Contents

Preface vii

A Note to the Reader xv

1. Introduction to Nonparametric Statistics 1

1. Introduction, *1*
2. Analysis of Data by Statistical Inference, *4*
   - 2.1 Preliminaries, *4*
   - 2.2 Hypothesis Testing, *10*
   - 2.3 Estimation, *15*
3. Classification of Data, *17*
4. Nonparametric Statistical Methods, *22*
5. Advantages of Nonparametric Methods, *24*
6. Guide for Selection of Test Procedures, *28*
7. Organization of this Book, *31*
8. Suggestions for Further Reading, *34*

2. Goodness-of-Fit Tests 36

1. Introduction, *36*
2. The Chi-Square Goodness-of-Fit Test, *37*
3. Kolmogorov-Smirnov Procedures, *56*
   - 3.1 The Kolmogorov-Smirnov Goodness-of-Fit Test, *56*
   - 3.2 Other Inferences Based on the Kolmogorov-Smirnov Statistics, *72*
4. Comparison of the Chi-Square and Kolmogorov-Smirnov Tests for Goodness of Fit, *75*

Problems, *77*

3. Inferences Concerning Location Based on One Sample or Paired Samples 89

1. Introduction, *89*
2. Sign Test Procedures, *94*
   - 2.1 Ordinary Sign Test, *94*
   - 2.2 Sign Test for Location, *106*
   - 2.3 Confidence Intervals for the Median or Median Difference, *114*
   - 2.4 The Binomial Test and Quantile Test, *118*
3. Wilcoxon Signed Rank Procedures, *123*
   - 3.1 Wilcoxon Signed Rank Test for Location, *123*
   - 3.2 Tests for Symmetry, *135*
   - 3.3 Confidence Intervals for the Median or Median Difference, *137*
4. Comparison of the Sign Test and Signed Rank Test, *141*
5. Inference from Nonrandom Samples, *143*

Problems, *144*

4. Inferences Concerning Location Based on Two or More Samples 157

1. Introduction, *157*
2. Two Independent Samples: Mann-Whitney-Wilcoxon Procedures, *159*
   - 2.1 Mann-Whitney-Wilcoxon Test, *160*
   - 2.2 Confidence Interval Estimation of the Shift Parameter, *171*
3. k Independent Samples: Kruskal-Wallis Procedures, *173*
   - 3.1 Kruskal-Wallis Test, *175*
   - 3.2 Multiple Comparisons, *181*
4. Summary, *192*

Problems, *193*

5. Inferences Concerning Scale Parameters 205

1. Introduction, *205*
2. Test Procedures: Medians Equal or Known, *207*
   - 2.1 Siegel-Tukey Test, *207*
   - 2.2 Other Test Procedures, *218*
3. Confidence Interval Procedures, *223*
4. Inference Procedures: Medians Unequal and Unknown, *229*
5. Summary, *234*

Problems, *236*

6. General Distribution Tests for Two or More Independent Samples 241

1. Introduction, *241*
2. Two Independent Samples, *242*
   - 2.1 Chi-Square Two-Sample Test, *242*
   - 2.2 Kolmogorov-Smirnov Two-Sample Test, *250*
3. k Independent Samples, *258*
   - 3.1 Extensions of Chi-Square and Kolmogorov-Smirnov Tests, *258*
   - 3.2 Test for Equality of k Proportions, *259*
4. Summary, *262*

   Problems, *263*

7. Association Analysis 273

1. Introduction, *273*
2. Two Related Samples, *274*
   - 2.1 Rank Correlation, *275*
   - 2.2 Kendall Tau Statistic, *284*
   - 2.3 Additional Notes, *294*
   - 2.4 Comparison of the Rank Correlation Coefficient and Kendall Tau Statistic, *296*
   - 2.5 Partial Correlation, *298*
3. k Related Samples, *300*
   - 3.1 Kendall Coefficient of Concordance for Complete Rankings, *301*
   - 3.2 Friedman Test and Multiple Comparisons, *310*
   - 3.3 Kendall Coefficient of Concordance for Incomplete Rankings, *317*
4. Count Data from Classificatory Samples, *324*
   - 4.1 Chi-Square Test for Independence, *325*
   - 4.2 Measures of Association in Contingency Tables, *330*
5. Measures of Association for Special Types of Data, *339*
6. Summary, *341*

   Problems, *343*

8. Tests for Randomness 363

1. Introduction, *363*
2. Ordinary Runs Test, *365*
3. Runs Up and Down, *371*
4. Summary, *377*

   Problems, *378*

Appendix 383

Review of Sigma (Σ) Notation, *383*
Table A Normal Distribution, *385*
Table B Chi-Square Distribution, *386*
Table C Kolmogorov-Smirnov One-Sample Statistic, *388*
Table D Kolmogorov-Smirnov Two-Sample Statistic, *389*
Table E Cumulative Binomial Distribution, *392*
Table F Cumulative Binomial Distribution for $\theta = .5$, *404*
Table G Cumulative Probabilities for Wilcoxon Signed Rank Statistic, *406*
Table H Mann-Whitney-Wilcoxon Distribution, *409*
Table I Spearman Rank Correlation Statistic, *417*
Table J Kendall Tau Statistic, *420*
Table K Kendall Coefficient of Concordance and Friedman Analysis of Variance Statistics, *422*
Table L Number of Runs Distribution, *424*
Table M Number of Runs Up and Down Distribution, *429*
Table N Critical z Values for p Multiple Comparisons, *432*
Table O Random Numbers, *433*
Table P Squares and Square Roots, *436*

Bibliography 445

List of References, *445*
List of Experiments, *449*

Answers to Even-numbered Problems 453

Index 457