Algorithmic Trading using Machine Learning

By:
Raj Sharma
14B00081

Project Supervisor:
Ms. Ankita Dewan

Introduction

- Algorithmic trading is a process of using computer program to follow a defined set of instructions for placing a trade in order to generate profits at a speed and frequency that is impossible for a human trader.
- Rules are based on timing, price, quantity or any mathematical model.
- Trading algorithms - Moving average, Seasonality, Sentiment.

Goals & Motivation:

- Predicting stock market efficiently has been the holy grail of stock investors and researchers.
- Trades can executed orders at the best possible prices.
- Trade orders are instant and accurate to avoid significant price changes (thereby high chances of execution at desired levels).
- Backtest Testing of algorithm & multiple market conditions.
- Reduces possibility of mistakes by human traders based on emotional and psychological factors.

Literature Review & Challenges:

- Two key features: algorithmic trading's advantage in speed over human trading and the potentially high correlation in algorithmic traders' strategies and actions.
- Algorithmic traders speed advantage over humans & informativeness. (For / Against)
- Efficient Market Hypothesis (EMH) and Random Walk Theory.
- Bitcoin counter EMH.
- Preis on Google Trends
- Helen - Wikipedia usage patterns could indicate a market movement.
- Falinouss work on the Iranian financial market.
- Bollen, Mao & Zeng work on twitter data feed.
- Schumaker and Chen used financial news articles as the learning method.
- Limitations- Data, Sentiments (contex), Hardware, adaptive data analysis

Methodology Used:

- Determining relationship between the variables.
- Backtesting Engine: Quantopian
- Zipline is a Pythonic algorithmic trading library, Backtesting and live-trading.
- Initialize method, handle_data
- Alpha - performance return of the company compared to a benchmark
- Beta indicates how much the algorithm acted against the market(Volatility).
- Sharpe -risk assessment indicator helps to compare an strategy to another to to find the safer risk free approach. (1- desirable).
- Buying Strategy - moving average, Sentiment score (Sentdex)
- Selling Strategy
- Machine Learning Approach

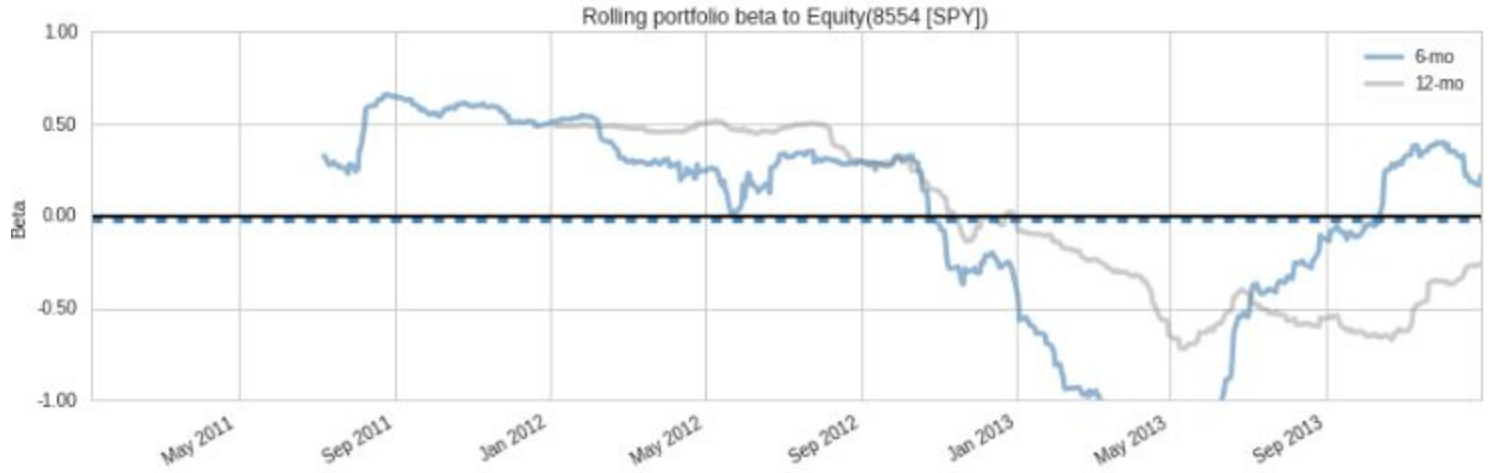
Simple Moving Averages Strategy

- Stock
- Benchmark

Cumulative returns
Equity(8554 [SPY])
Backtest
Cumulative returns
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
May 2011
Sep 2011
Jan 2012
May 2012
Sep 2012
Jan 2013
May 2013
Sep 2013

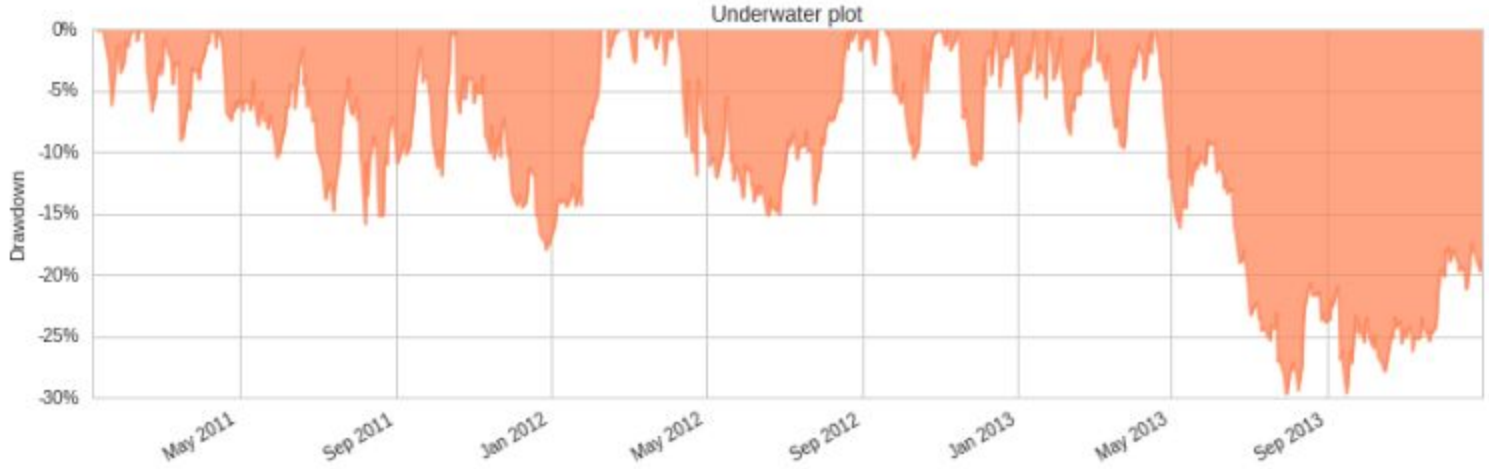
Cumulative returns volatility matched to benchmark
Cumulative returns
1.60
1.40
1.20
1.00
0.80
May 2011
Sep 2011
Jan 2012
May 2012
Sep 2012
Jan 2013
May 2013
Sep 2013

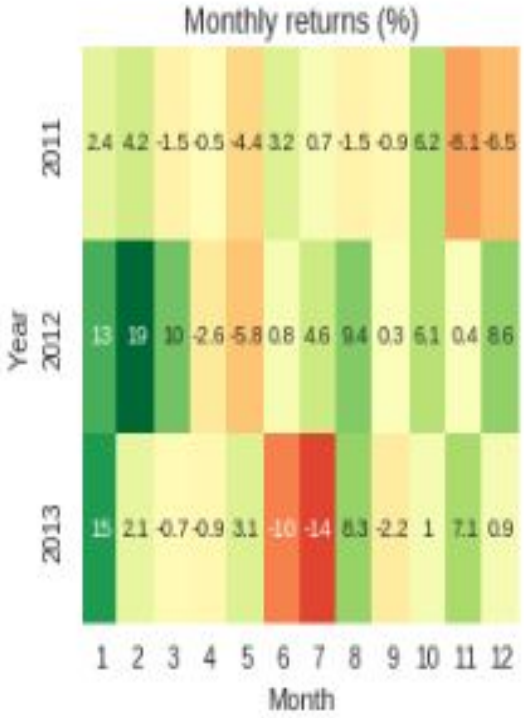
Returns
Returns
0.15
0.10
0.05
0.00
−0.05
−0.10
May 2011
Sep 2011
Jan 2012
May 2012
Sep 2012
Jan 2013
May 2013
Sep 2013

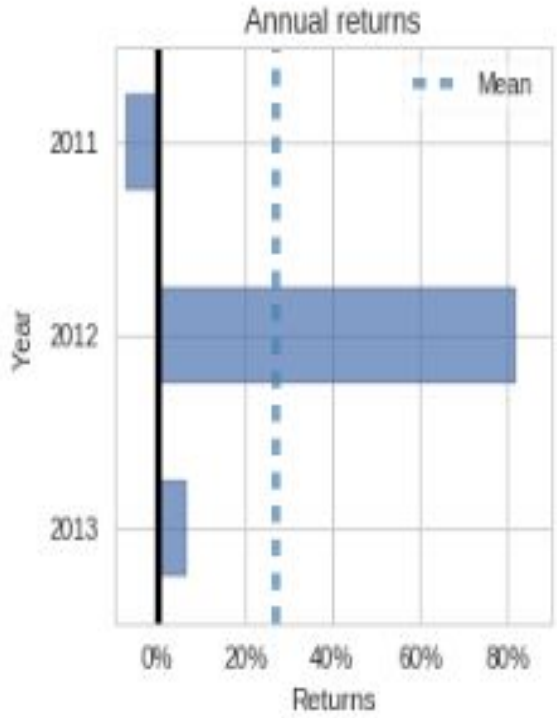

Rolling portfolio beta to Equity(8554 [SPY])
Beta
1.00
0.50
0.00
-0.50
-1.00
6-mo
12-mo
May 2011
Sep 2011
Jan 2012
May 2012
Sep 2012
Jan 2013
May 2013
Sep 2013

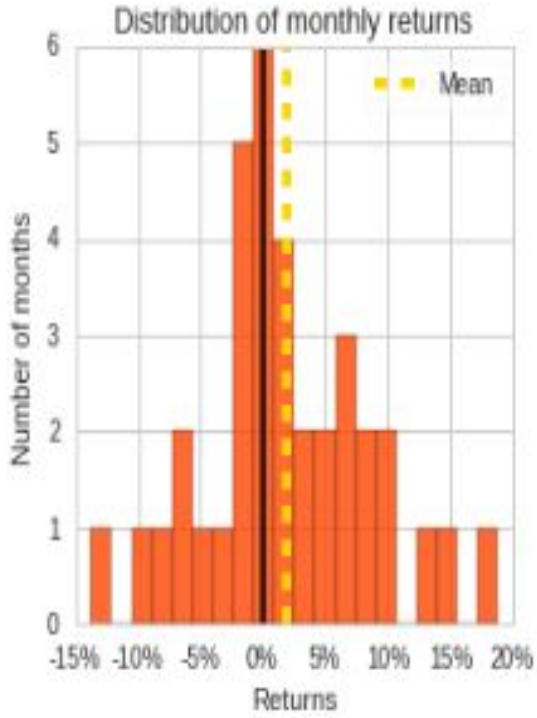
Rolling Sharpe ratio (6-month)
Sharpe ratio
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
May 2011
Sep 2011
Jan 2012
May 2012
Sep 2012
Jan 2013
May 2013
Sep 2013
Sharpe
Average

Top 5 drawdown periods
Portfolio
Cumulative returns
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
May 2011
Sep 2011
Jan 2012
May 2012
Sep 2012
Jan 2013
May 2013
Sep 2013


Underwater plot
Drawdown
0%
-5%
-10%
-15%
-20%
-25%
-30%
May 2011
Sep 2011
Jan 2012
May 2012
Sep 2012
Jan 2013
May 2013
Sep 2013


Monthly returns (%)
Year
2011
2012
2013
2.4 4.2 -1.5 -0.5 -4.4 3.2 0.7 -1.5 -0.9 6.2 -8.1 -6.5
13 19 10 -2.6 -5.8 0.8 4.6 9.4 0.3 6.1 0.4 8.6
15 2.1 -0.7 -0.9 3.1 -10 -14 8.3 -2.2 1 7.1 0.9
1 2 3 4 5 6 7 8 9 10 11 12
Month


Annual returns
Mean
Year
2011
2012
2013
0% 20% 40% 60% 80%
Returns


Distribution of monthly returns
Mean
Number of months
0 1 2 3 4 5 6
-15% -10% -5% 0% 5% 10% 15% 20%
Returns

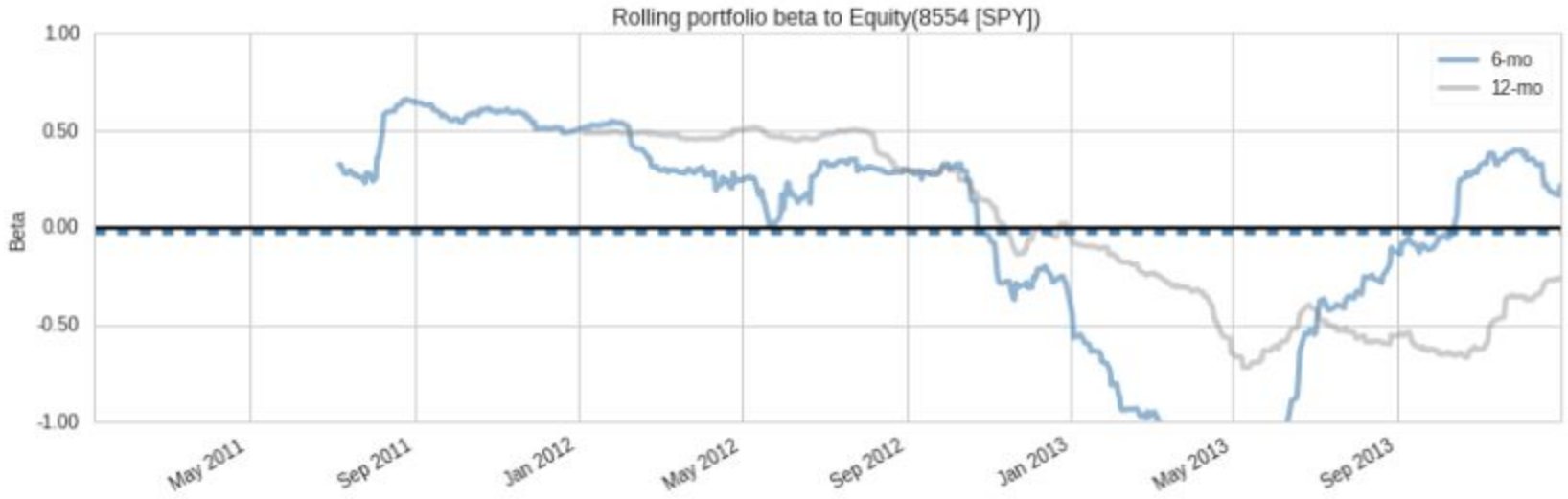
Google Trends Term

- Debt
- S&P500

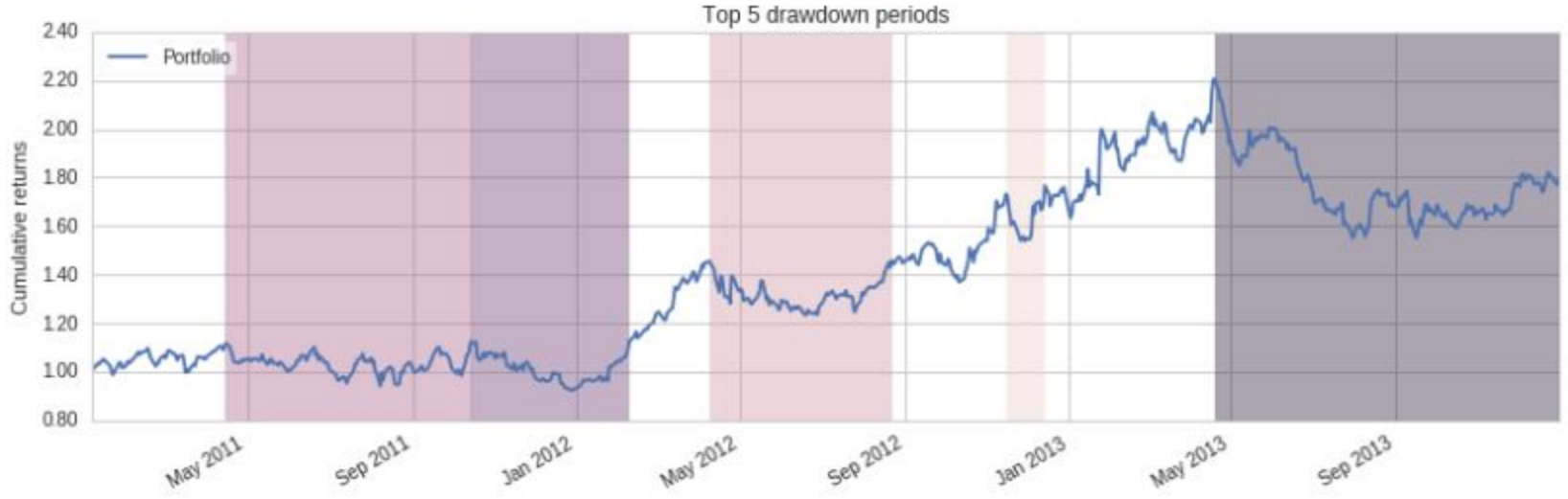
Cumulative returns
Equity(8554 [SPY])
Backtest
Cumulative returns
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
May 2011
Sep 2011
Jan 2012
May 2012
Sep 2012
Jan 2013
May 2013
Sep 2013

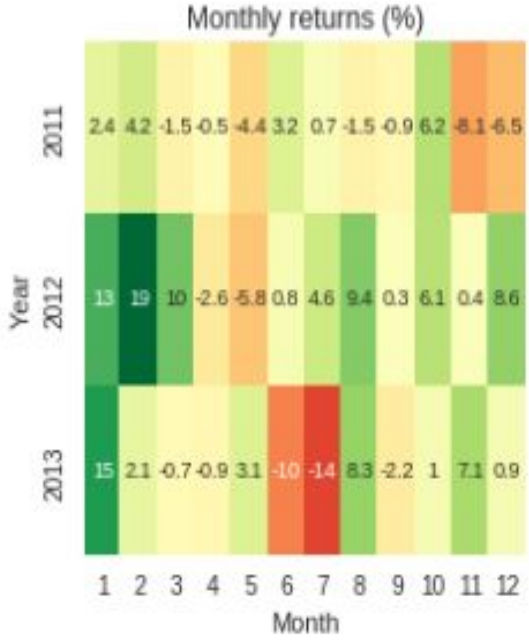
Cumulative returns volatility matched to benchmark
Cumulative returns
1.60
1.40
1.20
1.00
0.80
May 2011
Sep 2011
Jan 2012
May 2012
Sep 2012
Jan 2013
May 2013
Sep 2013

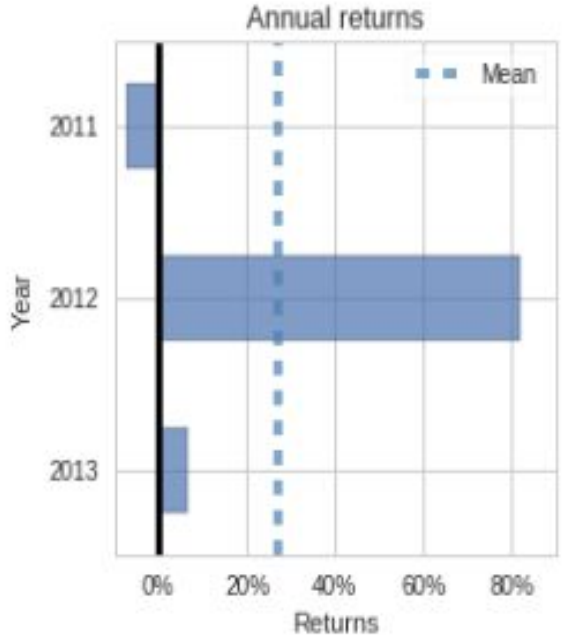
Returns
Returns
0.15
0.10
0.05
0.00
−0.05
−0.10
May 2011
Sep 2011
Jan 2012
May 2012
Sep 2012
Jan 2013
May 2013
Sep 2013

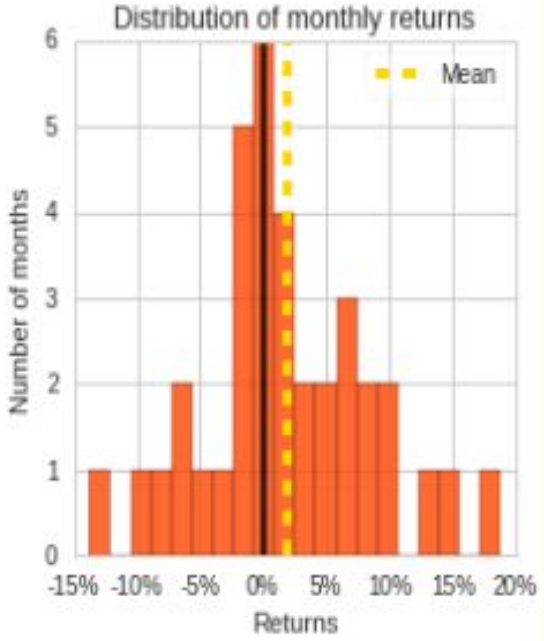

Rolling portfolio beta to Equity(8554 [SPY])
Beta
1.00
0.50
0.00
-0.50
-1.00
6-mo
12-mo
May 2011
Sep 2011
Jan 2012
May 2012
Sep 2012
Jan 2013
May 2013
Sep 2013

Rolling Sharpe ratio (6-month)
Sharpe ratio
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
May 2011
Sep 2011
Jan 2012
May 2012
Sep 2012
Jan 2013
May 2013
Sep 2013
Sharpe
Average


Top 5 drawdown periods
Portfolio
Cumulative returns
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
May 2011
Sep 2011
Jan 2012
May 2012
Sep 2012
Jan 2013
May 2013
Sep 2013


Monthly returns (%)
Year
2011
2012
2013
2.4 4.2 -1.5 -0.5 -4.4 3.2 0.7 -1.5 -0.9 6.2 -8.1 -6.5
13 19 10 -2.6 -5.8 0.8 4.6 9.4 0.3 6.1 0.4 8.6
15 2.1 -0.7 -0.9 3.1 -10 -14 8.3 -2.2 1 7.1 0.9
1 2 3 4 5 6 7 8 9 10 11 12
Month

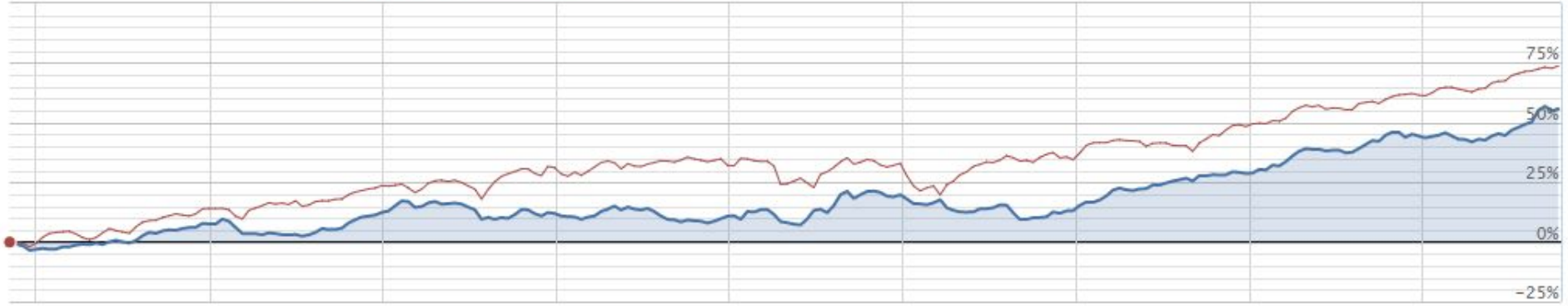

Annual returns
Mean
Year
2011
2012
2013
0% 20% 40% 60% 80%
Returns


Distribution of monthly returns
Mean
Number of months
0 1 2 3 4 5 6
-15% -10% -5% 0% 5% 10% 15% 20%
Returns

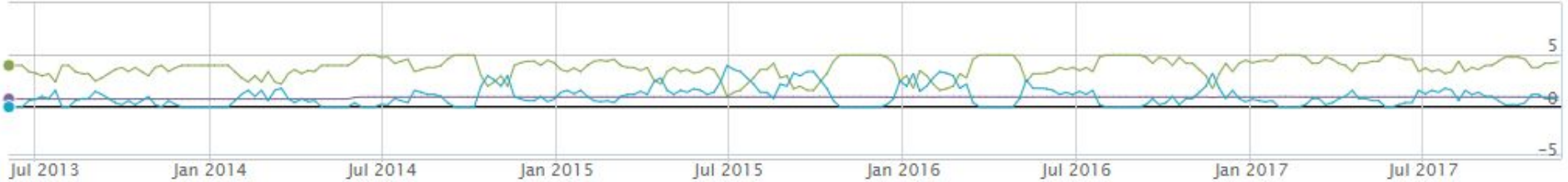
Machine Learning Strategy

Backtest from **2013-06-01** to **2017-11-23** with **$10,000,000** initial capital

Cumulative performance: Algorithm **-0.41%** Benchmark (SPY) **-0.07%** **Week of Jun 3, 2013**



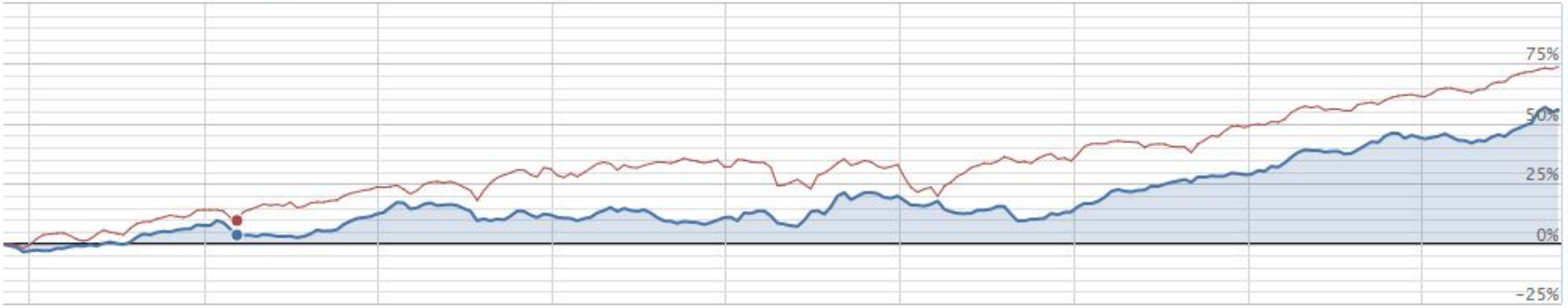
Custom data: num_long 4 leverage 0.76 num_short 0



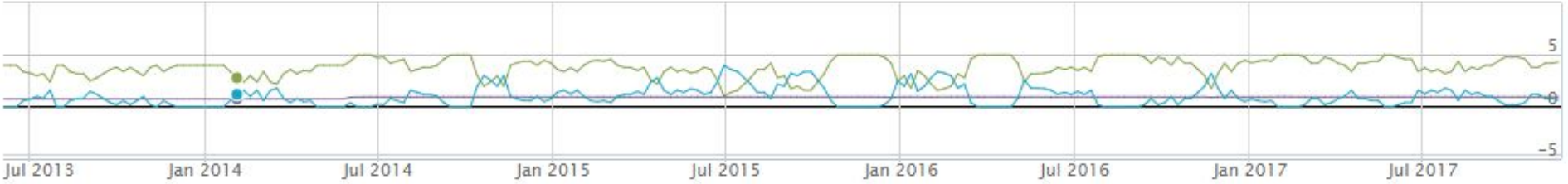
Backtest from **2013-06-01** to **2017-11-23** with **$10,000,000** initial capital

Cumulative performance: Algorithm **3.55%** Benchmark (SPY) **9.59%**

Week of Feb 3, 2014



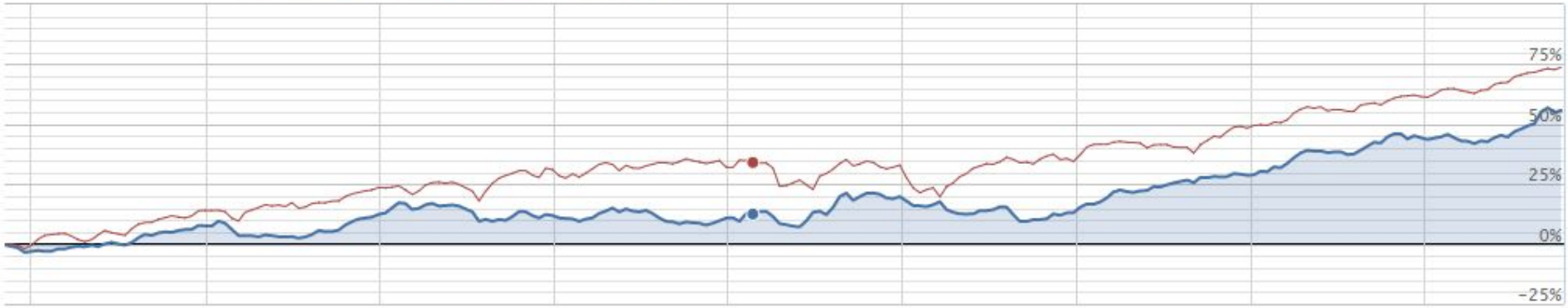
Custom data: num_long 2.8 leverage 0.76 num_short 1.2



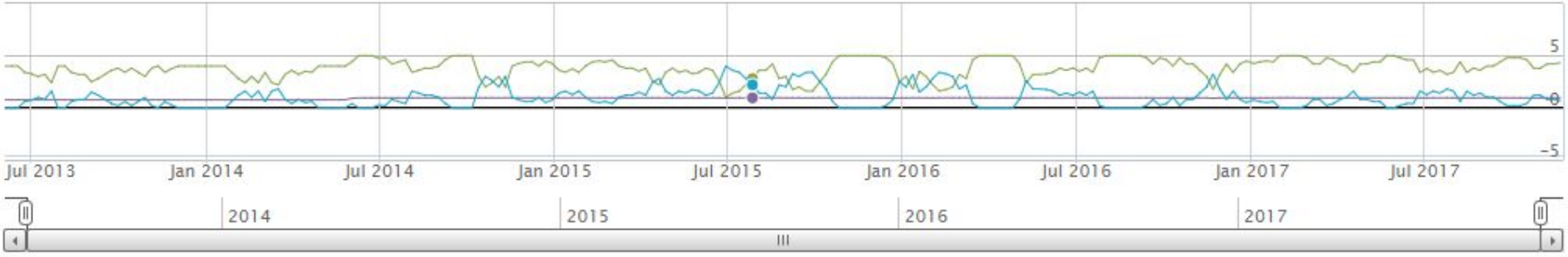
Backtest from **2013-06-01** to **2017-11-23** with **$10,000,000** initial capital

Cumulative performance: Algorithm 12.53% Benchmark (SPY) 34.04%

Week of Jul 27, 2015



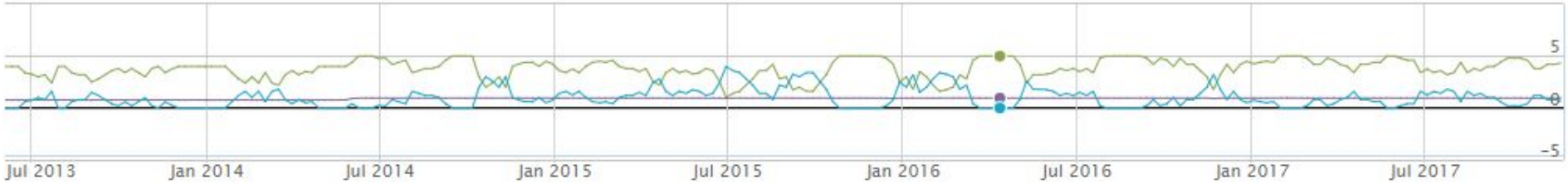
Custom data: num_long 2.8 leverage 0.95 num_short 2.2



Backtest from **2013-06-01** to **2017-11-23** with **$10,000,000** initial capital

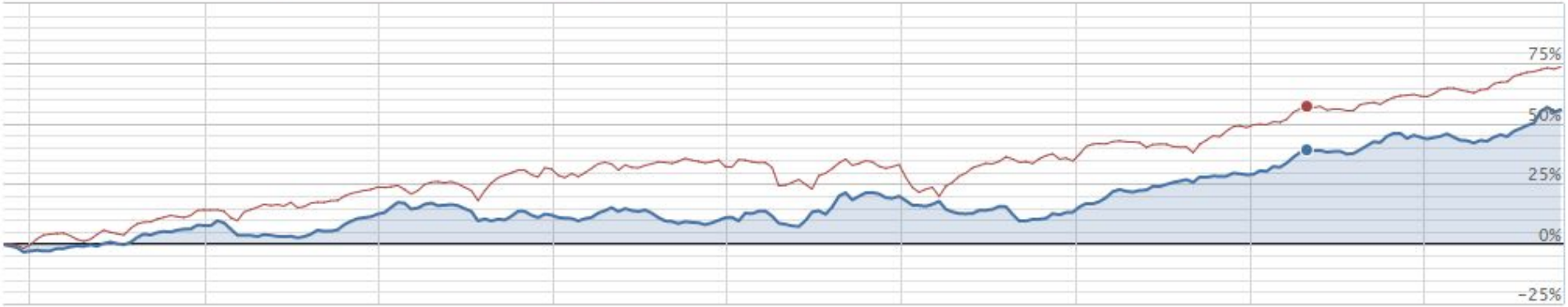
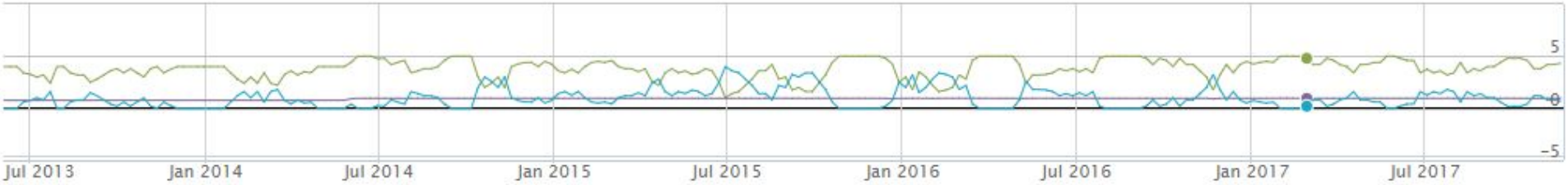
Cumulative performance: Algorithm **15.6%** Benchmark (SPY) **34.38%** Week of Apr 11, 2016

Custom data: num_long 5 leverage 0.95 num_short 0



Backtest from **2013-06-01** to **2017-11-23** with **$10,000,000** initial capital

Cumulative performance: Algorithm **39.08%** Benchmark (SPY) **57.23%** **Week of Feb 27, 2017**



Custom data: num_long 4.8 leverage 0.95 num_short 0.2