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Revolutionizing Forensic Medicine: The Power of Artificial Intelligence

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ABSTRACT

As the fourth industrial revolution, artificial intelligence is reshaping many industries. It has become a new cornerstone of digital conversion, and it is no exception in the field of forensic medicine. This paper mainly discusses how artificial intelligence can solve the problems related to forensic medicine. How to use artificial intelligence technology to develop into an auxiliary tool in the field of forensic medicine. This paper summarizes the exploratory data analysis, statistical modeling and machine learning in artificial intelligence, extracts insights and knowledge from the data, and applies them to various fields of forensic medicine. Artificial intelligence will improve the accuracy and efficiency of forensic work: it can automate some tasks and improve the quality of evidence. The comprehensive analysis results show that the artificial intelligence proposed in this paper will be an important auxiliary in the three directions of forensic medicine.

KEYWORDS: Artificial intelligence application, Forensic clinical medicine, Forensic pathology, Forensic psychiatry, Interdisciplinary application

1. INTRODUCTION

Artificial intelligence (AI) is increasingly infiltrating into modern human life, and it is increasingly difficult to find areas where it does not exist. This article shows the use of AI methods to solve forensic related problems.Specifically, artificial intelligence technology attempts to overcome the limitations of human subjective bias of traditional forensic methods, including imaging related injury relationships in forensic clinical medicine, or interdisciplinary discourse system differences in forensic psychiatry (Guo, 2018). Similarly, artificial intelligence has also been studied as an auxiliary tool

for forensic pathology, which is used to quickly and easily identify the classification of diatoms and autopsy pathology (Zhu, Zhang, Cheng, et al., 2022); (Zou, Zhuang, Fang, et al., 2020). Therefore, through the wide application of AI in forensic medicine and its future direction, this paper emphasizes the advantages, limitations and forensic significance relating to artificial intelligence. Forensic medicine is mainly consist of three main branches: forensic clinical medicine, forensic pathology and forensic material evidence. However, there are relatively few discussions on forensic psychiatry so far, so this paper will also specifically select three of them for discussion.This paper discusses the application of AI in three sub-divisions of forensic science and points out the problems associated with its application in real-life scenarios.

1. ARTIFICIAL INTELLIGENCE IN FORENSIC MEDICINE

Artificial intelligence in the field of forensic medicine mainly focuses on imaging, pathological sections after autopsy and machine learning in the form of suicide risk stratification. This technology is used to screen a large number of data and highlight patterns to expand the scope (Cockerill, 2020). In view of the growing popularity of artificial intelligence, the application of artificial intelligence set an example is integrated into a computer program or part there of that performs a specified task. This model could be constructed from applied data such as digital or classified variable tables, pictures, text, or other rules, which can assist in the decision-making process of forensic medicine and judge the relationship between injury and death (Richens, Lee, & Johri, 2020).

The learning process of machine learning can be regarded as supervised (data set is provided to the model, which requires the model to predict the answer and tell the model whether the answer is correct) or unsupervised (a model provides no difference related data, and requires pattern data in recognition).Among them, self supervised learning is a learning paradigm, which data provides supervision, and there is no label that needs to be manually labeled. Unlike supervised learning, which relies on external labels, its discovery mode has no specific target. Self-supervised learning creates target conversion or shields part of the data, and then trains the model to predict those converted or covered parts. Chatgpt, a large language model such as GPT-4, is a subset of AI whether to conduct written language training through self-monitoring and fine tune the response through manual input. Essentially, they predict the next natural word (Greyling, 2022); (GPT-4, n.d.); (Grabb & Angelotta, 2023).

AI has led to the popularity and potential of this technology, leading various industries to a turning point. The integration has been gradually discussed in clinical and forensic practice. It is found that the information generated by artificial intelligence is helpful for forensic medicine. At the same time, more intelligent artificial AI will also be integrated into legal and judicial practice psychiatry, etc (Grabb & Angelotta, 2023); (Ayers, Poliak, Dredze, et al., 2023).

1.1 Application of Artificial Intelligence in Forensic Clinical Medicine

Today, artificial intelligence can be regarded as a domain-specific modeling tool (Sarker, 2022). Examples, in clinical practice, artificial intelligence models might be specially designed to detect where breast cancer comes from (Shen, Margolies, Rothstein, Fluder, McBride, & Sieh, 2019). Forensic clinical diagnosis has as much history as the concept of clinical science and has even become an important element of scientific practice.

The condition classifications and sign category are the clinical diagnosis categories of forensic medicine, which are generated after dividing the pathological states observed in life. These two could be observed directly by practitioners or other inspection instruments. Artificial intelligence can intervene in the condition category and sign category of forensic clinical diagnosis at the same time, but it can also intervene in the mapping operation between the two spaces - therefore, it can intervene in the diagnosis. This process also serves as a connection between data, knowledge and operators. That is to say, diagnosis includes surgery between two spaces (Lefèvre & Tournois, 2023). People can call to mind the classification of diseases and related standards (signs, symptoms), such as DSM-5 (diagnostic and Statistical Manual)[13] or ICD-11 (International Classification of diseases) (World Health Organization, 2019). In this way, we can transform this definition into a world that is all digital at a clip. Different observed signs can be converted into data, and diseases can be classified or converted into data. These data can be processed in various forms by computing machinery.

Artificial intelligence can be applied in this process, which can be applied in forensic clinical imaging, such as brain injury, rib fracture, vertebral fracture, etc (Ma, Liu, Liu, et al., 2023); (Santin, Brama, Théro, et al., 2019); (Hosny, Parmar, Quackenbush, et al., 2018); (Chen, Zheng, Park, et al., 2016); (Ghafoorian, Karssemeijer, Heskes, et al., 2017); (Wang, Zhou, Li, Chen, et al., 2017) , In recent years, there have also been some improvements in scar measurement in forensic clinic due to machine learning (Xu, Liu, Fan, et al., 2000); (Lin, Li, Jin, et al., 2019), As well as the occurrence of artificial intelligence for understanding causality, the application of causality judgment participation in forensic clinic still has great potential to be developed(Richens, Lee, & Johri, 2020).

1.2 Application of Artificial Intelligence in Forensic Pathology

Forensic pathology is a branch of science. Today, it can learn from the new technology inherent in other medical fields more than any other discipline. In the history of forensic pathology in the 20th century, the inevitable combination of tradition and innovation reflects the characteristics of forensic pathology (De Matteis, Del Fante, & Santoro, 2020). In

forensic pathology, we can associate different causes and mechanisms of death in practice, as well as diagnostic autopsy intervals for autopsy, in which the algorithm of artificial intelligence plays a vital role of data analysis, normal pattern recognition, abnormal pattern recognition, and rapid decision planning. These include trauma, autopsy interval estimation, sexual assault/rape, scene of a crime rebuild, virtual postmortem, and medical behavior quality assessment in forensic pathology, among which diatom and time of death inference involving artificial intelligence in forensic pathology in China (Zhu, Zhang, Cheng, et al., 2022); (Zou, Zhuang, Fang, et al., 2020).

Time of death inference (PMI) is a practice of forensic pathology that is being carried out almost every day. The introduction of artificial intelligence in research has begun to identify biomarkers in a variety of different biological fluids (e.g., human blood, body fluids, and urine).Some people believe that femoral vein collection for determination the biochemical components thereof, such as lactate dehydrogenase LDH, triglycerides and cholesterol, and PH measurements. (Hachem & Sharma, 2019). After death, the levels of these biomarkers change in proportion to the time after death through the biological decomposition in the body. Zou et al.pointed out that artificial intelligence technology has been fully developed in data processing and has been used as a traditional method by some researchers(Zou, Zhuang, Fang, & Li, 2020). Through the application of next generation biological sequencing technology (NGS) and artificial intelligence technology, forensic pathologists can strengthen the data set of microbial community, so as to obtain the list of ecosystem-specific inventories, the quantification of biome diversity, the description of its ecological function, and the postmortem sequencing can be applied to the application of postmortem microbiome in forensic pathology (Wang, Zhang, Wang, Yuan, Guan, & Zhao, 2022).

The combination of artificial intelligence and virtual autopsy represents the field of forensic pathology. Artificial intelligence can identify pathology and fracture of organs and compare them with the database by CT or MRI. Artificial intelligence will also deal with these changes and form its own diagnosis and conclusion on the cause of death of anatomy and pathology. The technology can also provide information about the damage caused by guns, measure the entrance hole of the horizontal plane and compare it with different models, so as to estimate the caliber of bullets. In addition, the probability of collecting biological samples by this method helps forensic pathologists to make diagnoses and draw more correct conclusions (Sullivan, Holzinger, Zatloukal, et al., 2017).

1.3 Application of Artificial Intelligence in Forensic Psychiatry

Forensic psychiatry is an interdisciplinary subject, which lies in the integration of discourse systems between disciplines. On the other hand, the object of forensic psychiatry identification itself has the complexity of multiple causes, multiple causes and multiple outcomes (Tortora, Meynen, Bijlsma, et al., 2020). Functional diagnosis in forensic psychiatry,such as reaction at trauma or post-traumatic stress disorder, can be integrated into the application of artificial intelligence. More than 200 violence risk assessment tools have been developed in forensic psychiatry, usually integrated clinical actuarial tools, to predict violence, antisocial and sexual Behavior (Singh, Desmarais, Hurducas, et al., 2014) , The central goal of these methods is to correctly identify high-risk and low-risk criminals. They are used to provide information for a series of medical legal decisions, such as sentencing, parole, civil commitment, death penalty, disposal of juvenile court and release after finding insanity (Conroy & Murrie, 2007). In the past, non-invasive anatomy and functional neuroimaging technology have made significant progress and produced a large amount of data. Statistical machine learning methods help to analyze a large number of neural data with increasing accuracy (Lemm, Benjamin, Thorsten, et al., 2011) and high dimensional dataset modeling (Abraham, Pedregosa, Eickenberg, et al., 2014). The application of statistical machine learning to neuroimaging data is called multifactor pattern analysis (MVPA)] (Ombao, Lindquist, Thompson, et al., 2017).Among them, behavioral characteristics are related to the characteristics of human brain, sometimes even significantly, which provides a new possibility for the development of prediction algorithms and helps to predict the personality of individuals. "Neural prediction" refers to the use of structural or functional brain variables to predict prognosis, treatment outcome and behavior prediction (Morse, 2015).

2.RESULT AND ANALYSIS

Alan Turing, the founder of AI, gave the first definition AI is intelligent machines, especially in science and engineering of intelligent computer programs. (Turing, 1950). Salto et al. Believe that artificial intelligence is an advance techniques that meanings and understandings can be extracted. Machine series form databases from expanded data and extract relevant information from them in a manner that mimics humans. (Salto-Tellez, Maxwell, & Hamilton, 2019). Ability to correctly interpret external data and learn, as well as flexibility to adjust to achieve goals and tasks (Kaplan & Haenlein, 2019).

2.1 Research on Artificial Intelligence in Forensic Clinical Medicine

In the medical field, the most applied machine learning is precision medicine technology (Lee, Celik, Logsdon, et al., 2018). Machine Learning as a statistical technique that that fits the model to the data by using data to train the model (Deloitte Insights, 2018). This is also a potential Artificial Intelligence in forensic science, which is continuously trained and fitted in forensic clinic to obtain scientific and reasonable analysis results. Just like the effectiveness of artificial

intelligence in terms of diagnostic accuracy, the work of determining the complications and the effectiveness of treatment (Santin, Brama, Théro, et al., 2019); (Qiu, Joshi, Miller, et al., 2020); (Salazar, Vasquez, Torres, et al., 2023); (Attia, Kapa, Yao, et al., 2019); (Alsharqi, Woodward, Mumith, et al., 2018); (Zhang, Guo, Yuan, & Hu, 2020); (Rajpurkar, Chen, Banerjee, & Topol, 2022); (Young, Xiong, Pfau, Keiser, & Wei, 2020); (Dick, Sinz, Mittlböck, Kittler, & Tschandl, 2019); (Pedersen, Verspoor, Jenkinson, Law, Abbott, & Jackson, 2020); (Rathi, Tsui, Mehta, Zahid, & Schuman, 2017); (Kröner, Engels, Glicksberg, et al., 2021); (Idowu, Fergus, Hussain, Dobbins, Khalaf, Eslava, & Keight, 2015); (Sone, Toyohara, Taguchi, Miyamoto, et al., 2021).Configure a special case in a imaging, in which neurons are organized into many consecutive layers after learning the data autonomously and gradually extracting the complex processed data, such as to provide data for decision making to extract information from narrative text (Coppola, 2018). The convolutional neural network CNN can also be used to explicitly assume that the input has a specific structure such as an image.It can make neurons respond only locally, adding this property to the architecture by sharing the weights of locations in the data image. (Teuwen & Moriakov, Eds., 2020). In addition, artificial neural network can also be used to solve different aspects or elements of problem learning in forensic clinical practice, such as the learning mode, inductive mode and reasoning mode of clinical cases.

2.2 Research on Artificial Intelligence in Forensic Psychiatry

Forensic pathology in the field of artificial intelligence is in its infancy and must undergo changes to become a useful adjunctive application to medicine. Artificial intelligence can accurately provide help to forensic pathologists, including both macro anatomical pathological diagnosis and all complementary diagnosis, so as to reduce subjective judgment and fatigue; In addition, it can reduce the cost of all forensic activities. Sometimes, with the help of artificial intelligence, some necessary opinions and conclusions can be analyzed earlier and more reliably, and some possible human errors can also be eliminated. Artificial Intelligence algorithms have been shown to have the ability to reduce human subjective errors, minimize operational errors, amongst other things and come up with cost-effective solutions.

2.3 Research on Artificial Intelligence in Forensic Psychiatry

In forensic psychiatry, artificial intelligence technology can be applied in the field of auxiliary diagnosis and risk screening of mental disorders. Artificial intelligence neural prediction first only established the correlation between brain image and recidivism risk. However, if it is indeed possible to plan interventions based on neural data modeling, it would provide an opportunity for offenders to avoid jail time (Nadelhoffer, Bibas, Grafton, et al., 2012). While the purpose of neuroimaging is to reduce uncertainty and increase objectivity in the forensic work environment, there is a risk of misleading the use of neuroimaging in court due to cognitive bias in evidence evaluation (Scarpazza, Ferracuti, Miolla, et al., 2018). Therefore, the introduction of neural prediction may lead to excessive dependence on neural data.

3.CONCLUSION

Artificial intelligence technology is applied to all aspects of forensic medicine, which has certain feasibility and advantages. TThe combination of artificial intelligence and forensic science offers great promise for improving the accuracy and efficiency of medico-legal practice. Artificial intelligence algorithms appear to reduce the problem of human subjectivity, decrease the rate of incorrect ratings, and provide cost-effective solutions.

Although AI is innovating the world, it is still a immature technology, although it has proved that its algorithm is more objective and intelligent. From a long-term perspective, the opinions formed by AI may not be accepted as personal conclusive evidence, and it may continue to develop and be unanimously accepted in our daily life with the passage of time and the development of artificial intelligence. Gerke S. et al. point out that the challenges facing AI also include the ethical issues of the data, its transparency and cybersecurity, the correctness of the algorithms, and the confidentiality of the information data (Gerke, Minssen, & Cohen, 2020).

The progress of artificial intelligence marks a turning point in forensic science. In recent years, these techniques have proved to have great potential for optimizing the process of data profile analysis. While challenges remain in terms of ethical scoping considerations, data security, and correctness or incorrectness of modeling algorithms, continued research and scientific and technological advances are an important part of being fully utilized in forensic science applications. In any case, human expertise is still a crucial decision, and the most important link is the process of collecting and collating data. In fact, we need to ensure scientific data in order to maximize the potential of this technology in the field of forensic science.

The benefits of AI to forensic medicine include accelerating evidence analysis and clue interpretation, which can bring more efficient and accurate related procedures. However, we recognize that using full AI takes time and constant adjustment. At the end of the day, AI is not a substitute, but a very valuable partner. And human insight and own knowledge remain crucial for interpreting context and making sound judgments and decisions. Through different technologies and human expertise, a fair justice system is defended as much as possible in a developing modern society. The gradual integration of AI into forensic science is therefore an important step towards improving the welfare and safety of society.

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