Princeton University
New Jersey, USA
+1 518 475 8389
larock@princeton.edu
tlarock.github.io
0000-0003-0801-3917
Google Scholar

Timothy LaRock, PhD

Academic Appointments

April 2025–Present **Postdoctoral Research Associate**, *Civil and Environmental Engineering, Princeton University*, Princeton, USA, Complex Infrastructure Systems.
With Prof. Jürgen Hackl

April 2022–March 2025 **Postdoctoral Research Associate**, *Mathematical Institute, University of Oxford*, Oxford, UK, Structure & Dynamics of Multi-way Interactions.
With Prof. Renaud Lambiotte

Education

May 2022 **PhD in Network Science**, *Northeastern University Network Science Institute*, Boston, USA.

Dissertation Representing and Analyzing Pathway Data Through Networks

Committee Prof. Tina Eliassi-Rad (Advisor), Prof. Samuel V. Scarpino (Northeastern), Prof. Hongyang Zhang (Northeastern), Prof. Ingo Scholtes (University of Würzburg)

May 2016 **Bachelor of Science in Computer Science and Applied Mathematics**, *The Honors College, University at Albany, State University of New York*, Albany, USA.
Minor: Philosophy

Advisors Prof. Petko Bogdanov & Prof. Mariya Zheleva

Honors Thesis *Wireless Frequency Spectrum Characterization and Transmitter Detection Using Wavelets*

Funded Grants & Fellowships

2024 SoBigData++ Research Infrastructure Transnational Access Grant (€5,000). Funded a visiting research visit at the Institute of Information Science and Technologies, Italian National Research Council, Pisa, Italy (March–April 2024).

Publications

In Preparation

2026 Y. Li, **TL**, & J. Hackl. "Longitudinal analysis of the robustness of high-speed rail infrastructure in China 2008–2024".

Preprints

2026 **TL**, C. Zhang, & J. Hackl. "Do simulated agents move like real people?" *arXiv:2606.00733*, August 2026 https://arxiv.org/abs/2606.00733.

2026 **TL**, Y. Zhang, N. Eikmeier, J.G. Young, R. Lambiotte, & N. Landry. "The nestedness of higher-order networks". *arXiv:2605.18420*, May 2026 https://arxiv.org/abs/2605.18420. Submitted.

2025 C. Zhang, **TL**, A. Bagabaldo, & J. Hackl. "Rethinking the Sioux Falls Network: Insights from Path-Driven Higher-Order Network Analysis". *arXiv:2508.06234*, August 2025 https://arxiv.org/abs/2508.06234. Submitted.

Peer-Reviewed Journal Papers

2025 **TL** & R. Lambiotte. "Exploring the non-uniqueness of node co-occurrence matrices of hypergraphs". Forthcoming in *Journal of Complex Networks* (as of September 2026). https://arxiv.org/abs/2506.01479

2025 S. Medina, S. Babul, R. Sahasrabuddhe, **TL**, R. Lambiotte, & N. Pedreschi. "Detection of anomalous spatio-temporal patterns of app traffic in response to catastrophic events". *EPJ Data Science*, 14:35, May 2025 https://doi.org/10.1140/epjds/s13688-025-00546-w.

2024 B. Klein, **TL**, S. McCabe, L. Torres, L. Friedland, M. Kos, F. Privitera, B. Lake, M.U.G. Kraemer, J.S. Brownstein, R. Gonzalez, D. Lazer, T. Eliassi-Rad, S.V. Scarpino, A. Vespignani, & M. Chinazzi. "Characterizing the collective physical distancing of the United States during the first nine months of the COVID-19 pandemic". *PLOS Digital Health*, February 2024. https://doi.org/10.1371/journal.pdig.0000430.

2023 **TL** & R. Lambiotte, "Encapsulation Structure and Dynamics in Hypergraphs", *Journal of Physics: Complexity*, November 2023 https://doi.org/10.1088/2632-072X/ad0b39.

2022 **TL**, I. Scholtes, & T. Eliassi-Rad, "Sequential Motifs in Observed Walks", *Journal of Complex Networks*, 10:5, October 2022 https://doi.org/10.1093/comnet/cnac036.

2022 **TL**, M. Xu, & T. Eliassi-Rad, "A Path-based Approach to Analyzing the Global Liner Shipping Network", *EPJ Data Science*, 11:1, March 2022. https://doi.org/10.1140/epjds/s13688-022-00331-z.

2021 S. McCabe, L. Torres, **TL**, S.A. Haque, C-H Yang, H. Hartle, & B. Klein. "`netrd`: A library for network reconstruction and graph distances", *Journal of Open Source Software*. 6 (62), 2990. 10.21105/joss.02990. Open review: joss-reviews/issues/2990.

2020 **TL**, T. Sakharov, S. Bhadra, & T. Eliassi-Rad, "Understanding the Limitations of Network Online Learning", *Applied Network Science*, 5:60, September 2020. https://doi.org/10.1007/s41109-020-00296-w.

Peer-Reviewed Conference Papers

2020 **TL**, V. Nanumyan, I. Scholtes, G. Casiraghi, T. Eliassi-Rad, & F. Schweitzer, "HYPA: Efficient Detection of Path Anomalies in Time Series Data on Networks", Proceedings of the 2020 SIAM International Conference on Data Mining (SDM). May 2020. https://epubs.siam.org/doi/abs/10.1137/1.9781611976236.52.

2018 M. Zheleva, **TL**, P. Schmitt, & P. Bogdanov, "Efficient spectrum summarization using compressed spectrum scans", 2018 IEEE Conference on Computer Communications Poster and Demo (INFOCOM), April 2018.

2018 M. Zheleva, P. Bogdanov, **TL**, & P. Schmitt, "AirVIEW: Unsupervised transmitter detection for next generation spectrum sensing", IEEE International Conference on Computer Communications (INFOCOM2018), April 2018.

2016 **TL**, P. Schmitt, P. Bogdanov, E. Belding, & M. Zheleva, "AirPress: Towards Scalable Spectrum Inventory", 13th USENIX Symposium on Networked Systems Design and Implementation, March 2016.

2014 **TL**, L. Mathews, M. Roberts, D. Lim, & S. Small, "Siena's Twitter Information Retrieval System: The 2014 Microblog Track", In Proceedings of the Twenty-Third Text REtrieval Conference (TREC), November 2014.

Peer-Reviewed Workshop Papers

2018 **TL**, T. Sakharov, S. Bhadra, & T. Eliassi-Rad, "Reducing Network Incompleteness Through Online Learning: A Feasibility Study", 14th International Workshop on Mining and Learning with Graphs (MLG, co-located with The 24th ACM SIGKDD Conference on Knowledge Discovery and Data Mining), August 2018.

External Research Experience

March–April 2024 **Visiting Researcher**, *Institute of Information Science and Technologies, Italian National Research Council*, Pisa, Italy.
SoBigData++ Transnational Access placement (see Grants & Fellowships).

Summer 2018 **Visiting Researcher – Chair of Systems Design/Data Analytics Group**, *ETH Zürich/University of Zürich*, Zürich, Switzerland.
Supervised by Prof. Ingo Scholtes.

Summer 2014 **Research Assistant**, *NSF Research Experience for Undergraduates*, Siena College, Loudonville, USA.

Teaching & Supervision

Teaching Experience

Autumn 2023 **Tutorial Instructor – Networks**, *Oxford Mathematical Institute*, Oxford, UK.
Two tutorial groups of 25 students (final-year undergraduate and MSc)

June 2023 **Tutor – Network Analytics**, *Oxford Summer School in Economic Networks*, Oxford, UK.
Led a practicum in network analysis using Python for 75 students and professionals

Summer 2020 **Instructor – Algorithms & Data Structures**, *Khoury College of Computer Sciences, Northeastern University*, Boston, USA.
Sole Instructor of Record, 84 students; 4.6/5 mean on instructor evaluation items vs. 4.3 departmental and 4.4 university means (24 respondents)

Fall 2014 **Teaching Assistant – Introduction to Computer Science**, *Computer Science Department, University at Albany, SUNY*, Albany, USA.

Student Supervision & Mentoring

Princeton University

2026– **Michael Gan**, *Undergraduate research assistant*, Supervisor.
Large-scale simulation of the New York City subway.

2025– **Edward Kong**, *Undergraduate research assistant*, Supervisor.
Benchmarking map-matching algorithms for GPS data.

2025–2026 **Hassan Khan**, *Undergraduate research assistant*, Supervisor.
Agent-based mobility simulation.

2025–2026 **Nipuna Ginige**, *Undergraduate thesis*, Supervisor.
Anomalous delay detection for the New York City subway. Co-author, NetSci '26 poster.

2025–2026 **Iniabasi Ekpenyong**, *Undergraduate thesis*, Supervisor.
Adaptive higher-order graph learning for molecular property prediction.

University of Oxford

2023–2026 **Sofia Medina**, *DPhil*, Co-supervisor.
Directed hypergraph analysis of chemical reactions; anomaly detection in mobile app data. Co-author, *EPJ Data Science* (2025); NetSci '26 poster. Now: postdoctoral researcher, University of Oxford.

2024 **Yanting Zhang**, *MSc*, Co-supervisor.
Nestedness in hypergraphs. Co-author, *arXiv:2605.18420*. Now: PhD student, University of Hong Kong.

2023– **Willem Jump**, *Undergraduate*, Mentor.
Network analysis of public transit data. Now: PhD student, University of Birmingham.

Invited Talks

2026 "Higher-order Analysis of Human Mobility Data". Higher-order Networks Satellite (HONS) at the 20th International School and Conference on Network Science (NetSci '26). Boston, USA (June 2026).

2026 "Nestedness in Group Interaction Data". Higher-order Hackathon at the 20th International School and Conference on Network Science (NetSci '26). Boston, USA (June 2026).

2026 "Representing and Analyzing Higher-order Networks", Research Seminar, Department of Computer Science, University of Southern Maine, Portland, ME (Feb 2026)

2025 "Representing and Analyzing Higher-order Networks", Research Colloquium, Department of Mathematics and Computer Science, College of the Holy Cross, Worcester, MA (November 2025)

2025 "Exploring the non-uniqueness of node co-occurrence matrices of hypergraphs". Society for Industrial and Applied Mathematics Annual Meeting. Montreal, Quebec, Canada (July 2025)

2024 "Encapsulation Structure and Dynamics in Hypergraphs". Applied Mathematics Seminar. University of Warwick, Coventry, UK (October 2024).

2024 "Encapsulation Structure and Dynamics in Hypergraphs". **Keynote**. HyperSci Satellite at The 16th International Conference on Advances in Social Networks Analysis and Mining (ASONAM). University of Calabria, Rende (CS), Calabria, Italy (delivered virtually, September 2024).

2024 "Encapsulation Structure and Dynamics in Hypergraphs". Network Science Beyond Graphs, SIAM Conference on Discrete Mathematics. Spokane, Washington, USA (July 2024).

2024 "Encapsulation Structure and Dynamics in Hypergraphs". Workshop on Modeling and Mining Complex Networks as Hypergraphs, Toronto Metropolitan University (delivered virtually, May 2024).

2024 "Encapsulation Structure and Dynamics in Hypergraphs". NORDITA WINQ Program on Complex and Quantum Systems – Dynamics and Topology of Complex Network Systems, Stockholm, Sweden (April 2024).

2024 "Encapsulation Structure and Dynamics in Hypergraphs". IMT Lucca School for Advanced Studies, Networks Unit, Lucca, Italy (March 2024).

2022 "Sequential Motifs in Observed Walks". Queen Mary University of London Complex Systems Seminar, London, UK (November 2022).

2022 "Sequential Motifs in Observed Walks", Oxford Networks Seminar (June 2022).

2019 "Detecting Path Anomalies in Time Series Data on Networks". Higher Order Models in Network Science Satellite (HONS), Burlington, USA (May 2019).

Conference Presentations

2026 "Comparing real-world and simulated mobility data: a higher-order approach". 12th International Conference on Computational Social Science. Burlington, USA (accepted, July 2026).

2026 "Robustness of Directed Networks to Generalized Edge Set Removal". 20th International School and Conference on Network Science. Boston, USA (June 2026).

2026 "Cascade Processes in Directed Hypergraphs and the Architecture of the Chemical Space". Poster (with Sofia Medina & Renaud Lambiotte) at 20th International School and Conference on Network Science. Boston, USA (June 2026).

2026 "Detection of Anomalous Delays in Real-time New York City Subway Data". Poster (with Nipuna Ginige & Jürgen Hackl) at 20th International School and Conference on Network Science. Boston, USA (June 2026).

2025 "Exploring the non-uniqueness of hypergraph adjacency matrices". 2nd British Symposium on Network Science. London, UK (June 2025).

2025 "Exploring the non-uniqueness of hypergraph adjacency matrices". International School and Conference on Network Science (NetSci 25). Maastricht, the Netherlands (June 2025).

2024 "Exploring the non-uniqueness of hypergraph adjacency matrices". International School and Conference on Network Science (NetSci 24). Quebec City, Quebec, Canada (June 2024).

2024 "Exploring the Non-uniqueness of Hypergraph Adjacency Matrices" 15th International Conference on Complex Networks (CompleNet 24). Exeter, UK (April 2024).

2024 "Encapsulation Structure and Dynamics in Hypergraphs". International School and Conference on Network Science X (NetSciX 24). Venice, Italy (January 2024).

2023 "Starting a Fire with Twigs: Influence of Encapsulation Relations on Bottom-up Dynamics on Hypergraphs". International School and Conference on Network Science (NetSci 23). Vienna, Austria (July 2023).

2022 "Sequential Motifs in Observed Walks". Conference on Complex Systems. Palma de Mallorca, Spain (September 2022).

2022 "Sequential Motifs in Observed Walks". IMA Conference on Mathematical challenges of Big Data. Oxford, UK (September 2022).

2022 "A Path-Based Approach to Analyzing the Global Liner Shipping Network". The 11th International Conference on Complex Networks and their Applications. Palermo, Italy (November 2022).

2022 "Sequential Motifs in Observed Walks". American Physical Society March Meeting. Boston, MA (delivered virtually, March 2022).

2021 "Analyzing Maritime Shipping Routes With Higher-order Network Analysis". Networks 2021: A Joint Sunbelt and NetSci Conference. Virtual (June 2021).

2020 "Sequential Motifs in Observed Walks". International School and Conference on Network Science (NetSci 20). Virtual (September 2020).

2019 "Incompleteness in Networks: Biases, Skewed Results, and Some Solutions". 25th ACM SIGKDD Conference on Knowledge Discovery and Data Mining (KDD'19). Tutorial. Anchorage, Alaska, USA (August 2019).

2019 "Detecting Path Anomalies in Sequential Data on Networks". International School and Conference on Network Science (NetSci 19). Burlington, VT, USA (May 2019).

2018 "Understanding the limitations of network online learning". International School and Conference on Network Science (NetSci 18). Paris, France (June 2018).

2018 "Understanding the limitations of network online learning". International Conference on Complex Networks. Boston, MA, USA (March 2018).

Industrial Collaborations

2025– **Beacon Power Services Africa**, *Lagos, Nigeria*.
Ongoing collaboration on data mining and machine learning for power grid infrastructure analytics.

Professional Activities & Service

Workshop Organisation

2024 Oxford Workshop on Temporal and Dynamic Interactions. September 2024. Conference Website.

Satellite Meeting Co-organiser

2026 NetSci '26 Satellite TopoNets: 10 Years of TopoNets, June 2026.

2025 NetSci '25 Satellite TopoNets, June 2025.

2024 NetSci '24 Satellite TopoNets: Between higher-order mechanisms and phenomena, June 2024.

2021 Networks '21 Satellite on Dynamics and Motifs in Networks (DynaMo), June 2021.

Programme Committees

2026 International School and Conference on Network Science (NetSci 26)

2022 Complex Networks and Their Applications

Journal Editing

2023 Topic Coordinator, Frontiers in Physics Research Topic on Motifs of Complex Networks.

Outreach

2024 Speaker at Oxford Mathematical Sciences for Refugees and Asylum and Sanctuary Seekers Meeting (hosted by Mansfield College)

Departmental Service

2023 Poster Judge for Conference of the Oxford SIAM Student Chapter

2023–2025 Oxford Mathematical Institute Early Career Researchers (ECR) Committee

2023–2025 Oxford Mathematical Institute Representative to the University of Oxford Divisional Research Staff Forum

2023–2025 Oxford Mathematical Institute Happy Hour Committee

2022–2025 Oxford Networks Seminar Co-organiser

Journal Referee

Science Advances

Nature Communications

Humanities and Social Sciences Communications

Advances in Complex Systems

EPJ Data Science

Communications Physics

Communications Biology

Journal of Physics: Complexity

Transactions on Knowledge and Data Engineering

Heliyon

School Participation

2023 Complex Networks Winter Workshop, Quebec City, Quebec, Canada.

Software Tools

Core Developer, *XGI*: CompleX Group Interactions Python package, GitHub.

Core Developer, TwinSearch C++ library, GitHub.

Core Developer, Encapsulation Dynamics Python code, GitHub.

Core Developer, netrd: A library for network {reconstruction, distances, dynamics}, GitHub.

Core Developer, DeBruijnNets.jl Julia code, GitHub.

Core Developer, Hypergeometric Path Anomaly Detection Python code, GitHub.

Core Developer, Shipping Networks Python code, GitHub.

Contributor, Pathpy2 python package, GitHub.

Awards & Honours

Spring 2019 **Student-led Research on New Opportunities for Dynamic Spectrum Access Award**, *Awarded by Dynamic Spectrum Alliance, with Prof. Mariya Zheleva*.

Spring 2016 **Excellence in Undergraduate Research in Computer Science Award**, *University at Albany Computer Science*.

Fall 2015 **Computer Sciences Corporation Scholarship Award**, *Chosen by University at Albany Computer Science Faculty - 2 students per year*.

Spring 2015 **University at Albany Presidential Undergraduate Award For Research**.

References

Available upon request.