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EVOLUTION BASED HOPFIELD NEURAL NETWORK WITH WAVELET BASED FILTER FOR COMPLEX - CONSTRAINED PORTFOLIO OPTIMIZATION

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Abstract. Complex-constrained portfolio optimization deals with the problem of determining optimal portfolios that meet the twin objectives of maximizing return and minimizing risk, subject to constraints such as basic, cardinality, bounding, class, transaction costs and short sales.

Here, we investigate a heuristic solution strategy employing an Evolution based Hopfield Neural Network (EHNN), a hybrid model with Hopfield Neural Network acting as the host architecture to solve this portfolio optimization problem. Since covariance matrix obtained from historical data is biased by a high amount of statistical uncertainty, EHNN makes use of a wavelet-based filter to de-noise the covariance matrix yielding efficient portfolios with better reliability, when compared to the same obtained using Random Matrix Theory and Cluster analysis based filters. The EHNN also encompasses newly evolved weight standardization schemes to tackle all the constraints in the problem model.

Experimental studies have been demonstrated on the Bombay Stock Exchange (BSE 200 index: July 2001 to July 2006) and Tokyo Stock Exchange (Nikkei 225 index: March 2002 to March 2007) data sets.

Keywords.constrained portfolio optimization, Evolution-based Hopfield neural network, wavelet-based filter, k-means cluster analysis, short sales, transaction cost, bounding constraint, cardinality constraint, class constraint

1 Introduction

An essential component of asset management is the selection of appropriate portfolio of assets for investment. Portfolios are packages of tradable assets that are constructed by estimating the expected return and risk on individual assets and also the correlations that exist between them. Portfolio optimization is a process of determining the optimal proportion of capital (weights) that the investor should put on each asset of the portfolio to meet the twin objectives of maximizing return and minimizing risk associated with the investment. The risk-return tradeoff curve, called efficient frontier, represents the solution to the portfolio optimization problem.

Markowitz [1952] laid a quantitative framework for the selection of portfolios in what is termed today as Modern Portfolio Theory (MPT). The Mean-Variance model proposed by Markowitz assumed the asset returns to follow a Gaussian law. Therefore the expected return of a portfolio is described using the mean returns of the assets and the portfolio risk is represented by the covariance matrix of the asset returns. The optimal portfolios that