

# 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 fearless **concurrency**, is the ideal tool for my projects. Plus, it's just 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)

OPTANO GMBH

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

*Paderborn, Germany*

*May 2023 - June 2023*

### Postdoctoral Researcher

INSTITUTE FOR OPERATIONS RESEARCH, DEPARTMENT OF MATHEMATICS, ETH ZÜRICH

- 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.

*Zurich, Switzerland*

*April 2021 - today*

### Research Associate

RESEARCH GROUP: COMBINATORIAL OPTIMIZATION & GRAPH ALGORITHMS, INSTITUTE OF MATHEMATICS, TU BERLIN

- 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.

*Berlin, Germany*

*May 2017 - March 2021*

## Education

### Dr. rer. Nat. in Mathematics

DISSERTATION TITLE: NASH FLOWS OVER TIME, GRADE: SUMMA CUM LAUDE, MATH+ DISSERTATION AWARD

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

*TU Berlin, Germany*

*Sep. 2016 - Sep. 2020*

### Master of Advanced Studies

PART III OF THE MATHEMATICAL TRIPOS, GRADE: WITH HONOURS

*University of Cambridge, UK*

*Oct. 2013 - Jul. 2014*

### Bachelor and Master of Science in Mathematics

GRADES: 1.0 / 1.0, AWARDS: 2X OTTO-VOLK-MEDAL FOR EXCELLENT PERFORMANCES

*University of Würzburg, Germany*

*Oct. 2010 - Sep. 2014*

### Bachelor of Science in Computer Science

GRADE: 1.0, AWARD FOR EXCELLENT PERFORMANCES

*University of Würzburg, Germany*

*Oct. 2010 - Apr. 2013*

## Selected Projects

[leon.sering.eu/#projects](https://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

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## Computer Science

COMBINATORIAL OPTIMIZATION | META-HEURISTICS | FAST PARALLEL ALGORITHMS | MATHEMATICAL PROGRAMMING | TRAFFIC / LOGISTIC OPTIMIZATION

## Programming Languages

RUST | SCALA | C++ | PYTHON | JAVA

## Optimization Tools

GUROBI | SCIP

## Miscellaneous

GIT | GITLAB | GITHUB | BASH | NEOVIM | DOCKER | CI/CD | LATEX | LINUX | WINDOWS | OFFICE SOFTWARE

# Scholarships and Competitions

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## 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

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

# Interests

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

- [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 Haurert 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.