Leon **Sering**

Postdoctoral Researcher at ETH Zürich

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Summary

As a mathematician and computer scientist, I currently work as a Postdoc for the Institute for Operations Research at ETH Zürich. Beside my theoretical research on Nash flows over time (agent-based traffic modeling), my true passion lies in **optimization algorithms** and **high performance algorithm design**. I lead two exciting industry collaborations: For Swiss Post we solve a **vehicle routing** problem and for SBB I'm developing a high performance algorithm for optimal **rolling stock scheduling**. For more details visit my homepage: **https://leon.sering.eu**.

My programming language of choice? **Rust**. This high performance system programming language, with focus on **parallelism/concurrency**, is the perfect tool for my projects. Plus, it's just plain fun to use!

In my downtime, you will find me (and my family) exploring the wonders of our planet – through road trips, photography, and Scuba diving.

Work Experience

Operations Research Expert (Freelancer)

Paderborn, Germany

OPTANO GmbH — *May 2023 - June 2023*

- Consulting services for a line haul solution.
- Design of mixed-integer linear program.
- Implementation of a fast multi-objective routing algorithm.

Postdoctoral Researcher

Zurich, Switzerland

Institute for operations research, department of mathematics, ETH Zürich — *April 2021 - today*

- Leading scientific collaboration with Swiss Post and Swiss Federal Railways SBB.
- Design and implementation of fast clustering algorithm.
- Research in operations research, efficient algorithms, meta-heuristics, and parallelism.

Research Associate

Berlin, Germany

research group: combinatorial optimization & graph algorithms, institute of mathematics, TU Berlin — *May 2017 - March 2021*

- ECMath and MATH+ research projects: dynamic models and algorithms for equilibria in traffic networks.
- Research goals: improve agent-based mathematical flow over time models (Nash flow over time) to connect with large-scale traffic simulations such as MATSim.

Education

Dr. rer. Nat. in Mathematics

TU Berlin, Germany

Dissertation title: Nash Flows Over Time, Grade: summa cum laude, Math+ dissertation award — *Sep. 2016 - Sep. 2020*

- PhD topic: traffic simulation and optimization by using flows over time including game theoretical aspects.

Master of Advanced Studies

University of Cambridge, UK

Part III of the mathematical tripos, grade: with honours — *Oct. 2013 - Jul. 2014*

Bachelor and Master of Science in Mathematics

University of Würzburg, Germany

Grades: 1.0 / 1.0, Awards: 2x Otto-Volk-medal for excellent performances — *Oct. 2010 - Sep. 2014*

Bachelor of Science in Computer Science

University of Würzburg, Germany

Grade: 1.0, Award for excellent performances — *Oct. 2010 - Apr. 2013*

Selected Projects

leon.sering.eu/#projects

Rolling Stock Scheduling Optimization

ETH - SBB - Collaboration

Languages and Tools: Rust | Docker | HTTP Server

- Scheduling trains (rolling stock) for a given time tabel to minimize dead head trips.
- Approach: local-search heuristic using concurrency and min-cost flow optimization.

Fast Same-Day Delivery Optimization

ETH - Swiss Post - Collaboration

Languages and Tools: Scala | Gurobi | Docker | HTTP Server

- Vehicle Routing: Scheduling capacitated drivers to deliver shipments within time windows.
- Approaches: mixed integer program, local search heuristic, fast k-opt for TSP-subproblem.

Fair and Fast k-Center

Research Project at ETH Zürich

Languages: Rust | Python

- Linear-time algorithm for k-center with fairness criteria that runs very fast in practice.
- Highly optimized for parallelism/concurrency.
- ICML publication.

Nash Flow Computation

Research Project at TU Berlin

Languages and Tools: Python | Qt | SCIP

- Tool for computing Nash flows over time with mixed integer programming.

Drawing Road Networks with Focus Regions

Research Project

Languages and Tools: Java | Qt | CPLEX

- Tool for computing road network visualization with enlarged user-defined focus regions.
- TVCG publication.

Computer Skills

Computer Science

Combinatorial Optimization | Meta-Heuristics | Fast Parallel Algorithms | Mathematical Programming

Programming Languages

Rust | Scala | Python | Java

Optimization Tools

Gurobi | SCIP

Miscellaneous

Git | GitLab | GitHub | Bash | NeoVIM | Docker | CI/CD | LaTeX | Linux | Windows | Office software

Scholarships and Competitions

Deutschlandstipendium

University of Würzburg

National Scholarship

May 2011 - Sep. 2015

Vereinigte Stipendien- und Preisstiftung

University of Würzburg

Scholarship of the University of Würzburg

Aug. 2010 - Apr. 2011

Award Winner in the Final Round of *26. Bundeswettbewerb Informatik*

High School

National competition in computer science

Dec. 2007 - Sep. 2008

Languages

Fluent	**English**
Native	**German**

Interests

traveling | photography | scuba diving | running | computer games | virtual reality

Research Publications

leon.sering.eu/#publications

[1] Christoph Hertrich and Leon Sering. "ReLU Neural Networks of Polynomial Size for Exact Maximum Flow Computation". In: *International Conference on Integer Programming and Combinatorial Optimization (IPCO '23)*. 2023. arXiv: 2102.06635.

[2] Neil Olver, Leon Sering, and Laura Vargas Koch. "Convergence of Approximate and Packet Routing Equilibria to Nash Flows Over Time". In: *Annual Symposium on Foundations of Computer Science (FOCS'23)*. IEEE. 2023. arXiv: 2402.04935.

[3] Theresa Ziemke, Leon Sering, and Kai Nagel. "Spillback changes the long-term behavior of dynamic equilibria in fluid queuing networks". In: *Workshop on Algorithmic Approaches for Transportation Modelling, Optimization, and Systems (ATMOS'23)*. OpenAccess Series in Informatics (OASIcs). Dagstuhl, Germany, 2023.

[4] Antonia Adamik and Leon Sering. "Atomic Splittable Flow Over Time Games". In: *Symposium on Algorithmic Foundations of Dynamic Networks (SAND'22)*. 2022, p. 53. arXiv: 2010.02148.

[5] Haris Angelidakis, Adam Kurpisz, Leon Sering, and Rico Zenklusen. "Fair and Fast k-Center Clustering for Data Summarization". In: *International Conference on Machine Learning (ICML'22)*. PMLR. 2022, pp. 669–702.

[6] Neil Olver, Leon Sering, and Laura Vargas Koch. "Continuity, Uniqueness and Long-Term Behavior of Nash Flows Over Time". In: *Annual Symposium on Foundations of Computer Science (FOCS'21)*. IEEE. 2022, pp. 851–860. arXiv: 2111.06877.

[7] Leon Sering, Laura Vargas Koch, and Theresa Ziemke. "Convergence of a Packet Routing Model to Flows over Time". In: *Mathematics of Operations Research (MOR)* 0.0 (2022). A preliminary version was presented at the 22nd ACM Conference on Economics and Computation (EC'21). arXiv: 2105.13202.

[8] Stefan Felsner, Linda Kleist, Torsten Mütze, and Leon Sering. "Rainbow Cycles in Flip Graphs". In: *SIAM Journal on Discrete Mathematics* 34.1 (2020). A preliminary version was presented at the International Symposium on Computational Geometry (SoCG'18), pp. 1–39. arXiv: 1712.07421.

[9] Lukas Graf, Tobias Harks, and Leon Sering. "Dynamic Flows with Adaptive Route Choice". In: *Mathematical Programming* 183.1 (2020), pp. 309–335. arXiv: 1811.07381.

[10] Jonas Israel and Leon Sering. "The Impact of Spillback on the Price of Anarchy for Flows over Time". In: *International Symposium on Algorithmic Game Theory (SAGT'20)*. Springer. 2020, pp. 114–129. arXiv: 2007.04218.

[11] Hoang Minh Pham and Leon Sering. "Dynamic Equilibria in Time-Varying Networks". In: *International Symposium on Algorithmic Game Theory (SAGT'20)*. Springer. 2020, pp. 130–145. arXiv: 2007.01525.

[12] Leon Sering. "Nash Flows Over Time". PhD thesis. Technische Universität Berlin, 2020.

[13] Theresa Ziemke, Leon Sering, Laura Vargas Koch, Max Zimmer, Kai Nagel, and Martin Skutella. "Flows Over Time as Continuous Limits of Packet-Based Network Simulations". In: *Transportation Research Procedia* (2020). A preliminary version was presented at The Euro Working Group on Transportation (EWGT'20).

[14] Leon Sering and Laura Vargas Koch. "Nash Flows Over Time with Spillback". In: *ACM-SIAM Symposium on Discrete Algorithms (SODA'19)*. 2019, pp. 935–945. arXiv: 1807.05862.

[15] Leon Sering and Martin Skutella. "Multi-Source Multi-Sink Nash Flows over Time". In: *Workshop on Algorithmic Approaches for Transportation Modelling, Optimization, and Systems (ATMOS'18)*. Vol. 65. OpenAccess Series in Informatics (OASIcs). Dagstuhl, Germany, 2018, 12:1–12:20. arXiv: 1807.01098.

[16] Leon Sering. "A Combinatorial Upper Bound on the Length of Twang Cascades". In: *European Workshop on Computational Geometry (EuroCG'17)*. Malmö, 2017, pp. 177–180.

[17] Jan-Henrik Haunert and Leon Sering. "Drawing Road Networks with Focus Regions". In: *IEEE Transactions on Visualization and Computer Graphics* 17.12 (2011). A preliminary version was presented at IEEE Information Visualization Conference (INFOVIS'11), pp. 2555–2562.