Network based filtering tools: a machine learning framework

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Data are everywhere and carry valuable information, making their understanding, analysis, and filtering central to modern science, industry, and society. Developing tools that can analyze such information while it is generated, while reducing complexity and dimensionality without compromising data integrity, has become crucial. Network theory has emerged as a powerful framework for this purpose. In this talk, I will explore two complementary perspectives on network-based filtering and dimensionality reduction: one focusing on edges and the other on nodes within a network representation. I will first introduce correlation-based information filtering network tools [1], which have proven effective for analyzing complex datasets. These tools are particularly valuable for risk management and portfolio optimization, enabling the construction of probabilistic sparse models for financial systems that support forecasting, stress testing, and risk allocation [2–6]. Next, I will present a newly developed method, the Best-Path Algorithm Sparse Graphical Model (BPASGM) [7]. BPASGM extends the original Best-Path Algorithm by transforming dependency discovery into a structured, economically motivated asset-selection procedure. This machine-learning framework for portfolio construction combines sparse graphical modeling with portfolio theory, offering a statistically grounded and computationally efficient approach for dependence-aware asset selection. BPASGM is designed to improve realized portfolio performance in finite samples, addressing the high sensitivity to estimation error seen in classical sample-based Markowitz implementations. Monte Carlo simulations indicate that BPASGM-based portfolios exhibit more stable risk-return characteristics, lower realized volatility, and enhanced risk-adjusted performance compared to standard mean–variance portfolios. Applications to real financial datasets demonstrate the method's practical utility.

References:

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