ON THE CONSTRUCTION AND LIMIT BEHAVIOR OF A MULTIPLE STOCHASTIC INTEGRAL OF A DIFFUSION PROCESS

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(*Translated by A. B. Aries*)

In [1], a stochastic multiple integral of the form

(1) $$I_t=\int_0^T\cdots\int_0^T f(\xi(t_1),\cdots,\xi(t_m))\,d\xi(t_1)\cdots d\xi(t_m)$$

is constructed, where $\xi(t)$ is a one-dimensional Wiener process, $f(x)(x=(x_1,\cdots,x_m),-\infty<x_i<+\infty)$ is a nonrandom measurable function of the form

(2) $$f(x)=\sum_{\nu=1}^{\infty}\prod_{k=1}^{m}\varphi_{k\nu}(x_k),$$

and in any finite range of x: 1) $f(x)$ is bounded; 2) the series (2) is uniformly convergent. In [2] it has been proved with the aid of the results obtained in [1] that the limit distribution (as $T\to\infty$) of the stochastic integral

$$\int_0^T\int_0^T f(\xi(t_1),\xi(t_2))\,dt_1\,dt_2$$

exists (under some normalization) provided the function $\int_0^{x_1}\int_0^{x_2} f(u,v)\,du\,dv$ is regular for $|x_1|+|x_2|\to\infty$.

The main difficulty in constructing an integral of the form (1) lies in the fact that the integrand $f(\xi(t_1),\cdots,\xi(t_m))=g(t_1,\cdots,t_m)$ is random and measurable with respect to the σ-algebra $\sigma(\xi(s),s\leqq\max_{1\leqq i\leqq m}t_i)$. G. N. Sytaya surmounted this difficulty by employing properties of a Wiener process. In the case where the integrand $g(t_1,\cdots,t_m)$ is measurable with respect to the σ-algebra $\sigma(\xi(s),s\leqq\min_{1\leqq i\leqq m}t_i)$, and $\xi(t)$ is a local martingale with the properties $\langle\xi(t)\rangle=t$, $\xi(0)=0$, a multiple stochastic integral is formed in [3] over the region $0\leqq t_1<\cdots<t_m\leqq T$ by the method for constructing an Ito stochastic integral.

This paper uses Sytaya's method to determine a stochastic integral of the form (1) when $\xi(t)$ is a solution of the stochastic diffusion equation

(3) $$d\xi(t)=a(t,\xi(t))\,dt+\sigma(t,\xi(t))\,dw(t),\qquad \xi(0)=0,$$

where $w(t)$ is a Wiener process defined on the probability space $(\Omega,\mathcal{F},\mathbf{P})$, the functions $a(t,y)$, $\sigma(t,y)$ are defined for $0\leqq t\leqq T$, $-\infty<y<\infty$, and are measurable in the variables t, y, and

$$a^2(t,y)+\sigma^2(t,y)\leqq K(1+y^2).$$

We also consider the limit behavior as $T\to\infty$ of distributions of stochastic double integrals of the solutions $\xi(t)$ of a certain class of equations of the form (3).

DEFINITION. Let $f_N(x)$, $x=(x_1,\cdots,x_m)$, $-\infty<x_i<\infty$, be the measurable function

(4) $$f_N(x)=\sum_{\nu=1}^{N}\prod_{k=1}^{m}\varphi_{k\nu}(x_k)$$

Also, let the stochastic integrals

$$\int_0^T\varphi_{k\nu}(\xi(t_k))\,d\xi(t_k)=\int_0^T\varphi_{k\nu}(t_k,\xi(t_k))a(t_k,\xi(t_k))\,dt_k+\int_0^T\varphi_{k\nu}(\xi(t_k))\sigma(t_k,\xi(t_k))\,dw(t_k).$$

Multiple Stochastic Integral

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Multiple Stochastic Integral:

The Multiple Stochastic Integral David Douglas Engel,1979 One Multiple Stochastic Integral with Respect to a Strictly Semistable Random Measure P. Xavier Raja Retnam,1988 *Chaos Expansions, Multiple Wiener-Ito Integrals, and Their Applications* Christian Houdre,Victor Perez-Abreu,1994-04-05 The study of chaos expansions and multiple Wiener Ito integrals has become a field of considerable interest in applied and theoretical areas of probability stochastic processes mathematical physics and statistics Divided into four parts this book features a wide selection of surveys and recent developments on these subjects Part 1 introduces the concepts techniques and applications of multiple Wiener Ito and related integrals The second part includes papers on chaos random variables appearing in many limiting theorems Part 3 is devoted to mixing zero one laws and path continuity properties of chaos processes The final part presents several applications to stochastic analysis **The Malliavin Calculus and Related Topics** David Nualart,2013-12-11 The origin of this book lies in an invitation to give a series of lectures on Malliavin calculus at the Probability Seminar of Venezuela in April 1985 The contents of these lectures were published in Spanish in 176 Later these notes were completed and improved in two courses on Malliavin cal culus given at the University of California at Irvine in 1986 and at Ecole Polytechnique Federale de Lausanne in 1989 The contents of these courses correspond to the material presented in Chapters 1 and 2 of this book Chapter 3 deals with the anticipating stochastic calculus and it was de veloped from our collaboration with Moshe Zakai and Etienne Pardoux The series of lectures given at the Eighth Chilean Winter School in Prob ability and Statistics at Santiago de Chile in July 1989 allowed us to write a pedagogical approach to the anticipating calculus which is the basis of Chapter 3 Chapter 4 deals with the nonlinear transformations of the Wiener measure and their applications to the study of the Markov property for solutions to stochastic differential equations with boundary conditions *High Dimensional Probability* Evarist Giné,2006 *Introduction to Malliavin Calculus* David Nualart,Eulalia Nualart,2018-09-27 A compact introduction to this active and powerful area of research combining basic theory core techniques and recent applications Stable Processes and Related Topics Cambanis,2012-12-06 The Workshop on Stable Processes and Related Topics took place at Cor nell University in January 9 13 1990 under the sponsorship of the Mathemat ical Sciences Institute It attracted an international roster of probabilists from Brazil Japan Korea Poland Germany Holland and France as well as the U S This volume contains a sample of the papers presented at the Workshop All the papers have been refereed Gaussian processes have been studied extensively over the last fifty years and form the bedrock of stochastic modeling Their importance stems from the Central Limit Theorem They share a number of special properties which facilitates their analysis and makes them particularly suitable to statistical inference The many properties they share however is also the seed of their limitations What happens in the real world away from the ideal Gaussian model The non Gaussian world may contain random processes that are close to the Gaussian What are appropriate classes of nearly Gaussian models and how typical or robust is the Gaussian model amongst them Moving further away from normality what are appropriate non Gaussian models that are sufficiently different to encompass distinct behavior yet sufficiently simple to be amenable to efficient statistical inference The very Central Limit Theorem which provides the fundamental justifi cation for approximate normality points to stable and other infinitely divisible models Some of these may be close to and others very different from Gaussian models *Theory of Probability and Mathematical Statistics* ,1998 *Quantum Information - Proceedings Of The First International Conference* Takeyuki Hida,Kimiaki Saito,1999-08-16 **Introduction to Stochastic Integration** Hui-Hsiung Kuo,2006-02-04 In the Leibniz Newton calculus one learns the di erentiation and integration of deterministic functions A basic theorem in di erentiation is the chain rule which gives the derivative of a composite of two di erentiable functions The chain rule when written in an inde nite integral form yields the method of substitution In advanced calculus the Riemann Stieltjes integral is de ned through the same procedure of partition evaluation summation limit as in the Riemann integral In dealing with random functions such as functions of a Brownian motion the chain rule for the Leibniz Newton calculus breaks down A Brownian motionmovessorapidlyandirregularlythatalmostallofitssamplepathsare nowhere di erentiable Thus we cannot di erentiate functions of a Brownian motion in the same way as in the Leibniz Newton calculus In 1944 Kiyosi It o published the celebrated paper Stochastic Integral in the Proceedings of the Imperial Academy Tokyo It was the beginning of the It o calculus the counterpart of the Leibniz Newton calculus for random functions In this six page paper It o introduced the stochastic integral and a formula known since then as It o s formula The It o formula is the chain rule for the It ocalculus Butitcannotbe expressed as in the Leibniz Newton calculus in terms of derivatives since a Brownian motion path is nowhere di erentiable The It o formula can be interpreted only in the integral form Moreover there is an additional term in the formula called the It o correction term resulting from the nonzero quadratic variation of a Brownian motion *Probability Theory Subject Indexes from Mathematical Reviews* American Mathematical Society,1987 Product Stochastic Measures, Multiple Stochastic Integrals and Their Extensions to Nuclear Space Valued Processes Victor M. Perez-Abreu C.,NORTH CAROLINA UNIV AT CHAPEL HILL CENTER FOR STOCHASTIC PROCESSES.,1985 A theory of L sub 2 valued product stochastic measures of non identically distributed L sub 2 independently scattered measures is developed using concepts of symmetric tensor product Hilber spaces Applying the theory of vector valued measures we construct multiple stochastic integrals with respect to the product stochastic measures A clear relationship between the theories of vector valued measures and multiple stochastic integrals is established This work is related to the work by D D Engel 1982 who gives a different approach to the construction of product stochastic measures The two approaches are compared The second part of the work deals with multiple Wiener integrals and nonlinear functionals of a phi valued Wiener process W sub t where phi is the dual of a Countably Hilbert Nuclear Space We obtain the Wiener decomposition of the space of phi valued nonlinear functionals as an inductive limit of appropriate Hilbert spaces It is shown that every phi valued nonlinear functional admits an expansion in terms of multiple Wiener integrals in one of these Hilbert spaces and can be represented as an operator valued stochastic integral of the Ito type Author **Statistical Theory and Method Abstracts** ,1999 **Mathematical Reviews** ,1999

A Treatise on the Integral Calculus Joseph Edwards,1930 *III Simposio de Probabilidad y Procesos Estocasticos* ,1994 **Computational Techniques and Applications, CTAC** ,1995 **Chinese Journal of Mathematics** ,1994

SIAM Journal on Control and Optimization Society for Industrial and Applied Mathematics,2000 Contains research articles on the mathematics and applications of control theory and on those parts of optimization theory concerned with the dynamics of deterministic or stochastic systems in continuous or discrete time or otherwise dealing with differential equations dynamics infinite dimensional spaces or fundamental issues in variational analysis and geometry **Methods of Functional Analysis and Topology** ,2002

This book delves into Multiple Stochastic Integral. Multiple Stochastic Integral is a crucial topic that needs to be grasped by everyone, from students and scholars to the general public. The book will furnish comprehensive and in-depth insights into Multiple Stochastic Integral, encompassing both the fundamentals and more intricate discussions.

1. This book is structured into several chapters, namely:
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4. In chapter 3, this book will examine the practical applications of Multiple Stochastic Integral in daily life. This chapter will showcase real-world examples of how Multiple Stochastic Integral can be effectively utilized in everyday scenarios.
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6. In chapter 5, the author will draw a conclusion about Multiple Stochastic Integral. The final chapter will summarize the key points that have been discussed throughout the book.
   The book is crafted in an easy-to-understand language and is complemented by engaging illustrations. This book is highly recommended for anyone seeking to gain a comprehensive understanding of Multiple Stochastic Integral.

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