Lessons Learned from Development of a Dynamic Traffic Assignment Model for Northern Nevada

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Static Traffic Assignment (STA)

- V/C can be more than 1
- No spill back
  - The assigned link volume can be considered as demand—trips desired to traverse the link—instead of the actual flow.
  - In a static model, FIFO means that all vehicles traveling on the link experience the same travel time. What this implies is that there is no overtaking between vehicles and, in particular, this means no overtaking between vehicles that exit the link by different turning movements.
  - As there is no explicit representation of individual lanes in static models, there can be no distinction between the traffic conditions on different lanes of the same link. There is no way to represent the fact, for example, that the outside lane of a freeway is at a crawl due to an oversaturated off-ramp, while the other lanes are moving at a higher speed.
Other limitations include, for example, modeling of signal synchronization, modeling of lane-based effects, such as high-occupancy vehicle (HOV) or high occupancy toll (HOT) lanes, as they require representing the special lane as a parallel link. Most intelligent transportation systems (ITS)–related applications, such as traveler information systems and advanced network control schemes (e.g., adaptive control and ramp metering), are beyond the modeling capabilities of static assignment models.

The widely recognized advantages of static models, including the ability to solve large-scale problems, to converge to precise equilibriums and to provide consistency of solutions (if a proper algorithm is used with a sufficient number of iterations) have been aiding policy–project decision making for agencies for decades.
Dynamic traffic assignment is based on experienced travel costs.

At the moment that the link inflow becomes equal to the outflow, then the congestion continues to spread upstream into whichever upstream links are feeding traffic into the congested link. The outflows of these links are thus reduced, and the process repeats as described above. This queue spillback process also describes how a long queue (congested traffic) can be represented over a sequence of links in a dynamic traffic model.
Lesson

DTA and STA are different!
Example

Source: Dynamic Traffic Assignment: A Primer. TRANSPORTATION RESEARCH Number E-C153 June 2011
Instantaneous Route Travel time Calculation (Shortest Route for Departure Time 2)

(I-A) Travel time for Route 1-2-4-6 = 1+2+3 = 6

(E-a) Travel time for Route 1-2-4-6 = 1+3+4 = 8

(I-b) Travel time for Route 1-2-5-6 = 1+3+2 = 6

(E-b) Travel time for Route 1-2-5-6 = 1+3+1 = 5

(I-c) Travel time for Route 1-3-5-6 = 1+2+2 = 5

(E-c) Travel time for Route 1-3-5-6 = 1+1+1 = 3
DTA Software Packages

- DTALite
- DynusT
- DynaMIT-R, DYNASMART-X, DynaMIT-P and DYNASMRAT-P
- Dynameq
- TransModeler
- ...

7/15/2017
Challenges for Model Comparison

- Traffic simulation tools differ significantly
  - Software architecture
    - Data structures, loop implementation, procedures
  - Modeling features, assumptions, simplifications
    - Vehicle and user classes, value of time (VOT)
    - Network representation
      - Lanes, lane groups, turn bays
    - Shortest path, vehicle propagation algorithms
  - Default parameters
  - Visualization and output generation
Lesson

DTA software packages are different!
Example
Lesson

Expect learning curve!
Example
Another Example
# Dynamic Origin-Destination Demand Matrix Estimation (ODME) in DTALite

## File Group

<table>
<thead>
<tr>
<th>File Group</th>
<th>Input file list</th>
<th>Remark</th>
<th>Output file list</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demand</strong></td>
<td>1. input_demand.csv or input_agent.csv</td>
<td>Demand content for specifying distribution</td>
<td>1. output_agent.csv</td>
<td>Final estimation results represented in terms of agent trajectory format</td>
</tr>
<tr>
<td></td>
<td>2. input_demand_file_list.csv</td>
<td>Demand file specification, specify temporal departure time distribution</td>
<td>2. ODME_zone_based_log.csv 3. ODME_final_result.csv</td>
<td>Zone based production based ratio; Iteration by iteration zone based total production adjustment</td>
</tr>
<tr>
<td><strong>Sensor</strong></td>
<td>1. input_link.csv</td>
<td>Store count_sensor_id, speed_sensor_id for referring sensor data</td>
<td>1. ODME_link_based_log.csv</td>
<td>Iteration by iteration link based flow adjustment</td>
</tr>
<tr>
<td></td>
<td>2. sensor_count.csv</td>
<td>Link based sensor count data</td>
<td></td>
<td>Link based simulated vs. observed results</td>
</tr>
<tr>
<td></td>
<td>3. sensor_speed.csv</td>
<td>Link based sensor count data</td>
<td>2. debug_validation_results.csv</td>
<td></td>
</tr>
<tr>
<td><strong>Scenario</strong></td>
<td>1. input_scenario_settings.csv</td>
<td>ODME and assignment settings</td>
<td>1. output_summary.csv</td>
<td>Iteration-by-iteration UE and ODME statistics</td>
</tr>
<tr>
<td></td>
<td>2. DTASettings.txt</td>
<td>Default settings for sequential ODME run</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. scenario_work_zone.csv</td>
<td>Specify the capacity reduction scenarios in the estimation and prediction stages</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Sample Data

Sample data in sensor_count.csv

<table>
<thead>
<tr>
<th>count_sensor_id</th>
<th>from_node_id</th>
<th>to_node_id</th>
<th>day_no</th>
<th>start_time_in_min</th>
<th>end_time_in_min</th>
<th>link_count</th>
<th>speed</th>
<th>travel_time_in_min</th>
<th>lane_density</th>
</tr>
</thead>
<tbody>
<tr>
<td>5010-&gt;4958</td>
<td>5010</td>
<td>4958</td>
<td>1</td>
<td>990</td>
<td>1050</td>
<td></td>
<td>49.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4958-&gt;5010</td>
<td>4958</td>
<td>5010</td>
<td>1</td>
<td>990</td>
<td>1050</td>
<td></td>
<td>74.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4952-&gt;5022</td>
<td>4952</td>
<td>5022</td>
<td>1</td>
<td>990</td>
<td>1050</td>
<td></td>
<td>221.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sample data in input_link.csv

<table>
<thead>
<tr>
<th>link_id</th>
<th>from_node_id</th>
<th>to_node_id</th>
<th>direction</th>
<th>length</th>
<th>number_of_lanes</th>
<th>speed_limit</th>
<th>lane_capacity</th>
<th>count_sensor_id</th>
<th>speed_sensor_id</th>
</tr>
</thead>
<tbody>
<tr>
<td>1285</td>
<td>1285</td>
<td>5018</td>
<td>1</td>
<td>0.2384</td>
<td>7</td>
<td>21</td>
<td>1428.6</td>
<td>1285-&gt;5018</td>
<td></td>
</tr>
<tr>
<td>1286</td>
<td>1286</td>
<td>11125</td>
<td>1</td>
<td>0.466</td>
<td>7</td>
<td>21</td>
<td>1428.6</td>
<td>1286-&gt;11125</td>
<td></td>
</tr>
<tr>
<td>1289</td>
<td>1289</td>
<td>4952</td>
<td>1</td>
<td>0.2427</td>
<td>7</td>
<td>21</td>
<td>1428.6</td>
<td>1289-&gt;4952</td>
<td></td>
</tr>
</tbody>
</table>
Sensor Data
# Scenario Settings

<table>
<thead>
<tr>
<th>Data Field</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>number_of_iterations</td>
<td>50</td>
<td>The total number of iterations for ODME</td>
</tr>
<tr>
<td>traffic_flow_model</td>
<td>1</td>
<td>This parameter defines a specific traffic flow model used in both assignment and ODME of DTALite; 1 indicates a point queue model in this example. The selection of Newell’s KW model is also feasible.</td>
</tr>
<tr>
<td>signal_representation_model</td>
<td>0</td>
<td>This parameter defines a specific signal control for DTALite.</td>
</tr>
<tr>
<td>traffic_assignment_method</td>
<td>3</td>
<td>This assignment method of “3” is dedicated to ODME</td>
</tr>
<tr>
<td>ODME_start_iteration</td>
<td>20</td>
<td>It defines the first iterative assignment period to converge to the user equilibrium state, and could generate a sufficient number of paths for path flow adjustment. The iteration number also indicate that ODME will begin at the 21th iteration.</td>
</tr>
<tr>
<td>ODME_end_iteration</td>
<td>50</td>
<td>It defines that ODME will end at the 50th iterations.</td>
</tr>
<tr>
<td>ODME_max_percentage_deviation_wrt_hist_demand</td>
<td>40</td>
<td>The maximum percentage of demand deviation from base-line dynamic demand.</td>
</tr>
<tr>
<td>ODME_step_size</td>
<td>0.05</td>
<td>Moving size of each step in path flow adjustment algorithm</td>
</tr>
<tr>
<td>calibration_data_start_time_in_min</td>
<td>990</td>
<td>This and the following parameter specify the time window for ODME to use the sensor data. Note that, users can prepare a long period of sensor data, say from 0 to 24 hours, but only use part of sensor data, say between min 990 and 1050, for calibration.</td>
</tr>
<tr>
<td>calibration_data_end_time_in_min</td>
<td>1050</td>
<td></td>
</tr>
</tbody>
</table>

Scenario Settings

• 7/15/2017
Data Collection

• Part 1. Data for model calibration
  • 24-hour link volumes
    • Retrieved data from TRINA
    • I-80, I-580, McCarran, Virginia, and Kietzke
    • 693 links in total (incl. 119 ramps)
    • Approximately 200 links extracted
  • Travel speed and travel times
    • National Performance Management Research Data Set (NPMRDS) data from HERE
    • Travel times for April 2015 (5-min interval)
    • Extracted and mapped Nevada data
    • Converted travel times to speed
    • 240 links in total
    • To match the data with DTA network

• Part 2. Data for case studies
  • Link volume data for work zone
Model consistency with TransCAD

• Links
  • Consistent with TransCAD
  • Modified # of lanes to match reality

• Zones/Demand
  • Consistent with TransCAD

• Control types
  • Not available from Reno TransCAD model
Lesson

Do not trust import/export buttons!
Example
24 Hours
Lesson

Something is wrong with STA demand matrix!
Example
Need to Load Time-dependent Demand Profile

Weekday demand profile in California, Feb, 2005 Source: PeMS
Sensitivity analysis on number of detectors
Lesson

A good model is more important than extensive data!
Case Study Region AM Peak Calibration on Subarea

80% Interval

$R^2 = 0.1474$
Case Study Region AM Peak
Calibration on whole network
Lesson

DTA is not that much good for TIA! Focus on freeways!
Instead of Summary

Path of love seemed easy at first, what came was many hardships

Hafez’s Sonnets
Thank you!

Questions or Comments?