

Preface

Uncertainty theory is a branch of mathematics for modeling belief degrees. Within the framework of uncertainty theory, uncertain variable is used to represent quantities with uncertainty, and uncertain process is used to model the evolution of uncertain quantities. Uncertain differential equation is a type of differential equations involving uncertain processes. Since it was proposed in 2008, uncertain differential equation has been subsequently studied by many researchers. So far, it has become the main tool to deal with dynamic uncertain systems.

Uncertain Variable

Uncertain measure is used to quantify the belief degree that an uncertain event is supposed to occur, and uncertain variable is used to represent quantities with human uncertainty. Chapter 2 is devoted to uncertain measure, uncertain variable, uncertainty distribution, inverse uncertainty distribution, operational law, expected value, and variance.

Uncertain Process

Uncertain process is essentially a sequence of uncertain variables indexed by the time. Chapter 3 introduces some basic concepts about an uncertain process, including uncertainty distribution, extreme value, and time integral.

Contour Process

Contour process is a type of uncertain processes with some special structures so that its main properties are determined by a spectrum of its sample paths. Solutions of uncertain differential equations are the most frequently used contour processes. Chapter 4 is devoted to such processes and proves the set of contour processes is closed under the extreme value operator, time integral operator, and monotone function operator.

Uncertain Calculus

Uncertain calculus deals with the differentiation and integration of uncertain processes. Chapter 5 introduces the Liu process, the Liu integral, the fundamental theorem, and integration by parts.

Uncertain Differential Equation

Uncertain differential equation is a type of differential equations involving uncertain processes. Chapter 6 is devoted to the uncertain differential equations driven by the Liu processes. It discusses some analytic methods and numerical methods for solving uncertain differential equations. In addition, the existence and uniqueness theorem, and stability theorems on the solution of an uncertain differential equation are also covered. For application, it introduces two stock models and derives their option pricing formulas as well.

Uncertain Calculus with Renewal Process

Renewal process is a type of discontinuous uncertain processes, which is used to record the number of renewals of an uncertain system. Chapter 7 is devoted to uncertain calculus with respect to renewal process. It introduces the renewal process, the Yao integral and the Yao process, including the fundamental theorem and integration by parts.

Uncertain Differential Equation with Jumps

Uncertain differential equation with jumps is essentially a type of differential equations driven by both the Liu processes and the renewal processes. Chapter 8 is devoted to uncertain differential equation with jumps, including the existence and uniqueness, and stability of its solution. It also introduces a stock model with jumps and derives its option pricing formulas for application purpose.

Multi-Dimensional Uncertain Differential Equation

Multi-dimensional uncertain differential equation is a system of uncertain differential equations. Chapter 9 introduces multi-dimensional Liu process, multi-dimensional uncertain calculus, and multi-dimensional uncertain differential equation.

High-Order Uncertain Differential Equation

High-order uncertain differential equation is a type of differential equations involving the high-order derivatives of uncertain processes. Chapter 10 is devoted to high-order uncertain differential equations driven by the Liu processes. It gives a numerical method for solving high-order uncertain differential equations. In addition, the existence and uniqueness theorem on the solution of a high-order uncertain differential equation is also covered.

Uncertainty Theory Online

If you would like to read more papers related to uncertain differential equations, please visit the Web site at <http://orsc.edu.cn/online>.

Purpose

The purpose of this book was to provide a tool for handling dynamic systems with human uncertainty. The book is suitable for researchers, engineers, and students in the field of mathematics, information science, operations research, industrial engineering, economics, finance, and management science.

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