WSJ [Python]

WSJ NLP S&P500 MARKET PREDICTOR

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CAPSTONE PROJECT

TABLE OF CONTENTS

INTRODUCTION

WSJ NLP S&P500 Market Predictor

WSJ NLP S&P500 Market Predictor Capstone Project

- **Capstone idea:**
  - Originally the first idea was to create a classification model for newspaper/media websites to decided whether the article or headline was right leaning or left leaning
  - Instead, only one newspaper was selected to predict something different, the direction the market went on a given day
- **Sources:**
  - The WSJ was selected as the newspaper to be used
  - The WayBackMachine was used to obtain the historical newspaper data.
  - Yahoo Finance was used for the financial data (S&P500 Closing & Opening prices)
- **Main Python Packages:**
  - BeautifulSoup: Web scraping tool which easily takes down and organizes the html from web page in a digestible and Python friendly way
  - Selenium: Automated Web Driver, used to click through the WayBackMachine to switch between WSJ homepages

APPROACH & METHODOLOGY

WSJ NLP S&P500 Market Predictor

OSEMN Framework

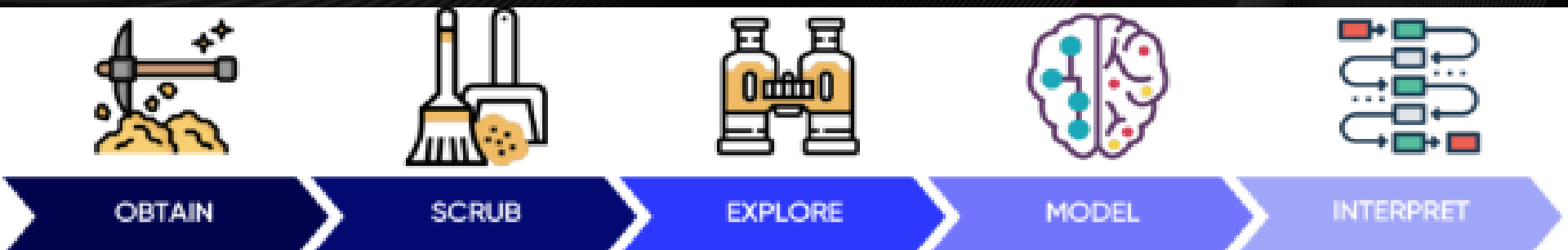
- **Obtain:** The text data needed was scraped from the WSJ homepage, and the financial data Yahoo Finance was used

- **Scrub:** The data needed the traditional Natural Language Processing cleaning
  - This consisted of lower casing the text data, and eliminating stop words and any other English language words or symbols
  - All of the text data was put into a DataFrame along with the corresponding label of a positive or negative day represented as 1 or -1 respectively

- **Explore:** A little bit of exploratory data analysis was conducted before the modeling to gain insight into the extracted data

- **Model:** For each of the different NLP strategies, I decided to run a very basic logistic regression model.
  - Advanced Modeling: Neural networks and pretrained word embeddings

- **Interpret:** Interpret all models along with all EDA results to form a conclusion of the data



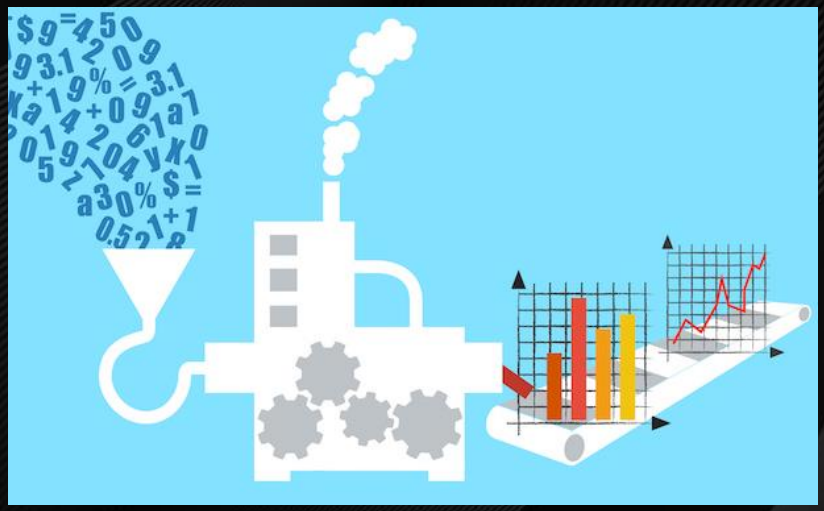
EXPLORATORY DATA ANALYSIS

WSJ NLP S&P500 Market Predictor

EDA

- **Word Frequencies**

- **Absolute Difference Word Frequencies**
- **Word Clouds**
- **Time Series**

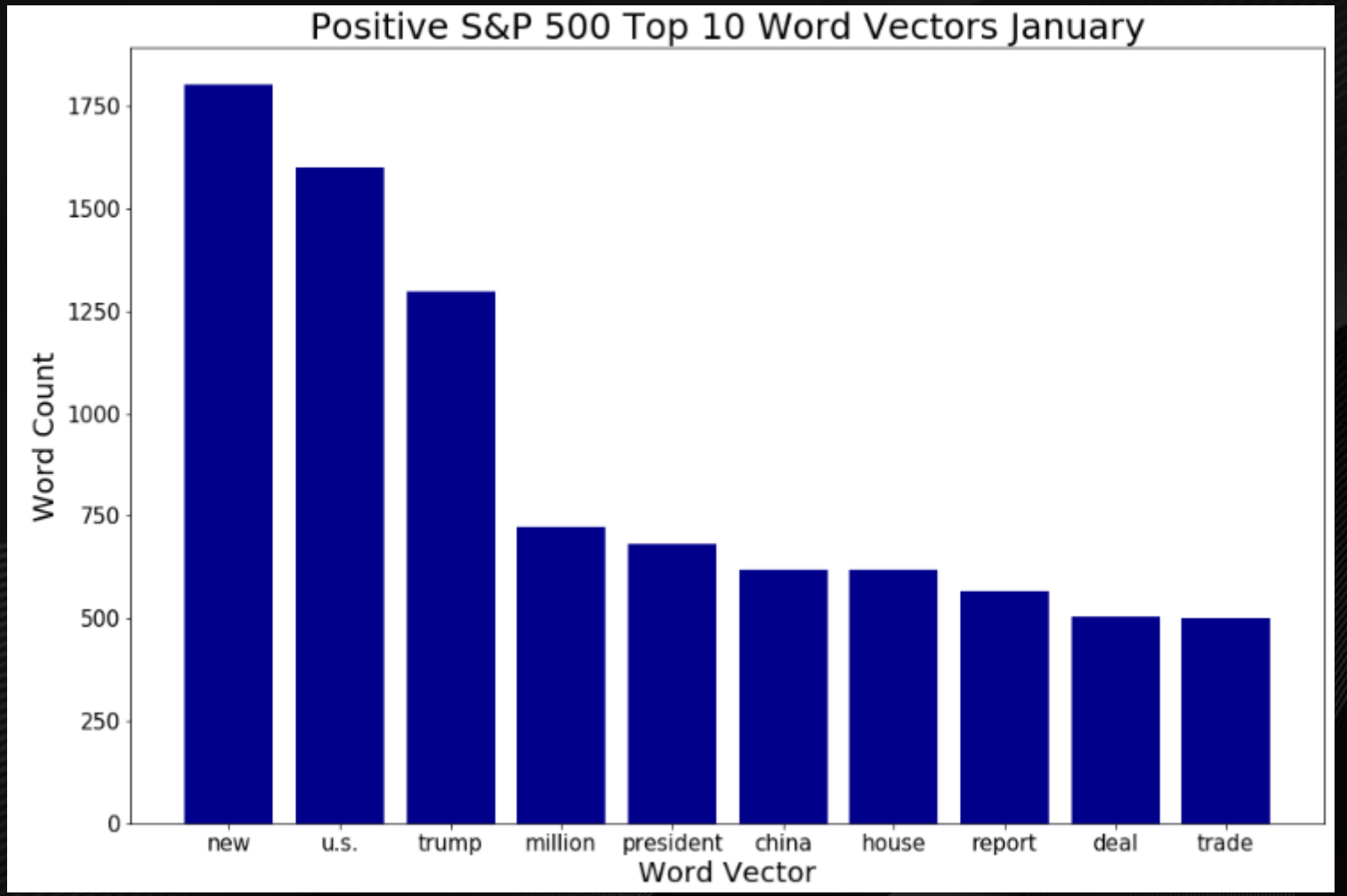


EDA WORD FREQUENCY

WSJ NLP S&P500 Market Predictor

Top Words on Positive S&P 500 Days:

1. **new**
2. **u.s**
3. **trump**
4. **million**
5. **president**
6. **china**
7. **house**
8. **report**
9. **deal**
10. **trade**

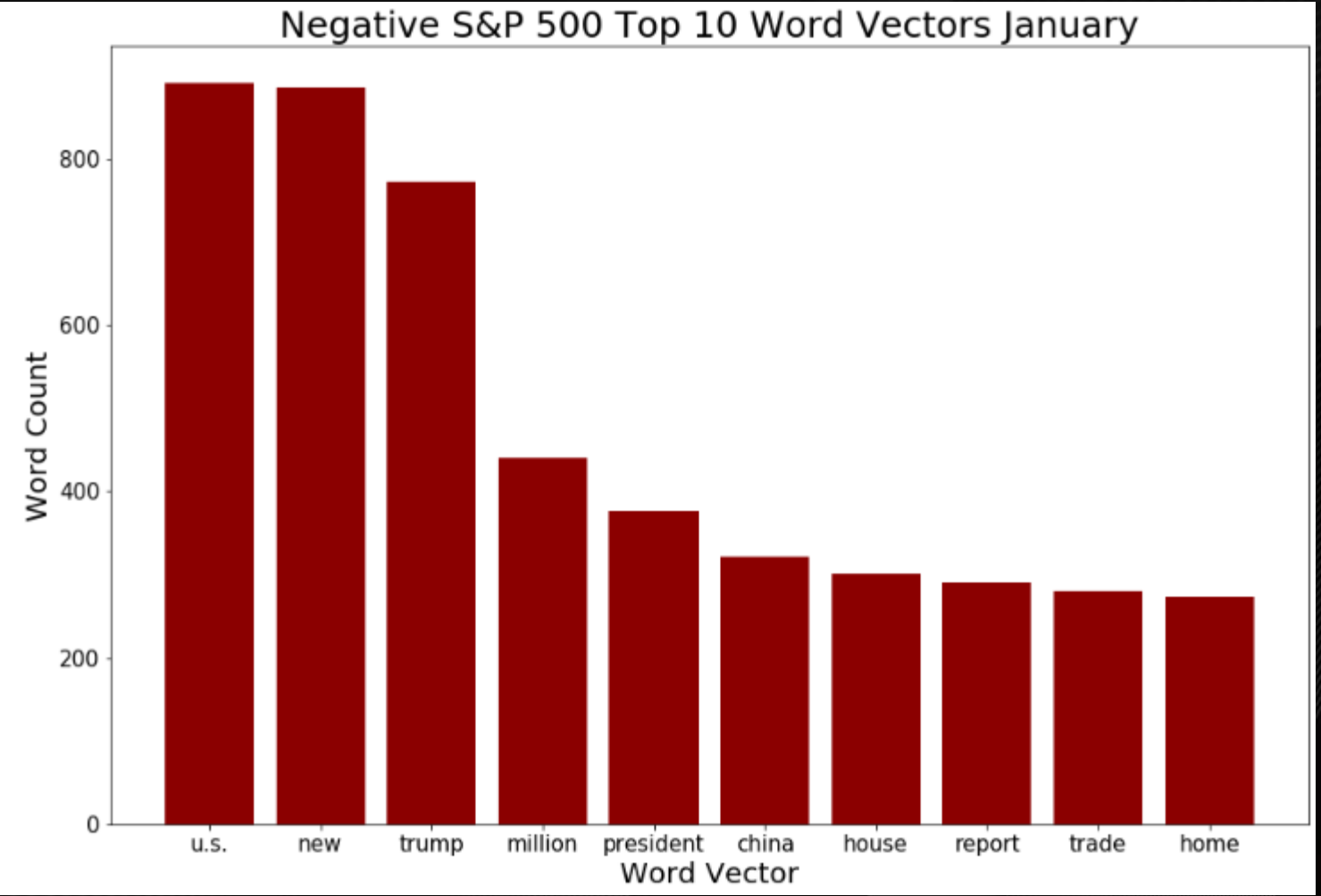


EDA WORD FREQUENCY

WSJ NLP S&P500 Market Predictor

Top Words on Negative S&P 500 Days:

1. **u.s**
2. **new**
3. **trump**
4. **million**
5. **president**
6. **china**
7. **house**
8. **report**
9. **trade**
10. **home**

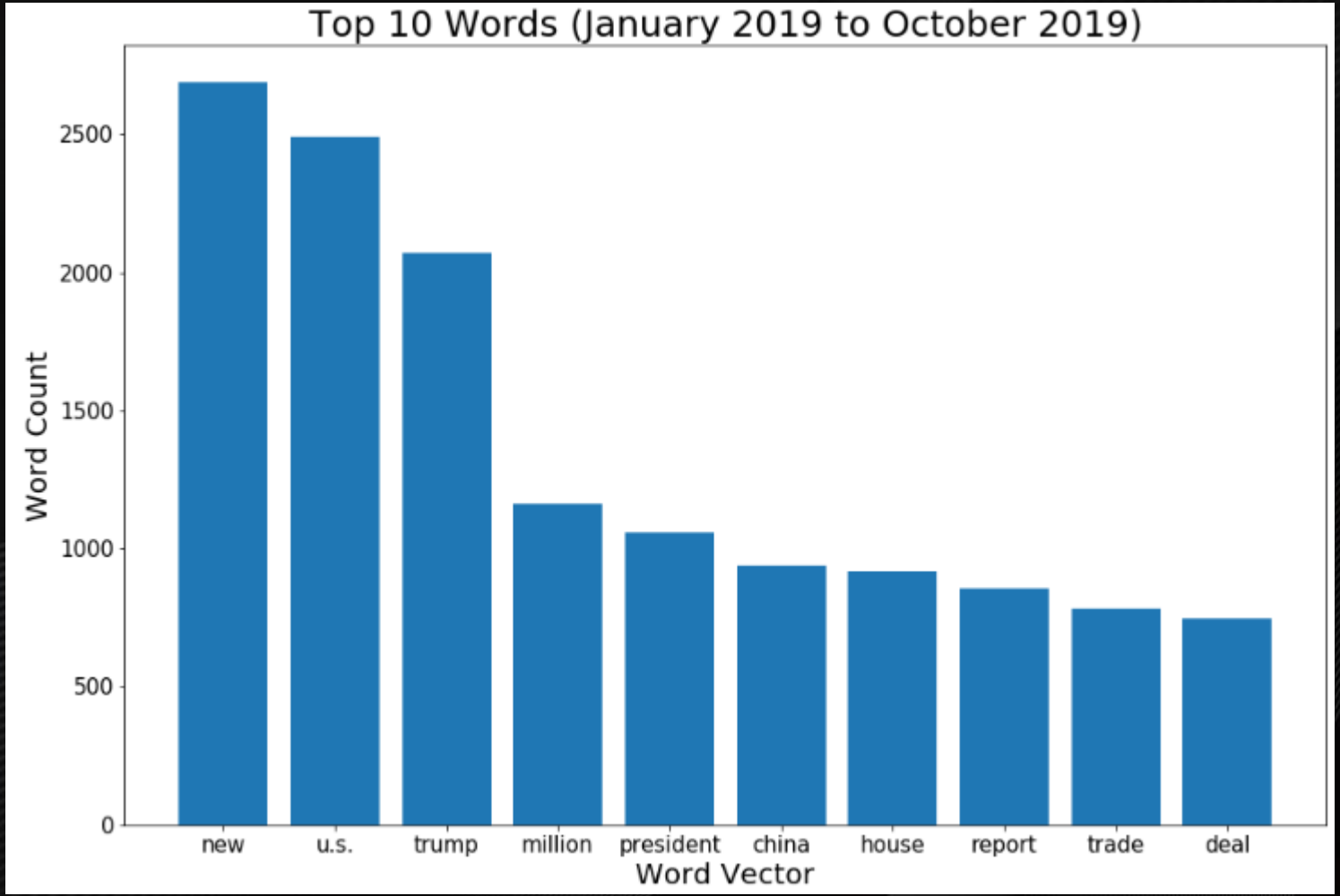


EDA WORD FREQUENCY

WSJ NLP S&P500 Market Predictor

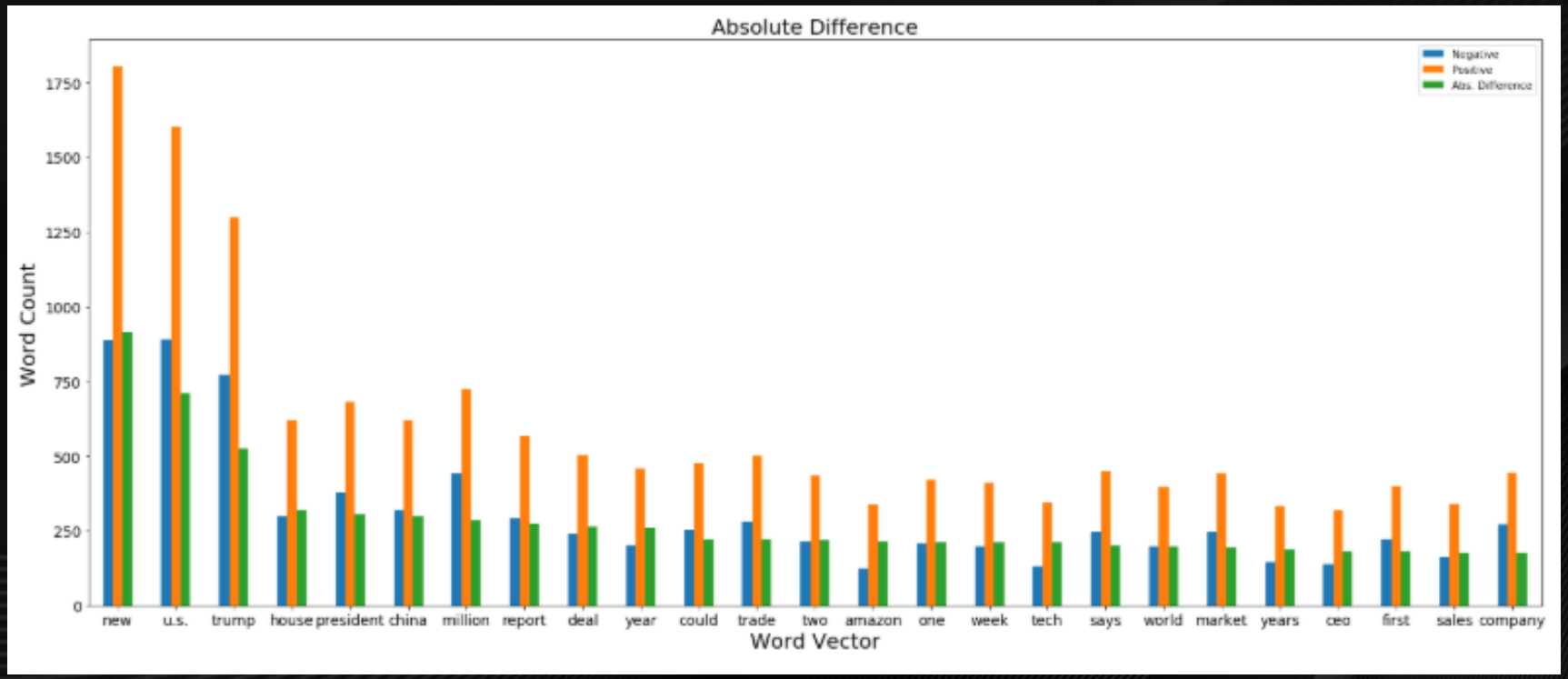
Top Words:

1. **new**
2. **u.s.**
3. **trump**
4. **million**
5. **president**
6. **china**
7. **house**
8. **report**
9. **trade**
10. **deal**



EDA ABSOLUTE DIFFERENCE

WSJ NLP S&P500 Market Predictor



EDA WORD CLOUDS

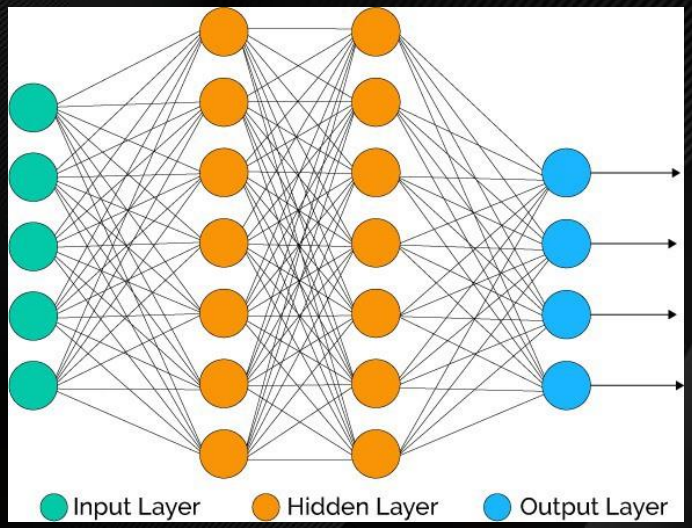
WSJ NLP S&P500 Market Predictor

EDA WORD CLOUDS

WSJ NLP S&P500 Market Predictor

Modeling

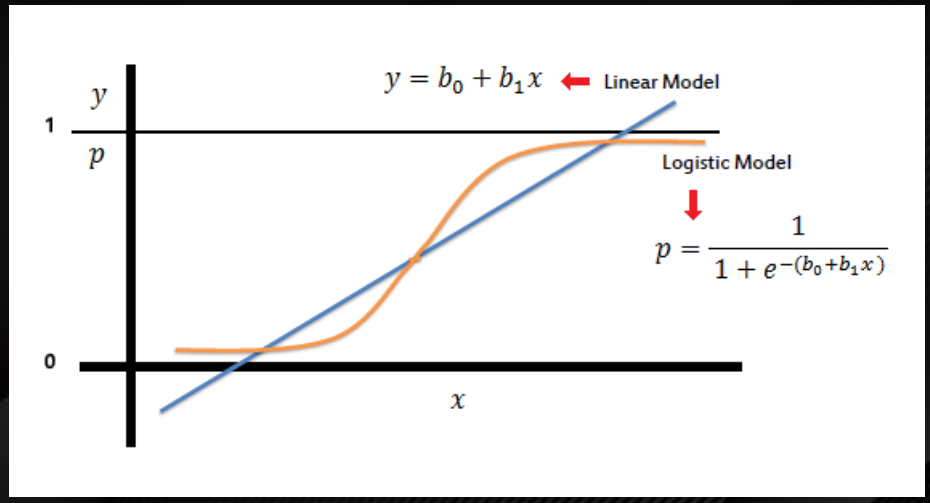
- **Logistic Regression**
  - **Bigrams, Lemmatization, Stemming**
- **Neural Networks**



MODELING – LOGISTIC REGRESSION

WSJ NLP S&P500 Market Predictor

- **Logistic Regression**
  - **Baseline:**
    - **Accuracy: 64.55%**
  - **Lemmatization:**
    - **Accuracy: 64.92%**
  - **Stemming:**
    - **Accuracy: 64.92%**
  - **Bigrams:**
    - **Accuracy: 69.08%**

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 (('new', 'york'), 0.0016830190772986618),
 (('logistics', 'report'), 0.0009216533042349815),
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 (('trump', 'administration'), 0.0009154883991899314),
 (('hong', 'kong'), 0.0008939112315322563),
 (('white', 'house'), 0.0008939112315322563),
 (('wall', 'street'), 0.0006473150297302546),
 (('morning', 'risk'), 0.0006010782418923793),
 (('risk', 'report'), 0.0006010782418923793),
 (('737', 'max'), 0.0005579239065770289),
 (('morning', 'download'), 0.0004901099510814785),
 (('york', 'city'), 0.0004746976884688534),
```

Top Bigrams

MODELING – LOGISTIC REGRESSION

WSJ NLP S&P500 Market Predictor

- **Neural Networks**
  - **Baseline:**
    - **Accuracy: 62.80%**
    - **Loss: .744**
  - **Optimal Model:**
    - **Accuracy: 65.10%**
    - **Loss: .650**

```
Model: "sequential_2"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
embedding_2 (Embedding)      (None, 250, 100)          250000
_________________________________________________________________
lstm_2 (LSTM)                (None, 100)               80400
_________________________________________________________________
dense_2 (Dense)              (None, 8)                 808
_________________________________________________________________
dense_3 (Dense)              (None, 2)                 18
=================================================================
Total params: 331,226
Trainable params: 331,226
Non-trainable params: 0
_________________________________________________________________
None
```

```
Model: "sequential_8"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
embedding_8 (Embedding)      (None, 250, 100)          250000
_________________________________________________________________
lstm_8 (LSTM)                (None, 120)               106080
_________________________________________________________________
dense_19 (Dense)             (None, 24)                2904
_________________________________________________________________
dense_20 (Dense)             (None, 16)                400
_________________________________________________________________
dense_21 (Dense)             (None, 8)                 136
_________________________________________________________________
dense_22 (Dense)             (None, 2)                 18
=================================================================
Total params: 359,538
Trainable params: 359,538
Non-trainable params: 0
_________________________________________________________________
None
```

CONCLUSION

WSJ NLP S&P500 Market Predictor

- **Key Takeaways:**
  - **Best Model:**
    - Bigram Logistic Regression: This model achieved around 69 percent accuracy in predicting the direction of the S&P 500 for the following day.
    - Neural networks were not sufficient and due to the black box component, the optimal number of layers were not found
  - **NLP Takeaways from WSJ:**
    - Trump's name was mentioned the most both in negative and positive days
    - Word clouds are a great visually appealing way to represent any type of text data
    - Amazon and Apple were the two companies mentioned the most
    - The model accuracy is very impressive considering the most mentioned words are very similar for positive and negative days
  - **Further Analysis:**
    - Time series modeling of Amazon and Apple to see whether the stock market went up or down when mentioned
    - Stacked modeling

THANK YOU, QUESTIONS?