Reproducibility review of: Optimizing Electric Vehicle Charging Schedules Based on Probabilistic Forecast of Individual Mobility

Carlos Granell

2022-06-10

This report is part of the reproducibility review at the AGILE conference. For more information see https://reproducible-agile.github.io/. This document is published on OSF at https://osf.io/jdtn3/. To cite the report use

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Reviewed paper

> *Cai, H., Xin, Y., Martin, H., and Raubal, M.: Optimizing Electric Vehicle Charging Schedules Based on Probabilistic Forecast of Individual Mobility, AGILE GIScience Ser., 3, 3, https://doi.org/10.5194/agile-giss-3-3-2022*

Summary

The authors included a Data and Software Availability ("DASA") section, where a link to an anonymous GitHub repo was provided. It contains a landing page with detailed instructions and an entry point (`main` script) to run the entire analysis. The authors also specified which scripts are involved in the different outputs of the paper (tables, figures, etc). The authors claimed that input data cannot be disclosed. After communicating with authors, they provided me a few synthetic input samples (CSV format) to run the probabilistic models and charging strategies for simulation and evaluation, therefore skipping the need to access and getting real data from a remote database, as coded in the original `main` scripts. Because only synthetic samples are provided, there are differences between the results of the reproduction and the ones in the original paper.

The reproduction described in this report uses the Python code provided in a GitHub repo. Even though the reproduction exercise with synthetic data failed during the last step of the script, I can consider the paper was *partially reproducible* based on the synthetic data prepared by the authors.

Reproducibility reviewer notes

The original paper submission did not provide a link to the input data. All scripts were provided on an anonymised GitHub repo https://anonymous.4open.science/r/agile22_evprediction-2F28/README.md. I got synthetic data via email by authors. Given a project folder, all scripts are included in the `<project-folder>/code` folder and synthetic data in the `<project-folder/data` folder. The authors updated the scripts on the anonymised GitHub repo (addition of comments, basically) to facilitate the reproduction check. In particular, I commented the code in `main.py` that refers to get real data from a remote database to use instead the synthetics data, and adjusted some file paths. Next, I followed the steps below.

```
cgranell@DESKTOP-1PKOUTF:~/code/$ mkdir agile2022-010
cgranell@DESKTOP-1PKOUTF:~/code/agile2022-010$ cd agile2022-010
cgranell@DESKTOP-1PKOUTF:~/code/agile2022-010$ python3 -m venv venv --prompt="agile2022-010"
cgranell@DESKTOP-1PKOUTF:~/code/agile2022-010$ source venv/bin/activate

# Installing dependencies
(agile2022-010) cgranell@DESKTOP-1PKOUTF:~/code/agile2022-010$ python -m pip install geopandas, matplotlib, statsmodels

# Installing skgarden through github. Despite the errors on the console, it was successfully installed
(agile2022-010) cgranell@DESKTOP-1PKOUTF:~/code/agile2022-010$ python -m pip install skgarden
ERROR: Could not find a version that satisfies the requirement skgarden (from versions: none)
ERROR: No matching distribution found for skgarden

(agile2022-010) cgranell@DESKTOP-1PKOUTF:~/code/agile2022-010$ python -m pip install git+https://github.com/scikit-garden/scikit-garden
Collecting git+https://github.com/scikit-garden/scikit-garden
  Cloning https://github.com/scikit-garden/scikit-garden to /tmp/pip-req-build-mh2llzdv
  Running command git clone -q https://github.com/scikit-garden/scikit-garden /tmp/pip-req-build-mh2llzdv
Requirement already satisfied: numpy in ./venv/lib/python3.8/site-packages (from scikit-garden==0.1.3) (1.22.3)
Collecting scikit-learn>=0.22
  Using cached scikit_learn-1.0.2-cp38-cp38-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (26.7 MB)
Requirement already satisfied: scipy in ./venv/lib/python3.8/site-packages (from scikit-garden==0.1.3) (1.8.0)
Requirement already satisfied: six in ./venv/lib/python3.8/site-packages (from scikit-garden==0.1.3) (1.16.0)
Collecting threadpoolctl>=2.0.0
  Using cached threadpoolctl-3.1.0-py3-none-any.whl (14 kB)
Collecting joblib>=0.11
  Using cached joblib-1.1.0-py2.py3-none-any.whl (306 kB)
Building wheels for collected packages: scikit-garden
  Building wheel for scikit-garden (setup.py) ... error
  ERROR: Command errored out with exit status 1:
   command: /home/cgranell/code/agile2022-010/venv/bin/python -u -c 'import sys, setuptools, tokenize; sys.argv[0] = '"'"'/tmp/pip-req-build-m
       cwd: /tmp/pip-req-build-mh2llzdv/
  Complete output (7 lines):
  WARNING: The wheel package is not available.
  usage: setup.py [global_opts] cmd1 [cmd1_opts] [cmd2 [cmd2_opts] ...]
     or: setup.py --help [cmd1 cmd2 ...]
     or: setup.py --help-commands
     or: setup.py cmd --help

  error: invalid command 'bdist_wheel'
  ----------------------------------------
  ERROR: Failed building wheel for scikit-garden
  Running setup.py clean for scikit-garden
Failed to build scikit-garden
Installing collected packages: threadpoolctl, joblib, scikit-learn, scikit-garden
    Running setup.py install for scikit-garden ... done
Successfully installed joblib-1.1.0 scikit-garden-0.1.3 scikit-learn-1.0.2 threadpoolctl-3.1.0

# Copy scripts from anonymised repo in "code" folder

(agile2022-010) cgranell@DESKTOP-1PKOUTF:~/code/agile2022-010$ mkdir code

(agile2022-010) cgranell@DESKTOP-1PKOUTF:~/code/agile2022-010$ ls code/*.py
code/calculate_feature_importance.py          code/evaluate_unidirectional_smartcharging.py
code/calculate_under_overestimation.py        code/extract_arrival.py
code/compare_baseline_bismart.py              code/extract_depart.py
code/compare_baseline_unismart.py             code/extract_evfeatures.py
code/compare_probablistic_results.py          code/extract_mobility.py
code/compare_three_charging_onpeakdef2.py     code/extract_soc.py
code/evaluate_bidirectional_smartcharging.py  code/main.py
code/evaluate_uncontrolled_charging.py        code/predict_probablistic_results.py


# Copy synthetic input samples in "data" folder
(agile2022-010) cgranell@DESKTOP-1PKOUTF:~/code/agile2022-010$ mkdir data
(agile2022-010) cgranell@DESKTOP-1PKOUTF:~/code/agile2022-010$ ls -R data
data:
inputs

data/inputs:
arrival_prediction
auction_spot_prices_switzerland_2017_syn.csv
```

```
depart_prediction
electricity_load_profile_day_Jun2nd.csv
soc_prediction

data/inputs/arrival_prediction:
1_input.csv
2_input.csv
3_input.csv

data/inputs/depart_prediction:
1_input.csv
2_input.csv
3_input.csv

data/inputs/soc_prediction:
1_input.csv
2_input.csv
3_input.csv
```

Execution of the `main.py` script. The output on the console is quite large, so I only copy below some parts of the output, including the generated error at the end of the execution of the `main.py` script.

```
# in ./agile2022-010
(agile2022-010) cgranell@DESKTOP-1PKOUTF:~/code/agile2022-010$ python3 code/main.py
Current working directory: /home/cgranell/code/agile2022-010
##REPRODUCTION CHECK##: Run Quantile Regression Predictions
3dayavr
START------------------------------
soc
lqr_mob
----------------------START--------------------------
1
Index(['day_of_week', 'realentro_3dayavr', 'ev_duration_3dayavr',
       'ev_dist_3dayavr', 'radgyr_3dayavr', 'avrjumplen_3dayavr',
       'top10locfre_3dayavr', 'ecar_hhindex_3dayavr', 'weekend_flag', 'soc_p1',
       'soc_p2', 'soc_p3'],
      dtype='object')
12
0       1.0
1       2.0
2       0.5
3      67.0
4      87.0
       ...
194    81.5
195    61.5
196    60.5
197     7.0
198     6.5
Name: soc, Length: 199, dtype: float64
2
Index(['day_of_week', 'realentro_3dayavr', 'ev_duration_3dayavr',
       'ev_dist_3dayavr', 'radgyr_3dayavr', 'avrjumplen_3dayavr',
       'top10locfre_3dayavr', 'ecar_hhindex_3dayavr', 'weekend_flag', 'soc_p1',
       'soc_p2', 'soc_p3'],
      dtype='object')
12
0       0.5
1       2.5
2       3.5
3      37.0
4      46.5
       ...
253    61.5
254     3.0
255    30.0
256     9.0
257    41.5
Name: soc, Length: 258, dtype: float64
3
Index(['day_of_week', 'realentro_3dayavr', 'ev_duration_3dayavr',
       'ev_dist_3dayavr', 'radgyr_3dayavr', 'avrjumplen_3dayavr',
       'top10locfre_3dayavr', 'ecar_hhindex_3dayavr', 'weekend_flag', 'soc_p1',
       'soc_p2', 'soc_p3'],
      dtype='object')
12
0       5.5
1       6.0
2      68.0
3      77.5
4      21.0
       ...
269     9.5
270    19.0
```

```
271    19.5
272    19.0
273    10.0
Name: soc, Length: 274, dtype: float64
lqr
----------------------START--------------------------
1
Index(['day_of_week', 'ev_duration_3dayavr', 'ev_dist_3dayavr', 'weekend_flag',
       'soc_p1', 'soc_p2', 'soc_p3'],
      dtype='object')
7
0       1.0
1       2.0
2       0.5
3      67.0
4      87.0
       ...
194    81.5
195    61.5
196    60.5
197     7.0
198     6.5
Name: soc, Length: 199, dtype: float64
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Index(['day_of_week', 'ev_duration_3dayavr', 'ev_dist_3dayavr', 'weekend_flag',
       'soc_p1', 'soc_p2', 'soc_p3'],
      dtype='object')
7
0       0.5
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2       3.5
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257    41.5
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Index(['day_of_week', 'ev_duration_3dayavr', 'ev_dist_3dayavr', 'weekend_flag',
       'soc_p1', 'soc_p2', 'soc_p3'],
      dtype='object')
7
0       5.5
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2      68.0
3      77.5
4      21.0
       ...
269     9.5
270    19.0
271    19.5
272    19.0
273    10.0
Name: soc, Length: 274, dtype: float64
qrf_mob
----------------------START--------------------------
1
Index(['day_of_week', 'realentro_3dayavr', 'ev_duration_3dayavr',
       'ev_dist_3dayavr', 'radgyr_3dayavr', 'avrjumplen_3dayavr',
       'top10locfre_3dayavr', 'ecar_hhindex_3dayavr', 'weekend_flag', 'soc_p1',
       'soc_p2', 'soc_p3'],
      dtype='object')
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Name: soc, Length: 199, dtype: float64
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Index(['day_of_week', 'realentro_3dayavr', 'ev_duration_3dayavr',
       'ev_dist_3dayavr', 'radgyr_3dayavr', 'avrjumplen_3dayavr',
       'top10locfre_3dayavr', 'ecar_hhindex_3dayavr', 'weekend_flag', 'soc_p1',
       'soc_p2', 'soc_p3'],
      dtype='object')
12
0       0.5
```

```
1       2.5
2       3.5
3      37.0
4      46.5
       ...
253    61.5
254     3.0
255    30.0
256     9.0
257    41.5
Name: soc, Length: 258, dtype: float64
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Index(['day_of_week', 'realentro_3dayavr', 'ev_duration_3dayavr',
       'ev_dist_3dayavr', 'radgyr_3dayavr', 'avrjumplen_3dayavr',
       'top10locfre_3dayavr', 'ecar_hhindex_3dayavr', 'weekend_flag', 'soc_p1',
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      dtype='object')
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272    19.0
273    10.0
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       'soc_p1', 'soc_p2', 'soc_p3'],
      dtype='object')
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       'soc_p1', 'soc_p2', 'soc_p3'],
      dtype='object')
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       'soc_p1', 'soc_p2', 'soc_p3'],
      dtype='object')
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0       5.5
1       6.0
2      68.0
3      77.5
4      21.0
       ...
269     9.5
270    19.0
271    19.5
272    19.0
273    10.0
Name: soc, Length: 274, dtype: float64
gbqr_mob
----------------------START--------------------------
1
```

```
Index(['day_of_week', 'realentro_3dayavr', 'ev_duration_3dayavr',
       'ev_dist_3dayavr', 'radgyr_3dayavr', 'avrjumplen_3dayavr',
       'top10locfre_3dayavr', 'ecar_hhindex_3dayavr', 'weekend_flag', 'soc_p1',
       'soc_p2', 'soc_p3'],
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       ...
194    81.5
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198     6.5
Name: soc, Length: 199, dtype: float64
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Index(['day_of_week', 'realentro_3dayavr', 'ev_duration_3dayavr',
       'ev_dist_3dayavr', 'radgyr_3dayavr', 'avrjumplen_3dayavr',
       'top10locfre_3dayavr', 'ecar_hhindex_3dayavr', 'weekend_flag', 'soc_p1',
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       'top10locfre_3dayavr', 'ecar_hhindex_3dayavr', 'weekend_flag', 'soc_p1',
       'soc_p2', 'soc_p3'],
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271    19.5
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273    10.0
Name: soc, Length: 274, dtype: float64
gbqr
----------------------START--------------------------
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Index(['day_of_week', 'ev_duration_3dayavr', 'ev_dist_3dayavr', 'weekend_flag',
       'soc_p1', 'soc_p2', 'soc_p3'],
      dtype='object')
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       'soc_p1', 'soc_p2', 'soc_p3'],
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2       3.5
3      37.0
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```

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Index(['day_of_week', 'ev_duration_3dayavr', 'ev_dist_3dayavr', 'weekend_flag',
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      dtype='object')
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1       6.0
2      68.0
3      77.5
4      21.0
       ...
269     9.5
270    19.0
271    19.5
272    19.0
273    10.0
Name: soc, Length: 274, dtype: float64
depart
lqr_mob
----------------------START--------------------------
1
Index(['day_of_week', 'realentro_3dayavr', 'radgyr_3dayavr',
       'avrjumplen_3dayavr', 'top10locfre_3dayavr', 'weekend_flag',
       'depart_p1', 'depart_p2', 'depart_p3'],
      dtype='object')
9
0       9.783056
1       7.369727
2       7.314597
3      19.645551
4      24.000000
         ...
429     9.178611
430     9.259167
431     8.375833
432     9.425833
433    24.000000
Name: depart_float, Length: 434, dtype: float64
2
Index(['day_of_week', 'realentro_3dayavr', 'radgyr_3dayavr',
       'avrjumplen_3dayavr', 'top10locfre_3dayavr', 'weekend_flag',
       'depart_p1', 'depart_p2', 'depart_p3'],
      dtype='object')
9
0      16.017116
1       6.174167
2       7.948056
3      19.007569
4      11.058333
         ...
294     5.545866
295     9.120394
296    13.243917
297     6.311245
298     7.786509
Name: depart_float, Length: 299, dtype: float64
3
Index(['day_of_week', 'realentro_3dayavr', 'radgyr_3dayavr',
       'avrjumplen_3dayavr', 'top10locfre_3dayavr', 'weekend_flag',
       'depart_p1', 'depart_p2', 'depart_p3'],
      dtype='object')
9
0      17.884625
1      12.002403
2       8.950866
3      10.461139
4      10.976847
         ...
412    13.254444
413     5.775000
414     7.464444
415    15.018611
416    24.000000
Name: depart_float, Length: 417, dtype: float64
lqr
----------------------START--------------------------
1
Index(['day_of_week', 'weekend_flag', 'depart_p1', 'depart_p2', 'depart_p3'], dtype='object')
5
0       9.783056
```

```
1       7.369727
2       7.314597
3      19.645551
4      24.000000
         ...
429     9.178611
430     9.259167
431     8.375833
432     9.425833
433    24.000000
Name: depart_float, Length: 434, dtype: float64
2
Index(['day_of_week', 'weekend_flag', 'depart_p1', 'depart_p2', 'depart_p3'], dtype='object')
5
0      16.017116
1       6.174167
2       7.948056
3      19.007569
4      11.058333
         ...
294     5.545866
295     9.120394
296    13.243917
297     6.311245
298     7.786509
Name: depart_float, Length: 299, dtype: float64
3
Index(['day_of_week', 'weekend_flag', 'depart_p1', 'depart_p2', 'depart_p3'], dtype='object')
5
0      17.884625
1      12.002403
2       8.950866
3      10.461139
4      10.976847
         ...
412    13.254444
413     5.775000
414     7.464444
415    15.018611
416    24.000000
Name: depart_float, Length: 417, dtype: float64
qrf_mob
----------------------START--------------------------
1
Index(['day_of_week', 'realentro_3dayavr', 'radgyr_3dayavr',
       'avrjumplen_3dayavr', 'top10locfre_3dayavr', 'weekend_flag',
       'depart_p1', 'depart_p2', 'depart_p3'],
      dtype='object')
9
0       9.783056
1       7.369727
2       7.314597
3      19.645551
4      24.000000
         ...
429     9.178611
430     9.259167
431     8.375833
432     9.425833
433    24.000000
Name: depart_float, Length: 434, dtype: float64
2
Index(['day_of_week', 'realentro_3dayavr', 'radgyr_3dayavr',
       'avrjumplen_3dayavr', 'top10locfre_3dayavr', 'weekend_flag',
       'depart_p1', 'depart_p2', 'depart_p3'],
      dtype='object')
9
0      16.017116
1       6.174167
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4      11.058333
         ...
294     5.545866
295     9.120394
296    13.243917
297     6.311245
298     7.786509
Name: depart_float, Length: 299, dtype: float64
3
Index(['day_of_week', 'realentro_3dayavr', 'radgyr_3dayavr',
       'avrjumplen_3dayavr', 'top10locfre_3dayavr', 'weekend_flag',
       'depart_p1', 'depart_p2', 'depart_p3'],
      dtype='object')
9
0      17.884625
```

```
1      12.002403
2       8.950866
3      10.461139
4      10.976847
         ...
412    13.254444
413     5.775000
414     7.464444
415    15.018611
416    24.000000
Name: depart_float, Length: 417, dtype: float64
qrf
---------------------START--------------------------
1
Index(['day_of_week', 'weekend_flag', 'depart_p1', 'depart_p2', 'depart_p3'], dtype='object')
5
0       9.783056
1       7.369727
2       7.314597
3      19.645551
4      24.000000
         ...
429     9.178611
430     9.259167
431     8.375833
432     9.425833
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Name: depart_float, Length: 434, dtype: float64
2
Index(['day_of_week', 'weekend_flag', 'depart_p1', 'depart_p2', 'depart_p3'], dtype='object')
5
0      16.017116
1       6.174167
2       7.948056
3      19.007569
4      11.058333
         ...
294     5.545866
295     9.120394
296    13.243917
297     6.311245
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Name: depart_float, Length: 299, dtype: float64
3
Index(['day_of_week', 'weekend_flag', 'depart_p1', 'depart_p2', 'depart_p3'], dtype='object')
5
0      17.884625
1      12.002403
2       8.950866
3      10.461139
4      10.976847
         ...
412    13.254444
413     5.775000
414     7.464444
415    15.018611
416    24.000000
Name: depart_float, Length: 417, dtype: float64
gbqr_mob
---------------------START--------------------------
1
Index(['day_of_week', 'realentro_3dayavr', 'radgyr_3dayavr',
       'avrjumplen_3dayavr', 'top10locfre_3dayavr', 'weekend_flag',
       'depart_p1', 'depart_p2', 'depart_p3'],
      dtype='object')
9
0       9.783056
1       7.369727
2       7.314597
3      19.645551
4      24.000000
         ...
429     9.178611
430     9.259167
431     8.375833
432     9.425833
433    24.000000
Name: depart_float, Length: 434, dtype: float64
2
Index(['day_of_week', 'realentro_3dayavr', 'radgyr_3dayavr',
       'avrjumplen_3dayavr', 'top10locfre_3dayavr', 'weekend_flag',
       'depart_p1', 'depart_p2', 'depart_p3'],
      dtype='object')
9
0      16.017116
1       6.174167
```

```
2       7.948056
3      19.007569
4      11.058333
         ...
294     5.545866
295     9.120394
296    13.243917
297     6.311245
298     7.786509
Name: depart_float, Length: 299, dtype: float64
3
Index(['day_of_week', 'realentro_3dayavr', 'radgyr_3dayavr',
       'avrjumplen_3dayavr', 'top10locfre_3dayavr', 'weekend_flag',
       'depart_p1', 'depart_p2', 'depart_p3'],
      dtype='object')
9
0      17.884625
1      12.002403
2       8.950866
3      10.461139
4      10.976847
         ...
412    13.254444
413     5.775000
414     7.464444
415    15.018611
416    24.000000
Name: depart_float, Length: 417, dtype: float64
gbqr
----------------------START--------------------------
1
Index(['day_of_week', 'weekend_flag', 'depart_p1', 'depart_p2', 'depart_p3'], dtype='object')
5
0       9.783056
1       7.369727
2       7.314597
3      19.645551
4      24.000000
         ...
429     9.178611
430     9.259167
431     8.375833
432     9.425833
433    24.000000
Name: depart_float, Length: 434, dtype: float64
2
Index(['day_of_week', 'weekend_flag', 'depart_p1', 'depart_p2', 'depart_p3'], dtype='object')
5
0      16.017116
1       6.174167
2       7.948056
3      19.007569
4      11.058333
         ...
294     5.545866
295     9.120394
296    13.243917
297     6.311245
298     7.786509
Name: depart_float, Length: 299, dtype: float64
3
Index(['day_of_week', 'weekend_flag', 'depart_p1', 'depart_p2', 'depart_p3'], dtype='object')
5
0      17.884625
1      12.002403
2       8.950866
3      10.461139
4      10.976847
         ...
412    13.254444
413     5.775000
414     7.464444
415    15.018611
416    24.000000
Name: depart_float, Length: 417, dtype: float64
arrival
lqr_mob
----------------------START--------------------------
1
Index(['day_of_week', 'realentro_3dayavr', 'radgyr_3dayavr',
       'avrjumplen_3dayavr', 'top10locfre_3dayavr', 'weekend_flag',
       'arrival_p1', 'arrival_p2', 'arrival_p3'],
      dtype='object')
9
0      21.534167
1      20.613662
```

```
2      19.645551
3      22.909903
4      17.603444
         ...
425    17.302222
426    15.350556
427    16.310278
428    19.896944
429    16.257222
Name: arrival_float, Length: 430, dtype: float64
2
Index(['day_of_week', 'realentro_3dayavr', 'radgyr_3dayavr',
       'avrjumplen_3dayavr', 'top10locfre_3dayavr', 'weekend_flag',
       'arrival_p1', 'arrival_p2', 'arrival_p3'],
      dtype='object')
9
0      20.383056
1      20.369324
2      18.187500
3      16.514787
4      21.167375
         ...
250    16.617315
251    19.556801
252    16.581560
253    21.173500
254    20.691764
Name: arrival_float, Length: 255, dtype: float64
3
Index(['day_of_week', 'realentro_3dayavr', 'radgyr_3dayavr',
       'avrjumplen_3dayavr', 'top10locfre_3dayavr', 'weekend_flag',
       'arrival_p1', 'arrival_p2', 'arrival_p3'],
      dtype='object')
9
0      22.384718
1      22.006981
2      20.128889
3      17.662208
4      22.668546
         ...
378    21.835278
379    18.335833
380    17.041667
381    20.232778
382    20.276111
Name: arrival_float, Length: 383, dtype: float64
lqr
--------------------START-------------------------
1
Index(['day_of_week', 'weekend_flag', 'arrival_p1', 'arrival_p2',
       'arrival_p3'],
      dtype='object')
5
0      21.534167
1      20.613662
2      19.645551
3      22.909903
4      17.603444
         ...
425    17.302222
426    15.350556
427    16.310278
428    19.896944
429    16.257222
Name: arrival_float, Length: 430, dtype: float64
2
Index(['day_of_week', 'weekend_flag', 'arrival_p1', 'arrival_p2',
       'arrival_p3'],
      dtype='object')
5
0      20.383056
1      20.369324
2      18.187500
3      16.514787
4      21.167375
         ...
250    16.617315
251    19.556801
252    16.581560
253    21.173500
254    20.691764
Name: arrival_float, Length: 255, dtype: float64
3
Index(['day_of_week', 'weekend_flag', 'arrival_p1', 'arrival_p2',
       'arrival_p3'],
      dtype='object')
```

```
5
0      22.384718
1      22.006981
2      20.128889
3      17.662208
4      22.668546
         ...
378    21.835278
379    18.335833
380    17.041667
381    20.232778
382    20.276111
Name: arrival_float, Length: 383, dtype: float64
qrf_mob
---------------------START--------------------------
1
Index(['day_of_week', 'realentro_3dayavr', 'radgyr_3dayavr',
       'avrjumplen_3dayavr', 'top10locfre_3dayavr', 'weekend_flag',
       'arrival_p1', 'arrival_p2', 'arrival_p3'],
      dtype='object')
9
0      21.534167
1      20.613662
2      19.645551
3      22.909903
4      17.603444
         ...
425    17.302222
426    15.350556
427    16.310278
428    19.896944
429    16.257222
Name: arrival_float, Length: 430, dtype: float64
2
Index(['day_of_week', 'realentro_3dayavr', 'radgyr_3dayavr',
       'avrjumplen_3dayavr', 'top10locfre_3dayavr', 'weekend_flag',
       'arrival_p1', 'arrival_p2', 'arrival_p3'],
      dtype='object')
9
0      20.383056
1      20.369324
2      18.187500
3      16.514787
4      21.167375
         ...
250    16.617315
251    19.556801
252    16.581560
253    21.173500
254    20.691764
Name: arrival_float, Length: 255, dtype: float64
3
Index(['day_of_week', 'realentro_3dayavr', 'radgyr_3dayavr',
       'avrjumplen_3dayavr', 'top10locfre_3dayavr', 'weekend_flag',
       'arrival_p1', 'arrival_p2', 'arrival_p3'],
      dtype='object')
9
0      22.384718
1      22.006981
2      20.128889
3      17.662208
4      22.668546
         ...
378    21.835278
379    18.335833
380    17.041667
381    20.232778
382    20.276111
Name: arrival_float, Length: 383, dtype: float64
qrf
---------------------START--------------------------
1
Index(['day_of_week', 'weekend_flag', 'arrival_p1', 'arrival_p2',
       'arrival_p3'],
      dtype='object')
5
0      21.534167
1      20.613662
2      19.645551
3      22.909903
4      17.603444
         ...
425    17.302222
426    15.350556
427    16.310278
428    19.896944
```

```
429    16.257222
Name: arrival_float, Length: 430, dtype: float64
2
Index(['day_of_week', 'weekend_flag', 'arrival_p1', 'arrival_p2',
       'arrival_p3'],
      dtype='object')
5
0      20.383056
1      20.369324
2      18.187500
3      16.514787
4      21.167375
         ...
250    16.617315
251    19.556801
252    16.581560
253    21.173500
254    20.691764
Name: arrival_float, Length: 255, dtype: float64
3
Index(['day_of_week', 'weekend_flag', 'arrival_p1', 'arrival_p2',
       'arrival_p3'],
      dtype='object')
5
0      22.384718
1      22.006981
2      20.128889
3      17.662208
4      22.668546
         ...
378    21.835278
379    18.335833
380    17.041667
381    20.232778
382    20.276111
Name: arrival_float, Length: 383, dtype: float64
gbqr_mob
----------------------START--------------------------
1
Index(['day_of_week', 'realentro_3dayavr', 'radgyr_3dayavr',
       'avrjumplen_3dayavr', 'top10locfre_3dayavr', 'weekend_flag',
       'arrival_p1', 'arrival_p2', 'arrival_p3'],
      dtype='object')
9
0      21.534167
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3      22.909903
4      17.603444
         ...
425    17.302222
426    15.350556
427    16.310278
428    19.896944
429    16.257222
Name: arrival_float, Length: 430, dtype: float64
2
Index(['day_of_week', 'realentro_3dayavr', 'radgyr_3dayavr',
       'avrjumplen_3dayavr', 'top10locfre_3dayavr', 'weekend_flag',
       'arrival_p1', 'arrival_p2', 'arrival_p3'],
      dtype='object')
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2      18.187500
3      16.514787
4      21.167375
         ...
250    16.617315
251    19.556801
252    16.581560
253    21.173500
254    20.691764
Name: arrival_float, Length: 255, dtype: float64
3
Index(['day_of_week', 'realentro_3dayavr', 'radgyr_3dayavr',
       'avrjumplen_3dayavr', 'top10locfre_3dayavr', 'weekend_flag',
       'arrival_p1', 'arrival_p2', 'arrival_p3'],
      dtype='object')
9
0      22.384718
1      22.006981
2      20.128889
3      17.662208
4      22.668546
         ...
```

```
378    21.835278
379    18.335833
380    17.041667
381    20.232778
382    20.276111
Name: arrival_float, Length: 383, dtype: float64
gbqr
--------------------START-------------------------
1
Index(['day_of_week', 'weekend_flag', 'arrival_p1', 'arrival_p2',
       'arrival_p3'],
      dtype='object')
5
0      21.534167
1      20.613662
2      19.645551
3      22.909903
4      17.603444
         ...
425    17.302222
426    15.350556
427    16.310278
428    19.896944
429    16.257222
Name: arrival_float, Length: 430, dtype: float64
2
Index(['day_of_week', 'weekend_flag', 'arrival_p1', 'arrival_p2',
       'arrival_p3'],
      dtype='object')
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2      18.187500
3      16.514787
4      21.167375
         ...
250    16.617315
251    19.556801
252    16.581560
253    21.173500
254    20.691764
Name: arrival_float, Length: 255, dtype: float64
3
Index(['day_of_week', 'weekend_flag', 'arrival_p1', 'arrival_p2',
       'arrival_p3'],
      dtype='object')
5
0      22.384718
1      22.006981
2      20.128889
3      17.662208
4      22.668546
         ...
378    21.835278
379    18.335833
380    17.041667
381    20.232778
382    20.276111
Name: arrival_float, Length: 383, dtype: float64

[Skipeed intermediate results to aavoid a lengthy list of printed dates...]

##REPRODUCTION CHECK##: Simulate uncontrolled charging as baseline
1
-------------START-----------------
2
-------------START-----------------
3
-------------START-----------------
##REPRODUCTION CHECK##: Evaluate unidirectional smart charging compared with baseline
Model type: qrf_mob
Quantile prediction of soc: 0.5
------------------------------
------------------------------
Model type: qrf_mob
Quantile prediction of soc: 0.55
------------------------------
------------------------------
Model type: qrf_mob
Quantile prediction of soc: 0.6
------------------------------
------------------------------
Model type: qrf_mob
Quantile prediction of soc: 0.65
------------------------------
------------------------------
```

```
Model type: qrf_mob
Quantile prediction of soc: 0.7
------------------------------
------------------------------
Model type: qrf_mob
Quantile prediction of soc: 0.75
------------------------------
------------------------------
Model type: qrf_mob
Quantile prediction of soc: 0.8
------------------------------
------------------------------
Model type: qrf_mob
Quantile prediction of soc: 0.85
------------------------------
------------------------------
Model type: qrf_mob
Quantile prediction of soc: 0.9
------------------------------
------------------------------
Model type: qrf_mob
Quantile prediction of soc: 0.95
------------------------------
------------------------------
qrf_mob_soc0.5
On-peak hours [12, 13, 19, 20, 21, 22]
Traceback (most recent call last):
  File "code/main.py", line 309, in <module>
    base_uni.evaluate_peakshaving_way2(model_type, mob_flags, soc_quan_list, LOADPROFILE_PATH, BASELINE_PATH, UNISMARTCHARGE_PATH, RESULT_PATH
  File "/home/cgranell/code/agile2022-010/code/compare_baseline_unismart.py", line 379, in evaluate_peakshaving_way2
    base_max_time = base_load_hour.index[base_load_hour['load'] == base_max_load].values[0]
IndexError: index 0 is out of bounds for axis 0 with size 0
```

The exception raised appears to be related to an error in the contained data in one of the synthetic data files.