PASSAGE

A Travel Safety Assistant
CSE 6242 Fall ‘15 Capstone Project

Team
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Advisor
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**PROBLEM**

- Atlanta is one of the most crime-ridden cities in U.S.A.

- Pedestrians are highly susceptible to crime, especially at night.
Clery Act Safety Alert
Armed Robbery

Incident Date/Time: December 30, 2014, at approximately 6:15 p.m.

Incident Location: Hemphill Avenue, NW near Center Street Apartments

Incident Description: A student reported to the Atlanta Police Department that while walking north on Hemphill Avenue, just north of the Georgia Tech Police Department, he was approached by a black male who brandished a handgun and demanded the student's phone. When the student refused to give the suspect his phone, the suspect fired the weapon in the direction of the student. The student began to approach the male, who retreated to a black 4-door sedan that was parked a short distance away. As the student continued to approach the male, he fired a second shot in the direction of the student before climbing into the passenger seat. The vehicle was last seen heading northbound on Hemphill Avenue. The student believed the gun might have been loaded with blanks.

After the incident, the student continued walking north on Hemphill Avenue before deciding to contact the police approximately ten to fifteen minutes later. The student met with Atlanta Police and Georgia Tech Police at the McDonald’s on Northside Drive, where officers began to canvas the surrounding area. Investigators are currently processing the crime scene.
OBJECTIVES

- Enhance walking safety by providing routes with less crime risk
- Provide risk-distance trade-off path choices to users
- Enable safety alert to friends when user is in distress
ANALYTICS BUILDING BLOCKS

Collection
Cleaning
Integration
Analysis
Visualization
Presentation
Dissemination
CRIME DATA

- Atlanta Police Department website
- 2009 → 2015
- ~ 250k crimes
- All crime data in CSV format
CLASSES OF CRIMES

Legend

<table>
<thead>
<tr>
<th>Class</th>
<th>Count (2009 - 2015)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LARCENY-FROM VEHICLE</td>
<td>64345</td>
</tr>
<tr>
<td>LARCENY-NON VEHICLE</td>
<td>55902</td>
</tr>
<tr>
<td>BURGLARY-RESIDENCE</td>
<td>38277</td>
</tr>
<tr>
<td>AUTO THEFT</td>
<td>33256</td>
</tr>
<tr>
<td>AGG ASSAULT</td>
<td>16388</td>
</tr>
<tr>
<td>ROBBERY-PEDESTRIAN</td>
<td>12483</td>
</tr>
<tr>
<td>BURGLARY-NONRES</td>
<td>7243</td>
</tr>
<tr>
<td>ROBBERY-RESIDENCE</td>
<td>1632</td>
</tr>
<tr>
<td>ROBBERY-COMMERCIAL</td>
<td>1575</td>
</tr>
<tr>
<td>RAPE</td>
<td>789</td>
</tr>
<tr>
<td>HOMICIDE</td>
<td>592</td>
</tr>
</tbody>
</table>
MAP DATA

- OpenStreetMap of Atlanta
- Downloaded using Mapzen metro extracts
## Data is usually messy!

<table>
<thead>
<tr>
<th>offense_id</th>
<th>occur_date</th>
<th>occur_time</th>
<th>location</th>
<th>Shift</th>
<th>UC2 Literal</th>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>90360664</td>
<td>02/03/2009</td>
<td>13:50:00</td>
<td>55 MCDONOUGH BLVD SW</td>
<td>Day</td>
<td>LARCENY-NON</td>
<td>-84.38654</td>
<td>33.72024</td>
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<tr>
<td>91681984</td>
<td>06/17/2009</td>
<td>14:00:00</td>
<td>375 AUBURN AVE</td>
<td>Day</td>
<td>LARCENY-NON</td>
<td>-84.37521</td>
<td>33.7554</td>
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<tr>
<td>80081069</td>
<td>01/08/2008</td>
<td>13:14:00</td>
<td>447 ARNOLD STREET</td>
<td>NE</td>
<td>BURGLARY-RE</td>
<td>-84.36896</td>
<td>33.76658</td>
</tr>
<tr>
<td>82040835</td>
<td>07/21/2008</td>
<td>18:00:00</td>
<td>1721 BROWNING ST</td>
<td>Eve</td>
<td>BURGLARY-RE</td>
<td>-84.44342</td>
<td>33.75265</td>
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<tr>
<td>82922120</td>
<td>10/19/2008</td>
<td>18:30:00</td>
<td>3393 PEACHTREE ROAD</td>
<td>Eve</td>
<td>AUTO THEFT</td>
<td>-84.36212</td>
<td>33.84676</td>
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<tr>
<td>83271617</td>
<td>11/22/2008</td>
<td>16:00:00</td>
<td>106 DOGWOOD DR NW</td>
<td>Eve</td>
<td>BURGLARY-RE</td>
<td>-84.49389</td>
<td>33.78241</td>
</tr>
</tbody>
</table>
Integration of 2 datasets

City Crime Data – available by coordinates and time of day

City Map Data – in OpenStreetMap format
MAP DATA

- Converted to a graph using osm4routing
- Graph consists of nodes on every road segment in the city
- Nodes on the same road segment are successively connected by edges
- Nodes: 111,380
- Edges: 141,656
MAP DATA - EDGE LENGTH

Walkable Distance

- Skewed right with a mean of ~215m
- Majority of edges being under 150m
- Maximum 400m–500m
RISK OF EDGES

- Assign risk values to nodes based on crime density
- Assign risk values to edges based on node values
- Each edge has both a distance and risk value

[Diagram showing nodes and edges with labels Map Node and Crime Node]
OPTIMAL PATHS

Pulse algorithm

- shortest distance, more risk → least risk, more distance
- pruning algorithm
- outputs all dominant paths
TRADEOFF ANALYSIS

- Left Plot:
  - Ratio of Least-Risk-Path’s distance to the Shortest-Distance-Path’s distance
  - mean: 1.13
- Right Plot:
  - Ratio of Shortest-Distance-Path’s risk to the Least-Risk-Path’s risk
  - mean: 1.58
- Takeaway
  - Going from SDP to LRP produces a larger proportional decrease in risk than the proportional increase in distance
RUNTIME ANALYSIS

400 recorded runtime instances

Statistics (seconds)

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean</td>
<td>1.22</td>
</tr>
<tr>
<td>SD</td>
<td>0.51</td>
</tr>
<tr>
<td>max</td>
<td>6.8 (not shown)</td>
</tr>
<tr>
<td>min</td>
<td>1.15</td>
</tr>
</tbody>
</table>
TECHNOLOGY

- MongoDB  (Storing graph data, geospatial indexing)
- Apache Spark  (Preprocessing)
- Python 2.7  (Preprocessing / Back-end)
- Node.js  (Back-end)
- Phonegap – HTML/JS  (Front-end)
Collection  Cleaning  Integration  Analysis  Visualization  Presentation
Collection  Cleaning  Integration  Analysis  Visualization  Presentation
Alice and Bob login

Alice requests Bob to track her

Bob receives a notification from Alice

Alice confirms her destination

The algorithm offers Alice multiple routes which range from shortest (pink) to safest (green)

Alice starts “safe mode” and places her thumb on the screen

Bob will be notified if Alice removes her thumb, signaling distress
PASSAGE: A Travel Safety Assistant With Safe Path Recommendations For Pedestrians

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Figure 1: Paths recommended by PASSAGE

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Abstract

Atlanta has consistently ranked as one of the most dangerous cities in America with over 2.5 million crime events recorded within the past six years. People who commute by walking are highly susceptible to crime here. To address this problem, our group has developed a mobile application, PASSAGE, which includes crime data to find "safe paths" in Atlanta. 

Author Information

Safe Path by Pulse

ACM  
H.5.2  
User interface theory and systems design

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PASSAGE

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