

---

# Contents

<b>1</b>	<b>Introduction: basic notions about Bayesian inference</b>	<b>1</b>
1.1	Basic notions	2
1.2	Simple dependence structures	5
1.3	Synthesis of conditional distributions	11
1.4	Choice of the prior distribution	14
1.5	Bayesian inference in the linear regression model	18
1.6	Markov chain Monte Carlo methods	22
1.6.1	Gibbs sampler	24
1.6.2	Metropolis–Hastings algorithm	24
1.6.3	Adaptive rejection Metropolis sampling	25
	Problems	29
<b>2</b>	<b>Dynamic linear models</b>	<b>31</b>
2.1	Introduction	31
2.2	A simple example	35
2.3	State space models	39
2.4	Dynamic linear models	41
2.5	Dynamic linear models in package <code>dlm</code>	43
2.6	Examples of nonlinear and non-Gaussian state space models	48
2.7	State estimation and forecasting	49
2.7.1	Filtering	51
2.7.2	Kalman filter for dynamic linear models	53
2.7.3	Filtering with missing observations	59
2.7.4	Smoothing	60
2.8	Forecasting	66
2.9	The innovation process and model checking	73
2.10	Controllability and observability of time-invariant DLMs	77
2.11	Filter stability	80
	Problems	83

<b>3</b>	<b>Model specification</b> . . . . .	85
3.1	Classical tools for time series analysis . . . . .	85
3.1.1	Empirical methods . . . . .	85
3.1.2	ARIMA models . . . . .	87
3.2	Univariate DLMs for time series analysis . . . . .	88
3.2.1	Trend models . . . . .	89
3.2.2	Seasonal factor models . . . . .	100
3.2.3	Fourier form seasonal models . . . . .	102
3.2.4	General periodic components . . . . .	109
3.2.5	DLM representation of ARIMA models . . . . .	112
3.2.6	Example: estimating the output gap . . . . .	115
3.2.7	Regression models . . . . .	121
3.3	Models for multivariate time series . . . . .	125
3.3.1	DLMs for longitudinal data . . . . .	126
3.3.2	Seemingly unrelated time series equations . . . . .	127
3.3.3	Seemingly unrelated regression models . . . . .	132
3.3.4	Hierarchical DLMs . . . . .	134
3.3.5	Dynamic regression . . . . .	136
3.3.6	Common factors . . . . .	138
3.3.7	Multivariate ARMA models . . . . .	139
	Problems . . . . .	142
<b>4</b>	<b>Models with unknown parameters</b> . . . . .	143
4.1	Maximum likelihood estimation . . . . .	144
4.2	Bayesian inference . . . . .	148
4.3	Conjugate Bayesian inference . . . . .	149
4.3.1	Unknown covariance matrices: conjugate inference . . . . .	150
4.3.2	Specification of $W_t$ by discount factors . . . . .	152
4.3.3	A discount factor model for time-varying $V_t$ . . . . .	158
4.4	Simulation-based Bayesian inference . . . . .	160
4.4.1	Drawing the states given $y_{1:T}$ : forward filtering backward sampling . . . . .	161
4.4.2	General strategies for MCMC . . . . .	162
4.4.3	Illustration: Gibbs sampling for a local level model . . . . .	165
4.5	Unknown variances . . . . .	167
4.5.1	Constant unknown variances: $d$ Inverse Gamma prior . . . . .	167
4.5.2	Multivariate extensions . . . . .	171
4.5.3	A model for outliers and structural breaks . . . . .	177
4.6	Further examples . . . . .	186
4.6.1	Estimating the output gap: Bayesian inference . . . . .	186
4.6.2	Dynamic regression . . . . .	192
4.6.3	Factor models . . . . .	200
	Problems . . . . .	206

**5 Sequential Monte Carlo methods** ..... 207

5.1 The basic particle filter ..... 208

5.1.1 A simple example ..... 213

5.2 Auxiliary particle filter ..... 216

5.3 Sequential Monte Carlo with unknown parameters ..... 219

5.3.1 A simple example with unknown parameters ..... 226

5.4 Concluding remarks ..... 228

**A Useful distributions** ..... 231

**B Matrix algebra: Singular Value Decomposition** ..... 237

**Index** ..... 241

**References** ..... 245



<http://www.springer.com/978-0-387-77237-0>

Dynamic Linear Models with R  
Petris, G.; Petrone, S.; Campagnoli, P.  
2009, XIII, 252 p., Softcover  
ISBN: 978-0-387-77237-0