

# *Contents*

<b>Dedication</b>	<b>v</b>
<b>Preface</b>	<b>xiii</b>
<b>1 Time Series Following Generalized Linear Models</b>	<b>1</b>
1.1 <i>Partial Likelihood</i>	2
1.2 <i>Generalized Linear Models and Time Series</i>	4
1.3 <i>Partial Likelihood Inference</i>	10
1.3.1 <i>Estimation of the Dispersion Parameter</i>	14
1.3.2 <i>Iterative Reweighted Least Squares</i>	14
1.4 <i>Asymptotic Theory</i>	16
1.4.1 <i>Uniqueness and Existence</i>	17
1.4.2 <i>Large Sample Properties</i>	17
1.5 <i>Testing Hypotheses</i>	20
1.6 <i>Diagnostics</i>	23
1.6.1 <i>Deviance</i>	24
1.6.2 <i>Model Selection Criteria</i>	25
1.6.3 <i>Residuals</i>	25
1.7 <i>Quasi-Partial Likelihood</i>	28
1.7.1 <i>Generalized Estimating Equations</i>	31
1.8 <i>Real Data Examples</i>	33

**vii**

1.8.1	<i>A Note on Computation</i>	33
1.8.2	<i>A Note on Model Building</i>	33
1.8.3	<i>Analysis of Mortality Count Data</i>	34
1.8.4	<i>Application to Evapotranspiration</i>	39
1.9	<i>Problems and Complements</i>	42
<b>2</b>	<b>Regression Models for Binary Time Series</b>	<b>49</b>
2.1	<i>Link Functions for Binary Time Series</i>	50
2.1.1	<i>The Logistic Regression Model</i>	51
2.1.2	<i>Probit and Other Links</i>	54
2.2	<i>Partial Likelihood Estimation</i>	56
2.3	<i>Inference for Logistic Regression</i>	59
2.3.1	<i>Asymptotic Relative Efficiency</i>	64
2.4	<i>Goodness of Fit</i>	65
2.4.1	<i>Deviance</i>	66
2.4.2	<i>Goodness of Fit Based on Response Classification</i>	66
2.5	<i>Real Data Examples</i>	70
2.5.1	<i>Rainfall Prediction</i>	70
2.5.2	<i>Modeling Successive Eruptions</i>	72
2.5.3	<i>Stock Price Prediction</i>	76
2.5.4	<i>Modeling Sleep Data</i>	79
2.6	<i>Problems and Complements</i>	81
<b>3</b>	<b>Regression Models for Categorical Time Series</b>	<b>89</b>
3.1	<i>Modeling</i>	90
3.2	<i>Link Functions for Categorical Time Series</i>	92
3.2.1	<i>Models for Nominal Time Series</i>	93
3.2.2	<i>Models for Ordinal Time Series</i>	97
3.3	<i>Partial Likelihood Estimation</i>	101
3.3.1	<i>Inference for m=3</i>	101
3.3.2	<i>Inference for m&gt;3</i>	104
3.3.3	<i>Large Sample Theory</i>	107
3.3.4	<i>Inference for the Multinomial Logit Model</i>	108
3.3.5	<i>Testing Hypotheses</i>	109
3.4	<i>Goodness of Fit</i>	110
3.4.1	<i>Goodness of Fit Based on Response Classification</i>	111

3.4.2	<i>Power Divergence Family of Goodness of Fit Tests</i>	112
3.4.3	<i>A Family of Goodness of Fit Tests</i>	113
3.4.4	<i>Further Diagnostic Tools</i>	115
3.5	<i>Examples</i>	116
3.5.1	<i>Explanatory Analysis of DNA Sequence Data</i>	116
3.5.2	<i>Soccer Forecasting</i>	119
3.5.3	<i>Sleep Data Revisited</i>	121
3.6	<i>Additional Topics</i>	125
3.6.1	<i>Alternative Modeling</i>	125
3.6.2	<i>Spectral Analysis</i>	125
3.6.3	<i>Longitudinal Data</i>	125
3.7	<i>Problems and Complements</i>	126
	<i>Appendix: Asymptotic Theory</i>	130
<b>4</b>	<b>Regression Models for Count Time Series</b>	<b>139</b>
4.1	<i>Modeling</i>	140
4.2	<i>Models for Time Series of Counts</i>	142
4.2.1	<i>The Poisson Model</i>	142
4.2.2	<i>The Doubly Truncated Poisson Model</i>	148
4.2.3	<i>The Zeger–Qaqish Model</i>	153
4.3	<i>Inference</i>	154
4.3.1	<i>Partial Likelihood Estimation for the Poisson Model</i>	154
4.3.2	<i>Asymptotic Theory</i>	156
4.3.3	<i>Prediction Intervals</i>	157
4.3.4	<i>Inference for the Zeger–Qaqish Model</i>	157
4.3.5	<i>Hypothesis Testing</i>	158
4.4	<i>Goodness of Fit</i>	159
4.4.1	<i>Deviance</i>	159
4.4.2	<i>Residuals</i>	159
4.5	<i>Data Examples</i>	159
4.5.1	<i>Monthly Count of Rainy Days</i>	160
4.5.2	<i>Tourist Arrival Data</i>	163
4.6	<i>Problems and Complements</i>	168
<b>5</b>	<b>Other Models and Alternative Approaches</b>	<b>175</b>
5.1	<i>Integer Autoregressive and Moving Average Models</i>	175
5.1.1	<i>Branching Processes with Immigration</i>	175

5.1.2	<i>Integer Autoregressive Models of Order 1</i>	178
5.1.3	<i>Estimation for INAR(1) Process</i>	183
5.1.4	<i>Integer Autoregressive Models of Order p</i>	184
5.1.5	<i>Regression Analysis of Integer Autoregressive Models</i>	185
5.1.6	<i>Integer Moving Average Models</i>	185
5.1.7	<i>Extensions and Modifications</i>	188
5.2	<i>Discrete Autoregressive Moving Average Models</i>	189
5.3	<i>The Mixture Transition Distribution Model</i>	190
5.3.1	<i>Estimation in MTD Models</i>	192
5.3.2	<i>Old Faithful Data Revisited</i>	192
5.3.3	<i>Explanatory Analysis of DNA Sequence Data Revisited</i>	193
5.3.4	<i>Soccer Forecasting Data Revisited</i>	193
5.4	<i>Hidden Markov Models</i>	194
5.5	<i>Variable Mixture Models</i>	197
5.5.1	<i>Threshold Models</i>	198
5.5.2	<i>Partial Likelihood Inference</i>	198
5.5.3	<i>Comparison with the Threshold Model</i>	199
5.6	<i>ARCH Models</i>	199
5.6.1	<i>The ARCH(1) Model</i>	199
5.6.2	<i>Maximum Likelihood Estimation</i>	200
5.6.3	<i>Extensions of ARCH Models</i>	200
5.7	<i>Sinusoidal Regression Model</i>	201
5.8	<i>Mixed Models for Longitudinal Data</i>	205
5.9	<i>Problems and Complements</i>	208
<b>6</b>	<b>State Space Models</b>	<b>213</b>
6.1	<i>Introduction</i>	213
6.1.1	<i>Historical Note</i>	214
6.2	<i>Linear Gaussian State Space Models</i>	215
6.2.1	<i>Examples of Linear State Space Models</i>	216
6.2.2	<i>Estimation by Kalman Filtering and Smoothing</i>	218
6.2.3	<i>Estimation in the Linear Gaussian Model</i>	221
6.3	<i>Nonlinear and Non-Gaussian State Space Models</i>	223
6.3.1	<i>General Filtering and Smoothing</i>	225
6.3.2	<i>Dynamic Generalized Linear Models</i>	227
6.4	<i>Simulation Based Methods for State Space Models</i>	231
6.4.1	<i>A Brief MCMC Tutorial</i>	232

6.4.2	<i>MCMC Inference for State Space Models</i>	233
6.4.3	<i>Sequential Monte Carlo Sampling Methods</i>	237
6.4.4	<i>Likelihood Inference</i>	240
6.4.5	<i>Longitudinal Data</i>	241
6.5	<i>Kalman Filtering in Space-Time Data</i>	241
6.6	<i>Problems and Complements</i>	241
<b>7</b>	<b>Prediction and Interpolation</b>	<b>249</b>
7.1	<i>Introduction</i>	249
7.1.1	<i>Elements of Stationary Random Fields</i>	251
7.1.2	<i>Ordinary Kriging</i>	252
7.2	<i>Bayesian Spatial Prediction</i>	258
7.2.1	<i>An Auxiliary Gaussian Process</i>	258
7.2.2	<i>The Likelihood</i>	260
7.2.3	<i>Prior and Posterior of Model Parameters</i>	262
7.2.4	<i>Prediction of <math>Z_0</math></i>	263
7.2.5	<i>Numerical Algorithm for the Case <math>k = 1</math></i>	264
7.2.6	<i>Normalizing Transformations</i>	265
7.2.7	<i>Software for BTG Implementation</i>	265
7.3	<i>Applications of BTG</i>	267
7.3.1	<i>Spatial Rainfall Prediction</i>	267
7.3.2	<i>Comparison with Kriging</i>	274
7.3.3	<i>Time Series Prediction</i>	274
7.3.4	<i>Seasonal Time Series</i>	278
7.4	<i>Problems and Complements</i>	282
<b>Appendix: Elements of Stationary Processes</b>		<b>285</b>
<b>References</b>		<b>297</b>
<b>Index</b>		<b>327</b>