Editorial for the Special Section on Energy-Efficient Edge Computing

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The future increase in the amount of data and workloads generated by Internet of Things (IoT) devices and connected sensors will lead to the necessity to move computational nodes from the cloud data centers closer to the data source, i.e., at the edge of the cloud, for reduced latency. An edge system is composed of any computing and networking resources along the path between data sources and cloud data centers. Depending on the specific computing needs, edge computing devices can use either a wireless or a wired connection to exchange messages with the data sources. IoT devices and sensors can then exploit the hierarchical structure of the edge and cloud system to analyze the collected data and provide useful information to users in a timely manner. For example, wearable sensors could use the computing resources of the user's smartphone, laptop, or even smart vehicle to analyze the collected data. Because a large majority of edge devices are battery operated and have limited connectivity, the energy efficiency of computation becomes critical. To this end, it is important to minimize the energy consumption of all the components of an edge system, including sensors, IoT devices, edge nodes, and network devices while guaranteeing the desired performance.

For this special section we selected eight articles that cover experimental, conceptual, and theoretical contributions to energy-efficient edge computing.

Zeng *et al.* [1] propose an effective object detection method based on the few-shot learning, which could achieve considerable performance and energy-efficiency with few data for new classes. Their proposed object detection method alleviates the impact of scale variation in the support set under few-shot settings. They show experimentally that their method is superior to the existing few-shot object detection methods.

Vitello *et al.* [2] address the problem of optimally placing the edge data centers in urban environments. The objective is to minimize outages while guaranteeing energy-efficiency. Their proposed approach takes into account the mobility of users and their spatial patterns to estimate the optimal placement of edge data centers. They propose three heuristics to solve the placement problem and investigate their performance in large-scale realistic urban environments by simulation.

Shekarisaz *et al.* [3] investigate the problem of improving the energy-efficiency of the memory subsystem in multi-core edge devices with hybrid scratchpad memory (e.g., composed of non-volatile memory and SRAM). They model the hybrid scratchpad memory allocation problem as an integer linear program with the objective to minimize the energy consumption of the memory subsystem. They propose a task mapping, task scheduling, and dynamic scratchpad memory allocation scheme, called MASTER, that minimizes the energy consumption of the memory system.

Aral *et al.* [4] propose ARES, a two-stage optimization algorithm for sustainable and reliable deployment of edge nodes in urban environments. ARES identifies an initial set of Pareto-optimal candidate solutions with respect to transmission time and energy, and then, it uses a dynamic Bayesian network-based reliability model to obtain a solution that guarantees the desired level of reliability.

Kumar *et al.* [5] study how to handle the limited computing, storage, energy, and network bandwidth capabilities of edge-enabled IoT devices for video surveillance. They propose an object identification scheme with two components: YLLO and BATS. YLLO exploits the cross-frame redundancy from the video stream of an IoT device to reduce the computational needs of video processing. BATS exploits the cross-devices frame redundancies to adapt the frame transmission rate to the edge according to the bandwidth availability.

Kumari *et al.* [6] focus on the problem of collecting and transmitting energy readings from user appliances to the energy operator using a LoRa network. They propose a deep-learning based compression-decompression model that reduces the size of the data to be transmitted by the LoRa node to the gateway and cloud. They also propose an algorithm that decides the compression size for minimized compression time and energy. Finally, they propose an algorithm to select the most suitable spreading factor for data transmission that balances the energy consumption of the nodes.

Cao and Madria [7] tackle the problem of redundant data transmissions in Mobile Edge Networks by proposing a spatial data collection scheme that achieves low latency and low overhead. Specifically, they propose a scheme that only gathers data from the IoT devices along a trajectory. In order to avoid privacy concerns due to location leaking during data transmissions, the authors propose a virtual coordinate system called *distance vector of hops to anchors*, which exploits

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Digital Object Identifier no. 10.1109/TSUSC.2022.3176986

ellipse and hyperbola constraints to encode the position of interest and the trajectory to it.

Xu *et al.* [8] design a dynamic service pricing strategy to optimize the payoffs of both users and fog service providers. They observe that while the geo-distributed users mostly care about performance/cost, the fog service provider is mainly concerned about maximizing profits and cover the heterogeneous operational costs in different user locations. The fog pricing is regarded as a two-stage Stackelberg competition model and it is formulated as a dual-objective payoff optimization problem by finding the subgame Nash equilibrium.

The guest editors would like to thank Prof. Albert Zomaya (Editor-In-Chief, IEEE Transactions on Sustainable Computing) for his help in putting together this special section. The guest editors are very grateful to the reviewers for their high-quality reviews and constructive feedback on the papers.

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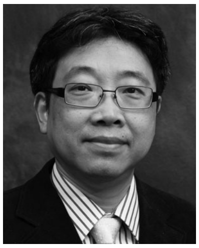

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