2023 年拓扑及其应用会议报告简介

<p align="center">(按报告人姓氏字母顺序排列)</p>

1. Some medical applications of topological data analysis

报告人：**Matthew Burfitt**

单　位：**BIMSA**

摘　要：Since its emergence over the last few decades, topological data analysis has found diverse application across many disciplines. Persistent homology is one of the most powerful and widely used methods form topological data analysis usually taking as input a filtered simplicial complex obtained from the data of interest. The output of the procedure can consist of a range of possible features and statistics that capture multi-scale geometric information about the data. In this talk I will discuss two examples of ongoing work using topological data analysis to study medical data. The first will be an application to of brain magnetic resonance imaging (MRI) classification and the second to studying changes in neurovascular structures within the skin and mussel of mice.

2. Simplicial approach to path homology of quivers, subsets of groups and submodules of algebras

报告人：**Sergei Ivanov**

单　位：**BIMSA**

摘　要：We develop the path homology theory in a general simplicial setting which includes as particular cases the original path homology theory for path complexes and new homology theories: homology of subsets of groups and Hochschild homology of submodules of algebras. Using our general machinery, we also introduce a new homology theory for quivers that we call square-commutative homology of quivers and compare it with the theory developed by Grigor'yan, Muranov, Vershinin and Yau.

3. A CW complex realization of minimal Sullivan algebras with the minimum number of cells

报告人：白杨

单　位：南开大学

摘　要：有理同伦论是对拓扑空间的有理同伦型的研究。与一般的同伦型相比，有理同伦型忽略了同伦群的挠，考虑的均是有理数域上的同伦与同调，进而有着非常漂亮的性质。有理同伦论由 Dennis Sullivan (1977) 与 Daniel Quillen (1969) 首创。其中，Sullivan 理论有个最基本的结论:对单连通有限性的拓扑空间，其有理同伦型一一对应于极小 Sullivan 代数的同构类。本次报告的前半部分将对有理同伦论进行基本的介绍。在后半部分，对给定的极小 Sullivan 代数(对应了一个有理同伦型)，我们将构造一个具有该有理同伦型的 CW 复形，这个 CW 复形所具有的胞腔个数是最少的。

4. The magnitude homology of a hypergraph

报告人：毕婉莹

单　位：河北师范大学**&BIMSA**

摘　要：The magnitude homology introduced by Hepworth and Willerton provides us with a topological invariant for studying the properties of graphs. Hypergraph, as a generalization of the notion of graphs, is a popular mathematical model of data with high-order structures. In this paper, to describe the topological properties of hypergraphs, we begin to consider the magnitude homology of hypergraphs. Firstly, we consider the distance of hyperedges on a hypergraph and give the magnitude homology of hypergraphs. At the same time, we show the relationship between the magnitude and the magnitude homology of hypergraphs. Moreover, we obtain some functorial properties of the magnitude homology of hypergraphs. At last, we give the Künneth theorem for the magnitude homology of hypergraphs.

5. On the cohomology of fake weighted projective spaces

报告人：范飞飞

单　位：华南师范大学

摘　要：Fake weighted projective spaces are toric varieties associated to simplices, which can be constructed as finite abelian quotients of weighted projective spaces. While the integral cohomology rings of weighted projective spaces are easy to compute by a formula due to Kawasaki, the integral cohomology rings of fake weighted projective spaces are much more complicated and a general formula is not known so far. In this talk, we describe the image of the cohomology of a fake weighted projective space in the cohomology of the corresponding weighted projective space, and introduce a way to compute its torsion subgroup.

6. Face-to-face interaction analysis from persistent hypergraph model

报告人：高亚茹

单　位：大连理工大学

摘　要：Close proximity interactions between individuals are usually measured and analyzed using the model of connectivity graphs. Recent researches show that the hypergraph model reveals more global and geometric features in high dimensions. We generalizes classical persistent homology on simplicial complexes to hypergraphs. Our theory is demonstrated by analyzing face-to-face interactions of different populations. We select data sets of baboons in primate center and people from rural Malawi, scientific conference, workplace and high school.

7. The motivic and singular cohomology of $BPGL_n$

报告人：古星
单　位：西湖大学

摘　要：For an odd prime p, we present some results on the p-torsion classes of singular and motivic integral cohomology of the $BPGL_n$, the classifying space of the projective general linear group.

8. Study of rational homotopy from an unstable homotopy theoretic point of view

报告人：黄瑞芝
单　位：中科院数学与系统科学研究院

摘　要：　Localization is a foundational method in homotopy theory. It is easy to believe that life is much easier after localization. In particular, integral/unstable homotopy theory should be much more complicated than rational homotopy theory. Indeed, by the famous work of Quillen and Sullivan, rational homotopy theory is purely algebraic. Therefore, one can expect that it is much easier to apply Quillen or Sullivan's theory to study rational homotopy than to apply the wilder unstable homotopy theory. However, in several recent joint work with Stephen Theriault, we are able to apply unstable homotopy theory techniques to study some rational homotopy properties of manifolds. In this talk, I will explain this with examples, ideas and its advantages.

9. An application of topological data analysis in predicting sumoylation sites

报告人：林小熙
单　位：大连理工大学

摘　要：Sumoylation, a reversible post-translational modification, is one of the most essential cellular processes in the regulation of various significant biochemical functions. Abberations in protein sumoylation are closely involved in kinds of human disease. Identification of sumoylation sites in proteins provides insights for further mechanistic research in sumoylation and drug developments. We propose a new computational approach for predicting sumoylation sites through the features constructed from topological data analysis. With the assistance of the Random Forest algorithm, the proposed method is trained and tested using a non-redundant dataset. In a 10-fold cross validation, our predictor yields an excellent performance with sensitivity, ac- curacy, Matthew's correlation coefficient equal to 91.27%, 94.26%, 0.8877, respectively. As a new application of topological data analysis, our results suggest that topological information as an additional parameter could assist the prediction of sumoylation sites.

10. Persistent Path-Spectral Based Machine Learning for Protein–Ligand Binding Affinity Prediction

报告人：刘冉

单　位：河北师范大学**&BIMSA**

摘　要：Molecular descriptors are essential to quantitative structure activity/property relationship (QSAR/QSPR) models and machine learning models. In this talk we will introduce our recently proposed persistent path-spectral (PPS), PPS-based molecular descriptors, and PPS-based machine learning model for the prediction of the protein-ligand binding affinity. For the graph, simplicial complex, and hypergraph representation of molecular structures and interactions, the path-Laplacian can be constructed and the derived pathspectral naturally gives a quantitative description of molecules. Further, by introducing the filtration process of the representation, the persistent path-spectral can be derived, which gives a multiscale characterization of molecules. Molecular descriptors from the persistent path-spectral attributes then are combined with the machine learning model, in particular, the gradient boosting tree, to form our PPS-ML model. We test our model on three most commonly used data sets, i.e., PDBbind-v2007, PDBbind-v2013, and PDBbind-v2016, and our model can achieve competitive results.

11. Persistent function based machine learning for drug design

报告人：刘祥

单　位：南开大学**&BIMSA**

摘　要：Artificial intelligence (AI) based drug design has demonstrated great potential to fundamentally change the pharmaceutical industries. However, a key issue in all AI-based drug design models is efficient molecular representation and featurization. Recently, topological data analysis (TDA) has been used for molecular representations and its combination with machine learning models have achieved great successes in drug design. In this talk, we will introduce our recently proposed persistent models for molecular representation and featurization. In our persistent models, molecular interactions and structures are characterized by various topological objects, including hypergraph, Dowker complex, Neighborhood complex, Hom-complex. Then mathematical invariants can be calculated to give quantitative featurization of the molecules. By considering a filtration process of the representations, various persistent functions can be constructed from the mathematical invariants of the representations through the filtration process, like the persistent homology, persistent spectral and persistent Tor-algebra. These persistent functions are used as molecular descriptors for the machine learning models. The state-of-the-art results can be obtained by these persistent functions based machine learning models.

12. Higher-order interaction network and Beyond-TDA

报告人：吴杰

单　位：**BIMSA**

摘　要：This talk will aim to junior researchers who are interested in working on applied topology. The talk will consist of three sections. In section 1, we will give some general suggestions to junior researchers for designing their future development in applied topology. In section 2, we start to discuss the higher-order interaction network, which is one of the most important scientific challenges. Comparing with that there are a lot of well-developed mathematical tool (from graph theory) on pairwise interaction networks, currently there are limited mathematical tools on higher-order interaction networks, which gives a big demand for mathematicians to study the higher-order structure of complex networks. We also give a short review on topological approaches to complex network. In the last section, we will discuss GLMY theory and its related theories and their successful applications of GLMY theory and its variations in biology and materials, which give beyond-TDA topological approaches to complex network.

13. On Determinations of Homotopy Groups

报告人：杨聚鑫

单　位：河北师范大学**&BIMSA**

摘　要：Homotopy groups are at the center of homotopy theory, however they are usually hard to determine. Roughly speaking, the key tasks to determine homotopy groups are to decide the composition relations of generators and sovle the extension problems. In this talk, we will introduce some important methods and examples on determinations of homotopy groups of 2-local spheres and finite cell complexes. The methods include the classical Toda bracket racket, matrix Toda bracket , four-fold Toda bracket and Gray's relative James construction.

14. The cohomology of S(2)

报告人：查家熙
单　位：南开大学

摘　要：考虑上代数 $S(2) = K(2)_* \otimes_{BP_*} BP_*BP \otimes_{BP_*} K(2)_* \otimes_{K(2)_*} F_p$. 本次报告将通过给出新的过滤来计算 S(2) 的上同调(p 为奇素数时)，并介绍与其相关的代数拓扑的背景.

15. 弱图映射同伦及其性质

报告人：张丛磊
单　位：河北师范大学

摘　要：基于数字图像分析的背景，我们引入有限图范畴中弱图映射同伦（简称为 M-同伦）的概念，在此基础上定义了简单图的 M-强形变收缩核以及图之间的 M-同伦等价。接着我们证明了，通过依次删除平凡顶点的方式可以找到一个简单图的任意 M-强形变收缩核，进一步证得如下结果：图之间 M-同伦等价的概念与丘成桐先生等定义的图同伦等价的概念是一致的。虽然两者是一致的，但是将变换的过程相比较，图之间 M-同伦等价意义下的变换可以通过映射对图的变换过程给出更加具体地刻画。最后，我们讨论 M-同伦的一些应用。

16. The Δ-twisted homology and fiber bundle structure of twisted simplicial sets

报告人：张蒙蒙
单　位：河北师范大学&BIMSA

摘　要：Different from classical homology theory, Alexander Grigor'yan, Yuri Muranov and Shing-Tung Yau recently introduced δ-(co)homology, taking the (co)boundary homomorphisms as δ-weighted alternating sum of (co)faces. For understanding the ideas of δ-homology, Li, Vershinin and Wu introduced δ-twisted homology and homotopy in 2017. On the other hand, the twisted Cartesian product of simplicial sets was introduced by Barratt, Gugenheim and Moore in 1959, playing a key role for establishing the simplicial theory of fibre bundles and fibrations. The corresponding chain version is twisted tensor product introduced by Brown in 1959.

In this talk, I will report our recent progress for unifying δ-homology and twisted Cartesian product. We introduce Δ-twisted Carlsson construction of Δ-groups and simplicial groups, whose abelianization gives a twisted chain complex generalizeing the δ-homology, called Δ-twisted homology. We show that Mayer-Vietoris sequence theorem holds for Δ-twisted homology. Moreover, we introduce the concept of Δ-twisted Cartesian product as a generalization of the twisted Cartesian product, and explore the fiber bundle structure. The notion of Δ-twisted smash product, which is a canonical quotient of Δ-twisted Cartesian product, is used for determining the homotopy type of Δ-twisted Carlsson construction of simplicial groups.

17. Motivic method and stable homotopy groups of spheres

报告人：张宇
单　位：南开大学

摘　要：The stable homotopy groups of spheres play a fundamental role in algebraic topology, and their calculations have significant applications in related research areas. In recent years, Isaksen-Wang-Xu achieved a significant breakthrough by utilizing motivic homotopy theory, resulting in brand new calculation results on the 2-primary components of these groups. In this talk, I will discuss the key ideas of their method, along with our recent findings on odd-primary computations. We obtained these outcomes following a comparable strategy.

18. The E_1-page of the chromatic spectral sequence which converges to $H^2(P;Q)$

报告人：张枝磊
单　位：南开大学

摘　要：Let p be an odd prime. Let $P = F_p\{t_1, t_2, t_3, \cdots\}$ be the polynomial part of the dual of Steenrod algebra and $Q = F_p\{q_0, q_1, q_2, \cdots\}$ which can be given a structure of P-comodule. The cohomology $H^*(P;Q)$ provides a connection between Adams spectral sequence and Adams-Novikov spectral sequence. In 1978, Haynes Miller constructed a chromatic spectral sequence which converges to this cohomology. In this spectral sequence, the E_1-page which converges to $H^2(P;Q)$ are $H^1(P; q_1^{-1}Q/(q_0^\infty))$ and $H^0(P; q_2^{-1}Q/(q_0^\infty, q_1^\infty))$. $H^*(P; q_1^{-1}Q/(q_0^\infty))$ was calculated by Michael Joseph Andrews in his thesis. In this talk, we introduce some results of $H^0(P; q_2^{-1}Q/(q_0^\infty, q_1^\infty))$.

19. 基于过滤曲线的图分类

报告人：祝欣然
单　位：南开大学

摘　要：图分类在生物、化学信息学等领域中有许多关键的应用，其研究方法主要是图核和图神经网络。它们主要基于两种方法：比较两个图中节点对的邻域、枚举两个图中匹配的子图，来计算相似度。我们使用拓扑数据分析中的过滤曲线来补充这两种方法，这种方法可以同时捕获边权值信息和图的全局结构信息。我们构造了新的过滤曲线，添加了图上一维 Betti 数的信息，捕获了图中的环结构，得到了更好的结果。