

Contents

<i>Preface</i>	<i>page vii</i>
1 Discrete-time Markov chains	1
1.1 The Markov property and its immediate consequences	1
1.2 Class division	17
1.3 Hitting times and probabilities	26
1.4 Strong Markov property	35
1.5 Recurrence and transience: definitions and basic facts	39
1.6 Recurrence and transience: random walks on lattices	45
1.7 Equilibrium distributions: definitions and basic facts	52
1.8 Positive and null recurrence	58
1.9 Convergence to equilibrium. Long-run proportions	70
1.10 Detailed balance and reversibility	80
1.11 Controlled and partially observed Markov chains	89
1.12 Geometric algebra of Markov chains, I	99
1.13 Geometric algebra of Markov chains, II	116
1.14 Geometric algebra of Markov chains, III	130
1.15 Large deviations for discrete-time Markov chains	138
1.16 Examination questions on discrete-time Markov chains	155
2 Continuous-time Markov chains	185
2.1 Q-matrices and transition matrices	185
2.2 Continuous-time Markov chains: definitions and basic constructions	196
2.3 The Poisson process	210
2.4 Inhomogeneous Poisson process	231
2.5 Birth-and-death process. Explosion	240
2.6 Continuous-time Markov chains with countably many states	250
2.7 Hitting times and probabilities. Recurrence and transience	266

2.8	Convergence to an equilibrium distribution. Reversibility	283
2.9	Applications to queueing theory. Markovian queues	291
2.10	Examination questions on continuous-time Markov chains	308
3	Statistics of discrete-time Markov chains	349
3.1	Introduction	349
3.2	Likelihood functions, 1. Maximum likelihood estimators	357
3.3	Consistency of estimators. Various forms of convergence	366
3.4	Likelihood functions, 2. Whittle's formula	390
3.5	Bayesian analysis of Markov chains: prior and posterior distributions	401
3.6	Elements of control and information theory	415
3.7	Hidden Markov models, 1. State estimation for Markov chains	434
3.8	Hidden Markov models, 2. The Baum–Welch learning algorithm	451
3.9	Generalisations of the Baum–Welch algorithm	461
	<i>Epilogue: Andrei Markov and his Time</i>	479
	<i>Bibliography</i>	483
	<i>Index</i>	485