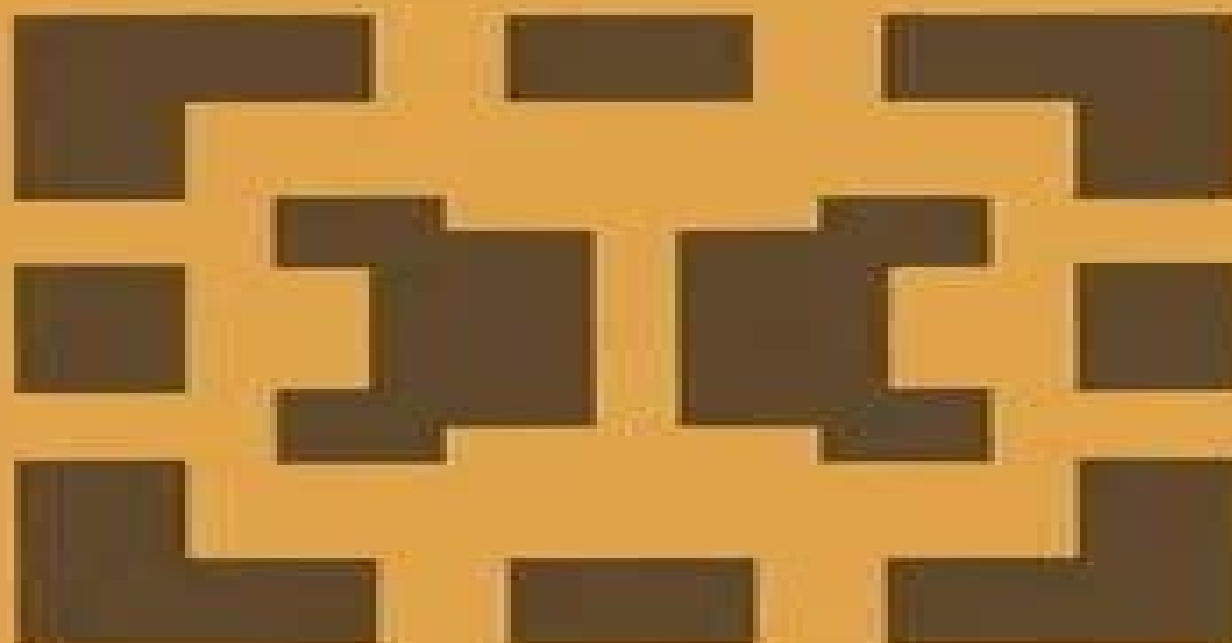


**Mathematics and Its Applications**

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**Semi-Markov  
Random Evolutions**



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# Semi Markov Random Evolutions

**Nikolaos Limnios, Anatoliy Swishchuk**



## **Semi Markov Random Evolutions:**

*Semi-Markov Random Evolutions* Vladimir S. Korolyuk, Anatoly Swishchuk, 2012-12-06 The evolution of systems in random media is a broad and fruitful field for the applications of different mathematical methods and theories This evolution can be characterized by a semigroup property In the abstract form this property is given by a semigroup of operators in a normed vector Banach space In the practically boundless variety of mathematical models of the evolutionary systems we have chosen the semi Markov random evolutions as an object of our consideration The definition of the evolutions of this type is based on rather simple initial assumptions The random medium is described by the Markov renewal processes or by the semi Markov processes The local characteristics of the system depend on the state of the random medium At the same time the evolution of the system does not affect the medium Hence the semi Markov random evolutions are described by two processes namely by the switching Markov renewal process which describes the changes of the state of the external random medium and by the switched process i e by the semigroup of operators describing the evolution of the system in the semi Markov random medium

*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

**Discrete-Time Semi-Markov Random Evolutions and Their Applications** Nikolaos Limnios, Anatoliy Swishchuk, 2023 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

Evolution of Systems in Random Media Vladimir S. Korolyuk, Anatoly V. Swishchuk, 1995-09-11 Evolution of Systems in Random Media is an innovative application oriented text that explores stochastic models of evolutionary stochastic systems in random media

Specially designed for researchers and practitioners who do not have a background in random evolutions the book allows non experts to explore the potential information and applications that random evolutions can provide **Random Evolutions**

**and their Applications** Anatoly Swishchuk,2013-03-14 The book is devoted to the new trends in random evolutions and their various applications to stochastic evolutionary systems SES Such new developments as the analogue of Dynkin's formulae boundary value problems stochastic stability and optimal control of random evolutions stochastic evolutionary equations driven by martingale measures are considered The book also contains such new trends in applied probability as stochastic models of financial and insurance mathematics in an incomplete market In the famous classical financial mathematics Black Scholes model of a B S market for securities prices which is used for the description of the evolution of bonds and stocks prices and also for their derivatives such as options futures forward contracts etc it is supposed that the dynamic of bonds and stocks prices are set by a linear differential and linear stochastic differential equations respectively with interest rate appreciation rate and volatility such that they are predictable processes Also in the Arrow Debreu economy the securities prices which support a Radner dynamic equilibrium are a combination of an Ito process and a random point process with the all coefficients and jumps being predictable processes **Random Evolutions and Their Applications**

Anatoly Swishchuk,2012-12-06 The main purpose of this handbook is to summarize and to put in order the ideas methods results and literature on the theory of random evolutions and their applications to the evolutionary stochastic systems in random media and also to present some new trends in the theory of random evolutions and their applications In physical language a random evolution RE is a model for a dynamical system whose state of evolution is subject to random variations Such systems arise in all branches of science For example random Hamiltonian and Schrodinger equations with random potential in quantum mechanics Maxwell's equation with a random refractive index in electrodynamics transport equations associated with the trajectory of a particle whose speed and direction change at random etc There are the examples of a single abstract situation in which an evolving system changes its mode of evolution or law of motion because of random changes of the environment or in a medium So in mathematical language a RE is a solution of stochastic operator integral equations in a Banach space The operator coefficients of such equations depend on random parameters Of course in such generality our equation includes any homogeneous linear evolving system Particular examples of such equations were studied in physical applications many years ago A general mathematical theory of such equations has been developed since 1969 the Theory of Random Evolutions *Random Motions in Markov and Semi-Markov Random Environments 2* Anatoliy Pogorui,Anatoliy Swishchuk,Ramon M. Rodriguez-Dagnino,2021-01-11 This book is the second of two volumes on random motions in Markov and semi Markov random environments This second volume focuses on high dimensional random motions This volume consists of two parts The first expands many of the results found in Volume 1 to higher dimensions It presents new results on the random motion of the realistic three dimensional case which has so far been barely mentioned in the

literature and deals with the interaction of particles in Markov and semi Markov media which has in contrast been a topic of intense study The second part contains applications of Markov and semi Markov motions in mathematical finance It includes applications of telegraph processes in modeling stock price dynamics and investigates the pricing of variance volatility covariance and correlation swaps with Markov volatility and the same pricing swaps with semi Markov volatilities

**Inhomogeneous Random Evolutions and Their Applications** Anatoliy Swishchuk,2019-12-11 Inhomogeneous Random Evolutions and Their Applications explains how to model various dynamical systems in finance and insurance with non homogeneous in time characteristics It includes modeling for financial underlying and derivatives via Levy processes with time dependent characteristics limit order books in the algorithmic and HFT with counting price changes processes having time dependent intensities risk processes which count number of claims with time dependent conditional intensities multi asset price impact from distressed selling regime switching Levy driven diffusion based price dynamics Initial models for those systems are very complicated which is why the author s approach helps to simplified their study The book uses a very general approach for modeling of those systems via abstract inhomogeneous random evolutions in Banach spaces To simplify their investigation it applies the first averaging principle long run stability property or law of large numbers LLN to get deterministic function on the long run To eliminate the rate of convergence in the LLN it uses secondly the functional central limit theorem FCLT such that the associated cumulative process centered around that deterministic function and suitably scaled in time may be approximated by an orthogonal martingale measure in general and by standard Brownian motion in particular if the scale parameter increases Thus this approach allows the author to easily link for example microscopic activities with macroscopic ones in HFT connecting the parameters driving the HFT with the daily volatilities This method also helps to easily calculate ruin and ultimate ruin probabilities for the risk process All results in the book are new and original and can be easily implemented in practice

**Random Motions in Markov and Semi-Markov Random Environments 1** Anatoliy Pogorui,Anatoliy Swishchuk,Ramon M. Rodriguez-Dagnino,2021-01-12 This book is the first of two volumes on random motions in Markov and semi Markov random environments This first volume focuses on homogenous 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

**Exploring Stochastic Laws** A.V. Skorokhod,Yu.V. Borovskikh,2020-05-18 No

detailed description available for Exploring Stochastic Laws      Asymptotic Expansion of Semi-Markov Random Evolutions  
 Sergio Albeverio, Volodymyr S. Koroljuk, Igor V. Samoilenko, 2006      **Limit Theorems for Randomly Stopped Stochastic Processes** Dmitrii S. Silvestrov, 2012-12-06 Limit theorems for stochastic processes are an important part of probability theory and mathematical statistics and one model that has attracted the attention of many researchers working in the area is that of limit theorems for randomly stopped stochastic processes This volume is the first to present a state of the art overview of this field with many of the results published for the first time It covers the general conditions as well as the basic applications of the theory and it covers and demystifies the vast and technically demanding Russian literature in detail A survey of the literature and an extended bibliography of works in the area are also provided The coverage is thorough streamlined and arranged according to difficulty for use as an upper level text if required It is an essential reference for theoretical and applied researchers in the fields of probability and statistics that will contribute to the continuing extensive studies in the area and remain relevant for years to come      *Random Motions in Markov and Semi-Markov Random Environments 1* Anatoliy Pogorui, Anatoliy Swishchuk, Ramon M. Rodriguez-Dagnino, 2020-12-31 This book is the first of two volumes on random motions in Markov and semi Markov random environments This first volume focuses on homogenous 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      **Perturbed Semi-Markov Type Processes II** Dmitrii Silvestrov, 2022-03-21 This book is the second 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 second volume presents a complete classification of ergodic theorems for alternating regenerative processes including more than twenty five such theorems The text addresses new asymptotic recurrent algorithms of phase space reduction for multi alternating regenerative processes modulating by regularly and singularly perturbed finite semi Markov processes It also features a new study of super long long and short time ergodic theorems for these 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

**Semi-Markov Models and Applications** Jacques Janssen, Nikolaos Limnios, 2013-12-01 This book presents a selection

of papers presented to the Second International Symposium on Semi Markov Models Theory and Applications held in Compiègne France in December 1998 This international meeting had the same aim as the first one held in Brussels in 1984 to make fourteen years later the state of the art in the field of semi Markov processes and their applications bring together researchers in this field and also to stimulate fruitful discussions The set of the subjects of the papers presented in Compiègne has a lot of similarities with the preceding Symposium this shows that the main fields of semi Markov processes are now well established particularly for basic applications in Reliability and Maintenance Queueing Control processes and production A growing field is the one of insurance and finance but this is not really a surprising fact as the problem of pricing derivative products represents now a crucial problem in economics and finance For example stochastic models can be applied to financial and insurance models as we have to evaluate the uncertainty of the future market behavior in order firstly to propose different measures for important risks such as the interest risk the risk of default or the risk of catastrophe and secondly to describe how to act in order to optimize the situation in time Recently the concept of VaR Value at Risk was discovered in portfolio theory enlarging so the fundamental model of Markowitz

**Data-Driven Modeling for Sustainable Engineering** Kondo H. Adjallah, Babiga Birregah, Henry Fonbeyin Abanda, 2019-06-21 This book gathers the proceedings of the 1st International Conference on Engineering Applied Sciences and System Modeling ICEASSM a four day event 18th 21st April 2017 held in Accra Ghana It focuses on research work promoting a better understanding of engineering problems through applied sciences and modeling and on solutions generated in an African setting but with relevance to the world as a whole The book provides a holistic overview of challenges facing Africa and addresses various areas from research and development perspectives Presenting contributions by scientists engineers and experts hailing from a host of international institutions the book offers original approaches and technological solutions to help solve real world problems through research and knowledge sharing Further it explores promising opportunities for collaborative research on issues of scientific economic and social development making it of interest to researchers scientists and practitioners looking to conduct research in disciplines such as water supply control civil engineering statistical modeling renewable energy and sustainable urban development

Matrix-Analytic Methods in Stochastic Models S. Chakravarthy, Attahiru S. Alfa, 2016-04-19 Based on the proceedings of the first International Conference on Matrix Analytic Methods MAM in Stochastic Models held in Flint Michigan this book presents a general working knowledge of MAM through tutorial articles and application papers It furnishes information on MAM studies carried out in the former Soviet Union

Probability Theory and Mathematical Statistics. Vol. 2 B. Grigelionis, Yu. V. Prohorov, V. V. Sazonov, V. Statulevičius, 2020-05-18 No detailed description available for PROB TH MATH ST GRIGELIONIS VOL 2 PROC 5 1989 E BOOK

**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

The book delves into Semi Markov Random Evolutions. Semi Markov Random Evolutions is a crucial topic that needs to be grasped by everyone, from students and scholars to the general public. This book will furnish comprehensive and in-depth insights into Semi Markov Random Evolutions, encompassing both the fundamentals and more intricate discussions.

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    - Chapter 2: Essential Elements of Semi Markov Random Evolutions
    - Chapter 3: Semi Markov Random Evolutions in Everyday Life
    - Chapter 4: Semi Markov Random Evolutions in Specific Contexts
    - Chapter 5: Conclusion
  2. In chapter 1, the author will provide an overview of Semi Markov Random Evolutions. The first chapter will explore what Semi Markov Random Evolutions is, why Semi Markov Random Evolutions is vital, and how to effectively learn about Semi Markov Random Evolutions.
  3. In chapter 2, this book will delve into the foundational concepts of Semi Markov Random Evolutions. This chapter will elucidate the essential principles that must be understood to grasp Semi Markov Random Evolutions in its entirety.
  4. In chapter 3, the author will examine the practical applications of Semi Markov Random Evolutions in daily life. The third chapter will showcase real-world examples of how Semi Markov Random Evolutions can be effectively utilized in everyday scenarios.
  5. In chapter 4, the author will scrutinize the relevance of Semi Markov Random Evolutions in specific contexts. This chapter will explore how Semi Markov Random Evolutions is applied in specialized fields, such as education, business, and technology.
  6. In chapter 5, the author will draw a conclusion about Semi Markov Random Evolutions. This chapter will summarize the key points that have been discussed throughout the book.
- The book is crafted in an easy-to-understand language and is complemented by engaging illustrations. It is highly recommended for anyone seeking to gain a comprehensive understanding of Semi Markov Random Evolutions.

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