CONTENTS

Preface	2
I I CIUCO	-

PART ONE PROBLEMS, DATA, AND PROBABILITY MODELS

1 Some Simple Data Analysis

- 1-1 Errors in Estimation and Prediction–Why we predict the way we do
- 1-2 Absolute-error, Mean-squared Error, Zero-one, and Threshold Loss-A little theory applied to some data 6
- 1-3 Robustness of Loss Functions-Some estimates are good even if we are uncertain of consequences 13
- 1-4 Inferring Population Characteristics from Sample Data-Looking beyond our present data 15
- 1-5 The Estimation and Comparison of Means and Standard Deviations-Just a suggestion that there is often some available background information
 16
- 1-6 Prediction with Many Variables-Some pretty clear evidence that the use of background information is necessary 18
- 1-7 Exercises 22

xiii

xvii

3

3

h	Analysis of Categorized Data		23
2	Creating and Expectancy Tables_Simple but useful tools 23		
2-1	The Lies of Expectancy Tables in Guidance—A little care goes a long way	32	
2-2	Double Entry Expectancy Tables—A lot of care required here 37		
2-5 7-1	Exercises 42		
2-7			
3	Probability Models		44
3-1	Probability Measures—The mathematical entity and its meanings in the real world 45		
3-2	Conditional Probability—The heart of all statistical inference 47		
3-3	Independence—A very careful look at just what this means 55		
3-4	Random Variables—A few symbols carrying much information 57		
3-5	Joint Distributions–Another feature of contingency tables 67		
3-6	Bayes' Theorem for Random Variables—A first look 70		
3-7	Exercises 73		
4	Regression and Correlation with Application to the Estimation of Ability		7
4-1	The Algebra of Expectations—A careful look at means and variances in subpopulations 75		
4-2	Regression Functions and Correlation Ratios-A short introduction to a		
	general method of prediction 81		
4-3	Innear Regression and Correlation Coefficients—A closer look at a simpler method 82		
4-4	4 The Concept of Error-The data show that there are many sources of error 85		
4-5	5 The Basic Relations of the Classical Test Theory Model-The variability		
	and unreliability of human response 87		
4-(6 Expressing Parameters of Unobservables in Terms of Parameters of		
	Observables—Some interesting and useful equations 89		
4-	7 The Estimation of True-Score–Truman Kelley was using Bayesian		
	methods 50 years ago, but neither he nor his successors realized it 93		
4-0	8 Exercises 96		
	PART TWO ELEMENTARY BAYESIAN METHODS		
	5 Bayesian Analysis of Binary Data		

- 5-1 Binary Data-The analysis of two-category data 99
- 5-2 The Binomial Model-The binomial distribution 100
- 5-3 Numerical Values for Binomial Probabilities-Tables and approximations 103

5

99

5-4	Inference for the Binomial Model—The simplest example of Bayesian inference 107	
5-5	Point and Interval Estimates of a Binomial Parameter—A close look at posterior distributions 113	
5-6	Exercises 126	
6	The Logical Basis of Bayesian Inference	128
6-1	Bayes' Theorem for Several Parameters—A more general form for Bayes' theorem 128	
6-2	Model Density, Likelihood, Sufficient Statistics–Some tools for organizing the analysis 129	
6-3	Prior and Posterior Bayes' Densities, Natural Conjugate Distributions– When appropriate, the latter make Bayesian analysis very easy 136	
6-4	Predictive Densities–Neglected tools 141	
6-5	Belief Probabilities: Subjective and Logical–How to write down your prior distribution 144	
6-6	Some Notes on Logical Probability–A usable, if imperfect zero point* 154	
6-7	A Worked Example of Bayesian Beta-binomial Analysis—Step-by-step, from specifying the prior to analyzing the posterior 156	
6-8	Computer-assisted Data Analysis–Beta-binomial analysis 160	
6-9	Case Studies in Beta-binomial Analysis 170	
6-10	Exercises 182	
7	Bayesian Inference for the Normal Model	183
7-1	Review of the Known-variance Model—A review with an elaboration of some further details 184	
7-2	The Chi-square Distribution–A distribution needed soon 186	
7-3	The Inverse Chi-square and Inverse Chi Distributions—Further distributions needed soon 188	
7-4	The Normal Model with Known Mean and Unknown Variance– Assessing the accuracy of measuring instruments 197	
7-5	Student's Distribution-A generalized form 204	
7-6	The Normal Model with Unknown Mean and Variance–Method and applications 206	
7-7	Quantification of Prior Information–It can be done 212	
7-8	Computer-assisted Data Analysis-The Two-parameter Normal Model 217	
7-9	Two-parameter Normal Analysis—The General Form 223	
7-10	Comparison of the Results for the Various Models-Some useful insights* 22	26
7-11	Two Important Distributional Results—Have a look at these if you are interested in the mathematics supporting our methods* 228	

x CONTENTS

229 7-12 Case Studies in Normal Analysis

7-13 Exercises 237

PART THREE BAYESIAN METHODS FOR COMPARING PARAMETERS

8 Bayesian Inference for Two Normal Distributions 8-1 Comparison of Two Normal Means-The workhorse statistical analysis 243 8-2 Comparison of Two Normal Variances-An infrequently used technique 255 8-3 Case Studies in Normal Analysis-Comparisons in Two Populations 263 8-4 Exercises 275 9 Regression and the Bivariate Normal Model 9-1 The Linear-regression Model 279 9-2 Correlation in the Bivariate Normal Model 295 9-3 The Difference between Means of Correlated Pairs of Observations-A method for estimating change 305 9-4 Estimation and Comparison of a Set of Normal Means-A glimpse at "modern" methods of simultaneous estimation 308 9-5 Classical Test Theory and the Estimation of Many Means-This "modern" method has a long history 312 9-6 Regressed Estimates of Error Variances and Means-A meaningful refinement 318 10 Further Bayesian Analysis of Discrete Data 323 10-1 Inferences about Proportions Using the Arcsine Transformation-Stabilized variances with small sample sizes 324 10-2 The Log-odds Transformation-Normality for moderate size samples 328 10-3 The Poisson Approximation-Useful with very small or very large proportions and large samples 330 10-4 The Normal Approximation-Useful with moderate size proportions and large samples 335

- 10-5 Direct Methods of Comparing Binomial Proportions-A simple technique if you have the right computer program 338
- 10-6 A Summary of Bayesian Methods for Binary Data 342
- 19-7 Bayesian Analysis of the Multicategory Model-Surprisingly simple and extremely useful 344

243

278

10-8	Regressed Estimates of Proportions-A contingency tables 351	simple method of "smoothing"				
10-9	A Smoothing of a Contingency Table 353 Appendix Contents Appendix		359			
				Statistical Tables		361
					Index	