

Assignment 3 concentrates on day-ahead generation scheduling from the perspective of the system operator. In this assignment, you will investigate how to benefit from classification for this application. The same as previous assignments, the work to undertake involves a bit of mathematical modelling, implementation in your favorite modelling language (preferably Python), generation and discussion of results, as well as presentation of the work in a short report.

The aim of Assignment 3 is to evaluate

- your understanding of day-ahead scheduling from the system operator perspective,
- your ability to implement linear and non-linear classification,
- your critical analysis of the results generated.

The expected outcome of Assignment 1 includes:

- a report of maximum 10 pages (excluding appendices),
- code delivered as supplementary material.

The evaluation of Assignment 1 will count for 32% of the final grade. **Individual contributions to the assignment must be clearly stated in the report.** If not, equal contribution will be assumed. Good luck!

Description of the assignment

In this assignment, you will apply linear and non-linear classification for the day-ahead scheduling problem, specifically unit commitment. Envision yourself as the system operator, aiming to accelerate solving the unit commitment problem by learning from historical data. Unit commitment in energy systems involves determining which power units should be online and offline in each period. This problem is crucial for operational planning, ensuring optimal resource utilization and stability. In this assignment, you will see one way of using machine learning for this application.

Step 1) Understanding the problem: Please describe the unit commitment problem, model it as an optimization problem, and identify the variables, objective function and constraints involved.

Step 2) Simulation setup: Please set up and run unit commitment simulations on the 118-bus test system or any other test system you would prefer (you are not restricted to this use case). The 118-bus test system includes 19 conventional units, 91 loads, and 186 transmission lines. The technical data related to generating units and transmission lines, the times series of load over 24 hours along with a template code using Gurobipy has been attached.

Step 3) Data preparation:

Step 3.1) Please create different samples of load, and run the unit commitment for each sample and observe the outcomes. For simplicity, you can assume an identical daily load profile across various samples but with different levels (A set of normalized samples has been attached; however, feel free to generate your own samples).

Step 3.2) Please identify the optimal values of binary variables and active constraints for each sample. For active constraints, you may only consider the transmission lines to identify which ones are active at the optimal solution.

Step 3.3) Now, you are ready to construct a dataset comprising training, validation, and testing samples. Using the results from the unit commitment simulations, define the features and labels. Please explain how you build up the dataset and split it into training, validation, and testing.

Step 4) Classification: Please train a set of binary classifiers using the prepared dataset to predict the optimal value of binary variables and active constraints. Please try both linear and non-linear classification.

Step 5) Evaluation: Please evaluate and compare the performance of linear and non-linear classifiers in predicting binary variables and active constraints.

Step 6) (Optional) Please analyze and discuss how this prediction can assist in solving the unit commitment problem faster.

Step 7) (Optional) Please visualize and compare the performance of linear and non-linear classifiers by using PCA.

Note: You can use Gurobipy and scikit-learn API for this assignment.