

OBJECTIVE

I am a **software engineer** and a **physicist**, bridging the gap between developing high-quality software and advancing interdisciplinary research. While I specialize in **network science**, **transport systems**, and **information theory**, I enjoy applying my expertise to diverse domains. I want to join teams that value open-source development, research-driven solutions, and collaborative innovation.

EXPERIENCE

- **Digital Linguistics (DiLi), Department of Computational Linguistics**
Research Software Engineer (Zurich, Switzerland)

 - Contribute to the development of the Python package [pymovements](#) for eye-tracking data analysis, with focus on tasks supporting the OpenEye project [C.2]
 - Develop preprocessing pipelines for the MultiPEYE corpus and organize community meetings to foster collaboration within the EU COST Action [C.1][C.4]
 - Improve eye-tracking data processing methods, creating tutorials and bridging computational linguistics with behavioral data methods

Oct 2025 - Present


- **Institute for Cross-Disciplinary Physics and Complex Systems (IFISC), CSIC-UIB**
Research Software Engineer & Predoctoral Researcher (Palma de Mallorca, Spain)

 - Conduct interdisciplinary research at the interface of network science, transport systems, and information theory, with a focus on delay and information propagation in air transport [J.6][J.7]
 - Develop open-source scientific software and scalable data analysis pipelines for time series, causal inference, and complex networks [J.3][J.4]
 - Collaborate within the ERC Starting Grant project ARCTIC [C.5], which reconceptualizes air transport as an information processing system, adapting methods from neuroscience and statistical physics to characterize and mitigate delay propagation

Nov 2023 - Present


- **Planning of Landscape and Urban Systems (PLUS), ETH Zürich**
External Scientist & SWE (Zurich, Switzerland)

 - Procurement of a high-performance biodiversity modeling pipeline and adapted model linkage for ValPar.CH [C.6]
 - Research on the societal, ecological, and economic values of ecological infrastructure [J.5]

Aug 2023 - Jan 2025


- **NEtworks, Data, and Society (NERDS), IT University of Copenhagen**
Associated Researcher & SWE (Copenhagen, Denmark)

 - Collaborated on quantitative research in urban mobility and computational network analysis [J.2]
 - Supported software development and data analysis for large-scale urban data projects

Oct 2022 - Sep 2023


- **Faculty of Technology, Policy and Management (TPM), TU Delft**
Visiting Researcher (Delft, The Netherlands)

 - Conducted systematic literature review and meta-analysis on bicycle helmet effectiveness for injury prevention
 - Published in Scientific Reports: [Sci Rep 13, 8540 \(2023\)](#) [J.1]

Mar 2022


- **Institute of Space Research, German Aerospace Center (DLR)**
External Scientist & SWE (Remote (Berlin, Germany))

 - Contributed to system-level testing of the Fine Guidance System (FGS) for ESA's PLATO mission [C.3]
 - Developed and evaluated automated robustness testing frameworks for satellite image processing

Mar 2021 - Aug 2021


- **Deans office Department VII - Psychology & Sports Sciences**
IT Admin, SRE & SWE

 - Provided IT administration and managed development of departmental software platforms
 - Developed and maintained systems for data management and analysis supporting teaching and examinations

Oct 2019 - Sep 2023
Münster, Germany

EDUCATION

- **University of the Balearic Islands** [🎓] Nov 2023 - 2026
Ph.D. in Physics Palma de Mallorca, Spain
 - “Towards more efficient transportation systems: real-time data and advanced analytics”
 - Developing open-source Python libraries (infomeasure, delaynet) for analysis of multi-modal transport networks.
 - Research conducted within the ERC project ARCTIC at IFISC (CSIC-UIB), supervised by Dr. Massimiliano Zanin.
- **University of Münster** Oct 2021 - Jul 2023
Master of Science in Physics [🎓] Münster, Germany
 - Grade: overall: sehr gut (1,5), thesis: sehr gut (1,1) [T.3]
 - Semester abroad in Winter Term 21/22 - Complex Systems at IFISC, Universitat de les Illes Balears, Spain
 - Year abroad 2022/10 – 2023/09 - Master thesis at NetwoRks, Data, and Society (NERDS), ITU, Denmark
- **University of Münster** Oct 2018 - Jul 2021
Bachelor of Science in Computer Science [🎓] Münster, Germany
 - Grade: overall: gut (2,4), thesis: sehr gut (1,0) [T.2]
- **University of Münster** Oct 2017 - Sep 2020
Bachelor of Science in Physics [🎓] Münster, Germany
 - Grade: overall: gut (2,2), thesis: sehr gut (1,0) [T.1]

PROJECTS

- **delaynet: Delay Functional Network Inference from Time Series** Jun 2024 - Sep 2025
Tools: Python, Network Science, Time Series Analysis, Information Theory, Transport Systems [J.7][🔗][📄]
 - Lead developer; designed and implemented a flexible Python package for reconstructing and analyzing delay-driven functional networks from time series, with applications in transport and complex systems
 - Developed modular components for preprocessing, detrending, and connectivity analysis (i.e. Granger causality, mutual information, transfer entropy), supporting simulation and visualization of delay propagation
 - Applied and extended information-theoretic methods to uncover causal structures in real and synthetic networks, bridging advanced theory with practical transport analysis
 - Ongoing maintenance and distribution on PyPI and conda-forge
- **SynthATDelays: Minimalist Generation of Synthetic Air Transport Delay Data** Jun 2024 - Aug 2024
Tools: Python, Testing, Code Quality, Performance Optimization, Network Simulation [J.4][🔗][📄]
 - Ensured code quality and maintainability through review, testing framework implementation, and performance optimization of transport simulation algorithms
 - Tested modular components for aircraft routing, airport capacity modeling, and delay mechanisms (en-route, airport-specific, time-dependent), enabling analysis of causality patterns without real-world data constraints
- **infomeasure: Python Library for Information-Theoretic Analysis** Jun 2024 - May 2025
Tools: Python, Information Theory, Data Science, Neuroscience, Modular API [J.3][🔗][📄]
 - Lead developer and maintainer: independently designed the software architecture and implemented the open-source Python library for information-theoretic analysis, supporting entropy, mutual information, transfer entropy, and divergence measures for both discrete and continuous data
 - Optimised and abstracted academic algorithms, integrating advanced estimators (kernel, kNN, ordinal) and enabling hypothesis testing, local measures, and plug-and-play extensibility
 - Developed comprehensive documentation and validation suite, ensuring reproducibility and accessibility for researchers in neuroscience, physics, data science, and more
- **Air Transport in Africa: Statistical Physics Approach to Delay Propagation** 2024 - 2025
Tools: Python, Time Series Analysis, Granger Causality, Flight Delay Networks [J.6]
 - Engineered a scalable pipeline to extract, aggregate, and normalize multi-year flight delay data (2020-2024) into high-resolution time series for the top 100 airports in Africa and the US, supporting advanced network analyses
 - Applied Granger causality testing to reveal and quantify delay propagation pathways between individual airports, enabling comparative studies of air transport network dynamics across continents
- **superblockify: Automated Generation, Visualization, and Analysis of Urban Superblocks** Oct 2022 - Sep 2023
Tools: Python, NetworkX, OSMnx, GeoPandas, Geospatial Analysis [T.3][J.2][🔗][📄]
 - Led all aspects of development as primary author and maintainer of superblockify, an open-source Python package for partitioning urban street networks into potential Superblocks and analyzing their spatial and network properties
 - Implemented robust algorithms for automated Superblock delineation using either residential street tags or betweenness centrality approaches
 - Integrated automated data retrieval from OpenStreetMap and population datasets, supporting export to standard GIS formats for downstream planning workflows

- Provided interactive visualization and comprehensive metrics—including global efficiency, directness, and betweenness centrality—to inform urban planners and researchers
 - Project serves as a foundational tool for sustainable city planning and large-scale urban mobility studies; used in preliminary analyses of 180 cities and the EU Horizon JUST STREETS project
 - Feature-complete and actively maintained with regular CI, compatibility updates, and user support; available on PyPI and conda-forge
- **Fault Injection for Robustness Testing of Satellite On-Board Image Processing** Mar 2021 - Aug 2021
Tools: Python, Automated Testing, Image Processing [T.2][🌐]
- Developed an automated, domain-specific fault injection framework to systematically test the robustness of the Fine Guidance System (FGS) for ESA's PLATO mission, ensuring mission-critical accuracy and reliability
 - Modeled and injected realistic sensor and environmental faults (e.g., hot/dead pixels, cosmic rays, optical blur) in simulated satellite imagery, based on literature and expert input
 - Evaluated FGS resilience using equivalence class testing, identifying robust and vulnerable fault classes to inform further algorithm improvements
 - Implementation is hosted in a private DLR GitLab due to project confidentiality

PUBLICATIONS

C=CONFERENCE, J=JOURNAL, P=PATENT, S=IN SUBMISSION, T=THESIS

- [J.7] **Carlson M. Büth**, Massimiliano Zanin (2026). **Functional Connectivity Networks for Transportation Delay Analysis: From Theory to Software**. *Transportation Research Interdisciplinary Perspectives* 39, 102187. DOI: [10.1016/j.trip.2026.102187](https://doi.org/10.1016/j.trip.2026.102187).
- [C.4] Deborah N. Jakobi, **Carlson M. Büth**, et al. (2026). **The MultipleYE Pipeline: An Open Source, Adaptable Eye-Tracking-while-Reading Preprocessing Pipeline including a Tutorial**. Conference, Skopje, North Macedonia, August 2026.
- [C.3] Cui Ding, **Carlson M. Büth**, et al. (2026). **The MultipleYE Psychometric Test Battery**. Conference, Skopje, North Macedonia, August 2026.
- [C.2] Daniel G. Krakowczyk, **Carlson M. Büth**, et al. (2026). **pymovements: Building Blocks for Reproducible Eye-Tracking Pipelines**. Conference, Skopje, North Macedonia, August 2026.
- [J.6] Pau Esteve, **Carlson M. Büth**, Massimiliano Zanin (2026). **Air Transport in Africa: A Statistical Physics Approach**. *Scientific Reports* Accepted 17 July 2026. DOI: [10.1038/s41598-026-62266-z](https://doi.org/10.1038/s41598-026-62266-z).
- [C.1] Marie-Luise Müller, **Carlson M. Büth**, et al. (2026). **Preprocessing Eye-Tracking Data for Reading: A Community Survey on Practices, Challenges, and Needs**. ETRA '26. DOI: [10.1145/3797246.3805480](https://doi.org/10.1145/3797246.3805480).
- [J.5] Benjamin Black, **Carlson M. Büth**, et al. (2025). **Identifying Robust Area-Based Conservation Strategies to Secure Ecosystem Service Provision under Uncertainties**. *Journal of Environmental Management* 398 (January 2026): 128395. [10.1016/j.jenvman.2025.128395](https://doi.org/10.1016/j.jenvman.2025.128395)
- [J.4] **Carlson M. Büth**, and Massimiliano Zanin. **SynthATDelays: A Minimalist Python Package for the Generation of Synthetic Air Transport Delay Data**. *Aerospace* 12, no. 10 (2025): 900. [10.3390/aerospace12100900](https://doi.org/10.3390/aerospace12100900).
- [J.3] **Carlson M. Büth**, Kishor Acharya, Massimiliano Zanin (2025). **Infomeasure: A Comprehensive Python Package for Information Theory Measures and Estimators**. *Scientific Reports* 15, no. 1 (2025): 29323. DOI: [10.1038/s41598-025-14053-5](https://doi.org/10.1038/s41598-025-14053-5). *arXiv preprint* [arXiv.2505.14696](https://arxiv.org/abs/2505.14696)
- [J.2] **Carlson M. Büth**, Anastassia Vybornova, Michael Szell (2024). **superblockify: A Python Package for Automated Generation, Visualization, and Analysis of Potential Superblocks in Cities**. *Journal of Open Source Software*, Vol. 9, No. 100, p. 6798. DOI: [10.21105/joss.06798](https://doi.org/10.21105/joss.06798). *arXiv preprint* [arXiv.2404.15062](https://arxiv.org/abs/2404.15062)
- [T.3] **Carlson M. Büth** (2023). **From Gridlocks to Greenways: Analyzing the Network Effects of Computationally Generated Low Traffic Neighborhoods**. Master's thesis, AG Wittkowski @ University of Münster and NERDS @ IT University of Copenhagen. DOI: [10.13140/RG.2.2.26204.36481](https://doi.org/10.13140/RG.2.2.26204.36481)
- [J.1] **Carlson M. Büth**, Natalia Barbour, Mohamed Abdel-Aty (2023). **Effectiveness of bicycle helmets and injury prevention: a systematic review of meta-analyses**. *Scientific Reports*, Vol. 13, 8540. DOI: [10.1038/s41598-023-35728-x](https://doi.org/10.1038/s41598-023-35728-x)
- [T.2] **Carlson M. Büth** (2021). **Fault Injection for Robustness Testing of Satellite On-Board Image Processing**. Bachelor's thesis, Embedded Systems Group @ University of Münster. *External copy: cbrueth.de*
- [T.1] **Carlson M. Büth** (2020). **Deep Inelastic $e^\pm p$ Scattering with Boson Exchange and Interference**. Bachelor's thesis, Institute of Theoretical Physics @ University of Münster.

TALKS, WORKSHOPS & TEACHING

- **Mathematical Foundations for Language Technology 2** Spring Term, 2027
- **Programming in Language Technology 2** Spring Term, 2027
- **MultipleYE Final Conference** August 20, 2026 [C.4][🌐]
The MultipleYE Pipeline: An Open Source, Adaptable Eye-Tracking-while-Reading Preprocessing Pipeline
- **Digital Linguistics (DiLi) Group Retreat Week** June 1–5, 2026
Organiser of the research group's retreat: managed the internal coordination and facilitation
- **Eye Tracking Interest Group Zurich (ETIZ)** May, 2026
Organiser of the Spring'26 community meet-up: curated the program including a lab tour, research talks, and a plenum discussion [🌐]
- **"Reproducible Information Theory: Standardizing Measures, Estimators, and Workflows in Academia"** Mar 11, 2026
Invited talk at NERDS (Networks, Data, and Society), IT University of Copenhagen [🌐]
- **pymovements guest lecture** Mar 9, 2026
For eye-tracking preprocessing course: intro to pymovements [📺]
- **MultipleYE: pymovements & preprocessing meeting** Feb 17-20 & July 20-22, 2026
Co-organised hands-on workshops on the MultipleYE preprocessing pipeline, University of Potsdam & Zürich
- **OpenEye: Building an eye-tracking preprocessing pipeline** Oct 20, 2025
Eye Tracking Interest Group Zurich (ETIZ) meet-up [🌐][🌐]
- **infomeasure Project Presentation** May 15, 2025
Public release of infomeasure: information theory measures and estimators [J.3][📺][🌐]
- **superblockify at VCD-Mobilitätsforum** Sep 6, 2024
VCD-Mobilitätsforum (Verkehrsclub Deutschland e. V.), Berlin [T.3][J.2][🌐]
- **HPC Crash Course** Jul 2024
University of the Balearic Islands (UIB), Spain (HPC/SSH/Slurm on Nuredduna + best practices)

SKILLS

- **Programming Languages:** Python, Bash, R, SQL, Rust, Fortran, HTML, Java
- **Software Engineering:** Software Development, Efficient Algorithms, Programming, Functional Testing, Scientific Computing, Data Structures, Project Planning, Software Architecture
- **Data Science & Scientific Analysis:** Complex Systems, Computational Physics, Transportation, Meta-analysis, Signal Processing, High Performance Computing (HPC), Environmental Science, Urban Studies, Active Transportation, Particle Physics, Quantum Mechanics, General Relativity, Thermodynamics
- **Research & Writing:** Scientific Writing, Literature Reviews, $\LaTeX$
- **DevOps & Version Control:** Git, GitLab, GitHub, CI/CD, PyPI, mamba, conda-forge
- **Operating Systems & Server Administration:** Linux, Slurm, Apache, Docker
- **Tooling & Libraries:** NetworkX, NumPy, SciPy, numba, statsmodels, scikit-learn, osmnx, geopandas, PyTorch, rasterio, shapely, sparse, Matplotlib, *among others*

ADDITIONAL INFORMATION

Languages: German (mother tongue), English (fluent), Spanish (fluent), Catalan (conversational), French (learning)
Interests: Trail Running, Hiking, Photography, Cooking, Information Society, Computational Social Sciences

HONORS AND AWARDS

- **VCD Promotional Award for Theses** September 2024
Verkehrsclub Deutschland e.V. (VCD) and Datagon GmbH [🌐]
 - Honored with first place for the master's thesis [T.3], recognised for advancing participatory digital tools that drive sustainable mobility transformation in cities
 - Celebrated for innovative impact on urban planning, demonstrating how technology and citizen engagement can meaningfully shape future transportation systems
- **Nominee, Promotion Award for Applied Computer Science** April 2022
School of Business and Economics, University of Münster and IHK Nord Westfalen [🌐]
 - Nominated as the only Bachelor's thesis finalist alongside Master's and doctoral theses for best thesis in Applied Computer Science at WWU Münster
 - Recognised for developing a novel fault injection framework to test ESA's PLATO mission guidance system [T.2]

VOLUNTEER EXPERIENCE

- **Student Volunteer**

July 2023

9th International Conference on Computational Social Science (IC2S2)



- Assisted in the execution of the conference, including registration, technical support, and hosting duties as part of the organizing team.
- Helped ensure the smooth operation of talks and other conference activities.

- **Student Representative**

October 2020 - September 2021

Student Council of the Department of Computer Science, University of Münster



- Attended and contributed to regular council meetings, addressing student concerns and academic policies.
- Represented student interests and supported council initiatives through assigned duties and responsibilities.

- **Student Representative**

October 2018 - September 2020

Student Council of the Department of Physics, University of Münster



- Actively represented the interests of students and organised meetings to address concerns and advocate needs.
- Planned and executed freshman events, providing essential information on study regulations and policies.
- Coordinated activities and events, fostering a supportive and informed student community.

PROFESSIONAL MEMBERSHIPS

- **Chaos Computer Club Zürich, Board Member**

2026 - Present

- **Swiss Alpine Club, Member**

2025 - Present

- **Federació Balear de Muntanyisme i Escalada, Member, Club Sa Milana d'Alaró**

2024 - 2025

- **Biciutat de Mallorca (urban cycling advocacy association), Member**

2024 - Present

- **Verkehrsclub Deutschland e. V. (VCD), Member**

2024 - Present

- **Fahrradstadt Münster (citizens' initiative for better cycling in Münster), Member**

2022 - 2024

SHORT INTERNSHIPS

- **Internship**

2015

Intectum GmbH & viveroo GmbH



- Gained insight into administrative processes and assisted in daily operational tasks.

- **Student Internship**

2014

PoolOne Giant Media GmbH



- Assisted in advertising campaigns and gained practical experience in public relations strategies.
- Contributed to the development of marketing materials.