A Systematic Traffic Balance Method in Network Levels
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Introduction

• Traffic counts are critical information for model calibration and validation
• There are significant amount of inconsistencies in traffic counts
  • Collected in different day/month/year
  • Collected by different agencies
  • Collected by faulty devices
  • Standardized by different local factors
  • Etc...
• It is necessary to reconcile the traffic counts
  • Improving model performance
  • Better OD estimation
Current traffic count balance practices

- Excel spreadsheet method
- Geocount on-line tool (https://geocounts.com/)
- Weakness:
  - Time consuming for organizing counts in topological orders
  - Tremendous manual work on balance and no unique solution (Spreadsheet)
  - Single corridor level balance
  - No batch mode option (one directional corridor/one time period)
Proposed traffic balance method framework

Traffic counts extractor

Least-square based traffic count balance model
Traffic count extractor I (Corridor Level)

- **Methodology**
  - Based on Depth-First-Search Algorithm (DFS)
  - Output link counts in a proper topological order
  - Users need to fill up missing ramp counts with the counts from other sources

\[
\begin{align*}
\text{Cnt1} & = 1 \\
\text{Cnt2} & = 2 \\
\text{Cnt3} & = 3 \\
\text{Cnt4} & = 4
\end{align*}
\]
Traffic count extractor II (Node Level)

• Methodology
  • Identify all the nodes in network with complete observed counts in all the connected links
  • The nodes could be intersections/normal connection nodes

\[
\text{SUM(In Counts)} = \text{SUM(Out Counts)}
\]
Traffic count extractor(Interface)

- Corridor level:
  - Starting/Ending links
  - Facility type for main line and Ramp

- Node level:
  - Automatically extracting all qualified nodes and link counts from networks
Traffic count extracting result

- **Corridor level**
  - 10 corridors (20 directional corridors)
  - 1,129 Links with counts
  - 339 basic segments

- **Node level**
  - 373 nodes
  - 1,295 links with counts
  - 373 basic segments
Traffic balance model

Assumption: Traffic counts reflect most of the real traffic information, therefore the adjustment (Adj%) should be minimized

\[ \text{Obj} = \min \left( \sum W \ast \left( \frac{\text{Count}_{\text{Bal}} - \text{Count}_{\text{Obs}}}{\text{Count}_{\text{Obs}}} \right)^2 \right) \]

Subject to:

- Count conservation constraint by location
- Count conservation constraint by time

GAMS software is used for the optimization:
free for the problem with up to 300 variables and 300 constraints. A free trial license can also be requested.

Advantage:
- Count confidence level
- Batch mode (TOD), faster
- Convex problem, global solution
Single corridor results (I4 Eastbound)

<table>
<thead>
<tr>
<th>Station</th>
<th>Direction</th>
<th>Type</th>
<th>Missing Count</th>
<th>Balanced Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>02</td>
<td>Off</td>
<td>Off</td>
<td>450</td>
<td>0</td>
</tr>
<tr>
<td>12</td>
<td>Off</td>
<td>On</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>22</td>
<td>Off</td>
<td>Off</td>
<td>450</td>
<td>0</td>
</tr>
<tr>
<td>32</td>
<td>Off</td>
<td>Off</td>
<td>450</td>
<td>0</td>
</tr>
<tr>
<td>42</td>
<td>Off</td>
<td>Off</td>
<td>450</td>
<td>0</td>
</tr>
</tbody>
</table>

Input count data

Missing Count

Balanced Count
I4 EB traffic balance result (Daily)
<table>
<thead>
<tr>
<th>Order</th>
<th>Station</th>
<th>Direction</th>
<th>Type</th>
<th>A</th>
<th>B</th>
<th>Org Cnt</th>
<th>Bal Cnt</th>
<th>DeltaCnt%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>160103</td>
<td>EB</td>
<td>M</td>
<td>88212</td>
<td>81185</td>
<td>66,927</td>
<td>54,778</td>
<td>-18%</td>
</tr>
<tr>
<td>2</td>
<td>974009</td>
<td>EB</td>
<td>Off</td>
<td>81185</td>
<td>81113</td>
<td>450</td>
<td>452</td>
<td>0%</td>
</tr>
<tr>
<td>3</td>
<td>974008</td>
<td>EB</td>
<td>On</td>
<td>81141</td>
<td>81088</td>
<td>450</td>
<td>448</td>
<td>0%</td>
</tr>
<tr>
<td>4</td>
<td>161005</td>
<td>EB</td>
<td>M</td>
<td>81088</td>
<td>81173</td>
<td>52,256</td>
<td>54,774</td>
<td>5%</td>
</tr>
<tr>
<td>5</td>
<td>167101</td>
<td>EB</td>
<td>Off</td>
<td>81173</td>
<td>81247</td>
<td>7,145</td>
<td>7,248</td>
<td>1%</td>
</tr>
<tr>
<td>6</td>
<td>167102</td>
<td>EB</td>
<td>On</td>
<td>81247</td>
<td>81125</td>
<td>2,800</td>
<td>2,752</td>
<td>-2%</td>
</tr>
<tr>
<td>7</td>
<td>160117</td>
<td>EB</td>
<td>M</td>
<td>81125</td>
<td>81189</td>
<td>52,486</td>
<td>50,278</td>
<td>-4%</td>
</tr>
</tbody>
</table>
Network level traffic balance

- **Assemble** all the corridor level and node level count data together into one balance model
  - Model can be easily scaled up due to its structure
  - Special treatment for the shared links from different systems
  - Some weight factor adjustment might need
- **Problem Scale: 10,120 variables and 712 constrains**
- **Performance:**
  - Computation is efficient, finished within 10 mins
  - Systematic consistent count balance result in network level
CFRPM network level balance result (Daily)

<table>
<thead>
<tr>
<th>abs(Adj)%</th>
<th>Numbe of Links</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%-10%</td>
<td>2,891</td>
<td>86%</td>
</tr>
<tr>
<td>10%-20%</td>
<td>286</td>
<td>8%</td>
</tr>
<tr>
<td>20%-30%</td>
<td>96</td>
<td>3%</td>
</tr>
<tr>
<td>30%-40%</td>
<td>44</td>
<td>1%</td>
</tr>
<tr>
<td>40%-50%</td>
<td>19</td>
<td>1%</td>
</tr>
<tr>
<td>50%-60%</td>
<td>17</td>
<td>1%</td>
</tr>
<tr>
<td>60%-70%</td>
<td>18</td>
<td>1%</td>
</tr>
<tr>
<td>70%-80%</td>
<td>2</td>
<td>0%</td>
</tr>
<tr>
<td>80%-90%</td>
<td>3</td>
<td>0%</td>
</tr>
<tr>
<td>90%-100%</td>
<td>4</td>
<td>0%</td>
</tr>
</tbody>
</table>
Summary

• A systematic method framework for traffic balance in network level
  • Link count extractor
  • Rigorous mathematic model for traffic balance
  • Efficient and effective way to solve the network-level traffic balance problem

• Future studies
  • Looking for some mathematic solver from open-sourced software packages
  • Improve the traffic count extractor for network levels
  • How to deal with the missing counts more effectively
Single Corridor/Node level balance

• Help user to make sure the link topological order is correct.

• Help user to identify the abnormal traffic count (large adjustment), and correct them
Traffic Balance Model (Interface)

- Create corridor Scenarios (Copy the templates)
- Prepare Corridor balance input file (input files for GAMS)
- Run the traffic balance program and copy the result back to the spreadsheet.
# Weight factors (Confidence Information)

## Corridor level weight factors

<table>
<thead>
<tr>
<th>Description For Corridor</th>
<th>Main/Ramp</th>
<th>Daily/TOD</th>
<th>W/WO TOD</th>
<th>WeightValue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Mainline (W TOD)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Daily Mainline (WO TOD)</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Daily Ramp (W TOD)</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Daily Ramp (WO TOD)</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>TOD Mainline (W TOD)</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>TOD Mainline (WO TOD)</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0.5</td>
</tr>
<tr>
<td>TOD RAMP (W TOD)</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>TOD RAMP (WO TOD)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.5</td>
</tr>
</tbody>
</table>

## Node level weight factors

<table>
<thead>
<tr>
<th>Description For Node</th>
<th>Daily/TOD</th>
<th>WeightValue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Count</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>TOD Count</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>