



# Classification and Time Series Models

## By David Hartsman



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What were we hoping  
to predict?

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models?

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**Results**

*Well, HOW'D IT GO?*

# Procuring Data



1	Yahoo Finance yfinance	<ul style="list-style-type: none"><li>• Price</li><li>• Open/High/Low</li><li>• Volume</li></ul>
2	Federal Reserve Economic Data	<ul style="list-style-type: none"><li>• GDP</li><li>• Interest Rates</li></ul>
3	Fama French Factors	<ul style="list-style-type: none"><li>• Size of Businesses</li><li>• Price to Book</li><li>• Return Minus Risk-Free Return</li></ul>
4	Pandas_ta Library	<ul style="list-style-type: none"><li>• MACD</li><li>• ATR</li><li>• RSI</li></ul>

# Final Data

Features for Presidential Term Year, Quarter, Month, Day of Week, Future Target Dates, Prices on Target Dates

## Index Data -

S&P Back to 1964, Dow 1992, Nasdaq 1971,  
Russell-2000 1987

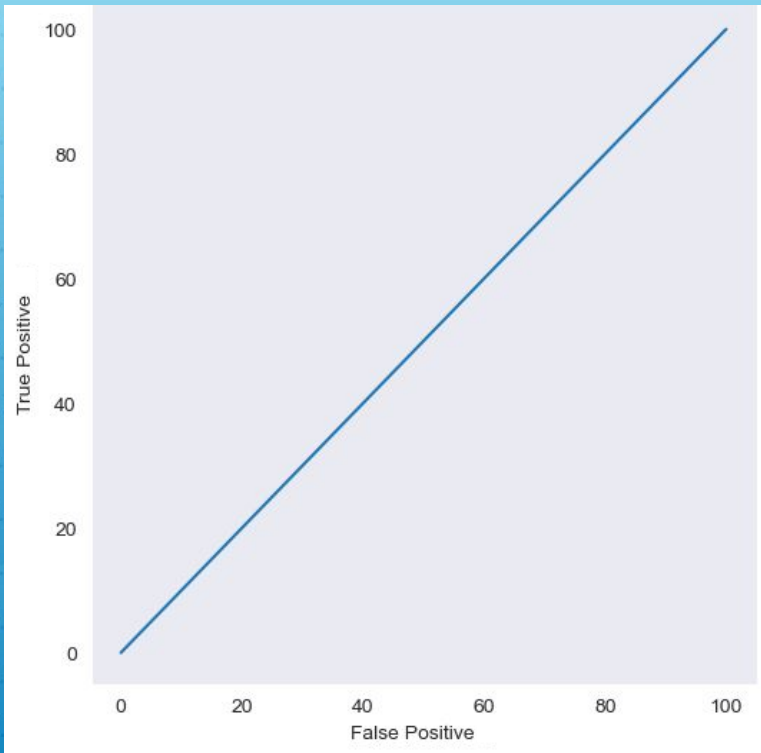
## Sector Data -

SPDRs Back to 1999 for most, only 2015 and  
2018 for XLRE and XLC respectively

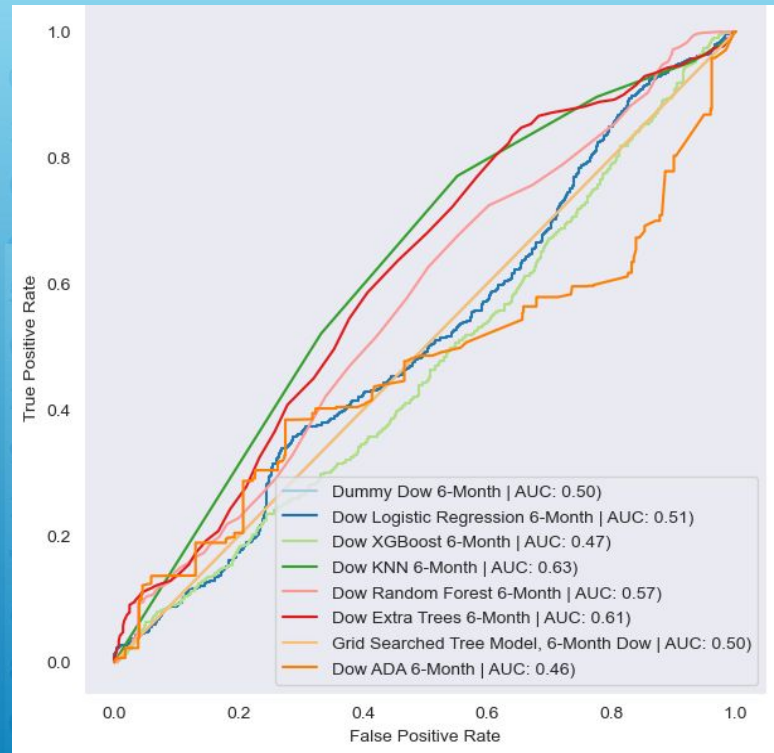


# Classification Models

*Dummy ROC Curve*



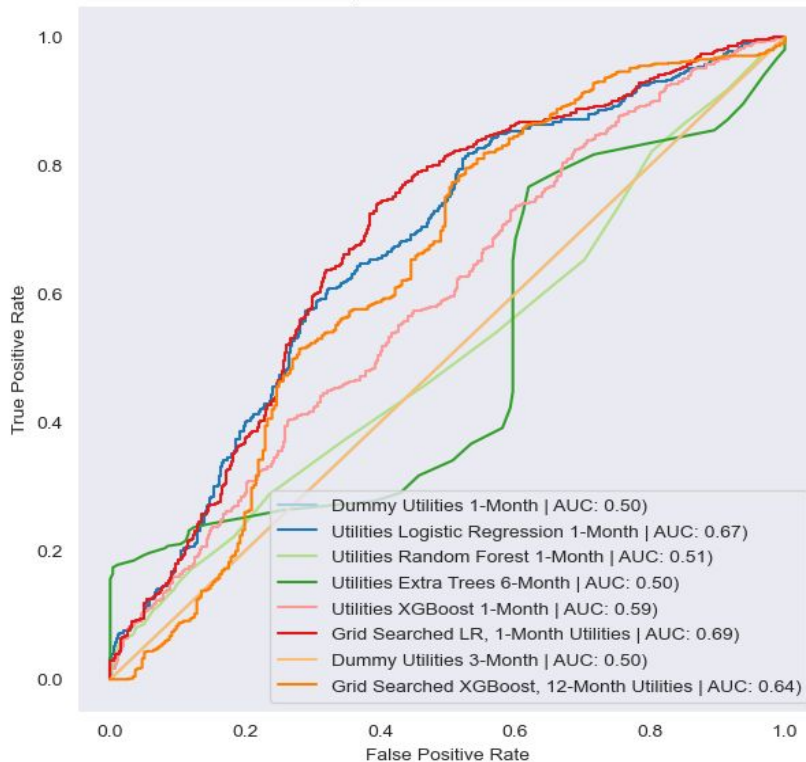
*Model ROC Curves*



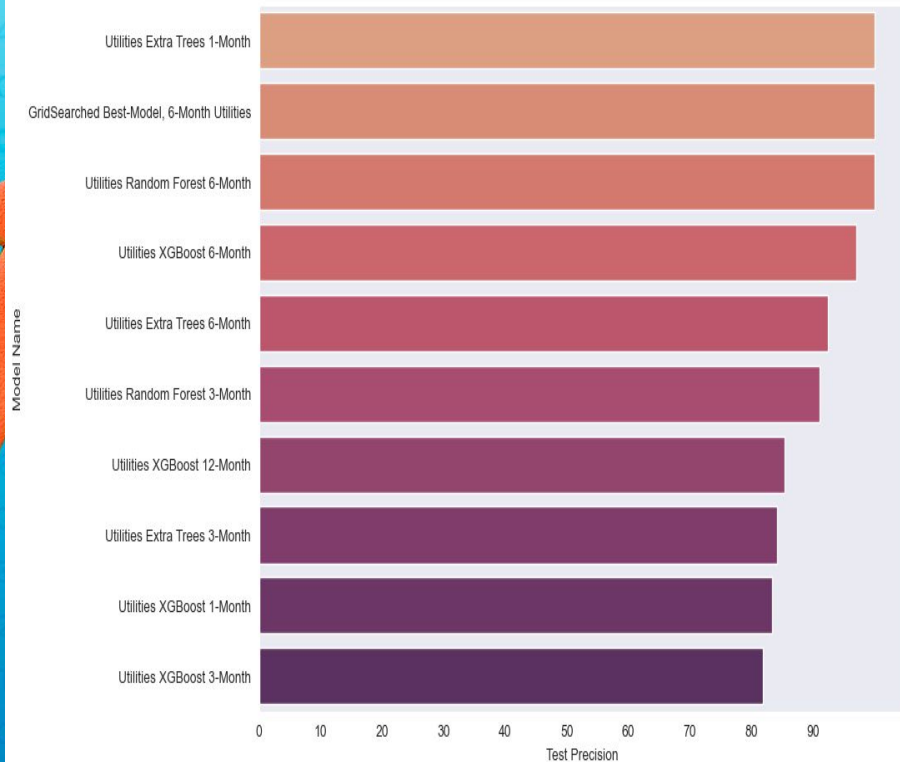


# Models: Precision as Target

Comparison of ROC Curves



Performance of Models - Utilities/XLU





# Most Precise SPDR Models



**1 Month**

**76% Prec**

RFC Industrials  
4% mean  
return/month



**3 Month**

**97% Prec**

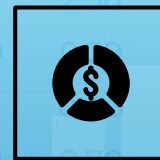
ETC Financials  
11.2% mean  
return/3 months



**6 Month**

**97% Prec**

XGBoost Industrials  
15.2% mean  
return/6 month



**12 Month**

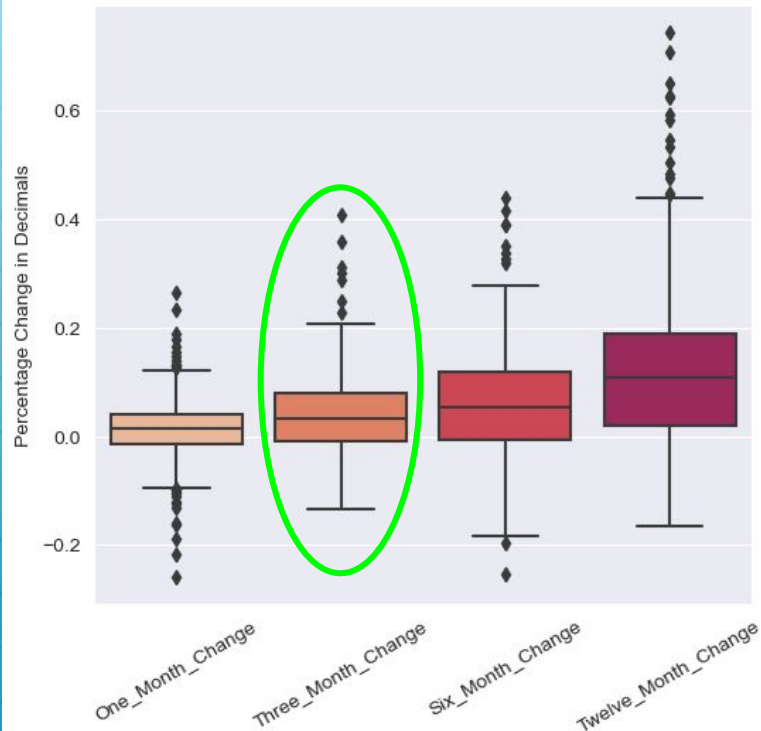
**98% Prec**

LR Staples  
13.4% mean  
return/12 months

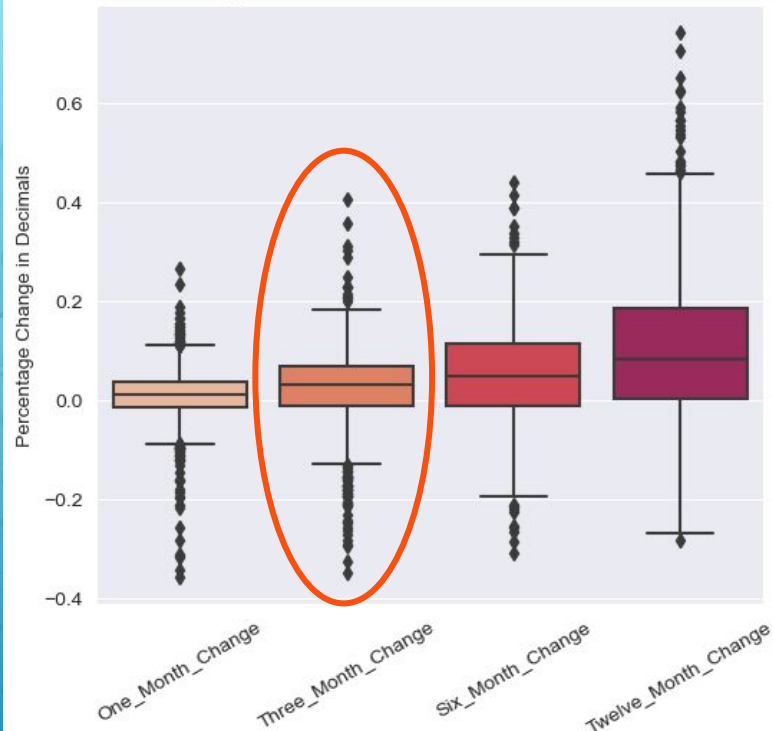


# Risk Reduction

Dow XGBoost 3-Month Box Plot for Each Timeframe




Dummy Dow 3-Month Box Plot for Each Timeframe



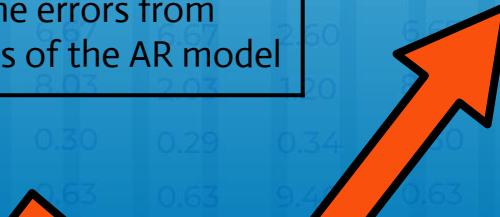




# Time Series ARIMA



AR	I	MA
"Auto-Regressive"	"Integrated"	"Moving Average"
Variable "p"	Variable "d"	Variable "q"
Value calculated through linear regression over "p" number observations	Based on the requirement that time series data is stationary, number of times "differencing" required	Models the relationship between the current value and the errors from predictions of the AR model

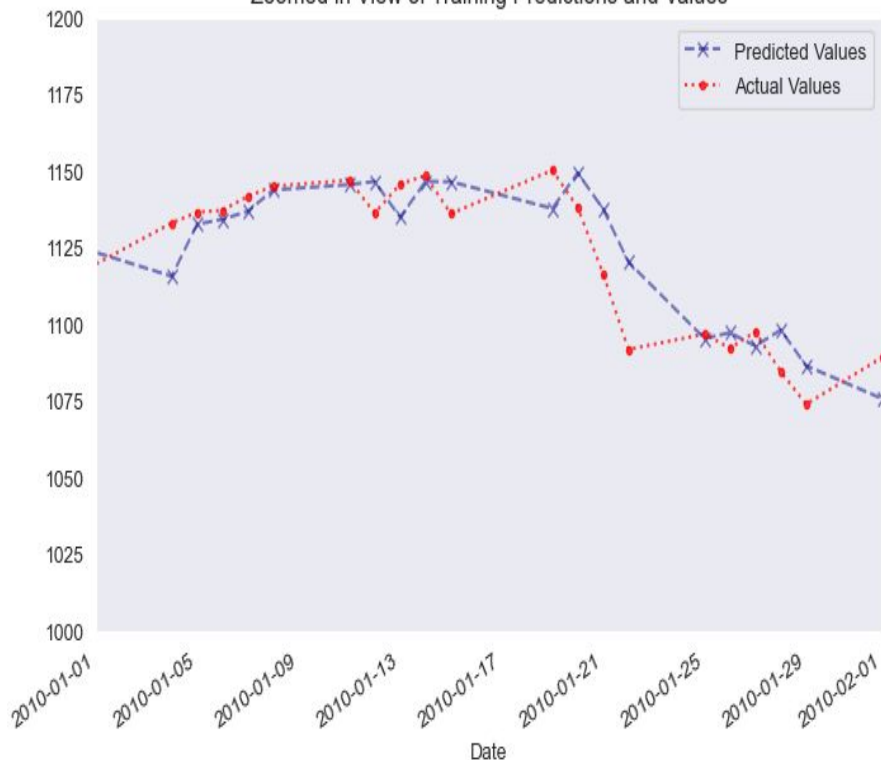


**Training/Regression**

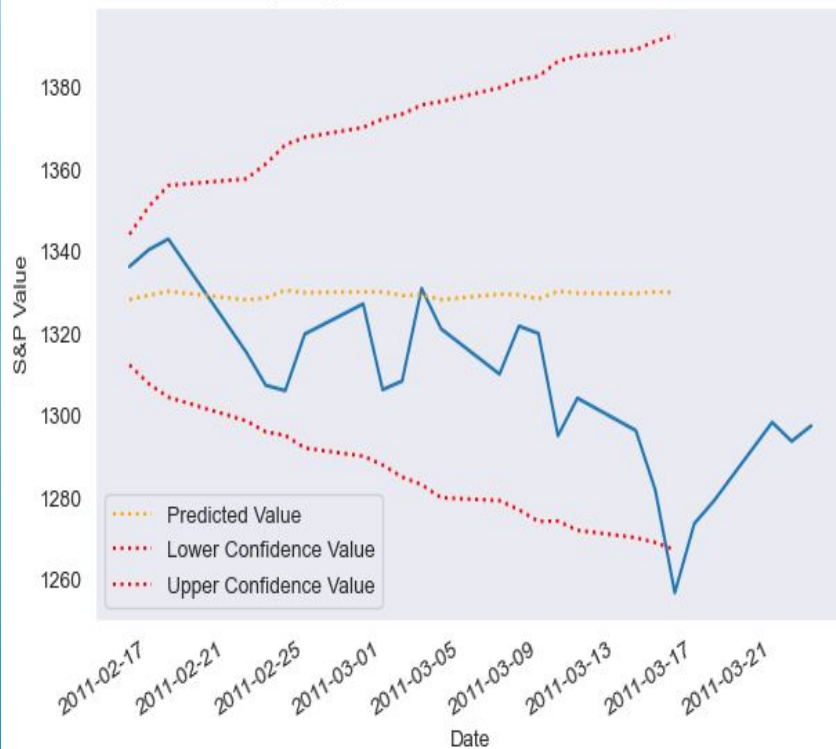
**ARIMA**

**Forecast values**

Zoomed in View of Training Predictions and Values

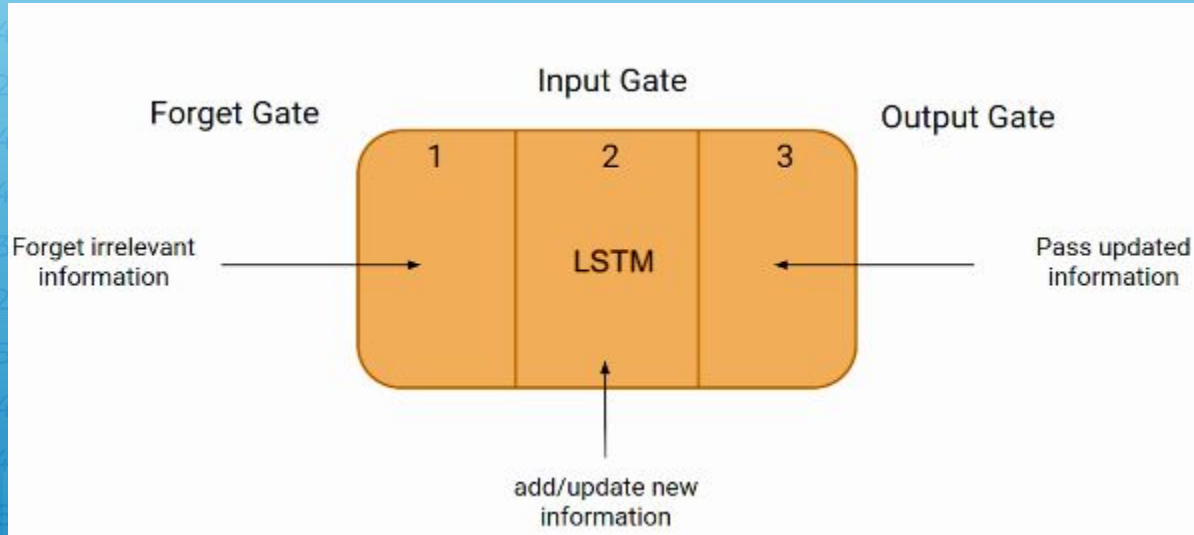


Comparing Extended Predictions to True Values



# LSTM Neural Networks

## “Cell State”



# First Simple LSTM



**R-squared**  
**99.6%** on training data

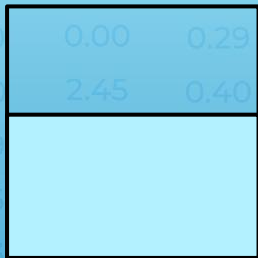
**R-squared**  
**-5.9%** on Unseen Test Data

# Best LSTM Model





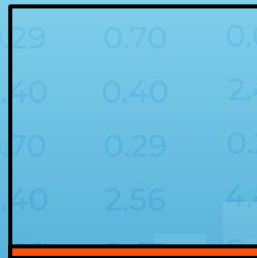
# Best Model Stats on Unseen Test Data



**61.3**

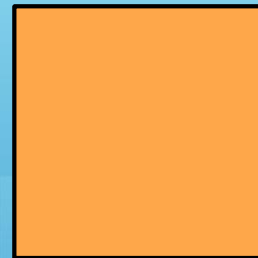
**Points**

Root Mean Squared  
Error



**1.2%**

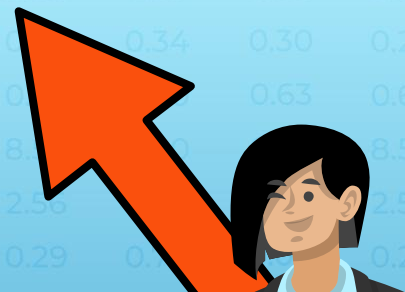
Mean Absolute  
Percentage Error



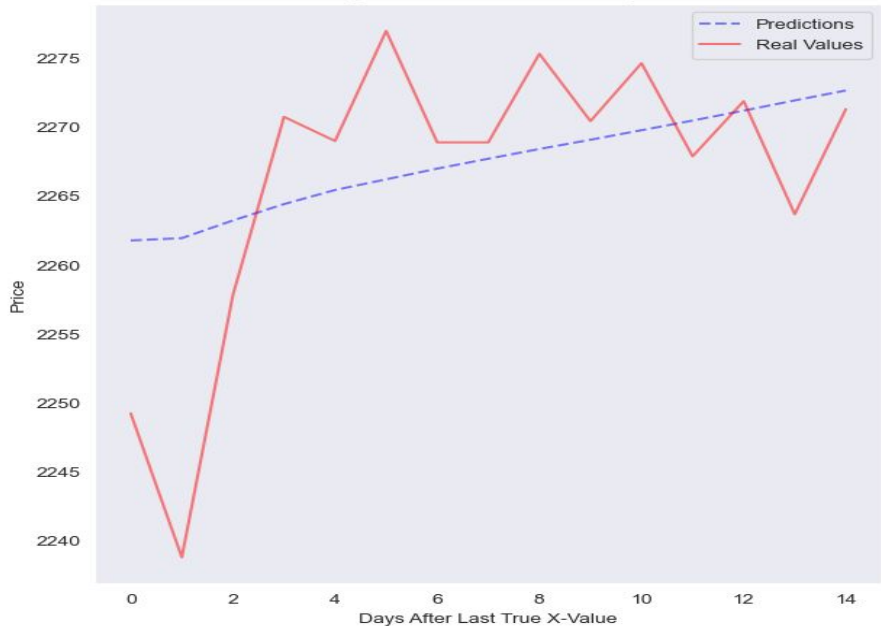
**99%**

R-Squared

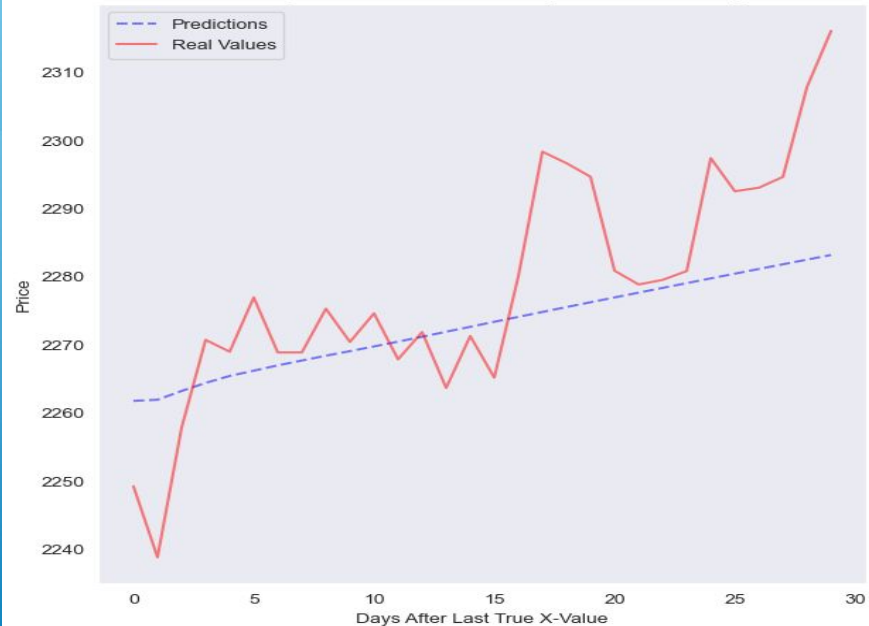
# How about when the music stops?



Inserting Predictions to Feed Projections



Inserting Predictions to Feed Projections for 30-Days





# Conclusions:

- **Binary Models Produced More Useable Results**
- **Trusting These Predictions Requires Enduring Swings**
- **Uni-Variate Time Series Models are Difficult to Apply**
- **Time Series Models DO NOT Provide Actionable Results**

## Next Steps:

**1.**

**Add More  
Features  
and Data**

**2.**

**Additional  
Model  
Types**

**3.**

**Less  
Diversified  
Assets**

# Thank You **FLATIRON!**



**GitHub**  
**Gmail**  
**LinkedIn**

