Introduction To Copulas Exercises Part 2

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.

With the advent of computers, very large datasets have become routine. Standard statistical methods don't have the power or flexibility to analyse these efficiently, and extract the required knowledge. An alternative approach is to summarize a large dataset in such a way that the resulting summary dataset is of a manageable size and yet retains as much of the knowledge in the original dataset as possible. One consequence of this is that the data may no longer be formatted as single values, but be represented by lists, intervals, distributions, etc. The summarized data have their own internal structure, which must be taken into account in any analysis. This text presents a unified account of symbolic data, how they arise, and how they are structured. The reader is introduced to symbolic analytic methods described in the consistent statistical framework required to carry out such a summary and subsequent analysis. Presents a detailed overview of the methods and applications of symbolic data analysis. Includes numerous real examples, taken from a variety of application areas, ranging from health and social sciences, to economics and computing. Features exercises at the end of each chapter, enabling the reader to develop their understanding of the theory. Provides a supplementary website featuring links to download the SODAS software developed exclusively for symbolic data analysis, data sets, and further material. Primarily aimed at statisticians and data analysts, Symbolic Data Analysis is also ideal for scientists working on problems involving large volumes of data from a range of disciplines, including computer science, health and the social sciences. There is also much of use to graduate students of statistical data analysis courses.

An essential resource for constructing and analyzing advanced actuarial models Loss Models: Further Topics presents extended coverage of modeling through the use of tools related to risk theory, loss distributions, and survival models. The book uses these methods to construct and evaluate actuarial models in the fields of insurance and business. Providing an advanced study of actuarial methods, the book features extended discussions of risk modeling and risk measures, including Tail-Value-at-Risk. Loss Models: Further Topics contains additional material to accompany the Fourth Edition of Loss Models: From Data to Decisions, such as: Extreme value distributions Coxian and related distributions Mixed Erlang distributions Computational and analytical methods for aggregate claim models Counting processes Compound distributions with time-dependent claim amounts Copula models Continuous time ruin models Interpolation and smoothing The book is an essential reference for practicing actuaries and actuarial researchers who want to go beyond the material required for actuarial qualification. Loss Models: Further Topics is also an excellent resource for graduate students in the actuarial field.

Since the publication of the first edition of this book, the area of mathematical finance has grown rapidly, with financial analysts using more sophisticated mathematical concepts, such as stochastic integration, to describe the behavior of markets and to derive computing methods. Maintaining the lucid style of its popular predecessor, Introduction

Includes summary statements of main points, worked-out examples with answers, and answers to additional exercises from the text.

Statistical pattern recognition relates to the use of statistical techniques for analysing data measurements in order to extract information and make justified decisions. It is a very active area of study and research, which has seen many advances in recent years. Applications such as data mining, web searching, multimedia data retrieval, face recognition, and cursive handwriting recognition, all require robust and efficient pattern recognition techniques. This third edition provides an introduction to statistical pattern theory and techniques, with material drawn from a wide range of fields, including the areas of engineering, statistics, computer science and the social sciences. The book has been updated to cover new methods and applications, and includes a wide range of techniques such as Bayesian methods, neural networks, support vector machines, feature selection and feature reduction techniques.Technical descriptions and motivations are provided, and the techniques are illustrated using real examples. Statistical Pattern Recognition, 3rd Edition: Provides a self-contained introduction to statistical pattern recognition. Includes new material presenting the analysis of complex networks. Introduces readers to methods for Bayesian density estimation. Presents descriptions of new applications in biometrics, security, finance and condition monitoring. Provides descriptions and guidance for implementing techniques, which will be invaluable to software engineers and developers seeking to develop real applications Describes mathematically the range of statistical pattern recognition techniques. Presents a variety of exercises including more extensive computer projects. The in-depth technical descriptions make the book suitable for senior undergraduate and graduate students in statistics, computer science and engineering. Statistical Pattern Recognition is also an excellent reference source for technical professionals. Chapters have been arranged to facilitate implementation of the techniques by software engineers and developers in non-statistical engineering fields. www.wiley.com/go/statistical_pattern_recognition

"In formulating a stochastic model to describe a real phenomenon, it used to be that one compromised between choosing a model that is a realistic replica of the actual situation and choosing one whose mathematical analysis is tractable. That is, there did not seem to be any payoff in choosing a model that faithfully conformed to the phenomenon under study if it were not possible to mathematically analyze that model. Similar considerations have led to the concentration on asymptotic or steady-state results as opposed to the more useful ones on transient time. However, the relatively recent advent of fast and inexpensive computational power has opened up another approach--namely, to try to model the phenomenon as faithfully as possible and then to rely on a simulation study to analyze it"--

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.

Modern Actuarial Risk Theory contains what every actuary needs to know about non-life insurance mathematics. It starts with the standard material like utility theory, individual and collective model and basic ruin theory. Other topics are risk measures and premium principles, bonus-malus systems, ordering of risks and credibility theory. It also contains some chapters about Generalized Linear Models, applied to rating and IBNR problems. As to the level of the mathematics, the book would fit in a bachelors or masters program in quantitative economics or mathematical statistics. This second and.

Introduces the richness and variety of inequalities in mathematics using illustration and visualisation.

Theorems and their proofs lie at the heart of mathematics. In speaking of the purely aesthetic qualities of theorems and proofs, G. H. Hardy wrote that in beautiful proofs 'there is a very high degree of unexpectedness, combined with inevitability and economy.' Charming Proofs present a collection of remarkable proofs in elementary mathematics that are exceptionally elegant, full of ingenuity, and succinct. By means of a surprising argument or a powerful visual representation, the proofs in this collection will invite readers to enjoy the beauty of mathematics, to share their discoveries with others, and to become involved in the process of creating new proofs. Charming Proofs is organized as follows. Following a short introduction about proofs and the process of creating proofs, the authors present, in twelve chapters, a wide and varied selection of proofs they consider charming. Topics include the integers, selected real numbers, points in the plane, triangles, squares and other polygons, curves, inequalities, plane tilings, origami, colorful proofs, threedimensional geometry, etc. At the end of each chapter are some challenges that will draw the reader into the process of creating charming proofs. There are over 130 such challenges. Charming Proofs concludes with solutions to all of the challenges, references, and a complete index. As in the authors' previous books with the MAA (Math Made Visual and When Less Is More), secondary school, college, and university teachers may wish to use some of the charming proofs in their classrooms to introduce their students to mathematical elegance. Some may wish to use the book as a supplement in an introductory course on proofs, mathematical reasoning, or problem solving.

Data simulation is a fundamental technique in statistical programming and research. Rick Wicklin's Simulating Data with SAS brings together the most useful algorithms and the best programming techniques for efficient data simulation in an accessible how-to book for practicing statisticians and statistical programmers. This book discusses in detail how to simulate data from common univariate and multivariate distributions, and how to use simulation to evaluate statistical techniques. It also covers simulating correlated data, data for regression models, spatial data, and data with given moments. It provides tips and techniques for beginning programmers, and offers libraries of functions for advanced practitioners. As the first book devoted to simulating data across a range of statistical applications, Simulating Data with SAS is an essential tool for programmers, analysts, researchers, and students who use SAS software.SAS Products and Releases: Base SAS: 9.3 SAS/ETS: 9.3 SAS/IML: 9.3 SAS/STAT: 9.3 Operating Systems: All

The implementation of sound quantitative risk models is a vital concern for all financial institutions, and this trend has accelerated in recent years with regulatory processes such as Basel II. This book provides a comprehensive treatment of the theoretical concepts and modelling techniques of quantitative risk management and equips readers--whether financial risk analysts, actuaries, regulators, or students of quantitative finance--with practical tools to solve real-world problems. The authors cover methods for market, credit, and operational risk modelling; place standard industry approaches on a more formal footing; and describe recent developments that go beyond, and address main deficiencies of, current practice. The book's methodology draws on diverse quantitative disciplines, from mathematical finance through statistics and econometrics to actuarial mathematics. Main concepts discussed include loss distributions, risk measures, and risk aggregation and allocation principles. A main theme is the need to satisfactorily address extreme outcomes and the dependence of key risk drivers. The techniques required derive from multivariate statistical analysis, financial time series modelling, copulas, and extreme value theory. A more technical chapter addresses credit derivatives. Based on courses taught to masters students and professionals, this book is a unique and fundamental reference that is set to become a standard in the field.

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.

Presents an introduction to Bayesian statistics, presents an emphasis on Bayesian methods (prior and posterior), Bayes estimation, prediction, MCMC,Bayesian regression, and Bayesian analysis of statistical modelsof dependence, and features a focus on copulas for risk management Introduction to Bayesian Estimation and Copula Models of Dependence emphasizes the applications of Bayesian analysis to copula modeling and equips readers with the tools needed to implement the procedures of Bayesian estimation in copula models of dependence. This book is structured in two parts: the first four chapters serve as a general introduction to Bayesian statistics with a clear emphasis on parametric estimation and the following four chapters stress statistical models of dependence with a focus of copulas. A review of the main concepts is discussed along with the basics of Bayesian statistics including prior information and experimental data, prior and posterior distributions, with an emphasis on Bayesian parametric estimation. The basic mathematical background of both Markov chains and Monte Carlo integration and simulation is also provided. The authors discuss statistical models of dependence with a focus on copulas and present a brief survey of pre-copula dependence models. The main definitions and notations of copula models are summarized followed by discussions of real-world cases that address particular risk management problems. In addition, this book includes: • Practical examples of copulas in use including within the Basel Accord II documents that regulate the world banking system as well as examples of Bayesian methods within current FDA recommendations • Step-by-step procedures of multivariate data analysis and copula modeling, allowing readers to gain insight for their own applied research and studies • Separate reference lists within each chapter and end-of-the-chapter exercises within Chapters 2 through 8 • A companion website containing appendices: data files and demo files in Microsoft® Office Excel®, basic code in R, and selected exercise solutions Introduction to Bayesian Estimation and Copula Models of Dependence is a reference and resource for statisticians who need to learn formal Bayesian analysis as well as professionals within analytical and risk management departments of banks and insurance companies who are involved in quantitative analysis and forecasting. This book can also be used as a textbook for upper-undergraduate and graduate-level courses in Bayesian statistics and analysis. ARKADY SHEMYAKIN, PhD, is Professor in the Department of Mathematics and Director of the Statistics Program at the University of St. Thomas. A member of the American Statistical Association and the International Society for Bayesian Analysis, Dr. Shemyakin's research interests include informationtheory, Bayesian methods of parametric estimation, and copula models in actuarial mathematics, finance, and engineering. ALEXANDER KNIAZEV, PhD, is Associate Professor and Head of the Department of Mathematics at Astrakhan State University in Russia. Dr. Kniazev's research interests include representation theory of Lie algebras and finite groups, mathematical statistics, econometrics, and financial mathematics.

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

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.

The increasing complexity of insurance and reinsurance products has seen a growing interest amongst actuaries in the modelling of dependent risks. For efficient risk management, actuaries need to be able to answer fundamental questions such as: Is the correlation structure dangerous? And, if yes, to what extent? Therefore tools to quantify, compare, and model the strength of dependence between different risks are vital. Combining coverage of stochastic order and risk measure theories with the basics of risk management and stochastic dependence, this book provides an essential guide to managing modern financial risk. * Describes how to model risks in incomplete markets, emphasising insurance risks. * Explains how to measure and compare the danger of risks, model their interactions, and measure the strength of their association. * Examines the type of dependence induced by GLM-based credibility models, the bounds on functions of dependent risks, and probabilistic distances between actuarial models. * Detailed presentation of risk measures, stochastic orderings, copula models, dependence concepts and dependence orderings. * Includes numerous exercises allowing a cementing of the concepts by all levels of readers. * Solutions to tasks as well as further examples and exercises can be found on a supporting website. An invaluable reference for both academics and practitioners alike, Actuarial Theory for Dependent Risks will appeal to all those eager to master the up-to-date modelling tools for dependent risks. The inclusion of exercises and practical examples makes the book suitable for advanced courses on risk management in incomplete markets. Traders looking for practical advice on insurance markets will also find much of interest.

Recent years have witnessed a growing importance of quantitative methods in both financial research and industry. This development requires the use of advanced techniques on a theoretical and applied level, especially when it comes to the quantification of risk and the valuation of modern financial products. Applied Quantitative Finance (2nd edition) provides a comprehensive and state-of-the-art treatment of cutting-edge topics and methods. It provides solutions to and presents theoretical developments in many practical problems such as risk management, pricing of credit derivatives, quantification of volatility and copula modelling. The synthesis of theory and practice supported by computational tools is reflected in the selection of topics as well as in a finely tuned balance of scientific contributions on practical implementation and theoretical concepts. This linkage between theory and practice offers theoreticians insights into considerations of applicability and, vice versa, provides practitioners comfortable access to new techniques in quantitative finance. Themes that are dominant in current research and which are presented in this book include among others the valuation of Collaterized Debt Obligations (CDOs), the high-frequency analysis of market liquidity, the pricing of Bermuda options and realized volatility. All Quantlets for the calculation of the given examples are downloadable from the Springer web pages.

Focusing on what actuaries need in practice, this introductory account provides readers with essential tools for handling complex problems and explains how simulation models can be created, used and re-used (with modifications) in related situations. The book begins by outlining the basic tools of modelling and simulation, including a discussion of the Monte Carlo method and its use. Part II deals with general insurance and Part III with life insurance and financial risk. Algorithms that can be implemented on any programming platform are spread throughout and a program library written in R is included. Numerous figures and experiments with R-code illustrate the text. The author's non-technical approach is ideal for graduate students, the only prerequisites being introductory courses in calculus and linear algebra, probability and statistics. The book will also be of value to actuaries and other analysts in the industry looking to update their skills.

Although portfolio management didn’t change much during the 40 years after the seminal works of Markowitz and Sharpe, the development of risk budgeting techniques marked an important milestone in the deepening of the relationship between risk and asset management. Risk parity then became a popular financial model of investment after the global financial crisis in 2008. Today, pension funds and institutional investors are using this approach in the development of smart indexing and the redefinition of long-term investment policies. Written by a well-known expert of asset management and risk parity, Introduction to Risk Parity and Budgeting provides an up-to-date treatment of this alternative method to Markowitz optimization. It builds financial exposure to equities and commodities, considers credit risk in the management of bond portfolios, and designs long-term investment policy. The first part of the book gives a theoretical account of portfolio optimization and risk parity. The author discusses modern portfolio theory and offers a comprehensive guide to risk budgeting. Each chapter in the second part presents an application of risk parity to a specific asset class. The text covers risk-based equity indexation (also called smart beta) and shows how to use risk budgeting techniques to manage bond portfolios. It also explores alternative investments, such as commodities and hedge funds, and applies risk parity techniques to multi-asset classes. The book’s first appendix provides technical materials on optimization problems, copula functions, and dynamic asset allocation. The second appendix contains 30 tutorial exercises. Solutions to the exercises, slides for instructors, and Gauss computer programs to reproduce the book’s examples, tables, and figures are available on the author’s website.

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.

This book provides the reader with a background on simulating copulas and multivariate distributions in general. It unifies the scattered literature on the simulation of various families of copulas (elliptical, Archimedean, Marshall-Olkin type, etc.)

as well as on different construction principles (factor models, pair-copula construction, etc.). The book is self-contained and unified in presentation and can be used as a textbook for advanced undergraduate or graduate students with a firm background in stochastics. Alongside the theoretical foundation, ready-to-implement algorithms and many examples make this book a valuable tool for anyone who is applying the methodology.Errata(s)Errata (128 KB)

Commodity markets present several challenges for quantitative modeling. These include high volatilities, small sample data sets, and physical, operational complexity. In addition, the set of traded products in commodity markets is more limited than in financial or equity markets, making value extraction through trading more difficult. These facts make it very easy for modeling efforts to run into serious problems, as many models are very sensitive to noise and hence can easily fail in practice. Modeling and Valuation of Energy Structures is a comprehensive guide to quantitative and statistical approaches that have been successfully employed in support of trading operations, reflecting the author's 17 years of experience as a front-office 'quant'. The major theme of the book is that simpler is usually better, a message that is drawn out through the reality of incomplete markets, small samples, and informational constraints. The necessary mathematical tools for understanding these issues are thoroughly developed, with many techniques (analytical, econometric, and numerical) collected in a single volume for the first time. A particular emphasis is placed on the central role that the underlying market resolution plays in valuation. Examples are provided to illustrate that robust, approximate valuations are to be preferred to overly ambitious attempts at detailed qualitative modeling.

Discover how to optimize business strategies from both qualitative and quantitative points of view Operational Risk: Modeling Analytics is organized around the principle that the analysis of operational risk consists, in part, of the collection of data and the building of mathematical models to describe risk. This book is designed to provide risk analysts with a framework of the mathematical models and methods used in the measurement and modeling of operational risk in both the banking and insurance sectors. Beginning with a foundation for operational risk modeling and a focus on the modeling process, the book flows logically to discussion of probabilistic tools for operational risk modeling and statistical methods for calibrating models of operational risk. Exercises are included in chapters involving numerical computations for students' practice and reinforcement of concepts. Written by Harry Panjer, one of the foremost authorities in the world on risk modeling and its effects in business management, this is the first comprehensive book dedicated to the quantitative assessment of operational risk using the tools of probability, statistics, and actuarial science. In addition to providing great detail of the many probabilistic and statistical methods used in operational risk, this book features: * Ample exercises to further elucidate the concepts in the text * Definitive coverage of distribution functions and related concepts * Models for the size of losses * Models for frequency of loss * Aggregate loss modeling * Extreme value modeling * Dependency modeling using copulas * Statistical methods in model selection and calibration Assuming no previous expertise in either operational risk terminology or in mathematical statistics, the text is designed for beginning graduate-level courses on risk and operational management or enterprise risk management. This book is also useful as a reference for practitioners in both enterprise risk management and risk and operational management.

Financial engineers have access to enormous quantities of data but need powerful methods for extracting quantitative information, particularly about volatility and risks. Key features of this textbook are: illustration of concepts with financial markets and economic data, R Labs with real-data exercises, and integration of graphical and analytic methods for modeling and diagnosing modeling errors. Despite some overlap with the author's undergraduate textbook Statistics and Finance: An Introduction, this book differs from that earlier volume in several important aspects: it is graduate-level; computations and graphics are done in R; and many advanced topics are covered, for example, multivariate distributions, copulas, Bayesian computations, VaR and expected shortfall, and cointegration. The prerequisites are basic statistics and probability, matrices and linear algebra, and calculus. Some exposure to finance is helpful.

The book provides the background on simulating copulas and multivariate distributions in general. It unifies the scattered literature on the simulation of various families of copulas (elliptical, Archimedean, Marshall-Olkin type, etc.) as well as on different construction principles (factor models, pair-copula construction, etc.). The book is self-contained and unified in presentation and can be used as a textbook for graduate and advanced undergraduate students with a firm background in stochastics. Besides the theoretical foundation, ready-to-implement algorithms and many examples make the book a valuable tool for anyone who is applying the methodology.

An Introduction to CopulasSpringer Science & Business Media

A comprehensive and accessible introduction to modernquantitative risk management. The business world is rife with risk and uncertainty, and riskmanagement is a vitally important topic for managers. The best wayto achieve a clear understanding of risk is to use quantitativetools and probability models. Written for students, this bookhas a quantitative emphasis but is accessible to those without astrong mathematical background. Business Risk Management: Models and Analysis Discusses novel modern approaches to risk management Introduces advanced topics in an accessible manner Includes motivating worked examples and exercises (includingselected solutions) Is written with the student in mind, and does not assumeadvanced mathematics Is suitable for self-study by the manager who wishes to betterunderstand this important field. Aimed at postgraduate students, this book is also suitable forsenior undergraduates, MBA students, and all those who have ageneral interest in business risk.

Risk being its raw material, insurance has developed various techniques of valuation and risk transfer. Nowadays, these techniques - and first of all reinsurance, the favourite way of transferring risk- are entirely reassessed considering the development of Corporate Finance theory. Therefore, the approach retained here, originally for the actuarial course at ENSAE, Paris may surprise some readers and students as it proposes a extended view of risk. We cover not only the mathematical aspects of Risk Management but also other fields relevant for Risk Management from economy or finance. We aim here at making bridges between all these fields through practical application to cat and life risk-management.

A thespian or cinematographer might define a cameo as a brief appearance of a known figure, while a gemologist or lapidary might define it as a precious or semiprecious stone. This book presents fifty short enhancements or supplements (the cameos) for

the first-year calculus course in which a geometric figure briefly appears. Some of the cameos illustrate mainstream topics such as the derivative, combinatorial formulas used to compute Riemann sums, or the geometry behind many geometric series. Other cameos present topics accessible to students at the calculus level but not usually encountered in the course, such as the Cauchy-Schwarz inequality, the arithmetic mean-geometric mean inequality, and the Euler-Mascheroni constant. There are fifty cameos in the book, grouped into five sections: Part I. Limits and Differentiation, Part II. Integration, Part III. Infinite Series, Part IV. Additional Topics, and Part V. Appendix: Some Precalculus Topics. Many of the cameos include exercises, so Solutions to all the Exercises follows Part V. The book concludes with references and an index. Many of the cameos are adapted from articles published in journals of the MAA, such as The American Mathematical Monthly, Mathematics Magazine, and The College Mathematics Journal. Some come from other mathematical journals, and some were created for this book. By gathering the cameos into a book the [Author]; hopes that they will be more accessible to teachers of calculus, both for use in the classroom and as supplementary explorations for students.
Certain geometric diagrams play a crucial role in visualizing mathematical proofs. Twenty of these icons of mathematics are presented in this book, where the authors explore the mathematics within them and the mathematics that can be created from them. A chapter is devoted to each icon, illustrating its presence in real life, its primary mathematical characteristics and how it plays a central role in visual proofs of a wide range of mathematical facts. Among these are classical results from plane geometry, properties of the integers, means and inequalities, trigonometric identities, theorems from calculus and puzzles from recreational mathematics. Each chapter concludes with a selection of challenges for the reader to explore further properties and applications of the icon. Those teaching undergraduate mathematics will find material here for problem solving sessions, as well as enrichment material for courses on proofs and mathematical reasoning.