SPY
A Financial Analysis

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Today's Goals

- To provide a complete time series analysis for SPY
  - Brief Overview and background
    - Why SPY was chosen and how it can be used as a market indicator
  - All Data was obtained using the Yahoo! Finance API
  - Use Machine Learning Models to establish market trends
    - Comparing and contrasting the models different time frames
    - Providing visuals
    - Highlighing the best performing model
- Draw Conclusions
  - Future Work
  - Look at a custom time series trading strategy

Understanding SPY

- SPDR S&P 500 Trust, Electronically Traded Fund (ETF)
  - Publicly traded
  - Tracks combined performance of the Standard and Poor 500 Index
    - Portfolio only comprised of the most common stocks included the index
    - Very Heavily Traded
    - Considered a great overall market trend indicator
    - S&P 500 currently is at 1.73% YTD gain while SPY is at 2.18%

Fund Overview

Category	Large Blend
Fund Family	SPDR State Street Global Advisors
Net Assets	316.46B
YTD Daily Total Return	2.18%
Yield	1.54%
Legal Type	Exchange Traded Fund

Fund Operations

Attributes	SPY	Category Average
Annual Report Expense Ratio (net)	0.09%	0.36%
Holdings Turnover	2.00%	5,076.00%
Total Net Assets	176,432.14	176,432.14

SPY - 3 Year/Daily Chart

- Overall up trend for past 3 years
  - Indicating bullish market
- Included technical indicators
  - Candles represent price movement
  - Bollinger Bands
    - Upper and lower
    - Relative high or low price movement
  - Simple Moving Average (SMA)
    - 21 Days
- Crash during as Covid hit the US
  - Extremely high volume
  - Effected entire market

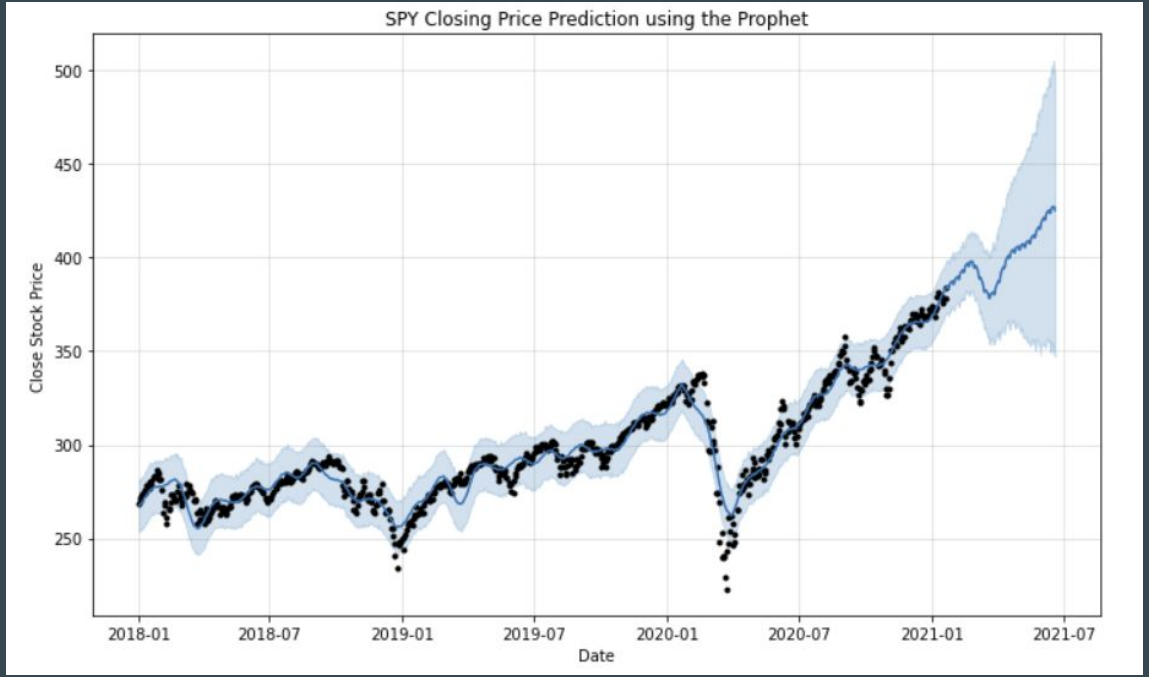
Time Series Analysis and Modeling

ARIMA

- Autoregressive Integrated Moving Average
- Conducted on same 3 year Daily time frame
- Strong Prediction for Overall stock trend
- Limited in overall predictive power regarding price
    - Does not take into account seasonality very well

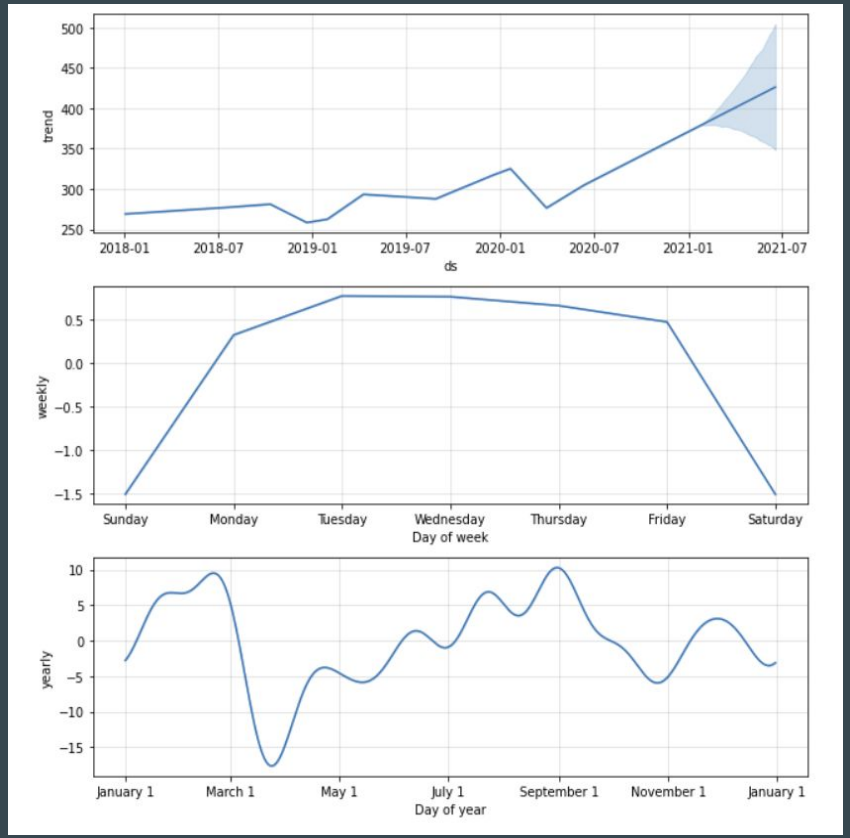
Facebook Prophet

- Autoregressive model designed to take into account seasonality
- Very effective in plotting overall trends
- Black dots are real values
- Blue line represents the models prediction
    - 150 days into the future
- Blue Shadow is confidence interval of 95%



Facebook Prophet Continued

- Great visualization
- Plot trends on different timelines
  - Seasonally
    - Top Chart
      - MACRO Movements
  - Weekley
    - Typically has higher value mid week compared to Monday and Fridays
  - Yearly
    - Stock price typically hits peak value in September and February



Machine Learning Regressive Models

- Compared 5 Regressive ML models
  - KNN Regressor
  - Gaussian Process Regressor
  - Support Vector Regressor
  - Random Forest Regressor
  - XGBoost
- 3 Different time frames
  - Top 1 day/1 minute
  - Middle 30 days/5min
  - Bottom 3 year/Daily
- Random Forest Outperformed on all time frames

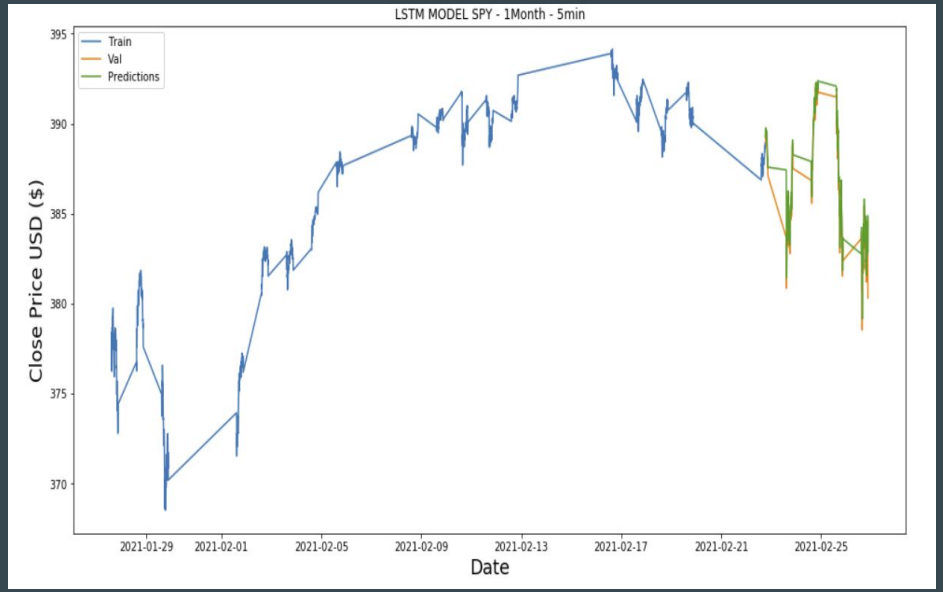
	Model	RMSE
0	KNN	1.306090
1	NB	382.849285
2	SVM	1.223802
3	RF	0.533869
4	XGBoost	0.796828

	Model	RMSE
0	KNN	6.131571
1	NB	385.735972
2	SVM	5.813167
3	RF	1.625753
4	XGBoost	3.608739

	Model	RMSE
0	KNN	33.452811
1	NB	302.710269
2	SVM	33.189462
3	RF	9.096482
4	XGBoost	21.274765

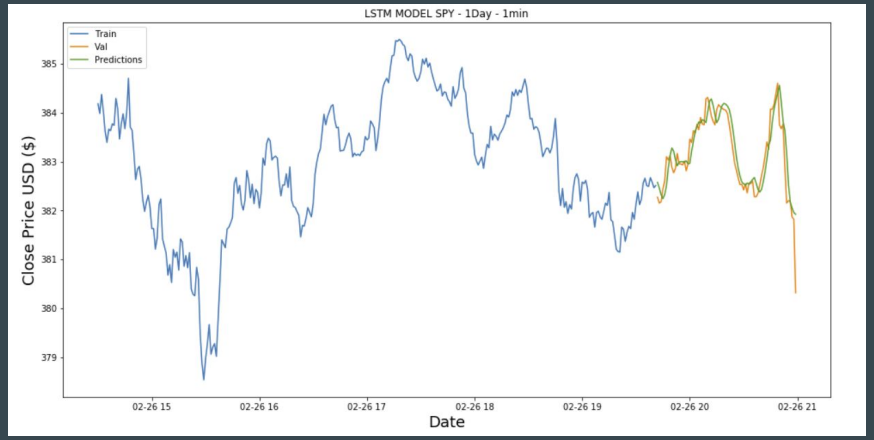
Long Short-term Memory or LSTM

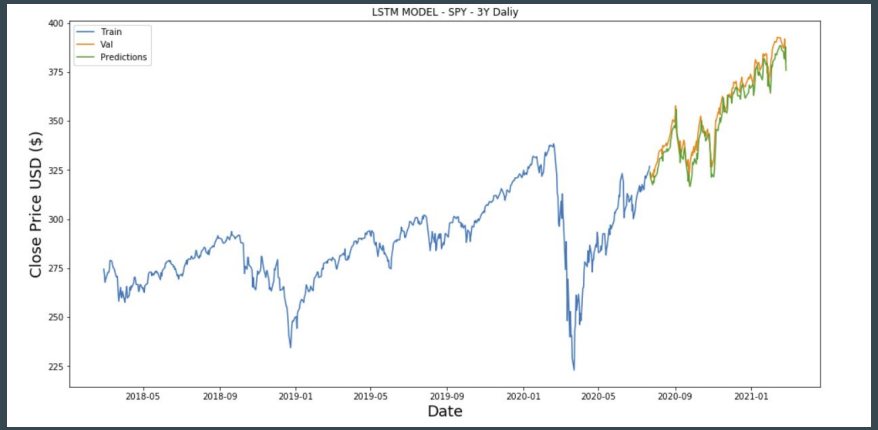
- Type of recurrent neural network
  - Improved Version of RNN
  - Very useful in the field of “Deep Learning”
- Ability to processes entire sequences of data
  - Very effective for time series
  - Accurate predictions and highly tunable
- Outperformed all other ML models
  - RMSE of .66
  - Almost 40% improvement from Random Forest Regression



LSTM Continued

- Multiple time frames
  - Top
    - 1 Day/ 1 min intervals
    - Friday 2/26/2021
    - RMSE of .352
    - 66% improvement from RF
  - Bottom
    - 3 years at daily intervals
    - RMSE of 5.93
    - 65% improvement from RF





Overview

- ARIMA and Facebook Prophet
  - Establishing MACRO or overall market trends
  - Provide good visuals
  - Can be limited in Predictive power
- LSTM
  - Out performed other ML models in terms of RMSE
  - Performed well on multiple timeframes
    - Can be difficult to interpret how models is actually working
- Conclusion
  - LSTM can be a very useful tool when analyzing stock prices
    - Accurately predict on both short and long time frames
  - Could perform better on a EFT than traditional stock

Future Work

- Conduct modeling on stocks in different sectors
  - Mid and Small cap
  - Penny stocks
  - Foreign Exchanges
  - Crypto Currencies
- Create a time-series based trading strategy
  - 4 Time Trends compared simultaneously
  - Buy and sell signals
    - Multiple Exponential Moving averages

Thanks for Listening !

- Github - https://github.com/Banner10/Capstone