Electricity Grid Congestion Manager

Team P20

Artem Grukhal, Bohdan Romashchenko, Jatan Shrestha

Project owner:

Kristjan Eljand (Eesti Energia)

Problem

- Rise of popularity of electric vehicles (EVs) causes additional electricity consumption and hence, load on electricity grids.
- To avoid huge investments in improving the grids, a smart EV charging system could be developed.

Tasks

- Prepare the datasets for analysis.
- Develop a prediction model that forecasts the grid load in specific location based on EV charging statistics.
- Develop a model for smart charging – a model that divides the electricity consumption of EVs such that the limits of the grid won't be exceeded and all of the EV owners receive the similar experience.
- Develop a graphical user interface (GUI) with following functionality:
    1. Selecting a time of day (hour) and location as an input and shows grid load forecast.
    2. Showing the optimized charging schedule if there is a threat of grid congestion.

Data

Provided data is separated into multiple files:

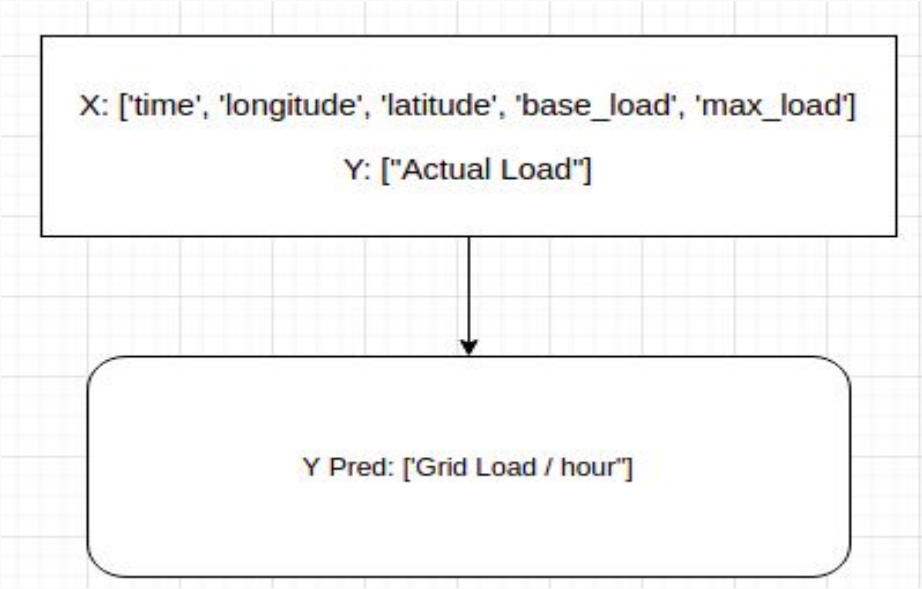
- Chargers' locations
- Grids' locations and max power
- Grids' baseload for each hour of the day
- EVs' descriptions
- EVs' home locations
- EVs' charging/moving history

Developed datasets:

- Grid-chargers based on haversine distance
- Grid loads for each hour of the day (base, max, actual)
- Charger statistics for each hour of the day (car model, charge need)

Predicting grid load

- With such set of features only Ensemble Learning models make sense
- GradientBoostingRegressor: Accuracy 96.46%
- RandomForestRegressor: Accuracy: 94.74%

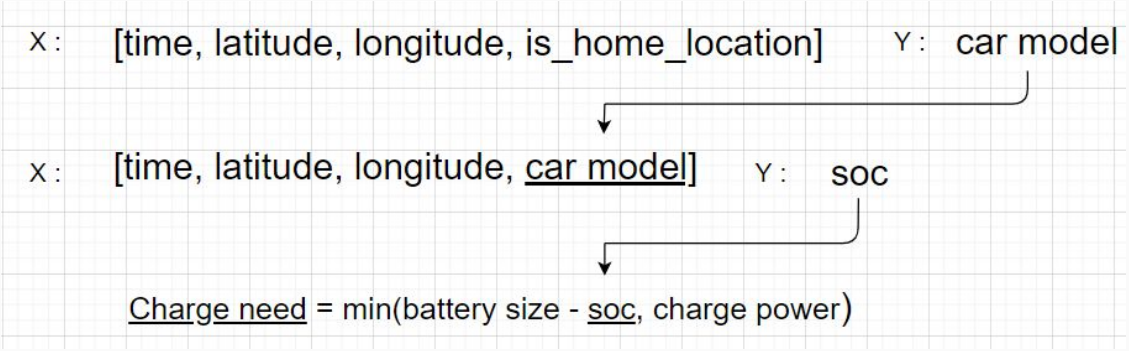


Smart charging

1. Get all the chargers that load some certain overloaded grid
2. Predict the charge need on each one of them
3. Decrease the output until the conditions are satisfied

Predicting charge need

1. Classify car model connected to the charger
2. Predict its state of charge (accuracy is higher than predicting charge need directly)
3. Calculate charge need



Predicting charge need

- Ensemble Methods- Random forests, Gradient Boosting, Histogram-based Gradient Boosting
- Accuracy of both models within 70-80%, final charge need accuracy is about 60-70%
- Definitely can be improved with more data

Smart charging algorithm

- If base load is higher than max load, output on the chargers is set to 0 kW
- Otherwise, decrease the output of the chargers by the same percentage until estimated load is higher than max load of the grid.

```
total = sum of charge predictions
decrease_rate = 0.1

if base_load >= max_load:
    set all outputs to 0
    return

while base_load + total > max_load:
    for each charger (c) in chargers:
        c[optimized] = c[need] * (1.0 - decrease_rate)

    total = sum of optimized charges
    decrease_rate += 0.1
```

Lessons

- Having enough data is quite important for good performance
- Data Preprocessing & Analysis could be the hardest part

DEMO TIME

Links

Github repo

Colab

Thank You