Time Series Forecasting:
TSLA Predictive Pricing Models

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Objective

Forecast the closing price of Tesla (NYSE: TSLA) by leveraging historical performance data spanning from January 1, 2021, to October 9, 2023.

The goal of price predictions, particularly with respect to financial markets, is to make informed forecasts about future price movement of assets for:

- Superior returns
- Risk management
- Portfolio Diversification
- Asset Allocation
- Economic Analysis

Workflow

Use Yahoo Finance API to scrape historical pricing data and financial statements

Web scrape Google News to collect current media headlines

Use Google News scrape to create sentiment indicator and analyze trends

Preprocess TSLA data for anomalies and control for stock splits and volume change.

Create various time series models to forecast TSLA pricing

Analyze LINE-M assumptions and control for trend, seasonality, and residuals as needed.

Evaluate models based on RMSE and AIC/BIC parameters when applicable.

Pickling the model & discussing recommendations for future study

```
tsla.history_metadata

{'currency': 'USD',
 'symbol': 'TSLA',
 'exchangeName': 'NMS',
 'instrumentType': 'EQUITY',
 'firstTradeDate': 1277818200,
 'regularMarketTime': 1696864952,
 'gmtoffset': -14400,
 'timezone': 'EDT',
 'exchangeTimezoneName': 'America/New_York',
 'regularMarketPrice': 253.09,
 'chartPreviousClose': 223.07,
 'priceHint': 2,
 'currentTradingPeriod': {'pre': {'timezone': 'EDT'
   'end': 1696858200,
   'start': 1696838400,
   'gmtoffset': -14400},
  'regular': {'timezone': 'EDT',
   'end': 1696881600,
   'start': 1696858200,
   'gmtoffset': -14400},
  'post': {'timezone': 'EDT',
   'end': 1696896000,
   'start': 1696881600,
   'gmtoffset': -14400}},
 'dataGranularity': '1d',
 'range': '1y',
 'validRanges': ['1d',
  '5d',
  '1mo',
  '3mo',
  '6mo',
  '1y',
```

Web Scrape

INSIDEEVs

Search

USA / GLOBAL

Tesla Built 60-70 Semi Trucks So Far, Engineering Head Tells Jay Leno

Tesla's Dan Priestley also said the Semi's price is "very competitive."

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CARS

Tesla Cuts Model Y & Model 3 Prices As It Tries To Meet Ambitious Sales Target

By Guest Contributor Published 24 hours ago

42 Comments

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Tesla, the dominant player in the electric vehicle (EV) market, is no stranger to high expectations. Despite being the top-selling EV brand in the United States, the company finds itself under pressure to meet its lofty production and sales goals set by Wall Street.

To achieve its ambitious target of 1.8 million unit sales this year, Tesla needs to sell a whopping 476,000 vehicles in the fourth quarter. In an effort to bolster

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	headline	date	time	neg	neu	pos	compound
0	Tesla Built 60-70 Semi Trucks So Far, Engineer...	2023-10-07	1900-01-01 15:05:17	0.000	1.000	0.000	0.0000
1	Jay Leno towed a Tesla Semi with a Tesla Semi	2023-10-04	1900-01-01 20:49:00	0.000	1.000	0.000	0.0000
2	Tesla Has Made 70 Semi Trucks, Sharing Parts w...	2023-10-08	1900-01-01 10:00:00	0.000	0.797	0.203	0.4215
3	Tesla cuts Model 3 and Model Y prices in the U...	2023-10-06	1900-01-01 19:56:51	0.155	0.845	0.000	-0.2960
4	Tesla Prices Now Rival Average US Cars After B...	2023-10-06	1900-01-01 09:15:44	0.180	0.820	0.000	-0.2960

Sentiment Indicator
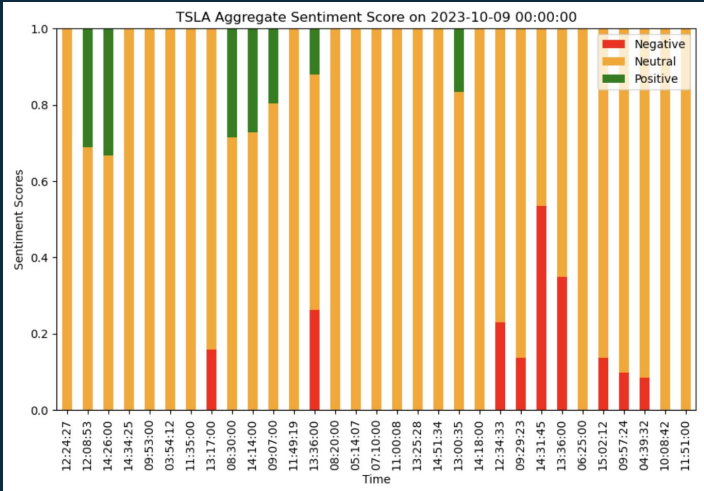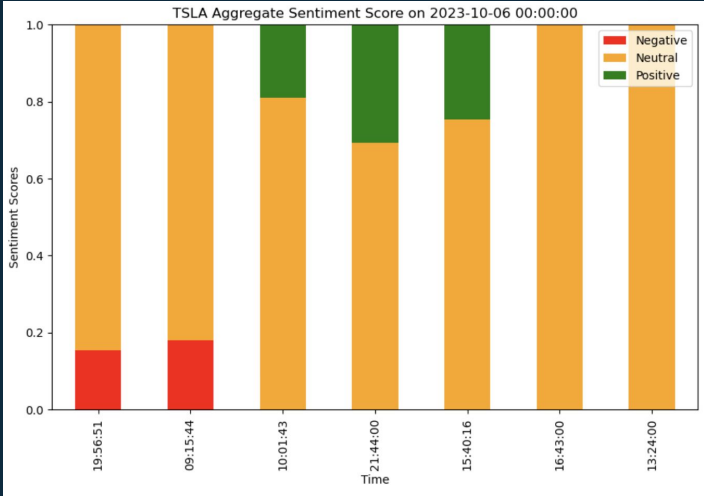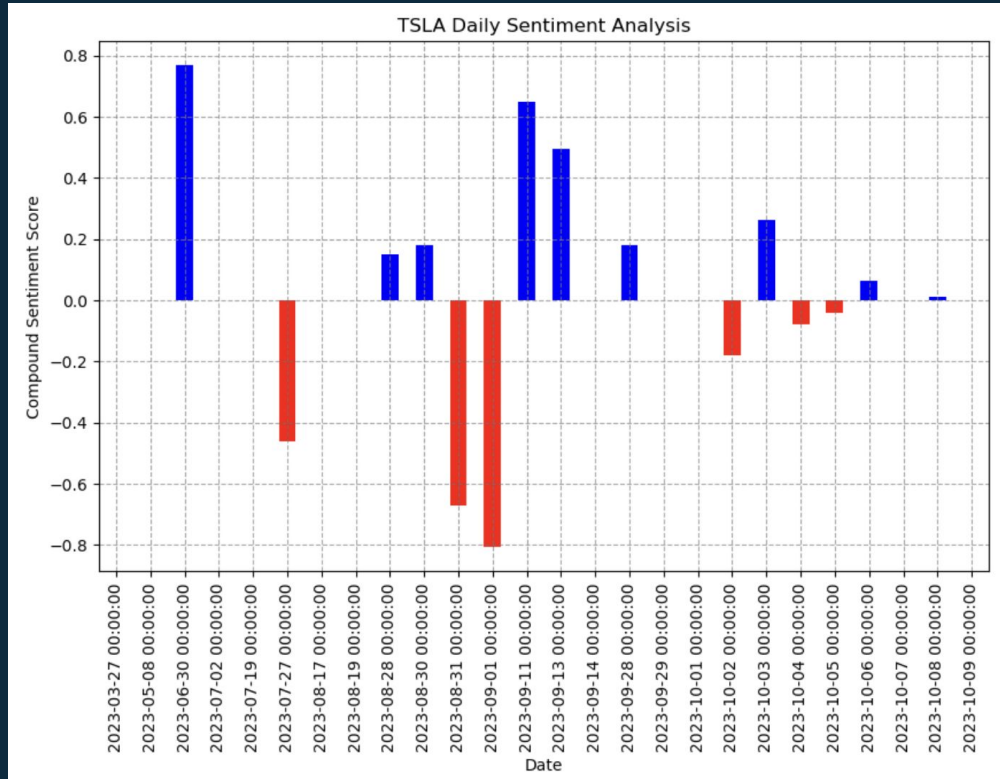
```
hw = ExponentialSmoothing(train['close'],
                    trend = 'add', # Chose additive
                    seasonal = 'add', # Chose additive
                    seasonal_periods=52).fit()
```

```
hw.summary()
```

ExponentialSmoothing Model Results

Dep. Variable:	close	No. Observations:	116
Model:	ExponentialSmoothing	SSE	24970.965
Optimized:	True	AIC	735.138
Trend:	Additive	BIC	889.339
Seasonal:	Additive	AICC	855.208
Seasonal Periods:	52	Date:	Tue, 10 Oct 2023
Box-Cox:	False	Time:	12:06:55
Box-Cox Coeff.:	None		

	coeff	code	optimized
smoothing_level	0.9999873	alpha	True
smoothing_trend	7.2529e-05	beta	True
smoothing_seasonal	1.0761e-12	gamma	True
initial_level	278.55551	l.0	True
initial_trend	-0.7732340	b.0	True
initial_seasons.0	-5.5468830	s.0	True
initial_seasons.1	-0.7408270	s.1	True
initial_seasons.2	-2.6155722	s.2	True
initial_seasons.3	-10.436573	s.3	True
initial_seasons.4	8.2894241	s.4	True
initial_seasons.5	12.705372	s.5	True

Modeling

Time Series Models Employed

01

Naive Forecast

02

Historic Mean

03

Simple Exponential Smoothing

04

Holt Winters

05

SARIMA

06

SARIMAX

Model Comparison

|	Description	Use Case	Complexity	Seasonality
Naive Forecast	Assumes future = last observed value	Baseline	Simplest	No
Historic Mean	Predicts using historical mean	Baseline	Simplest	No
Simple Exponential Smoothing	Weighted average of past observations	Short-term	Low	No
Holt Winters	Trends & seasonality in forecasts	Medium-term	Moderate	Yes (additional/ multiplicative)
SARIMA	Seasonal ARIMA model	Medium to long term	Moderate	Yes
SARIMAX	SARIMA with exogenous variables	Varied	Moderate	Yes

Naive Forecast & Historic Mean
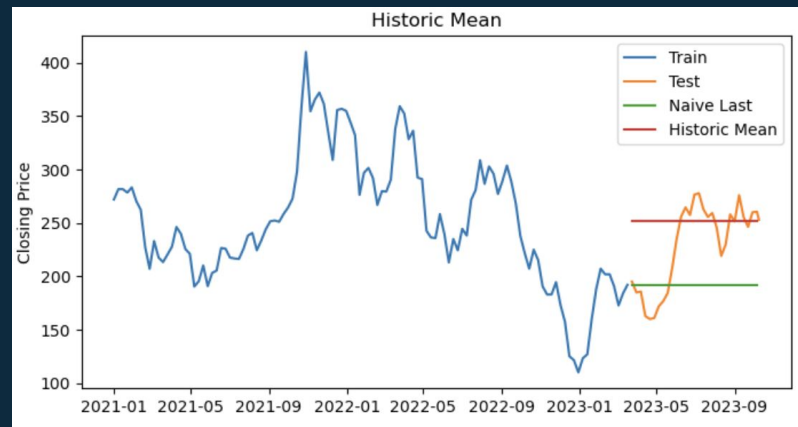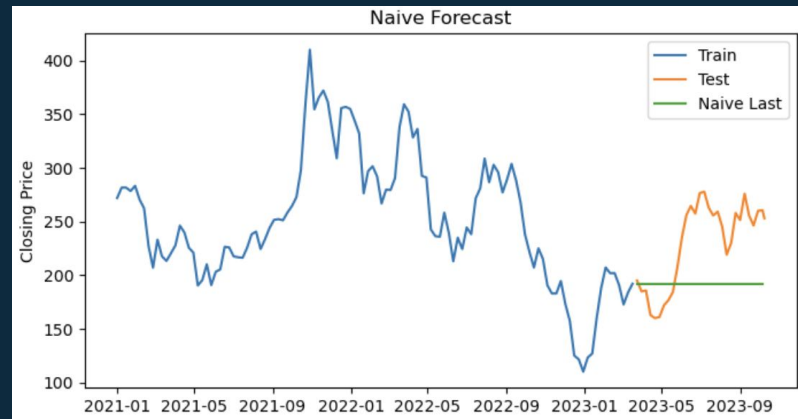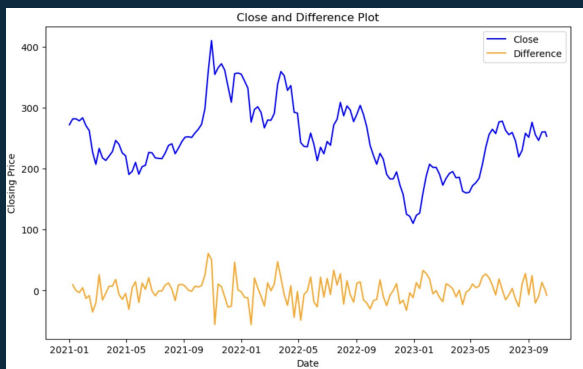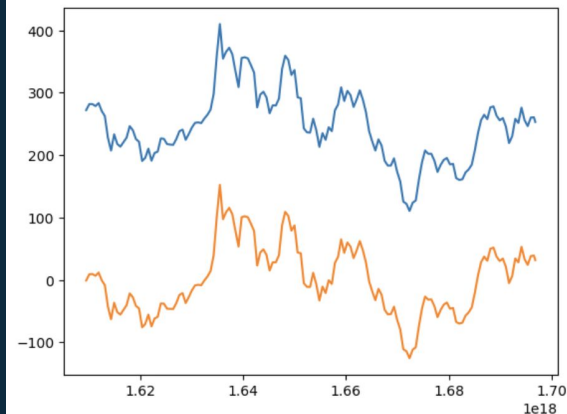
Simple Exponential Smoothing

$$\hat{y}_{t+1} = \alpha y_t + \alpha(1-\alpha)y_{t-1} + \alpha(1-\alpha)^2 y_{t-2} + \ldots$$

SimpleExpSmoothing Model Results

Dep. Variable:	close	No. Observations:	116
Model:	SimpleExpSmoothing	SSE	69243.267
Optimized:	True	AIC	745.448
Trend:	None	BIC	750.955
Seasonal:	None	AICC	745.808
Seasonal Periods:	None	Date:	Tue, 10 Oct 2023
Box-Cox:	False	Time:	02:56:34
Box-Cox Coeff.:	None		

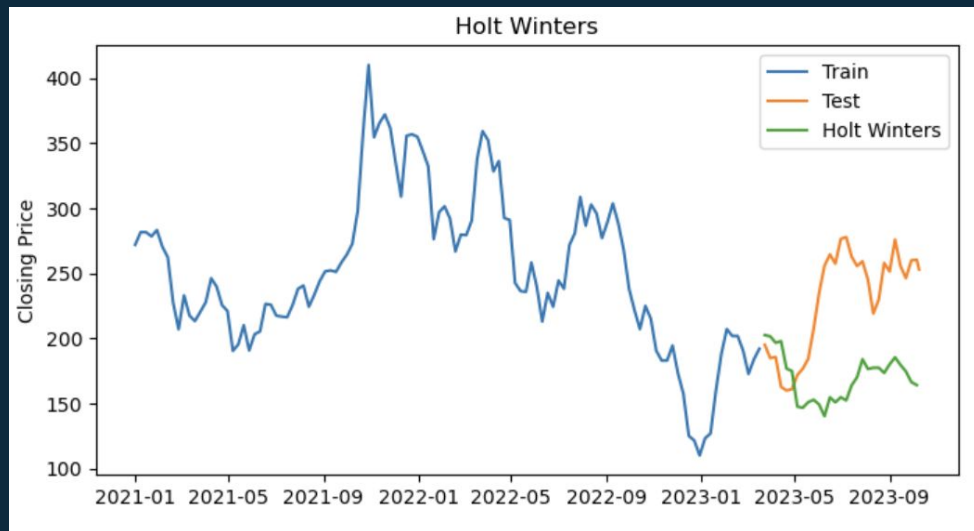|	coeff	code	optimized
smoothing_level	0.5000000	alpha	False
initial_level	275.90238	l.0	True

Simple Exp. Smoothing
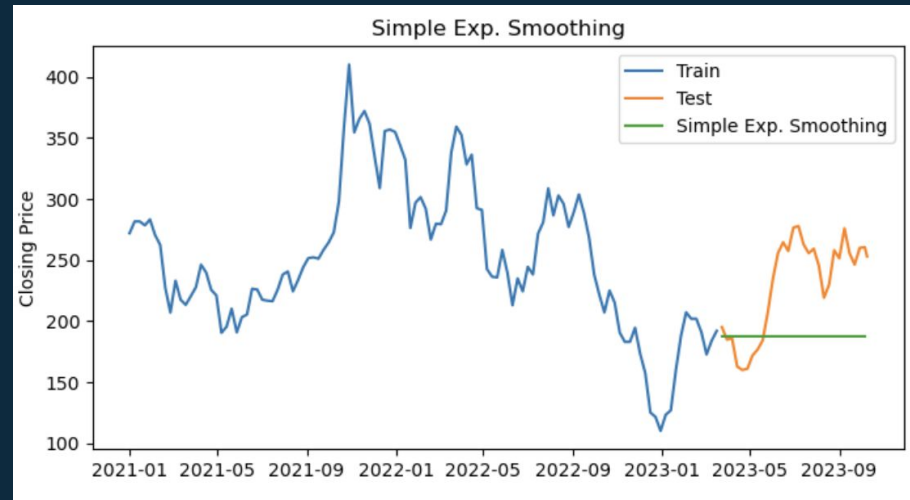
Holt Winters

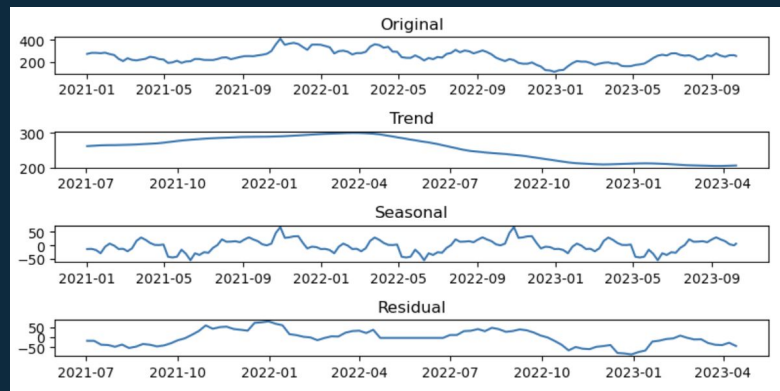$$L_t = \alpha(y_t - S_{t-s}) + (1 - \alpha)(L_{t-1} + b_{t-1})$$

$$b_t = \beta * (L_t - L_{t-1}) + (1 - \beta)b_{t-1}$$

$$S_t = \gamma(y_t - L_t) + (1 - \gamma)S_{t-s}$$

$$F_{t+k} = L_t + kb_t + S_{t+k-s}$$

ExponentialSmoothing Model Results

Dep. Variable:	close	**No. Observations:**	116
Model:	ExponentialSmoothing	**SSE**	24970.965
Optimized:	True	**AIC**	735.138
Trend:	Additive	**BIC**	889.339
Seasonal:	Additive	**AICC**	855.208
Seasonal Periods:	52	**Date:**	Tue, 10 Oct 2023
Box-Cox:	False	**Time:**	12:06:55
Box-Cox Coeff.:	None		

SARIMA

SARIMAX Results			
Dep. Variable:	y	No. Observations:	116
Model:	SARIMAX(0, 1, 0)	Log Likelihood	-509.488
Date:	Tue, 10 Oct 2023	AIC	1020.977
Time:	02:56:42	BIC	1023.722
Sample:	01-01-2021	HQIC	1022.091
	- 03-17-2023		
Covariance Type:	opg		

	coef	std err	z	P>|z|	[0.025	0.975]
sigma2	412.7421	46.234	8.927	0.000	322.126	503.358

Ljung-Box (L1) (Q):	0.98	Jarque-Bera (JB):	2.98
Prob(Q):	0.32	Prob(JB):	0.23
Heteroskedasticity (H):	1.82	Skew:	0.05
Prob(H) (two-sided):	0.07	Kurtosis:	3.78

Questions?