Instructor: Peter Bubenik
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Office: Little Hall 410, Office hours: MW 8th period or by appointment
My web page: http://people.clas.ufl.edu/peterbubenik/

Class meetings: MWF 7th period (1:55–2:45pm), Little Hall Room 235

Prerequisites: MAS 4105 with a minimum grade of C, or permission from instructor.

Textbook. A Short Course in Computational Geometry and Topology, by Herbert Edelsbrunner. (The UF library has an eBook copy that you may download.) We will use about half of this book, and about half of what we will cover is in this book.

Additional references. I have links to many resources on my web page. https://people.clas.ufl.edu/peterbubenik/intro-to-tda/

Course description. In this course you will learn the basics of computational topology and how they may be used to analyze data. Topological topics will include simplicial complexes, simplicial homology, filtered simplicial complexes, persistent homology, barcodes, persistence diagrams and persistence landscapes. We will learn how to apply these constructions to data by constructing Čech complexes, Vietoris-Rips complexes, Delaunay triangulations and alpha complexes. Once we have learned how to apply the mathematical and computational machinery, we will learn how to combine it with tools from statistics and machine learning. These will include the permutation test, principal component analysis and support vector machines.

Course schedule.

- Weeks 1–2 Simplicial complexes and simplicial homology
- Weeks 3–4 Filtered simplicial complexes and persistent homology
- Weeks 5–6 Barcodes, persistence diagrams and persistence landscapes
- Week 7 Constructing filtered simplicial complexes from data
- Weeks 8–9 Combining persistence computations with statistics and machine learning
- Weeks 10–15 Work on projects and presentations

Course Objectives. By the end of this course, you will have learned the basic concepts of computational topology and how they may be used to analyze data. In addition to learning some interesting mathematics, you will learn some important methods in modern data science. You will be able to use the statistical programming language R. You will apply sophisticated mathematics to analyze real data, and be able to present your work in writing and in a presentation. These skills will prepare you for further academic work and for working in technical and quantitative jobs in industry.

Course work and assessment. The grading for the course will be based on homework and homework presentations 50%, a written report on your project 30%, and an oral presentation of your project 20%.

Software. We will be using the open source statistical software package R. It is not assumed that you have any prior experience.
**Grading scheme.** A: 100% – 90%, A-: 89% – 85%, B+: 84% – 80%, B: 79% – 75%, B-: 74% – 70%, C+: 69% – 65%, C: 64% – 60%, D+: 59% – 57%, D: 56% – 54%, D-: 53% – 50%, E: 49% – 0%.

**Homework.** The best way to learn mathematics is to do mathematics. The textbook contains many good exercises and I will assign a selection of these as well as my own problems. You are encouraged to discuss the exercises with your classmates, but you must write up your own solutions. Copying solutions or allowing your solutions to be copied is considered cheating. If you are unable to do any of the homework ask me for help as soon as possible.

**Additional Resources.** [Wikipedia](https://en.wikipedia.org) has articles on some of the topics covered in this course.

**Class Demeanor.** Students are expected to arrive to class on time and behave in a manner that is respectful to the instructor and to fellow students. Please avoid the use of cell phones and restrict eating to outside of the classroom. Other students should be respected in discussion.

**Course evaluation.** Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at [https://evaluations.ufl.edu](https://evaluations.ufl.edu). Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at [https://evaluations.ufl.edu/results/](https://evaluations.ufl.edu/results/)

**Disabilities statement.** Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, [http://www.dso.ufl.edu/drc/](http://www.dso.ufl.edu/drc/)) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

**Academic honesty.** UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code.” On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Honor Code ([https://www.dso.ufl.edu/sccr/process/student-conduct-honor-code](https://www.dso.ufl.edu/sccr/process/student-conduct-honor-code)) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor.

**Grade points.** For current UF grading policies for assigning grade points see [http://gradcatalog.ufl.edu/content.php?catoid=8&navoid=1493&hl=grade+points&returnto=search#grades](http://gradcatalog.ufl.edu/content.php?catoid=8&navoid=1493&hl=grade+points&returnto=search#grades)

**Student complaint process.** See [https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf](https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf)

**Other contact info.** Contact information for the Counseling and Wellness Center: [http://www.counseling.ufl.edu/cwc/Default.aspx](http://www.counseling.ufl.edu/cwc/Default.aspx) 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.