

TABLE OF CONTENTS

Preface.....	1
Introduction.....	4
Chapter 1. Elements of probability and martingales.....	11
1. Probability.....	11
2. Random variables.....	13
3. Conditional probabilities and conditional expectations.....	17
4. Independence. Product measures.....	20
5. Martingales and supermartingales.....	22
Chapter 2. Discrete time Markov processes.....	29
1. Markov processes	29
2. Markov processes and supermartingales.....	32
3. Recursively defined processes.....	34
4. Discrete model of diffusion.....	37
5. Exit of sample functions from a domain.....	38
6. Series of independent random variables.....	41
7. Convergence of sample functions.....	43
8. Teaching pattern recognition.....	49
Chapter 3. Markov processes and stochastic equations.....	53
1. Continuous time Markov processes.....	53
2. Stochastic differential equations. I.....	57
3. Stochastic integrals.....	59
4. Stochastic differential equations. II.....	62
5. Itô's formula.....	64
6. Supermartingales.....	69
7. Existence of solutions in the large.....	70
8. Exit from a domain. Convergence of sample functions.....	73
Chapter 4. Convergence of stochastic approximation procedures. I.....	79
1. The Robbins-Monro procedure.....	79
2. The Kiefer-Wolfowitz procedure.....	83
3. Continuous procedures.....	86
4. Convergence of the Robbins-Monro procedure.....	88
5. Convergence of the Kiefer-Wolfowitz procedure.....	94

Chapter 5. Convergence of stochastic approximation procedures. II.....	101
1. Introductory remarks.....	101
2. General theorems.....	102
3. Auxiliary results (continuous time).....	106
4. Auxiliary results (discrete time).....	112
5. One-dimensional procedures.....	118
Chapter 6. Asymptotic normality of the Robbins-Monro procedure.....	123
1. Preliminary remarks.....	123
2. Asymptotic behavior of solutions.....	129
3. Investigation of the process $I_1(t)$	132
4. Investigation of the process $I_2(t)$	136
5. Asymptotic normality (continuous time).....	140
6. Asymptotic normality (discrete time).....	147
7. Convergence of moments.....	154
Chapter 7. Some modifications of stochastic approximation procedures.....	161
1. Statement of the problem.....	161
2. General theorem.....	162
3. Auxiliary results.....	165
4. Theorems on convergence and asymptotic normality.....	167
5. Adaptive Robbins-Monro procedures.....	169
6. Asymptotic optimality.....	175
Chapter 8. Recursive estimation (discrete time).....	181
1. The Cramér-Rao inequality. Efficiency of estimates.....	181
2. The Cramér-Rao inequality in the multidimensional case.....	186
3. Estimation of a one-dimensional parameter.....	189
4. Asymptotically efficient recursive procedure.....	194
5. Estimation of a multidimensional parameter.....	197
6. Estimation with dependent observations.....	202
Chapter 9. Recursive estimation (continuous time).....	207
1. The Cramér-Rao inequality.....	207
2. Application of the Robbins-Monro procedure.....	210
3. Time-dependent observations.....	212
4. Some applications.....	213
5. A modification.....	220
Chapter 10. Recursive estimation with a control parameter.....	221
1. Statement of the problem.....	221
2. Asymptotically optimal recursive plan.....	223
3. Two examples.....	226
4. Continuous case.....	229
Notes on the Literature.....	233
Bibliography.....	237
Subject Index.....	242
Main Notation.....	244

