Sentiment Analysis and Stock Price Prediction for **Tesla (TSLA)**

This project explores the sentiment analysis of Tesla stocks, analyzing the relationship between online sentiment and stock price fluctuations. We delve into different machine learning models to predict stock price movements based on sentiment data.

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WHY Tesla (TSLA)

- **High Volatility and Interest:**
  Tesla (TSLA) is known for its significant price fluctuations and high trading volume, making it an interesting subject for analysis.

- **Strong Media Presence:**
  Tesla frequently appears in news articles and social media discussions, providing ample data for sentiment analysis. The company's innovative approach and CEO Elon Musk's public persona often generate substantial media coverage.
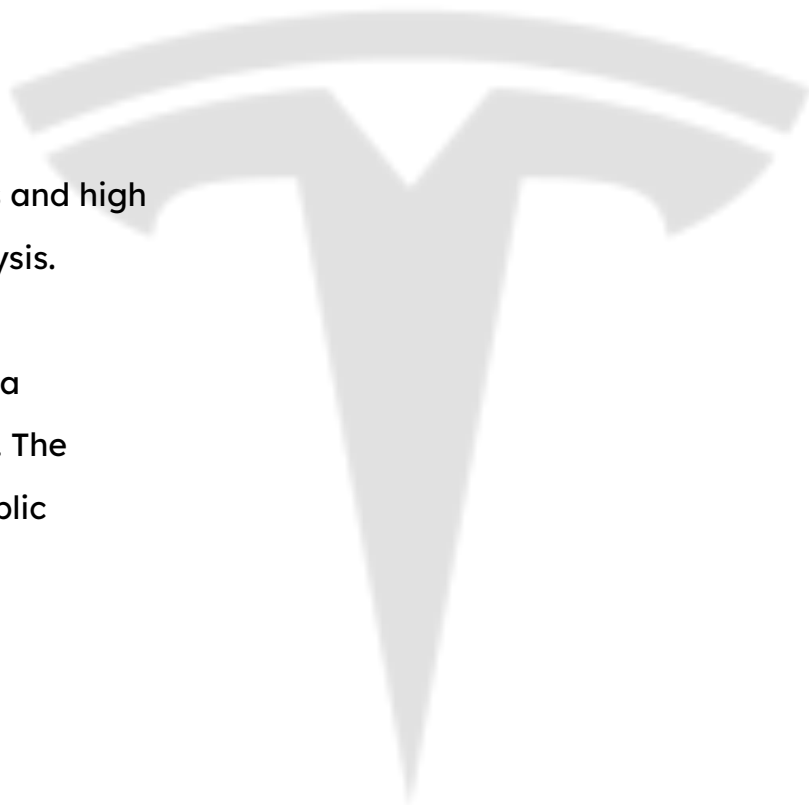
Project Overview and **Objectives**

- This project revolves around these main objectives
  - Gathering Tesla articles from different sources
  - Analyzing Online sentiments of articles
  - Detecting relationship with prices and Predicting stock prices

Data Overview

- The data used for this analysis consists of daily stock price data for Tesla, as well as a collection of online articles extracted from various sources like forbes, google news, etc.

- The sentiment scores were derived from sentiment analysis algorithms, which analyze text data and assign a polarity score [-1 to 1] to each piece of content.

- Data consists of total 278 articles

+1   **-1**

Scraped Articles (Oct 2023 – Dec 2023)

	A	B	C	D	E	F
	PublishedAt	Title	URL	Content		
	20231031T0900	Almost As Good As You : Elon Mus	https://www.ndtv.com/offbeat/almost-as-goo	Elon Musk and Maye Musk. Halloween is upon us, and it is widely celebrate		
	20231003T1930	Grimes Sues Ex Elon Musk Over P	https://www.usmagazine.com/celebrity-new	By clicking Sign In, you agree to our Terms and Conditions and that you ha		
	20231023T2100	Elon Musk offers $1B to Wikipedia i	https://www.myrtlebeachonline.com/news/politics-government/article280883988.html			
	20231107T0115(	Elon Musk X / Twitter Starts Selling	https://www.breitbart.com:443/economy/20	Elon Musk's X/Twitter is now planning to sell off coveted inactive account ha		
	20231002T1830	Tesla 3Q sales rise 27 % but fall sh	https://www.local10.com/business/2023/10/	WEATHER ALERT Associated Press Published: October 2, 2023 at 9:56 AM		
	20231023T2100	Elon Musk Wants Wikipedia to Cha	https://www.aceshowbiz.com/news/view/00213855.html			
	20231013T0700	Elon Musk Says Eu Has Not Provid	https://www.marketscreener.com/news/late	OK XID: 21188370513 Varnish cache server		
	20231010T0830	X premium users can now restrict p	https://indianexpress.com/article/technolog	X, previously known as Twitter, has now introduced a new feature that allow		
	20231025T2100	Elon Musk Claims Tesla Cybertruck	https://carbuzz.com/news/elon-musk-claims-tesla-cybertruck-underwent-al-capone-style-bulletproof-test			
	20231011T0445	Cathie Wood Ark Invest Keeps On (	https://www.benzinga.com/markets/equities	On Tuesday, Cathie Wood-led Ark Invest made a notable move by selling ov		
	20231110T1715(	Elon Musk biopic to be directed by	https://nypost.com/2023/11/10/business/elon-musk-biopic-to-be-directed-by-darren-aronofsky-source/			
	20231009T1845	Is Tesla Stock a Buy ? | The Motley	https://www.fool.com/investing/2023/10/	Founded in 1993, The Motley Fool is a financial services company dedicate		
				Elon Musk's venture into AI with Grok, intended a humorous and honest alte		
	20231216T2015	Elon Musk Grok AI Is Just as Wok	https://www.breitbart.com:443/tech/2023/12	Copyright © 2024 Breitbart		

Sentiment **Scores**

• Used NLTK's VADER (Valence Aware Dictionary and sEntiment Reasoner) for sentiment analysis

• VADER is specifically attuned to sentiments expressed in social media

• Calculated compound sentiment score for each article

• Aggregated sentiment scores for each day.

• Computed the mean of compound scores for all articles published on the same day to get a daily sentiment score

Distribution of Article Lengths

Distribution of Sentiment Scores
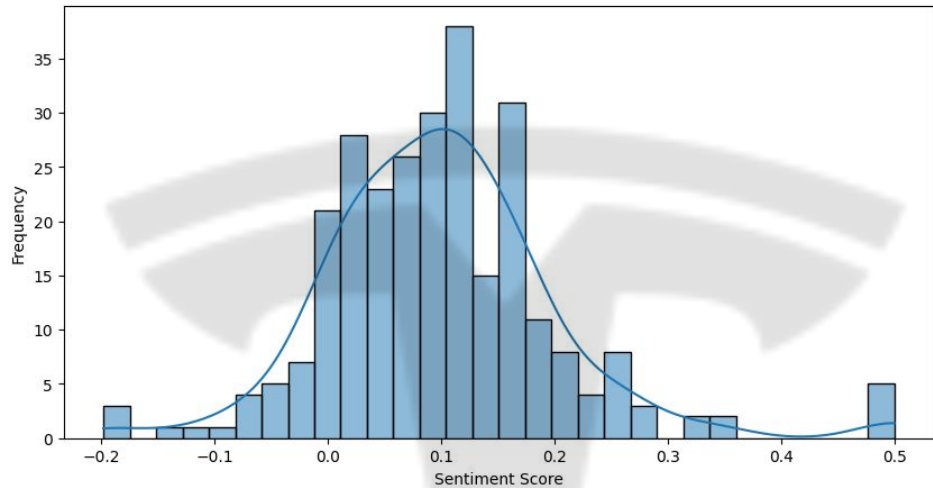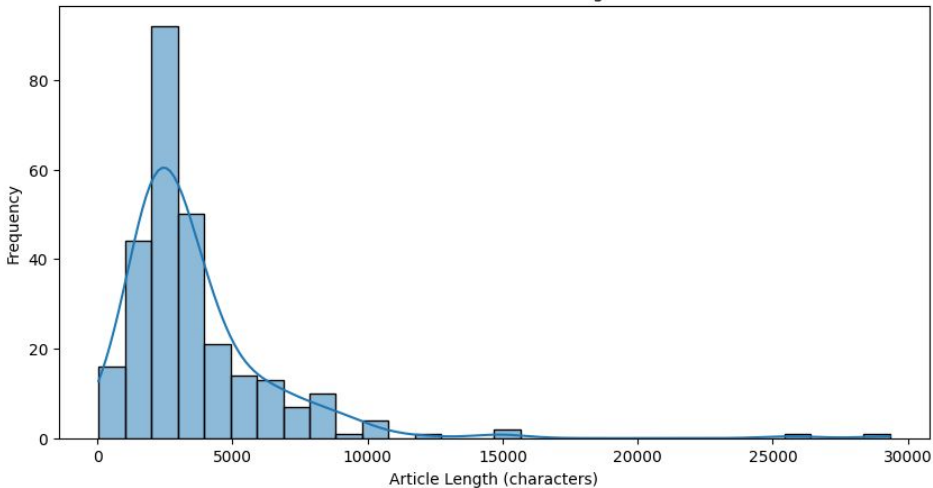
Sentiment Scores

```
                                   CleanedContent  Article_Length  \
202  spacex founder ceo elon musk slammed justin tr...            2173
161                     ok xid varnish cache server              40
168                     ok xid varnish cache server              40
65                      ok xid varnish cache server              40
227  associated press published october updated oct...            3905
..                                             ...             ...
50   tech billionaire elon musk disclosed electric ...            2281
180  tech billionaire elon musk disclosed electric ...            2281
208  tesla spacex ceo elon musk returned worlds ric...            1368
221  home news elon musk advocates improved nft imp...            8580
211  home news elon musk advocates improved nft imp...            8580

     Sentiment_Score  TitleSentiment  ContentSentiment
202         0.096651          0.2023           -0.9889
161         0.500000         -0.4215            0.2960
168         0.500000          0.0000            0.2960
65          0.500000          0.2235            0.2960
227         0.054679         -0.1901            0.9895
..               ...             ...               ...
50          0.047389          0.0000            0.9819
180         0.047389          0.6486            0.9819
208         0.033796          0.8271            0.9832
221         0.095722          0.4767            0.9989
211         0.095722         -0.1779            0.9989

[277 rows x 9 columns]
```
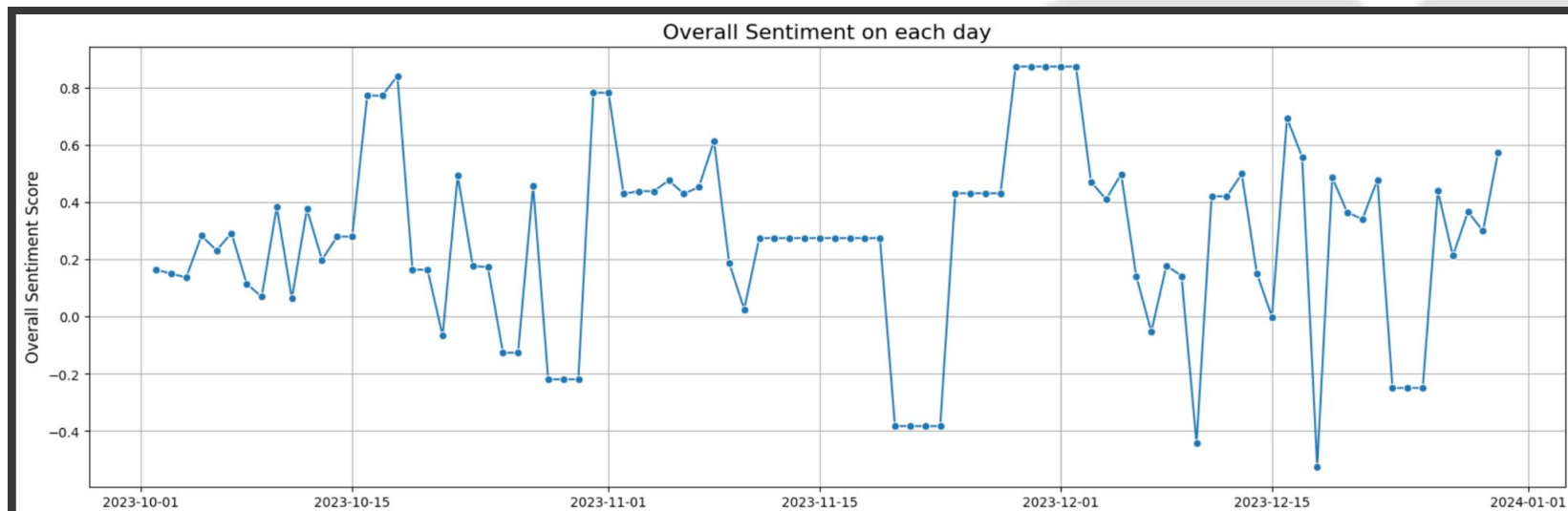
	PublishedAt	OverallSentiment
0	2023-10-02	0.164335
1	2023-10-03	0.150175
2	2023-10-04	0.137088
3	2023-10-05	0.283156
4	2023-10-06	0.232122
...	...	...
85	2023-12-26	0.439700
86	2023-12-27	0.212800
87	2023-12-28	0.367150
88	2023-12-29	0.299575
89	2023-12-30	0.574150

90 rows × 2 columns

Overall Sentiment on each day

Combined Sentiment **Scores** & Stock Prices

prices_and_sentiments

File Edit View Insert Format Data Tools Extensions Help

A1 | PublishedAt

	A	B	C	D	E	F	G	H	I
1	PublishedAt	OverallSentimen	Unnamed: 0	adjusted_close_	close_price	high_price	low_price	open_price	volume
2	2023-10-02	0.164335	187	251.6000061	251.6000061	254.2799988	242.6199951	244.8099976	123810400
3	2023-10-03	0.150175	188	246.5299988	246.5299988	250.0200043	244.4499969	248.6100006	101985300
4	2023-10-04	0.1370875	189	261.1600037	261.1600037	261.8599854	247.6000061	248.1399994	129721600
5	2023-10-05	0.2831555556	190	260.0499878	260.0499878	263.6000061	256.25	260	119159200
6	2023-10-06	0.2321222222	191	260.5299988	260.5299988	261.6499939	250.6499939	253.9799957	117947000

Technical **Approaches**

1. **Autoregressive (AR) Model:**
• Used past stock prices to predict future prices
• Implemented using statsmodels' AutoReg function
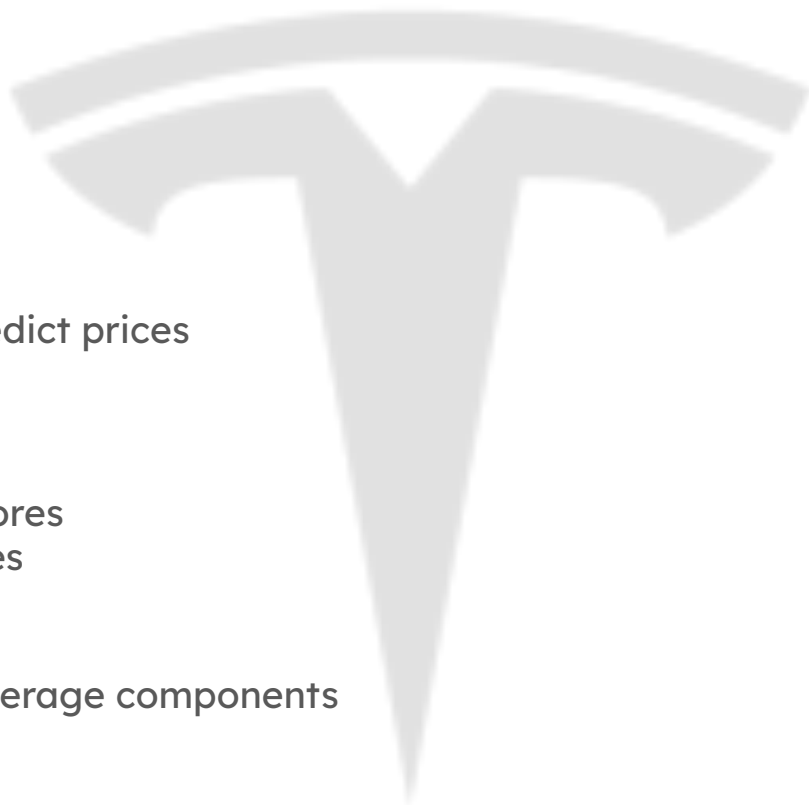
2. **Linear Regression Model:**
• Used sentiment scores and percentage change to predict prices
• Implemented using sklearn Linear Regression
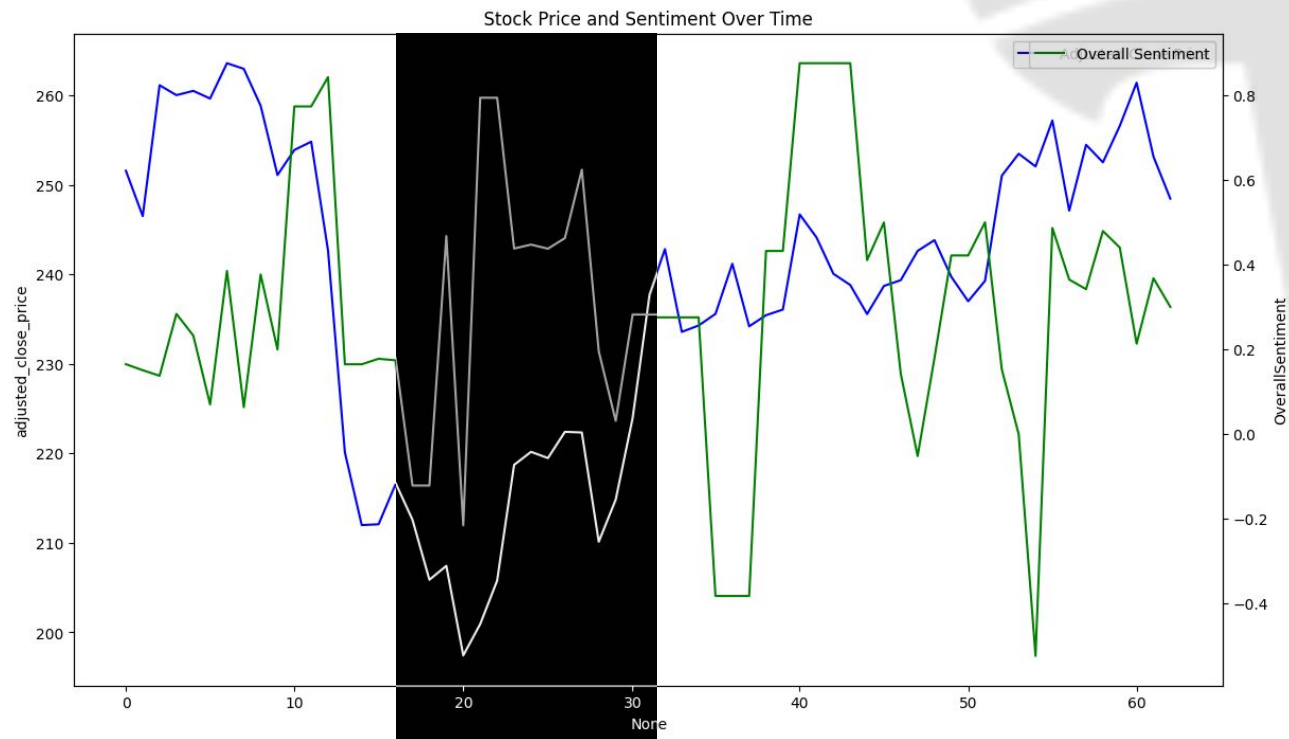
3. **Percentage Change Prediction:**
• Predicted percentage change based on sentiment scores
• Used predicted change to calculate future stock prices
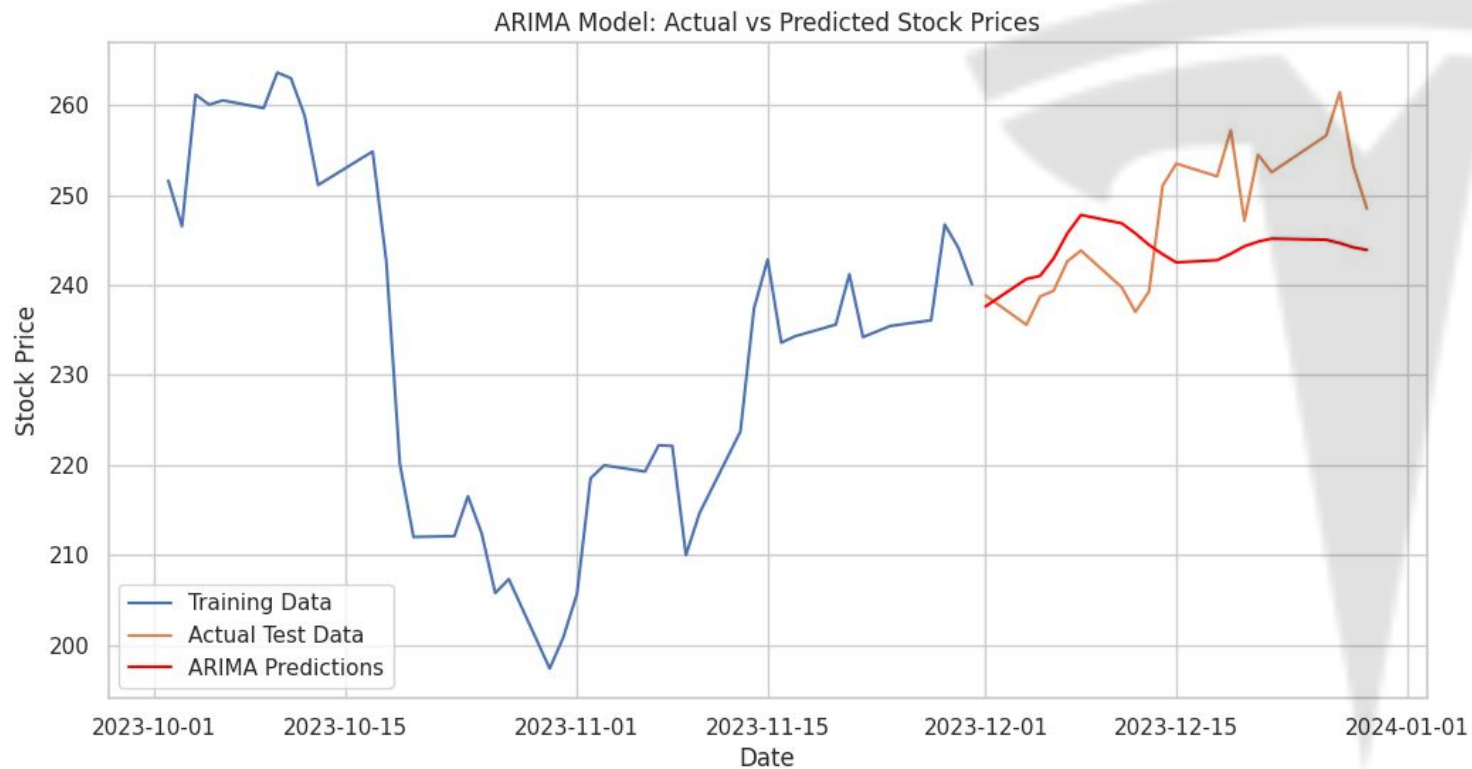
4. **ARIMA Model:**
• Combined autoregressive, integrated, and moving average components
• Implemented using statsmodels' ARIMA function
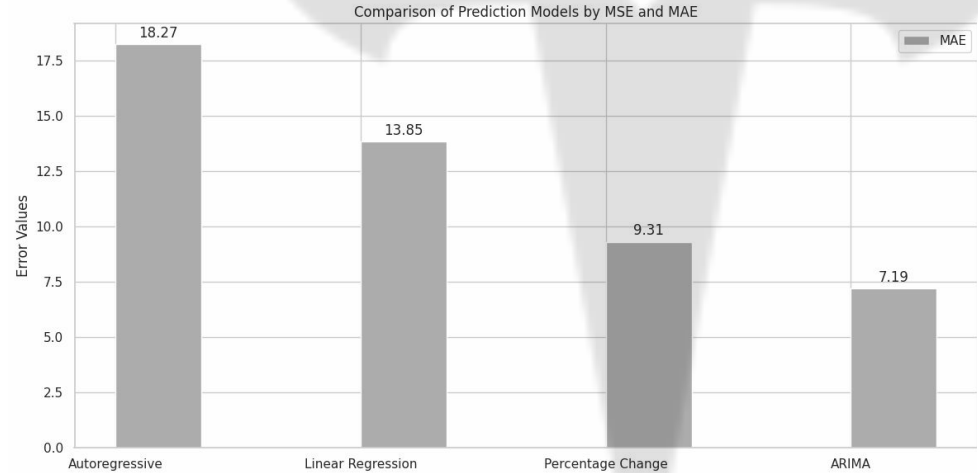
Correlation between Stock Price and Sentiments

Stock Price and Sentiment Over Time

ARIMA **Predictions**

ARIMA Model: Actual vs Predicted Stock Prices

Comparison of **Results**

Model	Metric (Mean Absolute Error)
Autoregressive	18.27
Linear regression	13.85
Percentage Change	9.31
ARIMA	7.31

Comparison of Prediction Models by MSE and MAE

Conclusion & Future Work - I

- ARIMA model outperformed other approaches in predicting Tesla stock prices, with the lowest Mean Squared Error (67.64) and Mean Absolute Error (7.19).
- Correlation analysis between sentiment scores and stock prices:
  - Calculated Pearson correlation coefficient between adjusted close price and Overall Sentiment
  - Found a weak positive correlation of 0.22 between sentiment and stock price
  - This suggests a slight tendency for stock prices to move in the same direction as sentiment, but the relationship is not strong
- Integration of sentiment scores with time series models (particularly ARIMA) yielded better results than using historical price data alone, indicating sentiment does play a role in stock price fluctuations, albeit a limited one.

Conclusion & Future Work - II

- Explore more advanced machine learning models like LSTM or ensemble methods
- Incorporate a wider range of external factors and extend the analysis to a longer time period
- Investigate the lag between sentiment changes and stock price movements to potentially improve prediction timing