CAMBRIDGE

Cambridge University Press
978-1-108-48103-8 — Computational Bayesian Statistics
M. Antónia Amaral Turkman , Carlos Daniel Paulino , Peter Müller
Table of Contents
More Information

Contents

Preface to the English Version viii
Preface ix

1 Bayesian Inference 1
1.1 The Classical Paradigm 2
1.2 The Bayesian Paradigm 5
1.3 Bayesian Inference 8
1.3.1 Parametric Inference 8
1.3.2 Predictive Inference 12
1.4 Conclusion 13
Problems 14

2 Representation of Prior Information 17
2.1 Non-Informative Priors 18
2.2 Natural Conjugate Priors 23
Problems 26

3 Bayesian Inference in Basic Problems 28
3.1 The Binomial ∧ Beta Model 28
3.2 The Poisson ∧ Gamma Model 30
3.3 Normal (Known μ) ∧ Inverse Gamma Model 31
3.4 Normal (Unknown μ, σ^2) ∧ Jeffreys' Prior 31
3.5 Two Independent Normal Models ∧ Marginal Jeffreys' Priors 33
3.6 Two Independent Binomials ∧ Beta Distributions 34
3.7 Multinomial ∧ Dirichlet Model 36
3.8 Inference in Finite Populations 38
Problems 40

4 Inference by Monte Carlo Methods 43
4.1 Simple Monte Carlo 43
4.1.1 Posterior Probabilities 47
4.1.2 Credible Intervals 47

© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-1-108-48103-8 — Computational Bayesian Statistics
M. Antónia Amaral Turkman , Carlos Daniel Paulino , Peter Müller
Table of Contents
More Information

4.1.3 Marginal Posterior Distributions 48
4.1.4 Predictive Summaries 50
4.2 Monte Carlo with Importance Sampling 50
4.2.1 Credible Intervals 54
4.2.2 Bayes Factors 56
4.2.3 Marginal Posterior Densities 57
4.3 Sequential Monte Carlo 59
4.3.1 Dynamic State Space Models 59
4.3.2 Particle Filter 60
4.3.3 Adapted Particle Filter 62
4.3.4 Parameter Learning 63
Problems 64

5 Model Assessment 70
5.1 Model Criticism and Adequacy 70
5.2 Model Selection and Comparison 76
5.2.1 Measures of Predictive Performance 76
5.2.2 Selection by Posterior Predictive Performance 81
5.2.3 Model Selection Using Bayes Factors 83
5.3 Further Notes on Simulation in Model Assessment 85
5.3.1 Evaluating Posterior Predictive Distributions 85
5.3.2 Prior Predictive Density Estimation 86
5.3.3 Sampling from Predictive Distributions 87
Problems 88

6 Markov Chain Monte Carlo Methods 90
6.1 Definitions and Basic Results for Markov Chains 91
6.2 Metropolis–Hastings Algorithm 94
6.3 Gibbs Sampler 98
6.4 Slice Sampler 105
6.5 Hamiltonian Monte Carlo 107
6.5.1 Hamiltonian Dynamics 107
6.5.2 Hamiltonian Monte Carlo Transition Probabilities 111
6.6 Implementation Details 113
Problems 116

7 Model Selection and Trans-dimensional MCMC 129
7.1 MC Simulation over the Parameter Space 129
7.2 MC Simulation over the Model Space 131
7.3 MC Simulation over Model and Parameter Space 135
7.4 Reversible Jump MCMC 138
Problems 143

© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-1-108-48103-8 — Computational Bayesian Statistics
M. Antónia Amaral Turkman , Carlos Daniel Paulino , Peter Müller
Table of Contents
More Information

8 Methods Based on Analytic Approximations 150
8.1 Analytical Methods 151
8.1.1 Multivariate Normal Posterior Approximation 151
8.1.2 The Classical Laplace Method 154
8.2 Latent Gaussian Models (LGM) 159
8.3 Integrated Nested Laplace Approximation 161
8.4 Variational Bayesian Inference 164
8.4.1 Posterior Approximation 164
8.4.2 Coordinate Ascent Algorithm 165
8.4.3 Automatic Differentiation Variational Inference 168
Problems 168

9 Software 172
9.1 Application Example 173
9.2 The BUGS Project: WinBUGS and OpenBUGS 173
9.2.1 Application Example: Using R2OpenBUGS 175
9.3 JAGS 181
9.3.1 Application Example: Using R2jags 181
9.4 Stan 185
9.4.1 Application Example: Using RStan 186
9.5 BayesX 192
9.5.1 Application Example: Using R2BayesX 194
9.6 Convergence Diagnostics: the Programs CODA and BOA 198
9.6.1 Convergence Diagnostics 199
9.6.2 The CODA and BOA Packages 201
9.6.3 Application Example: CODA and BOA 203
9.7 R-INLA and the Application Example 213
9.7.1 Application Example 215
Problems 222

Appendix A. Probability Distributions 224
Appendix B. Programming Notes 229
References 232
Index 241

© in this web service Cambridge University Press www.cambridge.org