KOTCHOURKO SERGE

links

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education

MASTER OF SCIENCE (M.Sc.) INFORMATIK
Apr 2022 - Mai 2025
University of Stuttgart, Stuttgart, Baden-Württemberg
Grade 1.2

My Master's degree heavily focused on Machine Learning and Information Security, building upon my diverse undergraduate foundation. In my Master's thesis in Scientific Machine Learning , I tackled the challenge of efficiently solving complex partial differential equations for physical systems, especially when traditional solution data is scarce and costly to obtain. I investigated a novel approach to integrate physical constraints directly into the pre-training of scientific foundation models and through the use of frequency analysis determined a possible factor for developing data-efficient generalizable PDE solvers.

BACHELOR OF SCIENCE (B.Sc.) INFORMATIK
Oct 2017 - Mar 2022
University of Stuttgart, Stuttgart, Baden-Württemberg
Grade: 1.9

My Bachelor of Science in Computer Science was marked by a commitment to broad interdisciplinary exploration, ranging from pure mathematics and theoretical computer science to electrical engineering and computer organization, alongside core software engineering principles. This diverse background led to my thesis in computational linguistics, where I applied graph theory to optimize the process of human data annotation. I developed a large scale, autonomous, simulation environment to test various sampling, clustering, and stopping procedures, which allowed me to model the characteristics of different annotation methods, ultimately identifying their key advantages and disadvantages for practical application.

experience

SOFTWARE ENGINEER
Aug 2025 - Present
itestra GmbH Stuttgart, Baden-Württemberg

Additionally to the projects from my working student position, I am also developing a high-availability, high-throughput thin layer that connects two emergency critical applications, designed to enable the efficient alerting of employees in such situations.

WORKING STUDENT SOFTWARE ENGINEER
Sep 2023 - Aug 2025
itestra GmbH Stuttgart, Baden-Württemberg

I was working on two projects. The first project included modernizing and extending an enterprise banking platform. My work included migrating legacy technical processes, optimizing communication interfaces for low latency and efficiency, and building new features to meet evolving business needs. The second project encompassed extending and a mobile application used as an educational platform by schools. My responsibilities included ensuring stable platform-to-hardware communication and seamless integration of new functionalities, providing a direct programming interface for students.

LEAD SOFTWARE ENGINEER
Aug 2022 - Aug 2023
TTI GmbH, DUREL TGU, Stuttgart, Baden-Württemberg

As a Lead Software Engineer, I designed and developed a full-stack, open-source platform for computational linguistics research. I was responsible for the project's architecture, including a robust backend to handle large, diverse datasets and a user-friendly frontend specialized for fast, accurate data annotation. I also ensured a secure and fault-tolerant deployment process.

STUDENT ASSISTANT
Oct 2021 - Jun 2022
University of Stuttgart, Stuttgart, Baden-Württemberg

I actively maintained and extended existing annotation software, ensuring its continued functionality and relevance. My responsibilities included correcting bugs, implementing new features to meet evolving user requirements, and proactively analyzing and mitigating potential security risks, such as the critical Log4Shell vulnerability.

ACADEMIC TUTOR
University of Stuttgart, Stuttgart, Baden-Württemberg

Apr 2021 - Jul 2021
Managed multiple groups of students, serving as a first point contact for assistance in understanding the lecture material and corresponding exercises for the lecture “Introduction to Software Engineering”. This also included holding group and one-to-to meetings and grading exercise sheets.

Nov 2020 - Feb 2021
Assisted multiple small groups, which were developing a software solution for a company based on their requirements, by providing feedback, teaching and deepening core software development concepts.

SOFTWARE DEVELOPER
Oct 2019 - Mar 2020
Radical Minds GmbH,
Karlsruhe, Baden-Württemberg

Development of a full-scale internal software solution designed to automate and streamline all aspects of customer relationship management. This platform was built to centralize customer data, automate key workflows, and improve the overall efficiency of customer management.

ACADEMIC TUTOR
University of Stuttgart, Stuttgart, Baden-Württemberg

May 2019 - Jul 2019
Holding multiple tutoring sessions accompanying the lecture about Computer Engineering/Architecture, deepening the understanding of the studied material.

Oct 2018 - Mar 2019
Holding multiple tutoring sessions accompanying the lecture for Programming and Software Development , deepening the understanding of the studied material.

research

Paving the Way for Scientific Foundation Models: Evaluating Physics-Informed Pre-Trainin Strategies
Mar 24, 2025
TBA

Scientific foundation models (SciFMs) aim to learn generalizable representations of physical systems governed by partial differential equations (PDEs), enabling transfer across a wide range of tasks and domains. While physics-informed methods—leveraging PDE residuals as supervisory signals—have shown promise in scientific machine learning (SciML) for improving accuracy and reducing data requirements, their potential in the context of SciFMs remains largely unexplored. In this evaluation study, we investigate whether incorporating physics-informed pre-training improves the generalization, robustness, and data efficiency of SciFMs. We conduct systematic experiments across a diverse set of PDEs, ranging from simple problems with periodic boundary conditions—where spectral derivatives are effective—to more challenging systems such as Navier-Stokes equations and problems with non-periodic geometries requiring finite-difference discretizations.
Our results show that physics-informed pre-training provides clear benefits in structured, well-aligned settings: it enhances generalization and reduces data dependence compared to data-only pre-training. However, these advantages diminish significantly as the downstream tasks deviate from the pre-training distribution. In complex or structurally different problems—such as those involving new boundary conditions or PDE operators—physics-informed models may perform on par with or worse than data-driven baselines.
These findings highlight both the promise and the current limitations of physics-informed SciFMs. While residual-based pre-training helps in idealized regimes, realizing broadly transferable scientific foundation models will likely require stronger inductive biases and more principled integration of physical knowledge into model architectures.

Paving the Way for Scientific Foundation Models: Enhancing Generalization and Robustness in PDEs with Constraint-Aware Pre-Training
Mar 24, 2025
arXiv:2503.19081

Partial differential equations (PDEs) govern a wide range of physical systems, but solving them efficiently remains a major challenge. The idea of a scientific foundation model (SciFM) is emerging as a promising tool for learning transferable representations across diverse domains. However, SciFMs require large amounts of solution data, which may be scarce or computationally expensive to generate. To maximize generalization while reducing data dependence, we propose incorporating PDE residuals into pre-training either as the sole learning signal or in combination with data loss to compensate for limited or infeasible training data. We evaluate this constraint-aware pre-training across three key benchmarks: (i) generalization to new physics, where material properties, e.g., the diffusion coefficient, is shifted with respect to the training distribution; (ii) generalization to entirely new PDEs, requiring adaptation to different operators; and (iii) robustness against noisy fine-tuning data, ensuring stability in real-world applications. Our results show that pre-training with PDE constraints significantly enhances generalization, outperforming models trained solely on solution data across all benchmarks. These findings prove the effectiveness of our proposed constraint-aware pre-training as a crucial component for SciFMs, providing a scalable approach to data-efficient, generalizable PDE solvers.

Effects of Pre- and Post-Processing on type-based Embeddings in Lexical Semantic Change Detection
Apr 22, 2021
Publication in Association for Computational Linguistics

Lexical semantic change detection is a new and innovative research field. The optimal fine-tuning of models including pre- and post-processing is largely unclear. We optimize existing models by (i) pre-training on large corpora and refining on diachronic target corpora tackling the notorious small data problem, and (ii) applying post-processing transformations that have been shown to improve performance on synchronic tasks. Our results provide a guide for the application and optimization of lexical semantic change detection models across various learning scenarios.