Obtaining spatial charging demand from road transport and analysing the resulting charging infrastructure need using ev contrib

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1 Short introduction

Two separate Swedish research projects, focusing on addressing the unknowns regarding placement of public charging infrastructure, are ongoing at the Division of Industrial Electrical Engineering and Automation (IEA) in Lund, Sweden. Both projects are using MATSim, more specifically the ev contrib, as their simulation toolbox.

2 Contributions to `matsim-libs`

With the assistance of the Department of Transport Systems Planning and Transport Telematics at TU Berlin, ideas formed at IEA have been implemented and merged with MATSim. Several Pull Requests (PRs) regarding tracking the State of Charge (SoC) of electric vehicles (EVs) during the mobsim were created as a result of these ideas.

Missing energy events

Firstly, the MissingEnergyEvent (MEE) was created to signal when an EV's battery runs out of energy. This event is triggered if, during the energy discharge from traversing a link, the energy of the EV's battery energy is negative. At first, this event would throw an exception but in the application of IEA research, the knowledge of where vehicles run out of energy is still of interest (PR #2316). Adding an EventHandler (PR #2388) made it possible for us at IEA to make use of these events.

Energy consumption events

The purpose of employing the MEEs is twofold. Firstly, it aimed to analyse the frequency of successful trips, i.e. trips where agents never triggers an MEE. Secondly, it aimed to gather information regarding the necessity of charging infrastructure location. Fast-charging infrastrucutre placement for EVs' long-distance trips based on the MEEs results in some agents never reaching their intended charging position. The introduction of DrivingEnergyConsumptionEvent (PR #2483) which is emitted after a vehicle has traversed a link. It makes tracking EVs' SoC at the end of each link or network node possible. By logging the locations at which individual vehicles reach predetermined SoC limits, charging infrastructure can be introduced with a SoC limit safety margin.

3 Possible contributions (not yet introduced to matsim-libs)

To make use of the implemented functionality, several post-processing additions have been implemented as well. These additions focus on making it convenient to visualise the main areas of interest for charging infrastructure evaluation. Depending on interest, these could be made open-access.

Logging and penalty event handler

The functionality introduced facilitated the development of event handlers to spatially log and penalise events related to SoC levels. The output files are in txt-format and can be added to any Geographical Information System (GIS) software with ease.

Range calculator

An event handler calculating the distance travelled, for each agent having emitted a MissingEnergyEvent, for each agent has been created. The handler can be used in a model with no charging infrastructure, in which EVs are allowed to travel longer than their estimated range, the EVs estimated energy consumption models can be evaluated.

No energy transfer charging events

A way to evaluate the charging infrastructure is to investigate the queuing. In the event of lengthy queuing, and since the time set for the charging event is calculated in the EvNetworkRoutingModule and before mobsim, it's possible for an agent to spend all its charging station interaction queuing. This can be evaluated by logging the event of no energy transferred between the ChargingStartEvent and the ChargingEndEvent.

Charging stations statistics

A PR (# 2612) opened by IEA focuses on creating time series curves of the power transferred from each charging station in the charger file. This PR is expected to be finished soon.

4 Future work

The main problems that need to be solved are to open up the routing module. Right now, allocation of charging activities based on the assumed energy consumption, it would for instance be relevant to instead plan the route based on a wanted end SoC. Also in the routing module, an estimation of the duration of the charging activity is calculated. This estimation could be improved by using the actual charging curve. An even better solution, given how EV users behave in reality, would be to add the possibility to abort the charging event at an appropriate SoC level.

The research will also introduce scenarios related to other types of charging infrastructure to be able to compare the differences in needs for different technologies. A first step to introduce electric roads has been taken.