

Carlson Moses Büth

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Palma de Mallorca, Spain | Oerlikon, Zürich, Switzerland

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

- **Institute for Cross-Disciplinary Physics and Complex Systems (IFISC), CSIC-UIB**  Nov 2023 - Present
Palma de Mallorca, Spain
Predoctoral Researcher & SWE
 - 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
 - Develop open-source scientific software and scalable data analysis pipelines for time series, causal inference, and complex networks
 - Collaborate within the ERC Starting Grant project ARCTIC , which reconceptualizes air transport as an information processing system, adapting methods from neuroscience and statistical physics to characterize and mitigate delay propagation
- **Planning of Landscape and Urban Systems (PLUS), ETH Zürich**  Aug 2023 - Jan 2025
Zurich, Switzerland
External Scientist & SWE
 - Procurement of a high-performance biodiversity modeling pipeline and adapted model linkage for ValPar.CH 
 - Research on the societal, ecological, and economic values of ecological infrastructure [S.2]
- **NETwoRks, Data, and Society (NERDS), IT University of Copenhagen**  Oct 2022 - Sep 2023
Copenhagen, Denmark
Associated Researcher & SWE
 - Collaborated on quantitative research in urban mobility and computational network analysis
 - Supported software development and data analysis for large-scale urban data projects
- **Faculty of Technology, Policy and Management (TPM), TU Delft**  Mar 2022
Delft, The Netherlands
Visiting Researcher
 - 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]
- **Institute of Space Research, German Aerospace Center (DLR)**  Mar 2021 - Aug 2021
Remote (Berlin, Germany)
External Scientist & SWE
 - Contributed to system-level testing of the Fine Guidance System (FGS) for ESAs PLATO mission 
 - Developed and evaluated automated robustness testing frameworks for satellite image processing
- **Deans office Department VII - Psychology & Sports Sciences** Oct 2019 - Sep 2023
Münster, Germany
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

EDUCATION

- **University of the Balearic Islands**  Nov 2023 - Present
Palma de Mallorca, Spain
Ph.D. in Physics
 - "Towards more efficient transportation systems: real-time data and advanced analytics"
 - Develops 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
Münster, Germany
Master of Science in Physics 
 - 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
Münster, Germany
Bachelor of Science in Computer Science 
 - Grade: overall: gut (2,4), thesis: sehr gut (1,0) [T.2]
- **University of Münster** Oct 2017 - Sep 2020
Münster, Germany
Bachelor of Science in Physics 
 - Grade: overall: gut (2,2), thesis: sehr gut (1,0) [T.1]

PROJECTS

- **delaynet: Delay Functional Network Inference from Time Series** Jun 2024 - Present
Tools: Python, Network Science, Time Series Analysis, Information Theory, Transport Systems To be open-sourced
 - Sole 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, normalization, 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 planned distribution on PyPI and conda-forge
- **infomeasure: Python Library for Information-Theoretic Analysis** Jun 2024 - May 2025
Tools: Python, Information Theory, Data Science, Neuroscience, Modular API [S.1][🔗][📄]
 - 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
 - Optimized 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
Tools: Python, Time Series Analysis, Granger Causality, Flight Delay Networks Manuscript in preparation
 - 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

- [S.2] Benjamin Black, **Carlson M. Büth**, et al. (2025). **Charting a course: Identifying robust conservation decisions to secure ecosystem service provision under future uncertainty in Switzerland**. Manuscript submitted for publication.
- [S.1] **Carlson M. Büth**, Kishor Acharya, Massimiliano Zanin (2025). **Infomeasure: A Comprehensive Python Package for Information Theory Measures and Estimators**. *arXiv preprint arXiv.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*: cbueth.de
- [T.1] **Carlson M. Büth** (2020). **Deep Inelastic e^+p Scattering with Boson Exchange and Interference**. Bachelor's thesis, Institute of Theoretical Physics @ University of Münster.

SKILLS

- **Programming Languages:** Python, Bash, R, SQL, Fortran, HTML, Rust, 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, L^AT_EX
- **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, 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], recognized 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
 - Recognized 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 organized 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

- **Federació Balear de Muntanyisme i Escalada**, [Member](#), [Club Sa Milana d'Alaró](#) 2024 - Present
- **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.