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Fuzzy stochastic differential equations driven by fractional Brownian motion

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Abstract

In this paper, we consider fuzzy stochastic differential equations (FSDEs) driven by fractional Brownian motion (fBm). These equations can be applied in hybrid real-world systems, including randomness, fuzziness and long-range dependence. Under some assumptions on the coefficients, we follow an approximation method to the fractional stochastic integral to study the existence and uniqueness of the solutions. As an example, in financial models, we obtain the solution for an equation with linear coefficients.

Keywords: Fuzzy set theory; Fuzzy stochastic processes; Fuzzy stochastic differential equation; Fractional Brownian motion

1 Introduction

The FSDEs are used in real-world systems that the phenomena are related to randomness and fuzziness as two kinds of uncertainties, such as in economics and finance. There are papers on FSDEs that each one is different from the others in the approach. The author in [9] presented a definition of the fuzzy stochastic Itô integral. In [12–15] the author used the fuzzy non-anticipating stochastic processes and Wiener process to drive the fuzzy Itô stochastic integral. The method deals with the embedding of a crisp Itô stochastic integral into fuzzy space to build a fuzzy random variable.

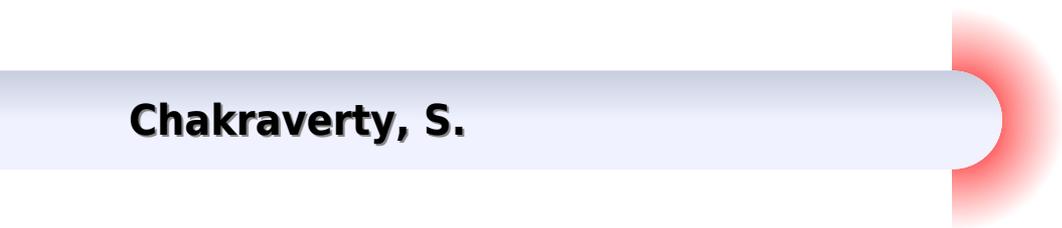
On the other hand, in the modeling of many stochastic systems, the fBm which shows a long-range dependence, is suggested to replace the Brownian motion as the driving process. The fBm with $H \in (0, 1)$ as Hurst parameter is a Gaussian process with beneficial properties, long-range dependence, self-similarity and stationary of increments. This process is appropriate for the analysis of phenomena which present long-range and scale-invariant correlations. Nevertheless, when $H \neq \frac{1}{2}$, the fBm is not a semimartingale.

In this paper, we introduce FSDEs with respect to the fBm. These equations can be helpful in the modeling of hybrid dynamic systems, including randomness, fuzziness and long-range dependence. We apply an approximation procedure to fractional stochastic integral to find the explicit solutions. We consider the Liouville form of the fBm with parameter $H \in (\frac{1}{2}, 1)$ to study the existence and uniqueness of strong solutions. Moreover, we consider an application of the equations in financial models.

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Stochastic Fuzzy Differential Equations With An Application

Chakraverty, S.



Stochastic Fuzzy Differential Equations With An Application:

Nonlinear Mathematics for Uncertainty and its Applications Shoumei Li, Xia Wang, Yoshiaki Okazaki, Jun Kawabe, Toshiaki Murofushi, Li Guan, 2011-07-21 This volume is a collection of papers presented at the international conference on Nonlinear Mathematics for Uncertainty and Its Applications NLMUA2011 held at Beijing University of Technology during the week of September 7-9 2011 The conference brought together leading researchers and practitioners involved with all aspects of nonlinear mathematics for uncertainty and its applications Over the last fifty years there have been many attempts in extending the theory of classical probability and statistical models to the generalized one which can cope with problems of inference and decision making when the model related information is scarce vague ambiguous or incomplete Such attempts include the study of nonadditive measures and their integrals imprecise probabilities and random sets and their applications in information sciences economics finance insurance engineering and social sciences The book presents topics including nonadditive measures and nonlinear integrals Choquet Sugeno and other types of integrals possibility theory Dempster Shafer theory random sets fuzzy random sets and related statistics set valued and fuzzy stochastic processes imprecise probability theory and related statistical models fuzzy mathematics nonlinear functional analysis information theory mathematical finance and risk managements decision making under various types of uncertainty and others

Mathematics of Uncertainty Modeling in the Analysis of Engineering and Science Problems Chakraverty, S., 2014-01-31 This book provides the reader with basic concepts for soft computing and other methods for various means of uncertainty in handling solutions analysis and applications Provided by publisher [Recent Trends in Wave Mechanics and Vibrations](#) S. Chakraverty, Paritosh Biswas, 2019-11-12 This book consists of select proceedings of the National Conference on Wave Mechanics and Vibrations WMVC 2018 It covers recent developments and cutting edge methods in wave mechanics and vibrations applied to a wide range of engineering problems The book presents analytical and computational studies in structural mechanics seismology and earthquake engineering mechanical engineering aeronautics robotics and nuclear engineering among others This book can be useful for students researchers and professionals interested in the wide ranging applications of wave mechanics and vibrations

Stochastic Differential Equations and Their Application in Finance. An Overview Erhabor Moses, 2020-02-14 Seminar paper from the year 2019 in the subject Mathematics Stochastics grade A University of Benin language English abstract The following work tries to examine and provide solutions to an array of equations most notably the Brownian motion the Ito integral and their application to finance In the context of this work chapter one deals with the introduction unique terms and notation and the usefulness in the project work Chapter two deals with Brownian motion and the Ito integral whereas chapter three deals with stochastic differential equations Chapter four handles the application of stochastic differential equations to finance and finally chapter five concludes the project

Dynamic Systems and Applications ,2007 **Journal of Dong Hua University** ,2004 *Journal of the Korean*

Mathematical Society, 2005 *Stochastic Differential Equations* Bernt Oksendal, 2013-03-09 These notes are based on a postgraduate course I gave on stochastic differential equations at Edinburgh University in the spring 1982 No previous knowledge about the subject was assumed but the presentation is based on some background in measure theory There are several reasons why one should learn more about stochastic differential equations They have a wide range of applications outside mathematics there are many fruitful connections to other mathematical disciplines and the subject has a rapidly developing life of its own as a fascinating research field with many interesting unanswered questions Unfortunately most of the literature about stochastic differential equations seems to place so much emphasis on rigor and completeness that it scares many nonexperts away These notes are an attempt to approach the subject from the nonexpert point of view Not knowing anything except rumours maybe about a subject to start with what would I like to know first of all My answer would be 1 In what situations does the subject arise 2 What are its essential features 3 What are the applications and the connections to other fields I would not be so interested in the proof of the most general case but rather in an easier proof of a special case which may give just as much of the basic idea in the argument And I would be willing to believe some basic results without proof at first stage anyway in order to have time for some more basic applications **2002 IEEE Region 10**

Conference on Computers, Communications, Control and Power Engineering TENCON (2002, Beijing), 2002

Mathematical Reviews, 2006 **Stochastic Differential Equations** Ludwig Arnold, 2013 Originally published New York Wiley 1974 **Neural Networks and Other Soft Computing Techniques with Applications in the Oil Industry** Fred Aminzadeh, Paul De Groot, 2006 *Computing Anticipatory Systems* D. M. Dubois, 2001-07-13 This AIP Conference proceedings contains all papers which received a Best Paper Award as well as a selection of invited papers The scope of this volume encompasses the study research and development of concepts methodologies theories and mathematical models for designing modeling simulating optimizing controlling of computing anticipatory systems Computing systems refer to any rule based and learning based evolving natural and artificial systems Computation deals with manipulation of symbols in a large sense A computing anticipatory system is a system which computes its current states in taking into account its anticipatory states Strong anticipation refers to an anticipation of events built by or embedded in a system Weak anticipation refers to an anticipation of events predicted or forecasted from a model of a system The topics of the chapters are computing anticipatory systems significant progress in quantum mechanics and relativity chaos and complex systems fuzzy dynamics genetic algorithms and soft computing time anticipation and hyperincursion anticipation in psychology and cognition anticipation decision making economy and social systems and computational intelligence control and computing systems *AIAA Journal* American Institute of Aeronautics and Astronautics, 2001 **Modeling and Analysis of Uncertainties in Survivability and Vulnerability Assessment** Felix S. Wong, 1986 **Proceedings in Print**, 1990 *Stochastic Differential Equations* K. Sobczyk, 2013-12-01 Et moi si lavait su CO llUlJalt en revc nir One acMcc matbcmatica bu JaIdcred the human rac c It bu

put COIDIDOD _ beet je n y serais point aBe Jules Verne wbac it bdoup 0Jl be IbcII _t to be dusty caualcr Iabc thc reforc we may be I ticT Bc I1 able to do something with it O Hcavisidc Mathematics is a tool for thought A highly necessary tool in a world when 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 statcmalts as One service topology has rendered mathematical physics One service logic has rendered c0m 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 19n 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 branc hes It also happens quite often in fact that branches which were thought to be completely Current Index to Statistics, Applications, Methods and Theory ,1998 The Current Index to Statistics CIS is a bibliographic index of publications in statistics probability and related fields **Stochastic Differential Equations and Applications** X Mao,2007-12-30 This advanced undergraduate and graduate text has now been revised and updated to cover the basic principles and applications of various types of stochastic systems with much on theory and applications not previously available in book form The text is also useful as a reference source for pure and applied mathematicians statisticians and probabilists engineers in control and communications and information scientists physicists and economists Has been revised and updated to cover the basic principles and applications of various types of stochastic systems Useful as a reference source for pure and applied mathematicians statisticians and probabilists engineers in control and communications and information scientists physicists and economists **Dynamics of Continuous, Discrete & Impulsive Systems** ,2003

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Stochastic Fuzzy Differential Equations With An Application Introduction

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