

Sushovan Majhi

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RESEARCH INTERESTS

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

My research primarily revolves around the interface of mathematics, computer science, and the foundation 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, applied problems arising in domains, like biology, medicine, genetics, finance, and dynamical systems.

TEACHING INTERESTS

Math: General and Algebraic Topology, Differential Geometry, Differentiable Manifolds, Analysis, Linear Algebra, Calculus

Data Science: Probability Theory, Mathematical Statistics, Regression Analysis

Computer Science: Computational Geometry, Algorithms and Data Structures

WORK EXPERIENCE

- **Postdoctoral Research Fellow** January 2021–current
School of Information, University of California, Berkeley, USA
Role: The responsibilities include conducting research broadly in data science, forging new research collaborations, organizing research webinar series.
- **Data Science Instructor** January 2021–current
School of Information, University of California, Berkeley, USA
Role: According to Fortune¹, **MIDS** is the No.2-ranked Master of Information and Data Science program in the US. Alongside instructing *Statistics for Data Science* for the program, I develop course materials, devise and maintain technology to facilitate teaching and learning.
- **Lecturer (MIDS Program)** August 2020–December 2020
School of Information, University of California, Berkeley, USA
Role: The position offered me (off-campus) work experience during my doctoral studies, and has served as a Curricular Practical Training (CPT).

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, 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.

¹<https://fortune.com/education/information-technology/masters/rankings/best-online-masters-in-data-science>

PUBLICATIONS AND PREPRINTS

- [Link](#) Sushovan Majhi. Demystifying Latschev’s theorem: Manifold reconstruction from noisy data. *arXiv:2204.14234 [math.AT]*, 2023
- [Link](#) Sushovan Majhi* and Carola Wenk. Distance Measures for Geometric Graphs. *arXiv:2209.12869 [cs.CG]*, 2022
Submitted to *Computational Geometry: Theory and Applications*
Presented at FWCG’22
- [Link](#) Sushovan Majhi. Vietoris–rips complexes of metric spaces near a metric graph. *Journal of Applied and Computational Topology*, May 2023
- [Link](#) Anish Rai, Ajit Mahata, Md Nurujjaman, Sushovan Majhi, 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
- [Link](#) Brittany Terese Fasy, Rafal Komendarczyk, Sushovan Majhi*, and Carola Wenk. On the reconstruction of geodesic subspaces of \mathbb{R}^n . *International Journal of Computational Geometry & Applications*, 32(1):91–117, 2022
- [Link](#) Sushovan Majhi*, Jeffrey Vitter, and Carola Wenk. Approximating Gromov-Hausdorff Distance in Euclidean Space. *arXiv:1912.13008 [math.MG]*, 2019
Accepted to *Computational Geometry: Theory and Applications*
- [Link](#) Brittany Terese Fasy, Sushovan Majhi*, and Carola Wenk. Threshold-based graph reconstruction using discrete Morse theory. In *Fall Workshop on Computational Geometry*, New York, NY, November 2018
- [Link](#) Brittany Terese Fasy, Rafal Komendarczyk, Sushovan Majhi*, and Carola Wenk. Topological reconstruction of metric graphs in \mathbb{R}^n . In *Fall Workshop on Computational Geometry*, New York, NY, October 2017

RESEARCH EXPERIENCE

- **Topological and Statistical Methods in Predicting the Crash and Recovery of Stock Markets** March 2021–current
Collaborator: [Md. Nurujjaman](#), NIT Sikkim, India
In the aftermath of stock market crash due to COVID-19, not all sectors recovered in the same way. We proposed novel models to capture the different types of recovery profiles for Indian stocks. We also employed the **Empirical Mode Decomposition** (EMD) for a statistical significance analysis of our model.
We currently look into the possibility of predicting a future crash in a financial sector—using tools from **Topological Data Analysis** (TDA).
- **Topological and Geometric Signature-Based Shape Comparison** October 2021–current
Collaborators: [Erin Chambers](#), [Liz Munch](#), and [Carola Wenk](#)
We consider geometric and topological signatures to concisely represent large datasets to facilitate their easy description and efficient comparison. To this end, we look for signatures in the class of algebraic, geometric, and graphical signatures. We have proposed new similarity measures for geometric graphs, and studied their computational aspects.
- **Computation of Gromov-Hausdorff Distance in Euclidean Space** April 2019–December 2020
Collaborators: [Helmut Alt](#), [Jeffrey Vitter](#), and [Carola Wenk](#)

*First author

We investigate the computational aspects of Gromov-Hausdorff distance between sets equipped with the Euclidean metric. We used the Hausdorff distance under isometry to develop an approximation algorithm for Gromov-Hausdorff distance on the real line with a tight approximation factor of $(1 + \frac{1}{4})$.

- **Topological Reconstruction of Geodesic Spaces**

December 2016–May 2019

Collaborators: [Brittany Fasy](#) and [Rafal Komendarczyk](#)

Role: Research Assistant

PI: [Carola Wenk](#) (NSF CCF-161846)

We investigate the reconstruction of geodesic subspaces of Euclidean spaces using the Vietoris-Rips and Čech complexes from a dense sample around it. We propose two new sampling parameters: **distortion** of embedding and **convexity radius** of the underlying geodesic space. We guarantee a successful computation of the Betti numbers. For the special case of planar graphs, we also develop an algorithm for its geometric reconstruction.

- **Dynamics and Prognosis of Chronic Myelogenous Leukemia (CML)**

August 2012–November 2013

National Center for Biological Sciences, TIFR, Bangalore, India

Role: Junior Research Fellow

PI: [Seema Nanda](#)

In this joint effort to develop better prognostic tools for doctors, computational scientists teamed up with medical officers and biologists to understand the dynamics of CML by modeling the disease by systems of **differential equations**. In our parameter fitting, we made use of the big existing data collected from a large pool of CML patients. We also performed (statistical) **sensitivity analysis** to better understand the parameter spaces for our model.

TEACHING EXPERIENCE

- **Statistics for Data Science, MIDS**

August 2020–current

School of Information, University of California, Berkeley, USA

The course covers the following topics: probability theory, sampling distributions, estimators and convergence theorems, confidence intervals, hypothesis testing, and regression.

- **Undergraduate Statistics for Business Students**

Summer 2019

Tulane University, USA

The course covered the following topics: sampling methods, probability theory, random variables, sampling distribution, confidence intervals, hypothesis testing, and linear 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

ACADEMIC SERVICES

- I have been a reviewer for the Journal of Combinatorial Optimization.
- I have been a reviewer for conferences, like 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 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 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.

AWARDS, SCHOLARSHIPS, RECOGNITION

- **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

INVITED TALKS AND ACCEPTED ABSTRACTS

- **The 30th Fall Workshop on Computational Geometry** October 14–15, 2022
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.