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Dilemmas and Regulatory Countermeasures of Artificial Intelligence Judicial Application in the Digital Age

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Abstract. The penetration of artificial intelligence technology into numerous links of judicial adjudication has become an established fact. The extensive development of the "Smart Courts" initiative has been largely driven by this technological trend. This paper systematically sorts out the regulatory status and practical progress of artificial intelligence judicial application in China, and identifies several practical problems: the lack of regulation in legislation, the dual restrictions of judicial data in security protection and system compatibility, as well as a series of chain problems caused by algorithm opacity. These problems are intertwined and point to a deeper key issue, namely the inherent defects of the existing governance framework model. The loopholes in the three dimensions of legal regulation, technical ethics and technical governance are not isolated technical omissions, but need to be addressed uniformly from an overall perspective. Following this train of thought, this paper puts forward specific improvement approaches for the above three aspects respectively, and attempts to outline a relatively systematic solution framework. The basic position of this paper is that the functional boundary of artificial intelligence should be strictly limited to assistance, and the exercise of adjudicative power cannot be undertaken or replaced by algorithms. Once legal regulation, ethical guidance and technical governance form a real joint force, the contradiction between the improvement of judicial efficiency and procedural justice and substantive justice will be readily resolved.

Keywords: artificial intelligence, algorithm black box, legal regulation, human-machine collaboration, data bias

1. Background introduction

The integration of legal services and artificial intelligence has been extensively discussed in academic circles. With the continuous advancement of the comprehensive law-based governance strategy and the rising number of litigation cases, the judicial model is under greater structural pressure. The introduction of artificial intelligence into the adjudication process is, on the one hand, an active response to practical dilemmas, and on the other hand, in line with the inherent trend of contemporary judicial development. The introduction of technical tools can help judicial institutions alleviate the backlog of cases, accelerate the circulation of adjudications, and to a certain extent, also bear the social expectations for the progress of the rule of law. In addition to efficiency gains, potential hidden dangers cannot be ignored. The problems exposed by the intervention of artificial

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intelligence in the adjudication process are roughly concentrated in two aspects: the endogenous risks of algorithms themselves and structural loopholes in information security. As the underlying foundation of artificial intelligence operation, algorithms have technical boundaries in large-scale data processing and the closed nature of code logic, both of which may pose hidden dangers in adjudication activities. If these factors exceed the controllable range, the foundation of judicial justice will be substantially threatened.

This paper intends to discuss the issue of artificial intelligence judicial adjudication, sort out the actual status of current technical application, face up to the existing deficiencies and difficulties, explore feasible paths for risk prevention and control, and attempt to put forward targeted legal regulatory schemes, so as to provide references for the construction of smart courts and the reform of the judicial system.

2. Current status of artificial intelligence judicial adjudication application in the digital context

2.1. Regulatory status of artificial intelligence technology application

China still lacks a unified high-level Artificial Intelligence Act, but a hierarchical and progressive regulatory system that is constantly evolving has been basically established. Although there is a vacancy in the formulation of the highest-level laws, relevant departments have adopted the strategy of "prioritizing specific scenarios" and successively issued special regulations and normative documents for various technical implementations and risk links. Among them, the Interim Measures for the Administration of Generative Artificial Intelligence Services promulgated jointly by seven ministries and commissions including the Cyberspace Administration of China is the world's first department-level regulation for generative artificial intelligence, establishing a full-chain control system for content identification, security review and algorithm registration. The Provisions on the Administration of Algorithm Recommendation for Internet Information Services focus on solving practical dilemmas such as "information cocoons" and "algorithm discrimination", laying a practical normative foundation for algorithm control. The Opinions on Regulating and Strengthening the Judicial Application of Artificial Intelligence issued by the Supreme People's Court has established the direction and scope for the application of artificial intelligence in the judicial field, and encouraged judicial institutions to enhance their adjudication capacity with the help of modern technical means.

Relevant explorations at the local level are advancing steadily. The Regulations of Shanghai Municipality on Promoting the Development of the Artificial Intelligence Industry has established an ethical evaluation committee, which attempts to introduce the ideas of hierarchical control and pilot supervision in institutional design. The Regulations of the Shenzhen Special Economic Zone on Promoting the Artificial Intelligence Industry clearly defines the prohibited boundaries of R&D and application activities, and requires enterprises to disclose the operating principles of algorithms to the public. The legislative paths of the two regions have certain focuses, but they are the same in strengthening the constraints of technical ethics.

Within the above institutional framework, the role played by judicial institutions is of high observational value. When handling a large number of new and difficult cases, specialized judicial institutions such as Internet courts do not merely resolve individual disputes, but gradually clarify and precipitate a number of key rules in continuous judicial practice. These rules have substantially reshaped the applicable scope and interpretative space of existing laws, and their impact has gone beyond individual cases, bearing considerable institutional significance.

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2.2. Practical status of artificial intelligence technology in judicial adjudication application

Since the continuous advancement of the "Smart Courts" construction, artificial intelligence has been deeply integrated into core links such as case filing, evidence identification, legal inquiry, penalty recommendation, and judicial document writing. From the very beginning, the role positioning of this technological intervention has a clear boundary setting, namely "human-machine interaction and auxiliary judgment", that is, artificial intelligence can provide reference and auxiliary guidance, while the judicial adjudication power is actually exercised by judges, and technology cannot substantially encroach on the space of judicial discretion. In specific operation, the application of artificial intelligence in the judicial field presents an overall form of multi-stage and multi-link penetration, and its main practical forms include the following situations:

2.2.1. Intelligent trial process and convenient litigation services

Infrastructure such as online litigation platforms, intelligent litigation guidance systems and case risk assessment tools have been continuously promoted, and many links such as case filing, fee payment, service and court session have basically realized online and automated transformation [1]. At present, this is the most widely penetrated and practically implemented application of artificial intelligence in the judicial field. The "court version ATM machine" launched by the People's Court of Jiangbei New Area in Nanjing is a typical example. The system operates 24 hours a day, allowing parties to independently complete the identification of case filing information and submission of applications, and the case filing time is reduced by about 60% compared with the traditional method [2].

2.2.2. Construction of a new human-machine collaboration model for case adjudication assistance

Through data training of a large number of judicial documents, artificial intelligence systems can recommend similar precedents and provide reference ranges for sentencing to judges, with the core purpose of assisting judges in standardizing adjudication standards and maintaining consistent judgment results, which is also the focus of current judicial artificial intelligence R&D. In specific operation, the system extracts the characteristic elements of cases, automatically matches similar cases and prompts possible judgment ranges, which has strengthened the review ability of judges and the accuracy of legal application to a certain extent. Overall, the current application of artificial intelligence in judicial trials has formed a typical "human-machine collaboration" model.

The information generated by the intelligent auxiliary case handling system of Suzhou Courts has the characteristics of traceability, verifiability and convertibility. The system led by the Higher People's Court of Shanghai and jointly developed with enterprises such as iFLYTEK consists of three parts: a big data resource library, intelligent application software and a network platform. It can capture evidence in real time through speech recognition during court trials and automatically display it on electronic screens to improve trial efficiency; it can also provide sentencing range suggestions for judges based on similarity retrieval of historical cases.

As an auxiliary tool, the artificial intelligence system is hidden behind the judge's decision-making process, providing information support, risk prompts and efficiency tools. Judges maintain their status as the main body of adjudication and are responsible for the final evidence judgment, value trade-off and adjudication [3]. This pattern aims to combine the computing power of machines with the judicial wisdom of human judges to jointly improve the quality and efficiency of trials.

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2.2.3. Automation of legal document generation and processing

The advancement of natural language processing technology has enabled artificial intelligence to assist in generating legal documents such as complaints, replies, trial transcripts and judicial documents. In particular, the emergence of generative artificial intelligence has provided more powerful tools for automatic document generation, legal provision retrieval and case summary extraction, significantly reducing the administrative workload of judges and clerks [4]. At present, many courts have adopted intelligent speech transcription, and the integrity and accuracy of trial transcripts in Jiangsu Courts can reach 95%. The "AI Future Judge Assistant" of Suzhou Courts can complete the generation of judicial documents in less than 20 minutes, which used to take at least one hour, greatly improving case handling efficiency [5].

3. Application dilemmas of artificial intelligence technology in judicial adjudication in the digital context

3.1. Lack of existing legislation on the regulation of artificial intelligence judicial application

Although the state has issued overall policy documents such as the New Generation Artificial Intelligence Development Plan, special laws, administrative regulations and even judicial interpretations formulated for judicial applications are still blank [6]. Basic issues such as the functional role of artificial intelligence in the judicial process and the legal liability of developers, maintainers or users in case of problems are not clearly defined by current norms, resulting in the accumulation of many institutional frictions in actual operation.

The blurred algorithm boundary cannot be ignored. Whether the depth of artificial intelligence intervention can break through the existing scope of application is related to sensitive links such as evidence identification and sentencing recommendations. There are neither prohibitive provisions nor clear authorization provisions in relevant regulations. Such institutional gaps objectively provide opportunities for technology to cross the boundary, and the substantive space for judges to independently exercise adjudication power may be eroded without being noticed [7].

3.2. Judicial data security and adaptability issues

The effective operation of judicial artificial intelligence largely relies on massive and high-quality judicial data. However, there are serious bottlenecks in data security and adaptability at present.

3.2.1. Limitations of training data

Artificial intelligence models establish judgment logic by "learning" from historical judicial documents. Such a mechanism itself indicates that it is difficult to avoid the historical biases retained in the data. The COMPAS system in the United States, namely the Correctional Offender Management Profiling for Alternative Sanctions system, is used by many state courts for bail decisions at the pre-trial stage. Specifically, it analyzes various factors such as the defendant's criminal history and social background to generate a recidivism risk coefficient for judges' reference. The state of Wisconsin even recognized the legality of algorithmic sentencing in the judicial precedent of State v. Loomis.

The inherent defects of the system have been gradually exposed with the passage of practice. Its decision-making process relies to a considerable extent on the questionnaires filled out by the defendant. Once the defendant refuses to cooperate, the system turns to previous criminal records as

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an alternative data source. This data collection mechanism directly leads to systematic discrimination against ethnic minorities – under the same criminal record, black defendants are significantly more likely to be rated as "high risk" than white defendants [8]. Ironically, the system's ability to predict actual violent recidivism is quite limited.

When such biased data is used in model training, the algorithm will identify it as a "law" and then amplify the bias. This bias has been internalized in the system architecture and cannot be eliminated by simple data cleaning, posing a more hidden threat to the substantive justice of the judiciary.

3.2.2. Difficulties in processing unstructured data

A large amount of unstructured data is continuously generated during the operation of judicial procedures, such as trial videos and audios, interrogation records, etc. Speech recognition technology has been applied to a certain extent in the trial recording link, but there is still a large gap between the existing technology and actual demand in terms of semantic understanding accuracy in judicial scenarios [9]. Legal language itself is highly professional and normative, and complex situations such as dialect use, cross-examination and emotional statements often occur at trial sites. Once there is mishearing of key facts or misinterpretation of negative statements, the subsequent case analysis may directly deviate from the right track.

3.3. Technical bottlenecks of algorithm black box and legal codification

The decision-making mechanism of artificial intelligence essentially presents a "black box" characteristic, in other words, the derivation process between input and output is difficult to trace, which is fundamentally contradictory to the principle of reasoning transparency and logical traceability that judicial activities must follow.

3.3.1. Dilemma of algorithm interpretability and "black box effect" of similar case push system

Judicial adjudication requires that conclusions must be based on sufficient facts and laws, and the reasoning process must be clear. However, many high-performance artificial intelligence models are not like this – the intermediate decision-making process from data input to result output is too complex for parties to understand [10]. When judges use such systems, they can only accept the conclusions and cannot understand how they are derived.

Complex legal facts and value judgments are simplified into mathematical operations in vector space, which is difficult to accurately reflect the real logic of legal reasoning. The intelligent push of similar cases by judicial artificial intelligence was originally intended to help judges find reference cases, but in practice, the algorithm model is opaque and the matching logic is often unclear. In practice, cases with completely different legal relationships and controversial focuses may be pushed just because several keywords are similar [11]. Such push may instead affect judges' judgment.

3.3.2. Challenge to the right of cross-examination caused by the logical untraceability of evidence chain analysis algorithms

Some artificial intelligence systems are used to analyze the correlation between evidence to assist in constructing or verifying evidence chains. In accordance with the requirements of due process, parties and lawyers have the right to cross-examine the qualification and probative force of

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evidence. However, the cross-examiner cannot question the reasoning steps or challenge the rationality of weight distribution for the conclusions generated by the algorithm as they can question witnesses. In fact, this actually deprives the parties of the right to effective cross-examination and is not conducive to protecting the rights of the parties.

4. Regulatory countermeasures for problems in artificial intelligence judicial adjudication application

4.1. Constructing a hierarchical and progressive normative legal network

The judicial changes brought about by artificial intelligence are very complex, and scattered legal provisions cannot cope with them. There is an urgent need to establish a hierarchical legal system covering judicial interpretations to special legislation, including core issues such as liability determination, privacy protection and governance framework.

First of all, judicial interpretations of the Guidelines for the Application of Artificial Intelligence in Civil Litigation should be formulated. The guidelines should directly address practical problems in judicial practice and clearly stipulate the access standards, application scope and operation procedures of artificial intelligence auxiliary case handling systems. In terms of regulatory thinking, a scenario-based approach can be adopted. For applications in different litigation stages, hierarchical classification shall be carried out, and different transparency requirements and review standards shall be set [12].

When judicial interpretations are accumulated to a certain extent, consideration may be given to adding relevant content of "special procedures for digital litigation" in the Civil Procedure Law. This chapter should establish the basic principles of digital litigation and the protection of parties' rights. More importantly, the legal status of artificial intelligence should be clearly defined from a legal perspective. In case of problems with artificial intelligence auxiliary systems, the fault liability of all parties should be reasonably divided according to the legal relationship between system developers, providers and judicial users, so as to achieve consistency of rights and responsibilities [13].

4.2. Constructing technical ethical norms in the judicial field

The application of technology is inseparable from the guiding role of values. Fundamentally, the governance of judicial artificial intelligence is a matter of value orientation. Establishing adaptive technical ethical norms is a necessary prerequisite for achieving the unity of instrumental rationality and value rationality, and also a basic point for clarifying the rights and responsibilities boundary of "human-machine collaboration".

4.2.1. Data bias governance based on expert annotation and context reconstruction

Ordinary data annotation is extremely easy to infiltrate and solidify cognitive biases into training data. In the practical construction of data annotation, individual behavior, process constraints and capital orientation work together to embed social biases into intelligent systems. By constructing training data sets, algorithms can learn to distinguish universal legal principles that should be followed, so as to establish an internal mechanism for identifying and resisting historical biases in the model.

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4.2.2. Multimodal verification of unstructured data

In view of the bias risk of unstructured data in the judicial field, establishing a "multimodal data fusion and dynamic verification" mechanism may be a path worthy of in-depth exploration. The key of this mechanism is not to replace judgment with a single technology, but to form an embedded collaborative structure between technical means and expert judgment, implement hierarchical semantic grasp and continuous correction for ambiguous and contradictory content in data, and compress the space for bias generation and diffusion through multiple references and repeated checks. For highly ambiguous or highly conflicting information that machines cannot independently judge, judicial experts should be introduced for manual annotation. The focus of this design is not to eliminate bias itself, which cannot be achieved overnight technically, but to integrate bias discovery and correction into the normal operation mechanism of the system, and improve the stability and fairness of algorithms when facing complex data.

4.3. Optimizing the implementation path of technical governance

No matter how perfect legal and ethical norms are, they ultimately need to be implemented into specific technical governance tools. Constructing a transparent and controllable mechanism throughout the entire life cycle of algorithms is the key link to ensure the responsible operation of judicial artificial intelligence, and also the technical guarantee for the effective implementation of governance design in the previous two dimensions.

4.3.1. Developing special explainable models for justice and establishing a feedback mechanism for correcting adjudication data bias

Judicial decision-making has high requirements for interpretability, so it is necessary to develop explainable artificial intelligence models specially designed for judicial scenarios, especially in-depth integration with specific applications such as element-based trials. Taking financial loan contract disputes as an example, the model should not only output a number representing the probability of default, but also clearly explain which specific factors such as "number of historical overdue payments" or "debt-to-income ratio" have affected the prediction results [14]. The essence of this idea is to gradually turn the "algorithm black box" into a "gray box" or even a "white box".

The root cause of algorithm bias is often hidden in the historical accumulation of training data, so it is difficult to expect complete elimination through one correction. In practice, the adjudication results generated by artificial intelligence assistance should be continuously monitored and systematically compared with judges' independent adjudications to investigate whether there are repeatable regular deviations. Once problems arise, relevant information should be immediately fed back to the model training link.

4.3.2. Constructing a guarantee system for the right of cross-examination of evidence chains

To solve the challenge to the right of cross-examination caused by the logical untraceability of artificial intelligence evidence chain analysis algorithms, the key is to construct a mandatory legal and technical framework that is interpretable and cross-examinable. Specifically, the law should clearly stipulate that any algorithm system used for judicial proof must meet the basic requirements of process transparency, that is, its core reasoning logic, evidence weight distribution rules and uncertainty measurement must be disclosed to the court in an understandable manner and accepted as part of the evidence material [15]. In addition, technically, explainable artificial intelligence

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technology can be adopted. Developers or deployers of algorithm systems have the obligation to assign professionals to appear in court to explain the design principles, training data limitations and specific parameters of this reasoning of the algorithm, which essentially turns the algorithm black box into a witness that can be questioned.

5. Conclusion

The in-depth penetration of artificial intelligence technology in the judiciary is both an inevitable choice to adapt to the digital age and an unprecedented challenge. However, technological progress is never the opposite of justice, but a tool to promote the realization of justice. Facing the changes brought about by artificial intelligence, what we need is not to reject technology, but to construct a three-in-one governance framework of "legal regulation-ethical guidance-technical governance" with systematic thinking. Only in this way can we ensure that artificial intelligence always serves as an auxiliary tool for judges rather than a decision-making subject replacing humans, and make the efficiency advantages of technology complement the justice value of the judiciary.

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