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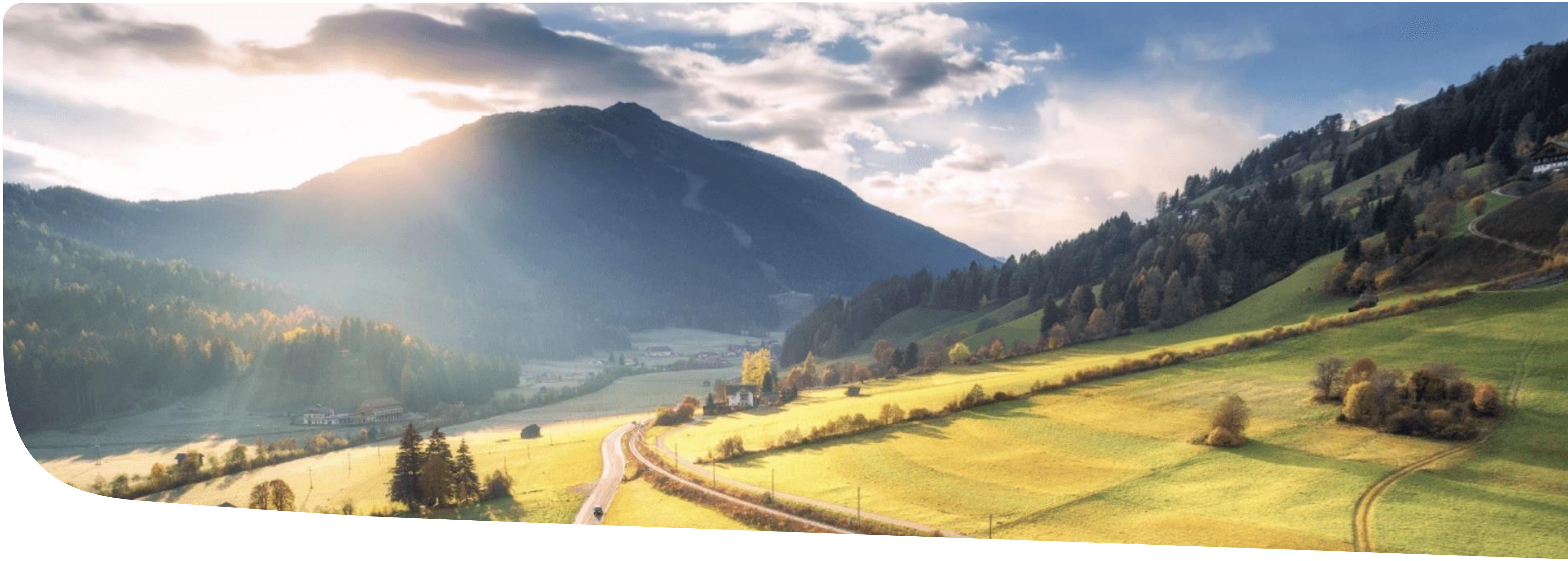
CDM Forecasting and Arbitration

FAURECIA CLEAN MOBILITY

24.Feb.2023 Jiaxue LI



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1. Introduction of CDM Forecasting

Objective:

Proposal a forecasting rate based on relationship between history Customer Demand and Actual Sales, to direct the future short–term and long-term sales for certain OEM and below Plants

1. Be able to compare the different customer behavior in a better way
2. Be able to have a short–term and long-term way to arbitrate customer demand and improve production plan arbitration process (PIC and PDP)

1. Introduction of CDM Forecasting

Available potential Data Source:

		Detail Level	Time horizon	Sources		
Forecast	EDI (Customer)	BG/ Div/ Plant/ Material/ Customer (Ship-to)	Weekly and Monthly	L37 BI report (Sunday)	Palantir (up -to-date data)	SAP (zppcd)
	Magritte (Finance)	BG/ Div/ Plant	Monthly	Sarah		
	IHS	Market Research	Monthly	IHS Web		
Actual Sales	Controlling	BG/ Div/ Plant/ Material/ Customer (Ship-to)	Weekly and Monthly	C35 BI report/ S10 BI report	Palantir (up -to-date data)	SAP (zqsd01)
	Magritte (Finance)	BG/ Div/ Plant	Monthly	Sarah		

Available potential Model:

- **Linear regression model** – Y = m X + b
- **Time series forecasting model** (Useful for ordered time series data) – AR, MA, ARIMA, SARIMA, SES, HWES
- **Relevant machine learning model** – LSTM ...

1. Introduction of CDM Forecasting

Introduction of available potential Model:

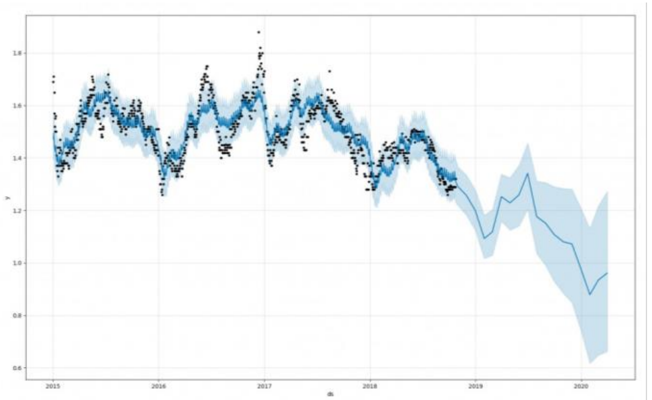
- **Time series forecasting model** – AR, MA, ARIMA, SARIMA, SES, HWES

1) Definition:

Use historical data feature of seasonality or trend to make future observations

2) Applications:

Weather forecasting, stock price forecasting, retail forecasting



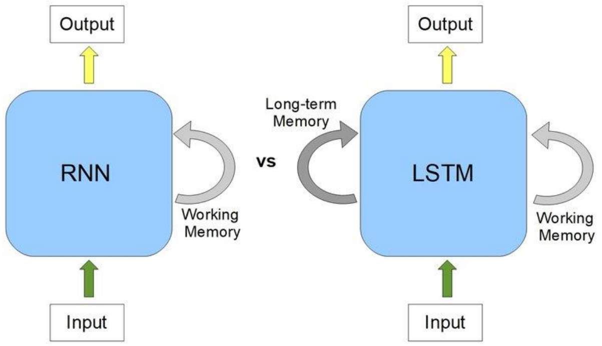
Possible machine learning model – LSTM

1) Definition:

- Long short-term memory (LSTM) is an artificial neural network used in deep learning, which can learn long-term dependencies between time steps of data
- It's a better traditional machine learning model (RNN model)

2) Applications:

Sentiment analysis, language modeling, speech recognition, and video analysis



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2.1 Selected Data Scope & Data Source for Division and Plant

BG Scope	FCM
Customer Scope	Stellantis
Division Scope	Europe Division
Data Source & Time Scope	S10: 2021 W48 – 2023 W07 (64 weeks) L37/EDI: 2021 W48 – 2023 W07 (64 weeks)
Forecasting & Arbitration level	Upper level: Per Customer/Division, for example Stellantis Europe Lower level: Per Customer/Plant, for example Stellantis Terni, Stellantis Pisek

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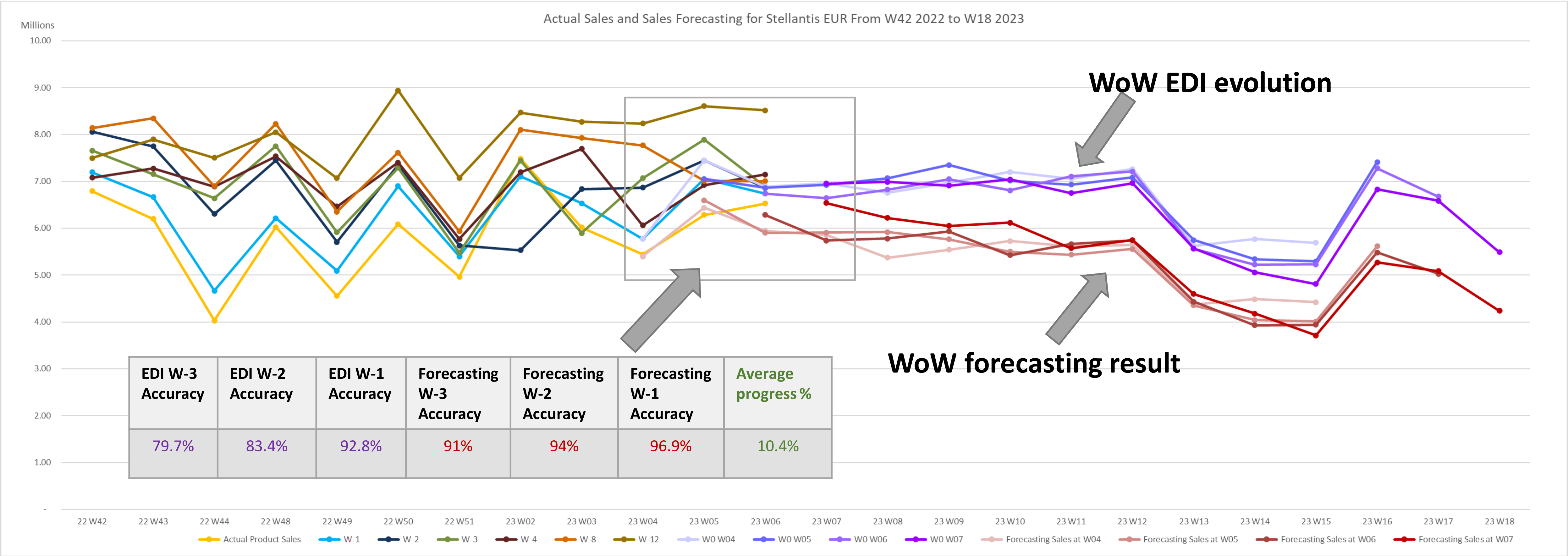
2.2 Forecasting results for Stellantis Europe Division

Example for Stellantis Europe Sales prediction in 2023 W04, W05, W06, and W07



EDI W-3 Accuracy	EDI W-2 Accuracy	EDI W-1 Accuracy	Forecasting W-3 Accuracy	Forecasting W-2 Accuracy	Forecasting W-1 Accuracy	Average progress %
79.7%	83.4%	92.8%	91%	94%	96.9%	10.4%

- **Principle: Apply on future EDI the historical customer demand behavior**
- **The Actual Sales value is closer the Red Forecasting results than EDI week by week**

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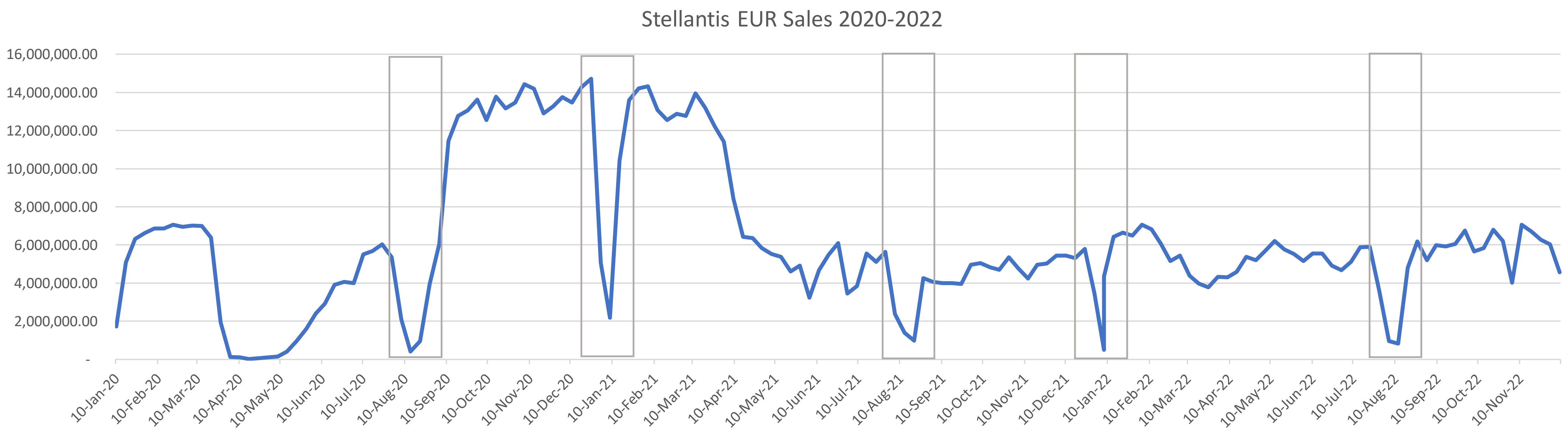
2.3 Logic for Stellantis Europe Division Forecasting

1. **Delete the regular drops in a year, January and August, so exclude W30 W31 W32 and W52 W01 for each of years.**



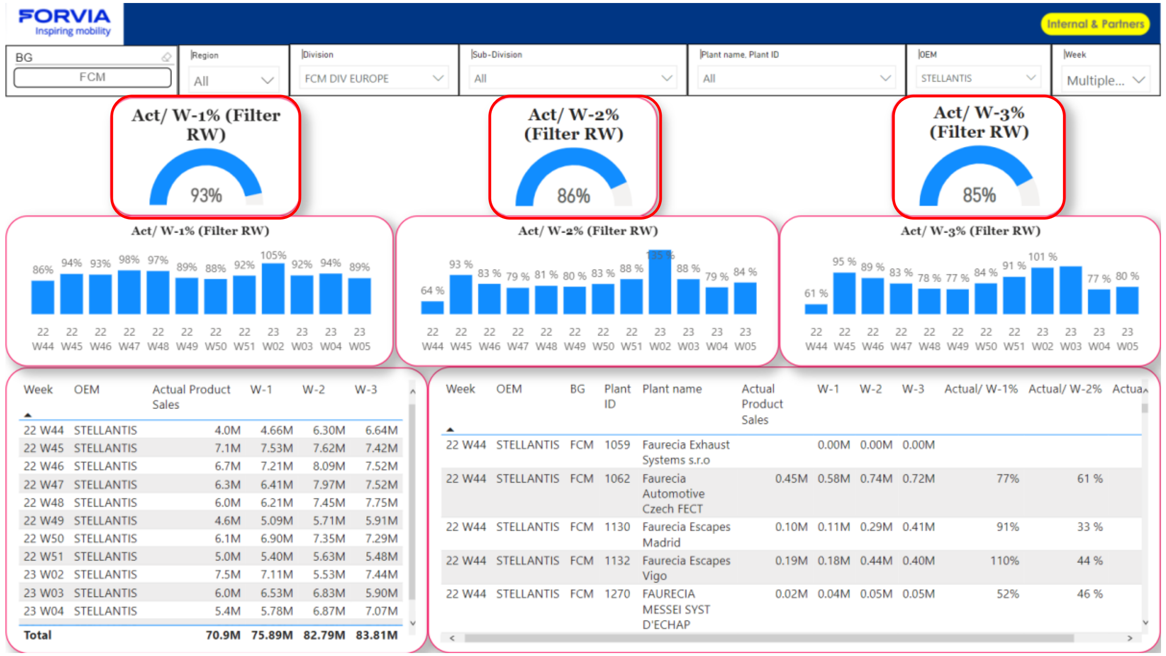
Data clean is mandatory

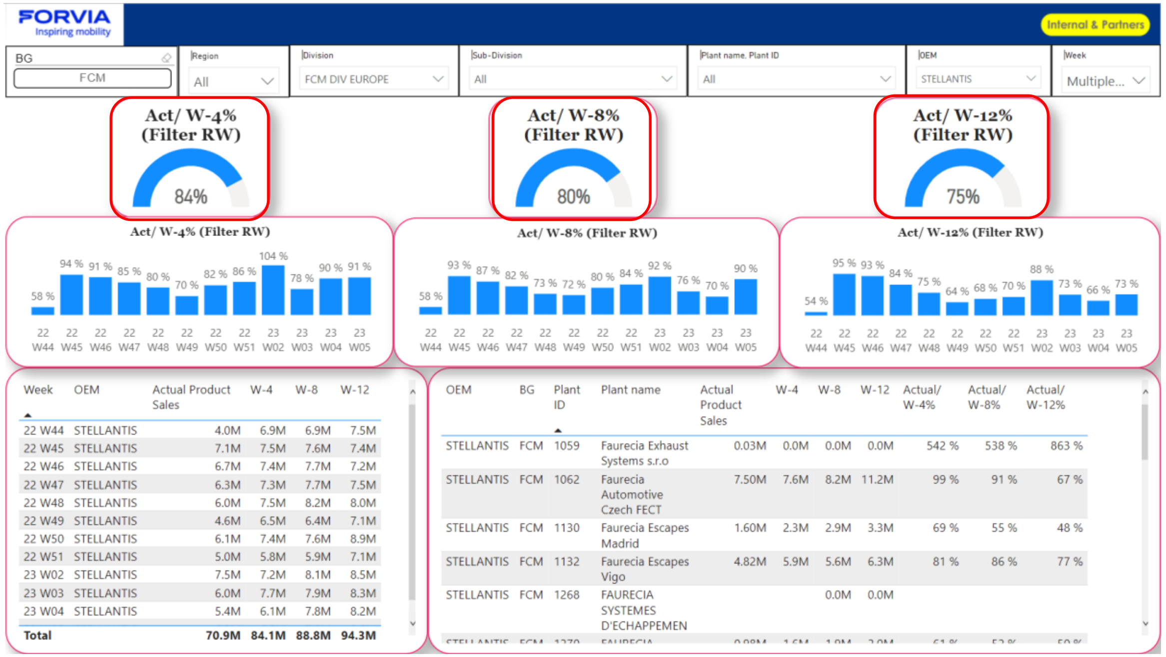
Methodologies: dropping detection (Sales is -50% vs. Sales W-2/W+2)

2.3 Logic for Stellantis Europe Division Forecasting

2. Principle:

- **Based on average of previous rolling weeks (12), EDI accuracy is defined, called “customer demand behavior”**
- **Apply the customer demand behavior defined per plant/ship-to on corresponding future EDI**





[Weekly EDI Accuracy in Power Bi]()

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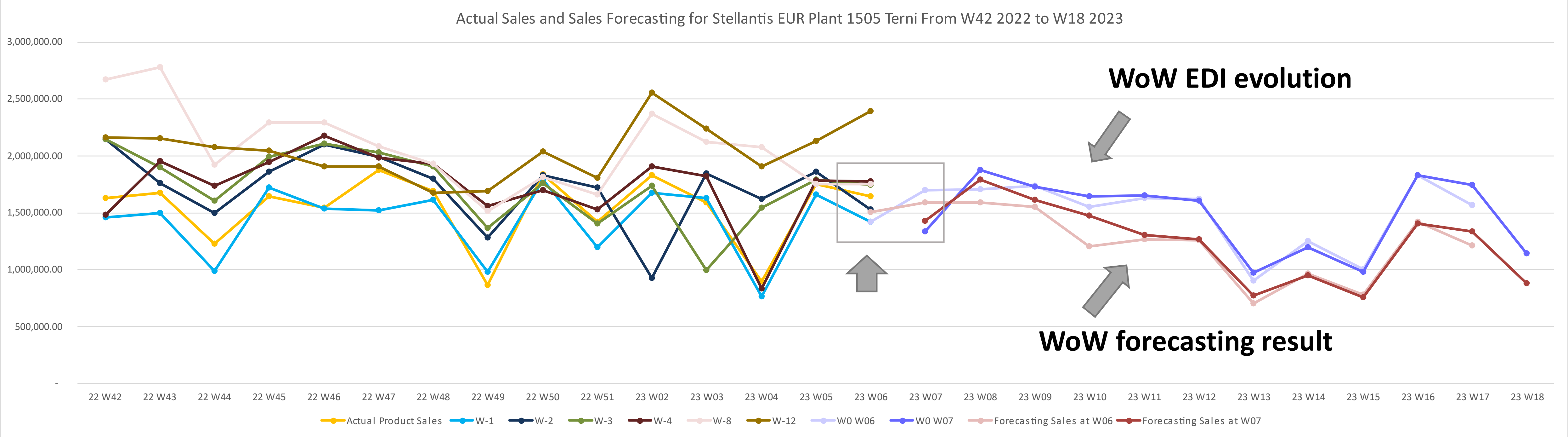
2.4 Forecasting results for Stellantis Plant example #1

Apply the same logic for the Plant level:
Example for Stellantis Plant 1505 Terni Sales prediction in W06 and W07



The Red Forecasting accuracy is better than EDI (91.3% vs. 86.2%)

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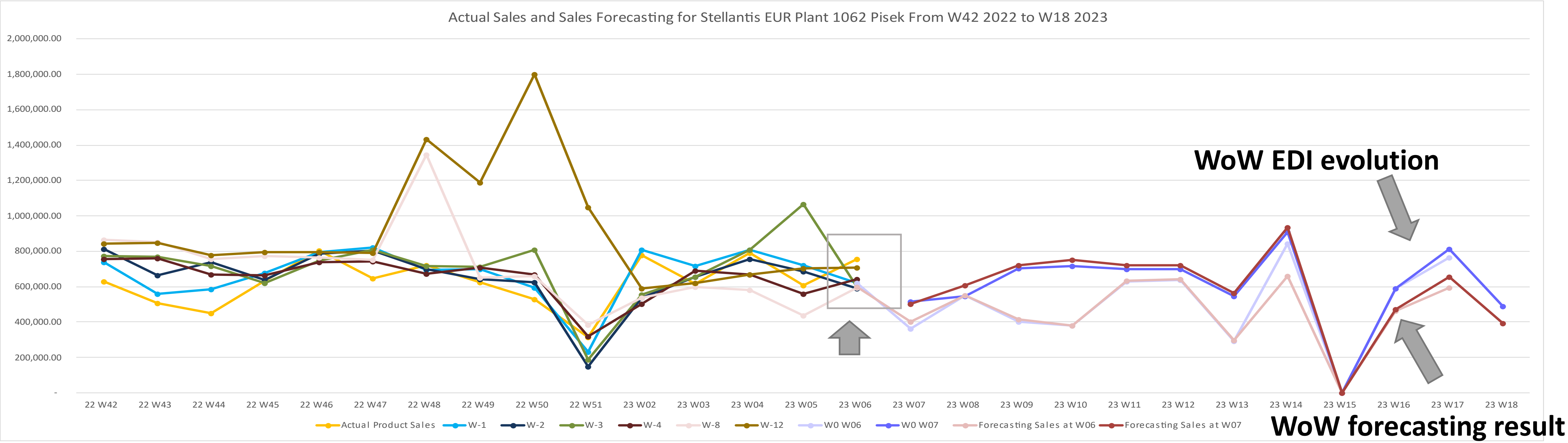
2.4 Forecasting results for Stellantis Plant example #2

Apply the same logic for the Plant level:
Example for Stellantis Plant 1062 Pisek Sales prediction in W06, and W07



The Red Forecasting accuracy is worse than EDI accuracy (78.7% vs 82.1%)

In the logic for the Plant Level, the model performance need to be tested more times

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3.1 Accuracy for Stellantis Europe Division Forecasting

Accuracy comparation for the Forecasting of W04, W05, W06 examples

EDI Accuracy	EDI W-12 Accuracy	EDI W-8 Accuracy	EDI W-4 Accuracy	EDI W-3 Accuracy	EDI W-2 Accuracy	EDI W-1 Accuracy	Average progress in only EDI %
	60.4%	79.4%	89.7%	79.7%	83.4%	92.8%	9.8%
Forecasting Accuracy				Forecasting W-3 Accuracy	Forecasting W-2 Accuracy	Forecasting W-1 Accuracy	Average progress in only Forecasting %
				91%	94%	96.9%	3.2%
Progress by weeks				14.2%	12.7%	4.3%	
Average progress Forecasting vs. EDI					10.4%		

- **The accuracy of EDI and the accuracy of Forecasting are both better when using the closer week results**
- **Forecasting results is better than EDI values in each of weeks**

The forecasting result is better than we only apply EDI, average progress is 10.4%

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3. Statistical test for Stellantis Europe Division Forecasting

In order to validate the accuracy of the model, Z-test done on 42 past weeks data

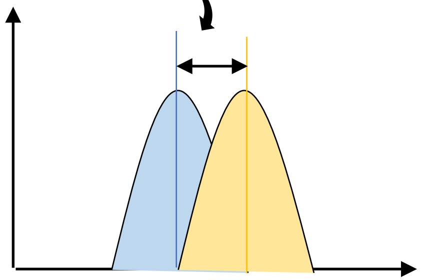
Z-Test: Compare the error of averages (Actual and Forecasting)

Z Test	
Z W-1	0.00346
Z W-2	0.01155
Z W-3	0.00587
Z W-4	0.00995
Z W-8	0.13892
Z W-12	(3.58715)

Z < 1.96 means The correct rate of "the two means are not significantly different" is higher than 95%

In 95% of time, the **average** of actual and forecasting value **is close to each other**

The forecasting results is good



RMSE (Root-mean-square deviation): Compare the error of extreme value

Variance/Error	
RMSE W-1	437,563
RMSE W-2	817,710
RMSE W-3	834,847
RMSE W-4	815,757
RMSE W-8	685,333
RMSE W-12	553,474

Average of weekly Stellantis EUR Sales is €5,397,739,
But the extreme error are under € 900,000 and far smaller than €5,397,738.7,
Then, the extreme error are acceptable,
The forecasting results is good

After Z-test and comparation of RMSE, the forecasting logic is confident enough to be used

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Future Work Plan

1. Testing different division sales for Stellantis, and different OEM sales for Europe to compare the results. (need to be transferred to Adam and Samir)
2. Apply the same logic or develop another one for the Plant Level, remember there will be 0 sales in plant on some weeks
3. Starting use IHS to combine with EDI prediction result

The optimization direction is determined by the results of the above 3 points