



INTERMEDIATE PORTFOLIO ANALYSIS IN R

# Portfolio Specification, Constraints, and Objectives

# Workflow Overview

General portfolio optimization problem workflow in PortfolioAnalytics:

- Portfolio specification
- Add constraints and objectives
- Run optimization
- Analyze optimization results

# Workflow: Portfolio Specification

```
portfolio.spec(assets = NULL,  
               ...)
```

```
# Character vector of assets  
> portfolio.spec(assets = c("SP00", "DJIA", "Nasdaq",  
                           "FTSE100", "DAX", "CAC40"))
```

```
# Named vector of assets with initial weights  
> initial_weights <- c("SP500" = 0.5, "FTSE100" = 0.3,  
                           "NIKKEI" = 0.2)  
> portfolio.spec(assets = initial_weights)
```

```
# Scalar of number of assets  
> portfolio.spec(assets = 4)
```

# Workflow: Add Constraints

```
add.constraint(portfolio,
                type = c("weight_sum", "box",
                        "full_investment", ...),
                ...)
```

```
# Initialize portfolio specification
> p <- portfolio.spec(assets = 4)

# Add full investment constraint
> p <- add.constraint(portfolio = p, type = "weight_sum",
                       min_sum = 1, max_sum = 1)

# Add box constraint
> p <- add.constraint(portfolio = p, type = "box",
                       min = 0.2, max = 0.6)
```

# Workflow: Add Objectives

```
add.objective(portfolio,  
              type = c("return", "risk", ...),  
              name,  
              arguments = NULL,  
              ... )
```

```
# Initialize portfolio specification  
> p <- portfolio.spec(assets = 4)  
  
# Add mean return objective  
> p <- add.objective(portfolio = p, type = "return",  
                      name = "mean")  
  
# Add expected shortfall risk objective  
> p <- add.objective(portfolio = p, type = "risk", name = "ES",  
                      arguments = list(p= 0.9, method = "gaussian"))
```



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# Running Optimizations

# Single Period Optimization

- Single period optimization with `optimize.portfolio()`
- Optimization with periodic rebalancing (backtesting) with `optimize.portfolio.rebalancing()`

# Single Period Optimization

```
optimize.portfolio(  
    R, portfolio = NULL,  
    optimize_method = c("DEoptim", "random", "ROI", ...),  
    search_size = 20000,  
    trace = TRUE,  
    momentFUN = "set.portfolio.moments",  
    ...)  
  
optimize.portfolio.rebalancing(  
    R, portfolio = NULL,  
    optimize_method = c("DEoptim", "random", "ROI", ...),  
    search_size = 20000,  
    trace = TRUE,  
    rebalance_on = "quarters",  
    training_period,  
    rolling_window,  
    momentFUN = "set.portfolio.moments",  
    ...)
```

# Optimization Methods

The following optimization methods are supported:

## Global Solvers:

- `DEoptim`: Differential Evolution Optimization
- `random`: Random Portfolios Optimization
- `GenSA`: Generalized Simulated Annealing
- `Analyze`: Analyze optimization results
- `pso`: Particle Swarm Optimization

## LP and QP Solvers:

- `ROI`: R Optimization Infrastructure for linear and quadratic programming solvers



# Example: Optimization



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# Analyze Results

# Workflow: Analyze Results

Visualization	Data Extraction
<code>plot()</code>	<code>extractObjectiveMeasures()</code>
<code>chart.Concentration()</code>	<code>extractStats()</code>
<code>chart.EfficientFrontier()</code>	<code>extractWeights()</code>
<code>chart.RiskReward()</code>	<code>print()</code>
<code>chart.RiskBudget()</code>	<code>summary()</code>
<code>chart.Weights()</code>	

# Example: Extract Weights

```
# Extract the optimal weights
> extractWeights(opt)
Convertible Arbitrage      CTA Global      Distressed Securities
0.000000e+00    6.515184e-02    5.840055e-18

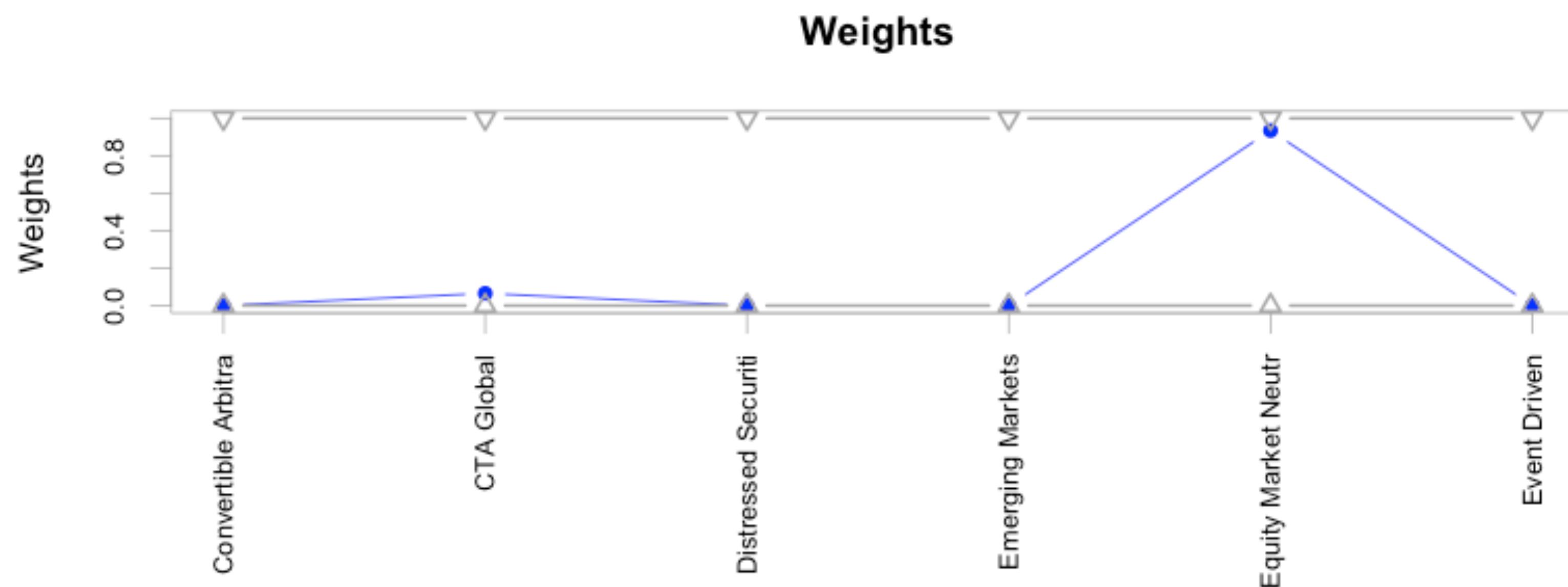
Emerging Markets          Equity Market Neutral      Event Driven
-8.501425e-18    9.348482e-01    4.105887e-18

> head(extractWeights(opt_rebal), n = 3)
          Convertible Arbitrage CTA Global  Distressed Securities
2001-12-31        0.12986589  0.06849445        0.00000000
2002-12-31        0.08738164  0.08645814        0.00000000
2003-12-31        0.09177469  0.03192720        0.02419038

          Emerging Markets  Equity Market Neutral  Event Driven
2001-12-31    7.113112e-18        0.8016397 -1.608927e-16
2002-12-31   -2.553006e-19        0.8261602 -3.837233e-17
2003-12-31    0.000000e+00        0.8521077  2.991493e-19
```

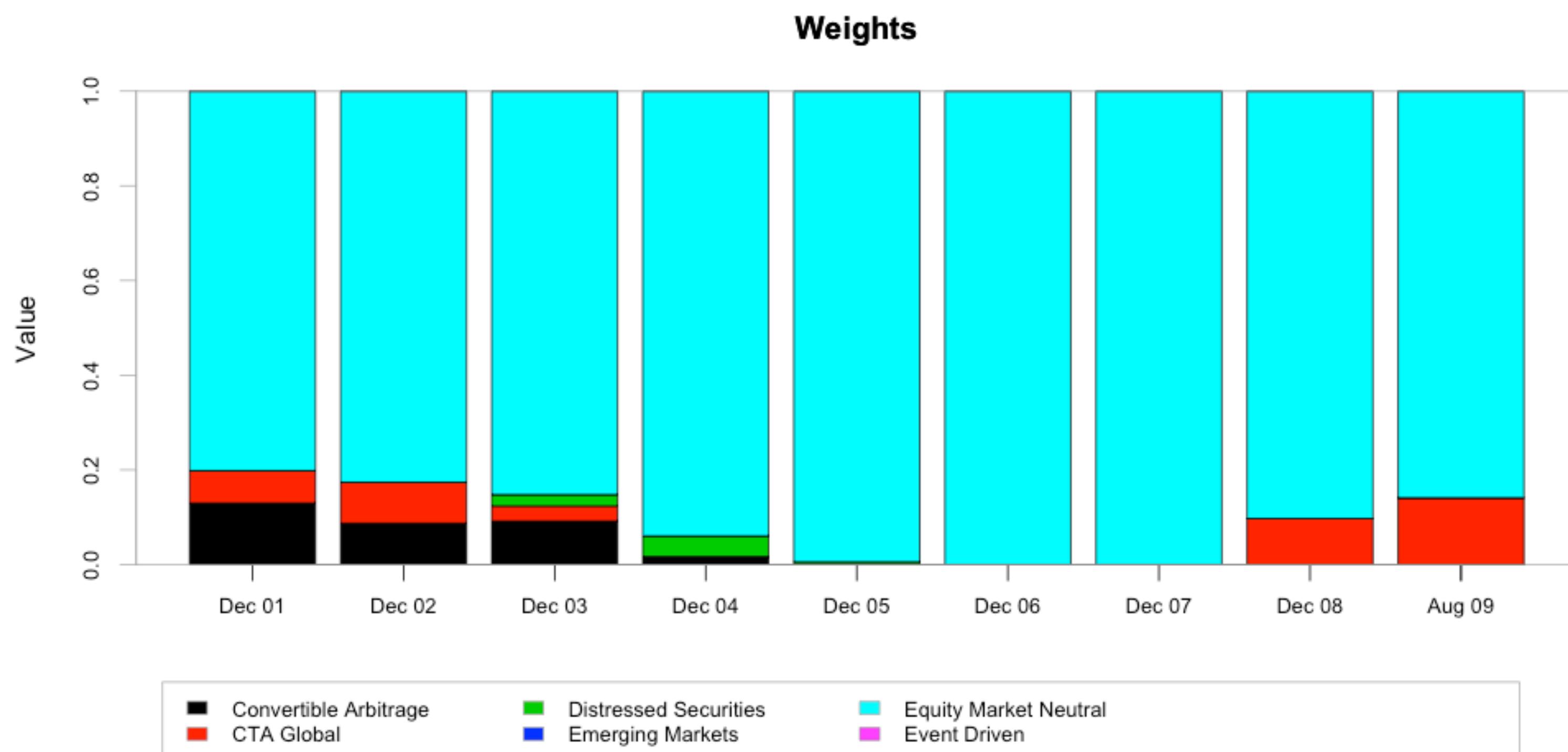
# Example: Chart Weights

```
# Chart the weights  
> chart.Weights(opt)  
  
> chart.Weights(opt_rebal)
```



# Example: Chart Weights

```
# Chart the weights  
> chart.Weights(opt)  
  
> chart.Weights(opt_rebal)
```



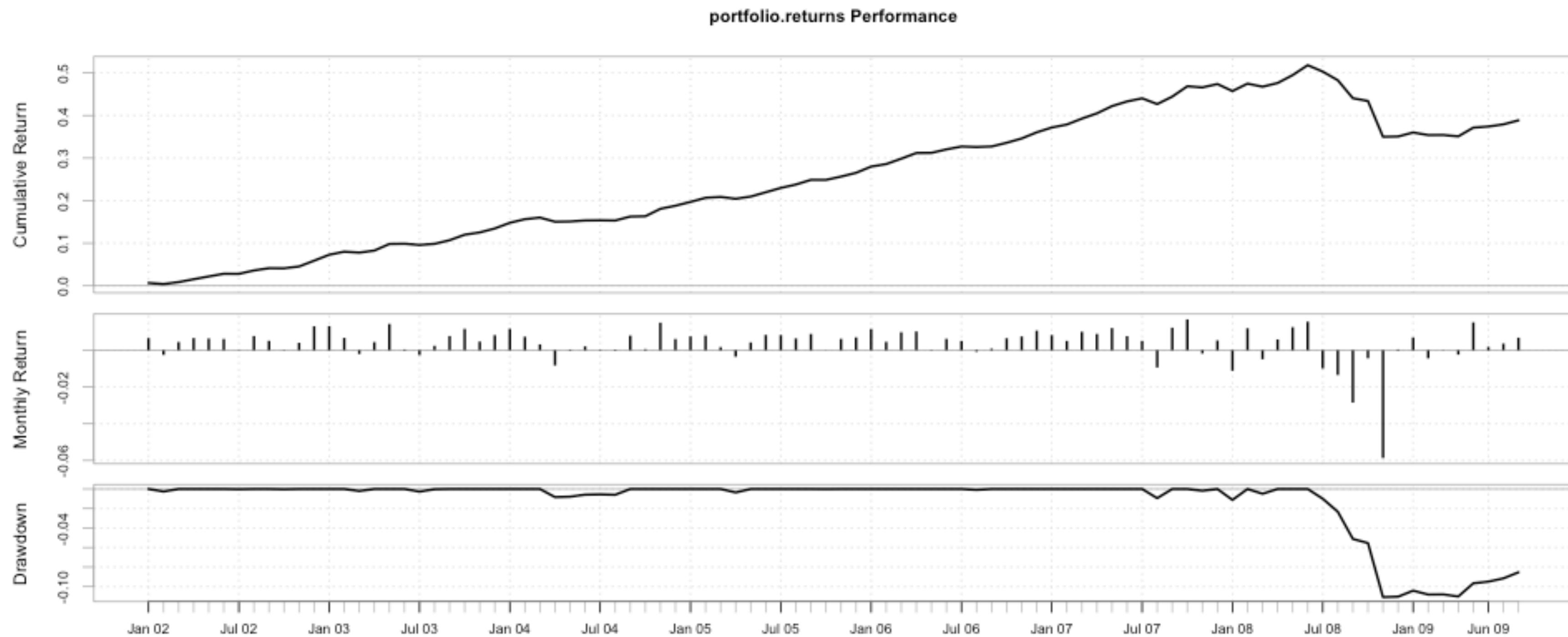
# Example: Extract Objective Measures

```
# Extract the objective measures
> extractObjectiveMeasures(opt)
$StdDev
  StdDev
0.008855401

> head(extractObjectiveMeasures(opt_rebal))
      StdDev
2001-12-31 0.006521328
2002-12-31 0.005886103
2003-12-31 0.005656744
2004-12-31 0.005855993
2005-12-31 0.004308911
2006-12-31 0.004198900
```

# Example: Optimization Analysis

```
# Compute the rebalancing returns  
> rr <- Return.portfolio(ret, weights = extractWeights(opt_rebal))  
> charts.PerformanceSummary(rr)
```





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