Stochastic Geometry And Its Applications 2nd Edition

This book provides a comprehensive treatment of the Poisson line Cox process (PLCP) and its applications to vehicular networks. The PLCP is constructed by placing points on each line of a Poisson line process (PLP) as per an independent Poisson point process (PPP). For vehicular applications, one can imagine the layout of the road network as a PLP and the vehicles on the roads as the points of the PLCP. First, a brief historical account of the evolution of the theory of PLP is provided to familiarize readers with the seminal contributions in this area. In order to provide a self-contained treatment of this topic, the construction and key fundamental properties of both PLP and PLCP are discussed in detail. The rest of the book is devoted to the applications of these models to a variety of wireless networks, including vehicular communication networks and localization networks. Specifically, modeling the locations of vehicular nodes and roadside units (RSUs) using PLCP, the signal-to-interference-plus-noise ratio (SINR)-based coverage analysis is presented for both ad hoc and cellular network models. For a similar setting, the load on the cellular macro base stations (MBSs) and RSUs in a vehicular network is also characterized analytically. For the localization networks, PLP is used to model blockages, which is shown to facilitate the characterization of asymptotic blind spot probability in a localization application. Finally, the path distance characteristics for a special case of PLCP are analyzed, which can be leveraged to answer critical questions in the areas of transportation networks and urban planning. The book is concluded with concrete suggestions on future directions of research. Based largely on the original research of the authors, this is the first book that specifically focuses on the self-contained mathematical treatment of the PLCP. The ideal audience of this book is graduate students as well as researchers in academia and industry who are familiar with probability theory, have some exposure to point processes, and are interested in the field of stochastic geometry and vehicular networks. Given the diverse backgrounds of the potential readers, the focus has been on providing an accessible and pedagogical treatment of this topic by consciously avoiding the measure theoretic details without compromising mathematical rigor.

A collection of chapters from leading scholars on the subject of stochastic geometry, laying the foundations for future research and providing fresh perspectives, ideas and interdisciplinary connections now arising from Stochastic Geometry.

"The previous edition of this book has served as the key reference in its field for over 20 years and is regarded as the best treatment of the subject of stochastic geometry. Extensively updated, this mew edition includes new sections on analytical and numerically tractable results and applications of Voronoi tessellations; introduces models such as Laguerre and iterated tessellations; and presents theoretical results. Statistics for planar point processes are introduced, and the text also includes a new section on random geometrical graphs and random networks"--

Unlike traditional books presenting stochastic processes in an academic way, this book includes concrete applications that students will find interesting such as gambling, finance, physics, signal processing, statistics, fractals, and biology. Written with an important illustrated guide in the beginning, it contains many illustrations, photos and pictures, along with several website links.

Computational tools such as simulation and Monte Carlo methods are included as well as complete toolboxes for both traditional and new computational techniques.

Pattern Theory

Theory of Random Sets

Foundations and Applications to Vehicular Networks

Stochastic Analysis for Poisson Point Processes

Introduction to Stochastic Processes

This volume provides a modern introduction to stochastic geometry, random fields and spatial statistics at a (post)graduate level. It is focused on asymptotic methods in geometric probability including weak and strong limit theorems for random spatial structures (point processes, sets, graphs, fields) with applications to statistics. Written as a contributed volume of lecture notes, it will be useful not only for students but also for lecturers and researchers interested in geometric probability and related subjects.

The objective here is to introduce the elements of stochastic processes in a rather concise manner where we present the two most important parts in stochastic processes -- Markov chains and stochastic analysis. The readers are lead directly to the core of the topics, and further details are collated in a section containing abundant exercises and more materials for further reading and studying.In the part on Markov chains, the core is the ergodicity. By using the minimal non-negative solution method, we deal with the recurrence and various ergodicity. This is done step by step, from finite state spaces to denumerable state spaces, and from discrete time to continuous time. The proof methods adopt the modern techniques, such as coupling and duality methods. Some very new results are included, such as the estimate of the spectral gap. The structure and proofs in the first part are rather different from other existing textbooks on Markov chains.In the part on stochastic analysis, we cover the martingale theory and Brownian motions, the stochastic integral and stochastic differential equations with emphasis on one dimension, and the multidimensional stochastic integral and stochastic equation based on semimartingales. We introduce three important topics here: the Feynman-Kac formula, random time transform and Girsanov transform. As an essential application of the probability theory in classical mathematics, we also deal with the famous Brunn-Minkowski inequality in convex geometry.This volume also features modern probability theory that is used in the non-random fields, such as MCMC, convex geometry and number theory. It provides a new and direct routine for students going through the classical Markov chains to the modern stochastic analysis. It employs more modern techniques, such as coupling and duality, and functional inequalities with Dirichlet form.

'Et moi, ... , si j'avait su comment en revenIT, One service mathematics has rendered the je n'y serais point allt\.' human race. It has put common sense back where it belongs, on the topmost shelf next Jules Verne to the dusty canister labelled 'discarded non- The series is divergent; therefore we may be sense'. 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 linearities 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 open access book focuses on processing, modeling, and visualization of anisotropy information...--

Modern Research Frontiers

Random Measures, Theory and Applications

Asymptotic Methods

Theory and Applications

A Geometric Approach to Modeling, Estimation and Identification

This concisely written book is a rigorous and self-contained introduction to the theory of continuous-time stochastic processes. Balancing theory and applications, the authors use stochastic methods and concrete examples to model real-world problems from engineering, biomathematics, biotechnology, and finance. Suitable as a textbook for graduate or advanced undergraduate courses, the work may also be used for self-study or as a reference. The book will be of interest to students, pure and applied mathematicians, and researchers or practitioners in mathematical finance, biomathematics, physics, and engineering.

Stochastic Geometry and Its ApplicationsWiley-Blackwell

An extensive update to a classic text Stochastic geometry and spatial statistics play a fundamental role in many modern branches of physics, materials sciences, engineering, biology and environmental sciences. They offer successful models for the description of random two- and three-dimensional micro and macro structures and statistical methods for their analysis. The previous edition of this book has served as the key reference in its field for over 18 years and is regarded as the best treatment of the subject of stochastic geometry, both as a subject with vital applications to spatial statistics and as a very interesting field of mathematics in its own right. This edition: Presents a wealth of models for spatial patterns and related statistical methods. Provides a great survey of the modern theory of random tessellations, including many new models that became tractable only in the last few years. Includes new sections on random networks and random graphs to review the recent ever growing interest in these areas. Provides an excellent introduction to theory and modelling of point processes, which covers some very latest developments. Illustrate the forefront theory of random sets, with many applications. Adds new results to the discussion of fibre and surface processes. Offers an updated collection of useful stereological methods. Includes 700 new references. Is written in an accessible style enabling non-mathematicians to benefit from this book. Provides a companion website hosting information on recent developments in the field www.wiley.com/go/cskm Stochastic Geometry and its Applications is ideally suited for researchers in physics, materials science, biology and ecological sciences as well as mathematicians and statisticians. It should also serve as a valuable introduction to the subject for students of mathematics and statistics.

This volume offers a unique and accessible overview of the most active fields in Stochastic Geometry, up to the frontiers of recent research. Since 2014, the yearly meeting of the French research structure GDR GeoSto has been preceded by two introductory courses. This book contains five of these introductory lectures. The first chapter is a historically motivated introduction to Stochastic Geometry which relates four classical problems (the Buffon needle problem, the Bertrand paradox, the Sylvester four-point problem and the bicycle wheel problem) to current topics. The remaining chapters give an application motivated introduction to contemporary Stochastic Geometry, each one devoted to a particular branch of the subject: understanding spatial point patterns through intensity and conditional intensities; stochastic methods for image analysis; random fields and scale invariance; and the theory of Gibbs point processes. Exposing readers to a rich theory, this book will encourage further exploration of the subject and its wide applications.

Stochastic Geometry for Image Analysis

From Applications to Theory

Lectures given at the C.I.M.E. Summer School held in Martina Franca, Italy, September 13-18, 2004

The Stochastic Analysis of Real-World Signals

Stochastic Processes and their Applications

This book focuses on information geometry manifolds of structured data/information and their advanced applications featuring new and fruitful interactions between several branches of science: information science, mathematics and physics. It addresses interrelations between different mathematical domains like shape spaces, probability/optimization & algorithms on manifolds, relational and discrete metric spaces, computational and Hessian information geometry, algebraic/infinite dimensional/Banach information manifolds, divergence geometry, tensor-valued morphology, optimal transport theory, manifold & topology learning, and applications like geometries of audio-processing, inverse problems and signal processing. The book collects the most important contributions to the conference GSI'2017 - Geometric Science of Information.

Stochastic geometry involves the study of random geometric structures, and blends geometric, probabilistic, and statistical methods to provide powerful techniques for modeling and analysis. Recent developments in computational statistical analysis, particularly Markov chain Monte Carlo, have enormously extended the range of feasible applications. Stochastic Geometry: Likelihood and Computation provides a coordinated collection of chapters on important aspects of the rapidly developing field of stochastic geometry, including: o a "crash-course" introduction to key stochastic geometry themes o considerations of geometric sampling bias issues o tesselations o shape o random sets o image analysis o spectacular advances in likelihood-based inference now available to stochastic geometry through the techniques of Markov chain Monte Carlo

Addressed to both pure and applied probabilitists, including graduate students, this text is a pedagogically-oriented introduction to the Schwartz-Meyer second-order geometry and its use in stochastic calculus. P.A. Meyer has contributed an appendix: "A short presentation of stochastic calculus" presenting the basis of stochastic calculus and thus making the book better accessible to non-probabilitists also. No prior knowledge of differential geometry is assumed of the reader: this is covered within the text to the extent. The general theory is presented only towards the end of the book, after the reader has been exposed to two particular instances - martingales and Brownian motions - in manifolds. The book also includes new material on non-confluence of martingales, s.d.e. from one manifold to another, approximation results for martingales, solutions to Stratonovich differential equations. Thus this book will prove very useful to specialists and non-specialists alike, as a self-contained introductory text or as a compact reference.

This volume bears on wireless network modeling and performance analysis. The aim is to show how stochastic geometry can be used in a more or less systematic way to analyze the phenomena that arise in this context. It first focuses on medium access control mechanisms used in ad hoc networks and in cellular networks. It then discusses the use of stochastic geometry for the quantitative analysis of routing algorithms in mobile ad hoc networks. The appendix also contains a concise summary of wireless communication principles and of the network architectures considered in the two volumes.

Geometric Structures of Information

Stochastic Geometry for Wireless Networks

The Geometric Process and Its Applications

Stochastic Geometry and Statistical Applications

Stochastic Geometry and Its Applications

This volume is an attempt to provide a graduate level introduction to various aspects of stochastic geometry, spatial statistics and random fields, with special emphasis placed on fundamental classes of models and algorithms as well as on their applications, e.g. in materials science, biology and genetics. This book has a strong focus on simulations and includes extensive codes in Matlab and R which are widely used in the mathematical community. It can be seen as a continuation of the recent volume 2068 of Lecture Notes in Mathematics, where other issues of stochastic geometry, spatial statistics and random fields were considered with a focus on asymptotic methods.

Analyse wireless network performance and improve design choices for future architectures and protocols with this rigorous introduction to stochastic geometry.

Stochastic geometry is the branch of mathematics that studies geometric structures associated with random configurations, such as random graphs, tilings and mosaics. Due to its close ties with stereology and spatial statistics, the results in this area are relevant for a large number of important applications, e.g. to the mathematical modeling and statistical analysis of telecommunication networks, geostatistics and image analysis. In recent years - due mainly to the impetus of the authors and their collaborators - a powerful connection has been established between stochastic geometry and the Malliavin calculus of variations, which is a collection of probabilistic techniques based on the properties of infinite-dimensional differential operators. This has led in particular to the discovery of a large number of new quantitative limit theorems for high-dimensional geometric objects. This unique book presents an organic collection of authoritative surveys written by the principal actors in this rapidly evolving field, offering a rigorous yet lively presentation of its many facets.

A modern introduction to the Poisson process, with general point processes and random measures, and applications to stochastic geometry.

in Mathematics and Physics

New Perspectives in Stochastic Geometry

Stochastic Calculus in Manifolds

Random Sets

Models and Algorithms

This book presents a treatise on the theory and modeling of second-order stationary processes, including an exposition on selected application areas that are important in the engineering and applied sciences. The foundational issues regarding stationary processes dealt with in the beginning of the book have a long history, starting in the 1940s with the work of Kolmogorov, Wiener, Cramér and his students, in particular Wold, and have since been refined and complemented by many others. Problems concerning the filtering and modeling of stationary random signals and systems have also been addressed and studied, fostered by the advent of modern digital computers, since the fundamental work of R.E. Kalman in the early 1960s. The book offers a unified and logically consistent view of the subject based on simple ideas from Hilbert space geometry and coordinate-free thinking. In this framework, the concepts of stochastic state space and state space modeling, based on the notion of the conditional independence of past and future flows of the relevant signals, are revealed to be fundamentally unifying ideas. The book, based on over 30 years of original research, represents a valuable contribution that will inform the fields of stochastic modeling, estimation, system identification, and time series analysis for decades to come. It also provides the mathematical tools needed to grasp and analyze the structures of algorithms in stochastic systems theory.

Offering the first comprehensive treatment of the theory of random measures, this book has a very broad scope, ranging from basic properties of Poisson and related processes to the modern theories of convergence, stationarity, Palm measures, conditioning, and compensation. The three large final chapters focus on applications within the areas of stochastic geometry, excursion theory, and branching processes. Although this theory plays a fundamental role in most areas of modern probability, much of it, including the most basic material, has previously been available only in scores of journal articles. The book is primarily directed towards researchers and advanced graduate students in stochastic processes and related areas.

Stochastic Geometry is the mathematical discipline which studies mathematical models for random geometric structures. This book collects lectures presented at the CIME summer school in Martina Franca in September 2004. The main lecturers covered Spatial Statistics, Random Points, Integral Geometry and Random Sets. These are complemented by two additional contributions on Random Mosaics and Crystallization Processes. The book presents a comprehensive and up-to-date description of important aspects of Stochastic Geometry.

Stochastic geometry, based on current developments in geometry, probability and measure theory, makes possible modeling of two- and three-dimensional random objects with interactions as they appear in the microstructure of materials, biological tissues, macroscopically in soil, geological sediments etc. In combination with spatial statistics it is used for the solution of practical problems such as the description of spatial arrangements and the estimation of object characteristics. A related field is stereology, which makes possible inference on the structures, based on lower-dimensional observations. Unfolding problems for particle systems and extremes of particle characteristics are studied. The reader can learn about current developments in stochastic geometry with mathematical rigor on one hand and find applications to real microstructure analysis in natural and material sciences on the other hand.

Stochastic Geometry and Wireless Networks

Progress in Information Geometry

An Introduction to Continuous-Time Stochastic Processes

Poisson Line Cox Process

Stochastic Geometry

This book develops the stochastic geometry framework for imageanalysis purpose. Two main frameworks are described: markedpoint process and random closed sets models. We derive the mainissues for defining an appropriate model. The algorithms forsampling and optimizing the models as well as for estimatingparameters are reviewed. Numerous applications, coveringremote sensing images, biological and medical imaging, aredetailed. This book provides all the necessary tools fordeveloping an image analysis application based on modern stochasticmodeling.

This book develops systematically and rigorously, yet in an expository and lively manner, the evolution of general random processes and their large time properties such as transience, recurrence, and convergence to steady states. The emphasis is on the most important classes of thes processes from the viewpoint of theory as well as applications, namely, Markov processes. The book features very broad coverage of the most applicable aspects of stochastic processes, including sufficient material for self-contained courses on random walks in one and multiple dimensions; Markov chains in discrete and continuous times, including birth-death processes; Brownian motion and diffusions; stochastic optimization; and stochastic differential equations. This book is for graduate students in mathematics, statistics, science and engineering, and it may also be used as a reference by professionals in diverse fields whose work involves the application of probability.

The reader can learn about current developments in stochastic geometry with mathematical rigor on one hand, and find applications to real microstructure analysis in natural and material sciences on the other hand." "Audience: This volume is suitable for scientists in mathematics, statistics, natural sciences, physics, engineering (materials), microscopy and image analysis, as well as postgraduate students in probability and statistics."--Jacket.

'Et moi ..., 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, on the topmost shelf next to the dusty canister labelled 'discarded n- sense'. 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 linearities 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.

Malliavin Calculus, Wiener-Itô Chaos Expansions and Stochastic Geometry

Selected Topics
Linear Stochastic Systems
Stochastic Processes
Tensor Valuations and Their Applications in Stochastic Geometry and Imaging
This book is for a general scientific and engineering audience as a guide to current ideas, methods, and models for stochastic modeling of microstructures. It is a reference for professionals in material modeling, mechanical engineering, materials science, chemical, civil, environmental engineering and applied mathematics.
This IMA Volume in Mathematics and its Applications RANDOM SETS: THEORY AND APPLICATIONS is based on the proceedings of a very successful 1996 three-day Summer Program on "Application and Theory of Random Sets." We would like to thank the scientific organizers: John Goutsias (Johns Hopkins University), Ronald P.S. Mahler (Lockheed Martin), and Hung T. Nguyen (New Mexico State University) for their excellent work as organizers of the meeting and for editing the proceedings. We also take this opportunity to thank the Army Research Office (ARO), the Office ofNaval Research (0NR), and the Eagan, MinnesotaEngineering Center ofLockheed Martin Tactical Defense Systems, whose financial support made the summer program possible. Avner Friedman Robert Gulliver v PREFACE "Later generations will regard set theory as a disease from which one has recovered. " - Henri Poincare Random set theory was independently conceived by D.G. Kendall and G. Matheron in connection with stochastic geometry. It was however G.
This book focuses on information-geometric manifolds of structured data and models and related applied mathematics. It features new and fruitful interactions between several branches of science: Advanced Signal/Image/Video Processing, Complex Data Modeling and Analysis, Statistics on Manifolds, Topology/Machine/Deep Learning and Artificial Intelligence. The selection of applications makes the book a substantial information source, not only for academic scientist but it is also highly relevant for industry. The book project was initiated following discussions at the international conference GSI ' 2019 - Geometric Science of Information that was held at ENAC, Toulouse (France).
Pattern theory is a distinctive approach to the analysis of all forms of real-world signals. At its core is the design of a large variety of probabilistic models whose samples reproduce the look and feel of the real signals, their patterns, and their variability. Bayesian statistical inference then allows you to apply these models in the analysis of new signals. This book treats the mathematical tools, the models themselves, and the computational algorithms for applying statistics to analyze six representative classes of signals of increasing complexity. The book covers patterns in text, sound, and images. Discussions of images include recognizing characters, textures, nature scenes, and human faces. The text includes online access to the materials (data, code, etc.) needed for the exercises.
Stochastic Modeling of Microstructures
Stochastic Processes with Applications
Theory, Models, and Applications to Finance, Biology, and Medicine
Stochastic Geometry, Spatial Statistics and Random Fields
Anisotropy Across Fields and Scales
This is the first systematic exposition of random sets theory since Matheron (1975), with full proofs, exhaustive bibliographies and literature notes Interdisciplinary connections and applications of random sets are emphasized throughout the book An extensive bibliography in the book is available on the Web at http://liinwww.ira.uka.de/bibliography/math/random.closed.sets.html, and is accompanied by a search engine
The exposition is mathematically precise and takes into account the latest results. However, in many cases proofs are omitted. Applied scientists who may not wish to follow the mathematical arguments in detail will still be able to interpret and use the formulae.
The purpose of this volume is to give an up-to-date introduction to tensor valuations and their applications. Starting with classical results concerning scalar-valued valuations on the families of convex bodies and convex polytopes, it proceeds to the modern theory of tensor valuations. Product and Fourier-type transforms are introduced and various integral formulae are derived. New and well-known results are presented, together with generalizations in several directions, including extensions to the non-Euclidean setting and to non-convex sets. A variety of applications of tensor valuations to models in stochastic geometry, to local stereology and to imaging are also discussed.
Stochastic geometry deals with models for random geometric structures. Its early beginnings are found in playful geometric probability questions, and it has vigorously developed during recent decades, when an increasing number of real-world applications in various sciences required solid mathematical foundations. Integral geometry studies geometric mean values with respect to invariant measures and is, therefore, the appropriate tool for the investigation of random geometric structures that exhibit invariance under translations or motions. Stochastic and Integral Geometry provides the mathematically oriented reader with a rigorous and detailed introduction to the basic stationary models used in stochastic geometry – random sets, point processes, random mosaics – and to the integral geometry that is needed for their investigation. The interplay between both disciplines is demonstrated by various fundamental results. A chapter on selected problems about geometric probabilities and an outlook to non-stationary models are included, and much additional information is given in the section notes.
Lectures on the Poisson Process
Stochastic and Integral Geometry
Likelihood and Computation
Stochastic Equations and Differential Geometry