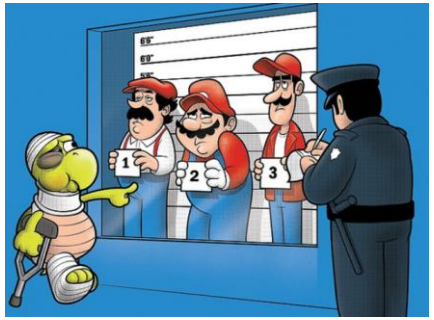
THE IMPACT OF DATA VISUALIZATION ON CRIME ANALYSIS

by Mina Aryaie

OUTLINE

- Introduction and key terms
- Why is data visualization important
- History of crime data visualization
- Data visualization in
  1. Crime scene
  2. Police line up
  3. Polygraph
  4. Geographic profiling
- Using data visualization to pinpoint crime by time & location.
- Enhancing justice through effective data visualization
- Visualizing Crime in Canada: Toronto Police and Fraser Institute



INTRODUCTION

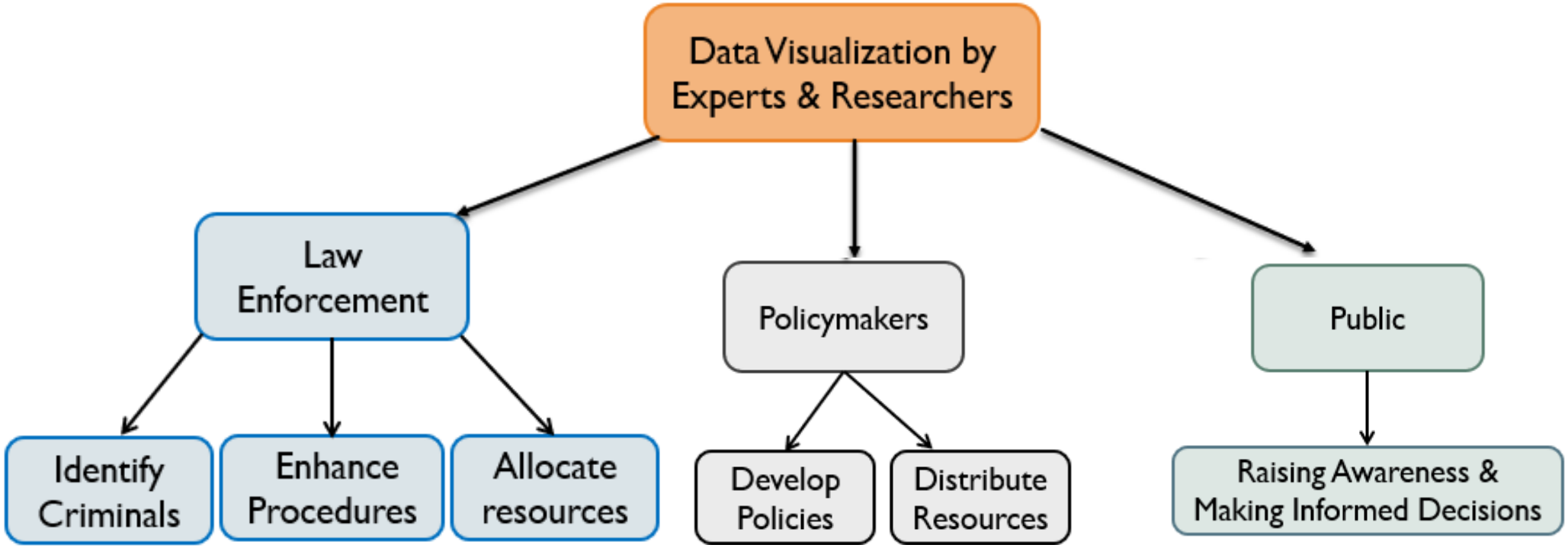
KEY CONCEPTS

Data visualization is the graphical representation of data using charts, maps, graphs, and other visual formats to reveal patterns, trends, and relationships.

Crime is any act or omission that violates a law and is punishable by the state.

Tompson, L., & Townsley, M. (2010). (Looking) Back to the Future: Using Space—Time Patterns to Better Predict the Location of Street Crime. *International journal of police science & management*, *12*(1), 23-40.

WHY IS DATA VISUALIZATION IMPORTANT?



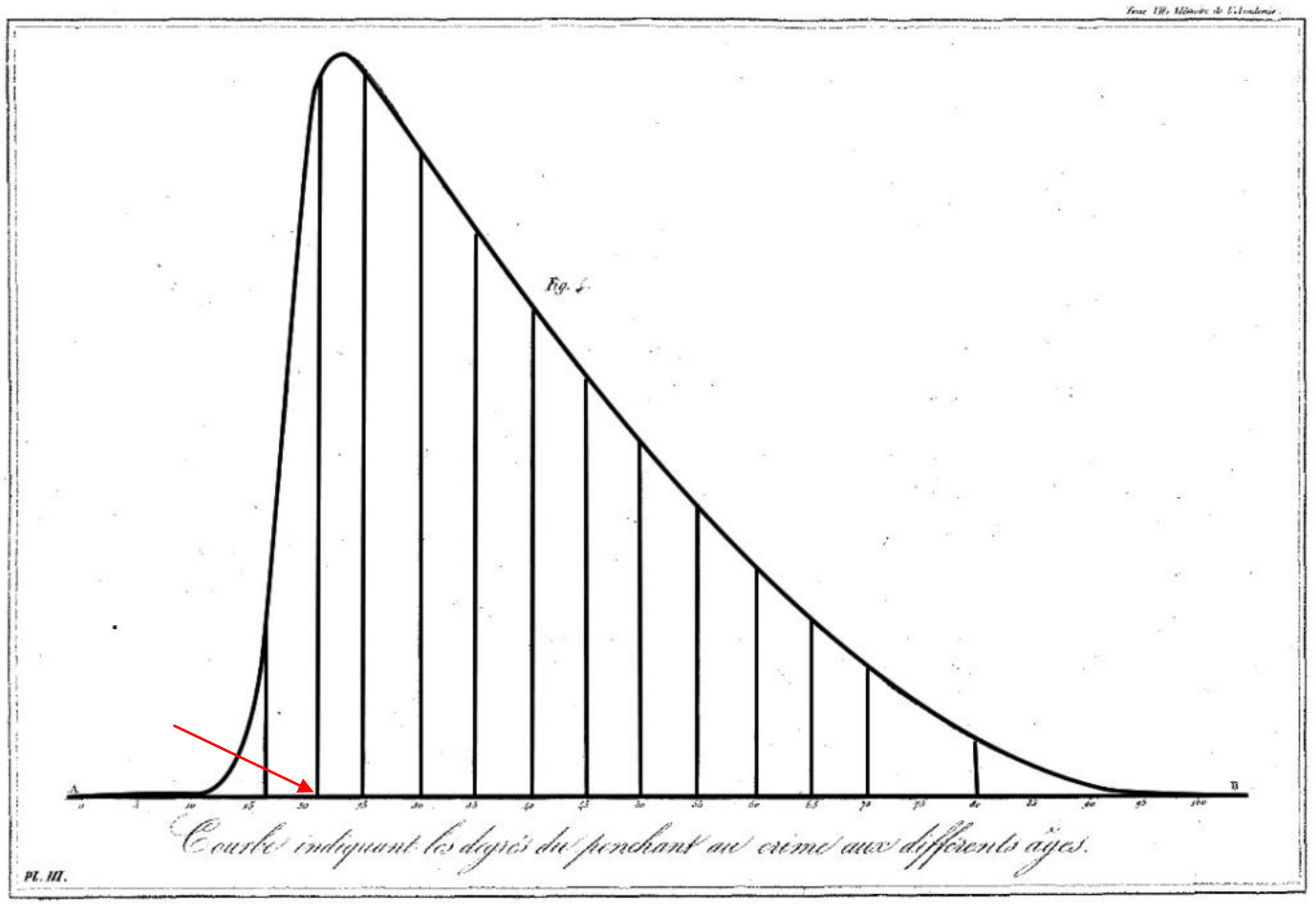
Chainey, S., Tompson, L., & Uhlig, S. (2008). The utility of hotspot mapping for predicting spatial patterns of crime. *Security journal*, *21*(1), 4-28.

THE HISTORY OF CRIME DATA VISUALIZATION

DATA VISUALIZATION IN CRIMINOLOGY

Adolphe Quetelet

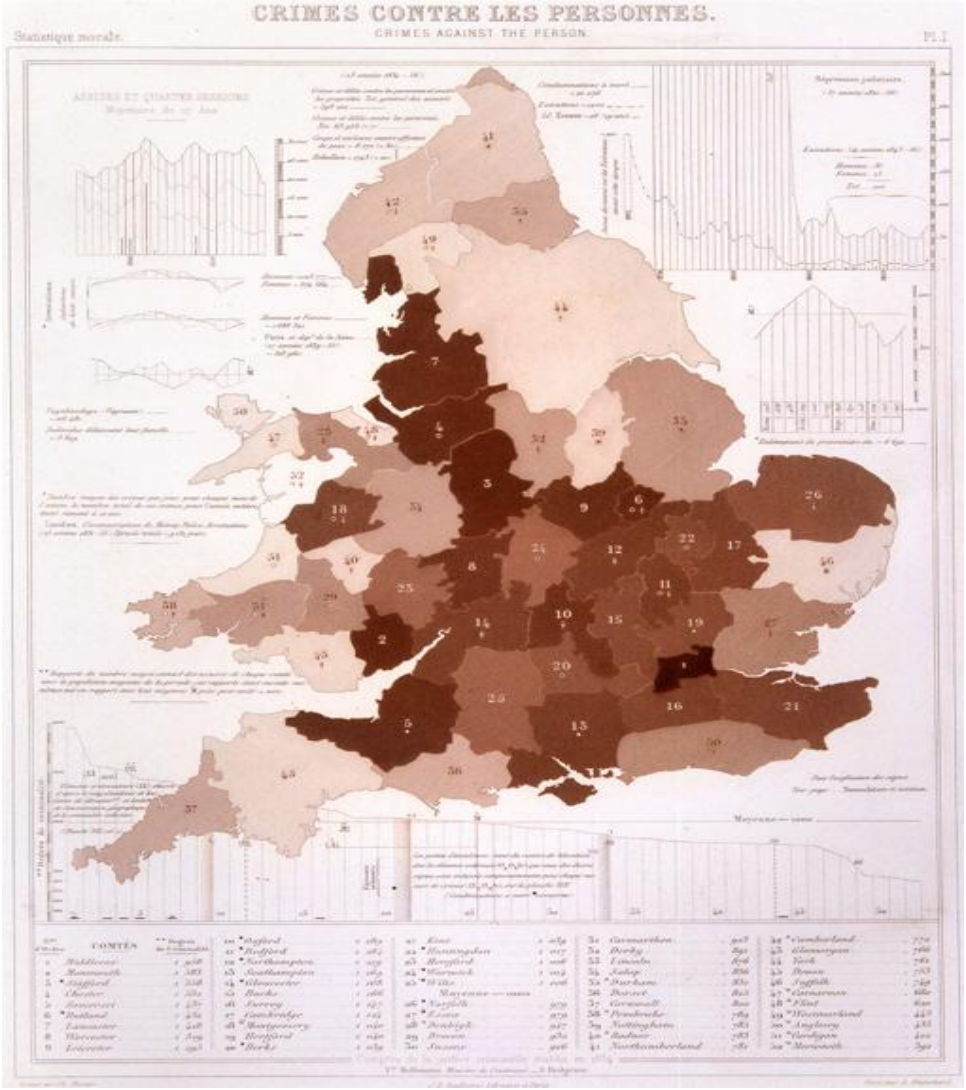
- Studied crime rates in France (1820s–1830s)
- Applied data visualization and statistical methods in criminology



Piers Beirne (1987). "Adolphe Quetelet and the Origins of Positivist Criminology". In; *American Journal of Sociology* 92(5): pp. 1140–1169.

André-Michel Guerry

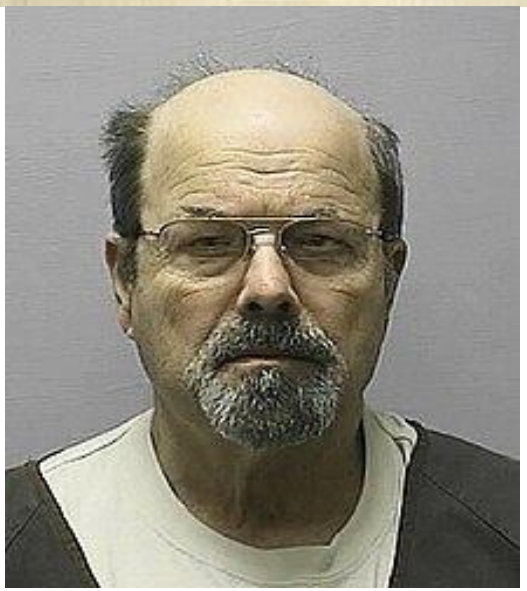
- Crimes against persons in England, 1864
- First, thematic maps of crime data



Friendly, (2007). "A.-M. Guerry's Moral Statistics of France: Challenges for Multivariable Spatial Analysis," *Statistical Science*, vol. 22, no. 3. https://www.datavis.ca/papers/guerry-STS241.pdf

Sir William Herschel

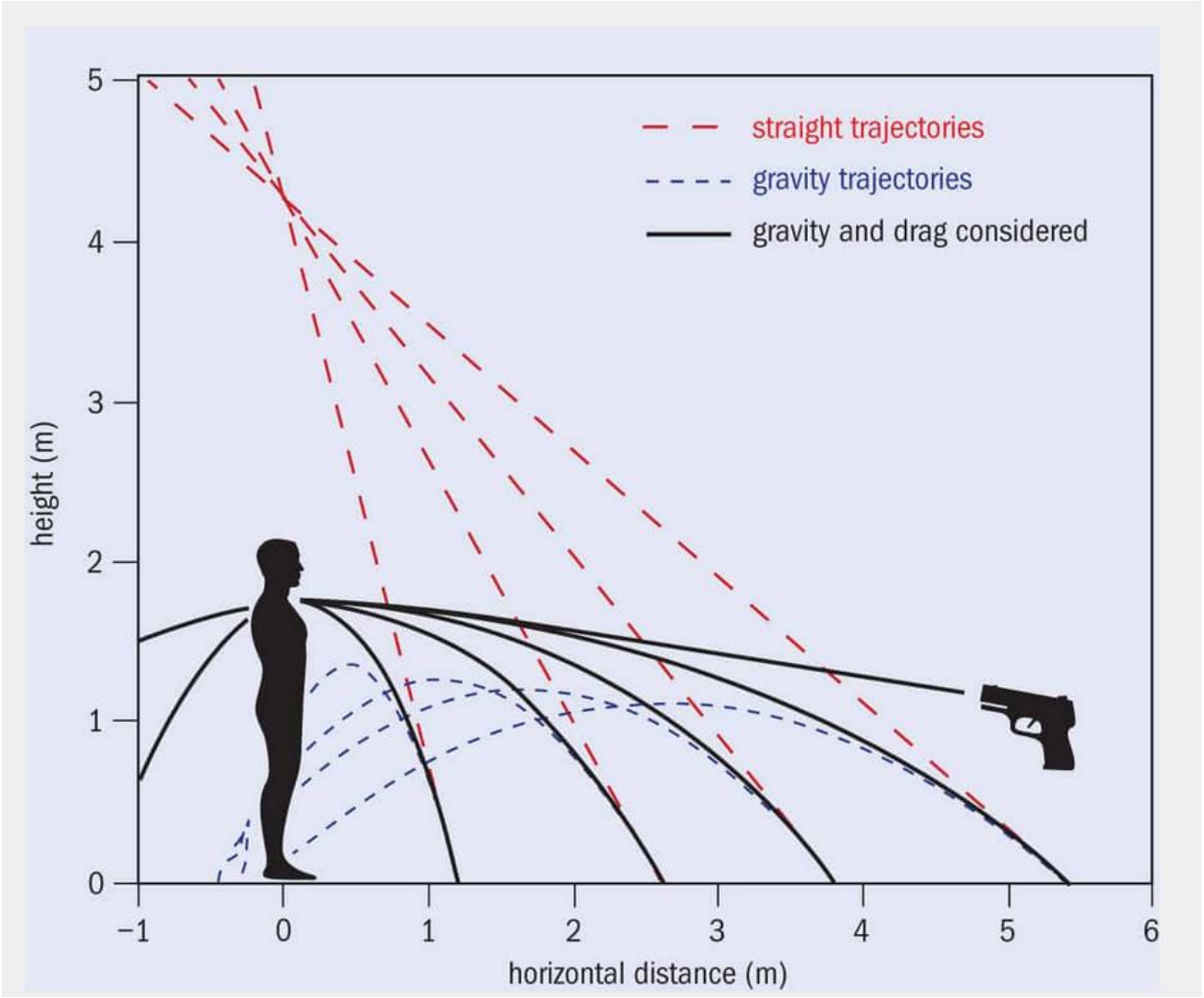
- Recognize fingerprints as unique and permanent
- First fingerprint case (Francisca Rojas, 1892, Argentina)
- BTK Killer (Dennis Rader) was identified using old fingerprint records



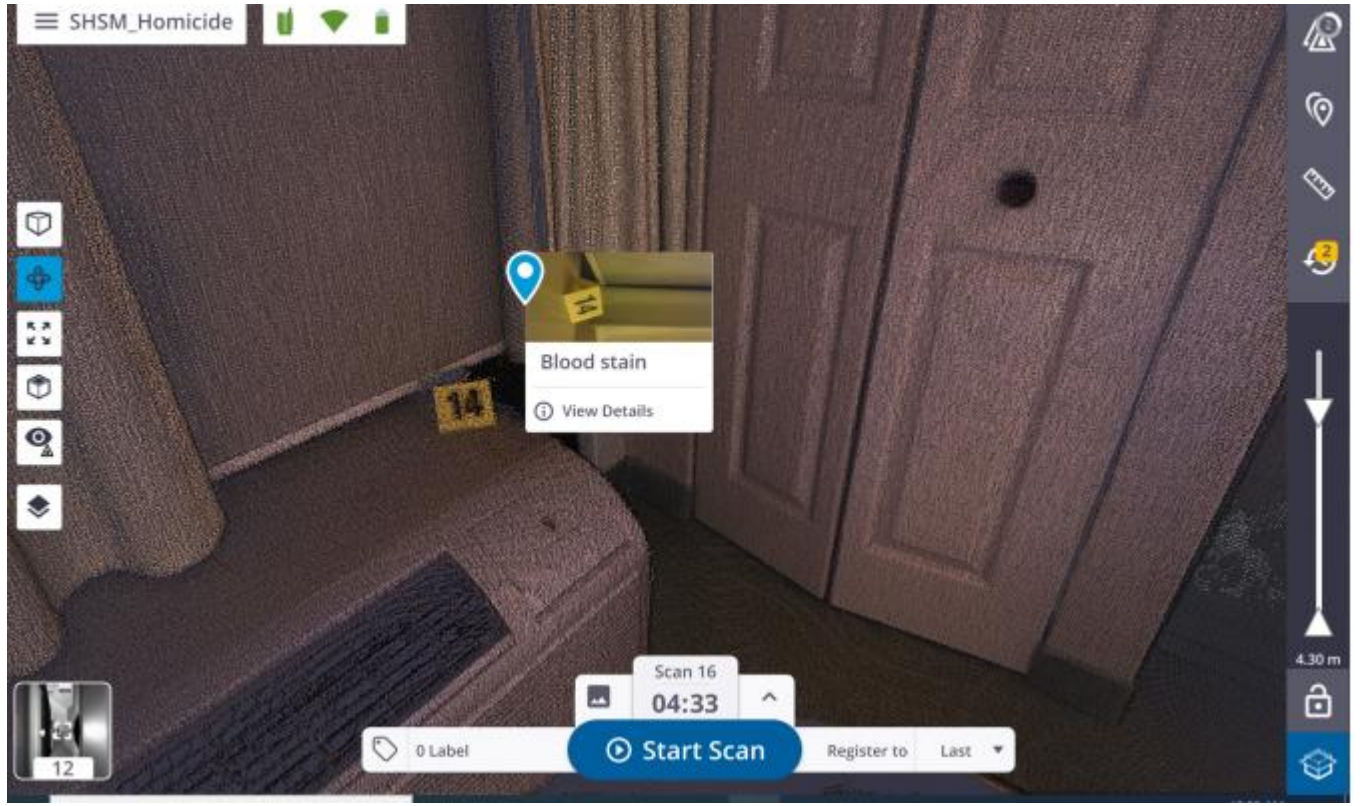
Dennis Rader

Sengoopta, C. (2003). *Imprint of the Raj: How fingerprinting was born in colonial India*. Macmillan.

DATA VISUALIZATION IN CRIME SCENE



https://physicsworld.com/a/the-physics-of-blood-spatter/



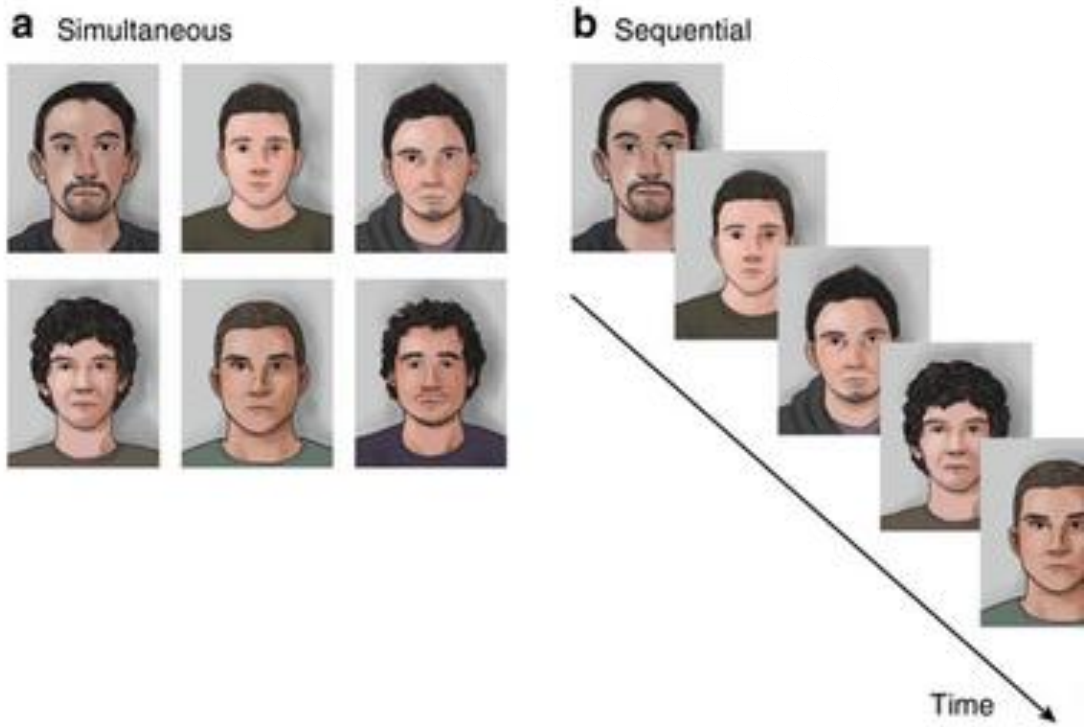
https://physicsworld.com/a/the-physics-of-blood-spatter/

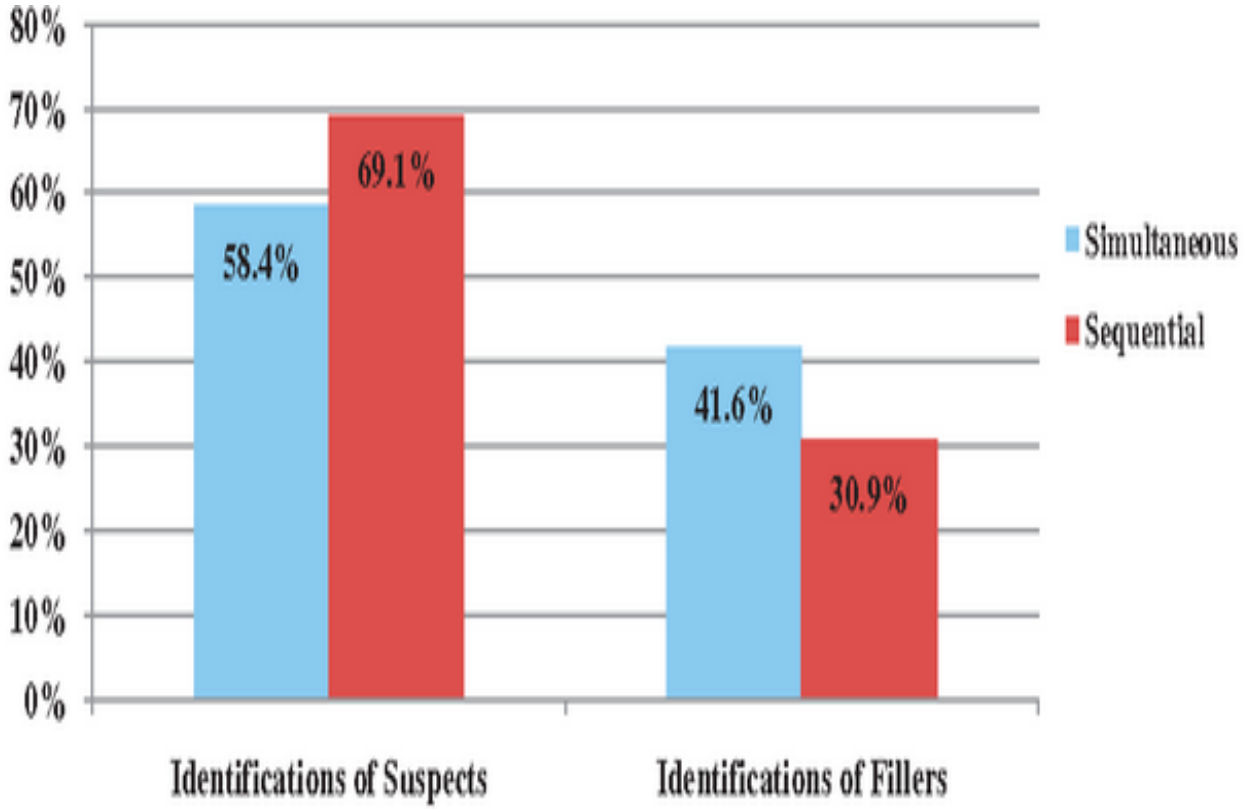
POLICE LINEUP

Ivan Henry, who spent 27 years in prison

...and a very poorly conducted lineup

HOW RELIABLE ARE POLICE LINEUPS? A DATA VISUALIZATION APPROACH

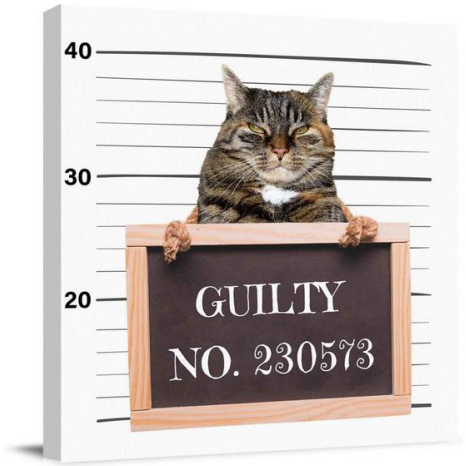


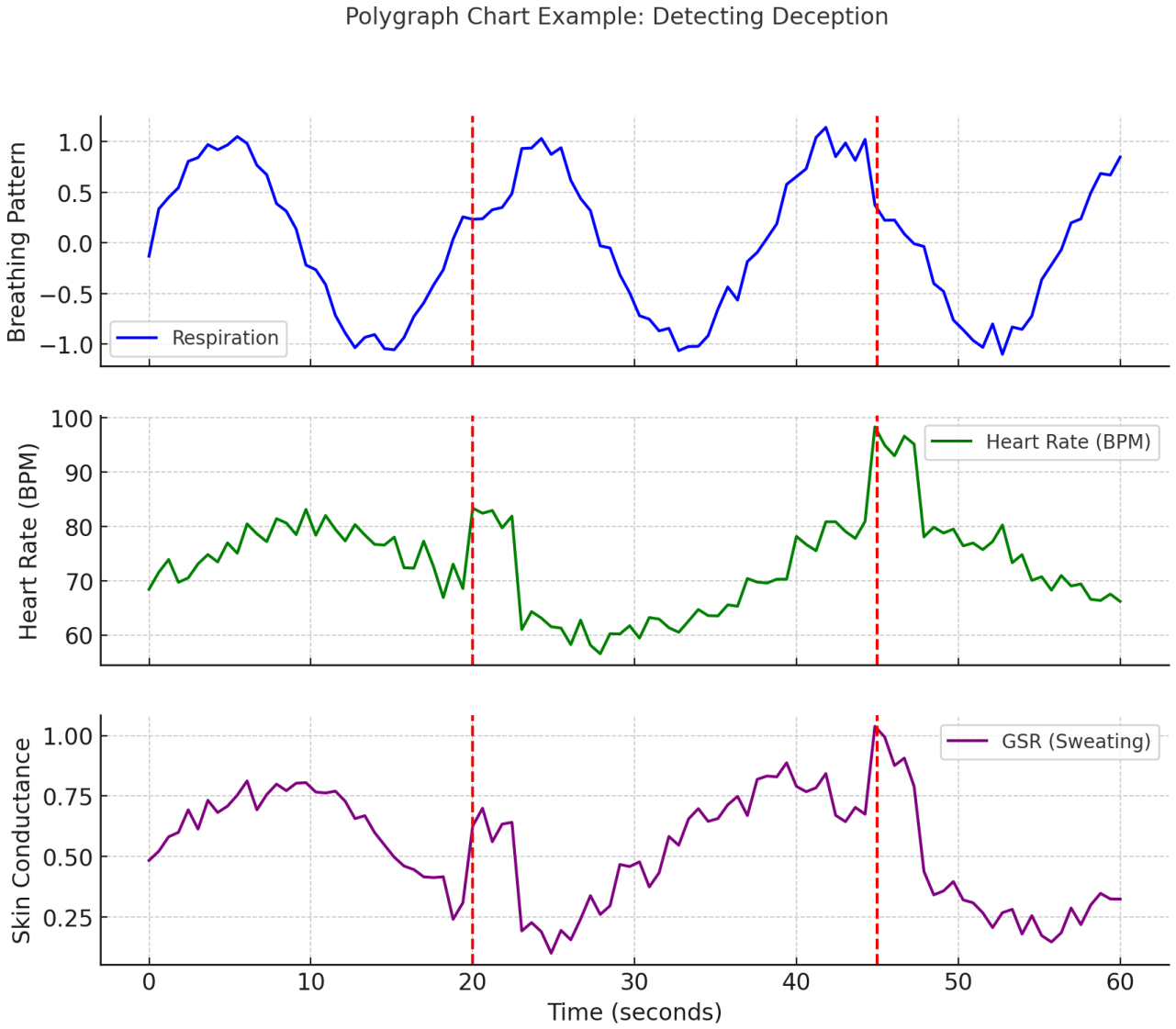


Wells, G. L., Steblay, N. K., & Dysart, J. E. (2011). A test of the simultaneous vs. sequential lineup methods. *Des Moines, IA: American Judicature Society*.

POLYGRAPH

- Deception detection at 20s and 45s due to physiological changes.
- Indicators of stress response: Increased heart rate, decreased breathing depth, higher skin conductance

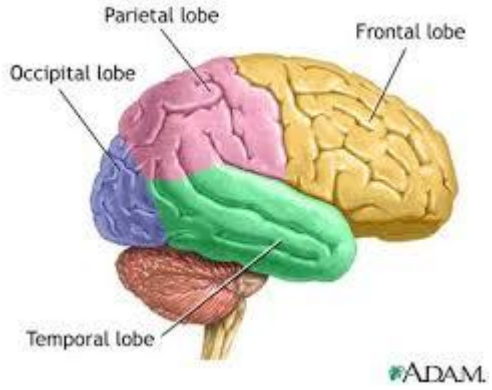


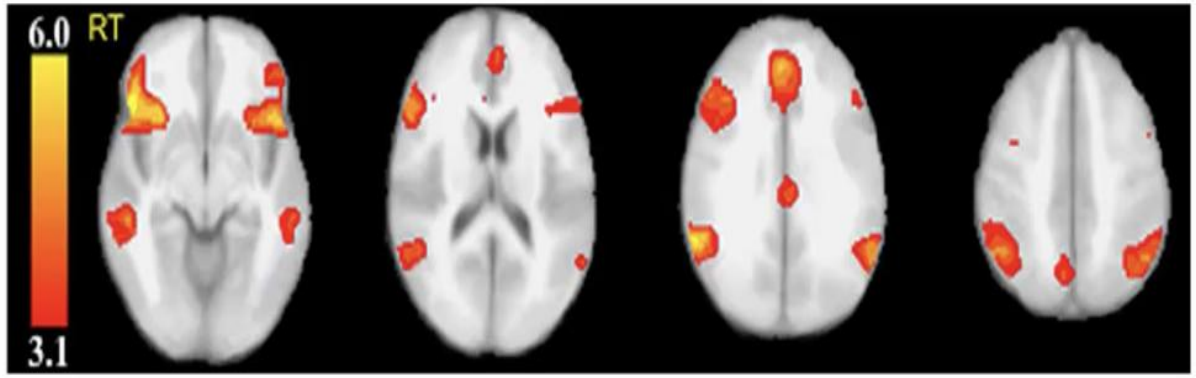


FMRI VS. POLYGRAPH: A BETTER WAY TO DETECT LIES?

Can we find a lie in the brain?

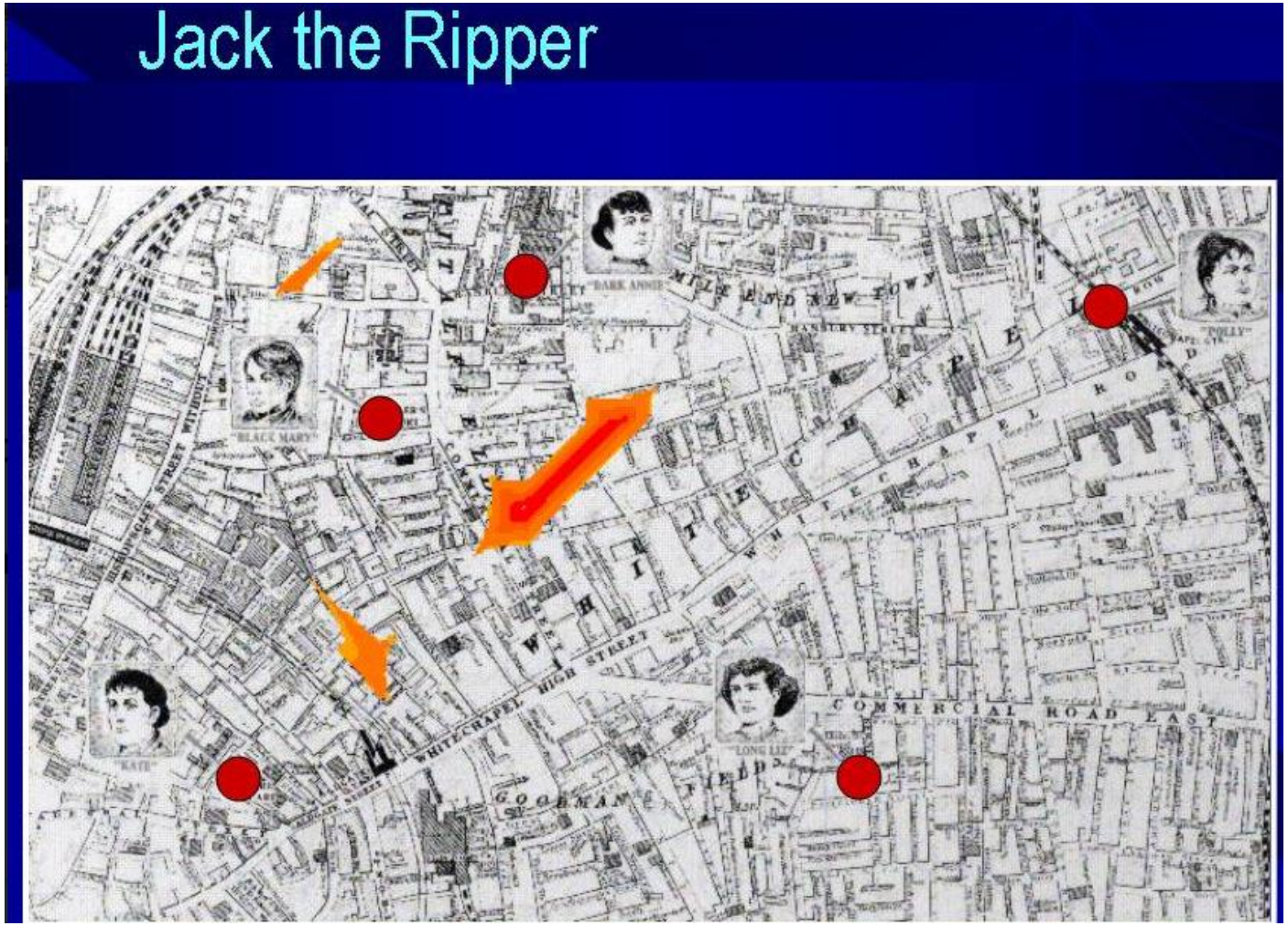
- Brain regions are activated when we lie:
  - Prefrontal cortex & parietal cortex





Langleben, D. D., Loughead, J. W., Bilker, W. B., Ruparel, K., Childress, A. R., Busch, S. I., & Gur, R. C. (2016). Polygraphy and functional magnetic resonance imaging in lie detection: A controlled blind comparison using the concealed information test. *The Journal of Clinical Psychiatry,* 77(10), 1372-1380.

GEOGRAPHIC PROFILING & DATA VISUALIZATION



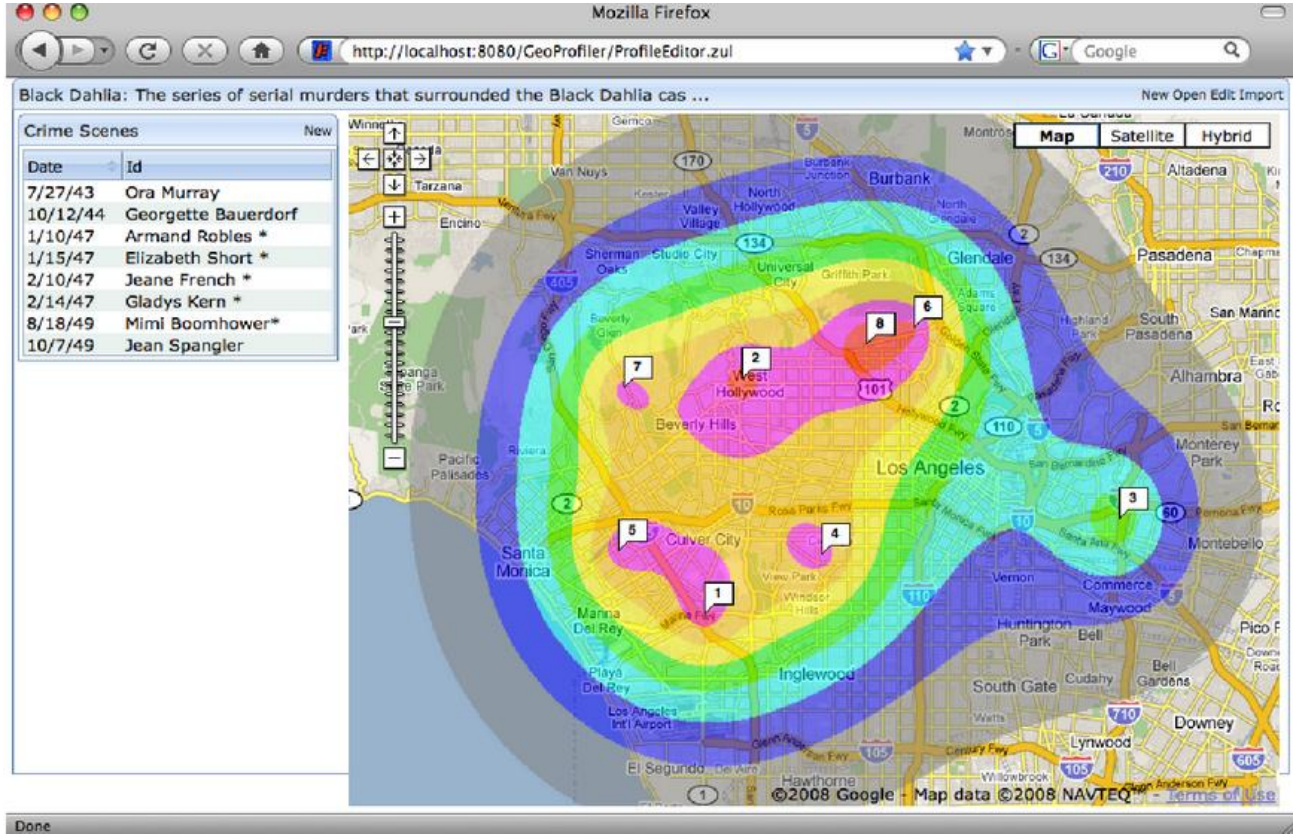
Dr. Kim Rossmo

- Joined Vancouver Police Department in 1978
- Developed geographic profiling: crime analysis software Rigel
- His analysis in 1998 suggested a serial killer was targeting missing sex workers, later confirmed with Robert Pickton's arrest (2002).

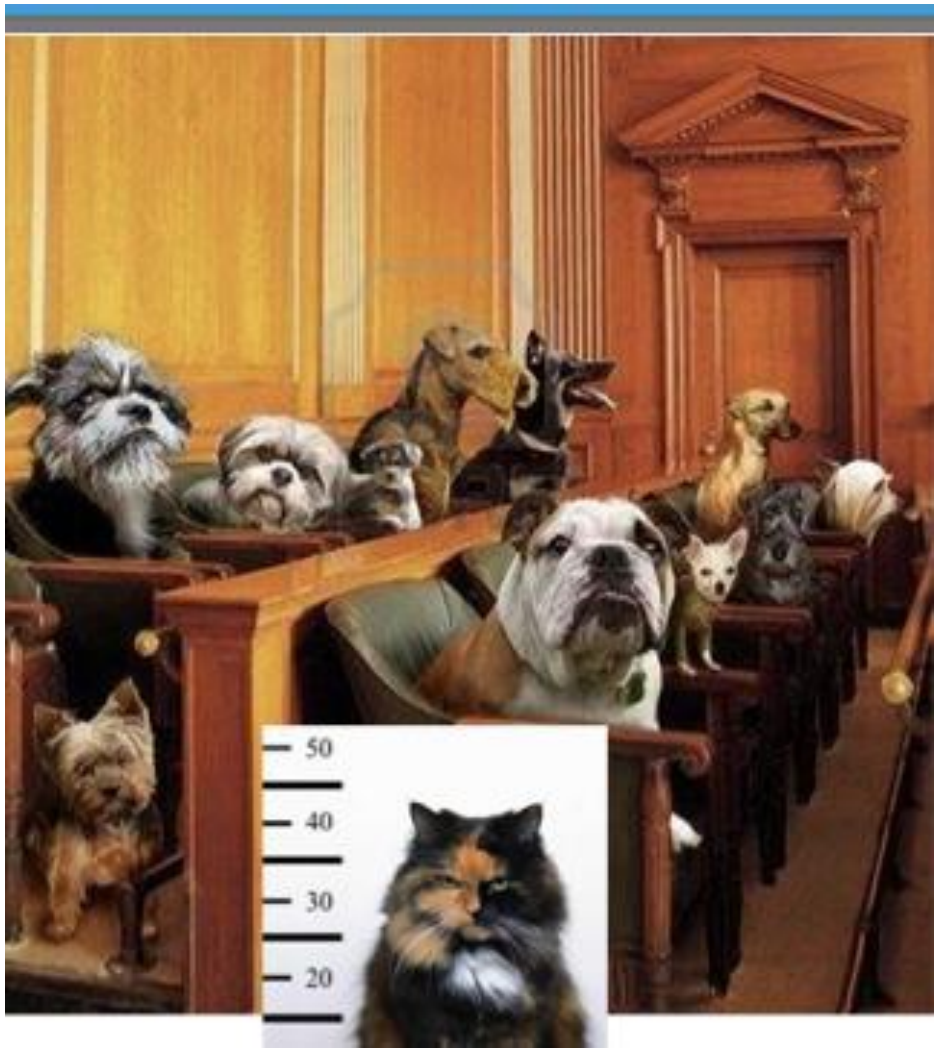
Professor: School of Criminal Justice & Criminology, Texas State University

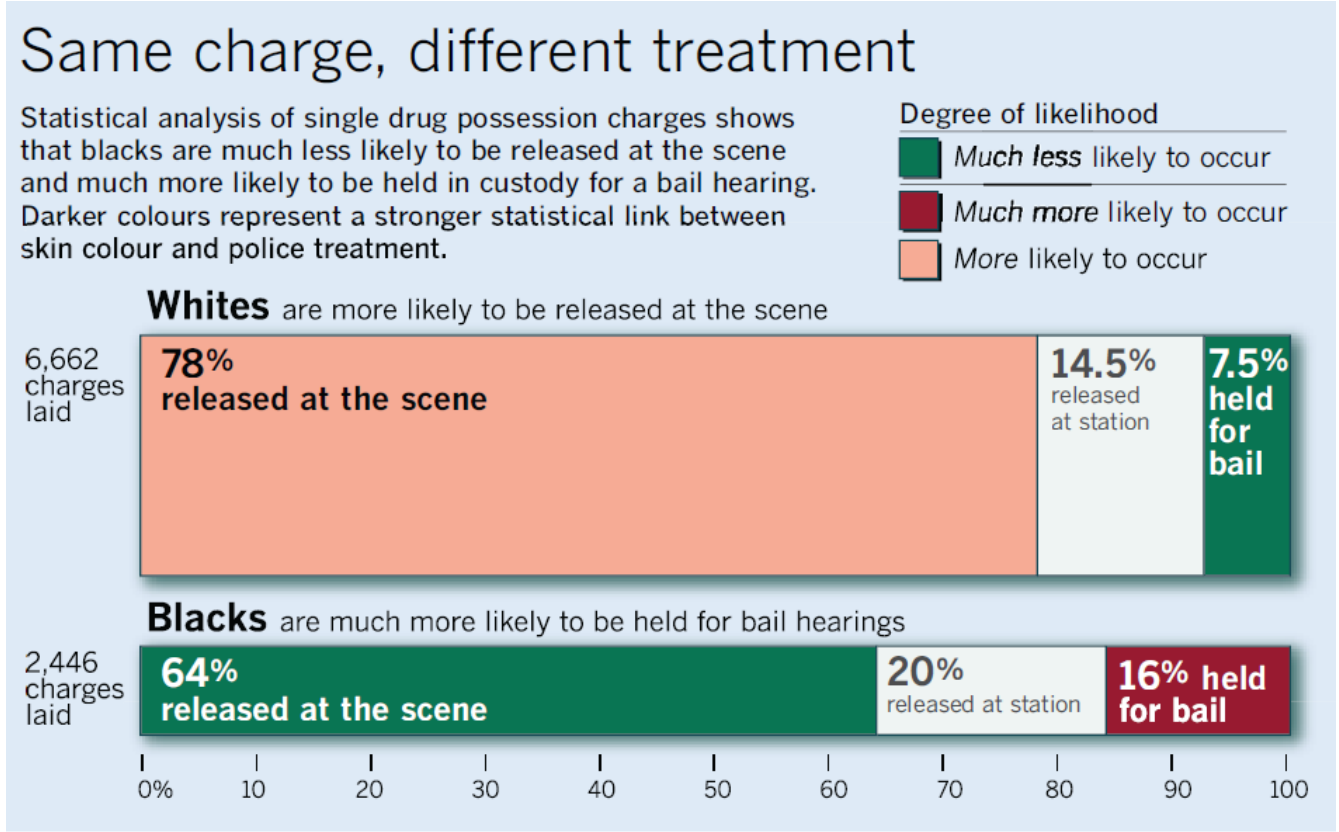
HOW GEOGRAPHIC PROFILING SOFTWARE WORKS

- A minimum of 5 crime sites is needed for accurate analysis.
- 3D heatmap
- Highlights areas where the offender most likely lives and works
- New crime data updates the system dynamically, improving accuracy

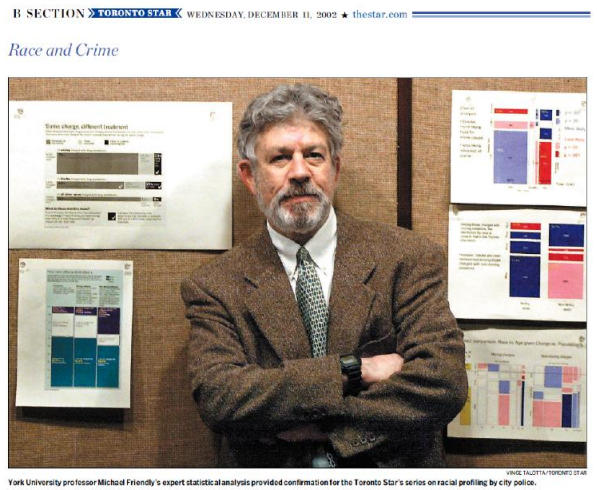


ENHANCING JUSTICE THROUGH EFFECTIVE DATA VISUALIZATION



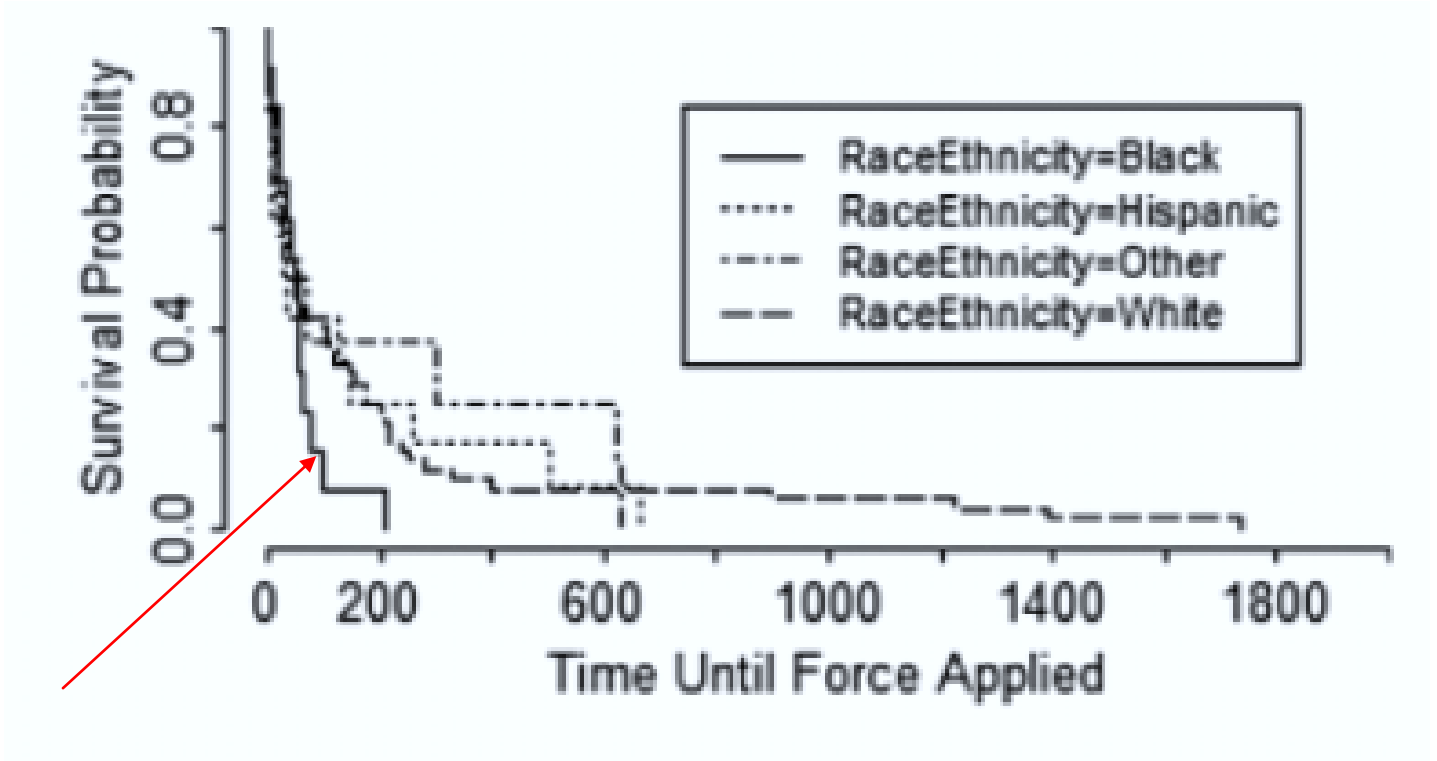


SOURCE: Toronto police arrest records 1996-2002



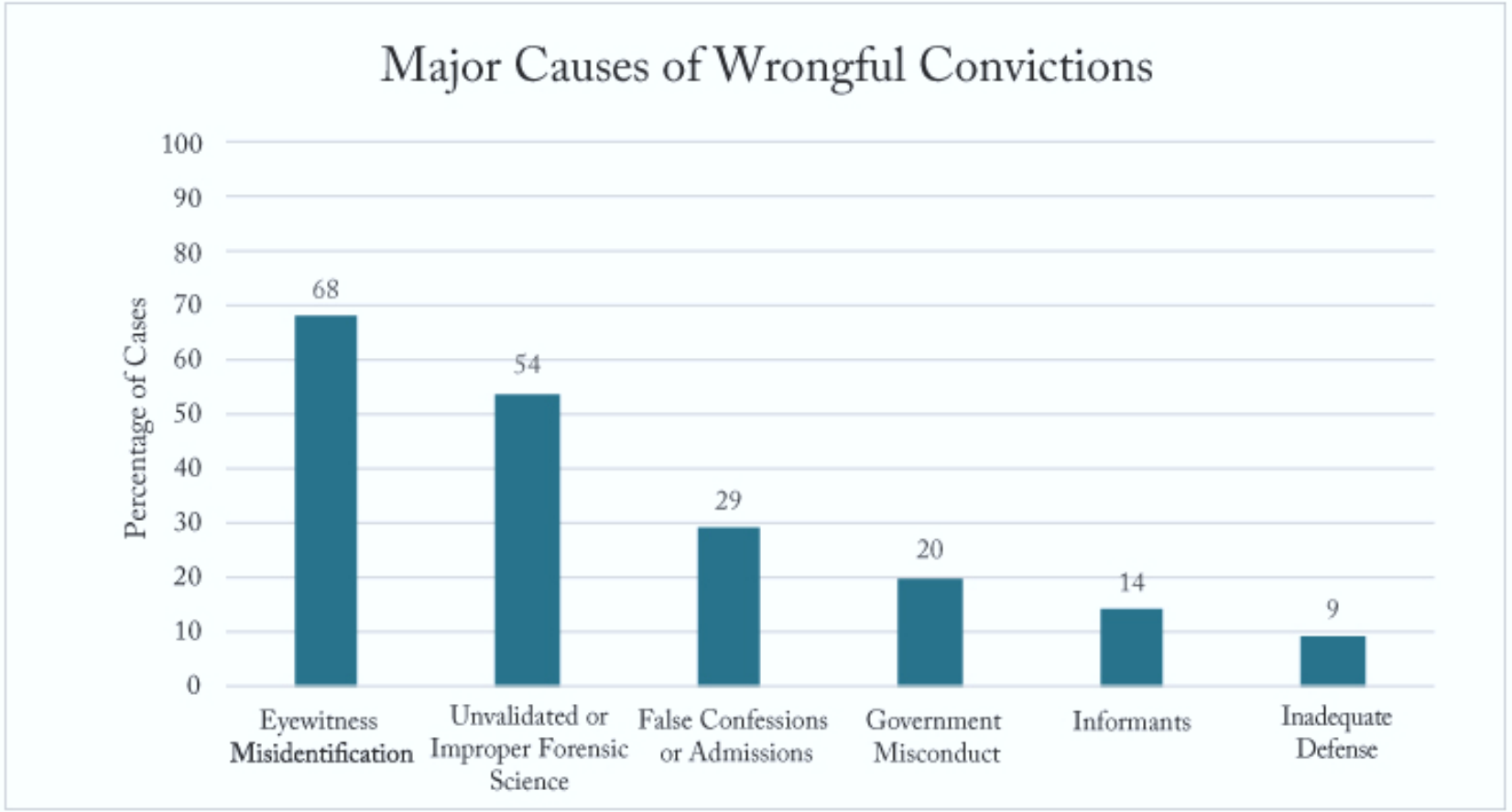
https://www.thestar.com/best-of/

Analyzed Body-Worn Camera footage using data visualization



Willits, D.W., & Makin, D.A. (2018). Show me what happened: Analyzing use of force through analysis of body-worn camera footage. *Journal of research in crime and delinquency*, *55*(1), 51-77.

VISUALIZING THE CAUSES OF WRONGFUL CONVICTIONS



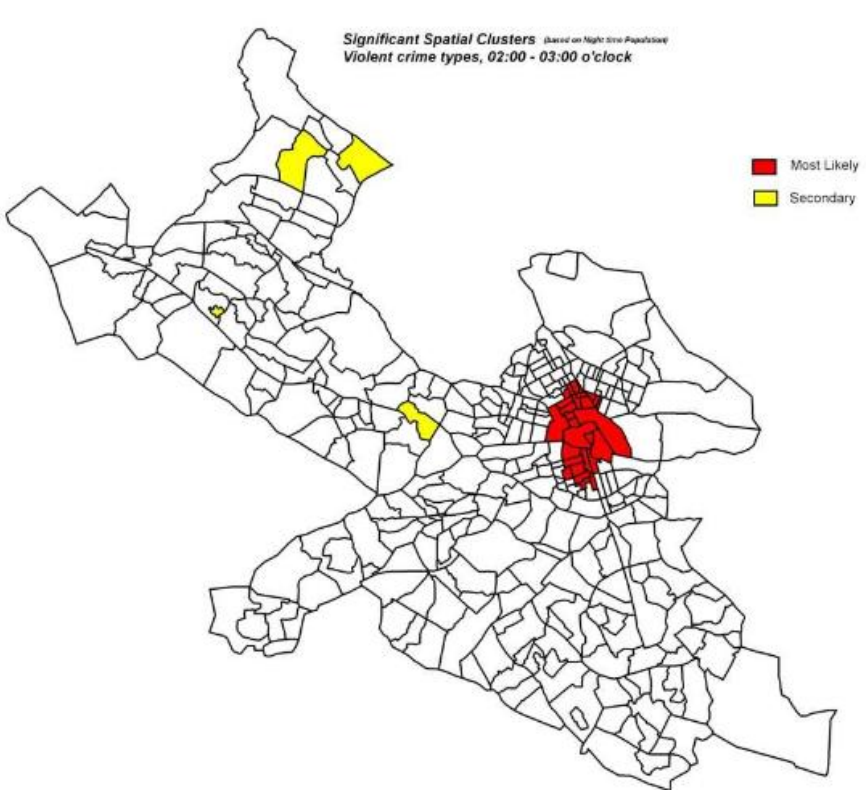
Innocence Project. (2024). *Major causes of wrongful convictions*. Retrieved from https://www.innocenceproject.org

USING DATA VISUALIZATION TO ANALYZE CRIME PATTERNS: TIME & LOCATION

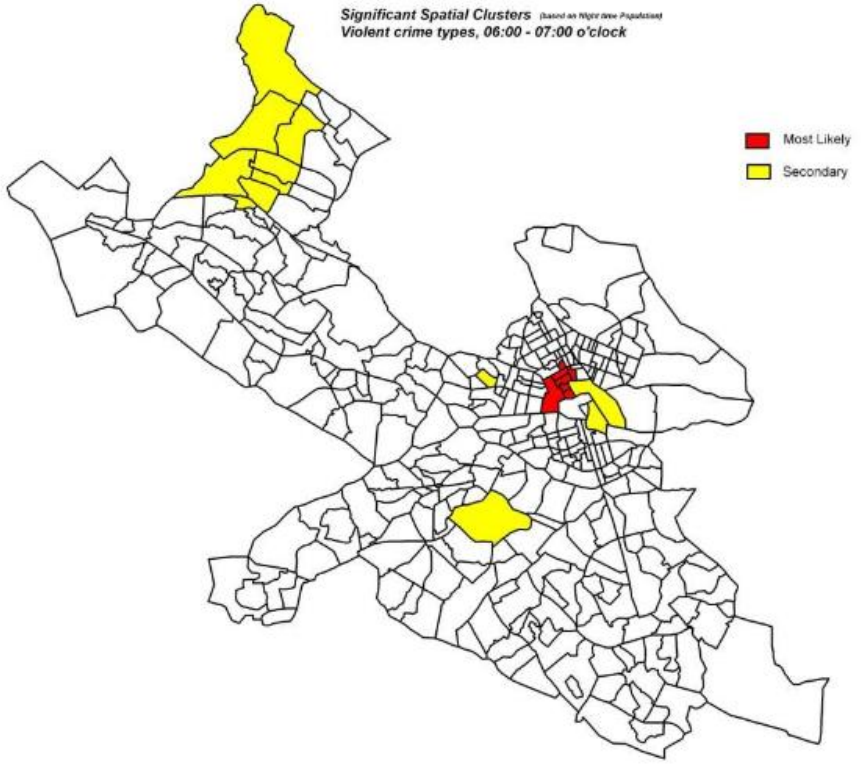
Generals Hwy
Bestgate Rd
John Hanson Hwy
Defense Hwy
50
301
2
Solomons Island Rd
Forest Dr
665
West St
450
Taylor Ave
436
Riva Rd
Aris Allen Blvd
Truxton Park
Edgewater
2
648
179
450
US Naval Academy Golf Club
US Naval Academy

SPACE-TIME CLUSTERS OF CRIME IN STOCKHOLM, SWEDEN

2am (Peak frequency)



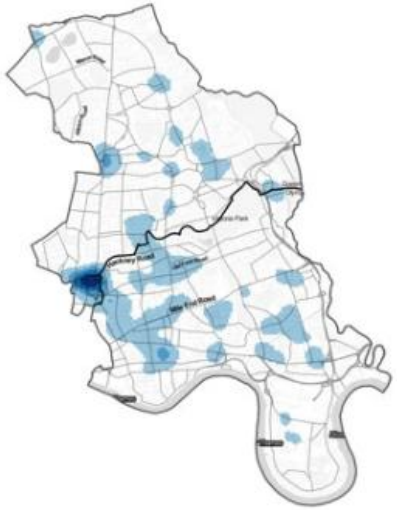
6am (Lowest frequency)

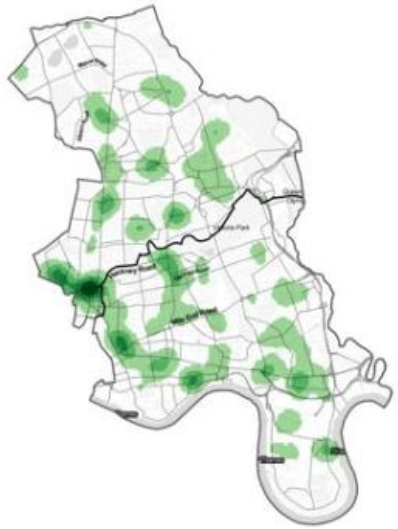


Uittenbogaard, A., & Ceccato, V. (2012). Space-time clusters of crime in Stockholm, Sweden. *Rev. Eur. Stud.*, *4*, 148.

HOT SPOTS OF VIOLENCE IN LONDON USING DIFFERENT DATA SOURCES

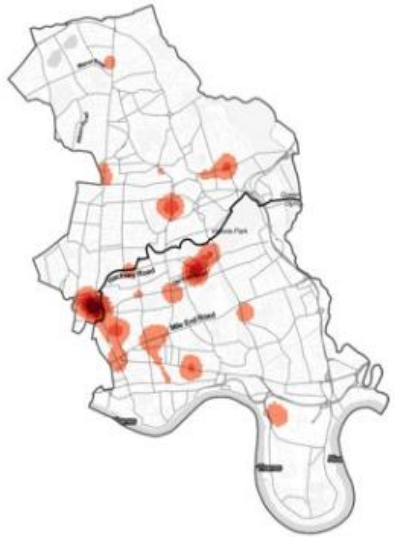
Police

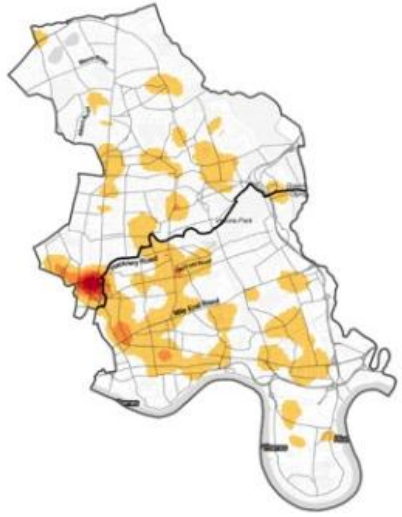




Ambulance

Emergency Department





Combined

https://popcenter.asu.edu/sites/default/files/problem_solving_violent_crime_guide_for_analysts_uk_college_of_policing_2024.pdf

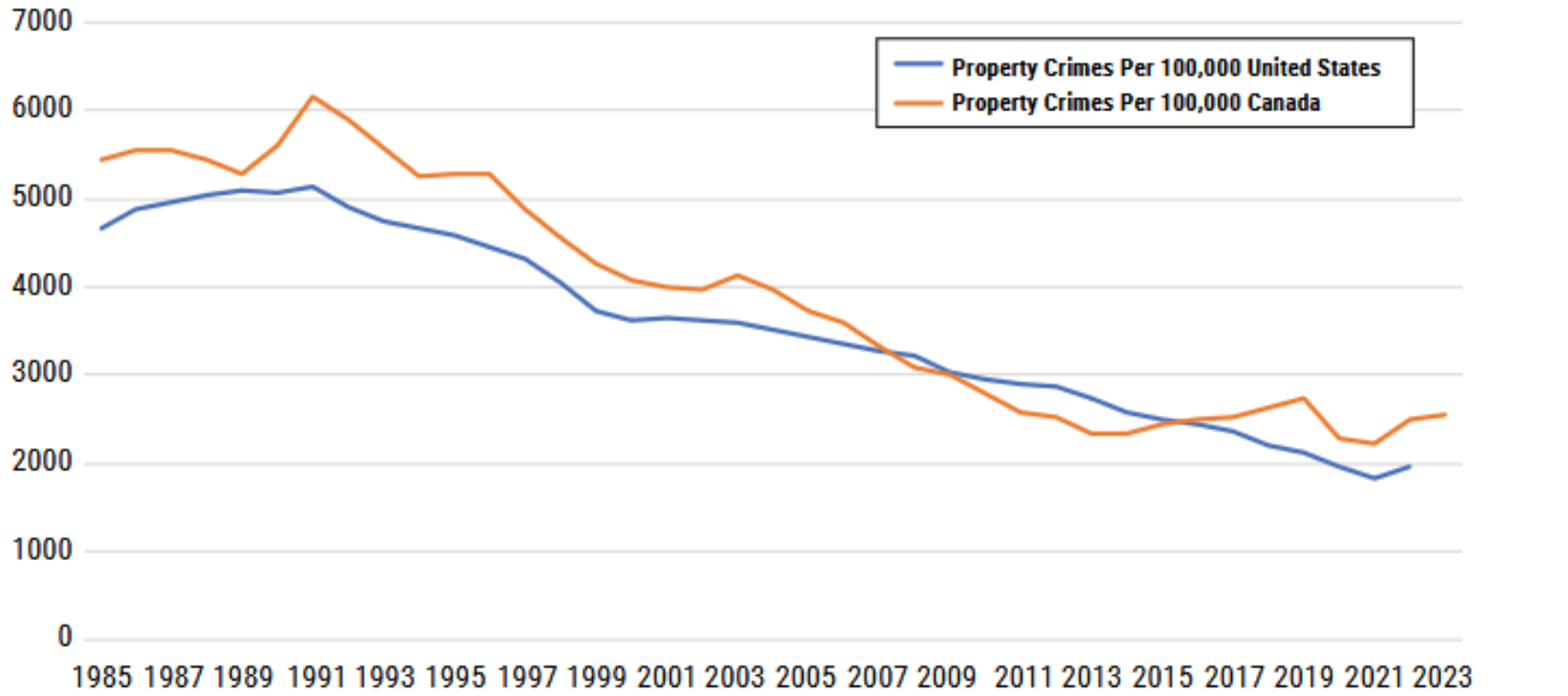
VISUALIZING CRIME IN CANADA: FRASER INSTITUTE VS TORONTO POLICE

HOW RESEARCHERS INTERPRET CRIME DATA

March 18, 2025

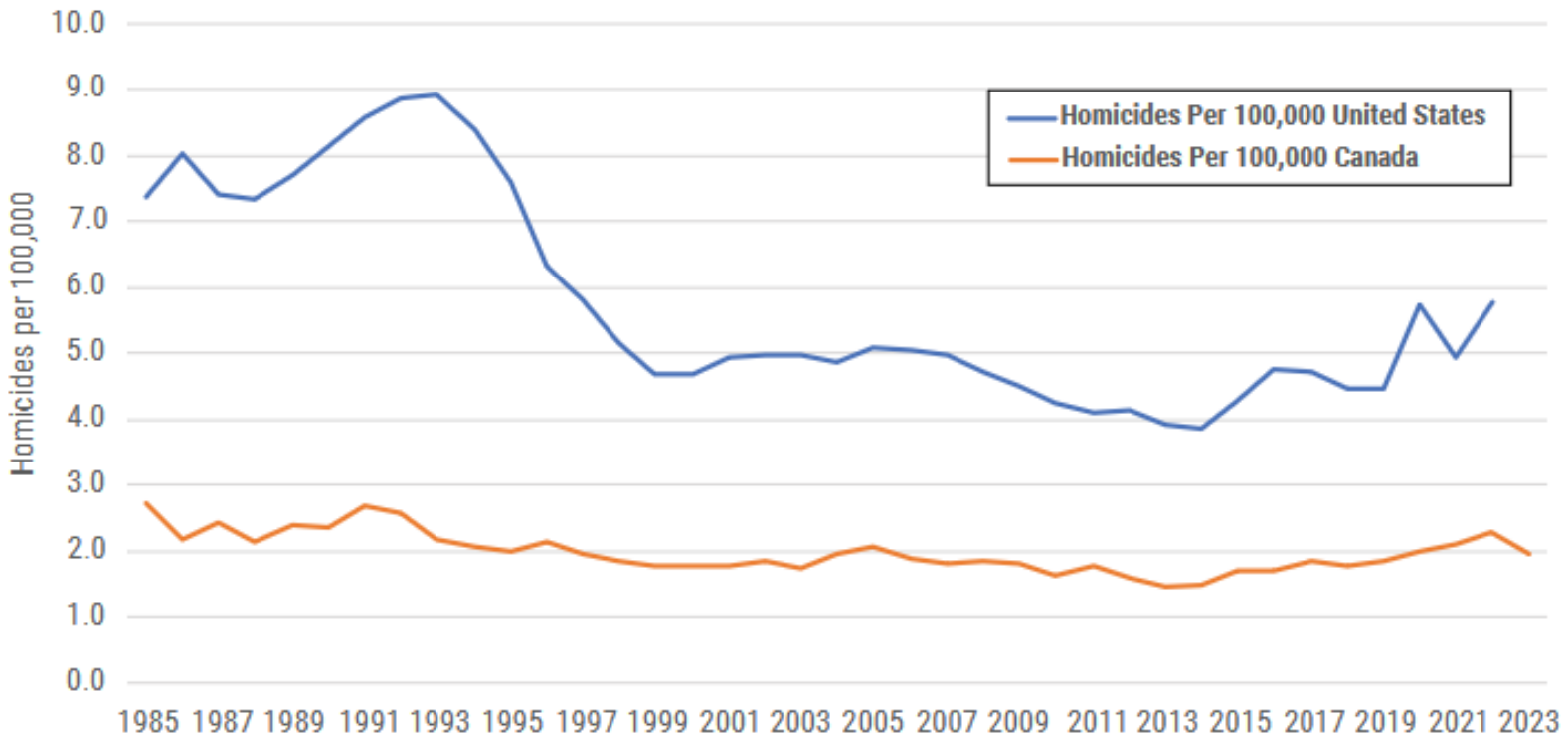
Di Matteo, L. (2024). Comparing Recent Crime Trends in Canada and the United States: An Introduction.

Figure 2: Property Crimes Per 100,000 Population, Canada vs the United States, 1985–2023



Di Matteo, L. (2024). Comparing Recent Crime Trends in Canada and the United States: An Introduction.

Figure 1: Homicides Per 100,000 Population, Canada Versus the United States, 1985–2023



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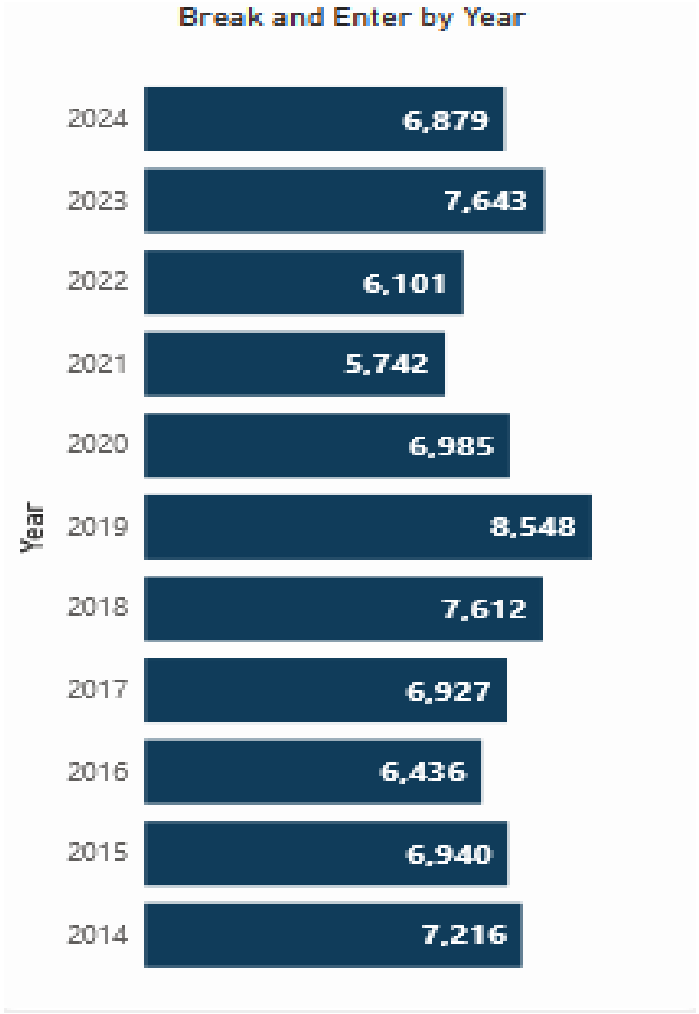
VISUALIZING UNCERTAINTY: POLICE DATA



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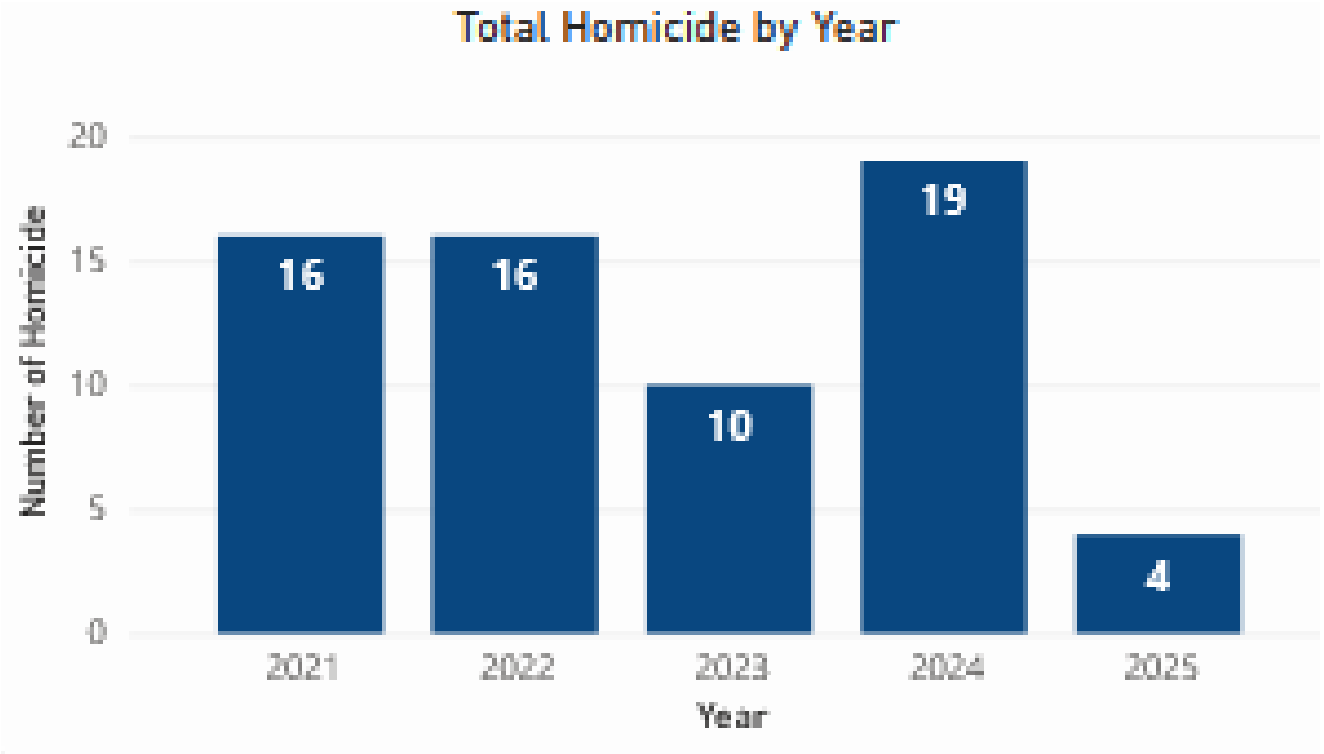
VISUALIZING UNCERTAINTY: POLICE DATA



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SUMMARY: THE POWER OF DATA VISUALIZATION IN CRIME

- Data visualization makes complex crime data easier to understand.
- It helps identify patterns in time, location, and offender behavior.
- Supports law enforcement, policymakers, and the public in making better decisions.
- Plays a key role in creating a fairer and more effective justice system.

THANK YOU!