Traffic Assignment and Feedback Research to Support Improved Travel Forecasting

presented by
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• Address Congressional interest in highway benefits of major transit improvements
• Examine the congested auto travel times from models that are used for transit forecasting
• Understand the consequences of assignment and feedback convergence for impact assessment
Project Overview

• Inventory/Assessment of Practices of the 30 Largest MPOs
• Tests with 5 of the better MPO Models
• Examination of Traffic Assignment Methods
• Examination of Feedback Methods
• Project Impact Analysis
• Comparison of Modeled & Measured Travel times
• Cross-cutting Conclusions
Inventory of Practices circa 2012

- Nearly universal coverage of the 30 largest MPOs
- Widespread deficiencies found in traffic assignment methods
- Use of problematic assignment techniques and closure metrics – only 50% used a good metric
- Of those, low convergence targets for the relative gap-many at .01 or larger, few at .001, 2 at .0001
- Feedback insufficiently computed when attempted-often only one time period, ad hoc methods and closure metrics, often stopping at 5% flow diff.
Experiments with 5 of the “better” MPO Models

- ARC, NCTCOG, MAG, SANDAG, & PSRC models
- Examination of tighter convergence
- Variations in assignment parameters
- Alternative feedback methods & metrics
- Tests of highway and transit project impacts
- Illustration of the value of a forensic approach to model assessment and validation
Some of the Research Questions

• How much convergence error is there in deployed MPO models?
• How much convergence is enough for project evaluation?
• How hard is it to achieve with current algorithms and commercial software?
• How significant is feedback convergence?
• How achievable is feedback convergence?
• How realistic are model-generated congested travel times?
• Classical methods don’t converge much after a certain point
• Seemingly innocuous & familiar practices can both impair and/or overstate convergence: e.g., using slack closure criteria, a VHT gap instead of the relative gap, V/C limits, a VDF lookup table, or limited precision travel times
• Newer algorithms such as the bi-conjugate FW method are more efficient than the classical FW
• Some path-based algorithms can go low enough to eliminate convergence error
Why it matters- Road Impacts of Blue Line Service Improvement at 1E-6 Relative Gap
### Good Convergence Need Not Take too Long

<table>
<thead>
<tr>
<th>MPO</th>
<th>ARC</th>
<th>MAG</th>
<th>NCTCOG</th>
<th>PSRC</th>
<th>SANDAG ABM</th>
<th>SANDAG trip-based</th>
</tr>
</thead>
<tbody>
<tr>
<td>METHOD</td>
<td>BFW</td>
<td>BFW</td>
<td>BFW</td>
<td>BFW</td>
<td>BFW</td>
<td>BFW</td>
</tr>
<tr>
<td>TIME PERIOD</td>
<td>AM</td>
<td>PM</td>
<td>AM</td>
<td>AM</td>
<td>AM</td>
<td>AM</td>
</tr>
<tr>
<td>CONVERGENCE</td>
<td>1.E-4</td>
<td>1.E-4</td>
<td>1.E-4</td>
<td>1.E-4</td>
<td>1.E-4</td>
<td>1.E-4</td>
</tr>
<tr>
<td>NUMBER OF ITERATIONS</td>
<td>80</td>
<td>51</td>
<td>153</td>
<td>66</td>
<td>45</td>
<td>39</td>
</tr>
<tr>
<td>COMPUTATIONAL TIME</td>
<td>1 h 4 min</td>
<td>8 min 22 s</td>
<td>1 h 2 min</td>
<td>1 h 24 min</td>
<td>1 h 1 min</td>
<td>48 min</td>
</tr>
<tr>
<td>TOTAL VMT</td>
<td>40,264,910</td>
<td>29,356,528</td>
<td>35,209,830</td>
<td>13,122,656</td>
<td>16,934,816</td>
<td>15,727,276</td>
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<tr>
<td>TOTAL VHT</td>
<td>1,244,615</td>
<td>889,645</td>
<td>1,089,180</td>
<td>447,006</td>
<td>490,625</td>
<td>443,313</td>
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</table>
Convergence Error as a Function of the Relative Gap

Flow Convergence Errors: NCTCOG

- Maximum
- Average

Relative Gap

Link Flow Differences (Trips)
Other Assignment Problems Encountered

- Missing turn prohibitions
- Too few centroid connectors
- Poor volume-delay functions
- Constrained minimum and maximum speeds
- Not enough traffic counts by direction and time period for even minimal validation
Traffic Assignment Findings

• Tighter convergence is useful and achievable with published methods
• Deployed models have substantial convergence error and yield spurious project impacts
• The degree of convergence that is useful is problem-dependent and can be assessed through straightforward comparisons
• Basic errors in network assignment models are fairly widespread even in the better models
## Impacts with Different Modeling Protocols

<table>
<thead>
<tr>
<th>Highway assign Rel. Gap</th>
<th>Type of model run</th>
<th>$\Delta$ AM VMT (Project-base)</th>
<th>$\Delta$ AM VHT (Project-base)</th>
<th>$\Delta$ AM veh trips (Project-base)</th>
<th>$\Delta$ AM Transit trips (Project-base)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5e-4</td>
<td>Highway AM assignment only</td>
<td>-33,360</td>
<td>-14,035</td>
<td>0</td>
<td>N/A</td>
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<tr>
<td>1.E-5</td>
<td>Highway AM assignment only</td>
<td>-56,950</td>
<td>-3,172</td>
<td>0</td>
<td>N/A</td>
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<tr>
<td>1.E-6</td>
<td>Highway AM assignment only</td>
<td>-56,850</td>
<td>-3,179</td>
<td>0</td>
<td>N/A</td>
</tr>
<tr>
<td>5e-4</td>
<td>Single loop run of ABM</td>
<td>-18,324</td>
<td>-1,262</td>
<td>+700</td>
<td>+1167</td>
</tr>
<tr>
<td>1.E-6</td>
<td>Single loop run of ABM</td>
<td>-28,519</td>
<td>-1,644</td>
<td>+275</td>
<td>+30</td>
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<tr>
<td>5e-4</td>
<td>Full model with feedback</td>
<td>-17,582</td>
<td>-1,214</td>
<td>+658</td>
<td>+1161</td>
</tr>
<tr>
<td>1.E-5</td>
<td>Full model with feedback</td>
<td>-33,774</td>
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<td>+88</td>
<td>+1004</td>
</tr>
<tr>
<td>1.E-6</td>
<td>Full model with feedback</td>
<td>-26,197</td>
<td>-1,565</td>
<td>+390</td>
<td>+43</td>
</tr>
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</table>
Model outputs were compared with 3 sources of commercial data.

HERE real time data were harvested for comparisons at the traffic message channel (TMC) level.

INRIX archival link data were used for MAG model comparisons.

Google data were queried for travel times to the CBD and District to district O-D times.
Comparison of MAG model & HERE Speeds

MAG Arterials and Collectors Suburban Area Type

Model_Speed
HERE_SPEED

%RMSE=21.72
Comparison of ARC and Google Times to the CBD
District to District AM O-D times for ARC

MCD-to-MCD travel times for ARC AM time period

%RMSE = 11.87
Congested Travel Time Comparisons

- MPO models do a poor job of matching measured congested travel times from commercial sources
- In general, modeled auto travel times are higher than the those that are measured
- Consequently, VHT tends to be overstated by models
- Performance measurement should not be based on modeled speeds from MPO models
Some Observations & Conclusions

- MPO models are continuously changing so characterizations are dated as soon as made.
- Estimates of project impacts vary significantly with assignment convergence levels.
- More convergence is needed, but convergence is, by itself, not enough.
- Better practices and better quality control are required.
- So are better modeled speeds and better validation.
- Existing methods appear to be able to resolve project impacts including the highway impacts of transit projects when properly implemented.
- Models need to provide evidence of their efficacy.
The project final report can be downloaded from


or