

# Frontiers of Statistics

— in honor of Professor Peter J. Bickel’s 65th Birthday

Edited by Jianqing Fan and Hira L. Koul

Imperial College Press

## Table of Contents

### 1. Our Steps on the Bickel Way

<i>Kjell Doksum and Ya’acov Ritov</i>	1
1.1 Introduction . . . . .	1
1.2 Doing Well at a Point and Beyond . . . . .	2
1.3 Robustness, Transformations, Oracle-free Inference, and Stable Parameters . . . . .	4
1.4 Distribution Free Tests, Higher Order Expansions, and Challenging Projects . . . . .	4
1.5 From Adaptive Estimation to Semiparametric Models . . . . .	5
1.6 Hidden Markov Models . . . . .	6
1.7 Non- and Semi-parametric Testing . . . . .	7
1.8 The Road to Real Life . . . . .	8
References . . . . .	8
Bickel’s Publication . . . . .	11

---

## Part I. Semiparametric Modeling

---

### 2. Semiparametric Models: A Review of Progress since BKRW (1993)

<i>Jon A. Wellner, Chris A. J. Klaassen and Ya’acov Ritov</i>	25
2.1 Introduction . . . . .	25
2.2 Missing Data Models . . . . .	28
2.3 Testing and Profile Likelihood Theory . . . . .	28
2.4 Semiparametric Mixture Model Theory . . . . .	29
2.5 Rates of Convergence via Empirical Process Methods . . . . .	30
2.6 Bayes Methods and Theory . . . . .	30
2.7 Model Selection Methods . . . . .	31
2.8 Empirical Likelihood . . . . .	32
2.9 Transformation and Frailty Models . . . . .	32
2.10 Semiparametric Regression Models . . . . .	33
2.11 Extensions to Non-i.i.d. Data . . . . .	34
2.12 Critiques and Possible Alternative Theories . . . . .	35
References . . . . .	36

### 3. Efficient Estimator for Time Series

<i>Anton Schick and Wolfgang Wefelmeyer</i>	45
3.1 Introduction . . . . .	45
3.2 Characterization of Efficient Estimators . . . . .	47
3.3 Autoregression Parameter . . . . .	50
3.4 Innovation Distribution . . . . .	52
3.5 Innovation Density . . . . .	54
3.6 Conditional Expectation . . . . .	55
3.7 Stationary Distribution . . . . .	57
3.8 Stationary Density . . . . .	58
3.9 Transition Density . . . . .	59
References . . . . .	60

<b>4. On the Efficiency of Estimation for a Single-index Model</b>	
<i>Yingcun Xia and Howell Tong</i>	63
4.1 Introduction . . . . .	63
4.2 Estimation via Outer Product of Gradients . . . . .	66
4.3 Global Minimization Estimation Methods . . . . .	68
4.4 Sliced Inverse Regression Method . . . . .	70
4.5 Asymptotic Distributions . . . . .	71
4.6 Comparisons in Some Special Cases . . . . .	73
4.7 Proofs of the Theorems . . . . .	74
References . . . . .	84
<b>5. Estimating Function Based Cross-Validation</b>	
<i>M.J. van der Laan and Dan Rubin</i>	87
5.1 Introduction . . . . .	87
5.2 Estimating Function Based Cross-Validation . . . . .	90
5.3 Some Examples . . . . .	96
5.4 General Finite Sample Result . . . . .	101
5.5 Appendix . . . . .	105
References . . . . .	108
<hr/>	
<b>Part II. Nonparametric Methods</b>	
<hr/>	
<b>6. Powerful Choices: Tuning Parameter Selection Based on Power</b>	
<i>Kjell Doksum and Chad Schafer</i>	113
6.1 Introduction: Local Testing and Asymptotic Power . . . . .	114
6.2 Maximizing Asymptotic Power . . . . .	116
6.3 Examples . . . . .	129
6.4 Appendix . . . . .	134
References . . . . .	139
<b>7. Nonparametric Assessment of Atypicality</b>	
<i>Peter Hall and Jim W. Kay</i>	143
7.1 Introduction . . . . .	144
7.2 Estimating Atypicality . . . . .	145
7.3 Theoretical Properties . . . . .	148
7.4 Numerical Properties . . . . .	151
7.5 Outline of Proof of Theorem 7.1 . . . . .	157
References . . . . .	160
<b>8. Selective Review on Wavelets in Statistics</b>	
<i>Yazhen Wang</i>	163
8.1 Introduction . . . . .	163
8.2 Wavelets . . . . .	164
8.3 Nonparametric Regression . . . . .	166
8.4 Inverse Problems . . . . .	172
8.5 Change-points . . . . .	174
8.6 Local Self-similarity and Non-stationary Stochastic Process . . . . .	176
8.7 Beyond Wavelets . . . . .	179
References . . . . .	179
<b>9. Model Diagnostics via Martingale Transforms: A Brief Review</b>	
<i>Hira L. Koul</i>	183
9.1 Introduction . . . . .	183
9.2 Lack-of-fit Tests . . . . .	197
9.3 Censoring . . . . .	201
9.4 Khamaladze Transform or Bootstrap . . . . .	202
References . . . . .	203

---

## Part III. Statistical Learning and Bootstrap

---

### 10. Boosting Algorithms: with an Application to Bootstrapping Multivariate Time Series

<i>Peter Bühlmann and Roman W. Lutz</i>	209
10.1 Introduction . . . . .	209
10.2 Boosting and Functional Gradient Descent . . . . .	211
10.3 $L_2$ -Boosting for High-dimensional Multivariate Regression . . . . .	217
10.4 $L_2$ -Boosting for Multivariate Linear Time Series . . . . .	222
References . . . . .	229

### 11. Bootstrap Methods: A Review

<i>S. N. Lahiri</i>	231
11.1 Introduction . . . . .	231
11.2 Bootstrap for i.i.d Data . . . . .	233
11.3 Model Based Bootstrap . . . . .	238
11.4 Block Bootstrap . . . . .	240
11.5 Sieve Bootstrap . . . . .	243
11.6 Transformation Based Bootstrap . . . . .	244
11.7 Bootstrap for Markov Processes . . . . .	245
11.8 Bootstrap under Long Range Dependence . . . . .	246
11.9 Bootstrap for Spatial Data . . . . .	248
References . . . . .	250

### 12. An Expansion for a Discrete Non-Lattice Distribution

<i>Friedrich Götze and Willem R. van Zwet</i>	257
12.1 Introduction . . . . .	257
12.2 Proof of Theorem 12.1 . . . . .	262
12.3 Evaluation of the Oscillatory Term . . . . .	271
References . . . . .	273

---

## Part IV. Longitudinal Data Analysis

---

### 13. An Overview on Nonparametric and Semiparametric Techniques for Longitudinal Data

<i>Jianqing Fan and Runze Li</i>	277
13.1 Introduction . . . . .	277
13.2 Nonparametric Model with a Single Covariate . . . . .	279
13.3 Partially Linear Models . . . . .	283
13.4 Varying-Coefficient Models . . . . .	291
13.5 An Illustration . . . . .	293
13.6 Generalizations . . . . .	294
13.7 Estimation of Covariance Matrix . . . . .	296
References . . . . .	299

### 14. Regressing Longitudinal Response Trajectories on a Covariate

<i>Hans-Georg Müller and Fang Yao</i>	305
14.1 Introduction and Review . . . . .	305
14.2 The Functional Approach to Longitudinal Responses . . . . .	311
14.3 Predicting Longitudinal Trajectories from a Covariate . . . . .	313
14.4 Illustrations . . . . .	316
References . . . . .	321

---

## Part V. Statistics in Science and Technology

---

### 15. Statistical Physics and Statistical Computing: A Critical Link

<i>James D. Servidea and Xiao-Li Meng</i>	327
15.1 MCMC Revolution and Cross-Fertilization . . . . .	328
15.2 The Ising Model . . . . .	328
15.3 The Swendsen-Wang Algorithm and Criticality . . . . .	329
15.4 Instantaneous Hellinger Distance and Heat Capacity . . . . .	331
15.5 A Brief Overview of Perfect Sampling . . . . .	334
15.6 Huber's Bounding Chain Algorithm . . . . .	336
15.7 Approximating Criticality via Coupling Time . . . . .	340
15.8 A Speculation . . . . .	342
References . . . . .	343

### 16. Network Tomography: A Review and Recent Developments

<i>Earl Lawrence, George Michailidis, Vijayan N. Nair and Bowei Xi</i>	345
16.1 Introduction . . . . .	346
16.2 Passive Tomography . . . . .	348
16.3 Active Tomography . . . . .	352
16.4 An Application . . . . .	359
16.5 Concluding Remarks . . . . .	363
References . . . . .	364

---

## Part VI. Financial Econometrics

---

### 17. Likelihood Inference for Diffusions: A Survey

<i>Yacine Aït-Sahalia</i>	369
17.1 Introduction . . . . .	369
17.2 The Univariate Case . . . . .	371
17.3 Multivariate Likelihood Expansions . . . . .	378
17.4 Connection to Saddlepoint Approximations . . . . .	383
17.5 An Example with Nonlinear Drift and Diffusion Specifications . . . . .	386
17.6 An Example with Stochastic Volatility . . . . .	389
17.7 Inference When the State is Partially Observed . . . . .	391
17.8 Application to Specification Testing . . . . .	399
17.9 Derivative Pricing Applications . . . . .	400
17.10 Likelihood Inference for Diffusions under Nonstationarity . . . . .	400
References . . . . .	402

### 18. Nonparametric Estimation of Production Efficiency

<i>Byeong U. Park, Seok-Oh Jeong, and Young Kyung Lee</i>	407
18.1 The Frontier Model . . . . .	407
18.2 Envelope Estimators . . . . .	409
18.3 Order- $m$ Estimators . . . . .	417
18.4 Conditional Frontier Models . . . . .	421
18.5 Outlook . . . . .	423
References . . . . .	424

---

## Part VII. Parametric Techniques and Inferences

---

<b>19. Convergence and Consistency of Newton’s Algorithm for Estimating Mixing Distribution</b>	
<i>Jayanta K. Ghosh and Surya T. Tokdar</i>	429
19.1 Introduction . . . . .	429
19.2 Newton’s Estimate of Mixing Distributions . . . . .	431
19.3 Review of Newton’s Result on Convergence . . . . .	432
19.4 Convergence Results . . . . .	433
19.5 Other Results . . . . .	438
19.6 Simulation . . . . .	440
References . . . . .	442
<b>20. Mixed Models: An Overview</b>	
<i>Jiming Jiang and Zhiyu Ge</i>	445
20.1 Introduction . . . . .	445
20.2 Linear Mixed Models . . . . .	446
20.3 Generalized Linear Mixed Models . . . . .	450
20.4 Nonlinear Mixed Effects Models . . . . .	455
References . . . . .	460
<b>21. Robust Location and Scatter Estimators in Multivariate Analysis</b>	
<i>Yijun Zuo</i>	467
21.1 Introduction . . . . .	467
21.2 Robustness Criteria . . . . .	469
21.3 Robust Multivariate Location and Scatter Estimators . . . . .	473
21.4 Applications . . . . .	481
21.5 Conclusions and Future Works . . . . .	484
References . . . . .	485
<b>22. Estimation of the Loss of an Estimate</b>	
<i>Wing Hung Wong</i>	491
22.1 Introduction . . . . .	491
22.2 Kullback-Leibler Loss and Exponential Families . . . . .	493
22.3 Mean Square Error Loss . . . . .	495
22.4 Location Families . . . . .	496
22.5 Approximate Solutions . . . . .	498
22.6 Convergence of the Loss Estimate . . . . .	502
References . . . . .	506
<b>Subject Index</b>	507
<b>Author Index</b>	511

# *Special Thanks*

*To*

Mary Beth Falke

Connie Brown

Zoya Kramer

and

Michael Bino, Lisa Glass, Noelina Hall , Kimberly Lupinacci