CASE STUDIES ON BUILDING ADVANCED DEMAND MODELS & TRAFFIC SIMULATION MODELS WITH BIG DATA SUPPORT

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AGENDA

- Transography from Caliper
- Advanced travel demand models
- Traffic simulation models
- Strengths of current Big Data sources
- Big Data challenges
- Conclusion
TRANSOGRAPHY FROM CALIPER

- Custom data products derived from
  - Smartphone app (LBS) data
  - Connected vehicle (CV) data

- Origin-Destination (OD) matrices
  - By time-of-day
  - By basic trip purpose
  - For select roadway links
  - For regional visitors

- Anonymized person travel diaries

- Custom metrics for model calibration/validation
ADVANCED TRAVEL DEMAND MODELS

- Activity-based & hybrid models
  - Capture disaggregate decisions/patterns
    - Discrete choice models
  - Have ability to include intra-household effects
  - Allow for nuanced policy evaluations
    - (e.g.) Accessibility impacts by demographics
  - Could generate higher-fidelity demand estimates
    - Better traffic assignments and simulations
ADVANCED TRAVEL DEMAND MODELS

- Estimated based on travel surveys
  - Advantages
    - Detailed demographic, behavioral & activity data
      - (e.g.) Activity purpose, travel mode, party size
  - Limitations
    - Small sample sizes
    - Missing trip/activity information
    - Time-consuming, costly, hard to repeat frequently

- Big Data can augment model accuracy through:
  - Better calibration targets
  - Information on less-represented market segments
ADVANCED TRAVEL DEMAND MODELS

- ABM calibration targets for Peoria, Illinois
ABM calibration targets for Peoria, Illinois

- Transography Data provided:
  - Tour Frequencies
  - Tour Start Times
  - Activity & Tour Durations
  - Number of Intermediate Stops
  - Trip Length Frequency Distributions
  - Observed OD patterns

- Big Data did not provide:
  - Tour/trip mode shares
  - Joint/Solo tour statistics
ADVANCED TRAVEL DEMAND MODELS

- Big Data for Las Vegas, Nevada
  - Spatio-temporal movement densities
  - Visitor hot spots
  - External trips

![Map of Las Vegas showing travel patterns and hot spots.](image-url)
Big Data for Las Vegas, Nevada

- Truck trips
- With and without a depot(s)

- Trucks without depot(s) are sighted on fewer days
- Helps develop higher-fidelity truck models
ADVANCED TRAVEL DEMAND MODELS

- Visitor data for Oahu, Hawaii
  - Visitor status determined via imputation of home location
    - Recurring activity patterns
    - Topological node centrality (page-rank)
    - Day, night, and total hours spent
    - Weekdays, weekends seen
ADVANCED TRAVEL DEMAND MODELS

- Visitor data for Oahu, Hawaii
  - LBS-based visitor OD matrix
  - CV-based airport rental car OD matrix
  - Imputation of lodging locations
TRAFFIC SIMULATION MODELS

- Microscopic, mesoscopic, hybrid
- Lane-level network, vehicle interactions
- Detailed operation of signals
- Supports wide range if ITS
- HCS-consistent LOS reports
- Dynamic Traffic Assignment (DTA)
TRAFFIC SIMULATION MODELS

- Highly realistic depiction of real-world phenomena
  - Advantages
    - Accurately estimates travel time and delay
    - Allows for inclusion of travel time reliability metrics
    - Evaluate emerging technologies (e.g.) CAV
  - Limitations
    - Data often unavailable for fine-grained aggregate validation
    - Easier to match traffic counts but harder to replicate speeds
    - Sets of reasonable paths for all/most OD pair were hard to obtain

- Big Data can augment model accuracy through:
  - Real-world path sets for validation and modeling
  - Time-varying link speeds for model calibration and validation
TRAFFIC SIMULATION MODELS

- Rich trajectory data for path set and route choice analyses
  - Ohio-Kentucky-Indiana (OKI) region
TRAFFIC SIMULATION MODELS

- Speed validation (Phoenix, Arizona)
  - Helps ensure that the model captures congestion evolution
STRENGTHS OF CURRENT BIG DATA SOURCES

- Covers a significant fraction of commuters
  - Surveys work with relatively small sample sizes

- Can capture detailed data on special segments
  - Visitors, trucks, external trips

- Does not rely on self-reporting via surveys
  - Reduces human error, some biases
BIG DATA CHALLENGES

- Sampling strategy is unknown; makes it challenging to weight
- Cannot get demographic data required for behavioral models
- Some information is hard to impute from Big Data
  - (e.g.) travel mode, trip purpose, vehicle occupancy
- Could yield “too much” detail for modeling use
- More data is not necessarily more information
CONCLUSION

- Big Data can help fill data gaps; may improve some model components
  - Modelers must ensure synergies with behavioral underpinnings

- Needs routine verification
  - (e.g.) Location-based data recently found to be imputed, not measured

- Requires sophisticated algorithms and computing power to tease out useful information at scale
THANK YOU!

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“Let’s shrink Big Data into Small Data ... and hope it magically becomes Great Data.”