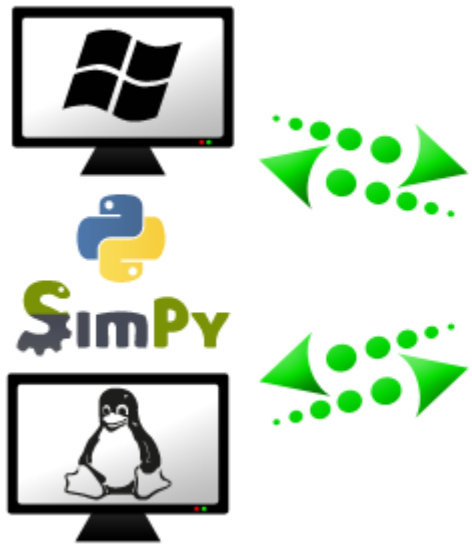


ETOS

EVENT BASED SIMULATION SYSTEM

Powered by python3 and SimPy

Mgr. Jiří Fišer, Ph.D.

Pavel Hronek

Josef Šenfeld

Jiří Škvára

Presentation outline

- SimPy
  - Pros
  - cons
- ETOS
  - Description
  - Basic Objects
- Sample model
  - Actor, transaction
  - Expected results
  - Sub-models
- Results

SimPy simulation language

- Object-oriented , process-based discrete event simulation language for Python
- Written in Python
- Latest Release is 2.3
- Comes with data collection capabilities, GUI and plotting packages

SimPy: pros and cons

- Pros
  - Natural model based on coroutines
  - Support of basic simulation objects and mechanisms
  - Plenty of Python libraries
- Cons
  - Behaviour of simulated object is modeled by single coroutine
  - Complicated declarative parametrization of models

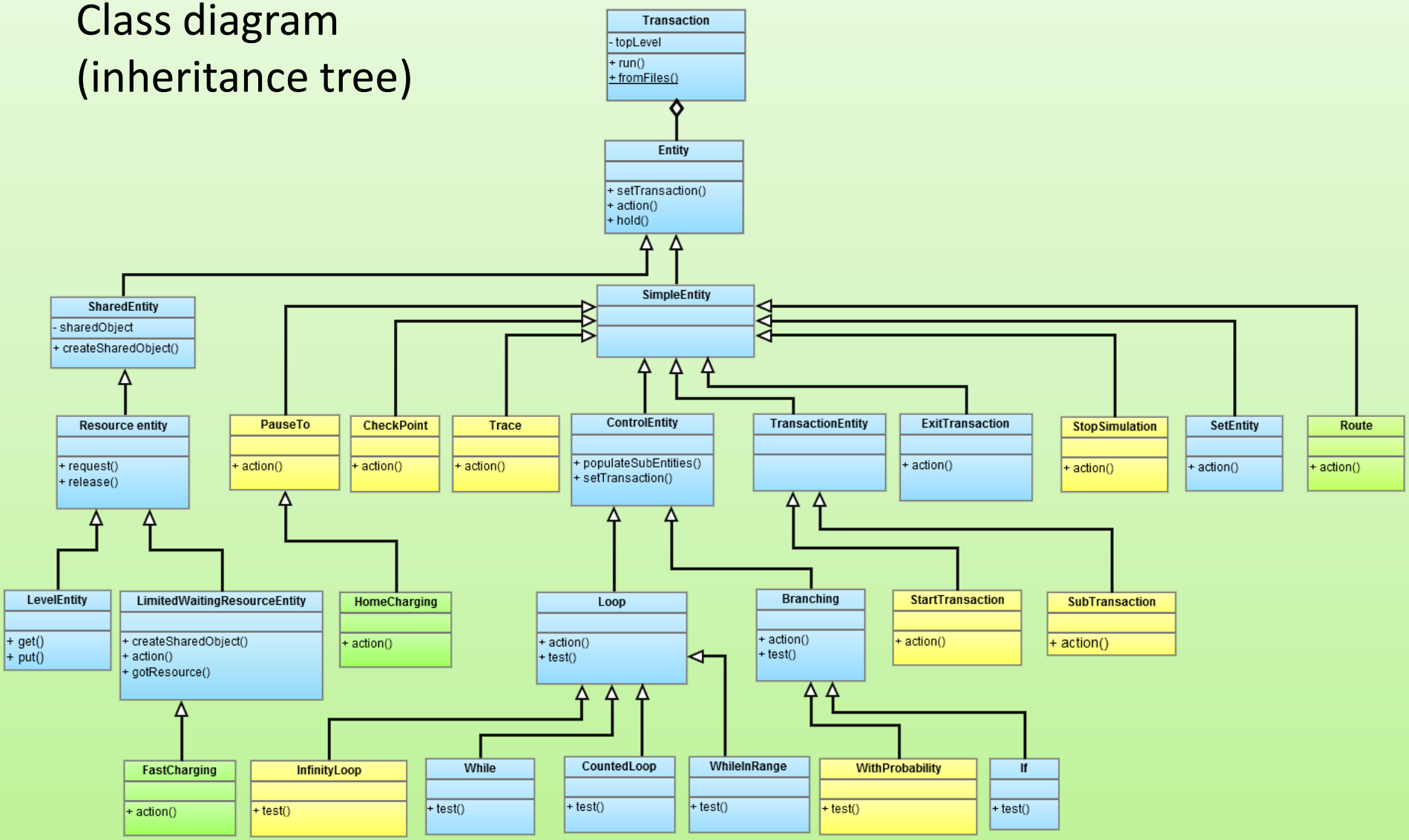
ETOS description

- Declarative extension of SimPy
- Models based on mixture of procedural and declarative code
- Procedural
  - Elementary actions
  - Data processing
- Declarative
  - Flow of elementary actions and their parameters,logging, statistics, XML representation

ETOS main objects

- **E**ntity
  - Basic actions and its states
- **T**ransaction
  - Defined processes
- Shared **O**bjects
  - Shared resources
- Actors
  - Active objects
- **S**imulations
  - Defines simulation time, collects data

Class diagram (inheritance tree)



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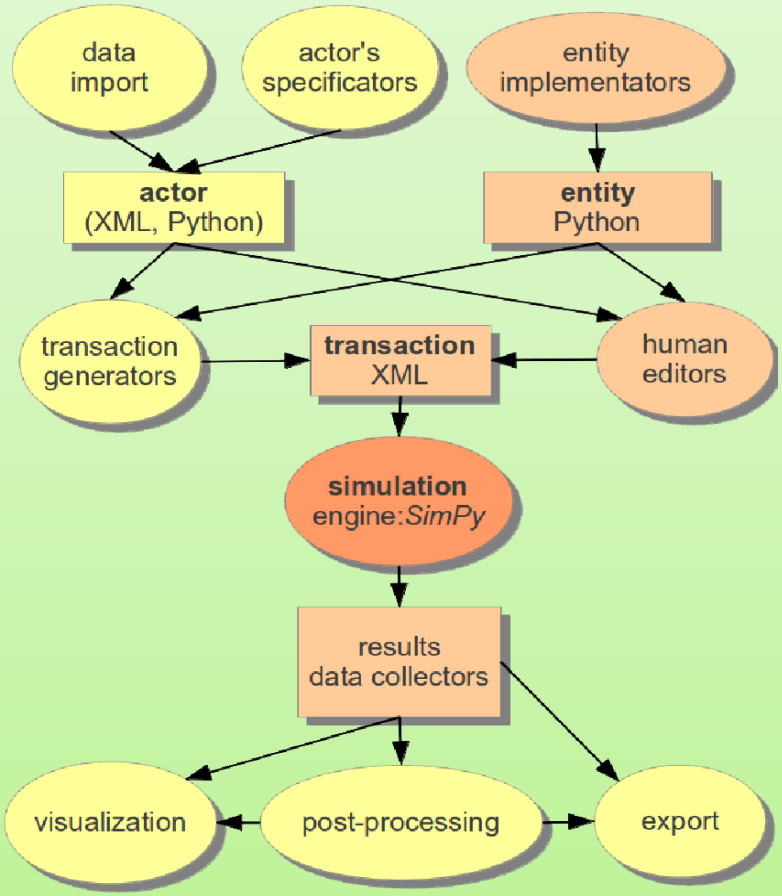
Mail goal of ETOS project

- Separations of roles during design and implementation of simulation model



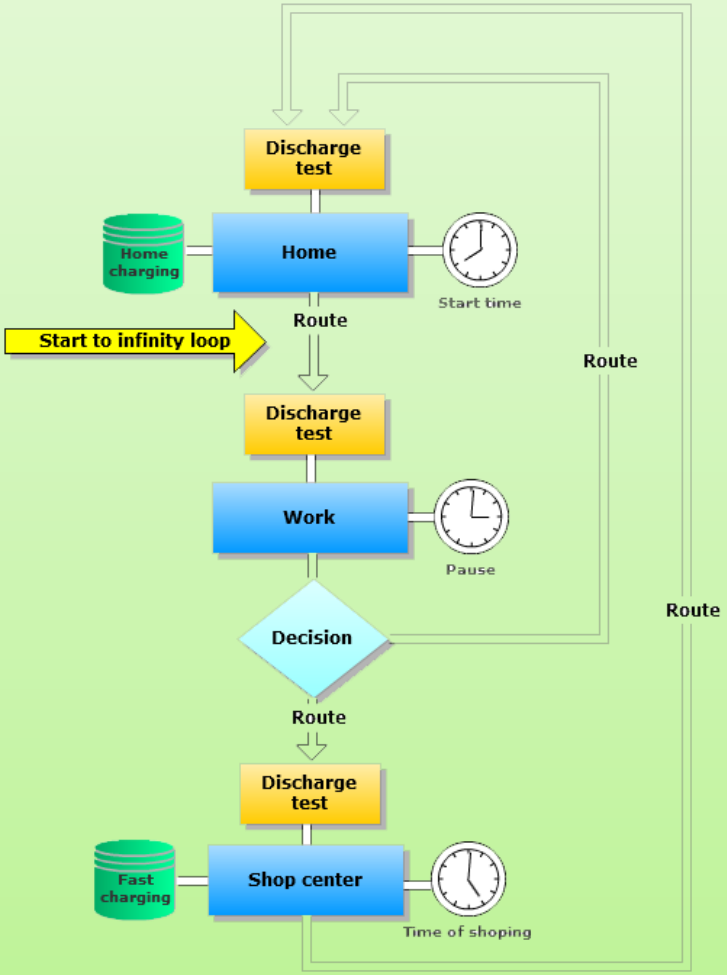
Innovative contributions

- Context model
  - Configurable context
- Subtransactions
  - Independent SimPy processes
- Data collectors
  - Collectors with support for counting, basic statistics and logging

Sample model

- Actor
  - E-car (battery powered)
- Transaction
  - Daily route from home to work and back
  - Sometimes includes route to shopping center
  - Two types of charging (slow,fast)
- Expected results
  - Frequence of out-of-battery events
  - Fast / Slow charging ratio
  - Utilization of fast charging stations
  - Etc.

Transaction



Transaction entities

HomeCharging
→ current (A)
→ voltage (V)
→ time of morning departure
← charged energy (kWh)

FastCharging (in shop center)
→ current (A)
→ voltage (V)
→ time of shopping
→ number of charging station
→ maximal waiting
← charged energy (kWh)

Work (Pause)
→ duration

Route
→ distance (km)
→ velocity (km/h)

Discharge test
(included in route entity)
→ limit (minimal threshold)
→ delay
← out of battery event

Decision
→ probability of shopping

Actor = E-car
– capacity (of battery) (kWh)
– actual energy
– energy consumption (kWh/km)
– out of battery event (within day)

Submodels

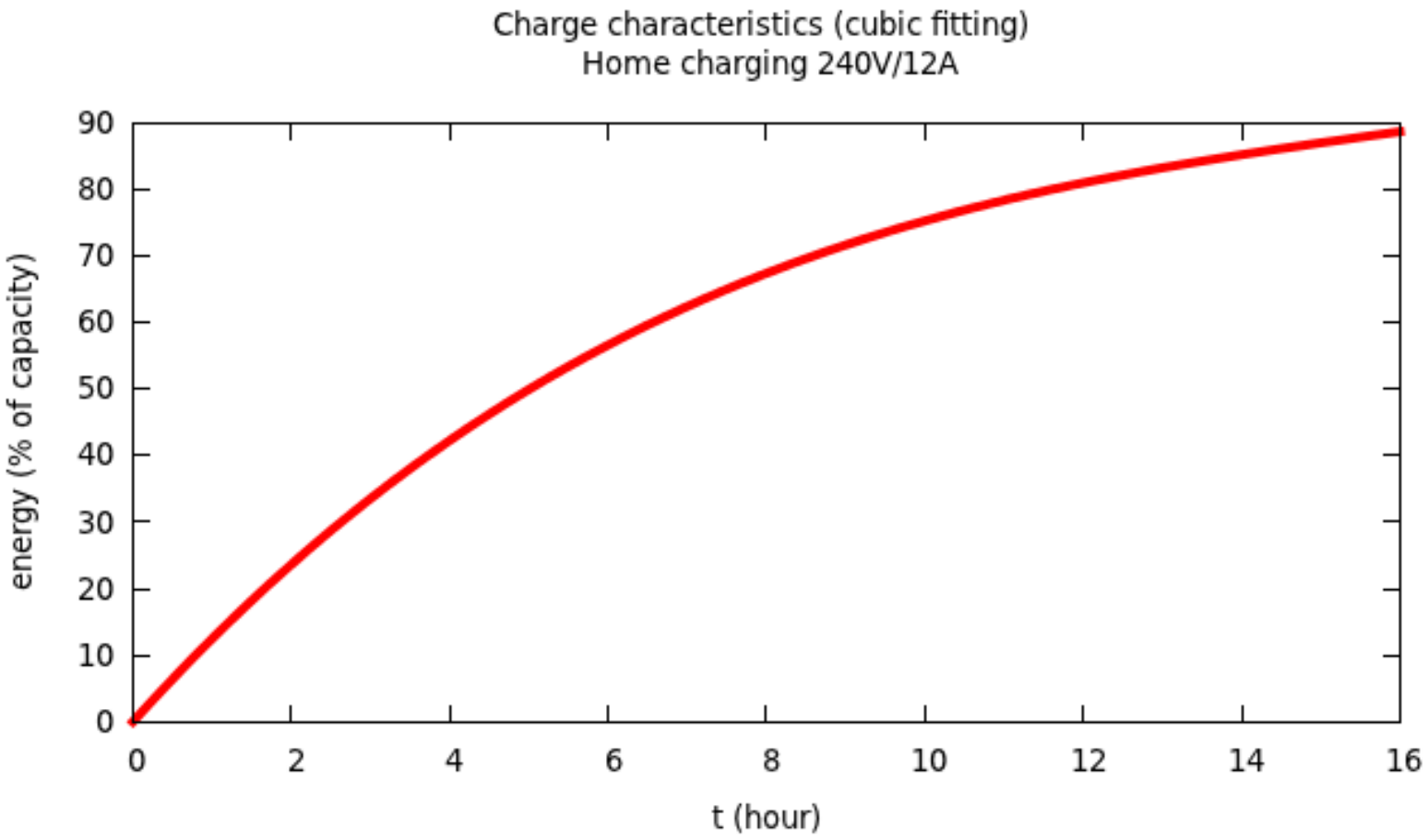
- E-car
  - Battery capacity and fixed consumption per km
- Charging
  - More sophisticated model
  - CC - constant charging current
  - CV - current gradually declines
- Out-of-battery events
  - Energy levels drops below the limit

Škoda Octavia Green-E-Line

Batteries specification

- Technology
  - Li-Ion
  - Cylindrical cells
- Electrical parameters
  - Energy 26kWh (324V x 80Ah)
  - Nominal Voltage 324V
  - Discharge Current 400A peak / 200A cont.
  - Capacity 80Ah
- Mechanical parameters
  - Weight 315kg
  - Volume 250l

Charge characteristics



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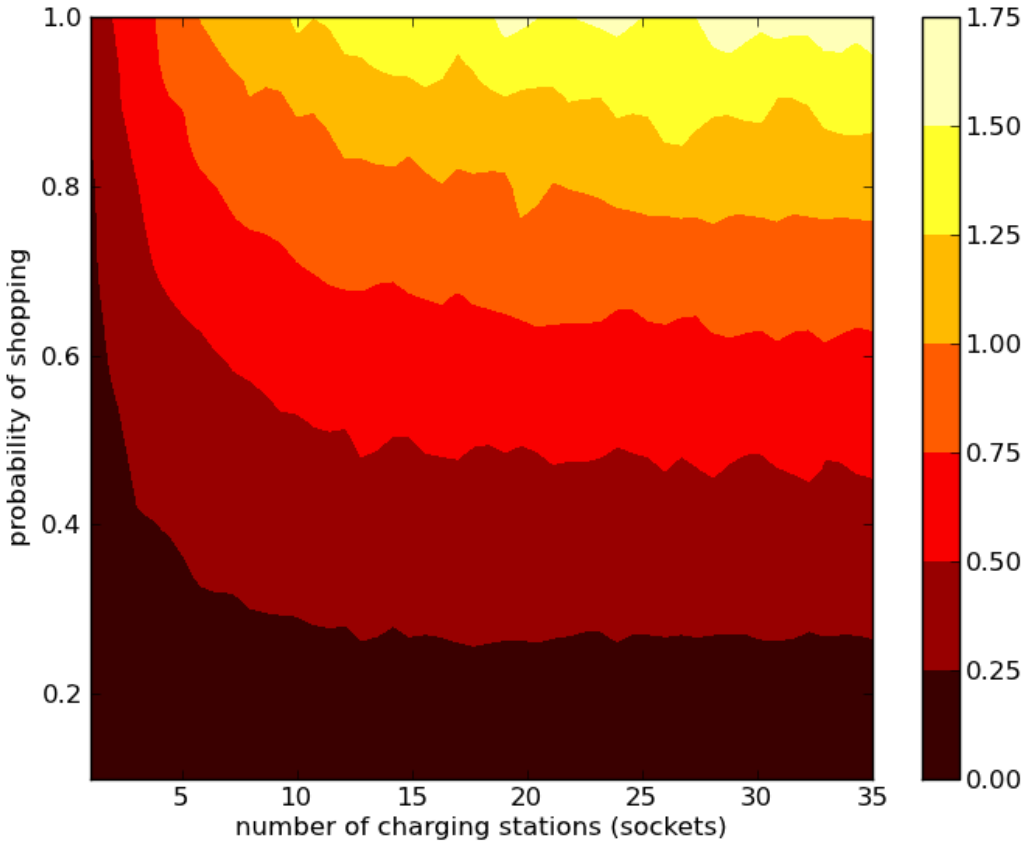
Model parameters

- Fixed parameters
  - Car count = 150
  - Traffic days simulated = 20
  - Simulations count = 500
  - Total e-car*days = 1 500 000
- Variable parameters
  - Ammount of stations in range of 1 to 50
  - Propability of shopping center visit

XML model (fragment)

```
<infinity_loop>
  <transaction>
    <set property="a.batteryOutEvent">
      <value>
        0.0
      </value>
    </set>
    <route id="City">
      <distance context="transaction">
        <pnormal mu="20" sigma="5"/>
      </distance>
    </route>
    <pause>
      <duration>
        8:30:00
      </duration>
    </pause>
```

Fast to home charging ratio



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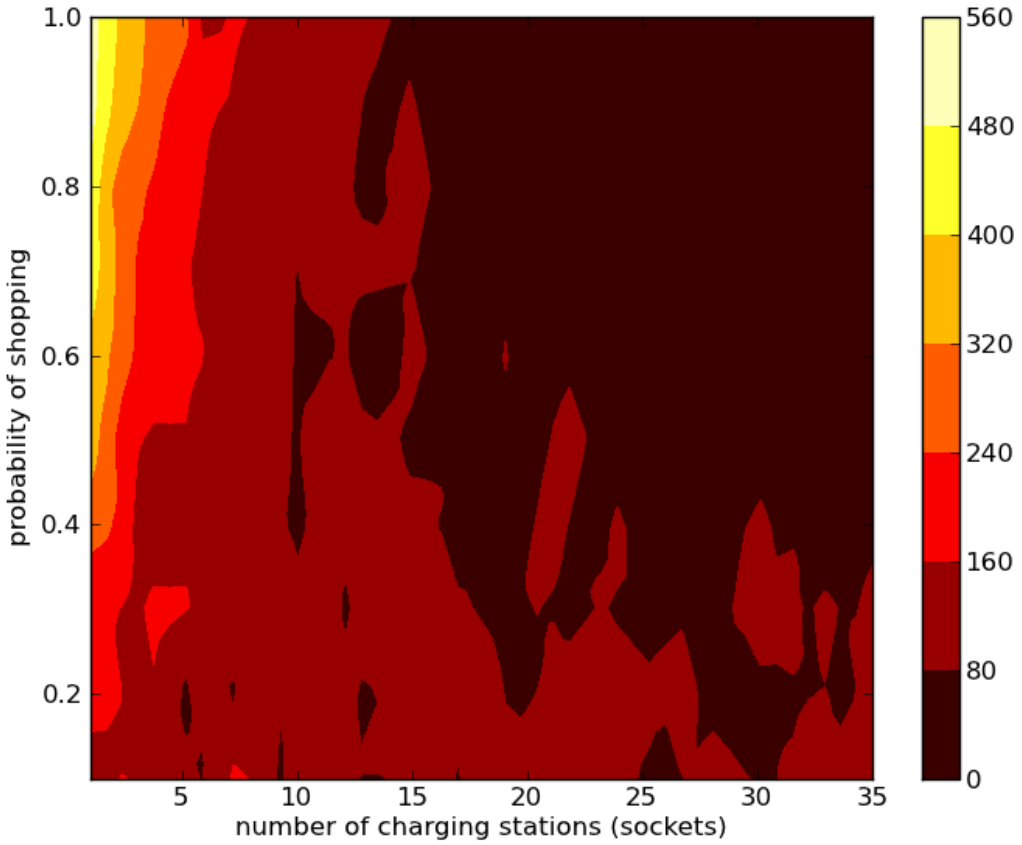
Out-of-battery events



Sources

- SimPy homesite: http://simpy.sourceforge.net/
- Our project subversion repository: http://code.google.com/p/etos/
- Skoda Octavia specification sheet: http://k616.fd.cvut.cz/vyuka/mgr/16PDP/prednasky/07c_Skoda_Octavia_Green_e_line_Jez_120418.pdf