Models and algorithms for efficient electromobility
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Challenges and opportunities for electromobility

**Challenges**
- Batteries are the limiting factor for a large scale launch of electromobility because of its weight and price
- Electric vehicles (EVs) have a limited cruising range and long recharge times
- Strong peak loads occur in the power grid if a huge amount of EVs is simultaneously recharging

**Opportunities**
- Battery of EVs are only moved for around 5% of the day and can be used the remaining time to balance the power grid
- Buffering offers income opportunity for battery owner
- Car batteries can substitute expensive energy storage facilities

Research plan

- Determine the required amount of energy for given routes
- Minimize mobility risk by using models for the car usage
- Develop schedulers to optimize charging of the EVs
- Modeling of a fleet of EVs as competing agents
- Implementation of a simulation framework
- Evaluation with real world data from the eE-Tour Allgäu project

Progress up to date

- Energetic vehicle model
- Construction of an energy graph
- Graph theoretic framework for EV routing
- Heuristic for A* with negative edges

From the road network to the energy graph

The energy graph represents for each road section its estimated energy consumption. The calculation considers road network, altitude values, the battery and the vehicle model.

The left graph represents a junction in a road network, followed by its topological expansion and finally the energy graph. The expansion is necessary to account for different velocities and consequently different kinetic energy values of predecessors of a node.

Routing with energy constraints

The energy graph has special a ability due to the law of conservation of energy and the underlying road network (A* heuristics)

Simulink simulation framework for the charging strategy

Fully charged battery:
Route $s \rightarrow x \rightarrow t$: costs 1
Route $s \rightarrow y \rightarrow t$: costs 2