

# Dynamic Origin-Destination Demand Estimation: A Review of Major Approaches, Limitations and the Future

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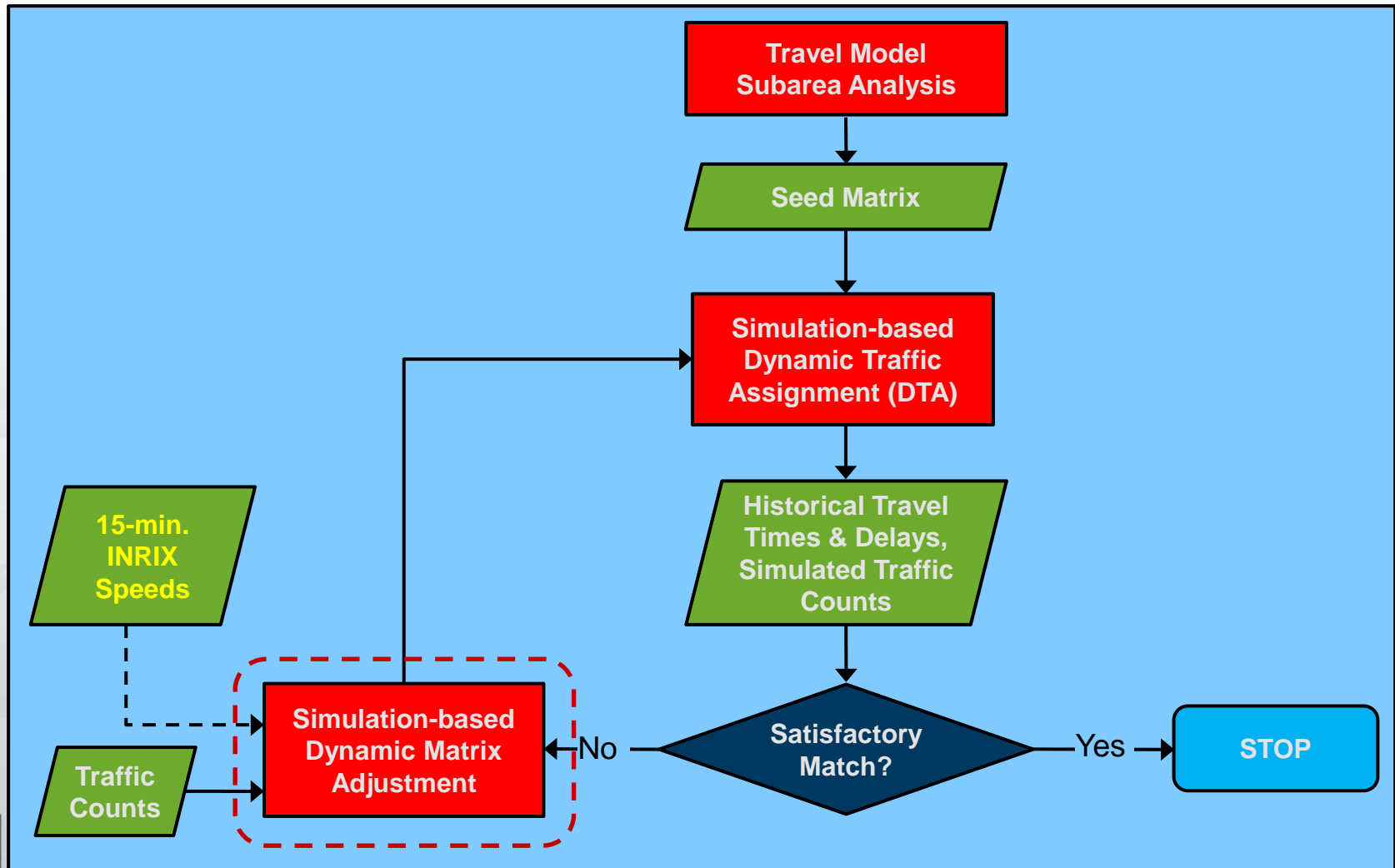
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# Dynamic Origin-Destination Estimation

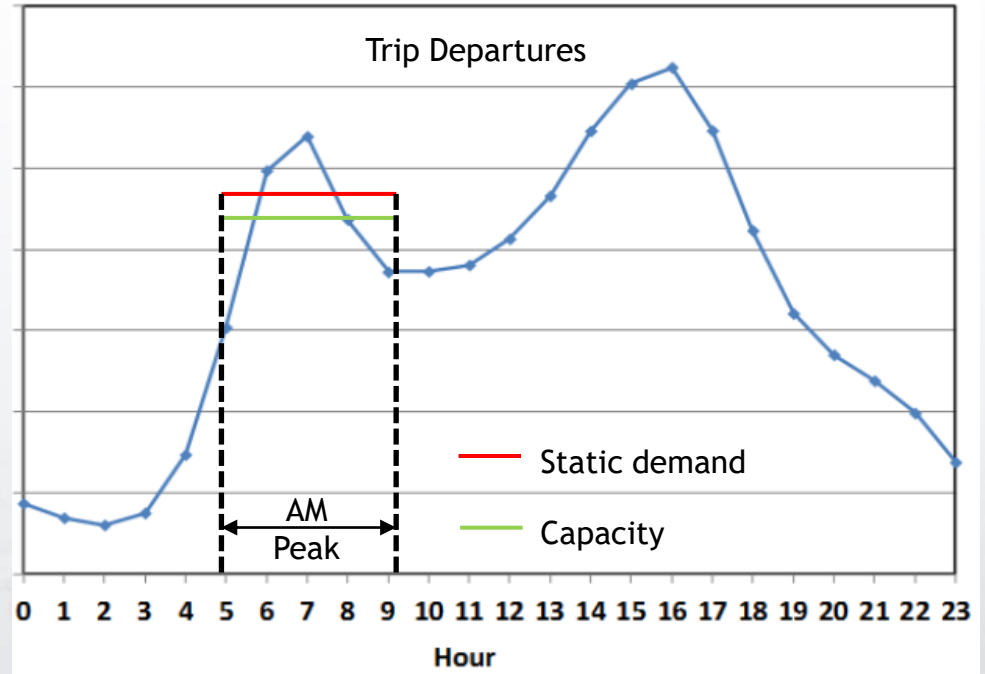
- Key component in simulation model calibration



# Review of the State of the Art/Practice

- **Static OD estimation**

- Based on static traffic assignment
- Ignores capacity constraints
- May cause gridlock in traffic simulation



- **Profiling a (planning) OD matrix**

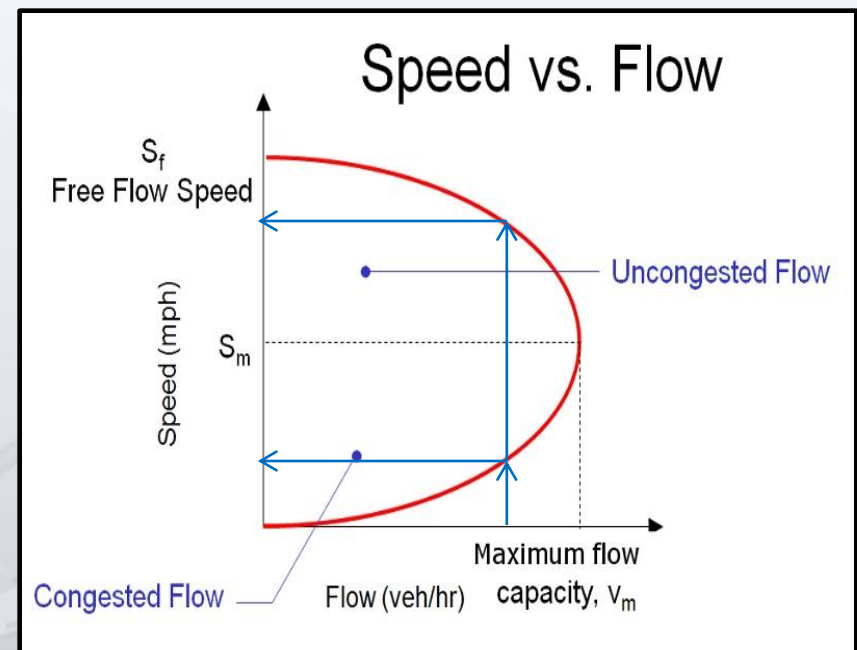
- Can capture traffic count dynamics
- Applies common profile to all (most) OD pairs

# Review of the State of the Art/Practice

Time Interval Handling	Estimated Parameters	Data	Formulation	Solution Algorithm
Sequential	OD Flows	Traffic Counts	Assignment Matrices	Matrix Inversion
Simultaneous	OD Flows Route Choice	Traffic Counts Speeds	Simulator as a Black-Box	Kalman Filtering
	OD Flows Route Choice Network Supply	Traffic Counts Speeds Densities		Gradient Descent
				Gradient-Like (e.g.) SPSA
				Genetic Algorithms
				Simulated Annealing

# Review of the State of the Art/Practice

- Remains a highly-challenging practical problem
  - Non-convex, stochastic objective function
    - Numerous local optima, stochastic gradients
  - High cost of function evaluations
  - Multiple solutions
    - Traffic counts alone are not sufficient
      - Speeds
      - Travel times
  - Poor starting solutions
    - Static assignment allows flows to exceed capacity



# Other Practical Aspects

- **Data consistency**
  - Sensors are often moved around the network
  - Spatio-temporal consistency is not guaranteed
    - Geographic Information Systems (GIS) analysis can help
- **Obtaining data on severe (historical) incidents**
  - Special events, accidents, etc.
- **Handling data from multiple days**
  - Repeating OD estimation for each day
  - Updating the historical database of OD flows by type of day

# Recent Literature

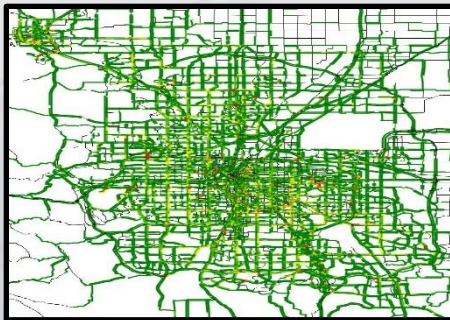
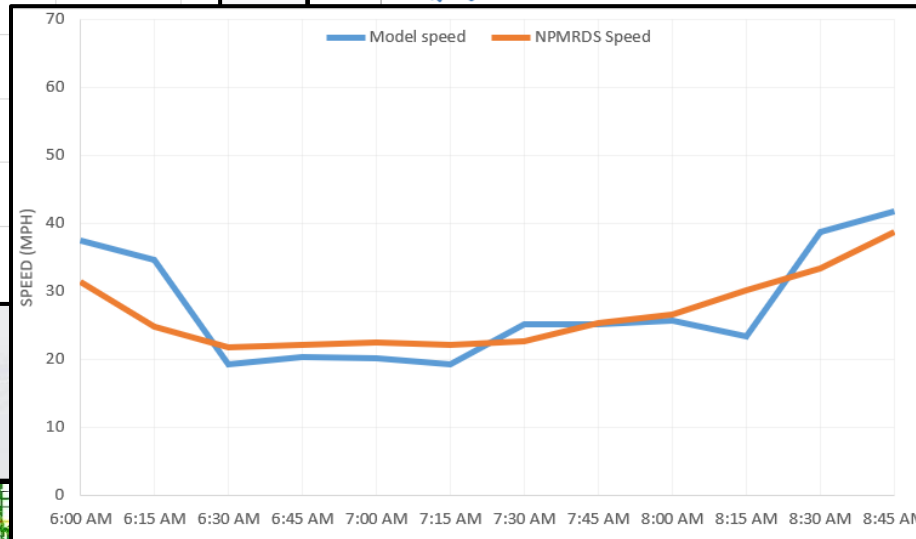
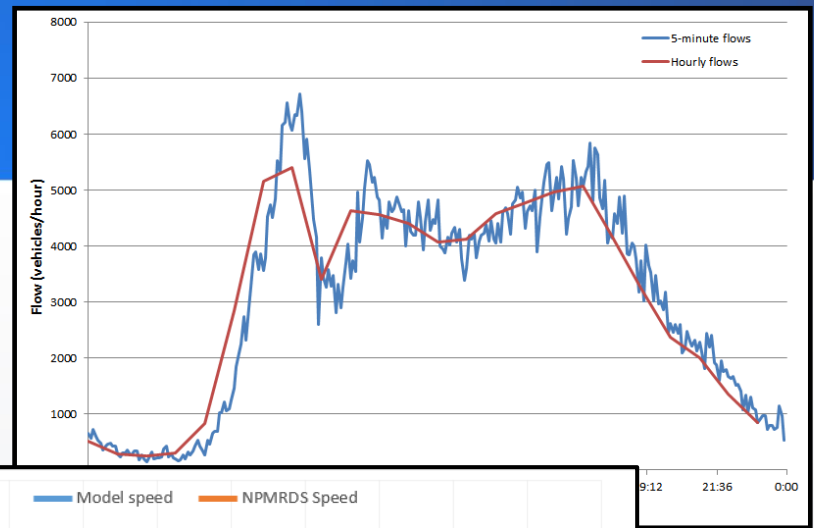
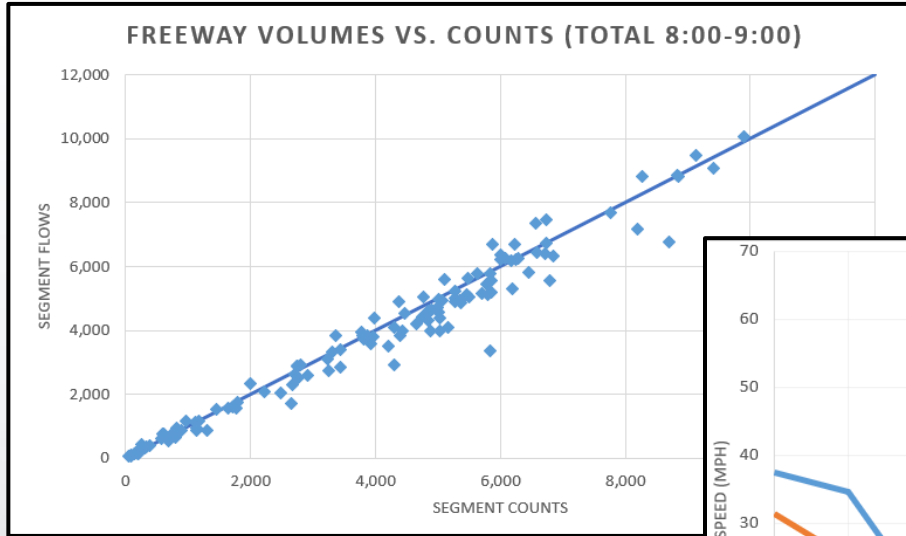
- **Duplicating/removing trips based on scoring**
  - Score individual trips on their ability to close gap between model output, measurement
  - Duplicate trips with high scores, remove those with low scores
  - Shift departure times
  
- **Machine learning approaches**
  - Often applied in the real-time context
    - Requires a well-calibrated set of historical OD flows
    - Challenging to include incident information
    - Still mostly in the research domain

# Enduring Challenges: Future Research

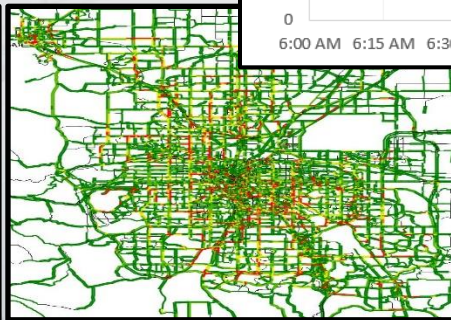
- **Estimates remain close to starting/seed OD flows**
  - Local optima, seed dependence
  - System observability has not been studied as much
    - Will more measurements reduce seed OD flow effects?
- **More data is not always better**
  - Data are often missing (at least for some time intervals)
  - Measurements could be correlated in space and time
- **Algorithms have been hard to generalize/reproduce**
  - Success depends on network structure, traffic data location
- **Machine learning/AI must be handled with care!**
  - Combine with network models



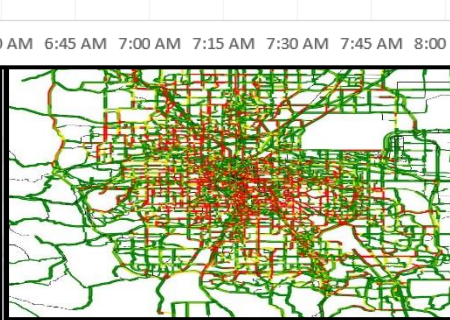
# Thank You!



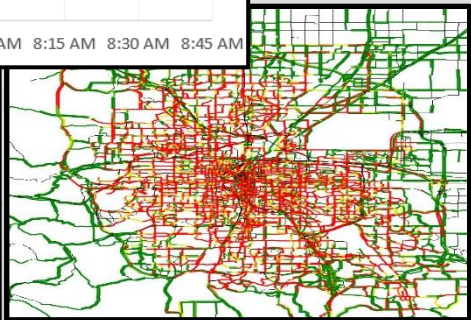
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