FACULTY OF ENGINEERING
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Forecasting and generative modeling of the Belgian electricity market

November Intermediate Report

Master Thesis

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Academic year: 2023–2024

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1 Intermediate Results

The electricity market is a complicated system with many different factors. During this thesis, we will try to model the day-ahead system imbalance. Using this imbalance, a model can be trained using reinforcement learning to trade on the electricity market to generate profit. The first step is to model the imbalance. The imbalance is the difference between the amount of electricity that is bought and sold on the day-ahead market and the amount of electricity that is actually consumed. Elia (Transmission System Operator) is responsible for keeping the grid stable and takes the steps necessary to do so. They provide electricity when there is a shortage and take electricity when there is a surplus. The amount of energy that is provided or consumed is called the Net Regulation Volume. Based on the Net Regulation Volume and the bid ladder, the electricity price can be calculated.

Elia publishes a lot of data on their website. This data can then be used as training data. First, simple baselines can be implemented to forecast the NRV of the next day.

The data available ranges from 01-01-2015 until the current date. The data is available in minute or quarter intervals. For our use case, the quarter interval will do. The data is split into training data and test data. The data from 2023 is used as the test set.

1.1 Previous day as forecast

One baseline can be to use the previous day NRV values as the forecast for the next day. This gives the following results on the test set:

MAE: 145.97317296006946
MSE: 39632.622958020256

1.2 All Zeros

Using all zeros as forecast gives the following results on the test set:

MAE: 106.1727146629051
MSE: 21977.654647179577

The first small conclusion that can be made is that just using all zeros as the forecast gives better results than using the previous day NRV values.

1.3 Linear Model

A simple linear model can also be trained on the data. This doesn't generatively model the NRV but forecasts the next value based on the given NRV values. This model can then be used autoregressively to forecast the NRV of the next day.

Training data range	MAE	MSE
2015-2022	78.04712677001953	10891.9501953125
2016-2022	77.98072814941406	10872.8173828125
2017-2022	77.94755554199219	10859.1943359375
2018-2022	77.90494537353516	10840.017578125
2019-2022	77.88092041015625	10830.2880859375
2020-2022	77.84571075439453	10823.6826171875
2021-2022	77.86540985107422	10831.35546875
2022-2022	77.95752716064453	10871.7685546875

Table 1: Results of the linear model with different ranges of training data

The experiments performed use a linear model. The input size is 96 (the quarter-hour values of the NRV) and the output is one value that represents the predicted next NRV value. The experiments use Adam as an optimizer with a learning rate of 0.0003. All input values were rescaled using the MinMaxScaler.

2 Schedule next months

An overview of the planning for the next months is given below. The planning is subject to change depending on the results of the experiments.

2.1 Other input features

For the moment, only the NRV is used as input. More inputs can be used to model the NRV. For example, Elia provides a load forecast for every quarter hour. This can also be used as input for the model. Weather and other dependencies should be further explored.

2.2 More complex models

For now, the models were kept simple. More complex models can however be used to generatively model the NRV. For example, diffusion models can be explored.

2.3 Reinforcement learning

Once a model is trained to generatively model the NRV, a reinforcement learning model can be trained to make better decisions on the electricity market. This step however, requires a good generative model of the NRV.