Final Presentation
Group 4

03.07.2025

Group members:

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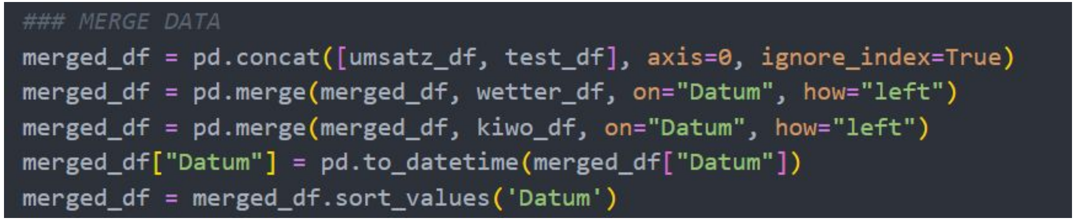
Data Characteristics

Data Preparation

- Importing Libraries and loading the data from the server
- Merging the data

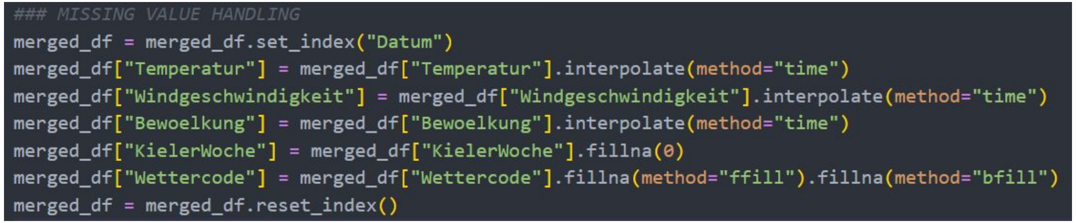


```
### MERGE DATA
merged_df = pd.concat([umsatz_df, test_df], axis=0, ignore_index=True)
merged_df = pd.merge(merged_df, wetter_df, on="Datum", how="left")
merged_df = pd.merge(merged_df, kiwo_df, on="Datum", how="left")
merged_df["Datum"] = pd.to_datetime(merged_df["Datum"])
merged_df = merged_df.sort_values('Datum')
```

Data Characteristics

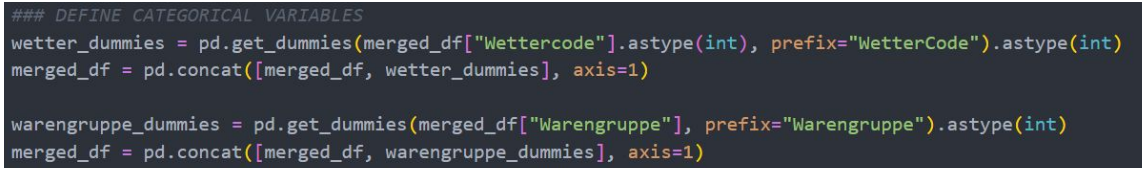
Data Preparation

- Data Cleaning and Imputing



```
### MISSING VALUE HANDLING
merged_df = merged_df.set_index("Datum")
merged_df["Temperatur"] = merged_df["Temperatur"].interpolate(method="time")
merged_df["Windgeschwindigkeit"] = merged_df["Windgeschwindigkeit"].interpolate(method="time")
merged_df["Bewoelkung"] = merged_df["Bewoelkung"].interpolate(method="time")
merged_df["KielerWoche"] = merged_df["KielerWoche"].fillna(0)
merged_df["Wettercode"] = merged_df["Wettercode"].fillna(method="ffill").fillna(method="bfill")
merged_df = merged_df.reset_index()
```

- Defining categorical variables



```
### DEFINE CATEGORICAL VARIABLES
wetter_dummies = pd.get_dummies(merged_df["Wettercode"].astype(int), prefix="WetterCode").astype(int)
merged_df = pd.concat([merged_df, wetter_dummies], axis=1)

warengruppe_dummies = pd.get_dummies(merged_df["Warengruppe"], prefix="Warengruppe").astype(int)
merged_df = pd.concat([merged_df, warengruppe_dummies], axis=1)
```

- Splitting and saving

Data Characteristics

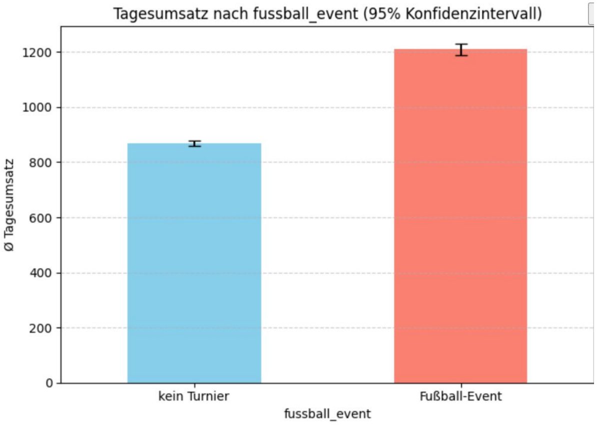
Additional Variables

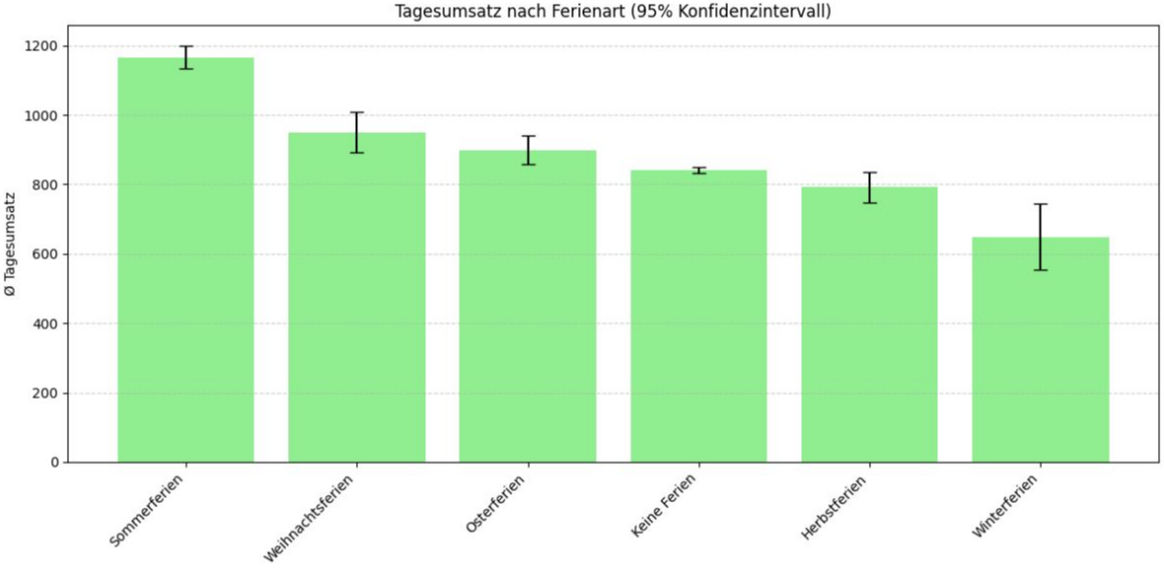
- National/Regional Holidays and the days before (Christmas Eve, etc) (`import holidays`)
- DAX (`import yfinance as yf1`)
- Weekday
- Sunhours (Sunrise - Sunset)... (`from astral import sun from astral import Observer obs = Observer(latitude=54.3233,longitude=10.1228)`)
- Major Football Events (`wm_2014 = pd.Timestamp('2014-06-12') <= datum <= pd.Timestamp('2014-07-13')`)
- School Vacation (`{"name": "Sommerferien", "start": "2013-06-24", "end": "2013-08-03"},`)

Feature Engineering

- Average Sales for a typical day of the week x in month y for the different product groups
- Average Sales on day n of the year averaged over the whole lota

Bar charts for two self-created variables





Baseline Model

- Built a **Linear Regression model** to predict sales (Umsatz) using both **categorical** (e.g., Warengruppe, Feiertag) and **numerical** features (e.g., Temperatur, Bewoelkung).

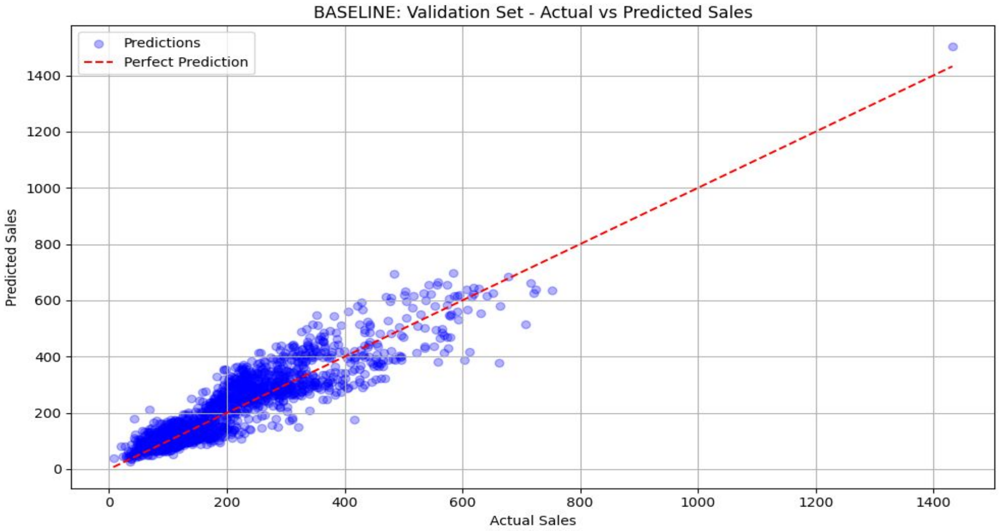
- Applied a **preprocessing pipeline**: imputed missing values, scaled numerical data, and one-hot encoded categorical variables.

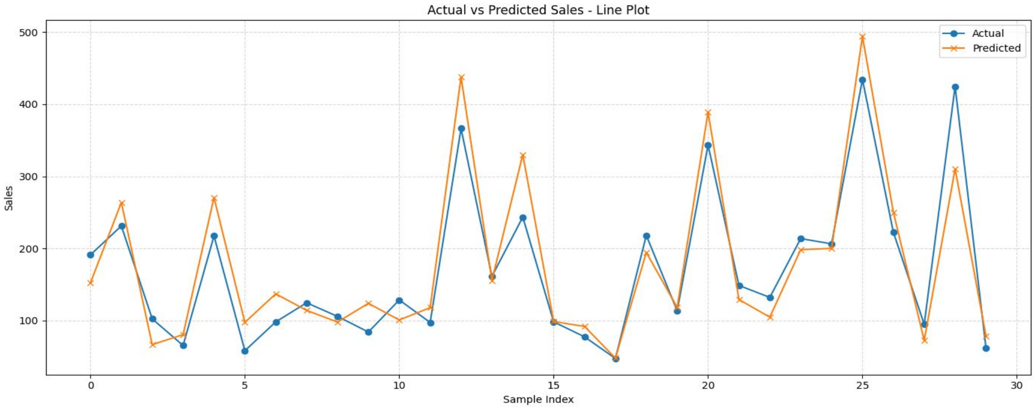
- Combined preprocessing and modeling in a **scikit-learn pipeline** for clean, consistent, and reproducible training and prediction.

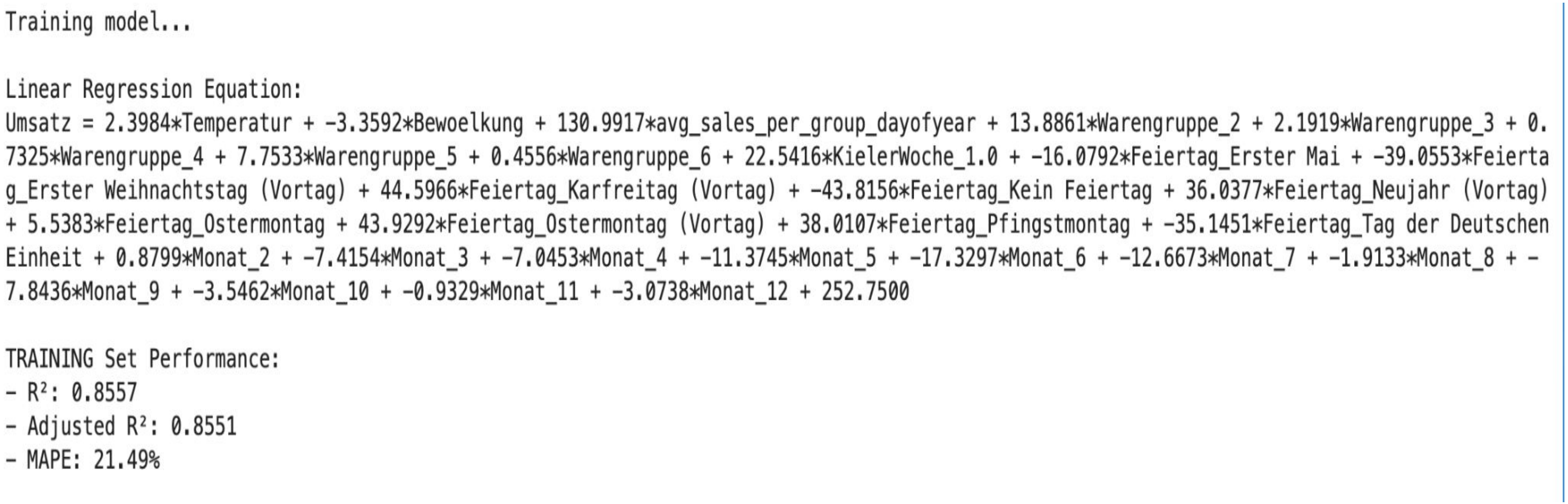
Baseline Model

- The **scatter plot** shows a strong linear relationship between actual and predicted sales, with most points close to the ideal prediction line — indicating good overall model accuracy.

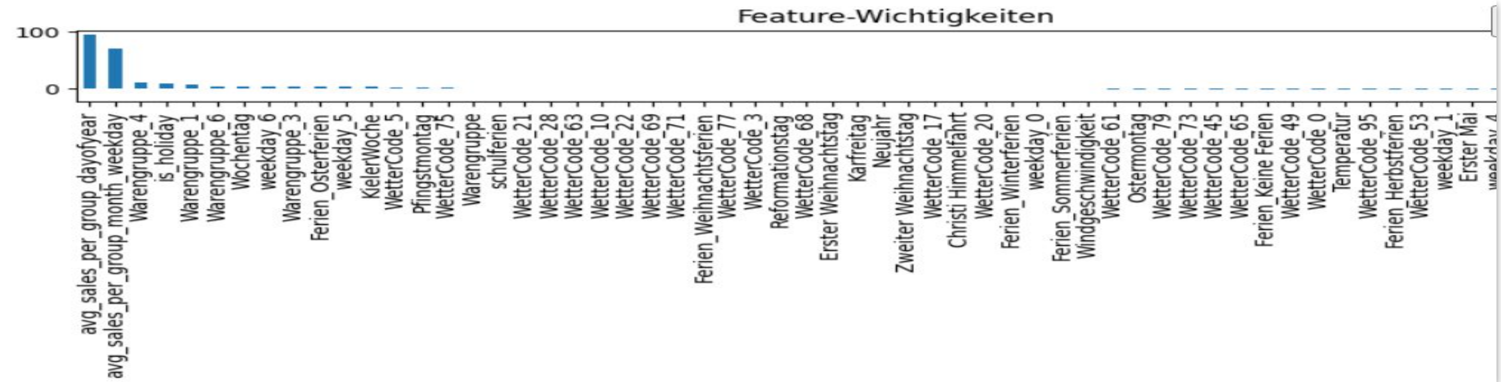
- The line chart confirms this by comparing actual and predicted values for a sample of cases, where most lines closely align





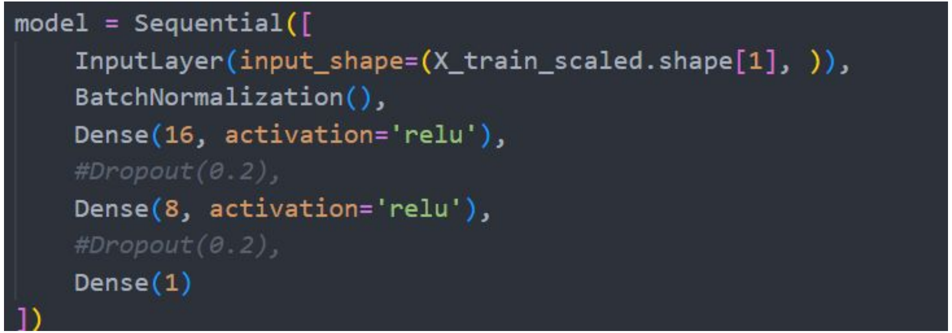


```
Training model...

Linear Regression Equation:
Umsatz = 2.3984*Temperatur + -3.3592*Bewoelkung + 130.9917*avg_sales_per_group_dayofyear + 13.8861*Warengruppe_2 + 2.1919*Warengruppe_3 + 0.
7325*Warengruppe_4 + 7.7533*Warengruppe_5 + 0.4556*Warengruppe_6 + 22.5416*KielerWoche_1.0 + -16.0792*Feiertag_Erster Mai + -39.0553*Feierta
g_Erster Weihnachtstag (Vortag) + 44.5966*Feiertag_Karfreitag (Vortag) + -43.8156*Feiertag_Kein Feiertag + 36.0377*Feiertag_Neujahr (Vortag)
+ 5.5383*Feiertag_Ostermontag + 43.9292*Feiertag_Ostermontag (Vortag) + 38.0107*Feiertag_Pfingstmontag + -35.1451*Feiertag_Tag der Deutschen
Einheit + 0.8799*Monat_2 + -7.4154*Monat_3 + -7.0453*Monat_4 + -11.3745*Monat_5 + -17.3297*Monat_6 + -12.6673*Monat_7 + -1.9133*Monat_8 + -
7.8436*Monat_9 + -3.5462*Monat_10 + -0.9329*Monat_11 + -3.0738*Monat_12 + 252.7500

TRAINING Set Performance:
- R²: 0.8557
- Adjusted R²: 0.8551
- MAPE: 21.49%
```


Feature-Wichtigkeiten
100
0
avg_sales_per_group_dayofyear
avg_sales_per_group_month_weekday
Warengruppe_4
is_holiday
Warengruppe_1
Warengruppe_6
Wochentag
weekday_6
Warengruppe_3
Ferien_Osterferien
weekday_5
KielerWoche
WetterCode_5
Pfingstmontag
WetterCode_75
Warengruppe
schulferien
WetterCode_21
WetterCode_28
WetterCode_63
WetterCode_10
WetterCode_22
WetterCode_69
WetterCode_71
Ferien_Weihnachtsferien
WetterCode_77
WetterCode_3
Reformationstag
WetterCode_68
Erster Weihnachtstag
Karfreitag
Neujahr
Zweiter Weihnachtstag
WetterCode_17
Christi Himmelfahrt
WetterCode_20
Ferien_Winterferien
weekday_0
Ferien_Sommerferien
Windgeschwindigkeit
WetterCode_61
Ostermontag
WetterCode_79
WetterCode_73
WetterCode_45
WetterCode_65
Ferien_Keine Ferien
WetterCode_49
WetterCode_0
Temperatur
WetterCode_95
Ferien_Herbstferien
WetterCode_53
weekday_1
Erster Mai
weekday_4

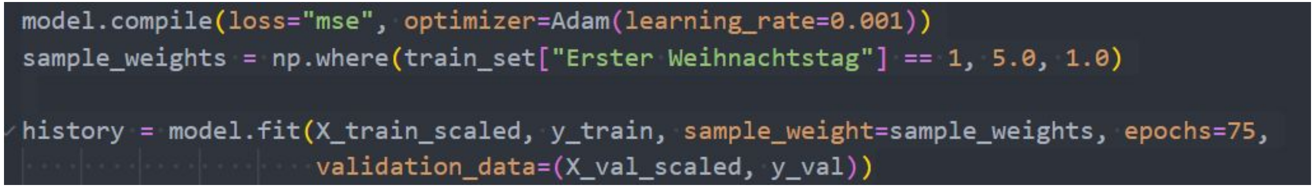
Neural network Definition

Source code defining the neural network:



```
model = Sequential([
    InputLayer(input_shape=(X_train_scaled.shape[1], )),
    BatchNormalization(),
    Dense(16, activation='relu'),
    #Dropout(0.2),
    Dense(8, activation='relu'),
    #Dropout(0.2),
    Dense(1)
])
```

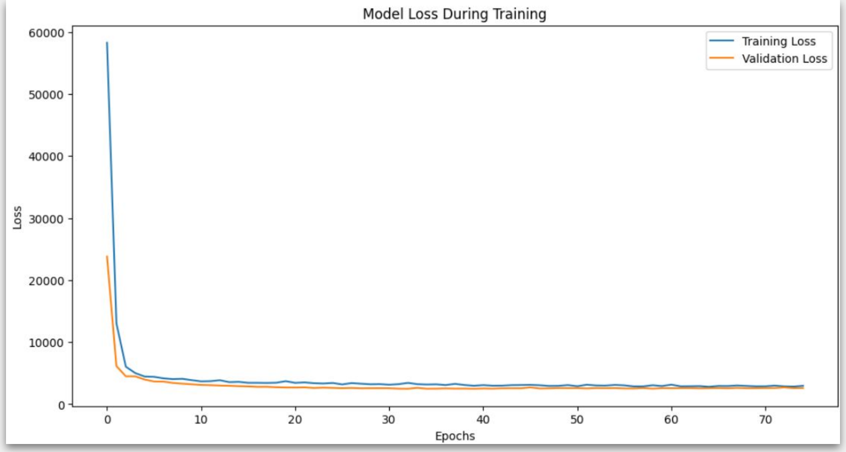
Training



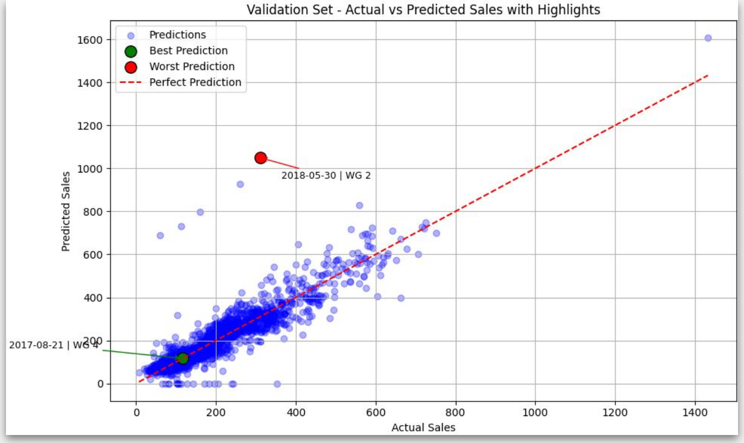
```
model.compile(loss="mse", optimizer=Adam(learning_rate=0.001))
sample_weights = np.where(train_set["Erster Weihnachtstag"] == 1, 5.0, 1.0)

history = model.fit(X_train_scaled, y_train, sample_weight=sample_weights, epochs=75,
                    validation_data=(X_val_scaled, y_val))
```

Neural network Evaluation 😊

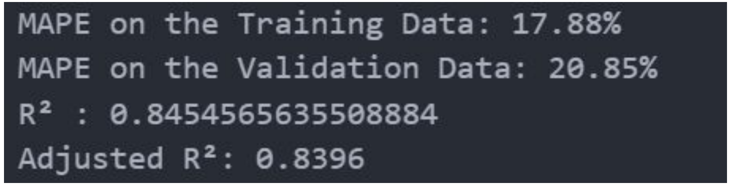
Loss function



Best and worst predictions



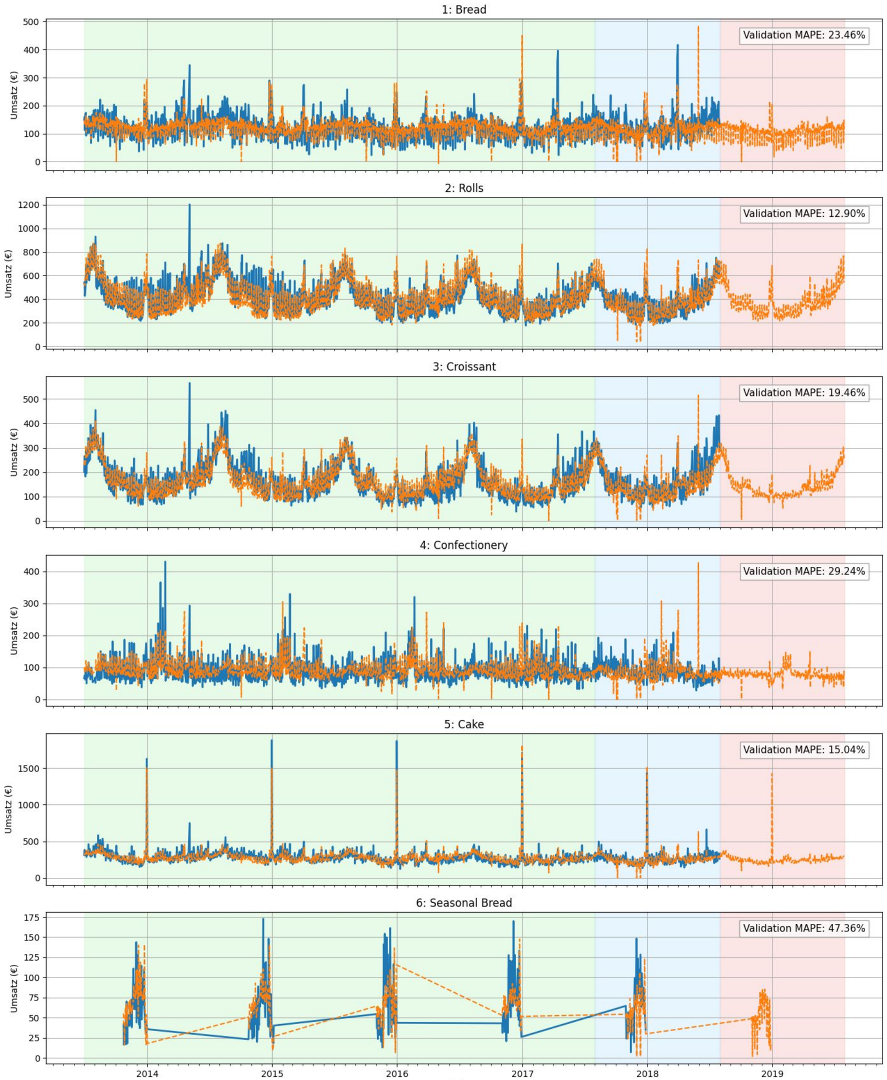
MAPE:



```
MAPE on the Training Data: 17.88%
MAPE on the Validation Data: 20.85%
R² : 0.845456563550884
Adjusted R²: 0.8396
```

Neural network

- Good prediction of the validation data
- Still lacks ‘variance’ and shows some weird dips



Challenges and Errors

- Bugs in the code
- Adding more variance in the model
- Defining reasonable additional variables
- Improving MAPE value

Q & A