

Date of current version August 18, 2020.

Digital Object Identifier 10.1109/ACCESS.2020.3014475

EDITORIAL

IEEE ACCESS SPECIAL SECTION EDITORIAL: ARTIFICIAL INTELLIGENCE AND COGNITIVE COMPUTING FOR COMMUNICATION AND NETWORK

With the rapid development of communication and network technologies, novel information services and applications are rapidly growing worldwide. Advanced communications and networks greatly enhance the user experience, and have a major impact on all aspects of people's lifestyles in terms of work, society, and the economy. Although advanced techniques have extensively improved users' quality of experience (QoE), they are not adequate to meet the various requirements of seamless wide-area coverage, high-capacity hot-spots, low-power massive-connections, low-latency and high-reliability, and other scenarios. Therefore, it is a great challenge to develop smart communications and networks that support optimized management, dynamic configuration, and feasible services.

Under the new service paradigm, artificial intelligence (AI) and cognitive computing are very promising approaches for dealing with dynamic and large-scale topology; thus, we should explore AI-based techniques, e.g., statistical learning, feedforward neural networks, deep recurrent neural networks, etc., for complicated decision making, network management, resource optimization, and in-depth knowledge discovery in complex environments. Furthermore, communications and network ecosystems must be upgraded with new capabilities such as machine learning, data analytics, and cognitive power for providing human intelligence.

This Special Section aims at bringing together academic and industrial researchers to identify and discuss technical challenges and recent results related to smart communication and networks. To meet the extreme requirements of the user experience, energy efficiency, and performance in a complex network environment, novel design, configuration, and optimization of network communication are needed. This section discusses how to improve the QoS of communications and networks using AI and cognitive computing.

The Call for Papers aroused great enthusiasm in the scientific community and received more than 100 submissions. Out of these, 47 articles were accepted for inclusion in the Special Section after a thorough revision process by at least two independent referees.

First, the invited article, "Wearable affective robot," by Chen *et al.*, proposes a wearable affective robot equipped with cognitive computing. The authors introduce innovative research in the brain wearable field from the aspects of hardware design, EEG data acquisition, and analysis, user behavior perception, algorithm deployment, etc. Through the use of cognitive computing and continuous data acquisition in depth and breadth, the life modeling of a user is achieved, thus truly realizing a personalized intelligent robot.

The article "The analysis of influencing factors of information dissemination on cascade size distribution in social networks," by Dong *et al.*, examines the influencing factors of information dissemination in the view of group cognitive computation, which quantitatively reveals the causality of cascade size power-law distribution from computational experiments, and clarifies the role of information attractiveness, influence, and information sources on the distribution of popularity in social networks.

The article "A high quality task assignment mechanism in vehicle-based crowdsourcing using predictable mobility based on Markov," by Jia *et al.*, proposes a new method of task assignment for a vehicle-based crowdsourcing platform. It focuses on the mobility characteristics of the node, then builds a model based on the participant's movement trajectory. It judges and matches the participants that are most suitable for the current task by inferring the participants' position information in the next stage.

In the article "An evolution model of group opinions based on social judgment theory," by Lu *et al.*, the authors explore how group opinions form and evolve in social situations and how personality impacts the evolution of opinions. Due to the limitations of the traditional Hegselmann–Krause (HK) model, the authors propose a novel agent-based model by combining social judgment theory and the bounded confidence principle, and give openness and vacillation to each agent. Finally, the effects of the two parameters on the model are compared and analyzed through system simulation.

In the article, "DROM: Optimizing the routing in software-defined networks with deep reinforcement learning," by Yu *et al.*, the authors present a deep

reinforcement learning framework for general purpose customizable routing optimization. The framework studies the routing process of optimizing SDN, which has good convergence and effectiveness and can also reduce latency and improve throughput. In addition, the authors introduce a routing configuration scheme based on the framework, which has proved to improve network performance through stable and superior routing services.

The article by Que and Zhang, "Efficient scheduling in training deep convolutional networks at large scale," proposes a scheduling algorithm to reduce communication delay in training deep neural networks. For the traditional data-parallel method, the efficiency of training on large deep networks is limited by the speed of network communication. The authors present a new collective algorithm based on a reverse-reduce tree technique to reduce link contentions. It finally obtains near linearly scaling performance on commodity Ethernet networks.

The article by Zhang *et al.*, "Combining sentiment analysis with a Fuzzy Kano Model for product aspect preference recommendation," proposes an aspect sentiment collaborative filtering algorithm (ASCF). The authors explore the views of users' reviews and calculate the similarity of items from the perspective of users' requirements, instead of the traditional similarity calculation method, to improve the recommendation precision. Experimental results show that the algorithm effectively improves the accuracy of the recommendation.

In the article "Lexicon-enhanced LSTM with attention for general sentiment analysis," Fu *et al.* propose a lexicon-enhanced LSTM model for sentiment analysis. This model solves the problem that word embeddings carry more semantic information than sentiment information. This model uses sentiment embeddings trained by the sentiment lexicon, combined with word embeddings as the input of LSTM, thus greatly improving the ability of LSTM to obtain global sentiment information and obtaining good results in sentiment analysis tasks.

In the article "SAP: A novel stationary peers assisted indoor positioning system," Cai *et al.* propose a novel infrastructure-free indoor positioning system. The positioning system to locate SPs is an enhanced version of the traditional fingerprinting method, which alleviates the painful fingerprint calibration process by leveraging the stationary peers in common indoor environments.

In the article "ULW-DMM: An effective topic modeling method for microblog short text," by Yu and Qiu, the authors propose a method to extend the Dirichlet multinomial mixture (DMM) topic model, which combines the user-LDA topic model based on internal data expansion with the potential feature vector representation of words trained on a very large external corpus. Taking advantage of each part and avoiding disadvantages, it produces a relatively large improvement in topic consistency and classification of tasks for topic modeling of short texts.

The article "Wide-area vehicle-drone cooperative sensing: Opportunities and approaches," by Peng *et al.*, investigates the optimal scheduling of drones. The authors propose a novel Hybrid Genetic algorithm for addressing the issues in Drone scheduling, which supports the cooperation of one vehicle and multiple drones for wide-area inspection applications. They also present a Minimum Visit Cost Crossover algorithm to generate an offspring solution in an inexpensive way.

In the article "Understanding the user's economical and psychological intentions to snatch electronic red envelopes: An experimental study," by Zhang *et al.*, the authors conducted three studies which show that individuals' motivations to snatch red envelopes are influenced by luck-chasing preference, mental accounting effect, motivating-uncertainty effect, and reference dependence. Specifically, individuals tend to pay more attention to the psychological consequences than the economic consequences of snatching WeChat red envelopes. Based on these results, theoretical and practical implications are provided.

In the article "QoE-oriented rate adaptation for DASH with enhanced deep Q-learning," by Liu *et al.*, the authors propose redirecting enhanced Deep Q-Learning toward DASH video QoE (RDQ), a QoE-oriented rate adaptation framework based on enhanced deep Q-learning. The breakdown analysis shows that RDQ can suppress the number and duration of the stalling events to the minimum, while maintaining high video bitrate, thus achieving better QoE performance than other methods.

The article "Specific emitter identification using convolutional neural network-based IQ imbalance estimators," by Wong *et al.*, presents an approach for identifying emitters using convolutional neural networks to estimate the in phase/quadrature (IQ) imbalance parameters of each emitter, using only the received raw IQ data as input. The proposed approach could track emitters, even as they change the modulation scheme. The developed approach is shown to outperform a comparable feature-based approach while making fewer assumptions and using fewer data per decision.

In the article "Deep learning-based sustainable data center energy cost minimization with temporal MACRO/MICRO scale management," by Kang *et al.*, the authors propose a novel joint optimization method for energy-efficient distributed sustainable data centers. The proposed method adopts a long short-term memory approach to improve the prediction accuracy of renewable power capacity for a long period, and an unsupervised deep learning (DL) solver to resolve the coordinated DRS/FS optimization. It also presents the MACRO/MICRO (MAMI) time scale-based data center management technique to achieve both high energy efficiency and low wake-up transition overhead of DRS.

The article "Enhancing attention-based LSTM with position context for aspect-level sentiment classification," by Zeng *et al.*, puts forward a new attentive LSTM model, dubbed PosATT-LSTM, which not only takes into account

the importance of each context word but also incorporates the position-aware vectors, which represents the explicit position context between the aspect and its context words.

In the article “Energy-delay evaluation and optimization for NB-IoT PSM with periodic uplink reporting,” by Bello *et al.*, the authors develop a semi-Markov chain with four states, namely, PSM, idle, random access (RACH), and transmission (Tx) states. RACH and Tx states are introduced from the well-known CONNECTED STATE to account for the extra power consumed due to increased access collisions under massive synchronous connections. Furthermore, an optimization model is introduced to find the best PSM duration, which is configured to minimize energy consumption and average delay according to users’ preference.

In the article, “An adaptive collection scheme-based matrix completion for data gathering in energy-harvesting wireless sensor networks,” Tan *et al.* propose an adaptive collection scheme based on matrix completion (ACMC) to reduce delay and to improve the energy utilization of the network. The ACMC scheme also proposed a method for reducing the delay by increasing the duty cycle of the nodes that are far from the CC. The experimental results of the ACMC scheme in planar networks show better performance than the traditional data collection schemes and can improve the energy utilization of the network by 4.26%–6.68% while reducing the maximum delay by 9.4%.

The article “AI-powered green cloud and data center,” by Yang *et al.*, proposes a new framework for green cloud data centers considering the high energy consumption of the data centers. The authors put forward a scheduling control engine and an intelligent refrigerating engine aimed at the reduction of energy consumption, and also build a green cloud data center platform, realize the scheduling control engine, and verify the feasibility of the framework. The framework can realize a cloud platform with low power consumption and a high-energy-efficient data center operation.

In the article “Cognitive smart healthcare for pathology detection and monitoring,” by Amin *et al.*, the authors propose a cognitive healthcare framework that adopts Internet of Things (IoT)-cloud technologies. This framework uses smart sensors for communications and deep learning for intelligent decision-making within the smart city perspective. The cognitive and smart framework monitors patients’ state in real-time and provides accurate, timely, and high-quality healthcare services at low cost.

In the article “Interest-related item similarity model based on multimodal data for Top-N recommendation,” by Lv *et al.*, the authors propose an end-to-end multimodal interest-related item similarity model (multimodal IRIS) to provide recommendations based on the multimodal data source. Specifically, the multimodal IRIS model consists of three modules, i.e., the multimodal feature learning module, the interest-related network (IRN) module, and the item similarity recommendation module. The proposed multimodal IRIS significantly improves accuracy and interpretability

on top-N recommendation task over the state-of-the-art methods.

The article “Digital twin-driven cyber-physical system for autonomously controlling of micro punching system,” by Zhao *et al.*, presents a context-aware autonomously controlling method for micro-dots punching machine tools via establishing the digital twin-driven cyber-physical system. A dynamic adjustment model of piezoelectric ceramics for micro-dots punching is presented based on a high-precision online detection and control system. A novel staggered punching approach is proposed for improving the punching speed. A joint optimization model is proposed for coordinating the micro-punching system and staggered process. Context-aware autonomous adjusting of the system with error analysis and compensations in the punching process is realized.

In the article “TCP-Drinc: Smart congestion control based on deep reinforcement learning,” by Xiao *et al.*, the authors present a model-free smart congestion control algorithm based on deep reinforcement learning, TCP-Deep Reinforcement learning-based Congestion control (Drinc), which learns from past experience in the form of a set of measured features to decide how to adjust the congestion window size and a framework for model-free, smart congestion control based on DRL. It also develops a realistic implementation of TCP-Drinc on the ns-3 and TensorFlow platforms and compares it with the five representative congestion controls benchmark schemes, which achieves better performance than that in throughput and RTT, and has high adaptability and robustness in dynamic networks.

The article by Li *et al.*, “Mobile payment with alipay: An application of extended technology acceptance model,” investigates the effects of a user’s risk perception, perceived ease of use, perceived usefulness, and attitude, on a user’s willingness to use Alipay, by using an extended version of the technology acceptance model (TAM) and testing the model with the use of structural equation modeling (SEM). The results show that perceived ease of use and perceived usefulness has a significant effect on users’ attitudes and intentions to use Alipay, and the risk perception has a negative effect on perceived ease of use and perceived usefulness. Meanwhile, risk perception also has a direct effect on users’ attitudes and intentions to use Alipay.

In the article “Blockchain and IoT-based cognitive edge framework for sharing economy services in a smart city,” by Rahman *et al.*, the authors propose a blockchain-based infrastructure to support security- and privacy-oriented spatio-temporal smart contract services for the sustainable Internet of Things (IoT)-enabled sharing economy in mega smart cities. The infrastructure leverages cognitive fog nodes at the edge to host and process offloaded geo-tagged multimedia payload and transactions from a mobile edge and IoT nodes, uses AI for processing and extracting significant event information, produces semantic digital analytics, and saves results in Blockchain and decentralized cloud repositories to facilitate sharing economy services. The framework offers

a sustainable incentive mechanism, which can potentially support secure smart city services.

In the article “Multilevel weighted feature fusion using convolutional neural networks for EEG motor imagery classification,” by Amin *et al.*, the authors use EEG motor imagery data to uncover the benefits of extracting and fusing multilevel convolutional features from different CNN layers, which are abstract representations of the input at various levels. The proposed CNN model can learn robust spectral and temporal features from the raw EEG data, and it is proven that such multilevel feature fusion outperforms the models that use features only from the last layer. The results are better than the state of the art for EEG decoding and classification.

In the article, “A novel two-stage deep learning model for efficient network intrusion detection,” by Khan *et al.*, the authors propose a novel two-stage deep learning (TSDL) model, based on a stacked auto-encoder with a soft-max classifier, for efficient network intrusion detection. The model comprises two decision stages: first, an initial stage responsible for classifying network traffic as normal or abnormal using a probability score value. This is then used in the final decision stage as an additional feature for detecting the normal state and other classes of attacks.

The article “Comparative study of supervised learning and metaheuristic algorithms for the development of bluetooth-based indoor localization mechanisms,” by Lovón-Melgarejo *et al.*, investigates the characterization of Bluetooth signal behavior using 12 different supervised learning algorithms as a first step toward the development of fingerprint-based localization mechanisms, and then explored the use of metaheuristics to determine the best radio power transmission setting evaluated in terms of accuracy and mean error of the localization mechanism, and further tune-up the supervised algorithm hyperparameters.

In the article “Multimodal mild depression recognition based on EEG-EM synchronization acquisition network,” by Zhu *et al.*, the authors use electroencephalography (EEG)-eye movement (EM) synchronization acquisition network to simultaneously record both EEG and EM physiological signals of mild depression and normal controls during free viewing. With a long-term aim of developing an objective multimodal system based on the EEG-EM synchronization acquisition network to assist doctors during the diagnosis and monitoring of mild depression, the mild depression recognition performance of EEG and EM is investigated individually, as well as when fused.

The article by Xu *et al.*, “Research on topic detection and tracking for online news texts,” proposes a method for the evolution of news topics over time to realize the tracking and evolution of topics in the news text set by effectively organizing large-scale news documents. The LDA model is used to extract topic information from news texts from different time windows, and then the improved Single-Pass algorithm is used for topic tracking, in which the time decay function and the JS divergence are used to measure the similarity

between the topics, and the content and strength of the topics are analyzed for the results of topic tracking.

In the article, “Imitation reinforcement learning-based remote rotary inverted pendulum control in OpenFlow network,” by Kim *et al.*, the authors use a rotary inverted pendulum as a deep reinforcement learning environment. The real device is composed of a cyber environment and physical environment based on the OpenFlow network, and the MQTT protocol is used on the Ethernet connection to connect the cyber environment and the physical environment. The reinforcement learning agent is taught to control the real device located remotely from the controller, and the classical PID controller is also utilized to implement the imitation reinforcement learning and facilitate the learning process.

The article “Machine-learning and 3D point-cloud based signal power path loss model for the deployment of wireless communication systems,” by Egi and Otero, provides a robust method using 3-D image color classification to extract tree and vegetation from point clouds for the purpose of smart deployment of WCS, which minimizes the need for predefined estimation parameters by creating a 3-D deployment environment taking into account the microvariations in the environment. The proposed model mainly focuses on the effect of tree canopies, can be applied to any environment, and uses a 2-D image color classification technique to extract features from a 3-D point cloud and a machine learning (ML) algorithm to predict SPPL.

The article by Savaglio *et al.*, “Lightweight reinforcement learning for energy efficient communications in wireless sensor networks,” investigates the potential of RL techniques to develop an enhanced and intelligent MAC protocol for WSNs and uses reinforcement learning, a prominent method in artificial intelligence, to design an energy-preserving MAC protocol, with the aim to extend the network lifetime. The QL-MAC protocol is derived from Q-learning, for iteratively tweaking the MAC parameters through a trial-and-error process to converge to a low energy state, which has a dual benefit while solving this minimization problem without the need for predetermining the system model: providing a self-adaptive protocol to topological and other external changes and self-adjusting the WSN node duty-cycle, thus reducing energy consumption without detrimental effects on the other network parameters.

In the article “An effective exponential-based trust and reputation evaluation system in wireless sensor networks,” by Zhao *et al.*, the authors present an exponential-based trust and reputation evaluation system (ETRES) for WSNs' node trust and reputation evaluation. The system is used to observe the nodes' behavior, and exponential distribution is applied to represent the distribution of nodes' trust. They also introduce that the entropy theory is used to measure the uncertainty of direct trust values. They also redefined the confidence factor, which can dynamically adjust the node trust value to weaken the harmful effects of the compromised nodes.

The article by Aggarwal *et al.*, “Probability-based centralized device for spectrum Handoff in cognitive radio networks,” presents a probability-based centralized device for increasing the efficiency of spectrum handoffs in cognitive radio networks. The authors propose the handoff strategy in order to improve the accuracy in sensing the right channel for handoff, reduce the energy consumed in the process, reduce the handoff time, and speed up the transmission of data. They present a complete model of the system, along with a detailed study of its parameters, which proves the effectiveness of the technique

In the article “Comprehensive review of artificial intelligence and statistical approaches in distributed denial of service attack and defense methods,” by Khalaf *et al.*, the authors focus on the most common defense methods against DDoS attacks that adopt artificial intelligence and statistical approaches. The authors introduce the attack types, the testing properties, the evaluation methods, and the testing datasets that are utilized in the methodology of the proposed defense methods. They also provide a guideline and possible points of encampments for developing improved solution models of defense methods against DDoS attacks.

In the article “A risk-based approach to automate preventive maintenance tasks generation by exploiting autonomous robot inspections in wind farms,” by Leonardi *et al.*, the authors design a risk-based maintenance approach to plan inspection tasks to be assigned to service robots in wind power plants. The authors deal with some problems of operation and maintenance in wind farms. They employ a supervisory control and data acquisition (SCADA) system to collect and manage suitable data (power, wind velocity, and related machine events), and evaluate the risk daily over the data collected.

The article “Sentiment analysis of comment texts based on BiLSTM,” by Xu *et al.*, presents an improved word representation method, which integrates the contribution of sentiment information into the traditional TF-IDF algorithm and generates weighted word vectors. It also introduces that the weighted word vectors are input into bidirectional long short term memory (BiLSTM) to capture the context information effectively, and the comment vectors are better represented.

The article by Mennes *et al.*, “Deep learning-based spectrum prediction collision avoidance for hybrid wireless environments,” presents Spectrum Prediction Collision Avoidance (SPCA): an algorithm that can predict the behavior of other surrounding networks by using supervised deep learning, and adapt its behavior to increase the overall throughput of both its own Multiple Frequencies Time Division Multiple Access networks as well as that of the other surrounding networks. The authors use a Convolutional Neural Network (CNN) that predicts the spectrum usage of the other neighboring networks.

The article by Refat *et al.*, “Interactive learning experience-driven smart communications networks for

cognitive load management in grammar learning context,” proposes smart communication networks that are driven by the student learning experience to manage cognitive load in the context of grammar learning. It also introduces a collaborative learning platform that combines a pedagogically informed instructional model named attention, relevance, confidence, and satisfaction (ARCS) and cyber interaction among teaching/learning agents.

In the article “Research on topic recognition of network sensitive information based on SW-LDA model,” by Xu *et al.*, the authors propose a topic recognition method of the network sensitive information based on a sensitive word weighted-latent Dirichlet allocation (LDA) model. The authors obtained the embedding representation of the word through the training of a large amount of network corpus based on Word2vec. They calculate the semantic similarity between the word embedding to extend the basic sensitive word vocabulary, to assist the topic model to capture more sensitive information, and to improve the quality of the topic words.

In the article “Named entity recognition from biomedical texts using a fusion attention-based BiLSTM-CRF,” by Wei *et al.*, the authors present an attention-based BiLSTM-CRF model, which adopts a bidirectional long short-term memory network (BiLSTM) to obtain more complete context information.

The article “Data driven spatio-info network modeling and evolution with population and economy,” by Dong *et al.*, proposes to construct a spatio-info network with a dataset from WeChat. It also analyzes and confirms the correlation between human factors and statistics characteristics of the network. The authors also study the evolution mechanism of cities’ interactive networks formed by the information dissemination process on online social networks.

The article by Hao *et al.*, “Leveraging cognitive context knowledge for argumentation-based object classification in multi-sensor networks,” investigates how rich contextual knowledge-equipped cognitive agents can facilitate semantic consensus in argumentation-based object classification. The authors propose a cognitive context knowledge-enriched method for classification conflict resolution.

In the article “Personalized scientific paper recommendation based on heterogeneous graph representation,” by Ma and Wang, the authors propose a heterogeneous graph representation based recommendation method named HGRec. The authors first construct the user and paper profiles by extracting the contents information, and the Doc2vec technique is employed to initialize the node representations in the heterogeneous graphs. Then, they design two meta-path based proximities to measure the relevance of node representations in the heterogeneous graphs.

The article “iAgent: When AI meets mobile agent,” by Lu *et al.*, presents a conceptual theoretical framework named iAgent, where i means intelligent and the agent refers to the mobile agent. It also introduces that the iAgent

has a learning ability, which means that it can dynamically plan a path according to the external environment in order to reduce energy consumption. Based on iAgent, the authors also propose a method to determine the number of iAgents and their visiting areas in a multi-iAgent WSN environment.

In the article “Real-time control for power cost efficient deep learning processing with renewable generation,” by Kang and Youn, the authors propose a real-time power controller called DeepPow-CTR for cost-efficient DL processing in GPU based clusters. The authors design the GPU frequency scaling algorithm based on model predictive control (MPC), to delicately tune the DL power consumption in response to dynamic renewable generation and electricity price.

In conclusion, the Lead Editor and the Guest Editors would like to thank all the authors who submitted their research articles to our Special Section. We highly appreciate the contributions of the reviewers for their constructive comments and suggestions. We also would like to acknowledge the guidance from the Editor-in-Chief and staff members.



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