‘Big Data’ in Personal Transportation
- for product planning, product design, policy analysis...
- for real-time system management

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Big Data – According to Mike

Masses of Data
- large sample size
- longitudinal

Diversity of Sources

Well Formed Questions
It Helps to Know What You are Looking For

Analyze Abstract Merge

Robust, Actionable Conclusions

- ‘Big’ Data Example: Real-World Vehicle Usage
- ‘Merged’ Data Example: Urban Mobility
Real World Vehicle Usage

For each vehicle:

| List of time-stamped GPS coordinates | List of trips (key-on-to-key-off) | List of trip chains (N hrs., 1-day) | Individual Trip Chain Distance-Frequency Distribution | ITCD Parameters: $\lambda, w, k, \mu, \sigma$ |

Rapid Computation of Decision Variables & Metrics

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Question #1: What is the ‘Optimal’ Range of a BEV or PHEV?

• Earliest work based on ensemble data (NHTS).
  – 80% of travel (90% of trips) electrified by BEV100

• Later work placed $ cost on inconvenience.
  – Lost time to charging
  – Penalty + rental cost of alternative vehicle

• Recent work posits ‘threshold of inconvenience’ where BEV is rejected entirely.
  – Requires individual, longitudinal (‘big’) data

• Combine threshold method with total cost of ownership (TCO).
BEV as 1-for-1 Replacements for ICEV

- Acceptance limited by infrequent, long trips.
- Below 300 miles range, acceptance is more sensitive to tolerance than to range itself!
- Optimal range is ~150 miles ...
- but is unaffordable at realistic battery cost!

8 days/year

6 year payback
Gas: 4 $/gal.
Elect: 0.10 $/kWh
BEV in Two-Vehicle Households
(82% of personal vehicles are in MVHH)

- Household usages are NOT correlated.
- Acceptance is high at only 80 miles range.
- One BEV in a 2VHH can electrify >50% of travel!
- Optimal range is 90-100 miles ... at today’s cost!
- At-home charging only.
- Better value to due better use of battery capacity.
Plug-In HEV

- Zero inconvenience
- Optimal range 40 miles at near-future cost
- 70% acceptance electrifies 50% of travel.
- Best value due to full use of battery capacity.
Question #2: What are benefits of charging away from home?

- PHEV: maximum benefit for PHEV15, diminishes quickly with range.
- BEV: maximum benefit for BEV30, < 4% for BEV100.
- BEV with range large enough to achieve high acceptance does not need at-work/around-town charging. Neither do BEV in MVHH and PHEV!
- Long range BEV need inter-city, ultra-high rate charging only: the Tesla model!
- Is it time to rethink our public charging strategy?
Other Findings & Applications

• Vehicle usage pattern appears to be universal (4 studies so far with more in progress).
  – Single scale factor: labor market population density.
• On-road fuel economy (ORFE) & regional emissions.
  – Cold & hot starts.
  – Fraction of freeway vs. surface street driving (from GPS or inferred from speed trace).
  – Driving style.
  – Climate correction.
• Market segmentation (FE technology take rates).
Thank You

Questions?

“It runs on its conventional gasoline-powered engine until it senses guilt, at which point it switches over to battery power.”