

Contents

Preface	vii
1 Representation and summary of data	1
Discrete data	1
Continuous data	2
Stem and leaf diagrams (stemplots)	4
Ways of grouping data	9
Histograms	11
Frequency polygons	17
Frequency curves	19
Circular diagrams or pie charts	24
The mean	28
Variability of data	38
The standard deviation, s , and the variance, s^2	38
Combining sets of data	47
Scaling sets of data	51
Using a method of coding to find the mean and standard deviation	56
Cumulative frequency	58
Cumulative percentage frequency diagrams	65
Median, quartiles and percentiles	68
Skewness	84
The normal distribution	89
Box and whisker diagrams (box plots)	92
Summary	102
2 Regression and correlation	118
Scatter diagrams	118
Regression function	119
Linear correlation and regression lines	119
The product-moment correlation coefficient, r	139
Spearman's coefficient of rank correlation, r_s	146
Summary	154
3 Probability	168
Experimental probability	169
Probability when outcomes are equally likely	171
Subjective probabilities	171
Probability notation and probability laws	171
Illustrating two or more events using Venn diagrams	175
Probability rule for combined events	175
Exclusive (or mutually exclusive) events	179

Exhaustive events	180
Conditional probability	182
Independent events	185
Probability trees	193
Bayes' Theorem	197
Some useful methods	204
Arrangements	206
Permutations of r objects from n objects	214
Combinations of r objects from n objects	214
Summary	221
4 Probability distributions I – discrete variables	233
Probability distributions	233
Expectation of X , $E(X)$	237
Expectation of any function of X , $E(g(X))$	245
Variance, $\text{Var}(X)$ or $V(X)$	248
The Cumulative distribution function, $F(x)$	253
Two independent random variables	256
Distribution of $X_1 + X_2 + \dots + X_n$	258
Comparing the distributions of $X_1 + X_2$ and $2X$	259
Summary	262
5 Special discrete probability distributions	270
The uniform distribution	270
The geometric distribution	271
Expectation and variance of the geometric distribution	275
The binomial distribution	278
Expectation and variance of the binomial distribution	286
The Poisson distribution	291
Using the Poisson distribution as an approximation to the binomial distribution	299
The sum of independent Poisson variables	301
Summary	304
6 Probability distributions II – continuous variables	314
Continuous random variables	314
Probability density function (p.d.f.)	314
Expectation of X , $E(X)$	320
Expectation of any function of X	324
Variance of X , $\text{Var}(X)$	327
The mode	329
Cumulative distribution function $F(x)$	334
Obtaining the p.d.f., $f(x)$, from the cumulative distribution function	341
The continuous uniform (or rectangular) distribution	345
Expectation and variance of the uniform distribution	347
The cumulative distribution function, $F(x)$, for a uniform distribution	348
Summary	351

7	The normal distribution	360
	Finding probabilities	361
	The standard normal variable, Z	361
	Using standard normal tables	362
	Using standard normal tables for any normal variable, X	368
	Using the standard normal tables in reverse to find z when $\Phi(z)$ is known	371
	Using the tables in reverse for <i>any</i> normal variable, X	374
	Value of μ or σ or both	378
	The normal approximation to the binomial distribution	382
	Continuity corrections	383
	Deciding when to use a normal approximation and when to use a Poisson approximation for a binomial distribution	387
	The normal approximation to the Poisson distribution	390
	Summary	392
8	Linear combinations of normal variables	403
	The sum of independent normal variables	403
	The difference of independent normal variables	407
	Multiples of independent normal variables	410
	Summary	414
9	Sampling and estimation	421
	Sampling	421
	Surveys	422
	Sampling methods	424
	Simulating random samples from given distributions	431
	Sample statistics	436
	The distribution of the sample mean	436
	Central limit theorem	441
	The distribution of the sample proportion, p	444
	Unbiased estimates of population parameters	447
	Point estimates	447
	Interval estimates	449
	The t -distribution	462
	Confidence intervals for the population proportion, p	469
	Summary	472
10	Hypothesis tests: discrete distributions	483
	Hypothesis test for a binomial proportion, p (small sample size)	483
	Procedure for carrying out a hypothesis test	486
	One-tailed and two-tailed tests	489
	Summary of stages of a hypothesis (significance) test	492
	Type I and Type II errors	493
	Significance test for a Poisson mean λ	496
	Summary of stages of a significance test	500
	Summary of Type I and Type II errors	501

11 Hypothesis testing (z-tests and t-tests)	507
Hypothesis testing	507
One-tailed and two-tailed tests	511
Critical z -values	512
Summary of critical values and rejection criteria	513
Stages in the hypothesis test	513
Hypothesis test 1: testing μ (the mean of a population)	514
Type I and Type II errors	520
Hypothesis test 2: testing a binomial proportion p when n is large	528
Hypothesis test 3: testing $\mu_1 - \mu_2$, the difference between means of two normal populations	534
Summary	547
12 The χ^2 significance test	560
The χ^2 significance test	560
Performing a χ^2 goodness-of-fit test	563
Summary of the procedure for performing a χ^2 goodness-of-fit test	566
Test 1 – goodness-of-fit test for a uniform distribution	567
Test 2 – goodness-of-fit test for a distribution in a given ratio	568
Test 3 – goodness-of-fit test for a binomial distribution	571
Test 4 – goodness-of-fit test for a Poisson distribution	573
Test 5 – goodness-of-fit test for a normal distribution	576
Summary of the number of degrees of freedom for a goodness-of-fit test	579
The χ^2 significance test for independence	582
Summary	590
13 Significance tests for correlation coefficients	600
Significance tests for correlation coefficients	600
Test for the product-moment correlation coefficient, r	600
Spearman's coefficient of rank correlation, r_s	605
Summary	608
ICT statistics supplement	617
Appendix	645
Cumulative binomial probabilities	645
Cumulative Poisson probabilities	648
The standard normal distribution function	649
Critical values for the normal distribution	649
Critical values for the t -distribution	650
Critical values for the χ^2 distribution	651
Critical values for correlation coefficients	652
Random numbers	653
Answers	655