Which validation is more valid?

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Introduction

- How to collect data for validation?
- A potential surrogate $X$ in road network...
  - Overall validation (correlate $X$ and accident frequency)
  - Define safe/unsafe roads, collect $X$, estimate cut-off value
  - Define a cut-off value and check the relationship to safety
  - Naturalistic driving study (safe behaviour $\rightarrow$ safe $X$ values)
Desired validation results...
Examples

- Floating car data
  - Company vehicle fleets, GPS + IMU

- Example analyses
  - Speeds
  - Accelerations
  - Jerks
Example 1: Speed consistency

- Theory: unsafe (unexpected) curves $\rightarrow$ hard braking
  - Speed consistency $dV = V_{\text{curve}} - V_{\text{tangent}}$
  - Negative $dV =$ braking (the less $dV$, the more risk)
- GPS data in 509 tangent-curve pairs (with 100+ drives)
- Safety level (6 yrs acc.) estimate adjusted by accident prediction model $\rightarrow$ empirical Bayes estimate ($EB$)
Approach 1: Overall validation

- Relationship between \( dV \) and \( EB \) ?
- No correlation
Approach 2: Safe roads → safe consistency?

- Using pivot tables
- The higher risk, the smaller sample
- Sign of trend, but no clear $dV$ threshold

<table>
<thead>
<tr>
<th>EB</th>
<th>avg $dV$</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>-1.27</td>
<td>252</td>
</tr>
<tr>
<td>1-2</td>
<td>-1.74</td>
<td>190</td>
</tr>
<tr>
<td>2-3</td>
<td>-3.60</td>
<td>42</td>
</tr>
<tr>
<td>3-4</td>
<td>-2.50</td>
<td>12</td>
</tr>
</tbody>
</table>

![Graph showing average $dV$ across different EB categories]
**Approach 3: Is there a cut-off value of $dV$?**

- Sample again limited on borders
- Cut-off at –20 km/h, consistent with past research

<table>
<thead>
<tr>
<th>$dV$</th>
<th>avg EB</th>
<th>$n$</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; -20</td>
<td>2.84</td>
<td>6</td>
</tr>
<tr>
<td>-20 ... -11</td>
<td>1.35</td>
<td>25</td>
</tr>
<tr>
<td>-10 ... -1</td>
<td>1.27</td>
<td>272</td>
</tr>
<tr>
<td>0-9</td>
<td>1.22</td>
<td>190</td>
</tr>
<tr>
<td>10-19</td>
<td>1.04</td>
<td>12</td>
</tr>
<tr>
<td>&gt; 20</td>
<td>0.80</td>
<td>4</td>
</tr>
</tbody>
</table>

![Bar chart showing average EB values for different $dV$ intervals.](chart.png)
Example 2: Accelerations

\( a_x \) … braking/accelerating
\( a_y \) … left/right turns

- Various risk space definitions
- Combined with speed and jerks:
  - Speed \( \leq 80 \text{ km/h} \) and acceleration norm \( > 0.6 \text{ g} \) and jerk \( > 2 \text{ g/s} \),
  - Speed \( > 80 \text{ km/h} \) and acceleration norm \( > 0.5 \text{ g} \) and jerk \( > 2 \text{ g/s} \),
  - Speed \( > 100 \text{ km/h} \) and acceleration norm \( > 0.4 \text{ g} \) and jerk \( > 2 \text{ g/s} \).
Example 3: Jerks

Rate of change of deceleration (da/dt)

- 21 jerk value thresholds were evaluated in the sensitivity analysis (...) The jerk-rate was then compared to the crash rate for each segment (Mousavi et al., 2015)

- The threshold value X was varied from 0.50 ft/s$^3$ to 2.75 ft/s$^3$ with an increment of 0.25 ft/s$^3$ (Pande et al., 2017) ... 10 thresholds

- Theory-based or data-based?
Summary

Larger ("cheap") studies

- Using other party datasets, such as vehicle fleet data
- One can remove outliers, select subsets…

Smaller ("expensive") studies

- Not network-wide
- For example traffic conflict studies: mostly 1 site only
Conclusions  Discussion

“Which validation is more valid?”

- Validation approach depends on amount of available data
- Big data → “data mining”
- Small “expensive” data → ???
- Product / process validation
Thank you for your attention

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