



# 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

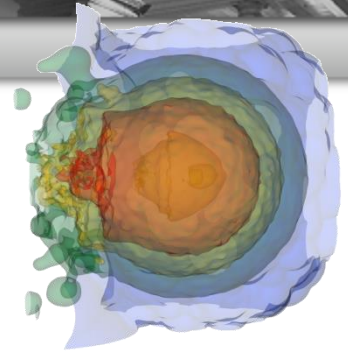
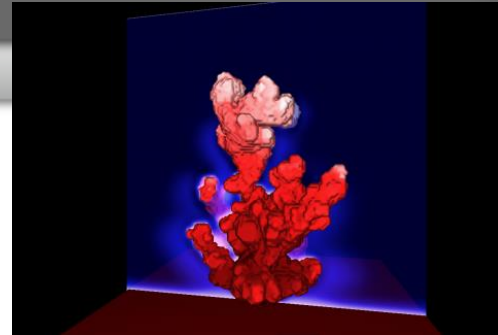
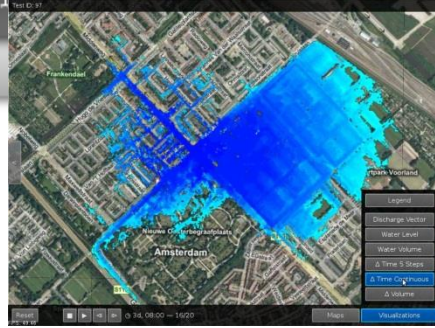
# Program for today

- 09:00 – 09:10 Welcome, overview and Who's who?
- 09:10 – 09:40 **Scientific Visualization**
- 09:40 – 09:55 Introduction to ParaView
- 09:55 – 09:45 Hands-on with ParaView
- 10:45 – 10:50 ParaView wrap-up
- 10:50 – 11:00 Demo: remote Visualization with ParaView
- 11:00 – 11:55 **Information visualization**
- 11:55 – 12:00 (room change to GIS studio C4.203)
- 12:00 – 13:00 **Geographic data visualization**
- 13:00 Closing

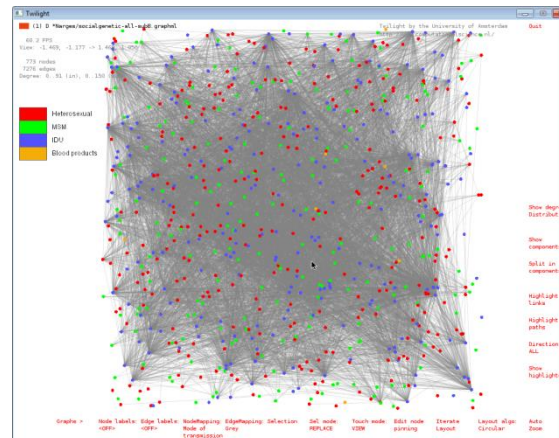
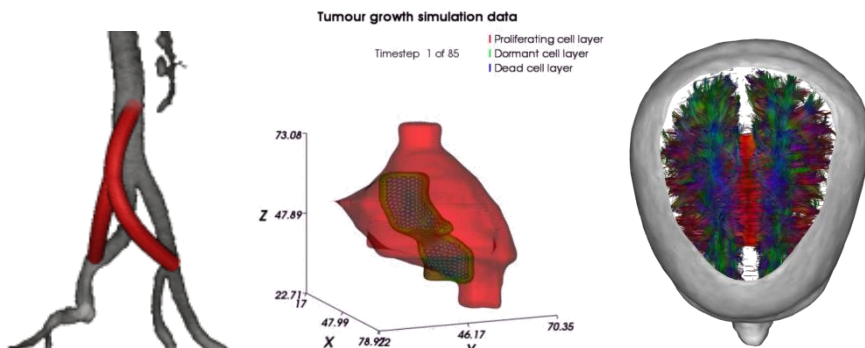
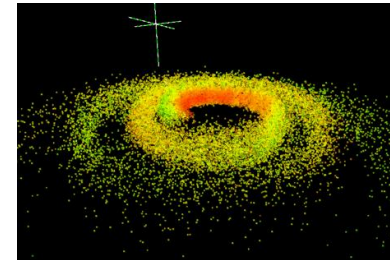
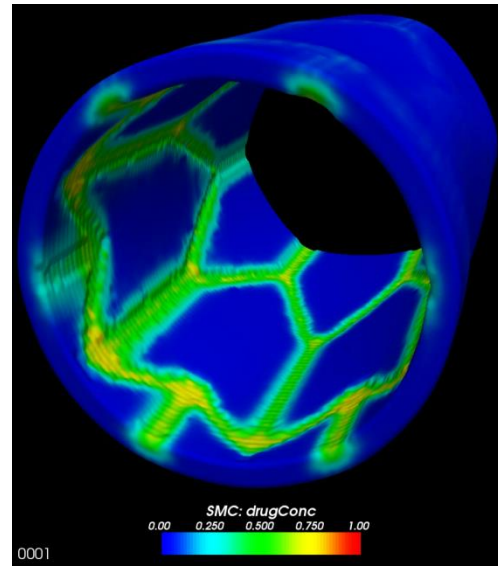


# Introduction to Data Visualization

**Robert Belleman, PhD**  
Informatics Institute  
University of Amsterdam  
R.G.Belleman@uva.nl



- **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, ...



X	Y	X	Y	X	Y	X	Y
10,00	8,04	10,00	9,14	10,00	7,46	8,00	6,58
8,00	6,95	8,00	8,14	8,00	6,77	8,00	5,76
13,00	7,58	13,00	8,74	13,00	12,74	8,00	7,71
9,00	8,81	9,00	8,77	9,00	7,11	8,00	8,84
11,00	8,33	11,00	9,26	11,00	7,81	8,00	8,47
14,00	9,96	14,00	8,10	14,00	8,84	8,00	7,04
6,00	7,24	6,00	6,13	6,00	6,08	8,00	5,25
4,00	4,26	4,00	3,10	4,00	5,39	19,00	12,50
12,00	10,84	12,00	9,11	12,00	8,15	8,00	5,56
7,00	4,82	7,00	7,26	7,00	6,42	8,00	7,91
5,00	5,68	5,00	4,74	5,00	5,73	8,00	6,89

**A**
**B**
**C**
**D**

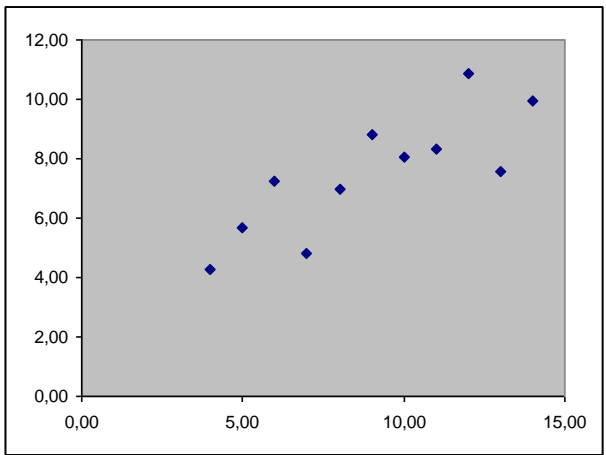
X	Y	X	Y	X	Y	X	Y
10,00	8,04	10,00	9,14	10,00	7,46	8,00	6,58
8,00	6,95	8,00	8,14	8,00	6,77	8,00	5,76
13,00	7,58	13,00	8,74	13,00	12,74	8,00	7,71
9,00	8,81	9,00	8,77	9,00	7,11	8,00	8,84
11,00	8,33	11,00	9,26	11,00	7,81	8,00	8,47
14,00	9,96	14,00	8,10	14,00	8,84	8,00	7,04
6,00	7,24	6,00	6,13	6,00	6,08	8,00	5,25
4,00	4,26	4,00	3,10	4,00	5,39	19,00	12,50
12,00	10,84	12,00	9,11	12,00	8,15	8,00	5,56
7,00	4,82	7,00	7,26	7,00	6,42	8,00	7,91
5,00	5,68	5,00	4,74	5,00	5,73	8,00	6,89

**A**
**B**
**C**
**D**

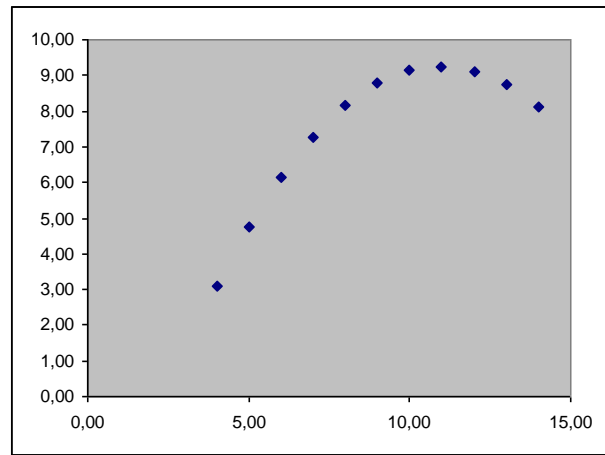
$$\mu_x = 9.00, \sigma_x = 3.32$$

$$\mu_y = 7.50, \sigma_y = 2.03$$

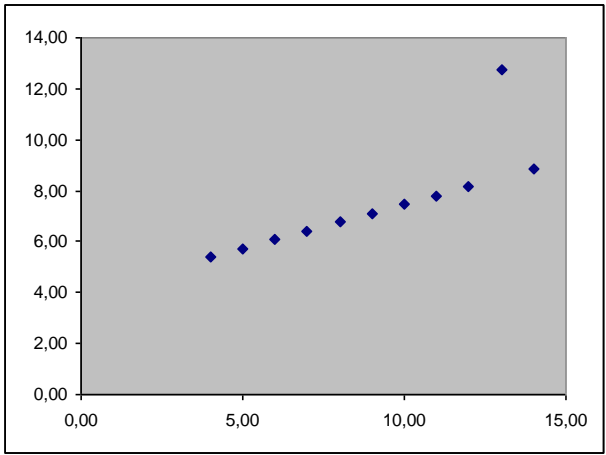
$$\text{linear regression: } y = \frac{1}{2}x + 3$$



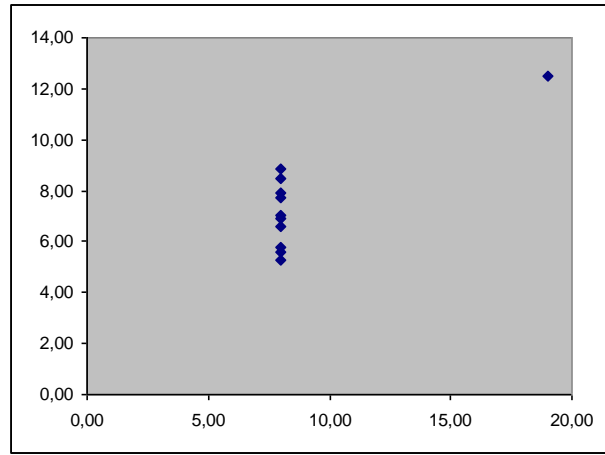
A



B



C



D

"Anscombe's quartet", F.J. Anscombe, "Graphs in Statistical Analysis", American Statistician, 27 (February 1973), 17-21.

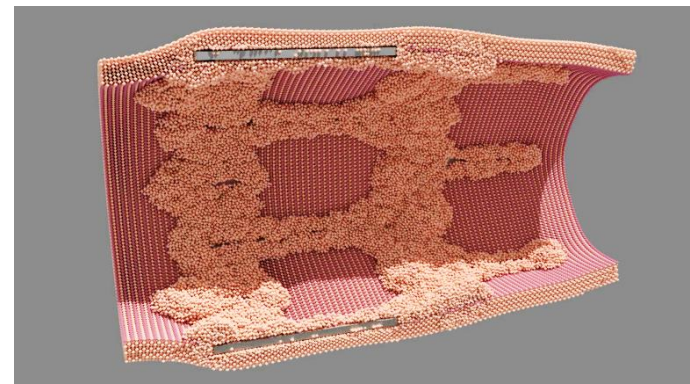
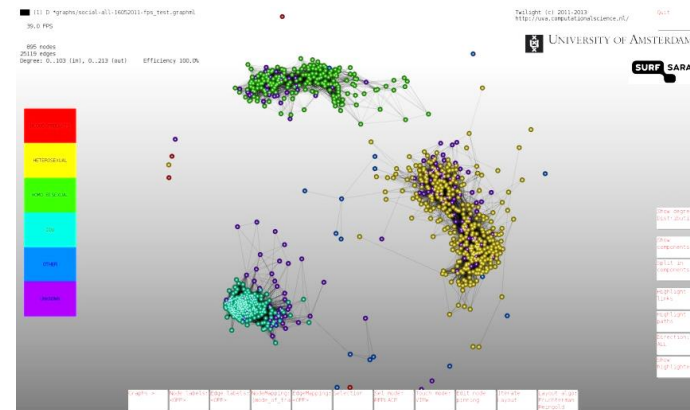
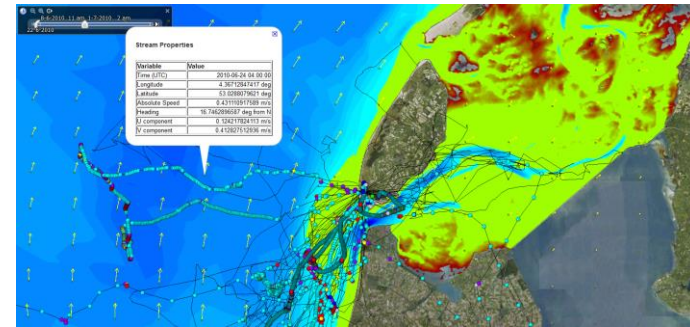
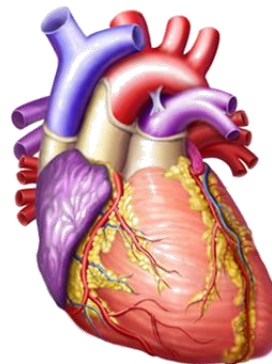


# Uses for visualization

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

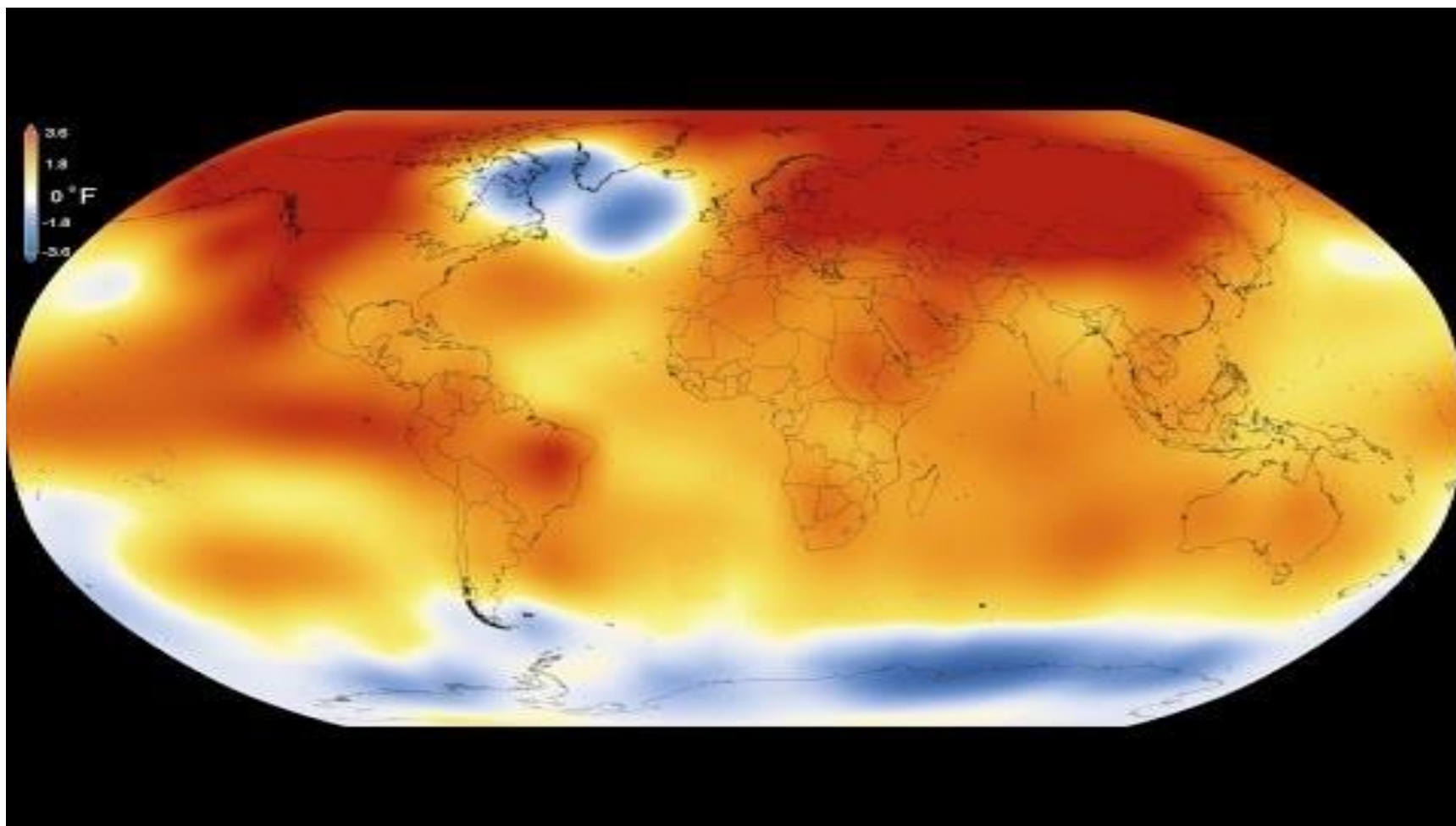
- Scientific visualization (“scivis”)
  - Data with an implicit or explicit geometric structure
    - Measurements, results from simulations or experiments
- Information visualization (“infovis”)
  - Data with an abstract structure
    - Relations, graphs and networks
- Visual analytics
  - Interactive 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.”

Martin Rotard, Daniel Weiskopf, and Thomas Ertl, Curriculum for a Course on Scientific Visualization, Eurographics / ACM SIGGRAPH Workshop on Computer Graphics Education (2004)

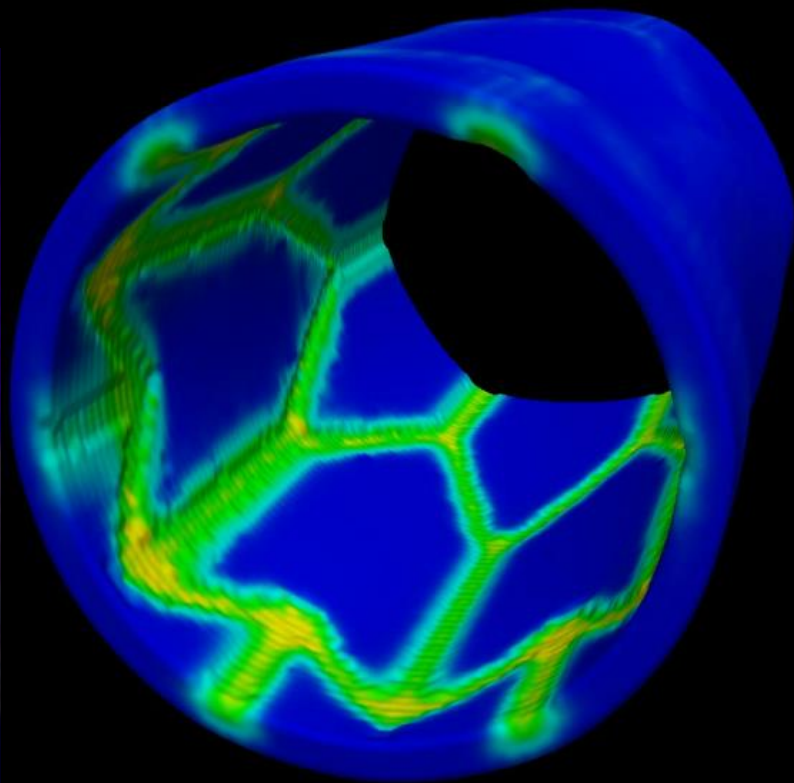
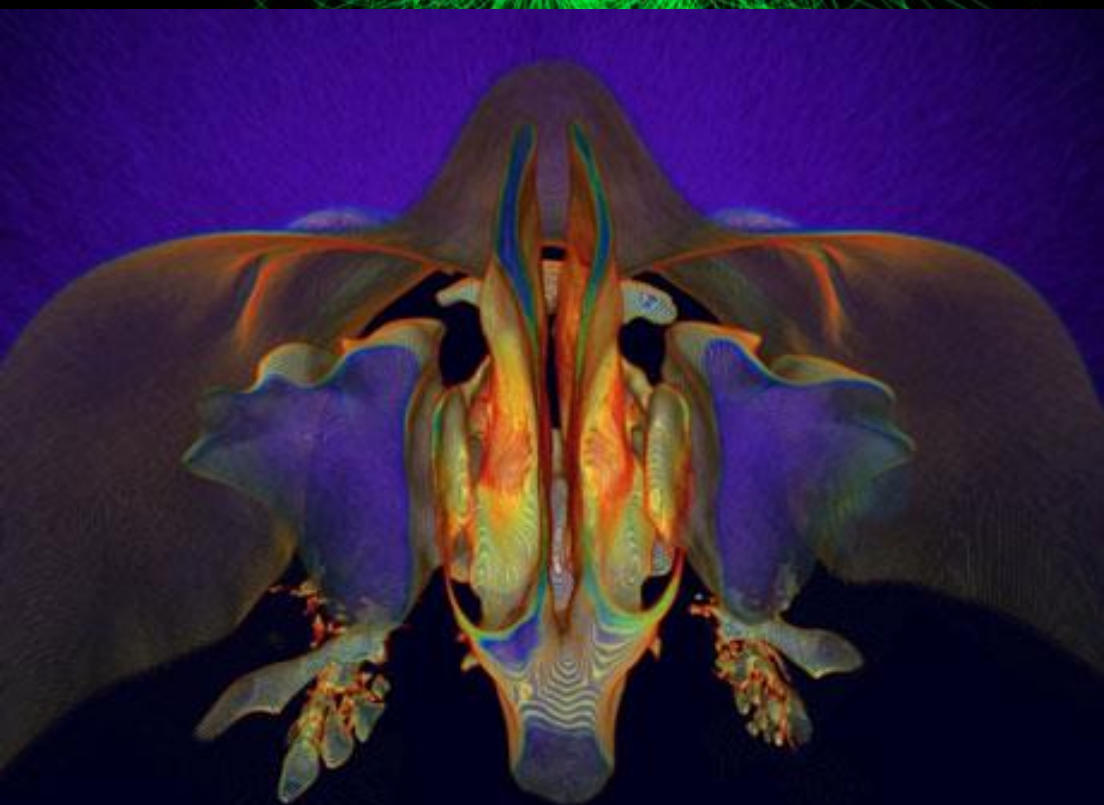
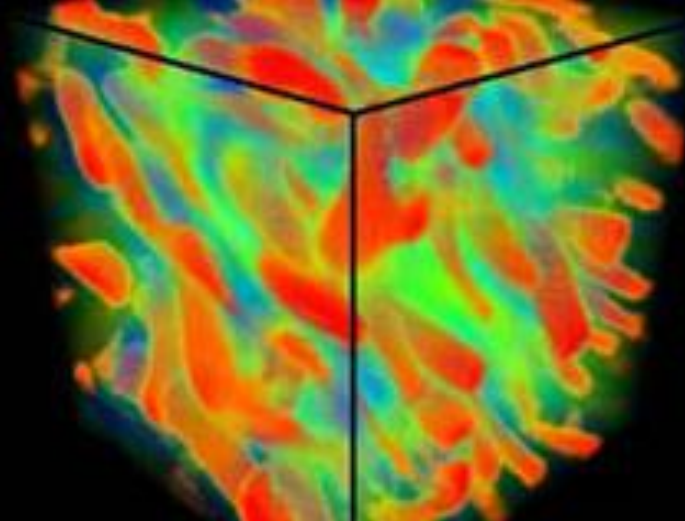
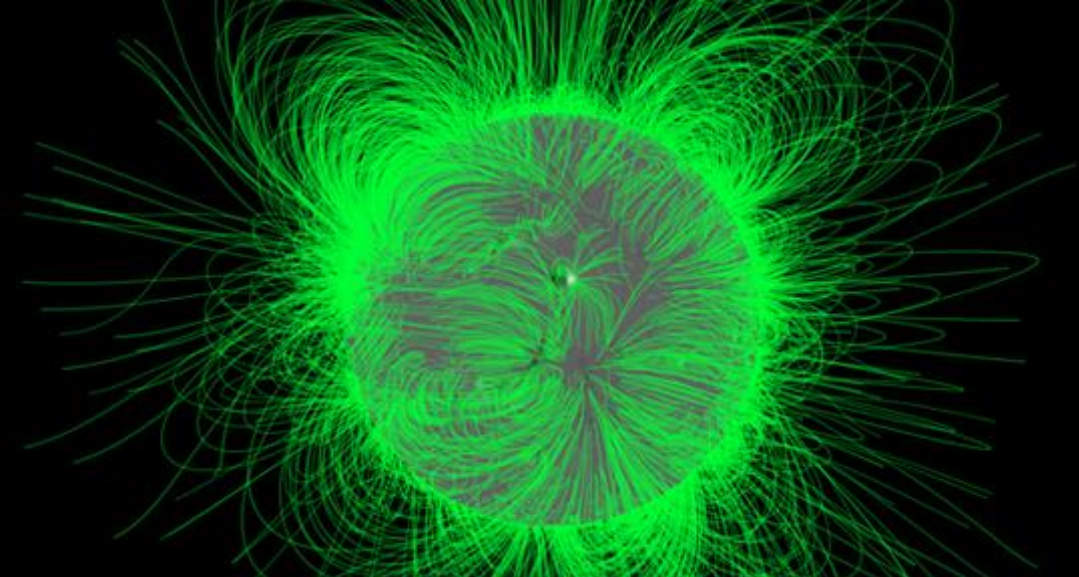
# Scientific visualization



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







SMC: drugConc  
0.00 0.250 0.500 0.750 1.00



0001

# Information visualization

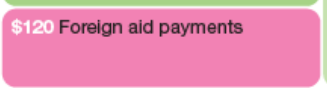
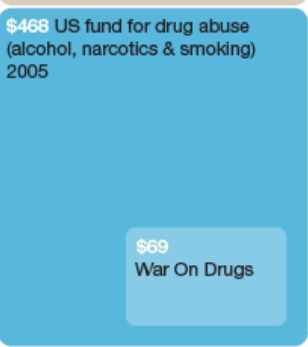
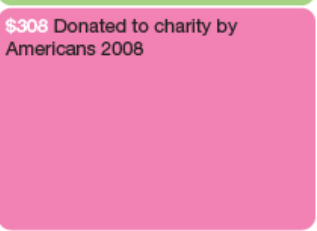
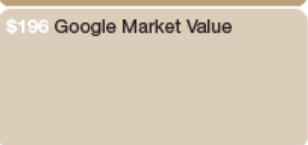
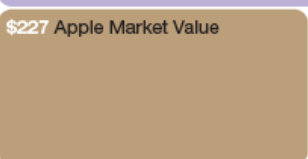
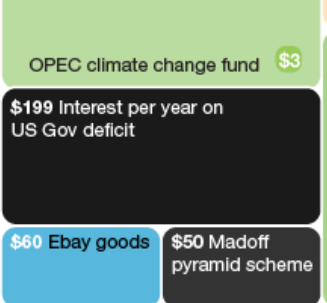
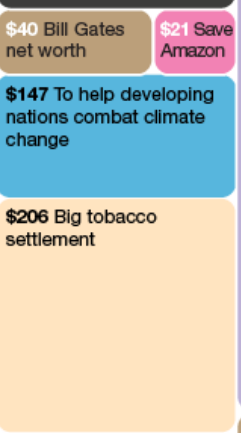
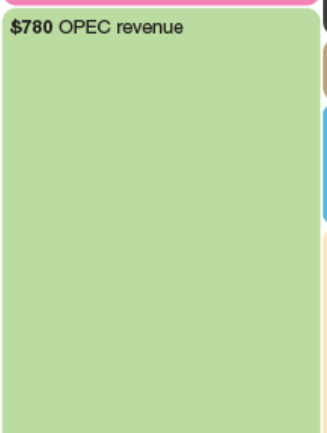
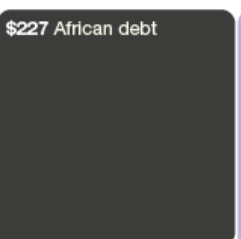
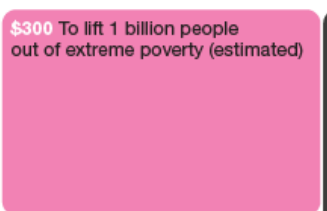
- “In information visualization, the graphical models may represent abstract concepts and relationships that do not necessarily have a counterpart in the physical world.”

Maria Cristina Ferreira de Oliveira, Haim Levkowitz, [[doi.ieeecomputersociety.org/10.1109/TVCG.2003.1207445](https://doi.org/10.1109/TVCG.2003.1207445) From Visual Data Exploration to Visual Data Mining: A Survey], IEEE Transactions on Visualization and Computer Graphics, vol. 9, no. 3, pp. 378-394, July-September, 2003.

# The Billion Dollar-o-gram

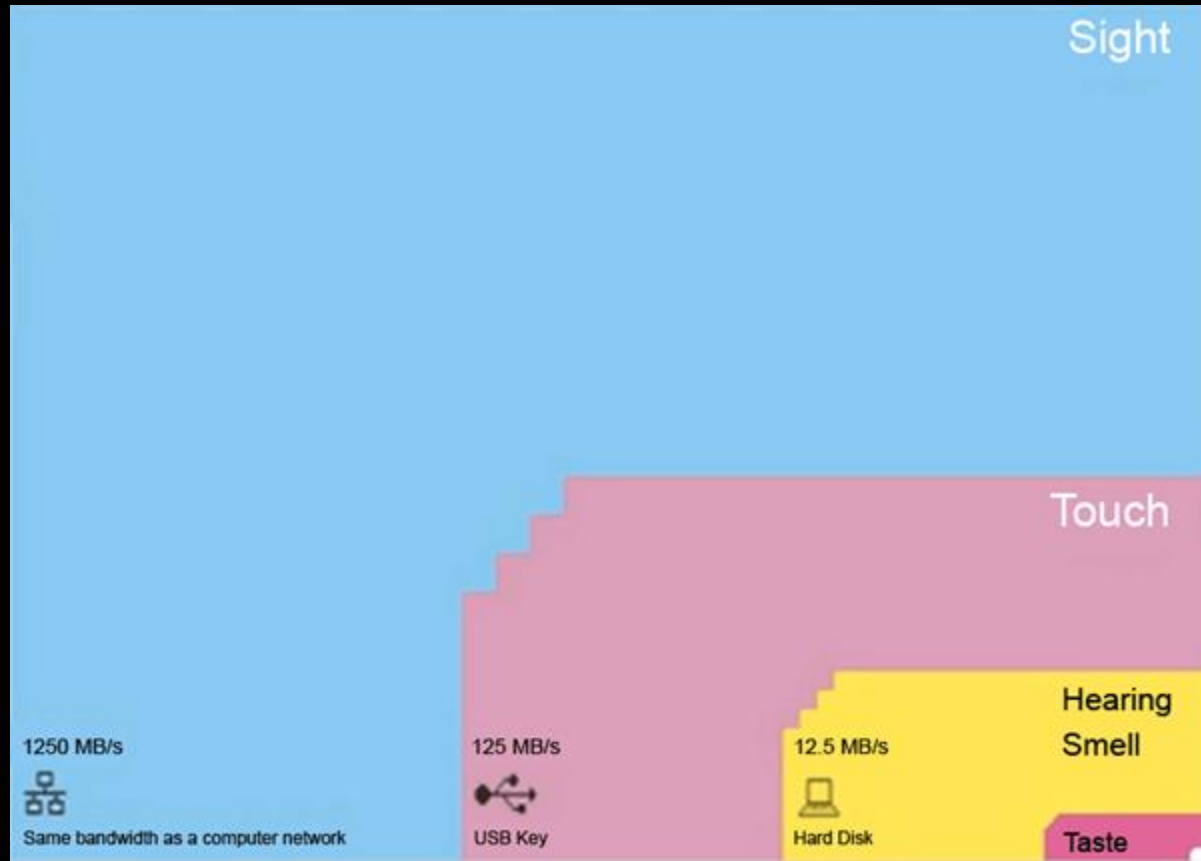
■ Giving   
 ■ Spending   
 ■ Fighting   
 ■ Accumulating   
 ■ Owing   
 ■ Losing   
 ■ Earning

\*Estimated





\$11,900 Worldwide cost of financial crisis

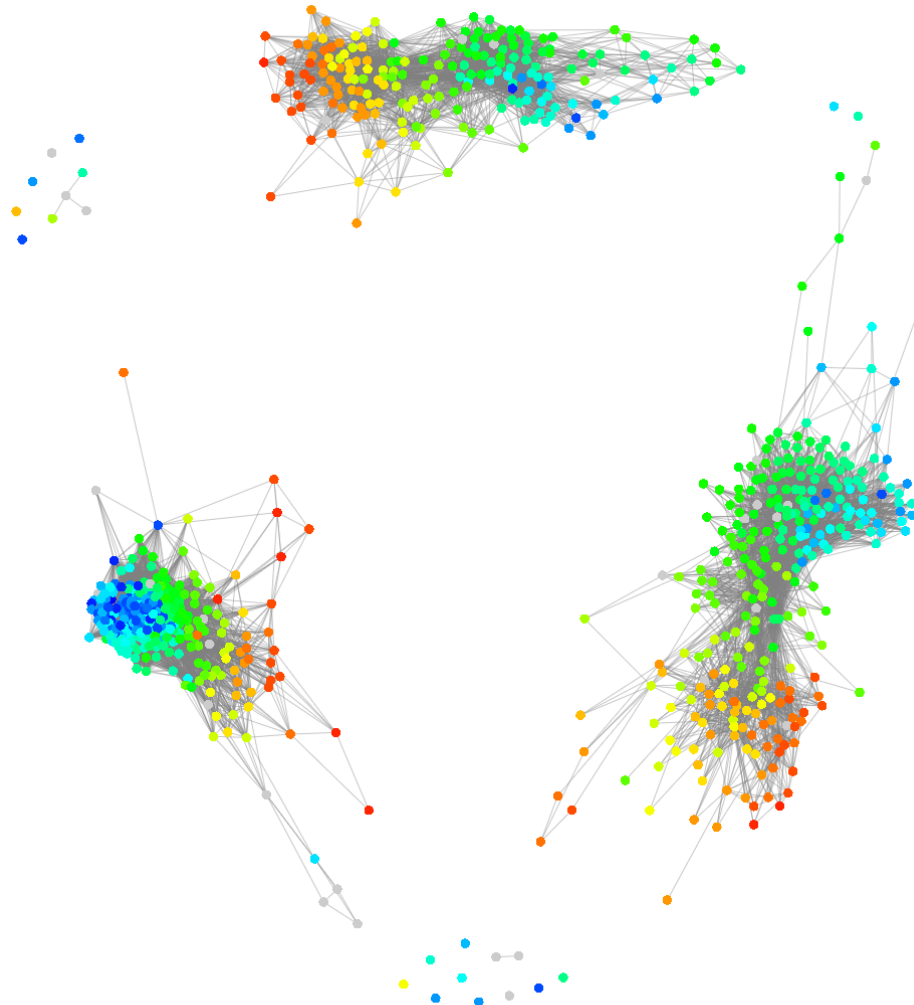
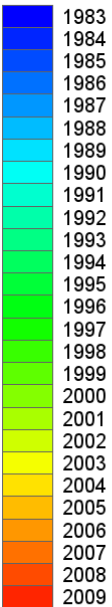


“Bandwidth of our senses”, Tor Norretanders

(1) D \*..../rewrite/graphs/use\_case\_narges/20110804/social-all-sub8.graphml

59.9 FPS  
View: -1.946, -1.139 -> 1.946, 1.050 (auto-zoom)

773 nodes  
22136 edges  
Degree: 0..103 (in), 0..211 (out)



Quit

Show degree Distribution

Show components

Split in components

Highlight links

Highlight paths

Direction: ALL

Show highlighted

Graphs > Node labels: <OFF> Edge labels: <OFF> NodeMapping: First positi Grey (thresholded) EdgeMapping: Selection Sel mode: REPLACE Touch mode: VIEW Edit node pinning Iterate Layout Layout algo: Circular

Help  
Close

Visualization of HIV infection networks using “Twilight”, Zarrabi, Melis, Belleman



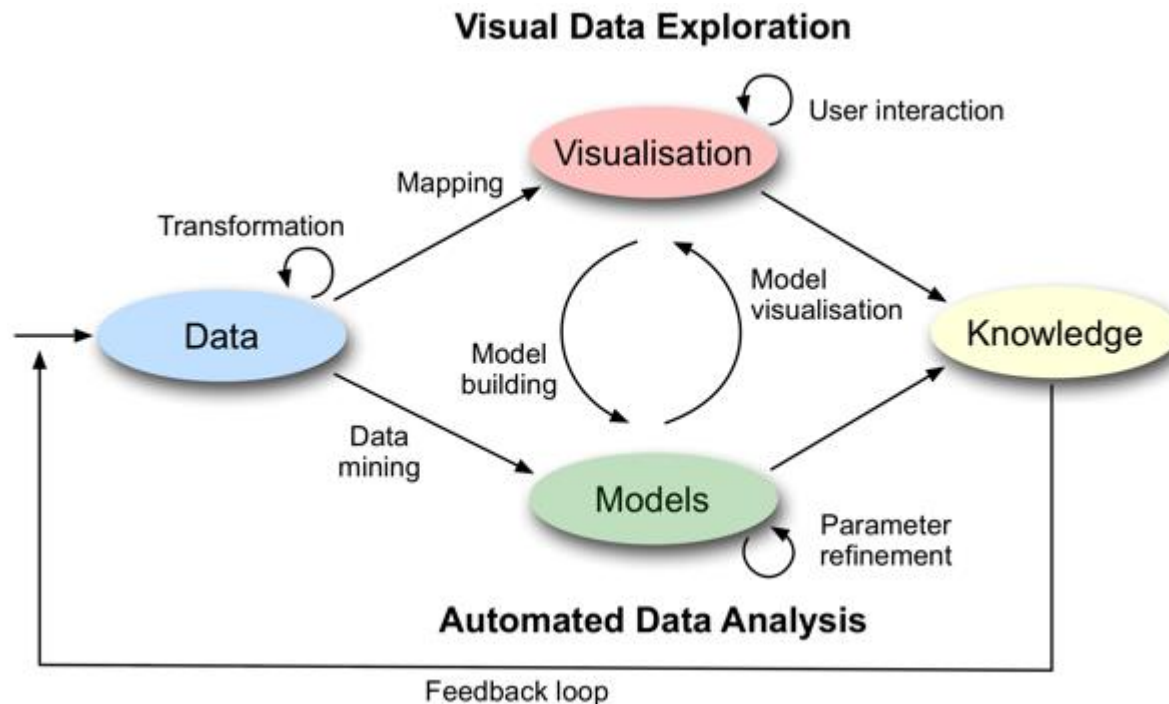
BBC FOUR

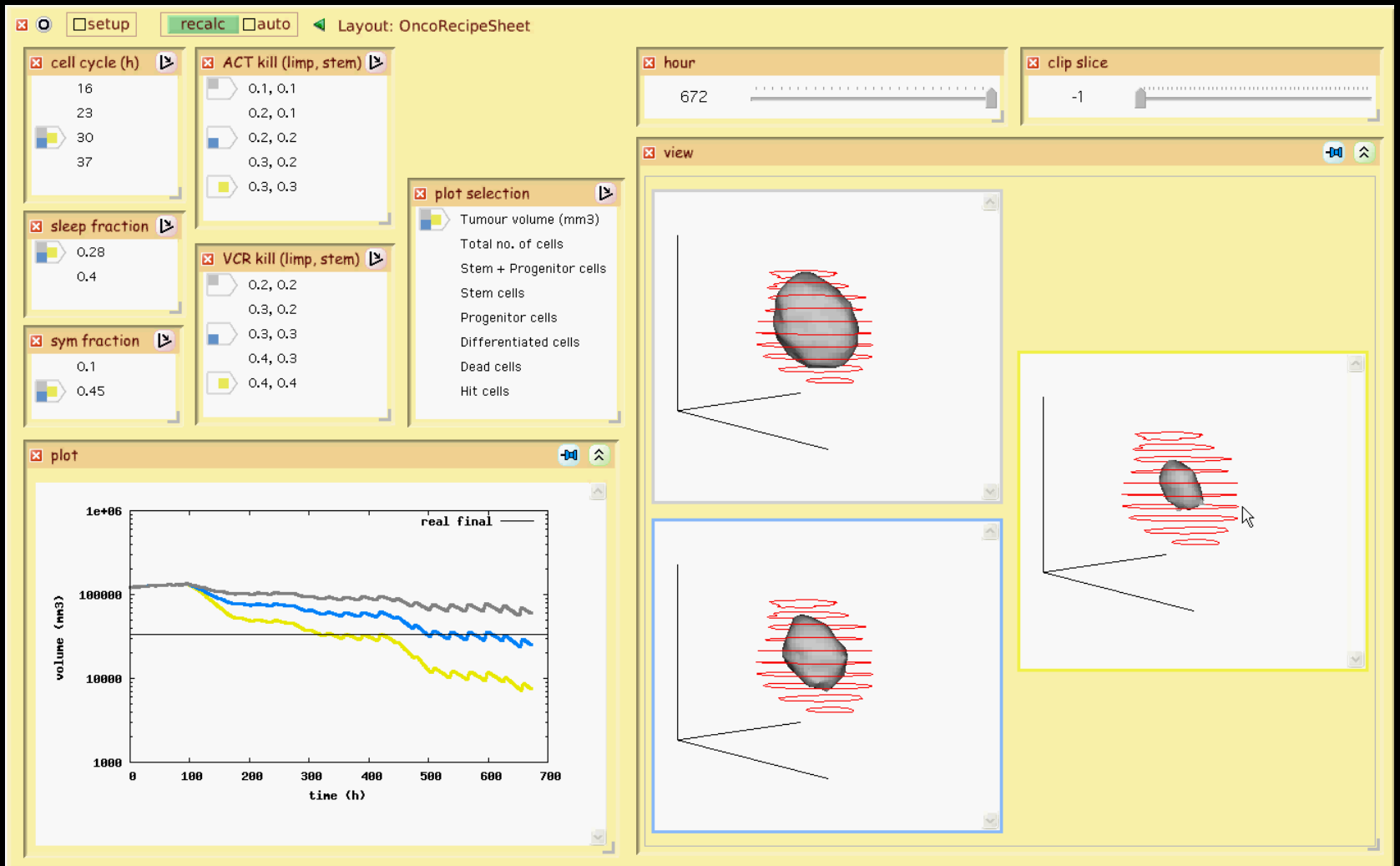


Hans Rosling's 200 Countries, 200 Years, 4 Minutes - The Joy of Stats - BBC Four

# 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:

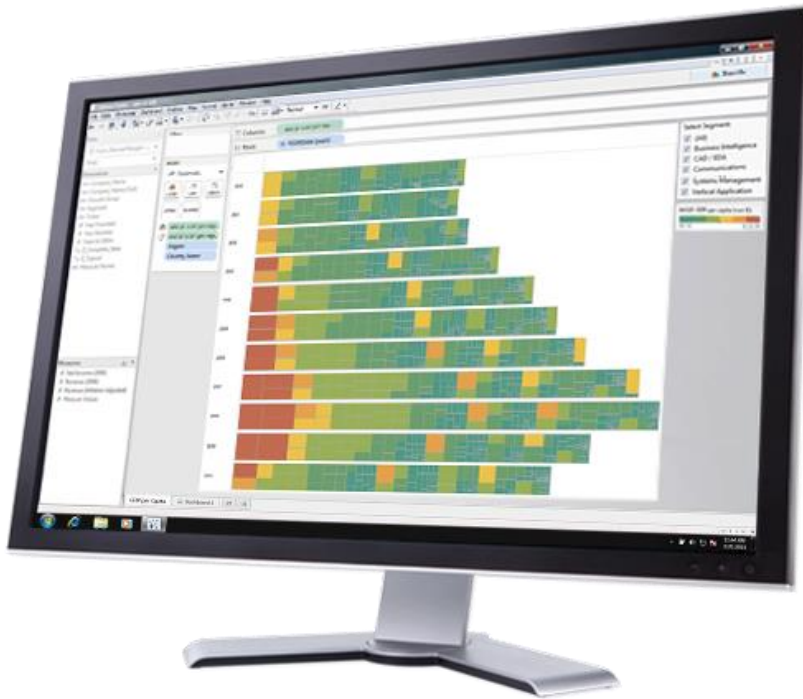
- Matlab, Mathematica, IDL
- [AVS](#) (Advanced Visual Systems)
- [IRIS Explorer](#) (?)
- [Amira](#)
- [Spotfire](#), [Tableau](#)
- ...

## 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)

Like 4

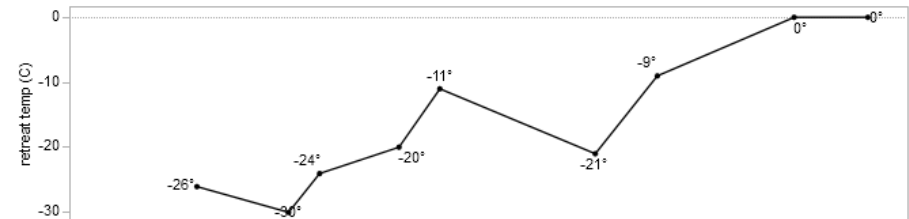
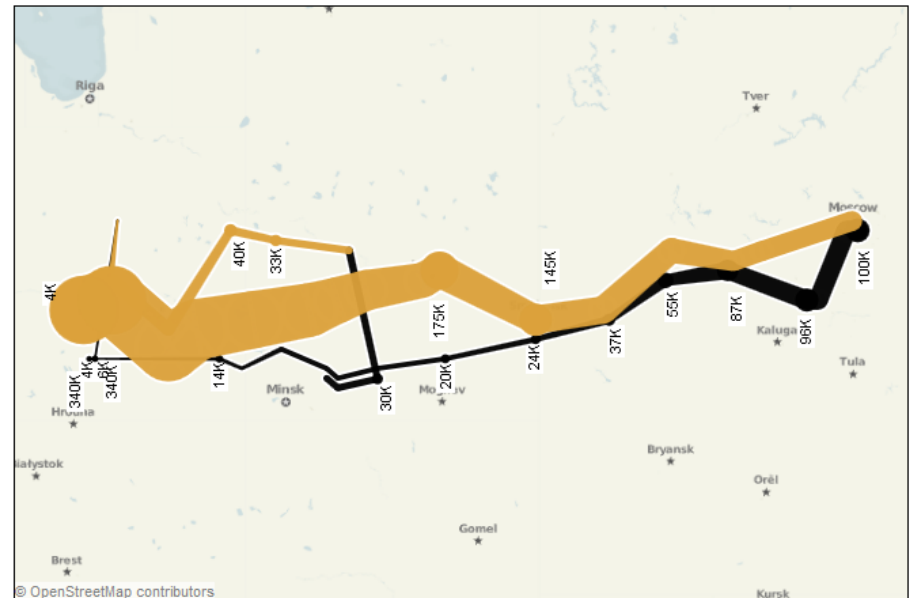
Tweet 10

by amorrison@table... - Jun. 23rd 2010

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 qua.

### Napoleon's March 1812

The losses of French army during the Russian campaign, 1812-1813.



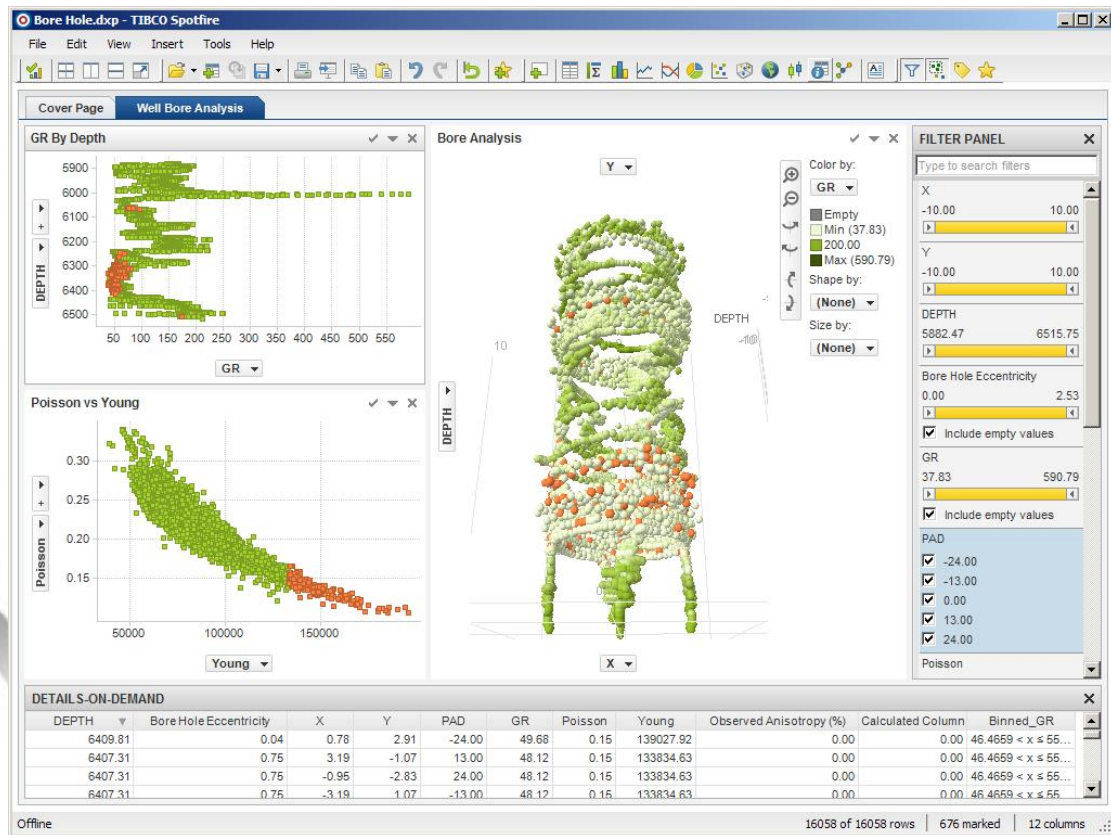
Share

Download

[See more by this author](#)



# Software: Spotfire



# DIY Software: D3.js

[D3.js tutorial](#)

## Data-Driven Documents





# Processing



Brownian | Processing 1.2.1

File Edit Sketch Tools Help

Brownian

```

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

int num = 2000;
int range = 6;

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()

```

16

OpenProcessing - Share your sketches! - SeaMonkey

OpenProcessing [browse](#) [classrooms](#) [collections](#) [bo](#)

[login](#) - [sign up](#)

featured sketches

- [Visualizing text](#)  
by Diana Lange
- [sketch](#)  
by Aris Bezas
- [Biomechanics](#)  
by Asher Salomon

A website to share Processing sketches  
**share your sketches with others**  
**help and collaborate with the community**  
**improve and polish your programming skills**  
**follow classes around the world teaching processing**

Processing is an open source programming language and

Waiting for www.openprocessing.org...

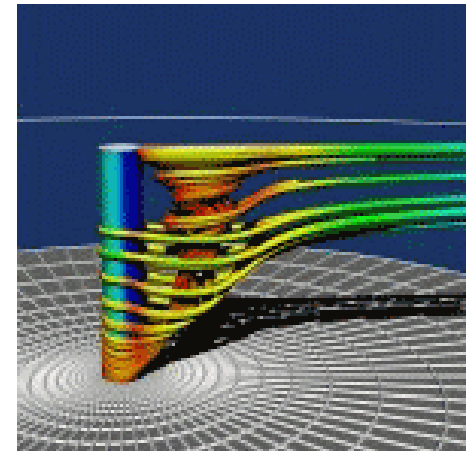
# The Visualization Toolkit ([VTK](#))

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



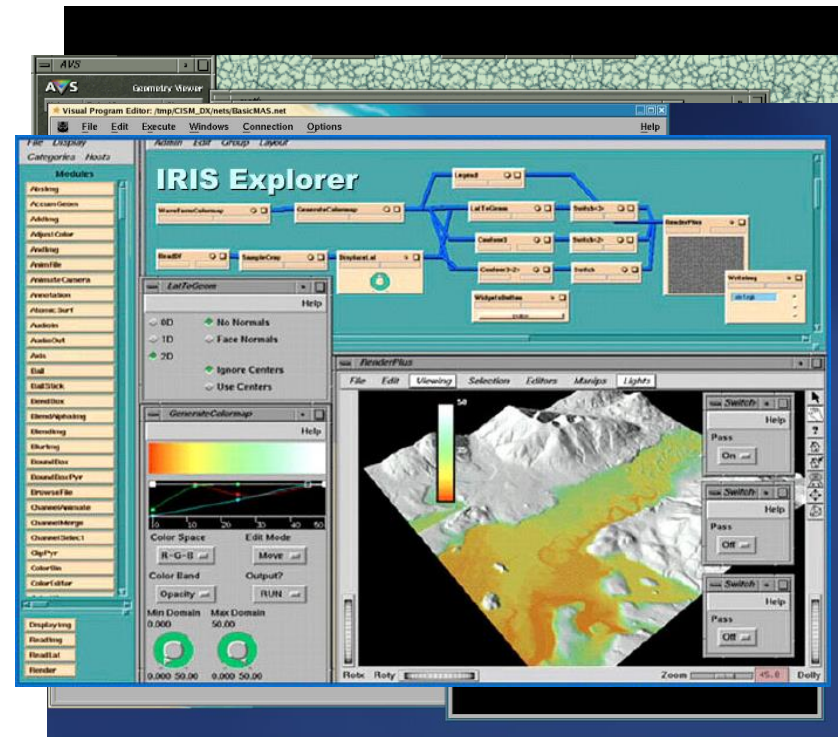
# The Visualization Toolkit (VTK)

VTK is *not*:

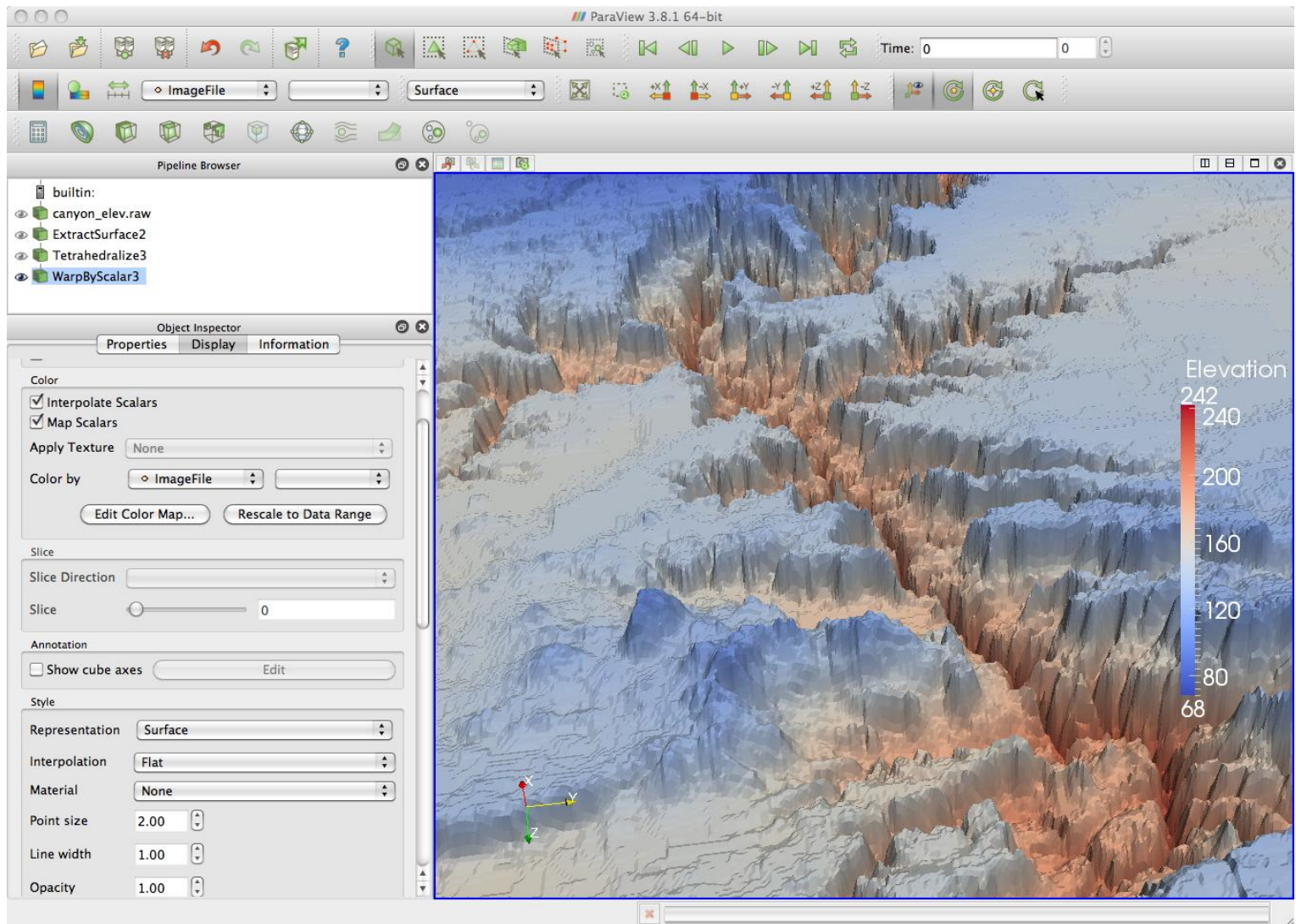
- VTK is *not* a programming language
- VTK is *not* an application
  - No drag-and-drop “visual program editor” as with AVS, Iris Explorer, OpenDX, etc.
  - You have to *program*

More info:

- <http://www.vtk.org/>
- <http://www.paraview.org/>



# ParaView





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