Preface

The purpose of this book is to present a systematic treatment of stochastic models which arise from genetics, carcinogenesis, AIDS epidemiology and HIV pathogenesis. It is meant to provide basic methodological tools to analyze these processes and to study the stochastic behavior of these processes. This book is useful because cancer and AIDS are the most dangerous diseases threatening the survival of human beings and because the genetic principle has been used in developing computer algorithms by computer scientists. Also, the genome project has made the genetic theories one of the most important disciplines in scientific research.

This book is organized into 9 chapters. To illustrate the basic stochastic processes which arise from genetics, cancer and AIDS, in Chapter 1, numerous examples from these areas are presented. These processes include univariate and multivariate Markov chains with discrete time and with continuous time, diffusion processes, state space models and hidden Markov models. Having introduced these processes, the rest of the book is then devoted to develop basic theories of these processes and applications of these processes to genetic, cancer and AIDS. Thus, in Chapter 2, we present the basic theories of Markov chains with discrete time and describe the stochastic dynamic behavior of these processes. In Chapter 3, we present some basic theories of limiting results and stationary distributions in Markov chains with discrete time; as applications of stationary distributions, in Chapter 3, we also present some MCMC (Markov Chain Monte Carlo) methods to develop optimal computer algorithms to estimate unknown parameters in the models and illustrate its applications.

Chapters 4 and 5 are devoted to develop basic theories of Markov chains with continuous time and describe the stochastic dynamic behavior of these processes. In Chapters 6 and 7, basic theories and methodologies of diffusion processes are presented and illustrated by examples from genetics and biomedical problems. Finally in Chapters 8 and 9, we present some basic theories of state space models and describe how to construct state space models in cancer and AIDS and illustrate applications in these areas.

This book is unique and differs from other books on stochastic processes and stochastic models in several ways: First, it has presented and developed approaches which are not discussed in other books of stochastic processes. This includes MCMC methods and stochastic difference and differential equation approaches to Markov chains. Second, the book describes how to apply the theories to solve problems in genetics, cancer and AIDS. Third, it has presented and discussed state space models and illustrate its applications to cancer and AIDS problems which are not discussed in other books of stochastic processes.

I originally compiled this book for students in the Department of Mathematical Sciences at the University of Memphis, Memphis, Tennessee, when I was offering a graduate course in applied stochastic models. These lecture notes have then been up-dated and expanded to include stochastic and state space models of carcinogenesis, AIDS epidemiology and HIV pathogenesis in HIV-infected individuals. Thus, the book may be used as a text for applied stochastic processes or applied stochastic models. It may also be used as a reference book for courses in mathematical modeling and in stochastic models of biomedical systems and as a reference for research tools by medical doctors and researchers.

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