Simulation-based Dynamic Traffic Assignment for Planning Applications

Daniel Morgan
Qi Yang, PhD
Howard Slavin, PhD
Caliper Corporation

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Context: Motivation

• Technical
  – Many transportation planning problems require dynamic models

• Practical
  – Effective transportation planning solutions require consensus/buy-in
Context: Technical Motivation

- Dynamic Traffic Assignments are needed for analyzing pricing strategies, capacity improvements, and ITS
- Congested travel times form the basis for crucial planning model estimation and application
- Static assignments produce biased travel times and biased models and forecasts
- These compromises are no longer necessary or justifiable
- ...
• Operational fidelity needed for traffic engineering work
• Many projects and traffic management measures have impacts that cannot be estimated with planning models
• These require detailed microsimulation in which lane level behavior is captured
Context: Practical Motivation

- Effective deployment hinges on usability, robustness
- DTAs lend themselves better to dynamic visualization and animation
- A more compelling tool for engaging stakeholders and the public
Context: Background

• Early experiments with macro DTA
• TRANSIMS & MITSIM
• Meso models-Integration, Dynasmart, & DYNAMIT
• Microsimulation thought to be impossible at the regional scale
• The TransModeler hybrid approach: Macro, Meso, and Micro in any combination on the same network
• 4-D lane level GIS for efficiency in simulation development
Context: Wide Area Micro DTA Successes

- Eureka, CA
- Burlington, VT
- Phoenix, AZ
- Lake County, CA
- Jacksonville, FL
- Virginia Beach, VA
- Ukiah, CA
- Practical, calibrated, validated, and deployed Microscopic DTA models
- Hybrid models neither needed nor warranted for any reason
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• 495 Express Lanes (Northern VA)
• 95 Express Lanes (Miami)
• 95 Express Lanes (Northern VA)
• I-4 (Orlando)
• C-470 (Denver)
• I-70 Mountain Corridor (West of Denver)
• Purposes varied: from practical applications to T&R to research
• Dynamic pricing a theme
Approach: Key DTA Elements

- Dynamic shortest paths based upon departure times
- Realistic route choice incorporating VOT, willingness to pay
- Queue build-up and dissipation
- Short time intervals for travel time measurement
- Dynamic User Equilibrium condition - Temporal extension of Wardrop’s principle that all used paths between each OD pair, have the same minimum cost for a given departure time interval and that there are no lower cost routes
- Iterative computation to achieve convergence
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Direct tie-in with activity-based models (ABM)
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While rooted in familiar trip-based model theory
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Key advantages
Approach: Microscopic DTA

• Microscopic in level of detail
  – Referenced to ground truth with accurate geometry
  – Lane level and intersection area representation
  – Temporal dynamics (as low as 0.1-sec)
  – 2-d and 3-d dynamic visualization

• Microscopic in modeling accuracy
  – Microscopic (car following, lane changing)
  – Employs realistic route choice models
  – Handles complex network infrastructure (Signals, variable message signs, sensors, etc.)
  – Simulates multiple modes, user classes, vehicle types
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Implementation: Jacksonville, FL

Region-wide, Six-county coverage
Implementation: Jacksonville, FL

Parcel-level activity location
Implementation: Jacksonville, FL

Major and local streets and centroid connectors
Implementation: Jacksonville, FL

Intersection geometry and signal timings
Implementation: Framework

• Parcel-level origins and destinations
  – 492,684 parcels
  – Point-to-point route choice
  – Trips produced by DAYSIM

• Zonal truck and external traffic
  – 2,578 TAZs
  – Zone-to-zone route choice
  – Matrices produced by CUBE

• Integration/Linkage
  – DAYSIM
  – CUBE
Implementation: Challenges
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Implementation: Features

• Read DAYSIM trips without temporal aggregation
• Handle parcel locations without spatial aggregation
• Use dense street network
  – Realistic accessibility, connectivity
• Simulate multiple travel modes
• Possess practical running times
Implementation: Input

- Demand: Disaggregate trip tables
  - Detailed demographic and trip information
  - Approximately 650K trips in 3-hour AM peak [6:00-9:00]
Implementation: Running Time

- DTA running time per iteration
  - Approx. 50 minutes overall
  - 3.1 GHz Intel Xeon Dual-Core 64-Bit CPU, 64 GB RAM
Implementation: Next Steps

- **Model Development Review**
  - Testing
  - Signal timings validation
  - Running time performance evaluation

- **Model Calibration**
  - Compare DTA volumes with counts

- **Software integration/linkage**
  - Refine
  - Deliver
  - Support