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Regulating the Use of Artificially Intelligent Driving Algorithms Within the Artificial Intelligence & Internet of Things (AIoT)

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ABSTRACT

The advancement of the underlying technology and hardware devices of the Internet of Things (IoT) has led to the emergence of several new applications that are influencing the progress of human society in the era of the Artificial Intelligence IoT (AIoT). The application of AIoT has not only revolutionized the efficiency of human social life but also brought about moral and ethical hazards as well as legal issues. At a technological level, the algorithmic mechanism of AI driving is more complex than typical machine learning and requires regulation because to its automated decision-making process. The design of algorithmic regulation for AI driving should prioritize system safety, continuous improvement of regulation technology, implementation of algorithmic audit mode, and enhancement of overall efficiency in regulating algorithms.

KEYWORDS

Artificial Intelligence IoT (AIoT); Algorithms; Automated Decision Making; Algorithmic Auditing.

1. THE CURRENT TRAJECTORY OF AI DRIVING WITHIN THE CONTEXT OF AIoT

The conventional Internet of Things (IoT) is a network framework comprising many networks, including the Internet, traditional telecommunication networks, and sensor networks. It facilitates the interchange of information and communication among things. The essence of the Internet of Things (IoT) is centered around its "things", which encompass a range of devices and objects. These entities gather data using sensors, controllers, and other devices, and then utilize the Internet to share information and interact. This enables the achievement of intelligent functions such as identification, positioning, tracking, monitoring, and management. The Internet of Things (IoT) technology has diverse applications in several domains such as smart home, smart city, industrial automation, healthcare, agricultural monitoring, transportation management, environmental monitoring, and more. As technology continues to advance, the Internet of Things (IoT) will enhance our lives by providing increased convenience and innovation.

The continual evolution of the underlying technology and hardware devices necessary for traditional IoT has led to the emergence of new development trends in this field. Firstly, there has been a widespread adoption of IoT terminal devices, leading to a significant increase in terminal data and connections. Secondly, there is a growing need for real-time and privacy-compliant data processing due to data compliance requirements. This has resulted in the emergence of new IoT businesses that demand higher real-time data processing and lower data transmission latency. The real-time data requirements in the IoT are demanding, necessitating low data transmission latency. However, due to the increasing integration of IoT into people's daily lives, there is an urgent need for privacy protection.

In terms of computing power, IoT terminal devices are constantly being upgraded. Compared to traditional IoT terminals, smart chips, embedded processors, and sensing devices are continuously developing and becoming smaller, enabling terminal equipment to possess intelligent data processing capabilities. Additionally, the emergence of artificial intelligence technologies like deep learning has further enhanced the functions of IoT. With the increasing number of network layers, the computational cost of IoT deployment and execution continues to rise, posing significant challenges. [1]

The emergence of AIoT represents a new phase in the evolution of traditional IoT. The term " artificial intelligent IoT," which stands for intelligent Internet of Things, AIoT, as defined in the "2020 China Intelligent Internet of Things (AIoT) White Paper," refers to the combined use of artificial intelligence and IoT. It involves the real-time collection of information through IoT system sensors, followed by intelligent data analysis at the terminal, edge, or cloud. This process ultimately leads to the creation of an intelligent ecosystem.

The concept of Intelligent Internet of Things focuses on the integration of human, machine, and physical objects in computing. With advancements in technologies such as Internet of Things and artificial intelligence, the computing system is expanding beyond the realm of information space to include the ternary space comprising human society, information space, and the physical world. This ternary fusion computing of human, machine, and physical objects has emerged as a significant paradigm. It can efficiently combine and include the diverse components of human, machine, and object, resulting in the creation of a novel intelligent computing system. This system provides robust assistance in addressing critical national requirements such as intelligent manufacturing, smart city development, and social governance.

Artificial intelligence driving has garnered significant interest in recent years as a crucial application in the advancement of intelligent Internet of Things. Currently, China has made significant advancements in this area of research. Some cities have already implemented driverless public vehicles. The achievement of driverless driving relies on the interconnection of various technologies, such as sensor technology, positioning technology, recognition technology, and control technology.[2] One of these vehicles, the driverless car, uses LiDAR technology to detect the road surface and traffic conditions. It can then calculate the optimal driving route to ensure safe operation and minimize congestion. Positioning technology can accurately determine the precise location of the car in real time. Recognition technology, aided by sensors, is used in vehicle operations to detect various obstacles, including pedestrians, vehicles, trees, etc. Through calculation and analysis, it can automatically modify the vehicle's trajectory to efficiently avoid collisions with obstacles. AI driving is a convergence of the Internet of Things (IoT) with Artificial Intelligence (AI), encompassing various levels of technical implementations: [3]

IoT devices play a crucial role in gathering substantial volumes of data through sensors, which serve as the foundation for AI-driven analysis in the field of data collecting and analysis. For instance, sensors installed in vehicles can gather information about the vehicle's condition and the surrounding environment, while artificial intelligence algorithms can process this data to enhance the driving experience and improve safety. Smart IoT systems in the domain of intelligent decision-making and automation have the capability to make informed judgments by using the outcomes of data analysis.

In the domain of automotive transportation, this encompasses activities such as determining the optimal route, regulating velocity, and making decisions to avoid obstacles for autonomous vehicles.

By utilizing advanced deep learning and machine learning techniques, the system demonstrates the capability to accurately anticipate and react to intricate traffic scenarios. Edge computing, a field that focuses on processing data in close proximity to its source, effectively minimizes data transmission delays, resulting in enhanced system responsiveness and efficiency.

Vehicle-to-Business (V2X) technology enables rapid communication between automobiles and various entities such as individuals, other vehicles, the road, and the cloud. This is achieved by the use of wireless communication devices installed in the vehicles. This technology enhances both the safety and efficiency of driving, while also offering crucial assistance for autonomous driving.

The integration of Internet of Things (IoT) with Artificial Intelligence (AI) is crucial in the domain of intelligent transportation systems. Through the implementation of a sensor network, it is possible to monitor and analyze traffic flow, road conditions, and environmental data in real time. This data may then be optimized using artificial intelligence algorithms. This contributes to the reduction of traffic congestion, enhancement of road safety, and improvement of travel efficiency.

Self-driving cars are a common example of how the combination of IoT (Internet of Things) and AI (Artificial Intelligence) is applied in the field of self-driving technology. Self-driving cars utilize onboard sensors and AI algorithms to assess the surrounding environment, make informed decisions, and execute driving maneuvers. The advancement of technology has led to continuous enhancement in the safety and dependability of autonomous vehicles.

In the realm of vehicle-circuit integration, the synergy between vehicles and circuits holds significant importance for the advancement of intelligent driving. Vehicle networking technology enables automobiles and road infrastructure to exchange information and work together, resulting in improved driving safety and efficiency. Intelligent traffic signal systems have the capability to adapt signals based on current traffic conditions and enhance traffic flow efficiency.

2. CHALLENGES IN DEVELOPING ALGORITHMS FOR AI DRIVING

The implementation of artificial intelligent driving features is closely tied to the advancement of intelligent driving hardware. This hardware primarily consists of in-vehicle sensors, controllers, actuator devices, and systems that are connected with modern communication and network technologies. The hardware components collaborate to enable the car's highly intelligent and automated driving function, facilitated by the operating system of the AIoT. The IoT operating system typically relies on a unified algorithmic system to create a collection of automated algorithmic decision-making mechanisms that can handle various driving conditions. If this combination of computational procedures is not developed in a sensible manner, it could result in substantial societal and legal dangers.

2.1. The Utilization of Algorithms in the Field of Artificial Intelligence Driving.

Algorithmic procedures, which are one of the three fundamental components of artificial intelligence, pertain to a problem-solving approach that is limited, predictable, effective, and well suited for computer implementation. An algorithm is a systematic and precise set of computer instructions that takes inputs and produces outputs. It is a powerful tool for solving computational issues and is used to design and implement certain input-output relationships. An algorithm is a set of technical rules in computer software that is designed to accomplish a certain task. It is integrated in the digital process or rules of the software and uses defined paths and mechanisms to compute the desired outcomes. The British Council for Artificial Intelligence provides a concise definition of an algorithm and also elucidates its connection to artificial intelligence. An algorithm is a set of instructions for carrying out calculations or resolving problems on a computer. The algorithm empowers the computer to execute the tasks it is designed to accomplish, making algorithms the fundamental building blocks of all artificial intelligence systems.

Algorithms used in AI driving differ from typical algorithms in that they are not limited to a simple "input-output" coding approach. Instead, they are able to adapt and respond to various inputs in a more dynamic and unpredictable manner. [4] If an issue is detected, the programmer has the ability to retrace their steps across the entire program and rectify it. The sequential execution method and the specific context in which these algorithms are used dictate their behavior and results can be precisely regulated. On the other hand, artificial intelligence algorithms are commonly referred to as "learning algorithms". These algorithms primarily focus on generating behavioral rules by processing and analyzing vast quantities of data. This process enables the algorithms to develop a self-learning system that can make independent decisions to handle intricate settings. In the case of standard algorithms, the programmer's objective is to determine how to effectively instruct the machine to perform a work. However, with intelligent algorithms, the programmer's goal is to address the challenge of enabling the machine to acquire the ability to learn and perform the task proficiently.

More precisely, algorithms used in AI driving encompass a variety of the following components:

Deep Learning techniques, such as Convolutional Neural Networks (CNNs), are crucial in AI driving, particularly in the perception module. They enhance the vehicle's understanding of the environment. Deep Reinforcement Learning (DRL) is employed in automated driving at the control level. It enables the vehicle to make decisions regarding its actions in dynamic environments. Reinforcement Learning agents learn the best strategies by maximizing cumulative rewards. Training algorithms using deep learning techniques enhances their ability to mimic human-like behavior in the practical implementation of AI driving.

Furthermore, the methods and algorithms used for perception and decision making in self-driving vehicles can be classified into two categories: indirect perception methods and direct perception methods. Indirect perception methods involve solving multiple sub-problems, such as recognizing lane lines and planning a path, in order to drive the vehicle. On the other hand, direct perception methods aim to directly map sensor data to control parameters for the vehicle.

Furthermore, the implementation of fully autonomous driving from start to finish. End-to-end autonomous driving algorithms aim to generate vehicle control signals, such as trajectory planning or control signals, directly from sensor data via a single network.

Furthermore, the utilization of AI large models. The utilization of AI big models can enhance the generalization capability of the automatic driving algorithm, particularly in urban scenarios that need addressing a greater number of uncommon issues.

Under the background of intelligent Internet of things, artificial intelligence driving integrates electronic control, artificial intelligence, network communication and Internet technology, etc., through a series of algorithms to form an automated decision-making mechanism in the process of automobile exercise, the original human driver as the core of the vehicle function, the role of the repositioning of the original human driver, not only change the human driver in the environment perception, analysis of the decision-making and vehicle control, and other driving tasks in the role and duties of the driver It not only changes the roles and responsibilities of human drivers in driving tasks such as environment perception, analysis and decision-making, and vehicle control, but also gradually shares the driving tasks and eventually replaces human drivers, and will change the social and legal order formed by human beings using automobiles as a means of transportation since the introduction of automobiles.

2.2. The Ethical, Moral, and Legal Concerns Arising from Automated Decision-Making Algorithms

While AI driving utilizes an algorithmic system to make automated decisions, it is important to note that this mechanism is distinct from the decision-making process of the human brain. Therefore, it cannot be regarded as autonomous decision-making or the expression of meaning based on free will.

Artificial intelligence (AI) driving systems, which utilize data and algorithms to make driving decisions, create complexities in the control and responsibility dynamics between drivers and other stakeholders. The task of preventing crashes in autonomous vehicles is not solely a technical obstacle, but also encompasses ethical and societal complexities. The conventional liability relationship in road accidents typically involves the driver, the victim, and the manufacturer. This relationship is relatively straightforward and clear. However, when the decision-making responsibility shifts from the driver to a sophisticated automated driving system, the liability for traffic accidents may extend to the developer, producer, seller, and user of the automated driving system. This complexity makes it challenging to determine the exact liability relationship. In general, the advancement of AI driving technology leads to the inevitable emergence of moral hazard and legal concerns associated with automated decision-making algorithms.

Autonomous driving algorithms distinguish themselves from conventional automated software by necessitating the ability to make questionable decisions in an unpredictable environment. Automated driving decision-making algorithms may face the dilemma of choosing between preserving life or causing death in unforeseen accidents, similar to human drivers. While it is understandable for a human driver to have an inefficient and irrational stress response during a crisis, the same leniency cannot be extended to a self-driving car. Unlike humans, self-driving cars are programmed to execute specific behaviors, so their actions are not stress responses but rather the outcome of meticulous calculations. Within the current legal system, it is quite unlikely to strongly condemn an average driver for being unable to prevent such an accident. However, the algorithm-based automated decision-making mechanism of AI driving may no longer be subject to the same standard of judgment. The inevitability of moral difficulties arising from AI-driven vehicles necessitates the examination of the intersection between technology and ethics. There is a growing recognition of the need of moral norms and their integration into the algorithmic design of AI driving, which involves programming complicated human morals. [5]

Furthermore, whether it is a self-driving car powered by artificial intelligence or a service driven by an algorithm, in the event of a crash, it cannot be held legally responsible because it lacks the awareness that its actions can harm humans or violate legal rights. Neither the intelligent car nor the algorithm can be attributed with responsibility. Using Germany as an example, although the legislation regarding high-level automated driving has imposed the responsibility of vigilance and the obligation to take over control, it still maintains the status of the human driver or operator as the subject. Furthermore, the liability system also maintains the allocation of traffic accident liability primarily to the owner. This demonstrates that the traffic legislation continues to retain the technological foundations of the era of mechanical driving, follows a forward-thinking legislative approach, and does not alter the fundamental rights and responsibilities of drivers, vehicle owners, and automotive manufacturers.

Hence, AI driving, being an AI product within the Internet of Smart Things, presents a legal difficulty in terms of allocating liability to the creator, user, or seller, since it lacks the autonomous decision-making ability of humans.

3. REGULATORY PATHWAYS FOR ARTIFICIALLY INTELLIGENT DRIVING ALGORITHMS

This paper aims to propose a preliminary plan for regulating the algorithms of AI driving systems in order to address the social problems and legal risks associated with AI driving. The proposal will focus on the purpose and technology of regulation in order to guide the future development of AI driving.

3.1. The Purpose of Regulation of Artificially Intelligent Driving Algorithms: A Focus on System Safety

The implementation of artificial intelligence in driving has altered the legal obstacles associated with its influence on the preservation of human life and the allocation of legal obligations. To address the technical, ethical, and legal obstacles of autonomous driving, it is necessary to design AI driving algorithms that align with the positive progress of human society. This involves prioritizing the algorithms used in AI driving and placing system safety at the core of regulation. The utilization of AI in driving encounters challenges related to both moral and ethical safety, as well as technical safety.

In order to address the moral and ethical concerns associated with the use of artificial intelligence in driving, it is necessary for the algorithmic subject to adhere to the reasonable objectives of human practice as defined by relevant laws and regulations. The artificial intelligence driving program for autonomous vehicles is comprised of a diverse range of algorithms. Typically, programmers employ convolutional neural network algorithms and other similar algorithms to design and build the perception and decision-making systems of the self-driving car. Regarding the sensing system of the self-driving car, it is important to determine whether the algorithmic component can predict the potential "trolley problem" during the early stages of technology development. This involves recognizing that in emergency situations where the right to life is at stake, the decision made by the self-driving program not only impacts the safety of the individual but also has implications for public safety. Algorithm engineers must incorporate the principles of safety and justice into the algorithms they utilize. Simultaneously, their conduct should adhere to legal standards and virtuous behavior to optimize the safeguarding of public interest and safety. [6]

Policymakers and automakers are prioritizing the integration of ethical issues into self-driving algorithms. Using Germany as an illustration, it assumed a pioneering role in 2017 by introducing explicit ethical guidelines for self-driving algorithms. These guidelines consist of a 20-point ethical code for self-driving cars, which encompasses three fundamental principles. There should be a clear and explicit prioritization of possibilities and constraints, with the primary focus being on protecting human beings. In situations where accidents cannot be avoided, it is acceptable to sacrifice animals or other property. However, it is strictly illegal to discriminate based on factors such as age, gender, physiological or psychological disorders, etc. Furthermore, it is crucial to maintain human authority over vehicles and prevent pre-programming of decision-making in moral quandaries. This is because the resolution of such dilemmas depends on the unique circumstances of each situation and cannot be easily standardized or predetermined. Therefore, it is necessary to evaluate and make specific judgments on an individual basis. Furthermore, it highlights the importance of using technology to proactively address ethical dilemmas. Automated driving technologies must implement proactive strategies to mitigate risks, such as ethical dilemmas, in order to minimize accidents and decrease the potential harm to vulnerable road users. Additionally, the manufacturer or operator bears the responsibility of overseeing and enhancing the automated driving algorithms to enhance the ability of automated vehicles to safeguard against ethical risks. [7] Implementing this approach to provide ethical safeguards is valuable for future lawmakers.

It is important to address the technical security risks associated with AI driving at two levels: establishing technical security standards within the framework of the AI Internet of Things (AIoT) and ensuring cybersecurity maintenance. Over the course of AI driving's evolution, officials in prominent nations have been investigating the implementation of novel safety standards and approval processes tailored to the advancement of autonomous vehicles. When considering the future advancement of self-driving cars, policymakers must focus on specific concerns while creating and enforcing safety standards and regulations for self-driving systems.

One crucial aspect is determining the safety threshold for self-driving algorithms. Furthermore, there are technical safety hazards associated with human-computer interaction. Self-driving cars is determining the safety threshold. This refers to the level at which the self-driving system must ensure the safety of both users and the general public. Furthermore, the evaluation, identification, and authentication of the safety efficacy of self-driving algorithms. The safety regulatory framework for autonomous vehicles, whether implemented through type approval, self-certification, or exemption procedures, relies on specific metrics to assess the safety of autonomous systems. Furthermore, there are technical safety hazards associated with human-computer interaction.

In order to address the cybersecurity issues associated with AI-driven vehicles, regulators should take into account the integration of conventional cybersecurity concepts. This will ensure the overall cybersecurity of self-driving cars and establish a new cybersecurity framework specifically designed for AI-driven vehicles.

First and foremost, it is imperative to build a cybersecurity certification process for AI-driven automobiles. This mechanism will ensure that only self-driving cars that have successfully undergone cybersecurity certification are permitted to be sold and utilized. In order to encompass the entire automotive supply chain, it is necessary to expand the mechanism to include both the hardware and software components. This is because the automotive supply chain now involves intricate and obscure machine learning algorithms, specialized AI models, and third-party pre-trained models, among other things.

Furthermore, it is imperative to enhance the protective capacity of cyber security and fortify the framework for sharing data. In the future, potential lawsmay mandate that manufacturers implement a range of cybersecurity safeguards. These measures could include technical methods like encryption, intrusion detection, anomaly detection, and vulnerability detection, as well as countermeasures against attacks such as redundancy design and anti-sample tolerance. Additionally, non-technical measures like security by design, risk management, and cybersecurity incident management may also be required. The enhanced algorithmic security of AI driving technology necessitates the exchange of data between the industry and the government, particularly data pertaining to safety occurrences such as security accidents, cybersecurity, and disengagement of autonomous driving systems. Creating a system for the collection and exchange of accident data is crucial for enhancing the overall autonomous driving sector.

3.2. Technical Implementation of Artificial Intelligence Driving Algorithms: Including Algorithmic Auditing

3.2.1. The Definition and Comparative Advantages of Algorithmic Auditing

As a solution to the issues and dangers associated with automated decision-making, an increasing number of governments and international organizations are endorsing the implementation of algorithmic audits to govern automated decision-making and encourage the promotion of "algorithmic goodness".

Algorithmic auditing is a novel socio-technical approach that comprehensively addresses the technical, legal, ethical, and other aspects of automated decision-making. It aims to address the limitations of current regulatory approaches and has already been implemented in certain countries. China's legal system and practice also allow for the potential adoption of algorithmic auditing. [8]

The societal dangers that arise from automated decision-making can be addressed by three classic approaches to regulation: individual empowerment, information regulation, and technology solutionism. These three pathways are significant in the current range of regulating automated decision-making, but none of them can completely resolve the regulatory issues that arise from automated decision-making.

Algorithmic auditing offers numerous methodological advantages in comparison to traditional regulatory approaches and can successfully mitigate various risks associated with automated decision-making. Algorithmic auditing is a crucial method for ensuring that ethical standards in science and technology are implemented in automated decision-making processes. AI governance has increasingly focused on the ethical governance of science and technology in recent years. Furthermore, the implementation of algorithmic audits can effectively address conflicts of interest by utilizing statutory permission processes. Furthermore, algorithmic auditing can enhance public confidence in automated decision-making by employing a somewhat autonomous evaluation procedure. Algorithm auditing allows for a thorough and independent evaluation of automated decision-making. It effectively monitors the use of data inputs and outputs in these decisions, providing the public with valuable information about the system's quality. This, in turn, enhances public trust in automated decision-making and reinforces the trust that is already built into it. By enhancing the public's confidence in automated decision making, we can unleash the economic and social benefits associated with it.

3.2.2. Model Construction for Algorithmic Auditing

An effective audit activity typically comprises three dimensions: audit standards, audit topic, and audit results, as per the general principles of auditing.

Legislation is required to set the fundamental framework for algorithmic auditing in accordance with auditing standards. The Ethical Guidelines for Trustworthy AI in the European Union emphasize the significance of auditing as a crucial method for incorporating ethical principles into the development and utilization of AI. In 2020, the Information Commissioner's Office (ICO) of the UK released Draft Guidance on an AI Audit Framework. The purpose of this guidance is to establish a dependable method for auditing AI applications and guaranteeing their fair processing of personal data. In 2021, the Dutch Court of Audit published the Understanding Algorithms audit report, which introduced a framework for assessing and examining algorithms. The legal framework in China for auditing algorithms is primarily derived from the Administrative Provisions on Algorithmic Recommendations for Internet Information Services, the Interim Measures for the Administration of Generative Artificial Intelligence Services, and the Personal Information Protection Law.

From the perspective of the audit subject, it can be divided into two different subjects, the first of which is internal auditing carried out by the implementation subject of automated decision-making. Internal algorithmic auditing by the implementation subject of automated decision-making can be regarded as self-regulation of automated decision-making, which can not only fully utilize the information advantages of internal auditors, but also help the implementation subject to carry out operational business planning by identifying the advantages and preventing the problems, and to mitigate the problems that may result in the financial or reputational risk. Second, external audits by government regulators and other organizations. In the case of algorithmic audits of automated decisionmaking, there is also a need for external audits by government regulators and other organizations. Government regulators can conduct algorithmic audits throughout the lifecycle of an automated decision-making system to determine whether the system complies with legal standards. However, given the wide range of application scenarios for automated decision-making, it may be financially and time burdensome on government resources for government regulators to take on the responsibility of 9 conducting external audits exclusively. [9]

Regarding audit outcomes, the stakeholders engaged in automated decision-making exhibit greater diversity, as do the potential recipients of algorithmic audit reports for publication. These recipients can be broadly categorized as follows: firstly, reports that are intended solely for internal management use within the organization; secondly, reports that are to be shared with shareholders or partners, such as consultants hired to provide guidance on organizational changes; thirdly, reports that are to be shared with government regulators to demonstrate compliance; and fourthly, reports that are to be made accessible to the public, enabling algorithmic systems to be held accountable through academic or journalistic criticism. The legal ramifications of automated audit reports. The legal implications of algorithmic audit results can vary for different stakeholders. Algorithmic audit reports can serve as a basis for regulatory decisions made by government regulators. These decisions may involve either ex ante regulation, which includes pre-launch testing environments like sandboxes, or ex post regulation, which involves administrative investigations or enforcement actions. Algorithmic audit reports can be presented to authorities as evidence of compliance or used for internal risk management in the case of implementing companies that automate decision-making .

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