An Introduction To Copulas Springer Series In Statistics

This is the first book at the graduate textbook level to discuss analyzing financial data with S-PLUS. Its originality lies in the introduction of tools for the estimation and simulation of heavy tail distributions and copulas, the computation of measures of risk, and the principal component analysis of yield curves. The book is aimed at undergraduate students in financial engineering; master students in finance and MBA's, and to practitioners with financial data analysis concerns.

An Introduction to CopulasSpringer Science & Business Media

This is a succinct guide to the application and modelling of dependence models or copulas in the financial markets. First applied to credit risk modelling, copulas are now widely used across a range of derivatives transactions, asset pricing techniques and risk models and are a core part of the financial engineer's toolkit.

This book is a collaborative effort from three workshops held over the last three years, all involving principal contributors to the vine-copula methodology. Research and applications in vines have been growing rapidly and there is now a growing need to collate basic results, and standardize terminology and methods. Specifically, this handbook will trace historical developments, standardizing notation and terminology, summarize results on bivariate copulae, summarize results for regular vines, and give an overview of its applications. In addition, many of these results are new and not readily available in any existing journals. New research directions are also discussed.

This book presents contributions and review articles on the theory of copulas and their applications. The authoritative and refereed contributions review the latest findings in the area with emphasis on “classical” topics like distributions with fixed marginals, measures of association, construction of copulas with given additional information, etc. The book celebrates the 75th birthday of Professor Roger B. Nelsen and his outstanding contribution to the development of copula theory. Most of the book’s contributions were presented at the conference “Copulas and Their Applications” held in his honor in Almería, Spain, July 3-5, 2017. The chapter 'When Gumbel met Galambos' is published open access under a CC BY 4.0 license.

Illustration of copula theory with detailed real-world case study examples in the fields of hydrology and water resources engineering.

Proofs without words are generally pictures or diagrams that help the reader see why a particular mathematical statement may be true, and how one could begin to go about proving it. While in some proofs without words an equation or two may appear to help guide that process, the emphasis is clearly on providing visual clues to stimulate mathematical thought. The proofs in this collection are arranged by topic into five chapters: Geometry and algebra; Trigonometry, calculus and analytic geometry; Inequalities; Integer sums; and Sequences and series. Teachers will find that many of the proofs in this collection are well suited for classroom discussion and for helping students to think visually in mathematics.

Copulas are functions that join multivariate distribution functions to their one-dimensional margins. The study of copulas and their role in statistics is a new but vigorously growing field. In this book the student or practitioner of statistics and probability will find discussions of the fundamental properties of copulas and some of their primary applications. The applications include the study of dependence and measures of association, and the construction of families of bivariate distributions. With nearly a hundred examples and over 150 exercises, this book is suitable as a text or for self-study. The only prerequisite is an upper level undergraduate course in probability and mathematical statistics,

although some familiarity with nonparametric statistics would be useful. Knowledge of measure-theoretic probability is not required. Roger B. Nelsen is Professor of Mathematics at Lewis & Clark College in Portland, Oregon. He is also the author of "Proofs Without Words: Exercises in Visual Thinking," published by the Mathematical Association of America.

Along with a review of general developments relating to bivariate distributions, this volume also covers copulas, a subject which has grown immensely in recent years. In addition, it examines conditionally specified distributions and skewed distributions.

This book is the first ever to deal exclusively with this class of operations. It offers an introduction to Fuzzy Implications, an analytical study of them, and an algebraic exploration into the structures that exist on the set of all FIs.

The new edition of this influential textbook, geared towards graduate or advanced undergraduate students, teaches the statistics necessary for financial engineering. In doing so, it illustrates concepts using financial markets and economic data, R Labs with real-data exercises, and graphical and analytic methods for modeling and diagnosing modeling errors. These methods are critical because financial engineers now have access to enormous quantities of data. To make use of this data, the powerful methods in this book for working with quantitative information, particularly about volatility and risks, are essential. Strengths of this fully-revised edition include major additions to the R code and the advanced topics covered. Individual chapters cover, among other topics, multivariate distributions, copulas, Bayesian computations, risk management, and cointegration. Suggested prerequisites are basic knowledge of statistics and probability, matrices and linear algebra, and calculus. There is an appendix on probability, statistics and linear algebra. Practicing financial engineers will also find this book of interest.

The high-level language of R is recognized as one of the most powerful and flexible statistical software environments, and is rapidly becoming the standard setting for quantitative analysis, statistics and graphics. R provides free access to unrivalled coverage and cutting-edge applications, enabling the user to apply numerous statistical methods ranging from simple regression to time series or multivariate analysis. Building on the success of the author’s bestselling Statistics: An Introduction using R, The R Book is packed with worked examples, providing an all inclusive guide to R, ideal for novice and more accomplished users alike. The book assumes no background in statistics or computing and introduces the advantages of the R environment, detailing its applications in a wide range of disciplines. Provides the first comprehensive reference manual for the R language, including practical guidance and full coverage of the graphics facilities. Introduces all the statistical models covered by R, beginning with simple classical tests such as chi-square and t-test. Proceeds to examine more advance methods, from regression and analysis of variance, through to generalized linear models, generalized mixed models, time series, spatial statistics, multivariate statistics and much more. The R

Book is aimed at undergraduates, postgraduates and professionals in science, engineering and medicine. It is also ideal for students and professionals in statistics, economics, geography and the social sciences.

This book is about the theoretical and practical aspects of the statistics of Extreme Events in Nature. Most importantly, this is the first text in which Copulas are introduced and used in Geophysics. Several topics are fully original, and show how standard models and calculations can be improved by exploiting the opportunities offered by Copulas. In addition, new quantities useful for design and risk assessment are introduced.

This book offers a unified approach to the study of crises, large fluctuations, dependence and contagion effects in economics and finance. It covers important topics in statistical modeling and estimation, which combine the notions of copulas and heavy tails — two particularly valuable tools of today's research in economics, finance, econometrics and other fields — in order to provide a new way of thinking about such vital problems as diversification of risk and propagation of crises through financial markets due to contagion phenomena, among others. The aim is to arm today's economists with a toolbox suited for analyzing multivariate data with many outliers and with arbitrary dependence patterns. The methods and topics discussed and used in the book include, in particular, majorization theory, heavy-tailed distributions and copula functions — all applied to study robustness of economic, financial and statistical models, and estimation methods to heavy tails and dependence.

This book introduces the main theoretical findings related to copulas and shows how statistical modeling of multivariate continuous distributions using copulas can be carried out in the R statistical environment with the package copula (among others). Copulas are multivariate distribution functions with standard uniform univariate margins. They are increasingly applied to modeling dependence among random variables in fields such as risk management, actuarial science, insurance, finance, engineering, hydrology, climatology, and meteorology, to name a few. In the spirit of the Use R! series, each chapter combines key theoretical definitions or results with illustrations in R. Aimed at statisticians, actuaries, risk managers, engineers and environmental scientists wanting to learn about the theory and practice of copula modeling using R without an overwhelming amount of mathematics, the book can also be used for teaching a course on copula modeling.

Like its predecessor, Proofs without Words, this book is a collection of pictures or diagrams that help the reader see why a particular mathematical statement may be true and how one could begin to go about proving it. While in some proofs without words an equation or two may appear to help guide that process, the emphasis is clearly on providing visual clues to stimulate mathematical thought. The proofs in this collection are arranged by topic into five chapters: geometry and algebra; trigonometry, calculus and analytic geometry; inequalities; integer sums; and sequences and series.

Teachers will find that many of the proofs in this collection are well suited for classroom discussion and for helping students to think visually in mathematics.

Principles of Copula Theory explores the state of the art on copulas and provides you with the foundation to use copulas in a variety of applications. Throughout the book, historical remarks and further readings highlight active research in the field, including new results, streamlined presentations, and new proofs of old results. After covering the essentials of copula theory, the book addresses the issue of modeling dependence among components of a random vector using copulas. It then presents copulas from the point of view of measure theory, compares methods for the approximation of copulas, and discusses the Markov product for 2-copulas. The authors also examine selected families of copulas that possess appealing features from both theoretical and applied viewpoints. The book concludes with in-depth discussions on two generalizations of copulas: quasi- and semi-copulas. Although copulas are not the solution to all stochastic problems, they are an indispensable tool for understanding several problems about stochastic dependence. This book gives you the solid and formal mathematical background to apply copulas to a range of mathematical areas, such as probability, real analysis, measure theory, and algebraic structures.

A self-contained introduction to probability, exchangeability and Bayes’ rule provides a theoretical understanding of the applied material. Numerous examples with R-code that can be run "as-is" allow the reader to perform the data analyses themselves. The development of Monte Carlo and Markov chain Monte Carlo methods in the context of data analysis examples provides motivation for these computational methods.

Copulas are mathematical objects that fully capture the dependence structure among random variables and hence offer great flexibility in building multivariate stochastic models. Since their introduction in the early 50's, copulas have gained considerable popularity in several fields of applied mathematics, such as finance, insurance and reliability theory. Today, they represent a well-recognized tool for market and credit models, aggregation of risks, portfolio selection, etc. This book is divided into two main parts: Part I - "Surveys" contains 11 chapters that provide an up-to-date account of essential aspects of copula models. Part II - "Contributions" collects the extended versions of 6 talks selected from papers presented at the workshop in Warsaw.

Copula Modeling explores the copula approach for econometrics modeling of joint parametric distributions. Copula Modeling demonstrates that practical implementation and estimation is relatively straightforward despite the complexity of its theoretical foundations. An attractive feature of parametrically specific copulas is that estimation and inference are based on standard maximum likelihood procedures. Thus, copulas can be estimated using desktop econometric software. This offers a substantial advantage of copulas over recently proposed simulation-based approaches to joint modeling. Copulas are useful in a variety of modeling situations including financial markets, actuarial science, and microeconometrics modeling. Copula Modeling provides practitioners and scholars with a useful guide to copula modeling with a focus on estimation and misspecification. The authors cover important theoretical foundations. Throughout, the authors use Monte Carlo experiments and simulations to demonstrate copula properties

The recent financial crisis has highlighted the need for better valuation models and risk management procedures, better understanding of structured products, and has called into question the actions of many financial institutions. It has become commonplace to blame the inadequacy of credit risk models, claiming that the crisis was due to sophisticated and obscure products being traded, but practitioners have for a long time been aware of the dangers and limitations of credit models. It would seem that a lack of understanding of these models is the root cause of their failures but until now little analysis had been published on the subject and, when published, it had gained very limited attention. Credit Models and the Crisis is a succinct but technical analysis of the key aspects of the credit derivatives modeling problems, tracing the development (and flaws) of new quantitative methods for credit derivatives and CDOs up to and through the credit crisis. Responding to the immediate need for clarity in the market and academic research environments, this book follows the development of credit derivatives and CDOs at a technical level, analyzing the impact, strengths and weaknesses of methods ranging from the introduction of the Gaussian Copula model and the related implied correlations to the introduction of arbitrage-free dynamic loss models capable of calibrating all the tranches for all the maturities at the same time. It also illustrates the implied copula, a method that can consistently account for CDOs with different attachment and detachment points but not for different maturities, and explains why the Gaussian Copula model is still used in its base correlation formulation. The book reports both alarming pre-crisis research and market examples, as well as commentary through history, using data up to the end of 2009, making it an important addition to modern derivatives literature. With banks and regulators struggling to fully analyze at a technical level, many of the flaws in modern financial models, it will be indispensable for quantitative practitioners and academics who want to develop stable and functional models in the future.

This book focuses on the application of statistical methods in the field of hydrology and hydroclimatology. Among the latest theories being used in these fields, the book introduces the theory of copulas and its applications in this context. The purpose is to develop an understanding and illustrate the usefulness of the statistical techniques with detailed theory and numerous worked out examples. Apart from this, MATLAB-based codes and solutions of some worked out examples are also provided to assist the readers to handle real life data. This book presents a comprehensive knowledge of statistical techniques combining the basics of probability and the current advances in stochastic hydrology. Besides serving as a textbook for graduate courses on stochastic modeling in hydrology and related disciplines, the book offers valuable resources for researchers and professionals involved in the field of hydrology and climatology.

The author's particular interest in the area of risk measures is to combine this theory with the analysis of dependence properties. The present volume gives an introduction of basic concepts and methods in mathematical risk analysis, in particular of those parts of risk theory that are of special relevance to finance and insurance. Describing the influence of dependence in multivariate stochastic models on risk vectors is the main focus of the text that presents main ideas and methods as well as their relevance to practical applications. The first part introduces basic probabilistic tools and methods of distributional analysis, and describes their use to the modeling of dependence and to the derivation of risk bounds in these models. In the second, part risk measures with a

particular focus on those in the financial and insurance context are presented. The final parts are then devoted to applications relevant to optimal risk allocation, optimal portfolio problems as well as to the optimization of insurance contracts. Good knowledge of basic probability and statistics as well as of basic general mathematics is a prerequisite for comfortably reading and working with the present volume, which is intended for graduate students, practitioners and researchers and can serve as a reference resource for the main concepts and techniques.

This open access book presents the key aspects of statistics in Wasserstein spaces, i.e. statistics in the space of probability measures when endowed with the geometry of optimal transportation. Further to reviewing state-of-the-art aspects, it also provides an accessible introduction to the fundamentals of this current topic, as well as an overview that will serve as an invitation and catalyst for further research. Statistics in Wasserstein spaces represents an emerging topic in mathematical statistics, situated at the interface between functional data analysis (where the data are functions, thus lying in infinite dimensional Hilbert space) and non-Euclidean statistics (where the data satisfy nonlinear constraints, thus lying on non-Euclidean manifolds). The Wasserstein space provides the natural mathematical formalism to describe data collections that are best modeled as random measures on Euclidean space (e.g. images and point processes). Such random measures carry the infinite dimensional traits of functional data, but are intrinsically nonlinear due to positivity and integrability restrictions. Indeed, their dominating statistical variation arises through random deformations of an underlying template, a theme that is pursued in depth in this monograph.

This book contains a selection of the papers presented at the meeting `Distributions with given marginals and statistical modelling', held in Barcelona (Spain), July 17-20, 2000. In 24 chapters, this book covers topics such as the theory of copulas and quasi-copulas, the theory and compatibility of distributions, models for survival distributions and other well-known distributions, time series, categorical models, definition and estimation of measures of dependence, monotonicity and stochastic ordering, shape and separability of distributions, hidden truncation models, diagonal families, orthogonal expansions, tests of independence, and goodness of fit assessment. These topics share the use and properties of distributions with given marginals, this being the fourth specialised text on this theme. The innovative aspect of the book is the inclusion of statistical aspects such as modelling, Bayesian statistics, estimation, and tests.

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 presen tation 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 applica tions outside mathematics, there are many fruitful connections to other mathematical disciplines and the subject has a rapidly develop ing 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 complete ness that is 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.

This textbook provides a step-by-step introduction to the class of vine copulas, their statistical inference and applications. It focuses on statistical estimation and selection methods for vine copulas in data applications. These flexible copula models can successfully accommodate any form of tail dependence and are vital to many applications in finance, insurance, hydrology, marketing, engineering, chemistry, aviation, climatology and health. The book explains the pair-copula construction principles underlying these statistical models and discusses how to perform model selection and inference. It also derives simulation algorithms and presents real-world examples to illustrate the methodological concepts. The book includes numerous exercises that facilitate and deepen readers understanding, and demonstrates how the R package VineCopula can be used to explore and build statistical dependence models from scratch. In closing, the book provides insights into recent developments and open research questions in vine copula based modeling. The book is intended for students as well as statisticians, data analysts and any other quantitatively oriented researchers who are new to the field of vine copulas. Accordingly, it provides the necessary background in multivariate statistics and copula theory for exploratory data tools, so that readers only need a basic grasp of statistics and probability.

Copulas are mathematical objects that fully capture the dependence structure among random variables and hence offer great flexibility in building multivariate stochastic models. Since their introduction in the early 1950s, copulas have gained considerable popularity in several fields of applied mathematics, especially finance and insurance. Today, copulas represent a well-recognized tool for market and credit models, aggregation of risks, and portfolio selection. Historically, the Gaussian copula model has been one of the most common models in credit risk. However, the recent financial crisis has underlined its limitations and drawbacks. In fact, despite their simplicity, Gaussian copula models severely underestimate the risk of the occurrence of joint extreme events. Recent theoretical investigations have put new tools for detecting and estimating dependence and risk (like tail dependence, time-varying models, etc) in the spotlight. All such investigations need to be further developed and promoted, a goal this book pursues. The book includes surveys that provide an up-to-date account of essential aspects of copula models in quantitative finance, as well as the extended versions of talks selected from papers presented at the workshop in Cracow.

This book provides an introduction to the statistical software R and its application with an empirical approach in finance and economics. It is specifically targeted towards undergraduate and graduate students. It provides beginner-level introduction to R using RStudio and reproducible research examples. It will enable students to use R for data cleaning, data visualization and quantitative model building using statistical methods like linear regression, econometrics (GARCH etc), Copulas, etc. Moreover, the book demonstrates latest research methods with applications featuring linear regression, quantile regression, panel

regression, econometrics, dependence modelling, etc. using a range of data sets and examples. Request Inspection Copy

This book presents an overview of copula theory and its application in hydrology, and provides valuable insights, useful methods and practical applications for multivariate hydrological analysis using copulas. In addition, it extends the traditional bivariate model to trivariate or multivariate models. The specific applications covered include the study of flood frequency analysis, drought frequency analysis, dependence analysis, flood coincidence risk analysis and statistical simulation using copulas. The book offers a valuable guide for researchers, scientists and engineers working in hydrology and water resources, and will also benefit graduate or doctoral students with a basic grasp of copula functions who want to learn about the latest research developments in the field.

This distinctly nonclassical treatment focuses on developing aspects that differ from the theory of ordinary metric spaces, working directly with probability distribution functions rather than random variables. The two-part treatment begins with an overview that discusses the theory's historical evolution, followed by a development of related mathematical machinery. The presentation defines all needed concepts, states all necessary results, and provides relevant proofs. The second part opens with definitions of probabilistic metric spaces and proceeds to examinations of special classes of probabilistic metric spaces, topologies, and several related structures, such as probabilistic normed and inner-product spaces. Throughout, the authors focus on developing aspects that differ from the theory of ordinary metric spaces, rather than simply transferring known metric space results to a more general setting.

This book presents a novel approach to time series econometrics, which studies the behavior of nonlinear stochastic processes. This approach allows for an arbitrary dependence structure in the increments and provides a generalization with respect to the standard linear independent increments assumption of classical time series models. The book offers a solution to the problem of a general semiparametric approach, which is given by a concept called C-convolution (convolution of dependent variables), and the corresponding theory of convolution-based copulas. Intended for econometrics and statistics scholars with a special interest in time series analysis and copula functions (or other nonparametric approaches), the book is also useful for doctoral students with a basic knowledge of copula functions wanting to learn about the latest research developments in the field.

This book introduces readers to copula-based statistical methods for analyzing survival data involving dependent censoring. Primarily focusing on likelihood-based methods performed under copula models, it is the first book solely devoted to the problem of dependent censoring. The book demonstrates the advantages of the copula-based methods in the context of medical research, especially with regard to cancer patients’ survival data. Needless to say, the statistical methods presented here can also be applied to many other branches of science, especially in reliability, where survival analysis plays an important role. The book can be used as a textbook for graduate coursework or a short course aimed at (bio-) statisticians. To deepen readers’ understanding of copula-based approaches, the book provides an accessible

introduction to basic survival analysis and explains the mathematical foundations of copula-based survival models. Focuses on theoretical results along with applications All the main topics covering the heart of the subject are introduced to the reader in a systematic fashion Concentration is on the probabilistic and statistical aspects of extreme values Excellent introduction to extreme value theory at the graduate level, requiring only some mathematical maturity

This encyclopedic, detailed resource covers all the steps of one-period allocation from the foundations to the most advanced developments. It includes a large number of figures and examples as well as real trading and asset management case studies.

Financial Engineers

Copula Methods in Finance is the first book to address the mathematics of copula functions illustrated with finance applications. It explains copulas by means of applications to major topics in derivative pricing and credit risk analysis. Examples include pricing of the main exotic derivatives (barrier, basket, rainbow options) as well as risk management issues. Particular focus is given to the pricing of asset-backed securities and basket credit derivative products and the evaluation of counterparty risk in derivative transactions.

This book provides a versatile and lucid treatment of classic as well as modern probability theory, while integrating them with core topics in statistical theory and also some key tools in machine learning. It is written in an extremely accessible style, with elaborate motivating discussions and numerous worked out examples and exercises. The book has 20 chapters on a wide range of topics, 423 worked out examples, and 808 exercises. It is unique in its unification of probability and statistics, its coverage and its superb exercise sets, detailed bibliography, and in its substantive treatment of many topics of current importance. This book can be used as a text for a year long graduate course in statistics, computer science, or mathematics, for self-study, and as an invaluable research reference on probabiliity and its applications. Particularly worth mentioning are the treatments of distribution theory, asymptotics, simulation and Markov Chain Monte Carlo, Markov chains and martingales, Gaussian processes, VC theory, probability metrics, large deviations, bootstrap, the EM algorithm, confidence intervals, maximum likelihood and Bayes estimates, exponential families, kernels, and Hilbert spaces, and a self contained complete review of univariate probability.