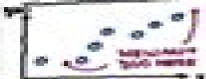
NUMERICAL METHODS

r/KAPPY | EXAM 2 | 11/14/2022

LEAST SQUARES REGRESSION:



GOAL: MINIMIZE THE SUM OF THE SQUARE OF THE RESIDUAL ERRORS

$S_r = \sum_{i=1}^{n} e_i^2 = \sum_{i=1}^{n} (y_i - a_0 - a_1 x_i)^2$

$a_1 = \frac{n\sum(y_i x_i) - \sum y_i \sum x_i}{n\sum(x_i^2) - (\sum x_i)^2}$

$a_0 = \frac{\sum y_i}{n} - a_1 \frac{\sum x_i}{n} \rightarrow a_0 = \bar{y} - a_1 \bar{x}$

$a_0 = \bar{y} - a_1 \bar{x}$

$y = a_0 + a_1 x$

STANDARD ERROR:

$s_{y/x} = \sqrt{\frac{S_r}{n-2}}$ $\quad s_{y/x} = \sqrt{\frac{\sum (y_i - y_i^{est})^2}{n-2}}$

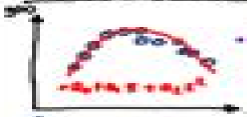
STAND. DEVIATION:

$s_y = \sqrt{\frac{S_t}{n-1}}$ $\quad s_y = \sqrt{\frac{\sum (y_i - \bar{y})^2}{n-1}}$

POLYNOMIAL (QUADRATIC) REGRESSION:

$S_r = \sum_{i=1}^{n} (y_i - a_0 - a_1 x_i - a_2 x_i^2)^2$

TAKE DERIVATIVE OF S_r TO FIND MINIMUM



$\frac{\partial S_r}{\partial a_0} = -2\left(\sum y_i - \sum a_0 - a_1 \sum x_i - a_2 \sum x_i^2\right) = 0$

$\frac{\partial S_r}{\partial a_1} = -2\left(\sum y_i x_i - \sum a_0 \sum x_i - a_1 \sum x_i^2 - a_2 \sum x_i^3\right) = 0$

$\frac{\partial S_r}{\partial a_2} = -2\left(\sum y_i x_i^2 - \sum a_0 \sum x_i^2 - a_1 \sum x_i^3 - a_2 \sum x_i^4\right) = 0$

$\sum_{1}^{n} a_0 = a_0 n$

$[A][X] = [B] \rightarrow [A][X] = [B]$

COEFFICIENT OF DETERMINATION: $r^2 = \frac{S_t - S_r}{S_t}$

$s_{y/x} = \sqrt{\frac{S_r}{n-(m+1)}}$

INTERPOLATION

USE A POLYNOMIAL FIT:

1 DEGREE: 2 PTS, 2 UNKNOWNS | DEGREE 2: 3 POINTS, 3 UNKNOWNS | DEGREE 3: 4 PTS, 4 UNKNOWNS | DEGREE n: n+1 PTS, n+1 UNKNOWNS

$P_n(x) = a_0 + a_1 x + a_2 x^2 + \cdots + a_n x^n$

ORDER		TURNS
n = 1		0
n = 2		1
n = 3		2
n = 4		3
n = n		n − 1

SPLINES: $m_i = \frac{f(x_{i+1}) - f(x_i)}{x_{i+1} - x_i}$

ODE'S

EULER'S METHOD:

$\frac{dy(x)}{dx} = f(x,y)$ $\quad y_{i+1} = y_i + f(x_i, y_i)h$

TAYLOR SERIES:

$y(x+\Delta x) = y(x) + \frac{dy}{dx}(x,y)\Delta x$

$y(x+\Delta x) = y(x) + f(x,y)\Delta x$

HEUN'S METHOD:

$\frac{dy(x)}{dx} = f(x,y)$

$y_{i+1}^0 = y_i + f(x_i, y_i)\Delta x$ (PREDICTOR)

$\frac{dy_{i+1}}{dx} = y'_{i+1} = f(x_{i+1}, y_{i+1}^0)$

$\frac{dy_i}{dx} = y'_i = f(x_i, y_i)$

$\bar{y}' = \frac{y'_i + y'_{i+1}}{2} = \frac{f(x_i, y_i) + f(x_{i+1}, y_{i+1}^0)}{2}$

$y_{i+1} = y_i + \frac{f(x_i, y_i) + f(x_{i+1}, y_{i+1}^0)}{2}\Delta x$ (CORRECTOR)

CLASSIC 4TH ORDER RUNGE-KUTTA:

$y_{i+1} = y_i + \frac{1}{6}(k_1 + 2k_2 + 2k_3 + k_4)\Delta x$

$k_1 = f(x_i, y_i)$

$k_2 = f(x_i + \frac{1}{2}\Delta x, y_i + \frac{1}{2}k_1 \Delta x)$

$k_3 = f(x_i + \frac{1}{2}\Delta x, y_i + \frac{1}{2}k_2 \Delta x)$

$k_4 = f(x_i + \Delta x, y_i + k_3 \Delta x)$

DORMAND PRINCE RUNGE-KUTTA:

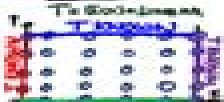
$y_{i+1} = y_i + \Delta x \sum_{j=1}^{7} b_j k_j$ LOWER ORDER

$y_{i+1} = y_i + \Delta x \sum_{j=1}^{7} a_j k_j$ HIGHER ORDER

PDE'S

FINITE DIFFERENCE METHOD:

DIRICHLET:



BC: TEMP KNOWN @ BOUNDARY

SIMPLIFIED HEAT EQN: $u_t = k(u_{xx} + u_{yy}) + q$; if $q = 0$, $k = 1$: $u_{xx} + u_{yy} = 0$

CENTRAL DIFFERENCE

$u_{xx}(x,y) = \frac{u(x-\Delta x, y) - 2u(x,y) + u(x+\Delta x, y)}{\Delta x^2}$

$u_{yy}(x,y) = \frac{u(x, y-\Delta y) - 2u(x,y) + u(x, y+\Delta y)}{\Delta y^2}$

EIGEN VALUES

λ = EIGEN VALUE

SIMPLE 2x2:

$A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$ $\quad \begin{bmatrix} a & b \\ c & d \end{bmatrix}^{-1} = \frac{1}{\det(A)} \begin{bmatrix} d & -b \\ -c & a \end{bmatrix}$

$\lambda = \frac{(a+d) \pm \sqrt{(a+d)^2 - 4(ad - bc)}}{2}$

NEUMANN:

BC: TEMP DERIVATIVE KNOWN ON BOUNDARY

CENTRAL DIFFERENCE:

$\frac{\partial u}{\partial x} = u_x = \frac{u_{i+1,j} - u_{i-1,j}}{2\Delta x}$

$\frac{\partial u}{\partial y} = u_y = \frac{u_{i,j+1} - u_{i,j-1}}{2\Delta x}$

5TH ROW OF A MATRIX:

RIGHT NEUMANN B.C.: $\frac{\partial u}{\partial x} = u_x = \frac{u_{i+1,j} - u_{i-1,j}}{2\Delta x}$; $u_{i+1,j} = u_{i-1,j} + 2\Delta x G_x$

BOTTOM NEUMANN B.C.: $\frac{\partial u}{\partial y} = u_y = \frac{u_{i,j+1} - u_{i,j-1}}{2\Delta x}$; $u_{i,j-1} = u_{i,j+1} - 2\Delta x G_y$

TOP NEUMANN BC: $\frac{\partial u}{\partial y} = u_y = \frac{u_{i,j+1} - u_{i,j-1}}{2\Delta x}$; $u_{i,j+1} = u_{i,j-1} + 2\Delta x G_y$

LEFT NEUMANN B.C.: $u_{i-1,j} = u_{i+1,j} - 2\Delta x G_x$

[A] MATRIX:

$u_{i-1,j} + 4u_{i,j} - u_{i,j-1} - u_{i,j+1} = 2\Delta x G_x$

LEFT: $-2u_{i+1,j} + 4u_{i,j} - u_{i,j-1} - u_{i,j+1} = -2\Delta x G_x$

RIGHT: $-2u_{i-1,j} + 4u_{i,j} - u_{i,j-1} - u_{i,j+1} = -2\Delta x G_x$

BOTTOM: $-u_{i-1,j} - u_{i+1,j} + 4u_{i,j} - 2u_{i,j+1} = -2\Delta x G_y$

TOP: $-u_{i-1,j} - u_{i+1,j} + 4u_{i,j} - 2u_{i,j-1} = -2\Delta x G_y$

MISC EQNS:

CENTERED FINITE-DIVIDED DIFF. FORMULAS:

FIRST: $f'(x_i) = \frac{f(x_{i+1}) - f(x_{i-1})}{2h}$

$f'(x_i) = \frac{-f(x_{i+2}) + 8f(x_{i+1}) - 8f(x_{i-1}) + f(x_{i-2})}{12h}$

Numerical Methods And Stochastics

S. S. Artemiev, T. A. Averina

Numerical Methods And Stochastics:

Numerical Methods and Stochastics T. J. Lyons,Thomas Stephenson Salisbury, This volume represents the proceedings of the Workshop on Numerical Methods and Stochastics held at The Fields Institute in April 1999 The goal of the workshop was to identify emerging ideas in probability theory that influence future work in both probability and numerical computation The book focuses on new results and gives novel approaches to computational problems based on the latest techniques from the theory of probability and stochastic processes Three papers discussparticle system approximations to solutions of the stochastic filtering problem Two papers treat particle system equations The paper on rough paths describes how to generate good approximations to stochastic integrals An expository paper discusses a long standing conjecture the stochastic fastdynamo effect A final paper gives an analysis of the error in binomial and trinomial approximations to solutions of the Black Scholes stochastic differential equations The book is intended for graduate students and research mathematicians interested in probability theory Numerical Methods for Stochastic Control Problems in Continuous Time Harold Kushner,Paul G. Dupuis,2012-12-06 This book is concerned with numerical methods for stochastic control and optimal stochastic control problems The random process models of the controlled or uncontrolled stochastic systems are either diffusions or jump diffusions Stochastic control is a very active area of research and new prob lem formulations and sometimes surprising applications appear regularly We have chosen forms of the models which cover the great bulk of the for mulations of the continuous time stochastic control problems which have appeared to date The standard formats are covered but much emphasis is given to the newer and less well known formulations The controlled process might be either stopped or absorbed on leaving a constraint set or upon first hitting a target set or it might be reflected or projected from the boundary of a constraining set In some of the more recent applications of the reflecting boundary problem for example the so called heavy traffic approximation problems the directions of reflection are actually discontin uous In general the control might be representable as a bounded function or it might be of the so called impulsive or singular control types Both the drift and the variance might be controlled The cost functions might be any of the standard types Discounted stopped on first exit from a set finite time optimal stopping average cost per unit time over the infinite time interval and so forth **Stochastic Dynamical Systems** Josef Honerkamp,1996-12-17 Dieser einzigartige Band f hrt den Leser in die mathematische Begriffsbildung f r komplexe Systeme ein Er ist ideal f r Studenten der Mathematik Physik Chemie und Medizin die sich in ihrem Studium erstmals mit stochastischen dynamischen Systemen besch ftigen Das Buch stellt praktische Methoden zur Verf gung um mit solchen Systemen umgehen zu k nnen und stellt die zugundeliegenden Definitionen und theoretischen Annahmen wo erforderlich klar heraus Im Gegensatz zu anderen B chern ber dieses Gebiet die oft einen bestimmten Zugang bevorzugen deckt Stochastical Dynamical Systems eine Vielzahl von stochastischen und statistischen Methoden ab die f r die Untersuchung von komplexen Systemen wie Polymerschmelzen dem menschlichen K rper und der Atmosph re absolut notwendig sind Das Buch behandelt die Datenanalyse ebenso wie Simulationsmethoden f r gegebene Modelle Die ganze Vielfalt der klassischen und neuartigen Begriffe der mathematischen Stochastik wird in einem leicht verst ndlichen Stil erkl rt so da die Leser diese Konzepte leicht f r die Untersuchung ihrer Daten anwenden k nnen Numerical Solution of Stochastic Differential Equations Peter E. Kloeden,Eckhard Platen,2013-04-17 The aim of this book is to provide an accessible introduction to stochastic differ ential equations and their applications together with a systematic presentation of methods available for their numerical solution During the past decade there has been an accelerating interest in the de velopment of numerical methods for stochastic differential equations SDEs This activity has been as strong in the engineering and physical sciences as it has in mathematics resulting inevitably in some duplication of effort due to an unfamiliarity with the developments in other disciplines Much of the reported work has been motivated by the need to solve particular types of problems for which even more so than in the deterministic context specific methods are required The treatment has often been heuristic and ad hoc in character Nevertheless there are underlying principles present in many of the papers an understanding of which will enable one to develop or apply appropriate numerical schemes for particular problems or classes of problems Numerical Methods for Stochastic Partial Differential Equations with White Noise Zhongqiang Zhang,George Em Karniadakis,2017-09-01 This book covers numerical methods for stochastic partial differential equations with white noise using the framework of Wong Zakai approximation The book begins with some motivational and background material in the introductory chapters and is divided into three parts Part I covers numerical stochastic ordinary differential equations Here the authors start with numerical methods for SDEs with delay using the Wong Zakai approximation and finite difference in time Part II covers temporal white noise Here the authors consider SPDEs as PDEs driven by white noise where discretization of white noise Brownian motion leads to PDEs with smooth noise which can then be treated by numerical methods for PDEs In this part recursive algorithms based on Wiener chaos expansion and stochastic collocation methods are presented for linear stochastic advection diffusion reaction equations In addition stochastic Euler equations are exploited as an application of stochastic collocation methods where a numerical comparison with other integration methods in random space is made Part III covers spatial white noise Here the authors discuss numerical methods for nonlinear elliptic equations as well as other equations with additive noise Numerical methods for SPDEs with multiplicative noise are also discussed using the Wiener chaos expansion method In addition some SPDEs driven by non Gaussian white noise are discussed and some model reduction methods based on Wick Malliavin calculus are presented for generalized polynomial chaos expansion methods Powerful techniques are provided for solving stochastic partial differential equations This book can be considered as self contained Necessary background knowledge is presented in the appendices Basic knowledge of probability theory and stochastic calculus is presented in Appendix A In Appendix B some semi analytical methods for SPDEs are presented In Appendix C an introduction to Gauss quadrature is provided In Appendix D all the conclusions which are needed for proofs are presented and in Appendix E a method to compute the convergence rate empirically is included In addition the authors provide a thorough review of the topics both theoretical and computational exercises in the book with practical discussion of the effectiveness of the methods Supporting Matlab files are made available to help illustrate some of the concepts further Bibliographic notes are included at the end of each chapter This book serves as a reference for graduate students and researchers in the mathematical sciences who would like to understand state of the art numerical methods for stochastic partial differential equations with white noise **Numerical methods and stochastics** T. J. Lyons,2002 This volume represents the proceedings of the Workshop on Numerical Methods and Stochastics held at The Fields Institute in April 1999 The goal of the workshop was to identify emerging ideas in probability theory that influence future work in both probability and numerical computation The book focuses on new results and gives novel approaches to computational problems based on the latest techniques from the theory of probability and stochastic processes Three papers discuss particle system approximations to solutions of the stochastic filtering problem Two papers treat particle system equa Numerical Methods for Stochastic Control Problems in Continuous Time Harold J. Kushner,Paul Dupuis,2001 The required background is surveyed and there is an extensive development of methods of approximation and computational algorithms The book is written on two levels algorithms and applications and mathematical proofs Thus the ideas should be very accessible to a broad audience BOOK JACKET **Stochastic Numerical Methods** Raúl Toral,Pere Colet,2014-06-26 Stochastic Numerical Methods introduces at Master level the numerical methods that use probability or stochastic concepts to analyze random processes The book aims at being rather general and is addressed at students of natural sciences Physics Chemistry Mathematics Biology etc and Engineering but also social sciences Economy Sociology etc where some of the techniques have been used recently to numerically simulate different agent based models Examples included in the book range from phase transitions and critical phenomena including details of data analysis extraction of critical exponents finite size effects etc to population dynamics interfacial growth chemical reactions etc Program listings are integrated in the discussion of numerical algorithms to facilitate their understanding From the contents Review of Probability Concepts Monte Carlo Integration Generation of Uniform and Non uniform Random Numbers Non correlated Values Dynamical Methods Applications to Statistical Mechanics Introduction to Stochastic Processes Numerical Simulation of Ordinary and Partial Stochastic Differential Equations Introduction to Master Equations Numerical Simulations of Master Equations Hybrid Monte Carlo Generation of n Dimensional Correlated Gaussian Variables Collective Algorithms for Spin Systems Histogram Extrapolation Multicanonical Simulations *Numerical Methods for Stochastic Computations* Dongbin Xiu,2010-07-01 The first graduate level textbook to focus on fundamental aspects of numerical methods for stochastic computations this book describes the class of numerical methods based on generalized polynomial chaos gPC These fast efficient and accurate methods are an extension of the classical spectral methods of high dimensional random spaces Designed to simulate complex systems subject to random inputs these methods are widely used in many areas of computer science and engineering The book introduces polynomial approximation theory and probability theory describes the basic theory of gPC methods through numerical examples and rigorous development details the procedure for converting stochastic equations into deterministic ones using both the Galerkin and collocation approaches and discusses the distinct differences and challenges arising from high dimensional problems The last section is devoted to the application of gPC methods to critical areas such as inverse problems and data assimilation Ideal for use by graduate students and researchers both in the classroom and for self study Numerical Methods for Stochastic Computations provides the required tools for in depth research related to stochastic computations The first graduate level textbook to focus on the fundamentals of numerical methods for stochastic computations Ideal introduction for graduate courses or self study Fast efficient and accurate numerical methods Polynomial approximation theory and probability theory included Basic gPC methods illustrated through examples **Numerical Analysis of Systems of Ordinary and Stochastic Differential Equations** S. S. Artemiev,T. A. Averina,2011-02-11 No detailed description available for Numerical Analysis of Systems of Ordinary and Stochastic Differential Equations *Numerical Solution of Stochastic Differential Equations with Jumps in Finance* Eckhard Platen,Nicola Bruti-Liberati,2010-07-23 In financial and actuarial modeling and other areas of application stochastic differential equations with jumps have been employed to describe the dynamics of various state variables The numerical solution of such equations is more complex than that of those only driven by Wiener processes described in Kloeden Platen Numerical Solution of Stochastic Differential Equations 1992 The present monograph builds on the above mentioned work and provides an introduction to stochastic differential equations with jumps in both theory and application emphasizing the numerical methods needed to solve such equations It presents many new results on higher order methods for scenario and Monte Carlo simulation including implicit predictor corrector extrapolation Markov chain and variance reduction methods stressing the importance of their numerical stability Furthermore it includes chapters on exact simulation estimation and filtering Besides serving as a basic text on quantitative methods it offers ready access to a large number of potential research problems in an area that is widely applicable and rapidly expanding Finance is chosen as the area of application because much of the recent research on stochastic numerical methods has been driven by challenges in quantitative finance Moreover the volume introduces readers to the modern benchmark approach that provides a general framework for modeling in finance and insurance beyond the standard risk neutral approach It requires undergraduate background in mathematical or quantitative methods is accessible to a broad readership including those who are only seeking numerical recipes and includes exercises that help the reader develop a deeper understanding of the underlying mathematics **Numerical Methods for Stochastic Processes** Nicolas Bouleau,Dominique Lépingle,1994-01-14 Gives greater rigor to numerical treatments of stochastic models Contains Monte Carlo and quasi Monte Carlo techniques simulation of major stochastic procedures deterministic methods adapted to Markovian problems and special problems related to stochastic integral and differential equations Simulation methods are given throughout the text as well as numerous exercises *Stochastic Simulation and Monte Carlo Methods* Carl Graham,Denis Talay,2013-07-16 In various scientific and industrial fields stochastic simulations are taking on a new importance This is due to the increasing power of computers and practitioners aim to simulate more and more complex systems and thus use random parameters as well as random noises to model the parametric uncertainties and the lack of knowledge on the physics of these systems The error analysis of these computations is a highly complex mathematical undertaking Approaching these issues the authors present stochastic numerical methods and prove accurate convergence rate estimates in terms of their numerical parameters number of simulations time discretization steps As a result the book is a self contained and rigorous study of the numerical methods within a theoretical framework After briefly reviewing the basics the authors first introduce fundamental notions in stochastic calculus and continuous time martingale theory then develop the analysis of pure jump Markov processes Poisson processes and stochastic differential equations In particular they review the essential properties of It integrals and prove fundamental results on the probabilistic analysis of parabolic partial differential equations These results in turn provide the basis for developing stochastic numerical methods both from an algorithmic and theoretical point of view The book combines advanced mathematical tools theoretical analysis of stochastic numerical methods and practical issues at a high level so as to provide optimal results on the accuracy of Monte Carlo simulations of stochastic processes It is intended for master and Ph D students in the field of stochastic processes and their numerical applications as well as for physicists biologists economists and other professionals working with stochastic simulations who will benefit from the ability to reliably estimate and control the accuracy of their simulations *Numerical Integration of Stochastic Differential Equations* G.N. Milstein,2013-03-09 This book is devoted to mean square and weak approximations of solutions of stochastic differential equations SDE These approximations represent two fundamental aspects in the contemporary theory of SDE Firstly the construction of numerical methods for such systems is important as the solutions provided serve as characteristics for a number of mathematical physics problems Secondly the employment of probability representations together with a Monte Carlo method allows us to reduce the solution of complex multidimensional problems of mathematical physics to the integration of stochastic equations Along with a general theory of numerical integrations of such systems both in the mean square and the weak sense a number of concrete and sufficiently constructive numerical schemes are considered Various applications and particularly the approximate calculation of Wiener integrals are also dealt with This book is of interest to graduate students in the mathematical physical and engineering sciences and to specialists whose work involves differential equations mathematical physics numerical mathematics the theory of random processes estimation and control theory *Numerical Methods for Ordinary Differential Equations* David F. Griffiths,Desmond J. Higham,2010-11-11 Numerical Methods for Ordinary

Differential Equations is a self contained introduction to a fundamental field of numerical analysis and scientific computation Written for undergraduate students with a mathematical background this book focuses on the analysis of numerical methods without losing sight of the practical nature of the subject It covers the topics traditionally treated in a first course but also highlights new and emerging themes Chapters are broken down into lecture sized pieces motivated and illustrated by numerous theoretical and computational examples Over 200 exercises are provided and these are starred according to their degree of difficulty Solutions to all exercises are available to authorized instructors The book covers key foundation topics o Taylor series methods o Runge Kutta methods o Linear multistep methods o Convergence o Stability and a range of modern themes o Adaptive stepsize selection o Long term dynamics o Modified equations o Geometric integration o Stochastic differential equations The prerequisite of a basic university level calculus class is assumed although appropriate background results are also summarized in appendices A dedicated website for the book containing extra information can be found via www springer com *Numerical Methods for Stochastic Control Problems in Continuous Time* Harold Joseph Kushner,Center for Intelligent Control Systems (U.S.),Lefschetz Center for Dynamical Systems,Brown University. Center for Control Sciences,Brown University. Division of Applied Mathematics,1988 *Stochastic and Differential Games* Martino Bardi,T.E.S. Raghavan,T. Parthasarathy,1999-06 The theory of two person zero sum differential games started at the be ginning of the 1960s with the works of R Isaacs in the United States and L S Pontryagin and his school in the former Soviet Union Isaacs based his work on the Dynamic Programming method He analyzed many special cases of the partial differential equation now called Hamilton Jacobi Isaacs briefiy HJI trying to solve them explicitly and synthe sizing optimal feedbacks from the solution He began a study of singular surfaces that was continued mainly by J Breakwell and P Bernhard and led to the explicit solution of some low dimensional but highly nontriv ial games a recent survey of this theory can be found in the book by J Lewin entitled Differential Games Springer 1994 Since the early stages of the theory several authors worked on making the notion of value of a differential game precise and providing a rigorous derivation of the HJI equation which does not have a classical solution in most cases we mention here the works of W Fleming A Friedman see his book Differential Games Wiley 1971 P P Varaiya E Roxin R J Elliott and N J Kalton N N Krasovskii and A I Subbotin see their book Po sitional Differential Games Nauka 1974 and Springer 1988 and L D Berkovitz A major breakthrough was the introduction in the 1980s of two new notions of generalized solution for Hamilton Jacobi equations namely viscosity solutions by M G Crandall and P L **Numerical Methods for Controlled Stochastic Delay Systems** Harold Kushner,2008-12-19 The Markov chain approximation methods are widely used for the numerical solution of nonlinear stochastic control problems in continuous time This book extends the methods to stochastic systems with delays The book is the first on the subject and will be of great interest to all those who work with stochastic delay equations and whose main interest is either in the use of the algorithms or in the mathematics An excellent resource for graduate students researchers and practitioners the work may be used as a graduate level textbook for a special topics course or seminar on numerical methods in stochastic control **Stochastic Numerics for Mathematical Physics** Grigori N. Milstein,Michael V. Tretyakov,2021-12-03 This book is a substantially revised and expanded edition reflecting major developments in stochastic numerics since the first edition was published in 2004 The new topics in particular include mean square and weak approximations in the case of nonglobally Lipschitz coefficients of Stochastic Differential Equations SDEs including the concept of rejecting trajectories conditional probabilistic representations and their application to practical variance reduction using regression methods multi level Monte Carlo method computing ergodic limits and additional classes of geometric integrators used in molecular dynamics numerical methods for FBSDEs approximation of parabolic SPDEs and nonlinear filtering problem based on the method of characteristics SDEs have many applications in the natural sciences and in finance Besides the employment of probabilistic representations together with the Monte Carlo technique allows us to reduce the solution of multi dimensional problems for partial differential equations to the integration of stochastic equations This approach leads to powerful computational mathematics that is presented in the treatise Many special schemes for SDEs are presented In the second part of the book numerical methods for solving complicated problems for partial differential equations occurring in practical applications both linear and nonlinear are constructed All the methods are presented with proofs and hence founded on rigorous reasoning thus giving the book textbook potential An overwhelming majority of the methods are accompanied by the corresponding numerical algorithms which are ready for implementation in practice The book addresses researchers and graduate students in numerical analysis applied probability physics chemistry and engineering as well as mathematical biology and financial mathematics *Invariant Measures for Stochastic Nonlinear Schrödinger Equations* Jialin Hong,Xu Wang,2019-08-22 This book provides some recent advance in the study of stochastic nonlinear Schr dinger equations and their numerical approximations including the well posedness ergodicity symplecticity and multi symplecticity It gives an accessible overview of the existence and uniqueness of invariant measures for stochastic differential equations introduces geometric structures including symplecticity and conformal multi symplecticity for nonlinear Schr dinger equations and their numerical approximations and studies the properties and convergence errors of numerical methods for stochastic nonlinear Schr dinger equations This book will appeal to researchers who are interested in numerical analysis stochastic analysis ergodic theory partial differential equation theory etc

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Numerical Methods And Stochastics Introduction

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