Seminar/Project Class

Discrete Differential Geometry: Theory and Applications

This seminar/project class is geared towards helping participants understand concepts and methods from differential geometry, in particular for 2 and 3-manifolds, in a discrete rather than discretized setup. Discrete differential geometry aims to preserve selected structure when going from a continuous abstraction to a finite representation for computational purposes. For example, for a piecewise linear approximation (“mesh”) of a surface one may define Gaussian curvature in such a way that important theorems are preserved in the discrete setting. Observations like this and many others have been made independently in a variety of areas ranging from electromagnetism to discrete minimal surfaces theory.

Together we will study the basic ideas underlying these approaches and see how they can be applied to theoretical and algorithmic investigations. Possible subject matter for the course, based on participant interests, includes but is not limited to: discrete exterior calculus; Whitney forms; deRham and Whitney complexes; Steiner polynomials, Hadwiger functionals, and Cauchy Quermass Integrale; Geodesics; Morse theory; computational and algebraic topology; discrete simulation: fluids, electro-magnetism, elasticity, minimal surfaces, and surface parameterization; Hodge star and Hodge decomposition; convergence and accuracy of discrete methods; higher order theories; geometric PDEs and flows.

Participants are expected to pursue a small research project as part of the class and report on it to the class, as well as serve as scribes for a lecture which is not their own. The captured lectures will go through a review cycle with the help of the lecturer and relevant faculty to create a repository of knowledge for dissemination via the web. Projects can be of a theoretical or algorithmic nature. For example, convergence analysis of a particular discrete method or the use of a particular method for computational purposes in the simulation of some relevant physical phenomenon.

Contact:

desbrun@usc.edu
ps@caltech.edu

Potential participants are urged to contact Profs. Desbrun and Schröder prior to the beginning of class to discuss interests and possible project directions. All class participants (undergraduate and graduate students, postdocs and faculty) are expected to actively contribute to the success of the class.