

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 Solution

Farhad Assadian, Kevin R. Mallon



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H-infinity Control and Estimation of State-multiplicative Linear Systems Eli Gershon, Uri Shaked, Isaac Yaesh, 2005-06-24
Multiplicative noise appears in systems where the process or measurement noise levels depend on the system state vector. Such systems are relevant for example in radar measurements where larger ranges involve higher noise level. This monograph embodies a comprehensive survey of the relevant literature with basic problems being formulated and solved by applying various techniques including game theory, linear matrix inequalities and Lyapunov parameter dependent functions. Topics covered include convex H_2 and H_∞ norms analysis of systems with multiplicative noise, state feedback control and state estimation of systems with multiplicative noise, dynamic and static output feedback of stochastic bilinear systems, tracking controllers for stochastic bilinear systems utilizing preview information. Various examples which demonstrate the applicability of the theory to practical control engineering problems are considered. Two such examples are taken from the aerospace and guidance control areas.

Numerical Methods for Linear Control Systems Biswa Datta, 2004-02-24
Numerical Methods for Linear Control Systems Design and Analysis is an interdisciplinary textbook aimed at systematic descriptions and implementations of numerically viable algorithms based on well established efficient and stable modern numerical linear techniques for mathematical problems arising in the design and analysis of linear control systems both for the first and second order models. Unique coverage of modern mathematical concepts such as parallel computations, second order systems and large scale solutions. Background material in linear algebra, numerical linear algebra and control theory included in text. Step by step explanations of the algorithms and examples.

Numerical Solution of Systems of Simultaneous Polynomial Equations Stanford University. Systems Optimization Laboratory, A. N. Rosenberg, 1983

LQ Dynamic Optimization and Differential Games Jacob Engwerda, 2005-11-01
Game theory is the theory of social situations and the majority of research into the topic focuses on how groups of people interact by developing formulas and algorithms to identify optimal strategies and to predict the outcome of interactions. Only fifty years old it has already revolutionized economics and finance and is spreading rapidly to a wide variety of fields. LQ Dynamic Optimization and Differential Games is an assessment of the state of the art in its field and the first modern book on linear quadratic game theory, one of the most commonly used tools for modelling and analysing strategic decision making problems in economics and management. Linear quadratic dynamic models have a long tradition in economics, operations research and control engineering and the author begins by describing the one decision maker LQ dynamic optimization problem before introducing LQ differential games. Covers cooperative and non cooperative scenarios and treats the standard information structures: open loop and feedback. Includes real life economic examples to illustrate theoretical concepts and results. Presents problem formulations and sound mathematical problem analysis. Includes exercises and solutions enabling use for self study or as a course text. Supported by a website featuring solutions to exercises, further examples and computer code for numerical examples.

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Optimization and Differential Games offers a comprehensive introduction to the theory and practice of this extensively used class of economic models and will appeal to applied mathematicians and econometricians as well as researchers and senior undergraduate graduate students in economics mathematics engineering and management science **An Invitation to Statistics in Wasserstein Space** Victor M. Panaretos,Yoav Zemel,2020-03-10 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 **Trust Region Methods** A. R. Conn,N. I. M. Gould,Ph. L. Toint,2000-01-01 This is the first comprehensive reference on trust region methods a class of numerical algorithms for the solution of nonlinear convex optimization methods Its unified treatment covers both unconstrained and constrained problems and reviews a large part of the specialized literature on the subject It also provides an up to date view of numerical optimization **Control and Dynamic Systems V17** C.T. Leonides,2012-12-02 Control and Dynamic Systems Advances in Theory and Application Volume 17 deals with the theory of differential games and its applications It provides a unique presentation of the differential game theory as well as the use of algorithms for solving this complex class problems This book discusses fundamental concepts and system problem formulation for differential game systems It also considers pursuit evasion games and on line real time computer control techniques This book will serve as a useful reference for those interested in effective computations for differential games **High-Performance Computing in Finance** M. A. H. Dempster,Juho Kanninen,John Keane,Erik Vynckier,2018-02-21 High Performance Computing HPC delivers higher computational performance to solve problems in science engineering and finance There are various HPC resources available for different needs ranging from cloud computing that can be used without much expertise and expense to more tailored hardware such as Field Programmable Gate Arrays FPGAs or D Wave s quantum computer systems High Performance Computing in Finance is the first book that provides a state of the art introduction to HPC for finance capturing both academically and practically relevant problems **Risk-sensitive Investment Management** Mark H A Davis,Sebastien Lleo,2014-07-21 Over the last two decades risk sensitive control has evolved into an innovative and successful framework for

solving dynamically a wide range of practical investment management problems This book shows how to use risk sensitive investment management to manage portfolios against an investment benchmark with constraints and with assets and liabilities It also addresses model implementation issues in parameter estimation and numerical methods Most importantly it shows how to integrate jump diffusion processes which are crucial to model market crashes With its emphasis on the interconnection between mathematical techniques and real world problems this book will be of interest to both academic researchers and money managers Risk sensitive investment management links stochastic control and portfolio management Because of its distinct emphasis on integrating advanced theoretical concepts into practical dynamic investment management tools this book stands out from the existing literature in fundamental ways It goes beyond mainstream research in portfolio management in a traditional static setting The theoretical developments build on contemporary research in stochastic control theory but are informed throughout by the need to construct an effective and practical framework for dynamic portfolio management This book fills a gap in the literature by connecting mathematical techniques with the real world of investment management Readers seeking to solve key problems such as benchmarked asset management or asset and liability management will certainly find it useful **Model-Based Fault Diagnosis Techniques** Steven X.

Ding,2012-12-20 Guaranteeing a high system performance over a wide operating range is an important issue surrounding the design of automatic control systems with successively increasing complexity As a key technology in the search for a solution advanced fault detection and identification FDI is receiving considerable attention This book introduces basic model based FDI schemes advanced analysis and design algorithms and mathematical and control theoretic tools This second edition of Model Based Fault Diagnosis Techniques contains new material on fault isolation and identification and alarm management extended and revised treatment of systematic threshold determination for systems with both deterministic unknown inputs and stochastic noises addition of the continuously stirred tank heater as a representative process industrial benchmark and enhanced discussion of residual evaluation which now deals with stochastic processes Model based Fault Diagnosis Techniques will interest academic researchers working in fault identification and diagnosis and as a text it is suitable for graduate students in a formal university based course or as a self study aid for practising engineers working with automatic control or mechatronic systems from backgrounds as diverse as chemical process and power engineering Robust Control Farhad Assadian, Kevin R. Mallon,2022-01-28 Robust Control Robust Control Youla Parameterization Approach Discover efficient methods for designing robust control systems In Robust Control Youla Parameterization Approach accomplished engineers Dr Farhad Assadian and Kevin R Mallon deliver an insightful treatment of robust control system design that does not require a theoretical background in controls The authors connect classical control theory to modern control concepts using the Youla method and offer practical examples from the automotive industry for designing control systems with the Youla method The book demonstrates that feedback control can be elegantly designed in the frequency domain using the

Youla parameterization approach It offers deep insights into the many practical applications from utilizing this technique in both Single Input Single Output SISO and Multiple Input Multiple Output MIMO design Finally the book provides an estimation technique using Youla parameterization and controller output observer for the first time Robust Control offers readers A thorough introduction to a review of the Laplace Transform including singularity functions and transfer functions Comprehensive explorations of the response of linear time invariant and dynamic systems as well as feedback principles and feedback design for SISO Practical discussions of norms and feedback systems feedback design by the optimization of closed loop norms and estimation design for SISO using the parameterization approach In depth examinations of MIMO control and multivariable transfer function properties Perfect for industrial researchers and engineers working with control systems Robust Control Youla Parameterization Approach is also an indispensable resource for graduate students in mechanical aerospace electrical and chemical engineering

Linear Optimization and Approximation K. Glashoff, S.-A. Gustafson, 2012-12-06 A linear optimization problem is the task of minimizing a linear real valued function of finitely many variables subject to linear constraints in general there may be infinitely many constraints This book is devoted to such problems Their mathematical properties are investigated and algorithms for their computational solution are presented Applications are discussed in detail Linear optimization problems are encountered in many areas of applications They have therefore been subject to mathematical analysis for a long time We mention here only two classical topics from this area the so called uniform approximation of functions which was used as a mathematical tool by Chebyshev in 1853 when he set out to design a crane and the theory of systems of linear inequalities which has already been studied by Fourier in 1823 We will not treat the historical development of the theory of linear optimization in detail However we point out that the decisive break through occurred in the middle of this century It was urged on by the need to solve complicated decision problems where the optimal deployment of military and civilian resources had to be determined The availability of electronic computers also played an important role The principal computational scheme for the solution of linear optimization problems the simplex algorithm was established by Dantzig about 1950 In addition the fundamental theorems on such problems were rapidly developed based on earlier published results on the properties of systems of linear inequalities *Paper*, 1994

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

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Local Stability and Ultimate Boundedness in the Control of Robot Manipulators Marco A. Arteaga, Alejandro Gutiérrez-Giles, Javier Pliego-Jiménez, 2021-11-08 This book offers a unique compendium of the authors own research on the use of theoretical stability analysis showing how to take advantage of local stability design and ultimate boundedness for practical robot control It addresses researchers and postgraduate students dealing with control theory particularly with nonlinear systems Thanks to the numerous worked examples it could also be used as a textbook in postgraduate courses

Mathematical Optimization in Computer Graphics and Vision Luiz Velho, Paulo Carvalho, Jonas Gomes, Luiz de Figueiredo, 2011-08-09 Mathematical optimization is used in nearly all computer graphics applications from computer vision to animation This book teaches readers the core set of techniques that every computer graphics professional should understand in order to envision and expand the boundaries of what is possible in their work Study of this authoritative reference will help readers develop a very powerful tool the ability to create and decipher mathematical models that can better realize solutions to even the toughest problems confronting computer graphics community today Distills down a vast and complex world of information on optimization into one short self contained volume especially for computer graphics Helps CG professionals identify the best technique for solving particular problems quickly by categorizing the most effective algorithms by application Keeps readers current by supplementing the focus on key classic methods with special end of chapter sections on cutting edge developments

Linear and Nonlinear Programming

Essentials Tanushri Kaniyar, 2025-02-20 Linear and Nonlinear Programming Essentials is a comprehensive textbook crafted for undergraduate students providing an in depth exploration of optimization theory and practice Designed to be both accessible and rigorous this book is an essential resource for students in mathematics computer science engineering economics and related fields We begin with an introduction to linear programming covering fundamental concepts such as linear programming models the simplex method duality theory and sensitivity analysis Building upon this foundation we delve into nonlinear programming exploring convex optimization gradient based methods and algorithms for solving nonlinear optimization problems Our emphasis on bridging theory with practice is a distinguishing feature Real world examples and case studies from fields like logistics finance and machine learning illustrate the practical relevance of optimization techniques providing tangible insights into their applications With clear explanations illustrative examples and engaging exercises we make the content suitable for students at all levels of expertise Whether you re encountering optimization for the first time or seeking to deepen your understanding of advanced techniques Linear and Nonlinear Programming Essentials offers a comprehensive and engaging journey into the world of optimization This book equips you with the tools to tackle optimization problems confidently and proficiently

Formulating Principal-Agent Service Contracts for a Revenue

Generating Unit Shuo Zeng, Moshe Dror, 2015-07-02 This book examines contractual options for a performance based contract between an owner of a revenue generating unit and a repair agent for such unit The framework of the analysis is that of economists principal agent problem The contractual options of a principal and an agent are modeled as a Markov process with an undetermined time horizon For a risk neutral principal the authors identify the conditions under which a principal contracts with a risk neutral risk averse or risk seeking agent and derive the principal s optimal offer together with the agent s optimal service capacity response In essence the book provides an extensive formulating analysis of principal agent contracts given any exogenous parameter values Ultimately a small number of formulas cover a large spectrum of principal agent conditions

Filtering and System Identification

Michel Verhaegen, Vincent Verdult, 2007-04-26 Filtering and system identification are powerful techniques for building models of complex systems This 2007 book discusses the design of reliable numerical methods to retrieve missing information in models derived using these techniques Emphasis is on the least squares approach as applied to the linear state space model and problems of increasing complexity are analyzed and solved within this framework starting with the Kalman filter and concluding with the estimation of a full model noise statistics and state estimator directly from the data Key background topics including linear matrix algebra and linear system theory are covered followed by different estimation and identification methods in the state space model With end of chapter exercises MATLAB simulations and numerous illustrations this book will appeal to graduate students and researchers in electrical mechanical and aerospace engineering It is also useful for practitioners Additional resources for this title including solutions for instructors are available online at www.cambridge.org 9780521875127

Electric Machines for Smart Grids

Applications Adel El-Shahat, 2018-12-12 In this book highly qualified scientists present their recent research motivated by the importance of electric machines. It addresses advanced studies for high speed electrical machine design, mechanical design of rotors with surface mounted permanent magnets, design of motor drive for brushless DC motor, single phase motors for household applications, battery electric propulsion systems for competition racing applications, robust diagnosis by observer using the bond graph approach, a DC motor simulator based on virtual instrumentation, start up of a PID fuzzy logic embedded control system for the speed of a DC motor using LabVIEW, advanced control of the permanent magnet synchronous motor, and optimization of fuzzy logic controllers by particle swarm optimization to increase the lifetime in power electronic stages.

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