Handguns and Hotspots: Spatio-Temporal Models of Gun Crime in Chicago, IL

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Research Objectives

- Observe and predict the spatio-temporal spread of gun crime in Chicago, Illinois
- Apply methods of control to a cellular automata model and create evidence-informed policies

The Epidemic of Gun Violence in the United States

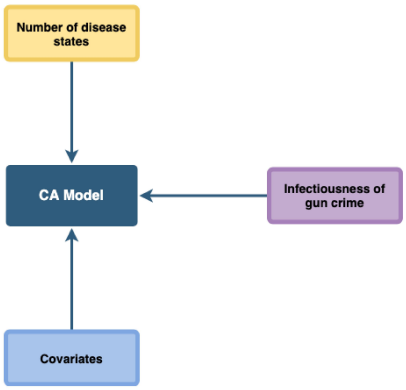
- 33,000 deaths each year due to firearms
- Exposure to gun violence at a young age increases risk of chronic health conditions as an adult and increases likelihood for risky behavior in youth
- Gun violence costs the United States $229 billion each year

Chicago, IL as a Study Area for Gun Violence

- In 2012, Chicago had the highest number of citywide murders
- Ecological factors are associated with gun violence
- Between 2015 and 2016, there was a 68% increase in Chicago gun crimes, disproportionately affecting disadvantaged communities
- Most recent violence is carried out by teens and young adults, usually with illegal firearms

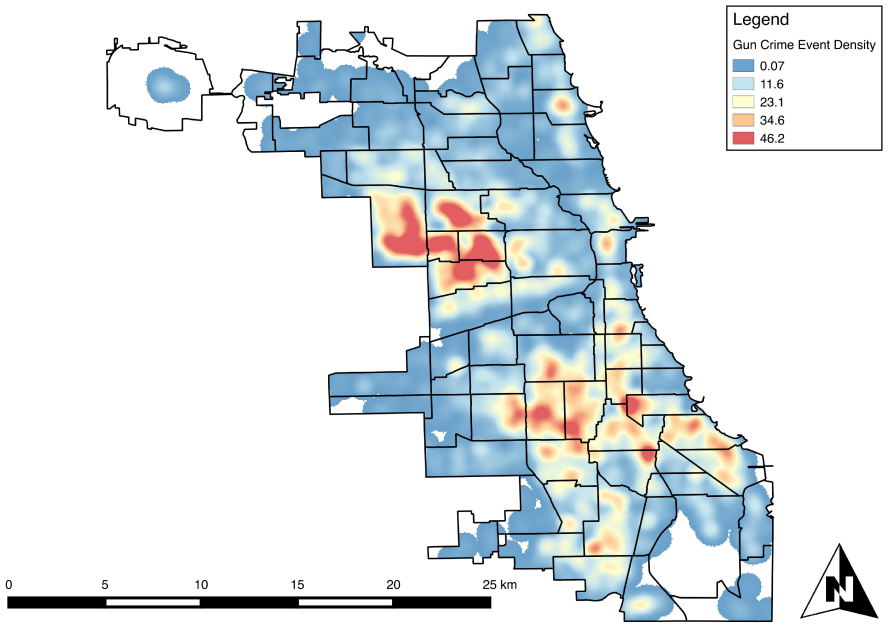
Cellular Automata (CA) Models

- Discrete in space and time
- Consist of a lattice of cells, each existing in a particular state
- Local rules determine how states update over time
- Our model is composed of a number of statistical models, each contributing to an overall cellular automata



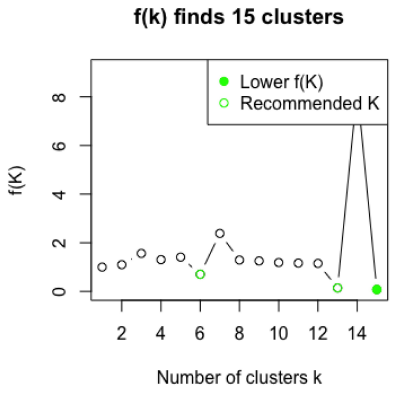
For More Details and References:

Overall Conclusions



Conclusion: A cellular automata model informed by statistical models can be used to observe and predict the epidemic spread of gun crime in Chicago, IL.

Determining the Appropriate Number of Disease States



- **Method:** K-selection algorithm
- **Details:** The value of $f(K)$ is the ratio of real distortion to estimated distortion and is close to 1 when the data distribution is uniform.
- **Conclusions:** We can divide the number of crimes per community area into 15 different crime categories and then into three different crime levels (low, medium, high)

Acknowledgments

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Subset Selection of Socioeconomic Conditions

- **Method:** Negative binomial model with Bayesian subset selection
- **Factors tested:**
  - Crowding
  - Poverty
  - Unemployment
  - Education level
  - Dependents
  - Per capita income
- **Results:** Poverty, unemployment, and dependents are significantly associated with the number of gun crimes in each community area

Predictor	Coefficient
Poverty	1.0344
Unemployment	1.1123
Dependents	- 0.9477

$$log(\#\text{ Gun Crimes}) = 4.1258 + 0.0338 * \text{poverty} + 0.1064 * \text{unemployment} - 0.0537 * \text{dependents}$$

Evaluating the Infectiousness of Chicago's Gun Crime

- **Method:** Bayesian spatio-temporal point process
- **Objective:** Differentiate between crime that is clustering but not diffusing and crime that is clustering and diffusing over a subset of data

$$\lambda(x,y,t) = m_0\mu(x,y,t) + \theta \sum_{i:t_i<t} \omega \exp(-\omega(t-t_i)) \frac{1}{2\pi\sigma^2} \exp(-((x-x_i)^2) + (y-y_i)^2/(2\sigma^2))$$

- **Conclusions:** If we were to observe 100 crimes at a given point in space and time, we expect the next 93 crimes that occur in a 1.96km radius and over 12 hours to have been triggered by previous crimes

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