Math 595: Applied Topology

Section AT, CRN 45994

Instructor: Yuliy Baryshnikov

Day/time: TR 12:30-1:50pm

The course is an introduction into the tools of algebraic topology applicable to problems of engineering and science. The emphasis will be on operational side of the theorems, not on proving them.

We will be using some combination of recent textbooks (such as Rob Ghrist's text available online) and research papers. A computational project on one of the covered topics and a short presentation are expected from the participants.

Necessary prerequisites include good grasp of multivariate calculus and linear algebra.

Syllabus:

Useful topological spaces: manifolds; simplicial complexes; examples. (1 week)

Overview of tools of algebraic topology: homotopy equivalence, homologies (singular); elements of de Rham and Hodge theorems. Basic algebraic tools will be addressed as needed. (2 weeks).

Bjorner-Lovasz-Yao theory on lower bounds of decision trees. (1 week)

Definable sets, constructible functions and Integrals with respect to Euler characteristic and applications (2 weeks)

Alexander duality and applications (caging in robotics) (1 week)

Topological data analysis: shape of data, persistence, cyclicity (2 weeks)

Classical configuration spaces; their cohomologies, Arnold-Brieskorn relations. Configuration spaces on graphs; hard disk configuration spaces (2 weeks)

Spaces of directed paths, their topology and applications (2 weeks)