Joint Control of Bidirectional Electric Vehicle Charging and Home Energy Scheduling Using Reinforcement Learning

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1 Introduction

Electric vehicles (EVs) that allow bidirectional charging can be used as batteries in smart homes to store energy e.g. from photovoltaic (PV) systems and used later on. When consuming mentioned energy it has to be in such a way that the users requirements on the use of the EV are still satisfied. Therefore this project tries to find a control strategy using reinforcement learning that jointly controls the charging / discharging of the EV and the home energy systems.

2 Objectives and Goals

The goal of this thesis is to learn a control strategy using model-free reinforcement learning from past data and implement it in a real-world application at Empa.

2.1 Base Problem

Control of EV charging and heating considering energy from PV. The driving patterns of the EV are assumed to be known at least a few hours ahead.

2.2 Extended Problem

Same setup as in the base problem, but adding air conditioning and natural ventilation as control objectives. Use weather forecasts to improve control strategy.

Optional: Analyze impact of larger number of EVs. Use real-time electricity prices with forecast model.

3 Methods of Investigation / Implementation

As a reinforcement learning algorithm, fitted Q-iteration will be used as is done e.g. in [Rue+17; CLK15; SDD19; Van+15]. The authors of [Rue+17] even extend it to take into account predictions of future state information. The implementation will be done in python.

4 Background / Prior Work

Blah blah, papers.

5 Timetable and Milestones

5.1 Task 1

Finalize the scope of control problem, i.e. build the final list of inputs (measurements, information signals, past data) and outputs (P/Q charging/discharging profiles at Empa side) and come up with a ML-based control strategy.

5.2 Task 2

Building prediction models for the measurements of interest and doing dimension reduction. Get results from past measurement and / or simulated data.

5.3 Task 3

Implementing the control strategy at Empa.

5.4 Task 4

Test implementation and analyze results.

5.5 Task 5

Finalize report and presentation.

References

[CLK15] A. Chiş, J. Lundén, and V. Koivunen. "Optimization of plug-in electric vehicle charging with forecasted price". In: *2015 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*. 2015, pp. 2086–2089. DOI: `10.1109/ICASSP.2015.7178338`.

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