Guest Editorial: Special Section on End–Edge–Cloud Orchestrated Algorithms, Systems and Applications

SENDING data to cloud for analysis was a prominent trend during the past decades, driving cloud computing as a dominant computing paradigm. However, the dramatically increasing devices and data traffic in the Internet-of-Things (IoT) era are posing significant burdens on the capacity-limited Internet and uncontrollable service delay. It becomes difficult, especially in the industrial process, to meet the delay-sensitive and context-aware service requirements of applications by using cloud computing alone. Facing these challenges, computing paradigms are shifting from the centralized cloud computing to distributed edge computing. Several new computing paradigms, including Mobile Edge Computing, Fog Computing, and Cloudlet, have emerged to leverage the distributed resources at the network edge to enable timely and context-aware services, providing a complement for cloud computing to make it only responsible for delay nonsensitive, resource-intensive, or computationally complex tasks. By integrating end devices, edge servers, and the cloud, one trend from both academia and industry toward the end–edge–cloud orchestrated architecture aims at well exploiting the differentiated capabilities of heterogeneous devices/facilities to meet the different service requirements.

However, the newly emerged hierarchical architecture also faces significant challenges caused by the orchestration of the end, edge, and cloud resources. Due to the differentiated capabilities of end devices, edge servers, and the cloud, the design of computation offloading, network resource allocation, and multilayered caching strategies should jointly consider the priorities and requirements of tasks, available resources of heterogeneous devices, as well as the stochastic and distributed network computing environment, leading to great challenges on the performance optimization of IoT systems. Moreover, since most of the existing machine learning and big data analysis algorithms are proposed for centralized computing, tailored solutions should be carefully studied for the hierarchical architecture to enable timely intelligent services and data analytics for IoT applications by redesigning the traditional algorithms and distributing them on different layers. These open challenges have attracted increasing research attentions on developing end–edge–cloud orchestrated systems aiming at enhancing the performance of IoT systems.

This Special Section (SS) aims at providing a platform for sharing the state-of-the-art research and development on end–edge–cloud orchestration and publishing original research and peer-reviewed articles targeted to all readers of the IEEE TRANSACTIONS ON INDUSTRIAL INFORMATICS. The content of the Special Issue focuses on several topics that are recently concerned in the community, including the architectures and implementations, communication and networking protocols, computation offloading strategies, advanced machine learning and data analytical methods, performance modeling and optimization, and other enabling technologies for end–edge–cloud orchestrated systems and its industrial applications.

We received nearly 50 submitted manuscripts for this SS, reflecting the importance of the SS theme in industrial informatics. Each submission went through a rigorous peer-review process done by at least three or four reviewers and was followed by another round of review after revision. Finally, only seven articles have been accepted. We summarize the accepted articles in this editorial as follows.

The end–edge–cloud orchestrated systems provide an opportunity of computation offloading. The first article entitled "Bidirectional prediction based underwater data collection protocol for end–edge–cloud orchestrated system" designs a data collection protocol with mobile edge elements (AUV). With this protocol, computing paradigms are shifted from centralized cloud to distributed edge, and the differentiated capability of heterogeneous devices is exploited. The authors, in the second article entitled "A Code-oriented partitioning computation offloading strategy for multiple users and multiple mobile edge computing servers," work on code-oriented partitioning computation offloading strategy for multiple user equipment (UE) and multiple mobile edge computing (MEC) servers with limited resources. They aim to develop an offloading strategy to decide the execution location, CPU frequency, and transmission power for UE while minimizing the execution overhead (i.e., a weighted sum of energy consumption and computational time) of UE's applications. The third article entitled "Energy-efficient multi-task multi-access computation offloading via NOMA transmission for IoTs" investigates an energy-efficient multitask MED design via NOMA. Using NOMA, multiple tasks can be offloaded to different ESs simultaneously. The authors solved this problem via a two-step approach. Specifically, they first considered a given task-ES assignment and formulate a joint optimization of

Digital Object Identifier 10.1109/TII.2020.2969315

the tasks' computation-offloading, local computation-resource allocation, and the NOMA-transmission duration, with the objective of minimizing the ST's total energy consumption for completing all tasks. Next, based on the offloading solution for the given task-ES assignment, they assigned different tasks to the ESs for further minimizing the ST's total energy consumption.

The behavior of heterogeneous devices in end–edge–cloud orchestrated systems is of interest. The fourth article entitled "PTASIM: Incentivizing crowd sensing with POI-tagging cooperation over edge clouds" focuses on the incentive mechanism in MEC, which exploits the hybrid platform cooperation for efficient cost reduction and effective participants recruitment. The authors model the interactions of PTASIM as the three-stage decision process to optimize their strategies and maximize total social warfare. The fifth article entitled "A truthful online mechanism for collaborative computation offloading in mobile edge computing" studies collaborative computation offloading in MEC. The authors model the task scheduling problem as an NP-hard social welfare maximization problem and first devise an offline optimal mechanism as a performance benchmark. Then, the authors further propose an online mechanism without leveraging the future information, which not only schedules tasks and computes payments in polynomial time without the future information, but also optimizes long-term social welfare in a near-optimal way.

The sixth article entitled "On-demand transmission for edge-assisted remote control in industrial network systems" presents an edge-assisted remote control architecture for the industrial network system, which integrates the control performance together with the information transmission of measurements and estimates. To respond to video queries with low latency at the edge, a dynamic edge-configuration algorithm has been developed in the seventh article entitled "Edge coordinated query configuration for low-latency and accurate video analytics." It is designed to adjust the quality of generated video frames at the end cameras, as well as the allocated edge resources for each video query. Theoretical analysis demonstrated that the proposed algorithm achieves near-optimal utility while satisfying the latency requirements. The performance has been further validated by extensive simulation results.

The guest editors would like to thank all the authors who submitted their valuable contributions and anonymous reviewers who took part in the review process. Also, they would like to extend their sincere thanks to the Editor-in-Chief of the IEEE TRANSACTIONS ON INDUSTRIAL INFORMATICS, Prof. R. Luo, for providing this opportunity to organize this SS and the editorial staff of the IEEE TRANSACTIONS ON INDUSTRIAL INFORMATICS for their continuous support during the preparation of the SS.

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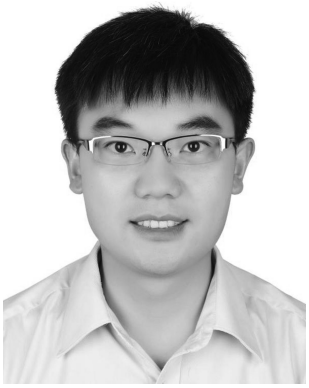

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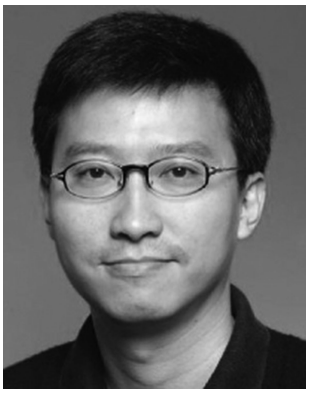

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