Headlines and Market Trends: Exploring Causality between News Sentiment and Stock Movement Prediction

Erdos Deep Learning Bootcamp - Summer 2024

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Central Question

- Can we predict the stock price movements of a company using the sentiment scores of financial news headlines?
- Understand the causality between sentiment scores from financial news impact stock movements and vice versa

Approach

- Stock News API for financial news data
- Alpaca API for intraday stock prices

- Finetune LLM Transformer (RoBERTa) to improve sentiment scores

- Implement LSTMs, CNNs and Transformers on both directions
- Predicted trading signals to be used as inputs for an intraday trading strategy buy and hold **simulation**

Deliverables

Estimated Portfolio Growth and quantify the causal relationship of sentiment scores with stock movements and vice versa

Business perspective: Do the models make profit or not?

Data Gathering

- **Gathered 63,000 articles of financial news data from Stock News API from various news sources**

The Motley Fool Investor's Business
Daily Zacks Investment Research
Market Watch
24/7 Wall Street Reuters
CNBC
Business Wire Forbes
The Guardian
Fox Business
NY Times
... and more ...

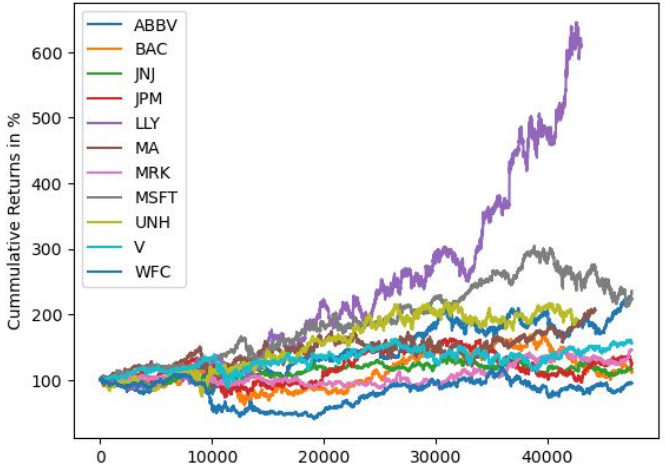
- **Collected 5 years worth market data (03/2019 - 03/2024), with 15 min frequency using Alpaca API, and selected the top 3 sectors based on market weight: Healthcare, Technology, Finance**
- **First four years used as training set, last year for test**

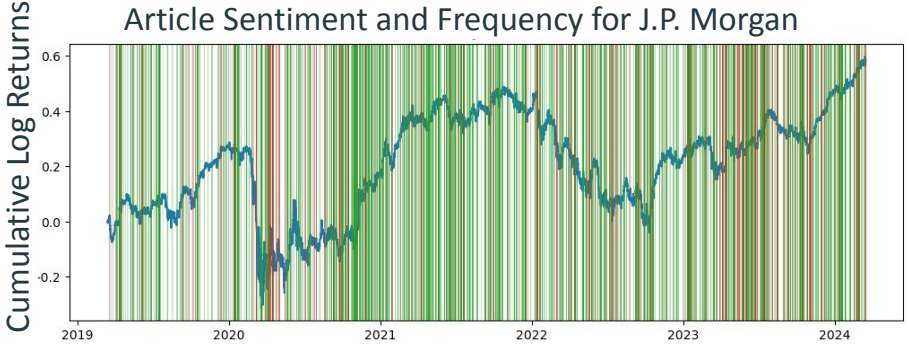
Healthcare	Technology
Eli Lilly & Co	Apple
United Health	Microsoft
Johnson & Johnson	Nvidia
Merck & Co Inc	Google
AbbVie Inc	Amazon

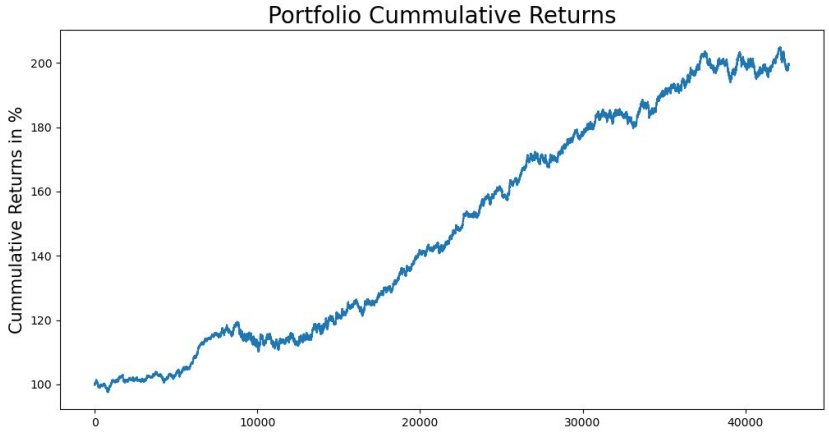
Finance
JP Morgan Chase & Co
Visa
Mastercard
Bank of America
Wells Fargo

Exploratory Data Analysis

- We examined the frequency and sentiment of tickers to be considered
- We perform a “fundamental” quantitative analysis to build a variance-balanced portfolio to use as a baseline comparison
- The aim of this project is to examine if the additional information from article sentiment can outperform this reference portfolio



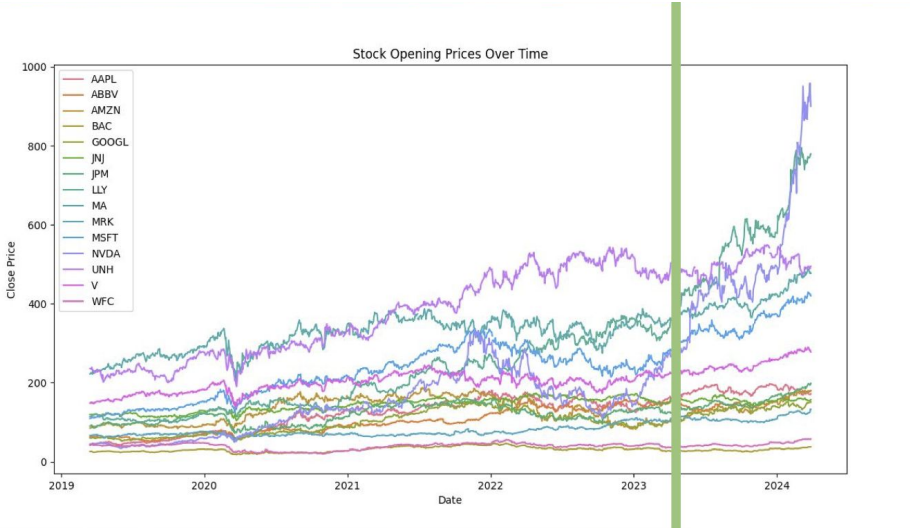




Modeling

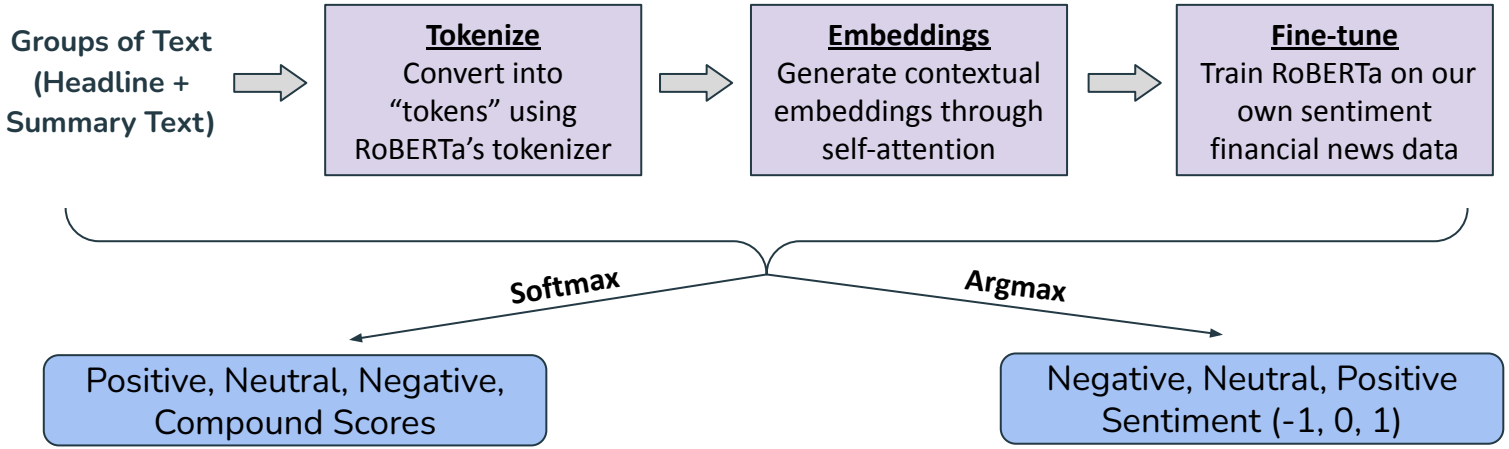
Our dataset included 5 years of stock prices and news headlines.

- We set aside the last year of data as our test set (March 2023 - March 2024)
- From the 4 years in our training set, we used the last year, broken into four 3-month increments as validation sets.
- Implemented Long Short Term Memory (LSTMs), Convoluted Neural Networks, Transformers



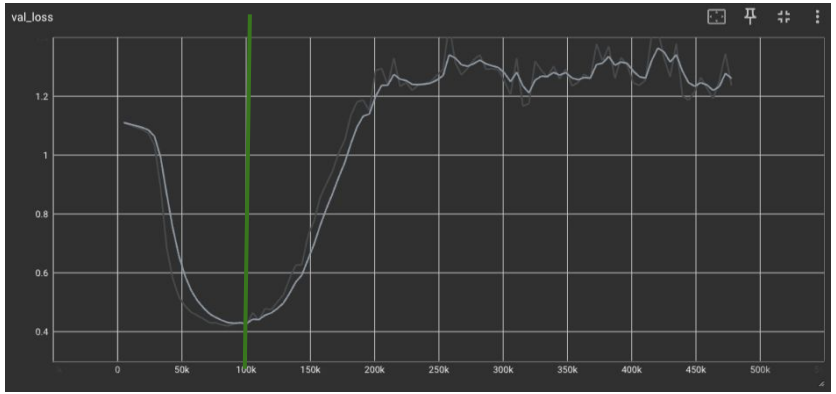
Sentiment Analysis

Sentiment analysis is the process of analyzing groups of texts (sentences or articles) to assign a value that reflects how positive, negative, or neutral the overall sentiment seems toward the financial news articles.



Fine-tuning process

- First run: 100 epochs, to understand the training and validation loss



- Second run: 30 epochs, with early stopping
- Third run: 30 epochs, with early stopping and fine-tuned learning rate
- Saved the best model and predicted on the whole dataset
- **Got a +35% increase in accuracy in comparison to using RoBERTa model (not fine-tuned)**

Sentiment Analysis Results

- Used Openai API to get ground truth labels as inputs for the fine-tuning process
- Table 1 compares sentiment scores that match between different tools
  - RoBERTa here is defined as a pre-trained RoBERTa model on a financial dataset
  - Got 86% matching sentiments from fine-tuned RoBERTa vs Openai sentiment, shows effective fine-tuning of RoBERTA

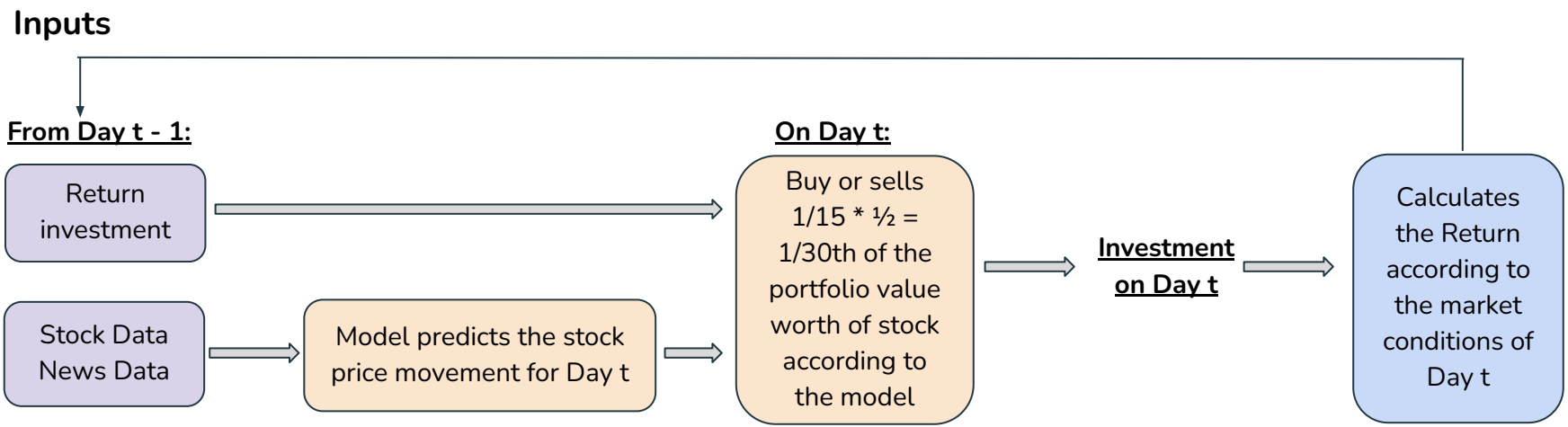
	Matching Sentiments (%)
Openai vs. Finvader	60.74
Openai vs. RoBERTa	58.19
Roberta vs. Finvader	58.76
Fine-tuned RoBERTa vs Roberta	61.97
Fine-tuned RoBERTa vs. Finvader	57.77
Fine-tuned RoBERTa vs. Openai	86.54

Table 1: Matching Sentiments between tools

Metric: Portfolio Growth

Aside from accuracy and root mean square error (RMSE) as metrics, we build a simple buy and hold simulation to measure the performance of our models.

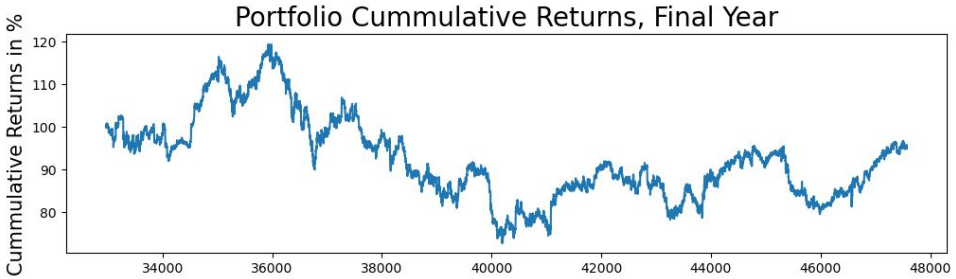
Did we make beyond a —% profit in the simulated scenario?



Results

Using the 4 3-month increments for validation set, results from the stock portfolio simulation

Model	Ave Quarterly Growth	Annual Growth
Fiducial (Variance Balanced)	-1.27%	-5.08%
LSTM	+0.3%	+1.20%
CNN	In Progress	In Progress
Transformer	In Progress	In Progress



Conclusion and Next Steps

Improved Sentiment Analysis:

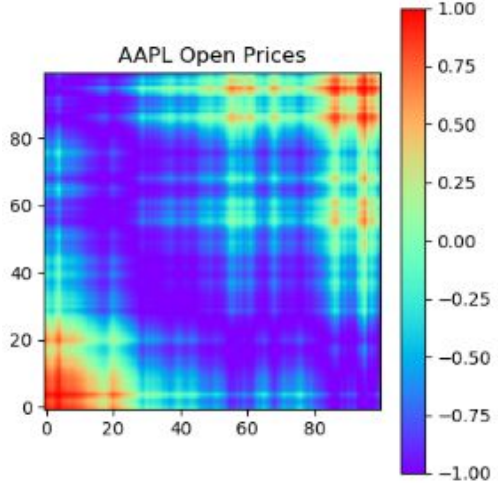
- **Fine-Tuning LLM Transformers (RoBERTa) for sentiment analysis:** achieved up to 89% accuracy using a fine-tuned RoBERTa model
- **Improvement over Other Models:** Saw large improvements in understanding nuance and sentiment compared to FinVADER and other pretrained RoBERTa models.

Future Studies - Erdos Deep Learning Bootcamp

- **Fine-Tuning Deep Learning Models for Prediction:** Adjust the current CNN and Transformer (Informer) models to a deliverable state

- Understand the **causality** of sentiment from news affecting stock movement and vice versa

- Understanding the model performance for each sector (Healthcare, Technology, and Finance)



Transforming time series into an image for inputs to CNN, work in progress! :)

THANK YOU TO ERDOS INSTITUTE!!

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