Workshop on Algebraic Topology and Applied Topology

23 January 2018

9.00am to 5.30pm

S17-04-05 (Seminar Room 2)

NUS National University of Singapore | Department of Mathematics Faculty of Science

Programme

09:00am – 09:50am	**Topological modelling and analysis of complex data in biomolecues** *Xia Kelin* *Nanyang Technological University*
10:00am – 10:50am	**An Introduction to Persistent Homology** *Wu Chengyuan* *National University of Singapore*
11:00am – 11:50am	**Quillen approach to cohomology and universal extensions** *Fedor Pavutniskiy* *National University of Singapore*
12:00noon – 12:50pm	Lunch
13:00pm – 14:50pm	**Groups G^k_n, recognition problems and relation to other groups** *Vassily Manturov* *Moscow State Technical University*
15:00pm – 15:50pm	**On the fundamental groups of small covers** *Yu Li* *Nanjing University*
16:00pm – 16:50pm	**On the mapping class group of complex 3-dimensional complete intersections** *Su Yang* *Chinese Academy of Sciences*
17:00pm – 17:15pm	**Journey to Bauman Moscow State Technical University** *Vassily Manturov* *Moscow State Technical University*

Abstract

Topological modelling and analysis of complex data in biomolecues

Xia Kelin, Nanyang Technological University

The understanding of biomolecular structure, flexibility, function, and dynamics is one of the most challenging tasks in biological science. We have introduced flexibility and rigidity index (FRI) for biomolecular flexibility analysis, particularly the B-factor prediction. Our FRI is highly accurate and computationally-efficient. We also introduce persistent homology for extracting molecular topological fingerprints (MTFs) based on the persistence of molecular topological invariants. MTFs are utilized for protein characterization, identification, and classification. The multidimensional persistent homology is proposed and further used to quantitatively predict the stability of protein folding configurations generated by steered molecular dynamics. An excellent consistence between my persistent homology prediction and molecular dynamics simulation is found. Further, we introduce multiresolution persistent homology to handle complex biomolecular data. The essential idea is to match the resolution with the scale of interest so as to represent large scale datasets with appropriate resolution. By appropriately tuning the resolution of a density function, we are able to focus the topological lens on the scale of interest. The proposed multiresolution topological method has potential applications in arbitrary data sets, such as social networks, biological networks and graphs. Finally, we offer persistent homology based new strategies for topological denoising and for resolving ill-posed inverse problems in Cryo-EM data.

An Introduction to Persistent Homology

Wu Chengyuan, National University of Singapore

Persistent homology is a recent branch of topology that has many applications. It is also used in topological data analysis. We give an introduction to persistent homology and some of its applications. We also discuss our recent research on weighted persistent homology (joint work with Shiquan Ren and Jie Wu).

Quillen approach to cohomology and universal extensions

Fedor Pavutniskiy, National University of Singapore

In this talk I want to introduce a homotopy theoretic point of view on universal central extensions. These extensions will be seen as principal objects, classified by a certain cocycles in Quillen cohomology of perfect groups. Turns out, that by varying the underlying category, one can describe other familiar group theoretic notions as some type of universal extensions.

Groups G^k_n, recognition problems and relation to other groups

Vassily Manturov, Moscow State Technical University

I will describe the algebraic methods of *rewriting*, which allows one to relate the groups G^k_n. I will speak on the solution of word and conjugacy problems for specific n, k. I will especially concentrate on the groups G^k_{k+1} which are isomorphic to fundamental groups of concrete configuration spaces.

On the fundamental groups of small covers

Yu Li, Nanjing University

We study the topology of small covers from their fundamental groups.We find a way to obtain explicit presentations of the fundamental group of a small cover. Then we use these presentations to study the relations between the fandamental groups of a small cover and its facial submanifolds. In particular, we can determine exactly when a facial submanifold of a small cover is π_1-injective in terms of some purely combinatorial condition on the underlying simple polytope. In addition, our study reveals some connections between several topological notions for 3-dimensional small covers. This allows us to determine when a 3-dimensional small cover and its regular $(\Z_2)^k$-covering spaces are Haken manifolds.

On the mapping class group of complex 3-dimensional complete intersections

Su Yang, Chinese Academy of Sciences

In a recent joint work with M.Kreck, we computed the mapping class group of certain simply-connected 6-manifolds, which include complex 3-dimensional complete intersections, especially the Calabi-Yau 3-folds. In this talk I will introduce the result and compare it with the mapping class group of surfaces.