

Zhengchao Wan

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Education

The Ohio State University

Ph.D. in Mathematics

Advisor: Facundo Mémoli

Columbus, OH, USA

2016-2021

Peking University

B.S. in Mathematics

Advisor: Bin Dong

Beijing, China

2012-2016

Employment

University of California San Diego

HDSI Postdoc Fellow

Mentors: Gal Mishne, Yusu Wang

La Jolla, CA, USA

2022-Present

Research Interests

My primary research interests lie in the development of novel mathematical tools and frameworks for understanding and analyzing complex data, with a focus on geometric and topological data analysis. My work spans across multiple domains, including probability theory, geometry, graph theory, and machine learning.

Publications

Author names are listed in alphabetical order by default; my name is bolded if otherwise.

Papers in Journals.....

Facundo Mémoli, Axel Munk, Zhengchao Wan, and Christoph Weitkamp. The ultrametric Gromov-Wasserstein distance. *To appear in Discrete & Computational Geometry*. *arXiv preprint arXiv:2101.05756*, 2023.

Facundo Mémoli and Zhengchao Wan. Characterization of Gromov-type geodesics. *Differential Geometry and its Applications*, 88:102006, 2023.

Facundo Mémoli, Zane Smith, and Zhengchao Wan. The Gromov-Hausdorff distance between ultrametric spaces: its structure and computation. *To appear in Journal of Computational Geometry*. *arXiv preprint arXiv:2110.03136*, 2023.

Facundo Mémoli, Zhengchao Wan, and Yusu Wang. Persistent laplacians: Properties, algorithms and implications. *SIAM Journal on Mathematics of Data Science*, 4(2):858–884, 2022.

Facundo Mémoli and Zhengchao Wan. On p -metric spaces and the p -Gromov-Hausdorff distance. *p -Adic Numbers, Ultrametric Analysis and Applications*, 14(3):173–223, 2022.

Zhengchao Wan. A novel construction of Urysohn universal ultrametric space via the Gromov-Hausdorff ultrametric. *Topology and its Applications*, 300:107759, 2021.

Papers in Peer-Refereed Conferences.....

Mitchell Black, Amir Nayyeri, Zhengchao Wan, and Yusu Wang. Understanding oversquashing in GNNs through the lens of effective resistance. *To appear in International Conference on Machine Learning (ICML)*. *arXiv preprint arXiv:2302.06835*, 2023.

Thomas Davies, **Zhengchao Wan**, and Ruben Sanchez-Garcia. The persistent Laplacian for data science: Evaluating higher-order persistent spectral representations of data. *To appear in International Conference on Machine Learning (ICML)*. *arXiv preprint arXiv:2302.06835*, 2023.

Gal Mishne, Zhengchao Wan, Yusu Wang, and Sheng Yang. The numerical stability of hyperbolic representation learning. *To appear in International Conference on Machine Learning (ICML)*. *arXiv preprint arXiv:2211.00181*, 2023.

Aziz Burak Gülen, Facundo Mémoli, Zhengchao Wan, and Yusu Wang. A generalization of the persistent Laplacian to simplicial maps. *To appear in 39th International Symposium on Computational Geometry (SoCG)*. *arXiv preprint arXiv:2302.03771*., 2023.

Samantha Chen, Sunhyuk Lim, Facundo Mémoli, Zhengchao Wan, and Yusu Wang. Weisfeiler-Lehman meets Gromov-Wasserstein. In *International Conference on Machine Learning (ICML)*, pages 3371–3416. PMLR, 2022.

Facundo Mémoli, Zane Smith, and Zhengchao Wan. The Wasserstein transform. In *International Conference on Machine Learning (ICML)*, pages 4496–4504. PMLR, 2019.

Preprints.....

Tristan Brugère, Zhengchao Wan, and Yusu Wang. Distances for Markov chains, and their differentiation. *arXiv preprint arXiv:2302.08621 (submitted)*, 2023.

Samantha Chen, Sunhyuk Lim, Facundo Mémoli, Zhengchao Wan, and Yusu Wang. The Weisfeiler-Lehman distance: reinterpretation and connection with GNNs. *arXiv preprint arXiv:2302.00713*, 2023.

Sunhyuk Lim, Facundo Memoli, Zhengchao Wan, Qingsong Wang, and Ling Zhou. Some results about the Tight Span of spheres. *arXiv preprint arXiv:2112.12646*, 2021.

Kun Jin, Facundo Mémoli, and Zhengchao Wan. The Gaussian transform. *arXiv preprint arXiv:2006.11698*, 2020.

Computational Software / Expository Webpages

Persistent Laplacian (with F. Mémoli and Y. Wang)

<https://github.com/ndag/Persistent-Laplacian>

Gromov-Hausdorff distances between ultrametric spaces (with F. Mémoli and Z. Smith)

<https://github.com/ndag/ultrametrics>

The ultrametric Gromov-Wasserstein distances (with F. Mémoli, A. Munk and C. Weitkamp)

<https://github.com/ndag/uGW>

Talks

2ND SIAM Northern States Section Conference

Distances between Markov chains and their differentiation

April 2023

EnCORE Student Meet at UCSD

The numerical stability of hyperbolic representation learning

Mar. 2023

TDA Conference at University of Florida

A generalization of the persistent Laplacian to simplicial maps

Feb. 2023

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| Computational Persistence 2022 <i>Persistent Laplacians: properties, algorithms and implications</i> | Oct. 2022 |
| International Conference on Machine Learning (ICML) 2022 <i>Weisfeiler-Lehman meets Gromov-Wasserstein</i> | July 2022 |
| Topology, Geometry and Data Analysis seminar at Ohio State <i>The Gromov-Hausdorff distance between ultrametric spaces</i> | Oct. 2021 |
| Geometry and Topology meet Data Analysis and Machine Learning (GTDAML 2021) <i>Persistent Laplacians: properties, algorithms and implications</i> | July 2021 |
| Seminar at Centre for Topological Data Analysis, Oxford University <i>Persistent Laplacians: properties, algorithms and implications</i> | May 2021 |
| Algebraic Topology: Methods, Computation, and Science (hosted by AATRN) <i>Computing the Gromov-Hausdorff distance between ultrametric spaces</i> | Jan. 2021 |
| Topology, Geometry, and Applications - Graduate Students Seminar at Ohio State <i>Urysohn universal ultrametric space</i> | Oct. 2020 |
| Geometry, Topology and Data Seminar, Florida State University <i>The Wasserstein transform</i> | Nov. 2019 |
| Topology, Geometry, and Applications - Graduate Students Seminar at Ohio State <i>Gromov-Hausdorff distance between ultrametric spaces</i> | Sep. 2019 |
| Air Force Research Lab in Dayton, Ohio <i>The Wasserstein transform</i> | July 2019 |

Poster Presentations.....

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| Conference on the Mathematical Theory of Deep Neural Networks <i>A numerical comparison between Lorentz and Poincaré models for representation learning</i> | Nov 2022 |
| TILOS Annual Retreat / Industry Day <i>WL-based distance for directed graphs with attributes and Markov chain metric spaces</i> | Oct 2022 |
| International Conference on Machine Learning (ICML) 2019 <i>The Wasserstein transform</i> | June 2019 |
| GTDAML2019, the Ohio State University <i>The Wasserstein transform</i> | May 2019 |
| Geometric Data Analysis, University of Chicago <i>The Wasserstein transform</i> | May 2019 |

Honors and Awards

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| Special Graduate Assignments, the Ohio State University | Spring 2020 |
| ICML (International Conference on Machine Learning) Travel Award | June 2019 |
| Alumina Yizheng Distinguished Scholar Award, Peking University | Oct. 2014 |
| Jiang Zehan Scholarship, Peking University | Sep. 2013 |

Teaching Experiences

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| DSC 214, University of California San Diego <i>Topological Data Analysis</i> | Spring 2023 |
| MATH 1172, the Ohio State University <i>Engineering Mathematics A</i> | Spring 2021 |

MATH 1172, the Ohio State University

Engineering Mathematics A

Autumn 2018

Mini-Course, Peking University

Information Geometry

Summer 2016

Professional Services

Organization of activities.....

Midwest Student Conference GTDAML2019, the Ohio State University

June 2019

Co-organizer

Referee.....

Journals

Analysis and Geometry in Metric Spaces

Computational Geometry: Theory and Applications

Discrete & Computational Geometry

Journal of Combinatorial Optimization

SIAM Journal on Applied Algebra and Geometry

Conferences

Symposium on Computational Geometry (2021, 2022, 2023)

ACM-SIAM Symposium on Discrete Algorithms (2019, 2023)

Conference on the Mathematical Theory of Deep Neural Networks (2022)