GEOMETRIC MESHES MODELING AND PROCESSING

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COURSE OUTLINE

Preliminaries (E. Puppo)

- Elements of combinatorial topology
- Elements of discrete differential geometry

Processing (E. Puppo)

- Analysis of discrete surfaces
- Smoothing and fairing
- Mesh parametrization
- Mesh simplification

COURSE OUTLINE

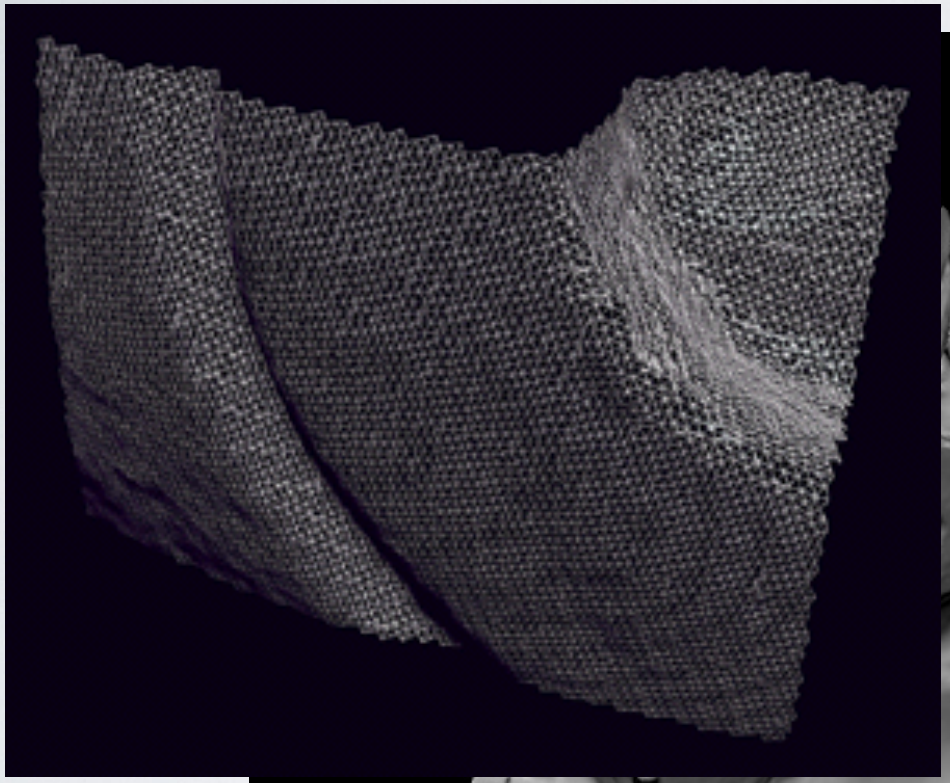
Modeling (L. De Floriani)

- A taxonomy of data structures for mesh representation
- Representations for polygonal, triangle and tetrahedral meshes
- Dimension-independent representations for cell and simplicial complexes
- Hierarchical representations: mesh hierarchies and spatial indexes

USE OF MESHES

- Polygonal geometric modeling:
  - By designers/artists through CAD
  - Start with a rough polygonal shape (usually a block)
  - Complex shapes built by refinement and assembly of pieces
  - Applications: videogames, virtual worlds, real-time graphics

USE OF MESHES



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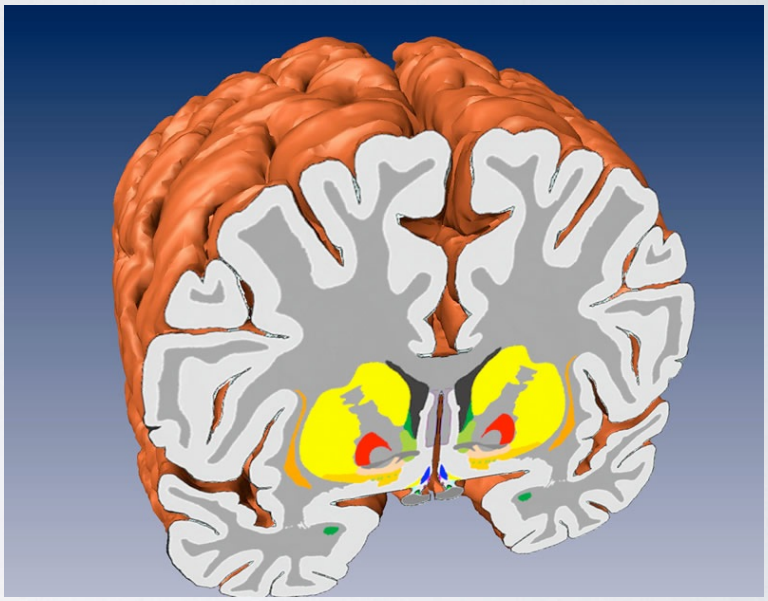
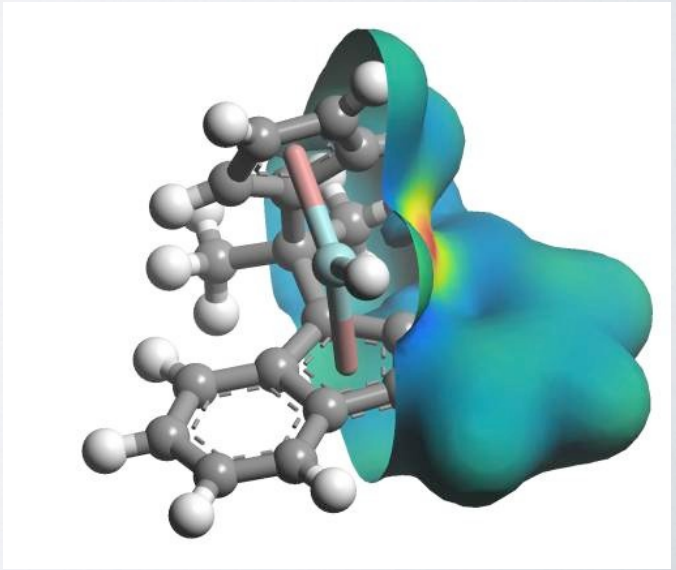
USE OF MESHES

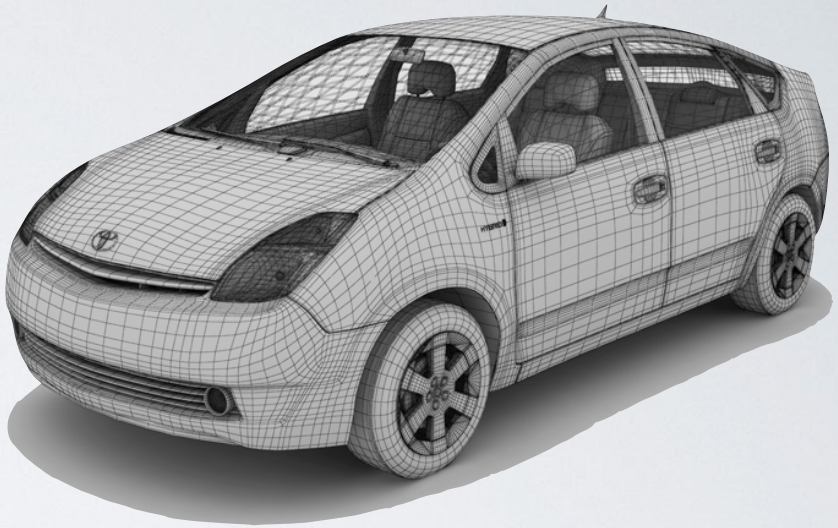
- Reconstruction (2):
  - Volume data ***F(x,y,z)***
  - A mesh is built which approximates an iso-surface of ***F***
  - Applications: medical imaging, scientific visualization
  - All methods produce triangle meshes

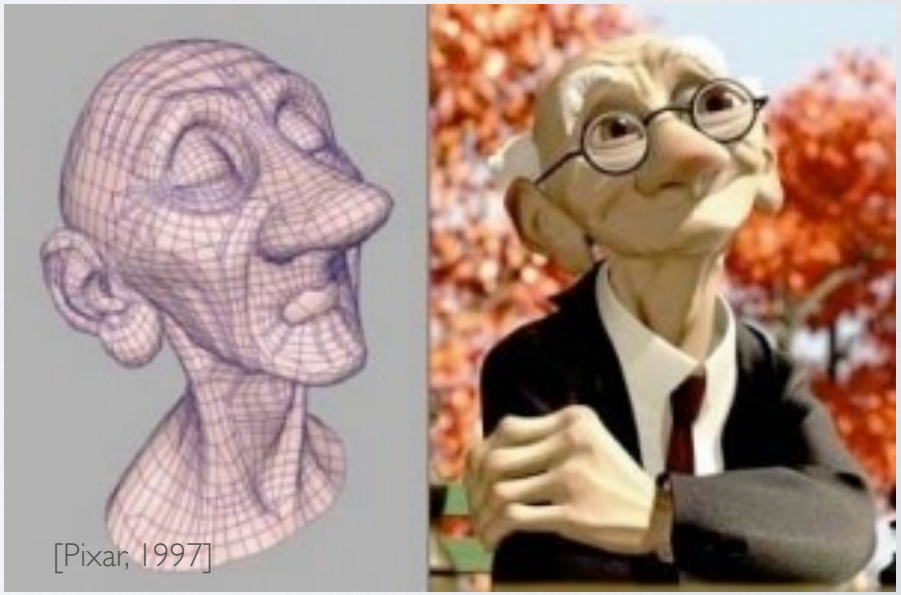




USE OF MESHES

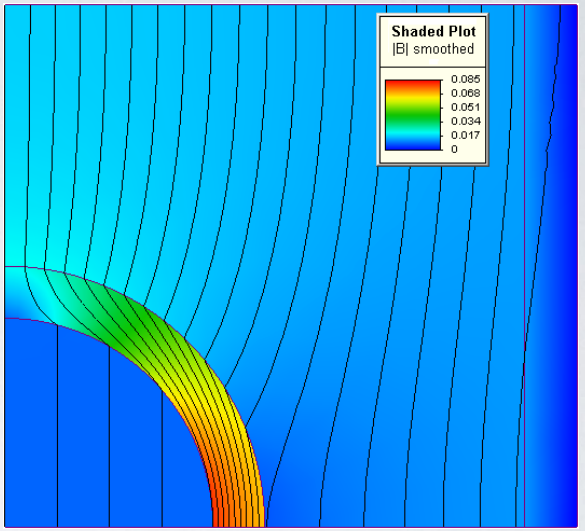
- Smooth surfaces:
  - A ***control mesh*** permits to define and edit the shape of a smooth surface:
    - B-splines (NURBS)
    - Subdivision surfaces
  - Applications: industrial design, cinema

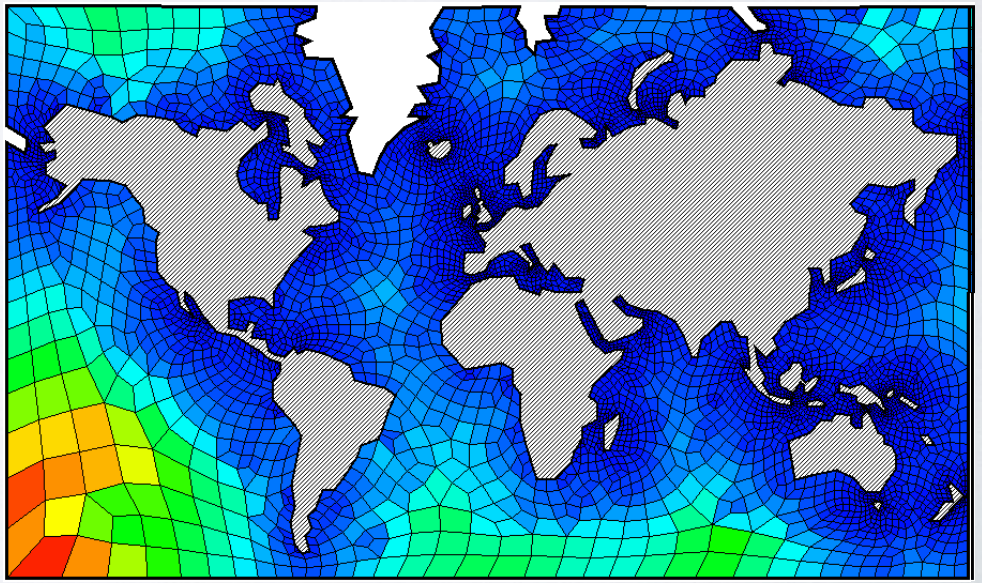




USE OF MESHES

- Finite Element Methods:
  - PDE's defined on cells of a mesh taken as atomic elements
  - Numerical methods to evaluate physical properties
  - Applications: engineering (mechanics, fluid-dynamics, electromagnetism)





USE OF MESHES

- Rendering:
  - Graphics cards are optimized to render polygons (convex - triangles)
  - Polygonal meshes give the fastest way to render (approximations of) complex shapes
  - Eye can be cheated by using texturing and advanced shading effects
  - Applications: real-time graphics

REFERENCES

- **Books:**
  - M. K. Agoston, 2005, ***Computer Graphics and Geometric Modeling - Mathematics***, Springer, ISBN 1-85233-817-2
  - M. Botsch, L. Kobbelt, M. Pauly, P. Alliez, B. Lévy, 2010, ***Polygon Mesh Processing***, A.K. Peters, ISBN 978-1-56881-426-1
- **Tutorial:** M. Botsch, M. Pauly, L. Kobbelt, P. Alliez, B. Lévy, S. Bishoff, C. Roessl, 2007, ***Geometric Modeling Based on Polygonal Meshes***, SIGGRAPH 2007

  (http://alice.loria.fr/index.php/publications.html?Paper=SigCourseGeoProc@2007)
- plus a number of papers