

Keynote

Graph Neural Sensing for Sensor Quality Monitoring

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Abstract

This talk will present a novel approach to soft sensing, integrating artificial intelligence with physical principles to improve measurement precision and reliability. Instead of relying solely on extensive networks of physical sensors, an advanced data-driven estimation method is developed using physics-enhanced Graph Neural Networks (GNNs) to infer key measurements while maintaining metrological accuracy.

In this approach, fundamental physical laws, such as the Darcy-Weisbach equation for fluid flow and heat transfer principles, are integrated directly into the graph structure. By incorporating sensor-relevant parameters, such as pipe and valve properties, the model enhances measurement consistency while ensuring compliance with established physical constraints. This integration allows for improved precision in sensor-based estimations and a reduction in systematic errors that often arise in complex industrial environments.

To evaluate this methodology, district heating networks are used as a test case, demonstrating that the physics-enhanced GNN outperforms traditional data-driven methods in estimating pressure and temperature.

The broader impact of this work lies in advancing data-driven metrology. By reducing dependence on dense physical sensor networks while maintaining traceability and accuracy, this method supports improved sensor calibration, measurement consistency, and predictive diagnostics in complex systems.



Olga Fink is an assistant professor leading the Laboratory of Intelligent Maintenance and Operations Systems at EPFL (Switzerland) since March 2022. Her research focuses on advancing intelligent maintenance and operations of complex infrastructure and industrial assets through the development of Physics-Informed Machine Learning, (physics-informed) Graph Neural Networks, (multimodal) Domain Adaptation and Generalization and Deep Reinforcement Learning. Previously, she was an assistant professor at ETH Zurich from 2018 to 2022, where she was awarded the Swiss National Science Foundation (SNSF) Professorship Grant. From 2014 to 2018, she led the “Smart Maintenance” group at Zurich University of Applied Sciences (ZHAW). Olga holds a Ph.D. from ETH Zurich and

a Diploma in Industrial Engineering from Hamburg University of Technology. She serves on the editorial boards of several prestigious journals, including Mechanical Systems and Signal Processing, Engineering Applications of Artificial Intelligence, Reliability Engineering and System Safety and IEEE Internet of Things.

Olga has received numerous awards and honors including being named one of Switzerland's 'Top 100 Women in Business' in 2018, recognition as a Young Scientist by the World Economic Forum and World Laureate Forum, and being named a Fellow of the Prognostics and Health Management Society in 2023.