Integration of Social Network Analysis (SNA) and Spatial Analysis (GIS)

Philadelphia Police Department

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Outline

• Overview of Analytics and Intelligence Bureau

• Analysis of Shootings by Combining Social Network Analysis and Spatial Analysis

• Analyzing Social and Geographic Gang Connections
Overview of Analytics at the PPD
Philadelphia Police Department Intelligence Bureau
Research & Analysis Unit
“It’s all about the data”
Evidence-based Policing

“We must understand what works, how it works, when it works, and where it works. The answers to these questions provide the foundation for “evidence-based” policing strategies.”

- **Research-based Evaluations (Smart Policing Initiative)**
  - Philadelphia Foot Patrol Experiment: A Randomized Controlled Trial of Police Patrol Effectiveness in Violent Crime Hotspots (Criminology, 2011)
    - Temple University (Ratcliffe, Taniguchi, Groff, Wood)
    - Results: 20% reduction of violent crime in comparison to control areas

- **Philadelphia Policing Tactics Experiment**
  - Temple University (Ratcliffe, Haberman, Groff, Sorg, Joyce, Taylor)
  - Tested Foot Patrol, Problem Oriented, and Offender Focused Approaches in 81 experimental places
  - Results: Need greater analysis capacity for Problem solving. **Offender focused strategies achieved 40% reduction**

- **Hypothesis Testing with Patrol Operations (Problem Solving)**
  - Temple University (Ratcliffe)
  - Crime-focused, scientific method of problem solving through advanced training of uniformed crime analysts and police supervisors. The PPD will develop a model for long-term crime reduction strategies through this scientific decision-making process
  - Results: On-going, however preliminary findings demonstrate difficulty with getting Patrol Ops to focus on crime prevention and not be reactive. Exploring use of central unit to drive the process.

**Other Evaluations**

- Predictive Policing Strategies RCT (Ratcliffe/Hunchlab)
- Acoustic Gunshot Sensor RCT (Ratcliffe)
- Focused Deterrence (Roman)
- Body Cameras (Groff/Wood)
- Ugh…the time these take!
Decentralized Analysis Model

- **Research & Analysis Unit (pre-2017)**
  - GIS Team (4)
  - Stat Team (5)
  - Analysis Team (4)

- **Analysis Coordinator Program**
  - 26 Police Officers
  - 10 Detectives
  - Direct reports to local command
  - Annual ArcGIS and web app training, began with Temple (Ratcliffe) now done in-house
  - R&A as “tech/analysis support”.
  - Blending cops and civilians gives the best of both worlds.
  - Central group doesn’t take “credit” for the support work. Keeps the analysts in operations coming back.
Philadelphia Police Department Intelligence Bureau
Chief Inspector Daniel MacDonald

Inspector Walter Smith
Strategic Intelligence & Information Sharing Division
- Research and Analysis Unit
  - Information Sharing Squad
  - Crime & Homeland Security Squad (Intel Analysis)
  - Strategy, Research & Evaluation Section
  - GIS & Business Intelligence Section
  - Statistics Section
- Real-Time Crime Center
- HIDTA Watch Center
- Federal Partner Integration

FBI • ATF • DHS • SEPTA • DRPA • Coast Guard • Customs/BP

• Inspector Michael McCarrick
  - Intelligence Division
• Collection Division
• Criminal Intelligence Unit
• Social Media Team
• Juvenile Enforcement Teams
- Philadelphia Police Department, Research and Analysis Unit
  - Analysis & Investigations Section (Operational / Tactical)
    - Information Sharing Squad
      - RFI's, Threat Assessments, TSC, Event Operations, “Fusion”
  - Crime and Homeland Security Squad (Intelligence or “Qualitative” Analysis)
    - Gangs, Counter-Terrorism, CIKR, Narcotics, Human Trafficking, Cyber
- Strategy, Research & Evaluation Section (Strategic / “Quantitative” Analysis)
- Statistics Section (Administrative / Crime Reporting)
- GIS & Business Intelligence (Data Aggregation / App Development / Data Sharing
• Philadelphia Police Department, Research and Analysis Unit
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*Human Source Information is just another dataset – Critical thinking, “scientific thinking”, remains the same*

  – Strategy, Research & Evaluation Section (Strategic / “Quantitative” Analysis)

  – Statistics Section (Administrative / Crime Reporting)

  – GIS & Business Intelligence (Data Aggregation / App Development / Data Sharing
Analysis of Shootings by Combining Social Network Analysis and Spatial Analysis

George Kikuchi
Welcome to the Link Analysis Search. With this application, you can view a Known Associate Network and the associated Arrest/Stop records. To begin, enter a valid PPN ID and select a Degree of Separation. You can search up to three PPNs. Add a PPN to the Search Collection using the gray icon next to the search bar.
Link Analysis App
Bosses’ requests

• Can we search multiple individuals at once?
  Yes

• Can we dump all shooting victims in a given time frame to the link analysis app
  .... Yes

• ... and plot the result on the map
  .................... Yes
- Dots represent shooting victims
- Everyone with the same color belong to the same network (within 1 degree)
• Dots represent shooting victims
• Everyone with the same color belong to the same network (within 1 degree)
Connections across districts and divisions

Detective Units are organized by 6 Divisions
Research Question and Hypothesis

• Besides social connection, what similarities exist among these connected victims?
  – Demographics
  – Criminal History
  – Location
  – Circumstances (underlying crime & weapons)
  – Arrests
  – Offenders

• H: Connected incidents are more similar than random incidents
Methodology

• Approach 1: Cross-tabs

• Approach 2: simulation
  – Calculate similarity index for observed data
  – Compare the above observed pattern with randomly paired shootings and run simulation

• Unit of analysis
  – grouped shootings (e.g., 283 connected shooting groups)

• Time period: 2005 – 2016
  – 17,700 victims (or 1,600 victims / year)
# of shooting victims that have connections (within 1 degree & 60 days)

Appx. 5%
900 victims over 11 years
# of connected shooting victims across divisions

Cross-Division connections = appx. 40%
Race:
Connected Incidents

- 90% of the connected incidents involved single race alone
- 82% were African American victims
African American victim incidents were 3% more likely to be connected than Caucasian victim incidents.
Sex:
Connected Incidents

- 96% of the connected incidents involved male only
- 92% of shooting victims in general are male in Philadelphia
Male victim incidents were 7% more likely to be connected than female victim incidents.
Criminal Circumstance: Connected Incidents

- 10% of the connected incidents were part of robbery
Criminal Circumstance: Connected vs. Non-Connected Incidents

Robbery/Shootings were 3% less likely to be connected than non-robbery shootings.
Victim’s Gun Crime Priors: Connected Incidents

- 75% of the connected incidents involved victims with gun crime priors.
Victim’s Narcotics Priors: Connected Incidents

- 85% of the connected incidents involved victims with narcotics priors
In 38% of the connected incidents, at least one incident occurred within a gang boundary.
Incidents occurring within a gang boundary were 3% more likely to be connected than other, non-gang shootings.
In 50% of the connected incidents, at least one incident has an arrest.
Descriptive Findings:

Summary

• About 5% of shooting victims have social connections
  – 1 degree of separation and incidents happening within 60 days
• A considerable proportion of connections crosses divisional boundaries (40%)
• Most of the connected incidents involve single race and sex
• Underlying circumstance of the connected incidents is not likely to be robbery
Implications

• We may be able to know quite a bit about victims and their network, if not already
  – 70% of shooting victims in general has prior arrests
  – >75% of the shooting victims that are connected have gun crime and narcotics priors
  – In about half of the connected shooting victim network, at least one arrest has been made
  – Cursory visual inspections also indicate abundant active warrants among victim network
Future Directions and Challenges

• Developing an application and procedure to provide investigative leads

• Challenges
  – Culture
  – Resistance to change
  – Analytical technology may not mix well with investigative work
    • Detectives love information look-up resources (e.g., CLEAR, LexusNexus)
Analyzing Social and Geographic Gang Connections

Matthew Lattanzio
Geography and Gang Relationships

Research Focus: The connection between gangs, their social relationships and the resulting changes in local crime.
## Edge List

<table>
<thead>
<tr>
<th>type</th>
<th>date_connected</th>
<th>Gang1</th>
<th>Gang2</th>
</tr>
</thead>
<tbody>
<tr>
<td>arrest</td>
<td>12/3/2015</td>
<td>Gang 82</td>
<td>Gang 125</td>
</tr>
<tr>
<td>stop</td>
<td>4/4/2018</td>
<td>Gang 151</td>
<td>Gang 142</td>
</tr>
<tr>
<td>victim</td>
<td>10/14/2010</td>
<td>Gang 123</td>
<td>Gang 37</td>
</tr>
<tr>
<td>victim</td>
<td>12/3/2015</td>
<td>Gang 125</td>
<td>Gang 82</td>
</tr>
<tr>
<td>victim</td>
<td>7/24/2002</td>
<td>Gang 68</td>
<td>Gang 72</td>
</tr>
</tbody>
</table>
Each cell summarizes the known positive connections between members of the two involved gangs.
Pivot Table (Excel) of Negative Connections

The instances of known negative connections between gangs.
Positive Ties and Information Sharing

Many gangs in the city are heavily connected. The potential for sharing information between groups is vast.
Many gangs are also connected by violent conflicts. Some groups have multiple feuds and share common enemies.
Focus

• Gangs with cross-divisional ties may be more organized than those that only have same-division ties
  – Higher organization increases the danger of that gang.
Gaps

• Does an area experience more crime if local gangs have more positive relationships than negative?
• How many gang-on-gang incidents are tied personal conflicts rather than gang business?
• Does being loosely structured change the quality of the ties to other gangs?
  – Are the ties between structured gangs more professional?
Web Map App
Displaying Gang Relationship
Web Map App
Displaying Gang Relationship
Web Map App
Displaying Gang Relationship

• Part of the stack of analysis apps based on ArcGIS environment
  – Meets the auditing and security requirements
  – Integration with other online contents

• Future directions
  – Standardization of gang names
  – Daily updates
  – Incorporation of human intelligence
Contact Information

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