
Contents

Preface	vii
List of Figures	xiii
List of Examples.....	xvii
1 Basic R Programming	1
1.1 Introduction	2
1.2 Getting started.....	3
1.3 R objects	5
1.3.1 The vector class	6
1.3.2 The matrix, array, and factor classes	9
1.3.3 The list and data.frame classes	12
1.4 Probability distributions in R	14
1.5 Basic and not-so-basic statistics	14
1.6 Graphical facilities.....	26
1.7 Writing new R functions	31
1.8 Input and output in R.....	35
1.9 Administration of R objects	36
1.10 The mcsm package.....	36
1.11 Additional exercises.....	37
2 Random Variable Generation	41
2.1 Introduction	42
2.1.1 Uniform simulation	42
2.1.2 The inverse transform	44
2.2 General transformation methods.....	46
2.2.1 A normal generator	47
2.2.2 Discrete distributions	48
2.2.3 Mixture representations	50
2.3 Accept–reject methods	51

2.4	Additional exercises	57
3	Monte Carlo Integration	61
3.1	Introduction	62
3.2	Classical Monte Carlo integration	65
3.3	Importance sampling	69
3.3.1	An arbitrary change of reference measure	69
3.3.2	Sampling importance resampling	75
3.3.3	Selection of the importance function	78
3.4	Additional exercises	86
4	Controlling and Accelerating Convergence	89
4.1	Introduction	90
4.2	Monitoring variation	91
4.3	Asymptotic variance of importance sampling estimators	92
4.4	Effective sample size and perplexity	98
4.5	Simultaneous monitoring	100
4.6	Rao–Blackwellization and deconditioning	107
4.7	Acceleration methods	111
4.7.1	Correlated simulations	111
4.7.2	Antithetic variables	113
4.7.3	Control variates	116
4.8	Additional exercises	122
5	Monte Carlo Optimization	125
5.1	Introduction	126
5.2	Numerical optimization methods	127
5.3	Stochastic search	130
5.3.1	A basic solution	130
5.3.2	Stochastic gradient methods	136
5.3.3	Simulated annealing	140
5.4	Stochastic approximation	146
5.4.1	Optimizing Monte Carlo approximations	146
5.4.2	Missing-data models and demarginalization	150
5.4.3	The EM algorithm	152
5.4.4	Monte Carlo EM	157
5.5	Additional exercises	163
6	Metropolis–Hastings Algorithms	167
6.1	Introduction	168
6.2	A peek at Markov chain theory	168
6.3	Basic Metropolis–Hastings algorithms	170
6.3.1	A generic Markov chain Monte Carlo algorithm	171
6.3.2	The independent Metropolis–Hastings algorithm	175
6.4	A selection of candidates	182

6.4.1	Random walks	182
6.4.2	Alternative candidates	185
6.5	Acceptance rates	192
6.6	Additional exercises	195
7	Gibbs Samplers	199
7.1	Introduction	200
7.2	The two-stage Gibbs sampler	200
7.3	The multistage Gibbs sampler	206
7.4	Missing data and latent variables	209
7.5	Hierarchical structures	221
7.6	Other considerations	224
7.6.1	Reparameterization	224
7.6.2	Rao–Blackwellization	227
7.6.3	Metropolis within Gibbs and hybrid strategies	230
7.6.4	Improper priors	232
7.7	Additional exercises	234
8	Monitoring and Adaptation for MCMC Algorithms	237
8.1	Introduction	238
8.2	Monitoring what and why	238
8.2.1	Convergence to the stationary distribution	238
8.2.2	Convergence of averages	240
8.2.3	Approximating iid sampling	240
8.2.4	The <i>coda</i> package	241
8.3	Monitoring convergence to stationarity	242
8.3.1	Graphical diagnoses	242
8.3.2	Nonparametric tests of stationarity	243
8.3.3	Spectral analysis	247
8.4	Monitoring convergence of averages	250
8.4.1	Graphical diagnoses	250
8.4.2	Within and between variances	253
8.4.3	Effective sample size	255
8.4.4	Fixed-width batch means	257
8.5	Adaptive MCMC	258
8.5.1	Cautions about adaptation	258
8.5.2	The <i>amcmc</i> package	264
8.6	Additional exercises	267
References	269	
Index of R Terms	275	
Index of Subjects	279	