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Blockchain and Machine learning as deep reinforcement

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ABSTRACT: Due to its capacity to make wise decisions, deep learning has become extremely popular in recent years. The current generation of deep learning, which heavily rely centralized servers, are unable to offer attributes like operational transparency, stability, security, and reliable data provenance. Additionally, Single point of failure is a problem that deep learning designs are susceptible since they need centralized data to train them. We review the body of research on the application of deep learning to blockchain. We categorize and arrange the literature for developing topic taxonomy based their criteria: Application domain, deep learning-specific consensus mechanisms, goals for deployment and blockchain type. To facilitate meaningful discussions, we list the benefits and drawbacks of the most cutting-edge blockchain-based deep learning frameworks.

1. INTRODUCTION

The (IoT) has entered a variety in industry sectors during the past several years, including: energy, healthcare, manufacturing and finance sectors. As a result, it called industrial IoT has grown [1]. It will serve as the industry's underlying framework together with machine learning . On the other hand, industrial IoT makes it easier to collect data in a business environment, As contrast to that data integrated allows machine learning algorithms to be well trained, particularly deep learning and deep reinforcement learning, algorithms in support the corporate automation and digitization that are transforming several conventional sectors [1].

Almost all industry sectors have realized the promise in deep learning. For instance, deep learning design are used with doctors in the healthcare sector to correctly identify the individual's illness based their symptoms. During of most recent pandemic brought on the spread with corona virus infection (COVID-19), deep learning designs were used to predict pace of disease spread with a specific area and to help authorities deal with the epidemic by using anticipated results [2]. Furthermore, modern deep learning have assisted healthcare practitioners of COVID-19 identifying patients using the dataset in CT or X-ray images [3]. Security officials at airports have utilized deep learning apps in addition to healthcare to confirm prohibited goods in travelers' bags or shield software from vulner abilitie [4]. By utilizing face recognition technology and biometric security, deep learning design may assist authorities in identifying physical threats at overall time. The quality of the data used for model training determines the effectiveness and efficiency of a deep learning system [5]. The use of storage in one location and processing for model training has been considered by the majority of deep learning algorithms, although this raises the possibility of single point in failure and adversarial data manipulation. If data used for deep learning facilities are changed in any manner, the training model may become corrupted. Blockchain is swiftly gaining acceptance because its applications of financial sector, supply chain management with cyber security [6]. Its connection with the Internet of Things (IoT), which streamlines corporate processes and reduces verification errors, has recently sparked a lot of debate among scholars. The key of facilitators industry and a growing off shoot in IoT, the Industrial IoT networks are advancing across a number of economic and social sectors, including

retail, manufacturing, ubiquitous monitoring, security surveillance, healthcare, and home automation [7]. Furthermore, a growing number of devices are being launched in the IoT area, where raw data is locally gathered and processed to assist decision-based processes, as a result of recent breakthroughs with wireless communications with sensor networks. These gadgets are capable of exchanging information, interacting with one other, and processing it without the need for human interaction [8]. In order to protect data integrity, in addition to guarantee resource availability in compute dependability, they must be kept secure. With a distributed, shared public ledger and a collective consensus process, blockchain offers a new design paradigm for next-generation transaction-based systems that encourage systemic trust, transparency, and accountability. An overview of these steps is presented in the diagram below, which shows transaction in (Figure 1). Due to its transparency, blockchain technology is being stressed by both the academic and business communities as potential solution to efficiently managing large industrial IoT networks [9].

Additionally, it is projected that trustless network topologies and decentralized industrial IoT devices will be essential for the development of industrial IoT networks in data can processed locally at point in creation rather than centrally. Through the use of sensors and gadgets that can function without the aid of a centralized authority, it will also make data storage unreliable and facilitate device communication. A blockchain can further give industrial IoT devices the secure architecture that resistant to single points in failure [10]. Decentralized networks maintain the networks' resilience and fault tolerance since they have numerous entry points. Additionally, distributed ledger technologies can make industrial IoT infrastructures more accessible. Improved design development to prediction purposes model sharing, and better robustness of deep learning systems are just a few benefits that can result from integrating deep learning and blockchain. Other benefits include data protection, effective data market management, automated and reliable decision making and improved model development. The critical of data collection stage, which entails the data gathering, labeling, and improvement, is important because it significantly affects the efficacy and standard of the developed deep learning models. In order for the training models to perform effectively of testing data from the real world, it is important to leverage a range of sources to produce broad, diversified, and high quality training data [5]. The model is frequently over fit and performs poorly on testing data because it was trained on a short amount of data [11]. The quality of the input data has a significant impact on the algorithm's performance, therefore models developed with high-quality data have higher predicted accuracy. Significant deep learning techniques' uses and advantages along with an explanation of each application's function. As shown in (Figure 2), It is now feasible to identify objects, persons, or any type of action in an image thanks to the support for use in picture analysis and recognition using deep learning. Image analysis approaches may be helpful for finding an autonomous vehicle's near area or counting the number of faces of an image by use segmentation techniques of image. Similar to this, voice recognition technologies are regularly employed to recognize voice-based requests and control smartphones or smart homes. Web services frequently employ text prediction models to foretell the text of incoming emails, condense communications, or paraphrase papers. In addition to producing predictions, the deep learning models can create content that appears to be written by a human in online web services [12].

Deep learning offers the capacity to analyze data efficiently for applications based on optical character recognition with sensory data analysis in addition to these key benefits. Traditional deep learning systems store and manage vast volumes of data used to train the algorithms on cloud based servers. Cloud computing facilitates the speedy completion of compute-intensive activities by using clusters of GPUs and CPUs, which speeds up the deep learning algorithm training process [14]. For example, telehealth and telemedicine apps using wearable technology may be able to collect and transfer massive amounts of healthcare to cloud satellites by dependable edge server [15]. By shielding the data from various sorts of attacks by adversaries, the distinctive characteristics of blockchain contribute to improving the robustness of the deep learning models. Blockchain tracks the data to ensure that it hasn't been changed since it was initially established and is tamper proof and tamper-resistant by design [16]. On blockchain platform, economy operations is automatable by self-executing smart contracts of stand in for third parties in the service execution process [17]. The smart contract enables the development of a low-cost, rapid, and reliable system for deep learning applications. The consensus algorithms utilized by current blockchain foundations maintain data integrity [18]. In earlier studies, various deep learning based applications were suggested using consortium, private, and public blockchains. Among these types public blockchain platforms are vulnerable to inference attacks because they make transactions, pseudonymous addresses, with other user information publicly available [19]. Private and consortium platforms, however, substantially more effectively safeguard data privacy when compared to open foundations.

Machine learning designs are Developed, Employed, and Trained by Different Organizations By enabling the provenance in machine learning designs, blockchain technology creates trusted in artificial intelligence. Users can receive rewards for sharing their data (data trading) via the reliable method provided by blockchain technology, which is subsequently utilized of prepare machine learning design. Machine learning storing related with there reduces the possibility that the model will contain issues because blockchain network won't contain duplicate, missing, or noisy data, which is fundamental requirement for artificial intelligence. Data utilization management and the introduction of new standards through automation are benefits of applications that combine the strengths of blockchain technology and machine learning

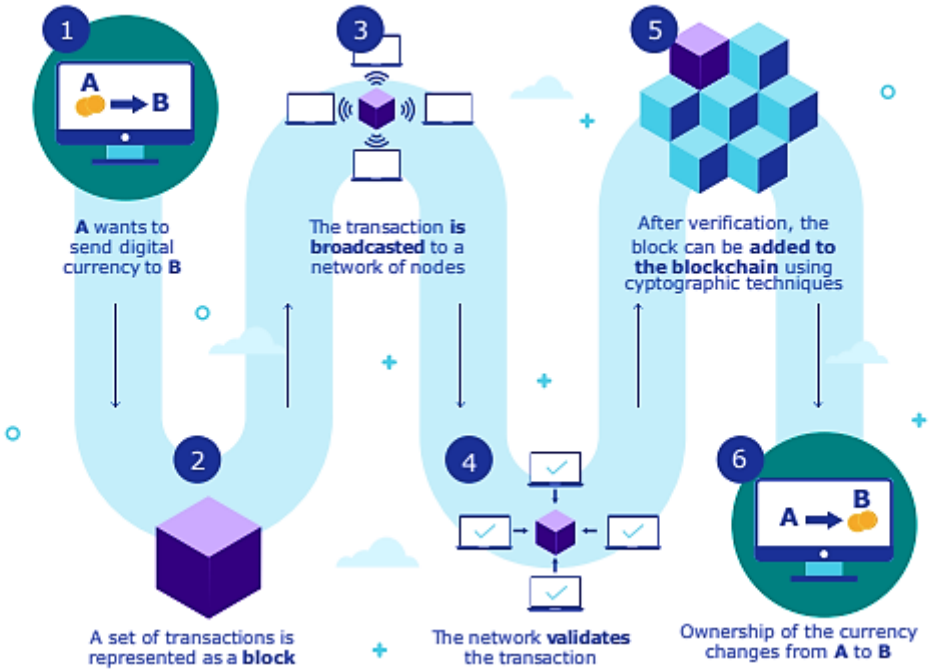

FIGURE 1. Example of trading digital economy in a blockchain [13].

Image Recognition	Image analysis and interpretation in the form of classification, detection, and segmentation.
Sensory Data Analysis	Biometric and wearable device data is used for analyzing the health of the patients.
OCR	To extract the textual data from images (scanned documents and photos).
Intelligent Data Interpretation	From data gathering to data comprehension, and using the data for automation.
Voice Recognition	Smart voice assistants such as Alexa, Siri, and Cortana uses deep learning to ensure flawless operations.
Text Prediction	Smart text prediction to generate the message based on previous input.

FIGURE 2. The main advantages of deep learning in numerous disciplines [12].

methodology. These benefits are made feasible by smart contracts. For example, smart contract machine learning models can automatically recommend a request to authorities to recall expired pharmaceuticals. Blockchain can capture all of the various stages of the model during its development, modification, or use and track the progress of machine learning models as they develop [20]. By using the record of immutable transactions recorded on blockchain, it is possible to identify the owner of machine learning algorithms, datasets, source of data, participants, the base design, and the techniques used during model development. Because of blockchain properties like the consensus algorithm, the immutability of the data assaults on artificial intelligence such as data and algorithm poisoning aren't feasible thanks to and cryptographic hash functions [21].

2. BLOCKCHAIN INNOVATION

When data is kept on a blockchain, hackers find it extremely difficult to remove, modify, or change it. There are many nodes in it, and they all work together to validate and store the transactions as blocks. Recorded in every block of the chain group transactions and is linked correctly to the freshly created block in form a chain blocks. To ensure data consistency, the newly added block is sent to all participating nodes after being added to the local chain by a miner [22]. The decentralized consensus process allows the miner nodes to independently verify and approve blockchain transactions. The proof work and proof stake consensus protocols, for instance, are implemented in a number of blockchain systems and can defend the blockchain from any internal or external data hacking attack. Another key component of blockchain technology is smart contracts, an electronic program that only runs when certain conditions are satisfied [19]. The goal of smart contracts is to lower company risk and expense. Immutability of data, smart contracts, consensus algorithms, and decentralization are among the fundamental qualities and aspects of blockchain technology that contribute to increased business effectiveness [23].

3. BLOCKCHAIN TECHNOLOGY BENEFITS

With the use of blockchain technology, patient electronic health records and personal health record can be safeguarded. Information on diagnoses, drugs, allergies, a history of illnesses, test results are included in EHR and PHR systems. EHRs include patient information from all doctors, hospitals, clinics, labs, and other healthcare providers. In contrast, the personal health records of patient centered system that is managed by patients in environment secure [24]. It may shared with other users of line with the patient's permission management policy, guaranteeing that data controlled or maintained by the patients. Self-executing smart contracts are used to apply the consent management policies. However, if adequate methods are not created to manage vast amounts of healthcare data, blockchain technology becomes expensive [15]. The pointers and linkers may play an important role in reducing the data amount so that blockchain can be used to its full potential in many healthcare applications. Decentralized storage systems can also safely store massive amounts of data while avoiding single-point failure-related issues. Inter Planetary File System is one of the most popular decentralized storage systems utilized in the healthcare industry (IPFS) [25], Cassandra [26], Storj [27], Orbit DB and Skeps to name a few [25].

4. MACHINE LEARNING AND DEEP LEARNING

The most using of recent deep learning methods, a model is created that represents the simplest basic types of the data, such as images, texts, and audio signals, in latent space. Figure 3 illustrates relationship between deep learning, artificial intelligence and machine learning. Deep learning enables hardware by carry out several tasks with accuracy comparable to or sometimes even superior to that of humans. Image classification serves as an example of how deep learning is widely used in various industries [28], object detection [29], self driving cars [30] , disease prediction [31], and voice control [32] are well-known applications for deep learning methods.

The deep learning designs are prepared on a large amount of labeled data. The globalized of data sequences are learned by machine learning algorithms with the aid in data representation approaches. In order for machine learning algorithms to use time series data to make the right conclusions, data quality is therefore crucial. More particular, no matter how complex the method is, the model will not work well on data that has insufficient descriptions. Therefore, feature engineering is considered because it can aid in data reconstruction by using collections of traits from the original data [34]. Since the models are intelligent when utilizing a deep learning technique, they automatically remove the rise level latent space properties from raw data. The deep learning models are built with many layers. Higher layers are in charge of extracting more abstract features from incoming data, whilst lower layers are in charge of extracting lower-level features. The number of levels in DL has an impact on accuracy and security. To get the best results for the specific application, tuning the deep learning model's hyper-parameters is essential [35]. When considering scalability, the network topology that the model is

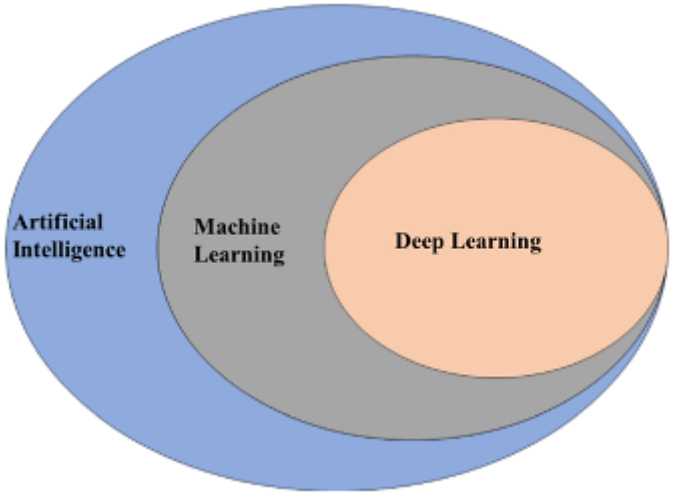

FIGURE 3. **Deep learning and machine learning relationships [33].**

deployed on must be carefully chosen. Since an example, a deep learning model instantiated in a client-server architecture offers a scalable solution as each node will acquire the trained design instance to help its intended purpose [36].

5. DEEP LEARNING BASED ON BLOCKCHAIN

Blockchain technology can help deep learning models be reused and trustedly shared, which is a crucial necessity. Similar to this, the primary elements driving the integration of blockchain with deep learning are auditability, data verification, attestation results, provenance, traceability of ownership, usage, and assurance of fairness [20]. Deep learning designs are fed an enormous quantity of varied example data in order to learn features and generate an output and probability vectors of place. Even while deep learning models excel at making predictions from raw data, many real-world scenarios still depend on the quality of the input. A decentralized, verifiable global database known as the blockchain allows network nodes to store and trade data. Deep learning-driven apps would need a reliable, durable, and decentralized infrastructure to collect, analyze, and utilise the critical data. Deep learning and blockchain can provide this infrastructure together. The benefits of fusing deep learning algorithms with blockchain technology are briefly stated below:

- **Data Security:** The data stored by blockchain technology is particularly secure because it is decentralized. Private blockchain networks are used to store and handle private and confidential data. Because they can be only way access blockchain data, the private keys of the nodes must be kept hidden. Deep learning algorithms may process stable data provided of the blockchain to provide decisions that are more dependable, accurate, and trustworthy [37].

- **Making Decisions Automatically** : A well-known P2P transaction processing system is blockchain. It is straightforward to validate the decisions made by the deep learning models thanks to the traceability feature. Additionally, it ensures that no alterations to the papers occurred during human facilitated auditing phase [38].

- **Cumulative Judgements** : The knowledge obtained in regard to a certain condition is typically the foundation for the autonomous digital agent's decisions. These agent-based decision-making systems include, for example, swarm robots and deep reinforcement learning [39]. The voting-based strategy may aid the robots' capacity to reach conclusions based of data obtained by robotic swarms on blockchain.

- **Enhanced Robustness**: To select few situations, deep learning models' decision accuracy exceeds that of humans. Consequently, the extremely correct deep learning design raises stakeholders' level of confidence in the decisions. Additionally, the deep learning-based system's robustness may be guaranteed because it is supported by decentralized technology. Blockchain and deep learning integration can be beneficial in business settings where the parties can cooperate in a trustless and automated setting [40].

6. BLOCKCHAIN TYPE:

The parameter categorizes that extant studies into three groups base blockchain platforms used the current deep learning frameworks for blockchain.

6.1 PUBLIC BLOCKCHAIN

The current deep learning foundations for blockchain use a public blockchain that provides permission-free and unrestricted access of distributed ledger for users and machine learning equipment. By gaining access to distributed ledger copy that is shared by nodes in public blockchain network, users can complete transactions. Due to decentralized data processing and storage, public blockchain platforms guarantee transaction anonymity. Additionally, since public blockchain platforms are resistant to a variety of threats, they help deep learning models provide accurate and reliable results [41].

6.2 PRIVATE BLOCKCHAIN

The frameworks for deep learning powered by blockchain use private blockchains that are under the management and control of a single company. When the governing entity possesses the required authority, private platforms are allowed [42]. Since the central authority is aware of the validators' and nodes' identities, private network requires significantly less difficult mathematical operations to verify the transactions. The private platform executes transactions more quickly than the public platform as a result.

6.3 CONSORTIUM BLOCKCHAIN

Since the central authority is aware of the validators' and nodes' identities, private network needs significantly less difficult mathematical operations of verify transactions. The secluded platform executes transactions more quickly than the public platform as a result (Li et al.,2018). The content on the blockchain may generally be seen by everyone connected to the network, but only a small number of individuals who have been granted access can add new data to the ledger. Additionally, consortium platforms' transaction validation rates outperform those of public blockchain platforms.

7. MODEL DEEP LEARNING

The gathered data is processed by a deep learning model, which identifies patterns that can be used in a variety of cases. Based on how the neural network layers are configured, deep learning designs used for making in numerous application domains are categorized into many primary categories:

7.1 CONVOLUTION NEURAL NETWORK

Convolution Neural Network , that examines an image to identify of objects, assign weights to the objects with classify the objects according to context. Additionally, it enables the search for specific objects within the altered image [43]. CNN has been used by the deep learning frameworks built on blockchain to classify photos, identify objects, and segment instances in a variety of use scenarios. Because CNN uses flexible filters to identify the qualities of the image, blockchain based studies benefit from the algorithm's minimal preprocessing time requirement.

7.2 RECURRENT NEURAL NETWORK

A CNN model performs better when visual data is provided as input. However, employing sequential or time-series data, recurrent neural networks (RNN) build patterns [44]. Voice recognition of speech conversion, voice search, and natural language processing are some in well-known RNN uses for blockchain-based solutions (NLP). Additionally, in CNN models, the input data are independent of one another, whereas in RNN models, The result is influenced and connected to the earlier inputs. As an improvement to RNN, Long Short-Term Memory [45] and Gated Recurrent Units [46] are frequently used to precise forecasting.

7.3 GENERATIVE ADVERSARIAL NETWORKS (GAN)

It generative model is able to produce original data and learns the patterns unsupervised. More specifically, it is a type of deep learning modeling that makes use of convolutional neural networks. The GAN design is built with generator network with discriminator network. The discriminator learns to distinguish between true and bogus data, whereas the generator creates fresh samples [47].

7.4 DEEP REINFORCEMENT LEARNING (DRL)

By taking cues from behavioral ecology-based theories of human behavior, DRL aids expert systems in better understanding the data. DRL models make up the environment in which intelligent agents act in order of learn. Agents are also implicitly rewarded and punished based their actions. Reinforced learning-based models are those that reward actions that result in the intended outcome [48].

7.5 DEEP LEARNING WITH GEOMETRY

It is an adaptation of deep learning focuses on building networks with no Euclidean data as their basis [49]. A graph is one type of non-euclidean data. Data modeling may be accomplished more quickly and easily with graph-based data. Graphs are input to geometric deep learning models instead of data in the traditional manner for generic networks. In other words, geometric deep learning can extract more minute information from the input.

8. CONCLUSION

The most cutting-edge blockchain of deep learning frameworks. We went into great length on benefits of combining blockchain and deep learning, as well as their key characteristics. In numerous applications, including those involving healthcare, blockchain security, the data traffic management, and vehicular communication of metropolitan areas, the successful integration of deep learning with blockchain may increase the quality in service. Additionally, it can facilitate current systems' data security and privacy measures and enhance them. Based on seven criteria, including type of blockchain, deep learning designs, deep learning specific consensus protocols, services, application domains, deployment goals and data, we built a taxonomy to classify the reported literature into distinct groups. Essential elements of the most recent deep learning frameworks based on blockchain are investigated through a careful analysis of published frameworks. At last, we identified and addressed a number of issues that need to be resolved in order to fully realize the promise in blockchain of deep learning systems. These issues include scientific, technological, and sociological ones.

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CONFLICTS OF INTEREST

The author declares no conflict of interest.

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