Travel Time Reliability of Signalized Arterials – MacLeod Trail Case Study

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What is Travel Time Reliability?

- Consistency or dependability in travel times measured from:
  - Vehicle to vehicle (spatial)
  - Across different times of day
  - Day-to-day (temporal)

- Measures the extend of the unexpected delay
Why Travel Time Reliability?

- Average is not a good measure of reliability

http://ops.fhwa.dot.gov/perf_measurement/reliability_measures/index.htm
Why Travel Time Reliability?

- It captures the benefits of traffic management.

Before: Small improvement in average travel times

After: Larger improvement in travel time reliability

Before: Worst day of month

After: Worst day of month

http://ops.fhwa.dot.gov/perf_measurement/reliability_measures/index.htm
Problem Statement

- There are many travel time reliability analysis for freeways.
- None for signalized arterials.
- Traffic flow interrupted by:
  - Signals
  - Speed limit
  - Presence of parking
  - Construction
  - Pedestrian crossing
  - Transit stops
- No analysis for extreme travel time.
Objective of the Study

- Evaluating travel time reliability of signalized arterials (Case study: Macleod Trail, Calgary, AB)

Vehicle-to-vehicle distribution for:
- All events
- Extreme events
Data Source

• Time of day
• Road segment
• uncongested travel time
• Average speed
• Segment length
• 6 month data
• Travel Data updated every 5 minutes
• 6 AM – 12 PM
• 880,000 data entries in total
• 13,000 data entries for Macleod Trail
Framework

6:00-10:00 am

July 16

July 17

Jan 16

6:00 - 10:00 am
Freeway

- Linear relationship between standard deviation (SD) and mean for
  - Travel time
  - Travel delay

Signalized arterial

- Same linear relationship between standard deviation (SD) and mean for
  - Travel time
  - Travel delay
Extreme Delay Analysis

**Extremes events:**
- Located on the tail of PDF
- Very low probable events

**Models of extreme values:**

1. **Block Maxima**

2. **$R^{th}$ order statistic**

3. **Extremes exceed a high threshold**

   - **Artificial block selection**
   - **PDF:** Weibull, Frechet or Gumbel
   - **PDF:** Exponential, Pareto or Beta
1. Block Maxima (event based)

- Block length of 1 hour -> 6 blocks each day, 384 blocks in total
- Choosing highest travel time and delay event in each block

Gumbel

\[ F(x) = \exp \left( -\exp \left( \frac{0.31 - x}{0.042} \right) \right) \]

MAE = 0.062
Extreme Delay Analysis: Block Maxima

Cumulative probability

Delay (min/km)

Empirical Frechet (2p) Frechet (3p) Weibull (2p) Weibull (3p) Gumble Max

<table>
<thead>
<tr>
<th>Distribution</th>
<th>FRECHET (2P)</th>
<th>FRECHET 3P</th>
<th>WEIBULL (2P)</th>
<th>WEIBULL (3P)</th>
<th>GUMBLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAE</td>
<td>0.119</td>
<td>0.585</td>
<td>0.071</td>
<td>0.063</td>
<td>0.062</td>
</tr>
</tbody>
</table>
Extreme events

- linear relationship between standard deviation (SD) and mean for
  - Travel time
  - Travel delay
Vehicle-to-vehicle distribution of signalized arterials is evaluated using INRIX data

Linear relationship between SD and mean of all travel time and delay were observed
- Highly positive correlation for travel time ($R^2 = 0.727$)
- Low positive correlation for travel delay ($R^2 = 0.343$)

Linear relationship between SD and mean of extreme travel time and delay were observed
- Low positive correlation for travel time ($R^2 = 0.235$)
- Low positive correlation for travel delay ($R^2 = 0.264$)

Gumbel distribution fits the best to the extreme vehicle-to-vehicle travel delays
Thank you

Questions??