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Shark Tank Poster Competition

SPATIAL ANALYSIS AND BAYESIAN MODELS TO IDENTIFY AND ANALYZE PEDESTRIAN CRASH HOTSPOTS

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Objective and Study Location

Objective

• To identify pedestrian crash hotspots
• To answer the following question: do locations with *specific pre-conditions* have a higher probability of becoming a pedestrian crash hotspot?

Study Location

• Miami-Dade County, Florida

Research Approach

1. Apply Network-based Kernel Density Estimation (NKDE) approach in ArcGIS to identify pedestrian crash hotspots
2. Select the important pedestrian crash contributing factors using Random Forests approach
3. Use Bayesian Random-effect Complementary Log-log model to determine the factors that influence the probability of a road segment identified as a potential hotspot
Network-based Kernel Density Estimation

- Estimates the density of point events (e.g., pedestrian crashes) over a one dimension (1-D) network space.
- Determines the spread of risk of a crash, i.e., the area around a cluster in which there is an increased likelihood for a crash to occur based on spatial dependency.
- Simple and easily applicable in ArcGIS.
Random Forests Approach

- Used to estimate prediction performance and quantify variable importance.
- Tests how worse the model would perform without each variable.
- The *variable importance plot* tells how important variables are in classifying the data.
# Bayesian Clog-log Model Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Variable Category</th>
<th>Mean</th>
<th>Median</th>
<th>SD</th>
<th>2.5% Interval (%)</th>
<th>97.5% Interval (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td></td>
<td>-4.744</td>
<td>-4.688</td>
<td>0.795</td>
<td>-6.457</td>
<td>-3.353</td>
</tr>
<tr>
<td>Density of bus stops</td>
<td></td>
<td>0.263</td>
<td>0.259</td>
<td>0.054</td>
<td>0.171</td>
<td>0.380</td>
</tr>
<tr>
<td>Density of shopping centers</td>
<td></td>
<td>0.802</td>
<td>0.788</td>
<td>0.187</td>
<td>0.478</td>
<td>1.207</td>
</tr>
<tr>
<td>Density of health facilities</td>
<td></td>
<td>0.862</td>
<td>0.839</td>
<td>0.302</td>
<td>0.334</td>
<td>1.518</td>
</tr>
<tr>
<td>Density of hotels</td>
<td></td>
<td>0.216</td>
<td>0.207</td>
<td>0.110</td>
<td>0.027</td>
<td>0.459</td>
</tr>
<tr>
<td>Density alcohol sales establishments</td>
<td></td>
<td>1.163</td>
<td>1.120</td>
<td>0.480</td>
<td>0.346</td>
<td>2.221</td>
</tr>
<tr>
<td>Income (%)</td>
<td>0-24 (low)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>25-50 (medium)</td>
<td>1.506</td>
<td>1.476</td>
<td>0.401</td>
<td>0.808</td>
<td>2.377</td>
</tr>
<tr>
<td></td>
<td>&gt;50 (high)</td>
<td>1.205</td>
<td>1.177</td>
<td>0.436</td>
<td>0.423</td>
<td>2.137</td>
</tr>
<tr>
<td>Land-use</td>
<td>Residential &amp; Institutional</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Commercial &amp; recreational</td>
<td>0.222</td>
<td>0.215</td>
<td>0.289</td>
<td>-0.336</td>
<td>0.806</td>
</tr>
<tr>
<td></td>
<td>Less pedestrian activity</td>
<td>-1.959</td>
<td>-1.904</td>
<td>0.802</td>
<td>-3.683</td>
<td>-0.533</td>
</tr>
<tr>
<td>Sidewalk presence</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>0.831</td>
<td>0.809</td>
<td>0.310</td>
<td>0.281</td>
<td>1.497</td>
</tr>
</tbody>
</table>

Note: SD = Standard Deviation, Significant variables are bolded.
Conclusions

• Specific pre-conditions of the built environment influence road segments becoming a hotspot.
  • Bus stops
  • Shopping centers
  • Bars
  • Health facilities
  • Hotels
  • Residential & Institutional areas
  • Sidewalk presence
  • Income level

• This study has provided simple and yet novel statistical tools to identify pedestrian crash hotspots, and the contributing factors that influence high pedestrian crash occurrence.

• Planners and engineers could use the methodological framework and findings of this study to identify high risk locations and develop targeted proactive countermeasures to reduce the occurrence of pedestrian crashes.