
Preface	<i>page</i>	x
Notation conventions		xiii
1 Some properties of basic statistical procedures		1
1.1 Problems of statistics		1
1.2 The t , χ^2 and F procedures		3
1.3 Standard assumptions and their plausibility		8
1.4* Tests of normality		13
1.5* Moments of \bar{x} and s^2		16
1.6* The effect of skewness and kurtosis on the t -test		18
1.7* The effect of skewness and kurtosis on inferences about variances		19
1.8* The effect of serial correlation		20
1.9* The effect of unequal variances on the two-sample t -test		21
1.10 Discussion		22
Further reading		23
2 Regression and the linear model		24
2.1 Linear models		24
2.2 The method of least squares		28
2.3 Properties of the estimators and sums of squares		32
2.4 Further analysis of Example 2.1		37
2.5 The regressions of y on x and of x on y		41
2.6 Two regressor variables		43
2.7 Discussion		46
3 Statistical models and statistical inference		47
3.1 Parametric inference		47
3.2 Point estimates		48
3.3 The likelihood function		53

3.4	The method of maximum likelihood	60
3.5	The Cramér–Rao inequality	62
3.6*	Sufficiency	65
3.7	The multivariate normal distribution	67
3.8*	Proof of the Cramér–Rao inequality	71
	Further reading	73
4	Properties of the method of maximum likelihood	74
4.1	Introduction	74
4.2	Formal statements of main properties	78
4.3	Practical aspects – one-parameter case	90
4.4	Practical aspects – multiparameter case	96
4.5	Other methods of estimation	102
5	The method of least squares	103
5.1	Basic model	103
5.2	Properties of the method	109
5.3	Properties of residuals	113
5.4	Properties of sums of squares	118
5.5	Application to multiple regression	124
	Further reading	129
6	Multiple regression: Further analysis and interpretation	130
6.1	Testing the significance of subsets of explanatory variables	130
6.2	Application of the extra sum-of-squares principle to multiple regression	132
6.3	Problems of interpretation	138
6.4*	Relationships between sums of squares	144
6.5	Departures from assumptions	146
6.6	Predictions from regression	148
6.7	Strategies for multiple regression analysis	150
6.8	Practical details	154
	Further reading on practical points	156
7	Polynomial regression	157
7.1	Introduction	157
7.2	General theory	161
7.3	Derivation of the polynomials	164
7.4	Tables of orthogonal polynomials	167
7.5	An illustrative example	167
8	The use of transformations	171
8.1	Introduction	171

8.2	One explanatory variable	173
8.3	Transformations for homogeneity of variance	175
8.4	An example	177
8.5	The Box–Cox transformation	179
8.6	Transformations of regressor variables	181
8.7	Application to bioassay data	183
	Further reading	184
9	Correlation	185
9.1	Definition and examples	185
9.2	Correlation or regression?	186
9.3	Estimation of ρ	188
9.4	Results on the distribution of R	189
9.5	Confidence intervals and hypothesis tests for ρ	191
9.6	Relationship with regression	194
9.7	Partial correlation	195
9.8	The multiple correlation coefficient	197
	Further reading	198
10	The analysis of variance	199
10.1	An example	199
10.2	Generalized inverses	203
10.3	Least squares using generalized inverses	206
10.4	One-way classification analysis of variance	207
10.5	A discussion of Example 10.1	214
10.6	Two-way classification	217
10.7	A discussion of Example 10.2	222
10.8	General method for analysis of variance	225
	Further reading	228
11	Designs with regressions in the treatment effects	229
11.1	One-way analysis	229
11.2	Parallel regressions	237
11.3	The two-way analysis	241
12	An analysis of data on trees	246
12.1	The data	246
12.2	Regression analyses	249
12.3	The analysis of covariance	251
12.4	Residuals	252
13	The analysis of variance: Subsidiary analyses	254
13.1	Multiple comparisons: Introduction	254
13.2	Multiple comparisons: Various techniques	256

13.3	Departures from underlying assumptions	263
13.4	Tests for heteroscedasticity	267
13.5	Residuals and outliers	268
13.6	Some points of experimental design: General points	269
13.7	Some points of experimental design: Randomized blocks	271
	Further reading on experimental design	275
14	Components of variance	276
14.1	Components of variance	276
14.2	Components of variance: Follow-up analysis	278
14.3	Nested classifications	286
14.4	Outline analysis of Example 14.3	291
14.5	Nested classifications: Finite population model	297
14.6*	Sampling from finite populations	300
14.7	Nested classifications with unequal numbers	303
	Further reading	306
15	Crossed classifications	307
15.1	Crossed classifications and interactions	307
15.2	More about interactions	311
15.3	Analysis of a two-way equally replicated design	313
15.4	An analysis of Example 15.1	317
15.5	Unit errors	322
15.6	Random-effects models	324
15.7*	Analysis of a two-way unequally replicated design	325
	Further reading	330
16	Further analysis of variance	331
16.1*	Three-way crossed classification	331
16.2	An analysis of Example 16.1	338
	Further reading	341
17	The generalized linear model	342
17.1	Introduction	342
17.2	The maximum likelihood ratio test	343
17.3	The family of probability distributions permitted	346
17.4	The generalized linear model	348
17.5	The analysis of deviance	349
17.6	Illustration using the radiation experiment data	350
	Further reading	353
	References	354
	Appendix A Some important definitions and results	360
	Appendix B Some published data sets	367

Appendix C Statistical tables	371
1. Cumulative distribution function of the standard normal distribution	371
2. Percentiles of the standard normal distribution	372
3. Percentage points of the t -distribution	373
4. Percentage points of the χ^2 -distribution	374
5. Percentage points of the F -distribution	375
6. Percentage points of the studentized range $q(\alpha\%, n, v)$	377
7. Coefficients of the Shapiro–Wilk W -test for normality	378
8. Percentage points of the W -test for $n = 3(1)50$	380
9. Expected normal order statistics $u_{i,n}$	381
10. Critical values of Stefansky's MNR test	383
11. Orthogonal polynomials	384
12. Orthogonal polynomial functions	388
13. Coefficients of orthogonal polynomial functions	388
Index	389