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Pantelis R. Vlachas

PROFILE

Machine Learning researcher with 10+ years of experience at the intersection of machine learning (ML) and the natural sciences. Expertise in modeling complex dynamical and spatiotemporal systems, including fluid flows and biological processes. Recently expanding into bio ML, focusing on protein modeling and digital pathology. Experienced in leading interdisciplinary research, publishing in top-tier journals, and developing scalable ML frameworks for scientific discovery and industrial applications.

ACADEMIC BACKGROUND

Swiss Federal Institute of Technology Zurich (ETHZ), Switzerland *Feb 2017 – Mar 2022*
Ph.D. in Computational Science and Machine Learning
Thesis: *Learning and Forecasting the Effective Dynamics of Complex Systems across Scales*
Supervisor: Prof. Petros Koumoutsakos

Swiss Federal Institute of Technology Zurich (ETHZ), Switzerland *Mar 2016 – Aug 2016*
Master Thesis on Model Predictive Control and Embedded Optimization
Supervisor: Prof. John Lygeros
GPA: 6.0/6.0 (top 1%)

Technische Universität München (TUM), Munich, Germany
M.Sc. in Electrical Engineering, GPA: 1.0/1.0 (top 1%) *Oct 2014 – Aug 2016*
B.Sc. in Electrical Engineering, GPA: 1.3/1.0 (top 3%) *Oct 2011 – Jul 2014*

INDUSTRIAL EXPERIENCE

Ai2C Technologies (ETH Zurich spin-off) Jan 2022 – Aug 2025
Head of Machine Learning Research *Zurich, Switzerland*

- Led a team of 6 ML scientists and engineers, defining R&D direction and ensuring technical excellence.
- Translated business goals into actionable ML roadmaps and deliverables.
- Planned and supervised scalable ML system development for financial applications.
- Designed and evaluated deep learning algorithms for intra-day market data.
- Reported technical progress to stakeholders, aligning research with business objectives.
- Managed ML hiring, including candidate selection and onboarding.

ACADEMIC EXPERIENCE

ETH Zurich, Structural Dynamics (Prof. Eleni Chatzi) Oct 2025 – current
Research Associate *Zurich, Switzerland*

- Extending the PHLieNets framework to high-dimensional partial differential equations and structural engineering applications, focusing on scalable modeling of parameter-dependent dynamical systems.
- Supervising Master's theses.

ETH Zurich, Structural Dynamics (Prof. Eleni Chatzi) May 2023 – Apr 2024
Research Associate *Zurich, Switzerland*

- Developed PHLieNets, a hypernetwork-based framework that conditions forecasting models on system parameters, enabling robust generalization across diverse regimes in high-dimensional dynamical systems through interpolation in a learned modal space.
- Applied PHLieNets to prototypical low-order chaotic systems, demonstrating strong generalization to unseen parametric regimes.

Harvard, SEAS, (Prof. Petros Koumoutsakos) May 2021 – Dec 2022
Associate in Applied Mathematics *Boston, USA*

- Extended previous work on deep learning–based modeling of multiscale systems by developing adaptive, interpretable, and generalizable ML architectures. Focused on creating robust surrogates capable of handling changing system dynamics in real-time and understanding the functional components of neural forecasting models.
- Led the development of AdaLED, an adaptive real-time learning framework that integrates surrogate models with physics solvers to accurately simulate complex dynamical systems across previously unseen regimes, enabling reliable and accelerated multiscale predictions.
- Led the conduct of an in-depth ablation study (Deconstructing Recurrence, Attention, and Gating) on RNN and Transformer architectures for chaotic time series forecasting. Demonstrated that gating and attention mechanisms significantly enhance RNN performance, while recurrence in Transformer variants may impair long-term stability.
- Supervised Bachelor's and Master's theses and contributed to teaching activities.

ETH Zurich, CSE Lab, (Prof. Petros Koumoutsakos) Feb 2017 – Dec 2022
Ph.D. Researcher *Zurich, Switzerland*

- Conducted original research at the intersection of machine learning, fluid dynamics, and uncertainty quantification, focusing on the development of deep learning architectures for modeling and forecasting high-dimensional, nonlinear, and chaotic systems. My work addressed multiscale simulation challenges using machine learning. Key research contributions:
- Developed MSM-LSTM, an LSTM-based architecture augmented with stochastic modeling for accurate short-term forecasting of chaotic systems (e.g., Lorenz-96, Kuramoto–Sivashinsky), outperforming Gaussian processes.
- Led a comparative study on Reservoir Computing vs. BPTT-trained RNNs, showing their complementary strengths for spatiotemporal chaotic forecasting under different data regimes.
- Designed the LED (Learning Effective Dynamics) framework, combining autoencoders and RNNs to simulate multiscale systems with up to 100× computational speedups, while retaining physical accuracy.
- Extended LED to molecular dynamics, achieving up to 1,000× faster simulations with physically meaningful atomistic behaviors.
- Introduced BPTT-SA, a scheduled autoregressive training technique that mitigates error accumulation in long-term forecasts of fluid flows and other complex systems.
- Architectures: Recurrent and temporal convolutional neural networks (RNNs, TCNs, CNNs), Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU) models, Mixture Density Networks (MDNs), Convolutional RNNs (ConvRNNs), autoencoders, probabilistic autoencoders, Variational Autoencoders (VAEs), and Reservoir Computing / Echo State Networks (RC/ESN).
- Methodologies: Dynamical systems modeling, probabilistic modeling, modeling of stochastic dynamics, long-horizon forecasting, uncertainty quantification, anomaly and data-shift detection, high-performance computing (HPC) simulations, computational fluid dynamics (CFD), and molecular dynamics (MD).
- Supervised Bachelor's and Master's theses and contributed to teaching activities.

THESIS SUPERVISION

- Dominik Weiss, Master Thesis ETH Zurich, 2025-2026 (expected)
- Vontas Konstantinos, *A machine learning application for the estimation of interface curvature in multiphase flows*, Master Thesis KU Leuven, 2022
- Jan-Philipp von Bassewitz, *Learning Residual Neural ODE Dynamics of Partially and Fully Observed Systems*, Bachelor Thesis ETH Zurich, 2021
- Clapes Roig Joan, *Surrogate Models for Reinforcement Learning*, Master Thesis ETH Zurich, 2021
- Joshua Jeffrey, *Learned Effective Dynamics of Flow Past Cylinder*, Master Thesis ETH Zurich, 2020
- Francesco Varoli, *Improved Memories Learning for Sample Efficient Reinforcement Learning*, Master Thesis ETH Zurich, 2020
- Zador Pataki, *Physics Informed Neural Networks for Identification and Forecasting of Chaotic Dynamics*, Bachelor Thesis ETH Zurich, 2020
- Marc Bär, *Uncertainty Quantification in High-Dimensional Chaotic Systems using Bayesian Deep Learning*, Master Thesis ETH Zurich, 2019
- Martin Tschechne, *A Study on Convolutional Autoencoder Architectures for the Latent Representation of Dynamical Systems and Fluid Flows*, Bachelor Thesis ETH Zurich, 2019
- Weber Pascal, *SpectralNet - Predicting the Time-Evolution of non-linear Partial Differential Equations using equation-supported LSTM-RNNs*, Master Thesis ETH Zurich, 2018
- Fink Jernej, *Uncertainty Quantification Using Neural Networks*, Master Thesis ETH Zurich, 2018

PUBLICATIONS

1. **Pantelis R. Vlachas**, Konstantinos Vlachas, Eleni Chatzi. *Beyond Static Models: Hypernetworks for Adaptive and Generalizable Forecasting in Complex Parametric Dynamical Systems.* ArXiv preprint. [link]
2. **Pantelis R. Vlachas**, Petros Koumoutsakos. *Learning on predictions: Fusing training and autoregressive inference for long-term spatiotemporal forecasts.* Physica D: Nonlinear Phenomena. [link]
3. Hunter Heidenreich, **Pantelis R. Vlachas**, Petros Koumoutsakos. *Deconstructing recurrence, attention, and gating: Investigating the transferability of transformers and gated recurrent neural networks in forecasting of dynamical systems.* Arxiv. [link]
4. Junaid Farooq, Danish Rafiq, **Pantelis R. Vlachas**, Mohammad Abid Bazaz *RefreshNet: learning multiscale dynamics through hierarchical refreshing* . Nonlinear Dynamics. [link]
5. Ivica Kičić, **Pantelis R. Vlachas**, Georgios Arampatzis, Marios Chatzimanolakis, Leonidas Guibas, Petros Koumoutsakos. *Adaptive learning of effective dynamics for online modeling of complex systems.* Computer Methods in Applied Mechanics and Engineering, 2022. [link]
6. **Pantelis R. Vlachas**, Georgios Arampatzis, Caroline Uhler, Petros Koumoutsakos. *Multiscale Simulations of Complex Systems by Learning their Effective Dynamics.* Nature Machine Intelligence, 2022. [link]
7. **Pantelis R. Vlachas**. *Learning and Forecasting the Effective Dynamics of Complex Systems Across Scales.* ETH Zurich Doctoral Dissertation, 2022. [link]
8. **Pantelis R. Vlachas**, Julija Zavadlav, Matej Praprotnik, Petros Koumoutsakos. *Accelerated Simulations of Molecular Systems through Learning of their Effective Dynamics.* Journal of Chemical Theory and Computation, 2021. [link]

9. **Pantelis R. Vlachas**, Jaideep Pathak, Brian R. Hunt, Themistoklis P. Sapsis, Michelle Girvan, Edward Ott, Petros Koumoutsakos. *Backpropagation algorithms and reservoir computing in recurrent neural networks for the forecasting of complex spatiotemporal dynamics.* Journal of Neural Networks, 2020. [link]
10. **Pantelis R. Vlachas**, Wonmin Byeon, Zhenyu Wan, Themistoklis P. Sapsis, Petros Koumoutsakos. *Data-Driven Forecasting of High-Dimensional Chaotic Systems with Long Short-Term Memory Networks.* Proceedings of the Royal Society A, 2018. [link]
11. Zhenyu Wan, **Pantelis R. Vlachas**, Petros Koumoutsakos, Themistoklis P. Sapsis. *Data-assisted reduced-order modeling of extreme events in complex dynamical systems.* PLOS ONE, 2018. [link]
12. Maximilian Zwerger, **Pantelis R. Vlachas**, Helmut Graeb. *A Fast Analytical Approach for Static Power-Down Mode Analysis.* IEEE International Conference on Electronics, Circuits, and Systems (ICECS), 2015. [link]

JOURNAL REVIEWING ACTIVITIES

- ◇ IEEE Trans. Neural Netw. Learn. Syst.
- ◇ IEEE Trans. Artif. Intell.
- ◇ IEEE Trans. Ind. Informat.
- ◇ IEEE Access
- ◇ J. Data-Centric Eng.
- ◇ Chaos
- ◇ Nonlinear Dyn.
- ◇ Nonlinear Process. Geophys.
- ◇ Phys. Rev. E
- ◇ Phys. Rev. Fluids
- ◇ Phys. Rev. Lett.
- ◇ Phys. Lett. A
- ◇ Comput. Methods Appl. Mech. Eng.
- ◇ Mech. Syst. Signal Process.
- ◇ AIP Adv.
- ◇ Nat. Commun. Phys.
- ◇ Nat. Commun.
- ◇ Sci. Rep.

TECHNICAL SKILLS

Programming	Python, C, C++, MATLAB, Bash, LaTeX
ML Frameworks	PyTorch, TensorFlow, Scikit-learn, Lightning, Optuna
Scientific Computing	NumPy, SciPy, Numba, JAX, MPI, CUDA
Modeling & Simulation	Simulink, ParaView, AutoLEV, Cadence, OpenFOAM
Research Tools	Git, Linux, Docker, Slurm, Weights & Biases
Domains	Time-series forecasting, Dynamical systems, PDEs, FinTech, BioML
Spoken Languages	Greek (native), English (fluent), German (fluent), French (basic)

HONORS AND AWARDS

- ◦ Scholarship for Exchange Research Semester, ETH Zurich, 2016
- ◦ Deutschlandstipendium (German National Scholarship), 2012–2016
- ◦ Bronze Medal, National Mathematics Olympiad "Archimedes"
- ◦ 4th Prize, National Physics Competition, Greece

TEACHING EXPERIENCE

- ◦ ETH Zurich: Models, Algorithms, Data (2018), HPC for Science and Engineering I/II (2019–2021)
- ◦ Harvard: Models, Algorithms, Data (2021)
- ◦ TUM: Optimization Methods, Analysis III, Control Systems I, and more

REFERENCES

Prof. Petros Koumoutsakos
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Prof. for Computational Science, ETHZ
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Laboratory for Molecular Modeling, National Institute of Chemistry,
University of Ljubljana, Slovenia
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Multiscale Modeling of Fluid Materials,
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