Contents

Preface xiii

List of Contributors xv

Publications of G. S. Watson xix

AUTOBIOGRAPHICAL ARTICLES BY G. S. WATSON xxvii

A Boy from the Bush xxix

"Circling the Square" xlviii

INTRODUCTION 1

Chapter 1 ***The Art of Statistical Science*** **and Geof Watson** 3
K. V. Mardia

1.1 Time series 3
1.2 Directional data analysis 4
1.3 Compositional and shape data analysis 4
1.4 Technical problems in inference 5
1.5 Spatial statistics 5
1.6 Statistics and genetics 6
1.7 Case studies on issues of public policy 6

PART I TIME SERIES 7

Chapter 2 **The Asymptotic Distribution of Autocorrelation Coefficients** 9
T. W. Anderson

2.1 Introduction 9
2.2 Proof of theorem 14
2.3 Proof of corollary 21
2.4 Discussion 22

Chapter 3 On a Test of Serial Correlation for Regression Models with Lagged Dependent Variables 27
J. Durbin

3.1 Introduction 27
3.2 The *h*-statistic 28
3.3 Derivation of significance points of *h* from those of the variance ratio distribution 30

Chapter 4 Missed Opportunities 33
E. J. Hannan

4.1 How is research done? 33
4.2 The missed opportunities 35
4.3 Conclusion 44

PART II DIRECTIONAL DATA ANALYSIS 45

Chapter 5 Bootstrap Methods for Directional Data 47
N. I. Fisher and P. Hall

5.1 Introduction 47
5.2 Some bootstrap confidence regions for directional data 48
5.3 Bootstrap comparison of mean direction and the fold test problem in palaeomagnetism 53
5.4 Concluding remarks 62

Chapter 6 Optimal Robust Estimators for the Concentration Parameter of a von Mises–Fisher Distribution 65
E. Ronchetti

6.1 Introduction 65
6.2 Robustness concepts 66
6.3 Optimal robust estimators for the concentration parameter 69
6.4 General *M*-estimators 72

Chapter 7 On Watson's ANOVA for Directions 75
M. A. Stephens

7.1 Introduction 75
7.2 The ANOVA technique 76
7.3 Exact and approximate tests 77
7.4 A multiway layout 79
7.5 Two dimensions 81
7.6 Higher dimensions 82
7.7 Conditional tests and ANOVA 83

PART III COMPOSITIONAL AND SHAPE DATA ANALYSIS 87

Chapter 8 The Triangle in Statistics 89
J. Aitchison

8.1 Prologue 89
8.2 The triangle as sample space 90
8.3 The triangle as parameter space 99
8.4 The triangle as design space 99
8.5 The triangle as a teaching aid 100
8.6 Postlude: the triangle and the sphere 102

Chapter 9 Spherical Triangles Revisited 105
D. G. Kendall

9.1 Introduction 105
9.2 The problem 107
9.3 The shape space is a 3-sphere 108
9.4 Discussion 110

Chapter 10 New Directions in Shape Analysis 115
J. T. Kent

10.1 Introduction 115
10.2 Combining data 116
10.3 Embeddings 122
10.4 Weighting functions 126

PART IV TECHNICAL PROBLEMS IN INFERENCE 129

Chapter 11 Inversion and Index Notation 131
O. E. Barndorff-Nielsen and P. Blæsild

11.1 Introduction 131
11.2 Preliminaries on notation 132
11.3 Lower triangular matrices 133
11.4 The multiderivatives of an inverse mapping 136
11.5 Inversion of asymptotic series 142
11.6 The case of 0–1 lower triangular matrices 144
11.7 Derivative strings 148

Chapter 12 Tests of Fit for Logistic Models 153
R. J. Beran and P. W. Millar

12.1 Introduction 153
12.2 The logistic model 155

12.3 Asymptotics for the test statistic (12.2.6) 157
12.4 A computable test statistic 158
12.5 Calculation of critical values 161
12.6 Asymptotics for the approximating test statistics (12.4.3) 162
12.7 Proofs 163
12.8 Appendix 167

Chapter 13 A Class of Nearly Exact Saddlepoint Approximations **173**
H. E. Daniels

13.1 Introduction 173
13.2 The birth process 174
13.3 A nearly exact distribution 175
13.4 Further examples 176
13.5 A case where the distribution function is unknown 178
13.6 Comments 180

Chapter 14 Exbrids: Simple Nearly Symmetrizing Reexpressions for Exponentially Distributed Quantities **183**
John W. Tukey

14.1 Introduction 183
14.2 Some candidates 184
14.3 Discussion 184
14.4 Conclusion 187

PART V SPATIAL STATISTICS **189**

Chapter 15 A Comparison of Variogram Estimation with Covariogram Estimation **191**
Noel Cressie and Martin O. Grondona

15.1 Introduction 191
15.2 Processes and estimators 193
15.3 Bias of variogram and covariogram estimators 194
15.4 Other points of comparison 202
15.5 Exact distribution theory for the variogram estimator 204
15.6 Conclusions and discussion 206

Chapter 16 How to Charge for Boundaries in a Pixel Image **209**
C. Jennison and B. W. Silverman

16.1 Introduction 209
16.2 Square lattices 212
16.3 Irregular and uneven pixel arrays 215
16.4 Regular arrays revisited 225

PART VI STATISTICS AND GENETICS 231

Chapter 17 On the Role of Mathematical Statistics in Population Genetics 233
W. J. Ewens

17.1 Introduction 233
17.2 Evolutionary theory 235
17.3 Fitness 242
17.4 Mathematical population genetics 243
17.5 Tactical questions 250
17.6 Retrospective analyses 253
17.7 Human genetics 254

Chapter 18 Stochastic Comparisons between Means and Medians for i.i.d. Random Variables 261
Samuel Karlin

18.1 Introduction 261
18.2 Proofs of Theorems 18.1 and 18.2 265
18.3 Stochastic ordering comparison of the mean and median for samples from the univariate normal density 269
18.4 Dynamics of sex ratios 272
18.5 Some open problems 274

PART VII CASE STUDIES ON ISSUES OF PUBLIC POLICY 275

Chapter 19 Parameter Estimation in the Operational Modelling of HIV/AIDS 277
Norman T. J. Bailey

19.1 Introduction 278
19.2 The data available 279
19.3 The problems of heterogeneity and complexity 282
19.4 Incubation period models 283
19.5 Total size of high-risk subgroup 284
19.6 Inclusion of demographic factors 285
19.7 Combined compartmental model for HIV/AIDS 286
19.8 Parameter estimation and model fitting 288
19.9 Analysis of San Francisco data on HIV and AIDS 291
19.10 Summary and conclusions 295

Chapter 20 Statistical Estimation of Climatic Trends 299
Peter Bloomfield

20.1 Introduction 299
20.2 Global temperature 300

20.3 Statistical models 301
20.4 Temperature change 307
20.5 Consistency of predictions and observations 307
20.6 Conclusions 309

Index 313

Photograph 1 Geoffrey Stuart Watson (taken at an exhibition of his paintings on 5 March 1989) ii

Photograph 2 Geoffrey Stuart Watson (1975) in his Fine Hall Office in Princeton xix

Photograph 3 Geoffrey Stuart Watson (1947) at the University of Melbourne xxviii

Photograph 4 Reproduction of "The Remarkables, N. Z. (1957)" xlviii

Photograph 5 A rare occurrence: specialists in Directional Statistics at a session on the topic at the European Meeting of Statisticians, Leuven, August 1989 2