DOWNLOAD PDF SIMULATION AND CHAOTIC BEHAVIOR OF A-STABLE STOCHASTIC PROCESSES (PURE AND APPLIED MATHEMATICS)

Chapter 1 : Simulation and Chaotic Behavior of Alpha-stable Stochastic Processes - CRC Press Book

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Show more This course will introduce students to the software development process, including applications in financial asset trading, research, hedging, portfolio management, and risk management. Students will use the Java programming language to develop object-oriented software, and will focus on the most broadly important elements of programming - superior design, effective problem solving, and the proper use of data structures and algorithms. Students will work with market and historical data to run simulations and test strategies. The course is designed to give students a feel for the practical considerations of software development and deployment. Several key technologies and recent innovations in financial computing will be presented and discussed. Undergraduate multivariate calculus and linear algebra. Programming experience strongly recommended but not required. This course is intended to provide a practical introduction to problem solving. The aim of this course is to provide the students with the mathematical tools and computational methods required to tackle these issues, and illustrate the methods with practical case studies such as American option pricing, uncertain volatility, uncertain mortality, different rates for borrowing and lending, calibration of models to market smiles, credit valuation adjustment CVA , portfolio optimization, transaction costs, illiquid markets, super-replication under delta and gamma constraints, etc. We will strive to make this course reasonably comprehensive, and to find the right balance between ideas, mathematical theory, and numerical implementations. We will spend some time on the theory: But the main focus will deliberately be on ideas and numerical examples, which we believe help a lot in understanding the tools and building intuition. A rigorous background in Bayesian statistics geared towards applications in finance, including decision theory and the Bayesian approach to modeling, inference, point estimation, and forecasting, sufficient statistics, exponential families and conjugate priors, and the posterior predictive density. Inference for classical time-series models, state estimation and parameter learning in Hidden Markov Models HMMs including the Kalman filter, the Baum-Welch algorithm and more generally, Bayesian networks and belief propagation. Real world examples drawn from finance to include stochastic volatility models, portfolio optimization with transaction costs, risk models, and multivariate forecasting. Undergraduate linear algebra or permission of the instructor. Linear dependence, linear independence; span, basis, dimension, isomorphism. Linear functionals, Dual spaces. Linear mappings, null space, range, fundamental theorem of linear algebra. Underdetermined systems of linear equations. Composition, inverse, transpose of linear maps, algebra of linear maps. Eigenvalue problem, eigenvalues and eigenvectors, characteristic polynomial, Cayley-Hamilton theorem. Upper Saddle River, NJ: Extensive lecture notes keyed to these texts will be issued by the instructor. Linear algebra is two things in one: This course will try to strike a balance between both. We will follow the book of our own Peter Lax, which does a superb job in describing the mathematical structure of linear algebra, and complement it with applications and computing. The most advanced topics include spectral theory, convexity, duality, and various matrix decompositions. Pure and Applied Mathematics: Elements of linear algebra and the theory of rings and fields. Basic concepts of groups, rings and fields. Symmetry groups, linear groups, Sylow theorems; quotient rings, polynomial rings, ideals, unique factorization, Nullstellensatz; field extensions, finite fields. Any knowledge of groups, rings, vector spaces and multivariable calculus is helpful. Undergraduate students planning to take this course must have V After introducing metric and general topological spaces, the emphasis will be on the algebraic topology of manifolds and cell complexes. Elements of algebraic topology to be covered include fundamental groups and covering spaces, homotopy and the degree of maps and its applications. Some differential topology will be introduced including transversality and intersection theory. Some examples will be taken from knot theory. Introduction to Riemannian metrics, connections and geodesics. Manifolds and Differential Geometry. This will include basic stability and ergodicity theorems for

Anosov and more genral Smale systems, including geodesic flows on manifolds with negative curvatures. The course will also prove basic results on Markov partitions and Markov codings. Spaces with negative curvatures: The course will start with the classical material on Riemannian manifolds, then will prove basic properties of singular spaces of Busemann and Alexandrov with negative curvatures and explain the main constructions of these spaces. The course will define these groups, prove their basic properties and discuss various classes of examples. Measure theory and integration. Lebesgue measure on the line and abstract measure spaces. Absolute continuity, Lebesgue differentiation, and the Radon-Nikodym theorem. Product measures, the Fubini theorem, etc. Advanced calculus or equivalent. Complex numbers, the complex plane. Power series, differentiability of convergent power series. Cauchy-Riemann equations, harmonic functions. Integration, Cauchy integral theorem, Cauchy integral formula. Taylor series, residue calculus. Weierstrass and Mittag-Leffler representation theorems. Singularities of analytic functions, poles, branch points, essential singularities, branch points. Analytic continuation, monodromy theorem, Schwarz reflection principle. Compactness of families of uniformly bounded analytic functions. Integral representations of special functions. Distribution of function values of entire functions. Knowledge of undergraduate level linear algebra and ODE; also some exposure to complex variables can be taken concurrently. A basic introduction to PDEs, designed for a broad range of students whose goals may range from theory to applications. This course emphasizes examples, representation formulas, and properties that can be understood using relatively elementary tools. We will take a broad viewpoint, including how the equations we consider emerge from applications, and how they can be solved numerically. Methods introduced through these topics will include: For more information including a tentative semester plan see the syllabus here. Graduate Studies in Mathematics [Series, Bk. Partial Differential Equations 2nd ed. Linear algebra, real variables or the equivalent, and some complex function-theory would be helpful. The course will concentrate on concrete aspects of the subject and on the spaces most commonly used in practice such as Lp 1? Working knowledge of Lebesgue measure and integral is expected. Special attention to Hilbert space L2, Hardy spaces, Sobolev spaces, etc. Fourier series and integrals in that setting. Compact operators and Fredholm determinants with an application or two. Some indications about non-linear analysis in an infinite-dimensional setting. Functional Analysis 1st ed. We will begin with an introduction to qualitative stochastic homogenization results, based on variational methods. Next we will discuss quantitative results based on the same variational methods which have a convex duality flavor, give explicit error estimates for the Dirichlet and Neumann problems, discuss variational methods for "non-variational" equations, develop a higher regularity theory and, time permitting, prove optimal error estimates and scaling limits for correctors. The course has few requisites apart from a basic knowledge of Sobolev spaces. The Euler Equations 3 Points, Wednesdays, 2:

Chapter 2 : Real Options with Monte Carlo Simulation

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The output of op amp 0 will correspond to the x variable, the output of 1 corresponds to the first derivative of x and the output of 2 corresponds to the second derivative. Spontaneous order[edit] Under the right conditions, chaos spontaneously evolves into a lockstep pattern. In the Kuramoto model , four conditions suffice to produce synchronization in a chaotic system. Natural forms ferns, clouds, mountains, etc. In the s, while studying the three-body problem , he found that there can be orbits that are nonperiodic, and yet not forever increasing nor approaching a fixed point. Chaos theory began in the field of ergodic theory. Despite initial insights in the first half of the twentieth century, chaos theory became formalized as such only after mid-century, when it first became evident to some scientists that linear theory , the prevailing system theory at that time, simply could not explain the observed behavior of certain experiments like that of the logistic map. What had been attributed to measure imprecision and simple " noise " was considered by chaos theorists as a full component of the studied systems. The main catalyst for the development of chaos theory was the electronic computer. Much of the mathematics of chaos theory involves the repeated iteration of simple mathematical formulas, which would be impractical to do by hand. Electronic computers made these repeated calculations practical, while figures and images made it possible to visualize these systems. Yet his advisor did not agree with his conclusions at the time, and did not allow him to report his findings until Studies of the critical point beyond which a system creates turbulence were important for chaos theory, analyzed for example by the Soviet physicist Lev Landau , who developed the Landau-Hopf theory of turbulence. David Ruelle and Floris Takens later predicted, against Landau, that fluid turbulence could develop through a strange attractor , a main concept of chaos theory. Edward Lorenz was an early pioneer of the theory. His interest in chaos came about accidentally through his work on weather prediction in He wanted to see a sequence of data again, and to save time he started the simulation in the middle of its course. He did this by entering a printout of the data that corresponded to conditions in the middle of the original simulation. To his surprise, the weather the machine began to predict was completely different from the previous calculation. Lorenz tracked this down to the computer printout. The computer worked with 6-digit precision, but the printout rounded variables off to a 3-digit number, so a value like 0. This difference is tiny, and the consensus at the time would have been that it should have no practical effect. However, Lorenz discovered that small changes in initial conditions produced large changes in long-term outcome. In , Benoit Mandelbrot found recurring patterns at every scale in data on cotton prices. In , he published " How long is the coast of Britain? In , Mandelbrot published The Fractal Geometry of Nature , which became a classic of chaos theory. Yorke coiner of the term "chaos" as used in mathematics , Robert Shaw , and the meteorologist Edward Lorenz. In , Albert J. Feigenbaum for their inspiring achievements. There, Bernardo Huberman presented a mathematical model of the eye tracking disorder among schizophrenics. In , Per Bak , Chao Tang and Kurt Wiesenfeld published a paper in Physical Review Letters [59] describing for the first time self-organized criticality SOC , considered one of the mechanisms by which complexity arises in nature. Alongside largely lab-based approaches such as the Bakâ€"Tangâ€"Wiesenfeld sandpile , many other investigations have focused on large-scale natural or social systems that are known or suspected to display scale-invariant behavior. Although these approaches were not always welcomed at least initially by specialists in the subjects examined, SOC has nevertheless become established as a strong candidate for explaining a number of natural phenomena, including earthquakes , which, long before SOC was discovered, were known as a source of scale-invariant behavior such as the Gutenbergâ€"Richter law describing the statistical distribution of earthquake sizes, and the Omori law [60] describing the frequency of aftershocks , solar flares , fluctuations in economic systems such as financial markets references to SOC are common in econophysics , landscape formation , forest fires , landslides , epidemics , and biological evolution where SOC has been invoked, for example, as the dynamical mechanism behind the theory of " punctuated equilibria " put forward by Niles Eldredge and Stephen Jay Gould. Given the implications of a scale-free distribution of event sizes, some researchers have suggested that another phenomenon that should be considered an example of SOC is the occurrence of wars. In the same year, James Gleick published Chaos: Making a New Science , which became a best-seller and introduced the general principles of chaos theory as well as its history to the broad public, though his history under-emphasized important Soviet contributions.

Chapter 3 : AMS :: Proceedings of the American Mathematical Society

Simulation and Chaotic Behavior of Alpha-stable Stochastic Processes - CRC Press Book Presents new computer methods in approximation, simulation, and visualization for a host of alpha-stable stochastic processes.

An estimator of that error and its rate of convergence are given. We study the rate of convergence when the spectral density have some behaviors at origin. Few long memory processes are taken here as example. Path delay model based on stable distribution for the 60GHz indoor channel. Proceeding of Global Telecommunications Conference, , Volume 3, pp. Stable limit theorem for U-statistic processes indexed by a random walk. Electronic Communications in Probability, 22, no. Complex symetric stable variables and processes. Essays in Honour of Norman L. Johnson, North-Holland, New York, pp. Two classes of self-similar stable processes with stationary increments. Stochastic Processes and their Applications, 32, pp. Wide band 60GHz indoor channel: Application of the polynomial kernels to the estimation of the spectra of discrete stable stationary processes. Signal modeling with self-similar alpha-stable processes: The fractional Levy motion model. Bounds for the expected number of level crossings of certain harmonizable infinitely divisible processes. Stochastic Processes and their Applications, 76, no. Spectral density estimation for stationary stable processes. Stochastic Processes and their Applications, 18, pp. Mathematical Geosciences, 47, no. Stable process with singular drift. Stochastic Processes and their Applications, , no. Laws of the iterated logarithm for symmetric jump processes. Modeling ultrasound echoes in skin tissues using symmetric alpha-stable processes. Spectral density estimate for stationary symmetric stable random field. Applicationes Mathematcaes, 23, 2, pp. Spectral density estimate for alpha-stable p-adic processes. Stable non Gaussian Processes. Chapman and Hall, New York. Signal processing with fractional lower order moments: Stable processes and their applications. Proceedings of IEEE, 81, pp. Some structure theorems for the symmetric stable laws. The Annals of Mathematical Statistics, 41, no. Performance of a spread spectrum packet radio network link in a Poisson field of interferences. Uniqueness of stable processes with drift. Proceedings of the American Mathematical Society, , pp. Particle filtering for acoustic source tracking in impulsive noise with alpha-stable process.

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Chapter 4 : å…•è´¹ä¸‹è½½-Simulation and Chaotic Behavior of Alpha-Stable Stochastic Processes - BookA

Presents computer methods in approximation, simulation, and visualization for a host of alpha-stable stochastic processes.

References References Applebaum, D. Cambridge studies in advanced mathematics. Computing deltas without derivatives. Finance and Stochastics, 21, Electronic Journal of Probability, 11 10 , â€" Quantitative Finance, 13 8 , â€" Hedging lookback and partial lookback options using Malliavin calculus. Applied Mathematical Finance, 7 2 , 75â€" The Bismut-Elworthy-li formula for jump-diffusions and applications to Monte Carlo methods in finance. Formulae for the derivatives of heat semigroups. Journal of Functional Analysis, , â€" Applications of Malliavin calculus to Monte Carlo methods in finance. Finance and Stochastics, 3 4 , â€" Simulation and chaotic behavior of alpha-stable stochastic processes. Parameter estimation for stable distributions with application to commodity futures log-returns. Computation of greeks and multidimensional density estimation for asset price models with time-changed brownian motion. Applied Mathematical Finance, 17 4 , â€" Computation of the delta in multidimensional jump-diffusion setting with applications to stochastic volatility models. Stochastic Analysis and Applications, 30 3 , â€" Malliavin calculus for stochastic differential equations driven by subordinated Brownian motions. Kyoto Journal of Mathematics, 50 3 , â€" Mathematical Modelling of Natural Phenomena, 8 2 , 1â€" Probability and Its applications. Chaotic and variational calculus in discrete and continuous time for the posisson process. Potential theory of subordinate killed Brownian motion in a domain. Probability Theory and Related Fields, , â€" Erlangung des Akademischen Grades. Smooth densities for SDEs driven by degenerate subordinated Brownian motion with state-dependent switching. Bismut-elworthy-li-type formulae for stochastic differential equations with jumps. Journal of Theoretical Probability, 23 2 , â€" Arithmetic Brownian motion subordinated by tempered stable and inverse tempered stable processes.

Chapter 5 : Samorodnitsky : Lower tails of self-similar stable processes

Simulation and Chaotic Behavior of Alpha-stable Stochastic Processes (Chapman & Hall/CRC Pure and Applied Mathematics) by Aleksander Janicki (): Books - calendrierdelascience.com

TBA 3 Points, Tuesdays, 1: Each of our six meetings will be independent. At each meeting, the first hour will be a lecture aimed at anyone interested in numerical analysis at a high level, organized around a well-known topic and mixing historical perspectives, recent developments, and always some new mathematics. In the final two weeks each student will complete a small project. Tentative schedule of topics: Polynomials and multivariate polynomials [Possible alternative topic: Computational Fluid Dynamics 3 Points, Tuesdays, 3: This course will cover advanced numerical techniques for solving PDEs, with a particular focus on fluid dynamics. This includes advection-diffusion-reaction equations, compressible and incompressible Navier-Stokes equations, and fluid-structure coupling. Basic familiarity with temporal integrators for ODEs multistep, Runge-Kutta , methods for solving PDEs finite difference, finite volume, finite elements for parabolic and elliptic problems , iterative solvers for linear systems, and the Navier-Stokes equations will be assumed. Topics covered will include: Students will use the Java programming language to develop object-oriented software, and will focus on the most broadly important elements of programming - superior design, effective problem solving, and the proper use of data structures and algorithms. Students will work with market and historical data to run simulations and test strategies. The course is designed to give students a feel for the practical considerations of software development and deployment. Several key technologies and recent innovations in financial computing will be presented and discussed. Undergraduate multivariate calculus and linear algebra. Programming experience strongly recommended but not required. This course is intended to provide a practical introduction to computational problem solving. Continuous Time Finance or permission of instructor. The aim of this course is to provide the students with the mathematical tools and computational methods required to tackle these issues, and illustrate the methods with practical case studies such as American option pricing, uncertain volatility, uncertain mortality, different rates for borrowing and lending, calibration of models to market smiles, credit valuation adjustment CVA , portfolio optimization, transaction costs, illiquid markets, super-replication under delta and gamma constraints, etc. We will strive to make this course reasonably comprehensive, and to find the right balance between ideas, mathematical theory, and numerical implementations. We will spend some time on the theory: But the main focus will deliberately be on ideas and numerical examples, which we believe help a lot in understanding the tools and building intuition. A rigorous background in Bayesian statistics geared towards applications in finance, including decision theory and the Bayesian approach to modeling, inference, point estimation, and forecasting, sufficient statistics, exponential families and conjugate priors, and the posterior predictive density. Inference for classical time-series models, state estimation and parameter learning in Hidden Markov Models HMMs including the Kalman filter, the Baum-Welch algorithm and more generally, Bayesian networks and belief propagation. Real world examples drawn from finance to include stochastic volatility models, portfolio optimization with transaction costs, risk models, and multivariate forecasting. This is a full semester course focusing on practical aspects of alternative data, machine learning and data science in quantitative finance. Homework and hands-on projects form an integral part of the course, where students get to explore real-world datasets and software. The course begins with an overview of the field, its technological and mathematical foundations, paying special attention to differences between data science in finance and other industries. We review the software that will be used throughout the course. We examine the basic problems of supervised and unsupervised machine learning, and learn the link between regression and conditioning. Then we deepen our understanding of the main challenge in data science â€” the curse of dimensionality â€” as well as the basic trade-off of variance model parsimony vs. Demonstrations are given for real world data sets and basic data acquisition techniques such as web scraping and the merging of data sets. As homework each student is assigned to take part in downloading, cleaning, and testing data in a common repository, to be used at later stages in the class. We examine linear and quadratic methods in regression, classification and unsupervised learning. We build a BARRA-style implicit risk-factor model and examine predictive models for county-level real estate, economic and demographic data, and macro economic data. We then take a dive into PCA, ICA and clustering methods to develop global macro indicators and estimate stable correlation matrices for equities. In many real-life problems, one needs to do SVD on a matrix with missing values. Common applications include noisy image-recognition and recommendation systems. The rest of the course focuses on non-linear or high-dimensional supervised learning problems. First, kernel smoothing and kernel regression methods are introduced as a way to tackle non-linear problems in low dimensions in a nearly model-free way. Then we proceed to generalize the kernel regression method in the Bayesian Regression framework of Gaussian Fields, and for classification as we introduce Support Vector Machines, Random Forest regression, Neural Nets and Universal Function Approximators. Undergraduate linear algebra or permission of the instructor. Linear dependence, linear independence; span, basis, dimension, isomorphism. Linear functionals, Dual spaces. Linear mappings, null space, range, fundamental theorem of linear algebra. Underdetermined systems of linear equations. Composition, inverse, transpose of linear maps, algebra of linear maps. Eigenvalue problem, eigenvalues and eigenvectors, characteristic polynomial, Cayley-Hamilton theorem. Linear Algebra 4th ed. Upper Saddle River, NJ: Extensive lecture notes keyed to these texts will be issued by the instructor. Linear algebra is two things in one: This course will try to strike a balance between both. We will follow the book of our own Peter Lax, which does a superb job in describing the mathematical structure of linear algebra, and complement it with applications and computing. The most advanced topics include spectral theory, convexity, duality, and various matrix decompositions. Pure and Applied Mathematics: Linear Algebra and Its Applications 2nd ed. Linear Algebra and Its Applications 4th ed. Elements of linear algebra and the theory of rings and fields. Basic concepts of groups, rings and fields. Symmetry groups, linear groups, Sylow theorems; quotient rings, polynomial rings, ideals, unique factorization, Nullstellensatz; field extensions, finite fields. Featured Titles for Abstract Algebra [Series]. Undergraduate Texts in Mathematics [Series]. A Field Guide to Algebra ed. Graduate Texts in Mathematics [Series, Vol. A Course in Arithmetic Corr.

Chapter 6 : Chaos theory - Wikipedia

We present a method of computer investigation of chaotic behavior of stationary Î±-stable stochastic processes, i.e., an important class of processes with cadlag trajectories.

Mathematics and Economics, vol. Seminumerical Algorithms" Addison-Wesley, 3rd Ed. The classic paper on Latin Hypercubic Sampling. Murtha Publisher , second printing , pp. Monte Carlo for European Real Options with Animation There are some real options applications which can be modeled as European type options. For European real options case, sometimes is possible to use the Black-Scholes solution without dividends, because there is no opportunity cost to retain the option. In this case only one underlying market uncertainty is relevant. In others case is better to consider other underlying uncertainties, like costs, preferences, demand, price, etc. For more complex cases of several sources of uncertainties but remaining European , the Monte Carlo simulation is a good alternative. Let us see one simple example, with only one source of uncertainty market uncertainty , using a risk-neutral simulation. The case is divided into two sequential animations and described below. The first and second steps are to simulate the risk-neutral sample paths for the underlying asset project value or output price and to take the cross-section distribution at the expiration T. You get the risk neutral distribution for the underlying asset. The figure below illustrates these initial steps: For details on the risk-neutral simulation, including the difference of a real simulation, see the FAQ 4. With the risk-neutral distribution of the project value V at the expiration T , the next step is to apply the options thinking. Rational managers will exercise the option only if this exercise results in positive expected values: In other words, managers are not obligated to exercise negative NPV projects. This equation creates an asymmetry in the distribution of the real option value F T. This asymmetric risk-neutral distribution for the European-type real options at T displaces the expected value to the higher value and represents the active management of real options. The figure below shows this process. In short, the European type real option valuation with Monte Carlo simulation is performed with the steps: NPV, 0 ; Calculate the expected value of the option value at the expiration; Use the risk-free discount rate and calculate the present value of the option value. Real Options Research Report: Evolutionary approach like genetic algorithms, is a very flexible technique that has been used lately in several applications of engineering and few but growing applications in finance. The main idea is: In the GA terminology, each guess is an organism or chromosome and the most adapted organisms that is, with higher option value evaluated by the Monte Carlo simulation has more probability to disseminate their genetic material, throughout the new generations. This approach is more general in the sense that, in a near future, it can get good solutions near the optimal for any free-boundary problem, not only in financial-economics. The main drawback of this procedure is the necessity to run a simulation for every new threshold generated by the GA algorithm, so that to get a near optimal threshold demand a lot of time. However, for the user point of view, the evolution of a solution like the GA approach is a very flexible method for Monte Carlo with American options because is a direct maximization method. So that with the passage of time, the faster computation environment this method will become very promising. The alternative is the famous Bellman dynamic-programming, which typically performed backwards. Nowadays, there are a lot of research in this area see bibliography , but not for using a modern direct maximization method like evolutionary computing. This research aims to fill this lacuna. The potential of this method is its flexibility for the user modeling, reducing the problem of "curse of modeling", permitting a large popularization of real options modeling for people without a comprehensive finance knowledge. The only commercial tool available combining Monte Carlo simulation and optimization with genetic algorithms is the Excel add-in RiskOptimizer, from Palaside. This tool has advantages like its great flexibility, but also important limitations user cannot choose the fraction of the population to be replaced in the steady-state reproduction among others. These issues are discussed in the paper below. Abstract Complex real options models for project economics evaluation suffer the curse of dimensionality, with several sources of uncertainties and with several options to invest in information. Details from the changing practical reality highlight the curse of modeling problem. Monte Carlo simulation is considered a good way to face these problems, but there is the difficult problem to optimize. This paper presents a model of optimization under uncertainty with genetic algorithms and Monte Carlo simulation. This approach permits to get new insights for the real options theory. Using the Excel-based software RiskOptimizer for a simple case with a known value and for a more complex real options model with investment in information. Some results from several experiments are presented with improvement suggestions. The strengths and weaknesses of RiskOptimizer are pointed out. Download the compressed zip Word for Windows 97 file with the complete paper: