LTCC Proposed Course

Title: Introduction to Applied Topology

Basic Details:

- Core audience: Pure
- Course Level/Format: Basic/core (5x2 hours)

Course Description:

- Keywords: Simplicial complexes, persistent (co)homology, Euler characteristic, Morse theory, manifold learning, stability of persistence diagrams.

- Synopsis: Applied topology is an area of study at the intersection of mathematics and computer science. It has developed rapidly over the last 10-15 years adapting tools from algebraic topology to applied settings. This course is meant as an introduction to some of the main results and tools developed in applied topology. It will introduce some of the problems which are considered – topics which will be covered include Euler characteristic curves and persistent (co)homology. There will be a strong emphasis on the stability of topological invariants and a focus on applications to manifold learning and random spaces. We will not cover the many applications or the computational aspects of applied topology.

- Recommended Reading:
    1. Elementary Applied Topology, Robert Ghrist, 2014
    2. Computational Topology: An Introduction, Edelsbrunner, Harer, 2010
    3. Weinberger S. What is ... persistent homology? Notices of the AMS, 2011, 58(1): 36-39.

- Optional Reading:
    1. Cohen-Steiner, Edelsbrunner, Harer, Stability of Persistence Diagrams. Discrete Computational Geometry. 2006
    2. Chazal et al. The structure and stability of persistence modules. Springer, 2016.
    3. Chazal, De Silva, Oudot, Persistence stability for geometric complexes. Geometriae Dedicata 173.1 (2014): 193-214.
    4. Niyogi, Smale, Weinberger Finding the homology of submanifolds with high confidence from random samples. Discrete Computational Geometry 39.1-3 (2008): 419-441.
    5. Bobrowski, Kahle. Topology of random geometric complexes: a survey. Journal of Applied and Computational Topology (2018): 1-34.

- Prerequisites: None

Format:
- No of problem sheets: 4
- Electronic lecture notes:
- Necessary support facilities:
- necessary software requirements for computing facilities:
- Lecture/computer session/tutorial/discussion split (hours of each): TBD

Lecturer Details:

- Lecturer: Dr. Primoz Skraba
- Lecturer home institution: QMUL
- Lecturer e-mail: p.skraba@qmul.ac.uk

Syllabus:
1. Introduction to Simplicial/Cellular Complexes. Invariants – Euler characteristic, (co)homology
2. Persistent homology and connections with Morse theory. Examples arising from geometric constructions
3. Stability of persistence and statistical applications
4. Probabilistic applications including manifold learning and the topology of random spaces
5. Next steps and current directions in applied topology