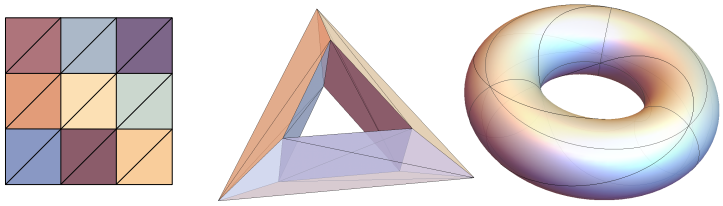
Math 496T: Spring 2019

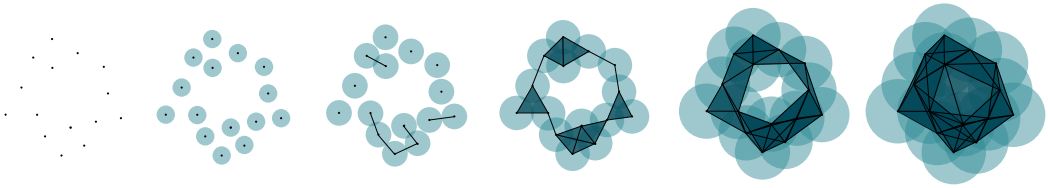
Introduction to Algebraic Topology (with Applications)

Dr. Rachel Neville



About the Course: For me, one of the joys of learning mathematics was the glimpse into how seemingly disparate fields in mathematics lend tools and concepts to each other in extremely fruitful ways. In this course, students will gain an elementary understanding of how algebraic tools can be used to answer questions that are topological and geometric in nature. Namely, homology groups measure something intrinsically geometric about surfaces. Focusing on triangulated objects and simplicial homology allows these concepts to be explored in a very concrete (and computable) way. Emphasis on low dimensional examples (graphs and surfaces) builds geometric intuition and provides examples that are interesting in their own right.

Prerequisites: This course will be accessible to students who have taken Math 313: Introduction to Linear Algebra. Point set topology is not assumed and necessary algebra will be contained in the course. Interested students may continue to abstract algebra or topology with greater intuition and motivation, but there is little overlap. Likewise, students who have already taken abstract algebra or topology may expect new material.



Text: *Graphs, Surfaces and Homology* by P.J. Giblin, a section from *A Short Course in Computational Geometry and Topology* by Herbert Edelsbrunner (free online through the library)

Objectives: Students will be able to define and compute homology groups for simple mathematical objects in terms of simplicial complexes. Additionally, students will learn elementary properties of abelian groups and quotient groups, basic topological results in graph theory, and basic results of embedding graphs in surfaces. Students will learn how to use persistent homology to begin to investigate structure in data.

- Part 1: abelian groups, exact sequences, quotient, graphs and surfaces, polygonal representations of surfaces, Euler characteristic
- Part 2: simplicial complexes, stars, joins, collapsing, chain groups, boundary homomorphisms,
- Part 3: homology groups, relative homology, homology groups of surfaces, Euler characteristic
- Part 4: geometric applications: regular neighborhoods, graphs in surfaces, orientation preserving loops
- Part 5: persistent homology