Issues in computer graphics

- Core:
  - Geometric modeling
  - Rendering
  - Animation
- Other:
  - Visualization
  - Human-computer interaction
  - Virtual reality
  - Shape analysis

etc

1

Issues in this course

- Core:
  - Geometric modeling
  - Rendering
  - Animation
- Other:
  - Visualization
  - Human-computer interaction
  - Virtual reality
  - Shape analysis

etc

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Course topics

1. Shape analysis
2. Scientific visualization
3. Information visualization
4. Animation

3

Course topics

1. Shape Analysis
   - Mesh segmentation
   - Retrieval
   - Feature lines
2. Scientific visualization
3. Information visualization
4. Animation

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Shape analysis – Why? Why now?

Development of effective techniques for representing, analyzing, searching, and reusing

Large repositories of 3D data more accessible

- Data storage
- Computing power
- Modeling techniques

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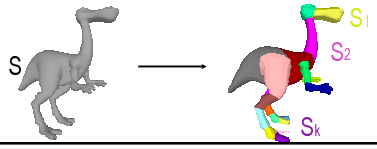
Shape analysis: Segmentation

Let S be an orientable mesh.

Goal: decompose S into connected sub-meshes S_1, S_2... S_k that are face-wise disjoint, and whose union gives S.



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Shape analysis: Retrieval of 3D Models

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Shape analysis: Feature lines

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Course topics

1. Shape analysis
2. Scientific visualization
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Why visualize?

"The purpose of computing is insight, not numbers"

hamming

- Computers produce too much data
- Bandwidth of human visual channel is high
- Large portions of brain devoted to visual processing
- Visual communication

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Data graphics

- The use of pictures to show numbers is a recent invention (~1770)
- Use to describe, explore, summarize, analyze and communicate a set of numbers

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Graphical display should

- Show the data
- Induce the viewer to think about substance
- Avoid distorting what the data have to say
- Present many numbers in a small space
- Make large data set coherent
- Encourage the eye to compare different pieces
- Reveal the data at several levels of details
- Serve a reasonable clear purpose

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Some classical visualizations

- Data maps
  - Cholera outbreak, 1854
- Time-series
  - Marey, Paris-Lyon line, 1885
- Narrative graphics of space and time
  - The march of Napoleon's army, 1861
- Relational graphics

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Data map: Cholera outbreak

- Placing the data in an appropriate context for assessing cause and effect
- Making quantitative comparisons (saved by the beer!)
- Considering alternative explanations and contrary cases
- Assessment of possible errors in the numbers reported in graphics

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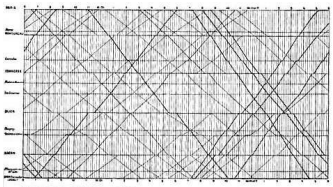
Time-series : Paris-Lyon line



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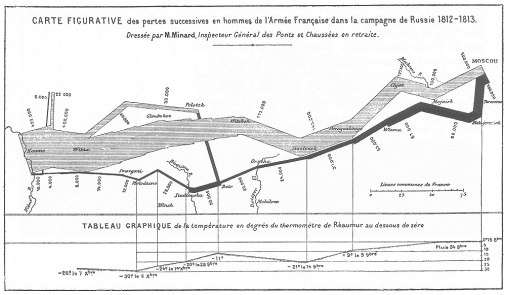
Narrative graphics: The march of Napoleon's army,1861



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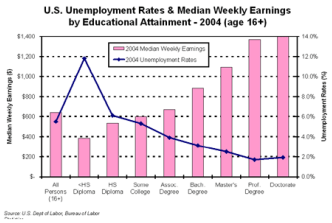
Relational graphics



Goals of scientific visualization

- Well-designed presentation of interesting data
- Complex ideas communicated with **clarity**, **precision** and **efficiency**
  - Visualize symbolic data
  - Visualize the invisible
- Visualize huge amounts of data
- Visualize multi-dimensional data
- Give the viewer greatest number of ideas in the shortest time in the smallest space

Uses of scientific visualization

- Data exploration
- Hypothesis testing
- Program /performance debugging
- Presentation
- Education

Visualization of large unstructured data sets

- Data generation and data reception
- Data enrichment and improvement
- Data analysis and data reduction
- Modeling
- Interrogation
- Rendering

Scientific Visualization Applications

- Engineering
- Medicine
- Mathematics
- Chemistry
- Biology
- Meteorology
- Business analysis
- Computer science
- Education

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Scientific Visualization Applications

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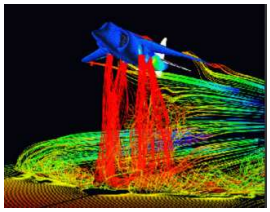

Harrier Jet flow during landing (NASA Ames)

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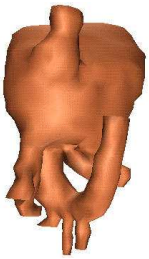

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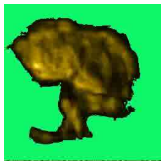

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Scientific Visualization Applications

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Voxel-Man (Hoehne)

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Scientific Visualization Applications

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Outside-In (Munzner)

http://www.geom.uiuc.edu/docs/outreach/oi/moregraphics.html

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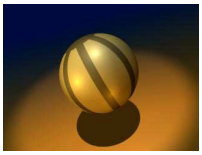

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Scientific Visualization Applications

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Minimal surface (Sullivan)

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Scientific Visualization Applications

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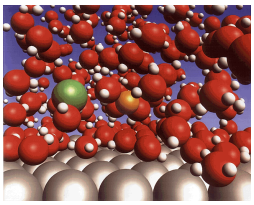

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Scientific Visualization Applications

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Prusinkiewicz

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Scientific Visualization Applications

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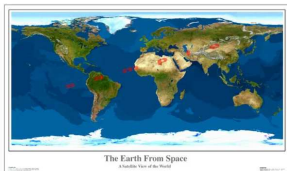

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Scientific Visualization Applications

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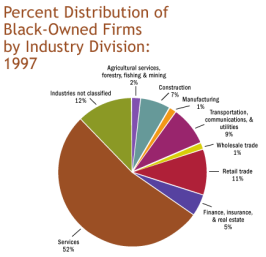

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Scientific Visualization Applications

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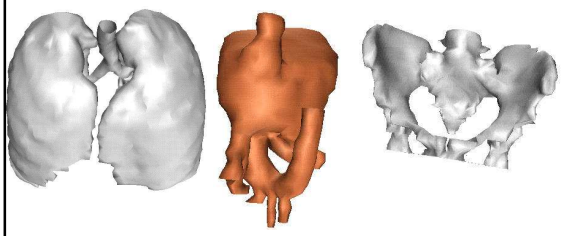
Demo Sort

Course topics

1. Shape Analysis
2. Scientific visualization
   - Reconstruction
     - Volume visualization
     - Marching cubes
     - Surface reconstruction – from points, slices, images
3. Information visualization
4. Animation

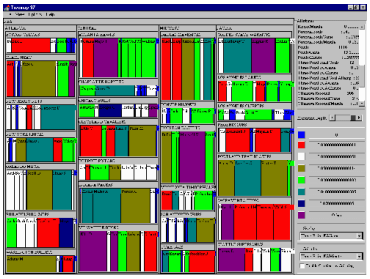
Visualization: Surface Reconstruction



Course topics

1. Shape Analysis
2. Scientific visualization
3. Information visualization
   - Visualizing structures
   - Graph drawing
   - Software visualization
4. Animation

Info visualization: Tree visualization



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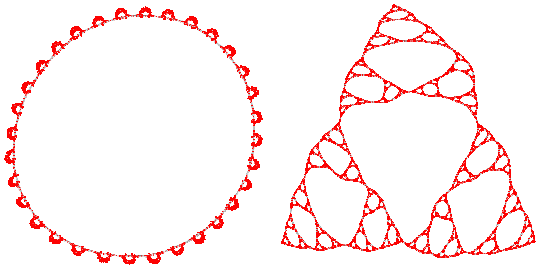
Info visualization: Graph drawing



260,000 edges

20,000 edges

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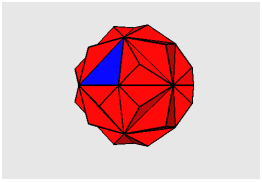
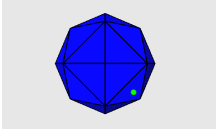
Info visualization: Algorithm Visualization





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Course topics

1. Shape analysis
2. Scientific visualization
3. Information visualization
4. Animation

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Animation

Animation is the presentation of a series of images to give the impression of motion

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Why use motion?

- Encode retinal variable
- Show causality
  - "There is more to perception than meets the eye"
  - http://cogweb.ucla.edu/Discourse/Narrative/michotte-demo.swf
- Clarify object's structure
- Show process

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Kinds of motion

- Rigid
  - Easy to understand
  - Position changes, but shape is static
- Distort / Morph
  - Object evolves
  - Object changes by viewpoint

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Design of an animation sequence

1. Storyboard layout
2. Object definition
3. Key-frame specification
4. Generation of in-between frames

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Animation

1989

45

Some topics in animation

- Automatic in-between *position, size, color,transparency, texture, camera, lights*
- Physically-based simulation
- Collision
- Metamorphosis
- Articulated objects
- Soft objects - *deformation*
- Facial expressions
- Character motion
- Transformations

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Animation

On the run (1991)

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Metamorphosis (morphing)

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Articulated objects

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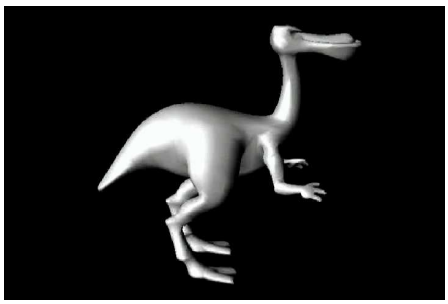
Articulated objects



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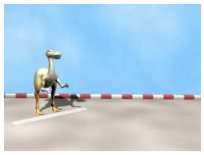
Articulated objects



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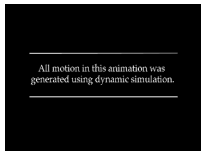
Character animation



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Physically-based simulation

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Animations - applications

- CAD
- Architecture
- Virtual reality
- Advertising
- Art
- Games
- Movies
- Education
- Science

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Course topics

1. Shape Analysis
2. Visualization
3. Information visualization
4. Animation
   - Animation basics: *transformations, quaternions, interpolation*
   - Collision detection
   - Metamorphosis
   - Facial animation
   - Animating nature

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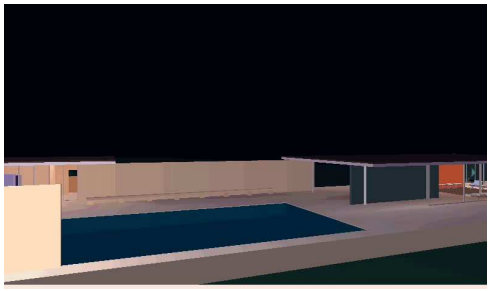
Animation: Collision Detection



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Animation: Metamorphosis

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Animation: Facial expression animation

14 Frames - 2 Full Frames

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Animation: Facial expression animation

72 Frames

59

Animation: Facial expression animation

72 Frames - 5 Full Frames

60

Animation: Animating nature

61