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CS 7646 – MC3P2
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Machine Learning for Trading
MC3-P2: Build a Trading Learner

Overview of Approach and Indicators: For this project I choose to use a modified version of my KNN Learner from MC3-Project 1 to server as the 'learner' behind my trading strategy. The indicators I selected to utilize for this project were:

X1: Normalized Bollinger Band Feature
X2: Normalized Momentum
X3: Normalized Rolling Standard Deviation of SMA
Y: 5-Day future return (proxy for predicting future price movements)

Datasets from these indicators were inputted into my modified KNN Learner for training and testing purposes (in and out of sample). A brief outline of my approach to each indicator, and overall trading policy has been provided below.

X1: Normalized Bollinger Band Feature – for this I used my existing Bollinger Band code and normalized it per the code snippet provide below.

```
# X1 Indicator: Normalized Boilinger Band Feature
# bb_value[t] = (price[t] - SMA[t])/(2 * stdev[t])
trainX[counter - 20, 0] = (prices_data.ix[counter][symbol] - temp_sma_df.mean()) / (2 * temp_sma_df.std())
```

X2: Normalized Momentum – for this I adapted the pseudo code provided in the course wiki per the code snippet provided below.

```
# X2 Indicator: Normalized Momentum
# momentum[t] = (price[t]/price[t-N]) - 1
trainX[counter - 20, 1] = ((prices_data.ix[counter][symbol] / prices_data.ix[counter - 19][symbol])) - 1
```

X3: Normalized Rolling Standard Deviation of SMA – this was a basic indicator I added to track the movements of the rolling standard deviation of the assets simple moving average.

Trading Strategy Overview: I followed a similar trading strategy to the one suggested on the course wiki page, with a few minor modifications I found to improve results. My strategy was as follows:

- Price Forecast (Prediction) Threshold: 0.05% or -0.05%
- Share Amount (Buy/Sell): 100
- Holding Period = 5 Days
- Starting Portfolio Value = $10,000

Based on predicted data from my KNN leaner, my trading agent executed trades when forecasted data indicated movements above of below a particular threshold. I originally used a threshold of 1%, but after further testing decided I wanted to make my agent even more sensitive to predicated data.

- When my forecaster predicted a future price movement (5 day window) of negative .05%, a short sell of 100 shares was triggered. Once the specified holding period (5 trading days) was reached, an exit was triggered.
- When my forecaster predicted a future price movement (5 day window) or positive .05% growth, a buy order of 100 shares was triggered. Once the specified holding period (5 trading days) was reached, an exit was triggered.

Discussion of Results: A snapshot of my results using SINE &IBM data is provided below.

SINE DATA:

Data Range: 2007-12-31 to 2009-12-31
RMSE: 0.000489858626518
corr: 0.999994352754
Average Daily Return of Fund: 0.00143110790718
Average Daily Return of SPY: -0.000206479400499
Final Portfolio Value: 19114.8494

Data Range: 2009-12-31 to 2010-12-31
RMSE: 0.00184003058165
corr: 0.999921037189
Average Daily Return of Fund: 0.001943510885
Average Daily Return of SPY: 0.000604173932453
Final Portfolio Value: 15744.054

IBM DATA:

Data Range: 2007-12-31 to 2009-12-31
RMSE: 0.033015636321
corr: 0.647893616273
Average Daily Return of Fund: 0.00154943169043
Average Daily Return of SPY: -0.000206479400499
Final Portfolio Value: 21234.0

Data Range: 2009-12-31 to 2010-12-31
RMSE: 0.0317172844637
corr: 0.0160994792001
Average Daily Return of Fund: 0.00102531028247
Average Daily Return of SPY: 0.000604173932453
Final Portfolio Value: 12752.0

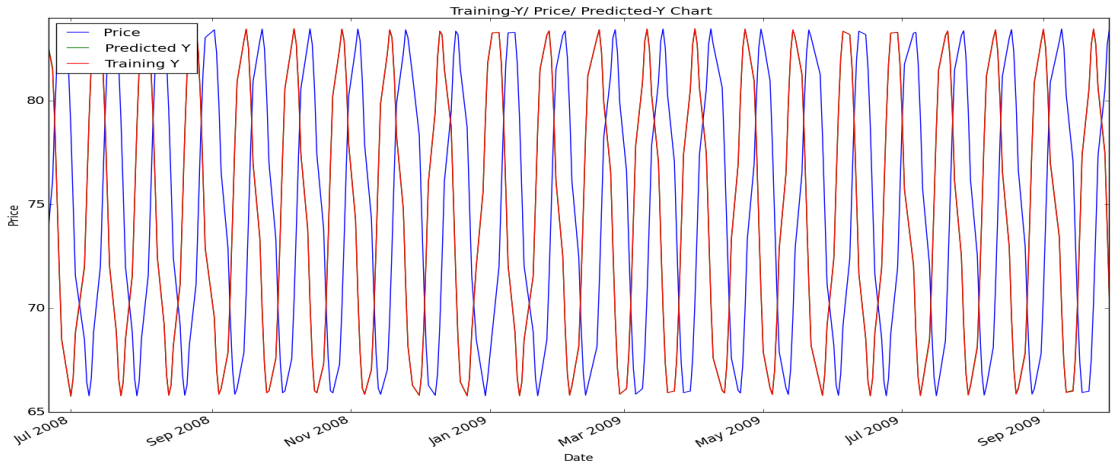
In order to improve my strategy, I would explore adding additional indicators as well as adding functionally to dynamically weight buy/sell amounts based on the strength of the associated indicator. Although this may add additional risk into the portfolio, if leveraged properly I think it could significantly improve expected returns.

Resources Consulted

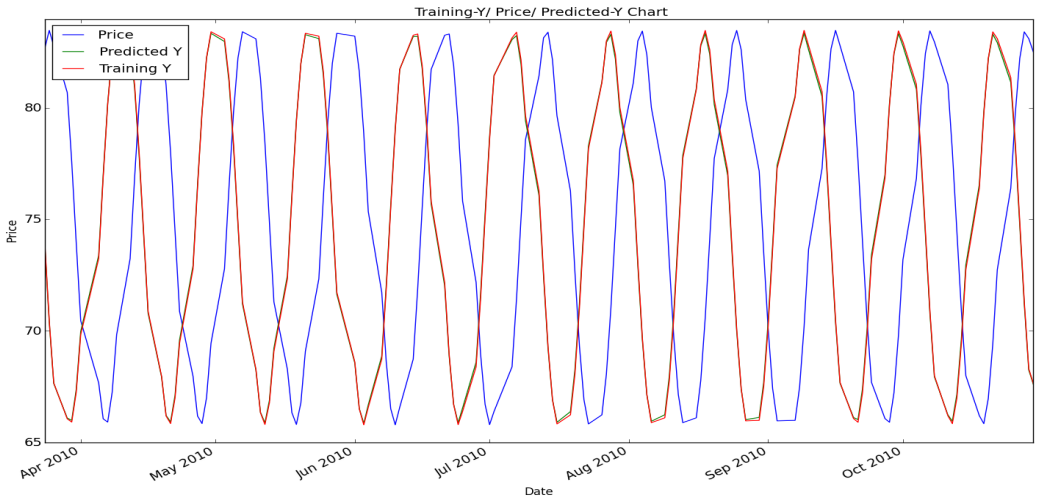
1. Course Piazza Page (all- @1383, @1370, @1332, @1326, @1366, @1219…)
2. http://quantsoftware.gatech.edu/MC3-Project-1#Hints_.26_resources
3. http://docs.scipy.org/doc/numpy/reference/generated/numpy.argsort.html
4. https://www.youtube.com/watch?v=0fEcg_ZsYNY
5. http://pandas.pydata.org/pandas-docs/stable/timeseries.html
6. http://stackoverflow.com/questions/28356492/how-to-create-all-zero-dataframe-in-python
7. http://pandas.pydata.org/pandas-docs/stable/indexing.html
8. http://stackoverflow.com/questions/16476924/how-to-iterate-over-rows-in-a-dataframe
9. http://docs.scipy.org/doc/numpy/reference/generated/numpy.sum.html

Plot 1A – SINE Data: Training Y, Predicted Y, and Price (In & Out of Sample)

In Sample Plot:



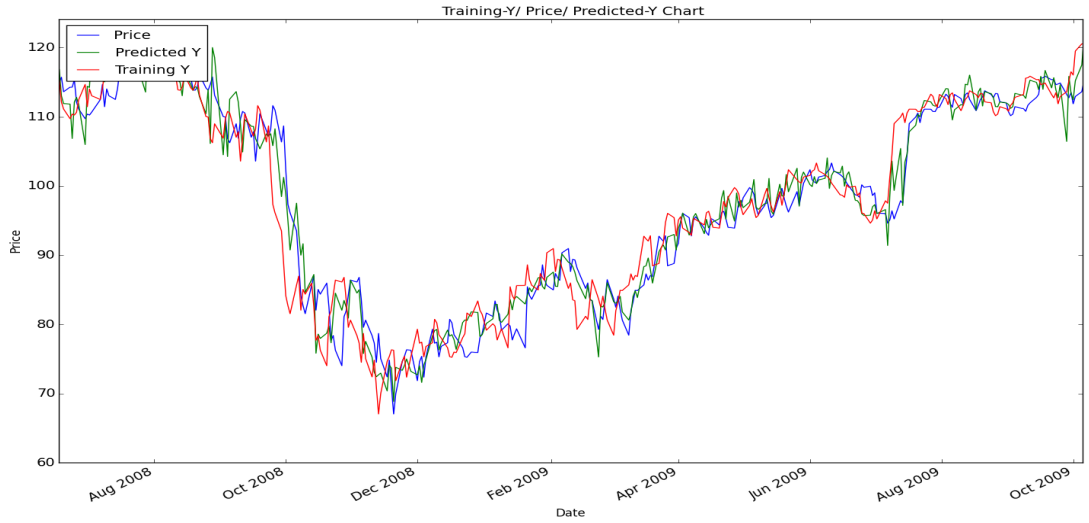
Out of Sample Plot:



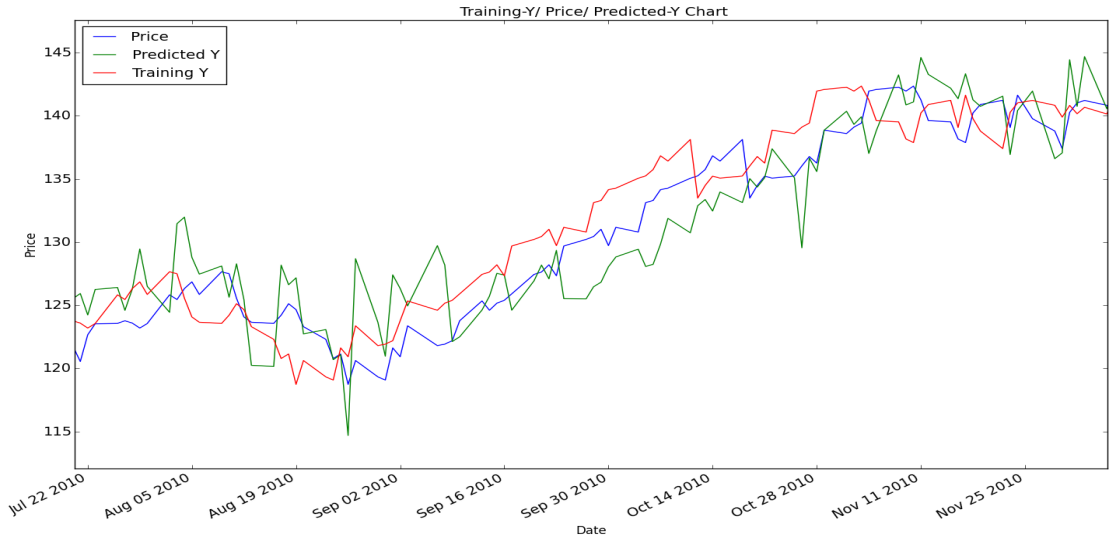
Price: Blue Line
Training Y: Red Line
Predicted Y: Green Line *(Note: overlays very closely with Training Y)*

Plot 1B – IBM Data: Training Y, Predicted Y, and Price (In & Out of Sample)

In Sample Plot:



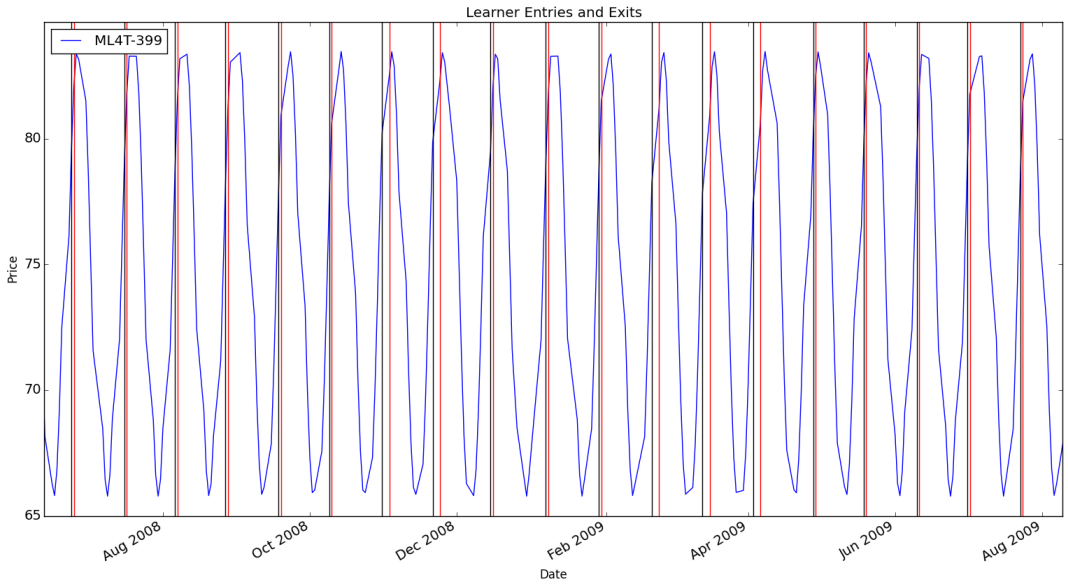
Out of Sample Plot:



Price: Blue Line
Training Y: Red Line
Predicted Y: Green Line

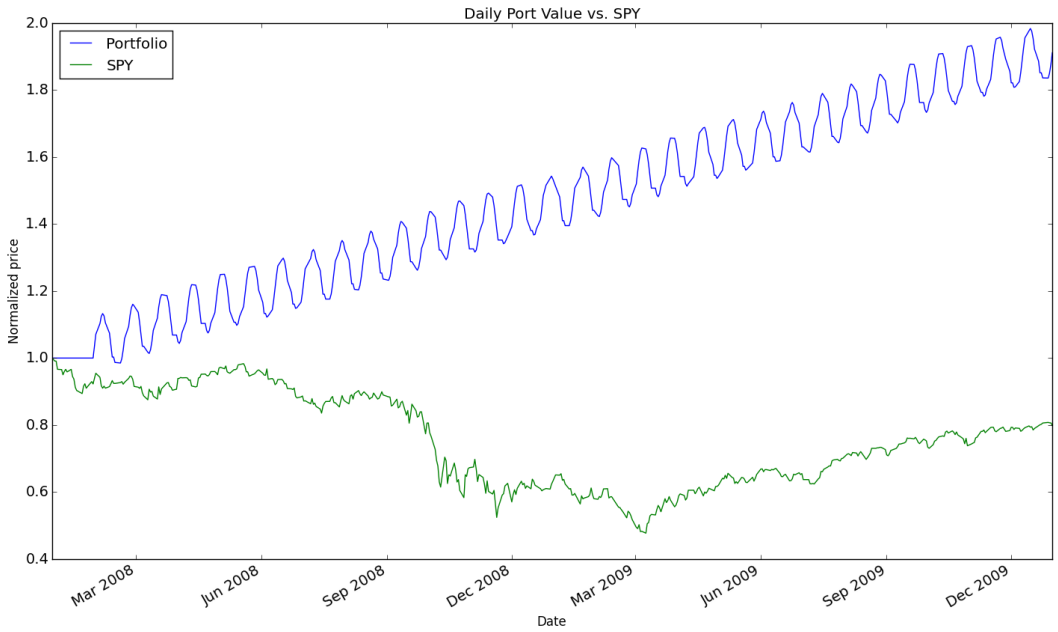
Plot 2: Sine Data Entries/Exits (In Sample)

Green Bar = long entry Red Bar = short entry Black Bar = short/long exit



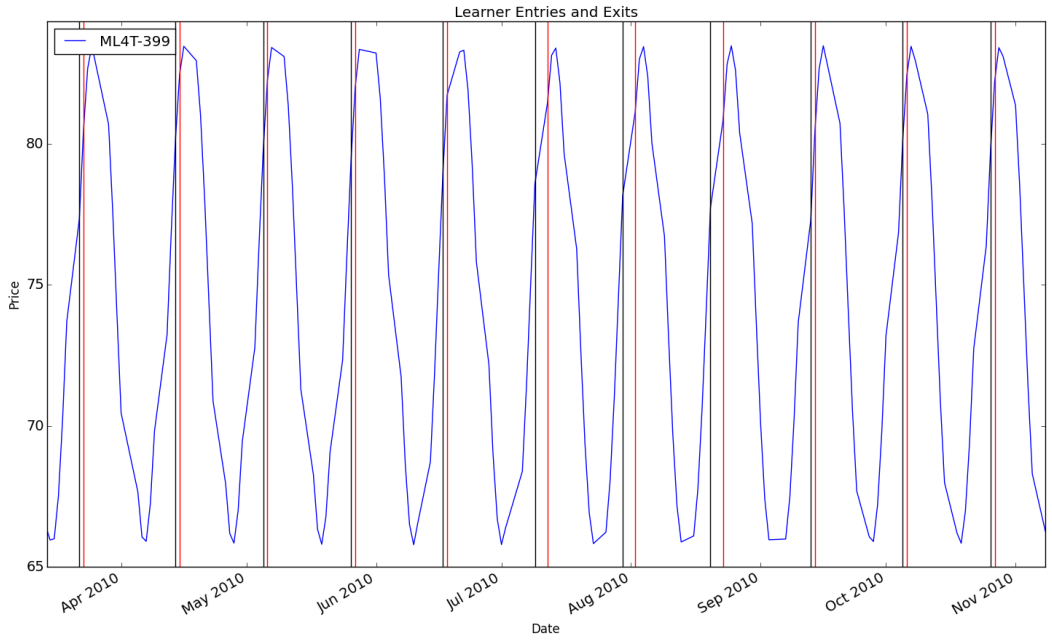
Plot 3: Sine Data Backtest (In Sample)

Green Line = SPY Blue Line = Portfolio



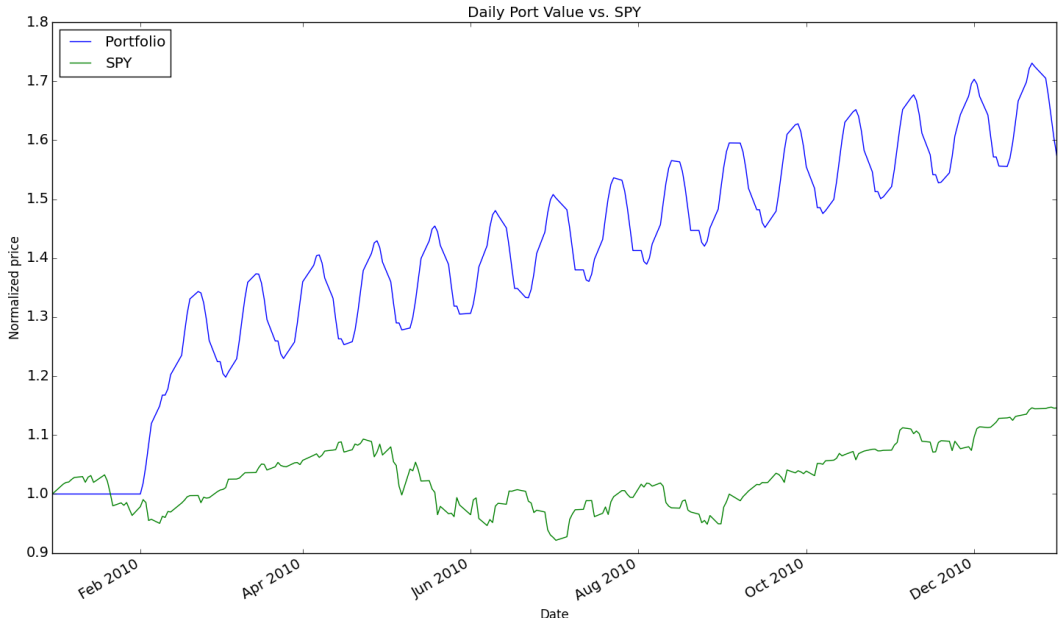
Plot 4: Sine Data Entries/Exits (Out of Sample)

Green Bar = long entry Red Bar = short entry Black Bar = short/long exit



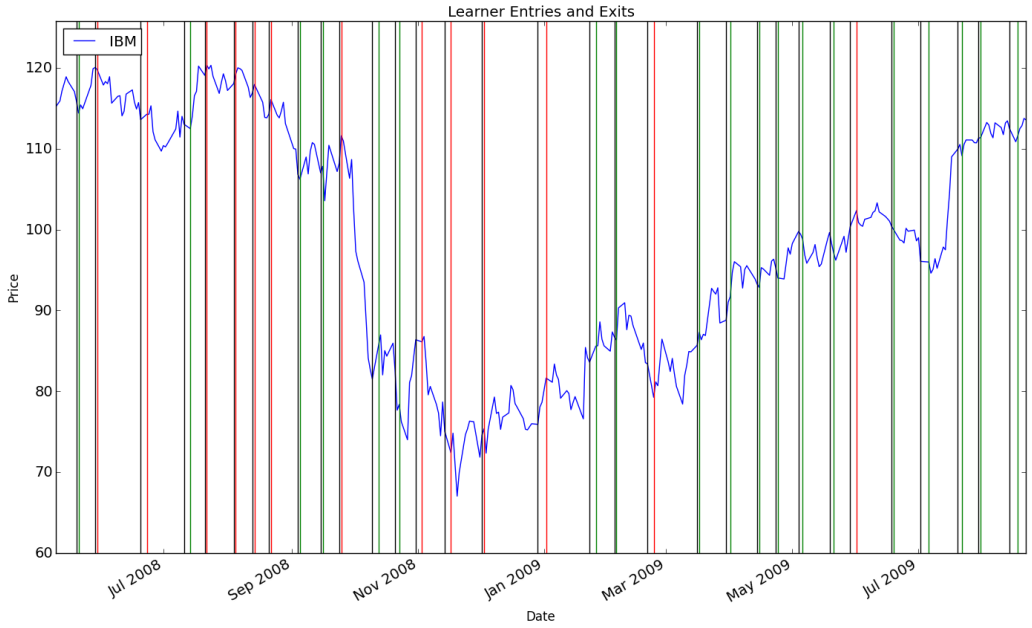
Plot 5: Sine Data Backtest (Out of Sample)

Green Line = SPY Blue Line = Portfolio



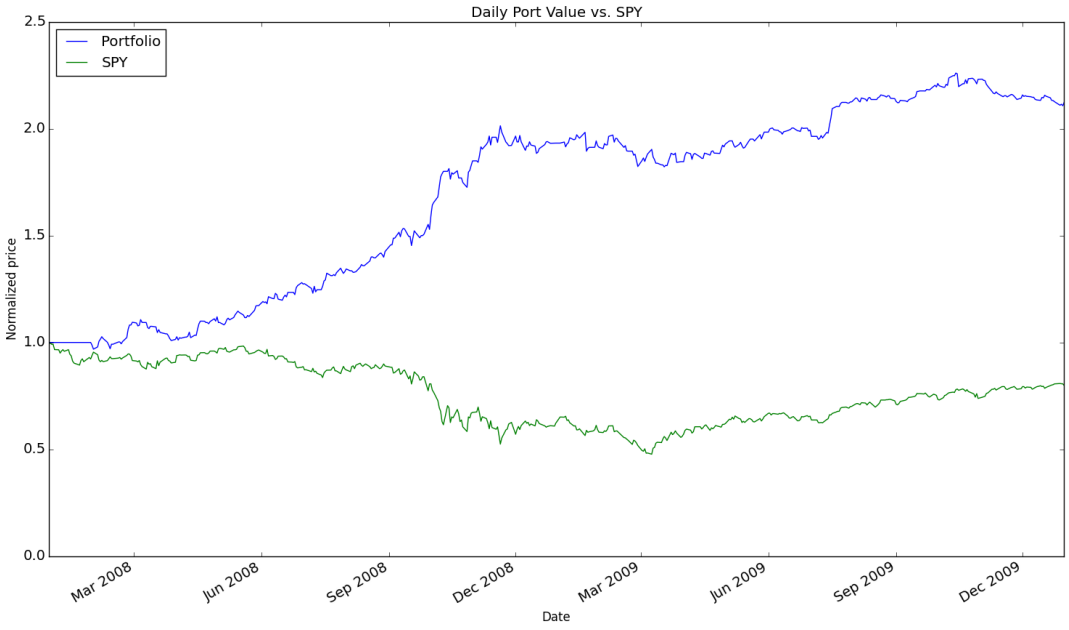
Plot 6: IBM Data Entries/Exits (In Sample)

Green Bar = long entry Red Bar = short entry Black Bar = short/long exit



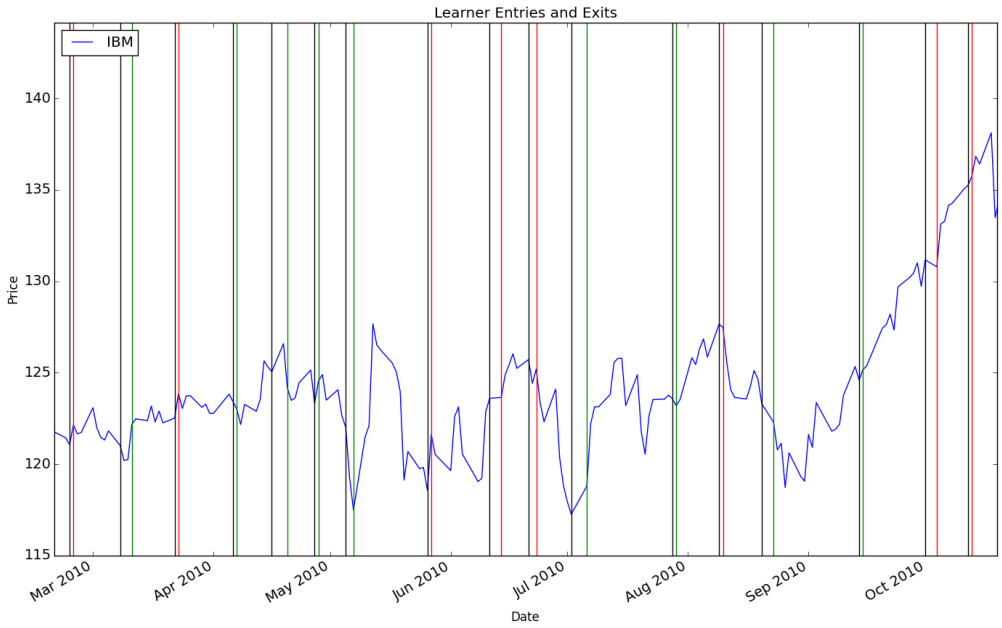
Plot 7: IBM Data Backtest (In Sample)

Green Line = SPY Blue Line = Portfolio



Plot 8: IBM Data Entries/Exits (Out of Sample)

Green Bar = long entry Red Bar = short entry Black Bar = short/long exit



Plot 9: IBM Data Backtest (Out of Sample)

Green Line = SPY Blue Line = Portfolio