Local and Remote Visualisation Techniques

UvA High Performance Computing course

Robert Belleman, UvA/II
Paul Melis, SURFsara
Casper van Leeuwen, SURFsara
Thijs de Boer, UvA/IBED
Program for today

13:00 – 13:10 Welcome, overview and Who’s who?

13:10 – 13:40 Introduction to Data Visualization (Robert Belleman, UvA/II)
13:40 – 14:55 Scientific visualization (Paul Melis, SURFsara)
14:55 – 15:55 Information visualization (Casper van Leeuwen, SURFsara)
15:55 – 16:00 (room change to GIS studio C4.203)
16:00 – 17:00 Geographic data visualization (Thijs de Boer, UvA/IBED)
17:00 Closing
Introduction to Data Visualization

Robert Belleman, PhD
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• **Scientific Visualization and Virtual Reality**
  – *Computational Science* at UvA/IvI
  – collaboration with SURFsara

• **Research theme: interactive visual exploration**
  – Software solutions and architectures, Problem Solving Environments, Interactive graphics devices

• **Application areas: computational science**
  – (astro)physics, medicine, biology, finance, architecture, computer science, …
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\[ \mu_x = 9.00, \sigma_x = 3.32 \]
\[ \mu_y = 7.50, \sigma_y = 2.03 \]
linear regression: \( y = \frac{1}{2}x + 3 \)

“Anscombe’s quartet”, F.J. Anscombe, “Graphs in Statistical Analysis”,
American Statistician, 27 (February 1973), 17-21.
Uses for visualization

1. Support research activities
   - Explore or compare datasets, verify simulation correctness, discuss results with peers, ...

2. For PR and communication purposes
   - Posters, journals, website, YouTube, funding proposals, ...

Depending on audience and goal need different type of visualization

- Scientific visualization (functional)
- Scientific illustration (pretty)
- No clear boundary between these two
Visualization taxonomy

- **Scientific visualization (“scivis”)**
  - Data with an implicit or explicit geometric structure
    - Measurements, results from simulations or experiments

- **Information visualization (“infovis”)**
  - Data with an abstract structure
    - Relations, graphs and networks

- **Visual analytics**
  - Interactive environments for the detection of the expected and discovery of the unexpected
Scientific visualization

“Scientific visualization deals with all aspects that are connected with the visual representation of data sets from scientific experiments or simulations to achieve a deeper understanding or a simpler representation of complex phenomena.”

Scientific visualization

This visualization illustrates Earth’s long-term warming trend, showing temperature changes from 1880 to 2015 as a rolling five-year average. Orange colors represent temperatures that are warmer than the 1951-80 baseline average, and blues represent temperatures cooler than the baseline.

Credits: Scientific Visualization Studio/NASA Goddard Space Flight Center
Information visualization

“In information visualization, the graphical models may represent abstract concepts and relationships that do not necessarily have a counterpart in the physical world.”

| $11,900 Worldwide cost of financial crisis |
“Bandwidth of our senses”, Tor Norretanders
Visualization of HIV infection networks using “Twilight”, Zarrabi, Melis, Belleman
Hans Rosling’s 200 Countries, 200 Years, 4 Minutes - The Joy of Stats - BBC Four
Visual Analytics

- “Detecting the expected, discovering the unexpected”
  - Combines automatic and visual analysis methods with a tight coupling through human interaction in order to gain knowledge from data.
The OncoRecipesheet, Stamatakos, Lunzer, Melis, Belleman
Visualization software

- Often domain-specific

Commercial:
- Matlab, Mathematica, IDL
- AVS (Advanced Visual Systems)
- IRIS Explorer (?)
- Amira
- Spotfire, Tableau
- ...

Public domain:
- Scientific visualization
  - VTK, ParaView, VolView
  - VisIt, DeVIDE, SCIRun
- Information visualization
  - Visualize Free, D3.js
- Medical visualization
  - MeVisLab
- Networks/graphs
  - Gephi, Cytoscape
- Plotting
  - R, gnuplot
- ...

Software: Tableau

Napoleon’s March to Moscow (and back)

Some call this viz – created by Charles Minard in 1869 – the best ever because it displays so many different kinds of information so clearly. Kim Rees of Information Aesthetics recreated this viz and used it as a measuring stick in her review of social visualization tools. We like the review and we love the viz. While not original, it has a certain je ne sais quoi.
Software: Spotfire
DIY Software: D3.js

D3.js tutorial
Processing

```java
/**
 * Brownian motion.
 * Recording random movement as a continuous line.
 */

int num = 2000;
int range = 5;

float[] ax = new float[num];
float[] ay = new float[num];

void setup()
{
    SIZE(200, 200);
    for(int i = 0; i < num; i++)
    {
        ax[i] = WIDTH/2;
        ay[i] = height/2;
    }
    framerate(30);
}

void draw()
{
    stroke(0);
    for(int i = 0; i < num; i++)
    {
        line(ax[i], ay[i], ax[i+1], ay[i+1]);
    }
}
```
The Visualization Toolkit (VTK)

VTK is:

- open source visualization library
  - C++ library with > 1500 classes
  - Language “bindings” to Java, Python, Tcl, Ruby
- works on Unix/Linux, Windows, MacOS
- object-oriented design

VTK provides:

- *Visualization* methods to turn data into geometry
- *Graphics* model to turn geometry into images (OpenGL)
- *Image processing* methods
The Visualization Toolkit (VTK)

VTK is *not*:  
- VTK is *not* a programming language  
- VTK is *not* an application  
  - No drag-and-drop “visual program editor” as with AVS, Iris Explorer, OpenDX, etc.  
  - You have to *program*

More info:  
- [http://www.vtk.org/](http://www.vtk.org/)  
ParaView
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