Guest Editorial
Introduction to the Special Section on AI-Powered Internet of Everything (IoE) Services in Next-Generation Wireless Networks

NEXT-GENERATION of wireless networks are undergoing a major revolution, connecting billions of machines and millions of people. These networks are marketed as the key enabler of an unprecedented Internet of Everything (IoE) services. Services include eXtended reality (XR) (encompassing virtual, mixed, and augmented reality), connected autonomous systems, telemedicine, haptics, flying vehicles, etc. To successfully enable these IoE applications, wireless systems must simultaneously provide ultra-low latency, high reliability, and high data rates, for heterogeneous devices, through downlink and uplink. In addition, an end-to-end co-design of computing, control and communication functionalities are also required by the emerging IoE services. To meet these requirements, next-generation networks are expected to address unique challenges to transform wireless systems into self-sustaining and intelligent systems, in order to dynamically provision and orchestrate computing-control-communication-storage-sensing resources tailored to the IoE services' requirements.

Besides, AI will bring many key research directions for emerging wireless networks. In fact, the revolution of next-generation networks is driven by massive availability of data trend which moves from big and centralized data towards distributed, massive, and small data. Future wireless systems must exploit both big and small data sets at their infrastructure, to optimize network functions. This trend motivates the use of new deep/machine learning techniques that go beyond classical ones. Furthermore, scalable, low-latency, high-reliability Deep/machine learning models must be deployed over wireless systems to deliver IoE applications.

This Special Issue intends to bring together researchers from industry and academia to explore recent advances and studies exploiting AI techniques, to enable IoE services in Next Generation Wireless Networks. Thanks to the extensive efforts of the reviewers and the great support from the Editor-in-Chief, Prof. Jianwei Huang, we were able to accept *11* contributed articles covering several important topics as well as applications, from IoT/IoE applications, to Internet of vehicles (IoV) applications, to Edge computing-related applications, to maritime IoT applications. A brief review follows:

In "I2M: Intelligent information management for rendering IoE services in society 5.0," T.Ghosh et al. proposed an intelligent informationmanagement scheme – I2M – a two level delay-tolerant profile matching scheme for provisioning Internet-of-Everything (IoE) services in a Society 5.0. I2M incorporates Information-Centric Satellite Network (ICSN) in the network architecture of Society 5.0, which is expected to enable efficient in-network caching, content delivery, and large area coverage. In I2M, a tabular data structure is introduced to store, update, and replace in-network information in the resource-constrained satellites. Using this tabular data structure, I2M performs a 2-level profile matching scheme, which helps to efficiently access the in-network information and reduce the delay for cache-miss in satellites. Additionally, to increase the transmission efficiency and network lifetime, the authors applied a long-short term memory (LSTM)-based intelligent load balancing mechanism in I2M.

In "Communication-efficient and cross-chain empowered federated learning for artificial intelligence of things," J. Kang et al. proposed a cross-chain empowered FL framework with parallel blockchains to achieve scalable and flexible model training management. Thus, the authors designed an efficient model update compression scheme to reduce communication costs of model update transmission. Furthermore, a dynamic pricing scheme using machine learning based auction is proposed to enable efficient model trading in artificial IoT.

In "Detection and prediction of FDI attacks in IoT systems via hidden markov model," H.Moudoud et al. proposed a process for detecting andpredicting False Data Injection (FDI) attacks, which aim to predict future attacks before they occur and induce IoT devices to behave reliably. First, they proposed a novel artificial intelligence (AI)-based detection and prediction module that uses a hidden Markov model (HMM), to observe the behavior of IoT devices and predict their future actions. Next, they designed a distributed trust management module, that establishes trust between devices using a set of weighted votes. To defend against FDI attacks in communication channels, they formulated a bandwidth optimization problem to meticulously allocate bandwidth to trusted devices. In addition, they proposed an efficient incentive mechanism that uses reputation rewards to encourage trustworthy behavior, and uses a punishment mechanism to neutralize malicious behavior.

P.Yuhuai et al. in "Securing radio resources allocation with deep reinforcement learning for IoE services in Next-generation wireless networks" leveraged Deep Reinforcement Learning to design a secure radio resources allocation approach for IoE

Digital Object Identifier 10.1109/TNSE.2022.3195385

services. First, the authors built a deep neural network for spectrum prediction, thereby optimizing the prediction accuracy and avoiding interference between authorized and unauthorized users. second, a spectrum sensing method based on deep reinforcement learning is proposed to detect/identify untrusted users, to improve the security of the radio resource allocation as well as the detection accuracy of spectrum holes.

In “Deep learning-based service distribution model for wireless network assisted internet of everything,” G. Manogaran et al. investigated the service distribution model for wireless networks powered by AI. Specifically, a mutable service distribution model is presented for leveraging the service response of IoE users. The proposed method focuses on mitigating service overlaps for reliable service distribution. In particular, the re-assignment and training are initiated based on the recurrent learning process. The intermediate computations identify the bias in service response and network requirements for retaining reliability.

In ” Graph neural Networks-driven traffic forecasting for connected internet of vehicles,” Q. Zhang et al. designed a novel graph neural networks-driven traffic forecasting model for connected Internet of vehicles. They considered the dynamics of traffic data as the situation of temporal evolution. Leveraging ensemble learning, three typical graph-level prediction models are created and employed to construct an efficient forecasting model. Such a design is able to take advantage of several methods to minimize the uncertainty in connected Internet of vehicles. Furthermore, a realistic and real-world dataset is used to demonstrate the feasibility of the developed models.

In “Adaptive partial offloading and resource harmonization in wireless edge computing-assisted IoE networks,” D. S. Lakew, et al. studied the edge computing deployment, which requires joint optimization of wireless resource harmonization and partial offloading scheduling, to accommodate heterogeneous IoE services. Therefore, they formulated the system model as a Markov decision process, to minimize the weighted sum of computation overheads, in terms of the latency and energy costs of all user equipment, where network dynamics are considered in the system state. Consequently, an actor-critic reinforcement learning algorithm with replay memory technique, is proposed to realize an adaptive offloading decision scheme and optimal wireless resource harmonization between the backhaul and fronthaul.

In “Federated learning and proactive computation reuse at the edge of smart homes,” B. Nour, et al. studied computation and communication optimization in edge intelligence networks. The authors applied federated edge learning to enforce data privacy for smart home applications at the edge network. A node weighting and dropping scheme have been designed to accelerate the learning and reduce the communication overhead. The scheme uses the Jaccard similarity index to select nodes with diverse quality data to be involved in the learning phase. The authors further applied computation reuse to reduce the computation by predicting future tasks using LSTM short-term and long-term commands prediction, and proactively storing them at the edge device.

In “Intelligent service deployment policy for next-generation industrial edge networks,” A. Hazra et al. designed an intelligent service deployment strategy for simultaneously handling both Industrial Internet of Things, generated dynamic service requests and edge resources in the next-generation industrial networks [A9]. They initially formulated an objective function as a mixed-integer nonlinear programming problem for optimizing the energy-delay trade-off in the edge environment. To accomplish this objective, they modeled a heuristic-based task execution strategy, and exploit the advantage of Deep Reinforcement Learning (DRL) to make accurate decisions in industrial networks.

In “Intelligent multi-AUG ocean data collection scheme in maritime wireless communication network,” J. Wen et al. studied the application of a new generation of Artificial Intelligence wireless communication technology in marine monitoring platforms. They designed a multi-Automatic Underwater Glider (AUG) trajectory optimization method, using intermittent satellite communication. They proposed a reinforcement learning reward rule, which can effectively increase the coverage of AUGs trajectory. Moreover, they proposed a 3-D matrix completion method, which searches for key nodes and edge nodes by designing regular sample points and operators to recover the entire space information.

Finally, in “Deep learning-powered vessel trajectory prediction for improving smart traffic services in maritime internet of things,” to promote smart traffic services in maritime IoT, R. W. Liu, et al. proposed an AIS (automatic identification system) data-driven trajectory prediction framework, whose main component is a long short term memory (LSTM) network. In particular, the vessel traffic conflict situation modeling, generated using the dynamic AIS data and social force concept, is embedded into the LSTM network to guarantee high-accuracy vessel trajectory prediction. In addition, a mixed loss function is reconstructed to make the prediction results more reliable and robust in different navigation environments.

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