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Machine learning and deep learning methods for wireless network applications

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Wireless networks have been widely adopted and introduced in the areas of engineering, manufacturing, weather monitoring, transportation, etc., to collect data to improve the quality of decision making, but issues arise, such as large volumes of data, incomplete and incompatible data sets, and noise data that prevent from realizing the true value and exploiting their full potentials. Machine learning and deep learning methods have been used as powerful tools to perform feature detection/extraction and trend estimation/forecasting in wireless networks applications. Supervised machine learning methods, for example, neural network (NN) [1, 2], convolutional neural network (CNN) [3], and recurrent neural network (RNN) [4], can be exploited in the applications pertinent to prediction and classification, whereas unsupervised machine learning methods such as restricted Boltzmann machine (RBM), deep belief network (DBN), deep Boltzmann machine (DBM), auto-encoder (AE), and denoising auto-encoder (DAE) [5] can be utilized for data denoising and model generalization. Furthermore, the reinforcement learning methods, including generative adversarial networks (GANs) and deep Q-networks (DQNs) [6], are tools for generative networks and discriminative networks to optimize the contesting process in a zero-sum game framework. These well-developed methods can contribute substantially, to better improve predictions and classifications in the relevant applications, but there are some issues and limitations that require further attention from the research communities.

Topics covered in this issue are categorized into the following six themes: (1) networking optimization, (2) unmanned aerial vehicle (UAV) applications, (3) wireless sensor networks, (4) network security, (5) mobile positioning, and (6) image-based applications. This special issue has collected a total of 24 published papers from the USA, Australia, China, India, Pakistan, South Korea, and Vietnam to ensure that high-quality papers with significant results are selected and published. The accepted papers categorized into the aforementioned eight themes are briefly introduced below.

1 Networking optimization

Four papers on networking optimization are listed as follows: (1) "Decentralized computation offloading for multi-user mobile edge computing: a deep reinforcement learning approach," by Zhao Chen and Xiaodong Wang from China and the USA [7]; (2)

"Network resource optimization with reinforcement learning for low power wide area networks," by Gyubong Park, Wooyeob Lee, and Inwhee Joe from South Korea [8]; (3) "A deep learning-aided temporal spectral ChannelNet for IEEE 802.11p-based channel estimation in vehicular communications," by Xuchen Zhu, Zhichao Sheng, Yong Fang, and Denghong Guo from China [9]; and (4) "A new deep sparse autoencoder for community detection in complex networks," by Rong Fei, Jingyuan Sha, Qingzheng Xu, Bo Hu, Kan Wang, and Shasha Li from China [10]. Detailed information of each article could be found in [7–10].

2 UAV applications

Two papers on UAV applications are listed as follows: (1) "Improving aerial image transmission quality using trajectory-aided OLSR in flying ad hoc networks," by B. Chen Hou, Zhexin Xu, Wen-Kang Jia, Jianyong Cai, and Hui Li from China [11]; (2) "Target tracking algorithm combined part-based and redetection for UAV," by Qiusheng He, Weifeng Zhang, Wei Chen, Gang Xie, and Yanxin Yao from China [12]. Detailed information of each article could be found in [11, 12].

3 Wireless sensor networks

Five papers on wireless sensor networks are listed as follows: (1) "A bi-population QUasi-Affine TRansformation Evolution algorithm for global optimization and its application to dynamic deployment in wireless sensor networks," by Nengxian Liu, Jeng-Shyang Pan, and Trong-The Nguyen from China and Vietnam [13]; (2) "Simplified clustering and improved intercluster cooperation approach for wireless sensor network energy balanced routing," by Yanxin Yao, Wei Chen, Jie Guo, Xiaoyu He, and Ruixuan Li from China [14]; (3) "Using improved support vector regression to predict the transmitted energy consumption data by distributed wireless sensor network," by Ni Guo, Weifeng Gui, Wei Chen, Xin Tian, Weiguo Qiu, Zijian Tian, and Xiangyang Zhang from China [15]; (4) "A signal reconstruction method of wireless sensor network based on compressed sensing," by Shiyu Zhu, Shanxiong Chen, Xihua Peng, Hailing Xiong, and Sheng Wu from China [16]; and (5) "Identifying correctness data scheme for aggregating data in cluster heads of wireless sensor network based on naive Bayes classification," by Shu-Chuan Chu, Thi-Kien Dao, Jeng-Shyang Pan, and Trong-The Nguyen from China and Vietnam [17]. Detailed information of each article could be found in [13–17].

4 Network security

Five papers on network security are listed as follows: (1) "Intrusion detection in internet of things using supervised machine learning based on application and transport layer features using UNSW-NB15 data-set," by Muhammad Ahmad, Qaiser Riaz, Muhammad Zeeshan, Hasan Tahir, Syed Ali Haider, and Muhammad Safeer Khan from Pakistan and the USA [18]; (2) "MSCR: multidimensional secure clustered routing scheme in hierarchical wireless sensor networks," by Weidong Fang, Wuxiong Zhang, Wei Chen, Jin Liu, Yepeng Ni, and Yinxuan Yang from China and Australia [19]; (3) "Analysis framework of network security situational awareness and comparison of implementation methods," by Yan Li, Guang-qiu Huang, Chun-zi Wang, and Ying-chao Li from China [20]; (4) "Digital signature scheme for information non-repudiation in blockchain: a state of the art

review," by Weidong Fang, Wei Chen, Wuxiong Zhang, Jun Pei, Weiwei Gao, and Guohui Wang from China [21]; and (5) "Web intrusion detection system combined with feature analysis and SVM optimization," by Chao Liu, Jing Yang, and Jinqiu Wu from China [22]. Detailed information of each article could be found in [18–22].

5 Mobile positioning

Five papers on mobile positioning are listed as follows: (1) "New three-dimensional positioning algorithm through integrating TDOA and Newton's method," by Junsuo Qu, Haonan Shi, Ning Qiao, Chen Wu, Chang Su, and Abolfazl Razi from China and the USA [23]; (2) "A parallel WOA with two communication strategies applied in DV-Hop localization method," by Qing-wei Chai, Shu-Chuan Chu, Jeng-Shyang Pan, Pei Hu, and Wei-min Zheng from China and the USA [24]; (3) "A fusion optimization algorithm of network element layout for indoor positioning," by Xiao-min Yu, Hui-qiang Wang, Hong-wu Lv, Xiu-bing Liu, and Jin-qiu Wu from China [25]; (4) "A 3D mobile positioning method based on deep learning for hospital applications," by Qingqing Zhang and Yuan Wang from China [26]; and (5) "A method of fingerprint indoor localization based on received signal strength difference by using compressive sensing," by Xiao-min Yu, Hui-qiang Wang, and Jin-qiu Wu from China [27]. Detailed information of each article could be found in [23–27].

6 Image-based applications

Three papers on image-based applications are listed as follows: (1) "Object detection in real time based on improved single shot multi-box detector algorithm," by Ashwani Kumar, Zuopeng Justin Zhang, and Hongbo Lyu from India, the USA, and China [28]; (2) "A hyperspectral image classification algorithm based on atrous convolution," by Xiaoqing Zhang, Yongguo Zheng, Weike Liu, and Zhiyong Wang from China [29]; and (3) "Spatial-spectral hyperspectral image classification based on information measurement and CNN," by Lianlei Lin, Cailu Chen, and Tiejun Xu from China [30]. Detailed information of each article could be found in [28–30].

Author contributions
All authors read and approved the final manuscript.

Declarations

Competing interests
Guest editors declare no competing interests.

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References

1. X. Xue, H. Wang, W. Liu, Matching sensor ontologies with unsupervised neural network with competitive learning. PeerJ Comput. Sci. **7**, e763 (2021). https://doi.org/10.7717/peerj-cs.763
2. C.H. Chen, An arrival time prediction method for bus system. IEEE Internet Things J. **5**(5), 4231–4232 (2018). https://doi.org/10.1109/JIOT.2018.2863555
3. C. Shi, L. Fang, Z. Lv, M. Zhao, Explainable scale distillation for hyperspectral image classification. Pattern Recognit. **122**, 108316 (2022). https://doi.org/10.1016/j.patcog.2021.108316

4. X. Xue, C. Jiang, J. Zhang, C. Hu, Biomedical ontology matching through attention-based bidirectional long short-term memory network. J. Database Manag. **32**(4), 14–27 (2021). https://doi.org/10.4018/JDM.2021100102
5. G. Liu, L. Xie, C.H. Chen, Unsupervised text feature learning via deep variational auto-encoder. Inf. Technol. Control. **49**(3), 421–437 (2020). https://doi.org/10.5755/j01.itc.49.3.25918
6. C. Shi, L. Fang, Z. Lv, H. Shen, Improved generative adversarial networks for VHR remote sensing image classification. IEEE Geosci. Remote. Sens. Lett. **19**, 1–5 (2022). https://doi.org/10.1109/LGRS.2020.3025099
7. Z. Chen, X. Wang, Decentralized computation offloading for multi-user mobile edge computing: a deep reinforcement learning approach. J. Wirel. Com Netw. (2020). https://doi.org/10.1186/s13638-020-01801-6
8. G. Park, W. Lee, I. Joe, Network resource optimization with reinforcement learning for low power wide area networks. J. Wirel. Com. Netw. (2020). https://doi.org/10.1186/s13638-020-01783-5
9. X. Zhu, Z. Sheng, Y. Fang et al., A deep learning-aided temporal spectral ChannelNet for IEEE 802.11p-based channel estimation in vehicular communications. J. Wirel. Com Netw. (2020). https://doi.org/10.1186/s13638-020-01714-4
10. R. Fei, J. Sha, Q. Xu et al., A new deep sparse autoencoder for community detection in complex networks. J. Wirel. Com Netw. (2020). https://doi.org/10.1186/s13638-020-01706-4
11. C. Hou, Z. Xu, W.K. Jia et al., Improving aerial image transmission quality using trajectory-aided OLSR in flying ad hoc networks. J. Wirel. Com Netw. (2020). https://doi.org/10.1186/s13638-020-01707-3
12. Q. He, W. Zhang, W. Chen et al., Target tracking algorithm combined part-based and redetection for UAV. J. Wirel. Com Netw. (2020). https://doi.org/10.1186/s13638-020-01696-3
13. N. Liu, J.S. Pan, T.T. Nguyen, A bi-population QUasi-Affine TRansformation evolution algorithm for global optimization and its application to dynamic deployment in wireless sensor networks. J. Wirel. Com Netw. (2019). https://doi.org/10.1186/s13638-019-1481-6
14. Y. Yao, W. Chen, J. Guo et al., Simplified clustering and improved intercluster cooperation approach for wireless sensor network energy balanced routing. J. Wirel. Com Netw. (2020). https://doi.org/10.1186/s13638-020-01748-8
15. N. Guo, W. Gui, W. Chen et al., Using improved support vector regression to predict the transmitted energy consumption data by distributed wireless sensor network. J. Wirel. Com Netw. (2020). https://doi.org/10.1186/s13638-020-01729-x
16. S. Zhu, S. Chen, X. Peng et al., A signal reconstruction method of wireless sensor network based on compressed sensing. J. Wirel. Com Netw. (2020). https://doi.org/10.1186/s13638-020-01724-2
17. S.C. Chu, T.K. Dao, J.S. Pan et al., Identifying correctness data scheme for aggregating data in cluster heads of wireless sensor network based on naive Bayes classification. J. Wirel. Com Netw. (2020). https://doi.org/10.1186/s13638-020-01671-y
18. M. Ahmad, Q. Riaz, M. Zeeshan et al., Intrusion detection in internet of things using supervised machine learning based on application and transport layer features using UNSW-NB15 data-set. J. Wirel. Com Netw. (2021). https://doi.org/10.1186/s13638-021-01893-8
19. W. Fang, W. Zhang, W. Chen et al., MSCR: multidimensional secure clustered routing scheme in hierarchical wireless sensor networks. J. Wirel. Com Netw. (2021). https://doi.org/10.1186/s13638-020-01884-1
20. Y. Li, G.Q. Huang, C.Z. Wang et al., Analysis framework of network security situational awareness and comparison of implementation methods. J. Wirel. Com Netw. (2019). https://doi.org/10.1186/s13638-019-1506-1
21. W. Fang, W. Chen, W. Zhang et al., Digital signature scheme for information non-repudiation in blockchain: a state of the art review. J. Wirel. Com Netw. (2020). https://doi.org/10.1186/s13638-020-01665-w
22. C. Liu, J. Yang, J. Wu, Web intrusion detection system combined with feature analysis and SVM optimization. J. Wirel. Com Netw. (2020). https://doi.org/10.1186/s13638-019-1591-1
23. J. Qu, H. Shi, N. Qiao et al., New three-dimensional positioning algorithm through integrating TDOA and Newton's method. J. Wirel. Com Netw. (2020). https://doi.org/10.1186/s13638-020-01684-7
24. Q.W. Chai, S.C. Chu, J.S. Pan et al., A parallel WOA with two communication strategies applied in DV-Hop localization method. J. Wirel. Com Netw. (2020). https://doi.org/10.1186/s13638-020-01663-y
25. X.M. Yu, H.Q. Wang, H.W. Lv et al., A fusion optimization algorithm of network element layout for indoor positioning. J. Wirel. Com Netw. (2019). https://doi.org/10.1186/s13638-019-1597-8
26. Q. Zhang, Y. Wang, A 3D mobile positioning method based on deep learning for hospital applications. J. Wirel. Com Netw. (2020). https://doi.org/10.1186/s13638-020-01784-4
27. X.M. Yu, H.Q. Wang, J.Q. Wu, A method of fingerprint indoor localization based on received signal strength difference by using compressive sensing. J. Wirel. Com Netw. (2020). https://doi.org/10.1186/s13638-020-01683-8
28. A. Kumar, Z.J. Zhang, H. Lyu, Object detection in real time based on improved single shot multi-box detector algorithm. J. Wirel. Com Netw. (2020). https://doi.org/10.1186/s13638-020-01826-x
29. X. Zhang, Y. Zheng, W. Liu et al., A hyperspectral image classification algorithm based on atrous convolution. J. Wirel. Com Netw. (2019). https://doi.org/10.1186/s13638-019-1594-y
30. L. Lin, C. Chen, T. Xu, Spatial-spectral hyperspectral image classification based on information measurement and CNN. J. Wirel. Com Netw. (2020). https://doi.org/10.1186/s13638-020-01666-9

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