# Zhengchao Wan

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## Education

**The Ohio State University** — **Columbus, OH, USA**
*Ph.D. in Mathematics* — *2016-2021*
Advisor: Facundo Mémoli

**Peking University** — **Beijing, China**
*B.S. in Mathematics* — *2012-2016*
Advisor: Bin Dong

## Employment

**University of California San Diego** — **La Jolla, CA, USA**
*HDSI Postdoc Fellow* — *2022-Present*
Mentors: Gal Mishne, Yusu Wang

## 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

Samantha Chen, Sunhyuk Lim, Facundo Mémoli, Zhengchao Wan, and Yusu Wang. The Weisfeiler-Lehman distance: reinterpretation and connection with GNNs. *To appear in ICML Workshop: Topology, Algebra, and Geometry in Machine Learning*, 2023.

Mitchell Black, **Zhengchao Wan**, Amir Nayyeri, and Yusu Wang. Understanding oversquashing in GNNs through the lens of effective resistance. In *International Conference on Machine Learning*, pages 2528–2547. PMLR, 2023.

Thomas Davies, **Zhengchao Wan**, and Ruben J Sanchez-Garcia. The persistent Laplacian for data science: Evaluating higher-order persistent spectral representations of data. In *International Conference on Machine Learning*, pages 7249–7263. PMLR, 2023.

Gal Mishne, Zhengchao Wan, Yusu Wang, and Sheng Yang. The numerical stability of hyperbolic representation learning. In *International Conference on Machine Learning*, pages 24925–24949. PMLR, 2023.

Aziz Burak Gülen, Facundo Mémoli, Zhengchao Wan, and Yusu Wang. A generalization of the persistent laplacian to simplicial maps. In *39th International Symposium on Computational Geometry (SoCG 2023)*. Schloss Dagstuhl-Leibniz-Zentrum für Informatik, 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.

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** *Apr 2023*
*Distances between Markov chains and their differentiation*

**EnCORE Student Meet at UCSD** *Mar 2023*
*The numerical stability of hyperbolic representation learning*

**TDA Conference at University of Florida** *Feb 2023*
*A generalization of the persistent Laplacian to simplicial maps*

**Computational Persistence 2022** *Oct 2022*
*Persistent Laplacians: properties, algorithms and implications*

**International Conference on Machine Learning (ICML) 2022** *Jul 2022*
*Weisfeiler-Lehman meets Gromov-Wasserstein*

**Topology, Geometry and Data Analysis seminar at Ohio State** *Oct 2021*
*The Gromov-Hausdorff distance between ultrametric spaces*

**Geometry and Topology meet Data Analysis and Machine Learning (GTDAML 2021)** *Jul 2021*
*Persistent Laplacians: properties, algorithms and implications*

**Seminar at Centre for Topological Data Analysis, Oxford University** *May 2021*
*Persistent Laplacians: properties, algorithms and implications*

**Algebraic Topology: Methods, Computation, and Science (hosted by AATRN)** *Jan 2021*
*Computing the Gromov-Hausdorff distance between ultrametric spaces*

**Topology, Geometry, and Applications - Graduate Students Seminar at Ohio State** *Oct 2020*
*Urysohn universal ultrametric space*

**Geometry, Topology and Data Seminar, Florida State University** *Nov 2019*
*The Wasserstein transform*

**Topology, Geometry, and Applications - Graduate Students Seminar at Ohio State** *Sep 2019*
*Gromov-Hausdorff distance between ultrametric spaces*

**Air Force Research Lab in Dayton, Ohio** *Jul 2019*
*The Wasserstein transform*

### Poster Presentations

**TILOS Annual Retreat / Industry Day** *Jul 2023*
*Understanding oversquashing in GNNs through the lens of effective resistance*

**EnCORE Annual Retreat 2023** *Jun 2023*
*The numerical stability of hyperbolic representation learning*

**Conference on the Mathematical Theory of Deep Neural Networks** *Nov 2022*
*A numerical comparison between Lorentz and Poincaré models for representation learning*

**TILOS Annual Retreat / Industry Day** *Oct 2022*
*WL-based distance for directed graphs with attributes and Markov chain metric spaces*

**International Conference on Machine Learning (ICML) 2019** *Jun 2019*
*The Wasserstein transform*

**GTDAML2019, the Ohio State University** *May 2019*
*The Wasserstein transform*

**Geometric Data Analysis, University of Chicago** *May 2019*
*The Wasserstein transform*

## Honors and Awards

**Special Graduate Assignments, the Ohio State University** *Spring 2020*

**ICML (International Conference on Machine Learning) Travel Award** *Jun 2019*

**Alumina Yizheng Distinguished Scholar Award, Peking University** *Oct 2014*

**Jiang Zehan Scholarship, Peking University** *Sep 2013*

## Teaching Experiences

**DSC 214, University of California San Diego** *Spring 2023*
*Topological Data Analysis*

**MATH 1172, the Ohio State University** *Spring 2021*
*Engineering Mathematics A*

**MATH 1172, the Ohio State University** *Autumn 2018*
*Engineering Mathematics A*

**Mini-Course, Peking University** *Summer 2016*
*Information Geometry*

## Professional Services

### Organization of activities

**Midwest Student Conference GTDAML2019, the Ohio State University** *Jun 2019*
*Co-organizer*

### Referee

**Journals**
Analysis and Geometry in Metric Spaces
Computational Geometry: Theory and Applications
Discrete & Computational Geometry
Journal of Applied and Computational Topology
Journal of Combinatorial Optimization
Machine Learning: Science and Technology
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, 2023)
Conference on Neural Information Processing Systems (NeurIPS) (2023)