Guest Editorial: Special Issue on AI-Enabled Internet of Dependable and Controllable Things

AI/MACHINE learning has demonstrated significant success in transforming massive and complex data sets into highly accurate knowledge as outcomes, greatly facilitating analysis, intelligence, decision making, and automation across a number of diverse systems. Through integration with advances in data processing, computing, and networking technologies, AI/machine learning is capable of providing a viable means for carrying out big modeling and intelligence and has achieved significant success in a number of fields. However, in order to achieve an AI-enabled Internet of Dependable and Controllable Things, AI/machine learning in Internet-of-Things (IoT) systems must overcome significant challenges and exceptional requirements for connectivity, latency, scalability, accessibility, security, and resiliency that IoT systems pose. Thus, the seamless integration of AI/machine learning into IoT systems creates tremendous opportunities for new research and necessitates interdisciplinary efforts to address these challenges.

For this special issue, we solicited papers that cover numerous topics of interests and selected papers focusing on state-of-the-art research and addressing challenges concerning the foundations and applications of synergizing AI/machine learning in IoT systems. We received a total of 87 submissions, and, after a rigorous peer review process, 24 papers were accepted.

The article titled "SDN-enabled adaptive and reliable communication in IoT-fog environment using machine learning and multiobjective optimization" addresses the performance issues of SDN-enabled multihop communication relevant to IoT-fog environments. A machine-learning-based scheme is proposed to identify reliable communication links, and trade-offs between communication reliability and latency are studied. The results demonstrate the efficacy of the proposed scheme with respect to latency and packet loss.

The article titled "Deep multiagent reinforcement-learning-based resource allocation for Internet of Controllable Things" addresses the power resource allocation problem for IoT by using deep reinforcement learning techniques. The subcarrier–power allocation problem is formalized as a Markov decision process and a double deep Q-network (DQN)-based algorithm is designed to learn the optimal policy, leading to the effective allocation of subcarrier–power.

The article titled "CDDPG: A deep-reinforcement-learning-based approach for electric vehicle charging control" proposes a deep reinforcement-learning-based approach with multiple strategies: a long short-term memory (LSTM) network to determine the strategy for charging control, replay buffers to deal with sparse rewards, and others. The developed approach is capable of satisfying the user's requirements for the battery energy and charging cost reduction.

The article titled "Realizing the heterogeneity: A self-organized federated learning framework for IoT" addresses the issues of federated learning in heterogeneous IoT environments that brings a large amount of noisy data, which reduces the accuracy of learning models and increases federated learning convergence time. This problem is addressed by utilizing a reinforcement learning method to identify clients with the same training target. The proposed scheme can improve the performance of federated learning clients with the same training target in a heterogeneous IoT environment.

The article titled "RFID reader anticollision based on distributed parallel particle swarm optimization" addresses the problem of collisions when a large number of RFID readers are deployed and proposes a distributed parallel cooperative co-evolution approach to produce a complex optimization for collision prevention. The developed approach can be used to improve the performance of RFID systems.

The article titled "Reinforcement-learning-enabled partial confident information coverage for IoT-based bridge structural health monitoring" presents an energy-efficient scheduling approach for sensors that are deployed to monitor the health of bridge structures. The learning automata model is leveraged to learn the optimal scheduling strategy for sensors. The designed approach integrates edge computing and machine learning to increase the network lifetime.

The article titled "ISOF: Information scheduling and optimization framework for improving the performance of agriculture systems aided by Industry 4.0" proposes an information scheduling and optimization framework to optimize the communication and information layer processes toward the reduction of process latency and stagnation. The benefit of this framework lies in its integration of IoT with edge computing.

The article titled "IHSF: An intelligent solution for improved performance of reliable and time-sensitive flows in hybrid SDN-based FC IoT systems" addresses the performance issues of SDN-based fog computing IoT systems and proposes an approach with several strategies: an algorithm to deploy SDN switches so that network observability can be improved, a regression learning algorithm to predict

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the reliability of network links, as well as a deep deterministic policy gradient algorithm to compute the forwarding paths of time-critical traffic flows. Extensive evaluation results confirm the efficacy of the proposed solution.

The article titled "Deep-reinforcement-learning-based proportional fair scheduling control scheme for underlay D2D communication" proposes a joint framework to optimize fair resource and power control for deep reinforcement-learning-based underlay device-to-device (D2D) communication in the IoT environment. The proposed framework includes a multiagent DQN to solve the resource allocation problem, a combined DQN and deep deterministic policy gradient scheme (DDPG) to enhance the fairness of the scheme, and an optimization scheme to control the power of both cellular users equipment (CUEs) and D2D devices.

The article titled "AIT: An AI-enabled trust management system for vehicular networks using blockchain technology" addresses the security and trustworthiness of vehicular networks by proposing AIT. Extensive performance evaluation results confirm the efficacy of AIT in terms of managing the trust of vehicles and detecting malicious vehicles in an accurate and efficient manner.

The article titled "An efficient deep learning framework for intelligent energy management in IoT networks" proposes a deep learning framework that can be used to provide intelligent energy management service. A machine-learning-based decision-making algorithm is designed to carry out short-term forecasting on resource-constrained devices. The evaluation results demonstrate the efficacy of the proposed framework in smart energy systems.

The article titled "Toward secure and efficient deep learning inference in dependable IoT systems" proposes a new approach called SUPER-IoT to enhance the security and efficiency of AI applications in IoT systems. The proposed approach leverages mechanisms (pixel dropping, pixel reconstruction, and image denoising) to defeat adversarial samples in deep neural networks (DNNs) and maintain good performance for normal samples.

The article titled "Combining pose invariant and discriminative features for vehicle reidentification" proposes to learn pose robust features and address the pose barrier problem in vehicle reidentification. The proposed framework containing two complementary post robust features: one is used to solve the vehicle reidentification task by introducing adversarial loss, and the other mines the local details by training an identity classifier and an orientation classifier together.

The article titled "HUNA: A method of hierarchical unsupervised network alignment for IoT" proposes a new deep learning approach to identify similar IoT devices under different networks. A bidirectional cycle structure is integrated to address state oscillation and instability issues. Furthermore, to optimize the alignment of network entities, a group structure aggregation optimization module is developed.

The article titled "Block-sparse coding-based machine learning approach for dependable device-free localization in IoT environment" presents a block-sparse scheme with a group structure of signals, aiming to achieve accurate and robust device-free localization in IoT environment. A severe Gaussian noise is added in the original received signals to degrade the signal-to-noise ratio and dealing with privacy concerns. The proposed approach shows highly robust signal-recovery performance in locating targets.

The article titled "Dynamic Bayesian collective awareness models for network of ego-things" proposes to learn collective awareness models from low-dimensional data sequences of a network with intelligent entities in IoT. A set of switching dynamic Bayesian network (DBN) models is used for each networked entity to carry out a synchronous estimation of possible abnormalities in a joint task. Furthermore, the robustness of the models in achieving distributed abnormality detection is investigated in a realistic communication channel model.

The article titled "CorrAUC: A malicious Bot-IoT traffic detection method in IoT network using machine-learning techniques" addresses the problem of detecting malicious Bot-IoT traffic and proposes a new feature selection scheme to find effective features for accurate malicious traffic detection in IoT. The efficacy of the scheme is demonstrated using a Bot-IoT data set and various machine learning algorithms.

The article titled "On designing a lesser obtrusive authentication protocol to prevent machine-learning-based threats in Internet of Things" proposes an authentication protocol to both prevent machine-learning-based threats in IoT and be more useful than other schemes.

The article titled "Caching in dynamic IoT networks by deep reinforcement learning" investigates the content placement problem, which determines data to be cached at each time epoch in dynamic IoT networks with the objective of minimizing the average data transmission delay constrained by the cache storage capacity and IoT data freshness. To solve the problem, a deep reinforcement learning algorithm is proposed.

The article titled "Privacy-preserving collaborative learning for multiarmed bandits in IoT" proposes a local differential privacy framework for the known decentralized collaborative learning algorithm for the fundamental multiarmed bandits problem. Both rigorous analysis and extensive experiments are provided to demonstrate its efficacy.

The article titled "Secure cloud-aided object recognition on hyperspectral remote sensing images" proposes a secure and efficient outsourcing algorithm for object recognition that enables resource-constrained IoT devices to delegate time-consuming learning-based object recognition to a powerful cloud server. The efficacy of the proposed algorithm is validated through both theoretical analysis and experiments.

The article titled "Low-latency privacy-preserving outsourcing of deep neural network inference" proposes an edge-computing-assisted framework to boost the efficiency of DNN inference tasks on IoT devices, which also protects the privacy of IoT data to be outsourced. The efficacy of the proposed framework is validated through analysis and experiments.

The article titled "PoisonGAN: Generative poisoning attacks against federated learning in edge computing systems" addresses one of the most critical poisoning attacks in a federated learning framework. The research first shows that it is feasible for adversaries to recover the data set of victims

in federated learning via the generative adversarial model. The attack methods are then further generalized into a model, called PoisonGAN. The evaluation results confirm the feasibility of the attack. This study raises a valuable alarm for security in federated learning IoT systems.

The article titled "Ensemble meteorological cloud classification meets Internet of Dependable and Controllable Things" proposes an ensemble learning method and resource allocation scheme to realize cloud observation and classification with the assistance of reliable and controllable infrastructures, achieving more accurate predictions and lower error rates than existing approaches.

We are very grateful to all the authors for their valuable contributions to this special issue, and to all the reviewers for volunteering their efforts on providing rigorous and timely reviews. We would like to give our special thanks to Dr. Honggang Wang, the Editor-in-Chief of IEEE INTERNET OF THINGS JOURNAL, for his help in the review and publication process. We expect that this special issue can greatly help research communities to have a better understanding of the recent advances and research directions on the AI-enabled Internet of Dependable and Controllable Things.

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