

Intelligent Anomaly Detection with Federated Learning and Digital Twin

| Conference paper | First Online: 21 February 2026

| pp 165–176 | [Cite this conference paper](#)



Proceedings of International Conference on Computational Intelligence, Data Science and... (IEM-ICDC 2025)

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Abstract

This paper addresses the challenges of anomaly detection in dynamic environments characterized by extensive real-time data and privacy concerns. A novel framework integrating Federated Learning (FL) and Digital Twin (DT) technologies is proposed. FL facilitates decentralized machine learning, maintaining data privacy, while DT provides virtual replicas for real-time system monitoring. The framework enhances anomaly detection rates, interpretability, and responsiveness, offering a robust solution for sectors

like healthcare and manufacturing. Using autoencoders for threshold-based anomaly identification and hybrid classifiers for anomaly classification, the approach achieves superior detection accuracy and computational efficiency. Results demonstrate the model's effectiveness in safeguarding systems from operational disruptions.

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About this paper

Cite this paper

Sur, K., Das, R., Singh, M. (2026). Intelligent Anomaly Detection with Federated Learning and Digital Twin. In: Singh, M., Das, B., Ghosh, S., Chakrabarti, A., R. S. Tavares, J.M. (eds) Proceedings of International Conference on Computational Intelligence, Data Science and Cloud Computing. IEM–ICDC 2025. Lecture Notes in Networks and Systems, vol 1541. Springer, Singapore. https://doi.org/10.1007/978-981-96-9494-5_15

[.RIS](#) [.ENW](#) [.BIB](#)

DOI	Published	Publisher Name
https://doi.org/10.1007/978-981-96-9494-5_15	21 February 2026	Springer, Singapore
Print ISBN	Online ISBN	eBook Packages
978-981-96-9493-8	978-981-96-9494-5	Intelligent Technologies and Robotics
		Intelligent Technologies and Robotics (R0)
		Springer Nature
		Proceedings excluding
		Computer Science

Keywords

[Anomaly detection](#) [Federated learning](#) [Digital twin](#) [Auto encoder](#) [IoT](#)

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Proceedings of International Conference on Computational Intelligence, Data Science and Cloud Computing

IEM-ICDC 2025

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Editors: Moutushi Singh, Baisakhi Das, Sanchita Ghosh, Amlan Chakrabarti, João Manuel R. S. Tavares

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This book includes selected papers presented in 3rd International Conference on Computational Intelligence, Data Science, and Cloud Computing (IEM-ICDC 2025), organized by the Department of Information Technology and Computer Science & Engineering, Institute of Engineering and Management, Kolkata, India, during April 11 – 12, 2025. It covers substantial new findings about AI and robotics, image processing and NLP, cloud computing and big data analytics as well as in cyber-security, blockchain and IoT, and various allied fields. The book serves as a reference resource for researchers and practitioners in academia and industry.

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Bibliographic Information

Book Title

Proceedings of
International Conference
on Computational
Intelligence, Data Science
and Cloud Computing

Book Subtitle

IEM-ICDC 2025

Editors

Moutushi Singh, Baisakhi
Das, Sanchita Ghosh,
Amlan Chakrabarti, João
Manuel R. S. Tavares

Series Title

DOI

Publisher

Springer Singapore

**Lecture Notes in Networks
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<https://doi.org/10.1007/978-981-96-9494-5>

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Pte Ltd. 2026

Softcover ISBN
978-981-96-9493-8
Published: 21 February
2026

eBook ISBN
978-981-96-9494-5
Published: 20 February
2026

Series ISSN
2367-3370

Series E-ISSN
2367-3389

Edition Number
1

Number of Pages
XX, 629

Number of Illustrations
89 b/w illustrations, 265
illustrations in colour

Topics

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