

Analysis on the Application of Blockchain Technology in the Development of Elderly Service Industry

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ABSTRACT

Stochastic model checking is the extension and generalization of the classical model checking. Compared with classical model checking, stochastic model checking faces more severe state explosion problem, because it combines classical model checking algorithms with numerical methods for calculating probabilities. Aiming at dealing with this, we first apply symmetric assume-guarantee rule symmetric (SYM) for two-component systems and symmetric assume-guarantee rule for n-component systems into stochastic model checking in this paper, and propose a compositional stochastic model checking framework of probabilistic automata based on the NL* algorithm. It optimizes the existed compositional stochastic model checking process to draw a conclusion quickly, in cases the system model does not satisfy the quantitative properties. We implement the framework based on the PRISM tool with several large cases used to demonstrate the performance of it.

Keywords: *blockchain, population aging, elderly care service industry*

1. INTRODUCTION

China has officially entered the population ageing since 2000, when 7 percent of the population aged 65 and over reached that level, and the aging process has been accelerating ever since. In 2019, the number of Chinese aged 65 and over was 176 million, or 12.6 percent, according to the National Bureau of Statistics of the People's Republic of China. The proportion of the population aged 65 and over is projected to exceed 20 per cent by 2040, while the number of the elderly aged 80 and over is projected to increase by 5 per cent a year to more than 74 million by 2040 [1]. The degree of population ageing, the size and proportion of the elderly population are decisive factors in the market demand for old-age services. The old-age service is the necessary life service to meet the needs of the old people's material life and spiritual life [2]. With the development of population ageing, the demands of the elderly for various services have been superimposed, mainly the demand for medical and health services and the demand for daily care, especially the rigid service demand such as health care for the aged will be released continuously. The biggest demand of the elderly group is to improve the quality of life in old age [3].

At present, the rapid development of the population ageing has triggered a huge demand for old-age service, which not only brings opportunities for the development of old-age service industry, but also brings new challenges for the high-quality development of old-age service industry [4]. According to the Green Paper on Social Security: China's

Social Security Development Report (2020) \, released on June 20, 2020, the construction of the old-age service system during the 14th five-year plan period must break through "blocking points" and eliminate "pain points", we will continue to improve the old-age care service system that combines care for the aged with medical care in community-based organizations [5]. The essence and characteristics of blockchain technology can effectively solve the security and data sharing of the old-age health data in the process of transmission and preservation, which brings an opportunity for the development and upgrading of the old-age service industry [6]. During a group study session at the Politburo on October 24, 2019, Xi stressed the need to actively promote the application of blockchain technology in areas such as education, employment, old age care, precision poverty alleviation, medical care and health care, to provide the people with more intelligent, more convenient and higher quality public services [7]. This paper mainly discusses the mechanism and prospect of the application of blockchain technology in the development of the old-age service industry.

2. DILEMMA OF DEVELOPMENT OF THE OLD-AGE SERVICE INDUSTRY IN CHINA

According to the arrangement of the 2019 Government Work Report on the future development of the old-age service industry, the core of the future development of the old-age service industry is the "three systems", that is, we will continue to improve the old-age care service system that is based on home, based on community support,

supplemented by institutions and combined with medical care, and establish and improve the long-term care service system for the aged and disabled, strengthen the service management system with credit as the core, quality as the guarantee, decentralization and supervision as well [8]. However, there are still some difficulties such as unbalanced supply of facilities, weak nursing ability, insufficient development of socialization, low level of security and short board in rural old-age service [9].

2.1. There are Still Many Problems and Obstacles in the Actual Promotion of the Combination of Medical Care and Rehabilitation

The main manifestations are as follows: the number of medical and nursing institutions is insufficient, the supply of nursing beds exceeds the demand; the Coordination Between Primary Medical and health institutions and old-age institutions is not close enough [10], The low level of specialization of the old-age service team, the low income and low social status of the front-line staff of the old-age service cause the graduates of the related specialties to be reluctant to engage in the old-age work for a long time, and the loss rate is high [11]; Most of the nursing staff in the market have not received professional training and there is a serious shortage of nursing staff. Most of the practitioners are rural surplus labor, especially the lack of high-quality and specialized nursing staff for the aged, difficulty in providing professional services [12].

2.2. Development of Socialized Old-age Institutions Has Encountered a Bottleneck

By the end of 2018, China had 163,800 old-age service institutions and facilities, with a total of 7.463 million beds. The problem of “not being able to live”, “not being able to afford” and “not being able to live well” in old-age institutions is still prominent [13]. The work in the field of providing for the aged can be said to have the highest degree of subdivision or even the most stringent requirements [14]. As a result, the aged care institutions which are used to extensive operation often fall into the predicament of “the institution providing for the aged is laborious and does not earn money”, and those high-end institutions make ordinary middle-class families feel out of reach, especially in the rural old-age services in the number, size and quality of service and so can not be compared with cities and towns [15].

2.3. Quality of Old-age Service Still Needs to be Improved

At present, the domestic old-age care industry generally focuses on centralized health care hospitals, communities

or resorts, with full-time nursing staff, and follows the heavy asset model of the old-age care real estate. As the old-age care industry is relatively extensive, the overall quality of the elderly and nursing staff is not high, the distributed home care service is relatively missing, and part of the nursing service quality is uneven [16]. At the same time, the old-age Health Service system is not perfect, and there is no service system that can meet the needs of the old-age health care, including daily health care, disease prevention, disease treatment, rehabilitation care and so on. The number of specialized rehabilitation medical institutions for the elderly, the rehabilitation and the disabled is insufficient, the service quality of the only old-age medical service institutions is not standardized enough, and the number of employees engaged in the health care industry for the elderly is limited [17].

3. FUNCTION MECHANISM OF BLOCK CHAIN TO PROMOTE THE DEVELOPMENT OF OLD-AGE SERVICE INDUSTRY

Block chain is a decentralized, trust-free, tamper-proof, collectively maintained, distributed ledger that effectively records transactions between parties in a verifiable and permanent manner [18], the ledger itself can also be programmed to automatically trigger transactions [19]. Block chain technology has five basic features: first, the distributed database. Each party on the block chain has access to the entire database and its complete history, and each party can verify the records of its trading partners directly without the need for an intermediary [20]. The other is peer-to-peer transmission. Communication occurs directly between peers rather than through central nodes, where each node stores and forwards information to all other nodes. The third is the anonymity of transparency. Each node or user on the block chain has a unique 30 + letter, numeric address that identifies itself, and users can choose to remain anonymous or provide their identification to others [21]. Four is the irreversibility of the record. Once a transaction is entered in the database and an account is updated, the records can not be changed. Various Algorithms are used to ensure that the records in the database are permanent and sorted in chronological order. Five is computational logic [22]. The Digital Nature of the ledger means that block chain transactions can be linked to computational logic, are essentially programmable, and users can set algorithms and rules that automatically trigger transactions between nodes [23]. Based on the core functions of the above technical features, block chain technology provides convenience for solving the “blocking points” and “difficulties” in the development of the old-age service industry.

3.1. Decentralization and Tamper-Proofing of the Block Chain Can Improve the Efficiency of the Old-age Supply Chain

The block chain is decentralized in the network structure and governance system, there is no network control center, every computer in the chain is equal, and the data in the block chain is maintained by all nodes in the chain. The historical data on the block chain can not be changed, the tampered block can not be accepted by other nodes, and can not enter the block chain according to consensus mechanism [24]. The existing data of food and medical information for the aged are at risk of being tampered in the links of storage, transmission and display. The tracing system relies heavily on government supervision measures and can not effectively restrict the rights of the supervisors. The decentralization and non-tamper-ability of block chain can ensure the reliability of information in the pension supply chain tracing system and avoid data tamper [25]. At the same time, if the technology of block chain and Internet of things are combined, the automatic data collection can be realized by machine, which can not only improve the efficiency, but also avoid data falsification and concealment [26]. Due to the openness and transparency of block chain technology and machine autonomy, consumers, producers and government departments can trust the data in the pension supply chain traceability system, which greatly reduces the uncertainty in the transaction process, it reduces a lot of the hidden costs. Using block chain technology to link hospitals, nursing homes, doctors, drug distribution companies and elderly patients into a single data network [27], the organizations of the old-age care institutions, hospitals, community old-age care, financial insurance and other related organizations are connected to the block chain network as nodes, taking advantage of the characteristics of the block chain technology such as non-tamper-ability, traceability and high transparency, the realization of online-offline interaction, remote service and wearable device connection can provide one-stop health management service for the elderly and build a win-win “block chain + pension” service system [28].

3.2. Block Chain Anonymity and Privacy Function Can Effectively Protect the Rights and Interests of the Elderly

There is no need to trust each other to exchange data between nodes on the block chain, no need to reveal the identities of counter-parties, and every participant in the system can remain anonymous. The data encryption technology is widely used in the data structure of block chain, and it has strong privacy protection function, without worrying about the possibility of the privacy and key data leakage stored on the block chain. Therefore, block chain technology can not only for the elderly their own pension planning to make optimization, but also for the elderly have three benefits: First, their own private key.

It can protect its privacy by denying access to data to financial institutions or to people with ulterior motives. In a block chain where there are no restrictions on access, each party can examine all records, and in a block chain where there are restrictions on access, each party can maintain data privacy by agreeing which users can view which data, and each side can cover its own identity when needed. The second is that it will not be changed. Private and financial institutions to avoid internal collusion, resulting in arbitrary reduction of premiums, lower interest rates and other fraudulent acts. The third is traceable. Better understanding of the past behaviour of older persons by old-age institutions in order to provide more targeted old-age and care programmes. The use of block chain technology to the elderly to achieve the whole process of the record, is conducive to the services of the relevant agencies can be more refined. Based on the contract service of family doctors and the platform of primary health care institutions, the contract service package is designed according to the health condition and service demand of the elderly. Through block chain technology, nurses are responsible for accessing, recording and maintaining data, which will enable nurses to be more confident about the accuracy and consistency of data, thereby improving patient care.

3.3. Openness of Block Chain and the Function of Removing Trust Can Enhance the Transparency of Pension Service

The data of the block chain is stored in every node, except the private information of each party is encrypted, the data of the block chain is open to all nodes, and anyone can query the data of the block chain through the public interface, therefore, the information of the whole system remains highly transparent and the integrity of the data is easy to verify. This function of block chain can enhance the transparency of medical care integration service and help to meet the needs of all parties in medical care integration [29]. If the current service process, and the elderly Guardian's information interaction is too single, tends to be inadequate or non-state, block chain can meet the needs of all parties. In the block chain, a node does not need to trust any other node, and under the assumption that the other nodes are uncooperative and untrusted, it can still get the trusted data from the block chain according to the consensus mechanism, this function is conducive to the use of block chain on the evidence of the audit data [30]. To put an end to the old-age pension subsidy data fraud, irregular transactions and other fraudulent acts, so as to ensure that the basic pension on time and in full.

3.4. Automatic Execution of Block Chain and the Simplification of Operation and Maintenance Function Can Reduce the Cost of Old-age Service

The block chain uses pre-agreed intelligent contract code to enable all nodes in the whole system to automatically and safely exchange data and automatically execute pre-defined business logic without any human intervention in an untrusted environment, the settlement of funds is carried out automatically on a block basis without external reconciliation and can be used to construct a 7*24 financial trading system. [31] Block chain technology can provide users with global transparency, permanent record of the customization of the elderly smart contract, according to the attributes of each stage of users, the platform will automatically cash the corresponding pension contract services. Florida State Pension Fund (SPF), Russia's largest social service, planned to introduce block chain technology into smart contracts in 2018 in an effort to reduce unnecessary paperwork and the cost of storing and maintaining large amounts of data. In addition, the technology of block chain adopts the mode of decentralization, the equipment is maintained by each network node, the availability requirement of single node is greatly reduced, the cost of system construction and operation can be significantly reduced, and the life cycle is longer [32].

3.5. The Extensive Application of Block Chain Technology in the Financial Field Can Promote the Development of Pension Finance.

Block chain can link individuals, families, financial institutions and governments, and promote the development of financial innovation in the field of smart pensions. The block chain can record the personal financial quality, credit record and family status of the elderly, including almost all data such as personal education, income, Consumption Habits, assets and liabilities, and the purchase of insurance, and gradually refine the complicated pension issue, it is advantageous for banks, insurance and other financial institutions to provide precise financial products and services for different senior citizens. The use of block chain technology can realize the tracking of individual or enterprise's financial behavior, financial quality and the process of its assets and credit generation, and can promote the deep development of financial innovation to the way of individuation, refinement and self-management, thus fundamentally change the old-age financial industry to earn money, extensive operation, the characteristics of the Information asymmetry, to ensure the safety of old-age pension [33].

4. PROSPECTS AND SUGGESTIONS OF THE APPLICATION OF BLOCK CHAIN IN THE OLD-AGE SERVICE INDUSTRY

From the perspective of the development trend of block chain, there must be some technical blind spots in the initial stage and some lag in data supervision, but these can't cover up the advantages of decentralization, openness and the untamability of information. More and more enterprises in China are beginning to explore "block chain + smart Pension". The application scenarios of block chain will gradually expand from pension care, pension finance and livable life to the fields of leisure and entertainment, health care, food supply, etc. , finally achieve cross-regional, cross-industry collaboration services. Specifically, the application scenario of block chain in the development of the old-age service industry mainly focuses on two aspects:

4.1. In the Mutual Support Service for the Aged, Block Chain Provides a Solution to the "Proof" Problem in the Service Record by Creating Trust and Cooperation Mechanism

On November 20, 2019, media reported that volunteers in the Jianye Taoyuan residential community in Nanjing City, Jiangsu Province can store public welfare time in the Alipay to exchange pension services for themselves, and the whole process has introduced block chain technology to prevent loss or tampering. "Time Bank" is a new model of mutual support for the aged, volunteers to do good "public welfare" can be deposited into the "Bank" [34] , the future for their own or others exchange the same length of old-age services. However, the exploration and application of block chain in the Mutual Pension Service (Time Bank) is still preliminary, and the following aspects need to be strengthened in the future. First, we should strengthen the top-level design of the mutual support model for the aged. We should focus on the coordination of market logic and social logic, study the matching mechanism of supply and demand and incentive mechanism of mutual support for the aged, and further define the public welfare orientation and value choice of "Time Bank" [35]. If we keep the original intention of "equal time and equal value", we can add other adjustment factors, and on the basis of embedding rules of block chain, we can consider more the independent will of both the supply side and the demand side. Second, we should pay attention to the risks of block chain. Mutual Assistance Pension Service (Time Bank) is endowed with certain financial attribute in fact, while exploring, we should also pay attention to the financial risk of "Time Bank" under the block chain technology, and seek the balance between service innovation and risk prevention. The IMF notes that any policy response to a virtual currency needs to strike the right balance between strong risk management and abuse in order to avoid over-

regulation that stifles innovation [36]. Therefore, the “Regulatory Sandbox” system in the UK and Singapore in promoting financial innovation, effective balance of risk practices in the domestic hot pursuit.

4.2. In the Old-age Service Supervision, Block Chain “Distributed” Characteristics, can Break Through the “Data Barriers” between Departments, to Achieve Information and Data Sharing

The supervision of old-age service presents three characteristics: First one is the nature of cross-sector. The supervision of old-age services involves the registration of legal persons, construction facilities, land use management, food safety, environmental protection, fire safety, medical and health, special equipment, bank credit investigation and other departments, the problem of inter-departmental information connectivity must be addressed. The second one is the whole process. The old-age service has been extended from the single organization service supervision to the home, the community and the medical care, the healthy support and the old people welfare subsidy, the bed subsidy, the service fund and so on closely related fund supervision. The third one is the possession multi-risks. The old-age service not only contains the service security risk, but also contains the old people property risk, the organization own construction and the management risk and so on [37]. “strong security mechanism under open architecture” is one of the basic characteristics of block chain, in which data is “co-managed and co-existed collectively”, this is highly consistent with the supervision characteristics of “cross-sector”, “whole process” and “multi-risks” in the supervision of pension service. This requires in-depth study of key issues related to this, such as the use of block chain technology to build public chain of care for the elderly for the sharing of data related to old-age care and cross-reference, using the block chain technology to establish the credit information system of the old-age Service Organization and the service personnel, to increase the cost of punishment for breaking faith, to set up supervision nodes for each supervision department under the block chain environment, to improve the timeliness and effectiveness of supervision, promoting Regulatory co-ordination.

5. CONCLUSION

The technical characteristics and core functions of the blockchain bring opportunities and convenience for solving some of the difficulties in the current development of the elderly care service industry, especially in dealing with the problems and obstacles in the advancement of the integration of medical care and elderly care, and socialized elderly care institutions. In terms of development bottlenecks and effective improvement of the quality of

elderly care services, the elderly care service industry is achieved by improving the efficiency of the elderly care supply chain, protecting the rights and interests of the elderly effectively, enhancing the transparency of elderly care services, reducing the cost of elderly care services, and promoting the development of elderly care finance, blockchain technology. Its development plays an important role in the boosting economic. Therefore, it is objectively necessary and feasible to introduce blockchain technology into the development of the elderly service industry.

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