

Sara Malacarne

Senior Research Scientist in AI/ML, Telenor Research and Innovation

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Research focus

Research on mathematical and computational methods for complex temporal data, spanning time-series and longitudinal modelling, representation and generative learning, graph-based methods, anomaly detection, and reservoir computing.

Current methodological work uses free probability and dynamical-systems perspectives to study reservoir systems and simulation-free hyperparameter selection. Broader research includes large-scale graph-based anomaly detection, time-series representation and generative modelling, and foundation models for temporal data.

Research experience

Senior Research Scientist in Analytics/AI

2022–Present

Telenor Research and Innovation

Oslo, Norway

Telenor lead for ML4ITS – Machine Learning for Irregular Time Series; Telenor representative in the NorwAI Hybrid AI and Data work packages; Telenor industry partner representative in SURE-AI.

- Developed context-aware graph-attention methods for unsupervised anomaly detection in large-scale mobile networks; the resulting model was deployed in one Telenor business unit and transferred to additional Telenor business units.
- Developed and evaluated machine-learning methods for complex temporal data, including generative modelling, representation learning, graph-based learning, irregular time series, and time-series foundation models.
- Initiated and developed research on free-probability methods for reservoir computing, linking spectral and kernel quantities to reservoir behaviour and zero-rollout / simulation-free hyperparameter selection.
- Built reproducible research pipelines for data processing, training, evaluation, ablation studies, inference, and large-scale empirical validation.
- Supervised PhD and Master’s students and coordinated collaborative research activities with academic and industrial partners.

Research Scientist in Analytics/AI

2018–2022

Telenor Research and Innovation

Oslo, Norway

- Developed statistical, probabilistic, and machine-learning methods for customer, service-quality, and network data, including Bayesian networks, recommendation systems, anomaly detection, and predictive modelling.
- Supervised Master’s students and contributed to academic collaborations and cross-team research activities.

Career interruptions: parental leave in 2020 and 2024.

Education

PhD in Mathematics, University of Oslo, Norway

2014–2018

Thesis: *Poisson and Martin Boundaries of Discrete Quantum Groups: A Noncommutative and Categorical Perspective*.

Main supervisor: Sergey Neshveyev. Research areas: noncommutative probability, operator algebras, quantum groups, graph and matrix theory, and probability.

Master’s in Mathematics, University of Rome Tor Vergata, Italy

2011–2014

Thesis: *Non-commutative Probability, R-Transform and Applications*.

Main supervisor: Florin Rădulescu. Grade: 110/110 with honours.

Bachelor’s in Pure and Applied Mathematics, University of Rome Tor Vergata, Italy

2007–2011

Publications

Peer-reviewed journal and conference publications

- 2026.** S. Malacarne *et al.*, *Context-Aware Graph Attention for Unsupervised Telco Anomaly Detection*, ESANN 2026.
- 2024.** D. Lee, S. Malacarne, E. Aune, *Explainable Time Series Anomaly Detection Using Masked Latent Generative Modeling*, *Pattern Recognition*, Vol. 156.
- 2023.** E. Haugsdal, S. Malacarne, M. Ruocco, *Circle Attention: Forecasting Network Traffic by Learning Interpretable Spatial Relationships from Intersecting Circles*, ECML-PKDD, pp. 106–121.
- 2023.** D. Lee, S. Malacarne, E. Aune, *Vector Quantized Time Series Generation with a Bidirectional Prior Model*, AISTATS, PMLR, pp. 7665–7693.
- 2022.** F. Michelinakis, J. S. Pujol-Roig, S. Malacarne, M. Xie, T. Dreibholz, S. Majumdar, W. Y. Poe, G. Patounas, C. Guerrero, A. Elmokashfi, V. Theodorou, *AI Anomaly Detection for Cloudified Mobile Core Architectures*, *IEEE Transactions on Network and Service Management*, 20(2), 1976–1992.
- 2021.** M. Xie, F. Michelinakis, T. Dreibholz, J. S. Pujol-Roig, S. Malacarne, S. Majumdar, W. Y. Poe, A. Elmokashfi, *An Exposed Closed-Loop Model for Customer-Driven Service Assurance Automation*, Joint European Conference on Networks and Communications & 6G Summit (EuCNC/6G Summit), pp. 419–424.
- 2019.** S. Malacarne, S. Neshveyev, *Martin Boundaries of the Duals of Free Unitary Quantum Groups*, *Compositio Mathematica*, 155(6), 1171–1193.
- 2018.** S. Malacarne, *Woronowicz Tannaka–Krein Duality and Free Orthogonal Quantum Groups*, *Mathematica Scandinavica*, 122(1).
- 2017.** S. Malacarne, S. Neshveyev, *Probabilistic Boundaries of Finite Extensions of Quantum Groups*, *Infinite Dimensional Analysis, Quantum Probability and Related Topics*, 20(4).

Workshop papers and accepted contributions

- 2026.** S. Malacarne, A. Ceni, C. Gallicchio, *Reservoir Computing for Temporal Sequence Learning: Overcoming the Hyperparameter Tuning Bottleneck via Free-Probability Kernels*. Accepted at the 11th Workshop on Advanced Analytics and Learning on Temporal Data (AALTD 2026), ECML-PKDD 2026.
- 2026.** S. Malacarne, A. Ceni, C. Gallicchio, *Simulation-Free Hyperparameter Selection for Reservoir Computing via Free-Probability Kernels*. Accepted at the 4th Workshop on Deep Learning Meets Neuromorphic Hardware (DLmNH 2026), ECML-PKDD 2026.
- 2025.** D. Lee, S. Malacarne, E. Aune, *Closing the Gap Between Synthetic and Ground Truth Time Series Distributions via Neural Mapping*. Workshop on Machine Learning for Irregular Time Series (ML4ITS 2025), ECML-PKDD 2025, Porto, Portugal.

Manuscripts under review

- 2026.** S. Malacarne, A. Ceni, C. Gallicchio, *Free-Probability Kernels for Zero-Rollout Hyperparameter Selection in Reservoir Computing*. Submitted to *IEEE Transactions on Neural Networks and Learning Systems*, 21 August 2026.
- 2026.** S. Malacarne *et al.*, *Scalable Context-Aware Graph Attention for Unsupervised Anomaly Detection in Large-Scale Mobile Networks*. Submitted to *IEEE Transactions on Network and Service Management*, 2 February 2026.

Research projects and representation

- **ML4ITS – Machine Learning for Irregular Time Series:** Telenor lead. Research Council of Norway-funded collaborative project on irregular and heterogeneous temporal data. [Project website](#).
- **NorwAI – Norwegian Research Center for AI Innovation:** Telenor representative in the Hybrid AI and Data work packages. [Project website](#).
- **SURE-AI:** Telenor industry partner representative in the Norwegian AI Centre. [Project website](#).

Supervision

Ongoing

- 2025–Present.** Christoph Eder, PhD, *Multi-View Data Augmentations for Time Series Data*, NTNU. Main supervisor: Benjamin Kille; co-supervisor: Sara Malacarne.
- 2026–Present.** Sebastian Munthe, Master's, *Deep Operator Networks for Telco Network Intelligence*, NTNU. Main supervisor: Massimiliano Ruocco; co-supervisors: Sara Malacarne and Michail Spitieris.
- 2026–Present.** Lasse Bærland Strand, Master's, *Shift-Conditioned Generative Adaptation for Robust Predictive Modelling Under Distribution Shift*, NTNU. Main supervisor: Massimiliano Ruocco; co-supervisors: Sara Malacarne and Michail Spitieris.
- 2026–Present.** Tobias Liene Borning and Isak Tønnesen, Master's, *Uncertainty-Aware Anomaly Detection with Generative Models*, NTNU. Main supervisor: Massimiliano Ruocco; co-supervisors: Sara Malacarne and Michail Spitieris.
- 2026–Present.** Vegard Aa Albretsen, Master's, *Wavelet-Based Representations for Time Series*, NTNU. Main supervisor: Benjamin Kille; co-supervisors: Christoph Eder and Sara Malacarne.

Completed

- 2026.** Daniel Kristiansen, Master's, *Zero Shot Time Series Foundation Models in the Telecom Domain*, NTNU. Supervisor: Massimiliano Ruocco; co-supervisor: Sara Malacarne.
- 2025.** Daesoo Lee, PhD, *Towards Universal Time Series Modeling: Deep Generative Modeling and Self-Supervised Learning for Time Series and Beyond*, NTNU. Main supervisor: Erlend Aune; co-supervisors: Jo Eidsvik and Sara Malacarne.
- 2024.** Simen Kristoffersen and Peter Skaar Nordby, Master's, *SiamTST: Improving Telecommunication Network Analysis Through Innovative Multivariate Time Series Representation Learning*, NTNU. Supervisors: Massimiliano Ruocco, Sara Malacarne, and Pablo Ortiz.
- 2021.** Sigurd Nybakk Vang, Master's, *Generative Adversarial Networks for Unsupervised Anomaly Detection in Multivariate Time-Series Telecommunications Data*, NTNU. Supervisor: Massimiliano Ruocco; co-supervisor: Sara Malacarne.
- 2021.** Axel Ø. Harstad and William E. G. Kvaale, Master's, *Spatio-Temporal Graph Attention Network for Anomaly Detection in the Telco Domain*, NTNU. Supervisor: Massimiliano Ruocco; co-supervisors: Sara Malacarne and Claudio Gallicchio.

Talks and invited presentations

- Apr 2026.** Contributed speaker, ESANN 2026, Bruges, Belgium. *Context-Aware Graph Attention for Unsupervised Telco Anomaly Detection*.
- Apr 2026.** Invited speaker, NTNU NorwAI Forum. *What survives deployment? Lessons from large-scale anomaly detection in mobile networks*.
- Feb 2026.** Invited lecturer, BI Norwegian Business School, graduate course *AI, Technologies and Applications*.
- Sep 2025.** Invited speaker, ML4ITS Workshop, ECML-PKDD, Porto, Portugal. *Anomaly Detection in Telecom Time Series: From Graph-Based Models Towards Representation Learning*.
- Mar 2025.** Invited speaker, NTNU NorwAI Forum. *Telenor's Journey in Network Anomaly Detection – Towards Generative AI Approaches in Complex Telecom Environments*.
- Feb 2023.** Invited lecturer, BI Norwegian Business School, graduate course *AI, Technologies and Applications*.
- Mar 2022.** Invited speaker, Oslo Data Science Meetup. *GANs for Anomaly Detection on Telco Multivariate Time Series*.
- Nov 2021.** Invited speaker, Friday AI Webinar (NTNU, NORA, NAIL). *Generative Adversarial Networks for Anomaly Detection on Telco Multivariate Time Series*.
- Sep 2021.** Invited panel participant, 1st International Workshop on Machine Learning for Irregular Time Series, ECML-PKDD 2021.
- Jul 2018.** Invited speaker, Operator Algebras Seminar, University of Rome Tor Vergata.
- Jun 2018.** Invited speaker, *Quantum homogeneous spaces* conference, ICMS, Edinburgh.
- Jan 2017.** Contributed speaker, Danish-Norwegian Operator Algebra Workshop, Lysebu, Oslo.
- Jul 2016.** Invited speaker, 7ECM Satellite Conference on Compact Quantum Groups, Alfried Krupp Wissenschaftskolleg, Greifswald, Germany.

Nov 2015. Contributed speaker, Norwegian Operator Algebras Meeting, NTNU, Trondheim.

Scientific service

- Program Committee member, 5th International Workshop on Machine Learning for Irregular Time Series, ECML-PKDD 2026.
- Program Committee member, 3rd International Workshop on Machine Learning for Irregular Time Series, ECML-PKDD 2024.
- Program Committee member, 2nd International Workshop on Machine Learning for Irregular Time Series, ECML-PKDD 2023.
- Program Committee member, 1st International Workshop on Machine Learning for Irregular Time Series, ECML-PKDD 2021.
- Problem/Data owner, Telenor use case on unsupervised anomaly detection (winning use case), AI Hackathon at NTNU, 2021.

Additional qualifications

- Successful candidate on the EPSO AD7 reserve list, competition EPSO/AD/413/24-5: *Research and applications in artificial intelligence, machine learning, and complex systems*.
- Programming and tools: Python, SQL, Git, Linux, Docker, PyTorch, TensorFlow/Keras, scikit-learn, Pandas/Polars, NumPy.
- Languages: Italian (mother tongue), English (bilingual), Norwegian (B2).
- Italian and Norwegian citizenship.