WeBike
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What?

- A fleet of 31 instrumented eBikes on campus
Who uses them?

- UW faculty, staff, and students
  - Trustworthy
  - Are willing to have usage measured

- Selected using a comprehensive survey
  - based on brain/behaviour models
  - designed by Prof. Tobias Schroeder, U. Potsdam
Why?

- Scaled down, cheaper version of EVs
- With solar charging, is a cost-effective off-grid transportation solution
- Urban transport alternative
- Cool!
When?

- **Started** deployment in July 2014
  - fully deployed in August 2014
  - data collection issues sorted out in mid-October 2014
  - clean data from all 30 bikes since November 7, 2014

- **3-year** duration
  - Bikes handed off to users at the end of study
Sensors

- Galaxy S III (Android)
  - Time
  - GPS location
  - Light (in lumens) for theft
  - Accelerometers

- Voltage
  - to infer battery state of charge

- Charging current

- Temperature sensors
  - inside sensor box
  - inside battery
Sensors

- Temperature sensor inside battery casing
- Sensor enclosure
- Current sensor
- Voltage sensor
- Phidget I/O board
- Samsung galaxy
Software system

- eBike & Hardware
  - Sensors
    - 1 hz
    - 1 hour of data
      - Compression
      - Encrypted SSH Tunnel
      - Server

- Analysis
  - DB
    - Decompression & storage scripts

- wifi
<table>
<thead>
<tr>
<th>Feature</th>
<th>Input/Date</th>
<th>Generate</th>
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<tbody>
<tr>
<td>Trips On Day</td>
<td>mm/dd/yy</td>
<td></td>
</tr>
<tr>
<td>Biking Per Day</td>
<td>mm/dd/yy</td>
<td></td>
</tr>
<tr>
<td>Battery Life on Day</td>
<td>mm/dd/yy</td>
<td></td>
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<tr>
<td>Trip Distribution</td>
<td>mm/dd/yy</td>
<td></td>
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<tr>
<td>Speed On Day</td>
<td>mm/dd/yy</td>
<td></td>
</tr>
<tr>
<td>Google Maps</td>
<td>mm/dd/yy: 09/25/14</td>
<td></td>
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</tbody>
</table>

Bottom: Map showing various locations.
Results
Sentiment analysis
Sentiment analysis
Data availability

End cap changed
KM per day

km traveled per day per eBike

cumulative km traveled

date
Trip lengths

trip length distribution

number of trips

distance in km
Range anxiety?
Potential projects

Trip information

- Estimation of remaining travel time
  - depends on the driver aggressiveness, state of charge, terrain, and/or temperature.

- Determining typical driving behaviour
  - as a function of age, gender, and/or social background of the driver
Potential projects

Range anxiety?

- Determine State of Charge (SOC) when people normally start charging

- Determine the frequency of battery depletion and the behaviour of participants in response to this situation.
Potential projects

Parking and charging habits

- Spatial and temporal distribution of parking/charging events.

- Determine “hotspots” for eBikes
  - potential installation of PEVSE (Public electric vehicle supply equipment) at these sites.
Potential projects

**LiON battery properties**

- Estimate charging losses
- Estimate the effects of different drive cycles and different levels of electric assistance on battery life, and range
- Estimate battery life/range depend on temperature
- Estimate the potential for charging EVs using stand-alone PV
- Estimate battery capacity degradation over time
Potential projects

**Human Computer Interaction:**

- Determine the **information to be displayed** (either visually or audibly) for the participants.

- Determine if the information displayed should be
  - health focused (e.g., calories burned),
  - environment focused (e.g., CO2 offset v.s. a car),
  - logistically focused (e.g., traffic conditions or route planning).

- Determine the **frequency** at which displayed information should be refreshed.

- Determine the **effect** of displaying information on user’s behaviour.
Multidisciplinarity

- **Chemical** engineering
  - battery performance with temperature and drive cycle

- **Civil** engineering
  - urban transportation
  - pollution sensing

- **Public health**
  - health benefits
Yet more research problems!

- Batteries to power other things in dev. regions
  - fan, cooler for medicines, cooking, cell phone, tv
- Validate EV adoption model from eBike adoption
- Transfer of power between bikes
  - pooling batteries (P2P energy)
Conclusions

- WeBike is a unique platform
- Up and running, with 1GB of data every 3 days
- We are open to collaboration