

Address: Müstergasse 30, Zurich, 8001
Contact: +41 76 445 2289
Mail: pvlachas@ethz.ch, prvlachas@gmail.com
Links: GitHub, LinkedIn, Google Scholar

Pantelis R. Vlachas

Profile

Machine Learning Research Scientist with over 14 years of experience developing deep learning methods for understanding, modeling, and forecasting complex systems, including spatiotemporal PDEs, fluid flows, and molecular dynamics, with applications spanning physics, engineering, and finance. Current research and longer-term interests are increasingly directed towards multi-modal generative modeling and foundation model approaches for computational pathology, spatial transcriptomics, and computational biology more broadly. Background includes leading interdisciplinary research teams and deploying ML systems in production. Adopts agentic AI workflows throughout the R&D cycle, building and using multi-agent pipelines for literature review, experiment planning, and research automation.

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 *Oct 2014 – Aug 2016*
M.Sc. in Electrical Engineering, GPA: 1.0/1.0 (top 1%)

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

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 engineers, driving R&D strategy and mentoring junior researchers.
- Managed full hiring cycle for ML roles: sourcing, technical interviews, and onboarding.
- Secured \$10M in funding by demonstrating ML capabilities and technical roadmap to investors.
- Designed deep learning models for intra-day market prediction.
- Architected and deployed production ML pipelines for high-frequency financial data.

Academic Experience

ETH Zurich, Biomedical Informatics (Prof. Gunnar Rätsch) *Nov 2025 – current*
Research Associate *Zurich, Switzerland*

- Developing a transcriptomics-conditioned framework combining gene foundation models with spatial omics for virtual tissue synthesis.
- Developing diffusion-based generative models with transformer backbones for high-resolution histopathology image synthesis and data augmentation.
- Designing latent diffusion architectures with dual conditioning on pathology (UNI, Prov-GigaPath) and gene foundation model embeddings for controllable tissue generation.

- Designing scalable parallel training pipelines for whole-slide image processing on HPC infrastructure.
- Assessing biological fidelity of generated tissue through downstream tasks.
- Developing a human-in-the-loop agentic research framework that augments the full R&D cycle: agents assist with literature retrieval, code implementation, experiment deployment on HPC clusters, parallel job coordination, and result aggregation. Scientific judgment, hypothesis formulation, architectural decisions, and code review remain with the researcher, who directs and validates each stage. This structure compresses iteration cycles while preserving rigor and full accountability over the research output.
- Working in collaboration with PhD student Kalin Nonchev.

ETH Zurich, Structural Dynamics (Prof. Eleni Chatzi)

Research Associate, part-time contract

Oct 2025 – current

Zurich, Switzerland

- Developing scalable conditioning mechanisms for parametric modeling of dynamical systems, exploring Feature-wise Linear Modulation (FiLM), mixture of experts, adaptive activations, and parameter-conditioned attention.
- Leveraging PHLieNets (hypernetworks that interpolate in weight space) to build active learning frameworks for parametric dynamical systems, enabling real-time adaptation and generalization to unseen dynamic regimes.

ETH Zurich, Structural Dynamics (Prof. Eleni Chatzi)

Research Associate, part-time contract

May 2023 – Apr 2024

Zurich, Switzerland

- Developed PHLieNets, a hypernetwork-based framework that conditions forecasting models on system parameters, enabling generalization to unseen dynamic regimes through interpolation in a learned modal space.
- Validated the framework on chaotic systems, demonstrating accurate forecasting in parametric regimes unseen during training.

Harvard, SEAS, (Prof. Petros Koumoutsakos)

Associate in Applied Mathematics

May 2021 – Dec 2022

Boston, USA

- Extended previous work on deep learningbased 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 with uncertainty quantification using Deep Ensembles, 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 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 Bachelors and Masters theses and contributed to teaching activities.

ETH Zurich, CSE Lab, (Prof. Petros Koumoutsakos)

Ph.D. Researcher

Feb 2017 – Dec 2022

Zurich, Switzerland

- Conducted original research at the intersection of ML, 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 ML.

- 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 and state observability regimes.
- Designed the LED (Learning Effective Dynamics) framework, combining autoencoders and RNNs to simulate multiscale systems with up to 100 $\times$ computational speedups, while retaining physical accuracy.
- Extended LED to molecular dynamics, achieving up to 1,000 $\times$ 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.
- Supervised Bachelors and Masters theses and contributed to teaching activities.

Doctoral Thesis

1. **Pantelis R. Vlachas**. *Learning and Forecasting the Effective Dynamics of Complex Systems Across Scales*. ETH Zurich Doctoral Dissertation, 2022. [\[link\]](#)

Selected Publications

1. **Pantelis R. Vlachas**, Kalin Nonchev, Viktor Koelzer, Gunnar Rätsch. *Transcriptomics-Conditioned Virtual Tissue Synthesis via Diffusion Transformers*. ICML 2026 Workshop on Structured Data for Health (SD4H), 2026.
2. **Pantelis R. Vlachas**, Konstantinos Vlachas, Eleni Chatzi. *Beyond Static Models: Hypernetworks for Adaptive and Generalizable Forecasting in Complex Parametric Dynamical Systems*. ArXiv preprint, 2025. [\[link\]](#)
3. **Pantelis R. Vlachas**, Petros Koumoutsakos. *Learning on predictions: Fusing training and autoregressive inference for long-term spatiotemporal forecasts*. Physica D: Nonlinear Phenomena, 2024. [\[link\]](#)
4. Ivica Kii, **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, 2023. [\[link\]](#)
5. **Pantelis R. Vlachas**, Georgios Arampatzis, Caroline Uhler, Petros Koumoutsakos. *Multiscale Simulations of Complex Systems by Learning their Effective Dynamics*. Nature Machine Intelligence, 2022. [\[link\]](#)
6. **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. [\[link\]](#)
7. **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. [\[link\]](#)
8. 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. [\[link\]](#)

9. **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]

Thesis Supervision

- Dominik Weiss, *Adaptive Hypernetwork-based learning for large-scale systems under variability*, Master Thesis ETH Zurich, 2026
- 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

Journal Reviewing Activities

- | | | |
|---|-------------------------------|-----------------|
| ◊ IEEE Trans. Neural Netw. Learn. Syst. | ◊ IEEE Trans. Artif. Intell. | ◊ Chaos |
| ◊ IEEE Trans. Ind. Informat. | ◊ J. Data-Centric Eng. | ◊ TMLR |
| ◊ 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, HuggingFace
Scientific Computing	NumPy, SciPy, Numba, JAX, MPI, CUDA
BioML Tools	OpenSlide, MONAI, Histolab, Scanpy, Squidpy
Modeling & Simulation	Simulink, ParaView, AutoLEV, Cadence, OpenFOAM
Research Tools	Git, Linux, Docker, Slurm, Snakemake, Weights & Biases, MLFlow
AI / Agent Tooling	Claude Code, LangChain, RAG pipelines, vector databases, multi-agent workflows
Domains	Dynamical systems, time-series, PDEs BioML, Computational pathology, Spatial transcriptomics
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