# Guest Editorial: Special Section on Cognitive Big Data Science Over Intelligent IoT Networking Systems in Industrial Informatics

## I. Introduction

THE NEW frontier research era, convergence of cognitive data science methods, models with reference to the Internet of Things (IoT), and big data systems have brought about various challenges in industrial systems that need to be addressed in the current scenario. Cognitive science will lead to a high level of fluidity to analytics. This special section aims to explore the domain knowledge, reasoning of data science technologies, and cognitive methods with the IoT over the big data systems. Data science techniques have been adopted to improve the IoT in terms of data throughput, optimization, and management, and to have a major impact on the future of IoT networking systems. The main focus is the design of best cognitive embedded data science technologies to process and analyze the large amount of data collected through industrial IoT systems, and help in good decision making. Consequently, the cognitive data science research facilitates a platform to the scientific community to work for the best solution to address the challenges related to cognitive methods and data science model issues, to support IoT solutions toward smart infrastructure, and to meet the requirement of modern world.

Therefore, this special section submission is dedicated to provide a sampling of the wide spectrum of cognitive computing paradigms, making decisions at an industry or organization happening at all the levels of data science applications. We received nearly 80 manuscripts for this special section, of which nine papers have been accepted while seven papers are still under review (as of September 1, 2020). These nine accepted articles have been grouped into two thematic sections as follows:

1) cognitive science, and big data;
2) IoT networking systems.

Each manuscript has undergone a rigorous peer review process with multiple rounds of review. Section I of this Introduction introduces the accepted article related to cognitive science, and big data. In Section II, the accepted articles related to IoT networking systems are discussed. Section III is acknowledgement of this editorial.

### A. Cognitive Science, and Big Data

There are four articles accepted in this thematic section. In the first article "Cognitive Optimal-setting Control of AIoT Industrial Applications with Deep Reinforcement Learning," Lai *et al.* proposed a practical expectation-based method for improving the industrial overfitting control of deep reinforcement learning (RL). The proposed expectation-based method can successfully decrease the degree of overfitting in cognitive computing. In their experimental study, the performance of the deep Q network algorithm, advantage learning (AL) algorithm, and the propose expected AL method were evaluated with the four criteria: the total score, the total step, the average score, and the highest score. Compared with the AL algorithm, the total score of the proposed expected AL method was increased by 6% in the same number of trainings. This shows that the action probability distribution of the proposed expected AL method helps to achieve a better performance than the traditional soft-max strategy for the optimal control of industrial applications.

The second article "A Parallel Military Dog based Algorithm for Clustering Big data in Cognitive Industrial Internet of Things," by Tripathi *et al.*, presented a novel method for clustering big IoT based datasets, produced from industry. The proposed method finds the optimal centroids by using the ability of trained military dogs to sense suspicious objects by their strong smell sense, and communication ability. The contribution of this article is twofold: 1) a novel meta-heuristic algorithm, inspired from trained military dogs has been introduced, 2) the optimization ability of the proposed algorithm has been tested on 17 standard benchmark functions, and the results are compared with five other state-of-the-art metaheuristics. The proposed MDBO scheme outperformed all the considered algorithms in terms of standard deviation, and fitness value of all the benchmark functions.

The third article "Cognitive Automation for Smart Decision Making in Industrial Internet of Things," by Rathee *et al.*, introduced an efficient, and novel decision-making process to ensure smooth data transmission, and data sharing among network entities. The proposed model classifies the significant parameters using the simple additive weighting, and analytic hierarchy process method so that sensors can efficiently manage the transfer of data over the Internet. The proposed mechanism was analyzed, and validated rigorously using various sensing, and decision-making parameters against a baseline solution in industrial parameter settings. The simulation results suggested that the proposed mechanism led to 87% efficiency in terms of better detection of the sensor node, decision-making,

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and alteration of transmitted data during analyses of product manufacturing in the IIoT.

The fourth article "Compound-TCP Performance for Industry 4.0 WiFi: A Cognitive Federated Learning Approach," by Pokhrel and Singh, designed a novel comprehensive analytic model to study the performance of long-lived Compound TCP flows over Industry 4.0 WiFi networks, while considering the correlated impacts of three types of losses at different layers of the protocol stack. The results of this study showed that using cognitive radio, and federated learning techniques in the industrial, multiple APs scenario could substantially improve the performance.

### B. IoT Networking Systems

In this section, we have five accepted articles. In the first article, titled "A Directed Edge Weight Prediction Model Using Decision Tree Ensembles in Industrial Internet of Things," by Qiu *et al*., the authors proposed a directed edge weight prediction model (DEWP) using decision tree ensembles. It extends the local similarity indices to directed weighted networks, and extracts a series of similarity indices between nodes as features of each edge. These features are used to construct a blended regression model of random forest, gradient boost decision tree, eXtreme gradient boosting, and light gradient boosting machine. The proposed algorithm was evaluated experimentally with the Bitcoin OTC, and Bitcoin Alpha datasets by removing 10% to 90% of edges in the original network. Compared with other classical algorithms, DEWP was shown to achieve higher prediction accuracy, and robustness.

The article "Deep Residual Learning based Enhanced JPEG Compression in the Internet of Things," by Qiu *et al*., proposed a novel method to significantly enhance the transformation-based compression standards like JPEG by transmitting much fewer data of a image at the senders end. At the receivers end, this study propose a two-step method by combining the state-of-the-art signal processing based recovery method with a deep residual learning model to recover the original data. Therefore, in the IoT use cases, the sender like edge device can transmit only 60% data of the original JPEG image without any additional computations, but the image quality can still be restored at the receivers end like cloud servers with PSNR over 31 dB. The proposed methods could help to significantly improve the efficiency of DCT based multimedia big data transmission in IoT scenarios.

The article "A Reinforcement Learning-based Network Traffic Prediction Mechanism in Intelligent Internet of Things," by Nie *et al*., investigated the problem of end-to-end network traffic prediction in IIoTs for industrial applications. This study has proposed an RL-based network traffic prediction mechanism with lower computational complexity, and a smaller scale training dataset. Aiming at a small training datasets, this study took advantage of RL to predict network traffic, and proposed a Kullback–Leibler divergence-based Monte-Carlo Q-learning algorithm. The proposed RL-based network traffic prediction mechanism was evaluated with real network traffic from a testbed, and the GEANT network. According to the evaluation, the proposed mechanism could effectively predict short-term traffic.

The article "A Novel Class Noise Detection Method for High-dimensional Data In Industrial Informatics," by Guan *et al*., integrated the two steps, and proposed a sequential ensemble noise filter (SENF). In the SENF, relevant features are selected, and used to generate a noise score for each instance. Continuously, these noise scores guide feature selection in regression learning. Thus, the SENF falls in the scope of sequential ensemble learning. The authors evaluated the proposed approach with several benchmark datasets with high dimensionality, and considerable label noise. It is shown that the SENF is significantly better than other existing label noise detection methods.

The last article "Edge-Cloud Computing for IoT Data Analytics: Embedding Intelligence in the Edge with Deep Learning," by Ghosh, and Grolinger, explored merging edge, and cloud computing for machine learning with IoT data with the objective of reducing network traffic, and latencies. Three scenarios were examined: all sensors together consider all the data at once, location-based scenario groups data according to the IoT device locations, and similarity-based scenario groups data according to the similarities of sensors. The evaluation was carried out on the HAR task considering two nonreversible approaches, AE, and PCA, and one nonreversible approach, vector magnitude. The results showed that data, and the corresponding network traffic could be reduced even up to about 80% without significant loss of accuracy if a large sliding window was used in the preprocessing.

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Patrick Siarry, *Guest Editor*
Universite Paris-Est Creteil Val-de-Marne
94000 Créteil, France

Arun Kumar Sangaiah, *Guest Editor*
Vellore Institute of Technology
Vellore 632014, India

J. Yi-Bing Lin, *Guest Editor*
National Chiao Tung University
Hsinchu 30010, Taiwan

Shiwen Mao, *Guest Editor*
Auburn University
Auburn, AL 36849 USA

Marek R. Ogiela, *Guest Editor*
AGH University of Science, and Technology
30-059 Kraków, Poland

**Patrick Siarry** was born in France in 1952. He received the Ph.D. degree in computer science and optimization from University Paris VI, Paris, France, in 1986, and the Doctorate of Sciences (Habilitation) degree in computer science and optimization from University Paris XI, Orsay, France, in 1994.

He was first involved in the development of analog and digital models of nuclear power plants with Electricité de France, Paris. Since 1995, he has been a Professor of Automatics and Informatics with Université Paris-Est Créteil, Créteil, France. His main research interests include computer-aided design of electronic circuits, cognitive intelligence, and the applications of new stochastic global optimization heuristics to various engineering fields, also including the fitting of process models to experimental data, the learning of fuzzy rule bases, and of neural networks.

**Arun Kumar Sangaiah** received the master's of engineering degree from Anna University, Chennai, India, and the Ph.D. degree from VIT University, Vellore, India.

He is currently a Professor with the School of Computing Science and Engineering, VIT University. He is holding a Visiting Professor position in various universities around the globe. Furthermore, he has visited many research centres and universities in China, Japan, Singapore, and South Korea to join collaboration toward research projects and publications. His outstanding scientific production spans more than 300 contributions published in high standard ISI journals, such as *IEEE Communication Magazine*, IEEE SYSTEMS JOURNALS, and IEEE INTERNET OF THINGS (IOT). In addition, he has authored/edited eight books (Elsevier, Springer, etc.) and edited several special issues in reputed ISI journals, such as *IEEE Communication Magazine*, IEEE TRANSACTIONS ON INDUSTRIAL INFORMATICS, IEEE INTERNET OF THINGS, *ACM Transaction on Intelligent Systems and Technology*, etc. He has also registered one Indian patent in the area of computational intelligence. His Google Scholar Citations reached more than 7500 with h-index: 46 and i10-index: 185. His research interests include E-learning, machine learning, software engineering, computational intelligence, IoT.

Dr. Sangaiah is an Editorial Board Member and an Associate Editor for many reputed ISI journals. Furthermore, he is the recipient of many awards that include India-Top-10 Researcher award, Chinese Academy of Science-PIFI overseas visiting scientist award, etc.

**J. Yi-Bing Lin** (Fellow, IEEE) was a Research Scientist with Bellcore (Telcordia), Piscataway, NJ, USA, from 1990 to 1995. He has since been with the National Chiao Tung University (NCTU), Hsinchu, Taiwan. In 2010, he became a Lifetime Chair Professor of NCTU and, in 2011, the Vice-President of NCTU. During 2014-2016, he was a Deputy Minister, Ministry of Science and Technology, Taiwan. Since 2016, he has been a Vice-Chancellor with the University System of Taiwan (for NCTU, NTHU, NCU, and NYM). He is the author of the books *Wireless and Mobile Network Architecture* (Wiley, 2001), *Wireless and Mobile AllIP Networks* (Wiley, 2005), and *Charging for Mobile All-IP Telecommunications* (Wiley, 2008).

Prof. Lin has been the recipient of numerous research awards, including 2005 NSC Distinguished Researcher, the 2006 Academic Award of Ministry of Education, the 2008 Award for Outstanding contributions in Science and Technology, etc. He serves on the Editorial Board of the IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY. He has been a General or Program Chair for prestigious conferences, including ACM MobiCom 2002. He is the Guest Editor for several journals, including the IEEE TRANSACTIONS ON COMPUTERS.

**Shiwen Mao** received the bachelor's and master's degrees in electronic engineering from Tsinghua University, Beijing, China, in 1994 and 1997, respectively, the bachelor's degree in business management from Tsinghua University in 1994, a master's degree in systems engineering from Polytechnic University (now NYU Tandon School of Engineering), Brooklyn, NY, USA, in 2000, and the Ph.D. degree in electrical and computer engineering from Polytechnic University in 2004.

He was a Research Staff Member with IBM China Research Laboratory, Beijing, from 1997 to 1998. From 2003 to 2006, he was a Postdoctoral Research Associate and then a Research Scientist with the Bradley Department of Electrical and Computer Engineering, Virginia Polytechnic Institute and State University (Virginia Tech), Blacksburg, VA, USA. In 2006, he joined the Department of Electrical and Computer Engineering, Auburn University, Auburn, AL, USA, as an Assistant Professor. His research interests include wireless networks, multimedia communications, and smart grid.

Dr. Mao was a Distinguished Lecturer from 2014 to 2018 and is a Distinguished Speaker for the period of 2018–2021 of IEEE Vehicular Technology Society. He was a corecipient of the IEEE ComSoc MMTC Best Journal Paper Award in 2019 and the MMTC Best Conference Paper Award in 2018, IEEE SECON 2017 Best Demo Award, Best Paper Awards from 2016 IEEE Global Communications Conference (GLOBECOM), 2015 IEEE GLOBECOM, 2015 IEEE Wireless Communications and Networking Conference, and 2013 IEEE International Conference on Communications, and the 2004 IEEE Communications Society Leonard G. Abraham Prize in the field of communications systems.

**Marek R. Ogiela** received the B.S. degree in mathematics and physics from the Department of Mathematics and Physics, Jagiellonian University, Kraków, Poland, in 1992.

Dr. Ogiela was the recipient of the title of Doctor of Control Engineering and Robotics for his honors doctoral thesis at the AGH University of Science and Technology, Kraków, in 1996. He was also the recipient of the title of Doctor Habilitated in computer science in 2001 and the Professor title in technical sciences in 2005. He is a member of numerous world scientific associations, i.e., SPIE Senior Member, etc., and a member of the Interdisciplinary Scientific Committee of the Polish Academy of Arts and Sciences.