

# Stochastic Systems In Merging Phase Space

Vladimir S. Koroliuk • Nikolaos Limnios

# Stochastic Systems In Merging Phase

**Dmitrii Silvestrov, Sergei Silvestrov**



### **Stochastic Systems In Merging Phase:**

*Stochastic Models of Systems* Vladimir S. Korolyuk, Vladimir V. Korolyuk, 2012-12-06 In this monograph stochastic models of systems analysis are discussed. It covers many aspects and different stages from the construction of mathematical models of real systems through mathematical analysis of models based on simplification methods to the interpretation of real stochastic systems. The stochastic models described here share the property that their evolutionary aspects develop under the influence of random factors. It has been assumed that the evolution takes place in a random medium, i.e. unilateral interaction between the system and the medium. As only Markovian models of random medium are considered in this book, the stochastic models described here are determined by two processes: a switching process describing the evolution of the systems and a switching process describing the changes of the random medium. Audience: This book will be of interest to postgraduate students and researchers whose work involves probability theory, stochastic processes, mathematical systems theory, ordinary differential equations, operator theory, or mathematical modelling and industrial mathematics.

*Quasi-Stationary Phenomena in Nonlinearly Perturbed Stochastic Systems* Mats Gyllenberg, Dmitrii S. Silvestrov, 2008-10-31 The book is devoted to studies of quasi-stationary phenomena in nonlinearly perturbed stochastic systems. New methods of asymptotic analysis for nonlinearly perturbed stochastic processes based on new types of asymptotic expansions for perturbed renewal equation and recurrence algorithms for construction of asymptotic expansions for Markov-type processes with absorption are presented. Asymptotic expansions are given in mixed ergodic for processes and large deviation theorems for absorption times for nonlinearly perturbed regenerative processes, semi-Markov processes and Markov chains. Applications to analysis of quasi-stationary phenomena in nonlinearly perturbed queueing systems, population dynamics and epidemic models and for risk processes are presented. The book also contains an extended bibliography of works in the area. It is an essential reference for theoretical and applied researchers in the field of stochastic processes and their applications and may be also useful for doctoral and advanced undergraduate students.

*Stochastic Systems in Merging Phase Space* Vladimir Semenovich Koroliuk, Nikolaos Limnios, 2005 This book provides recent results on the stochastic approximation of systems by weak convergence techniques. General and particular schemes of proofs for average diffusion and Poisson approximations of stochastic systems are presented, allowing one to simplify complex systems and obtain numerically tractable models. The systems discussed in the book include stochastic additive functionals, dynamical systems, stochastic integral functionals, increment processes and impulsive processes. All these systems are switched by Markov and semi-Markov processes whose phase space is considered in asymptotic split and merging schemes. Most of the results from semi-Markov processes are new and presented for the first time in this book.

**Stochastic Systems In Merging Phase Space** Vladimir S. Koroliuk, Nikolaos Limnios, 2005-12-21 This book provides recent results on the stochastic approximation of systems by weak convergence techniques. General and particular schemes of proofs for average diffusion

and Poisson approximations of stochastic systems are presented allowing one to simplify complex systems and obtain numerically tractable models The systems discussed in the book include stochastic additive functionals dynamical systems stochastic integral functionals increment processes and impulsive processes All these systems are switched by Markov and semi Markov processes whose phase space is considered in asymptotic split and merging schemes Most of the results from semi Markov processes are new and presented for the first time in this book

***Continuous-Time Markov Chains and Applications*** G. George Yin, Qing Zhang, 2012-11-14 This book gives a systematic treatment of singularly perturbed systems that naturally arise in control and optimization queueing networks manufacturing systems and financial engineering It presents results on asymptotic expansions of solutions of Komogorov forward and backward equations properties of functional occupation measures exponential upper bounds and functional limit results for Markov chains with weak and strong interactions To bridge the gap between theory and applications a large portion of the book is devoted to applications in controlled dynamic systems production planning and numerical methods for controlled Markovian systems with large scale and complex structures in the real world problems This second edition has been updated throughout and includes two new chapters on asymptotic expansions of solutions for backward equations and hybrid LQG problems The chapters on analytic and probabilistic properties of two time scale Markov chains have been almost completely rewritten and the notation has been streamlined and simplified This book is written for applied mathematicians engineers operations researchers and applied scientists Selected material from the book can also be used for a one semester advanced graduate level course in applied probability and stochastic processes

**Semi-Markov Processes** Franciszek Grabski, 2014-09-25 Semi Markov Processes Applications in System Reliability and Maintenance is a modern view of discrete state space and continuous time semi Markov processes and their applications in reliability and maintenance The book explains how to construct semi Markov models and discusses the different reliability parameters and characteristics that can be obtained from those models The book is a useful resource for mathematicians engineering practitioners and PhD and MSc students who want to understand the basic concepts and results of semi Markov process theory Clearly defines the properties and theorems from discrete state Semi Markov Process SMP theory Describes the method behind constructing Semi Markov SM models and SM decision models in the field of reliability and maintenance Provides numerous individual versions of SM models including the most recent and their impact on system reliability and maintenance

**Proceedings of 15th International Conference on Electromechanics and Robotics "Zavalishin's Readings"** Andrey Ronzhin, Vladislav Shishlakov, 2020-09-01 This book features selected papers presented at the 15th International Conference on Electromechanics and Robotics Zavalishin s Readings ER ZR 2020 held in Ufa Russia on 15 18 April 2020 The contributions written by professionals researchers and students cover topics in the field of automatic control systems electromechanics electric power engineering and electrical engineering mechatronics robotics automation and vibration technologies The Zavalishin s Readings conference was

established as a tribute to the memory of Dmitry Aleksandrovich Zavalishin 1900 1968 a Russian scientist corresponding member of the USSR Academy of Sciences and founder of the school of valve energy converters based on electric machines and valve converters energy The first conference was organized by the Institute of Innovative Technologies in Electromechanics and Robotics at the Saint Petersburg State University of Aerospace Instrumentation in 2006

*Nonlinearly Perturbed Semi-Markov Processes* Dmitrii Silvestrov, Sergei Silvestrov, 2017-09-06 The book presents new methods of asymptotic analysis for nonlinearly perturbed semi Markov processes with a finite phase space These methods are based on special time space screening procedures for sequential phase space reduction of semi Markov processes combined with the systematical use of operational calculus for Laurent asymptotic expansions Effective recurrent algorithms are composed for getting asymptotic expansions without and with explicit upper bounds for remainders for power moments of hitting times stationary and conditional quasi stationary distributions for nonlinearly perturbed semi Markov processes These results are illustrated by asymptotic expansions for birth death type semi Markov processes which play an important role in various applications The book will be a useful contribution to the continuing intensive studies in the area It is an essential reference for theoretical and applied researchers in the field of stochastic processes and their applications that will contribute to continuing extensive studies in the area and remain relevant for years to come Queueing Theory 1

, 2021-04-27 The aim of this book is to reflect the current cutting edge thinking and established practices in the investigation of queueing systems and networks This first volume includes ten chapters written by experts well known in their areas The book studies the analysis of queues with interdependent arrival and service times characteristics of fluid queues modifications of retrial queueing systems and finite source retrial queues with random breakdowns repairs and customers collisions Some recent tendencies in the asymptotic analysis include the average and diffusion approximation of Markov queueing systems and networks the diffusion and Gaussian limits of multi channel queueing networks with rather general input flow and the analysis of two time scale nonhomogenous Markov chains using the large deviations principle The book also analyzes transient behavior of infinite server queueing models with a mixed arrival process the strong stability of queueing systems and networks and applications of fast simulation methods for solving high dimension combinatorial problems

**Switching Processes in Queueing Models** Vladimir Anisimov, 2013-03-01 Switching processes invented by the author in 1977 is the main tool used in the investigation of traffic problems from automotive to telecommunications The title provides a new approach to low traffic problems based on the analysis of flows of rare events and queueing models In the case of fast switching averaging principle and diffusion approximation results are proved and applied to the investigation of transient phenomena for wide classes of overloading queueing networks The book is devoted to developing the asymptotic theory for the class of switching queueing models which covers models in a Markov or semi Markov environment models under the influence of flows of external or internal perturbations unreliable and hierarchic networks etc *Markov Random*

*Flights* Alexander D. Kolesnik, 2021-01-04 Markov Random Flights is the first systematic presentation of the theory of Markov random flights in the Euclidean spaces of different dimensions Markov random flights is a stochastic dynamic system subject to the control of an external Poisson process and represented by the stochastic motion of a particle that moves at constant finite speed and changes its direction at random Poisson time instants The initial and each new direction is taken at random according to some probability distribution on the unit sphere Such stochastic motion is the basic model for describing many real finite velocity transport phenomena arising in statistical physics chemistry biology environmental science and financial markets Markov random flights acts as an effective tool for modelling the slow and super slow diffusion processes arising in various fields of science and technology Features Provides the first systematic presentation of the theory of Markov random flights in the Euclidean spaces of different dimensions Suitable for graduate students and specialists and professionals in applied areas Introduces a new unified approach based on the powerful methods of mathematical analysis such as integral transforms generalized hypergeometric and special functions Author Alexander D Kolesnik is a professor Head of Laboratory 2015 2019 and principal researcher since 2020 at the Institute of Mathematics and Computer Science Kishinev Chi in u Moldova He graduated from Moldova State University in 1980 and earned his PhD from the Institute of Mathematics of the National Academy of Sciences of Ukraine Kiev in 1991 He also earned a PhD Habilitation in mathematics and physics with specialization in stochastic processes probability and statistics conferred by the Specialized Council at the Institute of Mathematics of the National Academy of Sciences of Ukraine and confirmed by the Supreme Attestation Commission of Ukraine in 2010 His research interests include probability and statistics stochastic processes random evolutions stochastic dynamic systems random flights diffusion processes transport processes random walks stochastic processes in random environments partial differential equations in stochastic models statistical physics and wave processes Dr Kolesnik has published more than 70 scientific publications mostly in high standard international journals and a monograph He has also acted as external referee for many outstanding international journals in mathematics and physics being awarded by the Certificate of Outstanding Contribution in Reviewing from the journal Stochastic Processes and their Applications He was the visiting professor and scholarship holder at universities in Italy and Germany and member of the Board of Global Advisors of the International Federation of Nonlinear Analysts IFNA United States of America

**Analytical and Computational Methods in Probability Theory** Vladimir V. Rykov, Nozer D. Singpurwalla, Andrey M. Zubkov, 2017-12-21 This book constitutes the refereed proceedings of the First International Conference on Analytical and Computational Methods in Probability Theory and its Applications ACMPT 2017 held in Moscow Russia in October 2017 The 42 full papers presented were carefully reviewed and selected from 173 submissions The conference program consisted of four main themes associated with significant contributions made by A D Soloviev These are Analytical methods in probability theory Computational methods in probability theory Asymptotical methods in probability theory the history of mathematics

Semi-Markov Risk Models for Finance, Insurance and Reliability Jacques Janssen, Raimondo Manca, 2007-05-15 This book aims to give a complete and self contained presentation of semi Markov models with finitely many states in view of solving real life problems of risk management in three main fields Finance Insurance and Reliability providing a useful complement to our first book Janssen and Manca 2006 which gives a theoretical presentation of semi Markov theory However to help assure the book is self contained the first three chapters provide a summary of the basic tools on semi Markov theory that the reader will need to understand our presentation For more details we refer the reader to our first book Janssen and Manca 2006 whose notations definitions and results have been used in these four first chapters Nowadays the potential for theoretical models to be used on real life problems is severely limited if there are no good computer programs to process the relevant data We therefore systematically propose the basic algorithms so that effective numerical results can be obtained Another important feature of this book is its presentation of both homogeneous and non homogeneous models It is well known that the fundamental structure of many real life problems is non homogeneous in time and the application of homogeneous models to such problems gives in the best case only approximated results or in the worst case nonsense results

**Discrete-Time Semi-Markov Random Evolutions and Their Applications** Nikolaos Limnios, Anatoliy Swishchuk, 2023-07-24 This book extends the theory and applications of random evolutions to semi Markov random media in discrete time essentially focusing on semi Markov chains as switching or driving processes After giving the definitions of discrete time semi Markov chains and random evolutions it presents the asymptotic theory in a functional setting including weak convergence results in the series scheme and their extensions in some additional directions including reduced random media controlled processes and optimal stopping Finally applications of discrete time semi Markov random evolutions in epidemiology and financial mathematics are discussed This book will be of interest to researchers and graduate students in applied mathematics and statistics and other disciplines including engineering epidemiology finance and economics who are concerned with stochastic models of systems

**Perturbed Semi-Markov Type Processes I** Dmitrii Silvestrov, 2022-03-25 This book is the first volume of a two volume monograph devoted to the study of limit and ergodic theorems for regularly and singularly perturbed Markov chains semi Markov processes and multi alternating regenerative processes with semi Markov modulation The first volume presents necessary and sufficient conditions for weak convergence for first rare event times and convergence in the topology  $J$  for first rare event processes defined on regularly perturbed finite Markov chains and semi Markov processes The text introduces new asymptotic recurrent algorithms of phase space reduction It also addresses both effective conditions of weak convergence for distributions of hitting times as well as convergence of expectations of hitting times for regularly and singularly perturbed finite Markov chains and semi Markov processes The book also contains a comprehensive bibliography of major works in the field It provides an effective reference for both graduate students as well as theoretical and applied researchers studying stochastic processes and their applications

**Asymptotic Analyses for**

**Complex Evolutionary Systems with Markov and Semi-Markov Switching Using Approximation Schemes** Yaroslav Chabanyuk, Anatolii Nikitin, Uliana Khimka, 2020-10-02 This book analyzes stochastic evolutionary models under the impulse of diffusion as well as Markov and semi Markov switches Models are investigated under the conditions of classical and non classical Levy and Poisson approximations in addition to jumping stochastic approximations and continuous optimization procedures Among other asymptotic properties particular attention is given to weak convergence dissipativity stability and the control of processes and their generators Weak convergence of stochastic processes is usually proved by verifying two conditions the tightness of the distributions of the converging processes which ensures the existence of a converging subsequence and the uniqueness of the weak limit Achieving the limit can be done on the semigroups that correspond to the converging process as well as on appropriate generators While this provides the convergence of generators a natural question arises concerning the uniqueness of a limit semigroup

**Introduction to Ergodic rates for Markov chains and processes** Kulik, Alexei, 2015-10-20 The present lecture notes aim for an introduction to the ergodic behaviour of Markov Processes and addresses graduate students post graduate students and interested readers Different tools and methods for the study of upper bounds on uniform and weak ergodic rates of Markov Processes are introduced These techniques are then applied to study limit theorems for functionals of Markov processes This lecture course originates in two mini courses held at University of Potsdam Technical University of Berlin and Humboldt University in spring 2013 and Ritsumeikan University in summer 2013 Alexei Kulik Doctor of Sciences is a Leading researcher at the Institute of Mathematics of Ukrainian National Academy of Sciences

**Statistical and Probabilistic Models in Reliability** Nikolaos Limnios, Dumitru Cezar Ionescu, 2012-12-06 This volume consists of twenty four papers selected by the editors from the sixty one papers presented at the 1st International Conference on Mathematical Methods in Reliability held at the Politehnica University of Bucharest from 16 to 19 September 1997 The papers have been divided into three sections statistical methods probabilistic methods and special techniques and applications Of course as with any classification some papers could be as well assigned to other sections Problems in reliability are encountered in items in everyday usage Reliability is an important feature of household appliances cars telephones power supplies and so on whether viewed from the vantage of the producer or the consumer Important decisions are based on the reliability of the product Obtaining systems that perform adequately for a specified period of time in a given environment is an important goal for both government and industry Hence study and use of reliability theory which can be applied in the research development and production phases of a system to enable the user to evaluate and improve performance is a worthwhile venture If reliability theory is to be useful it must be quantitative in nature because reliability must be demonstrable Subsequently probability and statistics among others play an important part in its development

Nonlinear Dynamics of Chaotic and Stochastic Systems Vadim S. Anishchenko, Vladimir Astakhov, Alexander Neiman, Tatjana Vadivasova, Lutz Schimansky-Geier, 2007-07-20 We present an improved and enlarged

version of our book *Nonlinear Dynamics of Chaotic and Stochastic Systems* published by Springer in 2002. Basically the new edition of the book corresponds to its first version. While preparing this edition we made some clarifications in several sections and also corrected the misprints noticed in some formulas. Besides three new sections have been added to Chapter 2. They are Statistical Properties of Dynamical Chaos, Effects of Synchronization in Extended Self-Sustained Oscillatory Systems and Synchronization in Living Systems. The sections indicated reflect the most interesting results obtained by the authors after publication of the first edition. We hope that the new edition of the book will be of great interest for a wide section of readers who are already specialists or those who are beginning research in the fields of nonlinear oscillation and wave theory, dynamical chaos, synchronization and stochastic process theory.

Saratov, Berlin and St. Louis, V. S. Anishchenko, November 2006. A. B. Neiman, T. E. Vadiavasova, V. V. Astakhov, L. Schimansky-Geier.

**Preface to the First Edition**

This book is devoted to the classical background and to contemporary results on nonlinear dynamics of deterministic and stochastic systems. Considerable attention is given to the effects of noise on various regimes of dynamic systems with noise-induced order. On the one hand, there exists a rich literature of excellent books on nonlinear dynamics and chaos; on the other hand, there are many marvelous monographs and textbooks on the statistical physics of far from equilibrium and stochastic processes. This book is an attempt to combine the approach of nonlinear dynamics based on the deterministic evolution equations with the approach of statistical physics based on stochastic or kinetic equations. One of our main aims is to show the important role of noise in the organization and properties of dynamic regimes of nonlinear dissipative systems.

Random Motions in Markov and Semi-Markov Random Environments 1 Anatoliy Pogorui, Anatoliy Swishchuk, Ramon M. Rodriguez-Dagnino, 2021-03-16

This book is the first of two volumes on random motions in Markov and semi-Markov random environments. This first volume focuses on homogeneous random motions. This volume consists of two parts: the first describing the basic concepts and methods that have been developed for random evolutions. These methods are the foundational tools used in both volumes, and this description includes many results in potential operators. Some techniques to find closed-form expressions in relevant applications are also presented. The second part deals with asymptotic results and presents a variety of applications including random motion with different types of boundaries, the reliability of storage systems, and solutions of partial differential equations with constant coefficients using commutative algebra techniques. It also presents an alternative formulation to the Black-Scholes formula in finance, fading evolutions, and telegraph processes, including jump telegraph processes and the estimation of the number of level crossings for telegraph processes.

## **Stochastic Systems In Merging Phase** Book Review: Unveiling the Power of Words

In a world driven by information and connectivity, the energy of words has become more evident than ever. They have the capacity to inspire, provoke, and ignite change. Such could be the essence of the book **Stochastic Systems In Merging Phase**, a literary masterpiece that delves deep into the significance of words and their affect our lives. Compiled by a renowned author, this captivating work takes readers on a transformative journey, unraveling the secrets and potential behind every word. In this review, we will explore the book's key themes, examine its writing style, and analyze its overall affect readers.

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