

Stochastic Hybrid Systems: A Powerful Framework for Complex, Large Scale Applications

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Stochastic hybrid systems allow one to model the interaction between continuous dynamics, discrete dynamics and probabilistic uncertainty. Because of their versatility, stochastic hybrid systems have emerged as a powerful framework for capturing the intricacies of complex systems. Motivated by this, considerable research effort has been devoted to the development of modeling, analysis and control methods for stochastic hybrid systems. In this introductory paper to the special issue, we outline recent progress in this challenging research area and argue that synergies between methods developed by different communities in computer science, control engineering, and stochastic analysis should be exploited to allow progress in real life, large scale applications.

Keywords: Stochastic hybrid systems; Complex systems modelling and control

1. Introduction

Over the past two decades hybrid systems have become established as a convenient framework for modelling, analysis, and control of complex systems. Hybrid systems are dynamical systems that involve the interaction of continuous (or time driven) and discrete (or event driven) dynamics. An important driving force fueling research in the area of hybrid systems has been their application to embedded control and computation, where by design

digital, event driven devices have to interact with an analogue, time driven environment.

Much of the work on hybrid systems has focused on deterministic models that completely characterize the future of the system by defining its evolution in an imperative way (the model specifies what the evolution must be), without allowing any uncertainty. In practice, it is often desirable to introduce uncertainty, to allow, for example, under-modeling of certain parts of the system, external un-modeled disturbances, etc. Motivated by this, researchers in discrete event systems and in hybrid systems have introduced what are known as non-deterministic models. In non-deterministic hybrid systems, the evolution is defined in a declarative way (the system specifies what solutions are allowed) as opposed to the imperative way. Uncertainty can affect the dynamics of a non-deterministic hybrid system in different ways: choice of continuous evolution, choice of discrete transition destination, or choice between continuous evolution and a discrete transition. “Choice” in this setting may reflect disturbances that add uncertainty about the system evolution, but also control inputs that can be used to select among the different choices and hence steer the system evolution.

Deterministic and non-deterministic hybrid systems are versatile, can capture a wide range of behaviors encountered in large scale, complex systems and have proved invaluable in a number of applications, [49]. They do, however, have their limitations. In particular, non-deterministic systems provide no way of distinguishing between their many possible solutions. This implies that

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Stochastic Analysis On Large Scale Interaction Systems

Patrícia Gonçalves, Ana Jacinta Soares



Stochastic Analysis On Large Scale Interaction Systems:

Stochastic Analysis on Large Scale Interacting Systems Ryōta Fukushima, Tadahisa Funaki, Yukio Nagahata, Makoto Nakashima, Hirofumi Osada, Yoshiki Otake, 2016

Stochastic Analysis on Large Scale Interacting Systems Kyōto Daigaku. Kiso Butsurigaku Kenkyūjo. Conference, 2004 This volume is a collection of 15 research and survey papers written by the speakers from two international conferences held in Japan The 11th Mathematical Society of Japan International Research Institute's Stochastic Analysis on Large Scale Interacting Systems and Stochastic Analysis and Statistical Mechanics Topics discussed in the volume cover the hydrodynamic limit fluctuations large deviations spectral gap Poincaré inequality logarithmic Sobolev inequality Ornstein-Zernike asymptotics random environments determinantal expressions for systems including exclusion processes stochastic lattice gas Kawasaki dynamics zero range processes interacting Brownian particles random walks self-avoiding walks Ginzburg-Landau model interface models Ising model Widom-Rowlinson model directed polymers random matrices Dyson's model and more The material is suitable for graduate students and researchers interested in probability theory stochastic processes and statistical mechanics

Probability and Analysis in Interacting Physical Systems Peter Friz, Wolfgang König, Chiranjib Mukherjee, Stefano Olla, 2019-05-24 This Festschrift on the occasion of the 75th birthday of S. R. S. Varadhan one of the most influential researchers in probability of the last fifty years grew out of a workshop held at the Technical University of Berlin 15-19 August 2016 This volume contains ten research articles authored by several of Varadhan's former PhD students or close collaborators The topics of the contributions are more or less closely linked with some of Varadhan's deepest interests over the decades large deviations Markov processes interacting particle systems motions in random media and homogenization reaction-diffusion equations and directed last passage percolation The articles present original research on some of the most discussed current questions at the boundary between analysis and probability with an impact on understanding phenomena in physics This collection will be of great value to researchers with an interest in models of probability-based statistical mechanics

Recent Developments In Stochastic Analysis And Related Topics - Proceedings Of The First Sino-german Conf On Stochastic Analysis (A Satellite Conference Of Icm 2002) Sergio Albeverio, Zhi-ming Ma, Michael Georg Rockner, 2004-10-21 This volume contains 27 refereed research articles and survey papers written by experts in the field of stochastic analysis and related topics Most contributors are well known leading mathematicians worldwide and prominent young scientists The volume reflects a review of the recent developments in stochastic analysis and related topics It puts in evidence the strong interconnection of stochastic analysis with other areas of mathematics as well as with applications of mathematics in natural and social economic sciences The volume also provides some possible future directions for the field The proceedings have been selected for coverage in Index to Scientific Technical Proceedings ISTP ISI Proceedings Index to Scientific Technical Proceedings ISTP CDROM version ISI Proceedings CC Proceedings Engineering Physical Sciences

Selected Papers on Probability and Statistics, 2009 This

volume contains translations of papers that originally appeared in the Japanese journal *Sugaku* The papers range over a variety of topics in probability theory statistics and applications This volume is suitable for graduate students and research mathematicians interested in probability and statistics , *Lectures on Probability Theory and Statistics* Amir Dembo,Tadahisa Funaki,2005-11-03 This volume contains two of the three lectures that were given at the 33rd Probability Summer School in Saint Flour July 6 23 2003 Amir Dembo s course is devoted to recent studies of the fractal nature of random sets focusing on some fine properties of the sample path of random walk and Brownian motion In particular the cover time for Markov chains the dimension of discrete limsup random fractals the multi scale truncated second moment and the Ciesielski Taylor identities are explored Tadahisa Funaki s course reviews recent developments of the mathematical theory on stochastic interface models mostly on the so called nabla varphi interface model The results are formulated as classical limit theorems in probability theory and the text serves with good applications of basic probability techniques

From Particle Systems to Partial Differential Equations II Patrícia Gonçalves,Ana Jacinta Soares,2015-04-04 This book focuses on mathematical problems concerning different applications in physics engineering chemistry and biology It covers topics ranging from interacting particle systems to partial differential equations PDEs statistical mechanics and dynamical systems The purpose of the second meeting on Particle Systems and PDEs was to bring together renowned researchers working actively in the respective fields to discuss their topics of expertise and to present recent scientific results in both areas Further the meeting was intended to present the subject of interacting particle systems its roots in and impacts on the field of physics and its relation with PDEs to a vast and varied public including young researchers The book also includes the notes from two mini courses presented at the conference allowing readers who are less familiar with these areas of mathematics to more easily approach them The contributions will be of interest to mathematicians theoretical physicists and other researchers interested in interacting particle systems partial differential equations statistical mechanics stochastic processes kinetic theory dynamical systems and mathematical modeling aspects *Statistical Mechanics of Classical and Disordered Systems* Véronique Gaynard,Louis-Pierre Arguin,Nicola Kistler,Irina Kourkova,2019-09-15 These proceedings of the conference Advances in Statistical Mechanics held in Marseille France August 2018 focus on fundamental issues of equilibrium and non equilibrium dynamics for classical mechanical systems as well as on open problems in statistical mechanics related to probability mathematical physics computer science and biology Statistical mechanics as envisioned more than a century ago by Boltzmann Maxwell and Gibbs has recently undergone stunning twists and developments which have turned this old discipline into one of the most active areas of truly interdisciplinary and cutting edge research The contributions to this volume with their rather unique blend of rigorous mathematics and applications outline the state of the art of this success story in key subject areas of equilibrium and non equilibrium classical and quantum statistical mechanics of both disordered and non disordered systems Aimed at researchers in the broad field of applied

modern probability theory this book and in particular the review articles will also be of interest to graduate students looking for a gentle introduction to active topics of current research

Stochastic Analysis on Large Scale Interacting Systems

Ryōki Fukushima, 2016

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