



Multivariate Time series Models for Forecasting Mansfield Sales

Yulimar Rivero

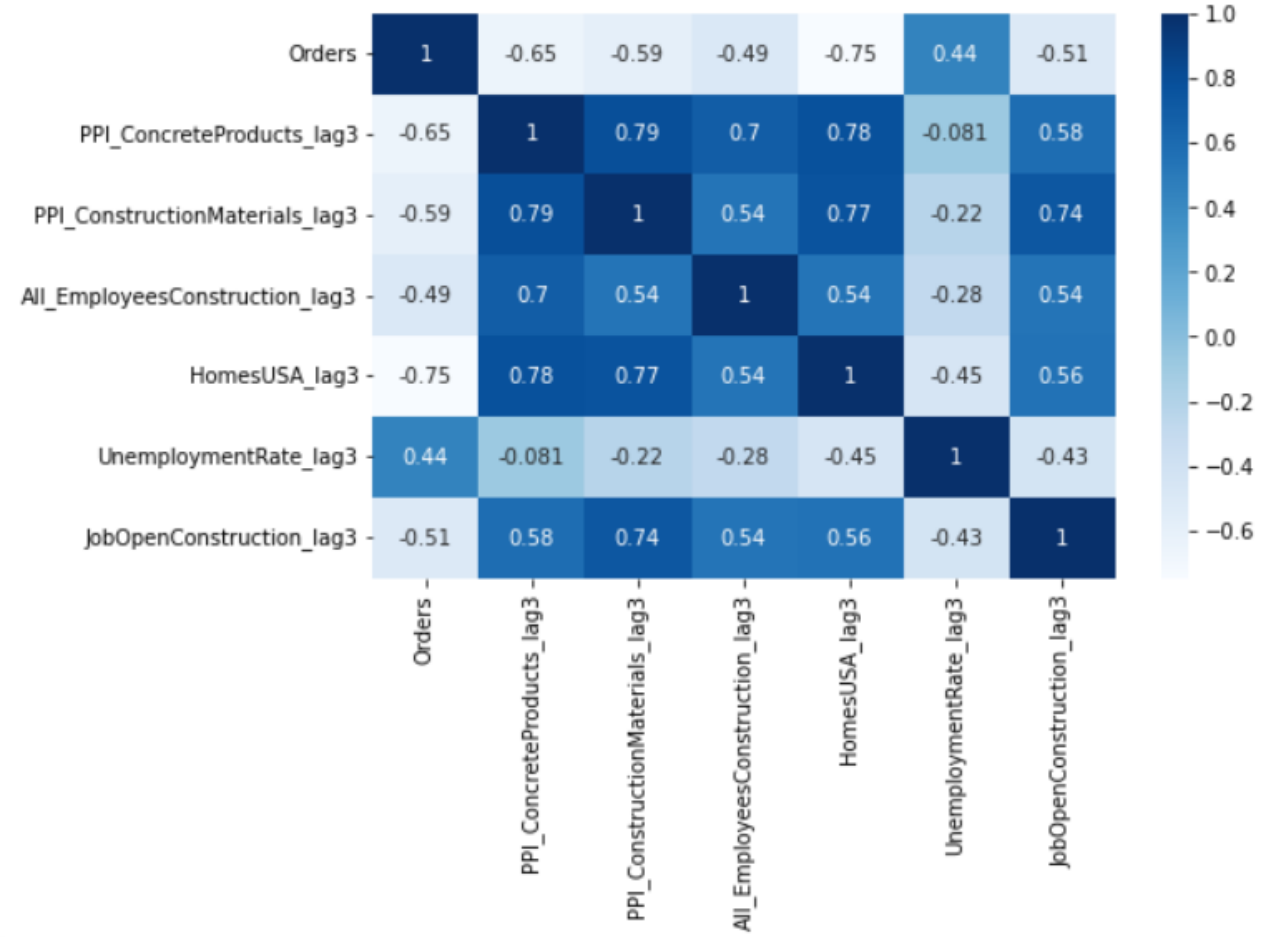
Agenda

- Features Selection
- Features Engineering
- Linear Regression Model
- Vector Autoregression Model (VAR)
- Vector Autoregression Moving-Average (VARMA) Model
- VARMA with Auto ARIMA Model
- Prophet Model
- LSTM Model
- Models Summary

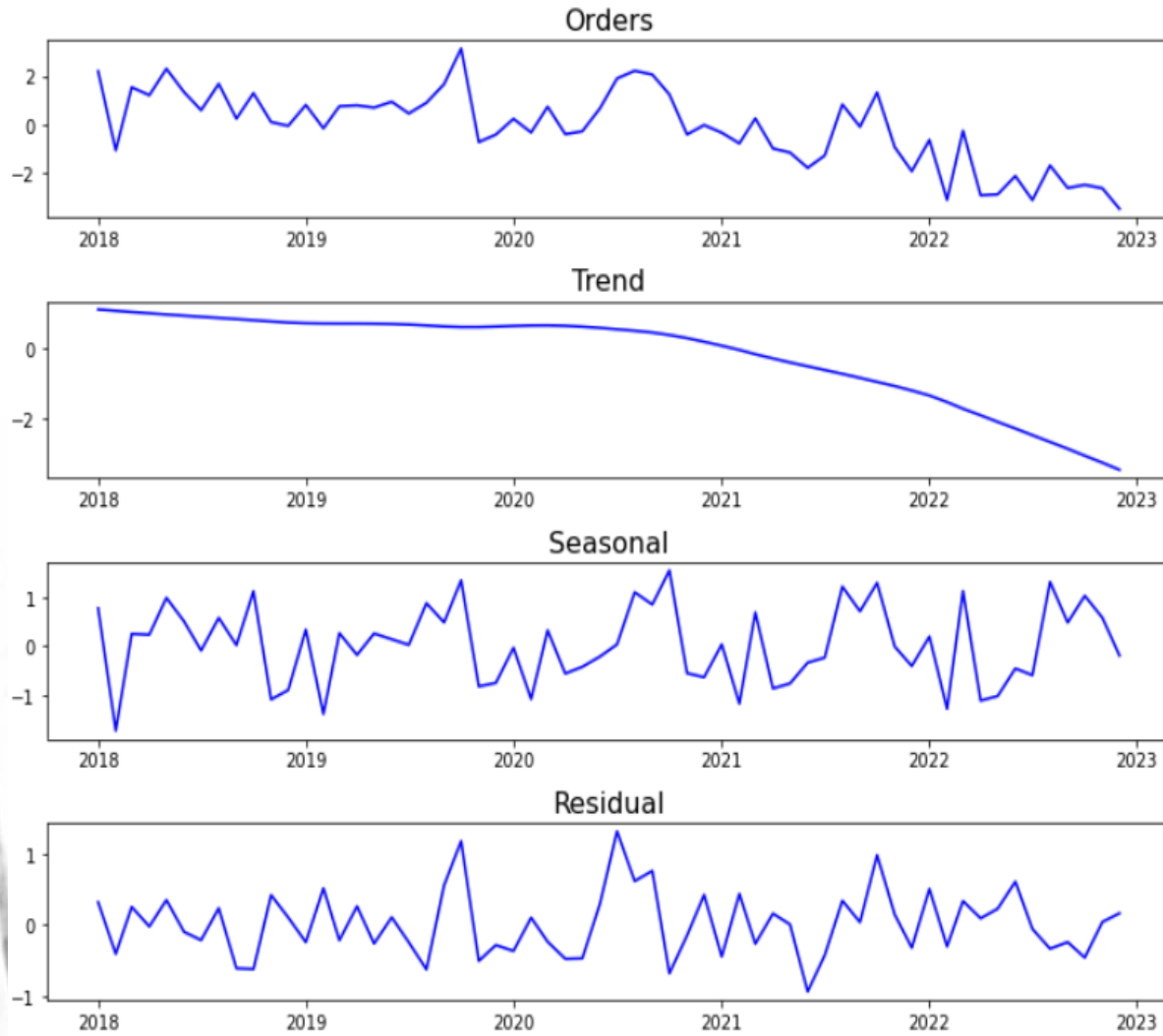
Features Selection

- Producer Price Index by Commodity: Special Indexes: Construction Materials (PPI_ConcreteProducts_lag3)
- Producer Price Index by Commodity: Special Indexes: Construction Materials (PPI_ConstructionMaterials_lag3)
- All Employees Construction (All_EmployeesConstruction_lag3)
- Total homes in the United States (HomesUSA_lag3)
- Unemployment Rate (UnemploymentRate_lag3)
- Job Open Constructions (JobOpenConstruction_lag3)

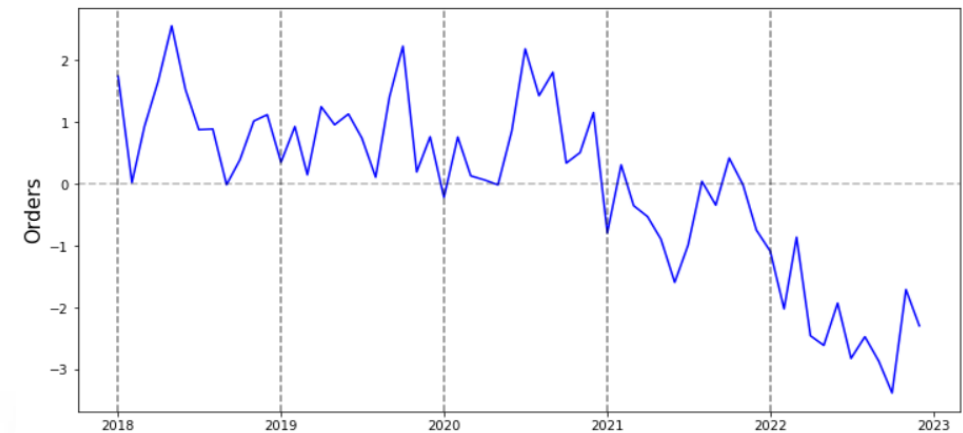
Correlation Map

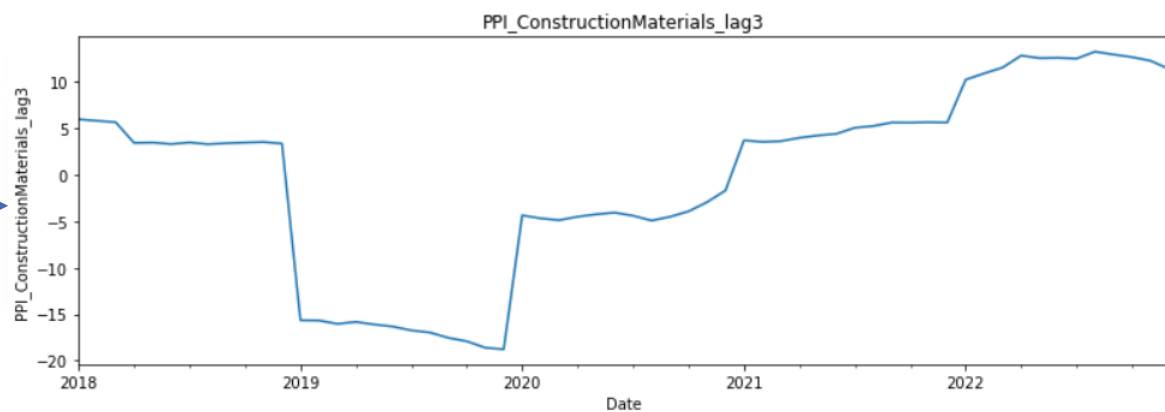
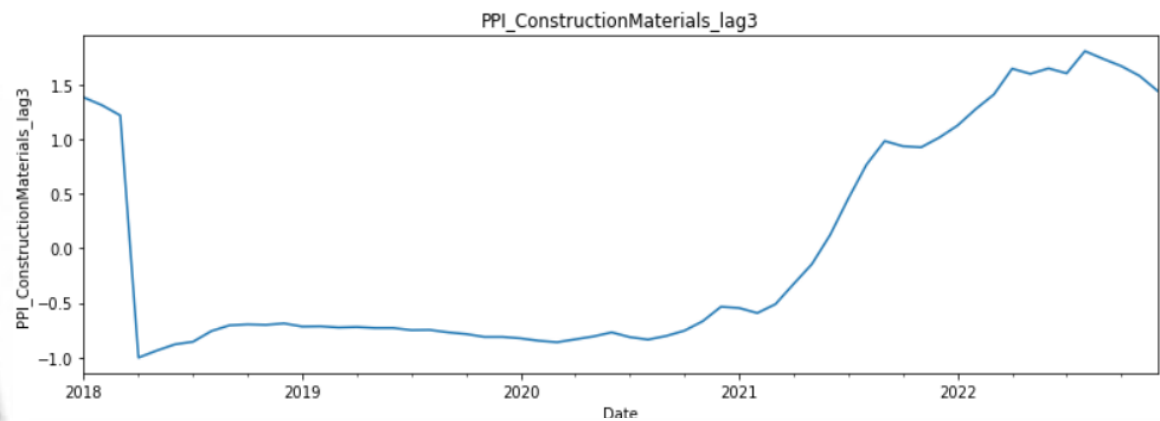
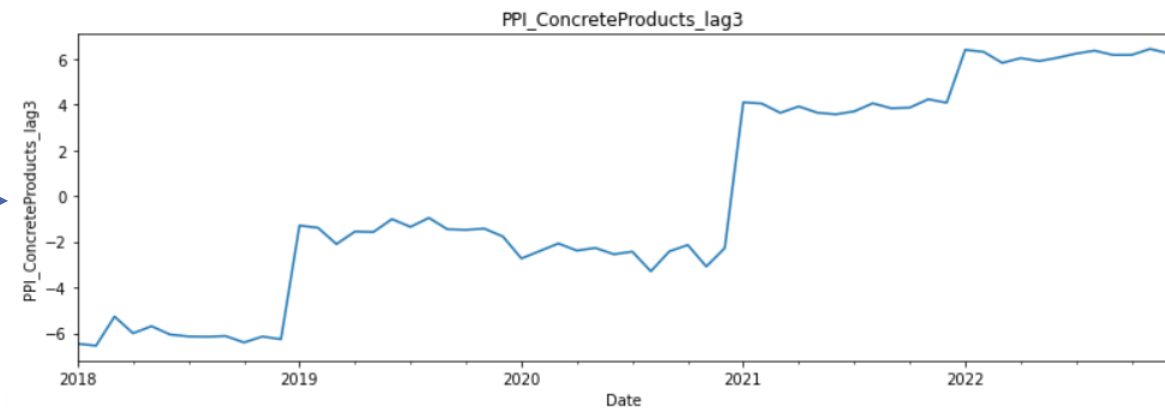
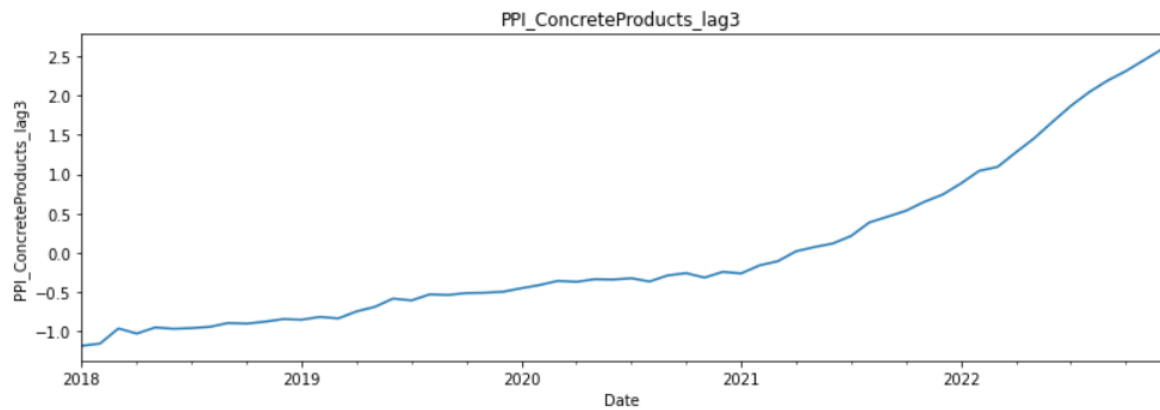


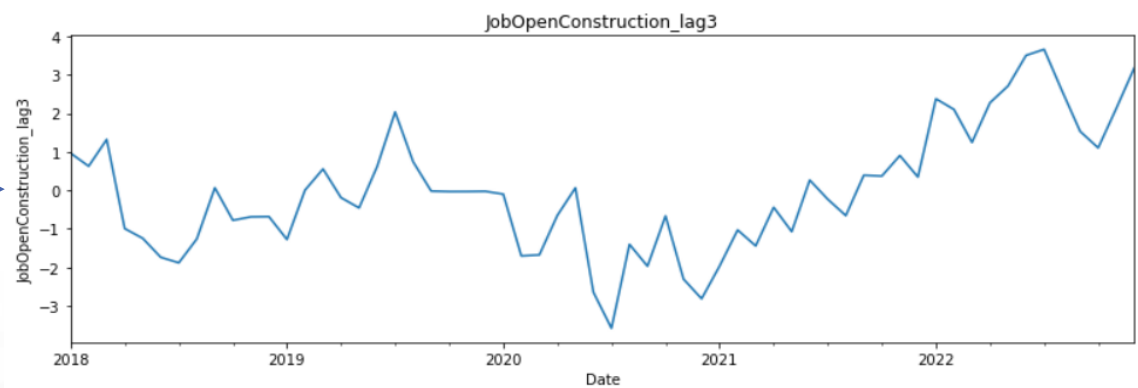
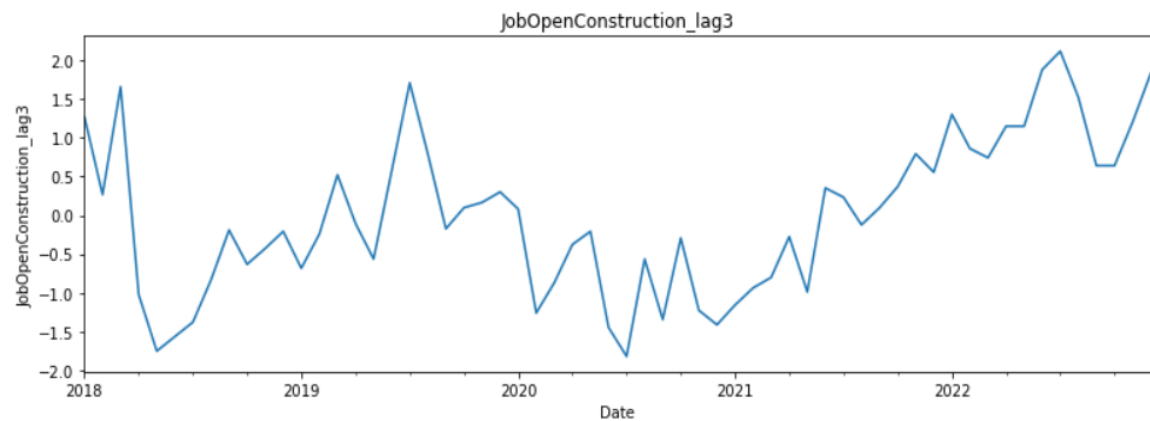
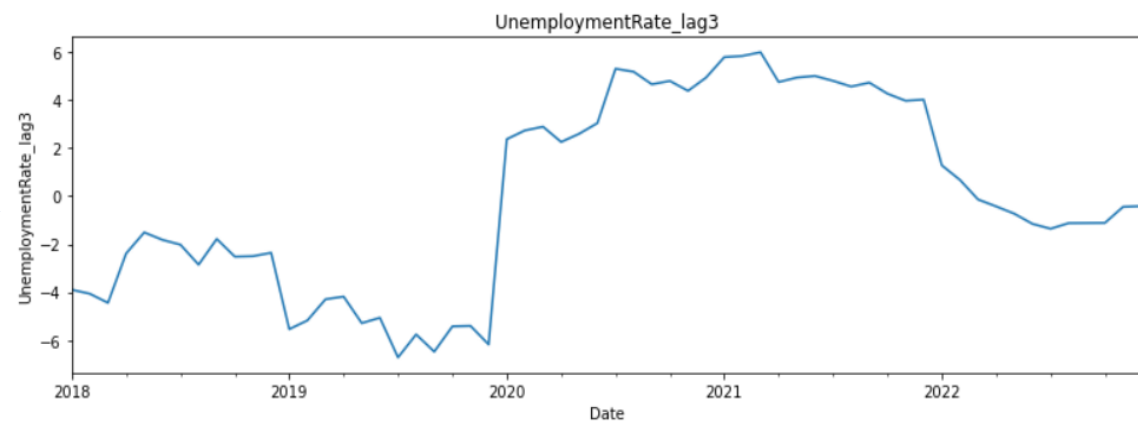
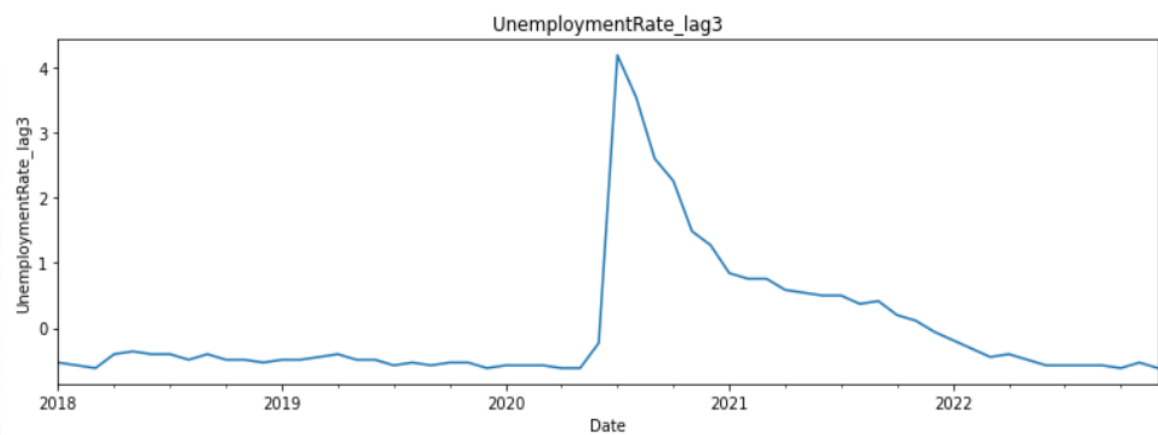
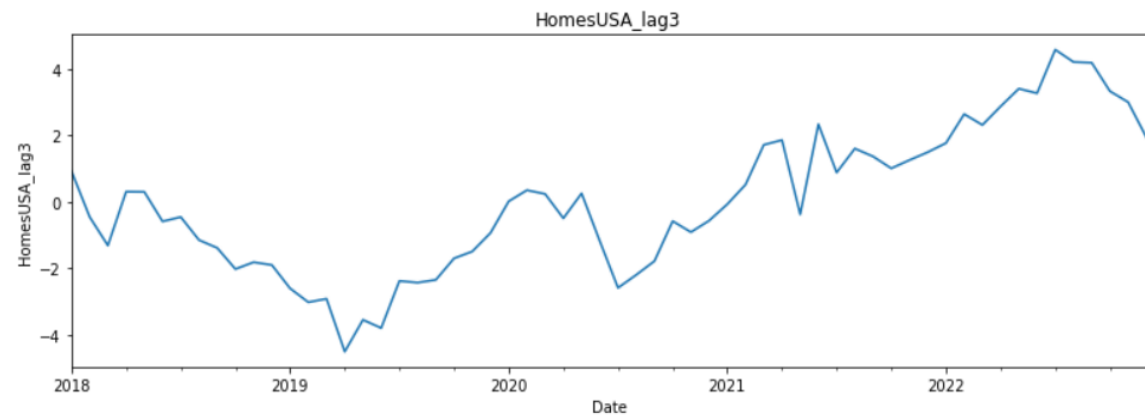
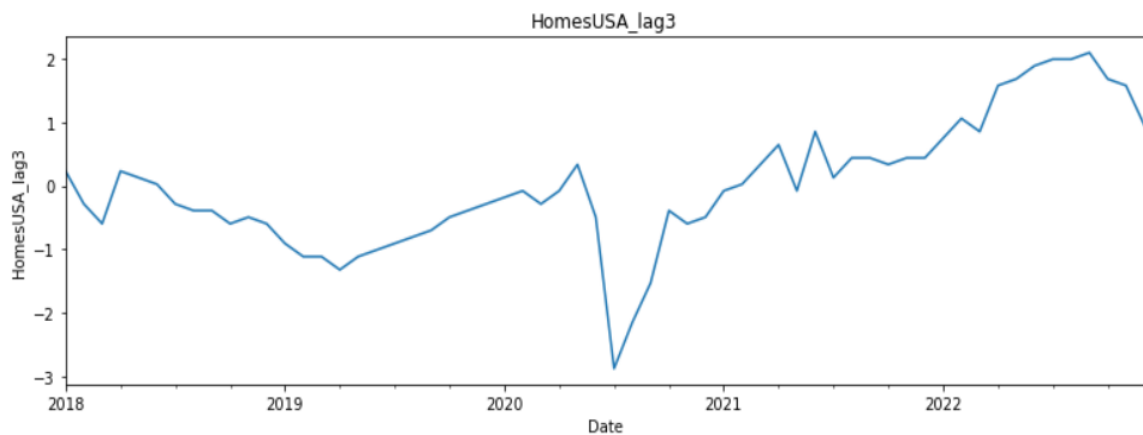
Features Engineering



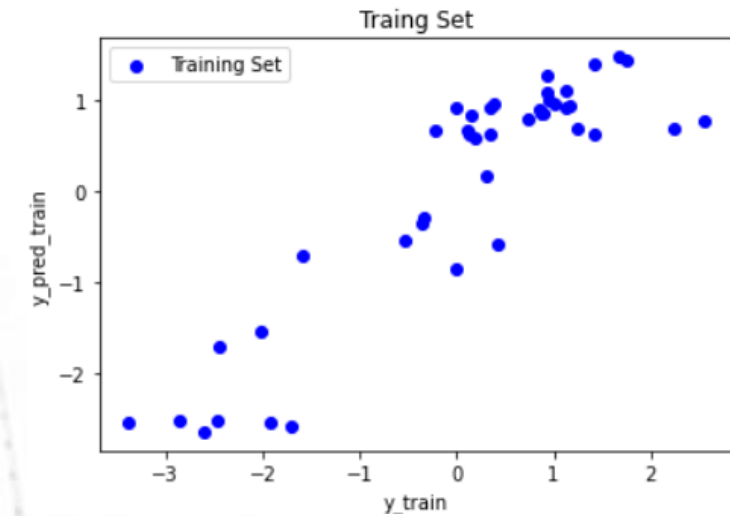
- Removing the seasonal component by applying Moving Window Functions





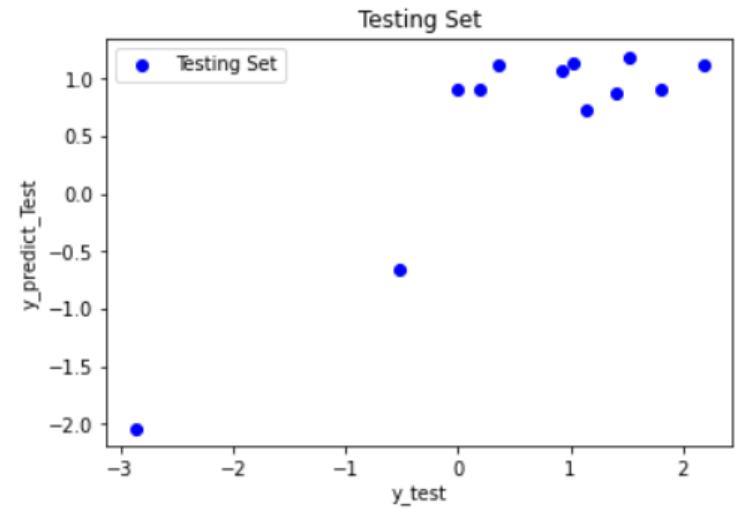


Linear Regression Model

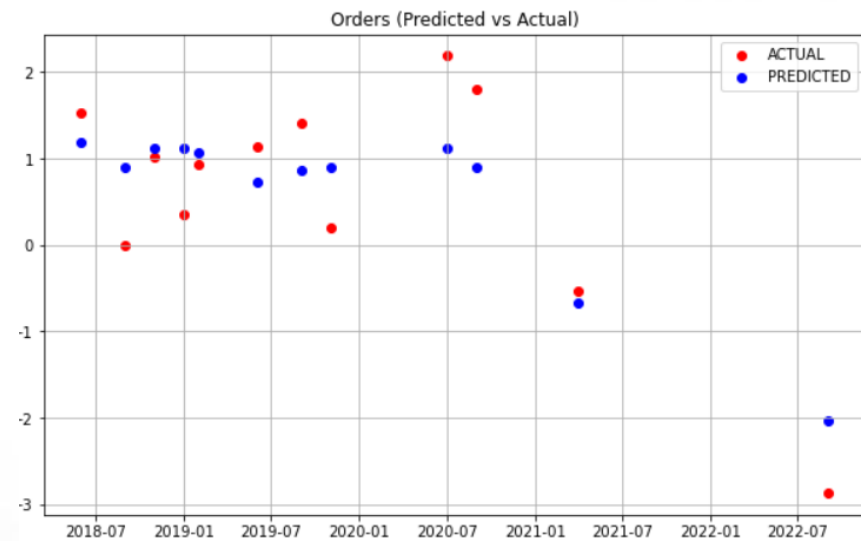


TRAINING SET
Metric Results:
MSE is : 0.4
MAE is : 0.51
RMSE is : 0.63

TESTING SET
Metric Results:
MSE is : 0.43
MAE is : 0.57
RMSE is : 0.66



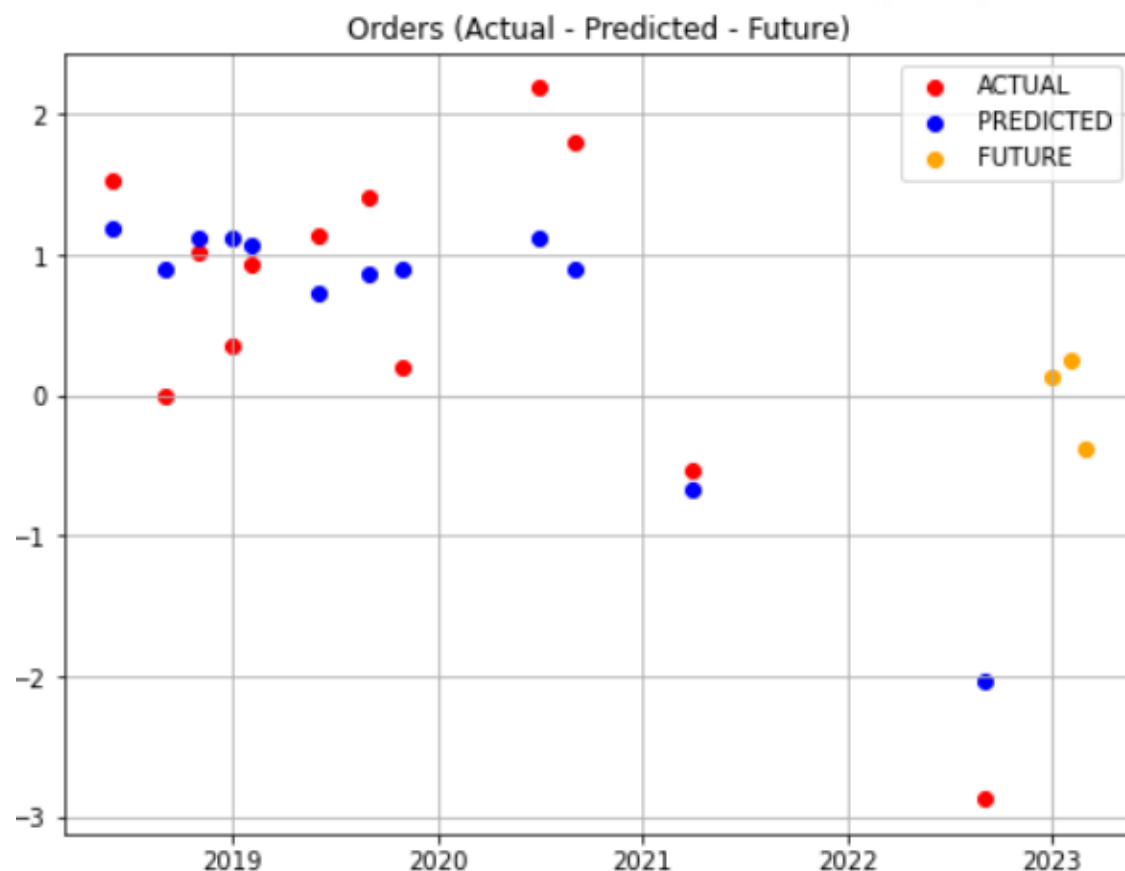
Actual vs Predicted



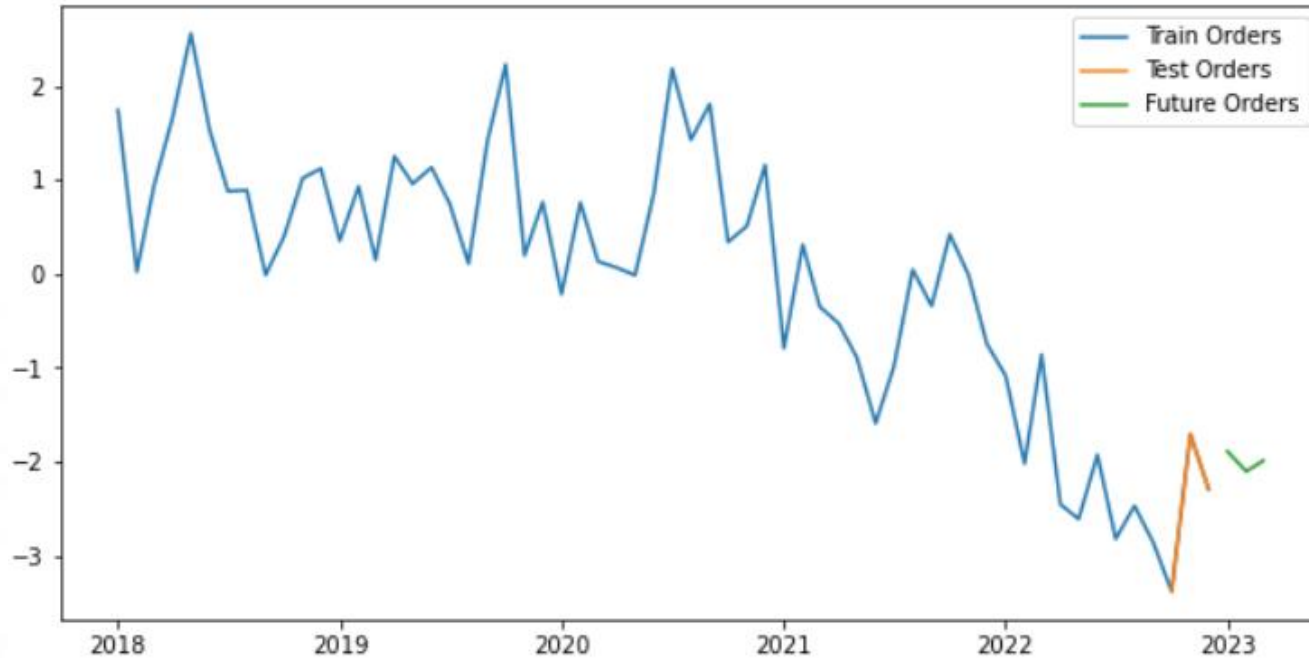
Linear Regression Future Predictions

Date	Orders_Future
2023-01-01	0.135838
2023-02-01	0.249891
2023-03-01	-0.382130

Features	Coefficients
PPI_ConcreteProducts_lag3	-0.077849
PPI_ConstructionMaterials_lag3	-0.029764
All_EmployeesConstruction_lag3	-0.217195
HomesUSA_lag3	-0.052794
UnemploymentRate_lag3	-0.043508
JobOpenConstruction_lag3	-0.157123



Vector Autoregression (VAR) Model



ORDERS EVALUATION

Metric Results:

MSE is : 0.92

MAE is : 0.91

RMSE is : 0.96

Future Orders

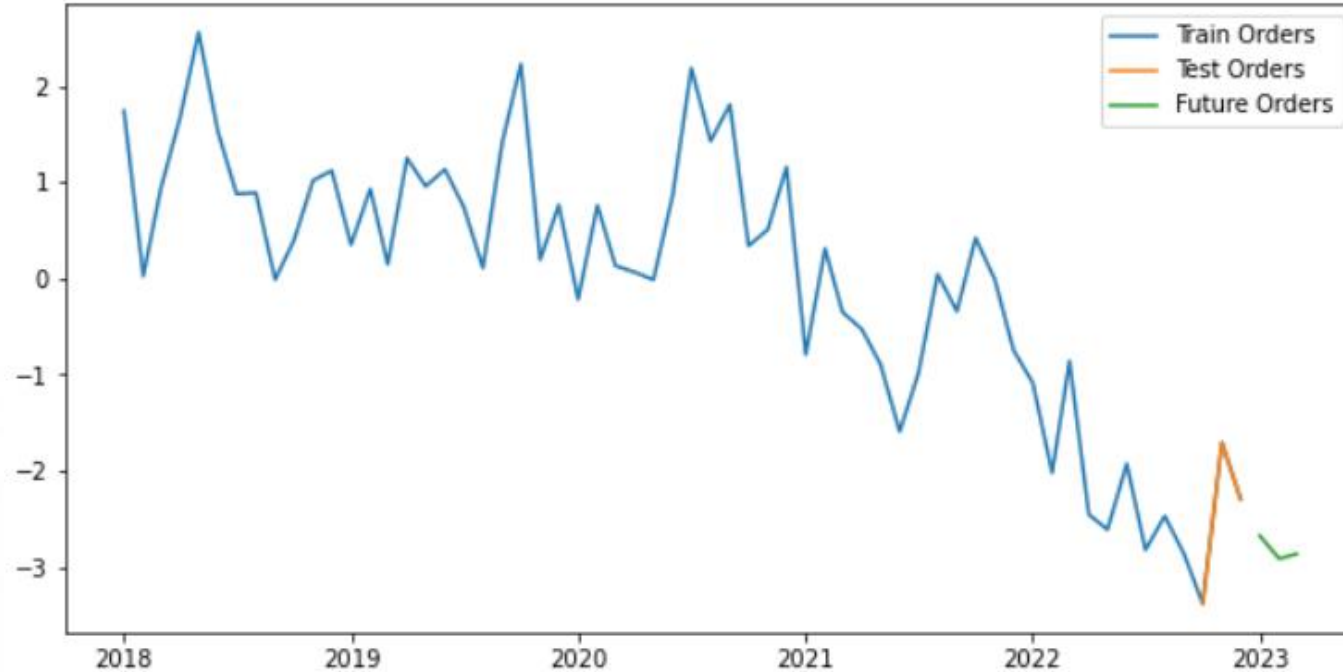
Date

2023-01-01 -1.893141

2023-02-01 -2.105377

2023-03-01 -1.990478

VARMA Model (order = 2, 2 trend= C)



ORDERS EVALUATION

Metric Results:

MSE is : 0.45

MAE is : 0.56

RMSE is : 0.67

Future Orders

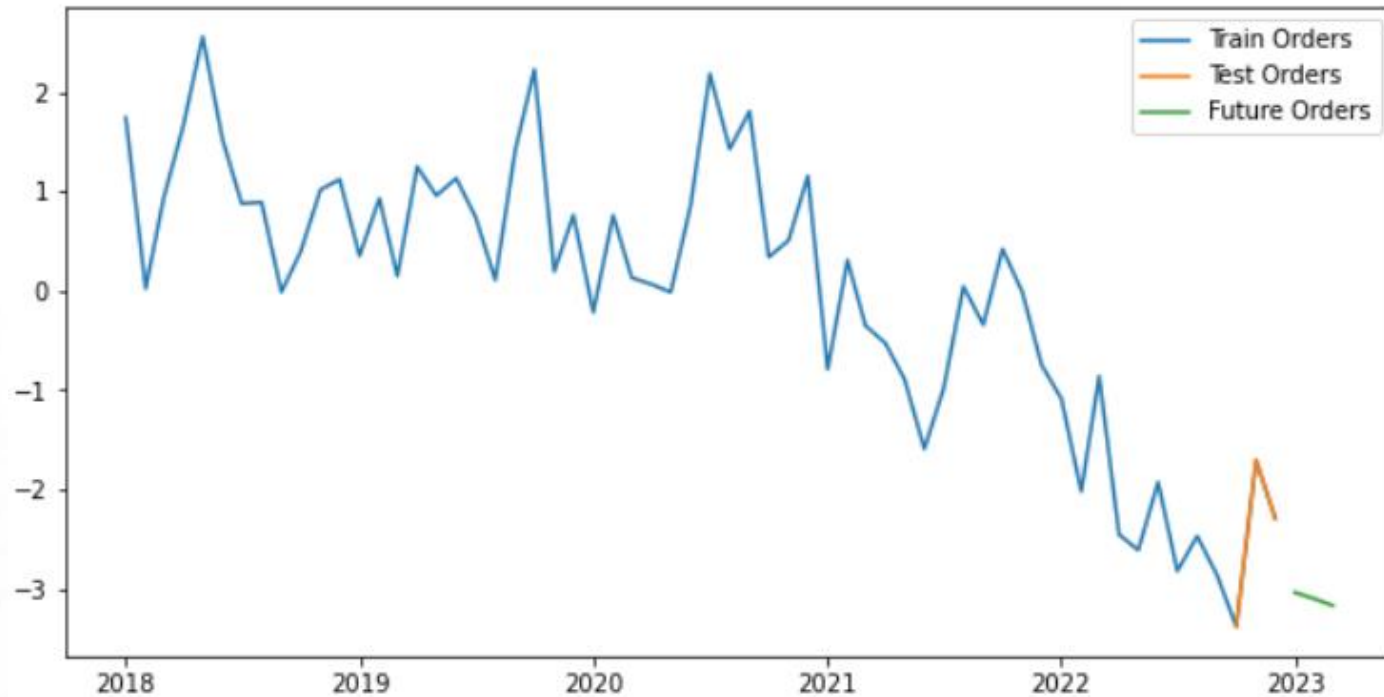
Date

2023-01-01 -2.678216

2023-02-01 -2.915992

2023-03-01 -2.866269

VARMA with Auto ARIMA (order = 0, 0, 1)



ORDERS EVALUATION

Metric Results:

MSE is : 0.73

MAE is : 0.81

RMSE is : 0.85

Future Orders

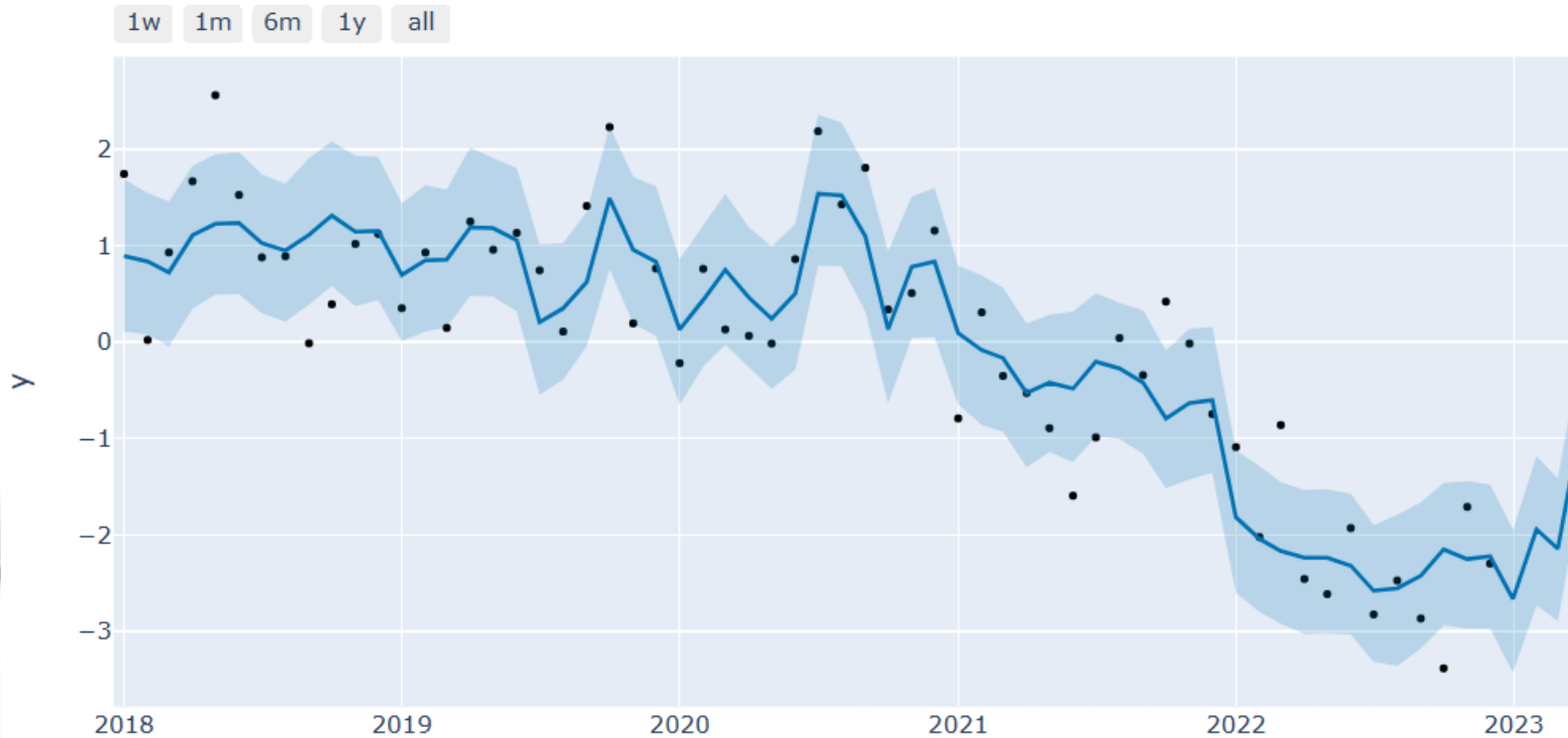
Date

2023-01-01 -3.041065

2023-02-01 -3.106690

2023-03-01 -3.172314

Prophet Model



ORDERS EVALUATION

Metric Results:

MSE is : 0.61

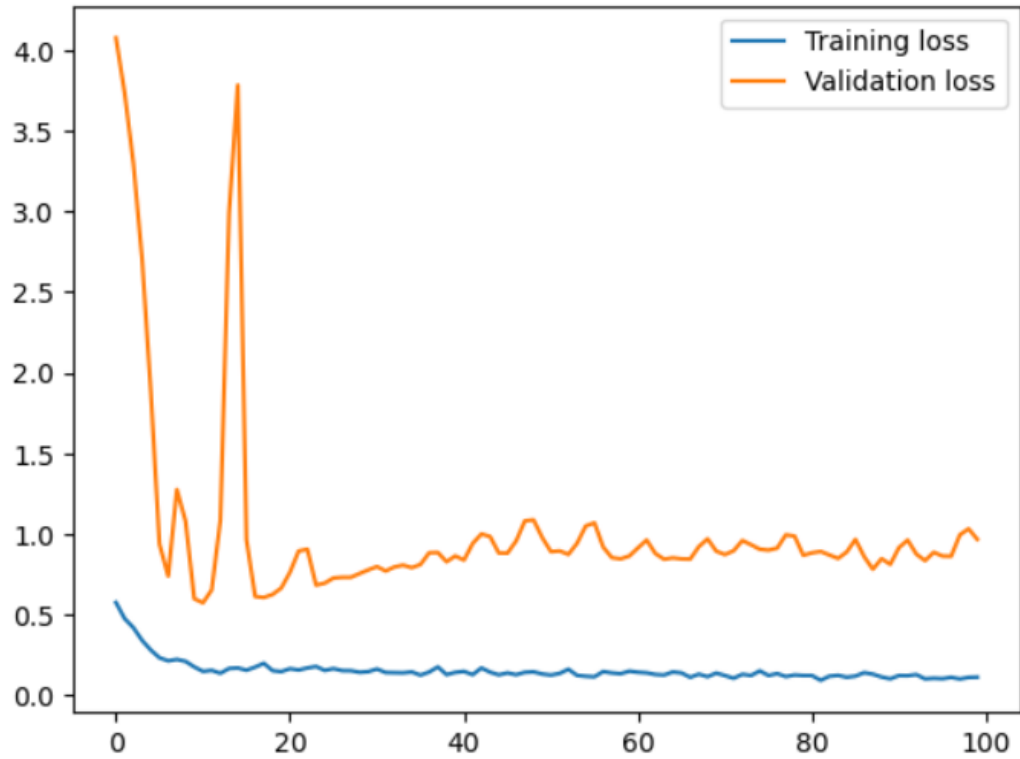
MAE is : 0.62

RMSE is : 0.78

Future Orders

ds	yhat
2023-01-31	-1.941796
2023-02-28	-2.143435
2023-03-31	-0.820943

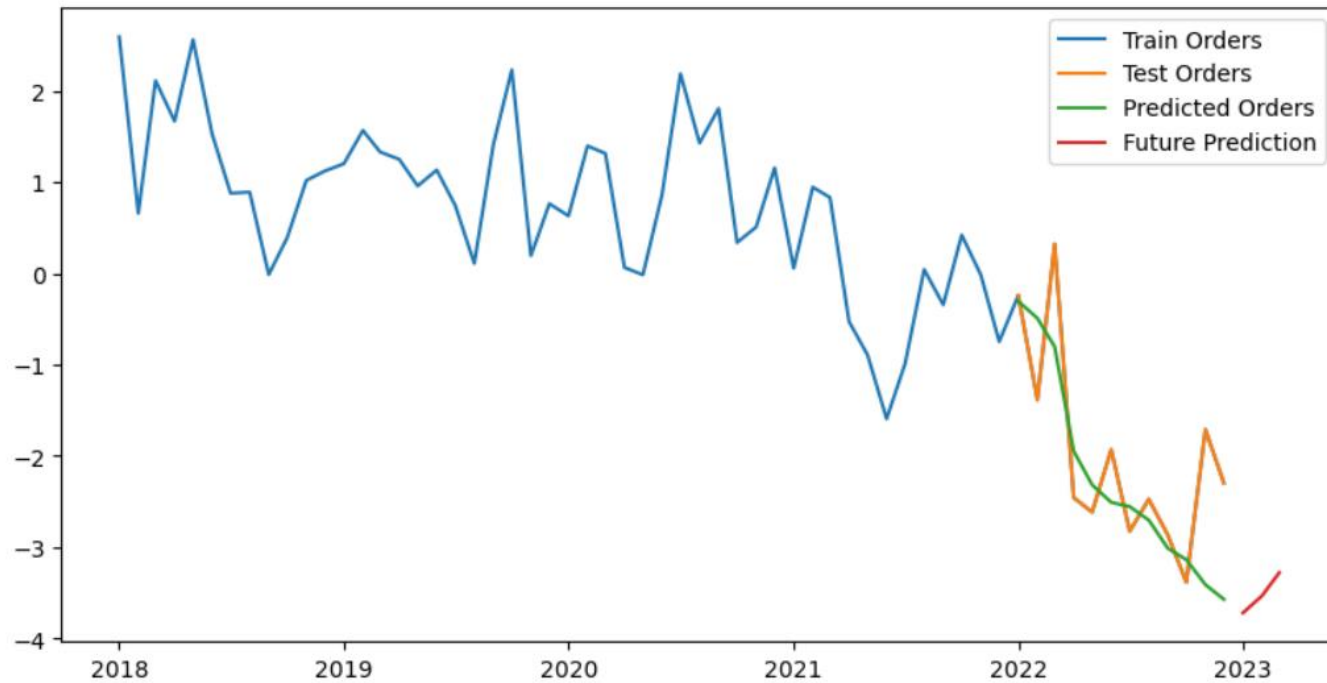
LSTM Model



Model: "sequential"

Layer (type)	Output Shape	Param #
lstm (LSTM)	(None, 12, 100)	43200
lstm_1 (LSTM)	(None, 32)	17024
dropout (Dropout)	(None, 32)	0
dense (Dense)	(None, 1)	33

LSTM Model Predictions



ORDERS EVALUATION

Metric Results:

MSE is : 0.99

MAE is : 0.72

RMSE is : 0.99

Future Predictions

Date

2023-01-01 -3.059438

2023-02-01 -2.644509

2023-03-01 -2.217821

Models Summary

Metric	Linear Regression	VAR	VARMA	VARMA with Auto Arima	Prophet	LSTM
MSE	0.43	0.92	0.45	0.73	0.61	0.99
MSE	0.57	0.91	0.56	0.81	0.62	0.78
RMSE	0.66	0.96	0.67	0.85	0.78	0.99

1. VAR
2. VARMA with Auto Arima
3. Prophet
4. VARMA
5. Linear Regression

The LSTM model must be evaluated with more details before selecting it as the best model

