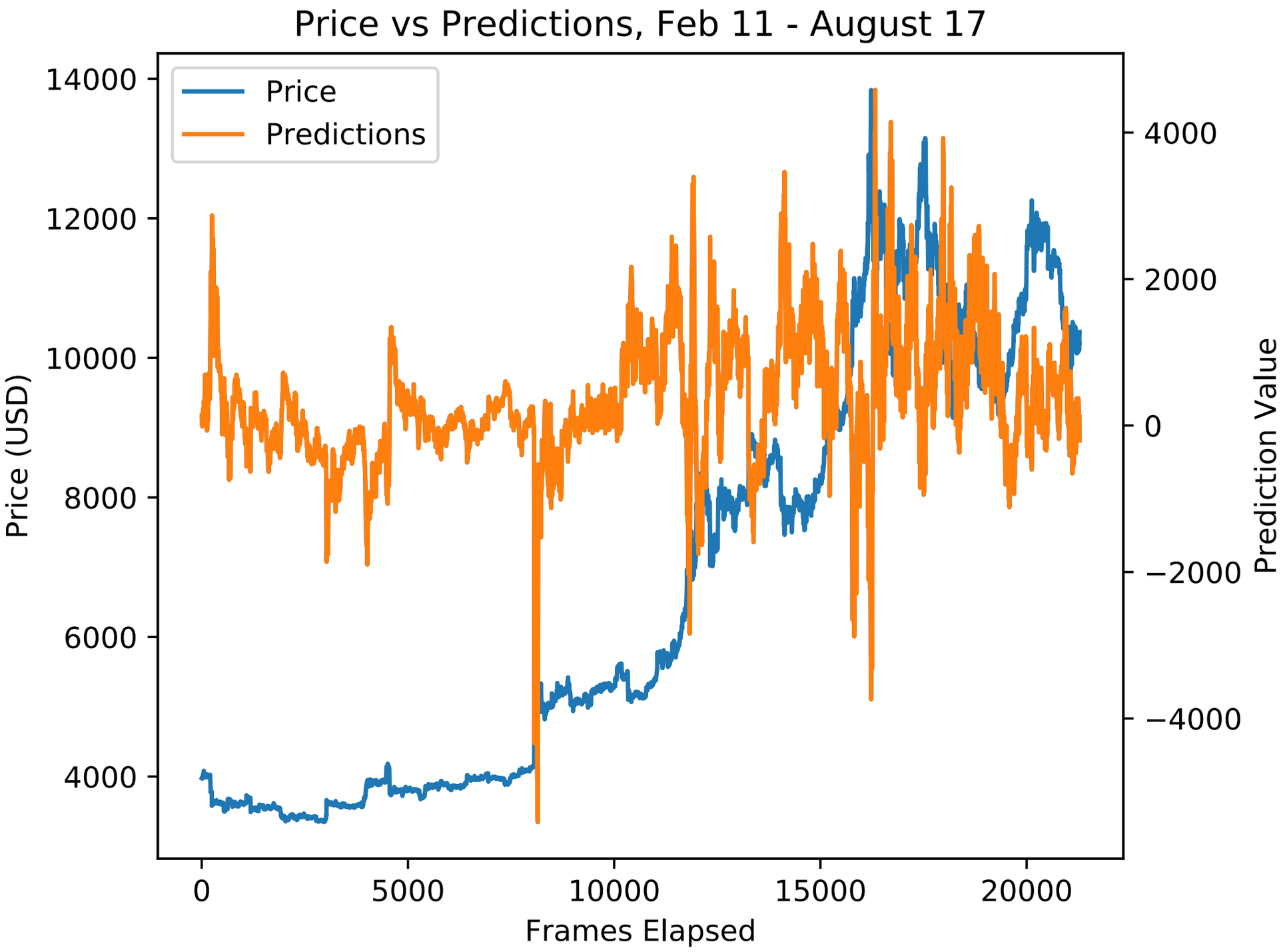
TradeBot:
Predicting and Trading Cryptocurrencies With Machine Learning

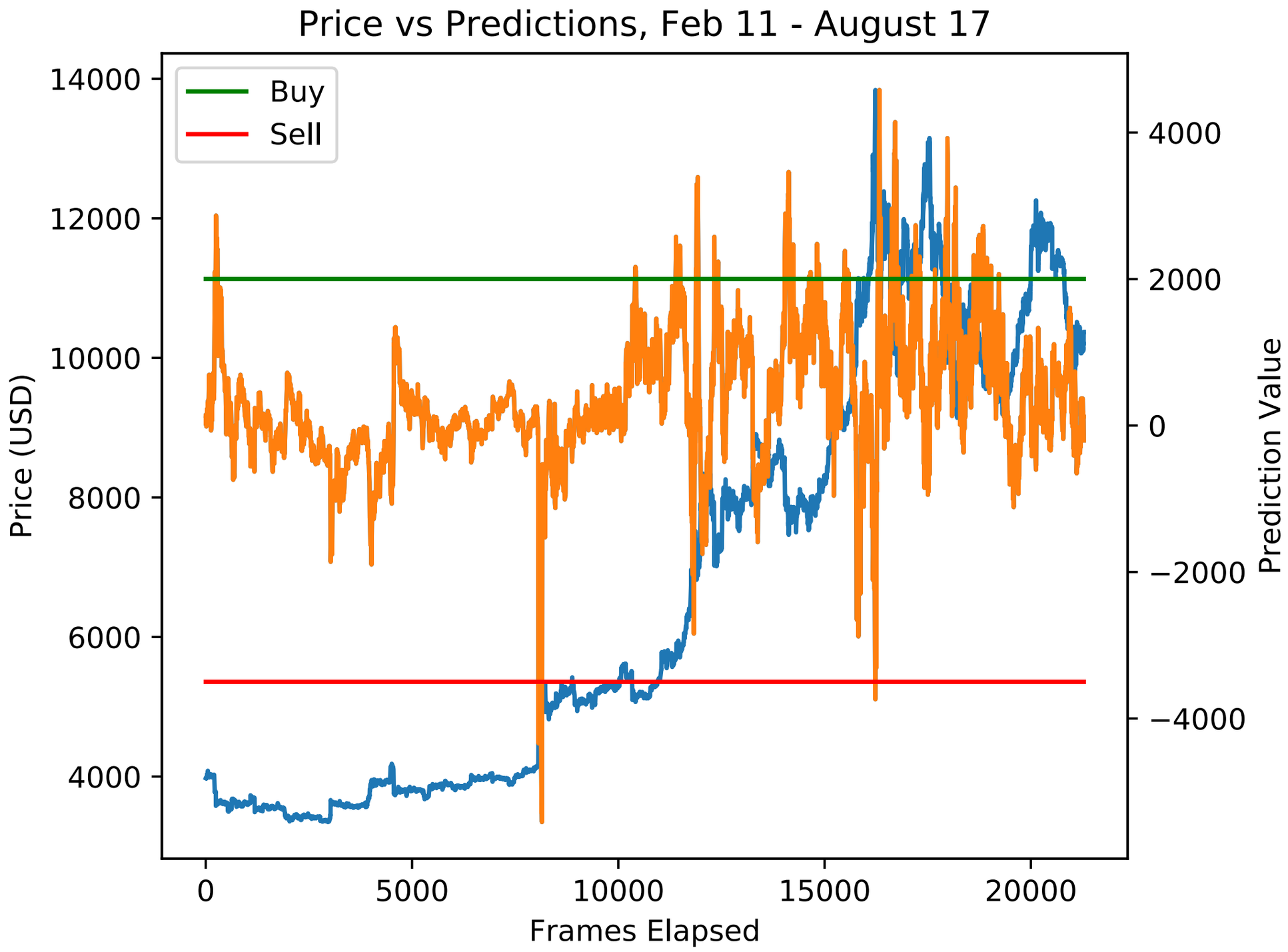
Technical Deck: Results and Methods

August 17, 2019

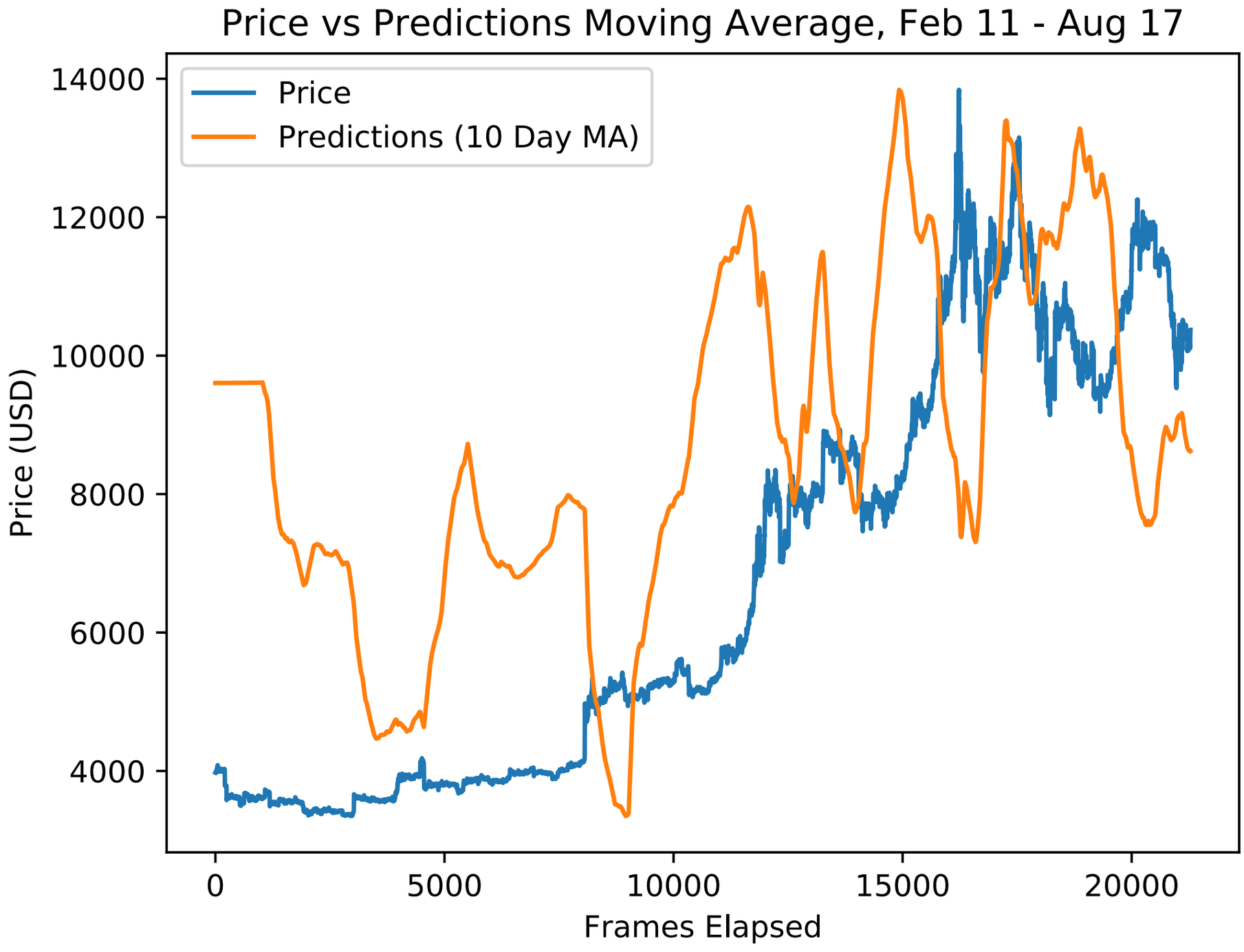
Raw Predictions
Higher Values = Better Time to Buy
Lower Values = Better Time to Sell



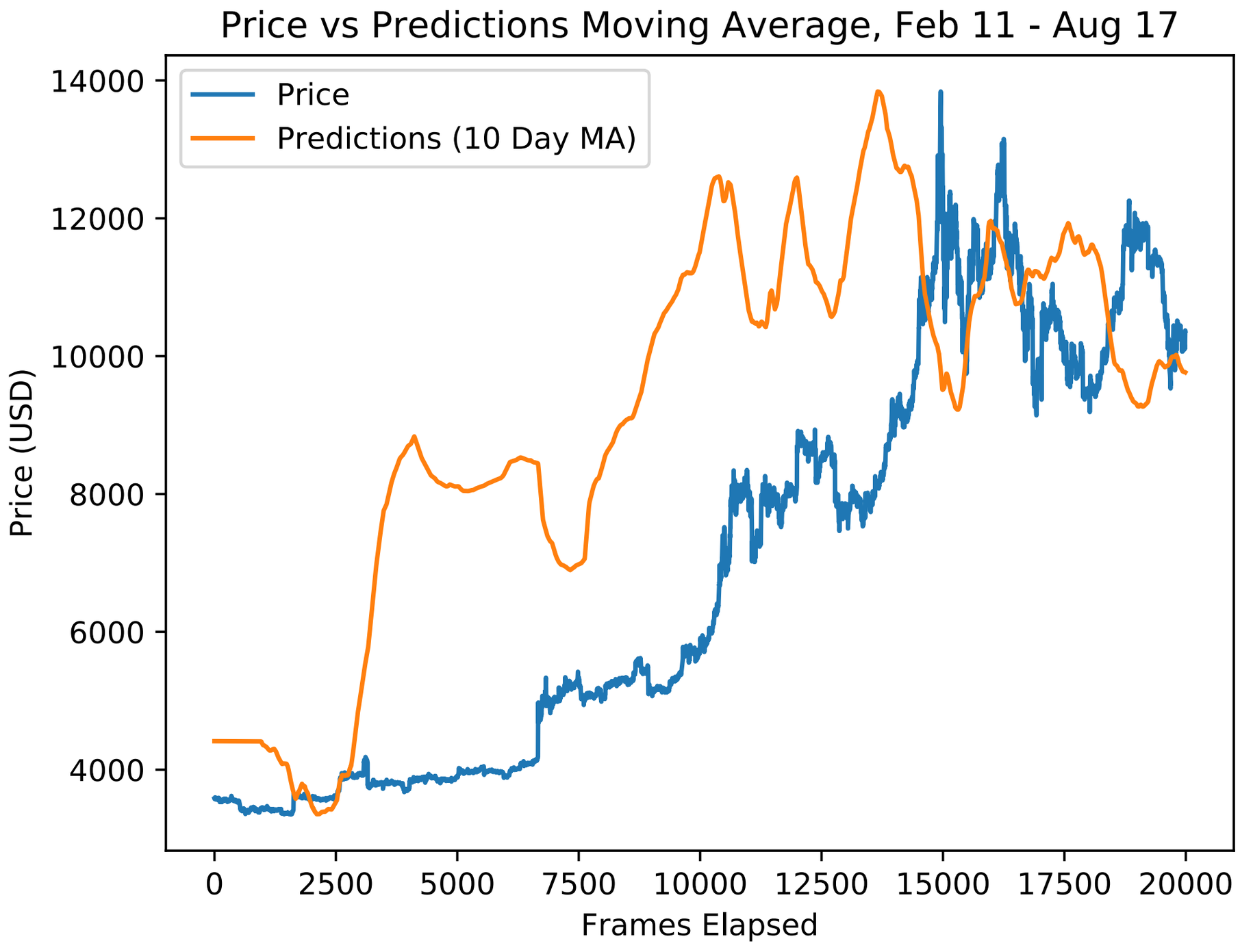
Raw Predictions with Best Path Threshold:
Buy at 2000, Sell at -3500
Wallet = 292, Wallet / Market = 110



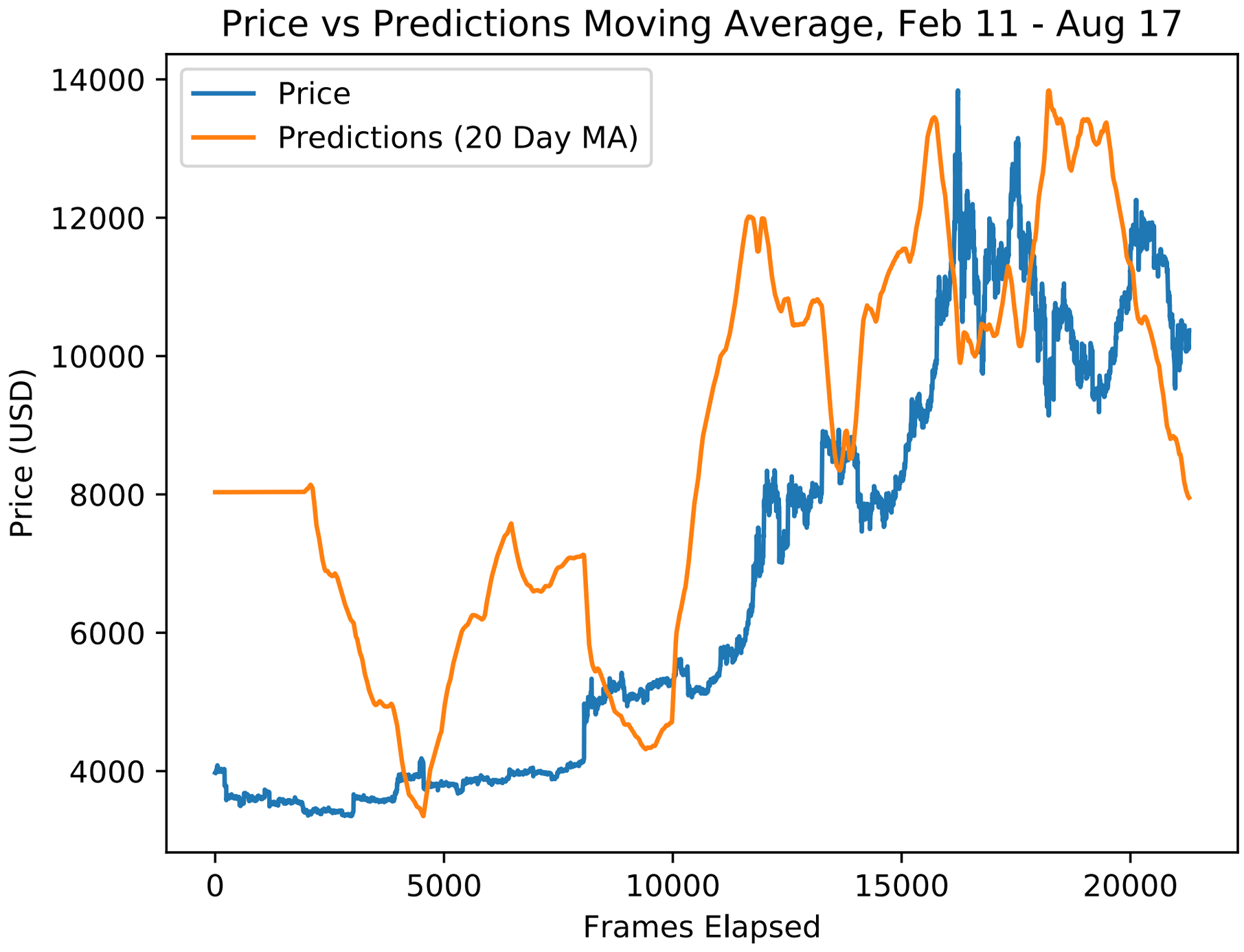
Raw Predictions 10 Day MA
(Predictions Normalized to Price)



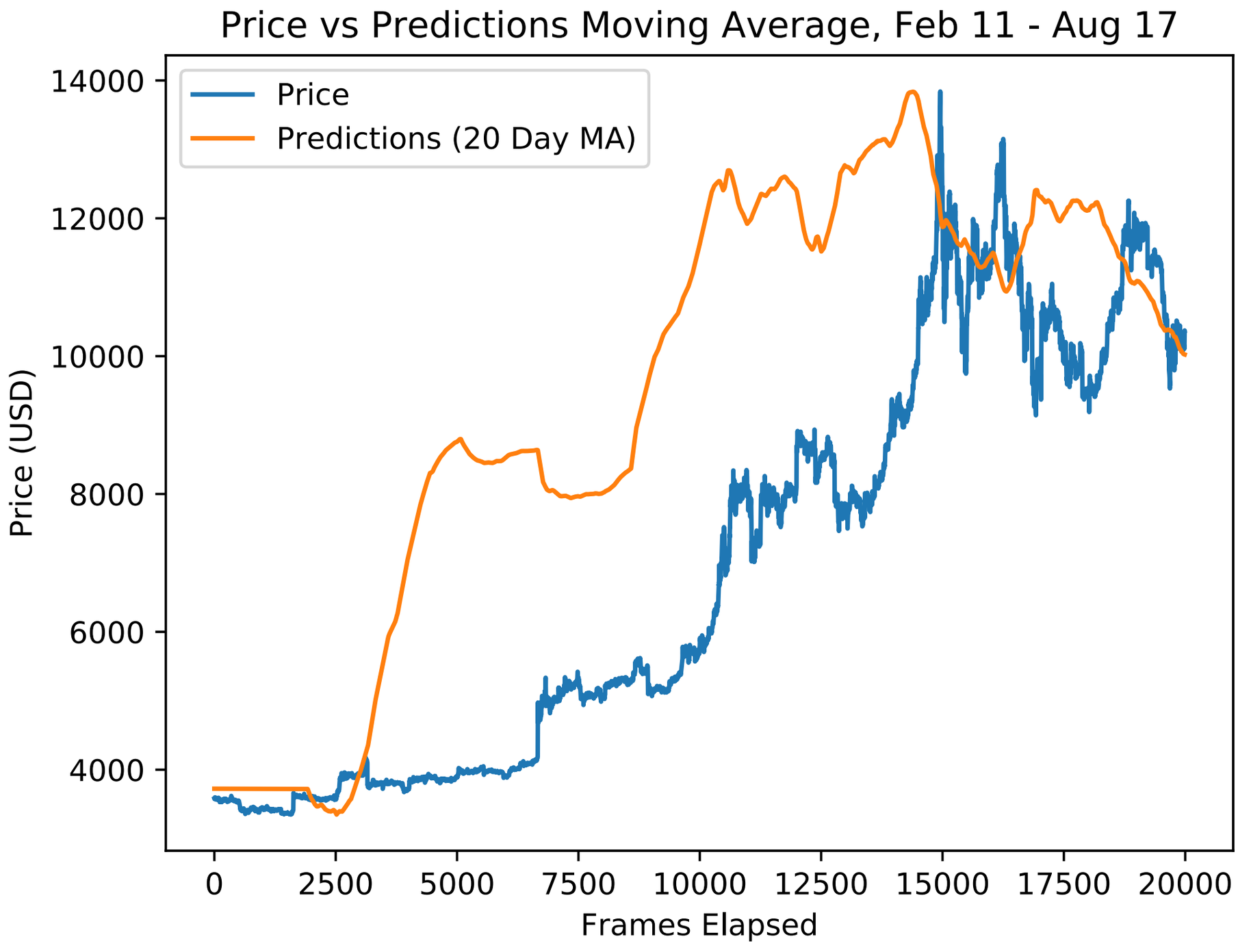
Adjusted Predictions 10 Day MA
(Predictions Normalized to Price)



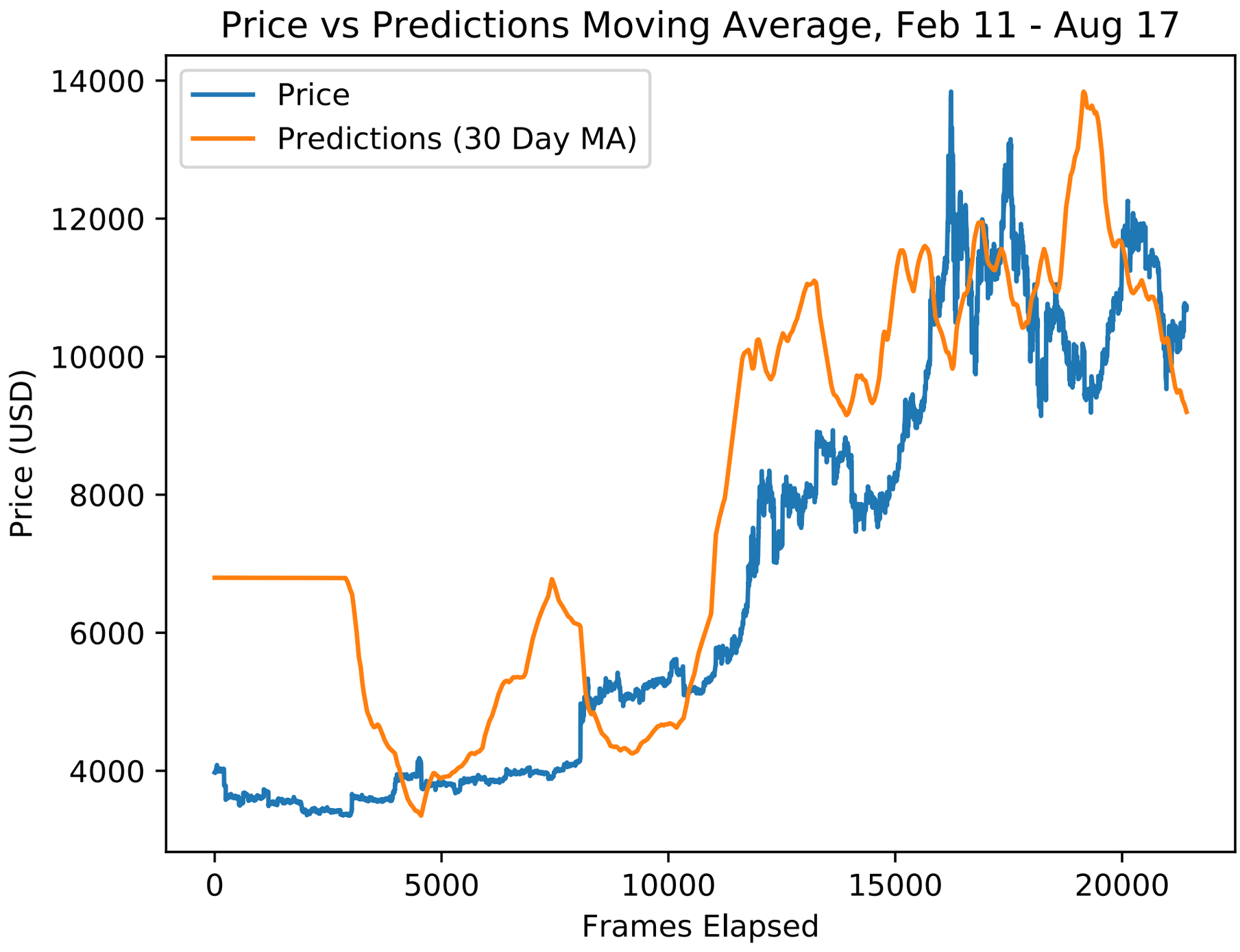
Raw Predictions 20 Day MA
(Predictions Normalized to Price)



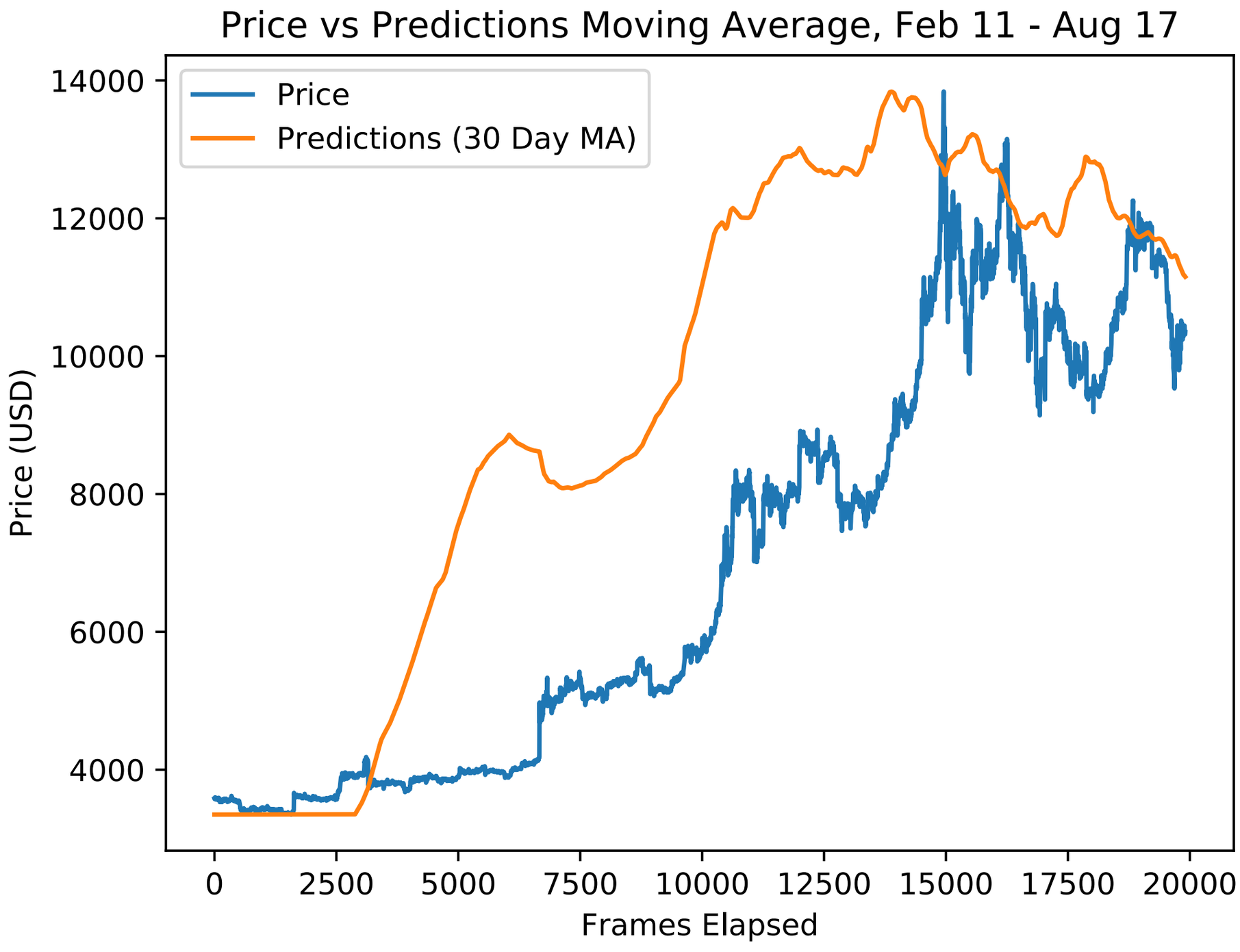
Adjusted Predictions 20 Day MA
(Predictions Normalized to Price)



Raw Predictions 30 Day MA
(Predictions Normalized to Price)



Adjusted Predictions 30 Day MA
(Predictions Normalized to Price)



We can divide this data for differently descriptive prediction sets:

Strategy variants derive from different ways of pooling raw output.

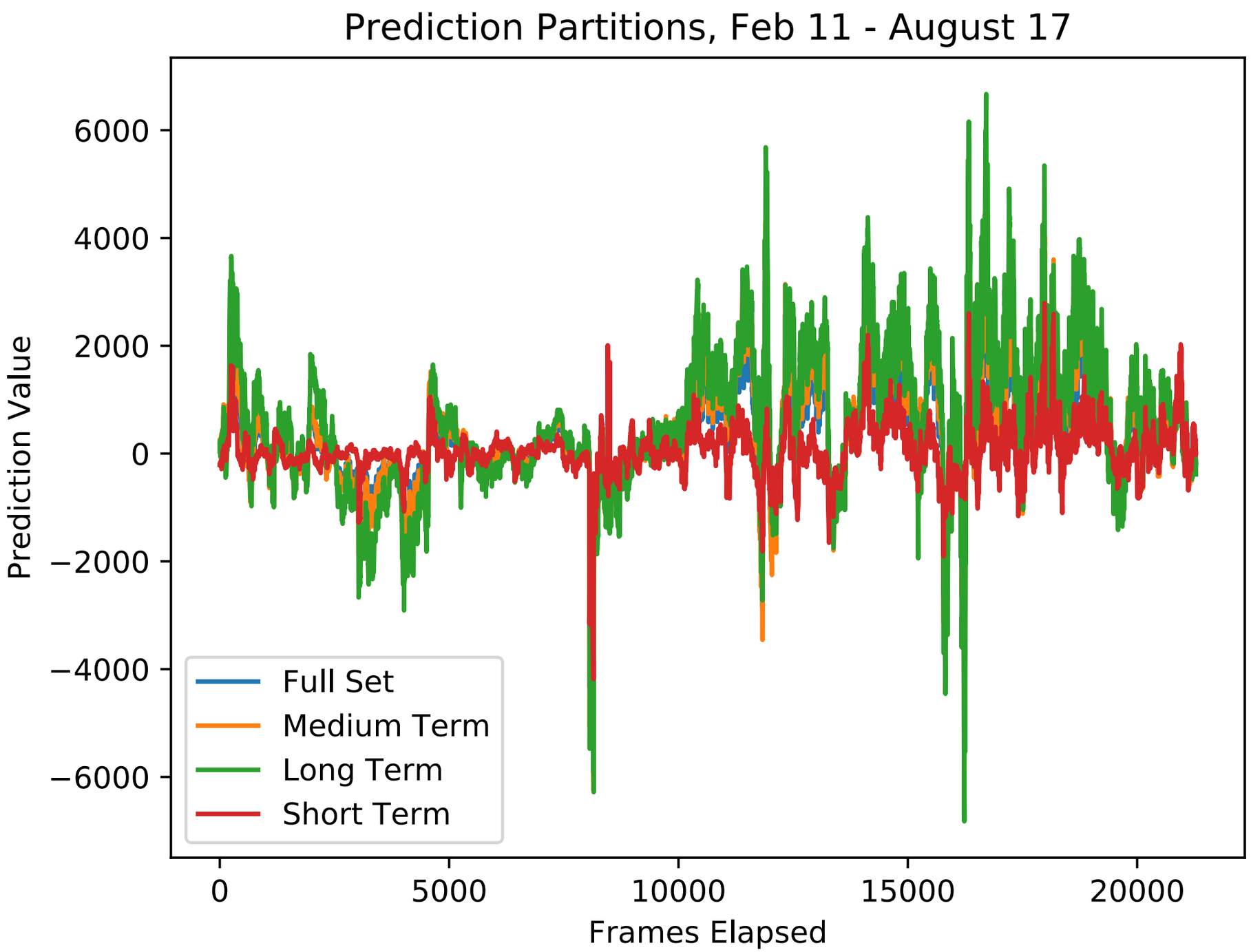
From our cohort of regressions, we partition 4 different time frames:
short term, medium term, long term, and “full set”, which includes every regression.
These time frames refer to the length of the period a given regression was trained on.

We also have 4 different prediction types:
the raw prediction from the regression,
a ‘normal’ prediction where the raw is adjusted to expected buy or sell thresholds,
a ‘raw optimized’ prediction where we correct previous bias on a per regression basis for the raw prediction,
and a ‘normal optimized’ prediction where we do the same for the normal.

Note that these all come from the same value at any given moment,
but the point at which they buy or sell may differ.

Lastly, we pool the predictions via either median or average. Hence, 4*4*2 = 32 variants.

We can divide this data for differently descriptive prediction sets:



Performance By Time Frame and Prediction Type;
Wallets from a Starting Value of 100;
Bitcoin Market Wallet = 283

Metric	Raw	Normal	Raw Optimized	Normal Optimized	Average
Short Term Average	198.19	181.1	204.13	273.74	214.29
Short Term Median	200.12	130.94	204.13	273.74	202.23
Medium Term Average	202.79	181.55	260.27	225.46	217.52
Medium Term Median	167.32	192.78	279.66	154.42	198.54
Long Term Average	161.02	234.73	218.23	226.1	210.02
Long Term Median	192.66	162.28	209.02	175.92	184.97
Full Set Average	200.3	286.94	260.05	265.31	253.15
Full Set Median	216.17	217.85	242.51	258.14	233.67
Total Average	192.32	198.52	234.75	231.6	214.3

As time goes on, Full Set is separating from the pack. This suggests that each regression is giving different insights (which we can confirm by looking at them individually) and is a good indicator of how to proceed.

Results of best path finding in real time through each set

Stats

Stat	Raw	Normal	Raw Optimized	Normal Optimized	All
Active Wallet Average:	192.32	198.52	234.75	231.6	214.3
Relative Performance:	0.68	0.7	0.83	0.82	0.76
Number of Trades:	18	72	20	60	170
Success Mean:	0.51	0.21	0.46	0.24	0.3
Failure Mean:	0.06	0.14	0.03	0.09	0.11
Total Success Rate:	0.83	0.6	0.85	0.62	0.66
Buy Success Rate:	1	0.84	1	0.9	0.9
Sell Success Rate:	0.67	0.32	0.7	0.33	0.41
Expected Value of Trade:	0.42	0.07	0.39	0.12	0.16
E(Change), Buy to Sell:	0.81	0.19	0.76	0.27	0.35
E(Change), Sell to Buy:	-0.03	0.07	-0.02	0.03	0.04

Results of best path finding in real time through each set

Volatility

Stat	Raw	Normal	Raw Optimized	Normal Optimized	All
Sharpe Ratio:	-2.46	-2.15	-2.37	-2.28	-2.31
Max Drawdown (%):	31.36	30.85	32.24	32.99	31.86
Relative Max Drawdown:	0.92	0.91	0.95	0.97	0.94
Standard Deviation:	46.54	47.77	63.3	62.04	54.91
Relative Standard Deviation:	0.58	0.59	0.78	0.77	0.68
Relative Performance / Relative Deviation:	1.18	1.19	1.06	1.06	1.11
Beta:	-0.44	-0.43	-0.22	-0.24	-0.33

(Sharpe Ratio calculated w Bitcoin market price as risk free rate, hence negative)

Best Thresholds (Buy, Sell)

Normal—Production (Nov 2018 - July 2019)

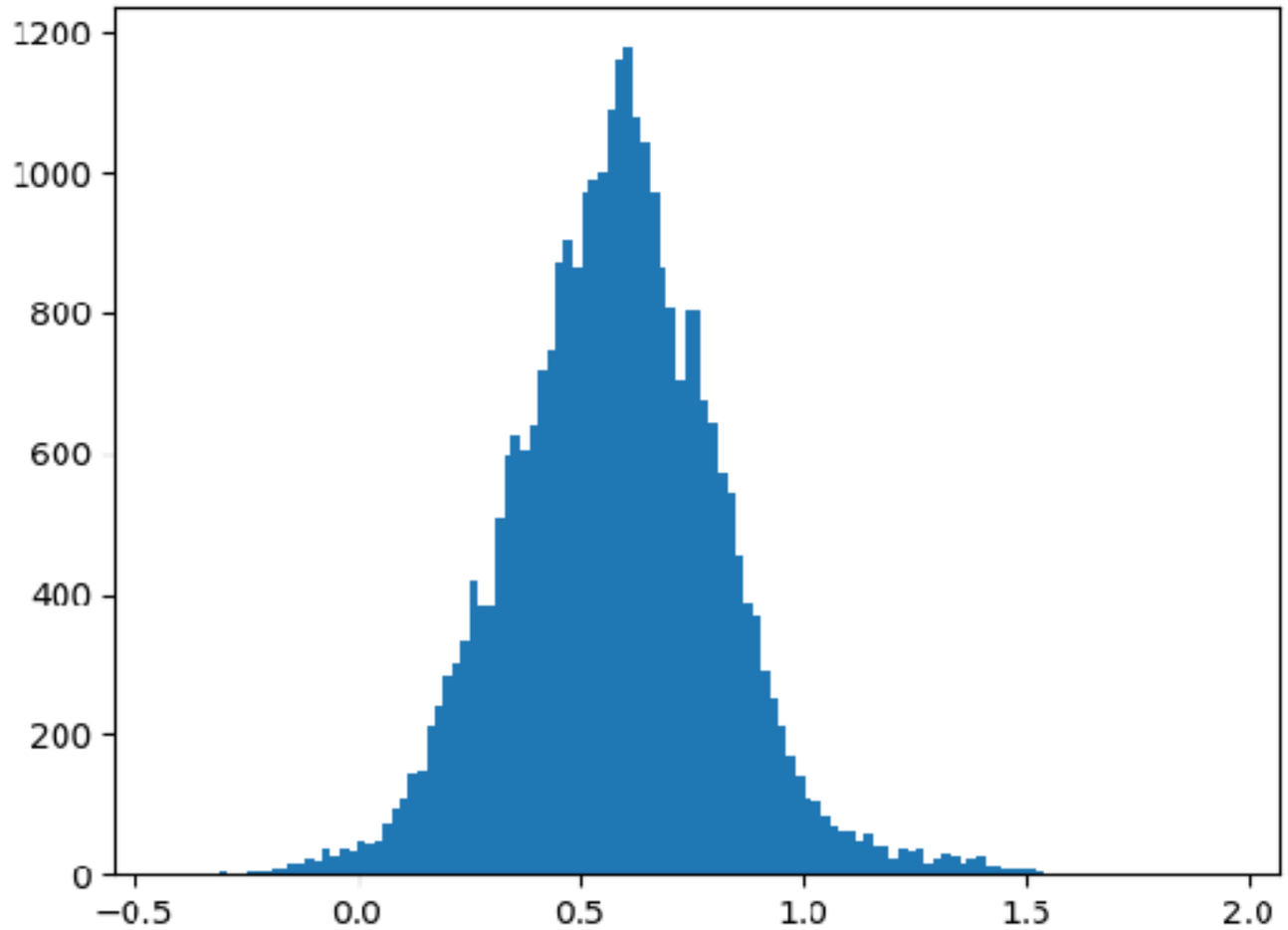
Type	Short Term	Medium Term	Long Term	Full Set	Average
BTC	0.85, -0.1	1.2, 0.2	0.85, -0.2	1.15, 0.3	1.01, 0.05
ZEC	1.15, 0.25	1.1, -0.2	1.15, 0.45	1.15, 0.45	1.14, 0.24
ZCASH_XBT	1.2, 0.4	1.2, 0.5	1.2, 0.3	1.2, 0.5	1.2, 0.42

Normal—Backtesting (Dec 2017 - Jan 2019)

Type	Short Term	Medium Term	Long Term	Full Set	Average
BTC	1.15, 0.4	1.1, 0.5	1.2, 0.45	1.2, 0.5	1.16, 0.46
ZEC	1.15, 0.45	1.2, 0.35	1.1, 0.45	1.15, 0.4	1.15, 0.41
ETH	1.15, 0.45	1.2, 0.5	1.2, 0.45	1.2, 0.5	1.19, 0.48

Observe the convergence to values above 0 and 1. Backtesting, which covered the bear market, has higher (more conservative) sell thresholds, but production does the same. This is important: we are underestimating the correct thresholds, but *consistently;* we can adjust for it.

Normal Scores by Frequency (Backtesting):



We are targeting .5 as our Normal peak, but everything is skewed slightly right—actual median .59. This explains why best thresholds skew right.

One higher performing walk forward test is:

total bias = absolute value (median - .5)
buy = 1 + total bias
sell = median - total bias

Best Thresholds Results—November 2018 to Jul 2019 (Production)

Wallets from a Starting Value of 100

Type	Short Term	Medium Term	Long Term	Full Set	Average
BTC	153.2	157.8	162.44	219.95	173
ZEC	183.39	127.9	139.24	140.15	148
ZCASH_XBT	89.02	78.15	61.94	84.88	78

Market Wallets (Wallet if you bought and held)

Type	Wallet
BTC	160.0
ZEC	75.00
ZCASH_XBT	50.00

Relative Performance (Wallet / Market Wallet)

Type	Short Term	Medium Term	Long Term	Full Set	Average
BTC	94.79	97.64	100.51	136.1	107
ZEC	241.42	168.37	183.3	184.49	194
ZCASH_XBT	182.6	160.31	127.05	174.11	161

Now we see average best paths beating market,
but time stamps show otherwise.
Why? A longer sample (Start Nov vs Feb) and 20/20 hindsight.

Best Thresholds Results—Dec 2017 to Jan 2019 (Backtesting)

Wallets from a Starting Value of 100

Type	Short Term	Medium Term	Long Term	Full Set	Average
BTC	135.43	69.94	87.02	106.92	100
ZEC	118.65	156.5	142.25	146.03	141
ETH	85.48	60.36	74.75	100.82	80

Market Wallets (Wallet if you bought and held)

Type	Wallet
BTC	35.0
ZEC	58.00
ETH	20.00

Relative Performance (Wallet / Market Wallet)

Type	Short Term	Medium Term	Long Term	Full Set	Average
BTC	386.14	199.41	248.11	304.85	285
ZEC	202.9	267.63	243.26	249.72	241
ETH	426.4	301.09	372.88	502.92	401

Relative performance much higher for backtesting set; easier when market performance is so low.

Walk Forward Results—Dec 2017 to Jan 2019 (Backtesting)

Wallets from a Starting Value of 100

Type	Short Term	Medium Term	Long Term	Full Set	Average
BTC	61.84	86.57	66.31	97.31	78
ETH	25.94	62.0	34.48	111.52	59

Market Wallets (Wallet if you bought and held)

Type	Wallet
BTC	35.0
ETH	20.00

Relative Performance (Wallet / Market Wallet)

Type	Short Term	Medium Term	Long Term	Full Set	Average
BTC	176.00	247.00	189.00	277.00	222
ETH	129.0	309.00	172.00	556.00	291

More robust than hindsight best thresholds;
full set's outperformance becomes very obvious.

Improving Trading Performance:

Data Science: Analysis
Machine Learning: Prediction
Artificial Intelligence: Action

Our analysis and prediction are strong; deciding when to take action is needs work

Some possibilities:

- **Buy/Sell based on relative frequency of scores**
- **Use only high performing prediction sets**
- **Trade based on expected value of sets/regressions**
- **Buy/Sell based on rate changes in moving averages**

Improving Predictions:
Control Variable Testing

We have achieved a high degree of performance to date by fixing different variables early in the process, and leaving our prediction values independent

To fully flesh out the system, we need to explore those control variables more deeply

Low hanging fruit likely includes:

—Different objective function values (how far in the future are we trying to see)
—Adding more regressions with different training periods
—Frequency of training
—Sampling: using the whole set of predictions instead of a 1/15 sample

Questions?

Email daniel.healy05@gmail.com