Batuhan Koyuncu

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About Me

Time-Series Foundation Models • *Generative AI* • *Probabilistic Modeling* • *Agentic AI Systems* • *LLM Applications* • *LoRA Fine-Tuning* • *Interpretability*

I build reliable, interpretable, and scalable AI systems for real-world deployment. My research focuses on probabilistic and generative models for temporal and heterogeneous data, with applications spanning macroeconomic forecasting, healthcare, and audio. I am particularly interested in combining foundation models with agentic AI frameworks to enable robust reasoning, forecasting, and decision-making under uncertainty.

Education

- **Ph.D. Computer Science** 2021 - Present
  Saarland University, Advisor: Prof. Isabel Valera *Saarbrücken, Germany*
  - **Research Interests:** Deep generative modeling, probabilistic modeling for time-series data.
  - ELLIS Ph.D. student, co-advised by Prof. Ole Winther.
- **M.Sc. Computer Engineering** 2018 - 2021
  Bogazici University, Advisor: Prof. Lale Akarun *Istanbul, Turkey*
  - GPA: 3.8/4
- **B.Sc. Physics** 2013 - 2018
  Bogazici University *Istanbul, Turkey*
  - Ranked as 3rd in the class of 2018 with GPA:3.47/4
  - Recipient of Fulbright Ph.D. Grant (2018)
  - Turkish Research Council Undergraduate Scholarship ($20k) (2014-2018)

Work Experience

- **Visiting Researcher - AI Internship** Spring 2025
  Bank for International Settlements, hosted by Fernando Perez-Cruz *Basel, Switzerland*
  - Built Macroeconomic Time-Series Foundation Models on multi-country economic data for forecasting, scenario-planning, and counterfactual analysis — enabling central-bank-grade policy simulations.
- **Visiting Researcher** Summer 2025
  Technical University of Denmark, hosted by Prof. Ole Winther *Copenhagen, Denmark*
  - Developed time-continuous generator functions for scalable generative modeling of sequential data.
- **AI Scientist** 2025 — Present
  Intor (intor.ai) *Remote*
  - Building Retrieval-Augmented Generation (RAG) systems for law firms, AI-powered chatbots, and full-stack web applications.
- **Ph.D. Researcher** 2021 - Present
  Saarland University, Advisor: Prof. Isabel Valera *Saarbrücken, Germany*
  - **Time-series foundation models:** probabilistic transformer architectures for interpretable, robust multivariate forecasting — applicable to finance, energy, and demand planning.
  - **From generative models to neural network parameterization:** leveraging deep generative models (hypernetworks) to parameterize neural networks — addressing finetuning bottlenecks, removing gradient dependency, and enabling amortized inference for up to 10× speed-ups.
  - **Healthcare applications:** scalable personalized imputation and forecasting pipelines; hierarchical ML systems for real-time stress nowcasting from wearable sensor data.
- **M.Sc. Researcher** 2020 - 2021
  Bogazici University, Advisors: Profs. Lale Akarun & Ali Taylan Cemgil *Istanbul, Turkey*
  - Analysis and regularization of deep generative second-order ODEs for temporal modeling.
- **Graduate Research Assistant** 2019 - 2020
  Bogazici University, Medical and Biological Physics Group *Istanbul, Turkey*
  - Built CNN-based spatio-temporal models for medical physics, including chemotherapy response prediction.

Selected Manuscripts

For a complete list, see my Google Scholar profile.

- **Koyuncu, B.**, Kwon, B., Lombardi, M. J., Perez-Cruz, F., Shin, H. S. (2026). BISTRO: A Foundational Model for Unconditional and Conditional Forecasting of Macroeconomic Time Series. *BIS Working Papers.*
- **Koyuncu, B.**, Koyuncu, B., DeVries, R., Winther O., Valera, I. (2026). Temporal Variational Implicit Neural Representations. Under review.
- **Koyuncu, B.**, Kwon, B., Lombardi, M. J., Perez-Cruz, F., Shin, H. S. (2025). A Foundational Model For Conditional Forecasting Macroeconomic Variables. Conference on Nontraditional Data, Machine Learning and Natural Language Processing in Macroeconomics (ECONDAT).
- Peis, I., **Koyuncu, B.**, Valera, I., Frellsen, J.(2025). Hyper-Transforming Latent Diffusion Models. International Conference on Machine Learning (ICML).
- **Koyuncu, B.**, Bauerschmidt, T.N., Valera, I.(2024). E-ProTran: Efficient Probabilistic Transformers for Forecasting. Workshop on Structured Probabilistic Inference & Generative Modeling, ICML.
- **Koyuncu, B.**, Kıran, A. D., ..., Valera, I. (2024). From Laboratory to Everyday Life: Personalized Stress Prediction via Smartwatches. Machine Learning for Life and Material Science Workshop, ICML.
- **Koyuncu, B**., Sanchez-Martin, P., Peis, I., Olmos, P. M., Valera, I. (2023). Variational Mixture of Hyper Generators for Learning Distributions Over Functions. International Conference on Machine Learning.
- Parlatan, U., Ozen, M. O., Kecoglu, I., **Koyuncu, B.**, ..., Demirci, U. (2023). Label-Free Identification of Exosomes using Raman Spectroscopy and Machine Learning. Small, 2205519.
- **Koyuncu, B.**, Melek, A., Yilmaz, D., Tuzer, M., Unlu, M. B. (2022). Chemotherapy Response Prediction with Diffuser Elapser Network. Scientific Reports, 12(1), 1-13.
- **Koyuncu, B.** (2021). Analysis of ODE2VAE with Examples. Fourth Workshop on Machine Learning and the Physical Sciences, NeurIPS. arXiv:2108.04899

Talks & Presentations

- **Using Hypernetworks for Parameterizing Neural Networks** — August 2025
  at Technical University of Denmark — *Copenhagen, Denmark*
- **VaMoH: Inferring distributions over functions** — April 2023
  at ELLIS Alicante Unit — *Alicante, Spain*
- **Using CNNs to learn dynamics of coupled PDEs** — March 2020
  at Bogazici University — *Istanbul, Turkey*
- **Utilizing deep learning models to predict chemotheraphy response** — February 2020
  at Kodluyoruz Research — *Istanbul, Turkey*
- **Solving Combinatorial Optimization Problems with RL** — November 2019
  at Inzva — *Istanbul, Turkey*

Teaching

- **Advanced Time Series Analysis** — Assistant Instructor, Saarland University — Spring 2025
  Taught EM, HMM, and Variational Inference modules; led sessions on Transformers and foundation models.
- **ProbAI Summer School** — Teaching Assistant, Copenhagen — Summer 2024
  TA for Variational Inference & Optimization and Introduction to Deep Generative Models.
- **Machine Learning Course** — Assistant Instructor, Saarland University — Spring 2023
  Prepared regression/classification material; designed semester project on Twitter sentiment prediction.
- **Student Supervision** — Saarland University — 2023 — 2025
  Co-supervised two B.Sc. theses (2025) and supervised B.Sc./M.Sc. students on the term project "Conformal Predictions for Traffic Sign Recognition" (2023).

Skills

- **Languages:** Turkish (native), English (advanced), German (B1)
- **Programming & tools:** Python, SQL, C++, MATLAB, Git, Docker, Slurm, AWS
- **ML & AI:** PyTorch, JAX, Hugging Face, Lightning, LangChain/LangGraph, RAG, MCP, OpenAI/Anthropic APIs