Visualisierung

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Visualization Examples

VolVis

InfoVis

FlowVis
Organizational Details

- **186.004 Visualisierung, VO**
  - 3.0 ECTS, 2 hours
  - Eduard Gröller, Andrej Varchola
  - BDS/W, BMIb/W, BZI/W, MCG/P
  - [http://www.cg.tuwien.ac.at/courses/Visualisierung/VO.html](http://www.cg.tuwien.ac.at/courses/Visualisierung/VO.html)

- **186.703 Visualisierung Übung, LU**
  - 3.0 ECTS, 2 hours
  - Andrej Varchola, Martin Ilcik, Thomas Mühlbacher, Eduard Gröller
  - BDS/W, BMIb/W, BZI/W, MCG/W
  - [http://www.cg.tuwien.ac.at/courses/Visualisierung/LU.html](http://www.cg.tuwien.ac.at/courses/Visualisierung/LU.html)

- **Exams:**
  - oral
  - registration: [http://www.cg.tuwien.ac.at/courses/anmeldung/](http://www.cg.tuwien.ac.at/courses/anmeldung/)
CS Project Topics Available

- 186.159 Projektpraktikum, 6.0/4.0 PR
- 186.168 Praktikum aus Computergraphik und digitaler Bildverarbeitung, 12.0/8.0 PR
- 186.188 Informatikpraktikum 1, 6.0/4.0 PR
- 186.196 Informatikpraktikum 2, 6.0/4.0 PR

http://www.cg.tuwien.ac.at/courses/#Praktika%20und%20Diplomarbeiten

http://www.cg.tuwien.ac.at/courses/projekte/
Visualization – Definition

The purpose of computing is insight, not numbers

[R. Hamming, 1962]

Visualization:

- **Tool** to enable a **User** insight into **Data**
- to form a **mental vision, image, or picture of** (something not visible or present to the sight, or of an abstraction); to make **visible to the mind or imagination**


- **Computer Graphics**, but not photorealistic rendering
Visualization – Background

- **Background:**
  - Visualization = rather old
  - Often an intuitive step: graphical illustration
  - Data in ever increasing sizes ⇒ graphical approach necessary
  - Simple approaches known from business graphics (Excel, etc.)
  - Visualization = own scientific discipline since 20 years
  - First dedicated conferences: 1990

L. da Vinci (1452-1519)

Scientific Visualization

Overviews · Methodologies · Techniques

Gregory Nielson, Hans Hagen, Heinrich Müller

1997
Travelling Routes of Yu the Great

Geographical Map using cartesian coordinates

Grid with longitudinal and latitudinal lines

China, 1137
Isolines to visualize compass deviations

Wind flow visualization
Military Campaign of Napoleon

Line thickness encodes troop strength
Cholera Epidemic in London

- Cartographic visualization
- Correlation between water supply and disease incidents detected
Weather Maps in Meteorology

Map with iso-pressure lines

Weather fronts

Map for pilots
Visualization in Medicine

- X-rays (Wilhelm Röntgen, 1895)
- Stereo X-ray images (1896)

- X-ray tomography
Experimental Flow Investigation

- Fixation of tufts, ribbons on
  - Aircraft in wind tunnels
  - Ship hull in fluid tanks
- Introduction of smoke particles (in wind tunnel)
- Introduction of dye (in fluids)
W. Playfair, engl. econometrist, 1785

Imports/Exports USA-England 1770-1782
Population Development

- Population size Schweden 1750-1785
- Population as function of year and age group
H. Chernoff, 1973, 2D scatterplot

Data characteristics encoded in geometric face features
Visualization – Sub Topics

- Visualization of …
  - Medical data ⇒ VolVis!
  - Flow data ⇒ FlowVis!
  - Abstract data ⇒ InfoVis!
  - GIS data
  - Historical data (archeologist)
  - Microscopic data (molecular physics), Macroscopic data (astronomy)
  - Extrem large data sets
  - etc. …
Visualization – Examples

- Medical data
Visualization – Examples

- Flow data

Visualization: Martin Reihs, ETH Zurich
Simulation: Sulzer Hydro Ltd., Zurich
https://www.ssc.eenthz.ch/SV/turbine

Eduard Gröller, Helwig Hauser
Visualization – Examples

- Abstract data
Visualization – Three Types of Goals

- Visualization, ...
  - ... to explore
    - Nothing is known,
      Vis. used for data exploration
  - ... to analyze
    - There are hypotheses,
      Vis. used for Verification or Falsification
  - ... to present
    - “everything” known about the data,
      Vis. used for Communication of Results
Visualization – Three Major Areas

Three major areas

- Volume Visualization
- Flow Visualization
- Information Visualization

Scientific Visualization

Inherent spatial reference

3D

nD

Usually no spatial reference
VolVis - Example

- Medical Visualization in Surgery Planning

- Image: Liver (blood vessels, tumors)

Oeltze et al., 2004
FlowVis - Example

For **DPF-Analysis**

(DFP: Diesel Particle Filter)
Visualization of **Search-Results**

- **Image:**
  - document lengths
  - frequencies
  - etc.

Hearst, 1995
Visualization Pipeline

Typical steps in the visualization process
Visualization-Pipeline – Overview

Data acquisition
Data are given

Data enhancement
Data are processed

Visualization mapping
Data are mapped to, e.g., geometry

Rendering (3D→2D)
Images generated
Data acquisition

- Measurements, e.g., CT/MRI
- Simulation, e.g., flow simulation
- Modelling, e.g., game theory
Data enhancement

- Filtering, e.g., smoothing (noise suppression)
- Resampling, e.g., on a different-resolution grid
- Data Derivation, e.g., gradients, curvature
- Data interpolation, e.g., linear, cubic, …
Visualization-Pipeline – 3. Step

Visualization mapping

- Data are processed
- Data are mapped to, e.g., geometry

Visualization mapping = data is renderable

- Iso-surface calculation
- Glyphs, Icons determination
- Graph-Layout calculation
- Voxel attributes: color, transparency, …
Visualization-Pipeline – 4. Step

Rendering (3D→2D)

- Rendering = image generation with Computer Graphics
  - Visibility calculation
  - Illumination
  - Compositing (combine transparent objects, …)
  - Animation

Data are mapped to, e.g., geometry

Images generated
SIMULATION DATA

Geometry: Surface Splines
Sampling Points:
X, Y, Z
Temperature
Pressure
(irregular in space, time)
DERIVED DATA

Geometry: Polygonal Patches
( Vertices at X, Y, Z )

Data at Vertices:
  Temperature, Pressure
( Regular in Time )
3D → 2D projection

Abstract Visualization Object

Pressure 0

Temperature
Visual Computing
- Scientific visualization
- Computer vision
- Human computer interaction