



Analysis of SP 500 Companies Data using Machine Learning and Deep Learning Techniques

- The primary purpose of this research is to see if other companies stock prices can be used to estimate or predict price of one particular stock (JPM)
- The study performs dimensionality reduction on selected SP 500 companies close price data for the period 2004 to end of June 2021, and then use LSTM algorithm, a deep learning techniques to predict the close price of one big finance company, in this case JP Morgan Chase (JPM).
- The project uses principal components with the JPM data, and then the original close prices of the selected big companies with JPM, to see how the estimations differ in terms of prediction accuracy.
- The project further explores Anomaly Detection to see periods of unusual close prices for JPM



Use Case

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Data

- The project uses daily stock data from yahoo finance for the period from 01 January 2005 to 30 June 2021.
- The study selects companies deemed as big or biggest in the finance, technology and industry or manufacturing sectors, based on various sources including S&P
- Study uses 8 big tech companies, 10 big finance companies and 10 big industry companies
- Study only considers movements in the Close Price for each stock

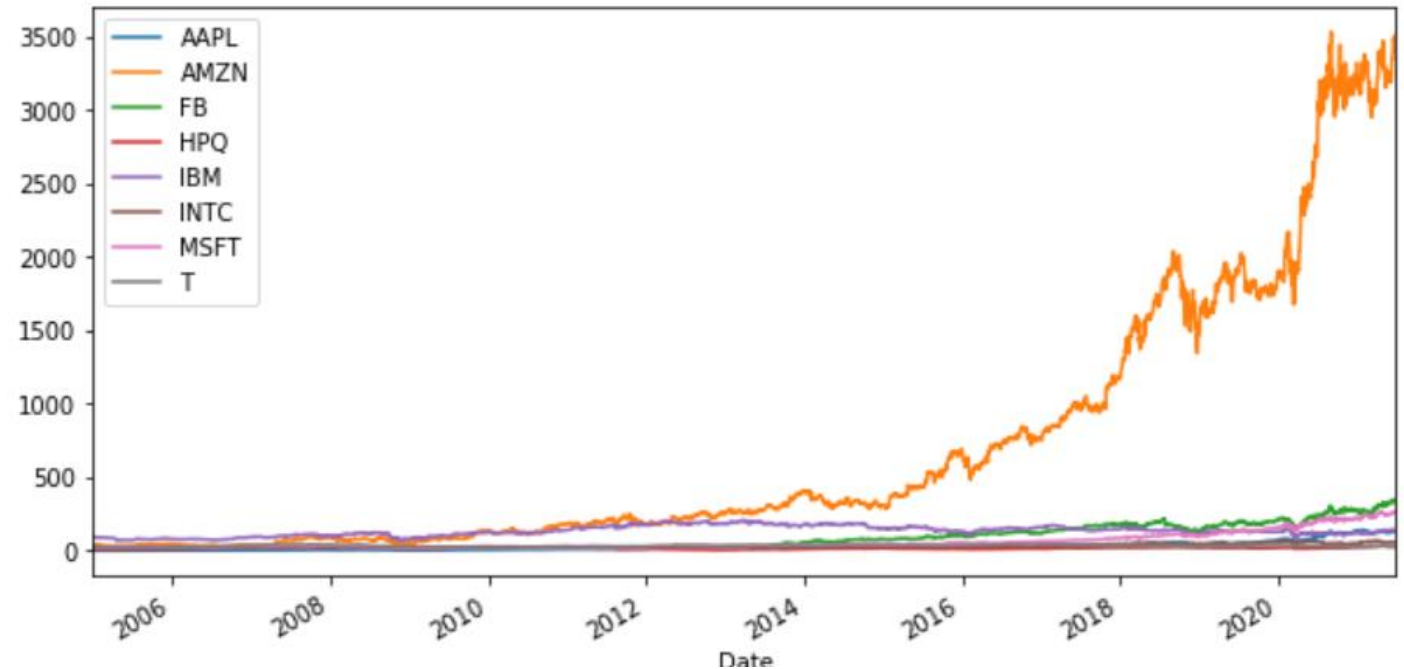
Companies Used

	ticker	sectors	Security
24	AMZN	Consumer Discretionary	Amazon
44	AAPL	Information Technology	Apple
51	T	Communication Services	AT&T
238	HPQ	Information Technology	HP
249	INTC	Information Technology	Intel
251	IBM	Information Technology	IBM
312	FB	Communication Services	Meta Platforms
318	MSFT	Information Technology	Microsoft

	ticker	sectors	Security
0	MMM	Industrials	3M
71	BA	Industrials	Boeing
91	CAT	Industrials	Caterpillar
141	DE	Industrials	Deere & Co.
212	GE	Industrials	General Electric
234	HON	Industrials	Honeywell
292	LMT	Industrials	Lockheed Martin
396	RTX	Industrials	Raytheon Technologies
460	UNP	Industrials	Union Pacific
463	UPS	Industrials	United Parcel Service

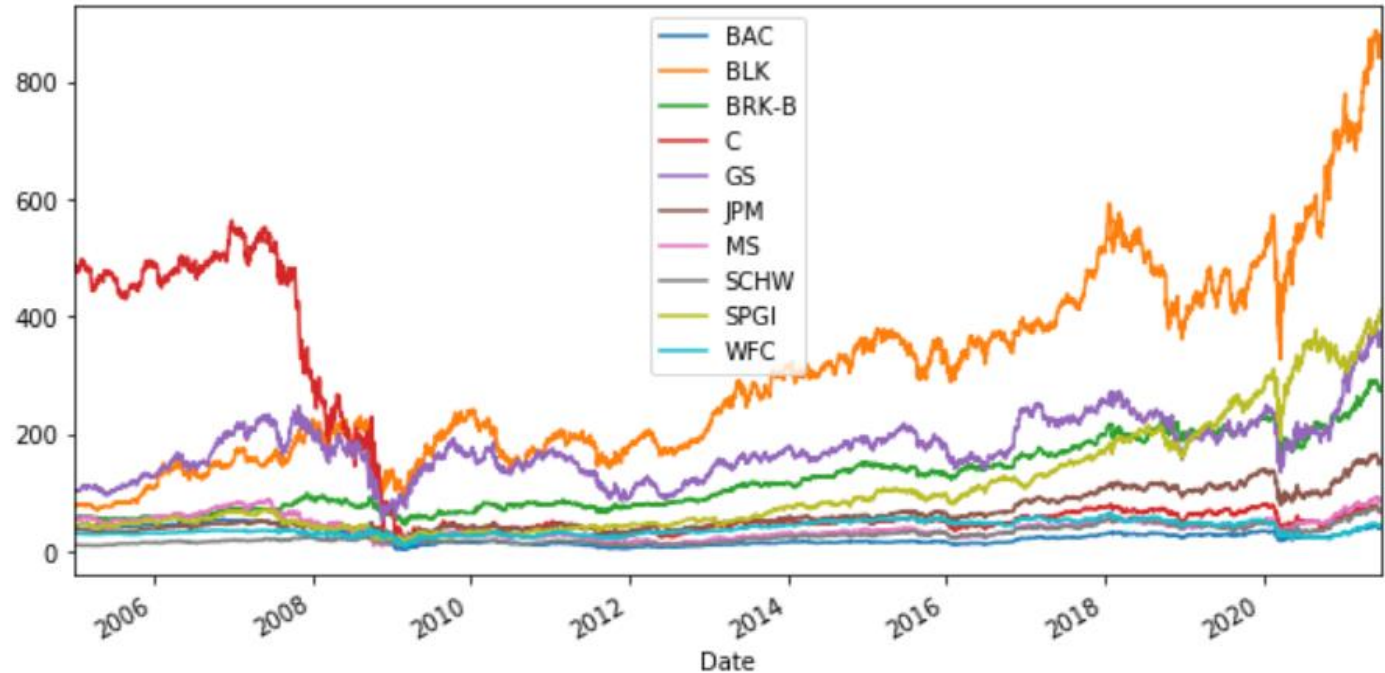
	ticker	sectors	Security
60	BAC	Financials	Bank of America
64	BRK.B	Financials	Berkshire Hathaway
69	BLK	Financials	BlackRock
102	SCHW	Financials	Charles Schwab
112	C	Financials	Citigroup
219	GS	Financials	Goldman Sachs
267	JPM	Financials	JPMorgan Chase
327	MS	Financials	Morgan Stanley
409	SPGI	Financials	S&P Global
486	WFC	Financials	Wells Fargo

Big Tech Data



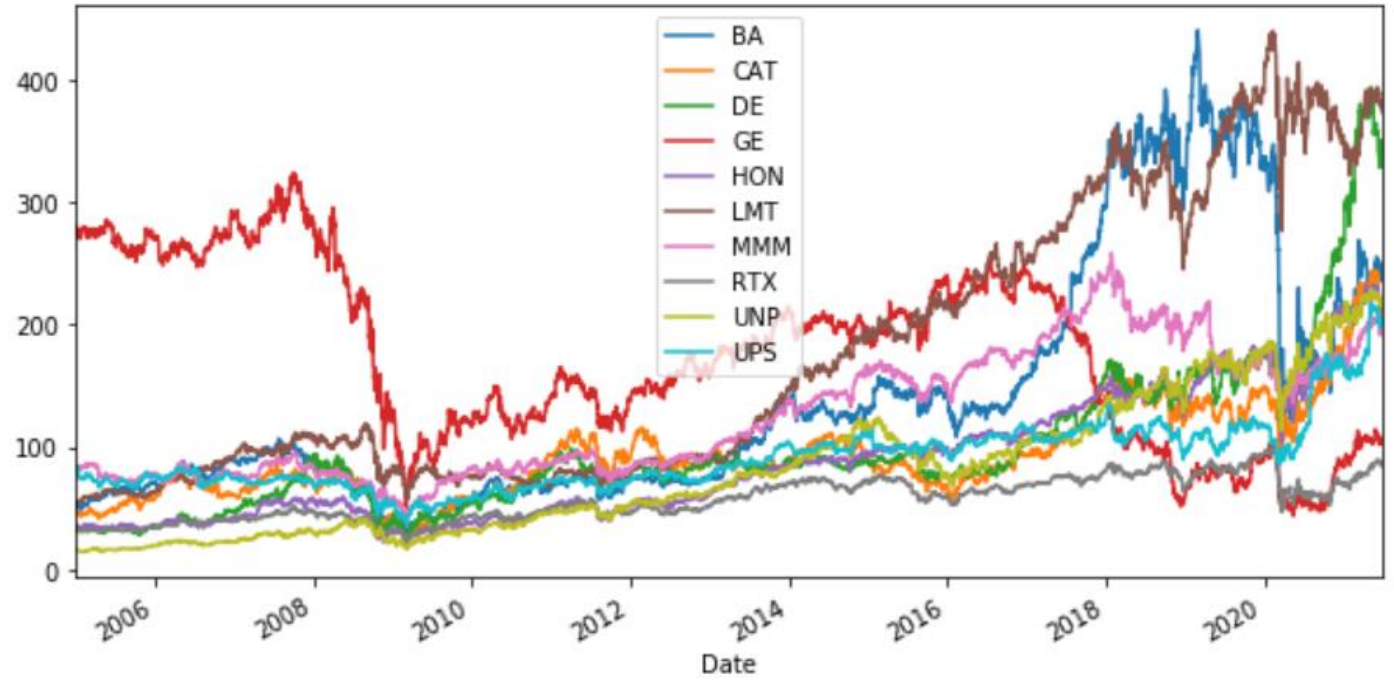
- Data shows that Amazon has a significantly higher stock price compared to other stocks
- Studies argue that this is because Amazon has a significantly lower number outstanding shares compared to its peers, eg Microsoft.
- All the other stock prices are generally comparable

Big Finance Data



- Line plot of Big Finance Companies Close Price shows that Blackrock stock is relatively more expensive.
- Citigroup was the most expensive before the global financial crisis of 2008/09 then the share price fell significantly and has been closer to the lower band up to the end of the study period.
- Analysts argue that BlackRock stock price is justified and below its estimated fair value.
- BlackRock is expectedly the only outright outlier in that regard.

Big Industry Companies



- Plot of big industry companies' data shows that the companies stock prices are generally very close together and there is no outright outlier.
- The prices show an upward trend since the global financial crises up to the onset of the COVID-19 pandemic in 2020 and begin to trend upward in 2021 as economies generally start to recover.

Machine Learning for Dimensionality Reduction

- Study applies machine learning to reduce dimension of the data
- Big tech data reduces to 5 components and most important companies are AMZN, IBM, T, HPQ, INTC
- Big finance also reduces to 5 components, with important names being JPM, BAC, WFC, GS, and SCHW
- Big industry is only reduced to 6 with the most important being LMT, GE, BA, LMT, BA, MMM

Deep Learning to Predict Stock Price of JPM

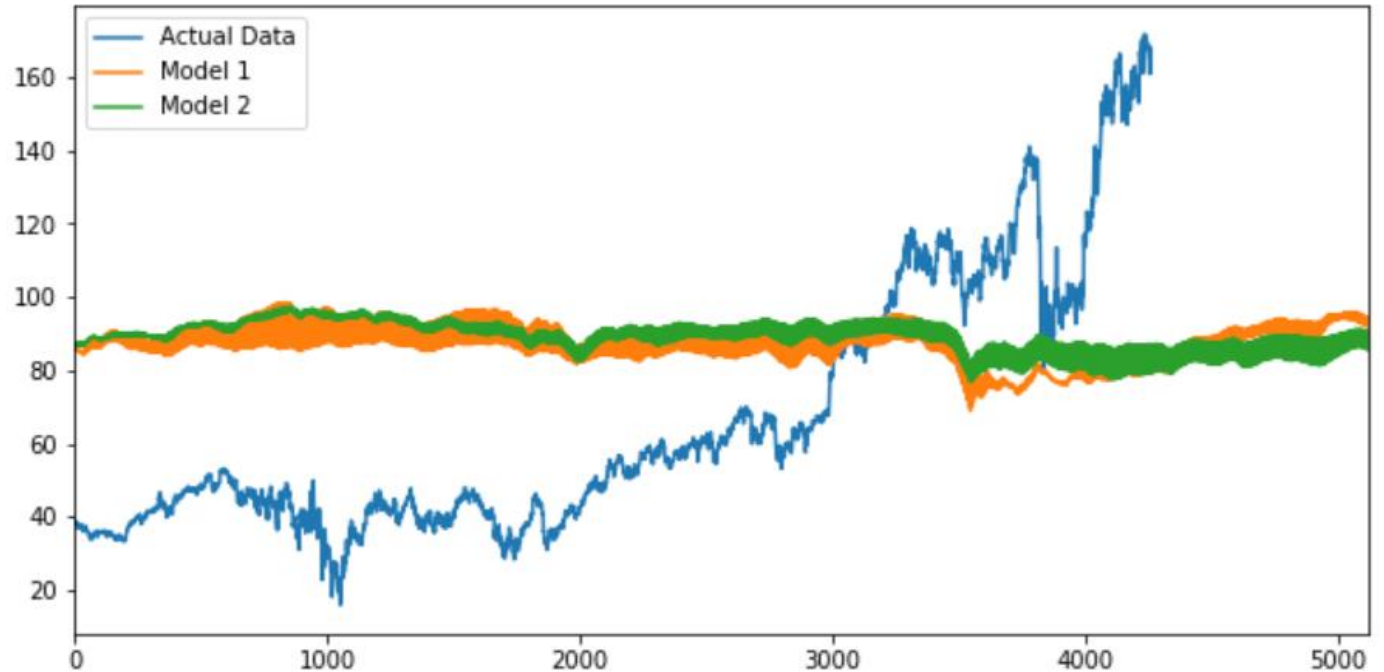
Study considers two datasets for deep learning.



- Plot shows predictions using principal components data with JPM data
- The estimations using two different specifications of the deep learning model are generally similar over the study period

Deep Learning to Predict Stock Price of JPM

Study considers two datasets for deep learning.



- Plot shows predictions using original close price data with JPM data
- The estimations using two different specifications is generally similar over the study period
- Overall the estimated stock price does not track the actual price for most periods, and it can be concluded that

Model Evaluation

- **Evaluation metrics: Mean Absolute Error**
- The projects evaluates prediction performance over 5 days for both datasets
- The two datasets used for estimation have generally similar predictive capacity and the estimated values are on average, similar.
- However, for the data using principal components, the model with one encoder and decoder layers predicts better
- For the data using original price data, the two layer model estimates better for all days except the first day
- Model using principal components with one layer is the best model for predicting the close price of JPM

- MAE for LSTM with Components

```
JPM
Day 1 :
MAE-E1D1 : 17.291715018451214, MAE-E2D2 : 21.93852910399437
Day 2 :
MAE-E1D1 : 18.129817612469196, MAE-E2D2 : 21.152161337435246
Day 3 :
MAE-E1D1 : 19.0236953869462, MAE-E2D2 : 21.15132212638855
Day 4 :
MAE-E1D1 : 19.94176197052002, MAE-E2D2 : 21.615675941109657
Day 5 :
MAE-E1D1 : 20.745098002254963, MAE-E2D2 : 22.344459287822247
```

- MAE for LSTM with Original Data

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JPM
Day 1 :
MAE-E1D1 : 23.55509153753519, MAE-E2D2 : 25.64178516715765
Day 2 :
MAE-E1D1 : 25.488271228969097, MAE-E2D2 : 24.026265785098076
Day 3 :
MAE-E1D1 : 26.79832075536251, MAE-E2D2 : 23.054026558995247
Day 4 :
MAE-E1D1 : 27.46422877907753, MAE-E2D2 : 22.51913034170866
Day 5 :
MAE-E1D1 : 27.755568742752075, MAE-E2D2 : 22.28118795156479
```

Conclusion

- Overall the estimated stock price does not track the actual price for most periods, and it can be concluded that using other companies stock prices to estimate price of another does not yield very accurate results.