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Timothy LaRock

Academic Appointments

April 2025 - Present **Postdoctoral Research Associate**, *Civil and Environmental Engineering, Princeton Univeristy*, Complex Infrastructure Systems.
Supervised by Prof. Jürgen Hackl

April 2022 - March 2025 **Postdoctoral Research Associate**, *Mathematical Institute, University of Oxford*, Oxford, UK, Structure & Dynamics of Multi-way Interactions.
Supervised by 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*

Research Experience

April 2025 - Present **Postdoctoral Researcher**, *Complex Infrastructure Systems*, Princeton University, USA.
Responsible for developing and carrying out an independent research program on complex networks for the analysis of infrastructure systems, including human mobility, railroad systems, and energy infrastructure. Also responsible for mentoring undergraduate and graduate students in the group.

April 2022 - March 2025 **Postdoctoral Researcher**, *Mathematical Institute, University of Oxford*, Oxford, UK.
Conducted research on the Structure and Dynamics of Multi-way Interaction data, including authoring multiple publications. Also co-organized the Oxford Networks Seminar and served as a mentor for students in the group and Department.

March-April 2024 **Visiting Researcher**, *Institute of Information Science and Technologies, Italian National Research Council* , Pisa, Italy.
Won €5k visitor grant from the SoBigData++ Research Infrastructure Transnational Access program.

August 2016 - December 2021 **Research Assistant, Rad Lab**, *Network Science Institute, Northeastern University*, Boston, USA.
Worked independently and collaboratively on various projects, including developing machine learning and data mining methods for (higher-order) network data. Led multiple projects that resulted in high-quality research publications.

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

Fall 2014 - Summer 2016 **Research Assistant, Data Management and Mining Lab**, *Computer Science Department, University at Albany, SUNY*, Albany, USA.

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

Teaching Experience

Autumn 2023 **Tutorial Instructor in Networks (2 sets)**, *Oxford Mathematical Institute*, Oxford, UK.
Taught Network Science concepts to two classes, each with more than 15 advanced undergraduate and masters students.

June 2023 **Tutorial Instructor**, *Oxford Summer School in Economic Networks*, Oxford, UK.
Demonstrated methods for network analysis and modeling using Python.

Summer 2020 **Instructor - CS 3000 - Algorithms & Data**, *Khoury College of Computer Sciences, Northeastern University*, Boston, USA.
Taught more than 80 undergraduate students in Computer Science and managed 9 Teaching Assistants. Online format with 4 live lectures per week given over Zoom. Website: https://tlarock.github.io/teaching/cs3000/syllabus.html

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

Publications

Preprints

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.

Peer-Reviewed Journal Papers

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** & Renaud 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 (2021). "`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.

Invited Talks

2025 “Exploring the non-uniqueness of node co-occurrence matrices of hypergraphs”. Society of 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 Quantam 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

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

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

2024 “Exploring the non-uniquness 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. Bostn, MA, USA (March 2018).

Professional Activities & Service

Workshop Organization

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

Satellite Meeting Co-organizer

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.

Journal Editing

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

Program Committees

2022 Complex Networks and Their Applications

Journal Referee

Science Advances

Advances in Complex Systems

EPJ Data Science

Communications Physics

Communications Biology

Journal of Physics: Complexity
Transactions on Knowledge and Data Engineering
Nature Humanities and Social Sciences Communications
Heliyon

Departmental Service

2022-2025 Oxford Networks Seminar Co-organizer
2023-2025 Oxford Mathematical Institute Early Career Researchers (ECR) Committee
2023-2025 Oxford Mathematical Institute Representative to the University of Oxford Research Staff Forum
2024 Oxford Mathematical Sciences for Refugees and Asylum and Sanctuary Seekers Co-organizer
2023 Poster Judge for Conference of the Oxford SIAM Student Chapter
2023-2025 Oxford Mathematical Institute Happy Hour Committee

Open-source Software

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

School Participation

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

Awards & Honors

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

Spring 2016 **Excellence in Undergraduate Research in Computer Science Award**, *Awarded to graduating University at Albany CS students for research contributions.*.

Spring 2015 **University at Albany Presidential Undergraduate Award For Research**, *Project: Adaptive Power Load Balancing in Cellular Networks*.

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