Comparing sentiment analysis models and topics on Elon Musk tweets and its correlation with stock price

Anonymous ACL submission

Abstract

We will be using sentiment analysis of all the tweets of Elon Musk during a given time frame using SentimentIntensityAnalyzer from vaderSentiment. By doing this we get the general emotion of Elon Musk. From this we quantify his emotions and compare it to the performance of the company Tesla which he is the CEO of. Since the data we are using is time series based, we have to quantify correlation using appropriate methods. We choose Euclidean distance between neutral sentiment and stock price as baseline for the Euclidean calculation. Since the sentiment and stock price could have some lagging correlation, we will also use Dynamic Time Warping and Pearson correlation. We get that in general there is a slight laggin correlation. To invesitgate this further, we use topic analysis to specify topics in the sentiment analysis to see if some topics gives better results than others, which we see that some do.

1 Introduction

We will be using sentiment analysis on twitter data of Elon Musk tweets to see correlation. This is of interest since a positive correlation could contribute to financial rewards for stock market traders if we can by analysing the current sentiment, choose winning buy sell targets for the stock trader. In this case we will be doing the correlation of the sentiment with the Tesla stock price. This since Elon Musk is the CEO of Tesla and also happen to tweet quite a lot. We will be using sentiment analyser from vaderSentiment to get polarity scores to classify tweets to positive, negative or neutral. [1] Furthermore, we will also use BERT which also outperforms other more sophisticated models. [2]

2 Theory

SKriv om det olika sakerna.

2.1 Vader Sentiment

about vader

2.2 BERT

BERT stands for "Bidirectional Encoder Representation from Transformers". We use pre-trained BERT which is already trained on large text corpus. This combined with fine tuning it for the specific task at hand can give us a powerful model to use. [2]

2.3 Logistic Regression

Logistic regression commonly used for dichotomous cases, we in this task will use it with it's multinomial case with 3 categories [3] in our case being positive, negative and neutral.

2.4 Euclidean Distance

We will use the Euclidean distance to see for similarities between the two time series.

2.5 Pearson Correlation

The time series of interest can be lagging or leading if there is a correlation, in this case we will use Pearson correlation coefficient to get in what direction and stregth the correlation is tilted to.

3 Data

The data used for sentiment analysis is tweets from Elon Musk on twitter. To fune tune the pre trained BERT model, we use pre labeled data, in this case we found pre labeled sentiment data that is based on Reddit data. Both of these data are downloaded from Kaggle [4] and [5] respectively.

The data used to see if there is a correlation of sentiment and stock price is the stock price of the company Tesla the data is from MarketWatch [6]

4 Method

4.1 data

The data is handled differently depending on the model being used.

For the Vader sentiment, we choose to go through each row of the tweets data and give in a score of 1, -1 or 0 for positive negative and neutral respectively.

For the BERT model, we use pre-labeled twitter data and fine tune it using keras tensorflow. After that we load the finished model and use it to get sentiment of the Elon Musk twitter data.

For the Regression, we use the pre-labled twitter-data and split it into training and testing. We train the data on the Logistics regression model since it will suite the nature of this type of classification. [7]

4.2 normalization

When the sentiment data for all the models are accumulative and in series. We will see a clear trend usually. To deal with this fact, we use linear detrending, this for both stock price and also sentiment. This will give us a better view to analyze the correlations to scale.

5 Results

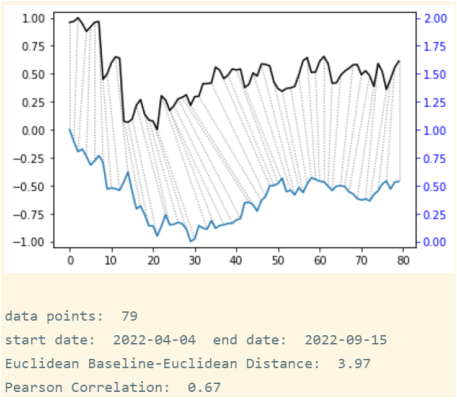


Figure 1: Using BERT sentiment analysis on all tweets. By using dynamic time warping, we get a plot where black is sentiment and blue is stock price

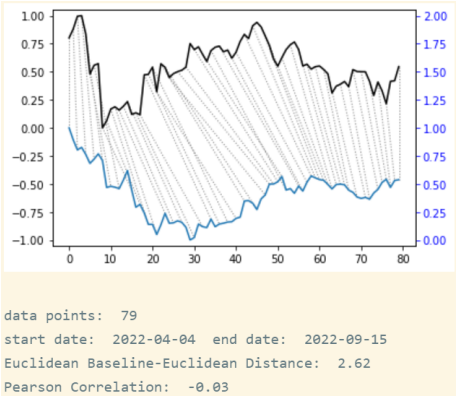


Figure 2: Using logistic regression model, sentiment analysis on all tweets. By using dynamic time warping, we get a plot where black is sentiment and blue is stock price

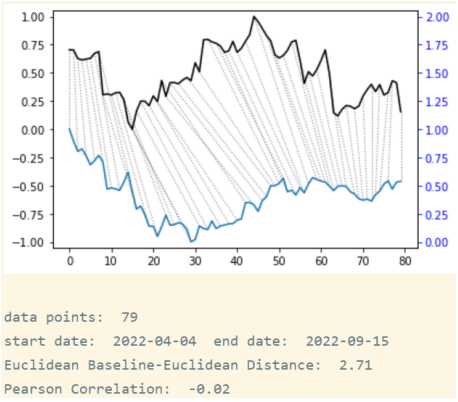


Figure 3: Using vader sentiment analysis on all tweets.By using dynamic time warping, we get a plot where black is sentiment and blue is stock price

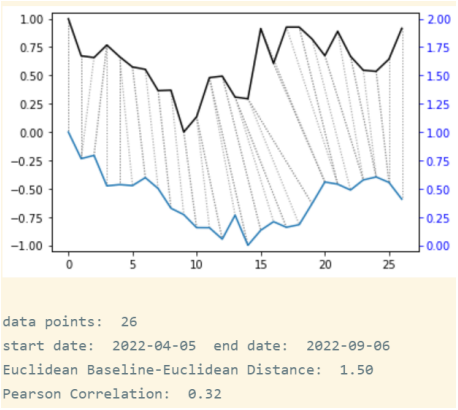
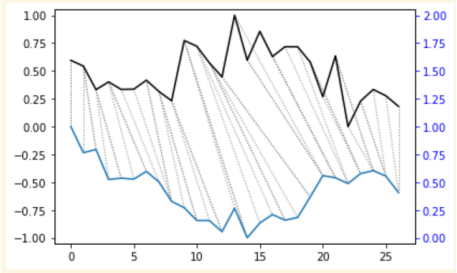


Figure 4: Using BERT sentiment analysis on tweets mentioning twitter. By using dynamic time warping, we get a plot where black is sentiment and blue is stock price



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data points:  26
start date:  2022-04-05  end date:  2022-09-06
Euclidean Baseline-Euclidean Distance:  1.18
Pearson Correlation:  -0.44
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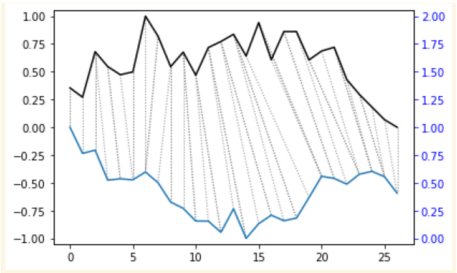
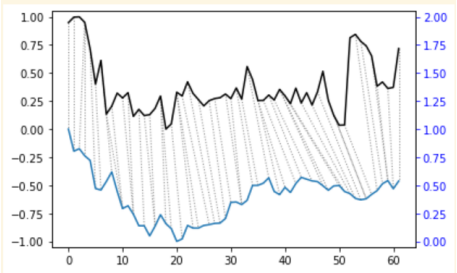
Figure 5: Using logistic regression model, sentiment analysis on tweets mentioning twitter. By using dynamic time warping, we get a plot where black is sentiment and blue is stock price



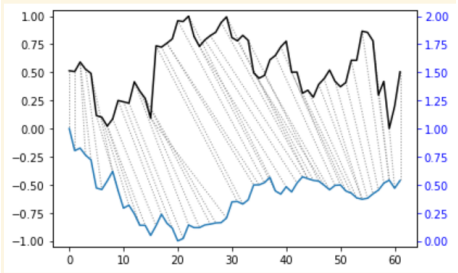
```
data points:  26
start date:  2022-04-05  end date:  2022-09-06
Euclidean Baseline-Euclidean Distance:  0.96
Pearson Correlation:  -0.42
```

Figure 6: Using vader sentiment analysis on tweets mentioning twitter. By using dynamic time warping, we get a plot where black is sentiment and blue is stock price



```
data points:  61
start date:  2022-04-04  end date:  2022-09-15
Euclidean Baseline-Euclidean Distance:  3.30
Pearson Correlation:  0.55
```

Figure 7: Using BERT sentiment analysis on tweets mentioning tesla. By using dynamic time warping, we get a plot where black is sentiment and blue is stock price



```
data points:  61
start date:  2022-04-04  end date:  2022-09-15
Euclidean Baseline-Euclidean Distance:  1.68
Pearson Correlation:  -0.42
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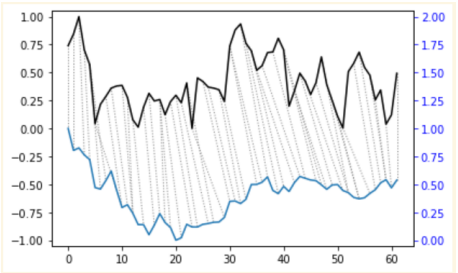
Figure 8: Using logistic regression model, sentiment analysis on tweets mentioning tesla. By using dynamic time warping, we get a plot where black is sentiment and blue is stock price



```
data points:  61
start date:  2022-04-04  end date:  2022-09-15
Euclidean Baseline-Euclidean Distance:  3.11
Pearson Correlation:  0.43
```

Figure 9: Using vader sentiment analysis on tweets mentioning tesla. By using dynamic time warping, we get a plot where black is sentiment and blue is stock price

6 Discussion

To make this discussion clear, we will be assuming that the Vader Sentiment is our baseline. Another important clarification to be made is that when we refer to "sentiment" in the case where we use all the tweets of Elon Musk, we mean that it is emotion analysis since using all the tweets imply that we are measuring Elon Musk's general mood and emotional state. These results are present from figures 1 to 3. However for results of figures 4 to 9, we are doing sentiment analysis of Elon Musk on the given topic. First we look at the results looking at figures 1,2 and 3 which are using all the tweets of Elon Musk and stock price of Tesla during 2022-04-04 and 2022-09-15. Since we have the

most data points on these results we will use it to compare between Vader Sentiment which is a lexicon based approach, logistic regression and BERT where the latter two are machine learning based. Starting our observations of the resulting dynamic time warping plot, we see a possible correlation where the stock price seems to be following Elon Musk's tweets sentiment some what. This makes us hope full that we can predict the stock price by using sentiment or emotion analysis. Since the plots seem quite similar between the three models, we will look deeper into some actual correlation values to get a better understanding of it. We see that the Vader and Logistic models have more similar Pearson correlation coefficient and Euclidean score. Where as the BERT model seem to find better correlation. Since the BERT is deviating from the other two models, it might be observing wrong correlations. Now that we do observe a difference between the models where we have a higher trust for the Vader and Logistic models, we will investigate if a certain topic of Elon Musk's tweets have a higher or lower correlation with the stock price of Tesla. We choose two topics to compare between, "Twitter" and "Tesla". The choice came down to the fact that Elon Musk during this period was talking actively about acquiring Twitter the company and could have caused his Tesla company's stock value to fluctuate depending on that. Furthermore, the choice of using Tesla is a natural decision since this topic is also the name of the company of this analysis. Comparing the sentiment analysis vs stock price of these two topics, we see that the Pearson correlation coefficient which indicates the lag shift of the correlation seems to be quite similar between the two topics, around 0.4 in either direction. However when looking at the Euclidean score, we see that the topic "Tesla" has a range of 1.68 to 3.30 whilst the topic "Twitter" has a significantly lower range between 0.96 to 1.50.

7 Conclusion

After investigating the correlation between sentiment and stock price using three different models for both specific topics and the general emotion analysis of Elon Musk's tweets without any specific topic. We can conclude that there seems to be some sort of correlation in the desired direction which is that the stock price follows the sentiment of Elon Musk's tweets. Furthermore, investigating if specifying certain topics have more correlation than others, we found that the topic Tesla had a greater correlation and the topic of Twitter. However the topic Tesla did not have a significantly higher correlation to the stock price than the general emotion analysis of Elon Musk's tweets without a given topic.

It is hard to say from the specific values of the Pearson correlation and Euclidean distance itself if it is worth the risk to do any buy sell stock trades based on Elon Musk's emotion or sentiment on specific topics. This is out of scope for this project but will be interesting for further studies to do further investigation on how this information can be used to do reliable stock trades.

References

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[7] Ravinder Ahuja, Aakarsha Chug, Shruti Kohli, Shaurya Gupta, and Pratyush Ahuja. The impact of features extraction on the sentiment analysis. *Procedia Computer Science*, 152:341–348, 2019. International Conference on Pervasive Computing Advances and Applications- PerCAA 2019.