R/Finance 2014:Complex Portfolio Optimization with PortfolioAnalytics

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Portfolio Optimization

General

TODO: Add some general comments here about goals and pitfalls of optimizatio in the context of constructing a portfolio.

Modern Portfolio Theory

"Modern" Portfolio Theory (MPT) was introduced by Harry Markowitz in 1952.

In general, MPT states that an investor's objective is to maximize portfolio expected return for a given amount of risk.

General Objectives

- Maximize a measure of gain per unit measure of risk
- Minimize a measure of risk
- Maximize a utility function

How do we define risk?

Portfolio Optimization Objectives

- Minimize Risk
  - Volatility
  - Tail Loss (VaR, ES)
  - Other Downside Risk Measure
- Maximize Risk Adjusted Return
  - Sharpe Ratio
  - Modified Sharpe Ratio
  - Several Others
- Risk Budgets
  - Equal Component Contribution to Risk (i.e. Risk Parity)
  - Limits on Component Contribution
- Maximize a Utility Function
  - Quadratic, CRRA, CARA, etc.

PortfolioAnalytics

Overview

PortfolioAnalytics is an R package designed to provide numerical solutions and visualizations for portfolio problems with complex constraints and objectives.

Key Features

- Support for multiple constraint and objective types
- Modular constraints and objectives
- An objective function can be any valid R function
- Custom moments
- Solver agnostic
- Visualizations

Support Multiple Solvers

Linear and Quadratic Programming Solvers

- R Optimization Infrastructure (ROI)
  - GLPK (Rglpk)
  - Symphony (Rsymphony)
  - Quadprog (quadprog)

Global (stochastic or continuous solvers)

- Random Portfolios
- Differential Evolution (DEoptim)
- Particle Swarm Optimization (pso)
- Generalized Simulated Annealing (GenSA)

Workflow

TODO: Add a nice graphic here (Guy might have one)

Specify a Portfolio –> Add Constraints –> Add Objectives –> Run Optimization –> Analyze Results

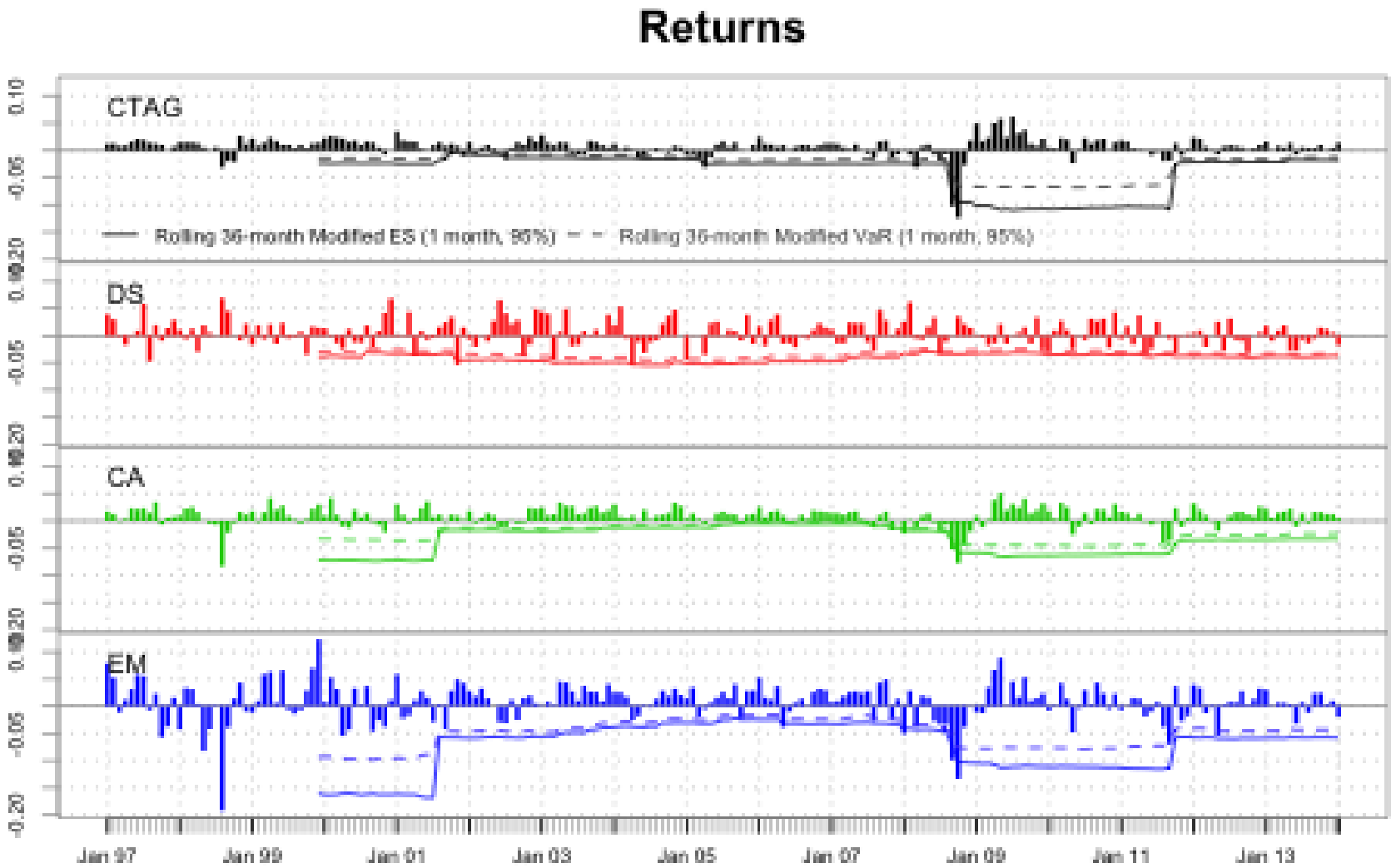
Data

Data Setup

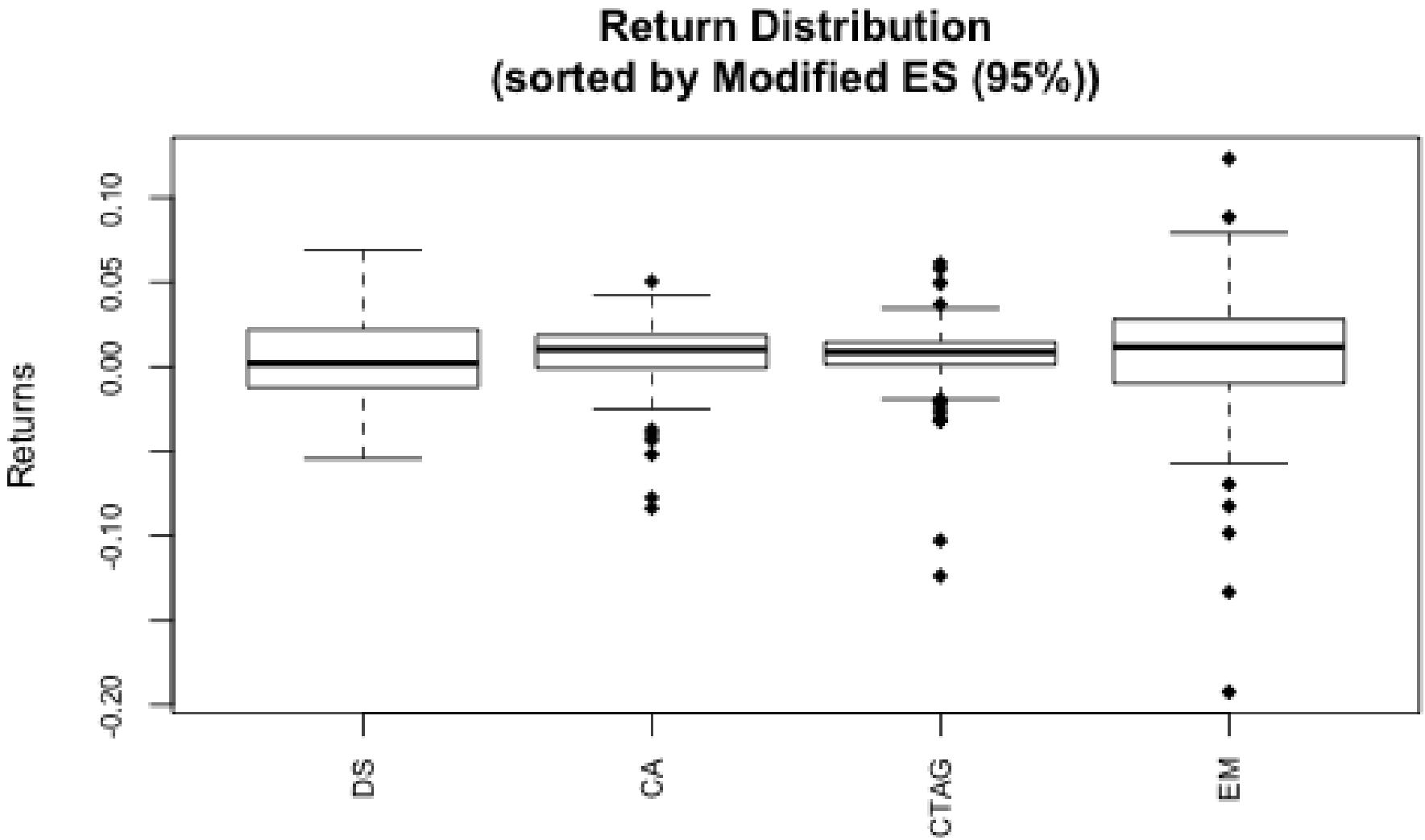
Here we will look at portfolio optimization in the context of portfolio of hedge funds

- EDHEC-Risk Alternative Indexes
- Monthly returns from 1/31/1997 to 1/31/2014
  - Convertible Arbitrage (CA)
  - CTA Global (CTAG)
  - Distressed Securities (DS)
  - Emerging Markets (EM)

Monthly Returns



Distribution of Monthly Returns



Example 1

Minimum Variance Portfolio

Set up portfolio to minimize variance

Conclusion

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