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A traceability chain algorithm for artificial neural networks using T–S fuzzy cognitive maps in blockchain

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HIGHLIGHTS

- The main goal is to reach traceability decision not consensus decision as fast as possible.
- A novelty approach is Takagi–Sugeno Fuzzy cognitive maps ANN as traceability chain algorithm.
- Deep learning network by Takagi–Sugeno Fuzzy ANN is presented.
- We provide optimized traceability in blockchain for hierarchical learning features representations on big transaction data.

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ABSTRACT

Blockchain acts on a big data analytics because transaction data belongs to streaming data and high-dimensional data from distributed computing network. Accordingly, such operation produces irrelevant data problem and further poorly optimized traceability in blockchain. So, we claim that the artificial intelligence of blockchain mining algorithm like traceability chain algorithm runs faster than consensus algorithm because of inference mechanism. Our main goal is to reach traceability decision not consensus decision as fast as possible. Thus, this article proposes a novelty approach called Takagi–Sugeno Fuzzy cognitive maps ANN as traceability chain algorithm. The numerical example of the proposed algorithm in blockchain mining is evaluated and optimized decisions experiment is analyzed. Objective functions for optimized decision computation is described as participant nodes constraint method. Thus contribution succeeds in meeting the reduction mining efforts for the traceability chain being processed. Our findings also provide a preliminary indication of deep learning applied big blockchain transactions data.

1. Introduction

Blockchain [1] is a time-stamped distributed database of every transaction by peer-to-peer method that does not need central authority and third party intermediaries across programming network. In other words, it consists of the block with many transactions that have been constructed in the chain for public ledger through open-source software execution. When a new transaction occurs, a token is broadcasted to the chain network in which different computers called nodes to validate the transaction correctness using copies of all or some information of the blockchain. Each node can execute the computation to represent its state within transaction from its neighbors. All nodes create a new block by mining these pending transactions together with a link to the previous block through proof of work process. This proof of work is used to cryptographic algorithm with hash function to prevent minority control over mining before the transaction is validated by miner. For this mining process to avoid double spend, hashing in a Merkle Tree [2] is used to encode the original content of the transaction into the blockchain by computing algorithm over hash string as a unique identifier and nonce as a pseudo-random number in an authentication protocol.

Along with digital data transactions within block by a set of consecutive periods, the consensus algorithm can be used to mining process to ensure they have a consensus what to store for replicating a bit of data as state machines [3]. In a distributed sensor network, consensus is a critical issue because of globally optimal decision without any central controller among computer nodes by mining mechanism. Some previous papers were discussed at consensus algorithm topic such as gossip algorithm [4], Paxos [5], and ZooKeeper [6]. The consensus mechanism consists of proof of work, proof of stake and proof of Existence. In the Proof of work model, it needs to electricity be wasted on extra computations because of gaining the longest proof-of-work chain. In the Proof of Stake model, it focuses on control proportionally how much the amount of coin held (called stake) for lower latency. Compared with proof of work, it does not require the extreme computational

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algorithm. In the Proof of Existence model, it offers blockchain attestation to prove document ownership of the transaction using website software service with hash function.

As the above-mentioned saying in blockchain, it also acts on a big data analytics because transaction data belongs to streaming data and high-dimensional data from distributed computing network. Thus, the blockchain deploys large quantity of transaction with related information because of two reasons problem. First reason is that the blockchain network produces together bitcoin and related information from huge business transaction. Second reason is that blockchain mining must also verify and store the entire history of all bitcoin transactions that is of no efficiency to them when a new bitcoin node is launched. The two reasons cause big data operation in blockchain mining, even though most are of no relevance to the traceability requirement of blockchain. Accordingly, such operation produces irrelevant data problem and further poorly optimized traceability in blockchain. In blockchain operation, it need traceability mechanism because of linked chain requirement. Traceability is a concept required by chain in blockchain involved to link the transaction flow of blocks with the related information among participant's nodes. To have an effective traceability system across the entire blockchain, it need tend to the ability to track and trace along the blockchain mining process. Thus, the blockchain mining can perform the audit transaction correctness through both a forwards and backwards direction during the entire history of transactions data. Such traceability mechanism can reach to blockchain's main objective such as trust, fraud prevention and fake without too much mining effort. Furthermore, the general focus of blockchain mining is the representation of a set of big transaction data for using on transition data. Thus, extraction of big transaction data representations (features) is crucial in blockchain mining. The features learning is the capability of allowing the blockchain mining process to automatically discover the representations for classification from transactions data. Thus, the blockchain mining should adopt feature extraction technique in order to learn and discover useful features to improve mining efficiency. In prior literature review, Lee et al. [7] presented feature learning to further improve the discriminative power of plant classification systems. Then, how to construct a hierarchical learning process is to extract high-level abstractions as data representations through Deep Learning algorithms. Some prior papers presented a good feature representation automatically from the input data using deep belief network by learning features [8,9]. Deep learning algorithms can discover multiple levels of distributed representations to solve traditional artificial intelligence problems [10,11]. Deep Learning algorithms derived from artificial intelligence with the deep hidden layers from big transaction data, especially unsupervised data. In terms of blockchain mining efficiency, AI-based mining makes it easier to create cost-efficient linked chain where transaction relationship of block can be tracked and traced without requiring a distributed point of all participant's nodes. Thus, the so-called traceability chain ideally is suited for artificial intelligence computing. At the moment, its goal is to speed up and simplify how blockchain is linked like audit trails without consensus mechanism. Then, AI-based traceability chain algorithm is able to change training data model to improve the trustworthiness of the data by intelligent method such as inference techniques. Accordingly, the concept of artificial intelligence in blockchain field can apply inference techniques to the distributed consensus databases. Each transaction of these databases is extracted representations for verifying by the consensus of a majority of the nodes in blockchain. However, the extracted representations by deep learning can be considered as a mining chain for consensus decision-making objective because of transformations in the layers of distributed nodes network. The objective aims to conduct non-linear transformations in a hierarchical manner. From this non-linear transformation, the previous transaction data is fed to the existing block (also called present layer) and further the output of each block is obtained as input to its new block (also called next layer) consequently. Compared to prior consensus mechanism, each node can use state transition to represent consensus of all nodes in the non-linear transformation. On the other hand, the "consensus" definition means to reach an agreement regarding a certain chain of relevance data that carries on the state of all history transactions. Consensus method via a cryptography aims to authenticate and validate a set of transaction in a distributed system without the need to trust and a centralized authority. It is important to focus on which consensus mechanisms are most relevant for agreed mathematical mechanism. In the meantime, consensus must face also on some requirement such as low latencies, immediate transaction finality, data capacity, governance, and consistency. These requirements are limited for existing consensus models because that 'agreement' among all participant's nodes is mainly pursued requirement. Thus, existing consensus algorithm also causes highly cost of participation by continuous expending energy resource. The blockchain mining may require more time based on the design of the consensus algorithm. As mentioned above, we know how to enhance mining efficiency is challenging. Thus, this article proposes traceability algorithm instead of consensus. The traceability algorithm is being recognized using deep learning concept. According to deep learning concept, we know mining efficiency can be improved by continuous learning. Achieving traceability chain may manifest as inconsistently high latencies in blockchain mining. So, we can claim that the artificial intelligence of blockchain mining algorithm like traceability chain algorithm runs faster than consensus algorithm because of inference mechanism for solving the above-mentioned two reasons problem. Our main goal is to reach traceability decision not consensus decision as fast as possible. In many cases, nodes will execute effectively but they make big effort in mining because consensus decisions might get huge amount of transactions data to spend more and more time by stronger computer utility such as Graphical Processing Units (GPUs). From traceability views of point, traceability needs powerful indices such as correctness, efficiency, and conciseness as consensus alternatives. Focusing on the traceability requirement that all relevance transactions' states relate to the same vector, the artificial neural networks (ANNs) is to describe the transactions' interconnection structure as a directed or an undirected graph by fuzzy cognitive map as a state transition mechanism.

A digital operation with bitcoin conducts transactions by transmitting state as debited or another state as credited in blockchain which is maintained by miners with computational process called mining. Once mined by miners, the new state is calculated to the state transition of the artificial neural networks and the next state shall be triggered in traceability chain through inference logic. The traceability chain is designed so that blockchains are globally updated in such a way that they are learned at each mine. Considering the situation where a previous state learns of a new state after being mined at another node, irrelevance data problem will soon be resolved because of learning elimination of irrelevance data. Given the state available at inference logic, we learn an appropriate feature representation in traceability chain. It is a traceability chain algorithm in order to build a state transition by deep learning with hidden layers. This traceability chain algorithm represents the blockchain network's traceability chain including all transactions history. In particular, the traceability chain algorithm can also be used to explore Takagi–Sugeno (T–S) fuzzy-based ANN of deep learning concept. Following the traceability chain of blocks with many transactions, it triggers state transition to infer a precisely defined state of the global transaction corresponding to each state. Furthermore, the new state onto the traceability chain is designed to always detect the best total effect in the T–S fuzzy-based ANN

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