19 036 -V-

Computational Topology

Summer 2008

Course Information

Instructor. Herbert Edelsbrunner, room 4034, Konrad-Zuse-Zentrum fü Informationstechnik Berlin (ZIB), Takusstr. 7, D-14195 Berlin-Dahlem. `edels@cs.duke.edu`.

Meetings. Tuesday and Wednesday 10:00–12:00, Arnimallee 3, SR 005.

Course information. Topology is the abstraction of geometry we obtain by single-mindedly focusing on how things are connected (as opposed to how big they are). That this abstraction is worthwhile has been ambly shown in the last century, during which topology flourished into a main trunk of mathematics. The computational aspects of topology have not been studies until very recently. Since connectivity is of paramount importance also in practice, it is not surprising that computational topology has its roots in diverse application areas, such as geometric modeling, visual perception, medical imaging, and structural molecular biology. The topics discussed in this course are grouped into six main themes, which are I. Graphs, II. Surfaces, III. Complexes, IV. Homology, V. Duality, VI. Morse Theory, VII. Persistence, VIII. Reconstruction.

Focus audience. BMS-students, students of the masters programs.

Literature. Computational topology is too young a field to have its own textbooks, although there do exist books on computation in specialized areas, including 3-manifolds and homology. If your background in topology is weak, I recommend any one of the following books motivating topology by connecting it to elementary mathematical concepts, such as graphs, surfaces, and continuous functions.

P. Alexandrov. *Elementary Concepts of Topology.* Dover, 1961.

P. J. Giblin. *Graphs, Surfaces and Homology.* Chapman and Hall, 1977.

In the course of its development, topology has split up into a number of different areas, including general, algebraic, and differential topology. Adding a text on algorithms, another on computational geometry, and a third on Morse theory, these topics are covered in the following six texts.

H. Edelsbrunner. *Geometry and Topology for Mesh Generation.* Cambridge, 2001.

Y. Matsumoto. *An Introduction to Morse Theory.* Amer. Math. Soc., 2002.

J. W. Milnor. *Topology from the Differential Viewpoint.* Princeton, 1965.

J. R. Munkres. *Topology. A First Course.* Prentice Hall, 1975.

J. R. Munkres. *Elements of Algebraic Topology.* Perseus, 1984.

R. E. Tarjan. *Data Structures and Network Algorithms.* SIAM, 1983.