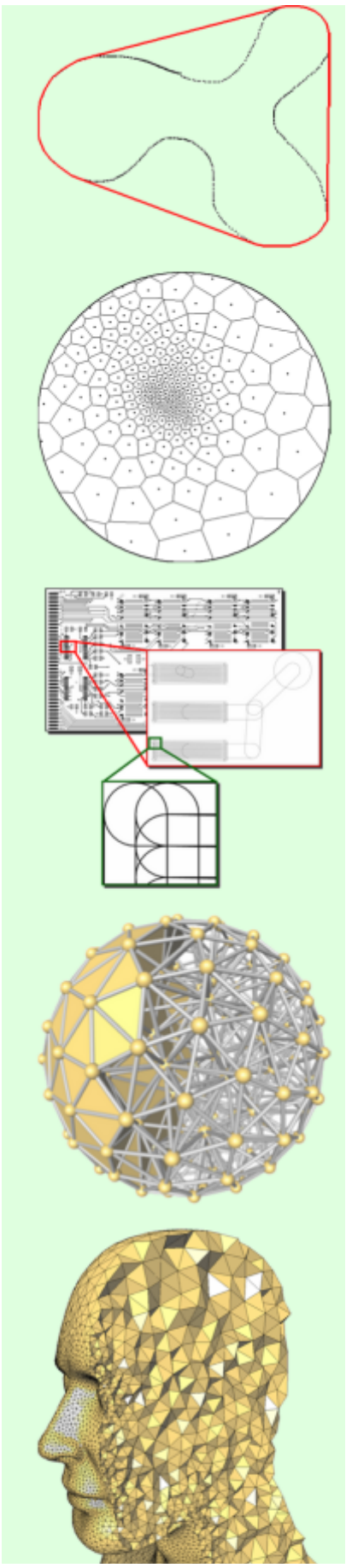
Synthesis, image and geometry



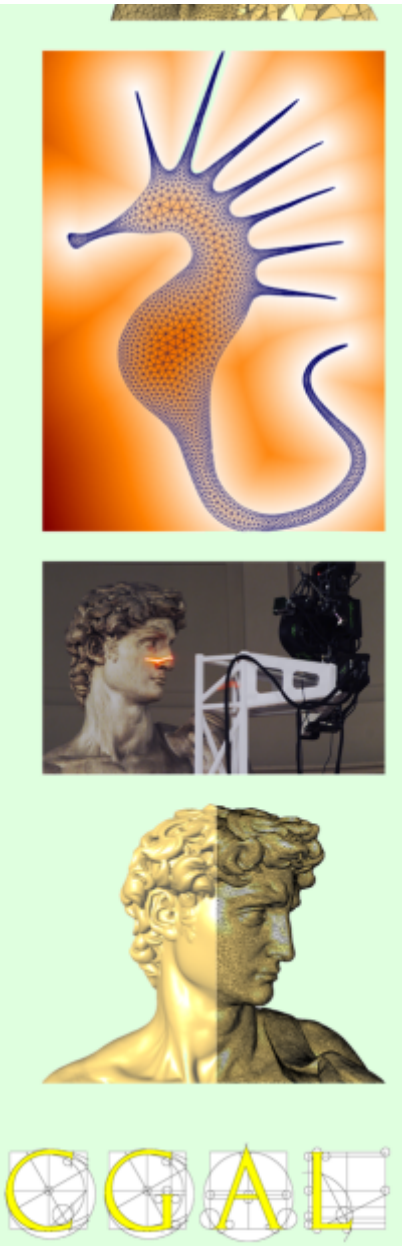
- Master IPAC-R ,
- Course: Synthesis, image and geometry
- University of Lorraine
- **Teachers:** Olivier Devillers and Bruno Lévy
- **Duration:** 8 classes / TD (3h) including 3 mini-exams + presentation / project defense.

Timetable 2017-2018, 3h sessions from 13h to 16h

- Tuesday 28 November [OD] (FTS-IECL-M09) Delaunay triangulation, intro, definitions and first properties. An algorithm O (n log n) in the worst case.
- Tuesday December 5th [OD] (FST-HP-E32) Simplify algorithms without losing too much in speed: randomization. [+ Exercises]
- Tuesday, January 9 [OD] (FST-HP-E32) A little complexity under probabilistic assumptions. [+ mini-exam]
- Tuesday 16 January [BL] () Reconstruction: How to find a surface from data points
- Tuesday, January 23 [OD] (FST-HP-E32) What to do when digital errors are geometrically insane? [+ mini-exam]
- Tuesday 6th February [BL] () Organize point clouds - trees kd (kd-tree)
- Tuesday, February 13 [BL] () Sampling - Lloyd's algorithm [+ mini-exam]
- Tuesday 20 February [BL] () Re-mesh of surfaces [+ mini-exam]

Control of knowledge

- a written exam, organized in 4 mini-sessions of 30 minutes on 9 and 23 January and 20 and 27 February from 16:30 to 17:00, documents allowed, computer forbidden. (coeff 0.7, September session if needed).
- a presentation (date by appointment before early March) to present a research article or a mini-project of programming. (coeff 0.3, [says continuous control] NO September session for continuous control). You must send your choice of subject to Olivier Devillers AND Bruno Lévy, by email, before December 13 (one student per subject).
- List of articles
  - LP Chew and S. Fortune. Sorting helps for Voronoi diagrams. Algorithmica, 18: 217-228, 1997. link
  - Olivier Devillers. Delaunay Triangulation of Imprecise Points, Preprocess and Actually Get a Fast Query Time. Journal of Computational Geometry, 2 (1): 30-45, 2011. link
  - Jeff Erickson. Dense point sets have sparse Delaunay gold triangulations "... but not too nasty". Discrete & Computational Geometry, 33: 83-115, 2005. link
  - Leonidas Guibas and David Marimont. Rounding arrangements dynamically. Internat. J. Comput. Geom. Appl., 8: 157-176, 1998. link
  - J. Hershberger. Finding the upper envelope of n line segments in O (n log n) time. Inform. Process. Lett., 33: 169-174, 1989. link



- John Hershberger. Stable snap rounding. Computational Geometry, 46 (4): 403-416, 2013. link
- David G. Kirkpatrick and Raimund Seidel. The ultimate planar convex hull algorithm? SIAM Journal on Computing, 15 (1): 287-299, 1986. link
- R. Seidel. A simple and fast incremental randomized algorithm for computing trapezoidal decompositions and for triangulating polygons. Comput. Geom. Theory Appl., 1 (1): 51-64, 1991. link
- Jonathan Richard Shewchuk. Adaptive precision floating point arithmetic and fast robust geometric predicates. Discrete & Computational Geometry, 18 (3): 305-363, October 1997. link
- Arya, Mount, Netanyahu, An optimal algorithm for approximate nearest neighbor searching link
- Du, Faber, Gunzburger, Centroidal Voronoi Tesselations: Applications and Algorithms link
- Aurenhammer, Power diagrams: properties, algorithms and applications link

- Development projects: (choice of languages) Contact B. Lévy for more details.
  - Project 1: Implement the Tutte parameterization method, which allows you to unfold in 2D a 3D mesh (homeomorphic to a disk). I provide some examples of meshes.
  - Project 2: The MindCuber "rubics cube" robot in LEGO solves the Rubics Cube. He must recognize the colors of the faces of the cube. We propose to develop an algorithm. I provide several robot sensor data sets (to be validated with an existing algorithm to solve the cube). For highly motivated students I can lend a LEGO kit and related software.
  - Project 3: Kd-tree data structure: we propose to develop the "K-means" algorithm which allows to detect the groups (clusters) in a point cloud. For this it will be necessary to develop a data structure Kd-tree, in order to be able to apply the algorithm to large clouds of data. I provide data points (from simulations of the Institute of Astrophysics of Paris).

Documents

- The slides (will be posted online depending on the course): slides 1 slides 2 slides 3 slides 4 slides 5
- Past exams from 2014-15 to 2016-17 (and also from Aravis, CIS, IV and IGMMV and IFI masters from 1995 to 2013, but course content has evolved over time): 1995-1996 , 1996- 1997 , 1997-1998 , 1998-1999 , 1999-2000 , 2000-2001 , 2001-2002 (and corrected) , 2002-2003 (and corrected) , 2003-2004 (and corrected) , 2004-2005 (and corrected) , 2005-2006 (and corrected) , 2006-2007 (and corrected) , 2008-2009 (and corrected) , 2009-2010 (and corrected) , 2010-2011 (and corrected), 2011-2012 (and corrected) , 2012-2013 (and corrected) , 2014-2015 (and corrected) , 2015-2016 (and corrected) , 2016-2017 (and partially corrected) .
- Bibliography

- lecture notes by Francis Lazarus
- Algorithmic geometry JD Boissonnat, M Yvinec. 1995 International Ediscience
- Computational geometry: algorithms and applications. Mark de Berg, Marc van Kreveld, Mark Overmars, Otfried Schwarzkopf. 2000. Springer Verlag
- Poly (a little old) corresponding pretty well to the first class

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Prerequisites of the course

- It would be desirable to know a little algorithmic. In particular some sorting algorithms (sorting fusion, quick sort) and balanced binary trees.

Contact the person in charge: Olivier.Devillers (at) inria.fr

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