

# Federated Management: Toward Federated Services and Federated Security in Federated Ecology

**W**ELCOME to the last issue of IEEE TRANSACTIONS ON COMPUTATIONAL SOCIAL SYSTEMS (IEEE TCSS) in 2021. For IEEE TCSS, 2021 is an exciting year. TCSS has been added to the ISI Web of Science Sources Citation Index Expanded (SCIE) database in 2021, and all articles published since 2018 have been indexed by SCIE. This is an important milestone in the development of TCSS. We would like to take this opportunity to thank and congratulate everyone for their great efforts and supports. We are looking forward to working together to further improve the publication quality and speed up the review process of TCSS in the upcoming 2022.

According to the latest update of CiteScoreTracker from Elsevier Scopus, the Citescore of TCSS has reached 7.4 by October 5, a new high. This indicates that the influence of TCSS is gradually increasing in the field of social computing and computational social systems research.

In this issue, we publish 17 regular papers. Moreover, we will give a brief introduction to federated management, which plays an important role in realizing federated services and federated security in federated ecology.

## I. SCANNING THE ISSUE

1. “Two-Level Attention Model of Representation Learning for Fraud Detection” by *Ruihao Cao, Guanjun Liu, Yu Xie, and Changjun Jiang*

This article presents a novel method for detecting fraud transactions by combining two modules learning hidden information at different levels of data in a unified framework. To address and explore the deep representation of features of transaction behaviors, the authors propose a two-level attention model to capture them by integrating two data embeddings at the data sample level and the feature level. In particular, the sample-level attention model captures the detailed information more centrally which is difficult to determine, and the feature-level attention model extends the information of feature dependences.

2. “Mitigating COVID-19 Transmission in Schools With Digital Contact Tracing” by *Hao-Chen Sun, Xiao-Fan Liu, Zhan-Wei Du, Xiao-Ke Xu, and Ye Wu*

This article studies the effectiveness and cost of digital contact tracing (DCT) technology-based on-campus mitigation strategy through epidemic simulations using high-resolution empirical contact networks of teachers and students. The authors further explore the necessary conditions to

ensure the effectiveness of DCT-based strategy and auxiliary strategies to enhance mitigation effectiveness and make the following recommendation: social distancing should be implemented along with DCT, the adoption rate of DCT devices should be assured, and swift virus tests should be carried out to discover asymptomatic infections and stop their subsequent transmissions.

3. “Profile-Free and Real-Time Task Recommendation in Mobile Crowdsensing” by *Guisong Yang, Yanting Li, Xingyu He, Yan Song, Jiangtao Wang, and Ming Liu*

This article proposes a profile-free and real-time task recommendation method. First, the authors apply the recommendation systems to mobile crowdsensing (MCS) to realize profile-free task recommendations. Second, a participant-task-location tensor is constructed, based on which an improved tensor factorization method is presented to provide task recommendations for participants at a given location. Finally, the authors design a real-time update algorithm based on the idea of one update at a time to update task recommendation lists for participants in real time.

4. “Syntactically Coherent Text Augmentation for Sequence Classification” by *Suraj Pandey, Md. Shad Akhtar, and Tanmoy Chakraborty*

This article addresses the problem of data scarcity for sequence classification tasks. The authors propose AugmentGAN, a simple-yet-effective generative-adversarial-network-based text augmentation model, which ensures syntactic coherency in the newly generated samples. Given an input with a label, AugmentGAN aims to generate a semantically similar sequence that follows the syntactic structure of the original sample. Exhaustive task-based evaluation is conducted to show the efficacy of AugmentGAN; the authors employ 12 different datasets across five classification tasks, i.e., sentiment analysis, emotion recognition, sarcasm detection, intent classification, and spam detection.

5. “Why Did Mr. Trump Oppose Globalization? An E-CARGO Approach” by *Haibin Zhu*

This article presents a new viewpoint from group multirole assignment (GMRA) and establishes a model for simulating the assignment of grand capitals over the world with the help of the Environments—Classes, Agents, Roles, Groups, and Objects (E-CARGO) model and the GMRA model. To support the conclusions, it simulates the situations of globalization and nonglobalization, compares, and analyzes the simulation results with a revised GMRA (RGMRA) model. The author contributes a new formalization of a new role assignment problem (RGMRA), a novel way to study globalization, and a clear and evident conclusion that globalization is not beneficial

for the United States from the point of view of capital investment.

6. “CEBD: Contact-Evidence-Driven Blackhole Detection Based on Machine Learning in OppNets” by *Yang Gao, Jun Tao, Yifan Xu, Zuyan Wang, Weice Sun, and Guang Cheng*

This article constructs behavior classifiers to distinguish the blackhole behaviors from rational ones and designs the collusion filtering strategy to improve detection accuracy by separating corrupted nodes from rational ones, laying a behavior identification foundation. The contact-evidence-driven blackhole detection based on machine learning is proposed to improve the routing performance. The soundness of the proposed scheme is statistically verified, and the detection accuracy is evaluated based on random waypoint model trace and Shanghai taxi trace.

7. “A New Hybrid VMD-ICSS-BiGRU Approach for Gold Futures Price Forecasting and Algorithmic Trading” by *Yuze Li, Shouyang Wang, Yunjie Wei, and Qing Zhu*

This article proposes a new hybrid forecasting approach named variational mode decomposition (VMD)-iterated cumulative sums of squares (ICSS)-bidirectional gated recurrent unit (BiGRU) by integrating a BiGRU deep learning model, VMD, iterated cumulative sum of squares algorithm, and also extends the proposed hybrid forecasting approach to generate trading strategies. The forecasting framework can accurately predict price movements in the gold futures market. The experimental results show that the hybrid forecasting approach can improve the prediction performance significantly in comparison to the benchmarks, and indicate that the strategy displays high levels of consistency in generating positive returns and outperforms several other common trading strategies under various market conditions.

8. “Identifying Groups of Fake Reviewers Using a Semisupervised Approach” by *Punit Rathore, Jayesh Soni, Nagarajan Prabakar, Marimuthu Palaniswami, and Paolo Santi*

This article proposes a top-down framework for candidate fake reviewer groups’ detection based on the DeepWalk approach on reviewers’ graph data and a (modified) semi-supervised clustering method, which can incorporate partial background knowledge. This article validates the proposed framework on a real review data set from the Google Play Store, which has partial ground-truth information about 2207 fraud reviewer-IDs out of all 38 123 reviewer-IDs in the data set. The experimental results demonstrate that the proposed approach can identify the candidate spammer groups with reasonable accuracy.

9. “Two-Phase Multidocument Summarization Through Content-Attention-Based Subtopic Detection” by *Luobing Dong, Meghana N. Satpute, Weili Wu, and Ding-Zhu Du*

This article proposes a new two-phase multidocument summarization strategy using content attention-based subtopic detection. Instead of complicated neural attention mechanisms, the authors propose a simple iteration-based content attention method to complete the subtopic detection task. They formulate summarization from different subtopics as a combinatorial optimization problem of minimizing

sentence distance and maximizing topic diversity, and prove the submodularity of the above optimization problem. They propose a new multidocument summarization algorithm based on the greedy mechanism, and experimentally validate the new algorithms on BBC news summary and wikiHow data. The results show the new algorithms outperform the state-of-the-art methods.

10. “Epidemic Spreading in a Social Network With Facial Mask Wearing Individuals” by *Duan-Shin Lee and Miao Zhu*

This article presents a susceptible-infected-recovered (SIR) model with individuals wearing facial masks and individuals who do not. The disease transmission rates, the recovering rates, and the fraction of individuals who wear masks are all time dependent in the model. The authors develop a progressive estimation of the disease transmission rates and the recovering rates based on the coronavirus disease 2019 (COVID-19) data published by The Johns Hopkins University. The approximation works well through numerical study. The authors develop a bond percolation analysis to predict the eventual fraction of the population who are infected, assuming that parameters of the SIR model do not change anymore.

11. “A Multimodal Author Profiling System for Tweets” by *Chanchal Suman, Anugunj Naman, Sriparna Saha, and Pushpak Bhattacharyya*

This article proposes an efficient multimodal neural framework to solve the task of automatic gender prediction from multimodal Twitter data. The bidirectional encoder representation from transformer BERT\_base (bidirectional encoder representation from a transformer with 12 transformer blocks) is utilized for learning the encoded representation for the text part of the Tweet, and the EfficientNet is used for extracting the features from images. Finally, a direct product-based fusion strategy is applied for fusing the text and image representations. The proposed model achieves accuracies of 82.05%, 86.22%, and 89.53% for pure-image, pure-text, and multimodal setting, respectively, which illustrates that the proposed model outperforms the previous state-of-the-art works in all the cases.

12. “An Upstream-Reciprocity-Based Strategy for Academic Social Networks Using Public Goods Game” by *Nakema Y. Deonauth, Mingchu Li, Shuo Yu, and Xiangtai Chen*

This article investigates the social phenomenon of upstream reciprocity (UR) using a game-theoretical framework. UR occurs when a person who has just received help, in turn, offers help to another. A suitable multiplayer game, the public goods game, is adopted to model scholarly interactions of coauthorship networks. Experiments are performed on real datasets in which cascades of UR scholars are identified. The proposed UR strategy achieves better performance than non-UR scholars as they are found to have a higher publication and citation count. Finally, theoretical proof and simulations suggest that UR has the potential to become an evolutionary stable strategy.

13. “A Random-Field-Environment-Based Multidimensional Time-Dependent Resilience Modeling of Complex Systems” by *Mengmeng Zhu, Xueqing Huang, and Hoang Pham*

This article first introduces a new definition of resilience and then proposes a general random field environment (RFE)-based multidimensional time-dependent resilience model connecting reliability, vulnerability, and recoverability. Besides, it presents a specific RFE-based multidimensional time-dependent resilience model by considering the specified functions of the impact of the RFE on system performance and recovery. Furthermore, the authors extend the proposed resilience model by incorporating multiple failure paths of complex systems. Finally, they apply the proposed resilience model to vehicular edge computing networks to evaluate the vehicular network resilience with the disruptive events on the communication links.

14. “Discovering Latent Topics of Digital Technologies From Venture Activities Using Structural Topic Modeling” by *Bongsug Chae and David L. Olson*

This article attempts to explain the interplay between digital technologies and venture creation using structural topic modeling, an automatic text analysis method, to detect latent topics related to digital technologies from large texts. The profile data of 133 344 U.S. companies from CrunchBase are analyzed. The proposed analytical framework and the findings make contributions to the growing discussion about the intersection between digital technologies and new business creation.

15. “LBCF: A Link-Based Collaborative Filtering for Overfitting Problem in Recommender System” by *Zhipeng Zhang, Mianxiong Dong, Kaoru Ota, Yao Zhang, and Yonggong Ren*

This article proposes a novel approach, namely, link-based collaborative filtering, to enhance the recommendation accuracy and diversity simultaneously without employing additional complex information. Experimental results from three real data sets of recommender systems suggest that, without taking advantage of special additional data, the proposed approach outperforms the state-of-the-art studies, and can generate personalized recommendations with satisfying accuracy and diversity simultaneously.

16. “Depression Intensity Estimation via Social Media: A Deep Learning Approach” by *Shreya Ghosh and Tarique Anwar*

This article proposes a method to predict depressed users as well as estimate their depression intensity via leveraging social media (Twitter) data, in order to aid in raising an alarm. The authors found that the depressed users frequently use negative words such as stress and sad, mostly post during late nights, highly use personal pronouns, and sometimes also share personal events. They perform extensive experiments to demonstrate the efficacy of their method.

17. “My EU = Your EU? Differences in the Perception of European Issues Across Geographic Regions” by *Koustav Rudra, Gerhard Backfried, Miroslav Shaltev, Claudia Niederée, and Erick Elejalde*

This article systematically analyzes the bias created in news reports and further analyzes the polarity variation among different subregions of large geographical areas, such as Africa, Asia, and America. The authors observe a contrasting

difference in their editorial policies. This trend also holds for news related to different topics, such as politics, business, economy, health, and international relation.

## II. FEDERATED MANAGEMENT: TOWARD FEDERATED SERVICES AND FEDERATED SECURITY IN FEDERATED ECOLOGY

With the rapid development of cloud computing, artificial intelligence, and the Internet of Things, the data privacy protection and information security have attracted a lot of attention, and thus the isolated data island is becoming more and more serious. As such, the concept of federated ecology was proposed, which can provide an effective solution for solving the issues of isolated data island under the privacy protection and information security [1]–[3]. In the framework of federated ecology, federated management is the core component and plays an important role. The main task of federated management is to make the management decisions in the federated ecology according to its overall objectives and requirements. Moreover, the federated management decisions will be dynamically adjusted in real time according to the changes of the states of the federated ecology system. With the federated management decisions, the federated ecology can reach the optimal state and better achieve its objectives, so as to realize the intelligent management of the whole federated ecology system on the premise of ensuring federated security. On one hand, federated management can realize personalized federated services through federated control and management of federated data. On the other hand, federated management can realize federated security through blockchain-based technologies including federated contract, federated incentives, and federated consensus [4], [5], and finally transforms federated data to federated intelligence on the premise of privacy protection and data security.

### A. From Federated Data to Federated Services

Federated data include the data of all the federated nodes, as well as their storage, computation, and communication resources [6]. Federated management aims to realize federated services through federated control of the federated data. As such, federated data are the data foundation of federated management, and they are also the data guarantee for realizing federated services. By designing a series of federated management rules, federated services can be realized through the management and control of federated data on the premise of ensuring the data security and privacy of the federated nodes. At the same time, in the process of realizing federated services, a lot of new data are constantly generated, which can be added to federated data and used to optimize the federated management decisions.

In the federated management processes, federated data can be divided into private federated data and non-private federated data [7], [8], and different federated management rules should be designed for different types of federated data. Therefore, the federated management processes of the federated data mainly include the following two aspects: for private federated data, the federated management carries out distributed management

of the ownership and usage right of federated data through technologies such as blockchain and privacy computing, so as to ensure the separation of the ownership and use the right of the private data, and the private data are stored with the local storage mode. Thus, on the premise of ensuring the data security and privacy in the whole processes of federated node data from generation to application, we can realize the rational use of federated data and maximize their value. For the non-private data, we can store these data on the blockchain, and the sharing and interactions of these data can be realized through the distributed management method on the blockchain, so as to maximize the value of these data.

In order to satisfy the personalized federated service requirements under different scenarios, types, and granularity, federated management needs to establish different federated service objectives and implementation plans according to the federated service requirements. After that, federated management needs to clarify the federated data requirements according to the specific objectives of the federated service, and determine the data selection strategy and data cooperation mode of these federated nodes, as well as specific federated control rules. Finally, the management, schedule, and control of the federated data will be realized with these federated control rules, and the goal of federated service can be reached.

### B. Federated Security: Goal of Federated Management

Since the goal of federated management is to provide federated service, security should be vital, which mainly includes data security, process security, and decision security. Data security mainly refers to the privacy protection, which relies on the federated contract to automatically transmit the intermedia features and computing results instead of raw data. Process security is to make sure there is no leakage during the data transmission, for which federated incentive plays the main role to encourage the revenue maximization-oriented nodes to honestly and efficiently participate in the data transmission. The asymmetric encryption technology is also used to avoid the transmitted information being accessed by an irrelevant node. Decision security means the scientific and rational management strategies are generated on the basis of a reliable data and trustable mechanism. It is believed that federated consensus will work well to realize this purpose because it provides an effective mechanism for all or majority of nodes to realize the consensus of the validity of all data-transmission transactions and decision-making transactions.

*Federated Contract:* Smart contract is generally defined as the computer protocols that digitally facilitate, verify, and enforce the contracts made between two or more parties on blockchain [9], [10]. Under the framework of federated management, federated contract takes the data protection and privacy protection as the highest priority, and is committed to building a protocol group that executes the automatic operation efficiently, safely, and stably regardless of whether there is a central node or not, so as to complete data access control,

nonprivate data exchange, safe data updating, and accident handling. To achieve this goal, federated contracts should be constructed in a decentralized way; specifically, the proposals can be offered by any node that cares about the federated management and then will be voted by all nodes that are involved in the federated management. This kind of contract construction mechanism ensures that none of the nodes can get improper gains from manipulating the basic rules of federated management.

*Federated Incentive:* Traditionally, incentive mechanism is regarded as the core power of keeping the blockchain system's vitality [11]. However, in our opinion, federated incentive should also be the important comprise of the security mechanism, for the reason that it encourages the nodes to make the individual revenues align with the social welfare of the system represented partially by the federated security. Federated incentive mechanism design must take into consideration of both the quantity and quality of all nodes' contributions, aiming to encourage more honest nodes to provide high-quality work during the whole process from data to decision and then to service, such that the process security of federated management can be ensured by federated incentive at a certain degree.

*Federated Consensus:* The blockchain consensus defines an agreement that enables each node to reach an agreement on the ownership of accounting rights in a decentralized system [12]. Federated consensus further broadens the scope of consensus, and it ensures all nodes reach the consistency of all the management decisions in the federated ecology. Temporary leader nodes are responsible for updating the system status and data, and the strategy of electing these nodes is crucial to realize the safe and effective federated consensus. Besides the key factors of consensus algorithm design for the traditional distributed systems, federated consensus should also consider the complexity and relevance of the federated management objectives, the federated data transmission process, and the federated service scenarios.

### C. Toward Federated Intelligence

On the premise of data security and privacy protection, federated management gathers more data, computing power, and human resources to produce scientific and reliable management decisions, thus improves management efficiency and effectiveness. With the support of artificial intelligence technology and blockchain technology, more data are gathered in the form of federated data, transformed into decision-making through the way of federated management, implemented into specific measures by means of federated control, and then enabled by federated services, so as to realize the evolution from data to knowledge and then to intelligence. Federated intelligence transforms individual intelligence of a single organization into group intelligence of multiple organizations. Federated management promotes the realization and development of federated intelligence, and federated intelligence can in turn assist the decision making of federated management.

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