Sushovan Majhi

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PROGRAMMING LANGUAGES: Java, C, Python, C++, Bash, Ruby, JavaScript, SQL, Matlab.
SKILLS: Databases, Git, Ruby on Rails, REST, AWS, Heroku, Jekyll.

RESEARCH INTERESTS

Topological data analysis (TDA), **applied algebraic topology**, **computational topology**, **computational geometry**, **road-map reconstruction** from GPS trajectory data.

My research primarily focuses on **shape reconstruction** and **big data analysis**. More specifically, I am interested in solving real-world problems using tools from **algebraic topology** and **geometry**. In order to analyze large, complex, and noisy data, I develop provable and efficient techniques to find and classify significant geometric and topological features.

EDUCATION

- **Doctor of Philosophy** in **Mathematics** **August 2014–May 2020 (expected)**
  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, and statistics.

RESEARCH EXPERIENCE

- **Computation of Gromov-Hausdorff Distance in Euclidean Space** **April 2019–*current***
  Collaborators: Carola Wenk, Jeffrey Vitter, and Helmut Alt
  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 $\left(1+\frac{1}{4}\right)$.

- **Discrete Morse Theory in Graph Reconstruction** **October 2018–*current***
  Collaborators: Carola Wenk and Brittany Terese Fasy
  We propose a threshold-based framework to obtain both topologically and geometrically faithful reconstruction of planar metric graphs from (noisy) spatial data. We make use of topological ideas, like discrete Morse theory and persistence homology and statistical ideas like kernel density estimation (KDE) to capture statistically significant features.

- **Topological Reconstruction of Geodesic Spaces** **December 2016–May 2019**
  Collaborator: Carola Wenk, Rafal Komendarczyk, Brittany Fasy
  Role: Research Assistant
  PI: Carola Wenk
  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 a planar metric 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, mathematicians 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.

PUBLICATIONS

Link Sushovan Majhi, Jeffrey Vitter, and Carola Wenk. Approximating Gromov-Hausdorff Distance in Euclidean Space. *arXiv:1912.13008 [math.MG]*, 2019

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. On the Reconstruction of Geodesic Subspaces of $\mathbb{R}^n$. *arXiv:1810.10144 [math.AT]*, 2018

Link Brittany Terese Fasy, Rafal Komendaczyk, 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

SOFTWARE PROJECTS

- **Shape Reconstruction Visualization** Link | Github
  To complement my 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.

- **Avimukh** Link
  Avimukh is a Bengali website for poets, writers, and bloggers. I designed its backend in Ruby on Rails framework. The web-app is hosted on Heroku.
  Skills: Ruby on Rails, Ruby, SQL, JavaScript, HTML.

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.