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POLICING PREDICTIVE POLICING

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ABSTRACT

Predictive policing is sweeping the nation, promising the holy grail of policing—preventing crime before it happens. The technology has far outpaced any legal or political accountability and has largely escaped academic scrutiny. This article examines predictive policing's evolution with the goal of providing the first practical and theoretical critique of this new policing strategy. Building on insights from scholars who have addressed the rise of risk assessment throughout the criminal justice system, this article provides an analytical framework to police new predictive technologies.

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> [T]he Santa Cruz Police Department became the first law enforcement agency in the nation to implement a predictive policing program. With about eight years of data on car and home burglaries, an algorithm predicts locations and days of future crimes each day. Police are given a list of places to go to try to prevent crime when they were not responding to calls for service.[1]

> We could name our top 300 offenders. . . . So we will focus on those individuals, the persons responsible for the criminal activity, regardless of who they are or where they live. . . . We're not just looking for crime. We're looking for people.[2]

INTRODUCTION

In police districts all over America, "prediction" has become the new watchword for innovative policing.[3] Using predictive analytics, high-powered computers, and good old-fashioned intuition, police are adopting predictive policing strategies that promise the holy grail of policing—stopping crime before it happens.[4] Major cities in California, South

1. Stephen Baxter, *Modest Gains in First Six Months of Santa Cruz's Predictive Police Program*, SANTA CRUZ SENTINEL (Feb. 26, 2012, 12:01 AM), http://www.santacruzsentinel.com/ general-news/20120226/modest-gains-in-first-six-months-of-santa-cruzs-predictive-police-program [https://perma.cc/U8JC-HZGW].

2. Robert L. Mitchell, *Predictive Policing Gets Personal*, COMPUTERWORLD (Oct. 24, 2013, 7:00 AM), http://www.computerworld.com/article/2486424/government-it/predictive-policing-gets-personal.html?page=2 [https://perma.cc/3YLU-5JHH] (quoting Police Chief Rodney Monroe, Charlotte-Mecklenburg County, N.C.).

3. *See* Ellen Huet, *Server and Protect: Predictive Policing Firm PredPol Promises to Map Crime Before It Happens*, FORBES (Feb. 11, 2015), http://www.forbes.com/sites/ellenhuet/2015/ 02/11/predpol-predictive-policing/#175113db407f ("In a 2012 survey of almost 200 police agencies 70% said they planned to implement or increase use of predictive policing technology in the next two to five years.") (citing CMTY. ORIENTED POLICING SERVS., U.S. DEP'T OF JUSTICE, FUTURE TRENDS IN POLICING 3 (2014), http://www.policeforum.org/assets/docs/Free_Online_Documents/Leadership/ future%20trends%20in%20policing%202014.pdf); DAVID ROBINSON & LOGAN KOEPKE, UPTURN, STUCK IN A PATTERN: EARLY EVIDENCE ON "PREDICTIVE POLICING" AND CIVIL RIGHTS 4–5 (2016), https://www.teamupturn.com/static/reports/2016/predictive-policing/files/Upturn_-_Stuck_In_a_ Pattern_v.1.01.pdf.

4. Justin Jouvenal, *Police are Using Software to Predict Crime. Is it a 'Holy Grail' or Biased Against Minorities?*, WASH. POST (Nov. 17, 2016), https://www.washingtonpost.com/local/public-safety/police-are-using-software-to-predict-crime-is-it-a-holy-grail-or-biased-against-minorities/2016/ 11/ 17/525a6649-0472-440a-aae1-b283aa8e5de8_story.html?utm_term=.72a9d2eb22ae; Sidney Perkowitz, *Crimes of the Future*, AEON (Oct. 27, 2016), https://aeon.co/essays/should-we-trust-predictive-policing-software-to-cut-crime; Darwin Bond-Graham & Ali Winston, *All Tomorrow's Crimes: The Future of Policing Looks a Lot Like Good Branding*, SFWEEKLY (Oct. 30, 2013), http://archives.sfweekly.com/sanfrancisco/all-tomorrows-crimes-the-future-of-policing-looks-a- lot-like-good-branding/Content?oid=2827968&showFullText=true [https://perma.cc/G35D-F543] ("[M]ore than 150 police departments nationally are deploying predictive policing analytics. Many departments are

Carolina, Washington, Tennessee, Florida, Pennsylvania, and New York, among others, have purchased new predictive policing software to combat property crimes such as burglaries, car thefts, and thefts from automobiles.[5] Data from past crimes, including crime types and locations, are fed into a computer algorithm to identify targeted city blocks with a daily (and sometimes hourly) forecast of crime.[6] Police officers patrol those predicted areas of crime to deter and catch criminals in the act.[7] In large cities such as Los Angeles, Chicago, and New Orleans, complex social network analysis has isolated likely perpetrators and victims of gun violence.[8] Social maps link friends, gangs, and enemies in a visual web of potential criminal actors.[9] Intervention strategies seek to reach these potential victims and perpetrators before the violence occurs.[10]

Law enforcement's embrace of predictive technology mirrors its adoption in other areas of the criminal justice system.[11] New pretrial risk

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developing their own open-source algorithms, and a few tech heavyweights like IBM and Palantir are getting in on the game.").

5. Huet, *supra* note 3 ("PredPol is being used in almost 60 departments, the biggest of which are Los Angeles and Atlanta, but [PredPol] is eyeing more. '[The] goal by the end of 2015 is to have the majority of large North American metro areas using this [technology].'") (quoting Larry Samuels, PredPol CEO). *See also infra* notes 119–130.

6. *See* Erica Goode, *Sending the Police Before There's a Crime*, N.Y. TIMES (Aug. 15, 2011), http://www.nytimes.com/2011/08/16/us/16police.html; Guy Adams, *LAPD's Sci-Fi Solution to Real Crime*, INDEPENDENT (Jan. 10, 2012), http://www.independent.co.uk/news/world/americas/lapds-scifi-solution-to-real-crime-6287800.html [https://perma.cc/84J5-KD3N] (describing maps with targeted "boxes" of predicted criminal activity measuring 500 feet by 500 feet).

7. *Predictive Policing: Don't Even Think About It*, THE ECONOMIST (July 20, 2013), http://www.economist.com/news/briefing/21582042-it-getting-easier-foresee-wrongdoing-and-spot-likely-wrongdoers-dont-even-think-about-it; Leslie A. Gordon, *Predictive Policing May Help Bag Burglars—But it May Also be a Constitutional Problem*, A.B.A. J. (Sept. 1, 2013, 8:40 AM), http://www.abajournal.com/mobile/mag_article/predictive_policing_may_help_bag_burglars--but_it_may_also_be_a_constitutio/ [https://perma.cc/A9PX-2JJD].

8. *See, e.g.*, John Buntin, *Social Media Transforms the Way Chicago Fights Gang Violence*, GOVERNING (Oct. 2013), http://www.governing.com/topics/urban/gov-social-media-transforms-chicago-policing.html [https://perma.cc/CM2B-LPRN]; Darwin Bond-Graham & Ali Winston, *Forget the NSA, the LAPD Spies on Millions of Innocent Folks*, LA WEEKLY (Feb. 27, 2014), http://www.laweekly.com/news/forget-the-nsa-the-lapd-spies-on-millions-of-innocent-folks-4473467 [https://perma.cc/67WQ-TZQK]*;* PALANTIR, NOLA MURDER REDUCTION: TECHNOLOGY TO POWER DATA-DRIVEN PUBLIC HEALTH STRATEGIES (2014) (describing NOLA for Life, a project to reduce homicides in New Orleans).

9. Scott Harris, *Product Feature: Predictive Policing Helps Law Enforcement "See Around the Corners"*, POLICE CHIEF MAG. (Nov. 2014), http://www.policechiefmagazine.org/magazine/index.cfm?fuseaction=display_arch&article_id=3539&issue_id=112014.

10. *See, e.g.*, Michael Sierra-Arevalo, *How Targeted Deterrence Helps Police Reduce Gun Deaths*, SCHOLARS STRATEGY NETWORK (June 3, 2013), http://thesocietypages.org/ ssn/2013/06/03/targeted-deterrence/ [https://perma.cc/88MD-TZVR]; Mark Guarino, *Can Math Stop Murder?*, THE CHRISTIAN SCI. MONITOR (July 20, 2014); http://www.csmonitor.com/USA/2014/ 0720/Can-math-stop-murder-video [https://perma.cc/UDT2-A4FH].

11. *See infra* Part I.

assessment models claim to be able to predict future dangerousness.[12] Post-trial sentencing predictions forecast likely recidivism.[13] Probability outcomes forecast likely probation violations.[14] It is no wonder, then, that predictive analytics have begun to shape policing strategies. Predictive analytics not only sounds like a futuristic solution to the age-old problem of crime, but also has the appeal of seemingly being based on empirical data free from human biases or inefficiencies.[15] Such marketing allure has resulted in a series of national news stories that have proclaimed predictive policing to be the future of law enforcement.[16]

Predictive policing thus raises some profound questions about the nature of prediction in an era influenced by data collection and analysis. The first generation of predictive policing technologies represents only the beginning of a fundamental transformation of how law enforcement prevents crime.[17] Identifying a future location of criminal activity may be statistically possible by studying where and why past crime patterns have developed over time.[18] But forecasting the precise identity of the future human "criminal" presents a far more troubling prediction. Both may be based on historical data with statistically significant correlations, but the analyses and civil liberties concerns differ.[19]

This article addresses the deeper questions behind the adoption of predictive analytics by law enforcement. The article develops a framework for how predictive technologies must be policed by legislators, courts, and the police themselves. Building off a wealth of theoretical insights of scholars who have addressed the rise of risk assessment in other areas of criminal justice, the article provides an analytical structure for future adoption of any new predictive technology.

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12. *See, e.g.*, Shima Baradaran & Frank L. McIntyre, *Predicting Violence*, 90 TEX. L. REV. 497, 500 (2012); Cynthia E. Jones, *"Give Us Free": Addressing Racial Disparities in Bail Determinations*, 16 N.Y.U. J. LEGIS. & PUB. POL'Y 919, 931–32 (2013).

13. *See, e.g.*, Melissa Hamilton, *Adventures in Risk: Predicting Violent and Sexual Recidivism in Sentencing Law*, 47 ARIZ. ST. L.J. 1, 5 (2015); Dawinder S. Sidhu, *Moneyball Sentencing*, 56 B.C. L. REV. 671, 718 (2015); Sonja B. Starr, *Evidence-Based Sentencing and the Scientific Rationalization of Discrimination*, 66 STAN. L. REV. 803, 807 (2014).

14. *See, e.g.*, Martin Hildebrand et al., *Predicting Probation Supervision Violations*, 19 PSYCHOL. PUB. POL'Y & L. 114, 115 (2013).

15. *See* Nate Berg, *Predicting Crime, LAPD-style*, THE GUARDIAN (June 25, 2014), http://www.theguardian.com/cities/2014/jun/25/predicting-crime-lapd-los-angeles-police-data-analysis-algorithm-minority-report.

16. *See, e.g.*, *supra* notes 1–8.

17. Beth Pearsall, *Predictive Policing: The Future of Law Enforcement?*, 266 NAT'L INST. JUST. J. (May 2010), http://www.nij.gov/journals/266/Pages/predictive.aspx [https://perma.cc/6UR2-MXMD]. *See also infra* Part II.

18. *See infra* Part II.A.

19. *See infra* Part II.C.

This article offers three insights to the rather sparse literature on the subject of predictive policing.[20] First, the article situates predictive policing within the decades-long search for predictive solutions to criminal justice problems. Predictive policing may be new, but the lure of predictive techniques is not. Second, the article examines the rapid evolution from place-based *property* crimes to place-based *violent* crimes and then to person-based crimes. This evolution has largely gone unchallenged, even though the social science justifications for the different crime types remain contested. Third, and most importantly, the article uses the example of predictive policing to develop a theoretical framework to police all future predictive techniques. With the rise of big data, the Internet of Things, intelligence-driven prosecution, and as yet uncreated surveillance tools, law enforcement will continue to adapt and innovate.[21]

Part I situates the debate over predictive policing within the larger context of prediction in the criminal justice system. Prediction has been a "new thing" for decades and significant scholarly work has been done demonstrating its effects on other aspects of the criminal justice system.[22] From pretrial release to parole, predictive mechanisms now control many aspects of the criminal justice system. Predictive policing is but the next iteration of this move toward actuarial justice.[23]

Part II examines the evolution of predictive policing techniques from placed-based property crime to place-based violent crime. I call this the move from Predictive Policing 1.0 to Predictive Policing 2.0, in which the insights of a rather rigorous empirical and scholarly approach to studying property-based crimes have been adopted without equivalent empirical studies to the problem of violent crime.[24] While similar logic prevails, equivalent research does not. Part II also analyzes a separate technique focusing on the identification of individuals predicted to be involved in

20. *See, e.g.*, Andrew Guthrie Ferguson, *Big Data and Predictive Reasonable Suspicion*, 163 U. PA. L. REV. 327, 329 (2015) [hereinafter *Big Data*]; Andrew Guthrie Ferguson, *Predictive Policing and Reasonable Suspicion*, 62 EMORY L.J. 259, 265–69 (2012) [hereinafter *Predictive Policing*]; Fabio Arcila Jr., *Nuance, Technology, and the Fourth Amendment: A Response to Predictive Policing and Reasonable Suspicion*, 63 EMORY L.J. ONLINE 87, 89 (2014).

21. *See, e.g.*, Ferguson, *Big Data*, *supra* note 20; Andrew Guthrie Ferguson, *The Internet of Things and the Fourth Amendment of Effects*, 104 CALIF. L. REV. 805, 812–23 (2016) [hereinafter *The Internet of Things*]; Andrew Guthrie Ferguson, *Predictive Prosecution*, 51 WAKE FOREST L. REV. 705, 705–06 (2016) [hereinafter *Predictive Prosecution*].

22. *See infra* Part I.A.

23. BERNARD E. HARCOURT, AGAINST PREDICTION: PROFILING, POLICING, AND PUNISHING IN AN ACTUARIAL AGE 145 (2007); Malcolm Feeley & Jonathan Simon, *Actuarial Justice: The Emerging New Criminal Law*, *in* THE FUTURES OF CRIMINOLOGY 173 (David Nelken ed., 1994) (coining the term "actuarial justice").

24. *See infra* Part II.B.

crime.[25] This is what I call Predictive Policing 3.0, with a focus away from places to persons. In cities like Chicago and New Orleans, sophisticated data programs are mapping shootings and studying the underlying human connections.[26] Mirroring a public health approach to disease, this focus on societal violence targets both potential shooting victims and offenders.[27] Targeted individuals are identified and interventions conducted to address (and hopefully prevent) future violent acts.

Part III then develops an analytical framework to evaluate police prediction. Specifically, I study nine core issues that must be addressed before adopting any predictive policing technology. These fundamental issues—data, methodology, social science, transparency, accountability, practical implementation, administration, vision, and security—present substantial risks and vulnerabilities for adopters of the technology. Because of the industry's rapid growth, police administrators and agencies have not adequately addressed these risks. The goal of this section is to move beyond Predictive Policing 2.0 or 3.0 to address universal concerns that will affect the next generation of technology, and all future predictive techniques.

The foundational insight of predictive policing is that certain aspects of the physical and social environment encourage quite predictable acts of criminal wrongdoing.[28] Interfering with that environment or those connections will—the theory goes—deter crime.[29] Predictive policing, thus, is less about blind fortunetelling, and more about divining hidden crime-inducing environmental conditions which can be deterred by an intentional police response. The same deterrence principle also can be applied to the predictive technologies themselves. This article seeks to show that parallel vulnerabilities exist in the adoption of new predictive technologies—vulnerabilities that can be addressed by identifying and remediating the underlying risks. This article then offers an analytical framework to analyze and improve implementation of predictive technologies, while allowing for continued innovations in the technology.

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25. *See infra* Part II.C.

26. *See infra* notes 182–189, 204–208.

27. TRACEY MEARES ET AL., PROJECT SAFE NEIGHBORHOODS IN CHICAGO, HOMICIDE AND GUN VIOLENCE IN CHICAGO: EVALUATION AND SUMMARY OF THE PROJECT SAFE NEIGHBORHOODS PROGRAM 2 (2009), http://www.saferfoundation.org/files/documents/2009-PSN-Research-Brief_v2.pdf.

28. Ferguson, *Predictive Policing*, *supra* note 20, at 277–78 (discussing the theory of environmental vulnerability).

29. Patrick Healey, *Predictive Policing Forecasts Crime That Officers Then Try to Deter*, NBC4 News (Jan. 7, 2013, 10:19 PM), http://www.nbclosangeles.com/news/local/LAPD-Chief-Charlie-Beck-Predictive-Policing-Forecasts-Crime-185970452.html [https://perma.cc/35MG-9HWQ].

I. PREDICTION AND THE CRIMINAL JUSTICE SYSTEM

At some level, most decision-making systems involve prediction. The criminal justice system is no exception. Police officers, judges, juries, probation officers, and parole boards all make risk-based assessments every single day. Predictive tools which seek to help make these difficult, life-altering decisions more objective and fair have been embraced throughout the criminal justice system.[30]

This article seeks to situate the specific technique of predictive policing within the larger move toward predictive technologies in the criminal justice system. This context is necessary because predictive policing has been billed as a new, magical "black box" solution to preventing crime,[31] yet like all "once new" predictive technologies it suffers from the same limitations and challenges of all predictive techniques.[32] Whether good, bad, ineffective, or distracting, the long-term trend has been to adopt predictive technologies regardless of effectiveness. Communities across the country will thus soon be confronted with the implementation of new technologies that promise to systematize and target the problem of crime. The next two sections detail the rise of data-driven prediction as a background to analyze the particular promise and concerns of predictive policing.

A. A Brief History of Actuarial Justice

The first experiments with prediction in the criminal justice system can be traced to the late 1920s and the Chicago School of Sociology's work on parole recidivism.[33] Early adopters such as Ernest Burgess looked at individual risk factors to predict the likelihood of convicted parolees

30. Jurek v. Texas, 428 U.S. 262, 275 (1976) ("[P]rediction of future criminal conduct is an essential element in many of the decisions rendered throughout our criminal justice system. The decision whether to admit a defendant to bail, for instance, must often turn on a judge's prediction of the defendant's future conduct. And any sentencing authority must predict a convicted person's probable future conduct when it engages in the process of determining what punishment to impose. For those sentenced to prison, these same predictions must be made by parole authorities.") (footnotes omitted).

31. Hannes Grassegger, *Simple Truth Inside the Black Box*. *Interview with Spencer Chainey*, W.I.R.E. (2016), http://www.thewire.ch/en/abstrakt/no-12---das-grosse-rauschen/in-der-black-box-gespraech-mit-spencer-chainey [https://perma.cc/67TJ-USDQ].

32. *See infra* Part III.

33. J.C. Oleson, *Training to See Risk: Measuring the Accuracy of Clinical and Actuarial Risk Assessments Among Federal Probation Officers*, 75 FED. PROBATION 52, 52 (2011) ("The statistical prediction of recidivism risk has an 80-year history, and can be traced at least as far back as the 1928 parole prediction instrument developed by Ernest Burgess.") (citation omitted); Nadya Labi, *Misfortune Teller*, THE ATLANTIC (Jan./Feb. 2012), http://www.theatlantic.com/magazine/archive/2012/01/misfortune-teller/308846/ ("In 1927, Ernest Burgess, a sociologist at the University of Chicago, drew on the records of 3,000 parolees in Illinois to estimate an individual's likelihood of recidivism.").

reoffending.[34] By systematizing risks and applying those factors to individual persons, Burgess institutionalized what we now know as the actuarial approach.[35] In his book, *Against Prediction*, Bernard Harcourt sets forth a detailed history of the influence of Burgess and other sociologists who experimented with designing the first risk assessment tools for parolees.[36] The history spans the mid-twentieth century, beginning with the slow adoption of actuarial recidivism predictions and then shifting to a more rapid growth during the later part of the twentieth century and the early part of the twenty-first century, when risk assessment mechanisms became the norm and not the exception.[37]

While initially focused only on parolees, the concept of actuarial prediction began to catch on in other parts of the criminal justice system. Actuarial (or statistical) prediction can be defined as:

> [A] formal method…[that provides] a probability, or expected value, of some outcome. It uses empirical research to relate numerical predictor variables to numerical outcomes. The *sine qua non* of actuarial assessment involves using an objective, mechanistic, reproducible combination of predictive factors, selected and validated through empirical research, against known outcomes that have also been quantified.[38]

Actuarial prediction turns on identifying and weighing specific factors that correlate with a probability of future actions.[39] The shift toward empirical,

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34. Bernard E. Harcourt, *From the Ne'er-Do-Well to the Criminal History Category: The Refinement of the Actuarial Model in Criminal Law*, 66 LAW & CONTEMP. PROBS. 99, 112 (2003).

35. *Id.*

36. HARCOURT, *supra* note 23, at 47–107.

37. *Id.*

38. Jordan M. Hyatt et al., *Reform in Motion: The Promise and Perils of Incorporating Risk Assessments and Cost-Benefit Analysis into Pennsylvania Sentencing*, 49 DUQ. L. REV. 707, 726 (2011) (quoting Don M. Gottfredson, *Prediction and Classification in Criminal Justice Decision Making*, 9 CRIME & JUST. 1 (1987)), *See also* Barbara D. Underwood, *Law and the Crystal Ball: Predicting Behavior with Statistical Inference and Individualized Judgment*, 88 YALE L.J. 1408, 1420–21 (1979) ("The alternative [to the clinical] method for making predictions evaluates each applicant according to a predetermined rule for counting and weighting key characteristics. The relevant characteristics are specified in advance, and so is the rule for combining them to produce a score for each applicant. . . . This method of making predictions is often called statistical prediction.").

39. Melissa Hamilton, *Public Safety, Individual Liberty, and Suspect Science: Future Dangerousness Assessments and Sex Offender Laws*, 83 TEMP. L. REV. 697, 720 (2011) ("The general idea for actuarial ratings for any risk at issue is to identify those factors that are correlative to the potential occurrence of the future event at issue, and to effectively assign appropriate weights to each factor based on the observation that some factors have greater correlative abilities than others relating to the particular result."); Christopher Slobogin, *Dangerousness and Expertise Redux*, 56 EMORY L.J. 275, 283 (2006) ("An actuarial approach relies, like insurance actuaries do, on a finite number of pre-identified variables that statistically correlate to risk and that produce a definitive probability or probability range of risk.")

replicable, and validated factors also meant a rejection of the "clinical method"[40] of prediction, which required an individualized, "expert" judgment not controlled by predetermined already-identified variables. The clinical method, while individualized, had recognized methodological flaws.[41]

Examples of actuarial prediction instruments include the Violence Risk Appraisal Guide (VRAG), which measures potential violent recidivism for offenders with mental disorders; the Rapid Risk Assessment for Sexual Offense Recidivism (RRASOR), which predicts sexual offender recidivism; and the Level of Services Inventory-Revised (LSI-R), which predicts parole and supervised release success.[42] Each of these assessment mechanisms shares a structure consisting of set questions, the answers to which statistically correlate with predictive scores for some future action. These assessments require responses to a series of questions that correlate to higher or lower risks of reoffending. For example, the LSI-R has been used in states to predict parole recidivism and asks questions about the individual's criminal history, education, employment, financial problems, family or marital situation, housing, hobbies, friends, alcohol and drug use, emotional or mental health issues, and attitudes about crime and supervision.[43] The questions are detailed, asking about school suspensions, dissatisfaction with spouses, use of free time, and mental health.[44] Of course, the questions also exist within certain socioeconomic realities, such that individuals can be penalized for living in a high-crime area, not having a job, accepting social assistance, or having friends with criminal records.[45] The difficulty of disentangling these poverty-correlated factors from individualized factors has opened these types of risk assessment

(emphasis omitted).

40. William M. Grove & Paul E. Meehl, *Comparative Efficiency of Informal (Subjective, Impressionistic) and Formal (Mechanical, Algorithmic) Prediction Procedures: The Clinical-Statistical Controversy*, 2 PSYCHOL. PUB. POL'Y & L. 293, 294 (1996); Bernard E. Harcourt, *The Shaping of Chance: Actuarial Models and Criminal Profiling at the Turn of the Twenty-First Century*, 70 U. CHI. L. REV. 105, 116–17 (2003).

41. Slobogin, *supra* note 39, at 283 ("Until the late 1980s, almost all expert testimony regarding dangerousness was clinical in nature.") (emphasis omitted); Alexander Scherr, Daubert *& Danger: The "Fit" of Expert Predictions in Civil Commitments*, 55 HASTINGS L.J. 1, 17 (2003) ("Clinical opinions have never received high marks for reliability. Early literature and studies almost completely discounted them, finding that clinicians did little better than chance. . . . Over the past decade, these second generation research methods have led to a conclusion that clinical methods perform somewhat better than random, but are still deeply imperfect.").

42. HARCOURT, *supra* note 23, at 78, 84.

43. *Id.* at 79–81.

44. *Id.* at 81, tbl.3.2.

45. *Id.*; Sonja B. Starr, *The New Profiling: Why Punishing Based on Poverty and Identity Is Unconstitutional and Wrong*, 27 FED. SENT'G. REP. 229, 229 (2015).

mechanisms to criticisms of racial and economic bias.[46]

Nevertheless, most states have adopted some measure of actuarial prediction in sentencing or parole determinations.[47] These risk assessment measures represent the firm, if contested, belief that formalized measures provide superior insight compared to traditional, clinical practices.[48] This belief has also impacted other parts of the criminal justice system, which will be discussed in the next section.

B. The Prevalence of Prediction in the Criminal Justice System

Today, actuarial prediction impacts almost all aspects of the criminal justice system, from the initial bail decision to the final parole release.[49] In the pretrial detention stage, judges in many states routinely rely on risk assessment instruments to predict future dangerousness before deciding on release conditions.[50] These measures have become so accepted that some researchers have proposed replacing individualized, human pretrial interviews with an automated assessment of predetermined risk factors to determine release.[51] Pretrial service workers would, in essence, be replaced with a risk assessment algorithm. While scholars have critiqued reliance on

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46. Starr, *supra* note 45, at 229.

47. *See* Starr, *supra* note 13, at 809.

48. *Compare* Christopher Slobogin, *Prevention as the Primary Goal of Sentencing: The Modern Case for Indeterminate Dispositions in Criminal Cases*, 48 SAN DIEGO L. REV. 1127, 1146 (2011) ("[R]esearch has firmly established that predictions based on the clinical method, although typically better than chance, are less valid than actuarial predictions by a significant magnitude."), *with* Grove & Meehl, *supra* note 40, at 295 (noting that "in around two fifths of studies the two methods were approximately equal in accuracy"). *See also* Thomas R. Litwack, *Actuarial Versus Clinical Assessments of Dangerousness*, 7 PSYCHOL. PUB. POL'Y & L. 409 (2001).

49. Shima Baradaran, *Race, Prediction, and Discretion*, 81 GEO. WASH. L. REV. 157, 176–77 (2013) ("Criminal justice actors often predict which defendants are going to commit an additional crime in determining whether to arrest defendants, to release them on bail, or to release them on parole, or in determining their sentence. This prediction is often based not only on individual evaluation, but also on a group's criminality and past behavior.").

50. Baradaran & McIntyre, *supra* note 12, at 513 ("While states have different considerations and definitions of dangerousness, the majority of states currently allow judges to detain the accused pretrial based on predictions of dangerousness."); Jack F. Williams, *Process and Prediction: A Return to a Fuzzy Model of Pretrial Detention*, 79 MINN. L. REV. 325, 337–38 (1994); Peggy M. Tobolowsky & James F. Quinn, *Drug-Related Behavior as a Predictor of Defendant Pretrial Misconduct*, 25 TEX. TECH. L. REV. 1019, 1028 (1994).

51. MARIE VANNOSTRAND & CHRISTOPHER T. LOWENKAMP, LAURA & JOHN ARNOLD FOUND., ASSESSING PRETRIAL RISK WITHOUT A DEFENDANT INTERVIEW (2013), http://www.arnoldfoundation.org/sites/default/files/pdf/LJAF_Report_no-interview_FNL.pdf.

such correlative factors,[52] some jurisdictions are beginning to adopt them.[53]

At the other end of trial, during sentencing, judges rely on established risk assessment instruments in an attempt to make sentences more uniform and predictable.[54] While judges have always had to make predictions about future danger, the difference today is that formalized mechanisms exist to guide the judges' discretion.[55] These mechanisms include actual risk assessment instruments, as well as formal sentencing guidelines, which were based on actuarial studies.[56] Further, upon release, probation, parole, or supervision officers also make predictions of recidivism based on risk assessment mechanisms which have been created for the task.[57]

Particular types of crimes (or criminals) have generated particularized predictive tools to assess future risk. In sex offender cases, risk assessment mechanisms[58] have been used to preventively detain suspects before trial,[59] and civilly commit them after they have served their sentences.[60] In

52. Baradaran & McIntyre, *supra* note 12, at 521–23 (analyzing past studies on predicting future dangerousness in the pretrial release context); Julia Angwin et. al., *Machine Bias*, PROPUBLICA (May 23, 2016), https://www.propublica.org/article/machine-bias-risk-assessments-in-criminal-sentencing.

53. DEVELOPING A NATIONAL MODEL FOR PRETRIAL RISK ASSESSMENT, LAURA & JOHN ARNOLD FOUND. (Nov. 2013), http://www.arnoldfoundation.org/wp-content/uploads/2014/02/LJAF-research-summary_PSA-Court_4_1.pdf.

54. J.C. Oleson, *Risk in Sentencing: Constitutionally Suspect Variables and Evidence-Based Sentencing*, 64 SMU L. REV. 1329, 1337 (2011) (discussing actuarial sentencing); Michael A. Wolff, *Evidence-Based Judicial Discretion: Promoting Public Safety Through State Sentencing Reform*, 83 N.Y.U. L. REV. 1389, 1404 (2008) (proposing risk assessment models for sentencing); Starr, *supra* note 13, at 807 (critiquing the rise of risk assessment instruments for sentencing).

55. Hyatt et al., *supra* note 38, at 724 ("Risk assessment is not a new concept in the criminal justice system. It is a tool—nothing more and nothing less. . . . Informally, sentencing judges have long assessed risk of re-offense in crafting a defendant's sentence.").

56. *See generally* Charles J. Ogletree, Jr., *The Death of Discretion? Reflections on the Federal Sentencing Guidelines*, 101 HARV. L. REV. 1938 (1988).

57. Matthew G. Rowland, *Too Many Going Back, Not Enough Getting Out? Supervision Violators, Probation Supervision, and Overcrowding in the Federal Bureau of Prisons*, 77 FED. PROBATION 3, 5 (2013) ("Since the 1990s, the federal probation and pretrial services system has used the Risk Prediction Index (RPI), an actuarial risk assessment tool developed by the Research Division of the Federal Judicial Center, to empirically measure the risk level of the supervisee population.").

58. Hamilton, *supra* note 39, at 726–27 (challenging the testing and scientific method for sex offender assessment measures).

59. Stephen J. Morse, *Preventive Confinement of Dangerous Offenders*, 32 J.L. MED. & ETHICS 56 (2004).

60. John A. Fennel, *Punishment by Another Name: The Inherent Overreaching in Sexually Dangerous Person Commitments*, 35 NEW ENG. J. ON CRIM. & CIV. CONFINEMENT 37, 51–52 (2009); Fredrick E. Vars, *Rethinking the Indefinite Detention of Sex Offenders*, 44 CONN. L. REV. 161, 164 (2011); Slobogin, *supra* note 39, at 276 ("Since 1990, about one third of the states have enacted laws that permit indeterminate post-sentence commitment of sex offenders considered to be 'predisposed' to violent behavior."); Robert A. Prentky et al., *Sexually Violent Predators in the Courtroom: Science on Trial*, 12 PSYCHOL. PUB. POL'Y & L. 357, 358 (2006); Eric S. Janus & Robert A. Prentky, *Forensic Use of Actuarial Risk Assessment with Sex Offenders: Accuracy, Admissibility and Accountability*, 40 AM. CRIM. L. REV. 1443, 1454–55 (2003) (describing trial court use of actuarial instruments).

domestic violence cases, courts have utilized Intimate Partner Violence (IPV) screening tools to identify factors that might signal future violence.[61] In non-domestic violence cases, predictors of future dangerousness are relied upon to determine sentences.[62] In juvenile cases, over 85% of jurisdictions use risk assessment mechanisms to evaluate young people.[63] In capital cases, experts regularly must make a determination of future dangerousness using risk assessment tools.[64] While each instrument incorporates a different calculus, they share the same underlying assumption that certain reliable correlations can be drawn from patterns in data.

This faith in predictive accuracy is not limited to the criminal context, as court decisions about child protection,[65] civil commitment,[66] and prisoner status[67] have been guided by new predictive tools. Determinations about civil liberty or family autonomy are also now guided by pre-determined assessments that help shape court decision-making.

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61. Amanda Hitt & Lynn McLain, *Stop the Killing: Potential Courtroom Use of a Questionnaire That Predicts the Likelihood That a Victim of Intimate Partner Violence Will Be Murdered By Her Partner*, 24 WIS. J.L. GENDER & SOC'Y 277, 283 (2009) ("Since the late 1970's, as researchers clamored to create instruments that could accurately predict the threat of physical violence, over thirty-three IPV screening tools have been created.").

62. John Monahan, *Violence Risk Assessment: Scientific Validity and Evidentiary Admissibility*, 57 WASH. & LEE L. REV. 901, 905–10 (2000); Erica Beecher-Monas & Edgar Garcia-Rill, *Genetic Predictions of Future Dangerousness: Is There a Blueprint for Violence?*, 68 LAW & CONTEMP. PROBS. 301, 318–19 (2006) ("The predominant instrument used in assessing violence (including sexual violence) is the Violence Risk Assessment Guide (VRAG)."). *See also id.* at 308 ("Predicting future dangerousness has become important as the criminal justice system has changed its focus from punishment to preventing violent recidivism.").

63. Christopher Slobogin, *Risk Assessment and Risk Management in Juvenile Justice*, 27 CRIM. JUST. 10, 11 (2013) ("Today over 85 percent of juvenile court jurisdictions in the United States use formal risk assessment at some point in the process, compared to 33 percent of American jurisdictions prior to 1990."); Jeffrey Fagan & Martin Guggenheim, *Preventative Detention and the Judicial Prediction of Dangerousness for Juveniles: A Natural Experiment*, 86 J. CRIM. L. & CRIMINOLOGY 415 (1996); Albert R. Roberts & Kimberly Bender, *Overcoming Sisyphus: Effective Prediction of Mental Health Disorders and Recidivism Among Delinquents*, 70 FED. PROBATION 19, 21–23 (2006) (evaluating risk prediction models for juveniles).

64. Jonathan R. Sorensen & Rocky L. Pilgrim, *Criminology: An Actuarial Risk Assessment of Violence Posed By Capital Murder Defendants*, 90 J. CRIM. L. & CRIMINOLOGY 1251, 1252 (2000); Lisa M. Dennis, *Constitutionality, Accuracy, Admissibility: Assessing Expert Predictions of Future Violence in Capital Sentencing Proceedings*, 10 VA. J. SOC. POL'Y & L. 292, 307 (2002).

65. Marsha Garrison, *Taking the Risks Out of Child Protection Risk Analysis*, 21 J.L. & POL'Y 5, 19–20 (2012) (describing the use of algorithms to guide child protection policymakers and case workers).

66. Douglas Mossman et al., *Risky Business Versus Overt Acts: What Relevance Do "Actuarial," Probabilistic Risk Assessments Have for Judicial Decisions on Involuntary Psychiatric Hospitalization?*, 11 HOUS. J. HEALTH L. & POL'Y 365, 368 (2011); Alexander Tsesis, *Due Process in Civil Commitments*, 68 WASH. & LEE L. REV. 253, 287 (2011).

67. John Monahan, *A Jurisprudence of Risk Assessment: Forecasting Harm Among Prisoners, Predators, and Patients*, 92 VA. L. REV. 391, 434–35 (2006) (discussing the release status of sexually violent prisoners).

The prevalence of predictive technologies in the criminal justice system has not gone unchallenged, and many scholars have critiqued the growing reliance and even legitimacy of some of the chosen tools.[68] Interestingly, these critiques have not necessarily slowed the acceptance of actuarial justice, although perhaps they have moderated a complete reliance on the new tools.[69] No matter the criticism, actuarial predictions are still considered superior to clinical predictions, and so the temptation has been to adopt and test new data-driven versions.[70]

That same temptation has impacted police administrators, who like judges wish to predict recidivism and future violence before it happens. The next section discusses the evolving impacts prediction has had on policing.

II. THE EVOLUTION OF PREDICTIVE POLICING

Prediction has always been part of policing. Police officers regularly predict the places and persons involved in criminal activity and seek to deter this pattern of lawbreaking. The move toward predictive policing, then, is more a shift in tools than strategy.[71]

Police use of predictive techniques parallels the history of actuarial prediction. The same Chicago School of Sociology that sought to predict at-risk individuals also generated interest in studying at-risk places.[72] The rise of environmental criminology grew alongside early experiments that studied the geography of crime.[73] These experiments informed police practice as crime mapping became a way to identify and study patterns of criminal behavior. As data collection and data analysis grew more sophisticated, new predictive techniques and computer-mapping

68. *See, e.g.*, Starr, *supra* note 45, at 229.

69. Stephen D. Hart, *The Role of Psychopathy in Assessing Risk for Violence: Conceptual and Methodological Issues*, 3 LEGAL & CRIMINOLOGICAL PSYCHOL. 121, 126 (1998) ("Reliance—at least complete reliance—on actuarial decision-making by professionals is unacceptable."); Harcourt, *supra* note 40, at 114.

70. *See* Samuel R. Wiseman, *Fixing Bail*, 84 GEO. WASH. L. REV. 417, 439–40 (2016) (discussing the superior accuracy of actuarial risk assessments to determine future dangerousness in sentencing and for pretrial release); Erica Beecher-Monas, *The Epistemology of Prediction: Future Dangerousness Testimony and Intellectual Due Process*, 60 WASH. & LEE L. REV. 353, 363 (2003) ("Repeated studies of actuarial methods have demonstrated them to be superior to clinical judgment standing alone.").

71. Some predictive techniques such as Risk Terrain Modeling have adopted a strategic shift to accompany new technological innovations. *See infra* Part II.A (discussing the Risk Terrain Modeling attempt at addressing environmental vulnerabilities based on predictive analytics).

72. Calvin Morrill et al., *Seeing Crime and Punishment Through A Sociological Lens: Contributions, Practices, and the Future*, 2005 U. CHI. LEGAL F. 289, 291 (2005).

73. Andrew Guthrie Ferguson, *Crime Mapping and the Fourth Amendment: Redrawing "High-Crime Areas"*, 63 HASTINGS L.J. 179, 186 (2011).

technologies also developed to make use of the information.[74]

Over the course of the twentieth century, push-pin wall maps identifying daily crimes morphed into digital maps displaying historical patterns of all recorded crimes.[75] Similarly, the insights of academic criminologists inspired police departments to hire professional crime analysts.[76] Those crime analysts, in turn, began crunching the collected data and advising police administrators about how best to deploy resources. "High crime areas,"[77] "hot spots,"[78] and other techniques informed by Geographic Information Systems (GIS) were developed to visualize and respond to problem areas.[79] Large-scale experiments like the CompStat system in New York City, in which crime data literally became the organizing principle of police response, were met with accolades and attention.[80] Suddenly the idea of "smart policing" turned from buzzword into reality.[81]

These predictive, data-driven techniques drew strength from the growing work of predictive analytics in other criminal justice fields. The predictive techniques were perceived as objective, focused on correlations as opposed to causation, and widely applicable across jurisdictions.[82] Especially after the economic recession in 2008, when police departments were faced with

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74. Andrew Guthrie Ferguson & Damien Bernache, *The "High-Crime Area" Question: Requiring Verifiable and Quantifiable Evidence for Fourth Amendment Reasonable Suspicion Analysis*, 57 AM. U. L. REV. 1587, 1605, 1607–08 (2008); WALTER L. PERRY ET AL., PREDICTIVE POLICING: THE ROLE OF CRIME FORECASTING IN LAW ENFORCEMENT OPERATIONS 2 (2013) (ebook) ("The use of statistical and geospatial analyses to forecast crime levels has been around for decades.").

75. *Predictive Crime Fighting*, IBM, http://www-03.ibm.com/ibm/history/ibm100/us/en/icons/crimefighting (last visited Nov. 13, 2016) (describing early hand drawn crayon maps of crime in New York City).

76. For a complete history of crime mapping technology, *see* Ferguson, *supra* note 73.

77. Illinois v. Wardlow, 528 U.S. 119, 123 (2000).

78. Anthony A. Braga et al., *The Relevance of Micro Places to Citywide Robbery Trends: A Longitudinal Analysis of Robbery Incidents at Street Corners and Block Faces in Boston*, 48 J. RES. CRIME & DELINQ. 7, 9 (2011) ("Criminological evidence on the spatial concentration of crime suggests that a small number of highly active micro places in cities—frequently called 'hot spots'—may be primarily responsible for overall citywide crime trends.").

79. *See, e.g.*, DEREK J. PAULSEN & MATTHEW B. ROBINSON, CRIME MAPPING AND SPATIAL ASPECTS OF CRIME 154 (2009); KEITH HARRIES, U.S. DEP'T OF JUSTICE, MAPPING CRIME: PRINCIPLE AND PRACTICE 92 (1999), https://www.ncjrs.gov/pdffiles1/nij/178919.pdf.

80. James J. Willis et al., *Making Sense of COMPSTAT: A Theory-Based Analysis of Organizational Change in Three Police Departments*, 41 LAW & SOC'Y REV. 147, 172 (2007) (discussing the rise of COMPSTAT).

81. Charlie Beck & Colleen McCue, Predictive *Policing: What Can We Learn from* WalMart *and Amazon about Fighting Crime in a Recession?*, 76 POLICE CHIEF MAG. 18–24 (Nov. 2009); Steve Lohr, *The Age of Big Data*, N.Y. TIMES, Feb. 12, 2012, at SR1 ("Police departments across the country, led by New York's, use computerized mapping and analysis of variables like historical arrest patterns, paydays, sporting events, rainfall and holidays to try to predict likely crime 'hot spots' and deploy officers there in advance.").

82. CATHY O'NEIL, WEAPONS OF MATH DESTRUCTION: HOW BIG DATA INCREASES INEQUALITY AND THREATENS DEMOCRACY, 85–91 (2016).

dwindling budgets, a cost-effective, supposedly high-tech solution to crime became especially attractive and drew investment.[83] With newspaper headlines hyping the technology as the future of policing, and federal grant money being invested in its design, predictive policing found itself leading the movement toward smart policing.[84]

Before discussing the evolution of predictive policing, the actual claims of predictive policing companies and technologies must be separated from the hype of media coverage around the technology. This is somewhat difficult, because the companies themselves helped to generate the hype.[85] In fact, one might cynically argue that companies promoting predictive policing technologies benefit from the misconception that their algorithms actually predict crime.[86] But, examined carefully, the claims and promises are much less grand. Predictive policing merely provides additional information about the places and persons involved in criminal activity that supplements, rather than replaces, existing police techniques and strategy.[87] It offers assessments of risk, rankings of risky areas or people, and can provide insights into associations and patterns that might be missed in the ordinary course of criminal investigation. As will be discussed in the next few sections, it has evolved rapidly, but, at base, remains a risk assessment tool adaptable to different problems and different jurisdictions.

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83. Pearsall, *supra* note 17, at 17 ("George Gascón, chief of police for the San Francisco Police Department, noted that predictive policing is the perfect tool to help departments become more efficient as budgets continue to be reduced. 'With predictive policing, we have the tools to put cops at the right place at the right time or bring other services to impact crime, and we can do so with less,' he said."); Huet, *supra* note 3 ("It's impossible to know if PredPol prevents crime, since crime rates fluctuate, or to know the details of the software's black-box algorithm, but budget-strapped police chiefs don't care.").

84. *See* Christopher Beam, *Time Cops: Can Police Really Predict Crime Before it Happens?*, SLATE (Jan. 24, 2011, 6:06 PM), http://www.slate.com/articles/news_and_politics/crime/2011/01/time_cops.html [https://perma.cc/WG3B-X9GM]; Lev Grossman et al., *The 50 Best Inventions of the Year*, TIME MAGAZINE (Nov. 28. 2011), http://content.time.com/time/magazine/article/0,9171,2099708,00.html [https://perma.cc/EA92-328K] (discussing preemptive policing); Vince Beiser, *Can Computers Predict Crimes of the Future?*, PAC. STANDARD (July 5, 2011), https://psmag. com/can-computers-predict-crimes-of-the-future-5dd5ecaab617#.uz71u3fty [https://perma.cc/9S7K-4MJP].

85. *See* Tim Kushing, *'Predictive Policing' Company Uses Bad Stats, Contractually-Obligated Shills To Tout Unproven 'Successes'*, Techdirt (Nov. 1, 2013, 9:48 AM) https://www.techdirt.com/articles/20131031/13033125091/predictive-policing-company-uses-bad-stats-contractually-obligated-shills-to-tout-unproven-successes.shtml [https://perma.cc/YD94-8SAT].

86. Bond-Graham & Winston, *supra* note 4.

87. PERRY ET AL., *supra* note 74, at 6, 115 (discussing the "hype" problem of predictive policing advertising).

A. Predictive Policing 1.0: Targeting Places of Property Crime

The origin myth of predictive policing has its birthplace in California under the leadership of Police Chief William Bratton.[88] Bratton, along with Jack Maple, has been credited with championing the CompStat system with the New York Police Department (NYPD), and when Bratton was asked to lead the Los Angeles Police Department (LAPD), he brought his faith in data-driven policing to the West Coast.[89] The idea, simply put, involved a data-analytics command structure that directed police resources to targeted areas of criminal activity.[90] In its first iteration, this version of predictive policing was basically computer-augmented hotspot policing. While given the label "predictive policing," it had all of the same characteristics of past crime pattern identification strategies that had been in use for years.

However, in collaboration with several academics at major universities,[91] the LAPD experimented with a predictive algorithm to identify predicted locations of criminal activity.[92] While other cities had experimented with data-driven systems,[93] two California cities, Los Angeles and Santa Cruz, embraced these predictive technologies and promoted their success.[94]

As originally designed in Los Angeles, predictive policing focused on addressing three types of crime: burglary, automobile theft, and theft from automobiles.[95] These crimes were selected for four main reasons. First, property crimes, while not the most serious, generated a significant amount of public concern for the safety of a community. Second, property crimes

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88. Like most origin myths, this story is incomplete and subject to interpretation and debate.

89. Interview by Jim Burch and Kris Rose with William Bratton, former LAPD Chief, in Los Angeles, Cal. (Nov. 2009), *available at* https://www.bja.gov/publications/podcasts/multimedia/transcript/Transcripts_Predictive_508.pdf [https://perma.cc/3KRN-V42W].

90. Beck & McCue, *supra* note 81, at 18 ("Predictive policing allows command staff and police managers to leverage advanced analytics in support of meaningful, information-based tactics, strategy, and policy decisions in the applied public safety environment.").

91. The LAPD collaborated with academics Jeffrey Brantingham (UCLA) and George Mohler (Santa Clara). *See* Jouvenal, *supra* note 4; Huet, *supra* note 3.

92. G.O. Mohler et al., *Self-Exciting Point Process Modeling of Crime*, 106 J. AM. STAT. ASS'N 100 (2011); Martin B. Short et al., *Dissipation and Displacement of Hotspots in Reaction-Diffusion Models of Crime*, 107 PROC. NAT'L ACAD. SCI. 3961 (2010).

93. Andrew Ashby, *Operation Blue C.R.U.S.H. Advances at MPD*, MEMPHIS DAILY NEWS (Apr. 7, 2006), http://www.memphisdailynews.com/editorial/Article.aspx?id=30029 [https://perma.cc/TZ5D-Y4SP] ("Operation Blue C.R.U.S.H. (Crime Reduction Using Statistical History) involves using mapping and statistical information to target crime hot spots and chronic perpetrators."). *See also Chicago Police Department Adopts Predictive Crime-Fighting Model*, 2 GEOGRAPHY & PUB. SAFETY (Cmty. Oriented Policing Servs.), Mar. 2011, at 14 ("In April 2010, the Chicago Police Department began piloting a crime prevention strategy called predictive analytics.").

94. Berg, *supra* note 15.

95. Ferguson, *Predictive Policing*, *supra* note 20, at 267.

tended to be reported, unlike drug crimes or even certain violent crimes, so police had a good sense of the level of crime, and could more easily measure any changes in frequency. Third, a large body of social science research suggested that these types of property crimes arose out of certain environmental vulnerabilities that could be identified and remedied.[96] Finally, because the crimes arose from place-based environmental factors, the theory became that targeted police presence in those areas might deter future criminal actions.

In practice, this first iteration of predictive policing[97]—Predictive Policing 1.0—involved the collection of historical crime data (time, place, and type) and the application of an experimental computer algorithm that used data to predict likely areas of criminal activity.[98] The predicted areas were precise—usually 500 by 500 square feet—and forecast a particular type of crime.[99] Police officers on patrol received highlighted maps and visited those targeted areas as often as practicable within their regular patrols.[100] It was believed that increased police presence at the identified areas would disrupt the continued pattern of property crimes.[101] In Los Angeles, police officers in the Foothill Division were provided maps to guide them on patrol.[102] In Santa Cruz, every morning at roll call officers were handed detailed maps with predictive forecasts of crime broken down

96. *See, e.g.*, Lawrence W. Sherman et al., *Hot Spots of Predatory Crime: Routine Activities and the Criminology of Place*, 27 CRIMINOLOGY 27 (1989); Braga et al., *supra* note 78, at 9; Leslie W. Kennedy et al., *Risk Clusters, Hotspots, and Spatial Intelligence: Risk Terrain Modeling as an Algorithm for Police Resource Allocation Strategies*, 27 J. QUANTITATIVE CRIMINOLOGY 339, 358 (2011); Spencer Chainey et al., *The Utility of Hotspot Mapping for Predicting Spatial Patterns of Crime*, 21 SECURITY J. 4, 4–5 (2008).

97. The analysis here primarily focuses on what is now understood to be the model designed by PredPol. The precursor to PredPol was tested and developed with the LAPD under Chief Bratton.

98. Gordon, *supra* note 7; Ronald Bailey, *Stopping Crime Before It Starts*, REASON (July 10, 2012, 5:00 PM), http://reason.com/archives/2012/07/10/predictive-policing-criminals-crime [https://perma.cc/LYK5-U6K]; Zach Friend, *Predictive Policing: Using Technology to Reduce Crime*, FBI LAW ENFORCEMENT BULLETIN (Apr. 9, 2013), http://www.fbi.gov/stats-services/publications/law-enforcement-bulletin/2013/April/predictive-policing-using-technology-to-reduce-crime [https://perma.cc/GRN5-GD8A].

99. Adams, *supra* note 6.

100. *See* Lawrence W. Sherman, *The Rise of Evidence-Based Policing: Targeting, Testing, and Tracking*, 42 CRIME & JUST. 377, 426 (2013) ("PredPol, the predictive policing company, sells police agencies proprietary software that identifies extremely tight bounding of time and place in which crime is predicted to occur.").

101. Goode, *supra* note 6.

102. Aaron Mendelson, *Can LAPD Anticipate Crime with 'Predictive Policing'?*, THE CALIFORNIA REPORT (Sept. 6, 2013), http://audio.californiareport.org/archive/R201309061630/b [https://perma.cc/ZQS2-2ZJ2].

by location and time.[103] In other jurisdictions, patrol car computers displayed the data in real time.[104] In all cases, police hoped their presence would deter lawbreaking.[105]

The theory behind Predictive Policing 1.0 can be traced back to the work of criminologists who found that certain property-based crimes tended to have ripple effects in neighboring areas. Like contagious viruses,[106] these crimes spurred additional crimes in the area, because either the same criminals came back to commit them, or certain environmental vulnerabilities existed to encourage crime.[107] For example, a successful burglary of one house might encourage future attempts at nearby houses because the area would be familiar to the burglar, the houses might be built similarly, or the police presence inadequate.[108] Perhaps the same burglar or group would strike again, or perhaps word would get out about easy targets in the area. Empirical studies had confirmed this "near repeat effect,"[109] and

103. Tessa Stuart, *Santa Cruz's Predictive Policing Experiment*, SANTACRUZ.COM (Feb. 14, 2012), http://www.santacruz.com/news/santa_cruzs_predictive_policing_experiment.html [http://perma.cc/U2YD-VPYC].

104. Zen Vuong, *Alhambra Police Chief Says Predictive Policing Has Been Successful*, PASADENA STAR-NEWS (Feb. 11, 2014, 6:53 PM) http://www.pasadenastarnews.com/government-and-politics/20140211/alhambra-police-chief-says-predictive-policing-has-been-successful [https://perma.cc/ACE2-X55B] ("In addition to printouts of potential crime areas, [Alhambra Police Chief] Yokoyama said every police car is now equipped with in-car computers that receive refreshed information every five minutes."); Maurice Chammah, *Policing the Future*, THE MARSHALL PROJECT (Feb. 3, 2016, 7:15 AM), https://www.themarshallproject.org/2016/02/03/policing-the-future#.fFzTrlZVp [https://perma.cc/QZ3V-838D].

105. Timothy B. Clark, *How Predictive Policing Is Using Algorithms to Deliver Crime-Reduction Results for Cities*, GOV'T EXEC. MEDIA GRP.: ROUTE FIFTY (Mar. 9, 2015), http://www.govexec.com/state-local/2015/03/predictive-policing-santa-cruz-predpol/107013/ [https://perma.cc/G3L3-NYHA] ("LAPD patrol cars are equipped with GPS-enabled mini-iPads to automatically track 'time in the box.'").

106. Daniel B. Neill & Wilpen L. Gorr, *Detecting and Preventing Emerging Epidemics of Crime*, 4 ADVANCES IN DISEASE SURVEILLANCE, no. 13 (2007).

107. Jerry H. Ratcliffe & George F. Rengert, *Near-Repeat Patterns in Philadelphia Shootings*, 21 SECURITY J. 58, 58 (2008) ("The near-repeat phenomenon states that if a location is the target of a crime such as burglary, the homes within a relatively short distance have an increased chance of being burgled for a limited number of weeks."); Kate J. Bowers & Shane D. Johnson, *Who Commits Near Repeats?: A Test of the Boost Explanation*, 5 W. CRIMINOLOGY REV. 12, 13 (2004) ("[T]he (communicated) risk of burglary to nearby properties (within 400m of each other) was shown to be elevated for a short period of time, typically one-month, after which risks returned to pre-event levels. This pattern of space-time clustering has been referred to as the 'near repeat' phenomenon to reflect the association with repeat victimisation.").

108. Shane D. Johnson, *Repeat Burglary Victimisation: A Tale of Two Theories*, 4 J. EXPERIMENTAL CRIMINOLOGY 215, 236 (2008); Gordon, *supra* note 7 (quoting George Mason University professor Cynthia Lum as saying, "[crime is] most likely to occur tomorrow where it occurred yesterday. We know that about offenders too: People who commit crimes are likely to commit them again.").

109. Wim Bernasco, *Them Again?: Same-Offender Involvement in Repeat and Near Repeat Burglaries*, 5 EUR. J. CRIMINOLOGY 411, 412 (2008) ("Since the introduction of victimization surveys

theories of "routine activity,"[110] "rational choice," and "crime patterns"[111] all have identified a similar phenomenon with these types of property crimes.[112] Additional variables such as the weather (hot, dry), season (holidays), time of day (night), day of the week (paydays), or nearness to a particular event (concert, club) could increase the risk of crime.[113] Predictive Policing 1.0 reduced those theories to data points and provided rather precise predictions for certain crimes at certain times and in certain areas.[114]

If accurate, this theory supports why placing a police officer at the predicted location of crime might create a deterrent effect. Car thieves prefer dark, isolated parking lots with easy escape routes and limited police presence.[115] If the attraction to the place for the criminal is the environmental vulnerability of the area, a heightened police presence will (temporarily) cure the vulnerability.[116] Other remedial options might include better lighting, surveillance cameras, or civilian guards.[117] For crimes of opportunity like car theft, the deterrence rationale makes sense.[118]

In application, the early rollouts of Predictive Policing 1.0 were reported

in the 1970s, it has become widely recognized that crime is concentrated among relatively few victims. A significant number of people become repeat victims, some of them over and over again.") (citation omitted); Bowers & Johnson, *supra* note 107, at 12, 21 ("[P]rospective mapping is significantly more accurate than extant methods, correctly identifying the future locations of between 64%–80% of burglary events for the period considered.").

110. Lisa Tompson & Michael Townsley, *(Looking) Back to the Future: Using Space-Time Patterns to Better Predict the Location of Street Crime*, 12 INT'L J. POLICE SCI. & MGMT. 23, 24 (2010) ("Research has repeatedly demonstrated that offenders prefer to return to a location associated with a high chance of success instead of choosing random targets.").

111. Shane D. Johnson et al., *Space-Time Patterns of Risk: A Cross National Assessment of Residential Burglary Victimization*, 23 J. QUANTITATIVE CRIMINOLOGY 201, 203–04 (2007); Bowers & Johnson, *supra* note 107, at 13; Chainey et al., *supra* note 96, at 5 ("Crime also does not occur randomly. It tends to concentrate at particular places for reasons that can be explained in relation to victim and offender interaction and the opportunities that exist to commit crime.").

112. Megan Yerxa, *Evaluating the Temporal Parameters of Risk Terrain Modeling with Residential Burglary*, 5 CRIME MAPPING 7, 10–11 (2013) (discussing environmental criminology and the different theories underlying predictive crime modeling).

113. PERRY, ET AL., *supra* note 74, at 44–45.

114. Josh Koehn, *Algorithmic Crime Fighting*, SANJOSE.COM (Feb. 22, 2012), http://www.sanjose.com/2012/02/22/sheriffs_office_fights_property_crimes_with_predictive_policing/ (recognizing that the most common time for vehicle and residential crimes was between 5:00 PM and 8:00 PM on Tuesdays and Thursdays).

115. Jill Drucker, *Risk Factors of Larceny-Theft*, RTM INSIGHTS (2010), http://www.rutgerscps.org/uploads/2/7/3/7/27370595/theftrisks.pdf.

116. Joel Rubin, *Stopping Crime Before It Starts*, L.A. TIMES (Aug. 21, 2010), http://articles.latimes.com/2010/aug/21/local/la-me-predictcrime-20100427-1 [https://perma.cc/J5CJ-JVTJ] ("[A] would-be criminal must find a target that is sufficiently vulnerable to attack and that offers an appealing payout. An empty house with no alarm on a poorly lighted street, for example, has a much higher chance of being burglarized than one with a barking dog on a busy block.").

117. Researchers of environmental criminology have well documented this phenomenon.

118. Tompson & Townsley, *supra* note 110, at 25.

as successful. In the Los Angeles test, the first six months saw a 25% drop in burglaries.[119] In Santa Cruz, California, property crimes reportedly dropped between 4% and 11%.[120] In Alhambra, California, police reported that after a year of using the technology, thefts from automobiles dropped 21% and auto theft dropped 8%.[121] In Modesto, California, property crimes dropped by double digits.[122] Outside California, metropolitan areas like Seattle,[123] Atlanta,[124] and Reading, Pennsylvania[125] adopted the technology with similar positive results. Of course, these initial studies may provide an imperfect sampling because crime across the country also decreased, and not all of the experiments have resulted in positive outcomes.[126] Follow-up studies have been inconclusive,[127] with some cities—including Los

119. Mitchell, *supra* note 2 (citing a 25% reduction in burglary for the first six months using PredPol).

120. Koehn, *supra* note 114 ("[D]uring the first half of 2011, Zach Friend, a spokesman for the Santa Cruz Police Department, says that after using its predictive policing algorithm, the department reported a drop in property crimes ranging somewhere between 4 and 11 percent."); Baxter, *supra* note 1 ("From the program's start in Santa Cruz in July 2011 to Jan. 1, 2012, car burglaries and residential burglaries declined by 4 percent compared with the same period a year earlier, according to Santa Cruz crime analyst Zach Friend. Vehicle thefts remained about the same."); Brian Heaton, *Predictive Policing a Success in Santa Cruz, Calif.*, GOV'T TECH. (Oct. 8, 2012), http://www.govtech.com/ public-safety/Predictive-Policing-a-Success-in-Santa-Cruz-Calif.html [https://perma.cc/AW8X-853Q] (reporting that a comparison of the first six months of 2012 with the first six months of 2011 showed thefts were down 19% without any change in police resources).

121. Vuong, *supra* note 104 ("The Alhambra Police Department focused on the two most common crimes in Alhambra, Yokoyama said. By year's end, when compared to 2012 numbers, car burglaries decreased by 21 percent, and auto theft declined by 8 percent, a statistics report showed.").

122. Rosalio Ahumada, *Modesto Sees Double-Digit Drop in Property Crimes—Lowest in Three Years*, MODESTO BEE, (Nov. 11, 2014, 4:24 PM), http://www.modbee.com/news/local/crime/ article3790616.html [https://perma.cc/X5NX-Z3CA].

123. Martin Kaste, *Can Software That Predicts Crime Pass Constitutional Muster?*, NPR (July 26, 2013, 4:55 PM), http://www.npr.org/2013/07/26/205835674/can-software-that-predicts-crime-pass-constitutional-muster, [https://perma.cc/8TJZ-D6C8] (reporting on predictive policing in Seattle).

124. Will Frampton, *With New Software, Norcross Police Practice* Predictive Policing, CBS ATLANTA (Aug. 19, 2013), http://www.cbsatlanta.com/story/23178208/with-new-software-norcross-police-utilize-predictive-policing.; Clark, *supra* note 105 ("The Atlanta Police Department, for example, conducted a 90-day pilot project in two of its six policing zones late in 2013. The test showed a marked decline in crime as compared with the previous year.").

125. Clark, *supra* note 105 ("Reading, which adopted the technology in October 2013, observed a 23 percent decline in burglaries in the next 12 months, the police department reported."); Press Release, City of Reading, Pa., New Predictive Policing Strategies in Reading: Reducing Crime & Increasing Community Engagement, http://www.readingpa.gov/content/new-predictive-policing-strategies-reading -reducing-crime-increasing-community-engagement [https://perma.cc/CFN6-EDTG].

126. Vuong, *supra* note 104. *But see id.* ("Yet the crime rate for certain activities has increased. Residential burglaries went up by 17 percent and robberies increased by 22 percent, a report found.").

127. As of early 2016 there has only been a single peer-reviewed study of Predictive Policing 1.0, written in collaboration with the founders of PredPol. *See* George O. Mohler et al., *Randomized Controlled Field Trials of Predictive Policing*, 94 J. AM. STAT. ASS'N 1399 (2015), http://amstat.tandf online.com/doi/pdf/10.1080/01621459.2015.1077710. *See also infra* notes 287–289.

Angeles—showing a spike in crime after initial decreases.[128] In addition, questions exist about the validity of the crime statistics (absent any independent accounting).[129] In fact, during one of the few independent tests of predictive policing the RAND Corporation found no statistically significant improvement in crime reduction over control districts employing conventional hotspot mapping techniques.[130]

Nevertheless, as a result of the reported successes, the concept of predictive policing received widespread national attention. Media reports from national and international sources touted the technology.[131] The professors who began their initial tests with the LAPD formed a company, PredPol, to sell the software.[132] Other academics[133] and large technology players including IBM, Motorola, and Lexis-Nexis now compete in the growing analytics industry.[134] In short, the idea of predicting crime has

128. Ben Poston, *Crime in Los Angeles Rose in All Categories in 2015, LAPD Says*, L.A. TIMES (Dec. 31, 2015, 6:10 PM), http://www.latimes.com/local/crime/la-me-crime-stats-20151230-story.html [https://perma.cc/G6TC-AQY2]; Mike Aldax, *Richmond Police Chief Says Department Plans to Discontinue 'Predictive Policing' Software*, RICHMOND STANDARD (June 24, 2015), http://richmondstandard.com/2015/06/richmond-police-chief-says-department-plans-to-discontinue-predictive-policing-software/ [https://perma.cc/EF84-QP8E] (quoting Richmond, California Police Chief Chris Magnus as saying, "In Richmond crime went down, yes, but now it's going back up. . . . We're seeing double digit increases.").

129. Bond-Graham & Winston, *supra* note 4 (suggesting that PredPol's creators have been "most successful [with] its marketing algorithms").

130. PRISCILLIA HUNT ET AL., RAND CORP., EVALUATION OF THE SHREVEPORT PREDICTIVE POLICING EXPERIMENT 33 (2014) http://www.rand.org/content/dam/rand/pubs/research_reports/RR500/RR531/RAND_RR531.pdf.

131. *See, e.g.*, Goode, *supra* note 6; Bob Orr, *LAPD Computer Program Prevents Crime by Predicting It*, CBS NEWS, (Apr. 11, 2012, 8:40 PM), http://www.cbsnews.com/news/lapd-computer-program-prevents-crime-by-predicting-it/ [https://perma.cc/SP93-Q4VD]; Rubin, *supra* note 116; Beam, *supra* note 84; *Predictive Policing*, *supra* note 7.

132. PREDPOL: MANAGEMENT TEAM, http://www.predpol.com/about/company/ [https://perma.cc/3Z76-LSAS] (last visited Jan. 13, 2017).

133. RUTGERS CTR. ON PUB. SEC., RISK TERRAIN MODELING COMPENDIUM (Joel M. Caplan & Leslie W. Kennedy eds., 2011); Yerxa, *supra* note 112, at 27–29 (discussing Risk Terrain Modeling's (RTM) positive prediction for residential burglaries).

134. Rachael King, *IBM Analytics Help Memphis Cops Get 'Smart'*, BLOOMBERG BUSINESSWEEK (Dec. 5, 2011, 9:30 PM), http://www.businessweek.com/technology/ibm-analytics-help-memphis-cops-get-smart-12052011.html [http://perma.cc/Q77C-WCXW] (describing the technology used by law enforcement in Memphis, Tennessee, which has contributed to the lowest crime rates there in a quarter-century); Paul Bowers, *Predictive Policing Arrives in Charleston*, CHARLESTON CITY PAPER (June 27, 2012), http://www.charlestoncitypaper.com/charleston/predictive-policing-arrives-in-charleston/Content?oid=4101684 [http://perma.cc/JWL7-35TD] (discussing the use of predictive analytics to reduce armed robberies in Charleston, South Carolina); Juliana Reyes, *Philly Police Will Be First Big City Cops to Use Azavea's Crime Predicting Software*, TECHNICALLY MEDIA INC. (Nov. 7, 2013, 12:30 PM), http://technical.ly/philly/2013/11/07/azavea-philly-police-crime-prediction-software [https://perma.cc/MC69-84M2] (explaining that during 2013, Philadelphia became the first large city to use Azavea's HunchLab crime software); ROBINSON & KOEPKE, *supra* note 3, at 3–5 (listing adoption of technologies).

become a multi-million dollar business, and a large-scale marketing campaign to sell predictive policing programs has commenced across the country.[135]

Two points should be highlighted in this brief overview of Predictive Policing 1.0, with its focus on the PredPol technology. First, both the underlying theory and initial experiments focused on a limited number of property-based crimes and were firmly tied to place-based theories. Predicting violent crimes or individual criminals did not inform the early studies. Second, the excitement and promise of predictive policing has largely overtaken any perceived limitations. The belief that data-driven insights can transform policing has been with predictive policing since the beginning.[136] With the same enthusiasm that actuarial predictions displaced clinical predictions as the primary recidivism assessment tool, the lure of data-driven enlightenment has replaced traditional law enforcement strategy.[137]

B. Predictive Policing 2.0: Targeting Places of Violent Crime

Preventing property crimes, while important, pales in comparison to the goal of preventing violent crimes. Thus, it is perhaps unsurprising that despite its brief history, predictive policing technologies have already evolved to target violent crime.[138] Predictive policing software has been marketed to address robberies, shootings, and gang-related violence. This section looks at the move from Predictive Policing 1.0 (property crimes focused on place) to Predictive Policing 2.0 (violent crimes focused on place). This section also builds on traditional, computer-assisted hotspot policing.

Violent crimes repeatedly occur in particular locations. Certain alleys may be conducive to robberies because of dim lighting, easy escape routes,

135. ROBINSON & KOEPKE, *supra* note 3, at 3–5.

136. Stephen D. Mastrofski & James J. Willis, *Police Organization Continuity and Change: Into the Twenty-First Century*, 39 CRIME & JUST. 55, 92–93 (2010) ("Predictive policing is then a forward-looking crime diagnostic system designed to help police identify where and how their interventions can be most effective in preventing future crime. Its proponents envision a system that can focus narrowly (predicting future offenses of a serial killer) or large scale (predicting homicide patterns of an entire city), short term (predicting crime occurrences in hot spots over the next few days) or long term (predicting how city development plans will affect police resource allocations for many years).").

137. *See* Somini Sengupta, *In Hot Pursuit of Numbers to Ward Off Crime*, N.Y. TIMES (June 19, 2013, 10:48 PM), http://bits.blogs.nytimes.com/2013/06/19/in-hot-pursuit-of-numbers-to-ward-off-crime/.

138. *See* THE PREDICTIVE POLICING CO., PREDPOL PREDICTS GUN VIOLENCE (2013), http://cortecs.org/wp-content/uploads/2014/10/predpol_gun-violence.pdf; RUTGERS CTR. ON PUB. SEC., *supra* note 133.

or close proximity to a victim-class.[139] Certain clubs may be conducive to violent fights because of the typical mix of alcohol, drugs, and late-night errors in judgment.[140] Certain streets might demarcate gang territory and thus be the locus of battles for control. These place-based attractors of violence have long been studied.[141] Predictive policing has both mined this prior knowledge and developed new factors—like geographic vulnerabilities, precursor crimes, and temporal patterns—to allow for more sophisticated predictions.[142]

Several police departments were early adopters of predictive policing programs for violent crimes. For example, IBM partnered with the Charleston, South Carolina Police Department to address armed robberies.[143] Building off of an established system which collected robbery data in a CompStat-like system,[144] the new predictive approach targeted particular blocks at particular times to reduce robberies.[145] IBM has also worked with police in Memphis, Tennessee, utilizing similar technology but across a broader spectrum of crime.[146]

Criminologists funded by the Bureau of Justice Assistance developed several pilot projects in Boston, Baltimore, Kansas City, Las Vegas, and Los Angeles to apply smart policing principles to shootings.[147] In Boston, for example, researchers found that "fewer than 5 percent of Boston's street corners and block faces generated 74% of fatal and non-fatal shootings between 1980 and 2008, with the most-active 65 locations experiencing

139. Jeffrey S. Paul & Thomas M. Joiner, *Integration of Centralized Intelligence with Geographic Information Systems: A Countywide Initiative*, GEOGRAPHY & PUB. SAFETY (Cmty. Oriented Policing Servs.), Oct. 2011, at 5, 6.

140. Joel M. Caplan, *Mapping the Spatial Influence of Crime Correlates: A Comparison of Operationalization Schemes and Implications for Crime Analysis and Criminal Justice Practice*, CITYSCAPE: J. POL'Y DEV. & RES. (U.S. Dep't of Hous. & Urban Dev.), 2011, at 57, 70.

141. *See e.g.,* David Weisburd, *Does Hot Spots Policing Inevitably Lead to Unfair and Abusive Police Practices, or Can We Maximize Both Fairness and Effectiveness in the New Proactive Policing?*, 2016 U. CHI. LEGAL F. 661, 664–65 (2016) ("Perhaps the most important innovation to emerge in the new proactive policing to control crime is what has been termed 'hot spots' or 'place-based' policing. . . . Hot spots policing emerged out of empirical observations that crime was highly concentrated in urban areas. The logic behind it was simply that if crime was highly concentrated on specific streets in the city, the police should focus their interventions at those places.") (citing Lawrence W. Sherman et al., *Hot Spots of Predatory Crime: Routine Activities and the Criminology of Place*, 27 CRIMINOLOGY 27, 37–42 (1989)).

142. *See infra* notes 153–56, 273, 282.

143. Bowers, *supra* note 134 (discussing the use of predictive analytics to reduce armed robberies in Charleston, South Carolina).

144. *See* sources cited *supra* note 80, 89 (discussing COMPStat).

145. *Id.*

146. King, *supra* note 134.

147. ANTHONY A. BRAGA ET AL., U.S. DEP'T OF JUSTICE, SMART APPROACHES TO REDUCING GUN VIOLENCE 4 (2014).

more than 1,000 shootings during this time period."[148] In addition, "[t]he bulk of Boston shootings take place immediately after school dismissal and during the weekend evening hours, and tend to increase during summer months."[149] Thus, the targeted solution involved focusing on those predicted blocks during those particular times with intensive community patrols.[150] The results showed a dramatic reduction in violence, with a 17.3% reduction in violent crime, including a 19.2 percent reduction in robberies and a 15.4% reduction in aggravated assaults.[151] Similar projects using a place-based focus and proactive intervention have been implemented in other cities.[152]

PredPol has also adapted its focus to include gun violence. Using its predictive software, PredPol examined the 38,740 gun-related crimes that occurred in Chicago during 2009–2011 and analyzed them against the 1,331 homicides during that same timeframe.[153] The data revealed a correlation between precursor crimes involving handguns and future gun homicides. By studying these non-fatal precursor crimes, a fairly general predictive judgment could be made about fatal shootings.[154] An internal PredPol study of this Chicago data demonstrated that the technology could predict the location of 50% of gun homicides within a broad timeframe.[155] Specifically, the technology could show an elevated risk of a homicide for 30–100 days after the handgun crimes and within a half mile of the precursor crime.[156]

Researchers have also looked at gang violence as a similarly predictable event.[157] Gangs are territorial, defending and protecting particular areas from rival gangs.[158] In addition, gang violence tends to be retaliatory in nature, with one gang attacking another in response to a prior violent act.[159]

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148. *Id.* (citing Anthony A. Braga et al., *The Concentration and Stability of Gun Violence at Micro Places in Boston, 1980–2008*, 1 J. QUANTITATIVE CRIMINOLOGY 26, 33–53 (2010)).

149. *Id*.

150. *Id.*

151. *Id.* at 5.

152. *Id.* at 1–9.

153. *See* THE PREDICTIVE POLICING CO., *supra* note 138. This number included 17,020 robberies, 6,560 assaults, 8,252 weapons violations, 5,274 batteries, and 303 criminal sexual assaults, all described as involving a handgun. This data can also be found at https://data.cityofchicago.org/Public-Safety/Crimes-2001-to-present/ijzp-q8t2.

154. *Id.*

155. *Id.*

156. *Id.*

157. *See, e.g.*, Damon Paulo et al., Social Network Intelligence Analysis to Combat Street Gang Violence (2013), http://arxiv.org/pdf/1306.6834.pdf.

158. Leslie Brokaw, *Predictive Policing: Working the Odds to Prevent Future Crimes*, MIT SLOAN MGMT. REV. (Sept. 12, 2011), http://sloanreview.mit.edu/article/predictive-policing-working-the-odds-to-prevent-future-crimes/ [https://perma.cc/GX8M-UCGT] ("Crime is often a clustering event: if there is an act of inter-gang violence, for instance, there's likely to be a retaliatory act shortly after.").

159. *Id.*

The locations in between rival gangs' territories thus tend to be the focus of more violent actions. George Mohler, one of the founders of PredPol, worked with colleagues to study and map predicted gang shootings.[160] Other studies claim that 58% of gang crimes in Los Angeles occurred within two blocks of a known gang border, and 83% occurred within three blocks of that location.[161] This type of geographical awareness could be useful for diffusing gang tensions or preventing retaliatory attacks.

Other researchers have developed more sophisticated models to predict robberies, aggravated assaults, and shootings. Researchers at the Rutgers Center for Public Security have developed a risk assessment technique called Risk Terrain Modeling (RTM),[162] which has been successfully used to study certain types of violent crime.[163] RTM develops digitized risk terrain maps identifying particular factors associated with particular crimes. Identified factors are layered on a computer map to highlight the intensity of risk in particular micro-areas. Instead of focusing on past crimes, RTM focuses on current environmental risk factors which heighten the risk for crime. For example, the risk factors for armed robbery were found to be an area's proximity to or high density of each of the following seven types of location: drug dealing areas; prostitution areas; bus stops and rail stations; bars, pubs and exotic clubs; leisure and fast-food outlets; universities; and banks.[164] As can be seen, many of the factors attract potential victims who are then targeted by potential robbers. In a year-long study in Newark, New

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160. Laura M. Smith et al., *Adaption of an Ecological Territorial Model to Street Gang Spatial Patterns in Los Angeles*, 32 DISCRETE & CONTINUOUS DYNAMICAL SYS. 3223 (2012). *See also Predictive Policing: George Mohler Interview*, DATA SCI. WKLY., http://www.datascienceweekly.org/data-scientist-interviews/predictive-policing-george-mohler-interview [https://perma.cc/QF64-K958].

161. Meg Smith, *Remapping Gang Turf, Math Models Show Crimes Cluster on Borders Between Rivals*, UCLA NEWSROOM (June 25, 2012) (discussing P. Jeffrey Brantingham, et al., *The Ecology of Gang Territorial Boundaries*, 50 CRIMINOLOGY 851, 867 (2012)).

162. Kennedy et al., *supra* note 96, at 345–46; Leslie W. Kennedy et al., *Results Executive Summary: A Multi-Jurisdictional Test of Risk Terrain Modeling and a Place-Based Evaluation of Environmental Risk-Based Patrol Deployment Strategies*, RUTGERS CTR. ON PUB. SEC. 4–6 (2015), http://www.rutgerscps.org/uploads/2/7/3/7/27370595/nij6city_resultsexecsum_final.pdf [hereinafter *Results: Executive Summary*].

163. Jie Xu et al., *Crime Generators for Shootings in Urban Areas: A Test Using Conditional Locational Interdependence as an Extension of Risk Terrain Modeling*, RUTGERS CTR. ON PUB. SEC.,2 (2010) ("Gun shootings are not randomly distributed throughout a terrain; but rather, are concentrated in a statistically significant way around certain features. In Newark and Irvington, these features are middle and high schools, bus stops, and public housing."). As a disclosure, I have worked in a very limited capacity as an unpaid consultant with Professor Joel Caplan, Leslie Kennedy, and Eric Piza as part of a National Institute of Justice Grant studying "A Multi-Jurisdictional Test of Risk Terrain Modeling and a Place-Based Evaluation of Environmental Risk-Based Patrol Deployment Strategies." My role has been limited to a handful of brief consultations without financial compensation and I have had no role in the development of the RTM technology or the studies.

164. RUTGERS CTR. ON PUB. SEC., *supra* note 133, at 74.

Jersey, an RTM map demonstrated that for every additional risk factor there was a 2.3% increased risk of a robbery.[165]

For shootings, RTM examines the following factors: "locations of drug arrests, proximity to 'at-risk' housing developments, 'risky facilities,' locations of gang activity, known home addresses of parolees previously incarcerated for violent crimes and/or violations of drug distribution laws, locations of past shooting incidents, and locations of past gun robberies."[166] Recent RTM studies focused on predicting shootings and other assaultive conduct in Irvington, New Jersey,[167] with initial statistical success.[168] RTM's focus on risk allows for a more detailed place-based assessment of locations of violent crime. In a recent multi-jurisdictional survey, RTM demonstrated significant short- and long-term crime reduction across a wide variety of cities.[169]

Finally, one company has chosen to integrate the theories behind PredPol and RTM into a single commercial product.[170] HunchLab, part of the Azaeva company, was founded by a former crime analyst with the Philadelphia Police Department.[171] HunchLab 2.0 looks at baseline crime rates, near repeat patterns, routine activities theory, socioeconomic factors, seasons, time of month, day of week, time, holidays, sporting events, weather, and other RTM-like factors.[172] The information is integrated into a machine-learning algorithm with updates for every police shift. As of yet,

165. *Id*. at 75.

166. Kennedy et al., *supra* note 96, at 345–46.

167. Joel M. Caplan et al., *Risk Terrain Modeling: Brokering Criminological Theory and GIS Methods for Crime Forecasting*, 28 JUST. Q. 360 (2011) (discussing shootings in Irvington). *See generally* Joel M. Caplan et al., *Risk Terrain Modeling for Spatial Risk Assessment*, CITYSCAPE: J. POL'Y DEV. & RES. (U.S. Dep't of Hous. & Urban Dev.), 2015, at 7; William D. Moreto et al., "*A Plague on both Your Houses?": Risks, Repeats and Reconsiderations of Urban Residential Burglary,* 31 JUST. Q. 1102 (2014); Joel M. Caplan et al., *Joint Utility of Event-Dependent and Environmental Crime Analysis Techniques for Violent Crime Forecasting*, 59 CRIME & DELINQ. 243 (2013); Joel M. Caplan et al., *Kansas City's Violent Crime Initiative: A Place-Based Evaluation of Location-Specific Intervention Activities During a Fixed Time Period* 4 CRIME MAPPING 9 (2012).

168. Kennedy et al., *supra* note 96, at 345–46.

169. *See* Leslie W. Kennedy et al., *Results in Brief*: *A Multi-Jurisdictional Test of Risk Terrain Modeling and a Place-Based Evaluation of Environmental Risk-Based Patrol Deployment Strategies*, RUTGERS CTR. ON PUB. SEC. (2010), http://www.rutgerscps.org/uploads/2/7/3/7/27370595/nij6city_results_inbrief_final.pdf; Kennedy et al., *supra* note 162.

170. *See* HUNCHLAB, HUNCHLAB: UNDER THE HOOD (2015), https://cdn.azavea.com/pdfs/hunchlab/HunchLab-Under-the-Hood.pdf.

171. *Laura Nahmias & Miranda Neubauer*, NYPD testing crime-forecast software, POLITICO NEW YORK (July 8, 2015, 5:52 AM), http://www.capitalnewyork.com/article/city-hall/2015/07/8571608/nypd-testing-crime-forecast-software [https://perma.cc/38N9-7HW9].

172. *See* HUNCHLAB, *supra* note 170; Michael Thomsen, *Predictive Policing And The Fantasy Of Declining Violence In America*, FORBES (June 30, 2014), http://www.forbes.com/sites/michaelthomsen/2014/06/30/predictive-policing-and-the-fantasy-of-declining-violence-in-america/.

HunchLab has not publicly released any formal studies on the effectiveness of its combined approach.[173]

Applying predictive policing programs to prevent place-based violent crimes—Predictive Policing 2.0—follows the same logic as Predictive Policing 1.0. Essentially, place-based environmental vulnerabilities exist that encourage violent crime, and thus should create a higher risk that crime will occur in that location. Again, predictive policing is not actually predicting a particular crime, but predicting an elevated risk of crime based on pre-determined place-based factors.

C. Predictive Policing 3.0: Targeting Persons Involved in Criminal Activity

Place has been the central concept behind the rise of predictive policing. Place-based crimes can be predicted because of the environmental vulnerabilities that encourage criminal activity. Obviously, however, it takes a person to commit the crime in that place, and new predictive technologies are being created to target individuals predicted to be involved in criminal activity.[174] This section examines the use of predictive technologies to identify individuals and groups involved in predicted criminal activity.

This move to Predictive Policing 3.0 rests on the insight that negative social networks, like environmental vulnerabilities, can encourage criminal activity. In addition, it involves utilizing big data capabilities to develop predictive profiles of individuals based on past criminal activity, current associations, and other factors that correlate with criminal propensity.[175] While arrests based purely on pre-crime predictions will not likely happen any time soon, police have shifted surveillance and investigation resources to focus on prediction as part of a larger push toward proactive policing.[176]

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173. Chammah, *supra* note 104.

174. *See generally* Erin Murphy, *Databases, Doctrine & Constitutional Criminal Procedure*, 37 FORDHAM URB. L.J. 803, 830 (2010) ("But the use of databases to generate suspects represents a new kind of investigation altogether—whether based on particular information (e.g., 'who called this number') or upon predefined algorithms (e.g., 'who has traveled to these three countries and bought these two items within a one month period').").

175. Mark Ward, *Crime Fighting with Big Data Weapons*, BBC (Mar. 18, 2014), http://www.bbc.com/news/business-26520013 [http:// perma.cc/4ETS-GKDF]; Mitchell, supra note 2; Bond-Graham & Winston, *supra* note 8.

176. Richard A. McFeely, *Statement Before the Senate Judiciary Committee*, FBI (June 20, 2011), http://www.fbi.gov/news/testimony/information-sharing-efforts-with-partners-span-many-fbi-programs [https://perma.cc/KC33-GTJR].

The insight that social networks can reveal potential criminal actors arises from two separate avenues of study. The first involves a public health approach to crime that has attempted to understand the interconnected causes and sources of youth violence.[177] Similar to the insight that property crime is contagious, criminologists discovered that a small percentage of the population has an elevated risk of becoming the victim or perpetrator of gun violence.[178] Using data analysis, these individuals then could be mapped out as a social network. The second insight evolved out of technology developed to map international terror networks.[179] Social network theory maps associations and connections, and links to addresses, phone numbers, and other data sources, providing insights into ongoing investigations and identifying new patterns in crime.[180] Both share a similar goal of identifying, targeting, and tracking individuals who have a high risk of committing certain offenses.

In cities such as Chicago, Kansas City, and Boston, epidemic gun violence affected a relatively small group of young people.[181] For decades, criminologists studied this phenomenon and then sought to isolate the causes and identify the participants.[182] For example, in Chicago, researchers found that:

> [A] very small number of neighborhoods in Chicago are responsible for most of the city's violence trends. The "city's" crime problem is in fact geographically and socially concentrated in a few highly impoverished and socially isolated neighborhoods. Data also

177. Lenny Bernstein, *Gun Violence as a Public Health Issue*, WASH. POST (Apr. 10, 2014), https://www.washingtonpost.com/news/to-your-health/wp/2014/04/10/gun-violence-as-a-public-health-issue/.

178. *See infra* notes 181–189.

179. *Los Angeles Police Using CIA Software to Track Criminals, Ex-cons*, RT (Nov. 15, 2014) http://rt.com/usa/205727-lapd-criminals-data-collection/ [https://perma.cc/FTH4-M5MF].

180. *See generally* Cynthia Rudin, *Predictive Policing: Using Machine Learning to Detect Patterns of Crime*, WIRED (Aug. 22, 2013), http://www.wired.com/insights/2013/08/predictive-policing-using-machine-learning-to-detect-patterns-of-crime [http://perma.cc/84SQ-RCBG] ("The algorithm tries to construct a modus operandi (M.O.) of the offender. The M.O. is a set of habits that the offender follows and is a type of behavior used to characterize a pattern. The M.O. for the burglaries included factors like means of entry (front door, back door, window), day of the week, characteristics of the property (apartment, single family house), and geographic proximity to other break-ins.").

181. BRAGA ET AL., *supra* note 147 ("In 2006, roughly one percent of Boston youth between the ages of 15 and 24 participated in gangs, but these gangs generated more than half of all homicides, and gang members were involved in roughly 70 percent of fatal and non-fatal shootings as either a perpetrator and/or a victim.") (citing Anthony A. Braga et al., *Losing Faith? Police, Black Churches, and the Resurgence of Youth Violence in Boston*, 6 OHIO ST. J. CRIM. L. 141 (2008)).

182. *See, e.g.*, David M. Kennedy, *Pulling Levers: Chronic Offenders, High-Crime Settings, and a Theory of Prevention*, 31 VAL. U. L. REV. 449, 449–51 (1997); Andrew V. Papachristos et al., *Social Networks and the Risk of Gunshot Injury*, 89 J. URB. HEALTH 992, 993 (2012).

> revealed that most victims (and offenders) of gun violence in Chicago tend to be young African American men who live in neighborhoods on the West or South sides of the city.[183]

In Chicago, District Intelligence Officers were tasked with identifying those most at risk of gun violence. Police officers evaluated past criminal activity, past arrests involving other victims, whether the person had been identified as part of a gang audit,[184] or identified to be on a "strategic subjects list."[185] As described by Chicago Police Department Special Order S10-05:

> The Strategic Subjects List (SSL) is a rank-order list of potential victims and subjects with the greatest propensity for violence. The SSL model looks at individuals with criminal records who are ranked according to their probability of being involved in a shooting or murder, either as a victim or an offender, known as a "Party to Violence" (PTV). The software is generated based on empirical data that lists attributes of a person's criminal record, including the record of violence among criminal associates, the degree to which his criminal activities are on the rise, and the types of intensity of criminal history.[186]

Once an individual is identified and placed on this "heat list,"[187] a police detective, a social worker, and a community leader (such as a football coach or pastor) conduct a "custom notification," which involves a face-to-face meeting at home or a "call-in" at a public space, and the delivery of a custom notification letter.[188]

While designed as a public health approach, the same techniques have been used in a more punitive way to identify and track gang violence in the city. The Chicago Police Department now uses "network analysis" to map

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183. Meares et al., *supra* note 27.

184. *See* Chicago Police Department Special Order S10-05, § V.A (Oct. 6, 2015), http://directives.chicagopolice.org/directives/ (search "Basic Search" field for "S10-05," then select "Custom Notifications in Chicago").

185. *Id.* at § IV.B.

186. *Id.*

187. Monica Davey, *Chicago Tactics Put a Major Dent in Killing Trend*, N.Y. TIMES, June 11, 2013, at A1. *See also* Guarino, *supra* note 10.

188. Jeremey Gorner, *Chicago Police Use 'Heat List' As Strategy to Prevent Violence*, CHI. TRIB. (Aug. 21, 2013), http://articles.chicagotribune.com/2013-08-21/news/ct-met-heat-list-20130821_1_chicago-police-commander-andrew-papachristos-heat-list [https://perma.cc/GKJ7-29LQ]; Bryan Llenas, *The New World of 'Predictive Policing' Raises Specter of High-Tech Racial Profiling*, FOX NEWS LATINO (Feb. 25, 2014), http://latino.foxnews.com/latino/news/2014/02/24/brave-new-world-predictive-policing-raises-specter-high-tech-racial-profiling/ [https://perma.cc/N65R-JDND].

relationships between thousands of gang members in the city.[189] Police study social networks, and even social media, as many times retaliatory violence can be detected by monitoring such platforms.[190] The shift from predicting and ranking "hot spots" to "hot people" has become a new focus for police.[191] In fact, as a recent RAND study found, these early heat lists have been used to arrest suspects involved in suspected violence.[192] The Heat Lists transformed into data-driven most wanted lists, as opposed to violence prevention programs.[193]

A similar project has been undertaken in Kansas City. As part of a Smart Policing Initiative (SPI) funded by the Department of Justice's Bureau of Justice Assistance, a sophisticated social network analysis was conducted of the likely offenders in the city:[194]

> [T]he SPI team employs advanced social network analysis using official offense data, field interview forms, and gang data. The analysis identifies a social deviant network that depicts the connections between individuals. The analysis begins with an identified list of target offenders. In Kansas City, the initial target list of offenders included those who were suspects in murders, shootings, or other serious assaults. The team examined all formal police contacts with each of these initial offenders to identify their

189. Buntin, *supra* note 8 ("Today, the Chicago Police Department is doing something similar with gangs. Using a tool academics call 'network analysis,' the CPD is mapping the relationships among Chicago's 14,000 most active gang members. It's also ranking how likely those people are to be involved in a homicide, either as victims or offenders."). *See also* Joseph Goldstein & J. David Goodman, *Seeking Clues to Gangs and Crimes, Detectives Follow Internet Rap Videos*, N.Y. TIMES, Jan. 8, 2014, at A20 ("Directed by prosecutors to build evidence that individual shootings are part of larger criminal conspiracies, officers are listening to local rappers for a better sense of the hierarchy of the streets. 'You really have to listen to the songs because they're talking about ongoing violence.'") (quoting Officer Fred Vanpelt, part of an anti-gang squad in Brooklyn, NY).

190. Douglas Belkin, *Chicago Hunts for Answers to Gang Killings: Police Build Facebook-Like Database to Prevent Swift Cycles of Retaliation*, WALL ST. J. (July 12, 2012, 7:34 PM), http://www.wsj.com/articles/SB10001424052702303644004577520863051001848 [https://perma.cc/CUP4-UAMH].

191. Buntin, *supra* note 8 ("[T]he CPD has discovered something striking: Cities don't so much have 'hot spots' as 'hot people.' That finding is transforming the way the police do business in Chicago and has significant implications for how other cities should be policed."); Mitchell, *supra* note 2 ("Charlotte-Mecklenburg, N.C. is now going beyond predicting where and when crime will occur to predict who is likely to reoffend. Instead of studying just crimes and locations to decide where crimes will occur, police departments make predictions using criminal histories to predict who will commit a crime.").

192. Jessica Saunders et. al., *Predictions Put Into Practice: A Quasi-Experimental Evaluation of Chicago's Predictive Policing Pilot*, 12 J. EXP. CRIMINOLOGY 347, 363–64 (2016).

193. Matt Stroud, *Chicago's Predictive Policing Tool Just Failed a Major Test*, THE VERGE (Aug. 19, 2016), www.theverge.com/2016/8/19/12552384/chicago-heat-list-tool-failed-rand-test.

194. BRAGA ET AL., *supra* note 147, at 12–13.

> associates (e.g., who had been arrested or stopped with the initial offender). The team then performed the same analysis with the newly identified associates, resulting in a social network that includes three layers of offenders: the initial target offenders, the target offenders' associates, and the associates of the target offenders' associates.[195]

This initial process identified 120 individuals who were contacted by police and informed that they had been identified as a cause of the violence in the city.[196] Police informed these predicted suspects that they would be held responsible for future violence, and advised them of available social services.[197] When these individuals did commit a crime, they were punished more severely.[198] Similar projects identifying "socially deviant networks" have been initiated in Boston, Las Vegas, and other jurisdictions.[199]

Advanced analytics has also allowed police to begin collecting intelligence on suspected criminal networks and individuals. Palantir, a private company that once designed some of the most advanced data collection and analysis systems for the intelligence community, has partnered with police forces and local governments to address violent crime.[200] In Los Angeles, a project called Operation LASER (Los Angeles Strategic Extraction and Restoration) identifies likely criminal actors[201] and develops "Chronic Offender Bulletins" of targeted individuals.[202] These bulletins are provided to police for surveillance and investigation purposes. As described, "[t]he basic premise is to target with laser-like precision the violent repeat offenders and gang members who commit crimes in the

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195. *Id.* at 13.

196. *Id.*

197. *Id.* ("In April 2013, the team held their first offender call-ins (three were held throughout the day). Invitations were sent to more than 120 individuals and 38 attended the call-ins. Individuals received three basic messages at the call-in: (1) violence cannot be tolerated; (2) further violence will be met with certain and severe consequences from law enforcement; and (3) those who want help to change will receive it. A range of social services were available to the call-in attendees including education, job training, and substance abuse training.").

198. John Eligon & Timothy Williams, *On Police Radar for Crimes They Might Commit*, N.Y. TIMES, Sept. 25, 2015, at A1 ("Tammy Dickinson, the United States Attorney for the Western District of Missouri, related the story of a man in the program who was given a 15-year prison sentence for being caught with a bullet in his pocket."). *See also* Ferguson, *Predictive Prosecution*, *supra* note 21, at 717–20 (discussing how prosecutors enforce punishment through predictive policing systems).

199. Mitchell, *supra* note 2; BRAGA ET AL., *supra* note 146, at ii–iii.

200. RT, *supra* note 179; BRAGA ET AL., *supra* note 146, at 11 ("This data-driven approach includes the use of *Palantir*, a powerful analytical computer platform that allows CID to quickly access and search multiple databases.").

201. CRAIG D. UCHIDA ET AL., U.S. DEP'T OF JUSTICE, LOS ANGELES, CALIFORNIA SMART POLICING INITIATIVE: REDUCING GUN-RELATED VIOLENCE THROUGH OPERATION LASER 3 (2012).

202. *Id.* at 7; BRAGA ET AL., *supra* note 146, at 10 (describing the use of "*Chronic Offender Bulletins*, which contain detailed information about prolific offenders").

specific target areas. The program is analogous to laser surgery, where a trained medical doctor uses modern technology to remove tumors or improve eyesight."[203]

In Louisiana, Palantir has partnered with the City of New Orleans to address gun-related homicides.[204] Using network analysis, the technology is able to "illuminate[] the roles of feuds, retaliations, drugs, common disputes, and gangs in shootings and homicides."[205] Specifically, the technology identified approximately 3,000 individuals (1% of the population of 378,000) who had the highest risk of being involved in gun violence.[206] According to Palantir's own reporting, the technology could identify 35–50% of the likely shooting victims.[207] Acting on these tips, and implementing an intervention strategy to target and investigate those involved, the City of New Orleans' murder rate fell 21.9%.[208]

These approaches each share several commonalities. First, the predictive assessments focus on identifiable individuals.[209] Second, the technologies

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203. UCHIDA ET AL., *supra* note 201, at 6.

204. PALANTIR, *supra* note 8, at 1–5 (describing NOLA for Life, a project to reduce homicides in New Orleans). *See also* Jeffrey Goldberg, *A Matter of Black Lives*, THE ATLANTIC (Sept. 2015), http://www.theatlantic.com/magazine/archive/2015/09/a-matter-of-black-lives/399386/ [https://perma.cc/GZ49-JFWR]; Jason Shueh, *New Orleans Cuts Murder Rate Using Data Analytics*, GOV'T TECH. (Oct. 22, 2014), http://www.govtech.com/data/New-Orleans-Cuts-Murder-Rate-Using-Data-Analytics.html [https://perma.cc/R64Q-7AKL]; CITY OF NEW ORLEANS, NOLA FOR LIFE: COMPREHENSIVE MURDER REDUCTION STRATEGY (2016), http://www.nolaforlife.org/files/n4l-2016-comprehensive-murder-reduction-strategy-b/; PALANTIR TECHNOLOGIES, PHILANTHROPY ENGINEERING: 2015 ANNUAL IMPACT REPORT (2016), https://www.palantir.com/philanthropy-engineering/annual-report/2015/murder-reduction/ [https://perma.cc/LH8X-8CUJ] (quoting Sarah Schirmer, Criminal Justice Policy Advisor in the Mayor's Office of Criminal Justice Coordination, as saying, "Since 2012, Mayor Mitch Landrieu has committed significant resources and effort to reducing murder in New Orleans, and has asked every partner and stakeholder in the city to play a role. Palantir has made it possible for our intelligence analysts to question preconceived ideas about murder victims and suspects. The analysis has strengthened our ability to prevent and intervene in violent conflicts, and connect at-risk individuals to services.").

205. PALANTIR TECHNOLOGIES, *supra* note 8, at 6.

206. *Id.* at 8.

207. *Id.* at 7, 9 ("NOLA analysts have developed advanced techniques to identify the most high-risk and vulnerable populations. Using social graph analysis of data ranging from 2011 to the present, analysts can effectively identify 35–50% of the likely shooting victims from a population of approximately 3,900 citizens (1% of the total city population).").

208. *Id.* at 9.

209. Even smaller jurisdictions like Rochester, Minnesota have developed similar technologies. Partnering with IBM, the Rochester police use a program called "Infosphere Identity Insight," which allows police to identify juveniles who might be involved in criminal activity. Maya Rao, *Rochester hopes predictive policing can steer juveniles away from crime*, STAR TRIBUNE (Oct. 24, 2014, 11:18 PM), http://www.startribune.com/rochester-police-plan-to-target-at-risk-teens-raises-concerns/ 2803 85202/ [https://perma.cc/9BPT-ZXKU]; Sarah Rich, *Cities Turn to Analytics for Targeting Habitual Criminals*, GOV'T TECH. (Jan. 25, 2012) http://www.govtech.com/public-safety/Cities-Turn-to-Analytics-for-Targeting-Habitual-Criminals.html [https://perma.cc/75HG-CMCN].

augment identification, surveillance, investigation, and intervention, but do not independently create the justification to stop or arrest individuals.[210] Third, to ensure a deterrent effect, additional police resources are needed to interact with the identified suspects. Initial reports about reduced crime rates appear promising, but the potential of falsely accusing individuals based on associations or suspicions has raised many concerns.[211]

D. Reflections on New Versions of Predictive Policing

Predictive policing is evolving at a rapid rate. In fact, the technological developments have far outpaced legal or policy debates around the subject. Generally, local police administrators contract with predictive policing companies with little public oversight.[212] On occasion a media story reveals the purchase of new technology, but only rarely does this publicity have any effect on the adoption of the practice.[213] With the exception of a few journalists and scholars, the technology has largely escaped scrutiny.[214]

As such, the different strains of predictive policing have been analyzed together, without focusing on the different theoretical bases, practical implications, and social science support underlying the technology. Suspicion based on correlation may be acceptable when talking about place-based crimes, but it is insufficient when talking about person-based crimes. Sending a police car to patrol a suspected area is less consequential than sending a police detective to interrogate a suspect. Further, the hype surrounding property- and place-based predictive policing has been used to justify adoption of violent crime-focused or person-focused technology, despite a lack of equivalent empirical testing to support it.

In some ways, labeling these different strains of technology with the broad title of "predictive policing" may well encourage such misleading hype and expectations. The algorithms in their current state really amount

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210. Ferguson, *Big Data*, *supra* note 21, at 387–89.

211. *Id.* at 403; Jack Smith IV, *'Minority Report' is Real—And It's Really Reporting Minorities*, MIC (Nov. 9, 2015), http://mic.com/articles/127739/minority-reports-predictive-policing-technology-is-really-reporting-minorities#.zwXVV93jm [https://perma.cc/35GD-56VL].

212. *But see Bellingham police consider 'predictive policing' software*, ASSOCIATED PRESS (Aug. 6, 2015).

213. *But see Gov. Doug Ducey vetoes bill funding predictive policing program*, ASSOCIATED PRESS (Apr. 14, 2015).

214. *But see* Elizabeth E. Joh, *Policing by Numbers: Big Data and the Fourth Amendment*, 89 WASH. L. REV. 35 (2014); Kate Crawford & Jason Schultz, *Big Data and Due Process: Toward a Framework to Redress Predictive Privacy Harms*, 55 B.C. L. REV. 93, 103 (2014); Matt Stroud, *The minority report: Chicago's new police computer predicts crimes, but is it racist?*, THE VERGE (Feb. 19, 2014), http://www.theverge.com/2014/2/19/5419854/the-minority-report-this-computer-predicts-crime-but-is-it-racist; Bond-Graham & Winston, *supra* note 4.

to "crime forecasting," or perhaps even more precisely, "risk forecasting," rather than actual crime prediction.[215] Like an old-school weather forecast,[216] the data can provide localized forecasts—"cloudy with a chance of murder"—with a significant degree of variability and fallibility. As in weather forecasting, the move to objective, data-driven computer models signals an improvement from subjective instincts or traditional guesses about the weather.[217] And just as meteorology has improved its accuracy, the same will be true with predictive criminal forecasting as the data collection mechanisms and models grow in sophistication.

All predictive innovations raise difficult questions about how to evaluate such new technologies. The next section attempts to organize the larger theoretical questions underlying adoption of any predictive technology by studying the questions that arise from existing predictive policing technologies.

III. POLICING PREDICTION

How should predictive technologies be policed? As has been demonstrated, the criminal justice system has eagerly embraced a data-driven future without significant political oversight or public discussion. Worse, the temptations of new technology have at times overwhelmed considerations of utility or effectiveness and ignored considerations of fairness or justice. This claim is not to cast aspersions on police administrators adopting new approaches, or technologists inventing new predictive techniques, but simply to reflect the nature of new technologies. Certain vulnerabilities exist in predictive systems and this section proposes an analytical framework to evaluate current and future predictive policing technologies. The goal is to expose, analyze, and respond to these issues so that police departments, communities, courts, technologists, and citizens can honestly evaluate the next proposed predictive solution to crime.

Building off the fundamental insight of predictive policing—that by addressing environmental vulnerabilities police can deter actors seeking to exploit those vulnerabilities—this section seeks to address the potential systemic vulnerabilities of any future predictive technology. These

215. Sherman, *supra* note 100, at 425 (recognizing that evidence-based police targeting "employs forecasting, not precise predictions, about when and where crimes are likely to occur").

216. *See NOAA's Weather Forecasts Go Hyper Local With Next-Generation Weather Model*, (Sept. 30, 2014); http://www.noaanews.noaa.gov/stories2014/20140930_hrrr.html.

217. Jaikumar Vijayan, *Big Data Key to Bringing Hyperlocal Weather Forecasts to Georgia Farmers*, COMPUTERWORLD (April 25, 2014) http://www.computerworld.com/article/2488618/big-data/big-data-key-to-bringing-hyperlocal-weather-forecasts-to-georgia-farmers.html.

vulnerabilities involve: (1) data; (2) methodology; (3) social science limitations; (4) transparency; (5) accountability; (6) vision; (7) practical implementation; (8) administration; and (9) security. In building this risk analysis framework, Part III offers practical responses to counteract these vulnerabilities.

A. Data: Vulnerabilities and Responses

The backbone of any new predictive technology is data.[218] Predictive technologies require data, and the difficulty in obtaining usable, accurate, and clean data to integrate into a predictive system exposes a massive vulnerability.[219] Predictive Policing 1.0 and 2.0 require crime data. Predictive Policing 3.0 requires integrated crime data, personal data, and pattern matching programs. Because any future predictive policing technology will require the collection of some data, the difficulties of obtaining good data must be identified and addressed.

1. Bad Data

Any data-driven system risks being undermined by bad data. This data includes flaws, fragmentation, and the internal and external pressures to collect vast amounts of information constantly, instantaneously, and without adequate financial resources to ensure accuracy.

a. Human Error

To be used, data must be collected, and much of that collection is done by human beings. Human beings make mistakes.[220] Errors can arise in initial collection.[221] For example, a police officer might write down the wrong address of a crime scene. Errors can arise during data input. For example, the officer could input the wrong address by transposing a number or misspelling a name. Errors can arise in the integration of the data. For example, combining data from different datasets could create duplicate

218. Harry Surden, *Machine Learning and Law*, 89 WASH. L. REV. 87, 106 (2014) ("In general, machine learning algorithms are only as good as the data that they are given to analyze.").

219. Scherr, *supra* note 41, at 33 (2003) ("Prediction inevitably brings with it a risk of error. We can hope to reconstruct past events, but future events have not yet happened. Making 'findings' about the future thus carries a greater risk of error.").

220. Joh, *supra* note 214, at 58 ("[N]o predictive policing program is entirely objective. The basic building blocks of a predictive software program necessarily involve human discretion.").

221. Ferguson, *supra* note 73, at 191.

entries.[222] Errors can arise in the cleansing of the data. For example, in an attempt to avoid duplicates, an entry can be erroneously deleted.[223] The reality of this vast variety of error has been exposed in government-run databases relied upon by law enforcement.[224] These errors grow exponentially when law enforcement databases are combined with commercial big data sources.[225]

b. Fragmented and Biased Data

Crime data is notoriously incomplete. Certain crimes like murder, burglary, and auto theft tend to be consistently reported to authorities, while other crimes like sexual assault, domestic violence, and fraud tend to be underreported.[226] Some communities, frustrated with current policing practices, simply decline to report crimes.[227] The Department of Justice has

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222. Anita Ramasastry, *Lost in Translation? Data Mining, National Security and the "Adverse Inference" Problem*, 22 SANTA CLARA COMPUTER & HIGH TECH. L.J. 757, 774 (2006) ("One factor in error rates is data quality, which refers to the accuracy and completeness of data used to draw inferences. Duplicate records, the inconsistent or complete lack of data standards, the timeliness of updates, and human error (e.g. incorrect data entry) can all impact how effective data analysis will be.").

223. Alex R. Hess, Herring v. United States*: Are Errors in Government Databases Preventing Defendants from Receiving Fair Trials?*, 11 J. HIGH TECH. L. 129, 147 (2010) ("In . . . inter-linked databases, one error can spread like a disease, infecting every system it touches, plaguing the individual with false records and undue suspicion.").

224. *See, e.g.*, Herring v. United States, 555 U.S. 135, 155 (2009) (Ginsburg, J., dissenting) ("The risk of error stemming from these databases is not slim. Herring's *amici* warn that law enforcement databases are insufficiently monitored and often out of date. Government reports describe, for example, flaws in NCIC databases, terrorist watchlist databases, and databases associated with the Federal Government's employment eligibility verification system.") (citations omitted); Joshua D. Wright, *The Constitutional Failure of Gang Databases*, 2 STAN. J. C.R. & C.L. 115, 129 (2005) ("In sum, gang databases appear to be riddled with factual inaccuracies, administrative errors, lack of compliance with departmental guidelines, and lack of oversight."); Green v. City & Cty. of San Francisco, 751 F.3d 1039, 1042 (9th Cir. 2014) ("ALPR occasionally makes false 'hits' by misreading license plate numbers and mismatching passing license plate numbers with those listed as wanted in the database.").

225. Hess, *supra* note 223, at 147 ("According to the Bureau of Justice Statistics ('BJS'), '[i]n the view of most experts, inadequacies in the accuracy and completeness of criminal history records is *the single most serious deficiency* affecting the Nation's criminal history record information systems.'") (citations omitted).

226. James J. Tomkovicz, *On Teaching Rape: Reasons, Risks, and Rewards*, 102 YALE L.J. 481, 491 n.32 (1992) ("Statistics indicate that sexual assaults upon women are grossly underreported—more so than perhaps any other crime."); Rebecca S. Ross, *Because There Won't Be A "Next Time": Why Justice Court Is an Inappropriate Forum for Domestic Violence Cases*, 13 J.L. & FAM. STUD. 329, 333 (2011) ("Domestic violence is … chronically underreported."); Mark Mermelstein, *Strategic Remedies for Corporate Crime Victims*, 35 L.A. LAW. 12, 12 (2012) ("There is little doubt that crime, particularly fraud, goes underreported.").

227. Montré D. Carodine, *"Street Cred"*, 46 U. C. DAVIS L. REV. 1583, 1596–97 (2013) ("Minorities who do not trust the police are not as likely to report crimes or voluntarily assist police in their investigations and other law enforcement tasks.").

reported that half of crimes with victims go unreported.[228] Internal administrative pressures sometimes result in the manipulation of formal police reports.[229] Audits of the NYPD crime statistics exposed manipulated numbers.[230] Police-reported data about arrests in other jurisdictions has also been shown to be inaccurate, misleading, and occasionally fraudulent.[231] As such, the data that forms criminal predictions may be limited by the types of crime data collected, and may be further distorted by errors in the collection process.[232]

As to incompleteness, the fragmented nature of crime data on the state and local level makes reliance on it questionable. As Professor Ronald Wright explained, "there are 17,876 state and local law enforcement agencies operating in the United States. Only 6.1% of those agencies employ 100 or more full-time sworn officers. Seventy-four percent of the agencies employ fewer than twenty-four officers."[233] Necessarily, local data collections create small datasets from which to build a predictive system.[234]

228. Cecelia Klingele et al., *Reimagining Criminal Justice*, 2010 WIS. L. REV. 953, 956 (2010) ("[A]ccording to the U.S. Department of Justice, at least half of all crimes in which a victim is aware of having been victimized go unreported to police."); Press Release, U.S. Dep't of Justice, Nearly 3.4 Million Violent Crimes Per Year Went Unreported to Police from 2006 to 2010 (Aug. 9. 2012), http://www.bjs.gov/content/pub/press/vnrp0610pr.cfm [https://perma.cc/BH9L-UF9N].

229. Klingele et al., *supra* note 228, at 957 ("Sometimes offenses that are reported to police are not recorded as crimes, and consequently, may not be investigated fully. . . . Police may have reason to doubt the citizen-reporter's accuracy or truthfulness. The facts presented may not clearly establish that a crime has occurred. The investigating officer may feel administrative pressure to define incidents as non-criminal activity. Officers may believe that because little can or will be done to solve the crime, little will be gained by initiating an investigation."); William K. Rashbaum, *Retired Officers Raise Questions on Crime Data*, N.Y. TIMES, Feb. 7, 2010, at 1.

230. Jeff Morganteen, *What the CompStat audit reveals about the NYPD*, THE NEW YORK WORLD (July 3, 2013), http://www.thenewyorkworld.com/2013/07/03/compstat/ [https://perma.cc/PP7R-P2MX] ("The outside audit . . . not only confirmed that such data manipulation takes place but found several weak points in the ways the department tracks and uncovers it."); *see also* DAVID N. KELLEY & SHARON L. MCCARTHY, THE REPORT OF THE CRIME REPORTING REVIEW COMMITTEE TO COMMISSIONER RAYMOND W. KELLY CONCERNING COMPSTAT AUDITING (2013), http://www.nyc.gov/html/nypd/downloads/pdf/public_information/crime_reporting_review_committee_final_report_2013.pdf.

231. *See, e.g.*, David Rudovsky, *Law Enforcement by Stereotypes and Serendipity: Racial Profiling and Stops and Searches Without Cause*, 3 U. PA. J. CONST. L. 296, 312 (2001); David A. Harris, *The Reality of Racial Disparity in Criminal Justice: The Significance of Data Collection*, 66 LAW & CONTEMP. PROBS. 71, 81–82 (2003).

232. Klingele et al., *supra* note 228, at 956 ("Many crimes simply go undetected by police. It is estimated, for example, that police detect only about one out of every two hundred to five hundred illegal retail drug transactions and only about one out of every two thousand drunken driving trips.").

233. Ronald F. Wright, *Fragmented Users of Crime Predictions*, 52 ARIZ. L. REV. 91, 94 (2010) ("These markets are too small to offer reliable predictions of crime.").

234. Thomas E. Feucht & William J. Sabol, *Comment on A "Modest Proposal" for A Crime Prediction Market*, 52 ARIZ. L. REV. 81, 84 (2010) ("[L]ocal crime data may be subject to greater relative error and easier manipulation (compared to national data like UCR [Uniform Crime Reports]), and crime reports in local newspapers or other local media may be more vulnerable to spurious factors like

As discussed in the next section, predictive judgments suffer as sample size decreases. National crime statistics exist, but they cannot provide a relevant database necessary to predict local crime patterns because the information is not localized. The result is that the existing data may be of limited value for predictive validity in the vast majority of jurisdictions and only useful in large urban cities with significant crime data collection capabilities.

To be fair, predictive policing companies tend to focus on areas with sufficient data. The large test cities of Los Angeles, Chicago, Seattle, New York City, and so on, tend to be areas with not only large crime problems, but large enough data collection systems. Further, at least with Predictive Policing 1.0, the original models focused only on crimes that were regularly and rather consistently reported (burglary, auto theft, and theft from auto). So PredPol's primary business of targeting burglary and auto-related crimes avoids many of the data collection problems of a broader crime focus.

But beyond property crime, and with the advent of aggregating big data information sources, the vulnerabilities of bad data grow. Both limited datasets for non-property crime and rapidly growing datasets of personal information raise real concerns for the accuracy of data underlying any algorithm-based prediction.

Data can also be biased. The assumptions behind predictive technologies are affected by unseen influences that may have unintended and discriminatory consequences. First, the data itself can be the result of biased collection.[235] Implicit bias has been demonstrated to impact policing decisions on the street.[236] The targeting of certain areas or certain races creates the impression of higher crime rates in those areas, which then justifies continued police presence there.[237] As Professor Shima Baradaran has noted: "As law enforcement dedicates more of its resources to patrolling and investigating blacks in urban areas, the resulting arrest population is not a proportional representation of all offenders, but rather disproportionately represents black citizens."[238]

The result has been to justify disproportionate minority contacts and the collection of minority names in databases. These actions then feed a confirmation feedback loop that equates those currently in the system with

unbalanced crime reporting in the media. With local crime data, there is no corollary to the national compilation of UCR data that can help eliminate error.").

235. Ferguson, *Big Data*, *supra* note 21, at 389–90.

236. *See, e.g.*, L. Song Richardson, *Arrest Efficiency and the Fourth Amendment*, 95 MINN. L. REV. 2035 (2011); Adam Benforado, *Frames of Injustice: The Bias We Overlook*, 85 IND. L.J. 1333, 1367 (2010).

237. Ferguson, *supra* note 20, at 297.

238. Baradaran, *supra* note 49, at 180.

those who need to be policed by the system.[239] Essentially, high-crime areas or high-value suspects might only be considered "high" because police already have data about those areas or people. Some scholars have even argued that such a predictive focus merely increases arrests rather than decreases crime.[240] Finally, explicit bias has also been a factor in the collection of data on suspects, potentially undermining the basis of the predictive technologies. Sadly, racial and class-based bias remain a problem in American policing.[241]

More bluntly, the initial predictive policing projects have raised the question of whether this data-driven focus serves merely to enable, or even justify, a high-tech version of racial profiling.[242] If the underlying data is biased, then how can a data-driven system based on that data not also be biased?[243] As civil liberties advocate, Hanni Fakhoury, has warned:

> It ends up being a self-fulfilling prophecy. . . . The algorithm is telling you exactly what you programmed it to tell you. "Young black kids in the south side of Chicago are more likely to commit crimes," and the algorithm lets the police launder this belief. It's not racism, they can say. They are making the decision based on what the algorithm is, even though the algorithm is going to spit back what you put into it. And if the data is biased to begin with and based on human judgment, then the results the algorithm is going to spit out will reflect those biases.[244]

239. Aaron Cantú, *Algorithms and Future Crimes: Welcome to the Racial Profiling of the Future*, SAN DIEGO FREE PRESS (Mar. 1, 2014), http://sandiegofreepress.org/2014/03/algorithms-and-future-crimes-welcome-to-the-racial-profiling-of-the-future/ [https://perma.cc/YP5M-Q9FJ] ("Any attempt to predict future criminality will be based on the crime rates of the past. It's well known that blacks and Hispanics are arrested at a higher rate than whites and comprise the majority of the prison population. If that's the reality that is supposed to inform who we criminalize in the future, won't initiatives like predictive policing just perpetuate the racist criminal justice policies and practices of the present?").

240. Baradaran, *supra* note 49, at 176–77 ("When police rely on predictive methods, success is amplified by increased arrests (rather than decreased crime)."); HARCOURT, *supra* note 23, at 123 (arguing that focusing on maximizing arrest rates will only increase arrests of African-Americans).

241. James B. Comey, Director, Fed. Bureau of Investigation, Remarks at Georgetown University: Hard Truths: Law Enforcement and Race (Feb. 12, 2015), https://www.fbi.gov/news/speeches/hard-truths-law-enforcement-and-race [https://perma.cc/8VGG-8MUR]; Terrence M. Cunningham, President, Int'l Ass'n of Chiefs of Police (IACP, Remarks Made at the 2016 IACP Annual Conference: The Law Enforcement Profession and Historical Injustices (Oct. 17, 2016) http://www.iacp.org/ViewResult?SearchID=2690 [https://perma.cc/39E3-PGKT].

242. Stroud, *supra* note 214.

243. Ezekiel Edwards, *Predictive Policing Software is More Accurate at Predicting Policing than Predicting Crime*, HUFFINGTON POST (Aug. 31, 2016, 2:58 PM), http://www.huffingtonpost.com/entry/predictive-policing-reform_us_57c6ffe0e4b0e60d31dc9120 [https://perma.cc/8H79-3K9G]; ROBINSON & KOEPKE, *supra* note 3, at 3–5.

244. Llenas, *supra* note 188.

Some predictive companies, like PredPol, would respond by stating that their data is based on reported crime rather than arrest statistics, and thus is not biased by officer judgments. In other words, police responding to a reported crime (e.g., "my car has been stolen") creates a data point not dependent on police patrol patterns. This counterargument merits analysis. Reported crimes are less subject to bias than mere arrests. Some crime only comes to the attention of police because of a victim's report. In traditional Predictive Policing 1.0 cases, usually the homeowner reports the burglary or the car owner the theft. As such, in that instance, crime reports might be less biased and more reliable than arrest statistics. However, sometimes the crime and arrest overlap. When a police officer stops an individual breaking into cars with a screwdriver, there is both an arrest and a reported crime. But in the latter case all of the issues of implicit bias or other factors are present to explain the police officer's presence in the area and suspicion of the suspect. If this dual arrest and crime is included in the data, then the predictive model is still impacted by arrest patterns and not just reported crimes, thereby giving rise to the concern of data bias.

While "data bias" presents a potential vulnerability, it may not be any worse than the existing policing practice. The same implicit and explicit biases that influence the data also influence the police officer on the street (with or without the data). Thus, supporters of predictive policing might rightly argue that while predictive policing programs are not completely free from bias, the move to a data-driven system could reduce bias, or at worst maintain the status quo.[245] Further, if these vulnerabilities could be addressed, then an overall reduction of bias would occur.[246]

2. *Data: Responses*

In response to the problem of bad or biased data, predictive technologies' proponents must address the errors inherent in data collection, data matching, data warehousing, and data cleansing.[247] This section looks at

245. Marsha Garrison, *Taking the Risks Out of Child Protection Risk Analysis*, 21 J.L. & POL'Y 5, 19 (2012) ("Algorithms also have the capacity to improve the quality of predictive judgments, and they are particularly valuable in taming the biases that can flow from interview situations, where first impressions often overpower other important data.").

246. As I have written previously, this defense may fail when focused on Predictive Policing 3.0, which targets individuals based on data. Biased data can distort suspicion when it comes to person-based suspicion. With more information in the database about an individual, it is easier to generate a level of suspicion sufficient to justify stopping or arresting the individual. While it might be bad to rely on biased data for patrol decisions, it is unacceptable to allow biased data to justify deprivations of liberty. Ferguson, *Big Data*, *supra* note 20, at 403.

247. Tal Z. Zarsky, *Transparent Predictions*, 2013 U. ILL. L. REV. 1503, 1518 (2013).

mechanisms that could be adopted to improve data collection and retention. It first focuses on the raw material of data, and then addresses issues of predictive methodology, transparency, accountability, and security.

a. Acknowledging Error

Data-driven systems promote themselves as being better than human-controlled systems because of their perceived objectivity. Algorithms, the argument goes, cannot be biased or discriminatory. Yet the data underlying the algorithm can suffer from the influence of bias or error. The first step in responding to this reality is to acknowledge it.[248] Predictive technologies will be wrong at times, and police departments reliant on them must acknowledge this fact. Acknowledging error does not discount the value of predictive technologies, but only qualifies the findings and tempers the unquestioning acceptance of the information. Acknowledging error also sets the stage for correcting error, auditing error, and training humans to prevent error.

Many predictive policing systems, however, avoid admitting to the inherent data problems. This is so for two main reasons. First, the economic competition between companies that design such programs makes it more difficult to admit the flaws in the underlying data collection system. While police likely know that mistakes might be made or predictions may be wrong, an actual acknowledgment of systemic error is harder to sell. Second, the attractiveness of predictive technologies is bound up with a faith in technological precision. While society might not understand the algorithm (or even what an algorithm is),[249] there is a trust in technology. Acknowledging that the algorithm is based on an error-filled database, however, undercuts that trust.

Adopters of predictive policing technologies need to accept the limitations of the data itself, and the resulting limitations of the conclusions that can be drawn from it. Acknowledging the systemic error and looking for ways to remedy it will be ultimately more constructive than ignoring it.

b. Catching & Correcting Error

The vulnerability of data to error can be corrected by mechanisms to catch and correct the errors. Auditing mechanisms can be established to

248. Angwin et. al., *supra* note 52.
249. *See* Paul Ford, *What is Code?*, BLOOMBERG BUSINESSWEEK (June 11, 2015), https://www.bloomberg.com/graphics/2015-paul-ford-what-is-code/ [https://perma.cc/Z3DP-HG3W].

check the quality of inputs. This can be as simple as supervisors or analysts double-checking daily crime reports, to large-scale forensic audits of the reporting system.[250] Data services can cleanse databases for duplicate or erroneous records. Systems can be designed to manage error. While beyond the scope of this article, a systems approach to error in police databases might be needed to design a thorough error reduction strategy.[251]

The difficulty, of course, is that the sheer amount of data being collected—from daily crime statistics to individual citizens' personal information—will overwhelm most police systems. Police administrators, even those experienced with sophisticated data collection systems, do not have the resources (or sometimes the will) to make data inputting error-free.[252] Worse, the nature of shared and aggregated data systems means that even correcting an error in one location might not also correct the same error now populating other datasets. While steps can and should be taken to catch and correct error, the data will likely remain imperfect.

c. Training and Technology

To ease the burden on a system to catch and correct errors, adopters of predictive technologies must ensure proper training for the frontline collectors of the data. Most police officers did not go into the profession for the paperwork, and the training and incentives for perfectly accurate data inputs are lacking. Adopters of predictive policing technologies must focus on training and technology to address these concerns.

Formal training mechanisms, while burdensome, may be necessary for a data-driven system to be successful. Police officers obviously know the importance of police paperwork as it is regularly used in criminal prosecutions. Simple transposition errors, while embarrassing fodder for cross-examination, do not usually result in more than a few questions at trial. However, in a data-driven system, the wrong code or the wrong address can undermine the integrity of the system itself. Thus, police administrators will need to educate police officers about the importance of detail and accuracy in data collection. The inclusion of crime analysts into

250. Kelley & MCCARTHY, *supra* note 230.

251. *See generally* James M. Doyle, *Learning from Error in American Criminal Justice*, 100 J. CRIM. L. & CRIMINOLOGY 109 (2010).

252. Sherman, *supra* note 100, at 434 ("For all the progress that COMPSTAT has brought policing, it is striking how little measurement it has used of what police do. In 1999–2005, for example, the Philadelphia Police Department's COMPSTAT never reviewed data on where police patrolled, where they made arrests, where they conducted stop-and-frisks, or even how many police were scheduled to work by time or day in relation to the hourly frequency of crime in any police district.").

the police forces of some major police districts may have an added benefit of creating built-in trainers for these lessons.[253]

Similarly, data companies whose products are being adopted by police have an incentive to create and staff formal training programs. The police, by generating the crime data, in many ways are helping to fuel the development of future predictive technologies for those companies. The companies thus have a real incentive to ensure that police officers on the ground are accurately and completely collecting the data that will ultimately be relied upon.

As a final response to the vulnerabilities associated with data error, adopters of predictive technologies should look to advances in predictive technology and automation to minimize human error. Whereas most police officers are required to fill out a crime report with a statement or estimation of the crime time, duration, and location, new technology involving Global Positioning Satellite (GPS) might be used to automatically mark the time, date, and location of an incident.[254] For example, if the technology existed to automatically record a crime's precise time and geo-location, then estimates of addresses or transcribed number errors and other details would be minimized. Furthermore, technologies that encourage other passive collection of information would ease the burden on officers. Many police departments still require handwritten police forms, sometimes in duplicate form. New automated document generation forms would not only ease transcription work of arresting officers, but also allow for automated transmittal of that information into a central database.[255] Once automated, other data mechanisms could be implemented, including automated checklists to ensure completion, forcing functions to ensure compliance, and redundancy mechanisms to ensure accuracy. In these ways, technology can encourage the accuracy, completeness, and usefulness of data.

B. Methodology: Vulnerabilities and Responses

Beyond the fuel of data, the engine of predictive technologies lies in its methodology. Predictive policing relies on proprietary algorithms that adopt

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253. Bond-Graham & Winston, *supra* note 4 ("Virtually every police department in medium to large cities today has one or more crime analysts on staff to crunch numbers and plot past crimes on maps.").

254. Such technology may also create issues, as GPS technology has its limitations. GPS technology may need to be augmented with wireless Internet points of presence in order to capture the data. Thank you to John Hollywood for this and other suggestions.

255. Avery Hartmans, *This Startup Founder Rode Around in Police Cars for Hours to Build His Software*, BUSINESS INSIDER (Nov. 27, 2016) http://www.businessinsider.com/mark43-builds-software-to-aid-police-forces-2016-11.

a particular analytical methodology. Yet the methodologies surrounding predictive techniques are fraught with vulnerabilities. In fact, since the advent of prediction in the criminal justice system, critics have repeatedly pointed out the flaws inherent in many predictive techniques.[256]

1. *Methodological Vulnerabilities*

Not surprisingly, predictive technologies built on incomplete datasets exacerbate methodological vulnerabilities. These limitations go beyond human bias or incorrect assessments to complex statistical problems.[257] Three interrelated problems—validity, error rates, and overgeneralization—will be discussed in this section, with the recognition that a full discussion of methodological vulnerabilities is beyond the scope of this article.

a. *Internal Validity*

Predictive policing technologies purport to provide a more effective means of reducing crime. Studies demonstrating that claim exist, but have certain vulnerabilities in terms of validity. Internal validity "is the extent to which a methodology can accurately determine cause-effect relationships."[258] Internally valid studies must be such that individual variables can be isolated and results reproduced.[259] Currently, at the early stages of evaluation, most of the traditional concerns about internal validity (like selection bias, testing errors, and history) apply to predictive policing.[260]

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256. *See generally* Christopher Slobogin, *supra* note 63; Scherr, *supra* note 41.

257. Joh, *supra* note 214, at 58 ("The assumptions underlying any method of crime prediction rely upon the decision to choose one model of risk prediction over another. The data used to build the models will depend on discretionary judgments about the types of crimes used for prediction, and the type of information used to predict those crimes.").

258. John B. Meixner & Shari Seidman Diamond, *The Hidden* Daubert *Factor: How Judges Use Error Rates in Assessing Scientific Evidence*, 2014 WIS. L. REV. 1063, 1131 (2014).

259. William A. Woodruff, *Evidence of Lies and Rules of Evidence: The Admissibility of fMRI-Based Expert Opinion of Witness Truthfulness*, 16 N.C. J.L. & TECH. 105, 204 (2014) ("Internal validity 'refers to the degree to which the research design isolates the variable of interest and permits drawing valid inferences about the relationships between variables from the resulting data.'"); Tammy W. Cowart et al., *Two Methodologies for Predicting Patent Litigation Outcomes: Logistic Regression Versus Classification Trees*, 51 AM. BUS. L.J. 843, 875 (2014) ("Internal validity (reproducibility) is the ability to achieve the same results when applied to the same population of the data.").

260. Joseph Sanders, *Scientific Validity, Admissibility, and Mass Torts After* Daubert, 78 MINN. L. REV. 1387, 1401 (1994) (discussing "the threats to internal validity" including "history (the threat that an observed effect may be due to an event that takes place between two points of measurement when this event is not the treatment under investigation), testing (the threat that an effect may be due to the number of times responses are measured), and selection (a threat that groups being compared are composed of different types of individuals and, therefore, that observed differences are due to factors

The first PredPol test in the Foothill section of Los Angeles attempted a blind study that gave police officers predictive information about an area but not told whether the prediction came from an algorithm or from a crime analyst.[261] The positive results showed a reduction in crime, but could not be fully attributed to the technology due to flaws in the study and the complexity of testing in real world situations. Further studies have shown a significant decrease in predicted crime,[262] although some critics caution that the PredPol success story involves cherry-picked statistics.[263] Other technologies have also demonstrated positive correlative effects. Initial tests of RTM demonstrate a relatively accurate correlation between the predicted areas and actual gun violence.[264] But, however strong these correlations are, they do not show an actual causal connection. As such, it will be difficult for predictive policing to ever become an internally valid technology.

Simply put, for Predictive Policing 1.0 and 2.0, there have been no sustained studies demonstrating cause and effect. Crime rates go up and down.[265] Even in jurisdictions that have adopted PredPol with initial success, crime rates have later risen for unknown reasons.[266] Thus, as a measure of internal validity, the question is still open as to whether any particular predictive policing technology really shows a causal success.

In addition, the limited data available for some crimes interferes with measurement validity. For example, PredPol's White Paper on gun violence claims, "Crimes involving guns continue to have an impact on future gun homicides for 30–100 days and risk spreads over as much as 1/2 mile in area."[267] Even if completely accurate, this information offers little constructive information to police officers. Unlike the 500 by 500 square foot box for property crimes (updated every day), with gun crimes police

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other than the treatment under investigation)").

261. Bond-Graham & Winston, *supra* note 4 ("Foothill Division, a sprawling LAPD patrol sector in the northeast San Fernando Valley that, at 46 square miles, is about as big as San Francisco, was chosen as the site of a pilot program in 2012.").

262. PredPol reported a 29% drop in crime. *See PredPol Partners LAPD-Foothill Records Day Without Crime!*, PREDPOL BLOG, (Feb. 22, 2014), http://www.predpol.com/predpol-partners-lapd-foothill-records-day-without-crime/ [https://perma.cc/PN4H-YMWC].

263. Kushing, *supra* note 85.

264. Kennedy et al., *Results: Executive Summary*, *supra* note 162.

265. Bond-Graham & Winston, *supra* note 4 (Philip Stark, chair of the statistics department at UC Berkeley expressed caution at the findings, stating, "I'm less than convinced." When asked whether using PredPol leads to a decrease in a city's crime rate, he responded, "You would need to do a comparison of similar-sized cities, with similar conditions, similar trends in their crime rates, with one group of cities using predictive policing, and the others not. Then you'd compare them to each other. . . . A comparison of the same jurisdiction to itself means nothing. . . . Crime fluctuates normally from year to year in the same city.").

266. Aldax, *supra* note 128.

267. THE PREDICTIVE POLICING CO., *supra* note 138, at 3.

would need to be alert for one to three months and in a much larger geographical space. Extra police presence in that area might deter the next shooting, but it can hardly be considered a strong prediction. Nor is the prediction really all that insightful, as most experienced police officers could predict future gun violence three months out in particular areas.

Predictive Policing 3.0 presents an even more difficult causation versus correlation dilemma. As has been well debated in the context of preventative detention and recidivism, causal factors that can *identify* risk do not *determine* risk. The fact that a young man makes the Chicago "Heat List" might be in error, might mean nothing, or might mean he is a potential victim rather than a potential offender.[268] Further, risk factors might change in a way that a list does not reflect. For example, the heightened risk factor for being an unemployed high school dropout might be remedied by a career training program. The risks can change, but the lists of risk-associated people might not, distorting even the correlative accuracy of the prediction.

Initial reports from Chicago present a few contradictory conclusions.[269] First, the Heat List predictions have, according to police reports, been accurate at identifying victims of violence.[270] Police officials stated that on Memorial Day weekend in 2016, 78% of the 64 people shot had been identified on the Heat List,[271] and that on Mother's Day weekend in 2016, 80% of the 51 people shot had been identified on the Heat List.[272] At the same time, the first independent research study of the Heat List's effectiveness demonstrated that the identification process largely failed.[273] RAND conducted a study on the first iteration of the Chicago Heat List and found no predictive accuracy: "[T]he main result of this study is that at-risk individuals were not more or less likely to become victims of a homicide or shooting as a result of the SSL, and this is further supported by city-level

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268. In a public health model, the goal is to try to intervene with both potential victims and offenders involved in gun violence.

269. Nissa Rhee, *Can police big data stop Chicago's spike in crime?*, THE CHRISTIAN SCI. MONITOR (June 2, 2016), http://www.csmonitor.com/USA/Justice/2016/0602/Can-police-big-data-stop-Chicago-s-spike-in-crime [https://perma.cc/64SE-SLLD]; Monica Davey, *Chicago Police Try to Predict Who May Shoot or Be Shot*, N.Y. TIMES (May 23, 2016), http://www.nytimes.com/2016/05/24/us/armed-with-data-chicago-police-try-to-predict-who-may-shoot-or-be-shot.html?_r=0.

270. *Editorial: Who will kill or be killed in violence-plagued Chicago? The algorithm knows*, CHI. TRIB. (May 10, 2016, 5:00 PM), http://www.chicagotribune.com/news/opinion/editorials/ct-gangs-police-loury-algorithm-edit-md-20160510-story.html [https://perma.cc/8333-CVAZ].

271. Andrew V. Papachristos, *Commentary: CPD's Crucial Choice: Treat Its List as Offenders or as Potential Victims?*, CHI. TRIB. (July 29, 2016, 10:00 AM), http://www.chicagotribune.com/news/opinion/commentary/ct-gun-violence-list-chicago-police-murder-perspec-0801-jm-20160729-story.html [https://perma.cc/G8TU-PBXA].

272. *Editorial*, *supra* note 270.

273. Saunders et al., *supra* note 192, at 355–64.

analysis finding no effect on the city homicide trend. We do find, however, that SSL subjects were more likely to be arrested for a shooting."[274]

The RAND researchers found that police failed to follow up with Custom Notification Letters or social services, and used the program more as a "data-driven most-wanted list."[275] At-risk individuals became targets for arrest, rather than candidates for violence prevention.[276] The Chicago Police Department has responded to such criticism by pointing out that the early Heat List system studied by RAND has changed and any criticism relates to an out-of-date algorithm. But no matter the accuracy of the technology, the facts are that the use of the Heat List has not reduced violence in Chicago. In fact, in August 2016, Chicago saw its deadliest month in two decades with a spike of murders.[277]

b. External Validity – Overgeneralization

Because of the fragmented nature of crime data and the inexact nature of data aggregation, the few jurisdictions that have ample and accurate data are sometimes used to justify the universal application of the technology. Success in one jurisdiction is used to suggest future success in another jurisdiction. However, the predictive results in Los Angeles or Chicago may not apply to, say, Topeka or Anchorage because of differences in geography, crime patterns, or police culture. Generally speaking, the vulnerability of overgeneralization runs throughout predictive risk assessments and should be a caution for new adopters.[278]

Similarly, the predictive judgments of certain types of crime may be impacted by the lack of crime data. For example, because certain violent crimes like shootings are comparatively rare, the data can be of a limited predictive value. Partially for that reason, some predictive techniques have

274. *Id.* at 363–64.

275. Matt Stroud, *Chicago's Predictive Policing Tool Just Failed a Major Test*, THE VERGE (Aug. 19. 2016, 10:28 AM), http://www.theverge.com/2016/8/19/12552384/chicago-heat-list-tool-failed-rand-test [https://perma.cc/JAJ6-3BRX].

276. Nissa Rhee, *Study Casts Doubt on Chicago Police's Secretive "Heat List"*, CHI. MAG. (Aug. 17, 2016), http://www.chicagomag.com/city-life/August-2016/Chicago-Police-Data/; Papachristos, *supra* note 271.

277. Monica Davey, *Chicago Has Its Deadliest Month in About Two Decades*, N.Y. TIMES (Sept. 1, 2016), http://www.nytimes.com/2016/09/02/us/chicago-august-homicides.html?_r=0.

278. Hamilton, *supra* note 39, at 730 ("It is also important to recognize that one of the most important limitations of actuarial assessments as a rule is the problem of overgeneralization or, more empirically, external validity. One overgeneralizes results of research by presuming the results derived from one population (the reference group) are reliable when applied to a second population. If the second population differs in any risk-relevant way from the reference group, then the predictive result is invalid.").

chosen to focus on precursor crimes (not violent in and of themselves)[279] or fixed geographic markers (bus stops, liquor stores, etc.).[280] As a result of this limited data, the conclusions themselves may be weaker. As LAPD Sergeant Christi Robbin admitted to a reporter, "With gun crimes you have fewer incidents, so the predictions aren't as strong."[281] Of course, this is not to say that there are not numerous studies to demonstrate that violent acts generate retaliatory violent responses, or that social networks cannot be studied to show webs of violence in communities, but studying whether predictive policing can deter violence is only just now being tested in any rigorous way.[282]

c. Error Rates

Predictive technologies have error rates. Error rates encompass both false negatives and false positives.[283] For Predictive Policing 1.0 and 2.0, false positives (no crime in a predicted high risk area) create unwanted police-citizen contact or unwanted surveillance in certain areas. False negatives (crime in a predicted low risk area) divert police resources by sending officers to the wrong areas. Both are suboptimal, but not necessarily any worse than non-predictive policing, which also leads officers to investigate non-crimes and miss actual crimes.

For Predictive Policing 3.0, the risk of error grows when police use big data technologies to match suspicious patterns in large databases.[284] A false positive predictive tip could result in innocent individuals being singled out and investigated for noncriminal activity. These investigations could involve physical police contact, which might be threatening or even violent.

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279. THE PREDICTIVE POLICING CO., *supra* note 138.

280. RUTGERS CTR. ON PUB. SEC., *supra* note 133.

281. Mitchell, *supra* note 2.

282. Christopher Moraff, *The Problem with Some of the Most Powerful Numbers in Modern Policing*, NEXT CITY (Dec. 15, 2014), https://nextcity.org/daily/entry/predictive-policing-crime-stats-data-measure [https://perma.cc/RS9J-A7KB].

283. Slobogin, *supra* note 39, at 291.

284. Bruce Schneier, *Why Data Mining Won't Stop Terror*, WIRED (Mar. 9, 2006, 12:00 PM), http://www.wired.com/politics/security/commentary/securitymatters/2006/03/70357 [https://perma.cc/8PV5-ZV3U]; Bruce Schneier, *Data Mining for Terrorists*, SCHNEIER ON SECURITY (Mar. 9, 2006, 8:54 AM), http://www.schneier.com/blog/archives/2006/03/data_mining_for.html [https://perma.cc/87UU-NKF6]; Fred H. Cate, *Government Data Mining: The Need for A Legal Framework*, 43 HARV. C.R.-C.L. L. REV. 435, 473 (2008) ("Data mining for national security and law enforcement presents far greater challenges than data mining for target marketing for many reasons. . . . Government data mining often is searching for a needle not in a haystack, but among millions of other needles.").

Such contacts build resentment toward the perceived over-aggressive police presence.[285]

In addition, any understanding of error rates can only be evaluated by understanding the base rate.[286] A base rate is the frequency with which the behavior (suspected crime) occurs in the overall group studied (usually the population). Currently, because of poor reporting, inadequate resources, and the nature of certain crimes, police do not know the base rate for different crimes in many jurisdictions.

2. Methodological Responses

These methodological vulnerabilities lead to four main lessons for the future adoption of predictive technologies. First, because predictive policing is largely untested, jurisdictions must independently evaluate initial claims of success. The San Francisco Police Department examined the possibility of adopting predictive policing, but declined to adopt the PredPol technology due to concerns about effectiveness.[287] Currently, independent data does not exist to verify the methodology of the companies selling the technology.[288] Because the efficacy remains unknown, jurisdictions seeking to purchase the technology need to check the methodology and prepare responses to future legal and community challenges.

Second, adopting jurisdictions must remain cautious about extending conclusions from one jurisdiction to another. Problems of overgeneralization can be addressed by recognizing that the urban landscape, police culture, and economic realities might be very different in different parts of the country. Just because predictive policing works in sprawling areas of Los Angeles does not mean it would work in the vertically constructed New York City. Just because burglaries appear to encourage repeat offending in nearby areas does not mean that aggravated assault or other crimes will follow suit.

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285. SOC. PSYCHOL. ANSWERS TO REAL-WORLD QUESTIONS, STRATEGIES FOR CHANGE: RESEARCH INITIATIVES AND RECOMMENDATIONS TO IMPROVE POLICE-COMMUNITY RELATIONS IN OAKLAND, CALIF. (Jennifer L. Eberhardt ed., 2016); REBECCA C. HETEY ET AL., SOC. PSYCHOL. ANSWERS TO REAL-WORLD QUESTIONS, DATA FOR CHANGE: A STATISTICAL ANALYSIS OF POLICE STOPS, SEARCHES, HANDCUFFINGS, AND ARRESTS IN OAKLAND, CALIF., 2013–2014 (2016).

286. Slobogin, *supra* note 39, at 292 ("The accuracy of expert predictions can be fully understood only if base rates of recidivism are taken into account.").

287. Bond-Graham & Winston, *supra* note 4.

288. Moraff, *supra* note 282 ("[T]he vast majority of what we know about predictive policing comes from data released unilaterally by individual police agencies, or by the firms peddling software to them. This not only makes it hard to compare results from city to city, but raises serious questions of data reliability.").

Third, communities adopting predictive policing must remain cognizant of the temporal limitations of the predictions. One of the oft-ignored limitations of predictive policing involves its timeframe for predictions. For example, PredPol's property-based predictions occur on a daily (and even hourly) basis, allowing for a rather sophisticated matching of time and place. However, PredPol's violence-predicting technologies look at a 30–100 day window, allowing for far less useful actionable data.[289] Both might be accurate in their predictions, but the former provides a much more useful and relevant dataset for police officers looking for immediate suspicious activity.

Finally, the predictive technologies targeting individuals face even harder questions. Correlation should not be confused with causation when individual liberties are concerned.[290] When the physical and emotional impact of police authority is involved, some individualized suspicion is required.[291] The fact that a prediction identifies a particular individual should not, without more, be enough to initiate investigation. Strikingly, Jeffrey Brantingham, one of the founders of modern predictive policing and the creator of PredPol, was quoted saying: "These 'person-centric' models are problematic . . . because they carry an elevated margin of error and can legitimize racial, gender-based and socioeconomic-driven profiling. As a scientist you better be damn sure the model of causality is right or else it's going to lead to a lot of false positives."[292] These false positives have grave, liberty-eroding consequences, and so responses must be built in to ensure accuracy. Even if sufficient suspicion could be generated through pattern-matching or social network theory, acting on that suspicion should not be a foregone conclusion. While perhaps these predictive techniques could be useful for an initial lead, further screening mechanisms must be created before reliance on correlation leads to the physical and sometimes painful power of the state being brought to bear on an individual.

These methodological responses can be summarized into two simple recommendations. First, the acknowledged vulnerabilities of predictive

289. The near repeat effects of violent crime have not been strongly demonstrated, which may provide a second reason to qualify the utility of this approach.

290. Underwood, *supra* note 38, at 1446 ("A statistical correlation in data about one group of people may not hold when used as a basis for predictions about another group of people. A causal theory helps to identify any relevant differences between the two groups, or differences in the surrounding circumstances.").

291. Arguably, if all that were at issue were therapeutic interventions without coercive law enforcement or judicial impacts, a looser correlation standard might be justified. But, as predictive policing is connected with real policing, more than therapy is at issue.

292. Moraff, *supra* note 277.

methodologies need to be addressed before adopting the technology. Second, the limitations should encourage a more scientifically rigorous approach. The second response will be the subject of the next section.

C. Social Science: Vulnerabilities and Responses

Social science, not simply technology, underlies the promise of predictive policing.[293] As a legitimizing principle, the fact that predictive policing rests on established social science experiments has carried significant weight in its promotion and adoption. Decades of criminology theory and practice support many of the insights behind why crime can be predicted.[294] At the same time, new iterations of predictive policing have evolved without equivalent empirical testing. While some studies are currently in progress, police adoption has outpaced scientific findings, leading to ongoing uncertainty.

1. Social Science: Vulnerabilities

Only one published peer-reviewed scientific paper has evaluated the claims of PredPol.[295] The paper, written in collaboration with the founders of PredPol, offers a good illustration of the limits of current social science on predictive policing. This first published article describes the results of an approximately eight-month study in Los Angeles that compared PredPol predictions with professional crime analyst predictions.[296] The focus was on Predictive Policing 1.0 crimes (burglary, car theft, and theft from automobiles), and the algorithm and analyst alternated days of the week to offer criminal predictions.[297] Over the period of comparison (117 days), the analyst successful predicted 2.1% of crimes, while the PredPol algorithm predicted 4.7% of crimes. The PredPol model thus demonstrated a predictive accuracy 2.2 times greater than the control.[298]

As with any study, questions of size, scope, and generalizability arise.

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293. *See, e.g.*, Chainey et al., *supra* note 96, at 5; Braga et al., *supra* note 78, at 9.

294. Tompson & Townsley, *supra* note 110, at 25; Caplan, *supra* note 140, at 60.

295. *See* George O. Mohler et al., *Randomized Controlled Field Trials of Predictive Policing*, 94 J. AM. STAT. ASS'N 1399 (2015), http://paleo.sscnet.ucla.edu/MohlerEtAl-2015-JASA-Predictive-InPress.pdf. In contrast, the researchers conducting Risk Terrain Modeling tests have conducted several research studies emphasizing the risk factors underlying certain criminal activity. As detailed *supra* notes 115, 166, 263, they have published a series of scholarly articles demonstrating significant success in risk forecasting abilities. These reports have not been peer reviewed.

296. *See* Mohler, et al. *supra note* 295. The study also compared crime prediction in Kent, England, but a discussion of the Kent findings is omitted from this discussion.

297. *Id.*

298. *Id.*

But more fundamentally, the methodology underlying the PredPol study presents difficult questions. First, PredPol sets up the study comparing its algorithm to crime analysts. But the predictions of crime analysts themselves have no scientific or empirical validity; while the algorithm beats the analyst, the analyst is not a valid scientific control.[299] Second, "success" is difficult to prove. If the algorithm predicts a crime and the crime occurs (without police intervention), it is hard to claim a success (because actual crime increased). But if the crime is predicted and it doesn't occur because the police have acted as a deterrent, how can one measure that non-event as a success? Maybe the police deterred the crime, or maybe it was not going to happen, but it seems difficult to call it a measurable success. These concerns are emblematic of the type of methodological difficulties in studying real world crime.

While PredPol has begun to analyze its programs, most of the other commercial products claim no scientific proof of their technology's effectiveness.[300] Part of the reason for this absence of data and peer-reviewed publications is that scientists require time and funding to conduct experiments, and policing urban areas with real criminals and real victims provides an imperfect testing environment.[301] In addition, the variables for why crime occurs or why crime rates drop across jurisdictions and over time are multifaceted, so it remains difficult to draw causal conclusions.

Early criminology studies which developed the near repeat theory and the flag and boost theories all arose from academic settings.[302] These theories explained why predicting certain crimes might work, and offered scientifically valid studies to support the claims. These theories, tested over

299. A valid response to this criticism is that the study was designed specifically to see if it was better than the analysts because crime analysts are the professional norm. As Jeff Brantingham explained to me in an email, "The reason why we tested against real human analysts was that the critique of our [earlier] paper was: "Sure, you can beat another algorithm, but you could never beat a real human expert in the field." We took that criticism to heart and designed an experiment to test the hypothesis with two police agencies who reasonably represent the some of the best the profession has to offer in terms of analysis and its use in the field. The experiments establish what is called "ecological validity," which is essential for real-world functionality." *See* E-mail from Jeffrey Brantingham, Professor of Anthropology, UCLA, to Andrew Ferguson, Professor of Law, UDC David A. Clarke School of Law (Nov. 1, 2016) (on file with author).

300. Academic researchers at Rutgers University have produced studies on Risk Terrain Modeling, and further studies are ongoing. *See supra* notes 112, 167, 264, The Risk Terrain Modeling website includes a series of academic journal articles and book chapters detailing the results of RTM tests. *See Publications*, RUTGERS CTR. ON PUB. SEC., http://www.rutgerscps.org/publications.html (last visited Nov. 28, 2016).

301. Bond-Graham & Winston, *supra* note 4 (quoting Jerry Ratcliffe, the chair of Temple University's department of criminology, as saying, "Testing these systems requires experimental conditions which are rarely conducted in policing and crime prevention, unfortunately.").

302. *See supra* notes 107–109.

time with publicly released data, provided a means for other scholars to challenge and refine the theories. These studies did not, however, purport to prove that any particular technology could predict crime. While certain predictive policing theories have arisen from the academic environment, the drivers of predictive policing programs have largely been commercial entities. These companies, while supportive of the concept of scientific validity, also recognize that positive statistics, even without scientific validity, might be enough to convince police departments to purchase the technology. Thus, the veneer of scientific legitimacy has been embraced without significant peer-reviewed findings to back it up.

In fact, the only independent scientific assessment of predictive policing technology resulted in largely inconclusive findings. A 2012 RAND report studied a predictive policing pilot program in Shreveport, Louisiana.[303] Funded in part by the National Institute of Justice, RAND sought to compare predictive policing techniques with traditional law enforcement methods. The report was "the first published randomized controlled trial (RTC) of predictive policing."[304] According to the Report, "[Shreveport Police Department] wanted to predict and prevent the emergence of . . . property crime hot spots rather than employ control and suppression strategies after the hot spots emerged."[305] Researchers conducted a twenty-nine-week study evaluating six police units.[306] The researchers adopted a traditional Predictive Policing 1.0 approach. This approach was not based on the technology developed by PredPol, RTM, or HunchLab, but was designed by Shreveport Crime Analysts with technical assistance from RAND analysts.[307] To evaluate predicted areas of property crime, researchers factored in the presence of residents on probation or parole, the previous six months of tactical crime, forecasts of tactical crime, 911 calls for disorderly conduct, vandalism, juvenile arrests, and weighted fourteen days of tactical crime.[308] After a lengthy study, RAND concluded, "Overall, the program did not result in a statistically significant reduction in property crime, as envisioned. This could be because the program does not work, the program was not implemented as intended, or that there was insufficient

303. HUNT ET AL., *supra* note 130, at 1.
304. *Id.*
305. *Id.*
306. *Id.* at 4.
307. *Id.* at 9 ("The predictive analytics team used statistical software to build and test regression models that estimate probabilities of crime, along with geospatial software to plot these estimated future probabilities of crime per geospatial unit onto maps.").
308. *Id.* at 10.

statistical power to detect the effect."[309] Researchers conceded that such a finding does not mean that predictive policing cannot work, but merely that one approach in one location did not work.

The lack of scientific studies remains a real vulnerability in the development of predictive policing. As will be discussed in the next section on transparency, this problem is exacerbated by the fact that much of the data rests in private hands and is controlled by proprietary interests.

2. Scientific Studies: Responses

The simple response to the lack of scientific studies would be to develop studies to test competing predictive policing technologies. These studies will likely emerge over time as part of the larger movement of evidence-based policing. According to the Center for Evidence-Based Crime Policy at George Mason University, only a limited number of studies have been done with a moderate level of scientific rigor.[310] That is beginning to change with the influence of the National Institute of Justice, which has begun funding such projects,[311] and other philanthropic organizations focusing on data-driven criminal justice innovation.[312] Other academic institutions such as the Rutgers Center on Public Security, host of the RTM research, have provided more funding for scholarly research into the effectiveness of predictive policing technologies.[313] Further, as predictive policing gains currency in the media and academia, scholars will begin testing the scientific validity of the theories and how transferrable they are to other jurisdictions.[314]

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309. *Id.* at 38. *See also id.* at 33 ("There was no statistically significant impact of the program on crime overall, but it is unclear if that is because of a failure in the program model or a failure in the program implementation.").

310. *See Evidence-Based Policing Matrix*, CTR. FOR EVIDENCE BASED CRIME POLICY, http://cebcp.org/evidence-based-policing/the-matrix/ [https://perma.cc/29JV-VCTP] (providing a resource to collect and study evidence based policing studies).

311. *See Law Enforcement Policing Strategies*, NAT'L INST. OF JUSTICE, http://www.crimesolutions.gov/TopicDetails.aspx?ID=84 [https://perma.cc/ET64-9YUF].

312. PRETRIAL CRIMINAL JUSTICE RESEARCH, LAURA & JOHN ARNOLD FOUND. (Nov. 2013), http://www.arnoldfoundation.org/wp-content/uploads/2014/02/LJAF-Pretrial-CJ-Research-brief_FNL.pdf; LAURA & JOHN ARNOLD FOUND., *supra* note 53.

313. *See Risk Terrain Modeling*, RUTGERS CTR. ON PUB. SEC., http://www.rutgerscps.org/ rtm.html [https://perma.cc/ML96-SZM8] (last visited Jan. 15, 2017).

314. Sherman, *supra* note 100, at 432 ("There is also a scientific question of how reliably research in one police agency (or more) will predict effectiveness in any other agency.").

D. Transparency: Vulnerabilities and Responses

The appeal of predictive policing has in large measure been that it offers a “black box” solution to crime. The corresponding vulnerability, however, is that such solutions lack sufficient transparency to ensure that the “black box” really works. The lack of transparency in data collection, data use, and effectiveness requires designing processes to guarantee that predictive policing technologies live up to the promise of their creation.[315]

1. Transparency: Vulnerabilities

As currently implemented, a lack of transparency exists at all levels of predictive policing. Even something as simple as crime statistics, which in many cases are publicly available, remain rife with concerns about accuracy and completeness.[316] Adding personal data dossiers to these crime statistics creates new problems, as the sheer volume of information complicates transparent assessment of the sources underlying the predictions.[317] How do you fix an error in the data if you cannot see that such an error exists? How do you even know who has the responsibility to input information into these big aggregated databases?[318] In addition, unintended personal or cultural biases can infect the data, the scoring systems, the source codes, and thus the resulting predictive outcome.[319] Simply stated, without significant investment in exposing the data collection methods, weaknesses, and gaps, and without equal investment in understanding the challenges associated

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315. Zarsky, *supra* note 247 at 1521 (recognizing that transparency in the context of automated prediction must be broken down into three segments: “(1) the collection of data and aggregation of datasets, (2) data analysis, and (3) actual strategies and practices for using the predictive models, effectiveness of which could be measured by both the way they are applied ex ante and their final impact ex post”).

316. James F. Gilsinan, *The Numbers Dilemma: The Chimera of Modern Police Accountability Systems*, 32 ST. LOUIS U. PUB. L. REV. 93, 95 (2012) (“The simple act of deciding to count or not count something confers or denies a certain importance to an object or outcome.”).

317. Andrew M. Smith & Peter Gilbert, *Privacy and Fair Credit Reporting Act Update—2014*, 70 BUS. LAW. 585, 586 (2015) (“The sheer volume of big data and the complexity of algorithms used to analyze it complicate transparency in data collection and use, and the rapidly increasing volume of aggregated personal data increases the risks of data security breaches for consumers.”).

318. Erin Murphy, *supra* note 174, at 831 (“Databases also are often, by their nature, secret from within. They have multifarious inputs, which means both that the identity of the relevant agent can be difficult to discern, along with their responsibility for particular substance.”).

319. Danielle Keats Citron & Frank Pasquale, *The Scored Society: Due Process for Automated Predictions*, 89 WASH. L. REV. 1, 25 (2014) (arguing for FTC transparency: “The FTC’s expert technologists could test scoring systems for bias, arbitrariness, and unfair mischaracterizations. To do so, they would need to view not only the datasets mined by scoring systems but also the source code and programmers’ notes describing the variables, correlations, and inferences embedded in the scoring systems’ algorithms.”).

with inputting and analyzing the data, the entire system runs the risk of being built on an unknown and unknowable database.[320]

The nature of algorithms further obscures the process, except perhaps to technical experts. Police officers and administrators receive the results, but due to the complexity of the chosen algorithm they can rarely understand the underlying math. Thus, predictive policing runs into the same problems as other automated predictive technologies: the technical complexity of the design makes it nearly impossible for outsiders to determine the accuracy, effectiveness, or fairness of the program.[321] True, police can see if the system works, but police cannot see *how* the system works. This lack of transparency is not simply the result of new technology, but also the influence of the proprietary nature of the software. The companies involved in these real-world tests are in a multimillion-dollar race to convince police departments to adopt their particular products. The companies have financial interests and proprietary secrets to protect, and every incentive to report positive outcomes.[322]

Effectiveness itself remains a contested issue. Early tests show a correlation between use of certain predictive policing techniques and decreased crime rates (for some crimes). But how do police districts determine metrics in the future? Crime may go up or down independent of the chosen computer program. Crime analysts may make a more or less accurate comparative judgment. Most importantly, how can outsiders audit the data? In similar police data collection experiments (DNA databases, "stop and frisk" reporting), the police have audited themselves with mixed results.[323]

These vulnerabilities exist with any data-driven solution, and, as such, lessons can be learned from other data-based systems. Every aspect of the data collection system must be imbued with a focus on transparency in an effort to catch, correct, and understand errors.

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320. Wayne A. Logan & Andrew Guthrie Ferguson, *Policing Criminal Justice Data*, 101 MINN. L. REV. 541, 545–55 (2016).

321. Frank Pasquale, *Restoring Transparency to Automated Authority*, 9 J. ON TELECOMM. & HIGH TECH. L. 235 (2011) [hereinafter *Restoring Transparency*]; Zarsky, *supra* note 247, at 1534; Frank Pasquale, *Beyond Innovation and Competition: The Need for Qualified Transparency in Internet Intermediaries*, 104 NW. U. L. REV. 105 (2010); Oren Bracha & Frank Pasquale, *Federal Search Commission? Access, Fairness, and Accountability in the Law of Search*, 93 CORNELL L. REV. 1149, 1159 (2008); Mark Fenster, *The Opacity of Transparency*, 91 IOWA L. REV. 885, 895–96 (2006).

322. Bond-Graham & Winston, *supra* note 4.

323. Stephen Mercer & Jessica Gabel, *Shadow Dwellers: The Underregulated World of State and Local DNA Databases*, 69 N.Y.U. ANN. SURV. AM. L. 639, 681 (2014) (discussing lack of transparency in local DNA databases); KELLEY & MCCARTHY, *supra* note 230.

2. *Transparency: Responses*

Transparency is difficult, but it matters to a functioning predictive system that deals with individuals' lives and liberty. Transparency serves as a check on governmental power.[324] Intentional openness encourages better behavior of police on the street in recording data, administrators at headquarters in analyzing it, and error reduction at a systemic level.[325] In the context of sophisticated algorithms, it may not ever be perfect,[326] but a focus on transparency can create a better sense of trust in the technology.[327] It was for this reason that many people originally considered the public mapping of crime a victory for transparency advocates.[328]

To ensure transparency three basic things must happen. First, an independent auditing system must be created to span the entire collection, analysis, and data maintenance process.[329] Compliance systems must be created that can check whether and how data is being collected, recorded, and inputted.[330] Auditing of the system must include peer review and outside testing of the algorithms.[331] This audit would need to be conducted by professional data analysts who understand the predictive systems and can see whether the claims made are supported by the data. Finally, auditing systems must create a notice mechanism to preserve the auditing results and potentially publish them at the appropriate time.

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324. Zarsky, *supra* note 247, at 1533 ("The most basic and popular justification for transparency is that it facilitates a check on governmental actions.").

325. Mary D. Fan, *Panopticism for Police: Structural Reform Bargaining and Police Regulation by Data-Driven Surveillance*, 87 WASH. L. REV. 93, 129 (2012) ("Monitoring through data generation exerts its own control function. The greater transparency produced by data generation is a technique of police panopticism. When police are subject to the watchful gaze of courts, the public, and self-surveillance, they behave in better conformity with expectations."); Zarsky, *supra* note 247, at 1534 ("Transparency facilitates 'shaming.' The fear that a broad segment of the public will learn of the bureaucrats' missteps will deter these decision makers from initially engaging in problematic conduct.").

326. Cynthia Dwork & Deirdre K. Mulligan, *It's Not Privacy, and It's Not Fair*, 66 STAN. L. REV. ONLINE 35, 37 (2013) ("Exposing the datasets and algorithms of big data analysis to scrutiny—transparency solutions—may improve individual comprehension, but given the independent (sometimes intended) complexity of algorithms, it is unreasonable to expect transparency alone to root out bias.").

327. Julie Brill, *The Internet of Things: Building Trust and Maximizing Benefits Through Consumer Control*, 83 FORDHAM L. REV. 205, 215 (2014) (discussing transparency and trust in the context of the Internet of Things).

328. Gilsinan, *supra* note 316, at 93–94 ("The increasing use of accessible, web-based, real time crime data, using geographic information system (GIS) technology to display neighborhood crime patterns, represents the move toward transparency on the part of major city police departments.").

329. Zarsky, *supra* note 247, at 1553–68 (advocating for strong process protections to compensate for the difficulty of making predictive algorithms transparent). *See also, e.g.*, Pasquale, *Restoring Transparency*, *supra* note 321, at 235–36; Erik Luna, *Transparent Policing*, 85 IOWA L. REV. 1107, 1163 (2000).

330. Danielle K. Citron, *Technological Due Process*, 85 WASH. U. L. REV. 1249, 1305 (2008).

331. *See* Logan & Ferguson, *supra* note 320, at 599.

Second, metrics must be publicly released to allow a judgment about whether the promise of predictive policing has met its goal. A transparent system must provide a way to show that predictive policing works.[332] This metric may be objective—a set target for a crime rate reduction. The metric may be comparative—a target set in comparison to a crime analyst's prediction. The metric might be subjective—a judgment by a designated official that the program has met certain goals. Whichever types of metric are selected, some metrics that can be measured and evaluated are necessary to judge the effectiveness of any system.

Finally, training programs within police departments must be established at all levels to ensure that the data processes work and are being followed. Everything that is going to be audited and judged by an officer should first be made part of a comprehensive training program.

E. Accountability: Vulnerabilities and Responses

Improved transparency leads to increased accountability.[333] "Accountability refers to the ethical obligation of individuals (in this case, governmental officials) to answer for their actions, possible failings, and wrongdoings."[334] The concepts of transparency and accountability, while related, are distinct. As Tal Zarsky has written, "[t]ransparency is an essential tool for facilitating accountability because it subjects politicians and bureaucrats to the public spotlight."[335] But accountability involves more than transparency's sunlight, including providing citizens the power to hold decision-makers responsible for their actions.

1. Accountability: Vulnerabilities

Police accountability has long been a fraught issue, involving local political tensions, community tensions, and legal oversight.[336] Adoption of

332. *See* Ferguson, *Predictive Policing*, *supra* note 20, at 324 ("To allow predictive policing such influence without mechanisms of accountability for the data and analysis, and without full transparency, may result in a troubling lack of protection for individuals who end up in the forecasted areas.").

333. David A. Harris, *Across the Hudson: Taking the Stop and Frisk Debate Beyond New York City*, 16 N.Y.U. J. LEGIS. & PUB. POL'Y 853, 878 (2013) ("One hears the term 'transparency' in many contexts these days. The idea is that by making the workings of government open to public scrutiny, the public will better understand what those in charge are doing, and can hold officials accountable in appropriate ways.").

334. Zarsky, *supra* note 247, at 1533.

335. *Id.* at 1533–34.

336. *See generally* Rachel A. Harmon, *The Problem of Policing*, 110 MICH. L. REV. 761 (2012).

predictive policing technologies changes little about these ongoing issues. This section looks at specific concerns with predictive policing, putting aside larger structural issues with police accountability in general.

As discussed earlier, the lack of transparency and technological expertise make accountability very difficult. Political and community leaders can be held accountable only if individuals understand what the predictive technology is doing. As it currently stands, many politicians defer to the "black box" promise of predictive policing without actually understanding why or how it works. Even with robust data collection and sharing, most politically accountable leaders care as much about the bottom line crime statistics (up or down) than the efficiency or fairness of any particular technology. In fact, political accountability has only rarely taken the lead in police accountability, as politicians usually delegate authority to local police chiefs, thus insulating themselves from responsibility for the results.[337]

A larger issue involves lack of legal accountability for most internal policing decisions. With the exception of federal oversight through practice and pattern lawsuits[338] and individual civil rights lawsuits,[339] there are few legally cognizable claims a plaintiff or the government can raise regarding policing strategy. This means police administrators can choose the approach that they believe works best for their communities without running afoul of constitutional challenges.[340] Even the NYPD stop and frisk lawsuits—one of the most prominent challenges to policing in recent memory—did not directly focus on the choice of police tactics, but on the racially disparate impact of the practices.[341] Similarly, there will be no accountability-based legal challenges to predictive policing, absent some inequity in application.

Finally, a lack of accountability exists because of the immaturity of the technology. Predictive policing is still experimental, and as such it gets the benefit of being thought too new to judge. This may well be true, but the nature of the technology is that it will always be new. Predictive policing

337. *See* Barry Friedman & Maria Ponomarenko, *Democratic Policing*, 90 N.Y.U.L. REV. 1827, 1831 (2015) ("Policing agencies may not be entirely immune from democratic oversight–police chiefs typically serve at the pleasure of the mayor, police commission, or city council, and sheriffs are directly elected by the people…. Given their incentives, executive officials to whom police report typically will grant policing agencies *carte blanche* so long as crime remains in check.").

338. *See generally* Samuel Walker, *The New Paradigm of* Police Accountability*: The U.S. Justice Department "Pattern or Practice" Suits in Context*, 22 ST. LOUIS U. PUB. L. REV. 3 (2003).

339. *See* David Rudovsky, *Litigating Civil Rights Cases to Reform Racially Biased Criminal Justice Practices*, 39 COLUM. HUM. RTS. L. REV. 97, 116–19 (2007).

340. *But see* Henry Gass, *Chicago Police, ACLU Reach Agreement on 'Stop and Frisk' Practice*, THE CHRISTIAN SCI. MONITOR (Aug. 7, 2015), http://www.csmonitor.com/USA/Justice/2015/0807/Chicago-police-ACLU-reach-agreement-on-stop-and-frisk-practice [https://perma.cc/2KPQ-9P84].

341. *See, e.g.*, Floyd v. City of New York, 959 F. Supp. 2d 668 (S.D.N.Y. 2013) (addressing the constitutionality of the NYPD's stop and frisk practices).

technologies, almost by definition (if not design), will continue to improve, innovate, and change. In that constantly shifting framework, it will be a moving target to say any particular technique has failed.[342] Presumably, the next generation of the technology will fix the error, and there may never be a moment of true accountability.[343] Such is the nature and speed of continuously innovating technologies. By the time evaluators have accounted for past successes or failures, the technology will already have evolved to the next version.

2. Accountability: Responses

Despite vulnerabilities, predictive policing can be a force for accountability. The original data-driven police systems were created to foster accountability.[344] In New York City, Commissioner Bratton's innovation of demanding real-time reports of crime statistics allowed for both internal and external accountability about crime rates.[345] CompStat organizational meetings literally brought police leaders into a room to be held accountable for what had happened in their district.[346] The recognition that accountability matters should be central to the next generation of predictive policing technologies.

At an operational level, if accountability becomes a priority, the data-driven nature of the technologies makes accountability easier to implement. Building off the CompStat model, such statistics could be made available to city administrators and the larger community.[347] In some jurisdictions,

342. The 2016 RAND study of Chicago's Heat List proves the point. *See supra* note 192 and accompanying text. RAND found the algorithm and program provided no statistical evidence that the Heat List worked to reduce violence. The Chicago Police discounted this criticism, stating that the algorithm had since been improved, so any criticism was dated and unwarranted. *See* Stroud, *supra* note 192.

343. Stroud, *supra* note 193 (discussing the Chicago Police Department's upgrade of the algorithm since the RAND study had been conducted).

344. Ferguson, *supra* note 73, at 193 ("CompStat created an integrated data-management system for police statistics that required weekly data updates, crime mapping, targeted police responses, and an accountability mechanism that was primarily data driven."); Ronal W. Serpas & Matthew Morley, *The Next Step in Accountability Driven Leadership: "CompStating" the CompStat Data*, POLICE CHIEF MAG. (May 2008), http://www.policechiefmagazine.org/magazine/index.cfm?fuseaction=display_arch&article_id=1501&issue_id=52008.

345. Gilsinan, *supra* note 316, at 94 ("[T]he rapid adoption of COMPSTAT-like programs in mid to large size departments speaks to a willingness to be held accountable for crime occurrences and their control.").

346. Willis et al., *supra* note 80, at 148; Eli B. Silverman, *With a Hunch and a Punch*, 4 J.L. ECON. & POL'Y 133, 144–45 (2007).

347. Robert D. Behn, THE PERFORMANCESTAT POTENTIAL: A LEADERSHIP STRATEGY FOR PRODUCING RESULTS, 12–21 (2014).

crime data regularly gets reported to the public through open-access websites. Posting the predictive policing results (after they have been utilized by police) would provide the public with a mechanism to assess the technology's efficacy, fairness, and scope.

At a theoretical level, the world of data-driven police accountability is just being imagined.[348] While beyond the scope of this article, scholars have proposed a host of data-driven tactics to hold police accountable to the community.[349] Technologies that can track and record police activity have been proposed.[350] Consumer technologies that "police the police" have been developed.[351] Administrative procedures have been suggested.[352] New legal oversight structures that involve both federal intervention and community accountability have been envisioned.[353] What these suggestions share in common is a belief that a focus on police data might provide a two-way street of accountability—reducing crime and reducing police misconduct.[354]

F. Practical Implementation: Vulnerabilities and Responses

Even assuming perfect data collection and well-calibrated algorithms, vulnerabilities exist in applying predictive policing techniques to the real world of police practice. While application will be different in each

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348. I. Bennett Capers, *Crime, Surveillance, and Communities*, 40 FORDHAM URB. L.J. 959, 961 (2013); Kami Chavis Simmons, *New Governance and the "New Paradigm" of Police Accountability: A Democratic Approach to Police Reform*, 59 CATH. U. L. REV. 373 (2010).

349. Andrew Guthrie Ferguson, *Policing 'Stop and Frisk' with 'Stop and Track' Policing*, HUFFINGTON POST (Aug. 17, 2014, 4:54 PM), http://www.huffingtonpost.com/andrew-guthrie-ferguson/policing-stop-and-frisk-w_b_5686208.html [https://perma.cc/A3LW-8KT3]. *See also infra* Part III.H.1. *Cf.* Sherman, *supra* note 100, at 392.

350. Kenneth A. Bamberger, *Technologies of Compliance: Risk and Regulation in a Digital Age*, 88 TEX. L. REV. 669, 723 (2010) (discussing regulating technologies); Fan, *supra* note 325.

351. *ACLU Launches Police Watch App in Oregon and Other States*, ACLU (Nov. 6, 2014), https://www.aclu.org/news/aclu-launches-police-watch-app-oregon-and-other-states [https://perma.cc/5SRM-UW75]; *Law Enforcement Wants Police-Tracking App Waze Disabled*, U.S. NEWS & WORLD REPORT (Jan. 26, 2015, 5:00 PM), http://www.usnews.com/news/articles/2015/01/26/law-enforcement-wants-police-tracking-app-waze-disabled [https://perma.cc/TL2G-RLW5].

352. Harmon, *supra* note 336, at 762–64 (discussing the importance of sub-constitutional regulations to improve police accountability); David A. Harris, *How Accountability-Based Policing Can Reinforce—Or Replace—the Fourth Amendment Exclusionary Rule*, 7 OHIO ST. J. CRIM. L. 149, 195, 203–07 (2009).

353. Walker, *supra* note 338.

354. *See, e.g.*, Rachel Harmon, *Why Do We (Still) Lack Data on Policing*?, 96 MARQ. L. REV. 1119, 1134 (2013) ("Federal law authorizes federal agencies to produce data on law enforcement, but those data are not well tailored to facilitate public accountability, strengthen local governance, or improve state and federal regulation of the police."); Andrew E. Taslitz, *Foreword: The Political Geography of Race Data in the Criminal Justice System*, 66 LAW & CONTEMP. PROBS. 1, 11–12 (2003) ("Data collection and revelation can play a part in improving police-community relations because transparency and accountability breed trust.").

jurisdiction, certain commonalities exist that need to be studied before adoption. This section examines the reality for police officers on the street, and the next section examines the impact on police administration and policy.

1. Practical Implementation: Vulnerabilities

New predictive policing technologies may shift the way police officers do their jobs. This may include where police patrol, how they patrol, and how they treat the people they interact with on patrol. For example, early reports out of Los Angeles offer cautionary lessons about deployment. The San Francisco Police Department's Chief Information Officer, Susan Merritt, publicly expressed concern that police could become too fixated on the boxes.[355] "In L.A. I heard that many officers were only patrolling the red boxes, not other areas . . . . People became too focused on the boxes, and they had to come up with a slogan, 'Think outside the box.'"[356] While this was certainly not the intent of the program, in practice the goal of targeting certain areas overwrote normal policing strategy. Police officers, told to focus on predicted areas, focused on those areas to the neglect of others.

In addition, officers' perceptions about predicted areas can become distorted. If expecting to find a high crime area, police will become hyper-vigilant about the perceived dangerousness of the area. As criminologist Peter Scharf worried, "the red-box designation might cause young cops to exaggerate a neighborhood's dangers."[357] Obviously, this sense about an area or individuals in an area may also affect how police officers treat a suspect. Issues of implicit or explicit bias discussed earlier in the context of crime data are also at issue in how police treat citizens on the streets. The perception of danger may be well-grounded in crime data, making it difficult or dangerous for police officers to ignore. After all, if police are targeting violent shootings in particular areas, officers would be wise to be cautious in interacting with people they encounter.

Adoption of a predictive policing strategy can also have other unintended impacts on police practice. An interesting byproduct of the RAND study on the Shreveport Police Department's experiment was the revelation of how the new technology impacted routine police tactics.[358] As described in the RAND study, police shifted their emphasis from generating

355. Bond-Graham & Winston, *supra* note 4.
356. *Id.*
357. Huet, *supra* note 3.
358. HUNT ET AL., *supra* note 130, at 12.

arrests to developing intelligence, or (in the parlance of the officers) from increasing the quantity of arrests to increasing "quality arrests."[359] This meant in practice that police were encouraged to do more intelligence gathering by using their continuing presence in the predicted area. As described:

> There was a large emphasis on intelligence gathering through leveraging low-level offenders and offenses. Officers stopped individuals who were committing ordinance violations or otherwise acting suspiciously and would run their names through database systems. If an individual had significant prior convictions, he or she would be arrested for the violation (as applicable). If the individual was on probation or parole, officers would check his or her standing with the parole or probation officers. For those not in good standing, a parole or probation officer was asked to come to the scene. Lastly, individuals with warrants were arrested. For those not meeting these criteria, officers stated that they gave these individuals a warning and were as polite as possible in order to note that they were trying to take action against property crimes in the area and to ask whether the individual had any knowledge that would be useful to police.[360]

Police admitted that under this new guidance they "[s]topped and questioned juveniles committing truancy offenses" more often, "[w]alked around apartment complexes and discussed criminal activities in [the] area, particularly narcotics, with residents," and "[v]isited people they kn[e]w, especially parolees, probationers, and truants, to learn about criminal activities (largely drug activity) in the neighborhood."[361] This extra emphasis on individual interaction—arguably more of a micro-community policing initiative—[362] was caused by the data-driven targeting of particular areas. Patrol officers began focusing on who was in these areas and used information from those individuals to generate leads for other crimes.

One way to look at the result is that officers began prioritizing the investigation of other crimes and developing suspects not normally associated with the investigation of property crimes.[363] This extra

359. *Id.* at 12–13.

360. *Id.* at 12.

361. *Id.* at 13.

362. *See generally* James Forman, Jr., *Community Policing and Youth as Assets*, 95 J. CRIM. L. & CRIMINOLOGY 1 (2004); Tracey L. Meares, *Praying for Community Policing*, 90 CALIF. L. REV. 1593 (2002).

363. HUNT ET AL., *supra* note 130, at 13 ("Officers reported that PILOT changed the amount of recent information provided per case. This occurred because PILOT officers at a crime scene asked more

information was then passed on to detectives who, counter-intuitively, were less than appreciative because it added more investigative responsibilities from cold leads.[364] In practice, detectives resented receiving this information without a connection to an actual case. While the additional information should have been helpful in developing an intelligence-oriented approach to a community, without the appropriate information-management structure it actually produced resistance among police colleagues.[365] Further, this patrol-level intelligence focus delayed officers from continuing on to the next emergency call for service.[366]

This change in policing strategy resulted in both positive and negative community effects independent of the crime rate, which remained unchanged. From the positive side,

> According to officers, since the public saw so-called real criminals being inconvenienced and since police were conducting more follow-up questions after crimes, the public became more willing to provide additional information or call in with tips. This improved relationship with the public was evidenced, in part, by members of the public waving hello to patrol cars.[367]

On the less positive side, more people were stopped in these areas and inconvenienced without any corresponding reduction in the crime rate. Predictive policing resulted in more social control of communities already targeted by the criminal justice system. Predictive policing, thus, changed the reality on the street, even if it had no statistical impact on the crime rate.

On the opposite side of the spectrum from police being too engaged in predicted areas, or too involved in investigating individuals in those areas, is the concern that police will simply ignore the predictive tools. While initial adoption of predictive policing has been met with general acceptance, some veteran officers have dismissed the idea as telling them what they already know.[368] Many experienced police officers not only have a good sense of the likely areas of crime, but an instinct that has served them well

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questions of victims, their neighbors, and individuals in the neighborhood, which is not normally done for property theft cases, as there is not enough time before officers have to respond to another call for service.").

364. *Id.* ("Officers indicated that this was problematic for solving the case, because officers were essentially handing detectives a cold case when the detectives already had full caseloads.").

365. *Id.*

366. *Id.*

367. *Id.* at 26.

368. Vince Beiser, *To Catch a Thief*, SANTA CLARA MAG. (Winter 2013), http://www.scu.edu/scm/winter2013/features.cfm?c=15053 [http://perma.cc/H8U3-S6KW] ("On a more practical level, hard-headed street cops are understandably skeptical about the whole notion.").

before geo-locational mapping technology was available.[369] Further, some question the utility of only focusing on place. As one Santa Cruz patrol officer stated:

> This box here [pointing a PredPol predicted area], it doesn't tell us what crime or who to watch out for. We know this is a busy street with a lot of stuff getting stolen out of parked cars. We don't need predictive policing to tell us that. I personally don't think it's very helpful . . . . Most of my guys feel the same way.[370]

In the Shreveport RAND study, some officers complained that chasing the boxes was a waste of time and fuel, even as others thought the experiment was an improvement on traditional techniques.[371] Even the best predictive policing system will not provide useful information if it is ignored by the police charged with implementing it.

2. *Practical Implementation: Responses*

Two main responses exist to the vulnerabilities in implementing predictive policing technologies. First, the technology will require an additional level of administrative review to examine how police officers are implementing the data-driven mission. This administrative focus involves both an awareness of what is being measured and how this measurement may shape officer actions. Second, predictive policing requires training and compliance mechanisms to ensure that police are, in fact, utilizing the technology as designed. The administrative responses discussed in this section are targeted to the actions of police on the streets, independent of the concern discussed in the next section of how predictive policing might affect broader administration policy.

The need for oversight responds to the concern that police officers will react to how they are evaluated. If "quality arrests" means those individuals with more informational value, rather than the number of arrests, then police practice will change. If police are rewarded for spending more time in the targeted box, then police will follow those incentives. The difficulty is that neither of those ways might be the best way to reduce crime. That is to say, the metrics being established may be consistent with the technology, but not

369. Alene Tchekmedyian, *Police Push Back Against Using Crime-Prediction Technology to Deploy Officers*, L.A. TIMES (Oct. 4, 2016, 8:00 PM), http://www.latimes.com/local/lanow/la-me-police-predict-crime-20161002-snap-story.html [https://perma.cc/NL7V-3ZKW] (describing police officers in Burbank, California's reluctance to use the predictive policing technology).

370. Beiser, *supra* note 368.

371. HUNT ET AL., *supra* note 130, at 14.

the ultimate goal of crime reduction.

Similarly, following the technology without additional training may create a distorted picture of targeted areas or targeted individuals. Many people live and work in areas of targeted crime, and the vast majority of them do not engage in criminal activity. Priming police officers' responses in ways that encourage aggressive policing in particular areas might undermine the larger social goals of police-citizen cohesiveness or community building. Training on the implications of implicit bias or confirmation bias may reduce some of those negative impacts. And, as can be seen at least from the police perception of the RAND project, some community members had a better understanding of why police were present in their community and responded with positive acts of good will,[372] meaning that these programs might have positive results for those broader community goals.

In addition, training and compliance is necessary to ensure that the system designed becomes the system implemented. Many systems can be undercut at the ground level by very practical problems. For example, in Shreveport, the predictive policing experiment was hampered by the fact that the police had a limited number of police cars with air conditioning available during the hot Louisiana summer.[373] Fewer cars meant fewer volunteers for the project. Other problems arose, too; for example, while the "predictive analytics team produced the maps and attended roll calls to provide and discuss maps and other intelligence gathered, . . . [t]he participants did not attend the planned monthly deployment meetings."[374] This information gap created implementation problems.[375] Each of these problems could be addressed with better management, but it takes identifying these foreseeable challenges before implementation to solve them.

G. Administration: Vulnerabilities and Responses

Parallel to the practical concerns of implementing predictive policing on the streets are the administrative and management concerns associated with running a predictive policing system. Stepping back to consider the traditions of police practice, the act of centralizing data with administrators and analysts means a shift in power from police officers to police

372. *Id.* at 26.
373. *Id.* at 15.
374. *Id.* at 23.
375. *Id.*

administrators.[376] As has been noted concerning the proto-predictive policing CompStat system, data tend to centralize power to those who crunch the numbers.[377] In New York City under CompStat, police administrators studied and were held accountable for weekly changes in crime statistics, which shaped staffing allocation, police tactics, and resource deployment.[378] The result did contribute to the reduction of crime rates, but also dramatically shifted decision-making power to those who controlled the data.[379]

1. Administration: Vulnerabilities

For administrators, three interrelated vulnerabilities exist in any system influenced by predictive algorithms. The first involves the natural inclination to be overly influenced by data-based metrics. If the identified metrics revolve around arrests, then arrests are what get measured and tracked.[380] If monetary fines for minor crimes are the goal, then police focus on those fines.[381] If administrators are rewarded for crime-rate reduction, then crime-rate reduction data becomes the controlling focus.[382] The consequences of an arrest-driven stop and frisk policy in New York City, or a fine-driven system in Ferguson, Missouri, resulted in significant damage to the relationship between police and residents in those areas.[383] Similarly, a potential vulnerability for predictive policing systems is that data collected and analyzed becomes prioritized over other crime-stopping measures.

As a related concern, a well-understood byproduct of data-driven

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376. George L. Kelling, *Why Did People Stop Committing Crimes? An Essay About Criminology and Ideology*, 28 FORDHAM URB. L.J. 567, 578 (2000).

377. Silverman, *supra* note 346, at 146 (describing how COMPSTAT reinforced a top-down command and control model).

378. Willis et al., *supra* note 80, at 148.

379. *Id.*

380. Issa Kohler-Hausmann, *Managerial Justice and Mass Misdemeanors*, 66 STAN. L. REV. 611, 633 n.53 (2014) ("There is also significant evidence to show that as time passed misdemeanor arrests and summonses became institutionalized as performance metrics inside the NYPD and incentivized by their quantitative management system, irrespective of the quality-of-life or crime-reducing benefit of the activities.").

381. U.S. DEP'T OF JUSTICE, INVESTIGATION OF THE FERGUSON POLICE DEPARTMENT 79 (2015), https://www.justice.gov/sites/default/files/opa/press-releases/attachments/2015/03/04/ferguson_police_department_report.pdf [https://perma.cc/T6CM-JDB5] (detailing a systemic focus on collecting fines through minor criminal and civil enforcement actions).

382. Al Baker & Ray Rivera, *On Secret Tape, Police Press a Tickets Quota*, N.Y. TIMES, Sept. 10, 2010, at A1 ("[T]here is persuasive evidence of the existence of quotas."); Jim Hoffer, NYPD *Officer Claims Pressure To Make* Arrests, WABC-TV (Mar. 2, 2010, 10:37 PM), http://abclocal.go.com/wabc/story?section=news/investigators&id=7305356 [http://perma.cc/66T3-6VB7].

383. U.S. DEP'T OF JUSTICE, *supra* note 381, at 79.

systems is data-based myopia. Police administrators follow the data even if questions arise from it. This phenomenon is called "automation bias," and can be observed in many contexts.[384] As Kenneth Bamberger writes, "Human judgment is subject to an automation bias, which fosters a tendency to 'disregard or not search for contradictory information in light of a computer-generated solution that is accepted as correct.'"[385] In the predictive policing context, this focus might result in following the judgment of algorithms at the expense of other information. In the Predictive Policing 1.0 context, this could just amount to a waste of resources (such as sending patrol cars to the wrong box). But in the Predictive Policing 3.0 context, it could lead to erroneous contact with individuals wrongfully suspected of a crime. Blind reliance on such automated results leads to what Gary T. Marx, professor emeritus of sociology at the Massachusetts Institute of Technology, termed "the tyranny of the algorithm."[386]

The combination of policy priorities and automation bias can also create self-reinforcing or self-fulfilling predictions.[387] Predictive policing technologies direct officers to certain areas, which causes them to make arrests in those areas, which generates arrest statistics to be fed into some future algorithm, which in turn identifies those areas as higher crime areas.[388] Administrators focus on those areas because of the predictive validity of the tip, and the cycle repeats. This phenomenon has been recognized in both early crime mapping experiments[389] and modern predictive policing projects.[390] As the RAND study reported:

> An additional issue noted by officers was that the predicted hot spots changed little from month to month—for the most part, grid squares flagged one month would show up the next month. RAND team

384. Citron, *supra* note 330, at 1271–72 (2008) (defining "'automation bias'—the 'use of automation as a heuristic replacement for vigilant information seeking and processing.'") (quoting Linda J. Skitka et al., Automation Bias *and Errors: Are Crews Better Than Individuals*?, 10 INT'L J. AVIATION PSYCHOL. 85, 86 (2000)).

385. Bamberger, *supra* note 350, at 711–12 (2010) (quoting Mary L. Cummings, *Automation and Accountability in Decision Support System Interface Design*, 32 J. TECH. STUD. 23, 25 (2006)).

386. Berg, *supra* note 15.

387. Kevin Miller, *Total Surveillance, Big Data, and Predictive Crime Technology: Privacy's Perfect Storm*, 19 J. TECH. L. & POL'Y 105, 124 (2014) ("[E]ven relatively unbiased models may be plagued by self-reinforcement: police look for crime where the model tells them to look, and each time they find it the model seems more valid—much like the proverbial drunk who only looks for his keys under the streetlight because that is where the light is.").

388. Sengupta, *supra* note 137; Rashbaum, *supra* note 229, at 1.

389. Ferguson, *supra* note 73, at 195 (describing early crime mapping strategies in Miami-Dade County).

390. HUNT ET AL., *supra* note 130, at 27.

> members, for example, observed officers on ride alongs . . . looking at newly distributed maps and remarking that they already knew where the hot spots were.[391]

Some predictive technologies attempt to avoid this trap by only focusing on reported crimes, not arrests (like PredPol). But other technologies' predictions, as an examination of the RAND Shreveport factors shows (presence of residents on probation or parole, previous six months of tactical crime, juvenile arrests, etc.), analyze factors that will not quickly shift over time, creating rather fixed predicted areas of crime.

Finally, these self-fulfilling systems can create a ratchet effect that distorts a broader focus on crime suppression and undermines an efficient allocation of police resources. Harcourt has explained the inefficiency behind certain predictive strategies.[392] He describes how predictive techniques require resources to investigate and arrest certain groups, resulting in a higher distribution of arrests of those groups.[393] As he writes, "[c]riminal profiling, when it works, is a self-confirming prophecy. It aggravates over time the perception of a correlation between the group trait and crime."[394] At the same time, those not targeted may in fact increase their crime rates due to the shift in resources.[395] Overall, crime may go up, even if the targeted population's crime rate goes down. His insightful work carries far beyond the scope of this article, but offers another potential vulnerability associated with decisions by administrators as to how to allocate resources to implement predictive policing.

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391. *Id.*

392. HARCOURT, *supra* note 23, at 145; Harcourt, *supra* note 34, at 112; Harcourt, *supra* note 40; Bernard E. Harcourt, *A Reader's Companion to* Against Prediction*: A Reply to Ariela Gross, Yoram Margalioth, and Yoav Sapir on Economic Modeling, Selective Incapacitation, Governmentality, and Race*, 33 LAW & SOC. INQUIRY 265, 267–69 (2008) [hereinafter *A Reader's Companion to* Against Prediction].

393. HARCOURT, *supra* note 23, at 145 (describing a "ratchet effect").

394. *Id.* at 154.

395. *Id.* at 124–25 ("If the police shift their allocation of resources away from white motorists and toward minority motorists, the offending rate among minority motorists may well decrease, but simultaneously the offending rate among white motorists may increase. The problem is, of course, that there are more white motorists. Depending on the relationship between the comparative elasticity of offending to policing of white and minority motorists and the comparative offending rates, the total increase in absolute numbers of offending by white motorists may outweigh the total decrease in absolute numbers of minority offending."). *But see* Yoram Margalioth, *Looking at Prediction from an Economics Perspective: A Response to Harcourt's Against Prediction*, 33 LAW & SOC. INQUIRY 243, 248–49 (2008); Harcourt, *A Reader's Companion to* Against Prediction, *supra* note 392, at 267–69.

2. Administration: Responses

Because of the complexity and scale of police operations, the vulnerabilities inherent in administrating a predictive policing system are significant. Yet one of the most promising aspects of predictive policing systems is that they can be evaluated and changed in real time. For example, at the LAPD's Real-Time Analysis and Critical Response Division, police administrators can evaluate crime data, security cameras, and satellite images showing recent arrests, and observe patterns and trends instantly.[396] This allows police administrators to respond in real time to increase patrols or design other intervention strategies. Similar programs exist in other large cities, such as New York City.[397] These predictive systems go beyond using data as productivity metrics to using data as strategic intelligence, which can result in a more adaptive approach to policing.

Police systems can also adapt by taking select aspects of predictive policing and linking them to other types of police intervention. Certainly, by investing time and energy into building a predictive policing strategy, the risk becomes that the technology will control the outcome. But sometimes other synergies result. While the RAND study ultimately concluded that predictive policing did not reduce the crime rate in Shreveport, it did generate a more intelligence-focused policing strategy. Perhaps some jurisdictions will adopt predictive policing techniques not primarily to reduce crime, but to rethink their strategies for gathering information from the community. Predictive policing might inadvertently promote an intelligence-based, problem-solving approach, and that could be a positive result in its own right.

H. Vision: Vulnerabilities and Responses

One step removed from the administration of predictive policing technologies exist the deeper questions of whether a focus on predicting crime addresses the ultimate goal of reducing crime in society. Generally speaking, police administrators or police officers are not tasked with "the

396. Berg, *supra* note 15.

397. *See* Thomas H. Davenport, *How Big Data is Helping the NYPD Solve Crimes Faster*, FORTUNE (July 17, 2016), http://fortune.com/2016/07/17/big-data-nypd-situational-awareness/; Chris Dolmetsch & Henry Goldman, *New York, Microsoft Unveil Join Crime-Tracking System*, BLOOMBERG (Aug. 8, 2012) https://www.bloomberg.com/news/articles/2012-08-08/new-york-microsoft-unveil-joint-crime-tracking-system; TALKPOLITIX, *New York City - Domain Awareness*, YOUTUBE (June 7, 2013), https://www.youtube.com/watch?v=ozUHOHAAhzg (excerpt from *NOVA - Manhunt - Boston Bombers, New York City Domain Awareness System*).

vision question," but by adopting a predictive strategy they have, in part, helped answer it. This section explores three big questions about how predictive policing shapes our vision of criminal justice policy. By adopting a data-driven, crime-based predictive approach, certain other aspects of the crime problem become obscured or distorted.

1. Vision: Vulnerabilities

The vision question looks at three choices the current policing system has made which are reinforced by the move toward predictive policing: (1) a focus on targeted hotspot places, and not overall crime patterns; (2) a focus on crime statistics, and not root socio-economic problems; and (3) a focus on criminal activity, and not police activity.

First, predictive policing raises the problem of displacement. The utility of predictive policing relies on its geo-locational precision. The smaller the predicted areas, the easier it becomes for police to target and disrupt crime in those areas. The question, however, is whether—even assuming crime goes down in the hotspot areas—the *overall* crime rates also go down.[398] The general trends have been positive, but the continued focus on particular areas does not address the displacement effect. Scholars have been debating displacement for years, as the issue emerged in studying pre-predictive hot spots, or other targeted areas of crime.[399] The concern of displacement is that police may succeed in shifting crime from one place to another, but not actually in reducing overall crime.

Second, there exists the perennial question of why we direct our energy and investment to invent new police technologies, rather than spend that same money to target the root problems underlying crime. Most property-, drug-, and gang-related crime occurs in poor neighborhoods where residents have significant socio-economic disadvantages. Predicting levels of crime might be less constructive than addressing the foreseeable barriers to education, employment, and stable housing that contribute to an individual's decision to turn to crime. This is so because remedying some of those disadvantages might provide a positive forecast for less criminal activity overall.

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398. Bond-Graham & Winston, *supra* note 4 ("Ed Schmidt, a criminologist and veteran police officer. . . . [says] 'I look at this all with skepticism . . . . Where are they coming from, how are they implementing [the technology]? Are they just displacing crime between divisions? Are they just displacing crime from one precinct to another? Mine goes down, yours go up?'").

399. *See, e.g.*, Doron Teichman, *The Market for Criminal Justice: Federalism, Crime Control, and Jurisdictional Competition*, 103 MICH. L. REV. 1831, 1839–40 (2005) (discussing the displacement effect literature).

Third, another big question is why we focus on criminal activity and not also police activity to reduce crime. For example, crime mapping is now a routine part of policing, as reported crimes, calls for service, and arrests are regularly monitored and mapped.[400] But this mapping is incomplete because it does not include information about where the police officers were at the time of the crime. Were the officers two blocks away when the robbery occurred? Had they just passed the alley? Were there physical barriers keeping police from seeing the crime? These questions could be analyzed by a complete crime map that included both reported crimes and real-time police locations during those reported crimes. Just as seeing the place of crime can provide insights about the cause of crime, seeing the location of police officers (through GPS mapping) during the crime can provide insights about the failure to prevent it.[401] In addition, police supervisors would have a better sense of what the officer is doing on a daily basis, including a complete record of the officer's daily travels.[402] A focus on "stop and track policing"[403] would allow police administrators to see the near misses, the areas in need of attention, and even daily logs of police interaction with the community. By focusing on both aspects of the problem (the location of crimes and the location of police during the crimes), police administrators might be better able to address the gaps in coverage. Currently, we only see half the picture of how criminals and police interact.

2. Vision: Responses

The obvious response to concerns about "the vision question" is that predictive policing has never claimed to be the ultimate solution, but only an improvement over existing practices which have not managed to eradicate crime from society. While that is a fair response, it avoids addressing some of the intriguing possibilities arising from new predictive technologies if one takes the criticisms seriously.

For example, the displacement effect may very well occur from an intensive targeting of selected areas. Criminal actors may react to policing

400. Ferguson, *supra* note 73, at 185, 191.

401. Sherman, *supra* note 100, at 434 ("Since then, technologies such as GPS have made such measurement even easier. All that is required is a commitment to tracking policing along with crime and an investment in information technology to produce the data and graphics. Mapping police presence in relation to crime harm, for example, would produce an algorithm that could identify outliers. Wherever a patrol district deployed its patrols (or arrests) in too great a departure from the occurrence of crime, a list of such "exceptions" can be generated for police managers. If they fail to correct the discrepancies, the lists can be reviewed in aggregate at COMP-STAT meetings.").

402. *Id*. at 436.

403. Ferguson, *supra* note 349.

strategies in a way that avoids unnecessary exposure. But unlike some strategies, predictive policing is designed to account for that change. The targets of predictive policing are not static. An uptick in crimes in the next block over will make that block a new target. Many predictive policing strategies embrace the constantly evolving patterns of crime and the factors that contribute to it, designing equally evolving algorithms to track changes.

In addition, displacement disrupts crime, making it harder to complete. This disruption effect may well be the reason for the observed reduction in crime rates. As proponents of predictive policing explain, increasing deterrence can be more impactful than increasing arrests.[404] With Predictive Policing 1.0, placing the squad car in the box may not stop a thief from breaking into a car (it may only displace him), but it will disrupt him in the short term. For some, this disruption might be enough to prevent certain crimes of opportunity altogether. For other, more committed criminals, it might not. But either way, displacement acts as a barrier, increasing the costs, risks, and effort of crime. Similarly, while the nature of many violent crimes defies a pure deterrence rationale, displacement can at least reduce crimes on the margins. For example, retaliatory gang shootings regularly involve emotional motivations of loss, respect, bravado, and self-sacrifice.[405] The presence of additional police cruisers at the gang border may delay the immediate retaliatory shooting, and possibly even deter it completely. Estimates hold that one third of shootings are in retaliation for other shootings, so delaying the opportunity to retaliate and making it more difficult might reduce the overall number of violent acts.[406]

Furthermore, predictive policing may not address the root causes of crime, but it does offer ways to identify some of those root causes. To be clear, as predictive policing is currently implemented police have not embraced this secondary use of the technology, but it exists and responds quite forcefully to the concerns.

First, underlying the theory of Predictive Policing 1.0 are the environmental vulnerabilities that generate criminal activity. Instead of simply focusing on the targeted box, predictive policing can help ask why that box exists. Is it because the area is dark, difficult to patrol, or near other

404. Emily Thomas, *Why Oakland Police Turned Down Predictive Policing*, VICE MOTHERBOARD (Dec. 28., 2016), http://motherboard.vice.com/en_ca/read/minority-retort-why-oakland-police-turned-down-predictive-policing (discussing how predictive policing shifted the strategic focus from generating arrests to preventing victimization).

405. Madhumita Venkataramanan, *A Plague of Violence: Shootings are Infectious and Spread Like a Disease*, SLATE, (May 18, 2014) (interviewing Gary Slutkin, Professor at University of Illinois and founder and executive director of CURE Violence).

406. *Id.*

attractors of crime (like bars or ATMs)? Some of those environmental issues are root causes, and can be remedied once identified. Predictive policing, if so used, can map out the social and economic vulnerabilities in an area, and (given the political will) help to improve them.[407]

Second, the general theory behind Predictive Policing 3.0 is that certain individuals face external challenges that increase the chance for violence. The public health model for identifying people in need of protection could be expanded to identify people in need of other social services (education, employment, mental health treatment). While fraught with concern about stigma and stereotypes, this approach can lead to positive interventions between at-risk youth and government services.[408]

Finally, as to whether predictive policing should embrace the task of studying police activity as well as criminal activity, there are two added benefits of doing so. First, all data, including police routes, patterns, and practices could be mapped against crime, creating a full picture of crime patterns. This would allow police to react more quickly to changing crime realities. Second, one could go even farther to try to predict police activity that might have a negative impact on community relations. Just as police investigators are beginning to turn to predictive analytics to target particular people suspected of committing crimes, so that same technology could be used to identify red flags or patterns of police misconduct.[409] This is not to say that one could predict which officers will violate constitutional rights, but neither does the best system of predictive suspicion necessarily predict who will commit a crime. It simply focuses attention on potential vulnerabilities and risk factors that can and should be addressed.

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407. *See* Kennedy et al., *supra* note 162 (discussing the RTM model, which includes addressing environmental vulnerabilities through a more holistic approach).

408. Goldberg, *supra* note 204; CITY OF NEW ORLEANS, *supra* note 204; David M. Kennedy, DON'T SHOOT: ONE MAN, A STREET FELLOWSHIP, AND THE END OF VIOLENCE IN INNER-CITY AMERICA 4, 6 (2011).

409. In a similar vein, some jurisdictions have turned litigation data into early warning systems. *See, e.g.*, Joanna C. Schwartz, *What Police Learn from Lawsuits*, 33 CARDOZO L. REV. 841, 845 (2012); Joanna C. Schwartz, *Myths and Mechanics of Deterrence: The Role of Lawsuits in Law Enforcement Decisionmaking*, 57 UCLA L. REV. 1023, 1061 (2010). Other jurisdictions have asked big data scientists to examine causes of police stress and violence. *See, e.g.,* Michael Gordon, *CMPD's Goal: To Predict Misconduct Before it Can Happen*, CHARLOTTE OBSERVER (Feb. 26, 2016), http://www.charlotteobserver.com/news/local/crime/inside-courts-blog/article62772592.html; Jaeah Lee, *How Science Could Help Prevent Police Shootings*, MOTHER JONES (May/June 2016), http://www.motherjones.com/politics/2016/04/data-prediction-police-misconduct-shootings.

I. Security: Vulnerabilities and Responses

A predictive system based on crime data, police data, and personal data requires mechanisms to protect that data. Security difficulties arise both from generic data security vulnerabilities that affect all data-driven systems, as well as specific vulnerabilities that arise from the collection of law enforcement investigative data.

1. Security: Vulnerabilities

Police collect vast amounts of data, some quite personal. Pure crime statistics such as place, time, and type of crime present few concerns with privacy, and thus few concerns with security.[410] In fact, many jurisdictions publicly post such information on the Internet.[411] Other types of crime data—locations of domestic violence victims, gang associates, or known drug markets—may be more privileged, because they reveal personal information or because they could reveal tactical plans of police intervention. While police may wish to possess such data, public release could interfere with use of the information. For example, police would likely not want to forecast the next location of a predicted hot spot, in order to avoid undermining strategies to arrest the predicted perpetrators.

The real problem arises with personal data in big data systems. While police benefit from collecting, aggregating, and sharing that individualized and sometimes-sensitive data, concerns about data security exist. Social network predictions or pattern matches are built on databases with personal identifying information.[412] Social security numbers, dates of birth, addresses and other personal information form the basis of the networked information that can be linked and searched for clues about criminal patterns or relationships.[413] For many police departments, the available databases have been either locally and organically developed or borrowed from larger national sources. Part of the reason for a lax data control system is that much of the raw data was properly collected through the criminal justice system, which is largely a publicly run, if not publicly accessible, data system. Such

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410. Predictive Policing 1.0 systems, such as PredPol, thus have fewer data security issues.

411. *See, e.g.*, *Clear Map*, CHICAGO POLICE DEP'T, http://gis.chicagopolice.org/clearmap/startpage.htm (last visited Jan. 24, 2017).

412. EXEC. OFFICE OF THE PRESIDENT, BIG DATA: SEIZING OPPORTUNITIES, PRESERVING VALUES 30–31 (2014).

413. *See, e.g.*, Paul M. Schwartz & Daniel J. Solove, *The PII Problem: Privacy and a New Concept of Personally Identifiable Information*, 86 N.Y.U. L. REV. 1814, 1828–36 (2011); Tal Z. Zarsky, *Governmental Data Mining and Its Alternatives*, 116 PENN. ST. L. REV. 285, 330 (2011).

raw material requires fewer data security protocols, because of the perceived legitimate and quasi-public nature of the information. In addition, the posture of traditional police efforts did not embrace a robust data security mindset.[414] While it has always been theoretically possible that criminal elements might hack into police databases, the concerns seemed less important than obtaining and maintaining the data about criminals. Police officials take care to keep the information confidential, but the information is not necessarily secure from external cyber threats. As such, data controls and data security protocols in police systems have lagged behind private databases.

This reality has not changed despite the growing adoption and integration of larger third party and private networks.[415] While the FBI and national criminal justice databases recognize the need to protect personal data,[416] as these databases expand to include more sources of data, the information becomes more valuable and more vulnerable to data breaches. The recent inclusion of biometric data only increases the risk.[417] These threats include internal dangers from rogue police officers misusing the personal data[418] and external dangers of criminal elements hacking, manipulating, or erasing the data with damaging results to the investigative capabilities and legitimacy of the system.[419] Finally, while perhaps of lesser

414. *See* Paul Suarez, *AntiSec Hackers Steal, Post Police Data*, PCWORLD (Aug. 6, 2011, 1:31 PM), http://www.pcworld.com/article/237459/antisec_hackers_steal_post_police_data.html [https://perma.cc/432K-V2YD].

415. Robert O'Harrow Jr. & Ellen Nakashima, *National Dragnet Is a Click Away*, WASH. POST (Mar. 6, 2008), http://www.washingtonpost.com/wp-dyn/content/article/2008/03/05/AR2008030503656.html; Chris Jay Hoofnagle, *Big Brother's Little Helpers: How ChoicePoint and Other Commercial Data Brokers Collect and Package Your Data for Law Enforcement*, 29 N.C. J. INT'L L. & COM. REG. 595 (2004); Joshua L. Simmons, Note, *Buying You: The Government's Use of Fourth-Parties to Launder Data About "The People"*, 2009 COLUM. BUS. L. REV. 950, 951 (2009); Bob Sullivan, *Who's Buying Cell Phone Records Online? Cops*, MSNBC.COM (June 20, 2006, 11:59 AM), http://www.msnbc.msn.com/id/12534959/ [https://perma.cc/GPD3-8EPR].

416. U.S. DEP'T OF JUSTICE, CRIMINAL JUSTICE INFORMATION SERVICES (CJIS) SECURITY POLICY VERSION 5.5 (2016), https://www.fbi.gov/file-repository/cjis-security-policy-v5_5_20160601-2-1.pdf.

417. Laura K. Donohue, *Technological Leap, Statutory Gap, and Constitutional Abyss: Remote Biometric Identification Comes of Age*, 97 MINN. L. REV. 407, 437 (2012); Gina Kolata, *Poking Holes in Genetic Privacy*, N.Y. TIMES (June 16, 2013), http://www.nytimes.com/2013/06/18/science/poking-holes-in-the-privacy-of-dna.html.

418. Robert Abel, *NYPD Officer Arrested for Hacking FBI Databases*, SC MAG. (Mar. 19, 2015), http://www.scmagazine.com/nypd-officer-hacked-databases-to-get-info-on-accident-victims/article/404250/ [https://perma.cc/SLU7-EJB9].

419. Sandra Gittlen, *Six Hours to Hack the FBI (and Other Pen-Testing Adventures)*, COMPUTERWORLD (May 27, 2008, 1:00 AM), http://www.computerworld.com/article/2536061/cybercrime-hacking/six-hours-to-hack-the-fbi--and-other-pen-testing-adventures-.html [https://perma.cc/JA47-XUZW]; Jaikumar Vijayan, *FBI Declares Cloud Vendors Must Meet CJIS Security Rules*, COMPUTERWORLD (Feb. 7, 2012, 3:37 PM), http://www.computerworld.com/article/2501156/cloud-computing/fbi-declares-cloud-vendors-must-meet-cjis-security-rules.html [https://perma.cc/TY2U-

value, if criminal elements knew the location of predictive targets or social network linkages, such information might thwart on-going police intervention strategies.

2. Security: Responses

Security strategy in predictive policing parallels responses to data security risks in other industries.[420] Data security has become a big business because almost every private and public entity must account for the personal data it collects and stores. From health care services,[421] to consumer products,[422] to government agencies,[423] and even computer security firms themselves,[424] the concerns of data breaches have become all too real.

Predictive policing systems, especially as they move toward big data-infused surveillance, must protect against external and internal data threats. The first concern will be to build computer systems that include security by design against outside threats.[425] Privacy by design principles,[426] network

4NWC].

420. *See, e.g.*, Kim Zetter, *Citi Credit Card Hack Bigger Than Originally Disclosed*, WIRED (June 16, 2011, 10:35 AM), http://www.wired.com/threatlevel/2011/06/citibank-hacked/ [https://perma.cc/Y8DG-T665]; *Insider Data Breach Costs Bank of America Over $10 Million, Says Secret Service*, INFOSECURITY (May 26, 2011), http://www.infosecurity-magazine.com/view/18237/insider-databreach costs-bank-of-america-over-10-million-says-secret-service/ [https://perma.cc/Y6XD-E8XV]; Robert Lemos, *Data Thieves Nab 55,000 Student Records*, CNET NEWS (Mar. 7, 2003), http://news.com.com/2100-1002-991413.html [https://perma.cc/YE7W-YW4V].

421. *See, e.g.*, Andrea Peterson, *2015 Is Already the Year of the Health-Care Hack – And It's Only Going to Get Worse*, WASH. POST (Mar. 20, 2015), https://www.washingtonpost.com/news/the-switch/wp/2015/03/20/2015-is-already-the-year-of-the-health-care-hack-and-its-only-going-to-get-worse/; Elizabeth Weise, *Massive Breach at Health Care Company Anthem Inc.*, USA TODAY (Feb. 5, 2015), http://www.usatoday.com/story/tech/2015/02/04/health-care-anthem-hacked/22900925/.

422. *See, e.g.*, Sarah Halzack, *Target Data Breach Victims Could Get Up To $10,000 Each from Court Settlement*, WASH. POST (Mar, 19, 2015), https://www.washingtonpost.com/news/business/wp/2015/03/19/target-data-breach-victims-could-get-up-10000-each-from-court-settlement/.

423. *See*, *e.g.*, Julie Hirschfeld Davis, *Hacking of Government Computers Exposed 21.5 Million People*, N.Y. TIMES (July 9, 2015), http://www.nytimes.com/2015/07/10/us/office-of-personnel-management-hackers-got-data-of-millions.html?_r=0; Brian Naylor, *IRS Hack Bigger Than First Thought*, NPR (Aug. 17, 2015, 4:20 PM), http://www.npr.org/sections/thetwo-way/2015/08/17/432618109/irs-hack-bigger-than-first-thought [https://perma.cc/BDS5-7CSW].

424. Riva Richmond, *The RSA Hack: How They Did It*, N.Y. TIMES (Apr. 2, 2011), http://bits.blogs.nytimes.com/2011/04/02/the-rsa-hack-how-they-did-it/; Kim Zetter, *Hacker Spies Hit Security Firm RSA*, WIRED (Mar. 17, 2011, 6:40 PM), http://www.wired.com/threatlevel/2011/03/rsa-hacked/ [https://perma.cc/4XKB-Z9JJ]; Jason Mick, *Reports: Hackers Use Stolen RSA Information to Hack Lockheed Martin*, DAILYTECH (May 30, 2011, 10:14 AM), http://www.dailytech.com/Reports+Hackers+Use+Stolen+RSA+Information+to+Hack+Lockheed+Martin/article21757.htm.

425. *See, e.g.*, Derek E. Bambauer, *Privacy Versus Security*, 103 J. CRIM. L. & CRIMINOLOGY 667, 668–69 (2013); Gerard M. Stegmaier & Wendell Bartnick, *Psychics, Russian Roulette, and Data Security: The FTC's Hidden Data-Security Requirements*, 20 GEO. MASON L. REV. 673 (2013).

426. Woodrow Hartzog & Frederic Stutzman, *Obscurity by Design*, 88 WASH. L. REV. 385, 387–88 (2013) (discussing privacy by design through "back end" concerns, "such as data security through

protection,[427] increased firewalls,[428] and encryption must all be considered when designing the system.[429] Preventing the mischief that could occur if hackers were able to penetrate or manipulate crime statistics or police databases must be a priority. This protection from external threats becomes more complicated when networked systems are designed to be shared by different law enforcement organizations.[430] Access controls, password protection, and written memoranda of understanding must be put in place to ensure the confidentiality of the data. Such protections will also minimize internal threats, such as the intentional misuse by law enforcement officers or inadvertent exposure through lax procedures.[431]

Security by design must be supported by security protocols that include systemic network tracking, data audits, and policies to ensure data security compliance.[432] While difficult and time consuming, a positive byproduct of data-driven systems is that supervisors can track who has had access to the data in the system. These protocols will require formal training for police and analysts tasked with managing the information. Protocols will also need to be created to minimize or delete unnecessary data in the system. Finally, police administrators will need to make clear that new privacy protections may arise because of the connection to growing databases of private consumer information.[433]

CONCLUSION

The lessons of history show that predictive technologies will continue to be an attractive goal for police and the criminal justice system. As data

encryption, data minimization techniques, anonymity, and structural protection though organizational prioritization of privacy," and "front end" concerns, "such as privacy settings, search visibility, password protections, and the ability to use pseudonyms.").

427. Kathryn E. Picanso, *Protecting Information Security Under a Uniform Data Breach Notification Law*, 75 FORDHAM L. REV. 355, 358 (2006) ("[I]nsecure networks are susceptible to security attacks.").

428. Mark Lachniet, *From the Perspective of A Computer Security Consultant*, 7 THOMAS M. COOLEY J. PRAC. & CLINICAL L. 53, 59 (2004) (describing firewall design).

429. The Hunchlab White Paper devotes some significant time to the importance of security and protecting police generated data. *See* HUNCHLAB, *supra* note 170.

430. Ira S. Rubinstein et al., *Data Mining and Internet Profiling: Emerging Regulatory and Technological Approaches*, 75 U. CHI. L. REV. 261, 267 (2008) (discussing access controls and authorization controls).

431. Bret Cohen, *The Law of Securing Consumer Data on Networked Computers*, 18 J. INTERNET L. 3, 6 (2014).

432. Rubinstein et al., *supra* note 430 (suggesting a data audit system).

433. EXEC. OFFICE OF THE PRESIDENT, COUNCIL OF ADVISORS ON SCI. & TECH., REPORT TO THE PRESIDENT: BIG DATA AND PRIVACY: A TECHNOLOGICAL PERSPECTIVE 33 (2014), https://www.whitehouse.gov/sites/default/files/microsites/ostp/PCAST/pcast_big_data_and_privacy_-_may_2014.pdf.

becomes easier to collect, and as computer algorithms become more sophisticated, more advanced predictive technologies will be developed. From the Chicago School to the future, the desire to understand, categorize, and forecast criminal risk will continue to drive innovation and policing.

Police have entered the age of actuarial justice and, as demonstrated, there is no real hope of going back. The technology exists, is adapting, and is pushing much farther ahead than lawyers, courts, and policymakers. Predictive policing will alter policing strategy across the country. Real-time reporting, professional crime analysts, and expanding computer capabilities have turned the daily crush of incidents, reports, and human tragedies into measurable and usable data. The result will be to inform officers about the realities of criminal patterns in a community and redirect resources to address the causes of those criminal actions. At the same time, real vulnerabilities exist in the adoption of the technology. This article has sought to develop an analytical framework to analyze current and future predictive policing techniques. The vulnerabilities, while real, can be mitigated by thoughtful responses and careful implementation.

The recent pattern in predictive analytics has been invention first, then adoption, and finally assessment only after the fact. This article has sought to provide a framework to put assessment and predictive analysis at the beginning of the process. Simply put, if a community or administrator cannot respond to the nine vulnerabilities of all predictive technologies, they cannot responsibly move forward with next-generation technology. This systemic analysis should become the first step for all new predictive technologies. Any jurisdiction interested in adopting predictive policing techniques must be able to respond to the vulnerabilities discussed in this article. Without successful answers to these difficult questions about data, methodology, scientific legitimacy, transparency, accountability, vision, practice, administration, and security, any predictive policing system remains open to criticism and challenge.

Predicting the future of predictive technologies is never wise, but one safe prediction is that these issues will be coming to more cities and towns in the very near future. As former NYPD Commissioner Bratton stated in 2016, "Predictive policing used to be the future. Now it's the present."[434]

434. David Black, *Here Comes Predictive Policing*, NEW YORK DAILY NEWS (Jan. 24, 2016, 5:00 AM) http://www.nydailynews.com/opinion/david-black-predictive-policing-article-1.2506580 [https://perma.cc/Q2MX-8PZ5].