Math 569-002 Fall 2014: Computational Geometry and Topology I

TR 9:40–10:55am in Ayres 111. Office Hours in Ayres 244, time TBD.

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Introduction. Welcome to our class! The objective of this course is to give an introduction to Computational Geometry and Topology. The contents of this class will be split into two:

- In the first part of the class we will cover some basic concepts in point-set topology, and at the same time set up the computational platform that we will code with.
- The second part of the course will be focused on learning Computational techniques inspired by topology and implementing these on interesting data sets.

Books. For the basics on topology we will use J.R. Munkres' book "Topology," 2nd Edition, from Prentice Hall. For the second part of the course we will use "Computational Topology" by H. Edelsbrunner and J.L. Harer, by the AMS.

Evaluation. Your final grade depends on your homework average grade (50%) and the grade you get in the final project (50%).

Topics. Class contents include (some of) the following:

- **Point-Set Topology Intro:** Set theory and Logic; Point-set topology: Definitions, Examples; Product and Subspace Topologies; Closed Sets and Limit Points; Continuity; Connectedness; Compactness; Quotient Topology
- **Programming Intro:** Matlab, iPython Notebook
- **Complexes:** Simplicial Complexes; Convex Set Systems; Point Cloud Triangulations
- **Topological Software:** javaPlex, Mapper
- **Homological Topics:** Homology Groups; Simplicial Homology: Definitions, Examples; Induced Maps; Singular Homology, Functoriality; Matrix Reduction Algorithm; Relative Homology; Exact Sequences; Zig-zag Lemma
- **Topological Persistence:** Persistent Homology: Intro; The Persistence Algorithm; Morse Theory and Persistence; Stability Theorems and Homology Inference
- **Examples:** Gene Expression Data; Extended Persistence; Protein Docking and the Elevation Function

Initial Activities. A to-do list for the class:

- Form four teams of 2-3 people each
- Pick large dataset (from Kaggle.com, PhysioNet.org, or wherever you want.)
- Install software: Matlab and iPython Notebok
- Install Google Drive on your computer, and be prepared to share a folder entitled "YourName" with fernando.schwartz@gmail.com