

Sushovan Majhi

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RESEARCH INTERESTS

Algebraic and Applied Topology, Discrete and Computational Geometry, Topological Data Analysis (TDA), Pattern and Shape Matching, Statistical Finance.

My research primarily revolves around the interface of *computer science*, *mathematics*, 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 biology, medicine, genetics, finance, and dynamical systems.

WORK EXPERIENCE

- **Assistant Professor** August 2024–current
Data Science Program, George Washington University, Washington D.C., USA
- **Visiting Assistant Professor** August 2023–May 2023
Data Science Program, George Washington University, Washington D.C., USA
Role: Teaching data science and computer science courses to graduate students in the [Data Science Program](#).
- **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.

EDUCATION

- **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.

GRADUATE STUDENT ADVISEES

- Khush Shah and Shikha Kumari, current data science masters students,
George Washington University, August 2023–current
Project Title: Matching geometric graphs
- 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

PREPRINTS

4. 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 \[math.AT\]](#)
3. Anish Rai, Buddha Nath Sharma, Salam Rabindrajit Luwang, Md.Nurujjaman, **SM**. Identifying Extreme Events in the Stock Market: A Topological Data Analysis, 14 pages, June 2024. Available at: [arXiv:2405.05642 \[q-fin.ST\]](#)
 - Submitted to *Chaos: An Interdisciplinary Journal of Nonlinear Science*
2. Kundan Mukhia, Anish Rai, SR Luwang, Md Nurujjaman, **SM**, Chittaranjan Hens. Complex Network Analysis of Cryptocurrency Market During Crashes, 12 pages, May 2024. Available at: [arXiv:2405.05642 \[q-fin.ST\]](#)
 - Submitted to *Physica A: Statistical Mechanics and its Applications*
1. Henry Adams, Florian Frick, **SM**, Nichola McBride*. Hausdorff VS Gromov–Hausdorff Distances, 22 pages, Sep 2023. Available at: [arXiv:2309.16648 \[math.MG\]](#)
 - Submitted to *Discrete and Computational Geometry*

JOURNAL PAPERS

6. **SM**. Demystifying Latschev’s theorem: Manifold Reconstruction from noisy data. *Discrete & Computational Geometry*, 2024. DOI: [10.1016/j.comgeo.2023.102056](#). 2024. Available at: [arXiv: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](#). Also available at: [arXiv: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](#)
Also available at: [arXiv: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](#). Also available at: [arXiv: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](#)
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](#). Also available at: [arXiv:1810.10144 \[math.AT\]](#)

PEER-REVIEWED CONFERENCE PAPERS

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. Available at: [arXiv:2308.00900 \[cs.CG\]](#)

* Undergraduate student at the time of research or submission

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. Available at: [arXiv:2306.02133\[cs.CG\]](https://arxiv.org/abs/2306.02133)

WORKSHOP CONTRIBUTIONS

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 Komendarczyk, **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](#)

AWARDS, SCHOLARSHIPS, RECOGNITION

- 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

GRADUATE TEACHING

- **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.
- **Algorithm Design (DATS 6001)** Spring 2024
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 and greedy algorithms.
- **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.

* Undergraduate student at the time of research or submission

- **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
- **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

- **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

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

ACADEMIC SERVICES

- I have been a reviewer for Journal of Foundations of Data Science.
- I have been a reviewer for Journal of Combinatorial Optimization.
- 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

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

SOFTWARE PROJECTS

- **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.

ENTREPRENEURIAL EXPERIENCE

- **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.

INVITED TALKS AND ACCEPTED ABSTRACTS

- **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
Available on: [Google Drive](#)
- **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, ICFAI University, Tripura, India
- **Title:** A Taste of Topological Data Analysis (TDA): Reconstruction of Shapes September, 2021
Department of Mathematics, Hunter College, NY, USA
- **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

HOBBY

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.