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EDITORIAL

IEEE ACCESS SPECIAL SECTION EDITORIAL: EDGE COMPUTING AND NETWORKING FOR UBIQUITOUS AI

With its rapid development recently, edge computing with processing, storage, and networking capabilities has become an important solution to break through the bottleneck of emerging technology development by virtue of its advantages in reducing data transmission, decreasing service latency, and easing cloud computing pressure. Among several application scenarios such as network optimization, intelligent manufacturing, and real-time video analytics, edge computing can work with artificial intelligence (AI) synergistically. Therefore, many researchers are investigating edge computing with AI from two perspectives. One is that the emergence of AI solves the optimization problem of edge computing. For example, when network devices need to process some complex and fuzzy information, the powerful learning and reasoning ability of AI can help to extract valuable information from the massive data and realize intelligent management. Another is how edge computing supports AI in a networking environment. For example, AI training and inference can be efficiently enabled by a multitude of computing resources from edge computing. Therefore, edge computing and AI are mutually beneficial in networking.

This IEEE ACCESS Special Section on Edge Computing and Networking for Ubiquitous AI aims to explore the challenges of ubiquitous intelligence potentially enabled by both edge computing and machine learning, such as what can AI do for edge computing, what edge computing can do for AI, and novel applications of edge computing with AI.

The Call for Papers drew wide attention from the research community and received 46 submissions. Out of these, 14 articles were accepted for inclusion in the Special Section after a thorough review process involving at least two independent expert referees. The 14 accepted articles can be broadly categorized into three groups. The first, with five articles, tackles what AI can do for edge computing. The second group of four articles address the problems of what edge computing can do for AI. The remaining five articles discuss novel edge computing/AI applications.

In the first group, the article “IKW: Inter-kernel weights for power efficient edge computing,” by Udupa *et al.*, proposes the Inter-Kernel Weight (IKW) technique, which can be used to eliminate redundant multiplications for a subset of kernel weights in a convolutional neural network (CNN) layer. The proposed IKW architecture, as an alternative

approach for enhancing CNN kernel sparsity, enables power-efficient CNN inference on edge devices by reducing power consumption of 3-D convolution operations.

The article “Towards cost-efficient edge intelligent computing with elastic deployment of container-based microservices,” by Zhao *et al.*, formulates the container-based microservice deployment as a stochastic optimization problem while developing a cost-aware elastic microservice deployment algorithm to balance the tradeoff between system cost and quality of service (QoS). Based on the Lyapunov optimization framework, the proposed algorithm makes real-time decisions based on the current queue backlogs and system states without predicting the future knowledge.

In the article “Collaborative edge computing and caching with deep reinforcement learning decision agents,” by Ren *et al.*, the authors investigate the coordination between compute and cache resources in multi-level edge computing nodes. This dynamic and complex system relies on double deep Q-learning (DDQN) to make decisions, with the ability to maximize long-term gains while making quick decisions.

In the article “Deep learning for edge computing applications: A state-of-the-art survey,” by Wang *et al.*, the authors provide a comprehensive survey of the latest efforts on deep-learning-enabled edge computing applications, and particularly offer insights on how to leverage advances in deep learning to facilitate edge applications from four domains. The authors suggest that the convergence of edge computing and deep learning will bring new possibilities to both interdisciplinary research and industrial applications.

The article “An overview on edge computing research,” by Cao *et al.*, reviews the related research on edge computing. It systematically introduces the edge computing model from the aspects of basic concepts, architecture, key technologies, and security and privacy protection, and summarizes the applications of edge computing.

The article by Chabbouh *et al.*, entitled “Novel cloud-RRH architecture with radio resource management and QoS strategies for 5G HetNets,” proposes a cloud radio access network problem in fifth-generation (5G) heterogeneous networks (HetNets) architecture, using extra computing and storage resources in network edges to improve the QoS of mobile users and energy efficiency. The authors further consider two challenges, then study a two-stage remote radio-head

clustering mechanism, as well a cost-based scheduling scheme. Simulation results highlight superior performance.

In the second group of articles, “Multivariate seawater quality prediction based on PCA-RVM supported by edge computing towards smart ocean,” by Sun *et al.*, develops a hybrid multivariate prediction model for seawater quality assessment in an edge computing environment, considering the combination of principal component analysis (PCA) and relevance vector machine (RVM). Moreover, the case on real-world multivariate seawater data processing is implemented to evaluate the prediction ability and time consumption of the model.

“Intelligent search and find system for robotic platform based on smart edge computing service,” by Barnawi *et al.*, proposes a heterogeneous robotic system to facilitate the development of advanced robotic applications with minimal human interactions. Concretely, they introduce traversal and task division algorithms to support robots performing tasks in both near field and real time, contributing to intelligent search-and-find as an edge service.

“An intelligent path planning scheme of autonomous vehicles platoon using deep reinforcement learning on network edge,” by Chen *et al.*, integrates edge computing and platoon computing, and considers the task deadline and fuel consumption of each vehicle in the representative driving pattern of autonomous vehicles. A case study of the proposed solution is presented, and the fuel consumption of vehicle platoons is quantified while guaranteeing task deadlines.

“An effective training scheme for deep neural network in edge computing enabled internet of medical things (IoMTs) systems,” by Pustokhina *et al.*, presents a new effective training scheme to facilitate timely data collection and processing to make timely decisions using the patterns that exist in the data. The model incorporates a hybrid modified water wave optimization (HMWWO) algorithm for tuning the parameters of a deep neural network structure, and incorporates the ability to search a high-dimensional space and the competence in the discovery of new probable candidate solutions.

In the third group, the article by Sun *et al.*, titled “Edge computing in Internet of Things: A novel sensing-data reconstruction algorithm under intelligent-migration strategy,” proposes a novel sensing-data reconstruction algorithm under intelligent-migration strategy (RdS-ImS). RdS-ImS can yield a data packet loss predictive model based on the compressed sensing theory, thus preventing data losses by finding alternative paths for uploading sensing data to the cloud.

In the article “Points-of-interest recommendation algorithm based on LBSN in edge computing environment,” by Cao *et al.*, the authors investigate how to accurately obtain users’ places of interest based on location recommendations in location-based social networks (LBSNs). Using the Friendship Bayesian Personalized Ranking matrix decomposition framework to analyze the users’ personal preference function in the edge server, the authors propose to embed the geographic information into the framework to get the candidates’ points of interest.

The article by Guo *et al.*, titled “Intelligent and ubiquitous positioning framework in 5G edge computing scenarios,” proposes a 5G positioning simulation scheme to cater to this requirement. The implementation of such a simulation experiment includes scene generation, signal propagation simulation, and position estimation.

In the article “A power-efficient optimizing framework FPGA accelerator based on winograd for YOLO,” by Bao *et al.*, the authors propose to convert multiplication operations to addition operations in field-programmable gate arrays (FPGAs), thereby reducing the computational complexity of deep learning models.

In the article “Lightweight online profiling-based configuration adaptation for video analytics system in edge computing,” by Kim *et al.*, the authors design a video analytics system to adapt configurations for optimizing the resource-accuracy tradeoffs of multiple video streams with respect to frame rate and resolution under the constraint of limited resource capacity of a graphical processing unit (GPU)-enabled edge server, by utilizing the underlying characteristics of the video objects. The above two articles exploit efficient deep learning acceleration.

In conclusion, we 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 would also like to acknowledge the guidance from the IEEE ACCESS Editor-in-Chief, Editorial Board, and Editorial Staff.

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