



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



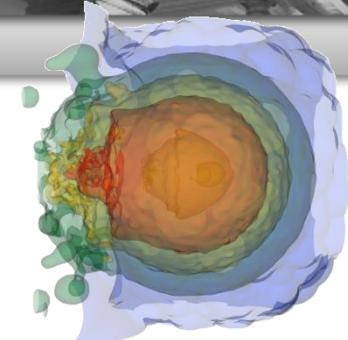
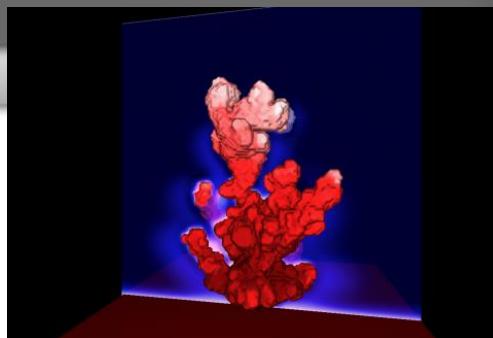
Introduction to Data Visualization

Robert Belleman, PhD

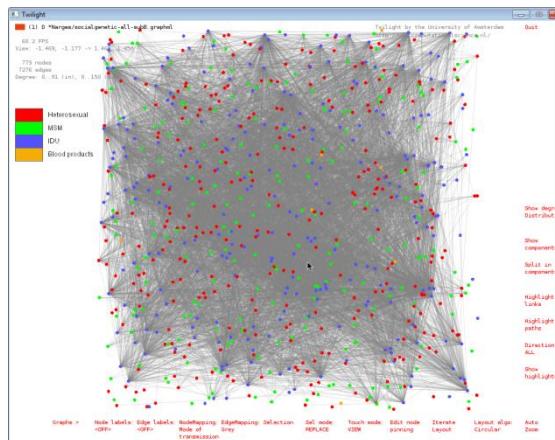
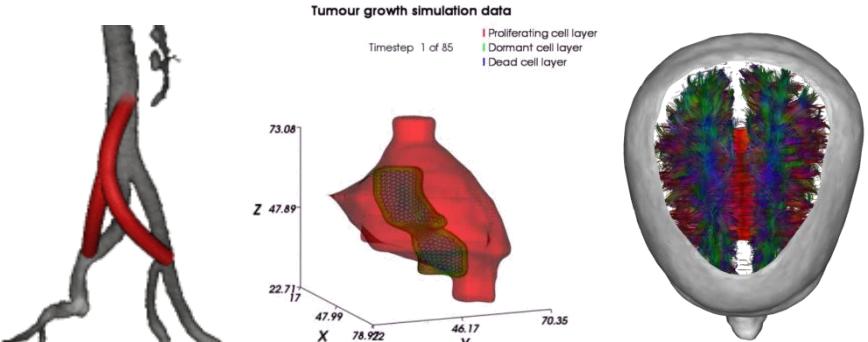
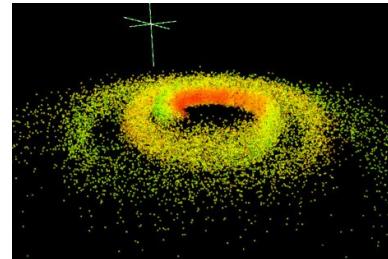
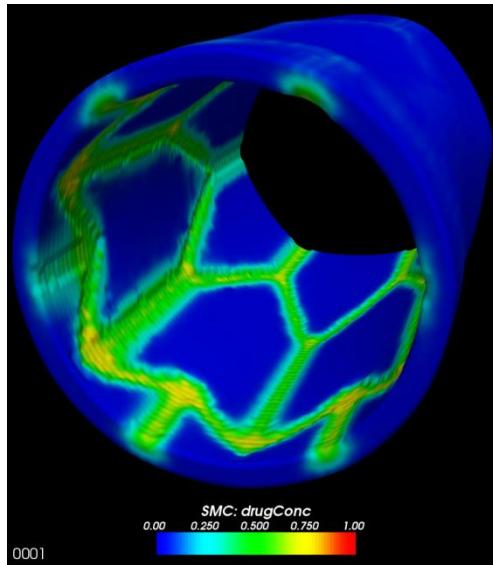
Informatics Institute

University of Amsterdam

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- **Scientific Visualization and Virtual Reality**
 - Computational Science at UvA/Ivl
 - 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
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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

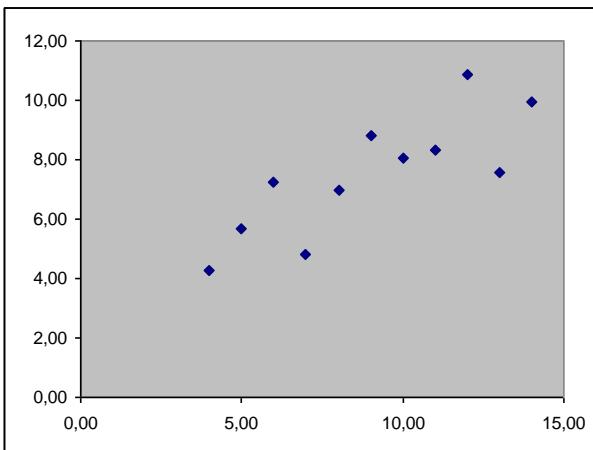
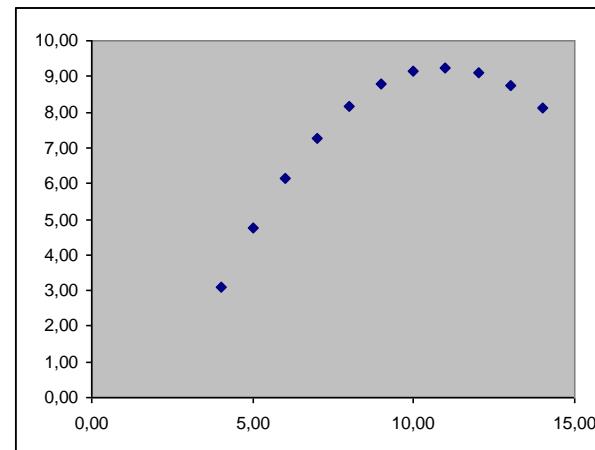
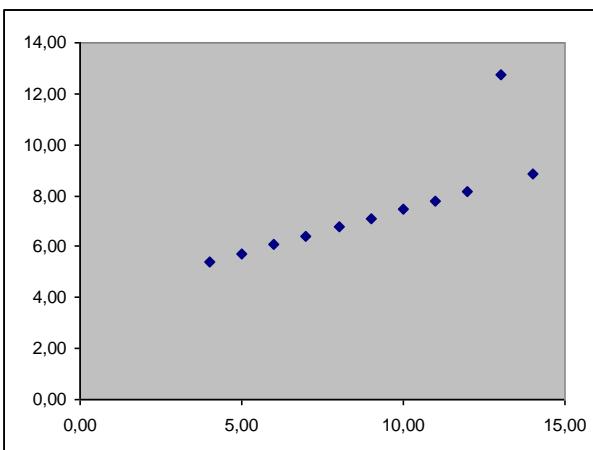
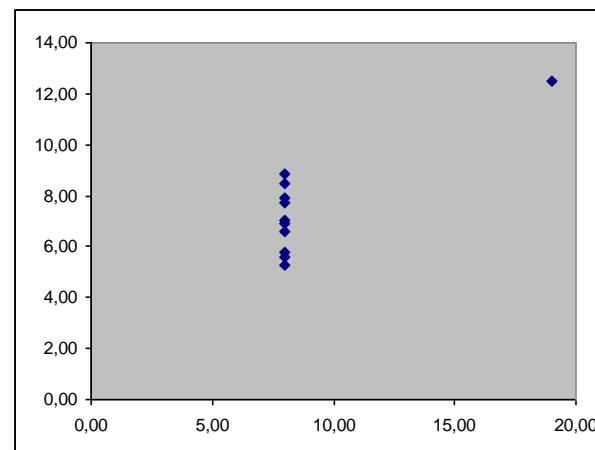
C

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**

Uses for visualization

1. Support research activities

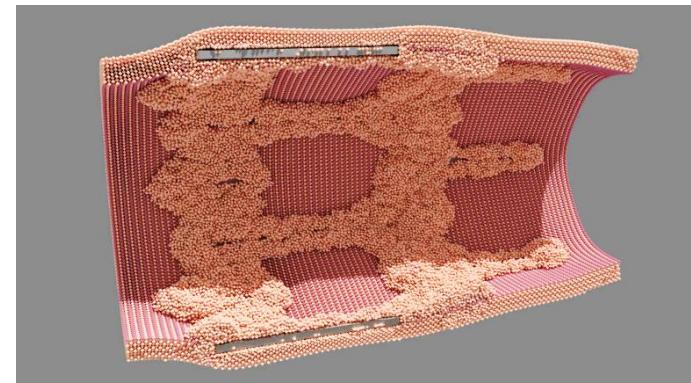
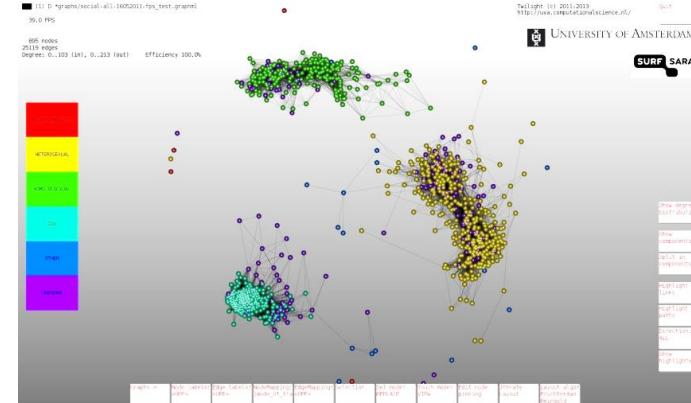
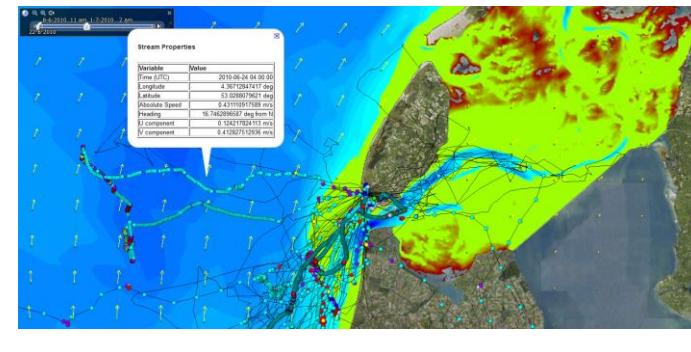
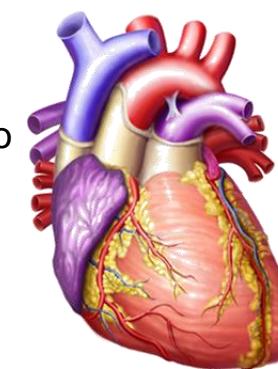
- Explore or compare datasets, verify simulation correctness, discuss results with peers, ...

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

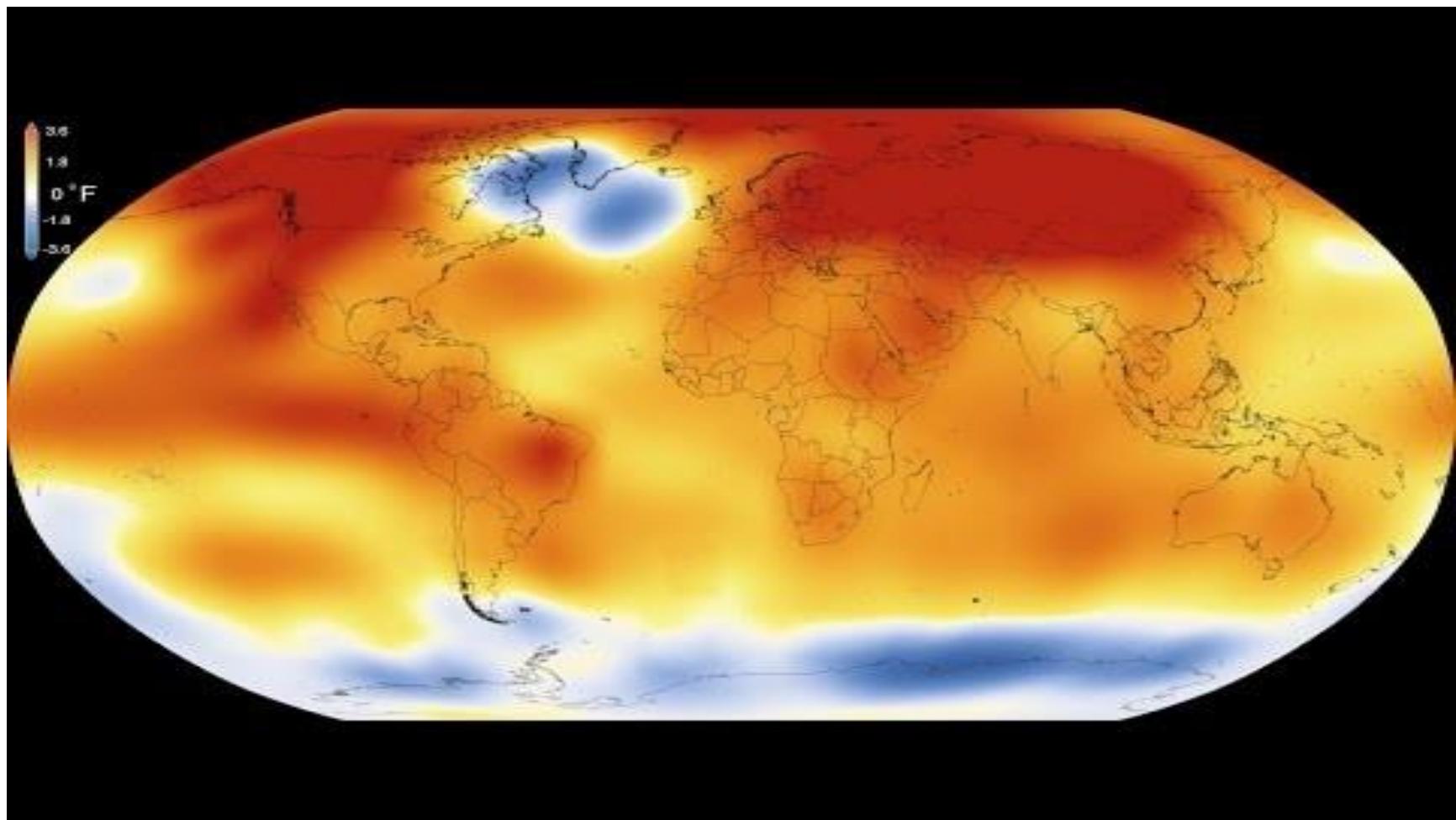
Scientific visualization

- “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)

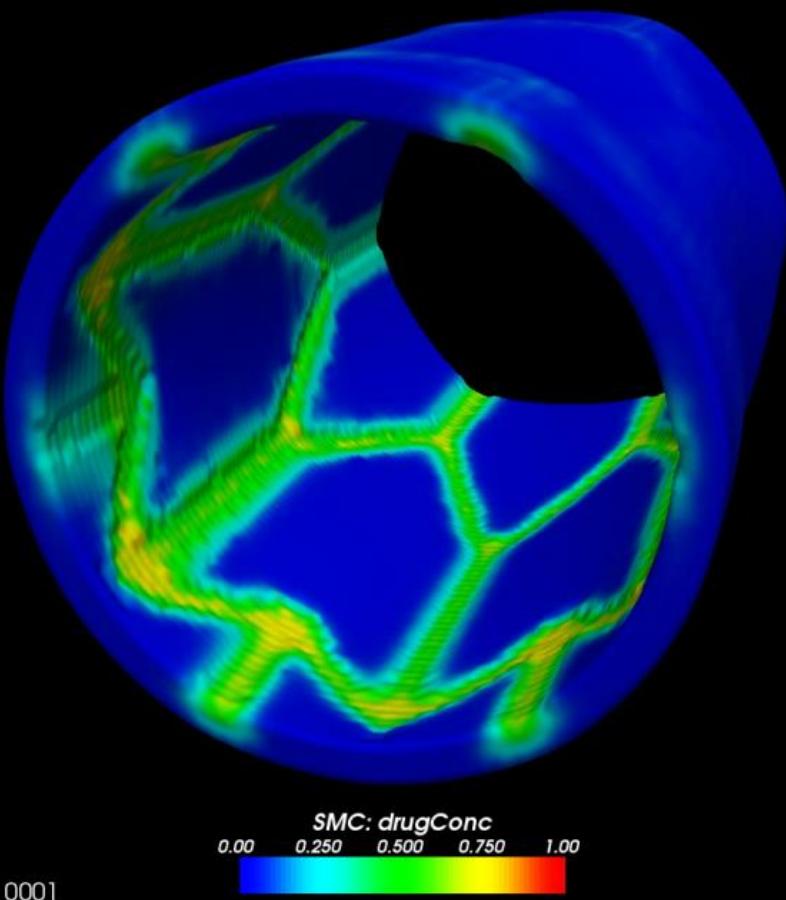
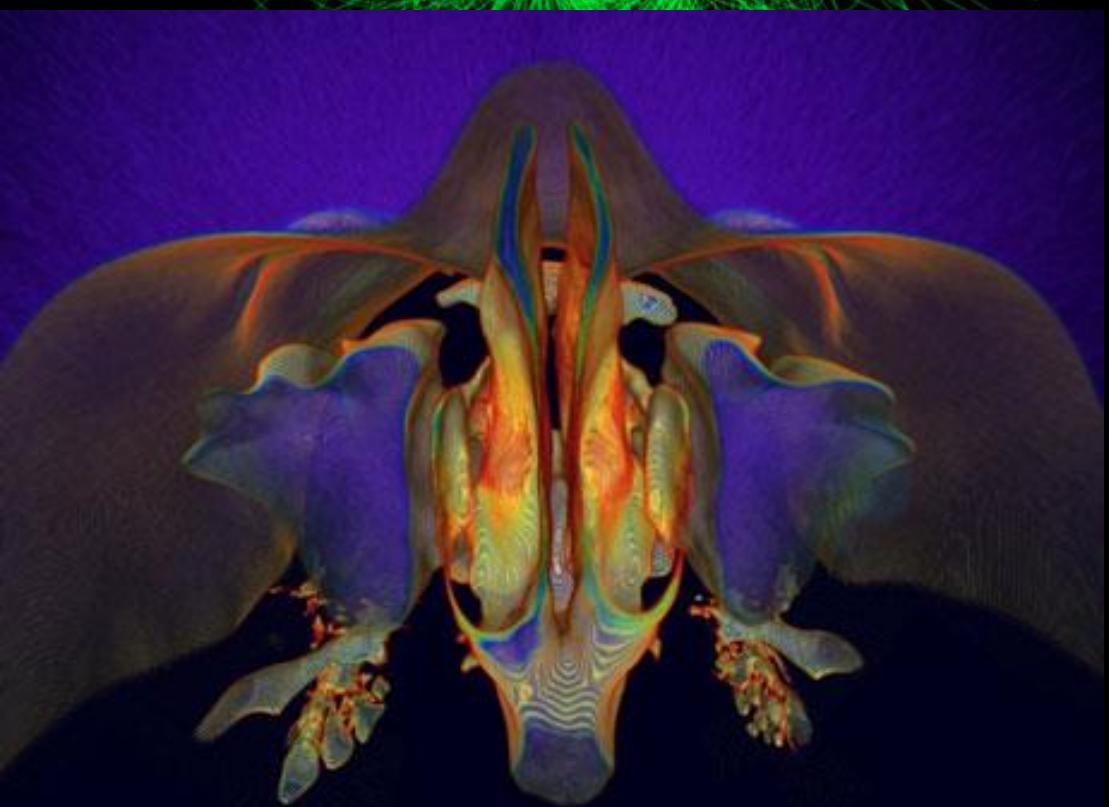
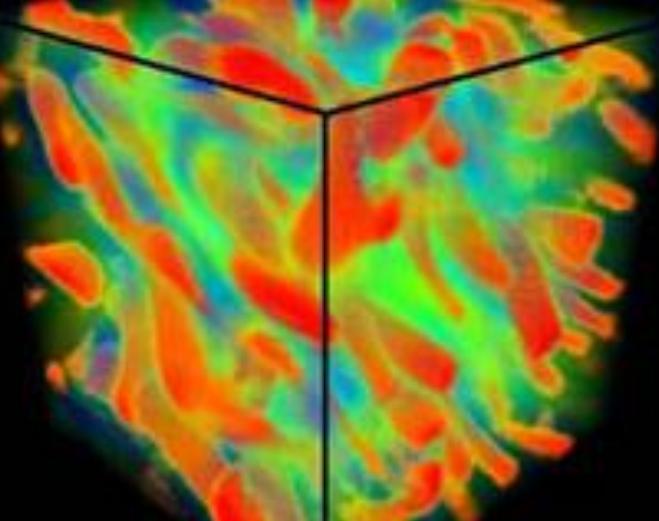
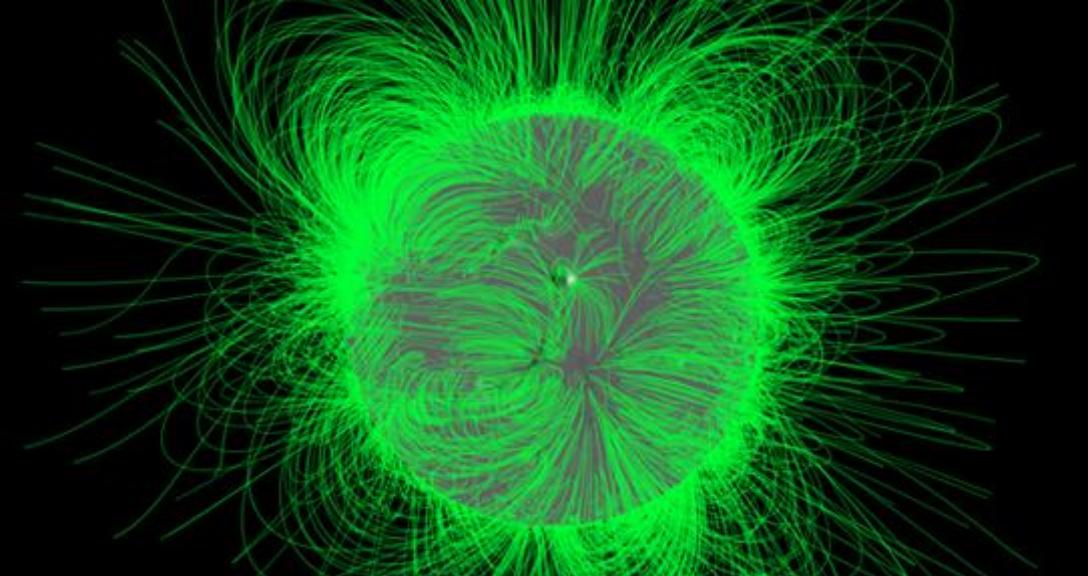


Scientific visualization



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







Information visualization

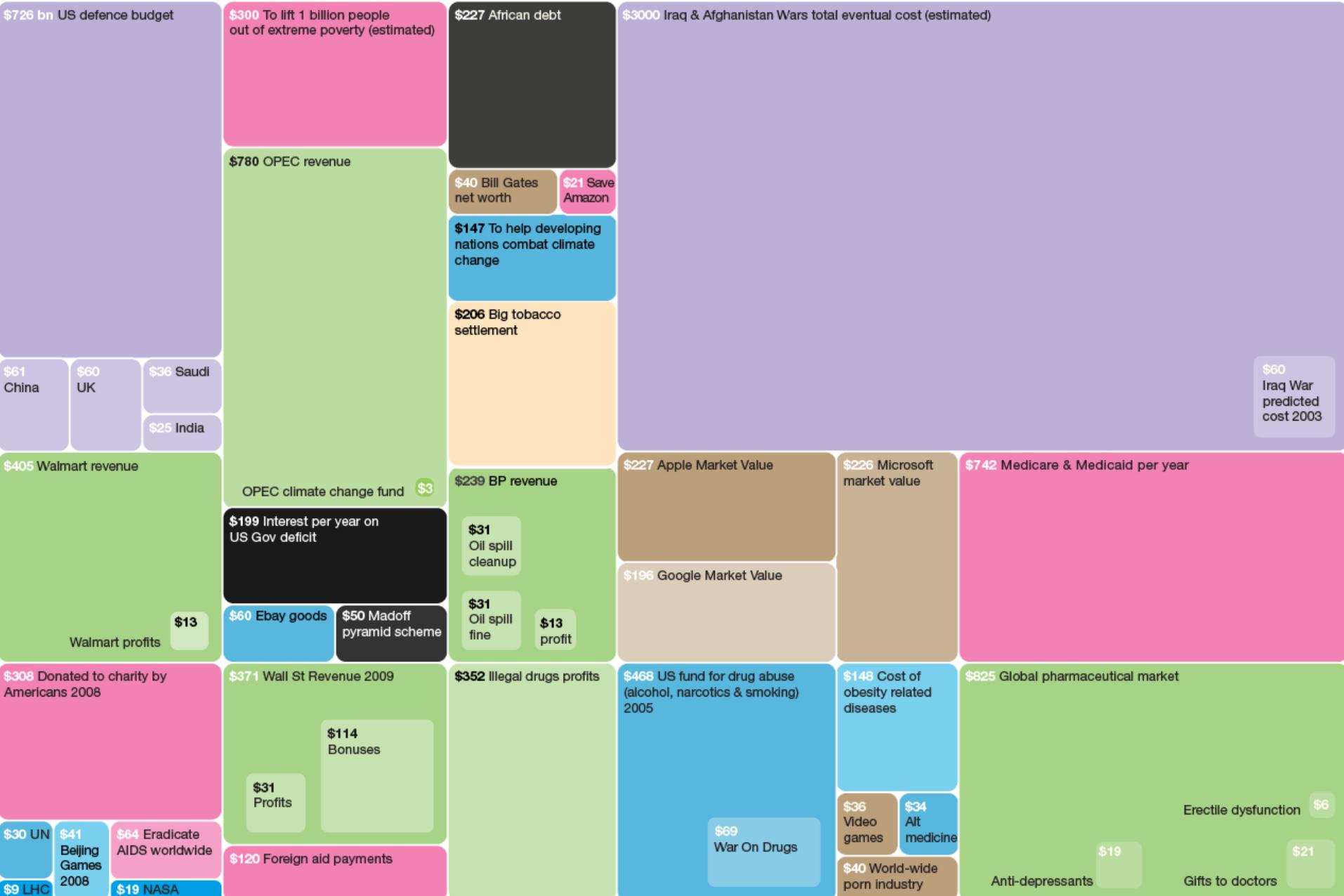
- “In information visualization, the graphical models may represent abstract concepts and relationships that do not necessarily have a counterpart in the physical world.”

Maria Cristina Ferreira de Oliveira, Haim Levkowitz, [doi.ieeecomputersociety.org/10.1109/TVCG.2003.1207445 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

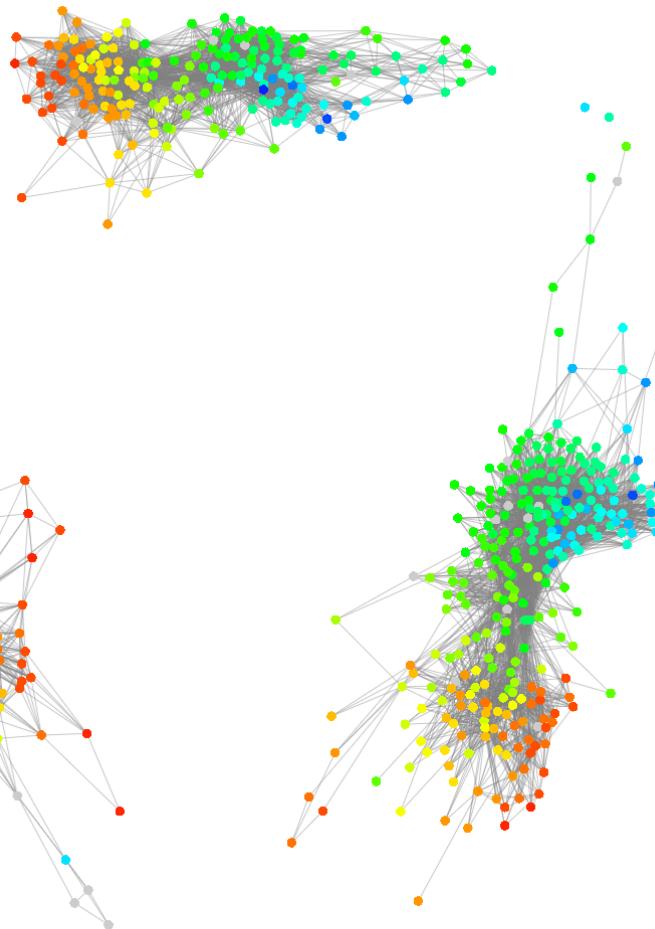


\$11,900 Worldwide cost of financial crisis



“Bandwidth of our senses”, Tor Norretanders

(1) D *..../rewrite/graphs/use_case_narges/20110804/social-all-subB.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)



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

Quit

Show degree Distribution

Show components

Split in components

Highlight links

Highlight paths

Direction: ALL

Show highlighted

Auto Zoom

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



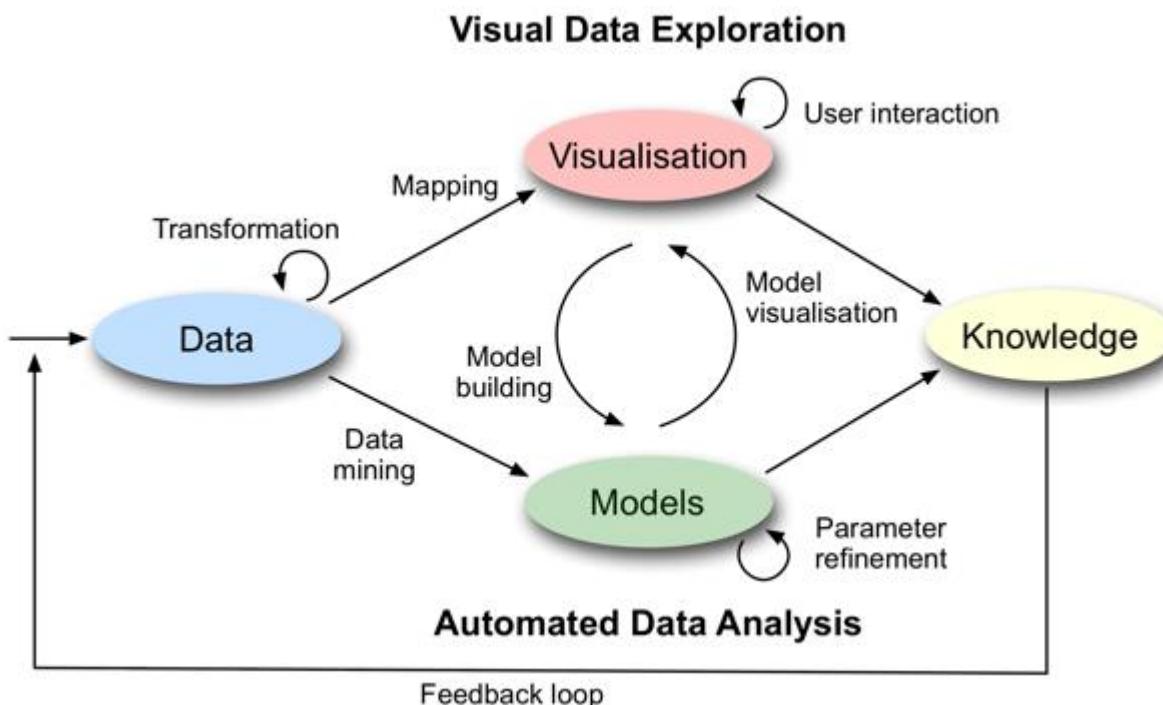
BBC FOUR

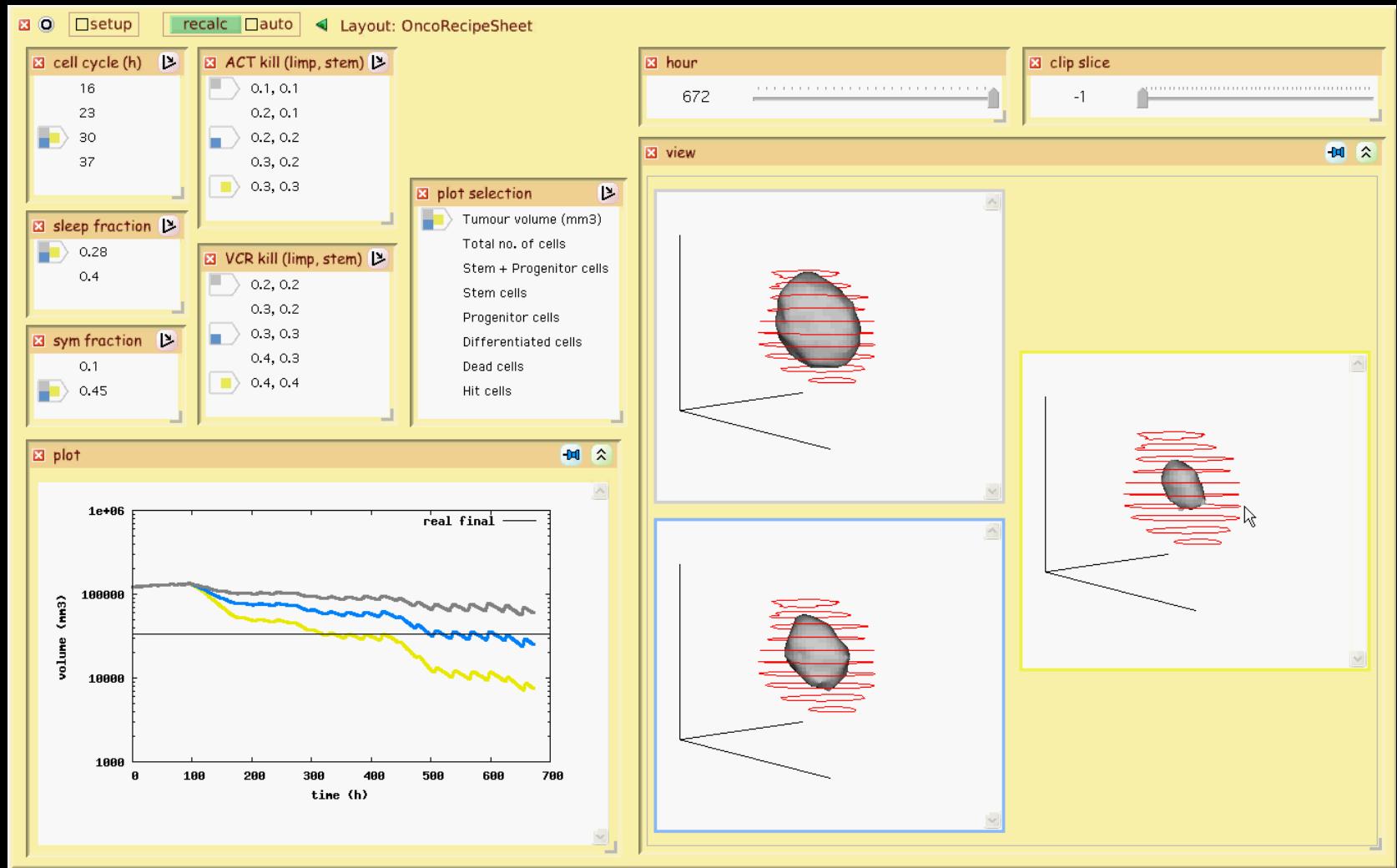


Hans Rosling's 200 Countries, 200 Years, 4 Minutes - The Joy of Stats - BBC Four

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, Bellemann

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

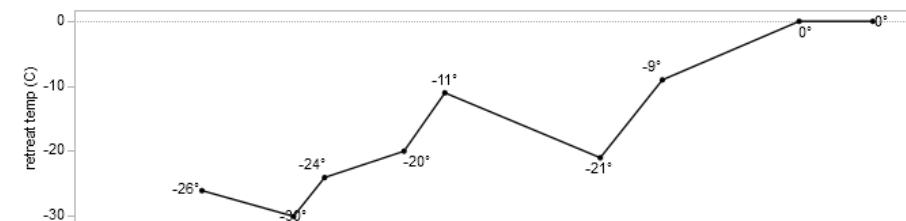
Tweet 10

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 quoi*.

Napoleon's March 1812

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



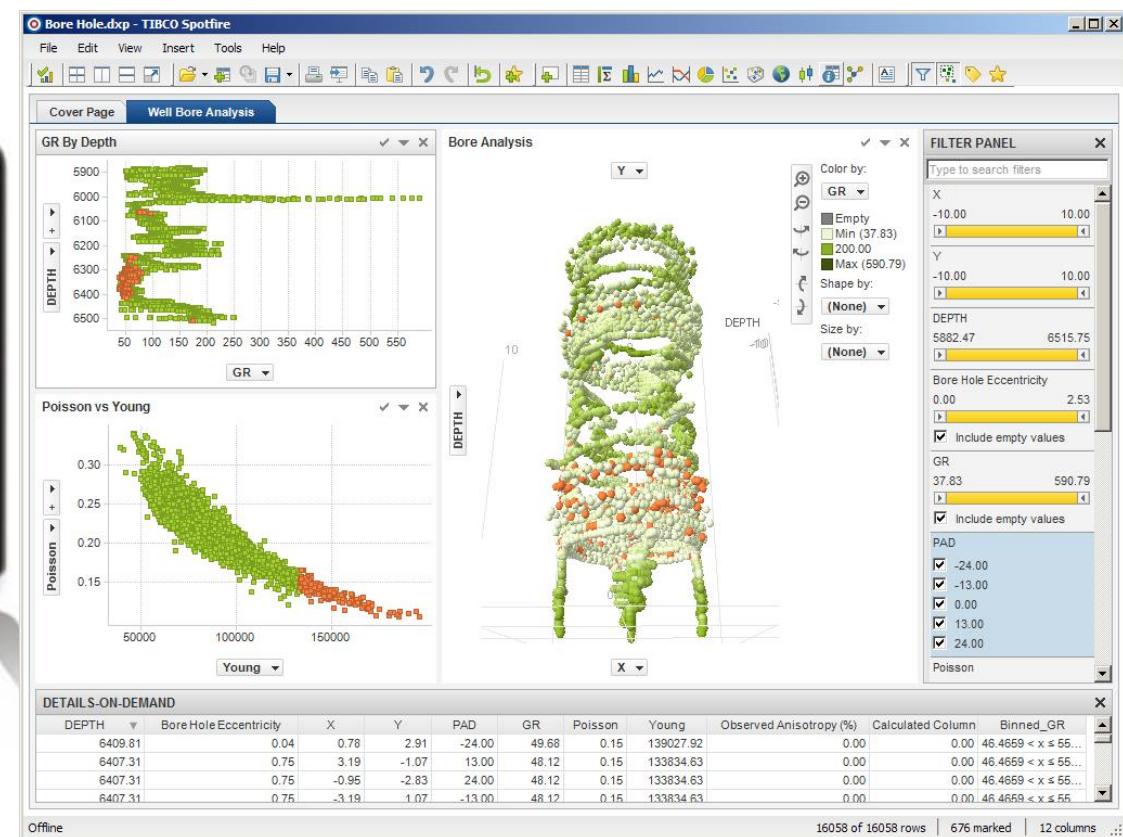
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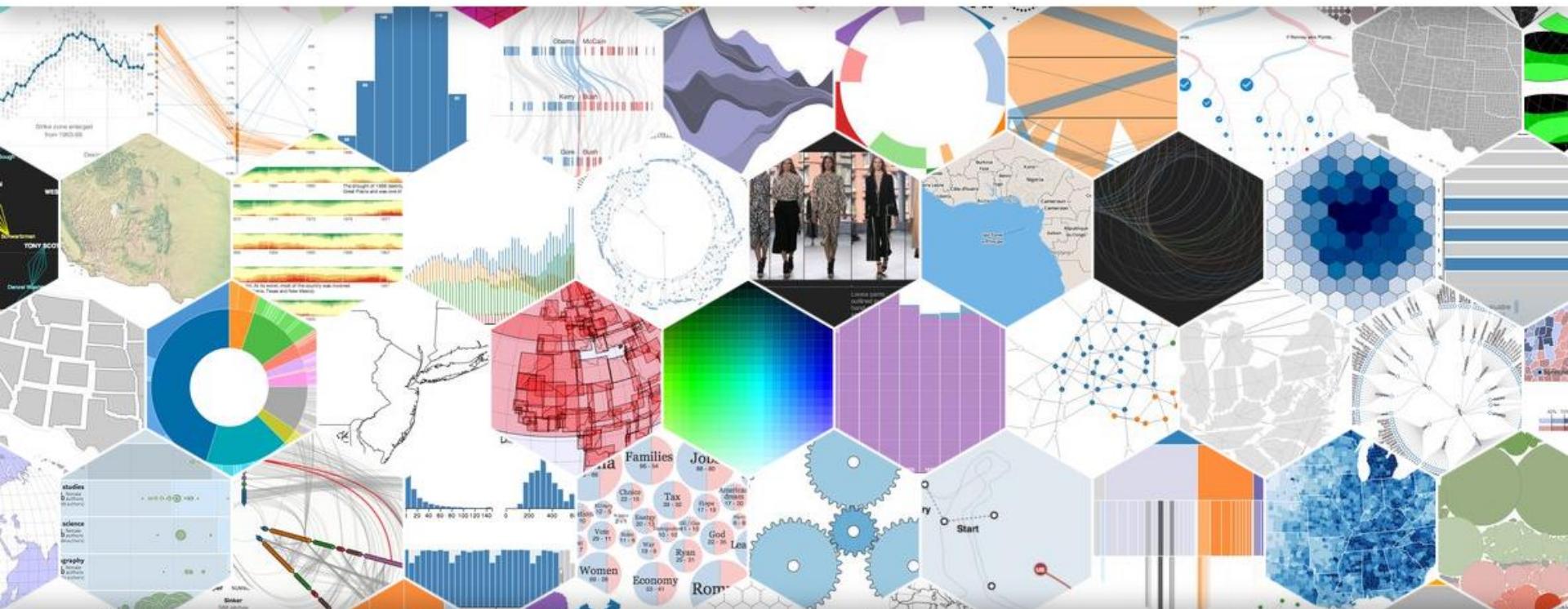
tableau

Software: Spotfire



DIY Software: D3.js

D3.js tutorial



Processing



Brownian | Processing 1.2.1

File Edit Sketch Tools Help

Brownian S

```
/**  
 * 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()  
{  
    // ...  
}
```

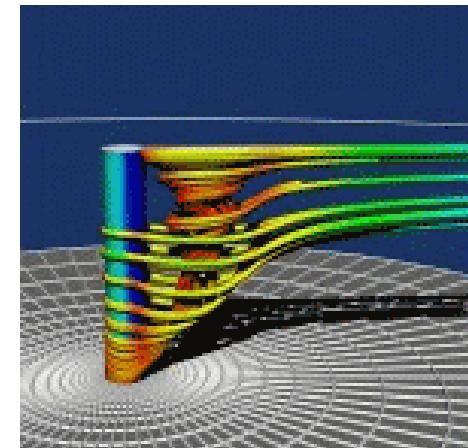
16



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

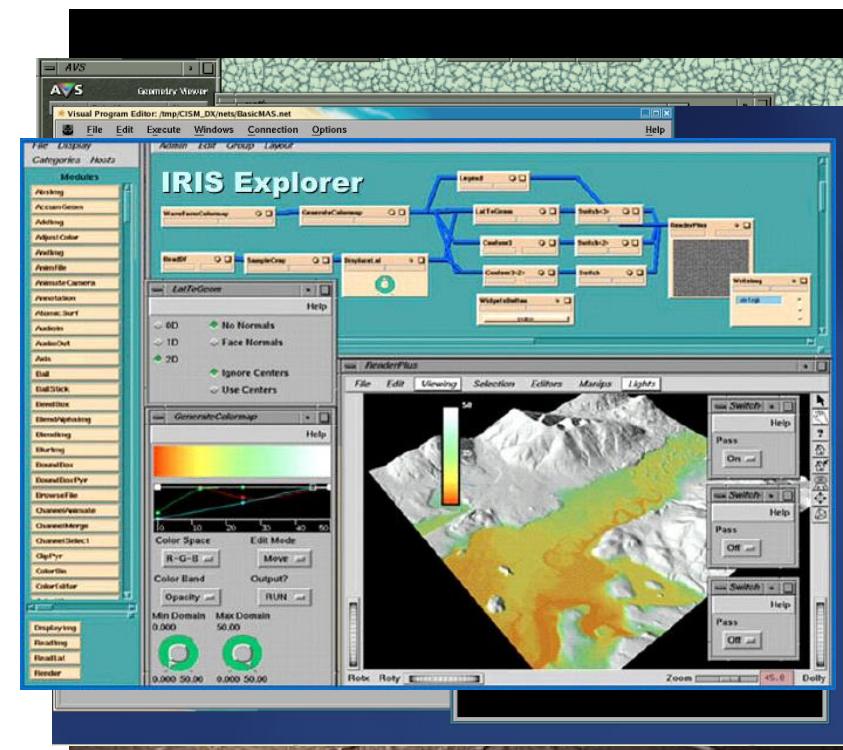
The Visualization Toolkit (VTK)

VTK is *not*:

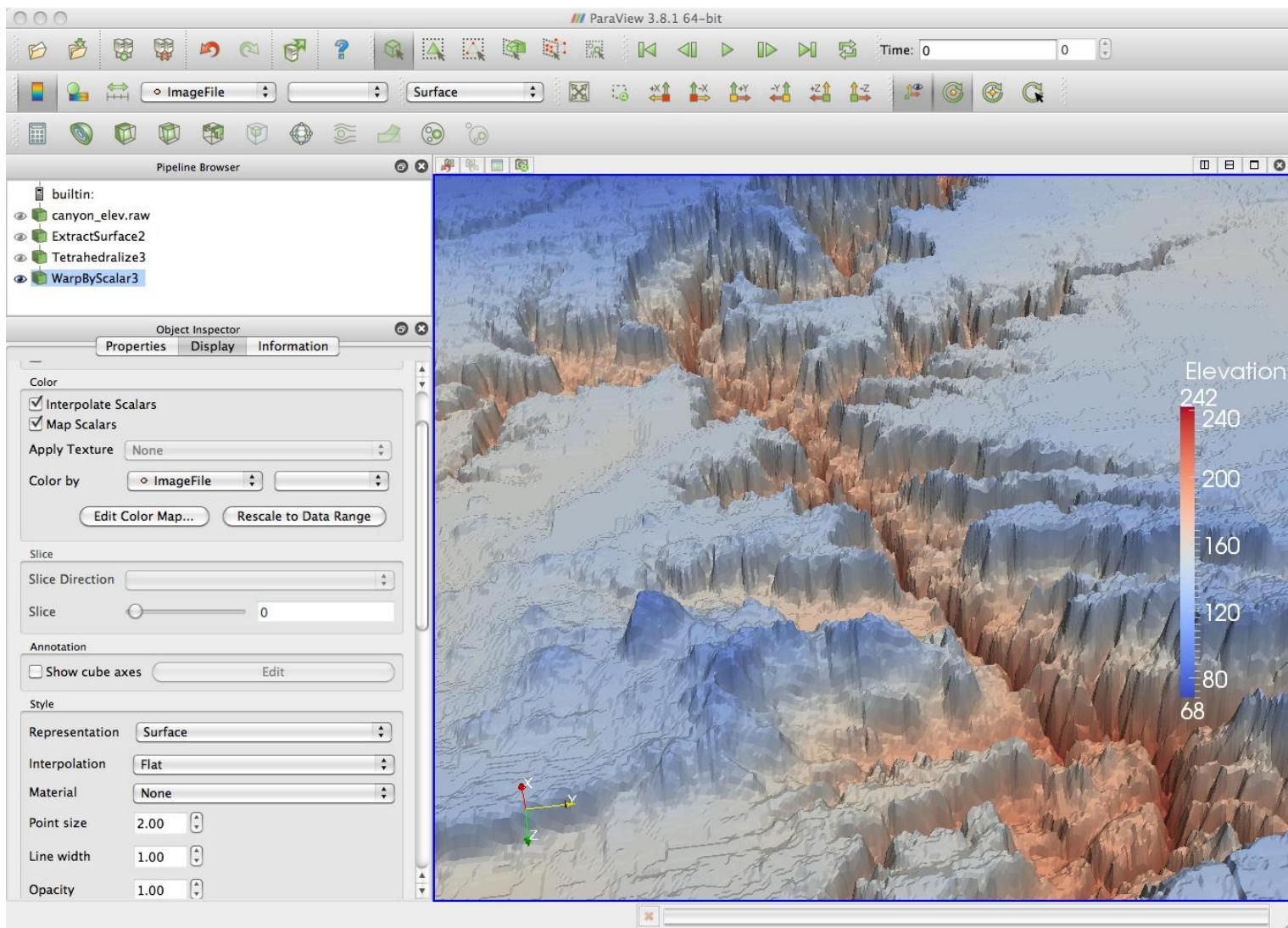
- VTK is *not* a programming language
- VTK is *not* an application
 - No drag-and-drop “visual program editor” as with AVS, Iris Explorer, OpenDX, etc.
 - You have to *program*

More info:

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



ParaView





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