

# Sushovan Majhi

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## RESEARCH INTERESTS

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**Applied Topology, Topological Data Analysis (TDA), Discrete and Computational Geometry, Shape Matching, Statistical Finance, and Topological Deep Learning.**

My research primarily revolves around the interface of *mathematics*, *computer science*, and the mathematical foundations of *data science*. More specifically, I am motivated to develop provable inference techniques for data science that are inspired by topology and geometry. I also keep a keen interest in applying TDA to fascinating, real-world problems arising in fields, like finance, dynamical systems, biology, medicine, and genetics.

## EDUCATION

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- **Doctor of Philosophy in Mathematics** August 2014–December 2020  
Tulane University, New Orleans, LA, USA.  
Advisor: **Prof. Carola Wenk**  
Courses: computational geometry, computational topology, topological data analysis, differential geometry, differentiable manifolds, algorithms, data structures, computational complexity, applied mathematics, and scientific computing.
- **Master of Science in Mathematics** August 2009–May 2012  
Tata Institute of Fundamental Research, Bangalore, India  
Courses: ordinary and partial differential equations, probability theory, complex analysis, functional analysis, numerical linear algebra, measure theory, mechanics.
- **Bachelor of Science in Mathematics (Hons.)** July 2006–May 2009  
Ramakrishna Mission Vidyamandira, Calcutta University, West Bengal, India  
Courses: calculus, real analysis, linear algebra, numerical analysis, game theory, statistics, physics.

## WORK EXPERIENCE

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- **Assistant Professor** August 2024–current  
Data Science Program, George Washington University, Washington D.C., USA
- **Visiting Assistant Professor** August 2023–July 2024  
Data Science Program, George Washington University, Washington D.C., USA
- **Postdoctoral Research Fellow** January 2021–July 2023  
School of Information, University of California, Berkeley, USA  
Role: The responsibilities included conducting research broadly in data science, forging new research collaborations, organizing research webinar series.

## PREPRINTS

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3. Henry Adams, **SM**, Fedya Manin, Nicolò Zava, Žiga Virk. Lower Bounding The Gromov–Hausdorff Distance In Metric Graphs, 25 pages, [In preparation, expected: October 2024]
2. Halley Fritze, **SM**, Marissa Masden, Atish Mitra, Michael Stickney. Embedded Graph Reconstruction under Hausdorff Noise. Available at: [arXiv:2410.19410](https://arxiv.org/abs/2410.19410) [cs.CG]
  - Presented at *FWCG'24*
1. Rafal Komendarczyk, **SM**, Will Tran. Topological Stability and Latschev-type Reconstruction Theorems for  $\text{CAT}(\kappa)$  Spaces, 29 pages, June 2024. Available at: [arXiv:2406.04259](https://arxiv.org/abs/2406.04259) [math.AT]
  - Submitted to *Advanced in Mathematics*

## REFEREED JOURNAL PUBLICATIONS

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9. Anish Rai, Buddha Nath Sharma, Salam Rabindrajit Luwang, Md.Nurujjaman, **SM**. Identifying Extreme Events in the Stock Market: A Topological Data Analysis. *Chaos: An Interdisciplinary Journal of Nonlinear Science*, October, 2024. DOI: [10.1063/5.0220424](https://doi.org/10.1063/5.0220424). 2024. Available at: [arXiv:2405.16052](https://arxiv.org/abs/2405.16052) [q-fin.ST]
8. Kundan Mukhia, Anish Rai, SR Luwang, Md Nurujjaman, **SM**, Chittaranjan Hens. Complex Network Analysis of Cryptocurrency Market During Crashes. *Physica A: Statistical Mechanics and its Applications*, 2024. DOI: [10.1016/j.physa.2024.130095](https://doi.org/10.1016/j.physa.2024.130095). Also available at: [arXiv:2405.05642](https://arxiv.org/abs/2405.05642) [q-fin.ST]
7. Henry Adams, Florian Frick, **SM**, Nichola McBride\*. Hausdorff VS Gromov–Hausdorff Distances, 22 pages, Sep 2023. Available at: [arXiv:2309.16648](https://arxiv.org/abs/2309.16648) [math.MG]
  - Accepted to *Discrete and Computational Geometry*
6. **SM**. Demystifying Latschev’s theorem: Manifold Reconstruction from noisy data. *Discrete & Computational Geometry*, 2024. DOI: [10.1007/s00454-024-00655-9](https://doi.org/10.1007/s00454-024-00655-9). 2024. Available at: [arXiv:2305.17288](https://arxiv.org/abs/2305.17288) [math.AT]
5. **SM** and Carola Wenk. Distance Measures for geometric graphs. *Computational Geometry: Theory and Applications*, 2023. DOI: [10.1016/j.comgeo.2023.102056](https://doi.org/10.1016/j.comgeo.2023.102056). Also available at: [arXiv:2209.12869](https://arxiv.org/abs/2209.12869) [cs.CG]
4. **SM**. Vietoris–Rips complexes of metric spaces near a metric graph. *Journal of Applied and Computational Topology*, May 2023. DOI: [10.1007/s41468-023-00122-z](https://doi.org/10.1007/s41468-023-00122-z). Available at: [arXiv:2204.14234](https://arxiv.org/abs/2204.14234) [math.AT]
3. **SM**, Jeffrey Vitter, and Carola Wenk. Approximating Gromov-Hausdorff distance in Euclidean space. *Computational Geometry: Theory and Applications*, 116:102034, 2024. DOI: [10.1016/j.comgeo.2023.102034](https://doi.org/10.1016/j.comgeo.2023.102034). Also available at: [arXiv:1912.13008](https://arxiv.org/abs/1912.13008) [math.MG]
2. Anish Rai, Ajit Mahata, Md Nurujjaman, **SM**, and Kanish Debnath. A sentiment-based modeling and analysis of stock price during the COVID-19: U- and Swoosh-shaped recovery. *Physica A: Statistical Mechanics and its Applications*, 592:126810, 2022. DOI: [10.1016/j.physa.2021.126810](https://doi.org/10.1016/j.physa.2021.126810). Available at: [arXiv:2110.03986](https://arxiv.org/abs/2110.03986) [q-fin.ST]
1. Brittany Terese Fasy, Rafal Komendarczyk, **SM**, and Carola Wenk. On the reconstruction of geodesic subspaces of  $\mathbb{R}^N$ . *International Journal of Computational Geometry & Applications*, 32(1):91–117, 2022. DOI: [10.1142/S0218195922500066](https://doi.org/10.1142/S0218195922500066). Also available at: [arXiv:1810.10144](https://arxiv.org/abs/1810.10144) [math.AT]

## REFEREED CONFERENCE PROCEEDINGS

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3. **SM**. Demystifying Latschev’s theorem: Manifold Reconstruction from noisy data. In Proceedings of the 40th International Symposium on Computational Geometry (SoCG), Athens, Greece, June 11–14, 2024. Available at: <https://doi.org/10.4230/LIPIcs.SoCG.2024.73>
2. Erin Chambers, Brittany Fasy, Benjamin Holmgren\*, **SM**, and Carola Wenk. Metric and path-connectedness properties of the Fréchet distance for paths and graphs. In Proceedings of the 34th Canadian Conference on Computational Geometry (CCCG), 2023. DBLP: [conf/cccg/2023](https://dblp.org/pdb/conf/cccg/2023). Available at: [arXiv:2308.00900](https://arxiv.org/abs/2308.00900) [cs.CG]
1. **SM**. Graph mover’s distance: An efficiently computable distance measure for geometric graphs. In Proceedings of the 34th Canadian Conference on Computational Geometry (CCCG), 2023. DBLP: [conf/cccg/2023](https://dblp.org/pdb/conf/cccg/2023). Available at: [arXiv:2306.02133](https://arxiv.org/abs/2306.02133) [cs.CG]

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\* Undergraduate student at the time of research or submission

## WORKSHOP CONTRIBUTIONS

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5. Halley Fritze, **SM**, Marissa Masden, Atish Mitra. Hausdorff–Approximation of Metric Graphs, At *Fall Workshop on Computational Geometry (FWCG)*, Tufts University, 2024. Available at: [arXiv:2410.19410 \[cs.CG\]](#)
4. E. Chambers, B. Fasy, B. Holmgren\* , **SM**, and C. Wenk. Path-Connectivity of Fréchet Spaces of Graphs. *Computational Geometry: Young Researchers Forum*, 2022
3. **SM** and Carola Wenk. Distance Measures for Geometric Graphs, At *Fall Workshop on Computational Geometry (FWCG)*, 2022
2. Brittany Terese Fasy, **SM** and Carola Wenk. Threshold-based graph reconstruction using discrete Morse theory. In *Fall Workshop on Computational Geometry (FWCG)*, 2018. Abstract available at: [Link](#)
1. Brittany Terese Fasy, Rafal Komendaczyk, **SM**, and Carola Wenk. Topological reconstruction of metric graphs in  $\mathbb{R}^N$ . At *Fall Workshop on Computational Geometry (FWCG)*, 2017. Abstract available at: [Link](#)

## GRADUATE TEACHING EXPERIENCE

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- **Linear Algebra for Data Science** Summer 2024  
Data Science Program, George Washington University, USA  
*Topics:* linear algebra foundations, Gaussian elimination, pivoting techniques for stability, LU decomposition, eigenvalues and eigenvectors, solving linear systems using iterative methods, projections and linear regression, SVD and applications. *Website:* [linalg.mathematics.land](#)
- **Algorithm Design (DATS 6001)** Spring 2024–current  
Data Science Program, George Washington University, USA  
*Topics:* basics of computational complexity, data structures (array, stack, queue, tree, etc), algorithms (search, sort, etc), and programming paradigms like dynamic programming and greedy algorithms.  
*Website:* [6001-majhi.datasci.land](#)
- **Topological Data Analysis (CS)** Fall 2023  
National Institute of Technology, Sikkim, India  
*Topics:* topological spaces, metric spaces and their examples, simplicial complexes, homology in  $\mathbb{Z}/2$  coeff, persistent homology, bottleneck and Wasserstein distance, and non-linear time-series analysis using TDA.
- **Computer Science Foundations (DATS 6450)** Fall 2023  
Data Science Program, George Washington University, USA  
*Topics:* computer design, programming in Python, object-oriented programming
- **Introduction to Data Mining (DATS 6103)** Fall 2023, Spring 2024  
Data Science Program, George Washington University, USA  
*Topics:* data wrangling, linear and logistic regression, classification, clustering, data visualization, support vector machines, machine learning algorithms.
- **Statistics for Data Science (MIDS 203)** August 2020–July 2023  
School of Information, University of California, Berkeley, USA  
*Topics:* probability theory, sampling distributions, estimators and convergence theorems, confidence intervals, hypothesis testing, and regression.
- **Linear Algebra, Complex Analysis** January 2013–June 2013  
Christ University and Scimetric Pvt Ltd, Bangalore, India

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\* Undergraduate student at the time of research or submission

- **Analysis, Linear Algebra, Complex Analysis** November 2011–July 2012  
GATE-IIT Coaching Institute, JP Nagar, Bangalore, India  
Graduate level, for competitive national exams, e.g., National Eligibility Test
- **Analysis and Linear Algebra** February 2012–July 2012  
MES College, Department of Mathematics, Malleswaram, Bangalore, India

## UNDERGRADUATE TEACHING EXPERIENCE

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- **Data Science Capstone (DATS 4001)** Fall 2024  
Data Science Program, George Washington University, USA
- **Undergraduate Statistics for Business Students (MATH 1140)** Summer 2019  
Tulane University, USA  
*Topics:* sampling methods, descriptive statistics, probability theory, random variables, limit theorems, confidence intervals, hypothesis testing, and linear regression.

## OTHER TEACHING

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- **Graduate Teaching Assistant** Fall 2014–Spring 2017  
Tulane University, USA

## INVITED TALKS AND ACCEPTED ABSTRACTS

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- **Title:** Predicting the Onset and Withdrawal of the Indian Monsoon using Persistent Homology *upcoming: January 9, 2025*  
AMS Special Session: Climate Science at the Interface Between Topological Data Analysis and Dynamical Systems Theory, Joint Mathematics Meetings, Seattle, 2025
- **Title:** Lower Bounding the Gromov–Hausdorff distance in Metric Graphs Nov 14–15, 2024  
The 31st Fall Workshop on Computational Geometry, Tufts University
- **Title:** A Taste of Topological Data Analysis (TDA): Reconstruction of Shapes Oct 14, 2024  
Indian Institute of Technology, Mandi, India
- **Title:** A Taste of Topological Data Analysis (TDA): Reconstruction of Shapes Oct 8, 2024  
Vellore Institute of Technology, Chennai, India
- **Title:** Demystifying Latschev’s Theorem June 14, 2024  
Symposium on Computational Geometry, Athens, Greece
- **Title:** Demystifying Latschev’s Theorem March 28, 2024  
Montana State University
- **Title:** Demystifying Latschev’s Theorem August 23, 2023  
Applied Algebraic Topology Research Network (AATRN)  
Available on: [YouTube](#)
- **Title:** Graph Mover’s Distance August 2–4, 2023  
The 34th Canadian Conference on Computational Geometry, Montreal, Canada
- **Title:** Similarity Measures for Geometric Graphs October 14–15, 2022  
The 30th Fall Workshop on Computational Geometry  
North Carolina State University, USA
- **Title:** Topological Methods in the Reconstruction and Comparison of Shapes February, 2022  
Mathematics Department, ICAI University, Tripura, India

- **Title:** A Taste of Topological Data Analysis (TDA): Reconstruction of Shapes  
Department of Mathematics, Hunter College, NY, USA September, 2021
- **Fall Workshop on Computational Geometry** October, 2018  
Queens College, New York, USA
- **Fall Workshop on Computational Geometry** November, 2017  
SUNY (Stony Brook), New York, USA

#### PHD THESES READER

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- Will Tran, Tulane University, Spring 2024  
*Thesis Title:* Distortion and Curvature in the Shape Reconstruction Problem

#### GRADUATE STUDENT ADVISEES

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- Khush Shah and Shikha Kumari, current data science masters students  
George Washington University, August 2023–current  
*Project Title:* Matching geometric graphs using Graph Neural Networks
- Anish Rai, PhD student at August 2022–August 2024  
National Institute of Technology, Sikkim, India  
*Project Title:* Prediction of stock market crashes using topological data analysis
- Buddha Nath Sharma, PhD student at August 2022–current  
National Institute of Technology, Sikkim, India  
*Project Title:* Applications of topological data analysis in financial markets

#### UNDERGRADUATE STUDENT MENTEES

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- James Moukheiber August 2024–current  
George Washington University,  
*Project Title:* Topological Deep Learning

#### DEPARTMENT/UNIVERSITY SERVICE

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- Undergraduate Advisor August 2024–current  
George Washington University, Data Science Program

#### AWARDS, SCHOLARSHIPS, RECOGNITION

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- NSF: Mathematical & Physical Sciences (MPS), **Declined**  
*Title:* Geometric Approach to the Shape Reconstruction from Noisy Data  
*Role:* co-PI  
*PI:* Rafal Komendarczyk, Tulane University, New Orleans.
- **Travel Grant**, University of California, Berkeley
- **UGC-CSIR NET Research Fellowship**, India, June 2012
- **TIFR Junior Research Fellowship** for pursuing Integrated PhD studies at TIFR-CAM, Bangalore, India. August 2009.
- **Secured grade “A” in SCIENCE TALENT SEARCH EXAMINATION**  
conducted by JATIYA VIJNAN PARISAD and INDIAN SCIENCE CONGRESS ASSOCIATION

## ACADEMIC SERVICES

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- I have been a reviewer for journals, like Discrete and Computational Geometry, Foundations of Data Science, Journal of Combinatorial Optimization, and International Journal of Computational Geometry.
- I have been a reviewer for conferences, like the International Symposium on Computational Geometry, International Symposium on Spatial and Temporal Databases, European Workshop on Computational Geometry, ACM International Conference on Advances in Geographic Information Systems, WADS Algorithms and Data Structures Symposium.
- I organized SIAM Graduate Student Chapters at Tulane University.
- I have been organizing a data science webinar series at the University of California, Berkeley.

## COMPUTATIONAL SKILLS

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Java, C, R, Python, Ruby, JavaScript, SQL, Bash.

## SOFTWARE PROJECTS

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- **Simplicial Complexes in JS** [GitHub](#)  
JavaScript implementation of some of the widely used computations on simplicial complexes. The library also implements the Smith Normal Form in order to compute the homology groups of an abstract complex.
- **Shape Reconstruction Visualization** [WebApp](#) | [GitHub](#)  
To complement my PhD research, I implemented my topological reconstruction algorithm for planar metric graphs in this library. The library is written in JavaScript and made available to users as a web-app.  
*Skills:* JavaScript, HTML, CSS.

## POPULAR MEDIA

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- Interviewed by GWU Hatchet for an [Article](#) August 2024

## ENTREPRENEURIAL EXPERIENCE

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- **Scimetric Edulabs Private Limited** December 2012–April 2017  
Bangalore, India  
*Role:* **co-founder** and **director**  
In this start-up venture, our objective was to motivate and train students in higher education. We won the franchise to work with several private colleges in India. We coached science students for standardized entrance tests for PhD and academic jobs. The company employed 6 trainers.

## HOBBY

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In my spare time, I write tutorials on *random* topics in order to make mathematics and statistics a little more interactive; they can be found here: <https://www.smajhi.com/tutorials>. I also enjoy playing the piano and classical guitar.