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EDITORIAL

IEEE ACCESS SPECIAL SECTION EDITORIAL: BIG DATA ANALYTICS IN THE INTERNET-OF-THINGS AND CYBER-PHYSICAL SYSTEMS

In recent years, with the rapid development of information technology and the increasing maturity of communication technology, embedded computing technology, sensing technology and automatic control technology have made tremendous impact on our lives. The perfect integration of computing process and physical process Internet-of-Things (IOT) has attracted much attention from government, academia and industry.

Cyber-Physical System (CPS) as a multidimensional and complex system is a comprehensive calculation, network and physical environment. Through the combination of computing technology, communication technology and control technology, the close integration of the information world and the physical world is realized. IOT is not only closely related to people's lives and social development, but also has many applications including; military, aerospace, reconnaissance, intelligence grid system, intelligent transportation, intelligent medical systems, environmental monitoring, industrial control, etc. Intelligent medical systems, as a typical application of IOT, will be used as a node of medical equipment to provide real-time, safe and reliable medical services for people. In intelligent transportation systems, roads, bridges, intersections, traffic signals and other key information will be monitored in real time. The vast amount of information is analyzed, released, and calculated by the system so that vehicles can share traffic information in real time. Road management personnel can observe and monitor the real-time situation of key sections in the system, and even release the information to guide the vehicle to improve the existing urban traffic conditions. The Internet of things can realize the function of object identification, positioning and monitoring through access to the network.

In order to motivate users of online social networks to share information and communicate with each other frequently, in ''Empirical analysis and modeling of the activity dilemmas in big social networks,'' Xiong *et al.* first analyzed the activity status of users in one of the famous social networks, Weibo, and then proposed a lurker game model for accumulating big data. In addition to the features of the public goods game, this model also introduces the factor of individual incentive depending on the person's degree. The authors found that the individual strategy to be chosen was not relevant to the user's degree, but to an incentive constant of the entire network. The simulation results showed that individual strategies asymptotically followed three different behaviors according to the dynamic organization of the individuals.

''Probabilistic CkNN queries of uncertain data in large road networks,'' by Li *et al.* addresses the issue of processing probabilistic CkNN queries of uncertain data (CPkNN) for road networks, where moving objects and query points are restricted by the connectivity of the road network and the object-query distance updates affect the query result. A novel model is proposed to estimate network distances between moving objects and a submitted moving query in the road network. Then, a CPkNN query monitoring method is presented to continuously report the possible result objects within a given time interval. In addition, an efficient method is proposed to arrange all the candidate objects according to their probabilities of being a kNN of a query. The method then chooses the top-k objects as the final query result. In addition, we extend our method to large networks with high efficiency. Finally, extensive experiments are conducted to demonstrate the effectiveness of the proposed schema.

The article ''Skyline preference query based on massive and incomplete dataset,'' by Wang *et al.* first presents a skyline preference query strategy based on strict clustering and implements it on dimensions that have higher importance. Second, a skyline preference query strategy based on loose clustering is implemented on dimensions that have lower importance. Finally, integrating local skyline query results, this article calculates global skyline query results by using information entropy theory. The efficiency and effectiveness of Skyline Preference Query (SPQ) algorithm have been evaluated in terms of response time and result set size through the comparative experiments with ISkyline algorithm and sort-based incomplete data skyline algorithm. A large number of simulation results show that the efficiency of SPQ algorithm is higher than that of other common methods.

In ''Mathematical models for simulating coded digital communication: A comprehensive tutorial by big data analytics in cyber-physical systems,'' Sheng *et al.* first present the significance of information theory and several commonly referred concepts associated with it. Then, the communication channel models constructed by information theory are

briefly introduced. Meanwhile, the channel capacity, as a key role in modeling a channel, is expatiated. In addition, source coding and channel coding are compared and explained with a number of simulations. By reading this article, the readers are expected to understand the significance of information theory as well as the indispensable roles of source coding and channel coding in a communication system. Furthermore, most of the techniques and fundamentals introduced and analyzed in this article are feasible for the big data analytics in cyber-physical systems, which pave the way for coding over these newborn systems.

In ''Quantifying user reputation scores, data trustworthiness, and user incentives in mobile crowd-sensing,'' Pouryazdan *et al.* study two existing approaches that quantify crowd-sensed data trustworthiness, based on statistical and vote-based user reputation scores. The authors introduce a new metric— collaborative reputation scores—to expand this definition. Simulation results show that collaborative reputation scores can provide an effective alternative to the previously proposed metrics and are able to extend crowd sensing to applications that are driven by a centralized as well as decentralized control.

In ''Spectrum-availability based routing for cognitive sensor networks,'' Zhang *et al.* estimate the spectrum availability and spectrum quality from the view of both the global statistical spectrum usage and the local instant spectrum status, and then introduce novel routing metrics to consider the estimation. In the authors' novel routing metrics, one retransmission is allowed to restrict the number of rerouting and then increase the routing performance. Then, the related two routing algorithms according to the proposed routing metrics are designed. Finally, our routing algorithms in extensive simulations are implemented to evaluate the routing performance, and we find that the proposed algorithms achieve a significant performance improvement compared with the reference algorithm.

In ''A model of telecommunication network performance anomaly detection based on service features clustering,'' by Wang *et al.* a network performance anomaly detection model based on service feature clustering is proposed. First, the complexity of the wireless network environment and the difference of user behavior are fully considered, an ensemble clustering algorithm is adopted for scene classification by combining the features of various data services with multi-dimensional physical scene characteristics, and, then, the cell categories with different characteristics are marked. Second, each category matches the corresponding network indicators and the weights of each indicator, which are trained from historical data. Finally, network performance anomaly detection is conducted on the basis of these indicators in every scene so that a new approach to evaluate the performance of wireless network can be realized.

''A cyber-physical system for product conceptual design based on an intelligent psycho-physiological approach,'' by Lou *et al.* proposes an architecture of CPS for conceptual design that realizes the acquisition of real-time physiological data from the physical world and the feedback of psychological states from the cyber world. As understanding and meeting the needs of customers have been recognized as significant aspects for conceptual design, an intelligent psycho-physiological approach that incorporates electroencephalogram (EEG) into the Kano model is adopted in this CPS for real-time customer needs analysis. The sample entropy (SampEn) extracted from EEG data is an endogenous neural indicator for customers' psychological states.

''Supervised collaborative filtering based on ridge alternating least squares and iterative projection pursuit,'' by Chen *et al.* presents a supervised data imputation based on the class-dependent matrix factors, which are generated during matrix factorization. The proposed ridge alternating least squares imputation uses class information to create substituted values, which approximate the characteristics of their corresponding classes, for missing entries. In the training phase, the incomplete data with label information are divided into different classes based on their labels, such that basis matrices become class-dependent. Subsequently, iterative projection pursuit is proposed to perform imputation for testing data by computing the linear combination of these class-dependent basis matrices and their corresponding reconstruction weights.

In ''System to recommend the best place to live based on wellness state of the user employing the heart rate variability,'' by Lacuesta *et al.*, the authors present a system that measures the wellness and stress levels of home buyers by employing sensors that measure the HRV. Our system is able to process the data and recommend the best neighborhood to live in considering the wellness state of the buyer. Several tests were performed utilizing different locations. In order to determine the best neighborhood, we have developed an algorithm that assigns different values to the area in accordance with the HRV measures. Results show that the system is effective in providing the recommendation of the place that would allow the person to live with the highest wellness state.

In ''Distributed parallel particle swarm optimization for multi-objective and many-objective large-scale optimization,'' by Cao *et al.*, the authors survey the related research on PSO: multi-objective large-scale optimization, many-objective optimization, and distributed parallelism. Based on the aforementioned three aspects, the multi-objective large-scale distributed parallel PSO and many-objective large-scale distributed parallel PSO methodologies are proposed and discussed, and the other future research trends are also illuminated.

In ''A branch history directed heuristic search for effective binary level dynamic symbolic execution,'' by Hu *et al.*, the authors propose a novel heuristic search algorithm, which analyzes the program execution history and uses the refined history information to inform the search. This article is based on the observation that the branch and input history generated during dynamic symbolic execution can help memorize the explored input space, and infer the partial structure of the program. With a summarized branch history, the proposed

heuristic search makes informed (and better) decisions about which input area to search next for better efficiency. To evaluate the search algorithm, we implement the core DSE engine, integrated with modules to perform execution history collection and analysis.

In "Statistical Twitter spam detection demystified: performance, stability and scalability," Lin *et al.* compared the performance of a wide range of mainstream machine learning algorithms, aiming to identify the ones offering satisfactory detection performance and stability based on a large amount of ground truth data. With the goal of achieving real-time Twitter spam detection capability, we further evaluated the algorithms in terms of the scalability. The performance study evaluates the detection accuracy, the true/false positive rate and the F-measure; the stability examines how stable the algorithms perform using randomly selected training samples of different sizes.

In "Water desalination fault detection using machine learning approaches: A comparative study," by Derbali *et al.*, a significant test for the given regression technique was used to validate the outcome. Machine learning techniques, such as decision trees and deep learning, are applied to the given data and the results reveal that the decision tree was able to obtain more than 95% accuracy and performed better than other algorithms when considering the tradeoff between the processing time and accuracy.

"Distributed data aggregation scheduling in multi-channel and multi-power wireless sensor networks," by Ren *et al.* proposes a cluster-based distributed data aggregation scheduling algorithm, distributed multi-power and multi-channel (DMPMC), that can minimize the data aggregation latency in multi-channel and multi-power WSNs. To save energy, low transmission power is used for packet transmissions inside a cluster, and high power is used for packet transmissions among clusters. Simulations are conducted to compare DMPMC with the best centralized algorithm in a single channel, named E-PAS, the best distributed algorithm in a single channel, named CLU-DDAS, and the best algorithm in multi-channels, named multi-channel.

In "Network traffic classifier with convolutional and recurrent neural networks for Internet of Things," Lopez Martin *et al.*, present a new technique for NTC based on a combination of deep learning models that can be used for IoT traffic. We show that a recurrent neural network (RNN) combined with a convolutional neural network (CNN) provides best detection results. The natural domain for a CNN, which is image processing, has been extended to NTC in an easy and natural way. We show that the proposed method provides better detection results than alternative algorithms without requiring any feature engineering, which is usual when applying other models. A complete study is presented on several architectures that integrate a CNN and an RNN, including the impact of the features chosen and the length of the network flows used for training.

"Agent-based simulation of smart beds with Internet-of-Things for exploring big data analytics," by Garcia-Magarino *et al.* proposes an agent-based simulation framework to simulate sleeper movements on a simulated smart bed with load sensors. This framework allows one to define sleeping posture recognition algorithms and compare their outcomes with the poses adopted by the sleeper. This novel presented ABS-BedIoT simulator allows users to graphically explore the results with starplots, evolution charts, and final visual representations of the states of the bed sensors. This simulator can also generate logs text files with big data for applying offline big data techniques on them. The source code of ABS-BedIoT and some examples of logs are freely available from a public research repository.

In the article, "Volleyball skill assessment using a single wearable micro inertial measurement unit at wrist," by Wang *et al.*, a wearable sensing device (WSD) based on microelectromechanical systems motion sensors (an inertial measurement unit consisting of sensors with three axes of acceleration and three axes of angular rate) was built to assess the skill levels of volleyball spikers. The developed WSD is inexpensive and requires much less computational power than conventional videography analysis in monitoring motions of volleyball players during spikes. This article presents the hardware and software design and the data processing algorithms used in the system. Six right-handed male subjects wore the WSD on their wrists and performed 120 spiking trials in a volleyball court.

To conclude, we would like to sincerely thank all the authors for submitting their articles to our Special Section, and the large number of reviewers who kindly volunteered their time and expertise to help us curate a high-quality Special Section on this important and timely topic. We would also like to thank the former and current IEEE ACCESS Editors-in-Chief Professor Michael Pecht and Professor Derek Abbott, and other staff members of IEEE ACCESS for their continuous support and guidance.

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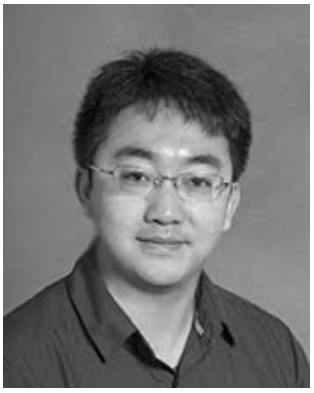

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