

Principles of Statistical Inference

D.R. COX

Nuffield College, Oxford



CAMBRIDGE
UNIVERSITY PRESS

Contents

<i>List of examples</i>	ix
<i>Preface</i>	xiii

1 Preliminaries	1
Summary	1
1.1 Starting point	1
1.2 Role of formal theory of inference	3
1.3 Some simple models	3
1.4 Formulation of objectives	7
1.5 Two broad approaches to statistical inference	7
1.6 Some further discussion	10
1.7 Parameters	13
Notes 1	14
2 Some concepts and simple applications	17
Summary	17
2.1 Likelihood	17
2.2 Sufficiency	18
2.3 Exponential family	20
2.4 Choice of priors for exponential family problems	23
2.5 Simple frequentist discussion	24
2.6 Pivots	25
Notes 2	27
3 Significance tests	30
Summary	30
3.1 General remarks	30
3.2 Simple significance test	31
3.3 One- and two-sided tests	35

3.4	Relation with acceptance and rejection	36
3.5	Formulation of alternatives and test statistics	36
3.6	Relation with interval estimation	40
3.7	Interpretation of significance tests	41
3.8	Bayesian testing	42
	Notes 3	43
4	More complicated situations	45
	Summary	45
4.1	General remarks	45
4.2	General Bayesian formulation	45
4.3	Frequentist analysis	47
4.4	Some more general frequentist developments	50
4.5	Some further Bayesian examples	59
	Notes 4	62
5	Interpretations of uncertainty	64
	Summary	64
5.1	General remarks	64
5.2	Broad roles of probability	65
5.3	Frequentist interpretation of upper limits	66
5.4	Neyman–Pearson operational criteria	68
5.5	Some general aspects of the frequentist approach	68
5.6	Yet more on the frequentist approach	69
5.7	Personalistic probability	71
5.8	Impersonal degree of belief	73
5.9	Reference priors	76
5.10	Temporal coherency	78
5.11	Degree of belief and frequency	79
5.12	Statistical implementation of Bayesian analysis	79
5.13	Model uncertainty	84
5.14	Consistency of data and prior	85
5.15	Relevance of frequentist assessment	85
5.16	Sequential stopping	88
5.17	A simple classification problem	91
	Notes 5	93
6	Asymptotic theory	96
	Summary	96
6.1	General remarks	96
6.2	Scalar parameter	97

6.3	Multidimensional parameter	107
6.4	Nuisance parameters	109
6.5	Tests and model reduction	114
6.6	Comparative discussion	117
6.7	Profile likelihood as an information summarizer	119
6.8	Constrained estimation	120
6.9	Semi-asymptotic arguments	124
6.10	Numerical-analytic aspects	125
6.11	Higher-order asymptotics	128
	Notes 6	130
7	Further aspects of maximum likelihood	133
	Summary	133
7.1	Multimodal likelihoods	133
7.2	Irregular form	135
7.3	Singular information matrix	139
7.4	Failure of model	141
7.5	Unusual parameter space	142
7.6	Modified likelihoods	144
	Notes 7	159
8	Additional objectives	161
	Summary	161
8.1	Prediction	161
8.2	Decision analysis	162
8.3	Point estimation	163
8.4	Non-likelihood-based methods	169
	Notes 8	175
9	Randomization-based analysis	178
	Summary	178
9.1	General remarks	178
9.2	Sampling a finite population	179
9.3	Design of experiments	184
	Notes 9	192
	<i>Appendix A: A brief history</i>	194
	<i>Appendix B: A personal view</i>	197
	<i>References</i>	201
	<i>Author index</i>	209
	<i>Subject index</i>	213