

Contents

Preface 11

Part One Introduction

- 1 Outline of statistics** 15
- 2 Simple ways of analysing data** 20
 - 2.1 Introduction 20
 - 2.2 Pictorial methods 21
 - 2.3 Arithmetical methods 28

Part Two Theory

- 3 The concept of probability** 37
 - 3.1 Probability and statistics 37
 - 3.2 Some definitions 38
 - 3.3 Types of events 40
 - 3.4 Permutations and combinations 49
 - 3.5 Random variables 51
- 4 Discrete distributions** 56
 - 4.1 The discrete probability distribution 56
 - 4.2 The binomial distribution 57
 - 4.3 The binomial model 59
 - 4.4 Types of distribution 64
 - 4.5 The mean and variance of the binomial distribution 64
 - 4.6 The Poisson distribution 69
 - 4.7 Bivariate discrete distributions 75
- 5 Continuous distributions** 81
 - 5.1 Definitions 81
 - 5.2 The mean and variance of continuous distributions 86
 - 5.3 The normal distribution 87
 - 5.4 Uses of the normal distribution 92
 - 5.5 Normal probability paper 95
 - 5.6 The exponential distribution 98
 - 5.7 Bivariate continuous distributions 103

6	Estimation	106
6.1	Point and interval estimates	106
6.2	Properties of the expected value	107
6.3	The sampling distribution of \bar{x}	111
6.4	The sampling distribution of s^2	116
6.5	Some properties of estimators	118
6.6	General methods of point estimation	121
6.7	Interval estimation	126
7	Significance tests	134
7.1	Introduction	134
7.2	Tests on a sample mean	140
7.3	Comparing two sample means	143
7.4	The t -test applied to paired comparisons	147
7.5	The χ^2 goodness-of-fit test	148
7.6	The F -test	155
7.7	Distribution-free or non-parametric tests	157
7.8	Power and other considerations	158
8	Regression and correlation	166
8.1	Scatter diagram	166
8.2	Curve fitting	167
8.3	Regression	171
8.4	Confidence intervals and significance tests in linear regression	174
8.5	The coefficient of determination	177
8.6	Multiple and curvilinear regression	178
8.7	Orthogonal polynomials	180
8.8	The design of regression experiments	185
8.9	The correlation coefficient	185
8.10	Estimating the regression lines	191
8.11	The bivariate normal distribution	194
8.12	Interpretation of the correlation coefficient	196
	<i>Part Three Applications</i>	
9	Planning the experiment	203
9.1	Preliminary remarks	203
9.2	Measurements	204
9.3	The propagation of error	206
9.4	Improving precision with series and parallel arrangements	215
9.5	Combining dissimilar estimates by the method of least squares	216
10	The design and analysis of experiments I Comparative experiments	224
10.1	Some basic considerations in experimental design	224
10.2	A mathematical model for simple comparative experiments	226

10.3	The number of replications	227
10.4	Randomization	230
10.5	The analysis of a randomized comparative experiment	231
10.6	The range test	235
10.7	One-way analysis of variance	237
10.8	Follow-up study of the treatment means	241
10.9	Verifying the model	243
10.10	The randomized block experiment	244
10.11	Two-way analysis of variance	248
10.12	Latin squares	252
10.13	Balanced incomplete block designs	253
11	The design and analysis of experiments 2 Factorial experiments	257
11.1	Introduction	257
11.2	The advantages of complete factorial experiments	258
11.3	The design of complete factorial experiments	260
11.4	The analysis of a complete factorial experiment	263
11.5	Follow-up procedure	269
11.6	The 2 ⁿ factorial design	271
11.7	Fixed effects and random effects	276
11.8	Other topics	277
11.9	The examination of residuals	279
11.10	The determination of optimum conditions	280
11.11	Summary	298
12	Quality control	288
12.1	Acceptance sampling	288
12.2	Operating characteristic curve	289
12.3	Types of sampling schemes	293
12.4	Rectifying schemes	296
12.5	The military standard plan	297
12.6	Sampling by variables	298
12.7	Practical problems	298
12.8	Process control	299
12.9	Control charts for samples	301
12.10	Cusum charts	306
12.11	Prediction, system identification and control	312
13	Life-testing	319
13.1	Problems in measuring reliability	319
13.2	The mathematical distribution of failure times	321
13.3	The exponential distribution	323
13.4	Estimating the conditional failure rate	324
13.5	The Weibull distribution	327

Appendix A The relationships between the normal, χ^2 , t - and F -distributions 332

Appendix B Statistical tables 335

Table 1. Areas under the normal curve 335

Table 2. Percentage points of Student's t -distribution 336

Table 3. Percentage points of the χ^2 distribution 337

Table 4. Upper percentage points of the F -distribution 338

Table 5. Values of e^{-x} 341

Table 6. Percentage points of the distribution of the Studentized range 342

Table 7. Random numbers 344

Appendix C Further reading 346

Appendix D Some other topics 351

D.1 Calculating the mean and standard deviation of a frequency distribution 351

D.2 Interpretation of the sample standard deviation 354

D.3 How to round numbers 355

D.4 Estimating and testing a proportion 360

Answers to exercises 362

Subject index 366