Alexandru Crăciun

Research Group Theoretical Foundations of Artificial Intelligence
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EDUCATION

06/2024 – Present	**Technical University of Munich** Doctoral Student
10/2021 – 02/2024	**Ludwig Maximilian University** MSc in Theoretical and Mathematical Physics GPA: 1.7/1.0 (German Scale, 1.0 is best)
10/2018 – 07/2021	**University of Bucharest** BSc in Physics Valedictorian, GPA: 10.0/10.0

RESEARCH INTERESTS

My research sits at the intersection of **geometry, topology, and optimization**. I investigate how results in pure mathematics can be used to understand neural network training. My work focuses on:

- **Optimization Dynamics:** Analyzing how the geometry of the loss landscape and the algorithm choice introduce biases, or define regimes where convergence is mathematically impossible.
- **Topological Data Analysis:** Investigating how the topological properties of data manifolds impose fundamental limits on model performance in unsupervised learning.
- **Theoretical Grounding:** Validating the structural assumptions of general optimization theory (e.g., smoothness or non-singularity) within the specific context of neural network architectures to bridge the gap between theory and practice.

PUBLICATIONS AND PREPRINTS

Published Articles

- **Non-Singularity of the Gradient Descent Map for Neural Networks with Piecewise Analytic Activations** (with D. Ghoshdastidar)
  NeurIPS 2025 - 39th Conference on Neural Information Processing Systems. San Diego, CA, USA, Nov 30–Dec 07, 2025. Poster Presentation. To be published.
- **Modelling the Unfair Toss of an Unbiased Coin** (with T. O. Cheche)
  Rom. Rep. Phys. 72, 106 (2020)

Preprints

- **Linear Independence of Powers for Polynomials**
  Preprint (2025) 1-4, arXiv:2507.10163
- **On the Convergence of Gradient Descent for Large Learning Rates** (with D. Ghoshdastidar)
  Preprint (2024), 1-24, arXiv:2402.13108

Theses

- **On the Stability of Gradient Descent for Large Learning Rate**
  MSc Thesis, LMU (2024). Advisor: Prof. Debarghya Ghoshdastidar

EMPLOYMENT

06/2024 – Present **Technical University of Munich**
Research Assistant

03/2021 – 06/2021 **Bosch Romania**
A.I. Research Student

RESEARCH STAYS

03/2026 – 04/2026 **Indian Institute of Technology Madras**
PhD Research Stay (Upcoming)
Topic: Investigating the interplay between feature learning and training dynamics within unsupervised learning regimes.

07/2020 – 09/2020 **Horia Hulubei National Institute of Physics and Nuclear Engineering, Magurele, Romania**
Undergraduate Summer Internship
Studied the fundamentals of Quantum Information Theory (based on Nielsen & Chuang). Applied theoretical concepts to algorithmic challenges by participating in a Quantum Machine Learning hackathon.

07/2019 – 07/2019 **Joint Institute for Nuclear Research, Dubna, Russia**
Undergraduate Summer Internship
Analyzed cosmological datasets to estimate the Hubble constant. Developed numerical simulations to model universe expansion trajectories under varying cosmological constant parameters.

TEACHING EXPERIENCE

Supervision of Students

- **Wanchen Li** (Student Project) 2026
  "Extensions to: Abide by the Law and Follow the Flow: Conservation Laws for Gradient Flows" (TUM)
- **Priyam Turakhia** (Bachelor Thesis) 2025
  "An Investigation of the Edge of Stability Phenomenon in Neural Network Training" (TUM)

Course Teaching (Technical University of Munich)

- **Discrete Probability Theory** (2nd year BSc) — Summer Semester 2025
  Teaching Assistant
- **Statistical Foundations of Learning** (2nd year MSc) — Summer Semester 2024
  Teaching Assistant

HONORS AND AWARDS

2021 – 2023 **DAAD Study Scholarship for Graduates of All Disciplines**
Full scholarship awarded by the German Academic Exchange Service for MSc studies.

TECHNICAL SKILLS

Languages
Python (PyTorch), Julia, Lean, C.
Software & Tools
LaTeX, Git, Mathematica.

ACADEMIC REFERENCES

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