Psychological Field Versus Physiological Field: From Qualitative Analysis to Quantitative Modeling of the Mental Status

WELCOME to the fifth issue of IEEE TRANSACTIONS ON COMPUTATIONAL SOCIAL SYSTEMS (TCSS) in 2022. After the usual introduction of our 24 regular articles, we would like to discuss the topic of "Psychological Field Versus Physiological Field: From Qualitative Analysis to Quantitative Modelling of the Mental Status."

I. SCANNING THE ISSUE

1. "Evaluation and Spatial–Temporal Difference Analysis of Urban Water Resource Utilization Efficiency Based on Two-Stage DEA Model" by *Qiwei Xie, Hewen Ma, Xiaolong Zheng, Xiao Wang, and Fei-Yue Wang*

This article was employed to evaluate and analyze the utilization efficiency of urban water resources and spatial-temporal differences in cities of China. According to the characteristics of water resource utilization efficiency, the study established a data envelopment analysis (DEA) model based on Shannon entropy, which overcomes the constraint of the degree of freedom while using the DEA method to directly calculate the comprehensive water resource utilization efficiency in the past and improved the discrimination ability.

2. "Social Development Paradox: An E-CARGO Perspective on the Formation of the Pareto 80/20 Distribution" by *Haibin Zhu*

The contribution of this article is a novel way to study the Pareto 80/20 principle from the viewpoint of iterative role assignment, i.e., using the group role assignment (GRA) to simulate the trend of distributions. This article reveals a social paradox: emphasizing individual differences will inevitably lead to the rapid accumulation and polarization of social wealth while ignoring this difference will inevitably lead to the slow accumulation of social wealth.

3. "V2AnomalyVec: Deep Discriminative Embeddings for Detecting Anomalous Activities in Surveillance Videos" by *S. Chandrakala and L. K. P. Vignesh*

In this article, V2anomalyVec embedding is proposed to detect anomalous activities in surveillance videos. The proposed discriminative embeddings are learned from residual spatiotemporal autoencoders (R-STAEs) trained with normal and abnormal events, respectively. The results on four benchmark datasets show that the method based on V2AnomalyVec performs better than the method based on a normal model and other most advanced methods. By reducing the number of abnormal video clips of the training model, it is proven that this method is suitable for the detection of abnormal events even if there is less abnormal training data.

4. "On Multimodal Microblog Summarization" by *Naveen Saini, Sriparna Saha, Pushpak Bhattacharyya, Shubhankar Mrinal, and Santosh Kumar Mishra*

This article discusses the effectiveness of an image dense caption model in a multimodal microblog summary task, in which a tweet text and an image must be used to generate a text summary. In order to extract information from the image, the dense captioning model is adopted, and the dense captions are further used to calculate the antiredundancy measure. This article uses a word movement distance to capture the semantic similarity between two tweets. Since the dataset of a multimodal microblog summary task in the considered disaster event scenario is not available, the dataset is created and made public to the community. The summary results are obtained using the famous Rouge measurement.

5. "Computational Experiments for Complex Social Systems—Part I: The Customization of Computational Model" by *Xiao Xue, Fangyi Chen, Deyu Zhou, Xiao Wang, Min Lu, and Fei-Yue Wang*

In this article, a customized design framework of a computational experimental model is proposed to meet the different application requirements of computational experiments in different fields. It mainly includes an individual model, an environmental model, and a social model. Finally, this article summarizes some typical applications of a computational experiment, which provides a roadmap for its rapid development and wide application. It mainly includes an individual model, an environmental model and a social model. Based on the principle of customized design, the application cases of the considered computing experiment can be divided into three categories: thinking experiment, mechanism exploration, and parallel optimization.

6. "Dual Distance Center Loss: The Improved Center Loss That Can Run Without the Combination of Softmax Loss, an Application for Vehicle Re-Identification and Person Re-Identification" by *Zhijun Hu, Yong Xu, Raja Soosaimarian Peter Raj, Guanghai Liu, Jie Wen, Lilei Sun, Lian Wu, and Xianjing Cheng*

This article summarizes five shortcomings of center loss, and solves all these shortcomings by proposing double distance center loss (DDCL). The inconsistency between the proposed DDCL and soft max losses is verified in the feature space. In addition, by designing a Euclidean distance threshold between all center pairs, not only the inter-class separability of center loss is enhanced, but also the center loss (or DDCL)

works well without a soft max loss combination. All of these make the proposed DDCL run without soft max loss and have high experimental accuracy.

7. "Medical Cyber–Physical Systems: A Solution to Smart Health and the State of the Art" by *Fulong Chen, Yuqing Tang, Canlin Wang, Jing Huang, Cheng Huang, Dong Xie, Taochun Wang, and Chuanxin Zhao*

A medical cyber–physical system (MCPS) is a kind of cyber–physical system (CPS) applied in the field of modern medicine. This overview introduces the architecture and framework of MCPS, modeling and verification methods, recognition and symbol sensing technology, key communication technology, data storage and analysis technology, monitoring system, data security, and privacy protection technology, as well as key research perspectives and directions. This article can offer a full understanding of the characteristics and technical route of MCP, and master its research status and progress.

8. "Movie Recommendation Systems Using Actor-Based Matrix Computations in South Korea" by *Syjung Hwang and Eunil Park*

This study aims to recommend specific films by considering film types and actors and using content-based filtering. The effectiveness of this method is evaluated by creating two content-based recommendation systems: one based on the correlation between movies and types, and the other based on the correlation between actors and types. This article calculates the correlation between different genres based on actors, and proposes a content-based recommendation system. The results show that considering actors as a key part of the film recommendation system is helpful to recommend more appropriate films to users.

9. "Attention on Global–Local Representation Spaces in Recommender Systems" by *Munlika Rattaphun, Wen-Chieh Fang, and Chih-Yi Chiu*

In this study, a new clustering-based recommendation system collaborative filtering (CF) method is proposed to learn user and item representations from multiple views according to global and local representation space and a point product/Euclidean distance loss function. The purpose of the attention network is to dynamically generate the joint representation of these views for each user project pair. The experimental results show that this method is effective and competitive compared with several CF methods considering only one representation space.

10. "Two-Dimensional Behavior-Marker-Based Data Forwarding Incentive Scheme for Fog-Computing-Based SIoVs" by *Zhuoqun Xia, Xiaoxiao Mao, Ke Gu, and Weijia Jia*

This article proposes a 2-D behavior-marker-based data-forwarding incentive scheme so as to motivate vehicle nodes to participate in data forwarding in fog-computing-based Social Internet of Vehicles (SIoVs). A 2-D behavior marker mechanism is designed to completely evaluate vehicle nodes, and a currency credit-based data-forwarding incentive strategy based on the 2-D marker and the social attributes of vehicle nodes is constructed to deal with vehicular normal behavior, vehicular selfish behavior, and vehicular malicious behavior. The experimental results show that this scheme is more efficient and stable in data forwarding in fog-computing-based SIoVs.

11. "A Location Recall Strategy for Improving Efficiency of User-Generated Short Text Geolocalization" by *Congjie Gao, Yongjun Li, Jiaqi Yang, and Yinyin Zhang*

This article summarizes three modes of user access to points of interest (PoIs), further proposes a variety of location recall methods, and then introduces these geolocation recall methods into the existing algorithm, to prevent the existing algorithm efficiency from being reduced when dealing with large-scale data in geolocalizing user-generated short texts (UGSTs). Geolocation recall generates a candidate location set for each user according to the user's historical behavior records. The calculation time of the three algorithms of the local recall can be shortened by approximately 70% and the accuracy of these algorithms is further improved.

12. "Familiarity-Based Collaborative Team Recognition in Academic Social Networks" by *Shuo Yu, Feng Xia, Chen Zhang, Haoran Wei, Kathleen Keogh, and Honglong Chen*

This article employs the definition of familiarity and then proposes a faMiliarity-based cOllaborative Team recOgnition (MOTO) algorithm to recognize collaborative teams. MOTO calculates the shortest distance matrix within the global collaboration network and the local density of each node, in which central team members are initially recognized based on local density. Then, MOTO recognizes the remaining team members by using the familiarity metric and shortest distance matrix. The experimental results show that MOTO can recognize the largest number of teams, and the teams recognized by the MOTO possess more cohesive team structures and lower team communication costs.

13. "DriveBFR: Driver Behavior and Fuel-Efficiency-Based Recommendation System" by *Jayant Vyas, Debasis Das, and Santanu Chaudhury*

This article presents a system for providing safe, accurate, comfortable, reliable, fuel-efficient, and economical driving behavior using machine learning techniques like the hidden Markov model (HMM), which recommends subsequent trips using a multiobjective optimization (MOO) technique for the driver. Suggestions concerning speed limits and alerts could be provided based on the driver's behavior score and fuel efficiency. The results of the experiment reveal that the proposed model predicts behavior with 95% accuracy and calculates fuel efficiency to improve driving quality and experience, in which the authors used a publicly available UAH-DriveSet dataset captured by the driving monitoring app DriveSafe.

14. "Quasi Group Role Assignment With Role Awareness in Self-Service Spatiotemporal Crowdsourcing" by *Qian Jiang, Dongning Liu, Haibin Zhu, Yan Qiao, and Baoying Huang*

This article contributes a new version of the GRA model, quasi GRA (QGRA), a creative formalization to solve the adaptive collaboration (AC) problem. First, a novel role perception method is proposed, which can effectively divide tasks, speed up the solving speed, and improve the task completion rate to a certain extent. Second, the agent satisfaction evaluation (ASE) method is defined to quantify the relationship between task completion rate and employee satisfaction. This method aims to significantly improve the task completion rate. Finally, the QGRA is extended, and a new AC algorithm

is proposed, which can realize AC of the workers while completing crowdsourcing tasks.

15. "Potential Requirements and Opportunities of Blockchain-Based Industrial IoT in Supply Chain: A Survey" by *Zhao-Hui Sun, Zhiyang Chen, Sijia Cao, and Xinguo Ming*

This article adopts the mixed method of enterprise survey and literature review to identify the actual industrial requirements in different supply chain scenes. The characteristics and applicable scenarios of the industrial Internet of Things (IoT) and blockchain have been analyzed, and the potential application opportunities of the industrial IoT based on blockchain in nine scenarios are discussed in detail. This article is the first to systematically discuss the potential application of blockchain-based industrial IoT under various potential scenes in the supply chain, which reveals the technical and practical challenges of these applications, and has potential guiding significance for the application research of the industrial Internet of things and blockchain technology in the supply chain.

16. "What Does Your Bio Say? Inferring Twitter Users' Depression Status From Multimodal Profile Information Using Deep Learning" by *Soumitra Ghosh, Asif Ekbal, and Pushpak Bhattacharyya*

This article investigates a hypothesis by developing an end-to-end multimodal multitask (MT) system for depression detection (primary task) and emotion recognition (auxiliary task), in which the authors hypothesize that Twitter's rich metadata information about their users can provide some valuable depression cues. The accuracy of the system on the depression detection task reached 70%, exceeding the multiple single-task (ST) baseline based on the combination of various input characteristics. Their research results show that the rich metadata information of Twitter can be used to detect users' depression, and they have great confidence.

17. "Warehouse LSTM-SVM-Based ECG Data Classification With Mitigated Device Heterogeneity" by *Pritam Khan, Priyesh Ranjan, Yashvardhan Singh, and Sudhir Kumar*

This article mitigates the problem of device heterogeneity using the proposed multiplicative convergence-based heterogeneity mitigation (MCHM) method, and further classifies healthcare electrocardiogram (ECG) data with improved performance using a proposed variant of long short-term memory (LSTM). In addition to a support vector machine (SVM), the proposed warehouse LSTM is leveraged in this work for healthcare data classification. They reduce the root-mean-squared error to the order of 10^{-6}–10^{-5}. In the data warehouse, the training accuracy of LSTM-SVM on the Massachusetts Institute of Technology-Beth Israel Hospital (MIT-BIH) and Physikalisch-Technische Bundesanstalt (PTB) datasets is 98.34% and 96.27%, respectively.

18. "Reinforcement-Learning-Based Competitive Opinion Maximization Approach in Signed Social Networks" by *Qiang He, Xingwei Wang, Yong Zhao, Bo Yi, Xijia Lu, Mingzhou Yang, and Min Huang*

This article studies the competitive opinion maximization (COM) in signature social networks and proposes a novel reinforcement-learning-based opinion maximization framework (RLOM) to solve the COM problem, which is composed of two phases: the activated dynamic opinion model and the reinforcement-learning-based seeding process. The authors theoretically prove the COM problem to be NP-hard and propose the activated dynamic opinion model based on a stateless Q-learning approach to model the opinion propagation process. Moreover, they propose a seeding scheme based on reinforcement learning, which is used for unknown opponent strategies.

19. "CollabLearn: An Uncertainty-Aware Crowd-AI Collaboration System for Cultural Heritage Damage Assessment" by *Yang Zhang, Ruohan Zong, Ziyi Kou, Lanyu Shang, and Dong Wang*

This article focuses on a cultural heritage damage assessment (CHDA) problem. Its goal is to accurately locate the damaged areas of cultural heritage sites by exploring the collective advantages of artificial intelligence (AI) and human intelligence from crowdsourcing systems, using the image data published on social media in disaster events. CollabLearn is developed, which is an uncertainty-aware crowd-AI collaborative assessment system that explicitly explores the human intelligence from crowdsourcing systems to identify and fix AI failure cases and boost the damage assessment accuracy in CHDA applications.

20. "Rethinking Auditory Affective Descriptors Through Zero-Shot Emotion Recognition in Speech" by *Xinzhou Xu, Jun Deng, Zixing Zhang, Xijian Fan, Li Zhao, Laurence Devillers, and Björn W. Schuller*

This article investigates auditory affective descriptors (AADs) to describe emotional states in speech, using zero-shot learning (ZSL) frameworks. The investigation contains two aspects: exploring the manually annotated and semantic-embedding sources of AADs and exploring the performance of per-emotion prototypes and per-sample annotations as AADs. The authors employed zero-shot emotion recognition strategies and performed experiments on the CINEMO corpus of French emotional speech. The results indicate that semantic-embedding prototypes performed better compared with manual descriptors from human annotators on both per-emotion and per-sample setups.

21. "Interval Type-2 Fuzzy Analysis and Comprehensive Evaluation for Neonatal Pathological Jaundice" by *Hong Mo, Chun Yang, Xiao Wang, and Fei-Yue Wang*

In this article, Interval type-2 fuzzy sets (IT2 FSs) and fuzzy comprehensive evaluation are used to evaluate the risk of Neonatal pathological jaundice (NPJ). The feasibility of interval type-2 fuzzy comprehensive evaluation in risk evaluation of NPJ is demonstrated by an example, and the fuzzy rule base for prevention and treatment for NPJ is constructed according to the results of risk evaluation. This article demonstrates that the proposed risk evaluation and treatment process of NPJ is actually a dynamic closed-loop control process, which is consistent with the clinical treatment process. This article provides a new solution for the treatment of NPJ.

22. "Learning to Extract Expert Teams in Social Networks" by *Chih-Chieh Chang, Ming-Yi Chang, Jhao-Yin Jhang, Lo-Yao Yeh, and Chih-Ya Shen*

The team formation problem is very challenging due to its NP-hardness and has attracted much attention. This article is the first attempt to automate the algorithm design with a machine-learning-based approach, named reinforcement-learning-based expert team identification (RELEXT).

Moreover, two important dimensions of the team formation problem, the skill and social dimensions, were considered. The authors evaluate the proposed approaches on multiple large-scale real datasets. The experimental results show that these methods are superior to other baselines in terms of solution quality and efficiency.

23. "DeSci Based on Web3 and DAO: A Comprehensive Overview and Reference Model" by *Wenwen Ding, Jiachen Hou, Juanjuan Li, Chao Guo, Jirong Qin, Robert Kozma, and Fei-Yue Wang*

Decentralized science (DeSci) is a hot topic emerging with the development of Web 3.0 and Decentralized Autonomous Organization (DAO). Given that DeSci lacks a unified technical and analytical framework, this article is committed to present a comprehensive introduction of DeSci via discussing its concept and characteristics, proposing a novel reference model with six-layer architecture, analyzing the typical applications, and pointing out the main challenges and future research directions. This article contributes to provide helpful guidance and support for its future research and industrial applications.

24. "Integration of Train Control and Online Rescheduling for High-Speed Railways in Case of Emergencies" by *Hairong Dong, Xuan Liu, Min Zhou, Wei Zheng, Jing Xun, Shigen Gao, Haifeng Song, Yidong Li, and Fei-Yue Wang*

In this article, the integration system of train control and online rescheduling is proposed by analyzing the structure of the CTCS-3 for high-speed railways (HSRS). According to the duration of the delay and the number of affected trains, the authors propose three methods, intelligent train speed trajectory optimization, multitrains cooperative control, and integration of train control and online rescheduling, to deal with different levels of delay. Three delay scenarios were taken to illustrate and explain the benefits of the integration system for HSRs in case of emergencies.

II. PSYCHOLOGICAL FIELD VERSUS PHYSIOLOGICAL FIELD: FROM QUALITATIVE ANALYSIS TO QUANTITATIVE MODELING OF THE MENTAL STATUS

Understanding the human mind mechanism can never be an easy task due to the factor that, the human's psychological status cannot be measured directly [1]. This bottleneck, in theory, brings plenty of limitations in brain science study and medical practice. For instance, the undiscovered mind mechanism restrains our knowledge about the pathogenesis of a series of mental disorders, e.g., depressive disorders. These disorders are increasingly bringing tremendous social burdens and economic costs, particularly during the ongoing COVID-19 pandemic. An estimated 350 million people worldwide suffer from depression, and approximately 800,000 depressed patients suicide every year [2]. On the one hand, there are still tremendous amounts of potential patients suffering from mental disorders that are not diagnosed accurately in time [3]. On the other hand, the current clinical diagnosis methods are mainly based on a variety of symptom analyses, which comes at inevitable drawbacks such as lacking a quantitative analysis.

To address this challenge, computational psychophysiology (CPP) was proposed in [4], which aims to measure the

human's mental status via the physiological data that can be acquired and analyzed by ubiquitous equipment, e.g., a brain–computer interface device. We have witnessed a plethora of progress and milestones achieved by CPP in the past years whereas some limitations are still existing in the current CPP paradigm which is built on signal processing and machine learning technologies: First, the data-driven models are lacking in explainability. As claimed in [5], the explainability can not only render us more confident over solutions but can also help us to obtain further insights from the learned models. Second, the dynamic processing of the human mind mechanisms cannot be well illustrated via the current CPP study paradigm.

In this editorial, we introduce the field theory to the domain of CPP, which aims to study the human psychological field by observing and modeling the physiological field. We hope this novel study paradigm can strengthen the fundamentals of CPP, which may contribute to reveal the pathological mechanism of mental disorders and provide more personalized and precise diagnosis tools.

A. Why Could Field Theory Help?

The concept of the "Psychological Field" was first introduced by Kurt Lewin [6]. As an important aspect of Gestalt theory, field theory holds that the behavior is a function of the person and their cultural environment, which can be expressed as follows:

$$B = f(p, e) \tag{1}$$

where B is the behavior, p is the person, and e is the cultural environment. The main principle of the theory is that an individual's behavior can be indicated by the codependent factors of the current "life space" or "psychological field." Therefore, a life space has an influence on an individual's behavior as a combination of all factors at any time.

The psychological field theory depicts that, an individual's life consists of various distinct spaces, which could be adjusted depending on certain events in the lifetime. Moreover, it also indicates that no two experiences are the same for a person and each part of a total field has the potential meaning and importance no matter how pointless it may seem [7]. However, Gestalt psychology falls behind in being sufficiently quantitative to conduct statistical analysis lacking controlled experimental settings [8].

The historical development by which psychology began to differentiate itself from other subjects largely took place during the late nineteenth and early twentieth centuries [9]. For decades, the qualitative method in psychology has demonstrated itself useful in certain classic works. However, quantitative strategies bear the trend of prevailing [10]. The paradigm in psychology started from methods of introspection, followed by behaviorism [11]. McFadden indicated that the consciousness is physically integrated and the conscious electromagnetic information (CEMI) field theory can account for most observed features of consciousness [12]. Therefore, it is reasonable to think that the modeling of the physiological field (based on mathematical and physical approaches) could help us ignite the dawn of the study on the psychological field, which was presented more than 80 years ago, but insufficiently researched. Benefiting from the great development of modern

information technologies like AI, big data, the IoT, smart wearables, and cloud computing, we are now standing on the shoulders of giants to re-explore the psychological field by observing and modeling the physiological field. A hypothesis is that the dynamic changes in the mental status can be reflected by the physiological status of a person, which was demonstrated to be efficient in CPP studies.

B. How Should We Leverage the Power of Field Theory?

Currently, the clinical diagnosis of mental disorders conducted by experts such as psychologists and psychiatrists mainly consists of a comprehensive assessment of a patient's life circumstances, symptoms and further more, which highly relies on the expert's subjective experiences, risking a range of subjective biases and lacking a more quantitative strategy [13]. The field theory features good explainability by nature and may provide more advanced psychology study paradigms by combining the named AI-enabled technologies. Moreover, the dynamic processing of the mental status can be well illustrated by observing the physiological field. In addition, with the help of modern data-driven techniques, the psychological field theory itself could be more applicable in clinical practice by revealing the human mind mechanisms in a mathematical and physical way.

We would like to share our insights and perspectives in this new area as follows.

1) The modeling of the physiological field can be solved by considering Maxwell's equations and/or wave equations, which can help us to indirectly estimate the psychological field. In addition, the visualization of the physiological field can further facilitate to reveal the human mind mechanism in a long-term point of view.

2) Compared to the classic features extracted from signal processing technologies, the novel representations learned from the models built by field theory could be more applicable and efficient in disclosing the wave characteristics of the physiological field, which would facilitate exploring the human mind mechanism.

3) An integration of multimodal physiological fields (e.g., the electromagnetic field and acoustic field) can help build a continuously "holographic field" that can reveal the human mental status in a more sophisticated manner.

4) Novel explainable deep learning models can be designed and constructed by considering the field theory, which may bring new insights into the learning paradigms of psychophysiological models.

5) The interaction of fields can bring a new study paradigm to discover novel nondrug methods for the treatment of mental disorders. For example, music therapy can be regarded as an interaction between the acoustic field (the music wave) and the subject's psychological field. This interaction process can be illustrated by observing the effects on the physiological field that can be measured via the equipment. It would be helpful to reveal the inherited mechanism of why music therapy works in a more quantitative way.

C. Conclusion

Despite a long run needed when exploring the psychological field by observing the physiological field, the great success of CPP has encouraged us to think there lies great potential in the full usage of the physiological data that can be measured by the ubiquitous equipment. Therefore, we can imagine that novel features can be found and/or learned from accordingly fed models built on field theory, which could benefit an explainable AI for mental healthcare. Furthermore, the mechanisms of the mind could be analyzed deeply via this novel paradigm by seeking the characteristics of the dynamic changing progress of the psychological field, which can be reflected by its corresponding physiological field.

There are plenty of mathematical and physical approaches that could be applied to the study of the physiological field. In addition, the fundamentals of CPP can be strengthened by introducing the field theory, which will not only provide us with a novel research paradigm for understanding the mind mechanisms but also facilitate the personalized and precision medicine plans for the treatment of mental disorders.

We are always on the road toward breaking the walls between different subjects, in particular, for the social well-being and an intelligent society. Most importantly, however, we always have to take all ethical issues into account when conducting a psychological field study. Moreover, the establishment of laws and regulations when using the promoted psychological field-inspired clinical methods needs to be fully considered.

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