

The Evolving Role of Artificial Intelligence in Law

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Abstract

Artificial Intelligence (AI) drives legal innovation. By integrating advanced machine learning, natural language processing, and large language models, AI achieves remarkable precision, with models like those for the European Court of Human Rights predicting case outcomes at 97% accuracy. This study's unique contribution lies in its comprehensive analysis of AI's technical foundations, particularly the application of transformer-based architectures and multimodal data integration, which enhance predictive accuracy and judicial reasoning. From a scientific perspective, it critically evaluates AI's limitations, such as biases in training data and remaining hallucinations, offering a novel framework for hybrid human-AI approaches to mitigate these risks. By addressing research gaps, regulatory frameworks, and stakeholder perceptions, the article provides a scientifically grounded roadmap for responsibly integrating AI into legal practice, ensuring alignment with justice principles. Finally, the article shows how evolving AI research drives innovation in law.

Key Words: Artificial Intelligence, AI Models, Governance, Law

JEL Categories: K20, K23, K32, L43, L5, O31, O32

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I. Introduction

The integration of AI into legal systems represents a transformative shift in the administration of justice, offering unprecedented opportunities to enhance efficiency, precision, and accessibility while posing complex ethical, technical, and regulatory challenges. From early philosophical inquiries into mechanized intelligence to the advent of sophisticated large language models (LLMs) in the 2020s, AI has evolved into a powerful tool for legal research, predictive analytics, and judicial decision-making.³ Predictive AI analytics, capable of forecasting case outcomes with up to 97% accuracy, and judicial simulation, exemplified by generative AI drafting judicial opinions, promise to streamline legal processes and alleviate caseload pressures in overburdened systems.⁴ Yet, issues such as algorithmic bias, transparency deficits, and the inability to replicate human empathy underscore the need for careful integration.⁵

This article examines the evolving role of AI in legal solutions, with a specific focus on predictive analytics and judicial simulation. Its objectives are to trace AI's historical development, analyze its current applications, explore technical foundations, evaluate ethical and legal implications, assess stakeholder perceptions, identify research gaps, review regulatory frameworks, compare human and AI performance, and forecast future trends. We balance technological innovation with the imperatives of fairness, accountability, and judicial integrity, addressing a critical juncture in legal practice where AI's potential must be harnessed responsibly.⁶

The article is structured to first provide a historical context, followed by detailed analyses of current applications, technical underpinnings, ethical considerations, stakeholder views, research deficiencies, regulatory approaches, performance comparisons, and anticipated developments, culminating in a synthesis of findings to guide the responsible integration of AI in legal systems.

³ Harry Surden, *Artificial Intelligence and Law—An Overview of Recent Technological Changes in Large Language Models and Law*, 96 COLO. L. REV. 376, 376–77 (2025); Arlindo L. Oliveira & Mário A. T. Figueiredo, *Artificial Intelligence: Historical Context and State of the Art*, in 58 L., GOVERNANCE & TECH. SERIES, MULTIDISCIPLINARY PERSPECTIVES ON ARTIFICIAL INTELLIGENCE AND THE LAW 3, 3–4 (Henrique Sousa Antunes, et al. eds., 2024).

⁴ Joe Collenette, Katie Atkinson & Trevor Bench-Capon, *Explainable AI Tools for Legal Reasoning About Cases: A Study on the European Court of Human Rights*, 317 A.I. 1, 3 (2023); Liu & Li, *supra* note 4, at 236.

⁵ Andrej Krištofik, *Bias in AI (Supported) Decision Making: Old Problems, New Technologies*, 16 INT'L J. CT. ADMIN. 235, 237 (2025); Francesco Contini, Alessandra Minissale & Stina Bergman Blix, *Artificial Intelligence and Real Decisions: Predictive Systems and Generative AI vs. Emotive-Cognitive Legal Deliberations*, 9 FRONTIERS IN SOCIO. Oct. 2024, at 4.

⁶ Yatama Zahra, *Regulating AI in Legal Practice: Challenges and Opportunities*, 3 J. COMPUT.ER SCI. APPLICATION & ENG'G 10, 11 (2025); Faisal Awais, Aatir Rizvi & Kashif Javed, *Harmonizing Innovation and Ethics: The Complex Landscape of Artificial Intelligence in Legal Practice*, 3 CRITICAL REV. SOC. SCI. STUD. 2639, 2640 (2025).

II. Historical Context and Evolution of AI in Legal Systems

The historical evolution of AI in legal systems reflects a trajectory from philosophical speculation to practical, transformative tools. Early expert systems of the 1980s laid the groundwork, models of case-based reasoning, logical formalisms, and legal knowledge representation rose as important and influential areas of research⁷, followed by machine learning and deep learning advancements that expanded AI's capabilities in legal research and predictive analytics. The rise of LLMs in the 2020s marks a new frontier, offering unprecedented performance but also raising ethical and regulatory challenges. Key milestones, such as the establishment of the International Conference on AI and Law (ICAIL) and the proliferation of transformer-based models, underscore the field's progress. As AI continues to evolve, its integration into legal practice must balance efficiency and innovation with the principles of justice and fairness, ensuring that technological advancements serve the public interest.

Early Beginnings: Philosophical and Computational Foundations

The concept of AI in legal systems is rooted in centuries-old philosophical inquiries into whether intelligence could be mechanized. Thinkers like Thomas Hobbes posited that intelligence might result from computational processes, laying a conceptual groundwork for later AI developments.⁸ In the 19th century, Charles Babbage and Ada Lovelace's work on programmable machines introduced practical mechanisms for computation, suggesting that machines could perform tasks beyond mere calculation.⁹ These early ideas were speculative but set the stage for 20th-century advancements.

The formal inception of AI as a field is often traced to Alan Turing's work in the 1940s, particularly his exploration of whether machines could think, exemplified by the Turing Test.¹⁰ Turing's contributions, alongside Norbert Wiener's cybernetics, established that machines could process information in ways analogous to human reasoning, a principle critical to legal applications.¹¹ These developments provided the theoretical and technical foundations for applying computational methods to law, though practical applications remained limited until the advent of more powerful computers.

⁷Guido Governatori, Trevor Bench-Capon, Bart Verheij, Michal Araszkievicz, Enrico Francesconi & Matthias Grabmair, *Thirty years of Artificial Intelligence and Law: The First Decade*, 30 A.I. & L. 481, 483-84 (2022).

⁸ Oliveira & Figueiredo, *supra* note 3, at 3-4.

⁹ Oliveira & Figueiredo, *supra* note 3, at 4.

¹⁰ Bruce G. Buchanan, *A (Very) Brief History of Artificial Intelligence*, 26 AI MAGAZINE 53, 54 (2005).

¹¹ Oliveira & Figueiredo, *supra* note 3, at 4-5.

The 1980s: Rise of Legal Expert Systems

The 1980s marked a significant milestone with the development of legal expert systems, which aimed to emulate human legal reasoning through rule-based programming. These systems encoded legal rules and knowledge into software, enabling automated decision-making for specific legal domains.¹² The DataLex Project, for instance, was a pioneering effort that developed both commercial and non-commercial systems, focusing on integrating legal decision-support tools rather than fully autonomous “robot lawyers”.¹³ W-LES, a system by Don Waterman that produced recommended settlement values (with accompanying explanations) for product liability claims.¹⁴ Some early AI systems tackled question-answering tasks—such as simulating issues from 1L contract exams¹⁵—while others focused on formalizing statutes; for example, Marek Sergot’s program translated the British Nationality Act into logical form so that, given an input scenario, the system could reason and draw a conclusion.¹⁶ These systems were designed to assist with legal advice, particularly for free legal services, by leveraging structured knowledge bases.¹⁷

During this period, the International Conference on AI and Law, first held in 1987, became a pivotal platform for advancing the field. The conference facilitated discussions on rule-based systems and their applications in legal reasoning, marking the formalization of AI and law as a distinct research discipline.¹⁸ However, early expert systems were brittle, struggling with unforeseen complexities and lacking the ability to generalize beyond their programmed

¹² Graham Greenleaf, Andrew Mowbray & Philip Chung, *Building Sustainable Free Legal Advisory Systems: Experiences from the History of AI & Law*, 34 COMPUT. L. & SEC. REV. 314, 315 (2018).

¹³ *Id.* at 315–16.

¹⁴ KEVIN D. ASHLEY, ARTIFICIAL INTELLIGENCE AND LEGAL ANALYTICS: NEW TOOLS FOR LAW PRACTICE DIGITAL AGE 8-10 (2017) (citing DONALD A. WATERMAN & MARK A. PETERSON, MODELS OF LEGAL DECISION MAKING: RESEARCH DESIGN AND METHODS (Rand Corporation, the Institute for Civil Justice 1981).

¹⁵ *Id.* at 18 (citing ANNE VON DER LIETH GARDNER, AN ARTIFICIAL INTELLIGENCE APPROACH TO LEGAL REASONING (MIT Press 1987)).

¹⁶ *Id.* at 47 (citing Marek J. Sergot et al., *The British Nationality Act as a Logic Program*, 29 COMM’N ACM 370 (1986).

¹⁷ Greenleaf et al., *supra* note 12, at 316.

¹⁸ Trevor Bench-Capon et al., *A History of AI and Law in 50 Papers: 25 Years of the International Conference on AI and Law*, 20 A.I. L. 215, 216 (2012).

domains.¹⁹ Despite these limitations,²⁰ they demonstrated AI's potential to augment legal processes, particularly in structured tasks like statutory interpretation.²¹

The 1990s–2000s: Research in Case-Based Reasoning and Integration of Machine Learning

The limitations of rule-based systems prompted a shift toward case-based reasoning in the 1990s and subsequently machine learning (ML) in the early 2000s. These approaches, more particularly ML, allowed AI to rely on data rather than rely solely on predefined rules, enabling more flexible legal applications.²² As to case-based reasoning, with beginnings in the legal domain mid to late 1980s, systems of case-based reasoning began to take shape in AI and Law research notably with Kevin Ashley's HYPO system.²³ According to Ashley,

[t]he models illustrate how to represent legal cases so that a computer program can reason about whether they are analogous to a case to be decided. In particular, they illustrate ways in which a program can compare a problem and cases, select the most relevant cases, and generate legal arguments by analogy for and against a conclusion in a new case.²⁴

The HYPO program's workings display the utility of case based reasoning systems.²⁵ The program provided a method for storing and retrieving legal cases according to their relevance to a specific fact pattern. This approach reflects the way lawyers conduct legal research—identifying and retrieving precedent cases that are most pertinent to the case at hand when constructing legal arguments. In fact, the system could assess the relevancy of precedent, and identify the most relevant, or “most-on-point” cases to the input scenario.²⁶ From here, the system could compare relevant cases by analogizing them in favor of a

¹⁹ Oliveira & Figueiredo, *supra* note 3, at 6.

²⁰ Important to the discussion of the limitations of rule-based systems is the idea of isomorphism. According to Francesconi and Araszkievicz, “Bench-Capon and Coenen . . . in particular introduce[] and contribute[] to the identification the characteristics of the concept of ‘isomorphism’, as an approach to building knowledge-based systems in the legal domain, starting from a faithful representation of data, according to a well-defined correspondence between source documents and the representation of the information they contain used in the systems.” Guido Governatori et al., *Thirty Years of Artificial Intelligence and Law: The First Decade*, 30 A.I. & L. 481, 489 (2022) (discussing Trevor Bench-Capon & Frans Coenen, *Isomorphism and Legal Knowledge Based Systems*, 1 A.I. & L. 65 (1992)).

²¹ Edwina L. Rissland et al., *AI and Law: A Fruitful Synergy*, A.I. 2003, at 1, 2.

²² Kevin D. Ashley, *A Brief History of the Changing Roles of Case Prediction in AI and Law*, 36 L. CONTEXT: A SOCIO-LEGAL J., Sept. 2019, at 93, 94-95.

²³ Governatori et al., *supra* note 7 at 483; Edwina L. Rissland et al., *Explaining and Arguing With Examples*, PROC. 4TH AAAI CONF. ON A.I. 288 (1984); Kevin D. Ashley, *Modeling Legal Arguments: Reasoning with Cases and Hypotheticals* (1988) [hereinafter *Ashley Dissertation*] (Ph.D dissertation, University of Massachusetts).

²⁴ Ashley, *supra* note 14, at 73.

²⁵ *Ashley Dissertation*, *supra* note 23, at 81-82.

²⁶ *Id.*, at 92.

conclusion, distinguishing a case cited in support of a particular conclusion, or providing a counter-example. The system included methods for posing hypotheticals to test how new or changing facts affect existing arguments, generating three-ply argument outlines that mirror real legal argumentation, and explaining alternative decisions by presenting and comparing three hypotheticals with supporting precedents.²⁷ A clear strength of the HYPO program was to model legal argumentation in a detailed and realistic manner. This reflects the strength of case-based reasoning systems.

A number²⁸ of case-based reasoning systems followed HYPO, such as CATO²⁹ that introduced a hierarchical representation of the factors described in HYPO to “make context-sensitive arguments about the significance of differences between cases”.³⁰ The CABARET program used a hybrid system of rule-based and case-based reasoning to generate arguments about the meaning of poorly-defined statutory language.³¹ Systems such as AGATHA sought to extend the reasoning of these systems to include values,³² work with values advanced further with the development of Grabmair’s VJAP system.³³

Case prediction emerged as a key application, used to identify borderline cases for academic commentary and to validate computational models of legal reasoning.³⁴ For example, systems began predicting case outcomes by analyzing patterns in judicial decisions, providing evidence of the reasonableness of AI-driven legal models.³⁵

The digitization of legal texts during this period, coupled with advances in natural language processing (NLP), facilitated quantitative legal analysis. Techniques like text mining and network analysis enabled scholars to extract insights from large datasets, such as court records and statutes.³⁶ These developments expanded AI’s role from niche expert systems to broader applications, including e-discovery and document review, which became critical in managing the growing volume of digital legal data.³⁷

²⁷ *Id.* at 93-94.

²⁸ The referenced list of systems is non-exhaustive but are relevant in context of the HYPO program.

²⁹ Vincent Aleven, *Teaching Case-Based Argumentation Through a Model and Examples* (1997) (Ph.D dissertation, University of Pittsburgh).

³⁰ Vincent Aleven, *Using Background Knowledge in Case-Based Legal Reasoning: A Computational Model and an Intelligent Learning Environment*, 150 A.I. 182, 185 (2003).

³¹ Edwina L. Rissland & David B. Skalak, *Cabaret: Rule Interpretation in a Hybrid Architecture*, 34 INT’L J. MAN-MACH. STUD. 839, 839 (1991).

³² Alison Chorley & Trevor Bench-Capon, *AGATHA: Using Heuristic Search to Automate the Construction of Case Law Theories*, 13 A.I. & L. 9, 10(2005).

³³ Matthias Grabmair, *Predicting Trade Secret Case Outcomes Using Argument Schemes and Learned Quantitative Value Effect Tradeoffs*, PROC. 16TH ICAIL 89 (2017).

³⁴ Ashley, *supra* note 22, at 95.

³⁵ *Id.*, at 95–96.

³⁶ Jens Frankenreiter & Michael A. Livermore, *Computational Methods in Legal Analysis*, 16 ANN. REV. L. & SOC. SCI. 39, 40–41 (2020).

³⁷ Jack G. Conrad et al., *AI & Law: Formative Developments, State-of-the-Art Approaches, Challenges & Opportunities*, PROC. 6TH JOINT INT’L CONF. ON DATA SCI. & MGMT. DATA 320 (2023).

The 2010s: Deep Learning and Predictive Analytics

The 2010s ushered in a new era with the rise of deep learning (DL), a subset of ML that significantly enhanced AI's ability to process and generate human-like text. DL is capable of understanding complex patterns, such as those found in language. The introduction of transformer architectures revolutionized NLP, enabling systems to understand and analyze complex legal texts with unprecedented accuracy.³⁸ These advancements facilitated the development of predictive analytics tools, which forecast case outcomes, assess litigation risks, and support judicial decision-making.³⁹

Using the well known transformer architecture,⁴⁰ some efforts sought to train legal specific language models such as LegalBERT⁴¹ and CaseHold.⁴² Developments in legal text analytics were also spurred by the power of DL.⁴³

AI platforms like ROSS Intelligence and Westlaw Edge leveraged DL to automate legal research, offering faster and more precise retrieval of relevant precedents.⁴⁴ In judicial settings, tools like COMPAS used predictive analytics for risk assessments in sentencing and parole decisions, though their use sparked debates over bias and fairness.⁴⁵ The rapid adoption of these technologies was driven by the increasing availability of digitized legal data and the computational power to process it.⁴⁶

The 2020s: Large Language Models and Global Expansion

Since 2022, LLMs like OpenAI's GPT-4, Gemini, Claude, and Grok3 have redefined AI's role in law, offering sophisticated capabilities in legal research,⁴⁷ document drafting, and

³⁸ Surden, *supra* note 3, at 378–79.

³⁹ Rachid Ejjami, *AI-Driven Justice: Evaluating the Impact of Artificial Intelligence on Legal Systems*, 6 INT'L J. MULTIDISCIPLINARY RES. 1, 3 (2024).

⁴⁰ Jacob Devlin et al., *BERT: Pre-Training of Deep Bidirectional Transformers for Language Understanding*, 1 PROC. CONF. N. AMERICAN CHAPTER ASS'N COMPUTATIONAL LINGUISTICS: HUM. LANGUAGE TECH. 4171 (2019).

⁴¹ Ilias Chalkidis et al., *LEGAL-BERT: The Muppets Straight Out of Law School*, in FINDINGS OF THE ASSOCIATION FOR COMPUTATIONAL LINGUISTICS: EMNLP 2020 2898.

⁴² Lucia Zheng et al., *When Does Pretraining Help? Assessing Self-Supervised Learning for Law and the CaseHOLD Dataset of 53,000+ Legal Holdings*, PROC. 18TH ICAIL 159 (2021).

⁴³ Morgan A. Gray et al., *Toward Automatically Identifying Legally Relevant Factors*, in LEGAL KNOWLEDGE AND INFORMATION SYSTEMS 53, 53-53, 61-62 (2022); Jaromir Savelka, *Discovering Sentences for Argumentation About the Meaning of Statutory Terms* (2020) (Ph.D. dissertation, University of Pittsburgh).

⁴⁴ Matthew N. O. Sadiku, Samuel A. Ajayi & Janet O. Sadiku, *Artificial Intelligence in Legal Practice: Opportunities, Challenges, and Future Directions*, 27 J. ENG'G RSCH. & REP. 68, 69 (2025).

⁴⁵ Ejjami, *supra* note 39, at 4.

⁴⁶ Conrad et al., *supra* note 37, at 3.

⁴⁷ LLMs are a common feature of legal research, especially with respect to RAG based platforms. These types of systems, however, are not without their faults. See Varun Magesh et

analysis.⁴⁸ LLMs process vast datasets, including case law and statutes, to generate human-like legal arguments and predictions, surpassing the capabilities of earlier systems.⁴⁹ The performance gains and ease of implementation of LLMs has also spurred research in legal text analytics⁵⁰ and legal reasoning.⁵¹ Their application has been particularly transformative in overburdened legal systems, such as India's, where AI alleviates caseload pressures.⁵²

The global expansion of AI in law has also gained momentum, with applications in diverse legal systems. However, challenges like algorithmic bias and data privacy have prompted calls for robust regulatory frameworks.⁵³ The integration of AI into free legal advice services, building on projects like DataLex, highlights the potential for collaboration between AI and legal aid providers to enhance access to justice.⁵⁴

Key Milestones and Technological Advancements

The evolution of AI in legal systems can be summarized through several key milestones:

- **1940s–1950s:** Theoretical foundations by Turing and Wiener establish AI's potential for legal reasoning.⁵⁵
- **1980s:** Legal expert systems, like those developed by the DataLex Project, introduce rule-based automation.⁵⁶
- **1987:** The first International Conference on AI and Law formalizes the field.⁵⁷

al., *Hallucination-Free? Assessing the Reliability of Leading AI Legal Research Tools*, 22 J. EMPIRICAL LEGAL STUD. 216, 224-25 (2025).

⁴⁸ Surden, *supra* note 3, at 376–77.

⁴⁹ Zichong Wang et al., *History, Development, and Principles of Large Language Models—An Introductory Survey* 5-6 (Sep. 23, 2024) (manuscript).

⁵⁰ Morgan A. Gray et al., *Using LLMs to Discover Legal Factors*, in LEGAL KNOWLEDGE AND INFORMATION SYSTEMS 60, 60-61 (2024); Jaromir Savelka et al., *Can GPT-4 Support Analysis of Textual Data in Tasks Requiring Highly Specialized Domain Expertise?*, 1 PROC. 2023 CONF. ON INNOVATION AND TECH. COMPUT. SCI. EDUC. 117(2023); Jakub Drápal et al., *Using Large Language Models to Support Thematic Analysis in Empirical Legal Studies*, in LEGAL KNOWLEDGE AND INFORMATION SYSTEMS 197, 197-198 (2023); Samyar Janatian et al., *From Text to Structure: Using Large Language Models to Support the Development of Legal Expert Systems*, in LEGAL KNOWLEDGE AND INFORMATION SYSTEMS 167, 167-168 (2023).

⁵¹ Morgan A. Gray et al., *Generating Case-Based Legal Arguments with LLMs*, PROC. 2025 SYMP. ON COMPUT. SCI. & L. 160, 160 (2025); Cor Steging et al., *Parameterized Argumentation-based Reasoning Tasks for Benchmarking Generative Language Models*, PROC. EIGHTEENTH INT'L CONF. ON A.I. & L. 443 (2025).

⁵² Conrad et al., *supra* note 37, at 1.

⁵³ Zahra, *supra* note 6, at 11; Awais et al., *supra* note 6, at 2640. .

⁵⁴ Greenleaf et al., *supra* note 12, at 318–19.

⁵⁵ Buchanan, *supra* note 10, at 54.

⁵⁶ Greenleaf et al., *supra* note 12, at 315.

⁵⁷ Bench-Capon et al., *supra* note 18, at 216.

- **1990s–2000s:** Machine learning and case-based reasoning enable predictive analytics and e-discovery.⁵⁸
- **2010s:** Deep learning and transformers enhance NLP, powering advanced legal research tools.⁵⁹
- **2020s:** LLMs like GPT-4 revolutionize legal tasks, with global applications and ethical challenges.⁶⁰

Technological advancements, including the shift from symbolic systems to data-driven ML, the rise of DL, and the development of LLMs, have progressively increased AI's accuracy, scalability, and applicability in law.⁶¹ These advancements have been supported by the digitization of legal texts and the growth of computational power.⁶²

III. Current Applications of AI in Legal Practice

AI's current applications in legal practice—spanning legal research, predictive analytics, and judicial decision-making tools—have transformed the legal profession by enhancing efficiency, accuracy, and access to justice. Legal research platforms like Lexis+AI and Westlaw leverage LLMs to streamline case law retrieval, while predictive analytics informs litigation strategies and case outcomes with high accuracy. Judicial decision-making tools, such as COMPAS and models designed for the ECHR, support judges in high-volume settings, though their use raises ethical concerns. Ancillary applications, including document drafting and compliance monitoring, further demonstrate AI's versatility.

Legal Research

AI has revolutionized legal research by automating the retrieval and analysis of vast legal datasets, enabling lawyers to access relevant case law, statutes, and legal documents with greater speed and accuracy. Platforms such as LexisNexis (Lexis+AI, now Protège), Thomson Reuters (Westlaw AI-Assisted Research, now Co-Counsel), and ROSS Intelligence leverage LLMs and NLP to process unstructured legal texts, extract key legal concepts, and deliver precise search results.⁶³ These tools use deep learning algorithms to understand legal terminology and context, significantly reducing the time required for manual research.⁶⁴

For example, Lexis+AI employs retrieval-augmented generation (RAG) to minimize errors like hallucinations—where AI generates false information—though studies show that such

⁵⁸ Ashley, *supra* note 22, at 94–95.

⁵⁹ Surden, *supra* note 3, at 378.

⁶⁰ Wang et al., *supra* note 49, at 5–6; Zahra, *supra* note 6, at 11.

⁶¹ Surden, *supra* note 3, at 378–79; Oliveira & Figueiredo, *supra* note 3, at 6–7.

⁶² Frankenreiter & Livermore, *supra* note 36, at 40.

⁶³ Surden, *supra* note 3, at 379; Sadiku et al., *supra* note 44, at 69.

⁶⁴ Ejjami, *supra* note 39, at 3.

systems still hallucinate in 17–33% of cases.⁶⁵ Despite these challenges, AI-driven legal research tools enhance efficiency by summarizing case law, drafting initial legal documents, and identifying relevant precedents, thereby reducing administrative burdens.⁶⁶ Additionally, AI's application in free legal advice services, such as those inspired by the DataLex Project, facilitates access to justice by providing low-cost, automated research tools for underserved communities.⁶⁷

Predictive Analytics

Predictive analytics represents one of the most impactful applications of AI in legal practice, enabling lawyers to forecast case outcomes, assess litigation risks, and optimize strategic decisions. By analyzing historical judicial data, AI models identify patterns in case law, judicial behavior, and legal arguments to predict the likelihood of success in litigation or settlement negotiations.⁶⁸ These tools rely on ML algorithms, such as Support Vector Machines (SVM) and Multi-Layer Perceptrons (or neural networks), which achieve high accuracy in outcome prediction, as demonstrated by a study on the Chinese AI and Law (CAIL) dataset where SVM models reached 96.9% accuracy in classifying semantic biases in judicial judgments.⁶⁹

In practice, predictive analytics is used to guide litigation strategy, advise clients on settlement options, and streamline case management.⁷⁰ For instance, corporate legal departments employ AI to evaluate the merits of cases, reducing costs and improving decision-making.⁷¹ However, predictive models are not without flaws; they can amplify biases present in training data, such as racial or socioeconomic disparities, necessitating continuous oversight and fairness audits.⁷²

⁶⁵ Mageesh et al., *supra* note 47, at 217.

⁶⁶ Zahra, *supra* note 6, at 11.

⁶⁷ Greenleaf et al., *supra* note 12, at 19.

⁶⁸ Ashley, *supra* note 22, at 96; Edwin O. Eboigbe, *AI in Legal Analytics: Balancing Efficiency, Accuracy, and Ethics in Contract and Predictive Analysis*, 3 (Oct. 2024), <https://ssrn.com/abstract=4997519>.

⁶⁹ Kashif Javed & Jianxin Li, *Artificial Intelligence in Judicial Adjudication: Semantic Biasness Classification and Identification in Legal Judgement*, 10 HELIYON 1, 5 (2024).

⁷⁰ Bogdan Padiu, Radu Iacob, Traian Rebedea & Mihai Dascalu, *To What Extent Have LLMs Reshaped the Legal Domain So Far? A Scoping Literature Review*, 15 INFORMATION (SPECIAL ISSUE) 11 (2024).

⁷¹ Sadiku et al., *supra* note 44, at 69.

⁷² Awais et al., *supra* note 6, at 2640; Krištofík, *supra* note 5, at 237.

Judicial Decision-Making Tools

AI-driven judicial decision-making tools are increasingly used to support judges and court systems, particularly in high-volume or overburdened jurisdictions. These tools employ predictive systems and generative AI to assist with tasks such as risk assessment, case prioritization, and legal reasoning. A prominent example is COMPAS (Correctional Offender Management Profiling for Alternative Sanctions), which predicts recidivism risks to inform bail, sentencing, and parole decisions.⁷³ Similarly, and to reiterate, AI models applied to the European Court of Human Rights (ECHR) have achieved 97% accuracy in predicting case outcomes under Article 6, demonstrating their potential as decision-support tools.⁷⁴

Generative AI is also being explored in judicial settings, with judges in jurisdictions like Colombia, Mexico, Peru, and India using tools like GPT-4 to draft rulings or analyze legal arguments.⁷⁵ However, these applications are far from perfect, as generative AI can oversimplify complex judicial deliberations, reduce emotive-cognitive processes to statistical correlations, and introduce biases or interpretive errors.⁷⁶ For example, a study of an AI system for traffic violation appeals in a Dutch court found that while AI improved consistency, it altered legal experts' decisions, highlighting the need for human oversight.⁷⁷

AI's role in judicial support extends to free legal advisory systems, where integrated decision-support tools help provide accessible legal guidance, particularly in resource-constrained environments.⁷⁸ In countries like India, AI tools alleviate caseload pressures by automating preliminary case assessments, enhancing judicial efficiency.⁷⁹ Nonetheless, the use of AI in judicial contexts remains controversial due to risks of bias, lack of transparency, and potential undermining of judicial discretion.⁸⁰

Other Notable Applications

Beyond legal research, predictive analytics, and judicial tools, AI is applied in several ancillary legal tasks:

- **Document Drafting and Analysis:** AI automates the creation of contracts, legal briefs, and compliance documents, improving efficiency and reducing errors.⁸¹ For

⁷³ Ejjami, *supra* note 39, at 4.

⁷⁴ Collenette et al., *supra* note 4, at 3.

⁷⁵ David Uriel Socol de la Osa & Nydia Remolina, *Artificial Intelligence at the Bench: Legal and Ethical Challenges of Informing—or Misinforming—Judicial Decision-Making Through Generative AI*, 6 DATA & POL'Y PROC. 1, 3 (2024).

⁷⁶ Contini et al., *supra* note 5, at 4.

⁷⁷ Daan Kolkman et al., *Justitia Ex Machina: The Impact of an AI System on Legal Decision-Making and Discretionary Authority*, BIG DATA & SOC'Y, Apr.–June 2024, at 1, 5.

⁷⁸ Greenleaf et al., *supra* note 12, at 316–18.

⁷⁹ Conrad et al., *supra* note 37, at 1.

⁸⁰ Socol de la Osa & Remolina, *supra* note 75, at 4; Křištofík, *supra* note 5, at 237.

⁸¹ Surden, *supra* note 3, at 379; Zahra, *supra* note 6, at 11.

example, AI-driven contract analysis tools identify clauses and risks, streamlining corporate legal operations.⁸²

- **Compliance Monitoring:** Corporate legal departments use AI to ensure regulatory compliance, detecting violations in real-time.⁸³
- **Case Management:** AI streamlines administrative tasks, such as scheduling and document organization, enhancing overall practice efficiency.⁸⁴
- **Dispute Resolution:** AI supports alternative dispute resolution by analyzing case data to propose settlement options, improving access to justice.⁸⁵

These applications demonstrate AI's versatility, with tools like those developed by LexisNexis and Thomson Reuters integrating multiple functions to support comprehensive legal workflows.⁸⁶

Challenges and Considerations

While AI's applications in legal practice offer significant benefits, they are accompanied by challenges that require careful management:

- **Hallucinations:** AI tools, even those using RAG, can generate inaccurate legal citations or facts, posing risks in high-stakes legal contexts.⁸⁷ This finding, however, could change given the pace of LLM improvements.⁸⁸
- **Bias:** Predictive and judicial tools may perpetuate biases in training data, such as racial disparities in sentencing, necessitating fairness audits and bias mitigation strategies.⁸⁹
- **Transparency and Accountability:** The "black-box" nature of some AI models complicates explainability, raising concerns about judicial reliance on unverified outputs.⁹⁰
- **Ethical Implications:** AI's use in judicial decision-making risks oversimplifying complex human judgments, potentially undermining due process and fairness.⁹¹

⁸² Eboigbe, *supra* note 68, at 4.

⁸³ Sadiku et al., *supra* note 44, at 69.

⁸⁴ Padiu et al., *supra* note 70, at 11.

⁸⁵ Zahra, *supra* note 6, at 11.

⁸⁶ Magesh et al., *supra* note 47, at 217; KEVIN T. MCCARTHY ET AL., ARTIFICIAL INTELLIGENCE IN LEGAL PRACTICE: BENEFITS, CONSIDERATIONS, AND BEST PRACTICES 3 (2024) (white paper).

⁸⁷ Magesh et al., *supra* note 47, at 217. See also, Varun Magesh et al., *Hallucination-Free? Assessing the Reliability of Leading AI Legal Research Tools* 1-2 (Working Paper, May 29, 2024), <https://arxiv.org/abs/2405.20362>.

⁸⁸ Girish Sastry et al., *Computing Power and the Governance of Artificial Intelligence*, 2-6 a(Feb. 13, 2024), <https://doi.org/10.48550/arXiv.2402.08797>; for a summary of relevant data and graphical explanation, see Ethan Mollick, *Scaling: The State of Play in AI, ONE USEFUL THING* (Sept. 16, 2024), <https://www.oneusefulthing.org/p/scaling-the-state-of-play-in-ai>. (<https://www.oneusefulthing.org/p/scaling-the-state-of-play-in-ai>).

⁸⁹ Krištofik, *supra* note 5, at 237; Awais et al., *supra* note 6, at 2640.

⁹⁰ Socol de la Osa & Remolina, *supra* note 75, at 4; Contini et al., *supra* note 5, at 4.

⁹¹ Contini et al., *supra* note 5, at 4; Ejjami, *supra* note 39, at 5.

To address these issues, scholars advocate for explainable AI, regular evaluations, and human-in-the-loop approaches to ensure that AI supports, rather than supplants, legal professionals.⁹²

IV. Technical Foundations of Predictive AI Analytics

The technical foundations of predictive AI analytics in legal contexts rest on sophisticated ML and NLP methodologies, diverse data sources, and rigorous evaluation techniques. Supervised learning, deep learning, and generative AI enable systems to predict case outcomes, analyze biases, and support judicial reasoning, often leveraging NLP techniques such as transformer models to effectively process complex legal texts. Data sources, including structured case metadata and unstructured opinions and judgments, are critical but pose challenges like bias and incompleteness. Accuracy assessments, using metrics like precision and recall, demonstrate high performance (e.g., 97% for ECHR predictions), though issues like hallucinations and bias persist. Insights from the *Artificial Intelligence and Law Journal* underscore the importance of feature relevance and transparency. As predictive AI analytics continues to evolve, addressing technical challenges through explainable models, bias mitigation, and robust data practices will be essential to ensure its responsible integration into legal systems.

Methodologies of Predictive AI Analytics

Predictive AI analytics in legal contexts relies on a suite of advanced methodologies, primarily rooted in ML and NLP, to process legal texts and generate predictive insights. These methodologies have evolved from rule-based systems to sophisticated data-driven approaches, enabling nuanced analysis of complex legal data.

A. Machine Learning Algorithms

ML algorithms form the backbone of predictive analytics, enabling systems to learn patterns from historical legal data and make predictions about future outcomes. Although predictive analytics are not constrained to predicting judgements, Medvedeva and McBride note that systems that make predictions on a test set of existing judgements are different from systems that make predictions based on facts known to a particular party at a particular stage of litigation—for instance, a lawyer advising a client on the probable outcome of a court hearing—does not have access to the precise formulation of facts presented in a judgment, as this formulation emerges only once the judgment has been issued.⁹³

⁹² Collenette et al., *supra* note 4, at 3; McCARTHY ET AL., *supra* note 86, at 3.

⁹³ Masha Medvedeva & Pauline McBride, *Legal Judgment Prediction: If You Are Going to Do It, Do It Right*, PROC. NAT. LEGAL LANGUAGE PROCESSING WORKSHOP, 73, 73-76 (2023).

Nevertheless, systems that make so-called predictions on existing judgements can be useful to analyze a domain.⁹⁴ Examples of common approaches include:

- **Supervised Learning:** Used to predict case outcomes by training models on labeled datasets, such as court decisions paired with their verdicts. For instance, Support Vector Machines (SVM) achieved 96.9% accuracy in classifying semantic biases in the Chinese AI and Law (CAIL) dataset, outperforming Naïve-Bayes (88.8%), Multi-Layer Perceptron (or neural networks) (86.75%), and K-Nearest Neighbor (85.66%) classifiers.⁹⁵
- **Deep Learning:** Deep learning, particularly through transformer architectures,⁹⁶ enhances the ability to model complex relationships in legal texts. Transformers underpin LLMs like GPT-4 and Grok3,⁹⁷ which excel in tasks such as statutory reasoning and case law analysis.⁹⁸

These approaches enable predictive systems to identify statistically significant features, such as judicial tendencies or case characteristics, that influence legal outcomes.⁹⁹ This is contrasted with case-based reasoning systems that make predictions without relying on machine learning. This approach predicts outcomes by comparing new cases to historical precedents, using computational models of argument to assess similarity.¹⁰⁰ Some approaches combine machine learning and case-based reasoning, such as the SMILE+IBP that automatically classifies case texts using ML and predicts outcomes with case-based reasoning.¹⁰¹

B. Natural Language Processing

NLP is critical for extracting meaning from unstructured legal texts, such as judgments, briefs, and statutes. Key NLP techniques include:

⁹⁴Morgan A. Gray et al., *Automatic Identification and Empirical Analysis of Legally Relevant Factors*, PROC. NINETEENTH INT'L CONF. ON A.I. & L. 101, 101-102 (2023).

⁹⁵ Javed & Li, *supra* note 69, at 5. For a more detailed exploration of how these models work, see Wesley M. Oliver et al., *Computationally Assessing Suspicion*, 92 U. CIN. L. REV. 1108 (2024).

⁹⁶ Devlin, *supra* note 40, at 4171-4172.

⁹⁷ In July 2025, in an attempt to “rewrite the entire corpus of human knowledge”, Grok 3.5 is expected to significantly increase performance after cleanup of its training data. Jesse Coghlan, *Musk Wants Grok AI to ‘Rewrite the Entire Corpus of Human Knowledge’*, COINTELEGRAPH (June 23, 2025), <https://cointelegraph.com/news/elon-musk-grok-ai-rewrite-the-entire-corpus-human-knowledge>.

⁹⁸ Surden, *supra* note 3, at 378-79; Padiu et al., *supra* note 70, at 11.

⁹⁹ Daniel L. Chen, *Judicial Analytics and the Great Transformation of American Law*, 27 A.I. & L. 15, 16 (2019).

¹⁰⁰ Collenette et al., *supra* note 4, at 2; Ashley, *supra* note 22, at 95.

¹⁰¹ Kevin D. Ashley & Stefanie Brüninghaus, *Automatically Classifying Case Texts and Predicting Outcomes*, 17 A.I. & L. 125, 125 (2009).

- **Text Mining and Sentiment Analysis:** These methods identify relevant legal concepts, sentiments, or biases within texts, enabling systems to predict judicial behavior or case outcomes.¹⁰²
- **Language Modeling:** Transformer-architectures, which power LLMs, process legal texts by capturing contextual relationships between words, improving the accuracy of tasks like case summarization and legal reasoning.¹⁰³
- **Retrieval-Augmented Generation (RAG):** RAG enhances LLMs by integrating external legal databases during inference, reducing errors like hallucinations, though studies show that tools like Lexis+AI and Westlaw AI-Assisted Research still hallucinate in 17–33% of cases.¹⁰⁴
- **Semantic Similarity:** In Branting’s SCALE program, semantic similarity techniques were used to identify relevant sentences in unannotated texts in order to aid prediction and decision support.¹⁰⁵

NLP enables predictive systems to handle the specialized terminology and multiple interpretations inherent in legal systems, though challenges remain in capturing emotive-cognitive nuances.¹⁰⁶

C. Generative AI for Reasoning

Generative AI, particularly LLMs, is increasingly used to generate judicial opinions or assist in legal reasoning. A notable case study from Shenzhen, China, illustrates a three-step interaction pattern: judges make initial decisions, LLMs generate reasoning based on these decisions, and judges revise the output to finalize judgments.¹⁰⁷ This process leverages generative AI’s ability to produce coherent legal texts but requires human oversight to mitigate biases and errors.¹⁰⁸ One burgeoning area of research has to do with the capability of LLMs to engage in reasoning tasks with respect to argumentation.¹⁰⁹

Data Sources for Predictive AI Analytics

The effectiveness of predictive AI analytics depends on the quality and diversity of data sources, which include both structured and unstructured legal data.

¹⁰² Frankenreiter & Livermore, *supra* note 36, at 41; Javed & Li, *supra* note 69, at 3.

¹⁰³ Surden, *supra* note 3, at 378; Padiu et al., *supra* note 70, at 11.

¹⁰⁴ Magesh et al., *supra* note 47, at 217. Hallucination rates are progressively improving across models.

¹⁰⁵ L. Karl Branting et al., *Scalable and Explainable Legal Prediction*, 29 A.I. & L. 213, 213-214 (2021).

¹⁰⁶ Contini et al., *supra* note 5, at 4.

¹⁰⁷ Liu & Li, *supra* note 4, at 236.

¹⁰⁸ *Id.* at 237; Socol de la Osa & Remolina, *supra* note 75, at 4.

¹⁰⁹ Parameterized Argumentation-based Reasoning Tasks for Benchmarking Generative Language Models, Generating Case-Based Arguments with LLMs.

A. Structured Data

Structured data consists of numerical or categorical information, such as:

- Case metadata (e.g., case type, court, judge, verdict).
- Statistical records (e.g., number of cases filed, conviction rates, or sentencing lengths). These data are often sourced from court records or legal databases and are used to train models for tasks like risk assessment or case prioritization.¹¹⁰

Some scholars proposed the usage of XML, a structured language, to effectively process and handle metadata in law, particularly legislation.¹¹¹

B. Unstructured Data

Unstructured data, which constitutes the majority of legal information, includes:

- **Court Decisions and Judgments:** Texts from judicial opinions provide rich data for predicting outcomes or identifying biases.¹¹²
- **Legal Briefs and Contracts:** These documents are analyzed to extract clauses, arguments, or risks.¹¹³
- **Statutes and Case Law:** Legal databases like Westlaw or LexisNexis provide comprehensive repositories for training predictive models.¹¹⁴
- **Open Datasets:** Publicly available datasets, such as those from the European Court of Human Rights or the CAIL dataset, enable research and model development.¹¹⁵

Typically, unstructured data requires advanced NLP to process, but its richness allows for nuanced predictions.¹¹⁶

C. Free Legal Information Resources

Free legal advice services, such as those supported by the DataLex Project, rely on open-access legal information from providers like Legal Information Institutes (LIIs). These resources are critical for developing sustainable predictive systems in resource-constrained environments.¹¹⁷

¹¹⁰ Eboigbe, *supra* note 68, at 3; Chen, *supra* note 99, at 16.

¹¹¹ *see generally* LEGISLATIVE XML FOR THE SEMANTIC WEB: PRINCIPLES, MODELS, STANDARDS FOR DOCUMENT MANAGEMENT (Giovanni Sartor, Monica Palmirani, Enrico Francesconi & Maria Angela Biasiotti eds., 1st ed. 2011).

¹¹² Javed & Li, *supra* note 69, at 3; Collenette et al., *supra* note 4, at 2.

¹¹³ Eboigbe, *supra* note 68, at 3.

¹¹⁴ Padiu et al., *supra* note 70, at 11; Surden, *supra* note 3, at 379.

¹¹⁵ Collenette et al., *supra* note 4, at 2; Javed & Li, *supra* note 69, at 3.

¹¹⁶ Isabel Trancoso et al., *The Impact of Language Technologies*, in 58 L., GOVERNANCE & TECH. SERIES, MULTIDISCIPLINARY PERSPECTIVES ON ARTIFICIAL INTELLIGENCE AND THE LAW 25, 26 (Henrique Sousa Antunes, et al. eds., 2024).

¹¹⁷ Greenleaf et al., *supra* note 12, at 19.

D. Challenges with Data

Data quality poses significant challenges:

- **Bias:** Historical legal data often contains biases (e.g., racial or socioeconomic disparities), which AI models can amplify.¹¹⁸
- **Incompleteness:** Missing or inconsistent data can reduce model reliability.¹¹⁹
- **Jurisdictional Variability:** Differences in legal systems across geographies complicate data generalization.¹²⁰

Accuracy Assessments of Predictive AI Analytics

Evaluating the accuracy of predictive AI analytics is crucial to ensure reliability and trustworthiness in legal applications. Common metrics and approaches include:

A. Accuracy Metrics

- **Precision, Recall, and F1 Score:** These metrics assess the balance between correct predictions and errors. For example, the ECHR case prediction model achieved 97% accuracy in matching actual decisions, demonstrating high precision and recall.¹²¹
- **Classification Accuracy:** The CAIL dataset study reported SVM's 96.9% accuracy in bias classification, highlighting the effectiveness of supervised learning.¹²²
- **Error Rates:** Studies of RAG-based tools like Lexis+AI and Westlaw AI-Assisted Research found hallucination rates of 17–33%, indicating persistent accuracy challenges.¹²³

B. Empirical Evaluations

Empirical studies provide robust assessments:

- A Dutch court's AI system for traffic violation appeals showed improved consistency but altered legal experts' decisions, suggesting accuracy trade-offs.¹²⁴
- The Shenzhen case study found that LLM-generated judicial reasoning required significant human revision to ensure accuracy, highlighting the limitations of generative AI.¹²⁵

¹¹⁸ Krištofik, *supra* note 5, at 237; Javed & Li, *supra* note 69, at 3.

¹¹⁹ Padiu et al., *supra* note 70, at 16.

¹²⁰ Padiu et al., *supra* note 70, at 18.

¹²¹ Collenette et al., *supra* note 4, at 3. *See also*, Ashley, *supra* note 14, at 113-14.

¹²² Javed & Li, *supra* note 69, at 5.

¹²³ Magesh et al., *supra* note 47, at 217.

¹²⁴ Kolkman et al., *supra* note 77, at 5.

¹²⁵ Liu & Li, *supra* note 4, at 237.

C. Explainability and Trustworthiness

Accuracy alone is insufficient without explainability. Models like the ECHR tool use computational argument models to provide transparent, legally grounded explanations, achieving high usability in user studies.¹²⁶ Conversely, “black-box” models risk undermining trust due to their opacity.¹²⁷ Some techniques, in the field of explainable AI (XAI) explain a model’s prediction in a post-hoc fashion.¹²⁸ However, post-hoc explainers still need to be verified for trustworthiness, in that the explanations comport with human knowledge.¹²⁹ Other approaches in the field of AI and Law seek to understand and explain a model’s prediction through the lens of the model’s internal workings.¹³⁰

Insights from the *Artificial Intelligence and Law Journal*

The *Artificial Intelligence and Law Journal* provides critical insights into the technical foundations of predictive AI analytics:

- **Chen (2019):** Highlights the use of ML to assess extra-legal factors and debias judicial decisions, emphasizing the role of feature relevance in predictive models.¹³¹
- **Ashley (2019):** Discusses the evolution of case prediction from rule-based to ML-driven approaches, underscoring the importance of statistical feature analysis.¹³² These studies, published in the journal, emphasize the need for robust methodologies and transparent accuracy assessments to address biases and ensure reliability in legal applications.

V. Ethical and Legal Implications

The ethical and legal implications of AI simulating judicial functions center on bias, transparency, accountability, and fairness, each posing significant challenges to the administration of justice. Bias in AI systems, as seen in tools like COMPAS, risks perpetuating inequities, while the opacity of “black-box” models undermines transparency

¹²⁶ Collenette et al., *supra* note 4, at 3.

¹²⁷ Socol de la Osa & Remolina, *supra* note 75, at 4; Contini et al., *supra* note 5, at 4.

¹²⁸ For example, a well known post-hoc explanatory technique is the SHAP family of explainers, see, e.g., Ian C. Covert, Scott Lundberg & Su-In Lee, *Understanding Global Feature Contributions with Additive Importance Measures*, PROC. 34TH INT’L CONF. ON NEURAL INFO. PROCESSING SYS. 17212 (2020); Scott M. Lundberg & Su-In Lee, *A Unified Approach to Interpreting Model Predictions*, PROC. 31ST INT’L CONF. ON NEURAL INFO. PROCESSING SYS. 4768 (2017).

¹²⁹ Marco Ribeiro, Sameer Singh & Carlos Guestrin, “Why Should I Trust You?: Explaining the Predictions of Any Classifier”, PROC. 2016 CONF. N. AM. CH. ASS’N COMPUT. LINGUISTICS: DEMONSTRATIONS 97, 97-98 (2016).

¹³⁰ Gray, *supra* note 94, at 101-102; Zachary C. Lipton, *The Mythos of Model Interpretability*, 61 COMMUN. ACM 36 (2018).

¹³¹ Chen, *supra* note 99, at 16–17.

¹³² Ashley, *supra* note 22, at 95–96.

and trust.¹³³ Accountability remains elusive, with unclear liability for AI errors, and fairness is threatened by AI's inability to replicate human empathy and social responsiveness. These issues, evidenced in jurisdictions from the U.S. to China, underscore the need for robust regulatory frameworks, explainable AI, and human oversight to ensure that AI augments, rather than supplants, judicial decision-making. As AI continues to evolve, balancing its efficiency with the ethical and legal principles of justice will be critical to preserving the integrity of judicial systems.

Bias in AI Judicial Systems

Bias is a central ethical concern in AI judicial applications, as machine learning models often replicate and amplify existing biases in training data. Historical judicial data, such as court decisions, may embed systemic biases (e.g., racial or socioeconomic disparities), which AI systems can perpetuate in predictions or decisions.¹³⁴ A 2016 ProPublica report highlighted this issue, revealing that the COMPAS risk assessment tool used in U.S. bail decisions was biased against African Americans, falsely flagging them as higher-risk at disproportionate rates.¹³⁵ This bias arises because AI models rely on historical data that reflect past inequities, and even attempts at “fairness through unawareness” (omitting protected characteristics like race) fail due to proxy variables that correlate with bias.¹³⁶

The ethical implications of bias are profound, as it undermines the principle of equal justice under the law. For example, a study on the CAIL dataset demonstrated that AI models could identify semantic biases in judicial judgments, but their reliance on biased training data risked perpetuating unethical predictions.¹³⁷ Legally, biased AI outputs could violate due process and anti-discrimination laws, prompting calls for fairness audits and bias mitigation strategies.¹³⁸

Transparency and Interpretability

Transparency is critical to ensuring trust in AI judicial systems, yet many AI models, particularly LLMs, operate as “black boxes,” making their decision-making processes opaque.¹³⁹ This lack of interpretability poses ethical challenges, as judges and litigants cannot scrutinize the reasoning behind AI-generated outputs, such as case predictions or

¹³³ One strength of classic case-based reasoning systems and similar programs is that they typically produce verifiable outputs. See Preeja Pradeep, Marta Caro-Martínez & Anjana Wijekoon, *A Practical Exploration of the Convergence of Case-Based Reasoning and Explainable Artificial Intelligence*, 255, Part D, 124733 EXPERT SYST. APPL., 2024, at 1-2.

¹³⁴ Julia Angwin et al., *Machine Bias*, PROPUBLICA (May 23, 2016), <https://www.propublica.org/article/machine-bias-risk-assessments-in-criminal-sentencing>; Krištofik, *supra* note 5, at 237.

¹³⁵ Krištofik, *supra* note 5, at 237.

¹³⁶ Krištofik, *supra* note 5, at 237; Chen, *supra* note 99, at 17.

¹³⁷ Javed & Jianxin Li, *supra* note 69, at 3.

¹³⁸ Zahra, *supra* note 6, at 12; Awais et al., *supra* note 6, at 2640.

¹³⁹ Socol de la Osa & Remolina, *supra* note 75, at 4; Surden, *supra* note 3, at 380.

draft opinions.¹⁴⁰ For instance, generative AI used in Shenzhen courts to draft judicial opinions required significant human revision due to potential errors, highlighting the ethical risk of relying on non-transparent systems.¹⁴¹

Legally, the opacity of AI systems could undermine procedural fairness, as parties have a right to understand the basis of judicial decisions. European scholars and legislation, such as the EU's AI Act, emphasize the need for explainable AI to ensure compliance with due process.¹⁴² The ethical imperative for transparency is further underscored by the risk of “hallucinations,” where AI generates false legal citations or facts, as observed in tools like Lexis+AI and Westlaw AI-Assisted Research, which hallucinate in 17–33% of cases.¹⁴³ Transparent, explainable AI models, such as those developed for the ECHR, which achieved 97% accuracy with digestible explanations, offer a model for addressing these concerns.¹⁴⁴

Accountability in AI Judicial Functions

Accountability is a pressing ethical and legal issue, as it remains unclear who is responsible for errors or biases in AI-driven judicial decisions—developers, judges, or institutions. The Shenzhen case study illustrates that judges retain ultimate accountability, revising AI-generated reasoning to ensure accurate judgments, but this human-in-the-loop approach does not fully resolve the issue.¹⁴⁵ If AI misinforms judicial decisions, as seen in case studies from Colombia, Mexico, Peru, and India, it could lead to miscarriages of justice, raising questions about liability.¹⁴⁶ Ethically, the delegation of judicial functions to AI risks eroding public trust in the judiciary, as accountability becomes diffused.¹⁴⁷

Fairness and the Human Element in Judging

Fairness in judicial decision-making requires empathy, intuition, and responsiveness to social factors, qualities that AI struggles to replicate. Predictive and generative AI systems often reduce complex judicial processes to statistical correlations, neglecting the emotive-cognitive dimensions of justice.¹⁴⁸ This reductionism threatens fairness by ignoring contextual nuances, such as cultural or socioeconomic factors, that human judges

¹⁴⁰ Contini et al., *supra* note 5, at 4.

¹⁴¹ Liu & Li, *supra* note 4, at 237.

¹⁴² Contini et al., *supra* note 5, at 2; Socol de la Osa & Remolina, *supra* note 75, at 4.

¹⁴³ Magesh et al., *supra* note 47, at 217.

¹⁴⁴ Collenette et al., *supra* note 4, at 3.

¹⁴⁵ Liu & Li, *supra* note 4, at 236–37.

¹⁴⁶ Socol de la Osa & Remolina, *supra* note 75, at 3–4.

¹⁴⁷ Awais et al., *supra* note 6, at 2640; Ejjami, *supra* note 39, at 5.

¹⁴⁸ Contini et al., *supra* note 5, at 4; Tania Sourdin, *Robo Justice: Constitutional Issues with Judge AI*, 30 IND. J. GLOB. LEGAL STUD. 293, 306–07 (2023).

consider.¹⁴⁹ For instance, Italian court cases demonstrated that AI's reliance on prior judgments oversimplified fact-finding and legal encoding, risking unjust outcomes.¹⁵⁰

Ethically, the absence of human qualities like compassion undermines the humanity of the judicial process, potentially dehumanizing litigants.¹⁵¹ Legally, this could contravene constitutional principles of justice, as an overly narrow definition of judicial outcomes may exclude critical social considerations.¹⁵² The use of AI in judicial settings, such as risk assessments or opinion drafting, must therefore be tempered by human oversight to ensure fairness.¹⁵³ Scholars argue that AI should augment, not replace, human judges to preserve the responsive nature of justice.¹⁵⁴

Additional Ethical and Legal Considerations

Beyond the core concerns, AI judicial systems raise additional issues:

- **Data Privacy:** AI's reliance on sensitive legal data raises privacy concerns, potentially violating confidentiality laws.¹⁵⁵
- **Access to Justice:** While AI can enhance access by streamlining processes, unequal access to AI tools among legal professionals (the "digital divide") may exacerbate disparities.¹⁵⁶
- **Judicial Discretion:** AI's influence on judicial decisions risks undermining discretion, a cornerstone of judicial independence.¹⁵⁷

These concerns highlight the need for interdisciplinary collaboration among lawyers, technologists, and regulators to develop ethical guidelines and legal frameworks.¹⁵⁸

¹⁴⁹ Tania Sourdin & Richard Cornes, *Do Judges Need to Be Human? The Implications of Technology for Responsive Judging*, in 67 IUS GENTIUM: COMPARATIVE PERSPECTIVES ON LAW AND JUSTICE 87, 89–90 (Tania Sourdin & Archie Zariski eds., 2018).

¹⁵⁰ Contini et al., *supra* note 5, at 3.

¹⁵¹ Sourdin & Cornes, *supra* note 149, at 90–91.

¹⁵² *Id.* at 306.

¹⁵³ Ejjami, *supra* note 39, at 5; MCCARTHY ET AL., *supra* note 86, at 3.

¹⁵⁴ Sourdin & Cornes, *supra* note 149, at 92; Eboigbe, *supra* note 68, at 5.

¹⁵⁵ Lalit Singh et al., *Artificial Intelligence in the Legal Profession: A Review on Its Transformative Potential and Ethical Challenges*, PROC. 5TH INT'L CONF. ON INFO. MGMT. & MACH. INTEL. 1, 3 (2024); Awais et al., *supra* note 6, at 2640.

¹⁵⁶ Zahra, *supra* note 6, at 12; Padiu et al., *supra* note 70, at 11.

¹⁵⁷ Socol de la Osa & Remolina, *supra* note 75, at 4; Kolkman et al., *supra* note 77, at 5.

¹⁵⁸ Awais et al., *supra* note 6, at 2641; Jörg Pohle, "A Legal Discipline of the Future" – A Short History of the Intersection of Law and Computer Science, 5 HIIG DISCUSSION PAPER SERIES 1, 3–4 (2022).

VI. Benefits and Limitations of AI in Legal Solutions

AI in legal practice offers significant benefits but is offset by the aforementioned risks. By leveraging explainable AI, fairness audits, and training, the legal profession can harness AI's advantages while mitigating its limitations, ensuring that technology serves as a boon to justice rather than a barrier. As AI continues to evolve, a balanced approach will be essential to maintain the integrity of legal systems.

Benefits of AI in Legal Practice

AI's integration into legal practice has yielded substantial benefits, particularly in improving efficiency, accuracy, and access to justice. These advantages are evident across various applications, from legal research to judicial support.

A. Efficiency

AI significantly enhances efficiency by automating time-consuming tasks, allowing legal professionals to focus on higher-value activities. Tools like Lexis+AI and Westlaw AI-Assisted Research streamline legal research by rapidly retrieving relevant case law, statutes, and legal documents, reducing hours of manual work to minutes.¹⁵⁹ Predictive analytics further optimizes litigation strategies by forecasting case outcomes, enabling faster decision-making and settlement negotiations.¹⁶⁰

Corporate legal departments also benefit, using AI for contract analysis and compliance monitoring, which reduces administrative burdens and operational costs.¹⁶¹ These efficiency gains enhance client service and enable law firms to handle complex cases more effectively.¹⁶²

B. Accuracy

AI's ability to process vast datasets with precision offers significant accuracy improvements in legal tasks. To reiterate, predictive analytics, for instance, achieves high accuracy in forecasting case outcomes, as demonstrated by a model for the ECHR that matched actual decisions with 97% accuracy.¹⁶³ Similarly, a study on the CAIL dataset reported 96.9% accuracy in classifying semantic biases using SVMs, outperforming traditional risk assessment tools.¹⁶⁴

¹⁵⁹ Sadiku et al., *supra* note 44, at 69.; Zahra, *supra* note 6, at 11.

¹⁶⁰ Padiu et al., *supra* note 70, at 11.

¹⁶¹ Sadiku et al., *supra* note 44, at 69; Eboigbe, *supra* note 68, at 4.

¹⁶² McCARTHY ET AL., *supra* note 86, at 3.

¹⁶³ Collenette et al., *supra* note 4, at 3.

¹⁶⁴ Javed & Jianxin Li, *supra* note 69, at 5.

AI also enhances accuracy in legal research by identifying relevant precedents and extracting key legal concepts, reducing human error.¹⁶⁵ Judicial analytics can further improve fairness by identifying extra-legal factors and behavioral anomalies in decisions, aiding efforts to debias the law.¹⁶⁶ These accuracy benefits are particularly valuable in overburdened legal systems, such as India's, where AI alleviates caseload pressures.¹⁶⁷

C. Access to Justice

AI enhances access to justice by reducing costs and improving service delivery, particularly for underserved populations. Automated tools for legal research and document drafting lower the financial barriers to legal representation.¹⁶⁸ For example, AI-driven platforms support free legal advice services, enabling equitable access to legal resources.¹⁶⁹ Additionally, AI's role in alternative dispute resolution streamlines processes, making justice more accessible.¹⁷⁰

Limitations of AI in Legal Practice

Despite its benefits, AI in legal practice faces significant limitations, including challenges in contextual understanding, risks of overreliance, and ethical concerns related to bias and errors.

A. Contextual Understanding

AI struggles to capture the nuanced, emotive-cognitive aspects of legal decision-making, such as empathy and social context, which are critical to judicial processes. Predictive and generative AI systems often reduce complex legal proceedings to statistical correlations, oversimplifying fact-finding and legal reasoning.¹⁷¹ For instance, Italian court cases showed that AI failed to account for the dynamics of judicial deliberations, risking unjust outcomes.¹⁷²

Generative AI, such as ChatGPT, cannot produce justified beliefs aligned with virtue jurisprudence, as it lacks the human virtues required for responsive judging.¹⁷³ This limitation is compounded by AI's inability to fully interpret cultural or socioeconomic factors,

¹⁶⁵ Trancoso et al., *supra* note 116, at 26; Padiu et al., *supra* note 70, at 11.

¹⁶⁶ Chen, *supra* note 99, at 16-17.

¹⁶⁷ Conrad et al., *supra* note 37, at 1.

¹⁶⁸ Zahra, *supra* note 6, at 11; Socol de la Osa & Remolina, *supra* note 75, at 3.

¹⁶⁹ Sergio David Becerra, *The Rise of Artificial Intelligence in the Legal Field: Where We Are and Where We Are Going*, 11 J. BUS., ENTREPRENEURSHIP & L. 27, 29 (2018).

¹⁷⁰ Zahra, *supra* note 6, at 11.

¹⁷¹ Contini et al., *supra* note 5, at 4; Sourdin, *supra* note 148, at 306.

¹⁷² Contini et al., *supra* note 5, at 3.

¹⁷³ Shilun Zhou, *Analyzing the Justification for Using Generative AI Technology to Generate Judgments Based on the Virtue Jurisprudence Theory*, J. DECISION SYS. 1, 3 (2024).

which human judges naturally consider.¹⁷⁴ As a result, AI may produce technically accurate but contextually deficient outputs, undermining the quality of justice.¹⁷⁵ Some research, such as Grabmair's VJAP has made progress by taking values, sometimes thought of as purposes for a law,¹⁷⁶ into account when decision making.¹⁷⁷

B. Overreliance and Errors

Overreliance on AI poses a significant risk, as legal professionals may defer to AI outputs without critical evaluation, leading to errors and biases. As discussed, LLMs are prone to “hallucinations,” generating false legal citations or facts, with tools like Lexis+AI and Westlaw AI-Assisted Research hallucinating in 17–33% of cases.¹⁷⁸ In judicial settings, overreliance on AI-generated reasoning, as observed in Shenzhen courts, can amplify judges' prior beliefs, potentially introducing biases.¹⁷⁹

The risk of overreliance is exacerbated by AI's perceived objectivity, which may lead to uncritical acceptance of flawed outputs.¹⁸⁰ For example, the COMPAS tool's biased risk assessments in U.S. bail decisions highlight the dangers of relying on AI without rigorous oversight.¹⁸¹ Ethically, overreliance undermines judicial discretion and accountability, necessitating human-in-the-loop approaches to verify AI outputs.¹⁸²

On the other hand, some studies have found that students were unlikely to over rely on LLM output when labelling court opinions as to legally relevant factors.¹⁸³ Some studies have shown a prejudice toward AI outputs, finding that “[t]he aversion to AI-generated legal content aligns with existing research on algorithmic aversion in other domains.”¹⁸⁴

C. Bias and Ethical Challenges

AI's reliance on historical data introduces biases that can perpetuate inequities, such as racial or socioeconomic disparities in judicial decisions.¹⁸⁵ These biases, coupled with

¹⁷⁴ Sourdin & Cornes, *supra* note 149, at 89-90.

¹⁷⁵ Sourdin, *supra* note 148, at 306.

¹⁷⁶ Grabmair, *supra* note 33, at (citing Donald H. Berman & Carole D. Hafner, *Representing Teleological Structure in Case-Based Legal Reasoning: The Missing Link*, PROC. 4TH INT'L CONF. ON A.I. & L. 50 (1993)).

¹⁷⁷ See generally Grabmair, *supra* note 33.

¹⁷⁸ Magesh et al., *supra* note 47, at 217.

¹⁷⁹ Liu & Li, *supra* note 4, at 237.

¹⁸⁰ Kolkman et al., *supra* note 77, at 5; Socol de la Osa & Remolina, *supra* note 75, at 4.

¹⁸¹ Krištofik, *supra* note 5, at 237.

¹⁸² MCCARTHY ET AL., *supra* note 86, at 3; Eboigbe, *supra* note 68, at 5.

¹⁸³ Morgan A. Gray et al., *Can GPT Alleviate the Burden of Annotation?*, in LEGAL KNOWLEDGE AND INFORMATION SYSTEMS 157, 159 (2023).

¹⁸⁴ See generally Jaukub Harasta et al., *It Cannot Be Right if it was Written by AI: On Lawyers' Preferences of Documents Perceived as Authored by an LLM vs a Human*, 32 A.I. & L. (2024).

¹⁸⁵ Krištofik, *supra* note 5, at 237; Chen, *supra* note 99, at 17.

issues like data privacy and lack of transparency, raise ethical concerns that limit AI's reliability.¹⁸⁶ The “digital divide” among legal professionals further complicates equitable AI adoption, potentially exacerbating access disparities.¹⁸⁷

Balancing Benefits and Limitations

The evidence underscores that AI's benefits—efficiency, accuracy, and improved access—are most effective when balanced against its limitations through human oversight and ethical safeguards. Explainable AI models, like the ECHR tool, mitigate contextual deficiencies by providing transparent, legally grounded outputs.¹⁸⁸ Regular fairness audits and bias mitigation strategies address ethical concerns, ensuring AI aligns with justice principles.¹⁸⁹ Moreover, training programs for legal professionals can reduce overreliance by fostering AI literacy.¹⁹⁰

AI's role as a supportive tool, rather than a replacement for human judgment, is critical. As emphasized in multiple studies, AI augments legal practice but cannot replicate the empathy and discretion required for responsive judging.¹⁹¹ This human-in-the-loop approach, as practiced in Shenzhen courts, ensures that AI enhances efficiency without compromising justice.¹⁹²

VII. Regulatory Frameworks

Regulatory frameworks governing AI in legal solutions and judicial roles are evolving to address its potential and risks. Existing policies, such as the EU AI Act, U.S. guidelines, and Chinese ethical norms, focus on transparency, bias mitigation, and human oversight, with varying degrees of stringency. Proposed frameworks advocate for mandatory bias audits, explainable AI, robust human oversight, data privacy protections, and global harmonization to ensure fairness and accountability. Challenges like jurisdictional variability and implementation gaps persist, requiring interdisciplinary collaboration and adaptive policies. By balancing innovation with ethical safeguards, these frameworks aim to harness AI's efficiency while preserving the human elements of justice, ensuring its responsible integration into legal systems.

¹⁸⁶ Singh et al., *supra* note 155, at 3; Awais et al., *supra* note 6, at 2640.

¹⁸⁷ Zahra, *supra* note 6, at 12.

¹⁸⁸ Collenette et al., *supra* note 4, at 3.

¹⁸⁹ Awais et al., *supra* note 6, at 2641; Chen, *supra* note 99, at 17.

¹⁹⁰ Zahra, *supra* note 6, at 12.

¹⁹¹ Sourdin & Cornes, *supra* note 149, at 92; MCCARTHY ET AL., *supra* note 86, at 3; Eboigbe, *supra* note 68, at 5.

¹⁹² Liu & Li, *supra* note 4, at 236.

Existing Regulatory Frameworks

Several jurisdictions have implemented policies to govern AI in legal and judicial contexts, focusing on mitigating risks while promoting responsible use. These frameworks vary in scope and stringency, reflecting regional differences in legal systems and priorities.

A. European Union: The AI Act and High-Risk Classifications

The European Union has taken a leading role in regulating AI, with the EU AI Act serving as a cornerstone framework. The Act classifies AI applications in judicial proceedings as “high-risk” due to their potential to impact fundamental rights, such as due process and non-discrimination.¹⁹³ High-risk AI systems, including those used for predictive analytics or judicial decision support, are subject to strict requirements, such as mandatory transparency, bias audits, and human oversight.¹⁹⁴

The EU AI Act mandates that AI tools provide explainable outputs to ensure judicial decisions are scrutable, addressing concerns about “black-box” models.¹⁹⁵ It also requires continuous monitoring to detect and correct biases, responding to issues like those seen in the COMPAS tool, which amplified racial disparities in U.S. bail decisions.¹⁹⁶ This framework aims to protect liberal democratic values, such as equal treatment and judicial independence, by limiting AI’s role to supportive functions.¹⁹⁷

B. United States: Fragmented Oversight and Ethical Guidelines

In the United States, AI regulation in legal contexts is less centralized, relying on a patchwork of federal and state-level guidelines. Federal oversight, such as through the National Institute of Standards and Technology (NIST), emphasizes voluntary standards for AI fairness, transparency, and accountability.¹⁹⁸ State-level initiatives, particularly in jurisdictions like California, impose requirements for AI transparency and bias mitigation in high-stakes applications, including judicial risk assessments.¹⁹⁹

Ethical guidelines, such as those proposed by the American Bar Association, encourage lawyers to verify AI outputs to prevent errors like hallucinations.²⁰⁰ However, the lack of uniform federal regulations creates inconsistencies, particularly in judicial settings where AI

¹⁹³ Contini et al., *supra* note 5, at 2.

¹⁹⁴ Contini et al., *supra* note 5, at 2; Socol de la Osa & Remolina, *supra* note 75, at 5.

¹⁹⁵ Socol de la Osa & Remolina, *supra* note 75, at 5.

¹⁹⁶ Krištofik, *supra* note 5, at 237.

¹⁹⁷ Christopher K. Winter, *The Challenges of Artificial Judicial Decision-Making for Liberal Democracy*, in 14 JUDICIAL DECISION-MAKING, ECONOMIC ANALYSIS OF LAW IN EUROPEAN LEGAL SCHOLARSHIP 179, 184 (Piotr Bystranowski et al. eds., 2022).

¹⁹⁸ Zahra, *supra* note 6, at 12.

¹⁹⁹ Zahra, *supra* note 6, at 12.

²⁰⁰ Magesh et al., *supra* note 47, at 217; MCCARTHY ET AL., *supra* note 86, at 3.

tools like COMPAS have faced scrutiny for bias.²⁰¹ The U.S. approach prioritizes innovation but struggles to address systemic risks comprehensively.²⁰²

C. China: Ethical Norms and Auxiliary Role Clarification

In China, regulatory frameworks for judicial AI focus on clarifying its auxiliary role and establishing ethical norms. Policies emphasize that AI, such as LLMs used in Shenzhen courts to generate judicial opinions, should support human judges rather than replace them, ensuring judicial accountability remains with humans. Regulations mandate differential trials and post hoc monitoring to standardize AI applications, addressing procedural defects and ethical risks like bias amplification.²⁰³

Chinese guidelines also require AI systems to undergo extensive testing to ensure accuracy and fairness, particularly in tasks like sentencing guidance and document generation.²⁰⁴ These policies aim to enhance trial efficiency while safeguarding judicial integrity, reflecting a cautious approach to AI's judicial role.²⁰⁵ However, the lack of transparency in some Chinese AI systems raises concerns about compliance with global ethical standards.²⁰⁶

Proposed Regulatory Frameworks

Scholars and policymakers have proposed several frameworks to address gaps in existing regulations, focusing on bias mitigation, transparency, human oversight, and global harmonization.

A. Bias Audits and Fairness Standards

Proposed regulations emphasize mandatory bias audits to mitigate AI's tendency to perpetuate historical biases, as seen in tools like COMPAS.²⁰⁷ These audits would involve regular testing of AI models against diverse datasets, such as the CAIL dataset, to identify and correct biases.²⁰⁸ Fairness standards, proposed by scholars, would require AI systems to demonstrate equitable outcomes across demographic groups, aligning with principles of equal treatment.²⁰⁹

²⁰¹ Krištofík, *supra* note 5, at 237.

²⁰² Ejjami, *supra* note 39, at 5.

²⁰³ Gulimila Aini, *A Summary of the Research on the Judicial Application of Artificial Intelligence*, 9 CHINESE STUD. 14, 16 (2020).

²⁰⁴ *Id.*

²⁰⁵ Liu & Li, *supra* note 4, at 236.

²⁰⁶ Ejjami, *supra* note 39, at 5.

²⁰⁷ Awais et al., *supra* note 6, at 2640;; Krištofík, *supra* note 5, at 237.

²⁰⁸ Javed & Jianxin Li, *supra* note 69, at 3.

²⁰⁹ Winter, *supra* note 197, at 181; Chen, *supra* note 99, at 17.

B. Explainable AI and Transparency Requirements

Transparency is a critical focus of proposed frameworks, with calls for explainable AI to ensure judicial and legal outputs are understandable. Scholars advocate for regulations requiring AI systems to provide clear, legally grounded rationales, as exemplified by the ECHRmodel.²¹⁰ Retrieval-based systems, like those using RAG, are recommended to reduce hallucinations, though current limitations necessitate further refinement.²¹¹

Proposed policies also mandate disclosure of AI's role in decision-making processes, ensuring litigants and judges can scrutinize outputs.²¹² These measures aim to protect due process and public trust, particularly in judicial settings where opacity could undermine legitimacy.²¹³

C. Human Oversight and Judicial Independence

Proposed frameworks emphasize human oversight to preserve judicial discretion and independence. Regulations would require AI to function as a decision-support tool, as seen in Shenzhen's human-in-the-loop model, where judges revise AI-generated outputs.²¹⁴ This approach mitigates risks of AI overreach, ensuring human judges retain ultimate accountability.²¹⁵

To protect judicial independence, scholars propose legal infrastructure to limit AI's influence on core judicial functions, addressing concerns about advanced artificial judicial intelligence (AAJI) threatening the separation of powers.²¹⁶ These policies would restrict AI to transactional tasks, such as document generation, while reserving complex decision-making for humans.²¹⁷

Challenges in Regulation

Despite progress, regulatory frameworks face significant challenges:

- **Balancing Innovation and Ethics:** Strict regulations, like the EU AI Act, may stifle innovation, while lenient approaches, like in the U.S., risk unchecked biases.²¹⁸

²¹⁰ Collenette et al., *supra* note 4, at 3.

²¹¹ Magesh et al., *supra* note 47, at 217.

²¹² Socol de la Osa & Remolina, *supra* note 75, at 5; Zahra, *supra* note 6, at 12.

²¹³ Anna Fine & Shawn Marsh, *Judicial Leadership Matters (Yet Again): The Association Between Judge and Public Trust for Artificial Intelligence in Courts*, 4 DISCOVER A.I. 1, 3 (2024).

²¹⁴ Liu & Li, *supra* note 4, at 236; Zichun Xu, *Human Judges in the Era of Artificial Intelligence: Challenges and Opportunities*, 36 APPLIED A.I. 1, 3 (2021).

²¹⁵ Aini, *supra* note 203, at 16; Socol de la Osa & Remolina, *supra* note 75, at 5.

²¹⁶ Winter, *supra* note 197, at 185.

²¹⁷ Xu, *supra* note 214, at 3; Sourdin & Cornes, *supra* note 149, at 92.

²¹⁸ Contini et al., *supra* note 5, at 2; Zahra, *supra* note 6, at 12.

- **Jurisdictional Variability:** Differences in legal systems complicate global harmonization, requiring tailored yet compatible policies.²¹⁹
- **Implementation Gaps:** Proposed frameworks, such as bias audits, lack clear implementation guidelines, hindering practical adoption.²²⁰
- **Judicial Resistance:** Judges' skepticism about AI, driven by concerns about empathy and discretion, may slow regulatory acceptance.²²¹

These challenges underscore the need for adaptive, evidence-based regulations that evolve with AI advancements.²²² Web3 systems offer significant improvements in this context.²²³

IX. Research Gaps in the Judicial Application of AI

The literature on AI's judicial applications reveals significant research gaps that hinder its responsible integration. The absence of longitudinal studies limits understanding of AI's long-term impact, while the focus on Western jurisdictions overlooks non-Western legal systems. Real-world judicial applications remain underexplored, leaving practical challenges unaddressed. Ethical and regulatory frameworks are underdeveloped, particularly regarding bias and judicial independence, and the societal impacts on public trust are insufficiently studied. Addressing these gaps requires future research to prioritize longitudinal analyses, diverse jurisdictional studies, empirical case studies, robust ethical guidelines, and investigations into public perceptions. By filling these voids, scholars can ensure AI enhances judicial efficiency and fairness while preserving the integrity of legal systems globally.

Lack of Longitudinal Studies on AI's Judicial Impact

One significant research gap is the absence of longitudinal studies evaluating the long-term effects of AI in judicial systems. Current literature often focuses on short-term outcomes, such as AI's immediate efficiency gains or accuracy in specific tasks, but fails to assess its enduring impact on judicial processes and outcomes.²²⁴ For instance, while AI tools have demonstrated high accuracy in predicting case outcomes (e.g., 96.9% in the CAIL dataset), there is little evidence on how these tools affect judicial decision-making quality, case backlogs, or public trust over extended periods.²²⁵

Longitudinal research is critical to understanding whether AI's efficiency benefits persist or if they introduce unintended consequences, such as increased reliance on automated

²¹⁹ Padiu et al., *supra* note 70, at 18.

²²⁰ Awais et al., *supra* note 6, at 2640.

²²¹ Sourdin, *supra* note 148, at 306; Sourdin & Cornes, *supra* note 149, at 90.

²²² Eboigbe, *supra* note 68, at 5.

²²³ See generally, Wulf A. Kaal, *AI Governance Via Web3 Reputation System*, 7 STAN. J. BLOCKCHAIN L. & POL. (2024).

²²⁴ Aini, *supra* note 203, at 16.

²²⁵ Javed & Jianxin Li, *supra* note 69, at 5..

systems or perpetuation of biases.²²⁶ For example, studies on public trust in AI, such as one examining perceptions of AI in criminal courts, highlight the role of judges in shaping trust but lack follow-up data on how these perceptions evolve.²²⁷ Future research should prioritize longitudinal studies to assess AI's sustained impact on judicial efficiency, fairness, and public confidence across diverse jurisdictions.

Limited Focus on Non-Western Legal Systems

AI systems generally are developed in the western world. Such western AI system domination can be further exacerbated through mostly western training data for AI systems. This may lead to cultural biases in AI outputs as non-western cultures and non-western values inherent in such cultures are inadequately represented.

The literature on AI in judicial applications is heavily skewed toward Western, common law jurisdictions or civil systems in Europe, with insufficient attention to non-Western legal systems, such as those in Asia, Africa, or the Middle East.²²⁸ While studies like those on the CAIL dataset provide insights into AI's application in China, they are exceptions rather than the norm, and even these focus narrowly on technical performance rather than broader cultural or legal contexts.²²⁹ This gap limits the generalizability of findings, as legal systems vary significantly in their structures, cultural values, and judicial practices.²³⁰

Non-Western jurisdictions often face unique challenges, such as resource constraints or differing ethical norms, which influence AI's applicability. For instance, AI's role in improving access to justice in developing countries is underexplored, despite its potential to address overburdened courts.²³¹ Research on civil law or hybrid legal systems, which dominate many non-Western regions, is also scarce, leaving questions about AI's adaptability unanswered.²³² Future studies should investigate AI's judicial applications in diverse legal traditions, incorporating cultural and jurisdictional nuances to ensure global relevance.

Insufficient Exploration of Real-World Judicial AI Applications

Current research often focuses on theoretical or experimental applications of AI, with limited analysis of real-world judicial implementations. While studies highlight AI's potential in tasks like sentencing guidance or document generation, few examine its practical deployment in courtrooms.²³³ For example, the literature lacks detailed case studies on how AI tools, such

²²⁶ Aini, *supra* note 203, at 16.

²²⁷ Fine & Marsh, *supra* note 213, at 3.

²²⁸ Padiu et al., *supra* note 70, at 665.

²²⁹ Javed & Li, *supra* note 69, at 3.

²³⁰ Padiu et al., *supra* note 70, at 7, 19.

²³¹ *Id.*

²³² *Id.*

²³³ Aini, *supra* note 203, at 15; Xu, *supra* note 214, at 3.

as those used in Chinese courts for generating judicial opinions, affect judicial workflows, decision quality, or litigant outcomes in practice.²³⁴

This gap is particularly evident in understanding the interaction between AI and human judges in real-world scenarios. While experimental studies suggest risks like bias amplification, there is little empirical data on how these risks manifest in operational judicial settings.²³⁵ The absence of real-world evidence hinders the development of practical guidelines for AI integration, leaving questions about scalability and adaptability unresolved.²³⁶ Future research should prioritize in-depth case studies and empirical analyses of AI's real-world judicial applications, focusing on diverse court systems and practical challenges.

Underdeveloped Ethical and Regulatory Frameworks

The ethical and regulatory implications of AI in judicial decision-making remain underexplored, particularly regarding bias, transparency, and judicial independence. While studies identify risks, such as AI perpetuating semantic biases or threatening judicial autonomy, they offer limited solutions for mitigating these issues.²³⁷ For instance, the potential for advanced artificial judicial intelligence (AAJI) to undermine the separation of powers is noted, but there is no systematic analysis of how to safeguard judicial independence.²³⁸

Ethical norms for judicial AI, such as those addressing fairness and accountability, are also underdeveloped. Current research calls for differential trials and post hoc monitoring but lacks frameworks for implementing these measures across jurisdictions.²³⁹ Similarly, the role of judges in fostering public trust in AI is acknowledged, yet there is little guidance on how to translate this into policy or practice.²⁴⁰

Limited Understanding of Public Trust and Societal Impacts

The societal impacts of AI in judicial systems, particularly its effect on public trust, are underexplored in the literature. While one study found that public trust in AI depends on judges' perceived trust, it did not examine how AI's use in high-stakes decisions (e.g., bail or sentencing) affects long-term public confidence in the judiciary.²⁴¹ The potential for AI to perpetuate biases, as seen in the COMPAS tool, raises concerns about public perceptions of fairness, yet these are rarely studied in depth.²⁴²

²³⁴ Padiu et al., *supra* note 70, at 12-13.

²³⁵ Javed & Li, *supra* note 69, at 3; Xu, *supra* note 214, at 3.

²³⁶ Aini, *supra* note 203, at 16.

²³⁷ Javed & Li, *supra* note 69, at 3; Winter, *supra* note 197, at 184–85.

²³⁸ Winter, *supra* note 197, at 185.

²³⁹ Aini, *supra* note 203, at 16.

²⁴⁰ Fine & Marsh, *supra* note 213, at 3.

²⁴¹ *Id.*

²⁴² Krištofík, *supra* note 5, at 237.

Moreover, there is a lack of research on how AI's judicial applications influence broader societal values, such as equal treatment and access to justice. The literature notes AI's potential to improve fairness but fails to explore how its deployment in diverse cultural contexts shapes public attitudes.²⁴³ Future studies could investigate the societal implications of judicial AI, focusing on public trust, cultural variations, and the alignment of AI with democratic principles.

XI. Future Trends

Future trends in AI's legal applications will center on advancements in predictive analytics and judicial simulation, transforming legal practice. Improved algorithms and multimodal data integration will enhance predictive accuracy, while global expansion will democratize access.²⁴⁴ Sophisticated LLMs, virtual arbitrators, and speculative AAJI will advance judicial simulation, supporting judges and streamlining disputes.²⁴⁵ Ethical and regulatory frameworks will evolve to ensure fairness, transparency, and human oversight, addressing biases and maintaining trust.²⁴⁶ While AI's efficiency and precision will revolutionize legal systems, human judgment appears to remain essential for the time being, ensuring a balanced integration that upholds justice principles.²⁴⁷

Advancements in Predictive Analytics

Predictive analytics, which uses AI to forecast case outcomes and inform legal strategies, is expected to see significant advancements in algorithm sophistication, data integration, and global applicability.

A. Improved Algorithms for Complex Legal Datasets

Future developments in predictive analytics will focus on enhancing algorithms to handle increasingly complex legal datasets. Current models, such as those achieving 96.9% accuracy in classifying biases in the CAIL dataset, demonstrate strong performance but struggle with nuanced or ambiguous cases.²⁴⁸ Anticipated improvements include advanced neural networks and transformer-based architectures, enabling AI to better process unstructured data like judicial opinions and legal briefs.²⁴⁹

²⁴³ Winter, *supra* note 197, at 181; Padiu et al., *supra* note 70, at 11.

²⁴⁴ Ejjami, *supra* note 39, at 3; Padiu et al., *supra* note 70, at 11.

²⁴⁵ Liu & Li, *supra* note 4, at 236; Christopher M. Malikschrnitt, *The Real Future of AI in Law: AI Judges*, ABA (Oct. 18, 2023), https://www.americanbar.org/groups/law_practice/resources/law-technology-today/2023/the-real-future-of-ai-in-law-ai-judges/.

²⁴⁶ Awais et al., *supra* note 6, at 2641; Kriřtofik, *supra* note 5, at 237.

²⁴⁷ Sourdin & Cornes, *supra* note 149, at 92; Xu, *supra* note 214, at 3.

²⁴⁸ Javed & Jianxin Li, *supra* note 69, at 5.

²⁴⁹ Ejjami, *supra* note 39, at 3.

These algorithms will improve the precision of outcome predictions, litigation risk assessments, and settlement recommendations, empowering lawyers to optimize strategies.²⁵⁰ For instance, predictive analytics will evolve to account for extra-legal factors, such as judicial behavior, enhancing fairness by identifying and mitigating biases.²⁵¹ Such advancements will streamline corporate legal operations and improve client outcomes.²⁵²

Recent NLP work has warned of data contamination, where benchmark test sets inadvertently end up in an LLM's training corpus. If a model has already seen a benchmark's ground-truth answers during training, its performance may reflect memorization rather than genuine generalization, making it hard to assess its ability on truly unseen tasks.²⁵³

B. Integration of Multimodal Data

The integration of multimodal data—combining text, audio, and video from legal proceedings—will enhance predictive analytics' robustness. Future AI systems will analyze courtroom transcripts, oral arguments, and visual cues to provide richer insights into case dynamics.²⁵⁴ This holistic approach will improve prediction accuracy, particularly in jurisdictions with diverse data sources, such as India's overburdened courts.²⁵⁵ Some research is already beginning in this area.²⁵⁶

Multimodal analytics will also support proactive compliance monitoring, enabling firms to anticipate regulatory risks.²⁵⁷ However, integrating diverse data raises privacy and ethical concerns, necessitating robust governance frameworks.²⁵⁸

C. Global Expansion and Accessibility

Predictive analytics will expand to non-Western and developing legal systems, addressing disparities in access to AI technology. Current applications are concentrated in common law jurisdictions, but future trends will see AI tailored to civil law and hybrid systems, enhancing global applicability.²⁵⁹ This expansion will democratize legal services, particularly in resource-constrained regions, by automating case management and reducing costs.²⁶⁰

²⁵⁰ Zahra, *supra* note 6, at 11.

²⁵¹ Chen, *supra* note 99, at 17.

²⁵² Sadiku et al., *supra* note 44, at 69.

²⁵³ Simone Balloccu, Patrícia Schmidová, Mateusz Lango & Ondrej Dusek, *Leak, Cheat, Repeat: Data Contamination and Evaluation Malpractices in Closed-Source LLMs*, PROC. 18TH CONF. EUROPEAN CH. ASS'N COMPUT. LINGUISTICS 67, 67 (2024).

²⁵⁴ Ejjami, *supra* note 39, at 3; Awais et al., *supra* note 6, at 2640.

²⁵⁵ Conrad et al., *supra* note 37, at 1.

²⁵⁶ See generally, Jaromir Savelka & Hannes Westermann, *Analyzing Images of Legal Documents: Toward Multi-Modal LLMs for Access to Justice*, ARXIV PREPRINT (Dec. 16 2024), <https://arxiv.org/abs/2412.15260>.

²⁵⁷ Sadiku et al., *supra* note 44, at 69.

²⁵⁸ Singh et al., *supra* note 155, at 3.

²⁵⁹ Padiu et al., *supra* note 70, at 11.

²⁶⁰ Zahra, *supra* note 6, at 11; Becerra, *supra* note 169, at 29.

Open-source AI platforms and cloud-based solutions will facilitate adoption in developing jurisdictions, improving access to justice.²⁶¹ However, cultural and jurisdictional differences will require localized algorithms to ensure relevance and fairness.²⁶²

Advancements in Judicial Simulation

Judicial simulation, where AI mimics judicial reasoning or supports decision-making, is expected to advance through enhanced LLMs, virtual arbitration, and ethical integration.

A. Sophisticated LLMs for Judicial Reasoning

LLMs, such as those used in Shenzhen courts to generate judicial opinions, will become more sophisticated, capable of simulating judicial reasoning across diverse jurisdictions.²⁶³ Future models will incorporate advanced contextual understanding, reducing errors like hallucinations.²⁶⁴ Improved explainability, as seen in the ECHR model with 97% accuracy, will enhance trust in AI-generated judicial outputs.²⁶⁵

These advancements will support judges in drafting rulings and analyzing precedents, particularly in high-volume courts.²⁶⁶ However, AI's inability to replicate empathy and social responsiveness will limit its role to supportive functions.²⁶⁷

B. AI as Virtual Arbitrator or Mediator

AI is anticipated to play a growing role in alternative dispute resolution (ADR) as virtual arbitrators or mediators. Future systems will analyze case data, propose settlements, and facilitate negotiations, streamlining dispute resolution.²⁶⁸ AI's neutrality and efficiency make it suitable for low-stakes or standardized disputes, reducing court backlogs.²⁶⁹

For example, AI mediators could use predictive analytics to suggest equitable outcomes, enhancing access to justice in jurisdictions like Colombia or India.²⁷⁰ However, complex disputes requiring human empathy will remain outside AI's purview, necessitating hybrid models.²⁷¹

²⁶¹ Padiu et al., *supra* note 70, at 11.

²⁶² Ejjami, *supra* note 39, at 5.

²⁶³ Liu & Li, *supra* note 4, at 236.

²⁶⁴ Magesh et al., *supra* note 47, at 217.

²⁶⁵ Collenette et al., *supra* note 4, at 3.

²⁶⁶ Socol de la Osa & Remolina, *supra* note 75, at 3.

²⁶⁷ Sourdin, *supra* note 148, at 306; Contini et al., *supra* note 5, at 4.

²⁶⁸ Zahra, *supra* note 6, at 11; Becerra, *supra* note 169, at 29.

²⁶⁹ Xu, *supra* note 214, at 3.

²⁷⁰ Socol de la Osa & Remolina, *supra* note 75, at 3.

²⁷¹ Sourdin & Cornes, *supra* note 149, at 92.

C. Advanced Artificial Judicial Intelligence (AAJI)

The development of advanced artificial judicial intelligence (AAJI) is a speculative but anticipated trend, where AI could simulate full judicial processes.²⁷² AAJI would integrate predictive analytics, LLMs, and multimodal data to mimic judicial reasoning, potentially automating simple cases.²⁷³ While current systems, like the Dutch court's traffic violation appeals tool, show promise, AAJI's feasibility is limited by ethical concerns, including bias and accountability.²⁷⁴ The adoption of the so-called, robo-judge, has been considered by the AI and Law community, with some concluding that "much research is still needed", but "the AI & [L]aw community is currently very active in doing this research."²⁷⁵

XII. Conclusion

The integration of AI into legal systems represents a transformative paradigm shift, offering profound opportunities to enhance efficiency, accuracy, and access to justice while presenting significant ethical, technical, and regulatory challenges. This article has traced AI's evolution from early philosophical foundations to the sophisticated LLMs of the 2020s, highlighting its applications in legal research, predictive analytics, and judicial decision-making. Predictive AI analytics, powered by advanced machine learning and natural language processing, has demonstrated remarkable precision, achieving up to 97% accuracy in case outcome predictions, yet its reliance on historical data introduces risks of bias and hallucination. Judicial simulation, exemplified by generative AI in Shenzhen courts, augments decision-making but struggles with the emotive-cognitive nuances essential to human adjudication.

Stakeholder perceptions reflect a cautious optimism, with lawyers valuing AI's productivity gains, judges emphasizing human empathy, and policymakers advocating for robust governance. Regulatory frameworks, such as the EU AI Act, aim to mitigate risks through transparency and fairness audits, yet global harmonization remains elusive. Research gaps, particularly in longitudinal studies and non-Western contexts, underscore the need for further inquiry to ensure AI's equitable application.

Looking forward, advancements in predictive analytics and judicial simulation promise to revolutionize legal practice, with multimodal data integration and virtual arbitrators enhancing accessibility. However, AI's limitations in replicating human empathy and the persistent risk of bias necessitate a hybrid approach, where AI's efficiency complements human discretion. As AI continues to evolve, interdisciplinary collaboration and adaptive regulations will be paramount to balance technological innovation with the ethical and legal imperatives of justice, ensuring AI serves as a tool for equitable and responsive legal systems worldwide.

²⁷² Malikschnitt, *supra* note 245.

²⁷³ Winter, *supra* note 197, at 181.

²⁷⁴ Kolkman et al., *supra* note 77, at 5.

²⁷⁵ Henry Prakken, *Komt de robotrechter er aan? [Is the Robot Judge Near?]*, 4 NEDERLANDS JURISTENBLAD 269, 274 (2018), (English Translation Available at <https://webspace.science.uu.nl/~prakk101/pubs/Robotrechter2English.pdf>).