

# 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. *Discrete & Computational Geometry*, pages 1–73, 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. *Journal of Computational Geometry*, 14(1):78–143, 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. *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*, pages 3371–3416. PMLR, 2022.

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

### Preprints

Alexander Cloninger, Gal Mishne, Andreas Oslandsbotn, Sawyer Jack Robertson, Zhengchao Wan, and Yusu Wang. Random walks, conductance, and resistance for the connection graph Laplacian. *arXiv preprint arXiv:2308.09690 (submitted)*, 2023.

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

Sunhyuk Lim, Facundo Mémoli, 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

### TRIPODS Postdoc Workshop at Toyota Technological Institute at Chicago

Aug 2023

*Distances between Markov chains and their differentiation*

### 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*

<b>TDA Conference at University of Florida</b> <i>A generalization of the persistent Laplacian to simplicial maps</i>	Feb 2023
<b>Computational Persistence 2022</b> <i>Persistent Laplacians: properties, algorithms and implications</i>	Oct 2022
<b>International Conference on Machine Learning (ICML) 2022</b> <i>Weisfeiler-Lehman meets Gromov-Wasserstein</i>	Jul 2022
<b>Topology, Geometry and Data Analysis seminar at Ohio State</b> <i>The Gromov-Hausdorff distance between ultrametric spaces</i>	Oct 2021
<b>Geometry and Topology meet Data Analysis and Machine Learning (GTDAML 2021)</b> <i>Persistent Laplacians: properties, algorithms and implications</i>	Jul 2021
<b>Seminar at Centre for Topological Data Analysis, Oxford University</b> <i>Persistent Laplacians: properties, algorithms and implications</i>	May 2021
<b>Algebraic Topology: Methods, Computation, and Science (hosted by AATRN)</b> <i>Computing the Gromov-Hausdorff distance between ultrametric spaces</i>	Jan 2021
<b>Topology, Geometry, and Applications - Graduate Students Seminar at Ohio State</b> <i>Urysohn universal ultrametric space</i>	Oct 2020
<b>Geometry, Topology and Data Seminar, Florida State University</b> <i>The Wasserstein transform</i>	Nov 2019
<b>Topology, Geometry, and Applications - Graduate Students Seminar at Ohio State</b> <i>Gromov-Hausdorff distance between ultrametric spaces</i>	Sep 2019
<b>Air Force Research Lab in Dayton, Ohio</b> <i>The Wasserstein transform</i>	Jul 2019
<b>Poster Presentations</b> .....	
<b>TAG in Machine Learning: a Workshop at ICML 2023</b> <i>The Weisfeiler-Lehman distance: reinterpretation and connection with GNNs.</i>	Jul 2023
<b>International Conference on Machine Learning (ICML) 2023</b> <i>The numerical stability of hyperbolic representation learning</i>	Jul 2023
<b>TILOS Annual Retreat / Industry Day</b> <i>Understanding oversquashing in GNNs through the lens of effective resistance</i>	Jul 2023
<b>EnCORE Annual Retreat 2023</b> <i>The numerical stability of hyperbolic representation learning</i>	Jun 2023
<b>Conference on the Mathematical Theory of Deep Neural Networks</b> <i>A numerical comparison between Lorentz and Poincaré models for representation learning</i>	Nov 2022
<b>TILOS Annual Retreat / Industry Day</b> <i>WL-based distance for directed graphs with attributes and Markov chain metric spaces</i>	Oct 2022
<b>International Conference on Machine Learning (ICML) 2019</b> <i>The Wasserstein transform</i>	Jun 2019
<b>GTDAML2019, the Ohio State University</b> <i>The Wasserstein transform</i>	May 2019
<b>Geometric Data Analysis, University of Chicago</b> <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	Jun 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 <i>Engineering Mathematics A</i>	Autumn 2018
Mini-Course, Peking University <i>Information Geometry</i>	Summer 2016

## Professional Services

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### Organization of activities.....

Midwest Student Conference GTDAML2019, the Ohio State University <i>Co-organizer</i>	Jun 2019
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### Referee.....

#### Journals

Analysis and Geometry in Metric Spaces  
Computational Geometry: Theory and Applications  
Discrete & Computational Geometry  
ESAIM: Probability and Statistics  
Homology, Homotopy and Applications  
Journal of Applied and Computational Topology  
Journal of Combinatorial Optimization  
Orbita Mathematicae  
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)  
International Conference on Learning Representations (ICLR) (2024)