Parallel Philosophy for MetaOrganizations With MetaOperations: From Leibniz's Monad to HanoiDAO

WELCOME to the third issue of IEEE TRANSACTIONS ON COMPUTATIONAL SOCIAL SYSTEMS (TCSS) of 2022. According to the latest update of CiteScoreTracker from Elsevier Scopus released on April 6, 2022, the CitesSore of IEEE TCSS has reached a historical high of 8.4. Many thanks to all for your great effort and support.

After the usual introduction of our 26 regular articles, we would like to discuss the topic of parallel philosophy for MetaOrganizations with MetaOperations, which takes an important role in realizing the intelligent systems for intelligent societies.

I. SCANNING THE ISSUE

1. "CogEmoNet: A Cognitive-Feature-Augmented Driver Emotion Recognition Model for Smart Cockpit" by *Wenbo Li, Guanzhong Zeng, Juncheng Zhang, Yan Xu, Yang Xing, Rui Zhou, Gang Guo, Yu Shen, Dongpu Cao, and Fei-Yue Wang*

In this article, a cognitive-feature-augmented model to detect driver emotion based on facial expression and cognitive process characteristics is proposed. CogEmoNet recognizes driver emotion by simultaneously considering the driver's facial expression and cognitive process characteristics. To verify the performance of the CogEmoNet, driver's emotion data collection is conducted. The results show that the CogEmoNet detection architecture is capable of achieving well detection results for different databases on the discrete emotion model and the dimensional emotion model, respectively.

2. "Detecting Suicide Ideation in the Online Environment: A Survey of Methods and Challenges" by *Xinyuan Xu*

In this article, an overview of different methods (e.g., technologies, algorithms, etc.) that can identify online suicide ideation is provided. During the summarization phase, this article develops a four-step workflow in this research area, including data collection, data preprocessing, feature engineering, and machine learning (ML) modeling. During the research, the methods clean and manually annotated data prior to extracting features for training the ML techniques. Most studies apply supervised learning algorithms such as support vector machine, logistic regression, and decision tree to construct automated detection models.

3. "Agent-Based Campus Novel Coronavirus Infection and Control Simulation" by *Pei Lv, Quan Zhang, Boya Xu, Ran Feng, Chaochao Li, Junxiao Xue, Bing Zhou, and Mingliang Xu*

In this article, a Campus Virus Infection and Control Simulation (CVICS) model of the novel coronavirus is proposed, which fully considers the characteristics of repeated contact and strong mobility of crowd in the closed environment. An agent-based infection model is also built to introduce the mean field theory to calculate the probability of virus transmission, and micro-simulate the daily prevalence of infection among individuals. The experimental results show that the proposed model can efficiently simulate how the virus spreads in the dense crowd in frequent contact under a closed environment.

4. "A Hybrid Classification to Detect Abstinent Heroin-Addicted Individuals Using EEG Microstates" by *Juan Wang, Ru Peng, Quanying Liu, and Hong Peng*

In this article, a hybrid classifier based on microstate features is proposed, which is extracted from resting state electroencephalography (EEG), to identify abstinent heroin-addicts individuals (AHAIs) and healthy controls (HCs). The result shows that the microstate features can effectively use the information of the time resolution of the EEG signal and the spatial resolution of the electrode. Moreover, the proposed methods and the selected features can provide electrophysiological insights for the assessment of the heroin withdrawal treatment effects.

5. "Fast Core Maintenance in Dynamic Graphs" by *Dongxiao Yu, Na Wang, Qi Luo, F. Li, Jiguo Yu, Xiuzhen Cheng, and Zhipeng Cai*

In order to solve the core maintenance problem in dynamic graphs, this article discovers a structure of inserted/deleted edges, a superior edge set, which can handle edges together to greatly reduce unnecessarily repeated visits of vertices in the procedure of sequential edge processing comparing with the single-edges process. Then, efficient algorithms are devised for incremental and decremental core maintenance for the structure of the superior edge set. The results show a significant speedup in the processing algorithms.

6. "Structural Hole Theory in Social Network Analysis: A Review" by *Zihang Lin, Yuwei Zhang, Qingyuan Gong, Yang Chen, Atte Oksanen, and Aaron Yi Ding*

This article reviews the use of structural hole (SH) theory in social network analysis, which takes advantage of both information and control benefits. It also investigates the existing algorithms of SH spanner detection and classifies them into information flow-based algorithms and network

Digital Object Identifier 10.1109/TCSS.2022.3172671

centrality-based algorithms. For practitioners, this article further illustrates the applications of SH theory in various practical scenarios. Besides, a comprehensive discussion on the foundation, detection, and practical applications of SHs is provided.

7. "Rating Prediction With Review Network Feedback: A New Direction in Recommendation" by *Supriyo Mandal and Abyayananda Maiti*

This article introduces a new class of feedback named review network feedback to bridge the gap in interpersonal relations or interactions among customers. This feedback comes from the concept of a review network where customers are nodes and the edges are created by their interaction in terms of reviewing the same product. Experiments on Amazon.com online review datasets establish the superiority of the proposed model over popular baselines when considering review network feedback.

8. "Edge Repartitioning via Structure-Aware Group Migration" by *He Li, Hang Yuan, Jianbin Huang, Xiaoke Ma, Jiangtao Cui, and Jaesoo Yoo*

This article proposes an edge repartitioning algorithm via structure-aware group migration (SAGM-ER), to improve the lower partitioning quality caused by the dynamics of the graph structure. A special structure edge group (EG) consisting of multiple edges is defined, which can reduce vertex replicas by migrating to other partitions. In repartitioning, after searching for EGs in parallel by a method based on a structure-aware priority and then by migrating EGs, SAGM-ER can reduce more vertex replicas compared with other methods.

9. "Global–Local Enhancement Network for Short Text Classification" by *Qiaohong Chen, Ji Wang, Qi Sun, and Yubo Jia*

This article proposes a global–local enhancement network (GLEN) to construct a high-quality text representation by integrating the global and local features of the text. The global-local pooling mechanism can filter out local features that are more relevant to the whole information of the text to deal with the information-loss problem of the traditional pooling operation. Both the group-wise enhancement mechanism and the global-local pooling mechanism can effectively improve the performance of the proposed model in the ablation experiment on GLEN.

10. "Hybrid Agent-Based Simulation of Adoption Behavior and Social Interactions: Alternatives, Opportunities, and Pitfalls" by *Ashkan Negahban and Philippe J. Giabbanelli*

This article examines the potential and pitfalls of extending adoption models used in agent-based diffusion via ML and soft computing (SC) techniques. They classify features related to agents' decision-making and social interactions that are generally not considered in current adoption models. Along with illustrative examples, an assessment of the potential of hybrid agent-based modeling and simulation (ABMS) involving ML and SC is proposed to incorporate and model these features. They identify essential considerations for the implementation and applicability of such adoption models. To support future efforts in developing computational systems based on these hybrid ABMS, they also highlight research areas to further investigate the intersection of ABMS, ML, and SC.

11. "Rational Task Assignment and Path Planning Based on Location and Task Characteristics in Mobile Crowdsensing" by *Bo Yin, Jiaqi Li, and Xuetao Wei*

This article studies the problem of rational task assignment and path planning for mobile crowdsensing (MCS), which aims to assign a set of task locations to a set of workers and generate a sequence of location visits. It is shown that the computational problem of reasonably maximizing task assignment is NP-hard. For the single-worker scenario, they reduce the problem to a simple one considering only route distance and task priority, since the similarity metric has a fixed value. Numerous experiments show that the proposed method achieves good results.

12. "Discovering Overlapping Communities in Dynamic Networks Based on Cascade Information Diffusion" by *Ling He, Wenzhong Guo, Yuzhong Chen, Kun Guo, and Qifeng Zhuang*

This article proposes an incremental clustering algorithm for discovering overlapping communities in dynamic networks. In the subsequent snapshot, a four-stage framework based on cascaded information diffusion is proposed to incrementally update the communities. In this framework, the evolution of communities is simulated using a cascading information diffusion model, and then the fitness of nodes to the communities they belong to is updated based on node similarity. The experiments show that the proposed algorithm can effectively discover overlapping communities in dynamic networks and outperforms state-of-the-art baseline algorithms.

13. "A Novel Spatiotemporal Behavior-Enabled Random Walk Strategy on Online Social Platforms" by *Chenbo Fu, Yinan Xia, Xinchen Yue, Shanqing Yu, Yong Min, Qingpeng Zhang, and Yan Leng*

This article proposes a user behavior proximity network and a new walking strategy based on this network. This strategy extracts hidden information from social contacts to replace the unobserved personal behavior information. The walking strategy is independent of the model and can be integrated with many existing walking-based deep-learning methods.

14. "Emotional Conversation Generation With Bilingual Interactive Decoding" by *Jiamin Wang, Xiao Sun, and Meng Wang*

This article proposes a bilingual assisted interaction method, which can generate bilingual emotional responses to monolingual posts at the same time. The qualitative and quantitative experiments of Natural Language Processing and Chinese Computing (NLPCC 2017) show that the model performs better in response to content and emotion than several most advanced methods.

15. "An Iterated Carousel Greedy Algorithm for Finding Minimum Positive Influence Dominating Sets in Social Networks" by *Yunfan Shan, Qinma Kang, Ran Xiao, Yiran Chen, and Yunfan Kang*

This article designs a simple and effective method and proposes an iterated carousel greedy (ICG) algorithm for solving the minimum positive influence dominating set problem. The destruction, carousel, and reconstruction procedures are carefully designed based on the knowledge of specific problems to improve the performance of the algorithm while maintaining

the simplicity of the ICG algorithm. The experimental results on real networks show that the proposed ICG algorithm is significantly better than the latest existing algorithms.

16. "Analyzing Biases in Perception of Truth in News Stories and Their Implications for Fact Checking" by *Mahmoudreza Babaei, Juhi Kulshrestha, Abhijnan Chakraborty, Elissa M. Redmiles, Meeyoung Cha, and Krishna P. Gummadi*

This article determines the possible bias in news cognition and discusses how partisan tendencies affect the news selection algorithm of fact verification through a large-scale survey. Their investigation revealed some cognitive biases or inaccuracies in estimating the level of truth of the story. Based on these observations, they propose a new framework that can use users' perception of the truth to eliminate false stories, correct users' misunderstandings, or reduce ideological differences.

17. "Evolution of Transaction Pattern in Ethereum: A Temporal Graph Perspective" by *Qianlan Bai, Chao Zhang, Nianyi Liu, Xiaowei Chen, Yuedong Xu, and Xin Wang*

This article studies the evolutionary behavior of Ethereum transactions from the perspective of time graph. According to the transaction relationship, three temporal graphs are constructed, namely, user-to-user graph (UUG), contract-to-contract graph (CCG), and user-contract graph (UCG), which are segmented with appropriate time windows. UUG describes the transaction relationship between all external accounts (EOA). CCG captures the complex function calls between smart contracts, and UCG is a bipartite graph that captures the transactions between EOA and smart contracts.

18. "Disentangling Multi-Facet Social Relations for Recommendation" by *Xiao Sha, Zhu Sun, and Jie Zhang*

This article proposes a novel disentangled social recommendation (DSR) framework to enhance project recommendation by using various social relationships. DSR is equipped with two designs to meet the challenges: 1) social network de entanglement, which explicitly decomposes social relations into multiple aspects, and encodes the social impact under each aspect as de entangled users embedded in the social network and 2) users embed aggregation to distinguish the importance of different aspects to project recommendation through aspect level attention mechanism.

19. "T-BERTSum: Topic-Aware Text Summarization Based on BERT" by *Tinghuai Ma, Qian Pan, Huan Rong, Yurong Qian, Yuan Tian, and Najla Al-Nabhan*

This article proposes a topic aware extraction and abstract summary model named T-BERTSum based on bidirectional encoder representations from transformers (BERTs). First, the encoded potential topic representation is matched with an embedded representation of BERTs by the neural topic model. Second, long-term dependencies are learned through a transformer network, and topic reasoning and text summarization are explored together in an end-to-end way. Third, the long and short-term memory network layer is stacked on the extraction model to capture the sequence timing information.

20. "Echo Chambers and Segregation in Social Networks: Markov Bridge Models and Estimation" by *Rui Luo, Buddhika Nettasinghe, and Vikram Krishnamurthy*

In this article, a new community-based graph model is proposed, which represents the emergence of a separated echo chamber as a Markov bridge (MB) process. MB is a 1-D Markov random field, which helps to model the formation and separation of communities in a deterministic time. They provide a maximum likelihood based on the model parameter estimation algorithm and a Bayesian filtering algorithm for recursively estimating the separation level using noise samples obtained from the network.

21. "Structure-Attribute-Based Social Network Deanonymization With Spectral Graph Partitioning" by *Honglu Jiang, Jiguo Yu, Xiuzhen Cheng, Cheng Zhang, Bei Gong, and Haotian Yu*

This article proposes a new method to measure the similarity of social network nodes, which considers structural similarity and attribute similarity. Then, a two-stage scheme is designed to perform deanonymization. They also conduct a large number of experiments on three real datasets to simulate the deanonymization attack. The experimental results show that their method can improve the accuracy and time complexity of deanonymization compared with the existing methods.

22. "A Quantitative and Content-Based Approach for Evaluating the Impact of Counter Narratives on Affective Polarization in Online Discussions" by *Dario Borrelli, Luca Iandoli, Jose Emmanuel Ramirez-Marquez, and Carlo Lipizzi*

This article proposes a quantitative method to evaluate emotional polarization and measure the effectiveness of anti-narrative. They first describe a controversial incident that occurred offline, involving two groups of people. Their used data on social media are collected through the application interface and preprocessed through the data cleaning process of text messages. Finally, the effectiveness of anti-narratives published by relevant participants on the internet to reduce emotional polarization is quantitatively evaluated.

23. "Multigraph Random Walk for Joint Learning of Multiview Clustering and Semisupervised Classification" by *Shiping Wang, Lele Fu, Zhewen Wang, Haiping Xu, and William Zhu*

In this article, a simple and effective multigraph random walk scheme is proposed for multiview clustering and semi-supervised classification tasks. In the proposed scheme, multiview learning is carried out in a multigraph roaming joint learning framework with automatic view weight allocation. In this framework, the view specific arrival probability matrix is recursively learned for further integration. In addition, a large number of experiments on eight real datasets show that this method is superior to other most advanced algorithms in multiview clustering and semi-supervised classification.

24. "Rapid Risk Assessment of Emergency Evacuation Based on Deep Learning" by *Jiaxu Li, Yuling Hu, and Jiafeng Li*

This article presents an evacuation evaluation model based on a convolutional neural network. Lenet and Resnet are selected to train the model. An actual case of a large stadium is used to illustrate the evaluation method, and a large number of experiments are carried out to obtain the data required for

training. The results show that the deep-learning method can achieve efficient and rapid risk assessment.

25. "Public Opinion Dynamics in Cyberspace on Russia–Ukraine War: A Case Analysis With Chinese Weibo" by *Bingyang Chen, Xiao Wang, Weishan Zhang, Tao Chen, Chenyu Sun, Zhenqi Wang, and F.-Y. Wang*

Taking the Chinese microblog on Russia–Ukraine war (RUW) as an example, this article puts forward a comprehensive method to explore the dynamics and evolution of network public opinion. First, the algorithm uses the unsupervised learning method assigned by potential Dirichlet to divide the microblog text into four categories, and then collects opinions by extracting keywords. At the same time, a viewpoint confrontation evolutionary algorithm is proposed to dynamically simulate the dominance of viewpoint in the evolution process, and a Chinese microblog dataset related to RUW is proposed.

26. "Dynamic Process in Threshold Weighted Indecisive-Voting Systems" by *Hainan Zhang and Hoang Pham*

To analyze system performance in terms of system reliability focusing on the indecisive effect, this article models threshold weighted voting systems with multifailure modes. First, to realize the flexibility of adjustment to satisfy different applications, the continuous distributed indecisive parameter is set, which can give an intuitive idea of how the model adapts from the decision rule. Second, by considering different indecisive effects, the time delay degradation process on voters' errors illuminates the opposite system performance for two types of inputs, which leads to further investigation of model sensitivity of input types.

II. Parallel Philosophy for MetaOrganizations With MetaOperations: From Leibniz's Monad to HanoiDAO

A. From Leibniz's Monad to Blockchain's DAO: Defining Monadao and Monadaology

The emergence of the concept of the mathematical category has transformed the classical concept of philosophical category from quality to quantity, and the concept of functor has sublimated Leibniz's function thought. In addition, the concept of natural transformation representing functor transformation and the existing algebraic-geometric calculus together form a complete mathematical system of descriptive knowledge, predictive knowledge, and prescriptive knowledge.

How to effectively play the role of the Monad concept based on category theory is one of the core tasks of intelligent science and technology [1]. However, recently Monad's perception and application do not play an essential part and do not match Leibniz's expectations [2], [3]. Therefore, we should understand the meaning of Leibniz's original Monad from a new perspective to better promote the development of intelligent technology.

First, reunderstand Monad. Monad corresponds to the atomic concept of matter. Monad is the basic unit that constitutes spirituality or intelligence, just as atoms are the basic unit that constitutes matter.

Second, define the meaning of Monad. Mathematical Monad is the expression of this knowledge from quality to quantity. Therefore, "standard structure" or "basic structure" [4] can be understood as the "standard particle" or "basic particle" for constructing an intelligent system, which provides more effective ways and tools for agent programming design. It is analogous to the transformation of philosophical categories into mathematical categories.

Furthermore, the successful application of Monad in functional programming languages shows its effectiveness in dealing with unconventional situations. At the same time, it also provides a feasible solution for the normalization of abnormal problems, especially the normalization of the long tail effect faced by artificial intelligence (AI) and ML. However, dealing with normal and unexpected problems is the key to moving from conventional systems to intelligent systems. Therefore, the more appropriate name of Monad in the framework of mathematical category theory should be "zhizi" or "sophon," rather than "Monad" in the original philosophical sense [5], [6].

The literature on parallel intelligent systems based on the Artificial Societies + Computational Experiments + Parallel Execution (ACP) method [7] pointed out that categories, functors, natural transformations, sophon-Monad, and parallel-specific specialized operating systems constitute a quintuple system of parallel intelligence in complex socio-economic systems structure.

The details are as follows: categories are used as artificial system construction units, functors as computational experimental process representations, natural transformations as the means of parallel execution implementation, and sophon-Monad as the intelligent mechanism to deal with unconventional situations and emergency management and control, coupled with parallel-specific specialized operating systems for virtual–real interaction.

In 1986, we tried to use categories as the mathematical basis of hierarchical intelligent control systems [8]. In 1999, categories, functors, and natural transformations were used as modeling and specification tools for complex economic and social systems [9], and the concept of non-self-functor generalized Monads across categories and multisegment fields was discussed. However, as software and programming expert Gilad Bracha said: "Once you understand monads, you immediately become incapable of explaining them to anyone else." The above efforts are far from enough to become an effective practical analytical tool for intelligent technology.

In recent years, with the innovation and development of the digital economy, the organizational structure is not limited to a centralized hierarchical structure but a decentralized autonomous organization (DAO) based on blockchain [10]. The emergence of DAO provides new ideas for the structure, process, and operation of new intelligent systems.

Can the structure and credit technology of the blockchain be used to improve group intelligence, thereby reducing the requirements for individual intelligence? Can agents or Dapps and software-defined knowledge robots based on Monad be embedded in DAO like biological humans to complete various operations and service functions? In other words, can we use

the following quintuple structure:

$$\text{PiDOS} = \{C, F, N, T, \text{DOS}\}$$

as the elemental composition of parallel intelligence? C represents the category set of artificial systems, which can also constitute a complete category, from knowledge graphs to knowledge categories. F is the functor set on C, representing computational experiments' possible process and results. N represents the feedback and correction mechanism for the control and management strategy in virtual-real interaction, that is, the natural transformation set of the corresponding functor. T is the sophon-Monad set, which represents the emergency mechanism to deal with unconventional situations in various categories. DOS is an application operating system based on DAO for specific scenarios and tasks.

We hope to accelerate and deepen the research and development work in this direction, integrate Leibniz's Monda with the blockchain's DAO, and convert philosophy Mondalogy into Mondao and Mondalogy of intelligent science. At the same time, it also makes the ancient concept of "Tao" in Chinese philosophy into a technical means and platform mechanism of today's intelligent science. Thus realizing the "TRUE and DAO" of intelligent technology.

TRUE = Trustable + Reliable + Usable + Effective and Efficient

DAO = Distributed and Decentralized + Autonomous and Automated + Organized and Ordered.

B. Blockchain's DAO and MetaOrganizations With MetaOperations: The Foundation of MetaEconomies for MetaSocieties

The essence of blockchain's DAO is to develop the artificial world. It makes "attention" and "trust," which are traditionally difficult to circulate and commercialize, into commodities that can be mass-produced and circulated. Therefore, it has revolutionized the scope of economic activities, expanded the ways to improve efficiency, and formed a Big Economy of Intelligence for social development.

Blockchain's DAO is a typical complex system with social and engineering complexity characteristics. Realizing its TRUE and DAO features needs to be implemented in a new set of theoretical methods and frameworks. The parallel intelligence theory based on the ACP method provides an effective solution for the operation and development of DAO. We call it parallel DAO.

Parallel DAO is closely linked to MetaEnterprises, MetaCities, MetaEconomies, and MetaSocieties. MetaEnterprises and MetaCities promote the formation of MetaEconomies. MetaEconomies can be regarded as virtual economies corresponding to the real economic system. It provides us with a new way to think and understand various real-world economic problems [10]. MetaSocieties is a new space formed with the development and successful application of ACP, CPSS, and digital technology. The development of MetaEconomies and MetaSocieties requires corresponding MetaOrganizations and MetaOperation. Parallel DAO, as a meta-organization, is the principal organizational structure of MetaEconomies and MetaSocieties. Its MetaGovernance and MetaOperation models lay the foundation for developing Meta Economies and MetaSocieties.

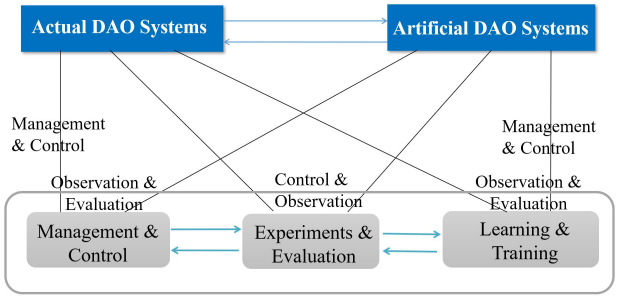

Fig. 1. Framework for parallel DAO.

How to realize MetaOperation and MetaGovernance is the main problem solved by parallel DAO. Parallel DAO is a combination of the ACP approach [11], [12] and the DAO. As shown in Fig. 1, in the parallel DAO, the artificial systems (A) part is used to model one or more artificial DAO systems corresponding to the real-world DAO systems. Based on the co-evolving real-world and artificial blockchain systems, diversified computational experiments could be designed and conducted in the computational experiments (C) part to evaluate and verify specific behavior, mechanisms, and strategies involved in the DAO systems. The optimal solution will emerge through these experiments and feedback to the real-world DAO systems in the parallel execution (P) part to realize the decision optimization and parallel tuning of the DAO systems. The core advantage of parallel DAO lies in its ability to effectively realize the learning and training, experiment and evaluation, and management and control for the actual DAO systems.

1) Learning and Training: In a parallel DAO, the artificial DAO systems can serve as a "testbed" for learners to study the workflow and thus become more familiar with DAO governance and operation. This might be increasingly important for governers before they conduct actual operations in the DAO systems. Parallel DAO governance systems can implement scenario-based and even gamified learning and training processes in a safe, flexible, and low-cost manner. For example, according to specific learning goals, parallel DAO governance systems can build one or more artificial DAO governance systems based on real DAO governance systems. Through the appropriate connection and combination of artificial and actual systems, learners can quickly grasp the various operations and possible effects of DAO governance systems in the artificial system and quantify the actual effects of learning and training.

2) Experiment and Evaluation: Researchers usually cannot carry out critical destructive, and innovative experiments in the real DAO governance systems due to cost, safety, and legal reasons. In the parallel governance system, however, diversified computational experiments can be designed and conducted in the artificial DAO systems to quantitatively evaluate and optimize the performance of the DAO systems and also realize the innovation of DAO governance elements. For

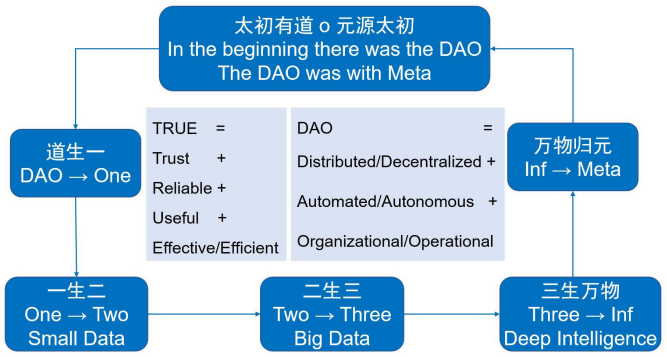

Fig. 2. TRUE DAO for intelligent systems: the journey to smart societies.

example, various "pressure" experiments, "limit" experiments, and "attack" experiments that typically cannot be implemented in the actual systems can now be simultaneously implemented in different artificial DAO governance systems. At the same time, when testing and evaluating the security performance of actual governance systems, the optimal configuration of governance mechanisms that can effectively resist destructive attacks can also be derived.

3) Management and Control: A parallel DAO system can be used as a "parallel sandbox" to implement macro-supervision, trend forecasting, and other management and control operations in a virtual-real interaction manner. On the one hand, new technologies and models emerging in the DAO field can be tested, evaluated, and improved in one or several artificial DAO systems that are as close to the actual state as possible. When the specific regulatory goals and performance requirements are met, they are applied to actual DAO systems. Therefore, the "incubation" function of the parallel sandbox is realized so that "the virtual system will converge to the actual system." On the other hand, new problems, requirements, and trends observed in the actual DAO system can also be modeled and studied in the artificial DAO system in real-time. The optimized solution can be obtained through computational experiments, which guide the development and evolution of the existing DAO system to realize the "innovative" function of the parallel sandbox so that "the actual system will converge to the virtual system."

The Intelligent Science and Systems Joint Laboratory, jointly established by the Institute of Automation, the Chinese Academy of Sciences, and the Macau University of Science and Technology, is developing a parallel distributed autonomous organization governance system, namely, CASCAD, which is realizing the above functions.

C. DAO to Hanoi Ecology: A New Philosophy for Intelligence of Being, Becoming, and Believing

A parallel DAO based on ACP and CPSS, which integrates blockchains, smart contracts, along with decentralized autonomous organizations (DAO, type I) and their distributed autonomous operations (DAO, type II), is a "TRUE DAO" (i.e., real journey). It realizes the intelligent systems for intelligent societies, as explained in Fig. 2 [13].

The "Dao" or "Tao" in Chinese means "journey" or "Meta" and is actually the core concept of Chinese philosophy, as stated by Lao Tzu or Laozi (6th-4th century BC during the Spring and Autumn period), an ancient Chinese philosopher and writer, in his classic Tao Te Ching or Dao De Jing: "The Dao produces The one, The one produces The two, The two produces The three, The three produces all." As we mentioned above, with the help of parallel intelligence in CPSS, and the help from blockchains, smart contracts, cloud/edge computing, and DAOs, this philosophical thinking is becoming a technical process of "producing big data from small data and generating deep intelligence from big data," a TRUE journey for intelligence and smartness.

In the west, the ancient root of Metaverses comes from Greek philosophical thoughts on the fundamental nature of reality, the first principles of being in space and time, becoming of identity and change, causality, necessity, and possibility, as described in Aristotle's Metaphysics. The modern origin of metaverses is obviously from Norbert Wiener's circular causality in 1943 and his book *Cybernetics, or Control and Communication in the Animal and the Machine* in 1948. From cybernetics, we have cyberculture, cyberspace, virtual reality, mirror worlds, and digital twins, and now Metaverses, but for their actual materialization, we must have actual and solid advances in hard technologies of control and communication, so come Internet, iPhones, the Internet of Things, 5G, Internet of Minds, brain–computer interface, and more.

However, relying on intelligent technology alone is not enough in the age of intelligence. The new era requires new thinking and philosophy and creates a corresponding new paradigm of society.

Therefore, we need to expand our philosophy of being and becoming to include a new "B," i.e., believing. Clearly, a new philosophy for intelligent humanity and smart societies with new IT, intelligent technology, of being, becoming, and believing, by parallel intelligence, DAOs, and CPSS, is in urgent need. We call it parallel philosophy.

The technical goal of the parallel philosophy era is to change from Newtonian's big laws with small data to Merton's big data with small laws. It uses data as a guiding element to generate big data through small data and uses big data to refine deep and precise knowledge. Namely, the new paradigm of knowledge automation and intelligence generation process of "small data, big data, and small intelligence." Moreover, the further utilization of the model-based approach of parallel systems and the corresponding parallel management and control led to the transformation of Hegel's utopian project into Popper's sporadic project. At the same time, the emergence of the edge is combined with the convergence capability of the cloud, so that the events and tasks in it can be described, predicted, and prescribed, and then move toward the "TRUE and DAO" of blockchain intelligence technology.

We are dealing with three worlds. The three worlds correspond to three kinds of consciousness, three kinds of knowledge, three kinds of philosophy, and three kinds of intelligence. As shown in Fig. 3, we must live with three Bs: being for the physical world, becoming of the mental world, and believing in the artificial world [14], [15].

Fig. 3. Parallel philosophy: process of parallel interaction and entanglement between virtual and real and correspondent prescriptive knowledge system.

Parallel philosophy leads people's conventional thinking objects from systems and platforms to ecological systems, integrates the natural ecology, social ecology, and knowledge ecology of the "three worlds," and moves toward the parallel ecology and federal ecology of virtual and real interaction, and then promotes human development to the "6S" societies with 6I: safe in the physical world, secure in the cyberworld, sustainable in the ecological world, sensitive to individual needs, serves for all, and smart in all, with cognitive intelligence and parallel intelligence for intelligent science and technology, crypto intelligence and federated intelligence for intelligent operations and management, and social intelligence and ecological intelligence for smart development and sustainability.

To this end, we must transform the Tower of Hanoi, the toy problem used in the early studies of robotics and AI, into the TRUE Tower of Hanoi Ecology: human, artificial, natural, and organizational intelligence [13], [16]–[18].

FEI-YUE WANG
The State Key Laboratory for Management and Control of Complex Systems
Institute of Automation
Chinese Academy of Sciences
Beijing 100190, China
e-mail: feiyue.trans@gmail.com

WENWEN DING
Faculty of Innovation Engineering
Macau University of Science and Technology
Taipa, Macau 999078, China

RUI QIN
The State Key Laboratory for Management and Control of Complex Systems
Institute of Automation
Chinese Academy of Sciences
Beijing 100190, China

BIN HU, *Editor-in-Chief*
School of Medical Technology
Beijing Institute of Technology
Beijing 100081, China
e-mail: tcss.ieee@gmail.com

REFERENCES

[1] F.-Y. Wang, "Parallel philosophy and intelligent science: From Leibniz's Monad to blockchain's DAO," *Patten Recognit. Artif. Intell.*, vol. 33, no. 12, pp. 1055–1065, 2020.
[2] E. Moggi, "Computational lambda-calculus and monads," Univ. Edinburgh, Dept. Comput. Sci., Lab. Found. Comput. Sci., Edinburgh, Scotland, Tech. Rep., 1988.
[3] E. Moggi, "Notions of computation and monads," *Inf. Comput.*, vol. 93, no. 1, pp. 55–92, Jul. 1991.
[4] R. Godement, *Algébriqueet Topologie des Thorie Faisceaux*. Paris, France: Éditions Hermann, 1958.
[5] F.-Y. Wang, "Parallel emergency: Social renormalization via monads and computational social systems," *IEEE Trans. Computat. Social Syst.*, vol. 7, no. 2, pp. 286–292, Apr. 2020.
[6] F.-Y. Wang, "Parallel intelligence: Belief and prescription for edge emergence and cloud convergence in CPSS," *IEEE Trans. Computat. Social Syst.*, vol. 7, no. 5, pp. 1105–1110, Oct. 2020.
[7] F.-Y. Wang, "Outline of a new mathematics for complex economic and management systems, technical report, the key laboratory of complex systems and intelligence science," CASIA, Chin. Acad. Sci., Beijing, China, Tech. Rep., Mar. 2009.
[8] F.-Y. Wang, "An organizational framework and its decision processes for hierarchical intelligent control systems using category and entropy," Robot. Automat. Lab., RPI, Troy, NY, USA, Tech. Rep., Dec. 1986.
[9] F.-Y. Wang, "Modeling and specifification of complex economic and social systems: Categories, functors, and natural transformations," Program Adv. Res. Complex Syst. (PARCS), Univ. Arizona, Tucson, AZ, USA, Tech. Rep., TR♯05-99, Nov. 1999.
[10] F.-Y. Wang, R. Qin, X. Wang, and B. Hu, "MetaSocieties in metaverse: MetaEconomics and MetaManagement for MetaEnterprises and MetaCities," *IEEE Trans. Computat. Social Syst.*, vol. 9, no. 1, pp. 2–7, Feb. 2022.
[11] F.-Y. Wang, "Toward a paradigm shift in social computing: The ACP approach," *IEEE Intell. Syst.*, vol. 22, no. 5, pp. 65–67, Sep. 2007.
[12] F.-Y. Wang, Y. Yuan, C. Rong, and J. J. Zhang, "Parallel blockchain: An architecture for CPSS-based smart societies," *IEEE Trans. Computat. Social Syst.*, vol. 5, no. 2, pp. 303–310, Jun. 2018.
[13] F.-Y. Wang, "Parallel intelligence in metaverses: Welcome to Hanoi!" *IEEE Intell. Syst.*, vol. 37, no. 1, pp. 16–20, Jan. 2022.
[14] F.-Y. Wang, "Parallel philosophy and intelligent technology: Dual equations and testing systems for parallel industries and smart societies," *Chin. J. Intell. Sci. Technol.*, vol. 3, no. 3, pp. 245–255, 2021.
[15] F.-Y. Wang, "Parallel philosophy: Origin and goal of intelligent industries and smart economics," *Bull. Chin. Acad. Sci.*, vol. 36, no. 3, pp. 308–318, 2021.
[16] Y.-J. Wang, F.-Y. Wang, G. Wang, X. Wang, Y.-L. Wang, and R. Li, "Parallel hospitals: From hospital information system (HIS) to hospital smart operating system (HSOS)," *Acta Automatica Sinica*, vol. 47, no. 11, pp. 2585–2599, 2021.
[17] F.-Y. Wang, "Parallel medicine: From warmness of medicare to medicine of smartness," *Chin. J. Intell. Sci. Technol.*, vol. 3, no. 1, pp. 1–9, 2021.
[18] F.-Y. Wang, "Digital doctors and parallel healthcare: From medical knowledge automation to intelligent metasystems medicine," *Med. J. Peking Union Med. College Hospital*, vol. 12, no. 6, pp. 829–833, 2021.

Fei-Yue Wang (Fellow, IEEE) received the Ph.D. degree in computer and systems engineering from Rensselaer Polytechnic Institute, Troy, NY, USA, in 1990.

In 1990, he joined The University of Arizona, Tucson, AZ, USA, where he became a Professor and the Director of the Robotics and Automation Laboratory and the Program in Advanced Research for Complex Systems. In 1999, he founded the Intelligent Control and Systems Engineering Center, Institute of Automation, Chinese Academy of Sciences (CAS), Beijing, China. In 2002, he participated in the development of the Key Laboratory of Complex Systems and Intelligence Science, CAS, as the Director, where he was also the Vice President of Research, Education, and Academic Exchanges at the Institute of Automation from 2006 to 2010. In 2011, he was named the Director of the State Key Laboratory for Management and Control of Complex Systems, Beijing. His current research interests include methods and applications for intelligent and parallel systems, social computing, parallel intelligence, and knowledge automation.

Dr. Wang was an elected Fellow of the International Council on Systems Engineering (INCOSE), the International Federation of Automatic Control (IFAC), the American Society of Mechanical Engineers (ASME), and the American Association for the Advancement of Science (AAAS). He received the best paper awards for his work from the IEEE Intelligent Transportation Systems Society (ITSS) in 2012 and the Computational Intelligence Society in 2017, the Franklin V. Taylor Memorial Award in 2002, and the Andrew P. Sage Award from the IEEE Systems, Man, and Cybernetics Society (SMCS) in 2019. In 2007, he was a recipient of the National Prize in Natural Sciences of China and was awarded the Outstanding Scientist by the Association for Computing Machinery (ACM) for his research contributions in intelligent control and social computing. He was also a recipient of the IEEE Intelligent Transportation Systems (ITS) Outstanding Application and Research Awards in 2009, 2011, and 2015, and the IEEE SMC Norbert Wiener Award in 2014. He has been the General or Program Chair for more than 50 IEEE, Institute for Operations Research and the Management Sciences (INFORMS), IFAC, INCOSE, ACM, ASME, and other professional conferences. He was the President of the IEEE ITS Society from 2005 to 2007; the Chinese Association for Science and Technology, USA, in 2005; and the American Zhu Kezhen Education Foundation from 2007 to 2008. He was the Vice President of the ACM China Council from 2010 to 2011 and the Chair of the IFAC Technical Committee (IFAC TC) on Economic and Social Systems from 2008 to 2014 and from 2017 to 2023. He is the President of the IEEE Council on Radio Frequency Identification (RFID) and the Vice President of the IEEE SMC Society. He was the Vice President and the Secretary General of the Chinese Association of Automation from 2008 to 2018 and has been the President of the Supervision Council since 2018. He was the Founding Editor-in-Chief (EiC) of *International Journal of Intelligent Control and Systems* from 1995 to 2000, *IEEE Intelligent Transportation Systems Magazine* from 2006 to 2007, and IEEE/CAA JOURNAL OF AUTOMATICA SINICA from 2014 to 2017. He was the EiC of IEEE INTELLIGENT SYSTEMS from 2009 to 2012, IEEE TRANSACTIONS ON INTELLIGENT TRANSPORTATION SYSTEMS from 2009 to 2016 and IEEE TRANSACTIONS ON COMPUTATIONAL SOCIAL SYSTEMS from 2017 to 2020, and the Founding EiC of the *Chinese Journal of Command and Control* and the *Chinese Journal of Intelligent Science and Technology*.

Wenwen Ding received the M.E. degree in administrative management from Zhengzhou University, Zhengzhou, Henan, China, in 2018. She is currently pursuing the Ph.D. degree with the Faculty of Innovation Engineering, Macau University of Science and Technology, Taipa, Macau.

She is currently a Research Assistant with the Faculty of Innovation Engineering, Macau University of Science and Technology. Her research interests include parallel intelligence, parallel governance, blockchain, and decentralized autonomous organization (DAO).

Rui Qin (Member, IEEE) received the B.S. degree in mathematics and applied mathematics and the M.S. degree in operational research and cybernetics from Hebei University, Baoding, China, in 2007 and 2010, respectively, and the Ph.D. degree in computer application technology from the University of Chinese Academy of Sciences, Beijing, China, in 2016.

She is currently an Associate Professor with the State Key Laboratory for Management and Control of Complex Systems, Institute of Automation, Chinese Academy of Sciences, Beijing. Her research interests include blockchain, social computing, computational advertising, and parallel management.

Bin Hu (Senior Member, IEEE) is currently a Professor and the former Dean of the School of Information Science and Engineering, Lanzhou University, Lanzhou, China, and an Adjunct Professor with the Computing Department, The Open University, Milton Keynes, U.K. His research interests include affective computing, pervasive computing, and computational behavior modeling.

Dr. Hu was an elected Fellow of the Institution of Engineering and Technology (IET). He was a recipient of many research awards, including the 2014 China Overseas Innovation Talent Award, the 2016 Chinese Ministry of Education Technology Invention Award, the 2018 Chinese National Technology Invention Award, and the 2019 World Intellectual Property Organization–China National Intellectual Property Administration (WIPO-CNIPA) Award for Chinese Outstanding Patented Invention. He is the Technical Committee (TC) Co-Chair of computational psychophysiology and cognitive computing in the IEEE Systems, Man, and Cybernetics Society (SMC) Society and the Vice-Chair of the TC 9.1. Economic, Business, and Financial Systems on Social Media at the International Federation of Automatic Control (IFAC). He is also a Member-at-Large of the Association for Computing Machinery (ACM) China Council and the Vice-Chair of the China Committee of the International Society for Social Neuroscience. He serves as the Editor-in-Chief for IEEE TRANSACTIONS ON COMPUTATIONAL SOCIAL SYSTEMS and an Associate Editor for IEEE TRANSACTIONS ON AFFECTIVE COMPUTING.