Applied and Computational Algebraic Topology

Organizer: Martin Raussen (*Aalborg Universitet, DK)*

Wednesday, July 4, 14:30–16:30, Seminar Hall

Talks:

Patrizio Frosini (*Università di Bologna, IT*), **Metric shape comparison via multidimensional persistent homology**

Lucile Vandembroucq (*University of Minho, PT*), **Topological complexity of motion planning**

Dmitry Feichtner-Kozlov (*Universität Bremen, DE*), **Topological methods in distributed computing**

Martin Raussen (*Aalborg Universitet, DK*), **Concurrency and directed algebraic topology**

Metric shape comparison via multidimensional persistent homology

Patrizio Frosini
Università di Bologna, IT

In many applications we are required to compare functions from a topological space to a real vector space, called "multidimensional filtering functions". A simple example is the comparison of paintings, where each function takes the points of the real plane to triples of real numbers, describing the colour at each point. A transformation group H on the topological space is usually considered, and two functions are defined to be equivalent if one can be obtained from the other by composition with an element in the group. As a trivial example, in the case of paintings we can take the group of translations or the group of rigid motions. A natural way of measuring the difference between two filtering functions f and g is to compute the sup-norm distance between the orbits of f and g under the action of H. While this pseudo-metric is quite difficult to compute, lower bounds can be easily obtained by multidimensional persistent homology (an extension of classical homology that is particularly suitable in presence of noise). In this talk we will illustrate how this methodology can be applied to shape comparison.

Topological complexity of motion planning

Lucile Vandembroucq
University of Minho, PT

The aim of this talk is to present one of the main topics studied in topological robotics, namely the topological complexity of the configuration space of a given mechanical system. This homotopy invariant has been introduced by M. Farber and corresponds to the minimal number of continuous rules of a program governing the motion of the system. The topological complexity turns out to be closely related to the classical Lusternik-Schnirelmann category, introduced in the 1930's in the context of the calculus of variations. The talk will present some of the most significant features of the topological complexity.

Topological methods in distributed computing

Dmitry Feichtner-Kozlov
Universität Bremen, DE

In this talk we will present the basic ideas behind applications of combinatorial topology in the modern theoretical distributed computing. We will present formal simplicial models for tasks and protocols, and will in particular concentrate on the immediate snapshot computational model as well as the read/write model. We will show how topological tools can be used to show impossibility of solving certain tasks. (Based on a joint book project with Maurice Herlihy and Sergio Rajsbaum).

Concurrency and directed algebraic topology

Martin Raussen
Aalborg Universitet, DK

Concurrency theory in theoretical computer science deals with methods, problems and algorithms occurring along with parallel computations. Higher-dimensional Automata are particular models for the study of concurrency; they can be described in a combinatorial/topological manner that takes particular care of the time flow. An analysis of these models has to incorporate direction into tools and methods from algebraic topology and gives rise to "directed algebraic topology". The main aim is an analysis of the properties of spaces of executions (= directed paths) in Higher Dimensional Automata.