Computational Topology: an introduction

Time:	2:15 - 3:30pm, Tuesdays and Thursdays, Fall 2009.
Place:	Gates 498
Instructor:	Dmitriy Morozov (dmitriy@mrzv.org)

Announcements

- Homework 1 is now available.
- Homework 2 is now available.
- Homework 3 is now available.
- Course project reports are due Sunday, December 6.

Schedule

Date	Topic	Notes
Tu, Sep 22	Introduction. Connected Components.	[EH09] Section I.1 On Wikipedia: Graph, Topological space, Connected space, Distjoint-set DS.
Th, Sep 24	Curves and Knots.	[EH09] Section I.2+3 On Wikipedia: Jordan Curve Theorem, Knot Theory, Links, Complexity.
Tu, Sep 29	Surfaces.	[EH09] Section II.1. See [M00] Sections 74,76,77 for rigorous treatment of polygonal schema, cutting pasting, and surface classification. On Wikipedia: Surface, Cross-cap, Projective plane, Klein bottle.
Th, Oct 1	Fundamental Group. Homotopy.	HE's notes on Fundamental Group are not part of [EH09]. Afra Zomorodian's notes provide concise and clear review of the relevant topics in Group Theory. He also hosts English translation of Markov's paper on insolubility of homeomorphy.
Tu, Oct 6	Simplicial Complexes.	[EH09] Section III.1

		On Wikipedia: Simplex, Simplicial complex, Abstract simplicial complex, Barycentric subdivision.
Th, Oct 8	Nerves.	[EH09] Sections III.2, III.3, III.4. [H01] *Section 4.G*, Bron-Kerbosch algorithm. On Wikipedia: Nerve, Vietoris-Rips complex, Voronoi diagram, Delaunay triangulation.
Tu, Oct 13	Homology. Matrix Reduction.	[EH09] Sections IV.1, IV.2. On Wikipedia: Homology, Reduced homology, Smith normal form.
Th, Oct 15	Relative Homology.	[EH09] Section IV.3. On Wikipedia: Relative homology, Exact sequence.
Tu, Oct 20	Exact Sequences.	[EH09] Section IV.4. On Wikipedia: Snake Lemma, Mayer-Vietoris sequence.
Th, Oct 22	Cohomology.	[EH09] Section V.1. On Wikipedia: Cohomology.
Tu, Oct 27	Poincare Duality.	[EH09] Section V.2. On Wikipedia: Poincare duality.
Th, Oct 29	Alexander Duality.	[EH09] Section V.4. On Wikipedia: Alexander duality.
Tu, Nov 3	Smooth Generic Functions.	[EH09] Section VI.1. [M02]. On Wikipedia: Morse Theory.
Th, Nov 5	PL Functions.	[EH09] Section VI.3.
Tu, Nov 10	Reeb graphs.	[EH09] Section VI.4.
Th, Nov 12	Persistent Homology.	[EH09] Sections VII.1-2.
Tu, Nov 17	Stability.	[EH09] Sections VIII.1-2.
Th, Nov 19	Zigzag Persistence.	[CdS08].
Tu, Dec 1	Extended Persistence	[EH09] Section VII.3.
Th, Dec 3	Levelset Zigzag.	

References

[EH09] *(1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18)*

Herbert Edelsbrunner and John Harer. Computational Topology: an Introduction. AMS Press, 2009.

> **Note**
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> This book will not be available until January. However, it is a superset of course notes which can serve as a good supplement until the book is out.

[CdS08]   Gunnar Carlsson and Vin de Silva. Zigzag Persistence. Manuscript, 2008.

[M02]   Yukio Matsumoto. An Introduction to Morse Theory. AMS Press, 2002.

[H01]   Allen Hatcher. Algebraic Topology. 2001.

[CLRS01]   Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein. Introduction to Algorithms. MIT Press, 2nd edition, 2001.

[M00]   James R. Munkres. Topology. Prentice Hall, 2000.

[M84]   James R. Munkres. Elements of Algebraic Topology. Perseus, 1984.