



Contents

Chapters

Page No.

1. Introduction	01
1.1 Introduction	01
1.2 Models	04
1.2.1 Instantaneous failure model	05
1.2.2 Early Failure model	06
1.2.3 Nearly instantaneous failure	07
1.2.4 M_k inliers Models and L_k inliers Model	07
1.3 Information criteria for inliers	10
1.4 Testing of hypothesis	13
1.4.1 Locally most powerful test	15
1.4.2 Large sample test	15
1.5 Inlier estimation through Sequential Probability Ratio Test (SPRT)	15
1.6 Most powerful test for detection of inliers when underlying parameters are specified	16
2. Inlier estimation in Pareto distribution	20
2.1 Introduction	20
2.2 Analysis for instantaneous failures	23
2.2.1 Fisher's information	23
2.2.2 Maximum likelihood estimation	25
2.2.3 Uniformly minimum variance unbiased estimator (UMVUE)	27
2.3 Analysis of early failures	29
2.4 Nearly instantaneous model	33
2.4.1 Representation of the model	33
2.4.2 Survival function, failure rate and mean residual life function of the nearly instantaneous model	35

2.4.3	Nearly instantaneous failure case ($x_0 = 0$)	38
2.5	Inlier estimation using Lk and Mk models	42
2.5.1	Inlier estimation for labeled slippage (Lk) models	43
2.5.2	Identified Inliers Model (Mk model)	47
2.5.3	Simulation study	47
2.6	Inlier detection using information criterion	49
2.7	Inlier estimation through Sequential Probability Ratio test (SPRT)	52
2.8	Illustrative example	53

3. Inliers estimation in normal models 59

3.1	Introduction	59
3.2	Inlier(s) prone models and estimation	60
3.2.1	Normal with instantaneous failures	61
3.2.2	Normal with early failures	62
3.3	Normal with nearly instantaneous failures	63
3.3.1	Graphs	65
3.4	Inlier detection methods	67
3.4.1	Identified inlier model (Mk)	67
3.4.2	Inlier detection in Labeled slippage model (Lk)	68
3.4.3	Information criterion for detection of inliers	70
3.5	Simulation study	70
3.6	Testing of hypothesis for inliers	72
3.6.1	Sequential Probability Ratio Test (SPRT) to detect number of inliers	72
3.6.2	Modified likelihood ratio test	74
3.6.3	Most powerful test for detection of inliers	75
3.6.4	F-Test to test whether data contains inlier observations	76
3.7	Masking effect on tests for inliers	76
3.7.1	Limiting masking effect	78
3.8	Illustrations	80
3.8.1	Vannman's data	80
3.8.2	Rainfall data	81

4. Inliers estimation in Weibull models 84

4.1	Introduction	84
4.2	Uniformly minimum variance unbiased estimator	85

	(UMVUE)	
4.3	Weibull identified inliers model	87
4.3.1	Inlier detection when the shape parameter is identical	87
4.3.2	Inlier detection when the scale parameters are identical	88
4.3.3	Labeled slippage inliers model for Model-1	88
4.4	Inliers detection using information criterion	91
4.4.1	Simulation study	92
4.5	Data Example	94
4.6	Inlier detection using conditional distribution of total lives	97
4.6.1	A test for abnormally early failures (inliers)	98
4.7	Predictive approach to inlier model detection	99
4.8	Numerical illustration	102
4.9	Goodness of fit	103
4.9.1	To test whether target observations are from exponential distribution	103
4.9.2	To test whether target observations are from Weibull distribution	104
4.9.3	Sequential Probability ratio test (SPRT)	104
4.10	Conclusion	106
5.	Inliers as complete mixture	109
5.1	Introduction	109
5.2	Inliers as mixture model	114
5.3	Methods to detect inliers	116
5.3.1	Graphical methods based on probability model	116
5.3.2	Method of moments	118
5.3.3	Method of maximum likelihood	119
5.3.4	Minimum distance method	119
5.3.5	Bayesian method	120
5.3.6	Expectation maximization (EM)	121
5.3.6.1	Inlier detection in normal distribution using EM method	121
5.3.6.2	Numerical Example	123
5.3.7	Newton Raphson method (NR)	124
5.3.8	Method of scoring	124
5.4	Testing of hypothesis	124
5.4.1	Locally most powerful test	125
5.4.2	Large sample test	126
5.5	Graphs representing mixture of inliers and target from exponential families	126

6. Inliers detection in generalized distribution	133
6.1 Introduction	133
6.2 Instantaneous failures	134
6.2.1 Maximum likelihood estimation in instantaneous failures	134
6.3 Early failures	136
6.3.1 Maximum likelihood estimation in early failures	136
6.4 Nearly instantaneous failures	138
6.4.1 Characteristics of the model	139
6.4.2 Particular case when ($X_0 = 0$)	142
6.5 Testing of hypothesis	143
6.5.1 Sequential Probability Ratio Test (SPRT) to detect inliers in the model	144
6.5.2 Most Powerful test	145
6.6 Information criterion	147
6.7 Estimation and test for specific distributions	147
6.7.1 Exponential model	148
6.7.2 Rayleigh model	148
6.7.3 Weibull model	149
6.7.4 Gamma model	150
6.7.4.1 Testing for one inlier in Weibull family	151
6.8 Application	153
6.9 Conclusion	156
Appendix	157
Bibliography	158