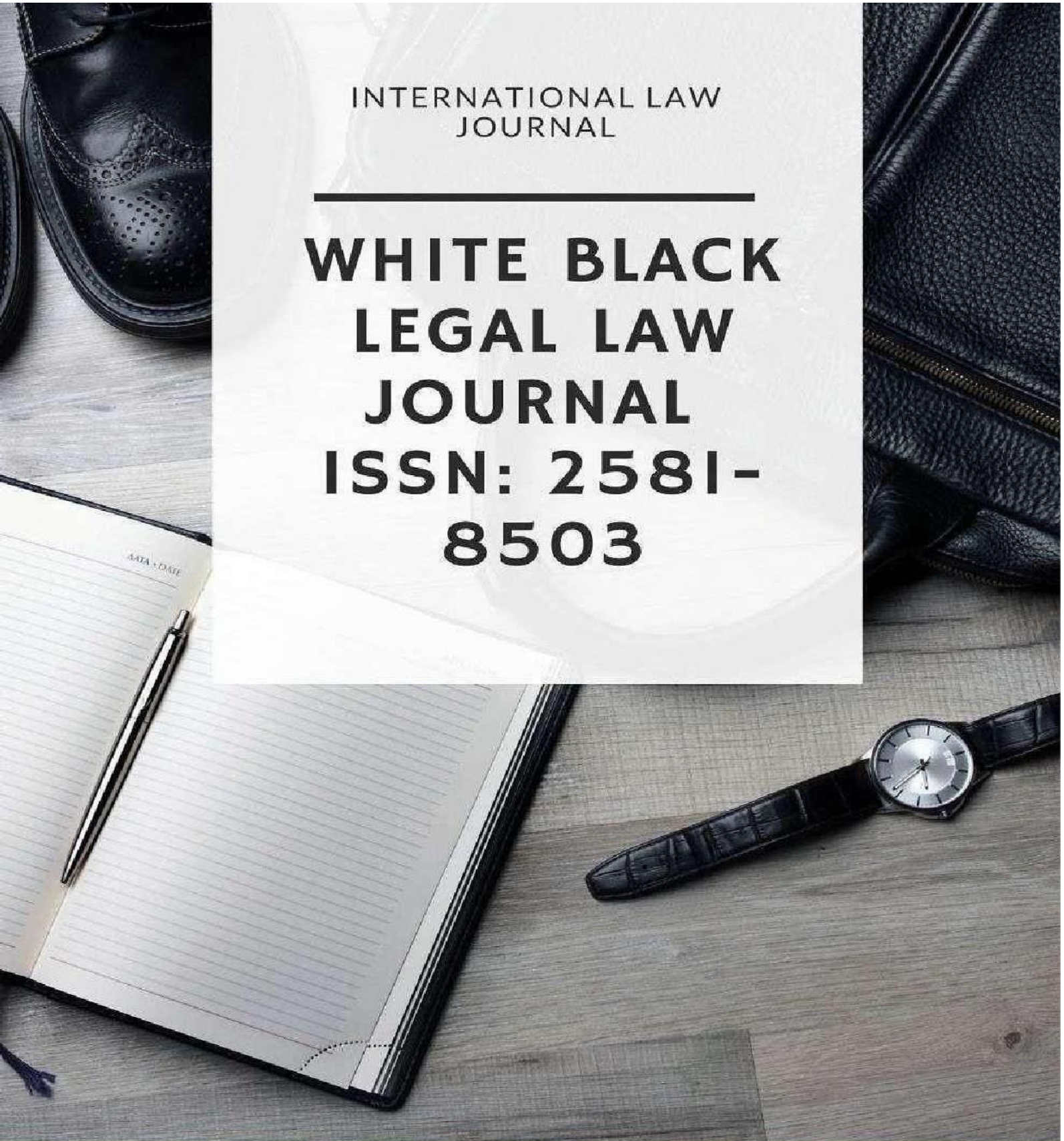




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AI VS. HUMAN FORENSIC EXPERTS: WHO IS MORE RELIABLE IN COURT?

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Abstract

Forensic evidence has been seen as scientifically foolproof in courtrooms all along, but the DNA-based exoneration after conviction has exposed the fragile empirical footing of many of the traditional fields of forensic science. Artificial Intelligence has entered into this field through probabilistic DNA genotyping, facial recognition, digital forensics, and risk assessment tools, bringing about reliability and freedom from human cognitive biases. This research explores the reliability of AI versus humans in this field, arguing that while reliability is not a property inherent to both of them, rather, it results from the interaction of methodology, admissibility tests in law, and institutional mechanisms like disclosure and cross-examination. The research looks into the known weaknesses of human evaluators, the risks of lack of transparency in proprietary algorithms, legal standards for evidence according to Frye/Daubert and Indian laws, and jurisprudence in this regard. The research argues that AI and human knowledge work best complementing each other and advocates for a combined approach strengthened by transparency, laboratory independence, and statistical literacy in law.

Keywords: *Forensic Evidence, Artificial Intelligence, Admissibility Standards, Algorithmic Bias, Expert Testimony.*

I. Introduction

Forensic evidence has always maintained its subtle place of dominance in legal proceedings. There is something about the fingerprint found on the windowsill, the bloodstain pattern presented in court, or the testimony of the firearms examiner that the bullet was fired by a certain firearm that conveys scientific certainty that no other type of evidence can offer. The jury is willing to put their faith in those who talk with the vocabulary of science and probabilities, and the courts have always relied upon professional training and experience as proof of reliability. However, there have been many instances within the last two decades when

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this has come under intense scrutiny, due to post-conviction DNA exonerations showing that the forensic disciplines were scientifically founded upon less substantial bases than believed by the courts.²

Artificial intelligence is a new and disruptive actor that has appeared in the arena of re-evaluation. The algorithmic approaches have become, and in certain cases have replaced, the role of a human evaluator in such activities as probabilistic DNA profiling, face recognition, computer forensics, and even risk prediction during sentencing. It is claimed that algorithmic methods ensure consistency, speed, and freedom from human cognitive biases.³ Criticism is leveled against the fact that the opacity of the algorithm, coding in private, and inadequate independent validation studies create additional problems of dependability that are even more dangerous and difficult for the lawyers to examine since they are hidden from view.⁴

II. The Evolving Landscape of Forensic Evidence

The forensic sciences were developed more often than not outside of academic scientific research. Areas such as fingerprinting, bite mark testing, and microscopic hair analysis have been developed through the process of policing, not scientific study, and the claim of infallibility of these processes depended for many years on the consensus of professionals rather than error studies.⁵ This origin story matters as it provides the rationale behind the acceptance of forensic identification evidence in courts for most of the twentieth century without any judicial scrutiny of the scientific basis of the discipline.

This happened when the National Research Council released its report in 2009, which concluded that the only forensic science discipline that has ever been conclusively demonstrated to reliably and consistently prove a link between an evidence and an individual or a source is that of nuclear DNA analysis.

Among the problems identified by the report were inconsistent nomenclature, lack of standards across laboratories, and the dearth of research on the validity of the underlying science of pattern matching disciplines.

Seven years later, President's Council of Advisors on Science and Technology reiterates these points by finding that some of the common feature comparison disciplines, like bite mark and

² Brandon L. Garrett, *Autopsy of a Crime Lab: Exposing the Flaws in Forensics* 12 (2021).

³ Itiel E. Dror, *Cognitive Neuroscience in Forensic Science: Understanding and Utilizing the Human Element*, 370 *Phil. Transactions Royal Soc'y B* 20140255, at 2 (2015).

⁴ Rebecca Wexler, *Life, Liberty, and Trade Secrets: Intellectual Property in the Criminal Justice System*, 70 *Stan. L. Rev.* 1343, 1350 (2018).

⁵ Michael J. Saks & Jonathan J. Koehler, *The Coming Paradigm Shift in Forensic Identification Science*, 309 *Science* 892, 892 (2005).

firearms tool marks, do not have a sufficient empirical basis whereas the fingerprint discipline is just now starting to develop error-rate studies⁶.

It is within this environment of scrutiny of its own practices that computational methods started making their appearance within forensics. Probabilistic genotyping software, using mathematical algorithms to decode complex and difficult to understand DNA mixes for human experts, was among the first types of technology widely accepted into the process.

Following it, facial recognition became used both to generate leads for further investigation and as evidence to support the identification made by an eyewitness. Digital forensics software uses machine learning methods to classify huge volumes of seized digital data, while risk assessment algorithms are used to make decisions related to pretrial detention and sentencing in several countries. Their appeal is not only in their novel nature but also in the hope that the computer, in contrast to an exhausted or psychologically biased expert, will apply the decision rule equally to all cases.

III. The Case for, and Against, Human Forensic Experts

Traditional expertise in forensic identification rests upon the ability of the human analyst to assess contextually. The human expert is able to adapt to novel and unusual circumstances – such as a partial or distorted fingerprint impression – in ways that inflexible computer algorithms might find difficult, and to explain the logic of a particular conclusion in terms which would be understandable to a jury composed of laypeople. Cross-examination, the basic driver of the adversarial system, presumes a witness who can be subjected to questioning on matters of training, methodology, and opinion justification. Forensic human experts possess professional and ethical accountability; they are licensed, subject to discipline, and can be called back to give testimony on their reasoning in a particular case.

There are, of course, also known weaknesses associated with such expertise. The cognitive science literature suggests that the human forensics examiner, like any human decision-maker, is prone to context effects, whereby non-relevant information concerning a suspect or the story surrounding a case unconsciously influences the analyst's evaluation of ambiguous evidence. Blind proficiency tests have uncovered instances where the same fingerprint was assessed differently when different contextual information accompanied it. Examples of forensics that have been deemed either faulty or overstated include microscopic hair analysis, bite mark

⁶ President's Council of Advisors on Sci. & Tech., Exec. Office of the President, Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods 46 (2016)

evidence, and certain types of blood spatter evidence. This problem has been prevalent enough in exonerations due to DNA evidence that the Federal Bureau of Investigation has acknowledged error in the results of hair analysis in many cases.⁷

Another structural problem that occurs is the lack of autonomy in forensic labs. This is because there are some forensic labs that are actually operated by the police department or prosecution rather than as a scientific body.⁸ It might well be the case, then, that the motivations behind working in the lab are aligned, perhaps unwittingly, with the goals of the investigation for which the lab is employed. The consequences of this weakness are very real. Indeed, the false confidence in the expert witnesses' scientifically sound testimony has led to a number of cases in publicly reported post-conviction reviews, where the highly convincing testimony from credentialed experts, in areas such as bite mark comparisons and hair microscopy, has been proved to be a result of flawed science and resulted in wrongful convictions that only after decades have been vacated due to DNA testing. This shows clearly that what is at stake is not the credibility of the expert or the persuasiveness of the testimony that he gives in court but the scientific validity of the methodology he uses. None of the above does imply that forensic human expertise cannot be trusted but rather that there is significant variation in terms of the reliability of human experts in the field and that the blind trust in credentialed human testimony has gone ahead of its empirical grounding.

IV. The Rise of Artificial Intelligence in Forensic Practice

The integration of artificial intelligence into forensic science happens through several different applications, which all have their own unique level of reliability, and all of them provide the second generation of scientific evidence, according to some experts. In the case of probabilistic genotyping software, the use of statistical models, which may be based on the Markov chain Monte Carlo simulation, helps calculate the likelihood ratio that shows how much more likely is the appearance of a particular DNA mixture with the help of a certain suspect in comparison to some random individual. The software is capable of performing more complex analyses of various genetic markers, which a human could not perform manually, thus making it possible for laboratories to interpret information that previously could not be analyzed because of the lack of reliability. The facial recognition technology makes use of the convolutional neural

⁷ Simon A. Cole, *Forensic Science and Wrongful Convictions: From Exposer to Contributor to Corrector*, 46 New Eng. L. Rev. 711, 715 (2012).

⁸ Sandra Guerra Thompson, *Cops in Lab Coats: Curbing Wrongful Convictions Through Independent Forensic Laboratories* 45 (2015).

networks trained on large data sets in order to represent the face through numbers.⁹ Predictive risk assessment tools, such as the popular COMPAS tool used in many US sentencing processes, use machine learning on historical data to predict the likelihood of future criminal activity.¹⁰

The supposed advantages of such technologies include uniformity and scalability. Algorithm always gives same weight to the same inputs, thus, eliminating the uncertainty between different examiners which limits credibility in many human-operated areas. Machine is able to process large amounts of information, including gigabytes of seized digital information, something impossible for humans to do during a limited period of an investigation.

On the other hand, such advantages are associated with reliability problems specific to computational technologies. Information used for training, which replicates the history of policing and enforcement practices, may contribute to sustaining the biases that the technology should eliminate – this problem is especially important concerning risk assessment algorithms, which demonstrated different error rates for different population groups.¹¹ Facial recognition technologies have also shown higher-than-average false positive rates for women and individuals with dark skin, as evidenced by various independent tests. The most important part of the issue, from the perspective of evidence, is the black box problem: many forensic AI tools are built using vendor-held, proprietary source code protected as a trade secret, thereby preventing defense lawyers from effectively challenging the rationale behind the decision of the machine.

Digital forensics is another example of the tradeoff at hand. Machine learning classifiers are becoming increasingly popular tools for classifying devices seized as evidence, as they determine which files should be examined further by people through statistical models created in past cases.¹² These tools may greatly reduce the time required to investigate a device that has hundreds of thousands of documents, but since their categories are probabilistic, not definite, and since a model that was mostly trained to operate in one set of circumstances may produce different results if applied to another one, it must usually be reviewed by a person before being presented in a court. Digital forensics AI is thus much more of an investigative prompter than a self-reliant witness, and this fact substantially affects its assessment in terms

⁹ Clare Garvie, Alvaro Bedoya & Jonathan Frankle, *The Perpetual Line-Up: Unregulated Police Face Recognition in America* 9 (Geo. L. Ctr. on Privacy & Tech., 2016).

¹⁰ Danielle Keats Citron & Frank Pasquale, *The Scored Society: Due Process for Automated Predictions*, 89 Wash. L. Rev. 1, 10 (2014).

¹¹ Sonia M. Gipson Rankin, *Technological Tethereds: Potential Impact of Untrustworthy Artificial Intelligence in Criminal Justice Risk Assessment Instruments*, 78 Wash. & Lee L. Rev. 647, 655 (2021).

¹² Joshua A. Kroll et al., *Accountable Algorithms*, 165 U. Pa. L. Rev. 633, 638 (2017).

of the reliability required of the testimony of a human witness.

V. Comparing Reliability: What the Empirical Evidence Shows

However, comparative evaluations of reliability of human evaluators and AI instruments are scarce, in part because of the rare use of standard metrics for both. In those cases when comparisons are conducted, the results are informative rather than definitive. Genotype-probability software usually outperforms human DNA mixture interpretation in interpreting complicated low-template samples, providing likelihood ratios based on empirical studies and proven error rates, an achievement that many traditional pattern-matching disciplines have failed to reach. Within the narrow scope, the machine appears more reliable than human without a doubt owing to its provable statistical foundations.

The issue of facial recognition provides a more complicated story. The best algorithms, tested in benchmark trials, sometimes outperform humans in some matching tasks provided that the images are taken in ideal lighting conditions and the resolution is high enough. However, the results become considerably worse in case of poor lighting, low resolution, and non-frontal images, which is common practice in reality. Such procedures tend to serve as clues to investigation rather than as identifying evidence, which means that their relative reliability compared to the identification testimony of a human witness tends not to be considered in connection with an in-court assertion of a person's identification through a particular image.

Reliability in all classes is inseparably bound up with openness. The technique that is somewhat less accurate but entirely open and verifiable independently may, on grounds of its evidentiary value, be more reliable than the technique that is seemingly more accurate but whose validity studies are secret, unpublished, and not available to the other party. In legal parlance, reliability goes beyond being just a statistical property of the procedure; it is also concerned with the verifiability of the property.¹³

There is a wide variety of approaches for measuring human and computational mistake rates, which makes comparison of the two difficult. Mistake rate for a human investigator would normally be estimated based on proficiency testing, which might take place under conditions recognized as such by the investigator, causing him to pay more attention and thus reducing his error rate in comparison with normal casework. Error rate for an algorithm, on the other hand, would usually be measured against a fixed test database, which does not necessarily capture the variability of the images' quality and condition that one might encounter in real-

¹³ Andrea Roth, Machine Testimony, 126 Yale L.J. 1972, 1980 (2017).

world experiments. Neither approach is objectively better; however, both show that any accuracy measurement reported as a statistic for either a human or a system should be treated as an approximation, limited by conditions of the testing.

VI. Legal Standards for Admissibility

The American judicial system has traditionally relied on the criterion of general acceptance that was set in the case *Frye v. United States* and asked whether a scientific technique had been widely accepted by the relevant scientific community before being admitted as evidence.¹⁴ However, the decision of the Supreme Court in *Daubert vs. Merrell Dow Pharmaceuticals Inc.* rendered obsolete this test in the context of the federal courts, and instructed trial judges to assume the role of gatekeepers of evidence that considers testability, peer review and publication, error rates, standards and general acceptance.¹⁵ *Kumho Tire Co. v. Carmichael* came later to confirm that this task of gatekeeping applies not only to conventional science but also to technical and other kinds of specialized knowledge, which would be relevant for algorithmic evidence.¹⁶

The use of Daubert criteria to evaluate AI-generated forensic evidence brings about a fundamental structural contradiction. The testability and error rate, which are intrinsic characteristics of computational methods, are precisely the characteristics that vendors try to keep away from the scrutiny by not disclosing their source code and training data because of being trade secrets. It may be that an instrument demonstrates great precision but proves to be non-testable in accordance with the Daubert criteria, as the defendant and any other independent party cannot examine how it reached a specific conclusion. Some specialists say that the courts have to treat the hidden algorithms as a factor that requires a higher degree of skepticism, as the absence of transparency prevents the adversarial assessment required by Daubert.

The law regulating expert opinion evidence in India is contained in section 45 of the Indian Evidence Act of 1872, where the court may take into account the opinion of persons who are skilled in science or art.¹⁷ The Indian judiciary has historically accorded considerable deference to forensic experts in the context of this legislation; nevertheless, it was observed that there has been a growing tendency of the Supreme Court of India, as exemplified by its decision in *Selvi*

¹⁴ *Frye v. United States*, 293 F. 1013, 1014 (D.C. Cir. 1923).

¹⁵ *Daubert v. Merrell Dow Pharms., Inc.*, 509 U.S. 579, 589 (1993).

¹⁶ *Kumho Tire Co. v. Carmichael*, 526 U.S. 137, 141 (1999).

¹⁷ Indian Evidence Act, No. 1 of 1872, § 45, India Code.

v. State of Karnataka, to assess the scientific merit of such investigation techniques before their use in any inquiry.¹⁸ With the introduction of the Bharatiya Sakshya Adhiniyam, 2023, as a replacement for the Indian Evidence Act, starting from mid-2024, there remains a largely similar expert-opinion scheme and an under-utilized possibility of further legislative or judicial clarification of the place of algorithmic evidence in it.

As AI-based forensic tools become a part of proceedings in Indian courts, the interpretation of sections 45 and 46 will have to be linked to the formation of an emerging test of reliability, which can be equated to Daubert in the US, in view of the present lack of a legal mechanism for dealing with algorithmic evidence. The comparison of the practice of American courts, based on the Daubert standard, may provide, although imperfectly, the following guideline: instead of focusing on the novelty of the method, the assessment of its reliability will be based on the rate of errors, its thorough testing, and the ability to scrutinize its basis on the part of the opposition side.

VII. Judicial Scrutiny of Algorithmic Evidence: Emerging Case Law

The judicial tribunals that have handled cases with respect to the use of AI generated evidence have been cautious in their handling of such evidence. They usually take the algorithm as a support to human reasoning rather than an independent source of validation. The State of Wisconsin versus Loomis case is one example where the Supreme Court of the state allowed the use of the COMPAS risk score when sentencing provided that there were written advisories on how the tool operates.¹⁹ The resolution represents a reluctant compromise, where the use of an algorithm as a basis for judicial determination was permitted without treating its results as equal to a scientific finding, nor did the Court require the company to disclose the underlying algorithm to the defense.

Academia argues that such a solution is theoretically questionable. If the algorithmic rating constitutes testimonial evidence about the freedom of the accused person, then confrontation clauses may require providing a considerable opportunity to review the reasoning underlying the score, which is currently obstructed due to the protection of trade secrets in many jurisdictions. This problem is compounded by the fact that machine-generated results cannot fit into existing categories of evidence because they are neither informal nor traditional expert testimony.

¹⁸ Selvi v. State of Karnataka, (2010) 7 S.C.C. 263, 297 (India).

¹⁹ State v. Loomis, 881 N.W.2d 749, 753 (Wis. 2016).

There has been another debate on the topic of face recognition evidence because a number of cases of false arrests based on faulty algorithms have been recorded, and some areas have already banned using this kind of evidence as a basis for probable cause unless it is corroborated independently. The common thread in this new legal landscape is that the judiciary does not wish to accept AI-derived information the way it accepts the findings provided by human experts since courts realize that such technology is new, little-known in terms of its error rate, and difficult to challenge through cross-examination.

VIII. Toward a Hybrid Model of Forensic Reliability

A mixed approach, where AI performs the computationally intensive initial analysis and a seasoned human expert interprets and validates the results, is the most promising path forward. This approach retains the accountability and openness required from a live witness by juries and courts while also making use of the consistency and analytical prowess of computer algorithms. Probabilistic genotyping operates in just such a fashion: the algorithm generates a likelihood ratio, but a human analyst reviews the underlying electropherogram, validates the assumptions of the algorithm with regard to the specific sample analyzed, and offers testimony about the result, subject to challenge both with regard to the validation studies of the algorithm as well as her independent evaluation.

In order for this algorithm to function as a proper dependability safeguard rather than a mere formality, there will be many changes needed in its structure. First, the courts must require high degrees of transparency about the algorithm's validation studies, the characteristics of the training data, and error rates before it can be admitted into evidence, resisting the natural tendency to extend the realm of trade secrets into the evidentiary realm. First, forensic labs need to be structurally independent from law enforcement and prosecution agencies to reduce the possibility of confirmation bias on behalf of both human analysts and computer algorithms. Third, the coverage of judges' education on statistical principles of both AI technologies and traditional forensic sciences should be expanded to ensure that gatekeeping pursuant to Daubert, Section 45, and other rules entails true technical analysis, rather than the veneration of credentials or innovation. In short, providing access to defense to independent experts capable of assessing findings of both humans and computers in forensic sciences should be considered the basic feature of procedural fairness, rather than a privilege.

None of these innovations require the court's resolution on which expert witness is more reliable – the one based on AI or human expert. They require that the court conducts equally

rigorous assessment of the reliability of both types of expertise, refusing the simplistic assumption that the qualifications of a human expert can substitute for scientific validation, and equally simplistic assumption that the mathematical precision of the machine can substitute for transparency. It is crucial to highlight the importance of legal education and constant judicial training in this regard. The judges and practitioners who have an elementary understanding of such statistical terms as likelihood ratio, false positives, and confidence interval will be much better positioned to examine both the validation study conducted with respect to the algorithm and the claimed proficiency rate of the expert witness in question, making them less vulnerable to the influence of assurance alone, irrespective of its source.

X. Conclusion

The initial question posed, relating to which is more reliable, artificial intelligence or human forensic experts in court, rests upon an erroneous presumption of exclusivity. As outlined in this paper, there is no basis to claim one is always more reliable than the other – both have their respective strengths and weaknesses. Humans provide contextual judgment and accountability, but are subject to cognitive bias and inconsistencies among individuals. Machines offer consistency and advanced analysis, but are often hidden in a world of secretiveness that prevents the adversarial process necessary to establish credibility.

Legislative and judicial bodies, along with forensic organizations, should abandon the false dichotomy of human vs. machine in favor of a more focused inquiry into all forensics, whether algorithmic or human: Has it been independently validated? What are the error rates? Is it possible for the other side to challenge the fundamentals? The combined approach of algorithmic reliability and human accountability, together with requirements of transparency and autonomy, represent the only path to forensic evidence that the courtroom can truly trust.

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