INDEX

Adaptive procedure, vol. 7
Almutawari, A., 311
Analysis of variance, 196
Andersen, S.L., 325
Andrews' sine wave, 100
Ansari-Bradley-Siegels-Tukey test, 113
Anscombe, F.J., 5, 71, 194
Asymmetric contamination, 101
Asymmetric approximations, 49
Asymmetric distribution
of M-estimate, 507
Asymmetric efficiency
of M-, L-, and R-estimate, 67
of scale estimate, 114
Asymptotic expansion, 49, 158
Asymptotic minimax theory for location, 71
for scale, 119
Asymptotic normality
of fixed value, 157, 158
of L-estimate, 60
of M-estimate, 51
of multiparameter M-estimate, 130
of regression M-estimate, 167
of robust estimate of scatter matrix, 223
via Frechet derivative, 40
Asymptotic properties
of M-estimate, 48
Asymptotic relative efficiency, 3, 6
of covariance/correlation estimate, 209
Asymptotic robustness
in Bayesian context, 330
Asymptotics
of robust regression, 163
Averbuch, V.I., 41
Bartlett's test, 257
Bayesian robustness, vol. 323
Bednarski, T., 369
Belief functions, 258, 351
Benam, B., 7
Berger, J.O., 324, 325, 327
Bernstein, S., 328
Bias, 7, 8
compared with statistical variability, 74
in regression, 239, 248
in robust regression, 168, 169
maximum, 12, 13, 164, 192
minimax, 72, 73
of L-estimate, 59
of M-estimate, 60
of scale estimate, 106

Bickel, P.J., 20, 162, 195, 240
Billingsley, P., 23

Binomial distribution
minimax robust test, 265

Bivouac weight, 99, 100

Bootstrap, 20, 162, 317, 319, 320

Borel σ-algebra, 24

Bounded Lipschitz metric, 32, 37, 40

Bourbaki, N., 76

Box, G.E.P., xvi, 248, 297, 298, 323, 325

Breakdown
by implosion, 139, 229
multivariate, 287
stochastic, 287

Breakdown point, 6, 8, 13, 102, 279
finite sample, 279
of "Proposed N", 140
of covariance matrices, 260
of Hodges-Lehmann estimate, 66
of joint estimate of location and scale,
138
of L-estimate, 60, 70
of M-estimate, 59
of M-estimate of location, 233
of M-estimate of scale, 106
of M-estimate of scatter matrix, 224
of M-estimate with preliminary scale,
141
of median absolute residual (MAD), 173
of normal scores estimate, 66
of R-estimate, 60
of re-descending M-estimate, 283
of symmetricized scale estimate, 112
of 104, 301
of trimmed mean, 14, 141
scaling problem, 153, 281
variance, 14, 103

Canonical link, 304

Cantor, L., 504, 505

Capacity, 259
2-monotone and 3-alternating, 255, 270
monotone and alternating of infinite order, 258

Carroll, R.J., 195

Cauchy distribution, 512
efficient estimate for, 69

Censoring, 259, 266

Chen, H., 201
Chen, S., 195
Chernoff, H., 60
Choquet, G., 256, 258
Clarke, B.R., 38, 41, 240
Coalition, 20, 21, 182

Collins, J.R., 28

Comparison function, 177, 178, 180, 234

Composite hypothesis, 217

Computation of M-estimate, 148
median residuals, 143
modified weights, 143

Computation of regression M-estimate, 18, 175

Convergence, 182

Computation of robust covariance estimate,
235

Confidential Polysampling, 18

Conjugate density, 340

Consistency, 7

Fisher, 9

of fixed value, 155
of L-estimate, 69
of M-estimate, 59
of multivariate M-estimate, 126

Consistent estimate, 42

Contaminated normal distribution, 2

minimum estimate for, 97

minimum M-estimate for, 95

Contamination
asymmetric, 104
by contamination, 281
scaling problem, 6, 153, 249, 278, 281

Contamination neighborhood, 12, 72, 83, 265, 270

Continuity
of L-estimate, 60
of M-estimate, 54
of statistical functional, 42
of trimmed mean, 59
of Winsorized mean, 59

Correlation
robust, 205

Correlation matrix, 199

Corruption
by contamination, 281
by modification, 281
by replacement, 281
Covariance
estimation of matrix elements through
robust variance, 203
estimation through robust correlation, 194
robust, 207
Covariance estimate
breakdown, 286
Covariance estimation
in regression, 170
in regression, correction factors, 170
Covariance matrix, 17, 199
Cramer-Rao bound, 4
Cumulant generating function, 308, 316
Daniel’s theorem, 27
Daniels, H.E., 40, 508, 509, 514, 515
Data analysis, 2, 9, 21, 197, 198, 281
Davies, P.L., 185, 197
Demetrescu, A.R., 258, 331
Derivative
Jäckel, 36, 37, 40
Gillespie, 36, 39
Design
robustness, 170, 259
Design matrix
condition on, 165
errors in, 169
Deviation
from linearity, 239
mean absolute and root mean square, 2
Devlin, S.J., 201, 204
Diagnostics, 2, 9, 21, 101, 198, 281
Díaz-Cano, I.J., 315
Dorichet prior, 126
Distance
Bounded Lipschitz, see Bounded
Lipschitz metric
Kolmogorov, see Kolmogorov metric
Lévy, see Lévy metric
Prohorov, see Prohorov metric
total variation, see Total variation metric
Distribution function
empirical, 9
Distribution-free
distinction from robust, 6
Distributional robustness, 2, 4
Dodge, Y., 193, 195
Donoho, D.L., 279
Doob, J.L., 127
Draper, N.R., 248
Dudley, R.M., 41
Dušić, V., 114
Dunier, F., 180, 182, 186
Eddington, A.N., 12, 2
Edgeworth expansion, 49, 307
Efficiency
absolute, 6
asymptotic relative, 3, 6
asymptotic of M-, L-, and R-estimate, 67
Efficient estimate
for Cauchy distribution, 69
for least informative distribution, 46
for Logistic distribution, 69
for normal distribution, 69
Efron, B., 318
Ellipsoid
to describe shape of pointcloud, 199
Elliptic density, 210, 247
Empirical distribution function, 9
Empirical likelihood, 318
Empirical measure, 9
Error
gross, 3
Esscher, F., 510
Estimate
adaptive, rev., 7
consistent, 42
defined through a minimum property, 126
defined through implicit equations, 129
defined from rank test, see R-estimate
defined from test, 272
Hodges-Lehmann, see Hodges-Lehmann estimate
L₂, see L₂-estimate
L₀, see L₀-estimate
Lₚ, see Lₚ-estimate
M-, see M-estimate
maximum likelihood type, see M-estimate
minmax of location and scale, 135
of location and scale, 125
et scale, 105
R-, see R-estimate
randomized, 272, 274, 278
Schweppe type, 188, 189
Exact distribution
of M-estimate, 49
Exchangeability, 20
Expansion
Edgeworth, 49, 307

F-test for linear models, 248
F-test for variances, 297
Factor analysis, 199
Fama, R., 315, 316
Fallen, B., 195
Feller, W., 52, 157, 357
Field, C.A., 306, 309, 311, 312, 315, 316
Filippova, A.A., 41
Finite sample
minimum robustness, 259
Finite sample breakdown point, 279
Finite sample theory, 6, 249
Fisher consistency, 9, 143, 200, 300, 305
of scale estimate, 106
Fisher information, 67, 76
convexity, 78
distribution minimizing, 76, 207
equivalent expressions, 89
for multivariate location, 225
for scale, 144
minimization by variational methods, 81
of r-contamination, 93
Fisher Information matrix, 132
Fisher, R.A., 2
Fitted value
asymptotic normality, 157, 158
consistency, 155
Fourier inversion, 308
Fréchet derivative, 39, 58, 60
Fréchet differentiability, 67, 306
Fraser, D.A.S., 315
Friedman, D.A., 528
Functional
scalar, 9
weakly continuous, 42
Galilean derivative, 36, 39, 113
Gale, D., 137
Generalized Linear Models, 304
Global fit
minimum, 240
Gnanadesikan, R., 201, 203
Green, E., 89, 90
Gray error, 3
Gray error model, see also Communication neighborhood
Gray error model, 12
generalized, 258
Gray error sensitivity, 15, 17, 20, 73, 290

of questionable value for
L- and R-estimates, 290

Hájek, J., 68, 114, 207
Hamilton, W.C., 163
Hampel estimate, 99
Hampel's breakdown point, 293
Hampel's theorem, 41
Hampel, F.R., 5, 11, 13, 17, 31, 42, 49,
72, 187, 195, 196, 279, 289, 290,
297, 298, 304, 310, 312
Harding, E.P., 258
Hartigan, J., 327
Hat matrix, 155, 163, 197, 285
updating, 158, 159
He, X., 301
Hettler, S., 300, 302, 303
Heuberger, A.M., 240
Herrenkiser, I.P., 208
High breakdown point
in regression, 195
Hodges, J.L., 285
Hodges-Lehmann estimate, 10, 62, 65, 142,
282, 283
breakdown point, 66
influence function, 63
Hogg, R.V., 7
Huber estimator, 319
Saddlepoint approximation, 312, 314
Huber's "Proposal 2", 319
Huber-Carol, C., 294
Hahn-Stein theorem, 278

Infinitesimal approach
tests, 298

Infinitesimal robustness, 286
Influence curve, see Influence function
Influence function, 14, 39
and asymptotic variance, 15
and jackknife, 17
of "Proposal 2", 135
of Hodges-Lehmann estimate, 63
of interquartile distance, 109
of joint estimation of location and scale,
134
of L-estimate, 56
of median, 299, 303
of M-estimate, 47, 291
of median, 57
of median absolute deviation (MAD),
115
of normal score estimate, 64
of one-step M-estimate, 138
of prove, 299
of quantile, 56
of R-estimate, 62
of robust estimate of scatter matrix, 220
of trimmed mean, 57, 58
of Winsorized mean, 58
self-standardized, 289, 300, 308
Interquantile distance
influence function, 100
Interquantile distance, 123
in median absolute deviation (MAD), 106
influence function, 110
Interquantile range, 11, 141
Interval estimate
dead from rank test, 7
Iterative reweighting, see Modified weights
Jackknife, 15, 146
Jackknife pseudo-value, 16
Jaccard, L.A., 8, 95, 162
Jeffreys, H., xv
Jensen, L.I., 208
Kamrovitch, I., 32
Keller, E.L., 25
Kameraman, J.H.B., 195
Kendall, D.G., 258
Kendall, G.D., 41
Keating, J.R., 261, 263
Klaassen, C.A.J., 7
Klein, B., 20
Klotz test, 112, 115
Kolmogorov metric, 35
Kolmogorov-Kuiper metric, 265
Kong, C.T.A., 332
Krasner, L.S., 195
Kühn-Tucker theorem, 32
Kullback-Leibler distance, 310
L1-estimate, 153, 193
of regression, 169, 173, 175
L2-estimate, 132
L-estimate, xvi, 45, 55, 125
asymptotic normality, 60
asymptotically efficient, 67
breakdown point, 60, 79
consistency, 60
continuity, 60
gross error sensitivity, 290
influence function, 56
maximum bias, 59
minimum properties, 95
of regression, 162
of scale, 105, 114
quantitative and qualitative robustness, 59
Laplace's method, 345, 322
Laplace, S., 195
Laar, R., 325
Least favorable, see also Least informative
Distribution
pair of distributions, 260
Least informative distribution
discussion of its realism, 89
efficient estimate for, 69
live e-contamination, 83, 84
for Kolmogorov metric, 85
for multivariate location, 225
for multivariate scatter, 227
for scale, 118, 117
Least squares, 154
asymptotic normality, 157, 159
consistency, 155
robustizing, 161
LeCam, L., 68, 328
Legendre transform, 318
Lehmacher, E., 53, 268, 269, 278
Lenny, A.M., 196
Leverage group, 152-154
Leverage point, 17, 152, 154, 158, 161, 186, 188-190, 192, 195, 197, 229,
285, 335
Levy metric, 27, 36, 40, 42
Levy neighborhood, 12, 13, 73, 265
Liggert, T., 78
Likelihood ratio test, 301, 317
Limiting distribution
of M-estimate, 49
Lindeberg condition, 51
Linear combination of order statistics, see
L-estimate
Linear models
breakdown, 284
Lipschitz metric, bounded, see Bounded
Lipschitz metric
LMS-estimate, 190
Location estimate
multivariate, 319
Location step
in computation of robust covariance
matrix, 233
with modified residuals, 178
with modified weights, 179
Logarithmic derivative, 348
Logistic distribution, 69
Moment estimate, 250
M-estimate, 45, 46, 125, 202, 203
asymptotic distribution, 49
asymptotic normality, 51
asymptotic multiparameter, 130
asymptotic properties, 48
asymptotically efficient, 67
asymptotically minimax, 94, 174
breakdown point, 54
consistency, 50, 126
exact distribution, 49
influence function, 47, 291
limiting distribution, 48
 marginal distribution, 314
maximum bias, 53
nonasymptotic limiting distribution, 82, 94
of regression, 101
of scale, 107, 114
one-step, 137
quantitative and qualitative robustness, 53
saddlepoint approximation, 311
weak continuity, 54
with preliminary scale estimate, 137
with preliminary scale estimate, breakdown point, 141
M-estimate of location, 46, 278
breakdown point, 283
M-estimate of location and scale, 133
breakdown point, 149
existence and uniqueness, 136
M-estimate of regression, 175
M-estimate of scale, 121
breakdown point, 106
minimum properties, 119
MAD, see Median absolute deviation
Malicious gross errors, 287
Mallows estimator, marginal distribution, 315
Mallows, C.L., 195
Maronna, A., 312
Marginal distributions, 314
M-estimators, 314
Mallows estimator, 315
Markatou, M., 299
Maronna, R.A., 188, 195, 214, 220, 223, 234
Martin, R.D., 193
Matheson, G., 258
Maximum asymptotic level, 299
Maximum bias, 101, 102
of M-estimate, 53
Maximum likelihood and Bayes estimates, 127
Maximum likelihood estimate, 210
Maximum likelihood estimator, 301
GLM, 304
Maximum likelihood type estimate, see M-estimate
Maximum variance
under asymmetric contamination, 102, 103
Mean
saddlepoint approximation, 308
Mean absolute deviation, 2
Measure
empirical, 2
regular, 24
substochastic, 76, 90
Median, 17, 95, 128, 141, 202, 204
continuity of, 54
has minimax bias, 73
influence function, 57, 135
Median absolute deviation (MAD), 106, 108,
112, 141, 172, 205, 283
as the most robust estimate of scale, 119
compared to interquartile distance, 106
influence function, 135
Median absolute residual, 172, 173
Median polish, 193
Merrill, H.M., 108
Method of steepest descent, 308
Metric
Bounded Lipschitz, see Bounded Lipschitz metric
Kolmogorov, see Kolmogorov metric
Lévy, see Levy metric
Prohorov, see Prohorov metric
total variation, see Total variation metric
Miller, R., 15
Minimax bias, 72, 73
Minimax global fit, 240
Minimax interval estimate, 276
Minimax methods
- pessimism, 91, 95, 119, 188, 244, 284, 287
Minimax properties
- of Least-estimate, 95
- of M-estimate, 91
- of M-estimate of scale, 119
- of M-estimate of scatter, 229
- of Restimate, 95
Minimax reweighting M-estimate, 97
Minimax robustness
- asymptotic, 17
- finite sample, 17, 259
Minimax slope, 246
Minimax test, 259, 265
  - for binomial distribution, 266
  - for contaminated normal distribution, 266
Minimax theory
  - asymptotic for location, 91
  - asymptotic for scale, 119
Minimax variance, 74
Minimum asymptotic power, 299
Mixture model, 21, 152, 154, 197, 281
Multicollinearity
  - corruption by, 281
Modified residuals, 19, 143, 182
  - in computing regression estimate, 178
Modified weights, 143, 182
  - in computing regression estimate, 179
Month, A.C., 314
Mood test, 113
Morgenstern, S., 18
Moser, E., 3
Multidimensional estimate of location, 283
Multiparameter problems, 125
Multivariate location estimate, 219

Neighborhood
  - closed δ, 29
  - contamination, see Contamination neighborhood
Kolmogorov, see Kolmogorov neighborhood
Levy, see Levy neighborhood
Probabilistic, see Probabilistic neighborhood
shrinking, 294
total variation, see Total variation neighborhood
Neveu, J., 23, 24, 27, 31

Newcomb, S., xi
Newton method, 167, 224
Neyman-Pearson lemma, 9, 264
  - for 2-alternating capacities, 269, 271
Nichols, H., 137
Nonparametric
  - distinction from robust, 6
  - Nonparametric techniques, 317
    - small sample asymptotics, 317
Normal distribution
  - contaminated, 2
  - efficient estimate for, 69
Normal distribution, contaminated
  - minimum robust test, 286
Normal scores estimate, 79, 142
  - breakdown point, 66
  - influence function, 64
One-step M-estimate
  - of regression, 162
One-step M-estimate, 137
  - of regression, 167
Optimal bounded-influence tests, 306, 308
Optimal design
  - breakdown, 285
Optimality properties
  - correspondence between test and estimate, 276
Order statistics, linear combinations, see 1-estimate
Outlier, 138
  - in regression, 4
  - rejection, 4
Outlier rejection
  - followed by sample mean, 283
Outlier resistant, 4
Outlier sensitivity, 324
Path of steepest descent, 308
Performance comparison, 18
Pessimism
  - of minimax methods, 91, 95, 119, 188, 244, 284, 287
Pratt's efficacy, 290
Poincaré
  - shape of, 199
Polish space, 23, 27, 31
Fortune, S.L., 301
Proctor, D.A., 153
Principal component analysis, 199
Probabilistic metric, 27-30, 37, 40, 42
Probabilistic neighborhood, 29, 31, 265, 270
Projection pursuit, 153, 198, 200, 225, 283
"Proposal 2", 135, 141, 143, 293
breakdown point, 140
Pseudo-covariance matrix, 211
determined by implicit equations, 212
Pseudo-observations, 19, 192
Pseudo-variance, 13

Quadratic correlation, 206
Qualitative robustness, 9, 11
of L-estimate, 59
of M-estimate, 53
of R-estimate, 64
Quantile
influence function, 56
Quantile range
normalization, 12
Quantitative robustness
of L-estimate, 59
of M-estimate, 53
of R-estimate, 64
Quasi-likelihood estimator
of M, 304
Quasi-likelihood function, 304
Quenouille, M.H., 15
R-estimate, xx, 45, 60, 125
asymptotically efficient, 67
bias, 65
breakdown point, 66
gross error sensitivity, 291
influence function, 62
minimax properties, 95
of location, 62
of regression, 152
of scale, 112, 113
of shift, 62
quantitative and qualitative robustness, 64
Randomization test, 298
Randomized estimate, 272, 274, 278
Rank correlation
Spearman, 205
Rank test, 275
estimate derived from, see R-estimate
Recentering M-estimate, 97
breakdown point, 283
effect of inessentialness, 55
minimax, 97
of regression, 186
sensitive to wrong scale, 98
Redundancy, 152, 154, 239, 283
Reeds, J.A., 41
Regression, 17, 149
asymptotics of robust, 163
high breakdown point, 154
high breakdown point estimate, 195
M-estimate, 161
one-step L-estimate, 162
one-step M-estimate, 167
R-estimate, 162
robust testing, 319
robust tests, 304
Regression design, 197
Regression M-estimate
asymptotic normality, 167
Regular measure, 24
Relative error, 308, 310, 312, 317
Repeated median algorithm, 196
Replacement
corruption by, 281
Residual, 128
Resistant
procedure, 8
Ridge, S.O., 315, 314
Ridge regression, 154
Rieder, H., 290, 294, 296
Riemann, B., 308
Robinson, J., 311, 316, 321
Robust
distinction from distribution-free, 6
distinction from nonparametric, 6
Robust correlation
interpretation, 209
Robust covariance
uniflaty invariant estimate, 210
comparison of estimate, 213
Robust deviance, 304
Robust estimate
construction, 70
standardization, 7
Robust likelihood ratio test
of M, 305
Robust quasi-likelihood, 205
Robust regression
bias, 168, 169
Robust test, 250, 259
Robust test statistic, 316
Robust testing, 297
Robustifying
of arbitrary procedures, 18
of least squares, 161
Robustness, 2
an attribute of modal, 325
Stigler, S.M., 60
Stine, C.R., 7
Strassen’s theorem, 30, 32, 42
Studentized, 145, 192
comparison between jackknife and influence function, 147
M-estimate of location, 147
robust mean, 147
Subadditive, 251
Substochastic measure, 76, 80, 83
Superadditive, 251
Superexponential
parametric, 324
Symmetrized scale estimate, 111
breakdown point, 112
Symmetry
asymptotic assumption, 93

T-Test, 298
Takahashi, K., 7
Test
for independence, 206
minimum robust, 259, 260
of independence, 199
robust, 250
sequential, 267
Tight, 28
Time series, 20
Topology
vague, 76
weak, 24
Torgerson, L.N., 274
Total variation metric, 36, 36
Total variation neighborhood, 265
Trimmed mean, 10, 69, 90, 91, 102, 141, 142
breakdown point, 141
continuity, 39
influence function, 57, 58
studentizing, 147
Trimmed standard deviation, 91, 122
Trimmed variance, 118
influence function, 110
Today, J.W., 2, 8, 15, 18, 193, 325

Upper expectation, 250
Upper probability, 250

Vague topology, 76, 78
Variance
iteratively reweighted estimate is inconsistent, 172
jackknife, 148
maximum, 12
maximum asymptotic, 13
Variance breakdown point, 193
Variance estimate
breakdown, 286
Variance ratio, 244
Von Mises, R., 41, 328
Wald test, 301, 317
Walsh of Chi²-distribution, 286
Weak continuity, 9–11, 24
Weak convergence
equivalence lemma, 25
on the real line, 20
Weak topology, 24, 25
generated by Prohorov and Bounded Lipschitz metric, 55
Weak-star continuity, see Weak continuity
Welch, R.F., 195
Welsh, A.H., 318
Wilcoxon test, 62, 275, 298, 309
Wilkinson, G., 325
Winson, C.P., 90
Winfiszion mean
continuity, 50
influence function, 58
Winfiszion residuals, 176, 178
Winfiszion sample, 147
Winfiszion variance, 111
Winnorzang, 162
metrically, 19
Wolf, G., 254
Weibull, P.L., 324

Yekhtesher, D., 88, 95, 240, 301
Yoda, V.I., 198, 195
Young, G.A., 316, 321
Zamar, R.H., 195