Data to Inform and Implement Policy and Practice: Homicide Investigations in Los Angeles, 1990-2010

Justice & Security Strategies, Inc.
UCLA
LAPD
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Overview

- Background and Context
- The Data
- Machine Learning
- Traditional Statistics Methods: Findings
Organizations Involved

• Justice & Security Strategies (JSS)
• LAPD
  • Robbery-Homicide Division (Detective Bureau)
  • South Bureau Homicide
• UCLA
  • Dr. P. Jeffrey Brantingham
  • Dr. Wei Wang
  • Dr. Andrea Bertozzi
Background and Context

- Funding from The Ahmanson Foundation and US Dept. of Justice
- Ahmanson – built the Library
- NIJ grant – Research funds for JSS and UCLA
  - Ended 12/2022
- BJA (SPI grant – LAPD and JSS)
  - End date -- 09/30/2023
In 2009 the FBI approached the LAPD about digitizing Murder Books.

Murder Books follow a consistent format:

- A compilation of multiple forms, files, notes, and written entries, per case.
- Maintained in 26 sections with specific information placed in each section.
- Homicide investigators follow this model across the Department.
## Data and Table of Contents

- Contains basic info about the case
  - Victim(s) name
  - Date of occurrence
  - LAPD division
  - DR number (unique identifier)
  - Assigned detectives

- Lays out the format for investigative notes and documents
  - Layout is consistent across LAPD
Data

- 4,111 optically scanned murder books that cover a 21-year period (1990-2010)
- 4,237 victims of homicides
machine learning
Machine-Learning Methods

- Machine Learning -- development of algorithms to construct knowledge graphs with little or no human supervision.

- Knowledge graphs offer a compact way to represent complex information.
  - What are the interactions associated with a homicide?
  - How do we link and demonstrate the associations?

- Let theory be our guide: Routine Activities Theory
  - Offender, Victim, and Setting
  - Homicides occur within a setting with an offender and victim

- Test the use of Knowledge Graphs to depict relationships: Does this method work?
<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Shooting Victims</th>
<th>Number of Homicides</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>1,821</td>
<td>359</td>
<td>2,180</td>
</tr>
<tr>
<td>2006</td>
<td>1,798</td>
<td>349</td>
<td>2,147</td>
</tr>
<tr>
<td>2007</td>
<td>1,584</td>
<td>281</td>
<td>1,865</td>
</tr>
<tr>
<td>2008</td>
<td>1,320</td>
<td>265</td>
<td>1,585</td>
</tr>
<tr>
<td>2009</td>
<td>1,072</td>
<td>206</td>
<td>1,278</td>
</tr>
<tr>
<td>2010</td>
<td>1,127</td>
<td>214</td>
<td>1,341</td>
</tr>
<tr>
<td>2011</td>
<td>1,066</td>
<td>206</td>
<td>1,272</td>
</tr>
<tr>
<td>2012</td>
<td>965</td>
<td>201</td>
<td>1,166</td>
</tr>
<tr>
<td>2013</td>
<td>814</td>
<td>182</td>
<td>996</td>
</tr>
<tr>
<td>2014</td>
<td>794</td>
<td>185</td>
<td>979</td>
</tr>
<tr>
<td>2015</td>
<td>919</td>
<td>191</td>
<td>1,110</td>
</tr>
<tr>
<td>2016</td>
<td>963</td>
<td>207</td>
<td>1,170</td>
</tr>
<tr>
<td>2017</td>
<td>835</td>
<td>204</td>
<td>1,039</td>
</tr>
<tr>
<td>2018</td>
<td>806</td>
<td>185</td>
<td>991</td>
</tr>
</tbody>
</table>
800-1,600 pages
2.5 million words
hundreds of items of evidence
dozens of evidence types
dozens of individuals
and DET2 arrived at crime scene, located at ADDRESS. Victim in street covered with sheet. Victim identified at scene by his Sister WIT as VICT, GENDER/ETHNICITY AGE. Victim had multiple gunshot wounds to his chest, back and possibly to BODYPART. I/O's conducted crime scene investigation See IR Report and Notes. Recovered evidence, two .45 caliber casings. Coroner's Investigator DET3 took charge of the victim's body and assigned Coroner's Case No. XXXX. DET1 took possession of two cell phones in victim's pockets and searched victim's MODEL MAKE, parked on west curb on ADDRESS. Provided victim's vehicle keys to WIT. SID Photographer NAME XXXX took photos that were directed by DET1, C # XXXX.

off-the-shelf & custom NLP tools for entity and event detection
rapid contextual search

node

node attributes

Victims were in their car in the drive thru at Churches Chicken at [Address].

[Person] Stopped their burgundy [Vehicle Brand] to talk to females in line.

Impounded victim's car, a Year-XXXX [Vehicle Appearance].
machine learning on graphs

knowledge graph

knowledge graph embedding

machine learning tasks

0.5623 0.1272 ... 0.0121 0.7767

0.5623 0.1272 ... 0.0121 0.7767

0.4435 0.0097 ... 0.6760 0.9974

0.4435 0.0097 ... 0.6760 0.9974

knowledge graph

knowledge graph embedding

machine learning tasks
legal & ethical framework

machine inferred link

backdoor path via setting
Traditional Statistical Methods
Murder Book Analysis

• # of Murder Books = 4,111
• # of victims = 4,237 (total sample)
  • Unit of analysis is based on victims rather than books/cases
• Predictors of solvability
  • Additional analyses using different models
Number of Victims by Year, 1990-2010
## Solved vs. Unsolved Cases of Murder Book Victims

<table>
<thead>
<tr>
<th>Case Status</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solved</td>
<td>2549</td>
<td>60.16%</td>
</tr>
<tr>
<td>Unsolved</td>
<td>1688</td>
<td>39.84%</td>
</tr>
<tr>
<td>Total</td>
<td>4237</td>
<td>100.0%</td>
</tr>
</tbody>
</table>
# Suspect Relationship to Victim, Solved and Unsolved Cases

<table>
<thead>
<tr>
<th>Suspect Relationship to Victim</th>
<th>Solved</th>
<th>Unsolved</th>
<th>Grand Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gang Related</td>
<td>942 (80.2%)</td>
<td>233 (19.8%)</td>
<td>1175 (100.0%)</td>
</tr>
<tr>
<td>Stranger/No Relationship</td>
<td>859 (88.8%)</td>
<td>108 (11.2%)</td>
<td>967 (100.0%)</td>
</tr>
<tr>
<td>Friend/Acquaintance</td>
<td>539 (88.2%)</td>
<td>72 (11.8%)</td>
<td>611 (100.0%)</td>
</tr>
<tr>
<td>Family</td>
<td>148 (94.3%)</td>
<td>9 (5.7%)</td>
<td>157 (100.0%)</td>
</tr>
<tr>
<td>Spouse/Cohabitant/Common Law/Dating</td>
<td>144 (95.4%)</td>
<td>7 (4.6%)</td>
<td>151 (100.0%)</td>
</tr>
<tr>
<td>Other</td>
<td>76 (95.0%)</td>
<td>4 (5.0%)</td>
<td>80 (100.0%)</td>
</tr>
<tr>
<td>Unknown</td>
<td>1888 (45.7%)</td>
<td>2245 (54.3%)</td>
<td>4133 (100.0%)</td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td>4596 (63.2%)</td>
<td>2678 (36.8%)</td>
<td>7274 (100.0%)</td>
</tr>
</tbody>
</table>
# Solved and Unsolved Cases by Weapon Used

<table>
<thead>
<tr>
<th>Weapon Used</th>
<th>Solved</th>
<th>Unsolved</th>
<th>Grand Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firearm</td>
<td>2116 (57.3%)</td>
<td>1578 (42.7%)</td>
<td>3694 (100.0%)</td>
</tr>
<tr>
<td>Knife</td>
<td>220 (83.7%)</td>
<td>43 (16.4%)</td>
<td>263 (100.0%)</td>
</tr>
<tr>
<td>Other</td>
<td>29 (72.5%)</td>
<td>11 (27.5%)</td>
<td>40 (100.0%)</td>
</tr>
<tr>
<td>Personal</td>
<td>180 (76.6%)</td>
<td>55 (23.4%)</td>
<td>235 (100.0%)</td>
</tr>
<tr>
<td>Unknown</td>
<td>4 (80.0%)</td>
<td>1 (20.0%)</td>
<td>5 (100.0%)</td>
</tr>
<tr>
<td>Grand Totals</td>
<td>2549 (60.2%)</td>
<td>1688 (39.8%)</td>
<td>4237 (100.0%)</td>
</tr>
</tbody>
</table>
Predictors of Solvability
Research Questions

- What are the leading predictors for solving homicides?
- What separates the solved and unsolved cases?
Methods

• Logit model for Clearances and Solvability
  • Dependent variable = Cleared (including cleared by other) / Not Cleared

• Homicide-Suicide and Domestic Homicides removed

• Separate models for all homicides and gun-involved homicides
  • All homicides = 4,054 victims in 3,939 incidents
  • Gun homicides = 3,588 victims in 3,480 incidents
Variables

- Variables entered in ‘Blocks’
  - Blocks represent additional information from investigation (building blocks)
  - Test significance of each block of variables

- Block 1 – Context and At-Scene
- Block 2 – Victim Demographics
- Block 3 – Additional Victim Information
- Block 4 – Circumstances of Incidents
- Block 5 – Evidence
Block 1: Context and at-Scene Findings

• Homicides occurring indoors had 83.5% higher odds of clearance than outside
• Homicides involving knives had 74.7% higher odds of clearance than those involving guns
• Homicides where victims were armed had 205.2% higher odds of clearance (odds over 3 times greater!)
Block 2: Victim Demographics

Findings

• Homicides with victims aged 0-14 had 115.8% higher odds of clearance (odds over double!) compared to homicides with victims 19-25.

• **Gun homicides** with female victims had 50% higher odds of clearance. No effect in all homicide model.

• Homicides with Latino victims had 20.3% lower odds of clearance compared to homicides with Black victims. No other race/ethnicity effects observed.
Block 3: Additional Victim Info

Findings

• Homicides where the victim was a known gang member had 18% higher odds of clearance. *Effects not seen in only-gun homicide model.*

• Homicides where the victim was homeless had 53.8% lower odds of clearance.

• Homicides where the victim was a known prostitute had 52.4% lower odds of clearance.
Block 4: Circumstances of the Incident Findings

• Homicides that are dispute-related have 438.5% higher odds of clearance (over 5 times greater!)

• Homicides where the victim was *unintended* had 141.8% higher odds of clearance (over 1.5 times greater!)

• No effects for drug-related, robbery, and gang-related circumstances
Block 5: ‘Evidence’ Findings

• Homicides where fingerprint evidence was collected had 29.3% higher odds of clearance

• Homicides where DNA evidence was tested had 315.4% higher odds of clearance (over 4 times greater!)
Block 5: ‘Evidence’ Findings

- Gun homicides where cellphone evidence was collected had 34.8% higher odds of clearance.

- Gun homicides where casings were collected had 30.5% higher odds of clearance.

- Gun homicides where casings were entered into NIBIN had 30.3% lower odds of clearance.

(NIBIN effect likely due to LAPD not using NIBIN extensively during the time period of study; NIBIN was unavailable.)
Implications

• Generally, each variable block increased prediction of clearance
  • More info collected on homicides, the better!

• Circumstances and evidence had particularly strong impacts on clearance
  • Demonstrates that detectives have an active role to play in solving homicides
Questions?

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