

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

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Caliper[®]
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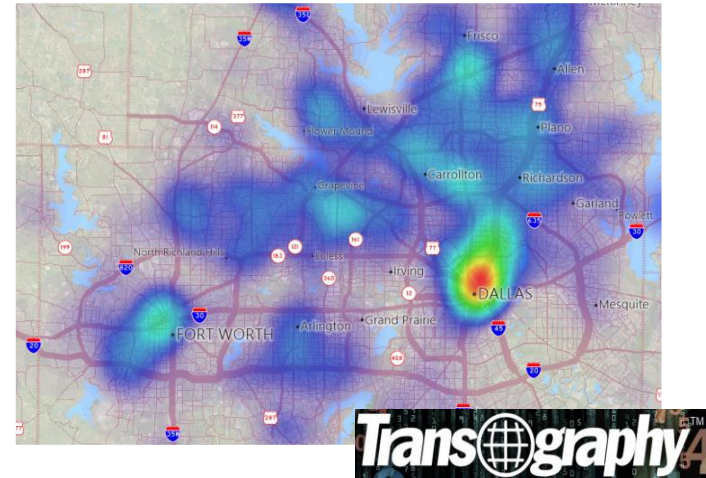
Transportation & Mapping Solutions
Maptitude • TransCAD • TransModeler

AGENDA

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

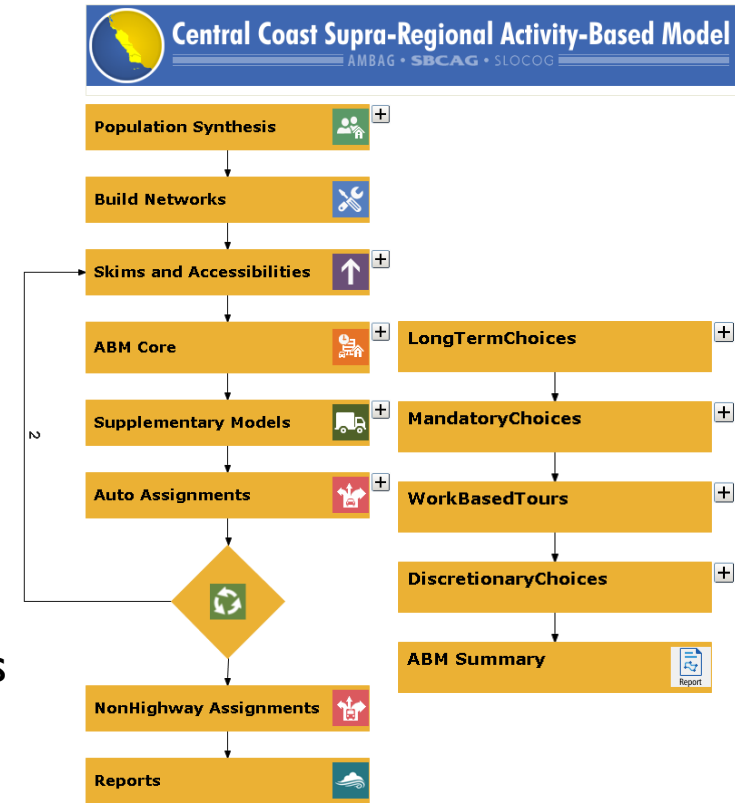
TRANSOGRAPHY FROM CALIPER

- 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

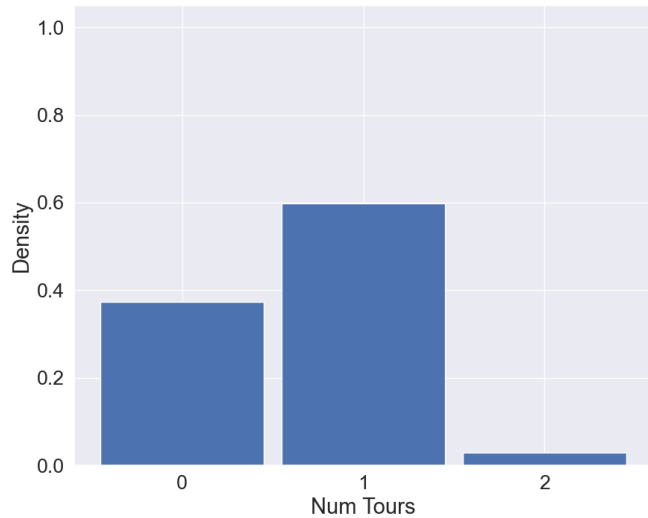
- Estimated based on travel surveys
 - Advantages
 - Detailed demographic, behavioral & activity data
 - (e.g.) Activity purpose, travel mode, party size
 - Limitations
 - Small sample sizes
 - Missing trip/activity information
 - Time-consuming, costly, hard to repeat frequently
- Big Data can augment model accuracy through:
 - Better calibration targets
 - Information on less-represented market segments



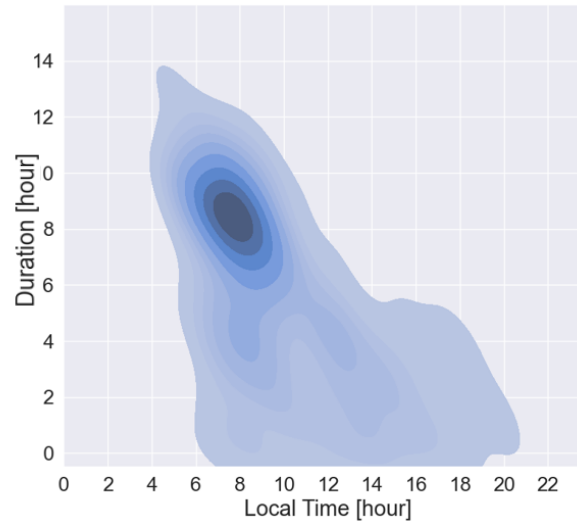
ADVANCED TRAVEL DEMAND MODELS

- ABM calibration targets for Peoria, Illinois

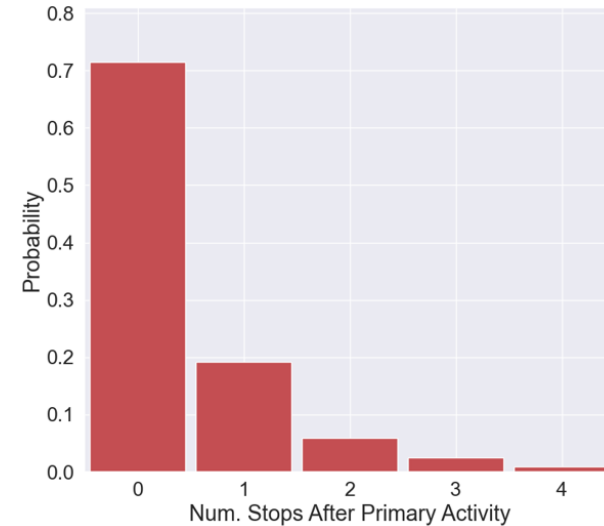
Work Tour Frequency for Workers



Duration vs. Start Time of **Work** Activities



Number of Stops during Backward Segments of **Store** Tours



ADVANCED TRAVEL DEMAND MODELS

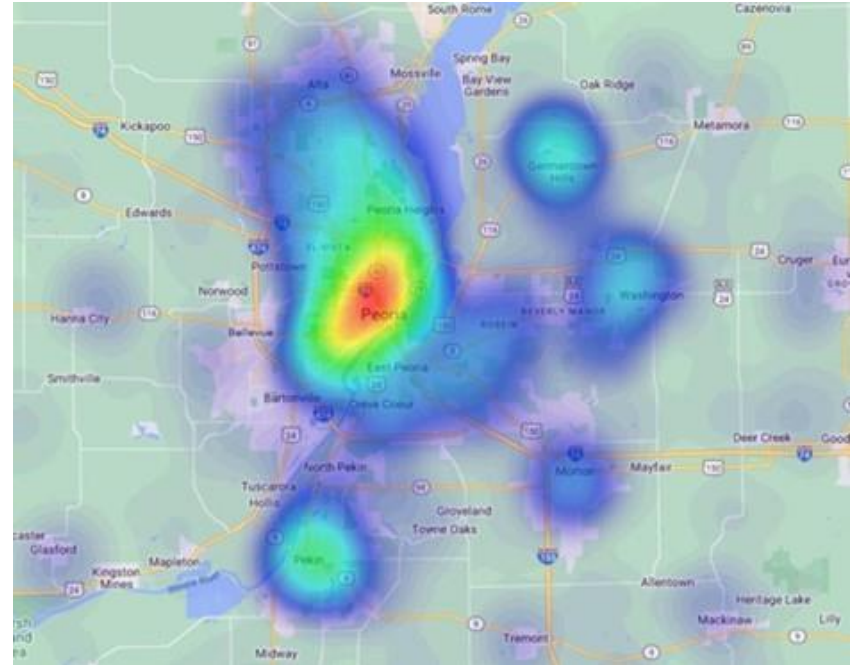
■ ABM calibration targets for Peoria, Illinois

– Transography Data provided:

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

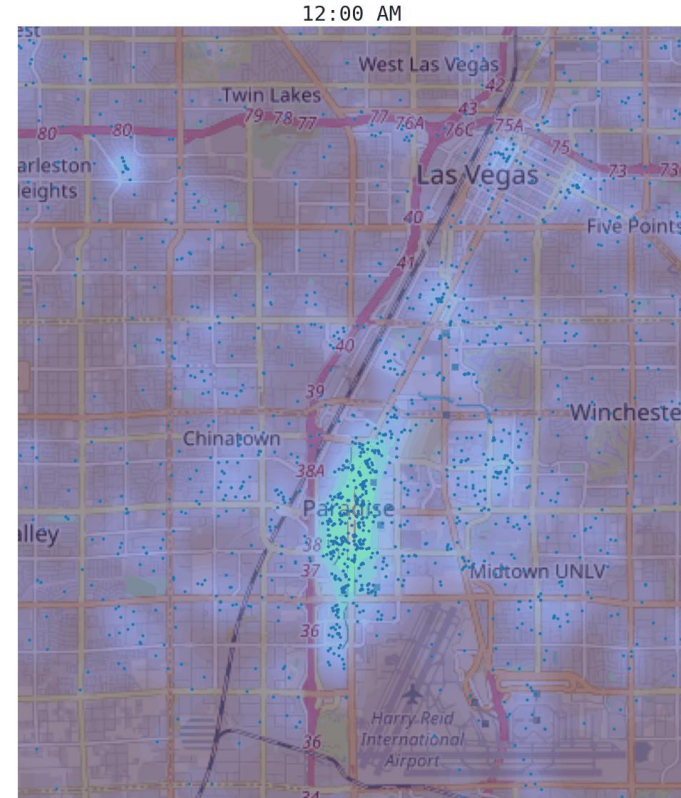
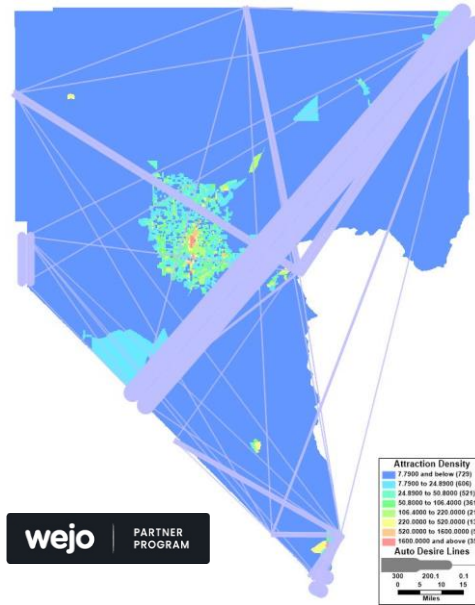
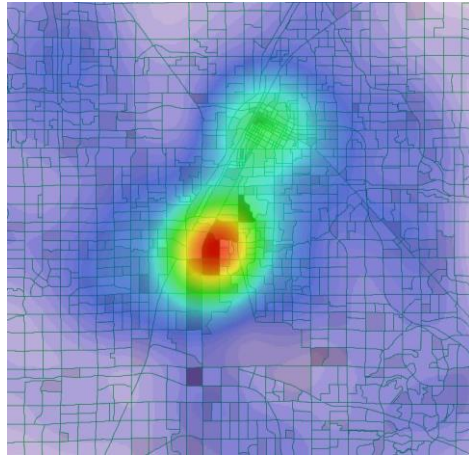
– Big Data did not provide:

- Tour/trip mode shares
- Joint/Solo tour statistics



ADVANCED TRAVEL DEMAND MODELS

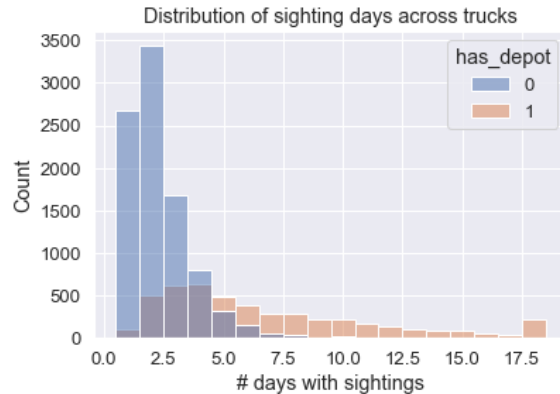
- Big Data for Las Vegas, Nevada
 - Spatio-temporal movement densities
 - Visitor hot spots
 - External trips



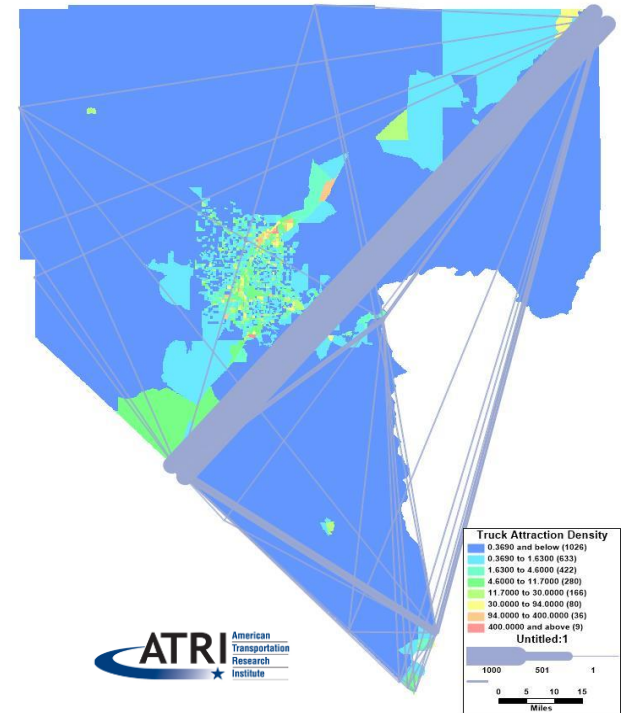
ADVANCED TRAVEL DEMAND MODELS

- 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



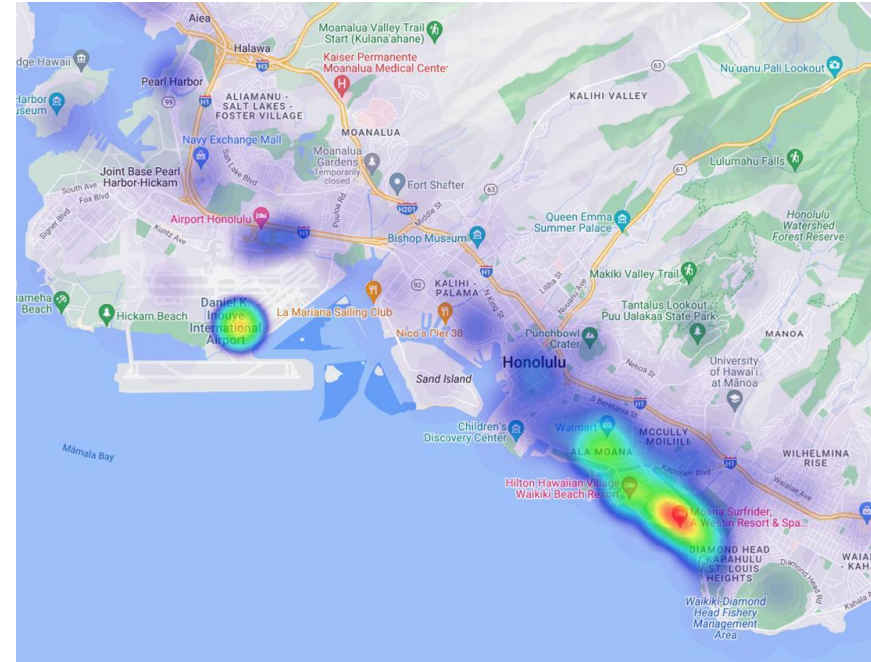
ADVANCED TRAVEL DEMAND MODELS

- 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 of ITS
- HCS-consistent LOS reports
- Dynamic Traffic Assignment (DTA)



TRAFFIC SIMULATION MODELS

- Highly realistic depiction of real-world phenomena

- Advantages

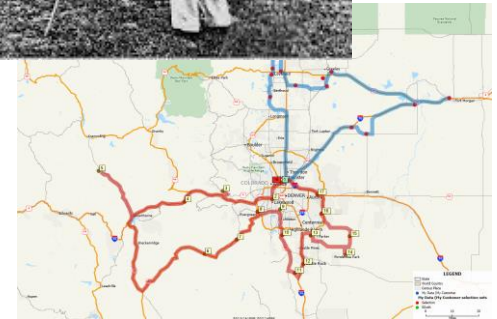
- Accurately estimates travel time and delay
 - Allows for inclusion of travel time reliability metrics
 - Evaluate emerging technologies (e.g.) CAV

- 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

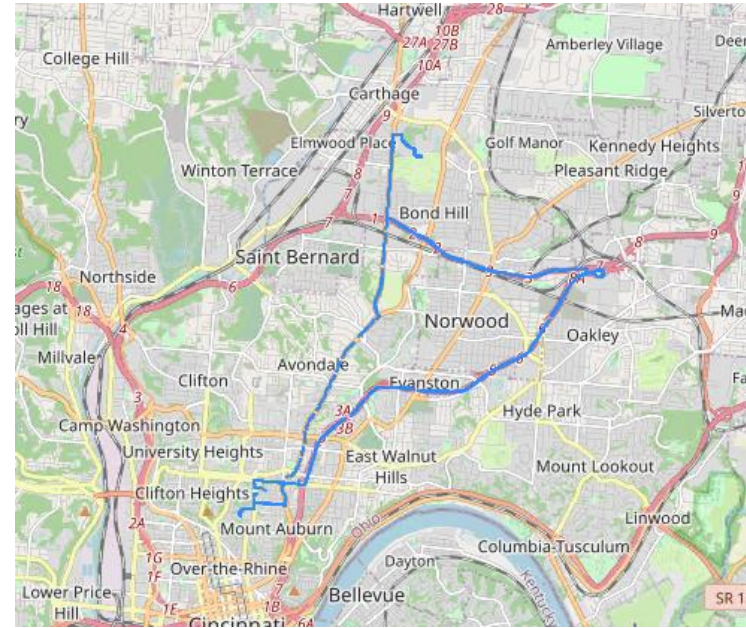
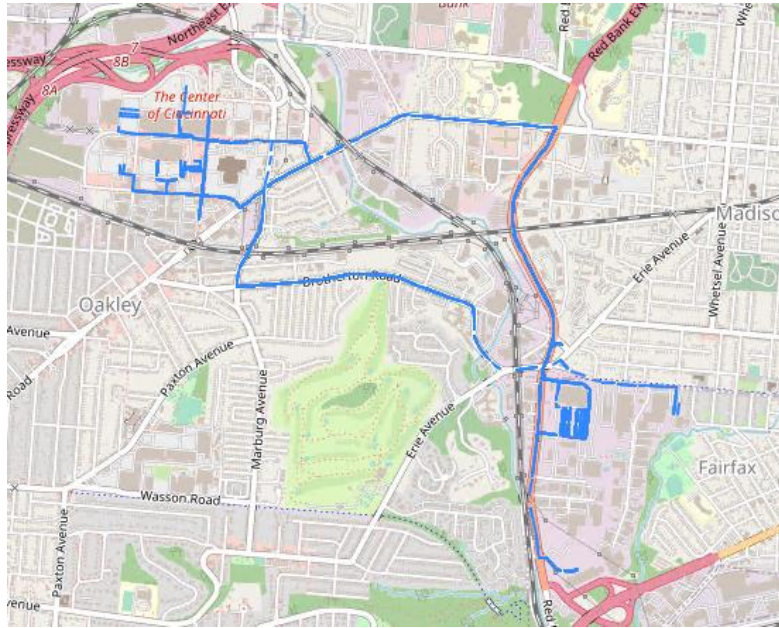
- Big Data can augment model accuracy through:

- Real-world path sets for validation and modeling
 - Time-varying link speeds for model calibration and validation



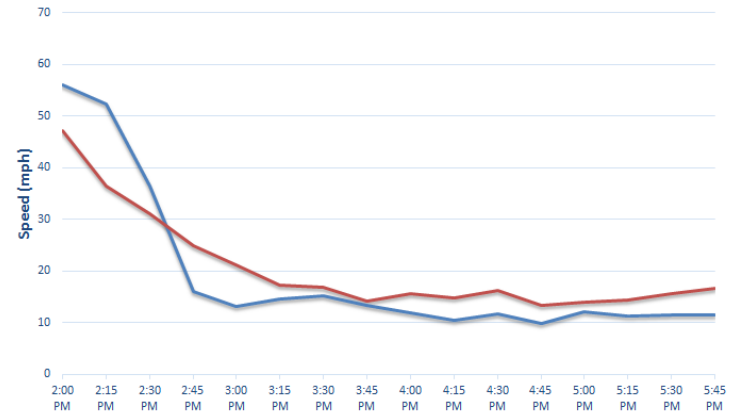
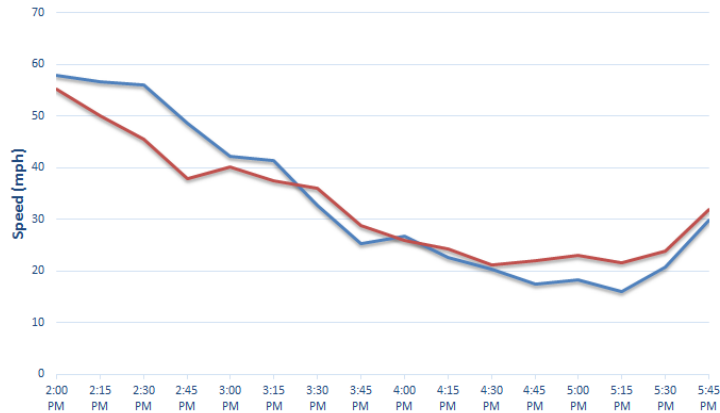
TRAFFIC SIMULATION MODELS

- 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



— Model speed — NPMRDS Speed

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!



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

alamy

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