

Chapter 6

Mean-Variance Portfolio Theory

1. (Shorting with margin) The money invested is X_0 . The money received at the end of a year is $X_0 - X_1 + X_0$. Hence,

$$R = \frac{2X_0 - X_1}{X_0}$$

2. (Dice product) Let a and b be the outcomes of two dice rolls. Then $Z = ab$. By independence, we know

$$\begin{aligned} E[ab] &= E[a]E[b] \\ \text{and } \text{var}[Z] &= E[a^2]E[b^2] - (E[a]E[b])^2 \\ &\approx 79.97 \end{aligned}$$

3. (Two correlated assets) For solution method, see solution to problem called Two stocks (below).

(a) α equals $19/23$.

(b) The minimum standard deviation is approximately 13.7%.

(c) The expected return of this portfolio is approximately 11.4%.

4. (Two stocks) Let α, β equal the percent of investment in stock 1 and stock 2, respectively. The problem is

$$\min \alpha^2 \sigma_1^2 + \beta^2 \sigma_2^2 + 2\alpha\beta\sigma_{12}$$

$$\text{subject to } \alpha + \beta = 1.$$

Setting up the Lagrangian, L , we have:

$$L = \alpha^2 \sigma_1^2 + \beta^2 \sigma_2^2 + 2\alpha\beta\sigma_{12} - \lambda(\alpha + \beta - 1)$$

The first order necessary conditions are:

$$0 = \frac{\partial L}{\partial \alpha} = 2\alpha\sigma_1^2 + 2\beta\sigma_{12} - \lambda$$

Luenberger Chapter 6 Exercise 6 Chapter 6

Mohammad Fathi, Hassan Bevrani



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Introduction to Nonlinear Control Christopher M. Kellett, Philipp Braun, 2023-06-27 This will be the first textbook on nonlinear control at the upper undergraduate level reflecting the many updates in the field that have occurred since the 1990s Nonlinear control is a control engineering course usually taught at the graduate level and preceded by a full semester course on nonlinear systems analysis yet as the authors of this textbook argue these tools and techniques are accessible to an undergraduate audience and practicing engineers if presented in the right way This book is class tested growing out of a third year undergraduate course on nonlinear control and estimation for mechatronics mechanical and electrical engineering and mathematics students at the University of Newcastle Australia It is part of a trend toward reimagining the content of undergraduate control engineering curricula to render widely used tools and techniques accessible to students much earlier in their education opening them up to those who will not go on to the graduate level This alternative course sequence currently begins with the text *Feedback Systems An Introduction for Scientists and Engineers* by Aström and Murray PUP 2008 this new project is designed to follow Aström and Murray in the undergraduate sequence as a second or third year course

Observers in Control Systems George Ellis, 2002-10-16 Observers are digital algorithms that combine sensor outputs with knowledge of the system to provide results superior to traditional structures which rely wholly on sensors Observers have been used in selected industries for years but most books explain them with complex mathematics *Observers in Control Systems* uses intuitive discussion software experiments and supporting analysis to explain the advantages and disadvantages of observers If you are working in controls and want to improve your control systems observers could be the technology you need and this book will give you a clear thorough explanation of how they work and how to use them Control systems and devices have become the most essential part of nearly all mechanical systems machines devices and manufacturing systems throughout the world Increasingly the efficiency of production the reliability of output and increased energy savings are a direct result of the quality and deployment of the control system A modern and essential tool within the engineer's kit is the Observer which helps improve the performance and reduce the cost of these systems George Ellis is the author of the highly successful *Control System Design Guide Second Edition* Unlike most controls books which are written by control theorists and academics Ellis is a leading engineer designer author and lecturer working in industry directly with the users of industrial motion control systems *Observers in Control Systems* is written for all professional engineers and is designed to be utilized without an in depth background in control theory This is a real world book which will demonstrate how observers work and how they can improve your control system It also shows how observers operate when conditions are not ideal and teaches the reader how to quickly tune an observer in a working system Software Available online A free updated and enhanced version of the author's popular Visual ModelQ allows the reader to practice the concepts with Visual ModelQ models on a PC Based on a virtual laboratory all key topics are demonstrated with more than twenty control system

models The models are written in Visual ModelQ and are available on the Internet to every reader with a PC Teaches observers and Kalman filters from an intuitive perspective Explains how to reduce control system susceptibility to noise Shows how to design an adaptive controller based on estimating parameter variation using observers Shows how to improve a control system's ability to reject disturbances Key topics are demonstrated with PC based models of control systems The models are written in both MatLab and ModelQ models are available free of charge Elementary Convexity with Optimization Vivek S. Borkar, K. S. Mallikarjuna Rao, 2023-06-26 This book develops the concepts of fundamental convex analysis and optimization by using advanced calculus and real analysis Brief accounts of advanced calculus and real analysis are included within the book The emphasis is on building a geometric intuition for the subject which is aided further by supporting figures Two distinguishing features of this book are the use of elementary alternative proofs of many results and an eclectic collection of useful concepts from optimization and convexity often needed by researchers in optimization game theory control theory and mathematical economics A full chapter on optimization algorithms gives an overview of the field touching upon many current themes The book is useful to advanced undergraduate and graduate students as well as researchers in the fields mentioned above and in various engineering disciplines **Optimal Control of Partial Differential Equations** Fredi Tröltzsch, 2024-03-21 Optimal control theory is concerned with finding control functions that minimize cost functions for systems described by differential equations The methods have found widespread applications in aeronautics mechanical engineering the life sciences and many other disciplines This book focuses on optimal control problems where the state equation is an elliptic or parabolic partial differential equation Included are topics such as the existence of optimal solutions necessary optimality conditions and adjoint equations second order sufficient conditions and main principles of selected numerical techniques It also contains a survey on the Karush Kuhn Tucker theory of nonlinear programming in Banach spaces The exposition begins with control problems with linear equations quadratic cost functions and control constraints To make the book self contained basic facts on weak solutions of elliptic and parabolic equations are introduced Principles of functional analysis are introduced and explained as they are needed Many simple examples illustrate the theory and its hidden difficulties This start to the book makes it fairly self contained and suitable for advanced undergraduates or beginning graduate students Advanced control problems for nonlinear partial differential equations are also discussed As prerequisites results on boundedness and continuity of solutions to semilinear elliptic and parabolic equations are addressed These topics are not yet readily available in books on PDEs making the exposition also interesting for researchers Alongside the main theme of the analysis of problems of optimal control Tröltzsch also discusses numerical techniques The exposition is confined to brief introductions into the basic ideas in order to give the reader an impression of how the theory can be realized numerically After reading this book the reader will be familiar with the main principles of the numerical analysis of PDE constrained optimization Linear and Nonlinear Programming David G. Luenberger, Yinyu

Ye,2008-06-20 This third edition of the classic textbook in Optimization has been fully revised and updated It comprehensively covers modern theoretical insights in this crucial computing area and will be required reading for analysts and operations researchers in a variety of fields The book connects the purely analytical character of an optimization problem and the behavior of algorithms used to solve it Now the third edition has been completely updated with recent Optimization Methods The book also has a new co author Yinyu Ye of California s Stanford University who has written lots of extra material including some on Interior Point Methods **Deterministic Observation Theory and Applications** Jean-Paul

Gauthier,Ivan Kupka,2001-10-08 This 2001 book presents a general theory as well as a constructive methodology to solve observation problems that is reconstructing the full information about a dynamical process on the basis of partial observed data A general methodology to control processes on the basis of the observations is also developed Illustrative but also practical applications in the chemical and petroleum industries are shown This book is intended for use by scientists in the areas of automatic control mathematics chemical engineering and physics Likelihood Methods in Survival Analysis Jun

Ma,Annabel Webb,Harold Malcolm Hudson,2024-10-01 Many conventional survival analysis methods such as the Kaplan Meier method for survival function estimation and the partial likelihood method for Cox model regression coefficients estimation were developed under the assumption that survival times are subject to right censoring only However in practice survival time observations may include interval censored data especially when the exact time of the event of interest cannot be observed When interval censored observations are present in a survival dataset one generally needs to consider likelihood based methods for inference If the survival model under consideration is fully parametric then likelihood based methods impose neither theoretical nor computational challenges However if the model is semi parametric there will be difficulties in both theoretical and computational aspects Likelihood Methods in Survival Analysis With R Examples explores these challenges and provides practical solutions It not only covers conventional Cox models where survival times are subject to interval censoring but also extends to more complicated models such as stratified Cox models extended Cox models where time varying covariates are present mixture cure Cox models and Cox models with dependent right censoring The book also discusses non Cox models particularly the additive hazards model and parametric log linear models for bivariate survival times where there is dependence among competing outcomes Features Provides a broad and accessible overview of likelihood methods in survival analysis Covers a wide range of data types and models from the semi parametric Cox model with interval censoring through to parametric survival models for competing risks Includes many examples using real data to illustrate the methods Includes integrated R code for implementation of the methods Supplemented by a GitHub repository with datasets and R code The book will make an ideal reference for researchers and graduate students of biostatistics statistics and data science whose interest in survival analysis extend beyond applications It offers useful and solid training to those who wish to enhance their knowledge in the methodology and computational aspects of biostatistics Differentiable

Optimization and Equation Solving John L. Nazareth, 2006-05-17 In 1984 N Karmarkar published a seminal paper on algorithmic linear programming During the subsequent decade it stimulated a huge outpouring of new algorithmic results by researchers world wide in many areas of mathematical programming and numerical computation This book gives an overview of the resulting dramatic reorganization that has occurred in one of these areas algorithmic differentiable optimization and equation solving or more simply algorithmic differentiable programming The book is aimed at readers familiar with advanced calculus numerical analysis in particular numerical linear algebra the theory and algorithms of linear and nonlinear programming and the fundamentals of computer science in particular computer programming and the basic models of computation and complexity theory Very fine monograph filled with great insights Joseph F Traub Columbia University

Constrained Optimization In The Calculus Of Variations and Optimal Control Theory J Gregory, 2018-01-18 The major purpose of this book is to present the theoretical ideas and the analytical and numerical methods to enable the reader to understand and efficiently solve these important optimizational problems The first half of this book should serve as the major component of a classical one or two semester course in the calculus of variations and optimal control theory The second half of the book will describe the current research of the authors which is directed to solving these problems numerically In particular we present new reformulations of constrained problems which leads to unconstrained problems in the calculus of variations and new general accurate and efficient numerical methods to solve the reformulated problems We believe that these new methods will allow the reader to solve important problems

Information Science David G. Luenberger, 2012-01-12 From cell phones to Web portals advances in information and communications technology have thrust society into an information age that is far reaching fast moving increasingly complex and yet essential to modern life Now renowned scholar and author David Luenberger has produced Information Science a text that distills and explains the most important concepts and insights at the core of this ongoing revolution The book represents the material used in a widely acclaimed course offered at Stanford University Drawing concepts from each of the constituent subfields that collectively comprise information science Luenberger builds his book around the five E s of information Entropy Economics Encryption Extraction and Emission Each area directly impacts modern information products services and technology everything from word processors to digital cash database systems to decision making marketing strategy to spread spectrum communication To study these principles is to learn how English text music and pictures can be compressed how it is possible to construct a digital signature that cannot simply be copied how beautiful photographs can be sent from distant planets with a tiny battery how communication networks expand and how producers of information products can make a profit under difficult market conditions The book contains vivid examples illustrations exercises and points of historic interest all of which bring to life the analytic methods presented Presents a unified approach to the field of information science Emphasizes basic principles Includes a wide range of examples and applications Helps students develop important new skills Suggests exercises with

solutions in an instructor's manual

Nonlinear Functional Analysis and its Applications E. Zeidler, 2013-12-11 As long as a branch of knowledge offers an abundance of problems it is full of vitality David Hilbert Over the last 15 years I have given lectures on a variety of problems in nonlinear functional analysis and its applications In doing this I have recommended to my students a number of excellent monographs devoted to specialized topics but there was no complete survey type exposition of nonlinear functional analysis making available a quick survey to the wide range of readers including mathematicians natural scientists and engineers who have only an elementary knowledge of linear functional analysis I have tried to close this gap with my five part lecture notes the first three parts of which have been published in the Teubner Texte series by Teubner Verlag Leipzig 1976 1977 and 1978 The present English edition was translated from a completely rewritten manuscript which is significantly longer than the original version in the Teubner Texte series The material is organized in the following way Part I Fixed Point Theorems Part II Monotone Operators Part III Variational Methods and Optimization Parts IV-V Applications to Mathematical Physics The exposition is guided by the following considerations a What are the supporting basic ideas and what intrinsic interrelations exist between them 3 In what relation do the basic ideas stand to the known propositions of classical analysis and linear functional analysis y What typical applications are there VII Preface viii Special emphasis is placed on motivation

Optimal Control for Chemical Engineers Simant Ranjan Upreti, 2016-04-19 This self contained book gives a detailed treatment of optimal control theory that enables readers to formulate and solve optimal control problems With a strong emphasis on problem solving it provides all the necessary mathematical analyses and derivations of important results including multiplier theorems and Pontryagin's principle The text presents various examples and basic concepts of optimal control and describes important numerical methods and computational algorithms for solving a wide range of optimal control problems including periodic processes

Theory of Stabilization for Linear Boundary Control Systems Takao Nambu, 2017-03-03 This book presents a unified algebraic approach to stabilization problems of linear boundary control systems with no assumption on finite dimensional approximations to the original systems such as the existence of the associated Riesz basis A new proof of the stabilization result for linear systems of finite dimension is also presented leading to an explicit design of the feedback scheme The problem of output stabilization is discussed and some interesting results are developed when the observability or the controllability conditions are not satisfied

Analytic Perturbation Theory and Its Applications Konstantin E. Avrachenkov, Jerzy A. Filar, Phil G. Howlett, 2013-12-11 Mathematical models are often used to describe complex phenomena such as climate change dynamics stock market fluctuations and the Internet These models typically depend on estimated values of key parameters that determine system behavior Hence it is important to know what happens when these values are changed The study of single parameter deviations provides a natural starting point for this analysis in many special settings in the sciences engineering and economics The difference between the actual and nominal values of the perturbation parameter is small but unknown

and it is important to understand the asymptotic behavior of the system as the perturbation tends to zero This is particularly true in applications with an apparent discontinuity in the limiting behavior the so called singularly perturbed problems Analytic Perturbation Theory and Its Applications includes a comprehensive treatment of analytic perturbations of matrices linear operators and polynomial systems particularly the singular perturbation of inverses and generalized inverses It also offers original applications in Markov chains Markov decision processes optimization and applications to Google PageRank and the Hamiltonian cycle problem as well as input retrieval in linear control systems and a problem section in every chapter to aid in course preparation

True Digital Control C. James Taylor, Peter C. Young, Arun Chotai, 2013-05-29 True Digital Control Statistical Modelling and Non Minimal State Space Design develops a true digital control design philosophy that encompasses data based model identification through to control algorithm design robustness evaluation and implementation With a heritage from both classical and modern control system synthesis this book is supported by detailed practical examples based on the authors research into environmental mechatronic and robotics systems Treatment of both statistical modelling and control design under one cover is unusual and highlights the important connections between these disciplines Starting from the ubiquitous proportional integral controller and with essential concepts such as pole assignment introduced using straightforward algebra and block diagrams this book addresses the needs of those students researchers and engineers who would like to advance their knowledge of control theory and practice into the state space domain and academics who are interested to learn more about non minimal state variable feedback control systems Such non minimal state feedback is utilised as a unifying framework for generalised digital control system design This approach provides a gentle learning curve from which potentially difficult topics such as optimal stochastic and multivariable control can be introduced and assimilated in an interesting and straightforward manner Key features Covers both system identification and control system design in a unified manner Includes practical design case studies and simulation examples Considers recent research into time variable and state dependent parameter modelling and control essential elements of adaptive and nonlinear control system design and the delta operator the discrete time equivalent of the differential operator systems Accompanied by a website hosting MATLAB examples True Digital Control Statistical Modelling and Non Minimal State Space Design is a comprehensive and practical guide for students and professionals who wish to further their knowledge in the areas of modern control and system identification

New Trends in Observer-Based Control Olfa Boubaker, Quanmin Zhu, Magdi S. Mahmoud, Jose Ragot, Hamid Reza Karimi, Jorge Dávila, 2019-03-30 New Trends in Observer Based Control An Introduction to Design Approaches and Engineering Applications Volume One presents a clear and concise introduction to the latest advances in observer based control design It provides a comprehensive tutorial on new trends in the design of observer based controllers for which the separation principle is well established In addition since the theoretical developments remain more advanced than the engineering applications more experimental results are still needed A wide range of applications are

covered and the book contains worked examples which make it ideal for both advanced courses and researchers starting in the field Presents a clear and concise introduction to the latest advances in observer based control design Offers concise content on the many facets of observer based control design Discusses key applications in the fields of power systems robotics and mechatronics and flight and automotive systems

Extremal Optimization Yong-Zai Lu, Yu-Wang Chen, Min-Rong Chen, Peng Chen, Guo-Qiang Zeng, 2018-09-03 Extremal Optimization Fundamentals Algorithms and Applications introduces state of the art extremal optimization EO and modified EO MEO solutions from fundamentals methodologies and algorithms to applications based on numerous classic publications and the authors recent original research results It promotes the movement of EO from academic study to practical applications The book covers four aspects beginning with a general review of real world optimization problems and popular solutions with a focus on computational complexity such as NP hard and the phase transitions occurring on the search landscape Next it introduces computational extremal dynamics and its applications in EO from principles mechanisms and algorithms to the experiments on some benchmark problems such as TSP spin glass Max SAT maximum satisfiability and graph partition It then presents studies on the fundamental features of search dynamics and mechanisms in EO with a focus on self organized optimization evolutionary probability distribution and structure features e g backbones which are based on the authors recent research results Finally it discusses applications of EO and MEO in multiobjective optimization systems modeling intelligent control and production scheduling The authors present the advanced features of EO in solving NP hard problems through problem formulation algorithms and simulation studies on popular benchmarks and industrial applications They also focus on the development of MEO and its applications This book can be used as a reference for graduate students research developers and practical engineers who work on developing optimization solutions for those complex systems with hardness that cannot be solved with mathematical optimization or other computational intelligence such as evolutionary computations

Optimization in Electrical Engineering Mohammad Fathi, Hassan Bevrani, 2019-03-01 This textbook provides students researchers and engineers in the area of electrical engineering with advanced mathematical optimization methods Presented in a readable format this book highlights fundamental concepts of advanced optimization used in electrical engineering Chapters provide a collection that ranges from simple yet important concepts such as unconstrained optimization to highly advanced topics such as linear matrix inequalities and artificial intelligence based optimization methodologies The reader is motivated to engage with the content via numerous application examples of optimization in the area of electrical engineering The book begins with an extended review of linear algebra that is a prerequisite to mathematical optimization It then precedes with unconstrained optimization convex programming duality linear matrix inequality and intelligent optimization methods This book can be used as the main text in courses such as Engineering Optimization Convex Engineering Optimization Advanced Engineering Mathematics and Robust Optimization and will be useful for practicing design engineers in electrical

engineering fields Author provided cases studies and worked examples are included for student and instructor use

Linearization of Nonlinear Control Systems Hong-Gi Lee, 2022-09-02 This textbook helps graduate level student to understand easily the linearization of nonlinear control system Differential geometry is essential to understand the linearization problems of the control nonlinear systems In this book the basics of differential geometry needed in linearization are explained on the Euclidean space instead of the manifold for students who are not accustomed to differential geometry Many Lie algebra formulas used often in linearization are also provided with proof The conditions in the linearization problems are complicated to check because the Lie bracket calculation of vector fields by hand needs much concentration and time This book provides MATLAB programs for most of the theorems The book also includes end of chapter problems and other pedagogical aids to help understanding and self study *Control and Filtering for Semi-Markovian Jump Systems* Fanbiao Li, Peng Shi, Ligang Wu, 2016-11-04 This book presents up to date research developments and novel methodologies on semi Markovian jump systems S MJS It presents solutions to a series of problems with new approaches for the control and filtering of S MJS including stability analysis sliding mode control dynamic output feedback control robust filter design and fault detection A set of newly developed techniques such as piecewise analysis method positively invariant set approach event triggered method and cone complementary linearization approaches are presented Control and Filtering for Semi Markovian Jump Systems is a comprehensive reference for researcher and practitioners working in control engineering system sciences and applied mathematics and is also a useful source of information for senior undergraduates and graduates in these areas The readers will benefit from some new concepts new models and new methodologies with practical significance in control engineering and signal processing

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