
Contents

Preface	<i>page</i>	ix
1 Introduction		1
1.1 What is an outlier?		1
1.2 Genesis of outliers		1
1.3 Treatment of outliers		3
1.4 Slippage tests		7
1.5 The meaning of significance levels		8
1.6 Brief early history of outlier rejection		9
2 General theoretical principles		13
2.1 Measures of performance		13
2.2 Specific optimal tests		14
2.3 Use of 'departure from model' statistics		20
2.4 Inadequacies of current optimality theory		21
2.5 Discrete random variables		22
2.6 Relationship with tolerance regions		23
2.7 Null hypothesis distributions		24
2.8 Relations between measures of performance		25
3 A single outlier in normal samples		27
3.1 Notation		27
3.2 Optimal statistics		28
3.3 Non-optimal statistics		34
3.4 Performance of the outlier tests		35
3.5 The use of normal approximations		40
4 The gamma distribution		42
4.1 Introduction		42
4.2 The problem of unequal v_i		45
4.3 Performance of the tests		45
4.4 Comparison with the Bartlett test		46
4.5 The maximum F -ratio		49

5	Multiple outliers	51
5.1	Introduction	51
5.2	Stepwise procedures	63
5.3	Performance of the procedures	67
6	Non-parametric tests	74
6.1	The Mosteller statistic	75
6.2	The Doornbos statistic	76
6.3	Slippage in scale	76
6.4	Multiple slippage	77
6.5	Amounts of slippage different	78
6.6	Large-sample outlier detection	83
7	Outliers from the linear model	85
7.1	The linear model	85
7.2	Recursive residuals and updating	87
7.3	A regression formulation for outliers	90
7.4	Distributional results	92
7.5	Identification of multiple outliers	95
7.6	Example	97
7.7	The general slippage problem	99
7.8	Slippage test performance	100
7.9	Exploring interactions	103
8	Multivariate outlier detection	104
8.1	General testing principles	106
8.2	Alternative approaches	110
8.3	Distribution theory	113
9	Bayesian approach to outliers	115
9.1	Example	117
9.2	A 'test' for outliers	118
9.3	Example	121
10	Miscellaneous topics	123
10.1	Discrete distributions	123
10.2	Outliers in time series	124

Bibliography	128
Appendix 1 Fractiles of B and B^* for normal samples	136
Appendix 2 Fractiles of L_k for normal samples	139
Appendix 3 Fractiles of E_k for normal samples	144
Appendix 4 Fractiles of $T_{n:i}$ for normal samples	148
Appendix 5 Fractiles for testing for two outliers in normal data	152
Appendix 6 Probabilities of the Mosteller test	155
Appendix 7 Fractiles of the Doornbos test	157
Appendix 8 Fractiles of the Wilks statistics	159
Appendix 9 Fractiles of $X_{(n)}/W$ for samples from the chi-squared distribution	163
Appendix 10 A single outlier in a two-way factorial experiment	174
Appendix 11 Fractiles of $X_{(n)}$ for the Poisson, binomial and negative binomial distributions	176
Index	183