Modeling Contagion Through Social Networks to Explain and Predict Gunshot Violence

Ben Green (Harvard)
Thibaut Horel (Harvard) & Andrew Papachristos (Yale)

Gun violence as an epidemic

- Gun violence is often described as an epidemic
- Typically modeled spatially, as an "airborne" pathogen
- Recent research suggests we should consider violence as a "bloodborne" pathogen that spreads via social interactions
  - Social networks are fundamental to diffusion processes across numerous domains
  - Victimization clusters within social networks
- We extend this research by studying the temporal dynamics of gunshot victimization in social networks

Does gun violence spread over social networks through a process of social contagion?

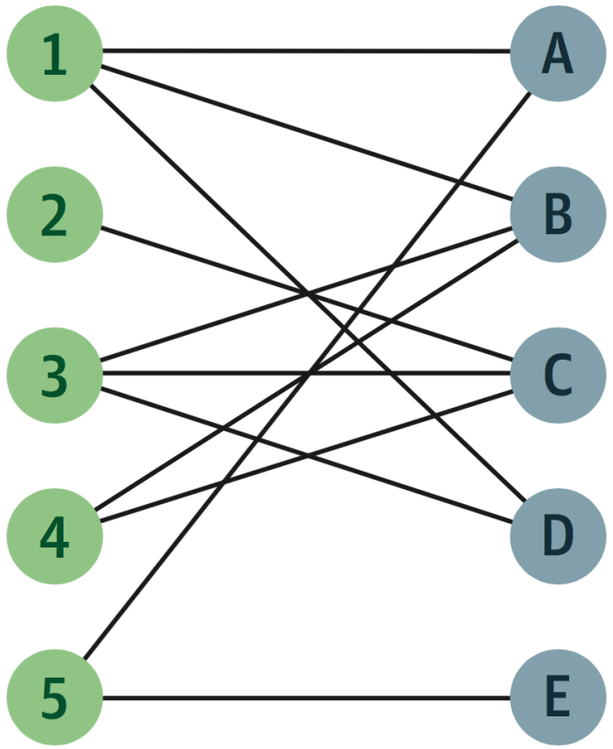
Data & co-offending network generation

- Setting: Chicago from 2006 to 2014
- Data source 1: Arrest records (n=1,189,225; 462,516 people)
- Data source 2: Gunshot victimizations (n=16,399; 14,695 people)

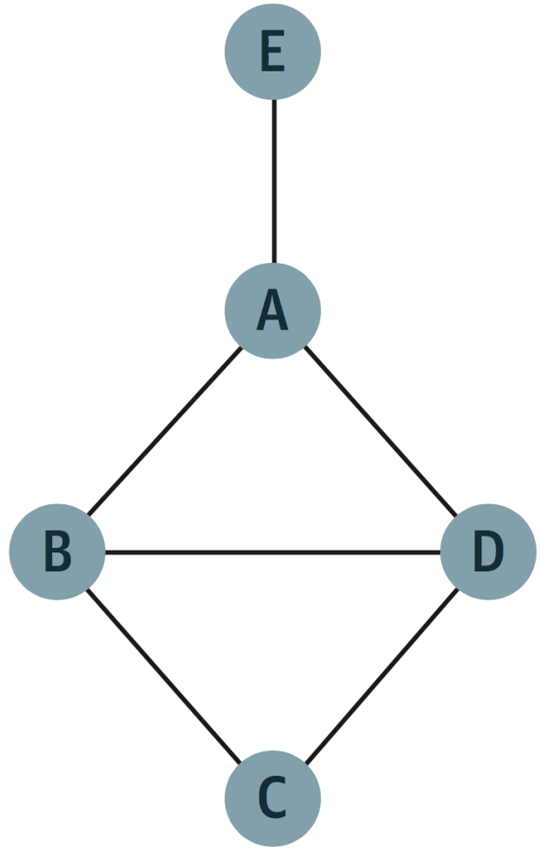
A Example data

Event Code	Identity Code
1	A
1	B
1	D
2	C
3	B
3	C
3	D
4	B
4	C
5	A
5	E

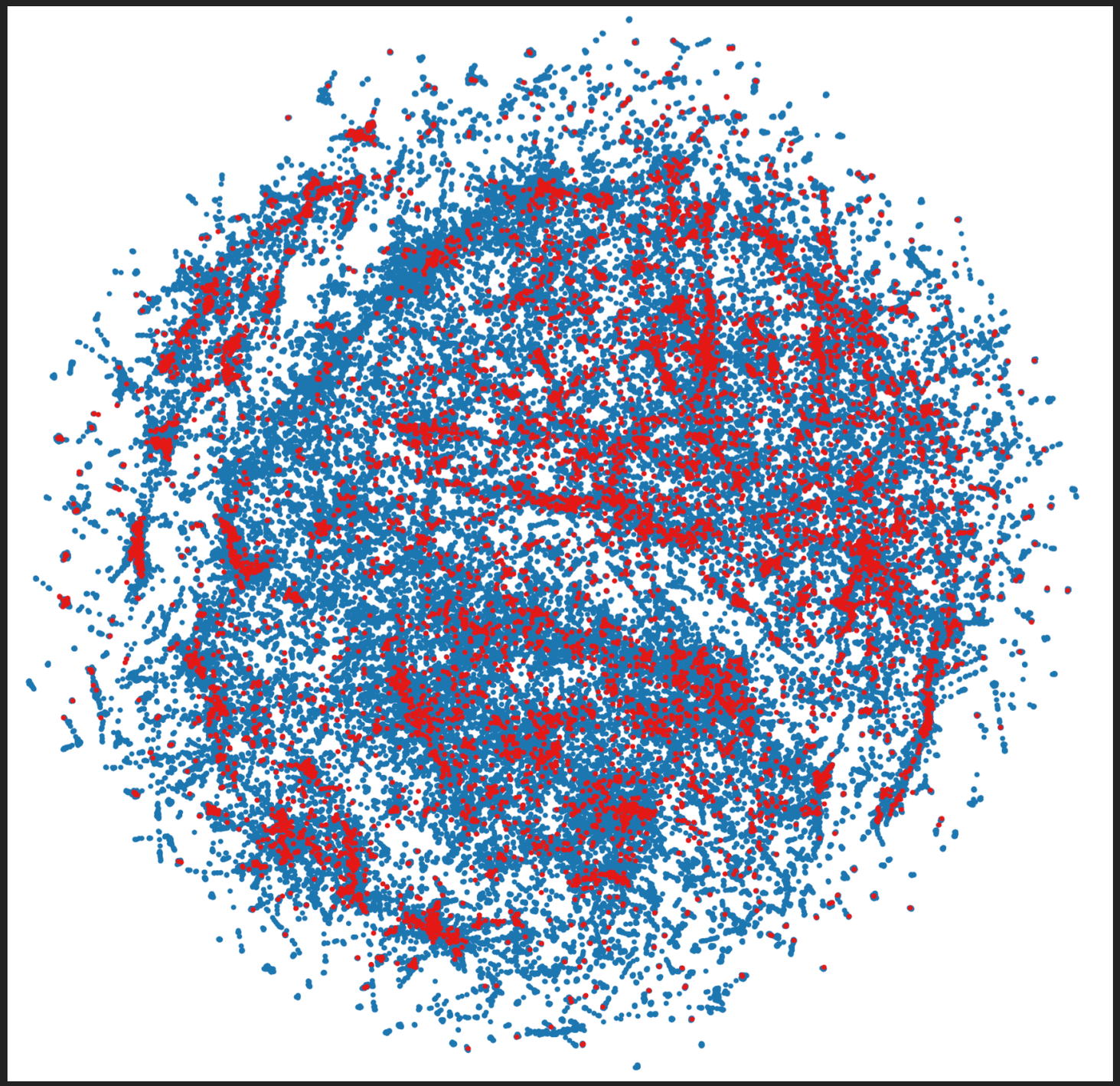
B Bipartite network



C Co-offending network



Largest connected component (LCC) of co-offending network



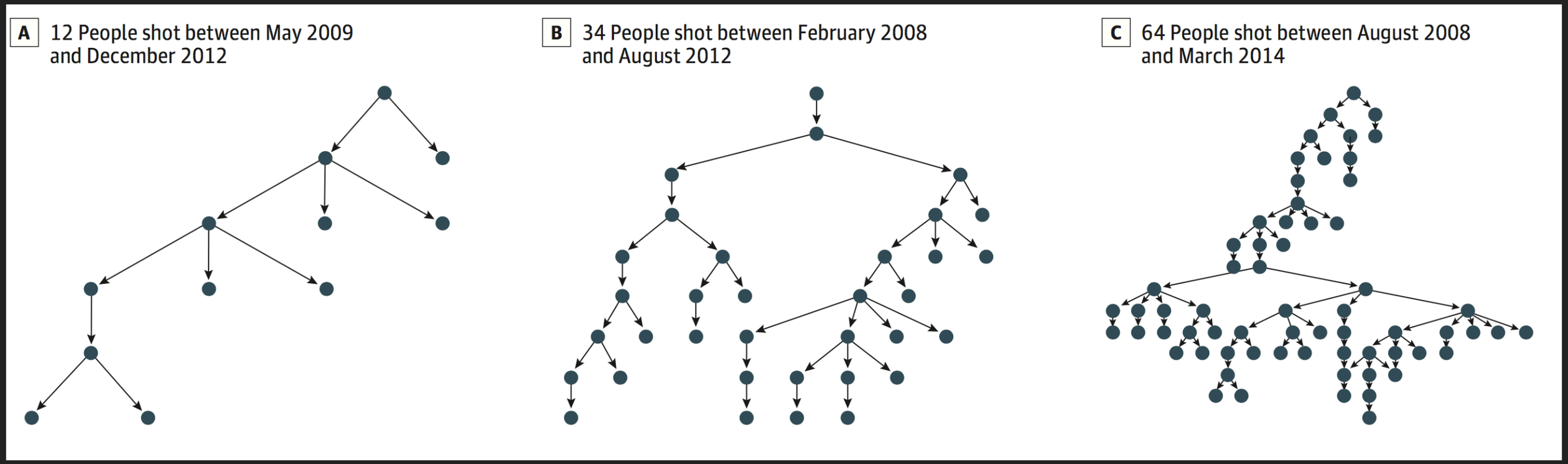
- 138,163 people
  - 9,773 victims (7%; in red)
- Victims are clustered

Modeling contagion over social networks

- Modeled the spread of gun violence using a Bayesian Hawkes Process (a self-exciting point process)
- Exposure to gun violence is based on social contagion and seasonal variations
- Social contagion based on two factors
  - Time: violence is most likely to spread immediately after another shooting
  - Network structure: violence is more likely to spread between people who are closely linked
- Calibrated this model to the data to determine dynamic patterns of gun violence across the network

Inferring contagion in the LCC

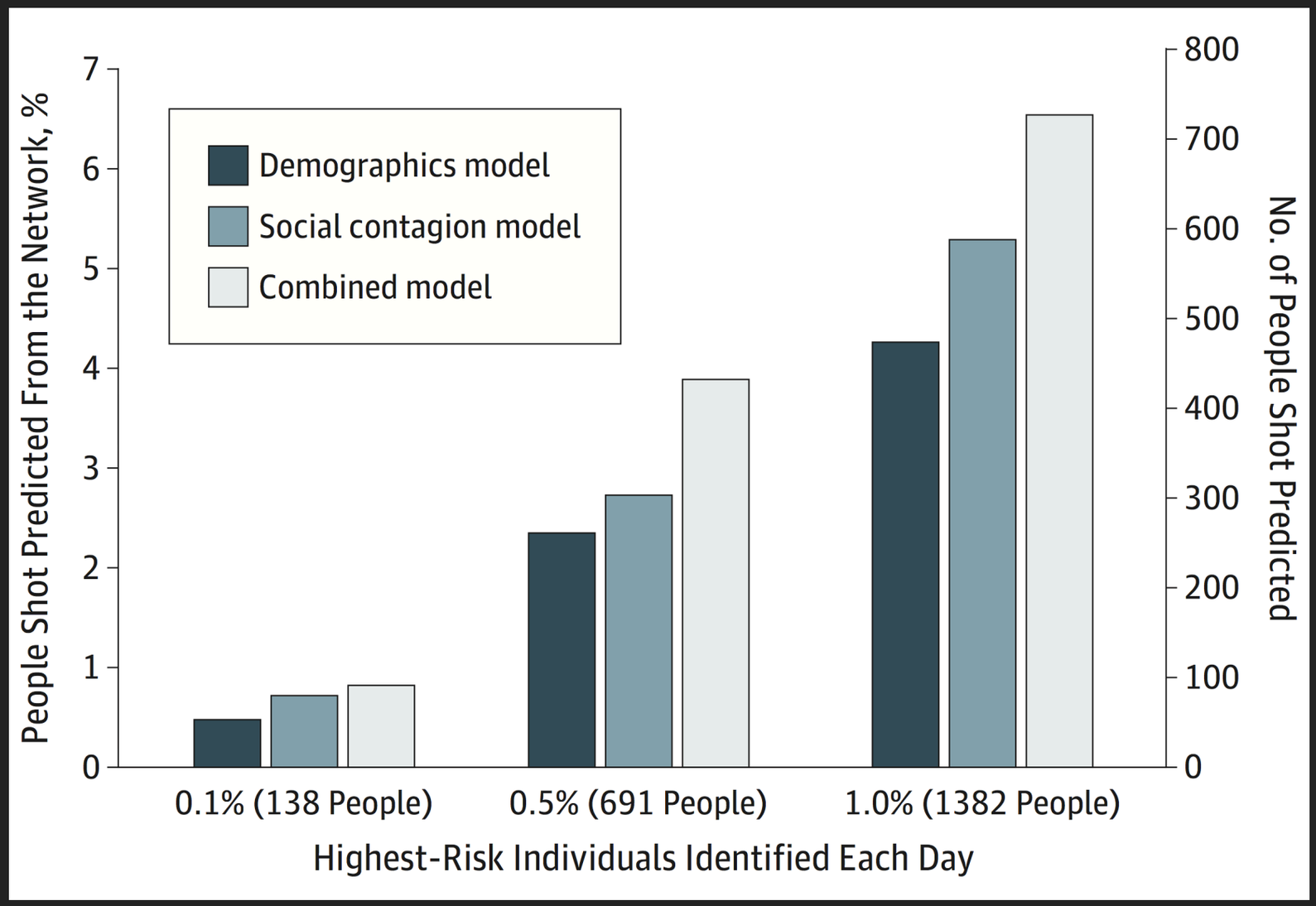
- Social contagion was responsible for 7,016 (63%) of victimizations
- Victims were shot on average 125 days after their infector (median = 83 days)
- 680 cascades with multiple people
- Mean cascade has 2.7 people (max=469)



Predictions of gunshot violence

- Test: predict the most likely victims for each day, comparing three models

	Model	# victims	% of victims	% improvement
1% high-risk population	Combined	728	6.5	53.3
	Contagion	589	5.3	24.0
	Demographics	475	4.3	N/A



Gun violence as a public health issue

- Gun violence follows an epidemic-like process of social contagion that is transmitted through networks
- Violence prevention efforts should account for contagion in addition to traditional risk factors
- Network-based approaches could help proactive prevention efforts by identifying those at highest risk
  - Target potential victims with preventative social services, not additional police surveillance
- Prevention efforts should be modeled on public health interventions developed for other epidemics

The future of data and technology in criminal justice

- Applying data science and social network techniques to gun violence has great upside, but also presents new risks
- Predictive policing based on hotspots and heatlists are biased due to historically inequitable police practices
- The use of technology, too often seen as objective, justifies and perpetuates systemic biases
- The impacts of new technologies are based on the social contexts in which they are developed and deployed
- We must be on the front lines of developing new approaches and the policies that govern them