Reducing Judicial Bias by Using Artificial Intelligence

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Abstract: Artificial intelligence (AI) technology offers new approaches for the prevention of judicial bias. Under appropriate institutional design, AI can reduce judges' perception of extra-legal factors, and it can also explore judges' existing judicial biases based on their historical trial data and provide helpful alerts to them. In addition, AI can help judges conduct similar case matching to improve the consistency of different judicial decisions. Using AI judges in some scenarios can also reduce judicial bias. These approaches can increase judges' capability of reducing bias, and can also play a certain role in supervision.

Keywords: AI, Judicial Bias, Extra-Legal Factor, Alert System, Similar Case Matching, AI Judge

1. Introduction

The word "Prejudice" refers to a preconceived opinion that lacks proper testing and is contrary to logic or reality [1]. In judicial practice, the judge's personal prejudice may lead to biased judicial decisions and sentencing disparity, whereas extra-legal factors such as race, gender, appearance and accent should not produce an effect on judicial decisions. Judicial bias may stem from pre-formed prejudices formed by judges, or it may originate from the reinforcement of judges' decisions based on their own belief systems. Biased judicial decisions expose the parties and criminal defendants to unequal treatment, which can infringe on their human rights, properties, freedoms or even lives [2]. Furthermore, judicial bias can have a negative impact on the legitimacy of the judicial system, which may pose threats to the functioning of society and even human civilization. However, judicial biases are insidious and unquantifiable, making it difficult for traditional systems to prevent them effectively.

The development of AI and other modern techniques has made the judicial system increasingly intelligent, which also provides new approaches for reducing judicial bias in the future. This article proposes four possible institutional ideas to reduce judicial bias by using AI.

2. Reducing Judges' Perception of Extra-Legal Factors Through AI Technology

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Numerous empirical studies have demonstrated that many extra-legal factors of parties and criminal defendants can affect judges' decision-making process. Judges observe the parties and criminal defendants through their own sensory organs in court and use biological brains to make judicial decisions. Subject to cognitive psychological biases such as "tunnel vision" and "confirmation bias", the subjective cognitive processes of judges can lead to explicit and implicit judicial biases. Therefore, if the cognitive processes of judges can be effectively intervened, the related judicial biases can be reduced to some extent. For instance, some countries have the legal habit of wearing hoods for criminal defendants in court, which guarantees their privacy and human rights on the basis of the "presumption of innocence" in criminal proceedings. Besides, this practice also reduces the judge's perception of the defendant's appearance and therefore reduces the related biases. At present, some countries have already adopted online courtroom systems within a certain range to improve the convenience and efficiency of the trial [3], which can be further combined with AI and other techniques to reduce judges' perceptions of extra-legal factors in a more appropriate and effective way. Referring to Figure 1 and Figure 2, this article proposes two designs in different application scenarios to reduce judges' perception of extra-legal information by using AI.

The first institutional design is more suitable for criminal proceedings. In a criminal trial, it is reasonable for the jury and the judge to observe the criminal defendant's facial expressions and physical gestures in order to observe whether the defendant is guilty or innocent. However, it has been proved that the observation of extra-legal factors such as race, appearance, gender [4], and accent [5] of a defendant may skew the final sentence away from fairness and justice. Furthermore, these extra-legal factors are more likely than other legal factors to have an impact on the cognitive process of judges and juries. For example, judges and juries may simply assume that a criminal defendant with facial scars has a higher level of dangerousness without exploring the causes of the scars. However, the characteristics of individuals can be changed by using AI techniques in different scenarios at present, which can be utilized to optimize traditional trial systems. On the one hand, Motion Capture (mo-cap) technology can record the detailed movements of a person's face and body and transform them into digital signals. Afterwards, a simulated virtual image (avatar) can be generated by rendering techniques and AI models based on Generative Adversarial Networks (GANs) or Variational Autoencoders (VAEs) in cyberspace to reproduce the real-time facial and physical movements of the person. Relevant techniques are currently being used in the fields of special effects, VR games, and social software, and they can also be used to reduce judges' and juries' perceptions of extra-legal factors related to the appearance of criminal defendants in the future. Referring to Figure 1, a criminal defendant can participate in a criminal trial through online video in a separate room. When the defendant is answering an inquiry or making a statement, his or her facial and body movements can be recorded by using mo-cap techniques such as specialized devices with marking points or professional optical lenses based on an Active Appearance Model (AAM) or Principal Component Analysis (PCA) model and further converted into digitized parameter data. After that, a highly-simulated avatar can be generated based on rendering and AI to reproduce the real-time movements of the defendant. In this way, judges and juries in different

trials can observe the expressions and movements of different criminal defendants through the real-time video of the same standardized avatar, which is also gender-neutral and race-neutral. This approach can reduce judges' and juries' perceptions of the individual features related to the race and appearance of different defendants. On the other hand, current AI voice changers such as Voicemod can be used as a modulator to modulate the fundamental frequency, harmonic spectrum, etc. of the waveform signal to change the speech rate, pitch and timbre of people's voices. In the trial, the voice of a criminal defendant can be converted into digital signals by recording devices and transformed into a processed and standardized form which shrouds many voice characteristics of the defendant by utilizing an AI voice modulator. Combining these two mechanisms, instead of observing the defendant in person, the jury and the judge build awareness of the criminal defendant through the real-time video of a standardized avatar and processed real-time audio, which actually filtered many extra-legal characteristics of the defendant. As a result, the jury and the judge can still observe the performance and condition of the defendant and interact with the defendant in real-time, but relevant biases related to the defendant's race, gender, accent, etc. can be reduced to a certain extent. Similar mechanisms can also be applied to victims and witnesses in criminal proceedings on the basis of safeguarding their human rights and privacy.

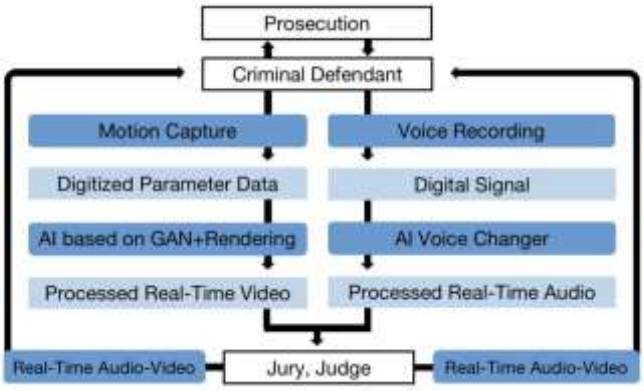

Fig.1 Design of using AI to reduce the perception of extra-legal factors in the criminal trial.

The first design can reduce relevant biases in criminal trials to a certain extent by reducing the judge's and the jury's perception of extra-legal information, and this effect can be further enhanced by Artificial Intelligence Generated Content (AIGC) technology. The second institutional design is more suitable for civil trials in which both the plaintiff and the defendant participate in the trial by using real-time online video in the online courtroom system. Referring to Figure 2, the plaintiff and the defendant can communicate via Real-Time Audio-Video (RTAV), but their conversations, as well as all their in-court statements, will be further processed to filter out most of the extra-legal factors before being presented to the judge. To begin

with, the video images of the parties will be blocked. At the same time, all the conversations between the parties and their statements in court will be recorded in real-time by using recording equipment and transformed into digital signals, which will be initially processed by Audio Signal Processing technology to remove irrelevant environmental noises. In the next stage, the digital signals will be converted into a standardized textual version of the parties' statements by utilizing Natural Language Processing (NLP) technology. Combining Audio Signal Processing and Digital Signal Processing (DSP) technology, modern NLP technology can accurately recognize the precise meaning of various colloquial and fragmented linguistic information of the parties' statements and convert them into a standardized textual version in real-time [6]. In the final stage, all the statements made by the parties in the court and the conversations between them (prompts) will be processed by an AIGC model to filter out contents without substantial meaning and most of the extra-legal factors. After continuous training and deep-learning process, the modern AIGC systems based on Transformers or different types of Recurrent Neural Networks (RNNs) such as the model of Long Short-Term Memory (LSTM) can combine NLP technology to identify and understand the nature category, and specific content of the statements and conversations of the parties and convert them into digitized vectors [7]. After that, the AIGC algorithmic model can tag the categories of different vectors embedded in the model and weigh the vectors of different importance, and then generate texts according to the probability distribution of different tags before filtering out all the vectors representing insubstantial content of the parties' statements. In this way, AIGC models can regenerate new texts with the same meaning from the original statements of the parties (prompts), in which all information such as modal particles and honorific words that are irrelevant to the substantial content of the parties' will be filtered out. As a result, the judge will have access to the textual version of the substantive information about the parties' statements and conversations in order to understand the parties' core views and positions in real-time and interact with them, but the judge cannot access most of the extra-legal factors such as the race, appearance, gender, accent and language habits of the parties. Ultimately, this approach can greatly reduce the influence of judicial biases when the judge is interacting and communicating with the parties and allowing the judge to focus more on the substantive part of the parties' real-time legal opinions.

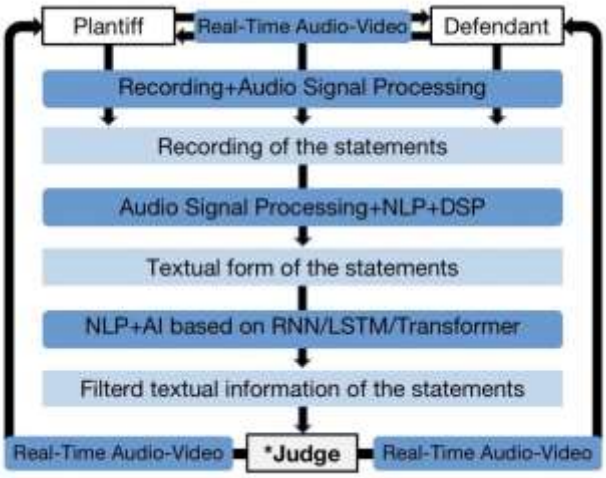

Fig.2 Design of using AI to reduce the perception of extra-legal factors in the civil trial.

3. Alert and Supervision Mechanism for Judicial Bias Based on AI

The theories of cognitive psychology suggest that a judge's unconscious cognitive process can lead to judicial bias. On this basis, many judges may not be clearly aware of their implicit biases, or have no intention and awareness of correcting the deep-rooted biased concepts which lead to relevant biases [8]. Nowadays, AI may be used to design an alert mechanism which analyzes the possible explicit biases and implicit biases of individual judges and help them to establish awareness of their own biases. This approach may help judges to constrain and balance their own biases through the counterforce of their moral concepts and will [8]. At the same time, AI can also be used to establish a better supervision mechanism against judges' judicial bias.

Biases existing in judges' decisions are difficult to observe and quantitatively measure in a traditional way [2], and it is also challenging to systematically organize and analyze a huge number of legal cases to explore the prevalent judicial biases with previous systems. However, modern AI technology may be able to explore the bias of human judges by using AI models with the architectures of Deep-Learning. First, mainstream Large Language Models (LLMs) based on RNN and Transformer need to be trained on a large amount of existing judicial data to improve the analytical ability, computing power and accuracy of the models. By analyzing comprehensive features from a large number of resolved cases in existing judicial databases, Artificial Neural Networks (ANNs) inserted in the LLMs can use multiple layers to progressively extract higher-level features from the original judicial data (input). That is to say, the models can go from analyzing the basic laws of the raw judicial data to exploring the potential linear trends and structural correlations between the data based on different

features in separate samples in order to explore the biases prevalent in different judges' decision based on the probability distribution. On this basis, a pre-trained AI algorithmic model (AI Model I) can continue to conduct a more detailed analysis of individual judges by using the data of the historical judicial decisions of the judges. Referring to Figure 3, all historical verdicts made by an individual judge can be digitized and stored in an electronic archive (E-Archive), in which the specific content of the judge's judicial decision of every case, as well as part of the extra-legal factors that can be quantified and digitally measured such as the race, gender, and nationality of the parties, will be recorded and categorized. In the next stage, all historical judicial data of the judge stored in the E-Archive will be imported into the pre-trained AI Model I to generate a detailed analysis report on the potential biases of the judge. During the processing and computation processes of AI Model I, on the one hand, all the historical judicial decisions of the judge will be made between-subject comparisons to explore whether the judge made different verdicts in different cases with similar legal facts and whether the deviation of the verdicts may have a potential correlation with different extra-legal features of the parties. On the other hand, the feature sentences of the judge's historical verdicts will be extracted and converted into digitized vectors. The vectors will be compared with the ones of other resolved cases in the judicial database to identify resolved cases with high similarity to the judge's historical cases. After that, the model can analyze whether the judge's decisions deviate from the general range of other judicial decisions and whether this deviation has a potential correlation with different features of the different parties. Afterwards, a detailed analysis report on the judge's possible biases will be generated by AI Model I and submitted to the judge for his or her reference. Reading the report helps the judge build awareness of his or her potential biases, which may help the judge reduce judicial bias in the future by using his or her internal binding force.

The aforementioned AI-based bias analysis system can help judges to build awareness of their own potential biases. However, it may be challenging for the judges to maintain awareness of their unconscious and implicit biases in a state of concentration and active thinking in the courtroom and to further effectively control the biases by using their internal binding force in the trial [9]. Therefore, the analytical results formed by AI Model I can be further input into a bias alert system based on AI (AI Model II). Referring to Figure 3, in the trial, the alert system can identify the features of the parties in the pending case and compare the features of the parties with the extra-legal factors that may trigger the trial judge's biases. If the judge may have made biased judicial decisions influenced by extra-legal factors similar to those of the parties to the pending case, AI Model II will send out alerts to the judge in private at a reasonable frequency during the trial to remind the judge that the judicial decisions should not be influenced by certain specific extra-legal factors. After the judge has made an initial judicial decision, the decision can also be further examined by a pre-trained AI model based on RNN or Transformer (AI Model III). By comparing the initial decision with historical judicial data of the trial judge and other judicial decisions of similar resolved cases in the database, the model can verify whether the judge's initial decision may have been biased and take further steps using the model of a decision tree. If the calculated value of the possibility of judicial bias reaches a certain level, it shows that the judge's initial decision may be biased. Then,

the model will submit the corresponding analysis results to the judge. Besides, the model can also push the collection of cases similar to the pending case and the recommended judicial decision generated by AI to the judge at the same time. The judge will further review the initial decision in conjunction with the model's analysis results and other information to decide whether to amend his or her original judicial decision.

Throughout the process, the three systems against judicial bias based on three different AI models serve as auxiliary tools for the judge to help him or her conduct a better trial, and the final judicial decision will be ultimately decided by the judge. However, if it is detected that the judge makes judicial decisions that deviate from the general range of similar cases in the database too frequently and does not amend the deviated decisions after being alerted, the model may respond to the higher regulator about the corresponding situation, which will actually play a certain role in supervision and further improve the original regulatory system. In addition, AI and other modern techniques can be utilized to further incorporate more extra-legal factors such as the appearance and voice characteristics of the parties into the analytical process by using technical means to improve the utility and accuracy of the different systems against judicial bias while ensuring data security and the privacy of the parties.

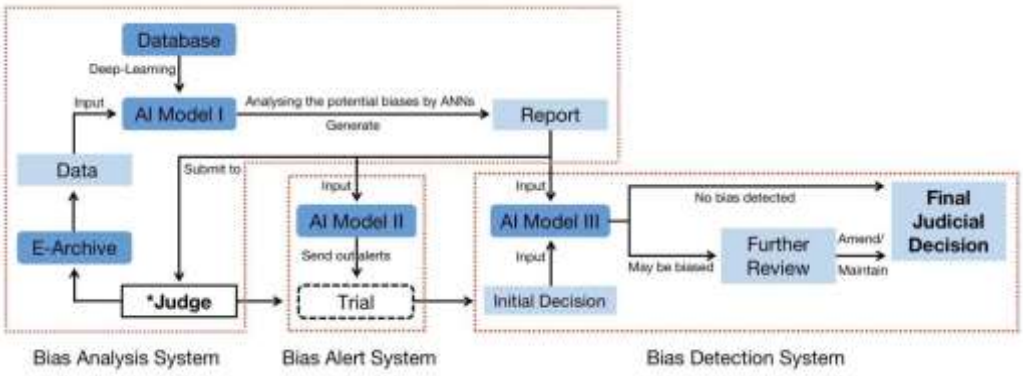

Fig.3 Design of using AI to alert and supervise potential judicial bias of the Judge.

4. Using AI to help judges with Similar Case Matching

Legal case matching is an essential part of legal research. For judges in judicial practice, conducting Similar Case Research (SCM) based on the pending case helps the judge to build a comprehensive understanding of the relevant precedents, which can strengthen the unification of the judgement scale under the same legal system. In addition, although judges have a certain amount of discretion and a certain power to make law, different judges should adopt consistent rules and make highly unanimous

judicial decisions on similar cases in most scenarios. Otherwise, it indicates that part of the judges may have made biased decisions influenced by extra-legal factors [2]. Actually, case law, an important source of law in the common law system, also shows the relevant legal principles. According to the principle of “stare decisis”, judicial decisions of resolved legal cases can be used as precedents to apply to future cases under the jurisdiction of the same court or the lower court in the future. As long as the basic facts of the cases are the same or similar to the precedent, these cases must be dealt with according to the rules established by the precedent. On this basis, conducting SCMs helps judges establish a more comprehensive understanding of the previous cases and make more consistent judicial decisions , which can make sure different parties in different cases with similar legal facts are able to receive similar legal treatment. As a result, the influence of extra-legal factors in different legal cases can be reduced to a certain extent.

Current AI techniques have better performance in the field of Semantic Matching [10], which can help judges to conduct SCM in a more efficient and accurate way. Different from using biological mechanisms to understand and compare the semantic and legal meanings of different legal cases, the AI SCM system based on neural networks utilizes data-driven algorithmic mechanisms to compare different legal cases at the data level. Referring to Figure 4, materials such as case files and verdicts of resolved legal cases need to be converted into digital form and stored in the E-Archive by using NLP technology. However, the current Semantic Matching system cannot directly compare two lengthy literal texts, so the specific information of legal cases needs to be split into separate sentences, which will be further filtered into feature sentences with substantive meanings by using an AI model based on RNN or Transformer. Afterwards, the selected feature sentences will be transformed into vectors by using an encoder and stored in the database. When the judge needs to conduct SCM for a pending case, the basic facts and information of the pending case need to be processed through a similar procedure, where the feature sentences of the case will be transformed into vectors by using an AI model and an encoder. Then, the digitized vectors of the pending case will be fed into the AI SCM system as input. In the next stage, the pre-trained AI SCM model will apply a metric such as cosine-similarity to compare the similarity between the vectors of the pending case and vectors of other resolved cases in the database and output a value between 0 and 1 to record the similarity between the pending case and every single resolved case in the database. Eventually, a subset of cases in the database with the highest similarity value to the pending case will be sorted out and collated into an SCM report for the judge’s reference. Judges can refer to other resolved cases with a high degree of similarity to the pending case to make a better judicial decision.

Currently, some lawyers are already using AI systems such as BERT, RoBERTa, ChatGPT, CaselQ and ChatLaw for case research and legal research. Meanwhile, systems that can be specifically used for SCM such as CAIL2019-SCM have also appeared. In the future, a more accurate and reliable SCM system can be developed, and a more comprehensive SCM report on the pending case can be generated by AI to assist the judge to make more consistent judicial decisions and reduce judicial bias.

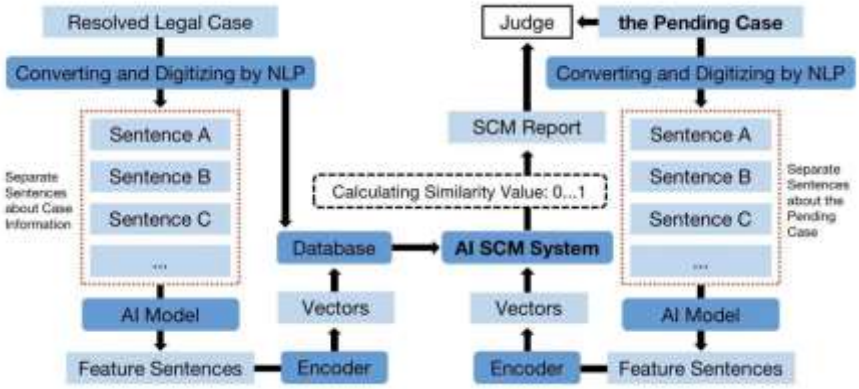

Fig.4 Mechanisms for the operation of the AI Similar Case Matching system

5. Wider Use of AI judges

Currently, AI judges based on historical judicial data analysis are able to generate complete judicial decisions independently in accordance with the content of the case and relevant legal regulations [11]. The basic operation principle of the AI judge is to generalize the intrinsic laws of human judicial decisions based on probability theory, the process of which is called "Predictive Analytics". In the initial stage, technicians will build an algorithmic meta-model for a specific legal issue by using the model of Autoregressive Integrated Moving Average (ARIMA) or other types of Time Series models, most of which also show the algorithmic structure of neural networks based on RNN or Transformer. By using training approaches such as Semantic Analysis and Data Analysis, the model can be trained with a large amount of labelled judicial data by conducting data analysis using methodologies such as regression analysis and linear analysis. Afterwards, the model can explore potential correlations between different vectors and further integrate the characteristic data into a structured knowledge chain that conforms to the algorithm logic and the logic of specific legal regulations. After repeated training and positive human intervention, the trained model can be used as an AI judge to generate judicial decisions independently.

Different from biological mechanisms used by human judges, the data-driven approach of the AI judge models does not have psychological mechanisms such as emotions and subjective predictions embedded in biological brains. Instead, the decision-making pattern of AI judges strictly adheres to the legal logic and algorithmic logic, so they have a stronger objectivity. Therefore, AI judges are less susceptible to extra-legal factors and are more likely to make judicial decisions more objectively based on legal factors exclusively. At the same time, AI judges can harness enormous amounts of computing power and data in order to obtain and process more information related to the pending case and are more likely to generate more comprehensive and accurate judicial decisions.

However, there are certain technical obstacles and ethical issues in the application of AI judges. On the one hand, AI judges may also have the issue of algorithmic bias. Since most of the current AI judge systems require deep-learning and training of existing judicial data, which is formed by human judges with human judicial bias included. Therefore, it has been shown that some AI judges are also subject to certain biases based on extra-legal factors and they can produce biased and inappropriate outcomes [12]. On the other hand, the AI judge system is still immature, therefore the accuracy and reliability of AI judges cannot be fully guaranteed [12]. Moreover, the black box form of AI may make it fail to comply with the core concerns of the parties and society, AI judge systems also have unresolved confidentiality risks and data security issues. As a result, the legitimacy of AI judges has not been confirmed at present, and the use of AI judges may trigger the public to question the legitimacy and authority of the judicial process and even pose threats to the existing judicial system, ethical system and social order.

In fact, with the development of the algorithmic model and the increase in the amount of training, the reliability of AI judges can be enhanced. Firstly, the algorithmic bias of AI judges can be further addressed through the improvement and optimization of the algorithmic patterns and positive intervention by humans. Effective regulatory mechanisms will be put in place to ensure that the features of the parties or criminal defendants extracted for the decision-making process of AI judges do not contain extra-legal factors, and the algorithmic pattern of the AI judge may be further optimised as a brute force algorithm that does not require the use of historical judicial data generated by human judges. Secondly, a study has indicated that the human-AI fairness gap can be partially offset by increasing the interpretability and ability to provide a hearing of the AI judge [13]. That is to say, people's acceptance of AI judges may gradually increase with the improvement of interpretability and transparency of the AI judge system. Although the obstacles of AI judges cannot be overcome within a short time, the mechanism of AI judges will continue to be optimized and the accuracy of the AI judges will be gradually improved. At the same time, human judges are not perfect either. Eugene Volokh pointed out, “Our question should not be whether AI judges are perfectly fair, only whether they are at least as fair as human judges” [13]. Actually, AI judges have their own inherent institutional advantages. Therefore, when the technical defects of AI judges are gradually remedied, wider use of AI judges becomes possible.

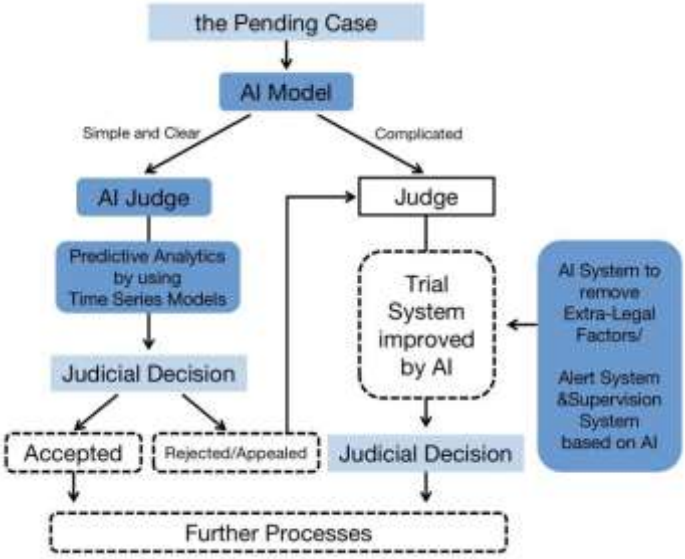

Fig.5 Using AI judges to help human judges conduct better trials.

Technologies related to AI judges such as NLP should be continuously developed, and the algorithmic model of AI judges can also be further optimized. During this process, the AI judge may be used as an auxiliary tool to the human judge or independently applied in some simple cases and administrative decisions with clear facts and logic [14]. Referring to Figure 5, A more reasonable and effective trial system can be established to classify the complexity of the pending case and distribute the case to the AI judge under certain scenarios. To begin with, an AI model based on RNN or Transformer can analyze the nature and basic legal facts of the pending case to confirm whether there is a mature algorithm model for this specific type of case and measure the complexity of the case. Afterwards, some simple cases and adjudications with clear legal facts can be distributed to the AI judge and initially tried by the AI judge system. At present, the shortage of judicial resources and the fatigue of human judges in court may also lead to judicial bias and other issues. On the one hand, AI judges can be used to help the human judge to undertake some of the judicial work so that the judge can concentrate more on hearing complicated cases. On the other hand, AI judges are not easily affected by extra-legal factors and can generate judicial decisions in a more objective way. However, if the parties file an appeal or have strong objections to the results generated by the AI judge, a redress mechanism should be established and the case may need to be handed over to a human judge for a second trial. At the same time, when the human judge is hearing the case, AI can also help the judge by utilizing the aforementioned mechanisms to reduce judicial bias and generate better judicial decisions.

6. Conclusion

Article 7 of the Universal Declaration of Human Rights (UDHR) states, "All are equal before the law and are entitled without any discrimination to equal protection of the law". Reducing judicial bias is always the pursuit of the judicial system and human civilization. Richard A. Posner pointed out, "Gatekeeping is one way of combating cognitive illusions; another is the adversary process itself" [15]. Actually, AI technology and other techniques can be used to establish a more reasonable and effective trial system and regulatory system against judicial bias in the AI era. To begin with, AI judges can undertake the trial work of some simple cases to reduce the burden on human judges. For complex cases, AI can “keep the gate” by reducing the judge's perception of extra-legal factors and providing effective references to help judges build awareness of their own implicit and unconscious judicial bias. Moreover, AI can be used to establish a better alert system against judicial bias, which can also play a certain role in supervision. The AI SCM system can also help judges conduct similar case matching to enhance the consistency of different judicial decisions. Such systems are not designed to replace human judges with AI and other techniques, but to enable judges to reduce judicial bias and better conduct the trials by using AI as an auxiliary tool.

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