CS-446  
Digital 3D geometry processing  
Pauly Mark

Summary
Students study & apply core concepts and algorithms for digital geometry processing. They create their own digital and physical geometry that follows the digital 3D content creation pipeline from data acquisition, geometry processing, to physical fabrication.

Content
The course will follow the digital 3D content creation pipeline. We will first discuss the fundamentals of geometry representations and cover continuous and discrete differential geometry concepts. Polygon mesh representations will be at the center of our investigations. We derive the core processing methods for triangle meshes, such as surface smoothing, parameterization, remeshing or deformation. Besides the mathematical concepts and algorithmic foundations, the course puts strong emphasis on implementation and features an extensive project. Students will scan their own 3D models, edit and enhance them with geometry processing algorithms, and map their geometric models to digital fabrication processes (3D printing, laser cutting) to create physical realizations of their models. A group project will explore dynamic simulation methods for physics-based animation of the scanned geometric models.

Keywords
geometry, 3D modeling, polygon meshes, numerical simulation, digital fabrication

Learning Prerequisites
Required courses
- Linear Algebra, Calculus, Programming

Recommended courses
- Introduction to Computer Graphics

Learning Outcomes
By the end of the course, the student must be able to:
- Explain and contrast fundamental geometry representations
- Explain and apply basic concepts from discrete differential geometry
- Analyze the 3D content creation pipeline and understand its limitations
- Implement and evaluate basic geometry processing algorithms, such as smoothing, remeshing, deformation, and constructive solid geometry
• Create digital 3D models from photographs and process the acquired raw geometry to build physical prototypes
• Coordinate a team during a software project

Teaching methods
Lectures, interactive demos, theory and programming exercises, programming project, project tutoring

Expected student activities
The student are expected to study the provided reading material and actively participate in class. They should prepare and resolve the exercises, prepare and carry out the programming project. Exercises in the first half of the course are done in groups of three students. For the second half of the course, the project is done in larger teams.

Assessment methods
Exercises, project, written examination

Supervision
Office hours Yes
Assistants Yes
Forum Yes

Resources
Bibliography
A list of books will be provided at the beginning of the class

Ressources en bibliothèque
• Polygon Mesh Processing / Botsch

Notes/Handbook
Slides and online resources will be provided in class

Websites
• http://lgg.epfl.ch/DGP