Series Editorial
The Sixth Issue of the Series on Machine Learning in Communications and Networks

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I. Introduction

THE fourth (and final) call for papers of the Series on Machine Learning in Communications and Networks has continued to receive a great number of high-quality papers covering various aspects of intelligent communications. In addition to those published in the August issue, we include in this issue 16 articles submitted to the call. In the following, we provide a brief review of these articles according to their topics.

In total, this series has received more than 400 original submissions, all of which have gone through a rigorous review process. The accepted articles have been published in six issues, i.e., January, July, and August issues of 2021, and January, August, and September issues of 2022.

II. Signal Processing

This issue consists of four articles that address various problems in signal processing using machine learning. In [A1], Kang *et al.* propose an end-to-end mixed-timescale deep-unfolding neural network-based joint channel estimation and hybrid beamforming algorithm to maximize the system sum rate of massive multiple-input multiple-output (MIMO) systems. The recursive least-squares algorithm is unfolded for channel estimation, and the stochastic successive convex approximation algorithm is unfolded for hybrid beamforming. The developed algorithm significantly outperforms conventional algorithms with reduced computational complexity. In [A2], Lauinger *et al.* generalize the concept of variational autoencoder (VAE) equalizers to higher order modulation formats. Then, a model-based equalizer based on a linear butterfly filter is proposed and the filter coefficients are trained using the variational inference paradigm. In [A3], Kosasih *et al.* develop a graph neural network-based framework to adjust the message passing detectors' cavity distributions to improve the posterior distribution approximation. In addition, the GEPNet detector is proposed to maximize detection performance and the GPICNet detector is proposed to balance the performance and complexity. In [A4], Zhong *et al.* investigate a simultaneous transmitting and reflecting reconfigurable intelligent surface (STAR-RIS) assisted multi-user downlink multiple-input single-output (MISO) communication system. In contrast to the existing ideal STAR-RIS model assuming an independent transmission and reflection phase-shift control, a practical coupled phase-shift model is considered and the problem is solved using hybrid reinforcement learning methods.

III. Learn to Transmit and Semantic Communications

There are three articles in the category of learn to transmit and semantic communications. In [A5], Tung and Gündüz develop an end-to-end scheme, named DeepWive, to convert videos to symbols directly by adopting a single neural network. Moreover, the scheme is trained with different bandwidth allocation for adaptive bandwidth transmission. The experimental results show that the developed DeepWive outperforms traditional methods for video transmission. In [A6], Xie *et al.* investigate deep-learning-based multi-user semantic communication transmitting single-modal data and multimodal data, respectively, and propose a transformer-based unique framework to unify the structure of transmitters for different tasks. The numerical results show that the proposed models are superior to traditional communications in terms of the robustness to channels, computational complexity, transmission delay, etc. In [A7], Wang *et al.* propose a semantic

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communication framework that enables a base station to transmit the meaning of textual data to its associated users. The resource allocation and semantic information transmission are optimized to improve the performance of semantic-enabled wireless networks. The article utilizes a proximal policy optimization-based reinforcement learning algorithm, integrated with an attention network, to optimize the policy for resource block allocation and semantic information selection.

IV. Resource Management and Network Optimization

We have four articles in this issue that deal with resource management and network optimization using machine learning techniques. In [A8], Feriani *et al.* propose a multi-objective reinforcement learning framework for load balancing in multi-band downlink cellular networks. Moreover, a policy distillation technique is introduced to enhance the generalization to new objective trade-offs. In [A9], Xia *et al.* use two unmanned automated aerial vehicles (UAVs), with accelerated motions and fixed altitudes, to realize a wireless edge network, where one UAV forwards downlink signals to user terminals distributed over an area while the other one collects uplink data. The authors develop a novel multi-agent Q-Learning algorithm to maximize the energy efficiency, by optimizing the trajectory and transmit power of the UAVs. In [A10], Cong *et al.* propose a lightweight router with small storage requirement while still retaining communication connection performance by using an AI-based Routing entry prediction strategy and a block-based entry insertion tactic. The experimental results based on real backbone traffic show that the lightweight scheme achieves comparable performance compared to the traditional schemes using only 1/8 storage. In [A11], Ye *et al.* consider traffic engineering in networks with growing sizes. To reduce the high time complexity while achieving good network performance simultaneously, they propose a novel destination-based traffic engineering solution called FlexEntry, which leverages emerging reinforcement learning. The presented results on six real-world network topologies demonstrate the effectiveness of FlexEntry and its generalization ability to unseen traffic matrices with near-optimal load balancing performance.

V. Distributed/Federated Learning and Communications

Two articles in this issue study distributed or federated learning in communications and networks. In [A12], Yan *et al.* study the communication-efficient distributed learning problem considering both gradient quantization and sparsification. They identify the joint impact of the sparsification and quantization parameters on the compression error so that one can choose the optimal parameters under a given compression constraint. In particular, the authors propose a strategy, termed Adaptively Compressed Stochastic Gradient Descent (AC-SGD), to adjust the number of quantization bits and the sparsification size. In [A13], Elkordy *et al.* propose a fast and Byzantine-robust learning algorithm for decentralized model training over a logical ring. The theoretical linear convergence rate is established for the proposed algorithm in i.i.d. dataset setting, followed by empirically demonstrating the robustness to various Byzantine attacks and non-i.i.d. dataset settings. To reduce overall latency, a Byzantine-robust parallel algorithm is further proposed to enable training across groups of logical rings.

VI. Selected Topics

We have three articles in this issue using machine learning to deal with channel prediction, user activity inference, and anomaly detection in wireless networks, respectively. In [A14], Jiang *et al.* propose a transformer-based parallel channel prediction scheme to predict future channels in parallel. A pilot-to-precoder prediction scheme is further developed that incorporates the transformer-based parallel channel prediction as well as pilot-based channel estimation and precoding to reduce the signal processing complexity. In [A15], Xue *et al.* study the problem of inferring user activity patterns from a sequence of device events by first extracting a small number of representative user activity patterns from the sequence of device events, and then applying unsupervised learning to compute an optimal subset of these user activity patterns to infer user activities. The scheme is shown resilient to device malfunctions and transient failures and delays, and outperforms the state-of-the-art solution. In [A16], Li *et al.* consider detecting anomalies in multivariate time series (MTS) monitoring metrics with the awareness of different application scenarios. To take advantage of the out-of-band information, the authors propose an MTS anomaly detection algorithm through active learning and contrast VAE-based detection models, which simultaneously learns MTS data's normal and anomalous patterns for anomaly detection.

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We would also like to acknowledge our series editorial board for their diligent work during the review and decision process. The editorial board of our Series is as follows.

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Finally, we wish the contents of our Series will inspire the readers to investigate the challenging and open problems in the field of machine learning in communications and networking. This is the final issue of the Series, but our effort to publish high-quality research in this area will not stop. We are pleased to announce that a new journal, IEEE TRANSACTIONS ON MACHINE LEARNING IN COMMUNICATIONS AND NETWORKING, will be established soon, dedicated to promoting cross-disciplinary research in the intersection of machine learning and communications and networking.

APPENDIX: RELATED ARTICLES

[A1] K. Kang, Q. Hu, Y. Cai, G. Yu, J. Hoydis, and Y. C. Eldar, "Mixed-timescale deep-unfolding for joint channel estimation and hybrid beamforming," *IEEE J. Sel. Areas Commun.*, early access, Jul. 15, 2022, doi: 10.1109/JSAC.2022.3191124.

[A2] V. Lauinger, F. Buchali, and L. Schmalen, "Blind equalization and channel estimation in coherent optical communications using variational autoencoders," *IEEE J. Sel. Areas Commun.*, early access, Jul. 18, 2022, doi: 10.1109/JSAC.2022.3191346.

[A3] A. Kosasih, V. Onasis, V. Miloslavskaya, W. Hardjawana, V. Andrean, and B. Vucetic, "Graph neural network aided MU-MIMO detectors," *IEEE J. Sel. Areas Commun.*, early access, Jul. 18, 2022, doi: 10.1109/JSAC.2022.3191344.

[A4] R. Zhong, Y. Liu, X. Mu, Y. Chen, X. Wang, and L. Hanzo, "Hybrid reinforcement learning for STAR-RISs: A coupled phase-shift model based beamformer," *IEEE J. Sel. Areas Commun.*, early access, Jul. 25, 2022, doi: 10.1109/JSAC.2022.3192053.

[A5] T.-Y. Tung and D. Gündüz, "DeepWiVe: Deep-learning-aided wireless video transmission," *IEEE J. Sel. Areas Commun.*, early access, Jul. 22, 2022, doi: 10.1109/JSAC.2022.3191354.

[A6] H. Xie, Z. Qin, X. Tao, and K. B. Letaief, "Task-oriented multi-user semantic communications," *IEEE J. Sel. Areas Commun.*, early access, Jul. 15, 2022, doi: 10.1109/JSAC.2022.3191326.

[A7] Y. Wang, M. Chen, W. Saad, T. Luo, S. Cui, and H. V. Poor, "Performance optimization for semantic communications: An attention-based learning approach," *IEEE J. Sel. Areas Commun.*, early access, Jul. 18, 2022, doi: 10.1109/JSAC.2022.3191112.

[A8] A. Feriani *et al.*, "Multi-objective load balancing for multiband downlink cellular networks: A meta-reinforcement learning approach," *IEEE J. Sel. Areas Commun.*, early access, Aug. 11, 2022, doi: 10.1109/JSAC.2022.3191114.

[A9] W. Xia, Y. Zhu, L. De Simone, A. Dagiuklas, K.-K. Wong, and G. Zhen, "Multiagent collaborative learning for UAV enabled wireless networks," *IEEE J. Sel. Areas Commun.*, early access, Jul. 15, 2022, doi: 10.1109/JSAC.2022.3191329.

[A10] P. Cong, Y. Zhang, B. Liu, W. Wang, Z. Xiong, and K. Xu, "A&B: AI and block-based TCAM entries replacement scheme for routers," *IEEE J. Sel. Areas Commun.*, early access, Jul. 18, 2022, doi: 10.1109/JSAC.2022.3191351.

[A11] M. Ye, Y. Hu, J. Zhang, Z. Guo, and H. J. Chao, "Mitigating routing update overhead for traffic engineering by combining destination-based routing with reinforcement learning," *IEEE J. Sel. Areas Commun.*, early access, Jul. 15, 2022, doi: 10.1109/JSAC.2022.3191337.

[A12] G. Yan, T. Li, S.-L. Huang, T. Lan, and L. Song, "AC-SGD: Adaptively compressed SGD for communication-efficient distributed learning," *IEEE J. Sel. Areas Commun.*, early access, Jul. 20, 2022, doi: 10.1109/JSAC.2022.3192050.

[A13] A. R. Elkordy, S. Prakash, and S. Avestimehr, "Basil: A fast and Byzantine-resilient approach for decentralized training," *IEEE J. Sel. Areas Commun.*, early access, Jul. 15, 2022, doi: 10.1109/JSAC.2022.3191347.

[A14] H. Jiang, M. Cui, D. W. K. Ng, and L. Dai, "Accurate channel prediction based on transformer: Making mobility negligible," *IEEE J. Sel. Areas Commun.*, early access, Jul. 19, 2022, doi: 10.1109/JSAC.2022.3191334.

[A15] G. Xue, Y. Wan, X. Lin, K. Xu, and F. Wang, "An effective machine learning based algorithm for inferring user activities from IoT device events," *IEEE J. Sel. Areas Commun.*, early access, Jul. 20, 2022, doi: 10.1109/JSAC.2022.3191123.

[A16] Z. Li *et al.*, "Situation-aware multivariate time series anomaly detection through active learning and contrast VAE-based models in large distributed systems," *IEEE J. Sel. Areas Commun.*, early access, Jul. 29, 2022, doi: 10.1109/JSAC.2022.3191341.