4	Censored Data	202
11.4.1	GAMP Tests	202
11.4.2	Fishery and Animal Counts	204

11.5	Censored Match Pairs	204
11.5.1	GAMP Test for Matched Pairs	205
11.5.2	Ranks	206
11.5.3	One-Sample: Bootstrap Estimates	206
11.6	Adaptive Tests	207
11.7	Exercises	208
12	Solving the Unsolved and the Insolvable	209
12.1	Key Criteria	209
12.1.1	Sufficient Statistics	209
12.1.2	Three Stratagems	210
12.1.3	Restrict the Alternatives	210
12.1.4	Consider the Loss Function	212
12.1.5	Impartiality	213
12.2	The Permutation Distribution	213
12.2.1	Ensuring Exchangeability	213
	12.2.1.1 Test for Parallelism	214
	12.2.1.2 Linear Transforms That Preserve Exchangeability	215
12.3	New Statistics	216
12.3.1	Nonresponders	216
	12.3.1.1 Extension to K -samples	217
12.3.2	Animal Movement	217
12.3.3	The Building Blocks of Life	217
12.3.4	Structured Exploratory Data Analysis	218
12.3.5	Comparing Multiple Methods of Assessment	219
12.4	Model Validation	221
12.4.1	Regression Models	221
	12.4.1.1 Via the Bootstrap	221
	12.4.1.2 Via Permutation Tests	221
12.4.2	Models With a Metric	222
12.5	Bootstrap Confidence Intervals	223
12.5.1	Hall–Wilson Criteria	224
12.5.2	Bias-Corrected Percentile	225
12.6	Exercises	226
13	Publishing Your Results	229
13.1	Design Methodology	229
13.1.1	Randomization in Assignment	229
13.1.2	Choosing the Experimental Unit	230
13.1.3	Determining Sample Size	231
13.1.4	Power Comparisons	231
13.2	Preparing Manuscripts for Publication	231
13.2.1	Reportable Elements	232
13.2.2	Details of the Analysis	232

14	Increasing Computational Efficiency	233
14.1	Seven Techniques	233
14.2	Monte Carlo	233
14.2.1	Stopping Rules	234
14.2.2	Variance of the Result	235
14.2.3	Cutting the Computation Time	235
14.3	Rapid Enumeration and Selection Algorithms	236
14.3.1	Matched Pairs	236
14.4	Recursive Relationships	236
14.5	Focus on the Tails	237
14.5.1	Contingency Tables	239
14.5.1.1	Network Representation	239
14.5.1.2	The Network Algorithm	241
14.5.2	Play the Winner Allocation	242
14.5.3	Directed Vertex Peeling	242
14.6	Gibbs Sampling	243
14.6.1	Metropolis–Hastings Sampling Methods	244
14.7	Characteristic Functions	245
14.8	Asymptotic Approximations	246
14.8.1	A Central Limit Theorem	246
14.8.2	Edgeworth Expansions	246
14.8.3	Generalized Correlation	247
14.9	Confidence Intervals	247
14.10	Sample Size and Power	248
14.10.1	Simulations	248
14.10.2	Network Algorithms	249
14.11	Some Conclusions	250
14.12	Software	251
14.12.1	Do-It-Yourself	251
14.12.2	Complete Packages	252
14.12.2.1	Freeware	252
14.12.2.2	Shareware	252
14.12.2.3	\$\$\$\$	252
14.13	Exercises	253
	Appendix: Theory of Testing Hypotheses	255
A.1	Probability	255
A.2	The Fundamental Lemma	257
A.3	Two-Sided Tests	258
A.3.1	One-Parameter Exponential Families	259
A.4	Tests for Multiparameter Families	262
A.4.1	Basu’s Theorem	262
A.4.2	Conditional Probability and Expectation	263
A.4.3	Multiparameter Exponential Families	263

A.5	Exchangeable Observations	268
	A.5.1 Order Statistics	269
	A.5.2 Transformably Exchangeable	270
	A.5.3 Exchangeability-Preserving Transforms	271
A.6	Confidence Intervals	272
A.7	Asymptotic Behavior	273
	A.7.1 A Theorem on Linear Forms	273
	A.7.2 Monte Carlo	274
	A.7.3 Asymptotic Efficiency	274
	A.7.4 Exchangeability	275
	A.7.5 Improved Bootstrap Confidence Intervals	276
A.8	Exercises	276
	Bibliography	279
	Author Index	303
	Subject Index	309



<http://www.springer.com/978-0-387-20279-2>

Permutation, Parametric, and Bootstrap Tests of Hypotheses

Good, P.I.

2005, XX, 316 p. 14 illus., Hardcover

ISBN: 978-0-387-20279-2