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Mark M. Meerschaert, Alla Sikorskii STOCHASTIC MODELS FOR FRACTIONAL CALCULUS

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Abdon Atangana, Seda İgret Araz

Stochastic Models for Fractional Calculus Mark M. Meerschaert, Alla Sikorskii, 2011-12-23 Fractional calculus is a rapidly growing field of research at the interface between probability differential equations and mathematical physics It is used to model anomalous diffusion in which a cloud of particles spreads in a different manner than traditional diffusion This monograph develops the basic theory of fractional calculus and anomalous diffusion from the point of view of probability In this book we will see how fractional calculus and anomalous diffusion can be understood at a deep and intuitive level using ideas from probability It covers basic limit theorems for random variables and random vectors with heavy tails This includes regular variation triangular arrays infinitely divisible laws random walks and stochastic process convergence in the Skorokhod topology The basic ideas of fractional calculus and anomalous diffusion are closely connected with heavy tail limit theorems Heavy tails are applied in finance insurance physics geophysics cell biology ecology medicine and computer engineering The goal of this book is to prepare graduate students in probability for research in the area of fractional calculus anomalous diffusion and heavy tails Many interesting problems in this area remain open This book will guide the motivated reader to understand the essential background needed to read and unerstand current research papers and to gain the insights and techniques needed to begin making their own contributions to this rapidly growing field for Fractional Calculus Mark M. Meerschaert, Alla Sikorskii, 2011-12-23 This monograph develops the basic theory of fractional calculus and anomalous diffusion from the point of view of probability The reader will see how fractional calculus and anomalous diffusion can be understood at a deep and intuitive level using ideas from probability The book covers basic limit theorems for random variables and random vectors with heavy tails Heavy tails are applied in finance insurance physics geophysics cell biology ecology medicine and computer engineering **Stochastic Models for Fractional Calculus Mark** M. Meerschaert, Alla Sikorskii, 2019-10-21 Fractional calculus is a rapidly growing field of research at the interface between probability differential equations and mathematical physics It is used to model anomalous diffusion in which a cloud of particles spreads in a different manner than traditional diffusion This monograph develops the basic theory of fractional calculus and anomalous diffusion from the point of view of probability In this book we will see how fractional calculus and anomalous diffusion can be understood at a deep and intuitive level using ideas from probability It covers basic limit theorems for random variables and random vectors with heavy tails This includes regular variation triangular arrays infinitely divisible laws random walks and stochastic process convergence in the Skorokhod topology The basic ideas of fractional calculus and anomalous diffusion are closely connected with heavy tail limit theorems Heavy tails are applied in finance insurance physics geophysics cell biology ecology medicine and computer engineering The goal of this book is to prepare graduate students in probability for research in the area of fractional calculus anomalous diffusion and heavy tails Many interesting problems in this area remain open This book will guide the motivated reader to understand the essential

background needed to read and unerstand current research papers and to gain the insights and techniques needed to begin making their own contributions to this rapidly growing field Markov Processes for Stochastic Modeling Oliver Ibe, 2013-05-22 Markov processes are processes that have limited memory In particular their dependence on the past is only through the previous state They are used to model the behavior of many systems including communications systems transportation networks image segmentation and analysis biological systems and DNA sequence analysis random atomic motion and diffusion in physics social mobility population studies epidemiology animal and insect migration queueing systems resource management dams financial engineering actuarial science and decision systems Covering a wide range of areas of application of Markov processes this second edition is revised to highlight the most important aspects as well as the most recent trends and applications of Markov processes. The author spent over 16 years in the industry before returning to academia and he has applied many of the principles covered in this book in multiple research projects Therefore this is an applications oriented book that also includes enough theory to provide a solid ground in the subject for the reader Presents both the theory and applications of the different aspects of Markov processes Includes numerous solved examples as well as detailed diagrams that make it easier to understand the principle being presented Discusses different applications of hidden Markov models such as DNA sequence analysis and speech analysis **Solved Exercises in Fractional Calculus** Edmundo Capelas de Oliveira, 2019-05-31 This book contains a brief historical introduction and state of the art in fractional calculus The author introduces some of the so called special functions in particular those which will be directly involved in calculations The concepts of fractional integral and fractional derivative are also presented Each chapter except for the first one contains a list of exercises containing suggestions for solving them and at last the resolution itself At the end of those chapters there is a list of complementary exercises The last chapter presents several applications of fractional calculus

New Trends in Nanotechnology and Fractional Calculus Applications Dumitru Baleanu, Ziya B. Guvenc, J.A. Tenreiro Machado, 2010-03-14 In recent years fractional calculus has played an important role in various fields such as mechanics electricity chemistry biology economics modeling identification control theory and signal processing The scope of this book is to present the state of the art in the study of fractional systems and the application of fractional differentiation Furthermore the manufacture of nanowires is important for the design of nanosensors and the development of high yield thin films is vital in procuring clean solar energy This wide range of applications is of interest to engineers physicists and mathematicians Fractional and Multivariable Calculus A.M. Mathai, H.J. Haubold, 2017-07-25 This textbook presents a rigorous approach to multivariable calculus in the context of model building and optimization problems This comprehensive overview is based on lectures given at five SERC Schools from 2008 to 2012 and covers a broad range of topics that will enable readers to understand and create deterministic and nondeterministic models Researchers advanced undergraduate and graduate students in mathematics statistics physics engineering and biological sciences will find this book to be a

valuable resource for finding appropriate models to describe real life situations. The first chapter begins with an introduction to fractional calculus moving on to discuss fractional integrals fractional derivatives fractional differential equations and their solutions. Multivariable calculus is covered in the second chapter and introduces the fundamentals of multivariable calculus multivariable functions limits and continuity differentiability directional derivatives and expansions of multivariable functions. Illustrative examples input output process optimal recovery of functions and approximations are given each section lists an ample number of exercises to heighten understanding of the material Chapter three discusses deterministic mathematical and optimization models evolving from differential equations difference equations algebraic models power function models input output models and pathway models Fractional integral and derivative models are examined Chapter four covers non deterministic stochastic models. The random walk model branching process model birth and death process model time series models and regression type models are examined. The fifth chapter covers optimal design General linear models from a statistical point of view are introduced the Gauss Markov theorem quadratic forms and generalized inverses of matrices are covered Pathway symmetric and asymmetric models are covered in chapter six the concepts are illustrated with graphs

<u>Fractional Stochastic Differential Equations</u> Abdon Atangana, Seda İgret Araz, 2022-04-22 This book provides a thorough conversation on the underpinnings of Covid 19 spread modelling by using stochastics nonlocal differential and integral operators with singular and non singular kernels The book presents the dynamic of Covid 19 spread behaviour worldwide It is noticed that the spread dynamic followed process with nonlocal behaviours which resemble power law fading memory crossover and stochastic behaviours Fractional stochastic differential equations are therefore used to model spread behaviours in different parts of the worlds The content coverage includes brief history of Covid 19 spread worldwide from December 2019 to September 2021 followed by statistical analysis of collected data for infected death and recovery classes

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