Stock Index Prediction with Machine Learning and Deep Learning Models

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Problem Overview

Why Predict Stock?

- Maximize profits
- Predict the economy
- Implement suitable economic policies

Challenges

- Stochastic nature
- Multiple factors

Project Objectives

What are the Goals?

- Build a working ARIMA (Autoregressive Moving Average) model
- Build a working LSTM model
- Build a working CNN model
- Build a working feature fusion LSTM - CNN model
- Outputs: predicted daily closing for Dow Jones Industrial Average (DJIA)

    $DJIA = \frac{\sum stock\ price}{d}$; Dow divisor: $d \approx 0.152$

Data Overview - Dow Jones 2009-2019

	Date	Open	High	Low	Close	Adj Close	Volume
0	2009-01-02	8772.250000	9065.280273	8760.780273	9034.690430	9034.690430	213700000
1	2009-01-05	9027.129883	9034.370117	8892.360352	8952.889648	8952.889648	233760000
2	2009-01-06	8954.570313	9088.059570	8940.950195	9015.099609	9015.099609	215410000
3	2009-01-07	8996.940430	8996.940430	8719.919922	8769.700195	8769.700195	266710000
4	2009-01-08	8769.940430	8770.019531	8651.190430	8742.459961	8742.459961	226620000
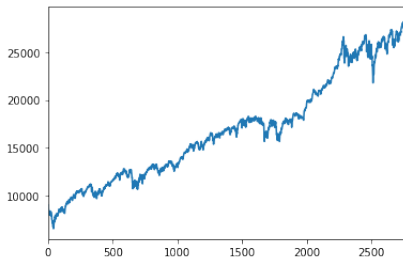
Data Overview - Dow Jones 2009-2019
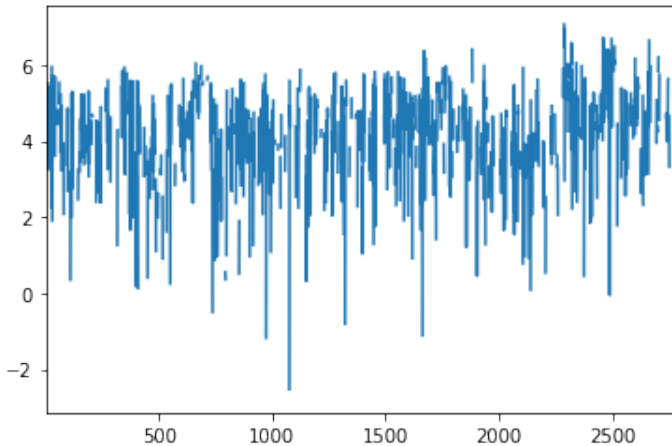
Previous 30 Days Data $\xrightarrow{\text{LSTM}}$ 5 Days Prediction
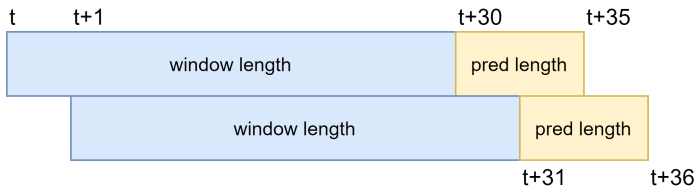
ARIMA Model Results

```
Dickey-Fuller test results

Test Statistic              0.220418
p-value                     0.973384
# of lags                  26.000000
# of obs                 2740.000000
dtype: float64
Critical value at 1%: -3.43274
Critical value at 5%: -2.86260
Critical value at 10%: -2.56733
```
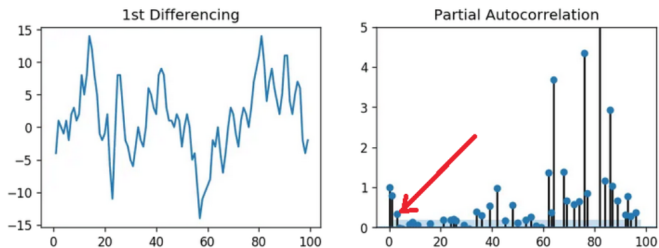
Figure: Test for Data Stationarity

ARIMA Model Results

Figure: First Order of Differencing and PACF plot

ARIMA Model Results

	timestamp	h	prediction	actual
0	9/12/16	t+1	18085.450160	18325.07031
1	9/13/16	t+1	18233.487478	18066.75000
2	9/14/16	t+1	18285.197045	18034.76953
3	9/15/16	t+1	18028.113227	18212.48047
4	9/16/16	t+1	18132.328241	18123.80078

Figure: Predictions from ARIMA

ARIMA Model Results
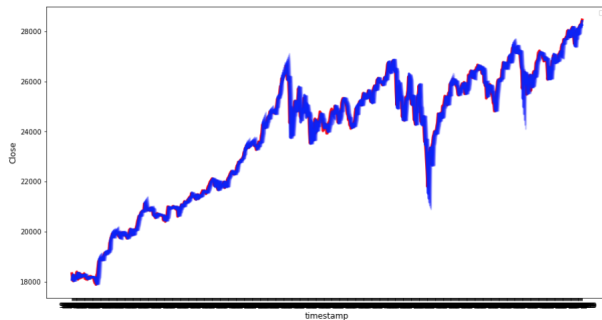
Figure: Plot of Actual and Predicted Values
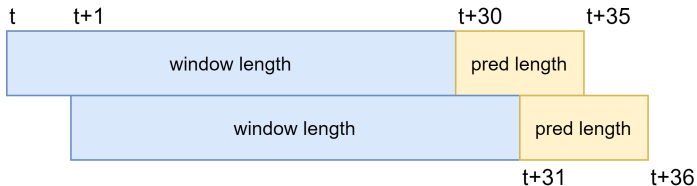
Previous 30 Days Data $\xrightarrow{\text{LSTM}}$ 5 Days Prediction

LSTM Model Results
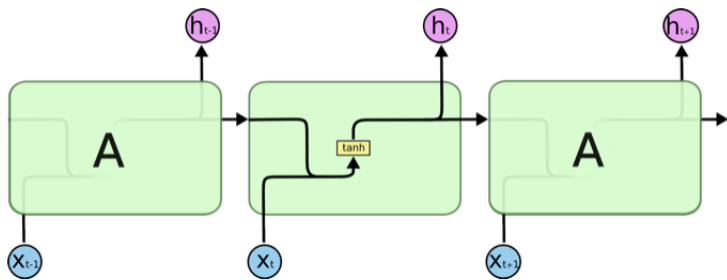
Figure: Simple 1-layer LSTM architecture
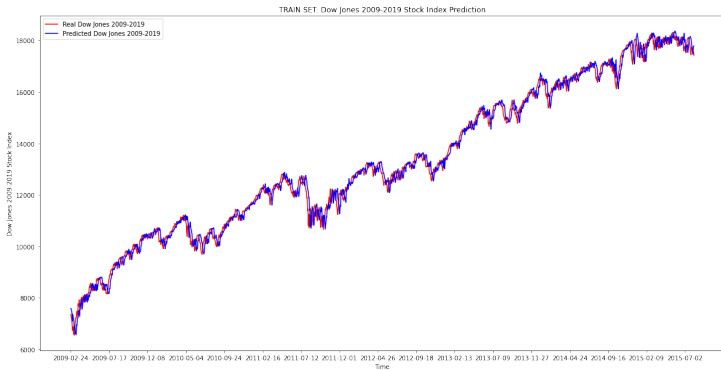
LSTM Model Results (Training)

Figure: CNN Model on Training Set

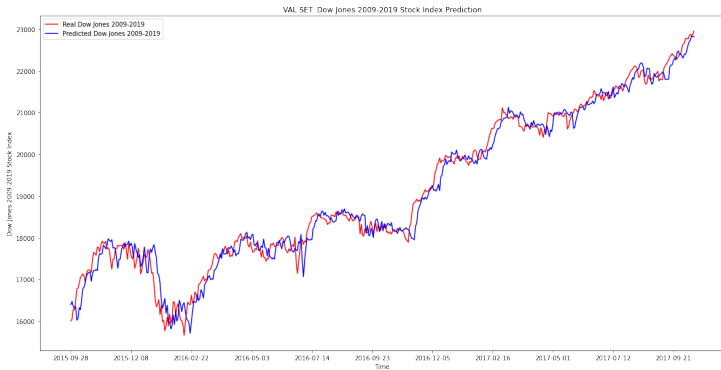# LSTM Model Results (Validation)

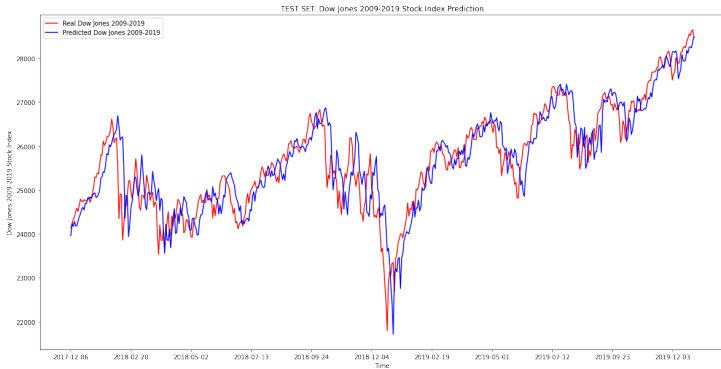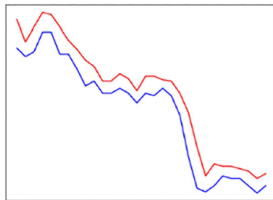Figure: CNN Model on Validation Set

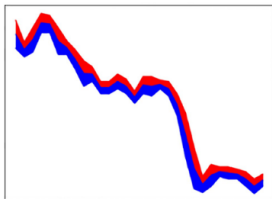# LSTM Model Results (Testing)
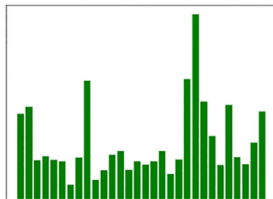

Figure: CNN Model on Test Set

(a)

(b)

(c)

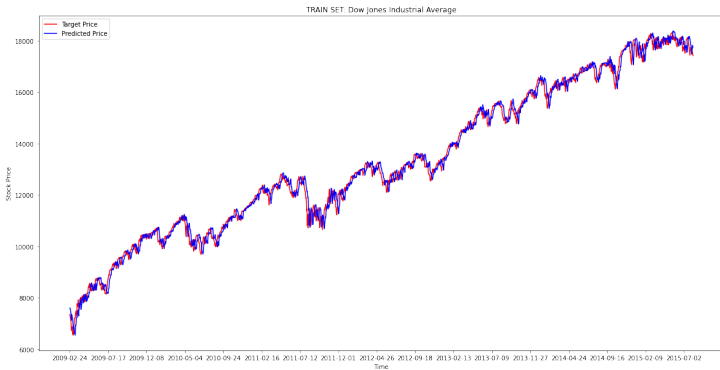(d)

CNN Model Results (Training)

Figure: CNN Model on Training Set

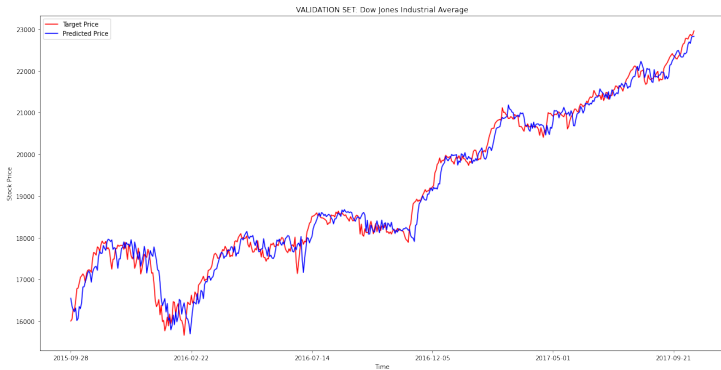# CNN Model Results (Validation)

Figure: CNN Model on Validation Set
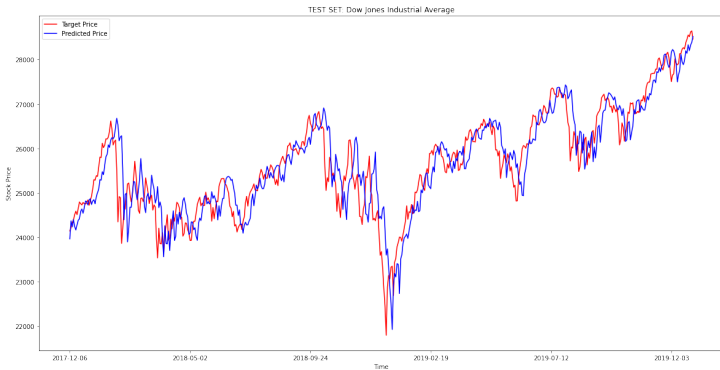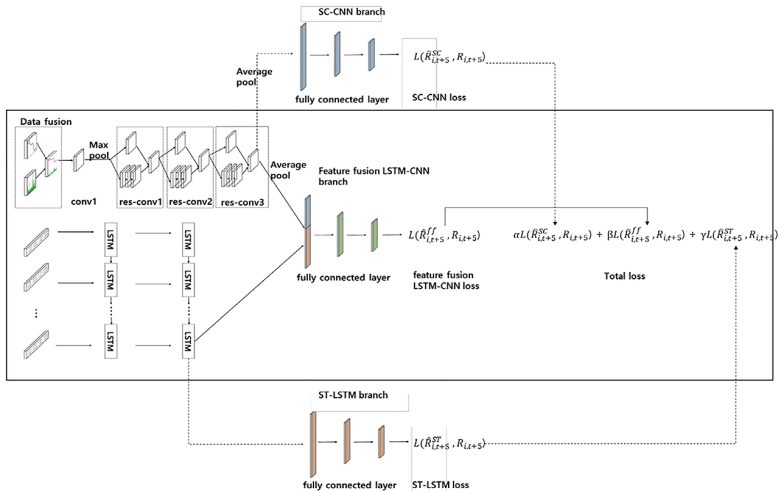
CNN Model Results (Testing)

Figure: CNN Model on Test Set

LSTM-CNN Model Results

LSTM-CNN Model Results (Training)

Figure: LSTM-CNN Model on Training Set
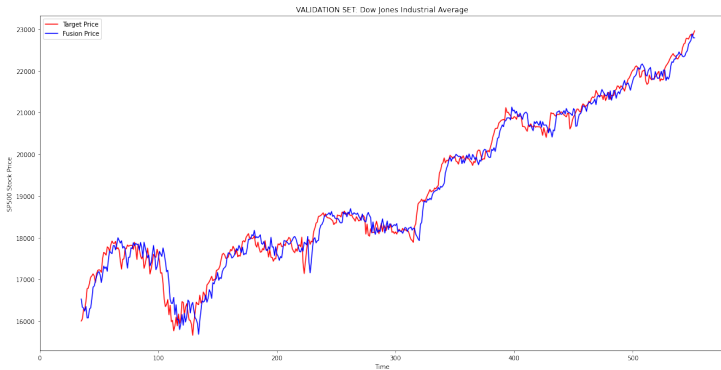
LSTM-CNN Model Results (Validation)

Figure: LSTM-CNN Model on Validation Set

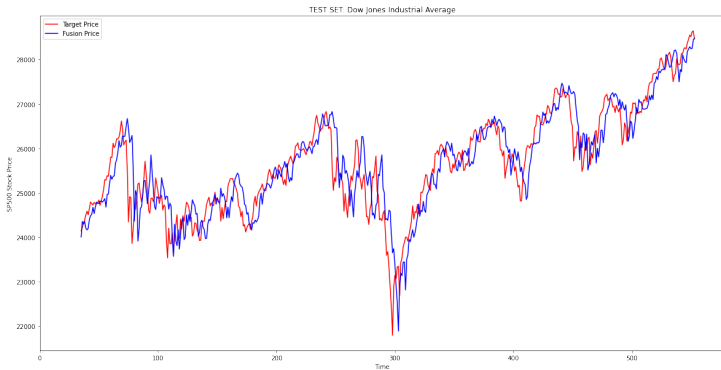# LSTM-CNN Model Results (Testing)

Figure: LSTM-CNN Model on Test Set

Future Work

- Implement sentiment analysis to extract relevant stock news.
- Implement Generative Adversarial Network (GAN) with LSTM.
- Use Deep Reinforcement Learning (DRL) for deciding GAN's hyper-parameters.

Reference

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Kim T, Kim HY. *Forecasting stock prices with a feature fusion LSTM-CNN model using different representations of the same data.* PLoS ONE 14(2): e0212320. https://doi.org/10.1371/journal.pone.0212320, 2019.

Hao Y, Gao Q. *Predicting the Trend of Stock Market Index Using the Hybrid Neural Network Based on Multiple Time Scale Machine Learning.* MDPI Appl. Sci. 2020, 10(11), 3961. https://doi.org/10.3390/app10113961, 2020.

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📄 Aston Zhang, Zachary C. Lipton. *Dive into Deep Learning*.

📄 *Understanding LSTM Network*. `https://colah.github.io/posts/2015-08-Understanding-LSTMs/`, 2015