



Predictive Policing and Ethical Implications in Forensic Science

Mrs. Shivani Saxena^{1 *}

1. M.sc In Forensic Science & Criminology, Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore, M.P., India
shivaniforensic27@gmail.com

Abstract: Predictive policing has become one of the most contentious uses of technology in law enforcement and forensic science. Predictive policing, grounded in data-driven approaches, aims to anticipate criminal activities utilizing algorithms, artificial intelligence (AI), and big data analytics. Proponents assert that these systems improve efficiency and resource allocation in law enforcement, while critics highlight issues of systematic bias, privacy violations, and the diminishment of civil freedoms. In forensic science, predictive policing signifies a transformative change in the interpretation of evidence, the profiling of suspects, and the administration of justice. This paper offers a thorough analysis of predictive policing, including its historical development, technological foundations, practical implementations, and, crucially, the ethical challenges it poses within forensic sciences. This paper critically assesses the relationship between algorithmic decision-making and forensic practice, evaluating the advantages and disadvantages of predictive policing while providing policy recommendations to reconcile security with justice, fairness, and accountability.

Keywords: Predictive Policing, Forensic, Investigation, Technology, Artificial Intelligence, Law, Justice

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INTRODUCTION

The convergence of technology and criminal justice has consistently prompted discussions over effectiveness, equity, and ethical accountability, with each breakthrough eliciting both hope and apprehension. One of the most notable and contentious advancements is predictive policing, a method that use statistical modeling, machine learning algorithms, and past crime data to forecast future criminal behavior. Predictive police systems seek to anticipate the locations of potential crimes, the individuals likely to perpetrate them, and the possible victims by analyzing patterns in historical events [1]. This approach signifies a transformative change in law enforcement strategy, transitioning from conventional reactive models to a proactive framework that aims to enhance patrol deployment, optimize resource allocation, and potentially prevent crimes before their occurrence. The appeal of predictive policing resides in its potential for accuracy and preemption, presenting the opportunity to utilize technology not only to resolve crimes but to avert them entirely [2].

The implementation of predictive policing technologies must be contextualized within the wider domain of forensic science, which underpins evidentiary processes in contemporary justice systems. Forensic science, based on the gathering, analysis, and interpretation of physical or digital evidence, has historically been linked to concepts of impartiality, neutrality, and scientific rigor. It is founded on the principle that facts whether represented by DNA, fingerprints, ballistic evidence, or digital forensics can be observed, tested, and presented as credible evidence in a court of law. Predictive policing complicates this concept by integrating probability and conjecture into domains where forensic methodologies have historically pursued

certainty. Instead of addressing past events, predictive policing focuses on potential future occurrences, substantially transforming the temporal and epistemic foundation of evidence. The conflation of objective forensic analysis and algorithmic prediction redefines the conceptualization of blame, suspicion, and accountability within the legal system [3] [4].

The ethical issues presented by this convergence are significant. Historical crime data, the basis for predictive models, is not impartial; it embodies entrenched patterns of monitoring, enforcement, and inequality. Communities historically subjected to excessive policing are more likely to be identified as high risk in predictive models, establishing feedback loops that reinforce social inequities under the pretense of technical impartiality. The secrecy of numerous prediction algorithms exacerbates this issue, as their mechanisms are frequently opaque to the public, judicial bodies, and occasionally even to the organizations utilizing them [5]. The absence of transparency undermines conventional evidentiary standards, as defendants may be exposed to surveillance or suspicion based on risk assessments or probabilistic forecasts that are not amenable to serious scrutiny or contestation. The integration of opaque and potentially biased systems in forensic science, which relies on credibility and replicability, poses significant concerns regarding its future function and legitimacy in the context of predictive justice [6].

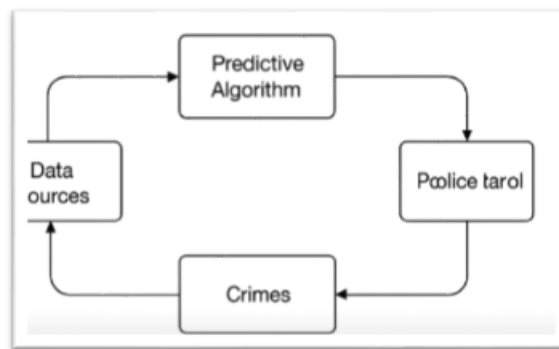


Figure 1: General framework of predictive policing and feedback loop.

The wider ramifications reach beyond the technological sphere to the fundamental principles of the legal system. Predictive policing elicits apprehensions over the presumption of innocence, the proportionality of surveillance, and the appropriate boundaries of state authority. By classifying persons and communities as possible threats prior to the commission of crimes, predictive algorithms jeopardize fundamental legal norms, transferring the burden of suspicion onto those who have not engaged in any wrongdoing but are yet considered likely to do so. This issue transcends technical and operational dimensions, presenting ethical and philosophical challenges that interrogate fundamental concepts of justice, fairness, and human rights. In this regard, predictive policing transcends being merely an additional instrument in forensic methodology; it serves as a transformative element that necessitates a reevaluation of the interplay of evidence, probability, and culpability [7].

The intersection between forensic science and predictive policing necessitates thorough examination. It is insufficient to inquire if predictive policing may enhance efficiency or diminish crime; it is also imperative to analyze how it alters evidence standards, affects investigative methodologies, and reinterprets the function of forensic knowledge. As predictive technologies become more prevalent in global criminal

justice systems, forensic science is increasingly required to interact with them either to verify their correctness, identify their shortcomings, or define their ethical limits. The implications of this interaction are significant: the integrity of forensic science, the equity of legal processes, and community trust in law enforcement depend on the integration, regulation, and oversight of predictive policing. Predictive policing is not a neutral or inevitable progression; rather, it is a contentious arena where technology, law, and ethics intersect. Its ramifications necessitate thorough examination to ensure that justice remains both effective and equitable [8].

LITERATURE REVIEW

Anantkumar et al. (2025) Over the past several years, artificial intelligence (AI) has brought about a tremendous transformation in the field of forensics. This has made it possible for investigators and law enforcement personnel to enhance the accuracy, efficiency, and speed of their investigations into criminal cases. The purpose of this essay is to provide a critical analysis of the difficulties that are associated with the incorporation of artificial intelligence in legal contexts, specifically within the field of forensic sciences. By doing so, the author highlights ethical limits and potential dangers to the integrity of analyses. Additionally, the paper makes suggestions for potential ways to solve these concerns and mitigate the limits that are preventing the seamless absorption of technology in forensic operations. These suggestions are made while taking into consideration the ethical and moral obligations of the authorities who are using these technologies [9].

Kumar et al. (2025) Artificial intelligence is revolutionizing forensic science evidence processing, pattern detection, and predictive modeling. Artificial intelligence may lead to advancements in processing complex data, suspect identification, and crime prediction. Despite its potential benefits, artificial intelligence in forensic science has many challenges that may restrict its effectiveness and acceptance in the field. This essay critically evaluates forensic science AI applications and addresses important technical, ethical, and practical challenges. Two difficulties are data quality and representativeness, which can greatly affect artificial intelligence model performance. Since biased data leads to unequal and discriminatory criminal justice outcomes, algorithmic bias is also a major issue. AI system interpretability remains a major concern. The complexity of those models can make it impossible for forensic and legal professionals to understand the decision-making processes, making AI-created evidence harder to validate and admit. Adding artificial intelligence to forensics operations presents logistical and operational obstacles. These require extensive training and disturb established practice. Applying artificial intelligence in sensitive criminal justice scenarios raises ethical concerns. These include privacy and accountability. The purpose of this research is to deepen our understanding of these issues and propose ways to improve the efficiency and reliability of artificial intelligence in forensic science. The forensic community might establish a future with appropriate and efficient use of artificial intelligence to improve juvenile justice by resolving these concerns [10].

Lexi (2025) As artificial intelligence (AI) becomes more firmly ingrained in criminal justice systems, particularly through predictive policing and the review of forensic evidence, the difficulties that arise in terms of ethics, law, and technology are becoming more intense. The purpose of this article is to investigate a contextualized empirical framework for AI-driven forensic validation within the year 2025, while simultaneously addressing important ethical problems in predictive police systems. We investigate the

ways in which machine prejudice, a lack of transparency, and abuses of due process can threaten the administration of justice. There is a proposal for a framework that is oriented on reform in order to guarantee legal responsibility in algorithmic decision-making. This framework places an emphasis on auditability, explain ability, and compliance with democratic values. This concept is supported by a body of literature as well as graphical models that illustrate the interdependencies that exist between ethics, legislation, and computational technology in research of the future generation [12].

Bharati K. (2024) The incorporation of AI into criminal justice systems poses significant prospects and challenges. This study critically investigates the ethical implications of AI in criminal justice, from predictive policing to sentencing algorithms. AI improves efficiency and data-driven decision-making, but it raises questions about fairness, transparency, and due process rights. This study uses legal analysis, ethical philosophy, and empirical research to assess criminal justice AI and predict its future. Case studies from many jurisdictions show AI system applications in law enforcement and judicial processes that were effective and controversial. Our findings show that AI efficiency and due process conflict. We highlight algorithmic prejudice, lack of transparency in decision-making, and the possible degradation of human judgment in essential legal decisions as ethical issues. The research also shows unequal affects on underprivileged communities, raising concerns about justice system disparities. We offer a comprehensive ethical framework for criminal justice AI development and implementation to address these issues. This paradigm emphasises human control, AI system audits, and unambiguous accountability measures. We propose a balanced approach that uses AI while protecting individual rights and legal processes. Finally, the article recommends policies and best practices for lawmakers, judges, and law enforcement. These guidelines promote responsible criminal justice AI innovation that meets ethical and constitutional requirements. Our research contributes to legal AI ethics discussions and outlines a path for ethical AI incorporation in criminal justice systems globally [14].

Li Jonathan (2022) In the field of law enforcement, a strategy known as predictive policing involves the utilization of computer algorithms to create predictions on the locations of probable crime centers. With the implementation of this method, which has been implemented in cities such as Los Angeles, the police are able to dispatch a greater number of policemen to "high-risk locations." On the other side, predictive policing violates the ethics of consequentialism as well as the ethical frameworks of justice and fairness. This is due to the fact that it causes low-income communities and high-minority regions to be unfairly targeted with increased police activity. Increasing the number of police patrols may, under certain circumstances, be useful in curbing criminal activity; but, it also causes people to feel anxious and scared of the police. The application of predictive policing for the goal of law enforcement is immoral and need to be subject to additional regulation or utilized in other ways. Attempts to control criminal behavior through the use of fear instilled by the police are not acceptable [16].

HISTORICAL BACKGROUND OF PREDICTIVE POLICING

Predictive policing did not emerge in a vacuum. Its development is deeply rooted in earlier traditions of crime mapping, criminological theory, and data-driven policing practices. Over time, advances in statistical analysis, urban sociology, and computational technology gradually converged to create the conditions under which predictive policing could flourish. Understanding this historical trajectory is essential, as it

highlights not only the intellectual and methodological foundations of predictive policing but also the recurring tensions between innovation, fairness, and accountability that have shaped its adoption [17] [20].

Table 1: Historical Milestones in Predictive Policing

Period	Development	Key Features	Forensic Implications
19th Century	Adolphe Quetelet's social statistics	Crime linked to social/environmental factors	Early linkage between crime data and social science
Early 20th Century	Chicago School of Sociology	Crime mapping and hotspot identification	Geographic criminology
1990s	CompStat (NYPD)	Data-driven crime reduction	Resource allocation, policing metrics
2000s	Emergence of PredPol, IBM Blue Crush	Algorithmic predictions	Integration with forensic databases
2010s–Present	AI and machine learning tools	Person-based risk assessment, surveillance integration	Predictive forensics in digital crime and biometrics

TECHNOLOGICAL FOUNDATIONS OF PREDICTIVE POLICING

Predictive policing is not a single technology but rather a convergence of several computational, analytical, and forensic tools designed to forecast criminal activity. It draws upon methods from statistics, artificial intelligence, big data analytics, and geospatial science, each of which contributes to its predictive capacity. Together, these technologies create a framework that shifts law enforcement from a reactive to a proactive paradigm, though not without significant implications for accuracy, fairness, and accountability [18].

Algorithmic Modeling

At the heart of predictive policing are algorithmic models that transform raw data into probabilistic forecasts. Early systems relied on relatively straightforward statistical methods such as regression models to identify correlations between crime rates and various social or environmental variables. Risk assessment instruments incorporated similar approaches, producing scores that estimate the likelihood of recidivism or criminal involvement. Bayesian inference models also played a role by incorporating prior probabilities into predictions, adjusting forecasts as new evidence or data emerged [19].

With advances in computational capacity, predictive policing has increasingly turned toward machine learning (ML) and artificial intelligence (AI). Unlike static models, ML systems adapt and refine

predictions continuously by ingesting new data inputs, allowing algorithms to detect emerging patterns that may not have been visible in traditional statistical analysis. For example, a model might learn that burglary rates increase in a specific neighborhood during certain hours and automatically recalibrate predictions as new incidents are reported. While this adaptability enhances predictive capacity, it also raises concerns about interpretability, as many of these models function as “black boxes,” producing risk scores or forecasts without transparent explanations of how conclusions were reached [20] [22].

Big Data Analytics

The effectiveness of predictive policing depends heavily on the scope and variety of data inputs. Modern systems incorporate vast datasets far beyond traditional crime reports. These may include arrest records, incident logs, emergency calls, probation data, parole records, and even social media activity that reveals patterns of communication or association. Increasingly, biometric data such as facial recognition outputs, gait analysis, and voice recognition are integrated into predictive systems, alongside real-time surveillance feeds from public and private cameras [23].

Forensic databases play an especially significant role in big data policing. The Combined DNA Index System (CODIS) maintained by the FBI, houses millions of DNA profiles that can link suspects to unsolved crimes. Similarly, the Automated Fingerprint Identification System (AFIS) enables rapid comparison of fingerprint samples against vast collections of prints. When integrated into predictive platforms, these forensic databases do not simply identify matches after crimes occur but can also be incorporated into risk modeling and prioritization systems, effectively merging retrospective evidence with prospective forecasting [26]. This convergence of forensic and predictive data blurs the line between past proof and future probability, expanding the reach of policing into both temporal directions [24].

Geospatial Prediction

Another cornerstone of predictive policing lies in geospatial analysis, which leverages the spatial concentration of crime to forecast where offenses are most likely to occur. Geographic Information Systems (GIS) are used to map crime data, overlaying it with demographic, economic, and environmental variables to identify hotspots. These systems allow law enforcement agencies to allocate patrols more efficiently by focusing on areas with heightened risk.

Geospatial prediction is strongly informed by environmental criminology theories, particularly the routine activity theory, which posits that crime occurs when three factors converge in time and space: a motivated offender, a suitable target, and the absence of a capable guardian. Similarly, crime pattern theory emphasizes that offenders often operate in familiar spaces, while rational choice theory suggests that they select targets based on opportunity structures. Predictive policing platforms operationalize these theories by highlighting neighborhoods, street corners, or even individual blocks that exhibit the structural conditions for criminal activity. The practical outcome is a spatial logic of policing that directs resources not uniformly but selectively, concentrating surveillance and enforcement in predicted hotspots [25].

Person-Based Prediction

In addition to forecasting crime by place, predictive policing increasingly employs person-based models,

sometimes referred to as individual risk assessment systems. These approaches flag individuals as potential offenders, victims, or associates based on patterns of past behavior, known affiliations, and social network analysis. For example, a system may identify someone as “high risk” because they have prior arrests, live in a neighborhood with elevated crime rates, or are socially connected to known offenders. The Chicago Police Department’s “Strategic Subjects List” (often dubbed a “heat list”) exemplified this approach by ranking individuals according to their probability of involvement in violent crime, either as perpetrators or victims [27].

Person-based prediction often relies on forensic data to bolster its risk assessments. DNA matches, fingerprint records, or digital forensic traces such as IP addresses and metadata can be incorporated into algorithmic scoring systems. In some cases, predictive platforms combine biometric markers with social data, creating composite profiles of individuals deemed likely to reoffend or engage in certain activities. While these methods aim to prioritize resources toward those at greatest risk, they raise profound ethical and legal questions. The use of forensic evidence in predictive scoring extends its role beyond establishing past culpability into forecasting future behavior, challenging long-standing principles of justice such as the presumption of innocence and the requirement of concrete evidence before suspicion is cast [28] [30].

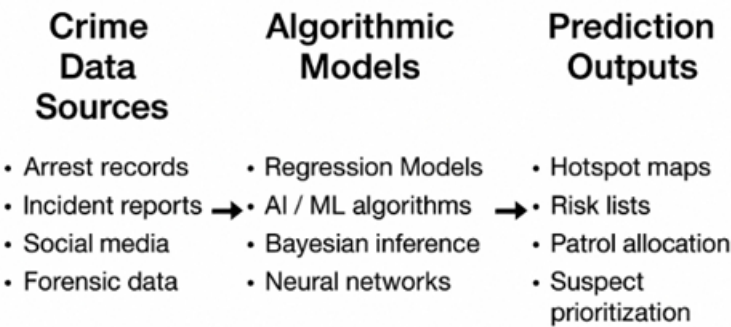


Figure 2: Components of Predictive Policing Technology

PREDICTIVE POLICING IN FORENSIC SCIENCE

In forensic science, predictive policing extends far beyond forecasting where or when crimes might occur. Its influence reaches into the collection, analysis, and interpretation of forensic evidence, reshaping the workflows of laboratories, the prioritization of cases, and even the epistemology of what counts as reliable knowledge in criminal justice. The convergence of predictive technologies with forensic practices has introduced new efficiencies but also new risks, particularly regarding bias, fairness, and the integrity of scientific evaluation [32].

Table 2: Applications of Predictive Policing in Forensic Science

Domain	Predictive Role	Ethical Challenge
DNA Analysis	Prioritization of samples based on suspect risk profile	Risk of biased sample testing

Fingerprint Analysis	Linking individuals to “high-risk” groups	Confirmation bias in examiner judgments
Digital Forensics	Anticipating cybercrime behaviors	Privacy intrusion and surveillance overreach
Criminal Profiling	AI-generated suspect lists	Violations of presumption of innocence

ETHICAL IMPLICATIONS

1. Bias and Discrimination

- Predictive algorithms are only as unbiased as the data they are trained on. Since historical policing data is often tainted by systemic racism and socioeconomic inequalities, predictive systems risk amplifying discriminatory practices.
- Minority neighborhoods are frequently over-policed, leading to a feedback loop: more arrests generate more data, which fuels more surveillance.

2. Erosion of Civil Liberties

- Predictive policing often relies on intrusive data collection, raising concerns about Fourth Amendment protections against unreasonable searches and seizures.
- Predicting crimes before they occur challenges the presumption of innocence, a cornerstone of justice.

3. Transparency and Accountability

- Proprietary algorithms are often opaque (“black box” systems), making it difficult for courts, forensic scientists, and defendants to challenge predictions.
- Lack of transparency undermines evidentiary standards in forensic practice.

4. Impact on Forensic Objectivity

- Forensic scientists, expected to maintain impartiality, may be subconsciously swayed by algorithmic predictions that label a suspect as high-risk.
- This introduces confirmation bias and jeopardizes the neutrality of forensic testimony.

5. Surveillance and Privacy

- Predictive policing encourages mass surveillance through cameras, biometric tracking, and digital monitoring raising ethical questions about proportionality and consent [34] [35].

CASE STUDIES

The theoretical promise of predictive policing has been tested in various real-world contexts, where pilot programs and large-scale deployments have sought to translate algorithmic forecasting into practical policing strategies. These experiments provide valuable insights into both the potential benefits and the serious limitations of predictive policing systems, especially when assessed through the lens of fairness, transparency, and forensic practice. Three prominent case studies PredPol in Los Angeles, Chicago’s “Heat List,” and the United Kingdom’s National Data Analytics Solution (NDAS) illustrate the complex interplay of technology, policing, and justice [36] [38] [40].

Table 3: Major Case Studies of Predictive Policing and Ethical Outcomes

Case	Location	Tool Used	Findings	Ethical Concerns
PredPol	Los Angeles	Hotspot prediction	Increased patrol efficiency claimed, minimal crime reduction proven	Over-policing of minority neighborhoods
“Heat List”	Chicago	Person-based risk list	Targeted individuals as potential offenders/victims	Due process violations, stigmatization
NDAS	United Kingdom	AI-driven risk assessment	Analyzed personal & mental health records	Data privacy, surveillance overreach

POLICY AND REGULATORY CONSIDERATIONS

The responsible use of predictive policing requires policies that protect fairness and accountability while allowing innovation.

- **Algorithmic Transparency:** Predictive systems should not operate as “black boxes.” Algorithms must be open to audit or review, ensuring stakeholders understand how predictions are generated and on what basis.
- **Bias Audits:** Independent audits should be conducted regularly to detect discriminatory outcomes. This helps identify biases in both datasets and algorithmic decisions, reducing the risk of reinforcing social inequalities.
- **Strict Data Governance:** Only relevant and necessary data should be used in predictive systems. Sensitive information such as health or personal records must be strictly limited, with clear rules on retention and consent.
- **Legal Safeguards:** Judicial oversight is essential to ensure predictive policing aligns with constitutional

protections. Individuals flagged by algorithms should have the right to challenge decisions affecting them.

- **Forensic Training and Ethics Education:** Forensic practitioners need training to understand algorithmic outputs and recognize potential biases. Ethics education can help prevent confirmation bias and ensure evidence is handled objectively.

FUTURE DIRECTIONS

- **Integration of Ethical AI:** Future predictive policing tools should incorporate fairness metrics, bias-detection mechanisms, and explainability features. This ensures algorithms are transparent, accountable, and less likely to reinforce existing inequalities.
- **Human-in-the-Loop Systems:** Human oversight must remain central. Algorithms can assist with predictions, but final forensic and policing decisions should be guided by trained professionals to reduce errors and prevent blind reliance on technology.
- **Interdisciplinary Collaboration:** Effective implementation requires cooperation between technologists, forensic scientists, ethicists, policymakers, and civil rights advocates. Such collaboration ensures systems are scientifically sound, ethically grounded, and socially acceptable.
- **Community Engagement:** Building trust is critical. Communities should have a voice in how predictive policing is designed, tested, and deployed. Transparency and community consultation can reduce suspicion and foster legitimacy.

CONCLUSION

Predictive policing embodies a technological advancement and an ethical quandary for forensic science. While its capacity to improve law enforcement efficacy is indisputable, the associated hazards to justice, equity, and civil liberties are equally substantial. Integrating forensic science into predictive models may convert forensic practice from an unbiased instrument of truth-seeking into a means of social regulation. Ethical safeguards, transparency, and accountability are essential to avert the exploitation of predictive technologies. The validity of predictive policing in forensic science hinges on both its technological precision and its conformity to democratic values, human rights, and the core tenets of justice.

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