



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
  - `pso`: Particle Swarm Optimization
- Analyze optimization results

## LP and QP Solvers:

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

[illegible]



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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)
```

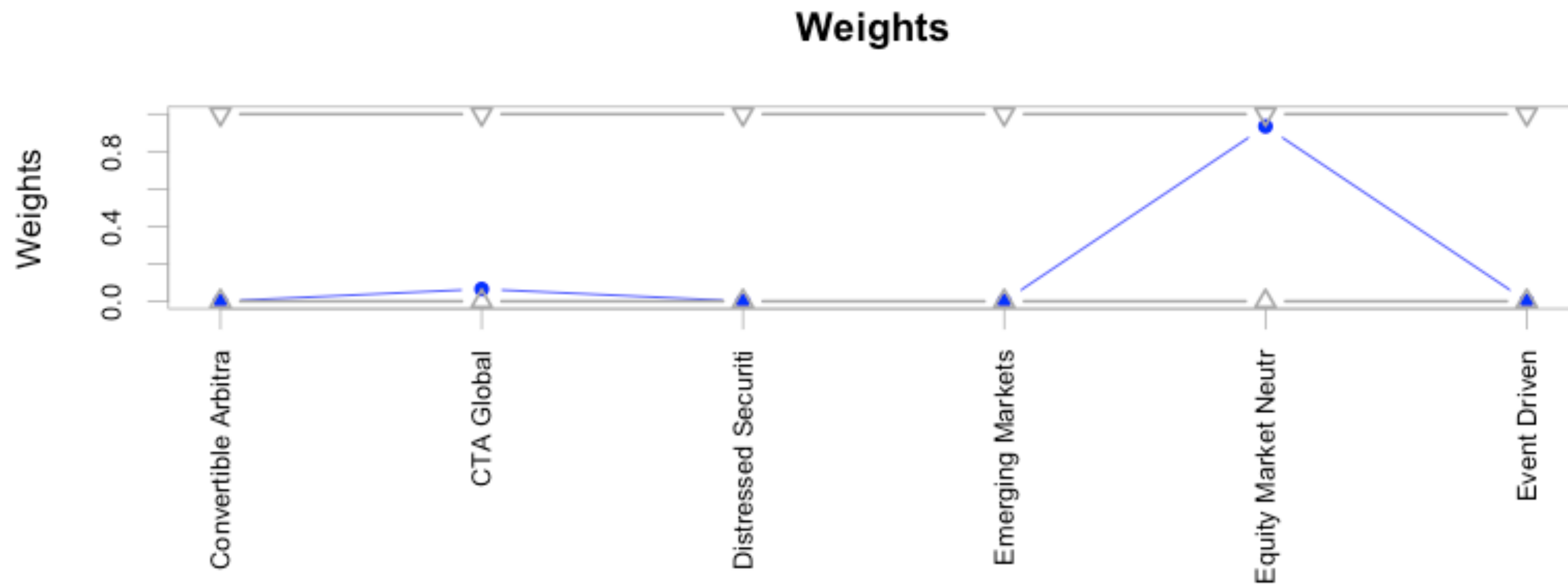
	Convertible Arbitrage	CTA Global	Distressed Securities
2001-12-31	0.12986589	0.06849445	0.000000000
2002-12-31	0.08738164	0.08645814	0.000000000
2003-12-31	0.09177469	0.03192720	0.02419038

	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

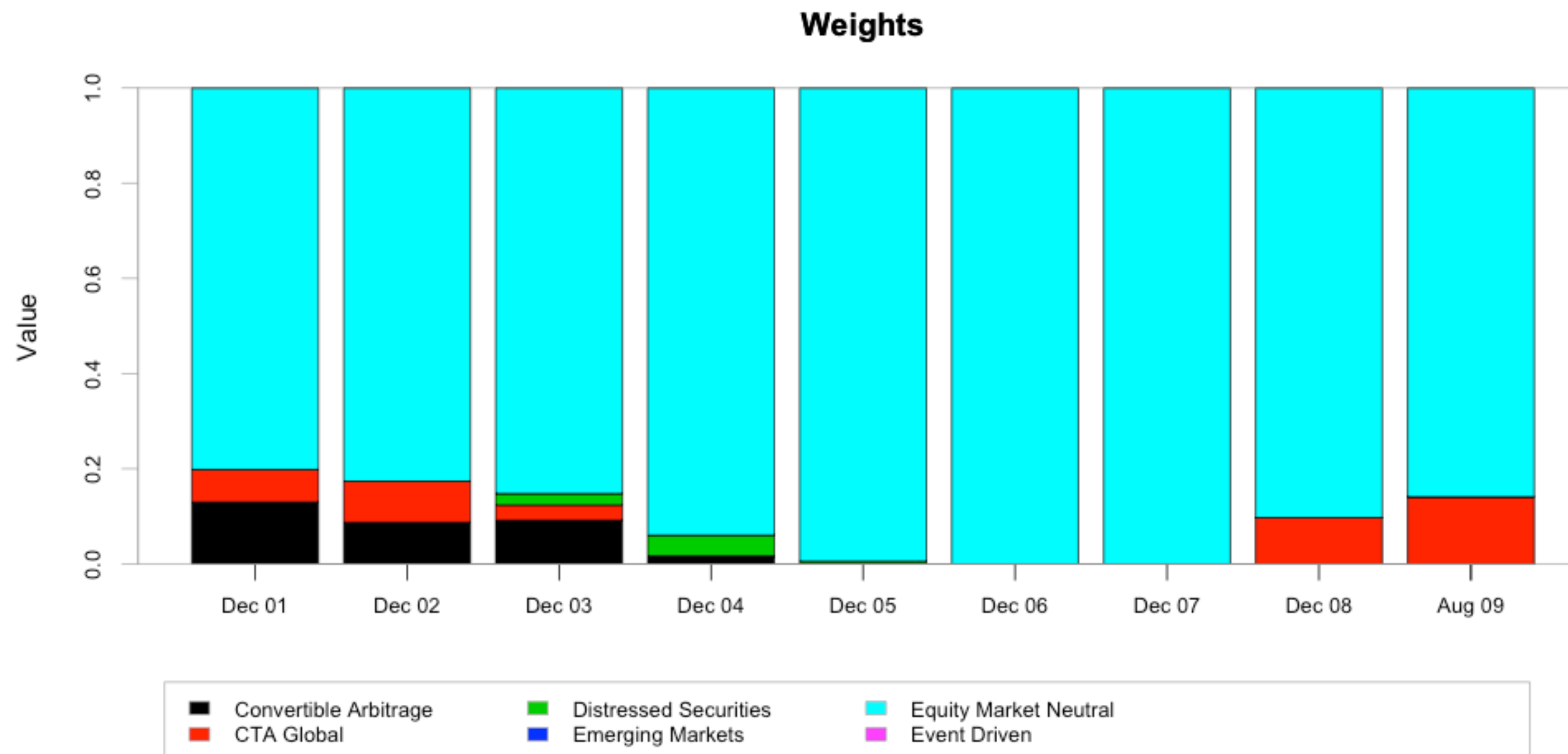
```
# Chart the weights  
> chart.Weights(opt)  
  
> chart.Weights(opt_rebal)
```





# Example: Chart Weights

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



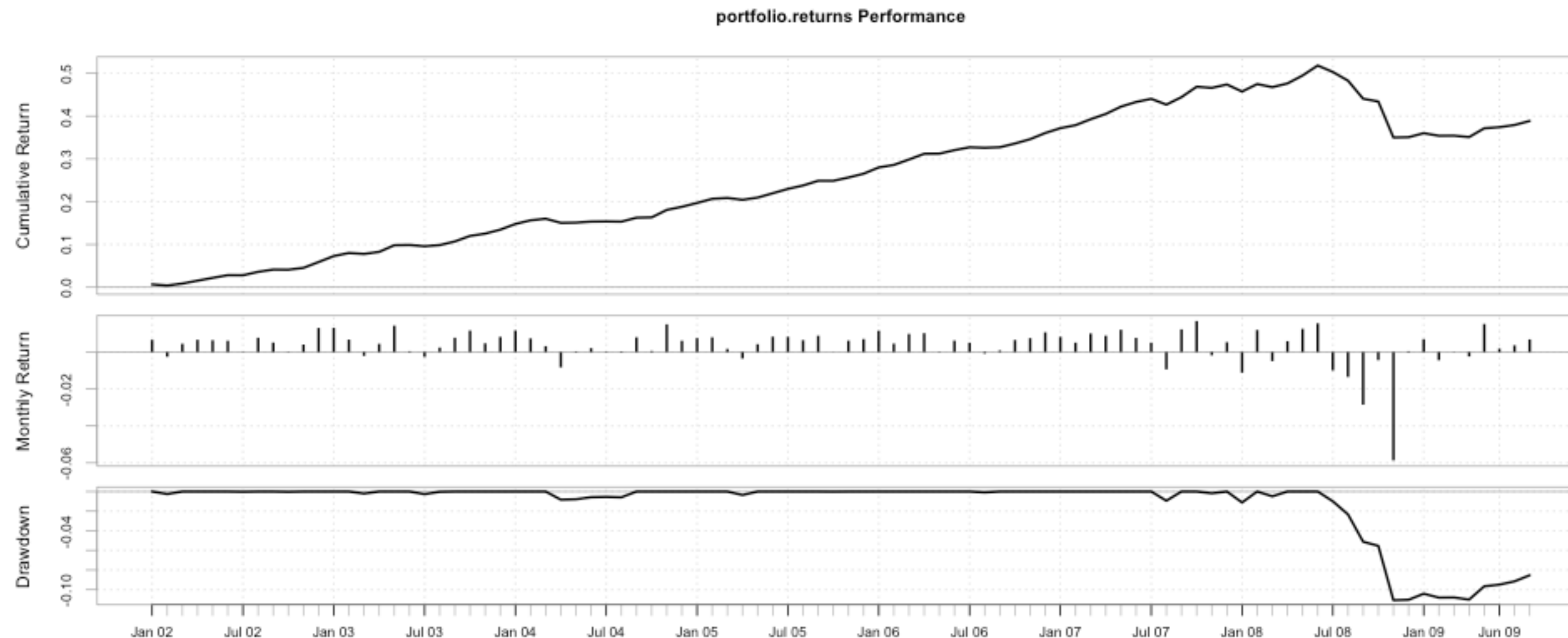
# Example: Extract Objective Measures

```
# 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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