FINANCIAL SIGNAL PROCESSING AND MACHINE LEARNING

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Preface

This edited volume collects and unifies a number of recent advances in the signal-processing and machine-learning literature with significant applications in financial risk and portfolio management. The topics in the volume include characterizing statistical dependence and correlation in high dimensions, constructing effective and robust risk measures, and using these notions of risk in portfolio optimization and rebalancing through the lens of convex optimization. It also presents signal-processing approaches to model return, momentum, and mean reversion, including both theoretical and implementation aspects. Modern finance has become global and highly interconnected. Hence, these topics are of great importance in portfolio management and trading, where the financial industry is forced to deal with large and diverse portfolios in a variety of asset classes. The investment universe now includes tens of thousands of international equities and corporate bonds, and a wide variety of other interest rate and derivative products-often with limited, sparse, and noisy market data.

Using traditional risk measures and return forecasting (such as historical sample covariance and sample means in Markowitz theory) in high-dimensional settings is fraught with peril for portfolio optimization, as widely recognized by practitioners. Tools from high-dimensional statistics, such as factor models, eigen-analysis, and various forms of regularization that are widely used in real-time risk measurement of massive portfolios and for designing a variety of trading strategies including statistical arbitrage, are highlighted in the book. The dramatic improvements in computational power and special-purpose hardware such as field programmable gate arrays (FPGAs) and graphics processing units (GPUs) along with low-latency data communications facilitate the realization of these sophisticated financial algorithms that not long ago were "hard to implement."

The book covers a number of topics that have been popular recently in machine learning and signal processing to solve problems with large portfolios. In particular, the connections between the portfolio theory and sparse learning and compressed sensing, robust optimization, non-Gaussian data-driven risk measures, graphical models, causal analysis through temporal-causal modeling, and large-scale copula-based approaches are highlighted in the book.

Although some of these techniques already have been used in finance and reported in journals and conferences of different disciplines, this book attempts to give a unified treatment from a common mathematical perspective of high-dimensional statistics and convex optimization. Traditionally, the academic quantitative finance community did not have much overlap with the signal and information-processing communities. However, the fields are seeing more interaction, and this trend is accelerating due to the paradigm in the financial sector which has embraced state-of-the-art, high-performance computing and signal-processing technologies. Thus, engineers play an important role in this financial ecosystem. The goal of this edited volume is to help to bridge the divide, and to highlight machine learning and signal processing as disciplines that may help drive innovations in quantitative finance and electronic trading, including high-frequency trading.

The reader is assumed to have graduate-level knowledge in linear algebra, probability, and statistics, and an appreciation for the key concepts in optimization. Each chapter provides a list of references for readers who would like to pursue the topic in more depth. The book, complemented with a primer in financial engineering, may serve as the main textbook for a graduate course in financial signal processing.

We would like to thank all the authors who contributed to this volume as well as all of the anonymous reviewers who provided valuable feedback on the chapters in this book. We also gratefully acknowledge the editors and staff at Wiley for their efforts in bringing this project to fruition.