

# Quadratic Optimization

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## Quadratic Optimization: Building a Rolling Backtesting Engine

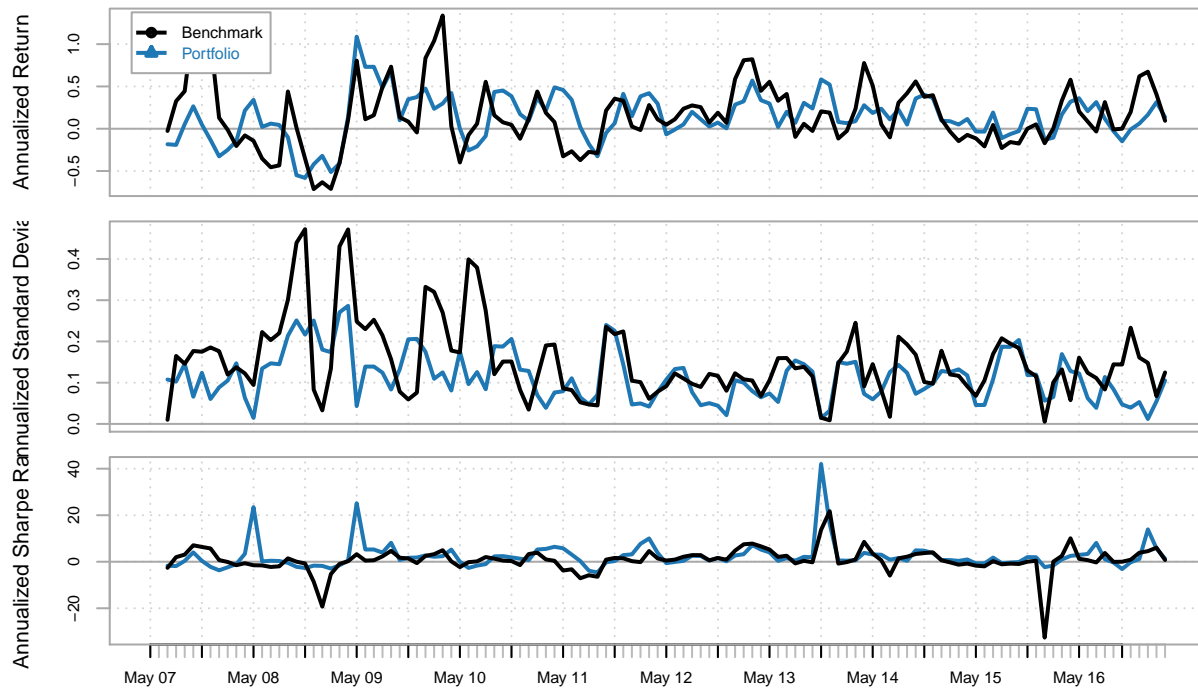
In this part of our course, we'll show you how to build a dynamic rolling backtesting engine and a quadratic optimization strategy to build a portfolio of assets that tracks a given benchmark. In this example, we use an ETF (SPY) that tracks the S&P 500 index as our benchmark.

Below is an example report which you will be able to generate by following the tutorial.

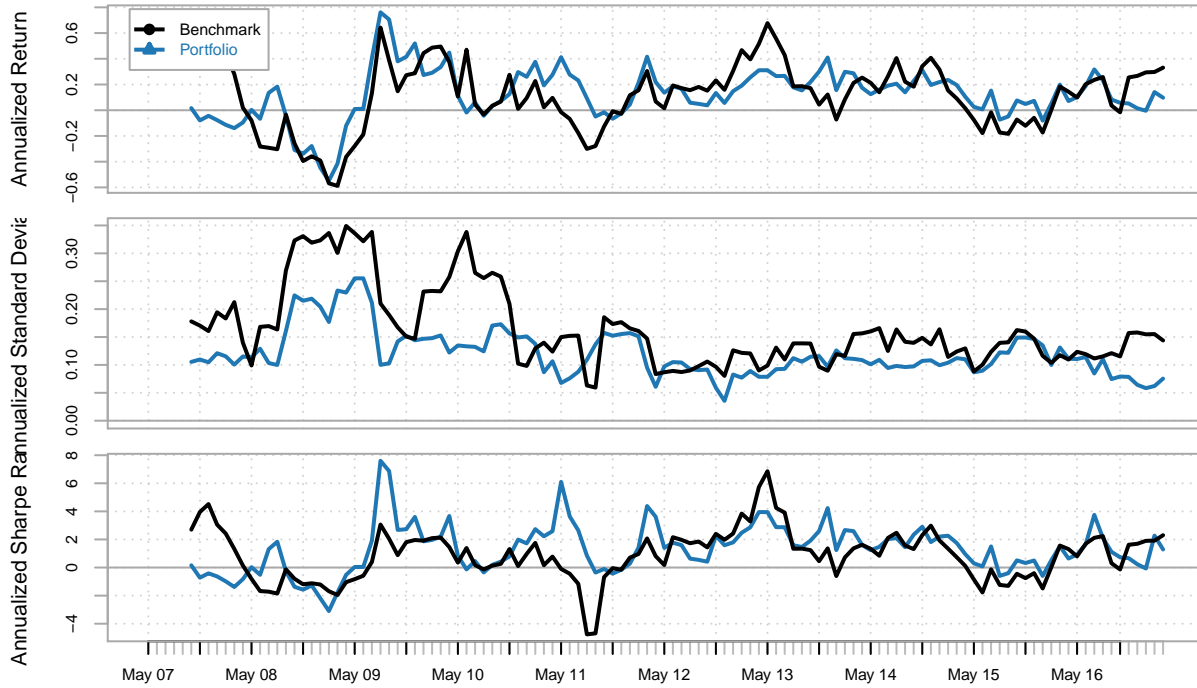
### Rolling Fund Performance

We'll examine the performance of your fund strategy vs the benchmark on a rolling basis.

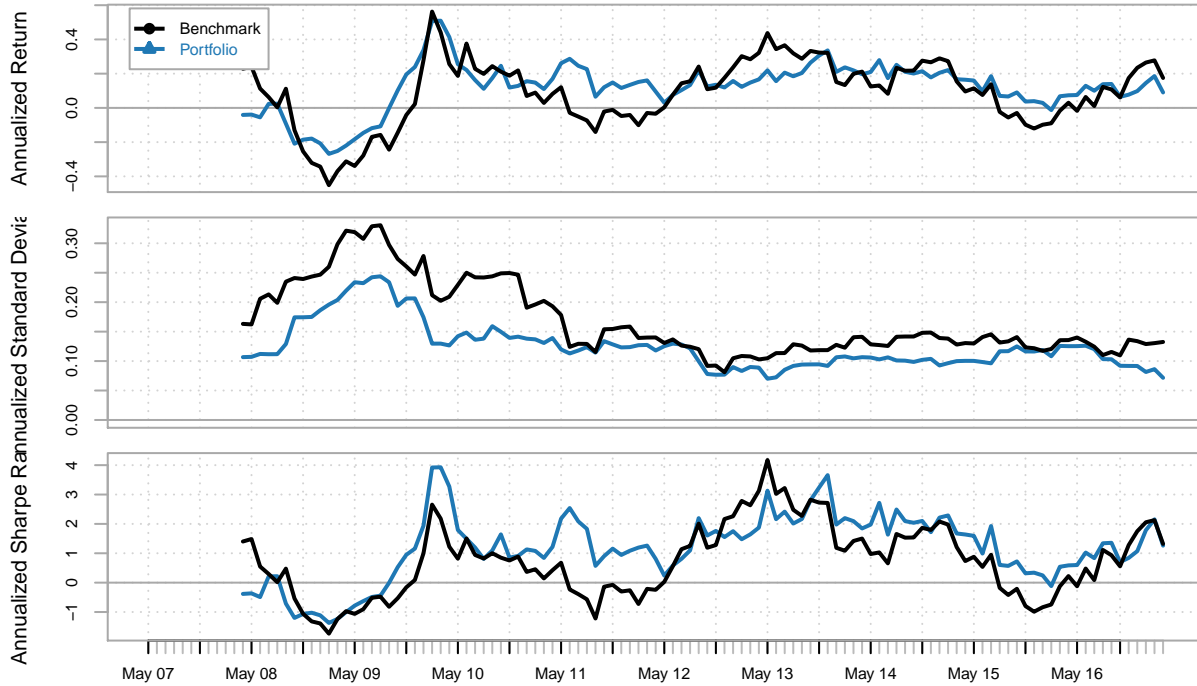
**Rolling Quarterly Portfolio Performance vs. Benchmark (BRK-B)**



### Rolling Semi-Annual Portfolio Performance vs. Benchmark (BRK-B)



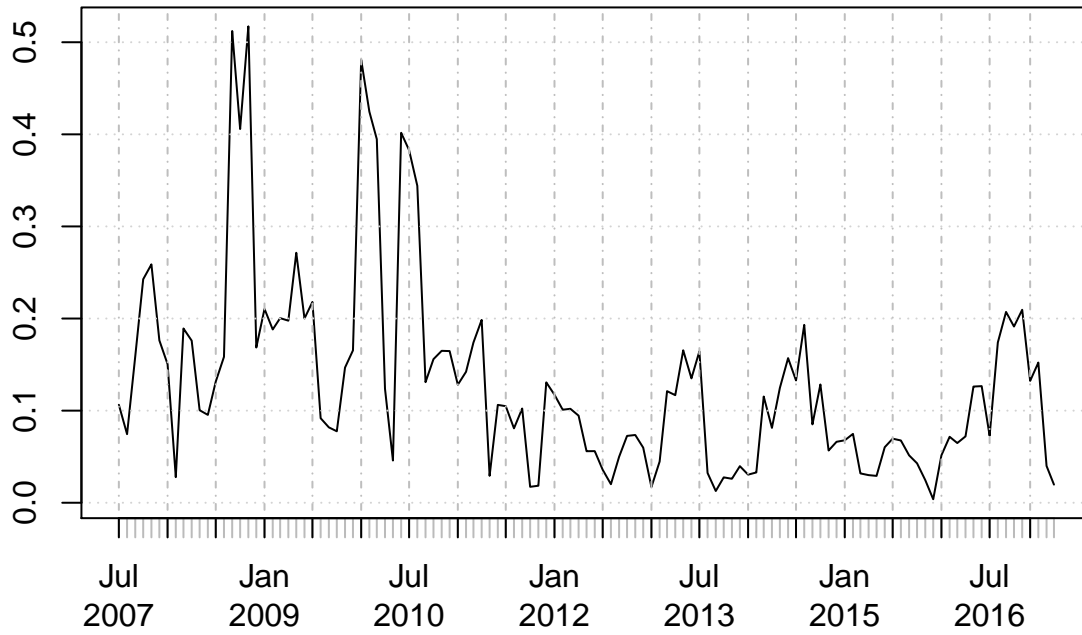
### Rolling Annual Portfolio Performance vs. Benchmark (BRK-B)



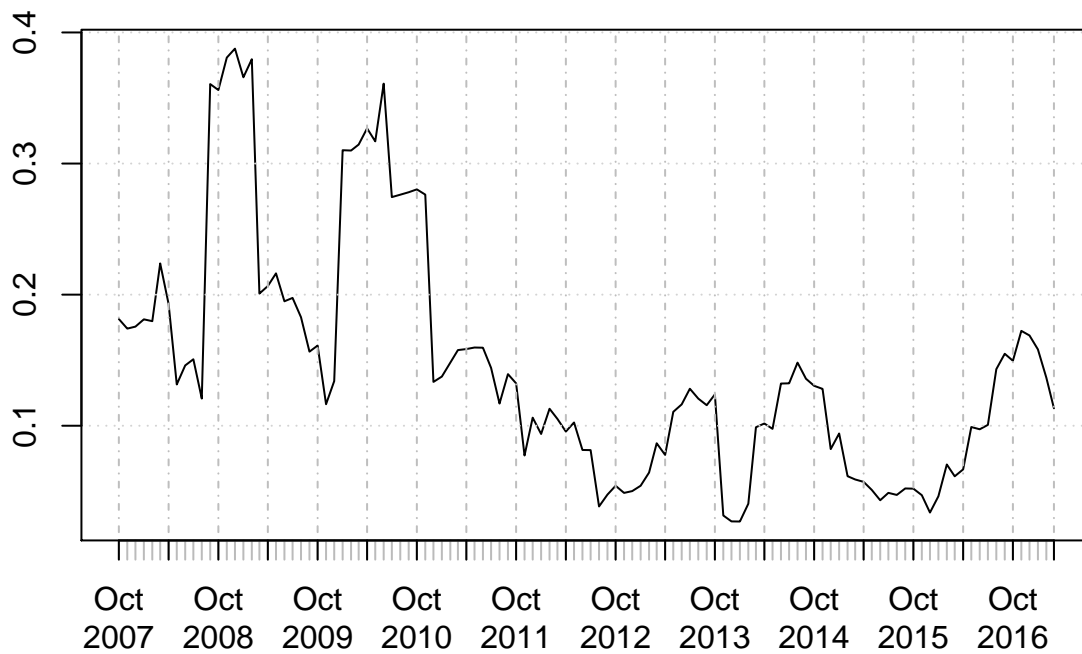
## Tracking Error

We'll show you how to calculate tracking error on a rolling basis as well.

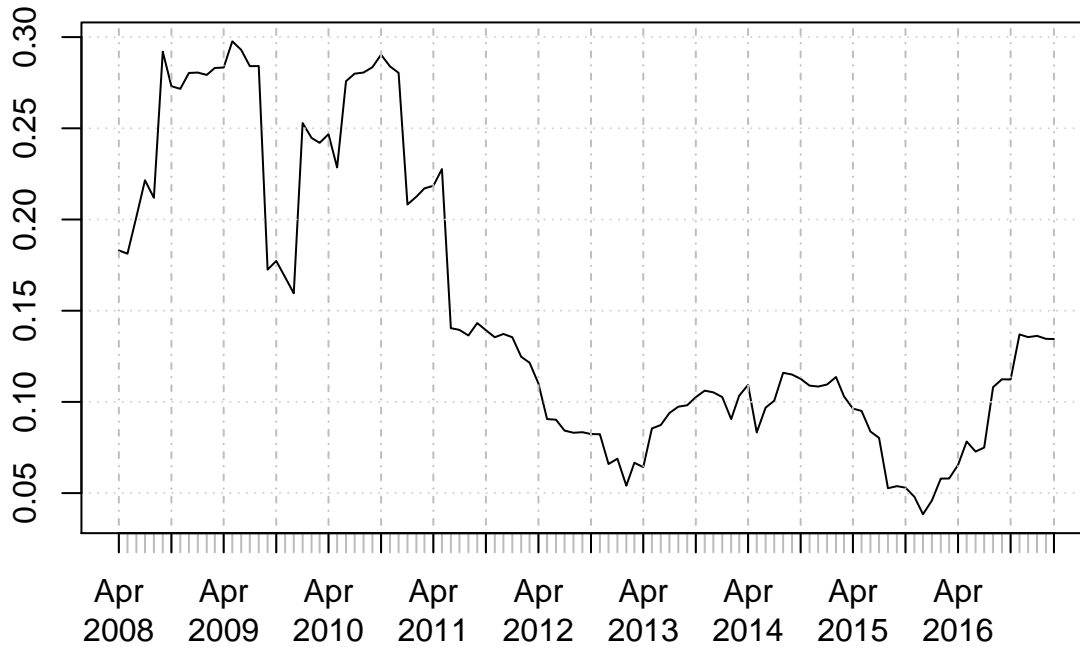
### Rolling Quarterly Tracking Error vs. Benchmark (BRK-B)



### Rolling Semi-Annual Tracking Error vs. Benchmark (BRK-B)



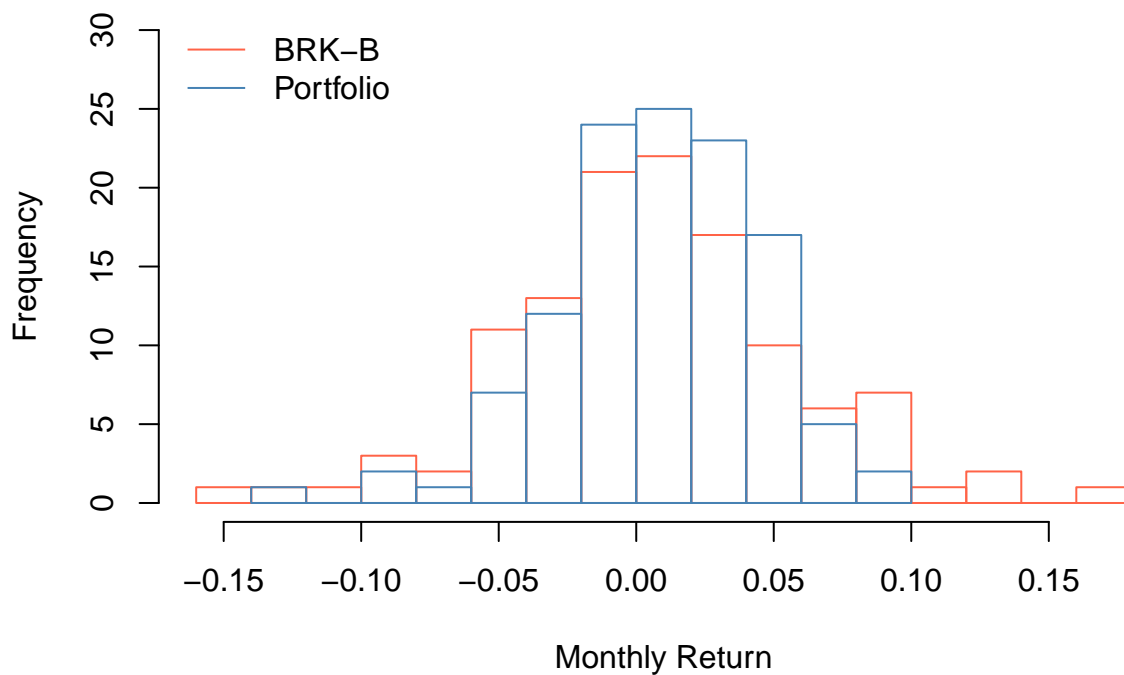
## Rolling Annual Tracking Error vs. Benchmark (BRK-B)



## Comparing Distributions

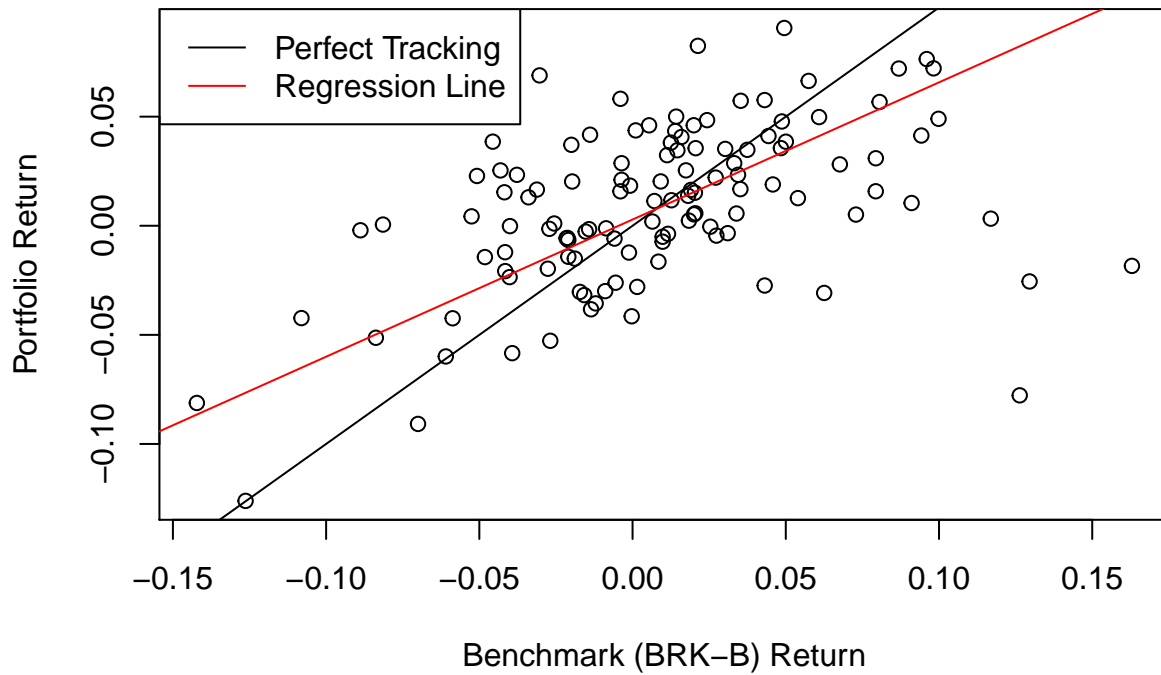
We'll compare the distributions of the returns of your portfolio strategy vs the benchmark.

### Benchmark vs Portfolio Distribution of Returns



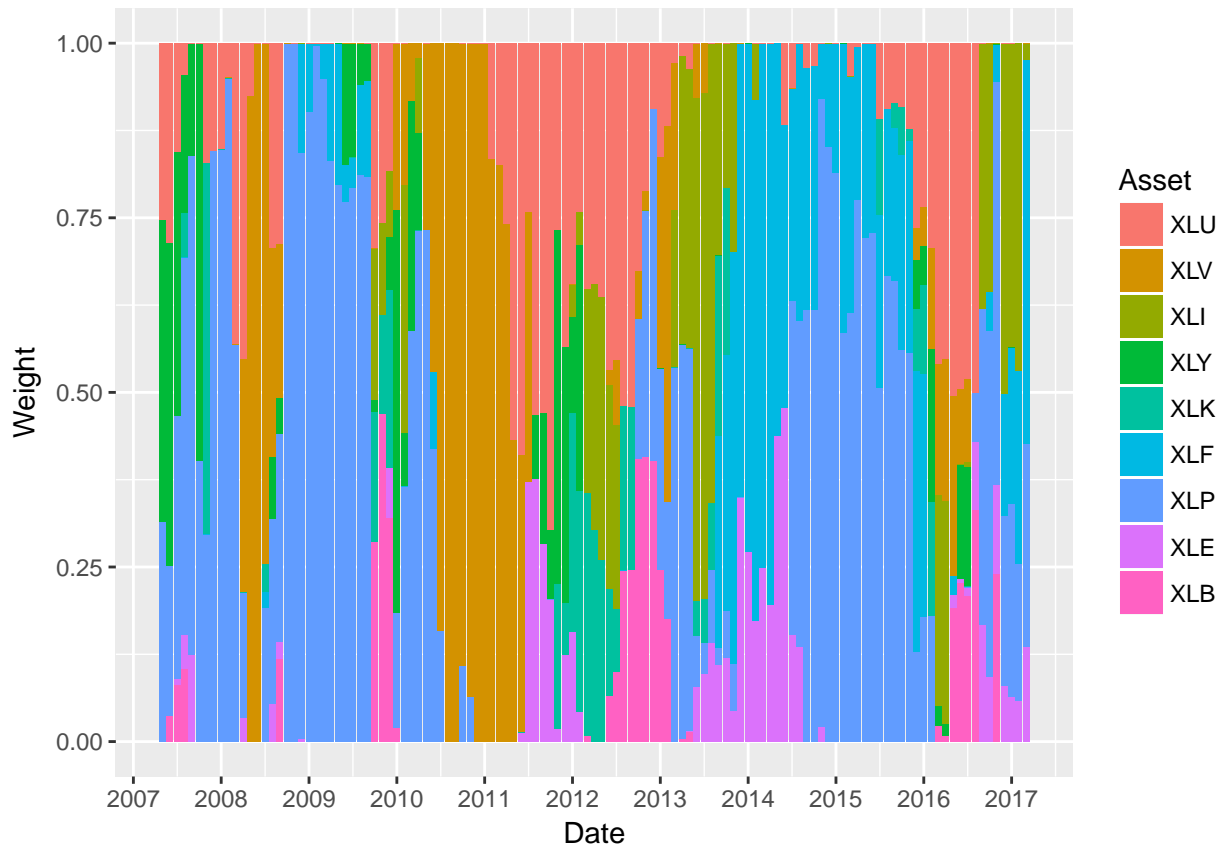
## Scatterplot of Returns & Regression Line

We'll build a simple scatterplot regression of your portfolio vs the benchmark.



## Plotting Portfolio Weights Over Time

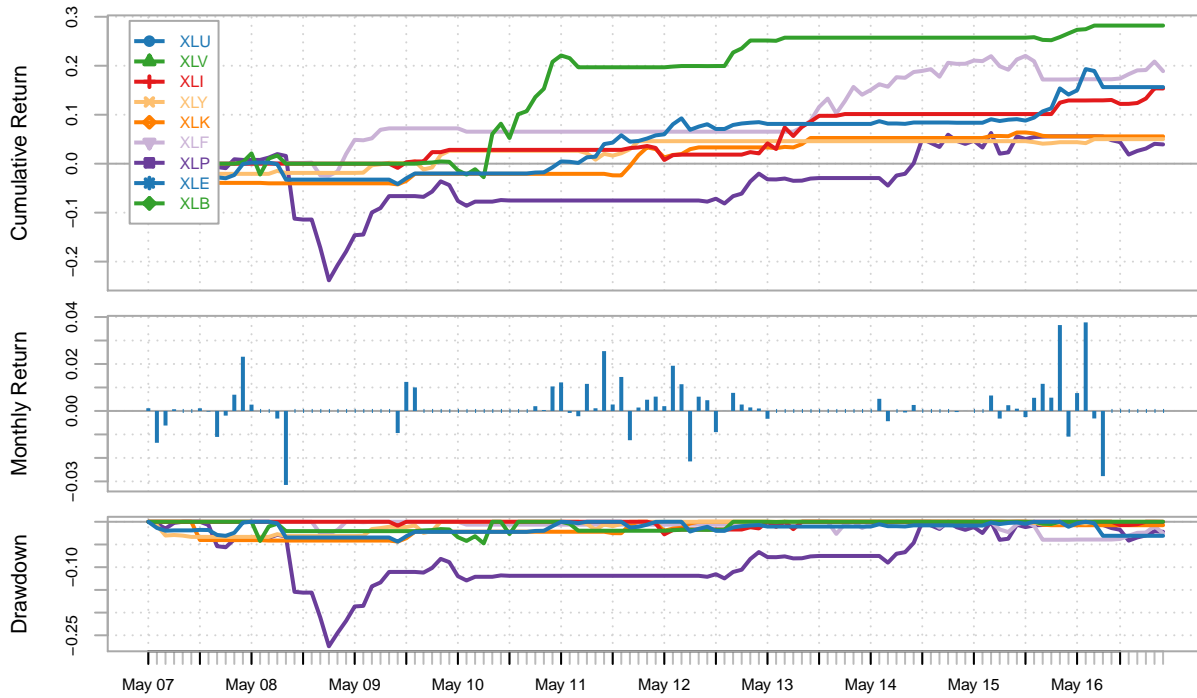
We'll plot the weights generated by your backtesting engine at each iteration over time.



### Plotting Individual Asset Weighted Contribution to Performance

Which assets are the biggest drivers of portfolio risk and return?

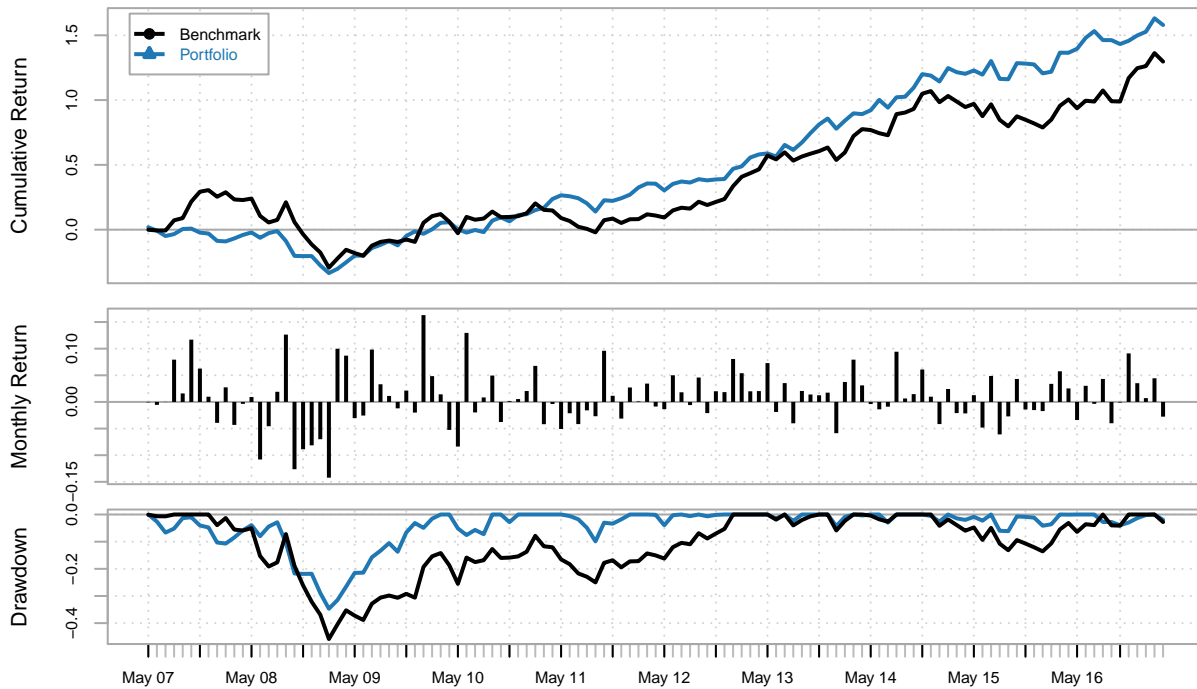
### Cumulative Performance Contribution of All Assets



### Plotting Cumulative Strategy Performance

How well does your portfolio stack up vs the benchmark?

#### Portfolio Performance vs. Benchmark



## Annualized Risk and Return Metrics

Would you rather invest in the benchmark, or in your custom portfolio strategy?

##		Benchmark	Portfolio
## Annualized Return		0.0875	0.1003
## Annualized Std Dev		0.1779	0.1288
## Annualized Sharpe (Rf=0%)		0.4917	0.7784

## Suggested Weights for the Next Time Period

These are the weights suggested by your quadratic portfolio strategy and backtesting engine.

##		XLU	XLV	XLI	XLY	XLK	XLF	XLP	XLE	XLB
## Oct 2016		0	0	0.36	0	0	0.06	0.50	0.09	0.00
## Nov 2016		0	0	0.00	0	0	0.05	0.58	0.13	0.24
## Dec 2016		0	0	0.50	0	0	0.18	0.24	0.08	0.00
## Jan 2017		0	0	0.44	0	0	0.22	0.28	0.06	0.00
## Feb 2017		0	0	0.47	0	0	0.28	0.20	0.06	0.00
## Mar 2017		0	0	0.02	0	0	0.55	0.29	0.14	0.00