Business Intelligence Workplace project
P02: Forecasting electricity prices

Preliminaries

1. Download day-ahead electricity load (demand) forecasts

   Please select only one dataset:

   - Germany (DE) – students born on an odd day (i.e., 1, 3, ..., 31)
   - France (FR) – students born on an even day (i.e., 2, 4, ..., 30)

   of the month. Note, that these files are already treated for daylight saving time (DST) changes.

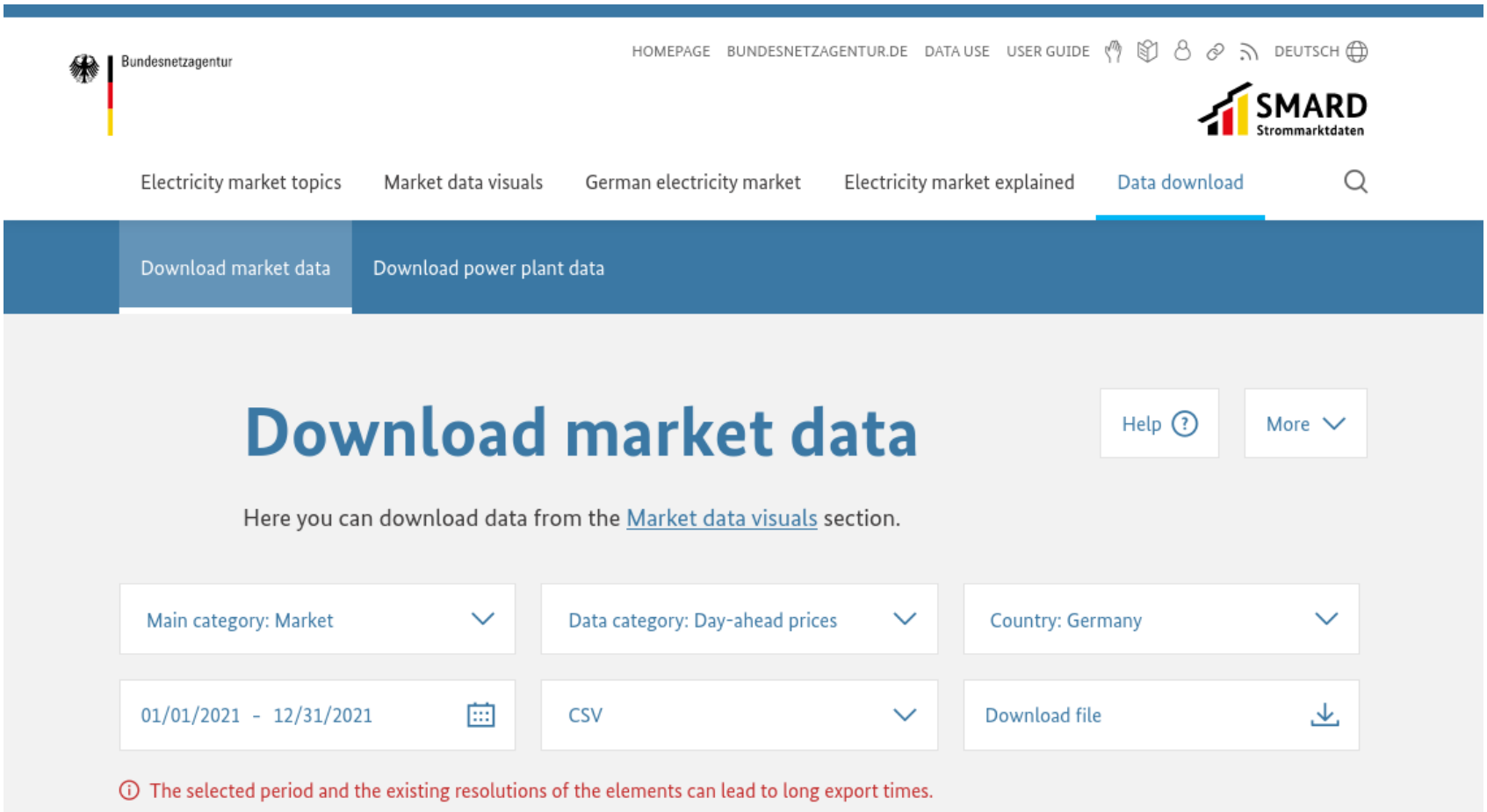
Preliminaries cont.

2. Download electricity price data for the respective country from `https://www.smard.de/en/downloadcenter/download-market-data`
   - category – Market,
   - data category – Day-ahead prices.

   Download price data spanning the whole period available in your load forecast file.

   Note that this data is listed in local time without DST treatment. Hence:
   - fill in the missing value in March with the average of the neighboring hours,
   - average the duplicate hour (2am) in October.

Price data download from the smard.de website



Tasks

3. Prepare scatter plots of forecasted load vs. price for data from years 2019-2020:
   - plot #1 for all data
   - plot #2 for all hours on Saturdays
   - plot #3 for hour 10am on all days of the week.

   For a sample scatter plot see T02, slide 32.
4. Prepare weekly and daily seasonal plots for both the price and load data from years 2019-2020. For sample plots see T02, slides 16-17.

Tasks cont.

5. Compute forecasts of the **naive #1** model:

$$\hat{P}_{d,h} = P_{d-7,h}$$

for all days (and hours) in 2021.

6. Compute forecasts of the **naive #2** model:

$$\begin{cases} \hat{P}_{d,h} = P_{d-7,h} & \text{for } d = \text{Mon, Sat, Sun} \\ \hat{P}_{d,h} = P_{d-1,h} & \text{otherwise} \end{cases}$$

for all days (and hours) in 2021.

ARX1 model definition

Consider an autoregressive model (called **ARX1**):

$$\begin{aligned} P_{d,h} = {} & \beta_{0,h} + \beta_{1,h} P_{d-1,h} + \beta_{2,h} P_{d-7,h} \\ & + \beta_{3,h} \hat{Z}_{d,h} + \beta_{4,h} \min_{k=1..24} P_{d-1,k} + \beta_{5,h} P_{d-1,24} \\ & + \beta_{6,h} D_{Sat} + \beta_{7,h} D_{Sun} + \beta_{8,h} D_{Mon} + \varepsilon_{d,h}, \end{aligned}$$

where

- $P_{d,h}$ – price for hour h day d,
- $\hat{Z}_{d,h}$ – load forecast for day d and hour h,
- $D_{Mon}, D_{Sat}, D_{Sun}$ – dummies for Monday, Saturday and Sunday, e.g., $D_{Mon} = 1$ for $d =$ Monday and 0 otherwise.

Tasks cont.

7. For each hour h of the day compute forecasts of the **ARX1** model for all days in 2021. Calibrate the model only once – using a fixed two year window (2019-2020).
8. For each hour h of the day compute forecasts of the **ARX1** model for all days in 2021. This time use a two-year rolling calibration window, i.e., for the 24h of 1.01.2021 use data from 1.01.2019-31.12.2020, for the 24h of 2.01.2021 use data from 2.01.2019-1.01.2021, etc.
9. Compute MAE and RMSE for the four models, for each hour of the day separately and jointly for all hours.

BONUS task

(worth 50% of points for P02, added to the final course grade)

10. For each hour h of the day compute forecasts for all days in 2021 of a multilayer perceptron (**MLP**) with
    - the same inputs as the 24 hourly ARX1 models,
    - 2 hidden layers,
    - 24 outputs, i.e., $P_{d,1}, P_{d,2}, ..., P_{d,24}$,
    - sigmoid activation function for both hidden layers,

    using a fixed two year calibration window (2019-2020). Calculate MAE and RMSE and compare with the other four models.

Note: The BONUS task can be implemented in a different programming language (preferably Python) than the remaining tasks of P02 (e.g., Matlab or R).

BONUS task: MLP architecture