

Introduction to Algebraic Topology at BIMS

Close Remarks

Summer School on Chromatic Homotopy Theory and Higher
(Infinity-Categorical) Algebra

August 15 - 26, 2022

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Full name of BIMSA: Yanqi Lake Beijing Institute of Mathematical Sciences and Applications

It is a newly launched **applied math center of Yau** from June 2020, linking to the Yau center at Tsinghua, connecting to other Yau centers.

Currently, BIMSA has over 100 researchers from postdocs to all level of regular positions.

Hiring of BIMSA is available with aiming to the final size of around 300 people.

President of BIMS A is Shing-Tung Yau



Currently, there are 11 people who hold professorship positions titled Research Fellow, including

- Caucher Birkar



- Nicolai Reshetikhin



Research Structure of Algebraic Topology at BIMSA

pure mathematical research on algebraic topology

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application-guided mathematical research on algebraic topology

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practical applications of algebraic topology

pure mathematical research on algebraic topology

- homotopy theory
- configuration spaces, braid groups, topological complexity
- homotopy aspects of knot theory
- homotopy patterns in group theory
- research interests will be extended when more people come.

application-guided mathematical research on algebraic topology

- Topological structures of the networks given by graphs/digraphs/quivers, aiming to **exploring new topological features of data**.
 - digraph homotopy and path homology.
 - hypergraph homology.
 - topological approaches to data beyond classical persistent homology.
- **Evolutionary system of topological structures**, aiming to
 - evolutionary dynamics of data
 - fundamental laws of biology

practical application of algebraic topology

- Jelena Grbic, Jie Wu, Kelin Xia and Guowei Wei, “Aspects of topological approaches for data science.” Foundations of Data Science, 4(2), 165 (2022).
- Xiang Liu, Huitao Feng, Jie Wu, and Kelin Xia, “Dowker complex based machine learning (DCML) models for protein-ligand binding affinity prediction.” PLOS Computational Biology, 18(4), e1009943 (2022)
- Xiang Liu, Xiangjun Wang, Jie Wu, and Kelin Xia, “Hypergraph based persistent cohomology (HPC) for molecular representations in drug design.” Briefings In Bioinformatics, 22 (5), bbaa411 (2021)

Invited speakers in our seminar

- **Jürgen Jost**, March 10, 2022.
- **Guo-Wei Wei**, March 24, 2022.
- **Gunnar Carlsson**, April 21, 2022.
- **Victor Buchstaber**, April 28, 2022
- **Konstantin Mischaikow**, May 5, 2022.
- **Herbert Edelsbrunner**, May 26, 2022.

Connection to Prof Shing-Tung Yau's work

Digraph homotopy and path homology, **the notion recently introduced by Yau.**

Path homology would be good and better in TDA (topological data analysis), particularly, for networks given by digraphs/quivers.

Bio-network, brain network, interactions between microbiomes and many others have directions.

Evolutionary system of spaces with dependent/correlated multi-parameters might be modeled by digraph/quiver with assigning a space as a weight to each node (i.e., representation of digraph/quiver in topological spaces).

Connection to Stephen Yau's work

Mathematical biology

Strategic goal: fundamental laws of biology

My dream: homotopy theory would become a proper descriptor for the structure and evolutionary dynamics of multi-layered complex networks, from molecules to cells to organs, which leads to life.

Connections with other people at BIMSA

- A partner of the lab of Big Data and AI at BIMSA.
 - Working together with statisticians on applications in BIG Data.
 - Statisticians work out **proper meaningful model of (di-)graphs** from practical problems, and **we do mathematics** for exploring **structures of data**.
- digital economics at BIMSA.
- quantum information at BIMSA.

Thank You for attending this
excellent program!

Thanks for the lecturers and all
people contributing to the
success!