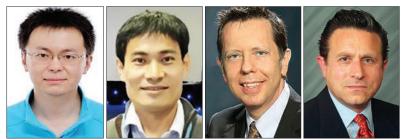
Deep Learning Driven Secure Communication for Cyber Physical Systems



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he proliferation of industrial cyber physical systems (CPSs) is changing our lives. CPS applications are often associated with sensitive data, core infrastructures, and assets, making them attractive in terms of vulnerability, data breach, and denial of services. Moreover, the heterogeneity in terms of protocols, operating systems, and devices combined with poor adoption of standard solutions create insecure design, architectures, and deployments. In addition, due to the use of wireless technologies, secure communication is strongly needed to protect valuable information. Therefore, secure communication management has become a crucial aspect of developing trustworthy systems with the preservation of security and privacy for CPSs. Deep learning (DL) has strong potential to overcome this challenge via data-driven solutions and improve the performance of CPSs while utilizing limited spectrum resources. DL is a more powerful method of data exploration to learn about "normal" and "abnormal" behavior according to how CPSs' components and devices interact with one another. The input data of each part of a CPS can be collected and investigated to determine normal patterns of interaction, thereby identifying malicious behavior at early stages. Moreover, DL can be important in predicting new attacks, which are often mutations of previous attacks, because they can intelligently predict future unknown attacks by learning from existing examples. Consequently, CPSs must have a transition from merely facilitating secure communication among devices to security-based intelligence enabled by DL methods for effective and secure systems.

However, the challenge in applying DL for secure communication in CPSs has yet to be addressed. Such challenges include but are not limited to risks and regulatory issues as well as other associated factors related to processing, storage, and availability for secure communication. Therefore, this Special Issue (SI) aims to bring together researchers from different sectors to focus on understanding security challenges of CPSs, and architect innovative solutions with the help of cutting edge DL related technologies. Based on the reviewers' feedback, as well as the evaluations of the Editors, 10 papers were selected for this SI from more than 90 submissions. The 10 articles, which cover broad topics, are introduced briefly as follow.

The article "Deep Learning Powered Adversarial Sample Attacks Approach for Security Detection of DGA Domain Name in Cyber Physical Systems" authored by Shen *et al.* proposes a domain name detection system to solve this security issue in CPSs. In the system, a DL-powered adversarial sample attacks approach is embedded to improve its performance. The experimental results prove that the proposed system achieves better performance in the malicious domain name recognition task.

The article "Deep Federated Learning-Enhanced Secure POI Microservices for Cyber Physical Systems" authored by Guo *et al.* proposes a deep federated-learning-based framework for secure POI microservices under CPSs. In order to enhance data security, the system architecture is designed by isolating the cloud center from accessing user data at edge nodes, and an interactive training mechanism is introduced between the cloud center and edge nodes. The experimental results prove that this proposal achieves optimal scheduling performance, which demonstrates its practical utility.

The article "An Ultra-Lightweight Data-Aggregation Scheme with Deep Learning Security for Smart-Grid" authored by Gope *et al.* proposes a DL-based ultra-lightweight data aggregation scheme for smart-grids. Unlike existing data aggregation schemes, the proposed solution does not require storing any secret but can still ensure a higher level of security. Also, to the best of the authors' knowledge, it is the first aggregation scheme that can ensure physical security of the smart meter.

The article "Attack Detection and Data Generation for Wireless Cyber-physical Systems Based on Self-Training Powered Generative Adversarial Networks" authored by Huang *et al.* proposes a self-training powered generative adversarial network (ST-GAN) to detect attacks in wireless CPSs. The proposed ST-GAN system solves the issue of limited data in the field of security for wireless CPSs, which is caused by confidentiality as well as the number of attacks. Experimental results prove that the proposed system can effectively detect attacks in wireless CPSs.

The article "Distributed Q-Learning Enabled Multi-Dimensional Spectrum Sharing Security Scheme for 6G Wireless Communication" authored by Ding *et al.* proposes a distributed Q-learning enabled multi-dimensional spectrum sharing security scheme for the millimeter-wave frequency band. To prove this scheme, the authors use simulations to verify the performance of the proposed distributed Q-learning algorithm for solving the spectrum sharing optimization problem. Results prove that the proposed multi-dimensional spectrum sharing security scheme can significantly reduce the access delay of users, increase the number of unauthorized users that can be accommodated, and improve the throughput while achieving good security performance of the network.

The article "A Deep Learning Assisted Software Defined Security Architecture For 6G Wireless Networks: IIoT Perspective" authored by Rahman *et al.* studies the security challenges on 6G networks posed by the recent convergence of operational technology and information technology networks, and proposes distributed DL-assisted software-defined security for 6G wireless networks that will autonomously detect, localize, and isolate security threats via security function virtualization.

The article "Deep-Learning Based Mobile Group Intelligence Perception Mechanism Oriented to User Privacy and Data Security in the Internet of Things" authored by Hu *et al.* proposes a mobile group intelligence perception mechanism oriented to user privacy and data security. This mechanism uses DL as its core algorithm to handle big data cases. It can provide authenticity and reliability guarantees for the subsequent data application on the premise of protecting user privacy. Experimental results prove that this proposed mechanism meets the security requirements, and its user-end computing overhead is small.

The article "Federated Learning Driven Secure Internet of Medical Things" authored by Fan *et al.* proposes a federated learning driven Internet of Medical Things (FLDIoMT) framework, which aims to support flexible deployment of IoMT services and address the privacy and security issues at the same time. Results prove the feasibility of the proposed FLDIoMT framework by implementing a novel sleep monitoring system called iSmile.

The article "Toward Industrial Private AI: A Two-Tier Framework for Data and Model Security" authored by Khowaja et *al.* proposes a federated learning and encryption-based private (FLEP) AI framework that provides two-tier security for data and model parameters in an Industrial Internet of Things environment. Experimental results prove that the proposed framework achieves better encryption quality at the expense of slightly increased execution time.

The article "Blockchain and Federated Deep Reinforcement Learning-Based Secure Cloud-Edge-End Collaboration in Power IoT" authored by Zhang *et al.* proposes a blockchain and Al-based secure cloud-edge-end collaboration Power Internet of Things architecture to ensure data security and intelligent computation offloading. Its advantages in flexible resource allocation, secure data sharing, and differentiated service guarantee are elaborated. Numerical results verify its excellent performance in total queuing delay and consensus delay.

The Guest Editors would like to thank all the authors who submitted their papers and anonymous reviewers who carefully reviewed and helped evaluate these papers. We would also like to extend our sincere thanks to the Editor-in-Chief, Yi Qian, and Associate Editor-in-Chief, Nirwan Ansari, for their support in the publication of this SI.

BIOGRAPHIES

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