Applications of Quantum Probability to Classical Stochastics

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New nonexplosion conditions for Markov processes are derived from the general operator form of the conservativity condition for a quantum dynamical semigroup.

1 Introduction

In this paper an operator-valued generalization of the Kolmogorov – Feller equation is discussed. The most remarkable feature of this generalization is that it also covers diffusion and Heisenberg equations as particular cases [L]. It is known that if intensity of jumps (or drift velocity, or diffusion coefficient)as a function on the phase space X of the corresponding Markov process is unbounded, then the probability measure of trajectories hitting singularities of the coefficients may be positive. If there exist a number of different ways to define the behaviour of the process after hitting a singular point then the formal evolution equation for the transition probability of the Markov jump process has a linear manifold of solutions. In the class of solutions $P(x,t|\Gamma)$ satisfying the initial condition $P(x,0|\Gamma) = I_\Gamma(x)$ there exists a minimal solution such that

$$P^{min}(x,t|X) < 1$$

(see [F]). A similar phenomenon exists for the operator-valued generalization of the Kolmogorov – Feller equation. Examples of Markov jump processes which explode or escape to infinity with positive probability are given in section 2 following [C1], [CF1]. In section 3 we describe an algebraic structure of operator-valued extensions of the basic evolution equations for Markov processes. Section 4 contains domain assumptions for coefficients of infinitesimal maps of semigroups in von Neumann algebras. In section 5 we introduce conditions which are necessary and sufficient for conservation of the total probability by the minimal solution for evolution equation [C2]. We call them *conservativity conditions*. If the minimal solution of the evolution equation is conservative (i.e. it preserves identity) then the corresponding Markov process is called *regular*. Section 6 contains a constructive form of sufficient conservativity conditions and give some applications to classical stochastic processes [C3], [CF2]. In Section 7 we present some new examples of regularity conditions derived for Markov processes from the general operator form of the conservativity condition for a quantum dynamical semigroup.

Stochastics Algebra And Analysis In Classical And Quantum Dynamics

Vladimir S. Korolyuk,Y.V. Borovskich

Stochastics Algebra And Analysis In Classical And Quantum Dynamics:

Stochastics, Algebra and Analysis in Classical and Quantum Dynamics Sergio Albeverio,Philip Blanchard,D. Testard,2012-12-06 Et moi f si j avait su comment en revenir One service mathematics has rendered the je n y serais point aile human race It has put common sense back Jules Verne where it belongs 011 the topmost shelf next to the dusty canister labelled discarded non The series is divergent therefore we may be able to do something with it Eric T Bell o Heaviside Mathematics is a tool for thought A highly necessary tool in a world where both feedback and non Iinearities abound Similarly all kinds of parts of mathematics serve as tools for other parts and for other sciences Applying a simple rewriting rule to the quote on the right above one finds such statements as One service topology has rendered mathematical physics One service logic has rendered com puter science One service category theory has rendered mathematics All arguably true And all statements obtainable this way form part of the raison d etre of this series_ This series Mathematics and Its Applications started in 1977 Now that over one hundred volumes have appeared it seems opportune to reexamine its scope At the time I wrote Growing specialization and diversification have brought a host of monographs and textbooks on increasingly specialized topics However the tree of knowledge of mathematics and related fields does not grow only by putting forth new branches   **Stochastic Processes and Operator Calculus on Quantum Groups** U. Franz,René Schott,2013-03-14 This book aims to present several new developments on stochastic processes and operator calculus on quantum groups Topics which are treated include operator calculus dual representations stochastic processes and diffusions Appell polynomials and systems in connection with evolution equations Audience This volume contains introductory material for graduate students who are new to the field as well as more advanced material for specialists in probability theory algebraic structures representation theory mathematical physics and theoretical physics   Stochastic Processes in Epidemic Theory Jean-Pierre Gabriel,Claude Lefevre,Philippe Picard,2014-03-11 This collection of papers gives a representative cross selectional view of recent developments in the field After a survey paper by C Lef vre 17 other research papers look at stochastic modeling of epidemics both from a theoretical and a statistical point of view Some look more specifically at a particular disease such as AIDS malaria schistosomiasis and diabetes   **Mathematical Methods in Queuing Theory** Vladimir V. Kalashnikov,1993-12-31 The material of this book is based on several courses which have been delivered for a long time at the Moscow Institute for Physics and Technology Some parts have formed the subject of lectures given at various universities throughout the world Freie Universitat of Berlin Chalmers University of Technology and the University of Goteborg University of California at Santa Barbara and others The subject of the book is the theory of queues This theory as a mathematical discipline begins with the work of A Erlang who examined a model of a telephone station and obtained the famous formula for the distribution of the number of busy lines which is named after him Queueing theory has been applied to the study of numerous models emergency aid road traffic computer systems etc Besides it has lead to several

related disciplines such as reliability and inventory theories which deal with similar models Nevertheless many parts of the theory of queues were developed as a pure science with no practical applications The aim of this book is to give the reader an insight into the mathematical methods which can be used in queueing theory and to present examples of solving problems with the help of these methods Of course the choice of the methods is quite subjective Thus many prominent results have not even been mentioned **Quantum Information Iv, Proceedings Of The Fourth International Conference** Takeyuki Hida,Kimiaki Saito,2002-05-30 *Probability Theory, Random Processes and Mathematical Statistics* Y. Rozanov,2012-12-06 Probability Theory Theory of Random Processes and Mathematical Statistics are important areas of modern mathematics and its applications They develop rigorous models for a proper treatment for various random phenomena which we encounter in the real world They provide us with numerous tools for an analysis prediction and ultimately control of random phenomena Statistics itself helps with choice of a proper mathematical model e g by estimation of unknown parameters on the basis of statistical data collected by observations This volume is intended to be a concise textbook for a graduate level course with carefully selected topics representing the most important areas of modern Probability Random Processes and Statistics The first part Ch 1 3 can serve as a self contained elementary introduction to Probability Random Processes and Statistics It contains a number of relatively sim ple and typical examples of random phenomena which allow a natural introduction of general structures and methods Only knowledge of elements of real complex analysis linear algebra and ordinary differential equations is required here The second part Ch 4 6 provides a foundation of Stochastic Analysis gives information on basic models of random processes and tools to study them Here a familiarity with elements of functional analysis is necessary Our intention to make this course fast moving made it necessary to present important material in a form of examples

Stochastic Point Processes S. Kidambi Srinivasan,A. Vijayakumar,2003 Stochastic Point Processes are interesting from many points of view From and abstract point of view point process is a simple version of random measure these processes have acquired importance mainly due their viability in modeling a variety of phenomena spanning physical biological economic and engineering sciences This volume with contributions from leading probabilists contains besides surveys on the state of art of the theory papers dealing with problems of queues inventory reliability and population evolution There are also papers dealing with practical aspects like statistical inference and nonlinear filtering The book will be of interest to a wide spectrum of people including those working in the area of operations research signal processing electrical communications control and neural network **Random Fields and Stochastic Partial Differential Equations** Y. Rozanov,2013-04-17 This book considers some models described by means of partial dif ferential equations and boundary conditions with chaotic stochastic disturbance In a framework of stochastic Partial Differential Equa tions an approach is suggested to generalize solutions of stochastic Boundary Problems The main topic concerns probabilistic aspects with applications to well known Random Fields models which are representative for the corresponding stochastic Sobolev spaces The term stochastic in

general indicates involvement of appropriate random elements It assumes certain knowledge in general Analysis and Probability Hilbert space methods Schwartz distributions Fourier transform I A very general description of the main problems considered can be given as follows Suppose we are considering a random field in a region T Rd which is associated with a chaotic stochastic source by means of the differential equation in T A typical chaotic source can be represented by an appropri ate random field with independent values i e generalized random function cp TJ cp E C T with independent random variables cp fJ for any test functions cp with disjoint supports The property of having independent values implies a certain roughness of the ran dom field which can only be treated functionally as a very irregular Schwarz distribution With the lack of a proper development of non linear analyses for generalized functions let us limit ourselves to the 1 For related material see for example J L Lions E *Handbook of Dynamical Systems* H. Broer,F. Takens,B. Hasselblatt,2010-11-10 In this volume the authors present a collection of surveys on various aspects of the theory of bifurcations of differentiable dynamical systems and related topics By selecting these subjects they focus on those developments from which research will be active in the coming years The surveys are intended to educate the reader on the recent literature on the following subjects transversality and generic properties like the various forms of the so called Kupka Smale theorem the Closing Lemma and generic local bifurcations of functions so called catastrophe theory and generic local bifurcations in 1 parameter families of dynamical systems and notions of structural stability and moduli Covers recent literature on various topics related to the theory of bifurcations of differentiable dynamical systems Highlights developments that are the foundation for future research in this field Provides material in the form of surveys which are important tools for introducing the bifurcations of differentiable dynamical systems **Unbiased Estimators and Their Applications** V.G. Voinov,M.S. Nikulin,2012-12-06 Statistical inferential methods are widely used in the study of various physical biological social and other phenomena Parametric estimation is one such method Although there are many books which consider problems of statistical point estimation this volume is the first to be devoted solely to the problem of unbiased estimation It contains three chapters dealing respectively with the theory of point statistical estimation techniques for constructing unbiased estimators and applications of unbiased estimation theory These chapters are followed by a comprehensive appendix which classifies and lists in the form of tables all known results relating to unbiased estimators of parameters for univariate distributions About one thousand minimum variance unbiased estimators are listed The volume also contains numerous examples and exercises This volume will serve as a handbook on point unbiased estimation for researchers whose work involves statistics It can also be recommended as a supplementary text for graduate students **Stochastic Analysis and Mathematical Physics** Rolando Rebolledo,2012-12-06 The seminar on Stochastic Analysis and Mathematical Physics started in 1984 at the Catholic University of Chile in Santiago and has been an on going research activity Since 1995 the group has organized international workshops as a way of promoting a broader dialogue among experts in the areas of classical and quantum stochastic analysis

mathematical physics and physics This volume consisting primarily of contributions to the Third Inter national Workshop on Stochastic Analysis and Mathematical Physics in Spanish ANESTOC held in Santiago Chile in October 1998 focuses on an analysis of quantum dynamics and related problems in probability the ory Various articles investigate quantum dynamical semigroups and new results on q deformed oscillator algebras while others examine the appli cation of classical stochastic processes in quantum modeling As in previous workshops the topic of quantum flows and semigroups occupied an important place In her paper R Carbone uses a spectral type analysis to obtain exponential rates of convergence towards the equilibrium of a quantum dynamical semigroup in the 2 sense The method is illus trated with a quantum extension of a classical birth and death process Quantum extensions of classical Markov processes lead to subtle problems of domains This is in particular illustrated by F Fagnola who presents a pathological example of a semigroup for which the largest subalgebra of the von Neumann algebra of bounded linear operators of 2 lR IC con tained in the domain of its infinitesimal generator is not a weakly dense   *Asymptotic Behaviour of Linearly Transformed Sums of Random Variables* V.V. Buldygin,Serguei Solntsev,2012-12-06 Limit theorems for random sequences may conventionally be divided into two large parts one of them dealing with convergence of distributions weak limit theorems and the other with almost sure convergence that is to say with asymptotic prop erties of almost all sample paths of the sequences involved strong limit theorems Although either of these directions is closely related to another one each of them has its own range of specific problems as well as the own methodology for solving the underlying problems This book is devoted to the second of the above mentioned lines which means that we study asymptotic behaviour of almost all sample paths of linearly transformed sums of independent random variables vectors and elements taking values in topological vector spaces In the classical works of P Levy A Ya Khintchine A N Kolmogorov P Hartman A Wintner W Feller Yu V Prokhorov and M Loeve the theory of almost sure asymptotic behaviour of increasing scalar normed sums of independent random vari ables was constructed This theory not only provides conditions of the almost sure convergence of series of independent random variables but also studies different ver sions of the strong law of large numbers and the law of the iterated logarithm One should point out that even in this traditional framework there are still problems which remain open while many definitive results have been obtained quite recently   **Theory of U-Statistics** Vladimir S. Korolyuk,Y.V. Borovskich,2013-03-09 The theory of U statistics goes back to the fundamental work of Hoeffding 1 in which he proved the central limit theorem During last forty years the interest to this class of random variables has been permanently increasing and thus the new intensively developing branch of probability theory has been formed The U statistics are one of the universal objects of the modem probability theory of summation On the one hand they are more complicated algebraically than sums of independent random variables and vectors and on the other hand they contain essential elements of dependence which display themselves in the martingale properties In addition the U statistics as an object of mathematical statistics occupy one of the central places in statistical problems The development of the theory of U

statistics is stipulated by the influence of the classical theory of summation of independent random variables The law of large num bers central limit theorem invariance principle and the law of the iterated logarithm we re proved the estimates of convergence rate were obtained etc **Stochastic Analysis And Mathematical Physics (Samp/anestoc 2002)** Rolando Rebolledo,Jean-claude Zambrini,Jorge Rezende,2004-09-15 The book collects a series of papers centered on two main streams Feynman path integral approach to Quantum Mechanics and statistical mechanics of quantum open systems Key authors discuss the state of the art within their fields of expertise In addition the volume includes a number of contributed papers with new results which have been thoroughly refereed The contributions in this volume highlight emergent research in the area of stochastic analysis and mathematical physics focusing in particular on Feynman functional integral approach and on the other hand in quantum probability The book is addressed to an audience of mathematical physicists as well as specialists in probability theory stochastic analysis and operator algebras The proceedings have been selected for coverage in Index to Scientific Technical Proceedings ISTP CDROM version ISI Proceedings CC Proceedings Engineering Physical Sciences <u>Advanced Financial Modelling</u> Hansjörg Albrecher,Wolfgang J. Runggaldier,Walter Schachermayer,2009-12-15 This book is a collection of state of the art surveys on various topics in mathematical finance with an emphasis on recent modelling and computational approaches The volume is related to a Special Semester on Stochastics with Emphasis on Finance that took place from September to December 2008 at the Johann Radon Institute for Computational and Applied Mathematics of the Austrian Academy of Sciences in Linz Austria **Error Calculus for Finance and Physics** Nicolas Bouleau,2008-08-22 Many recent advances in modelling within the applied sciences and engineering have focused on the increasing importance of sensitivity analyses For a given physical financial or environmental model increased emphasis is now placed on assessing the consequences of changes in model outputs that result from small changes or errors in both the hypotheses and parameters The approach proposed in this book is entirely new and features two main characteristics Even when extremely small errors possess biases and variances The methods presented here are able thanks to a specific differential calculus to provide information about the correlation between errors in different parameters of the model as well as information about the biases introduced by non linearity The approach makes use of very powerful mathematical tools Dirichlet forms which allow one to deal with errors in infinite dimensional spaces such as spaces of functions or stochastic processes The method is therefore applicable to non elementary models along the lines of those encountered in modern physics and finance This text has been drawn from presentations of research done over the past ten years and that is still ongoing The work was presented in conjunction with a course taught jointly at the Universities of Paris 1 and Paris 6 The book is intended for students researchers and engineers with good knowledge in probability theory **Dynamical Systems** Albert Fathi,J.-C. Yoccoz,2006-02-02 A collection of up to date research and classic papers reflecting the work of Michael Herman **The Theory of Partial Algebraic Operations** E.S. Ljapin,A.E. Evseev,2013-04-17 Nowadays algebra is

understood basically as the general theory of algebraic oper ations and relations It is characterised by a considerable intrinsic naturalness of its initial notions and problems the unity of its methods and a breadth that far exceeds that of its basic concepts It is more often that its power begins to be displayed when one moves outside its own limits This characteristic ability is seen when one investigates not only complete operations but partial operations To a considerable extent these are related to algebraic operators and algebraic operations The tendency to ever greater generality is amongst the reasons that playa role in explaining this development But other important reasons play an even greater role Within this same theory of total operations that is operations defined everywhere there persistently arises in its different sections a necessity of examining the emergent feature of various partial operations It is particularly important that this has been found in those parts of algebra it brings together and other areas of mathematics it interacts with as well as where algebra finds applica tion at the very limits of mathematics In this connection we mention the theory of the composition of mappings category theory the theory of formal languages and the related theory of mathematical linguistics coding theory information theory and algebraic automata theory In all these areas as well as in others from time to time there arises the need to consider one or another partial operation **Limit Theorems for Random Fields with Singular Spectrum** Nicolai Leonenko,2012-12-06 This book presents limit theorems for nonlinear functionals of random fields with singular spectrum on the basis of various asymptotic expansions The first chapter treats basic concepts of the spectral theory of random fields some important examples of random processes and fields with singular spectrum and Tauberian and Abelian theorems for covariance function of long memory random fields Chapter 2 is devoted to limit theorems for spherical averages of nonlinear transformations of Gaussian and chi square random fields Chapter 3 summarises some limit theorems for geometric type functionals of random fields Limit theorems for the solutions of Burgers equation with random data via parabolic and hyperbolic rescaling are demonstrated in Chapter 4 Lastly Chapter 5 deals with some problems for statistical analysis of random fields with singular spectrum Audience This book will be of interest to mathematicians who use random fields in engineering or other applications *Statistical Inference for Piecewise-deterministic Markov Processes* Romain Azais,Florian Bouguet,2018-08-14 Piecewise deterministic Markov processes form a class of stochastic models with a sizeable scope of applications biology insurance neuroscience networks finance Such processes are defined by a deterministic motion punctuated by random jumps at random times and offer simple yet challenging models to study Nevertheless the issue of statistical estimation of the parameters ruling the jump mechanism is far from trivial Responding to new developments in the field as well as to current research interests and needs Statistical inference for piecewise deterministic Markov processes offers a detailed and comprehensive survey of state of the art results It covers a wide range of general processes as well as applied models The present book also dwells on statistics in the context of Markov chains since piecewise deterministic Markov processes are characterized by an embedded Markov chain corresponding to the

position of the process right after the jumps

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