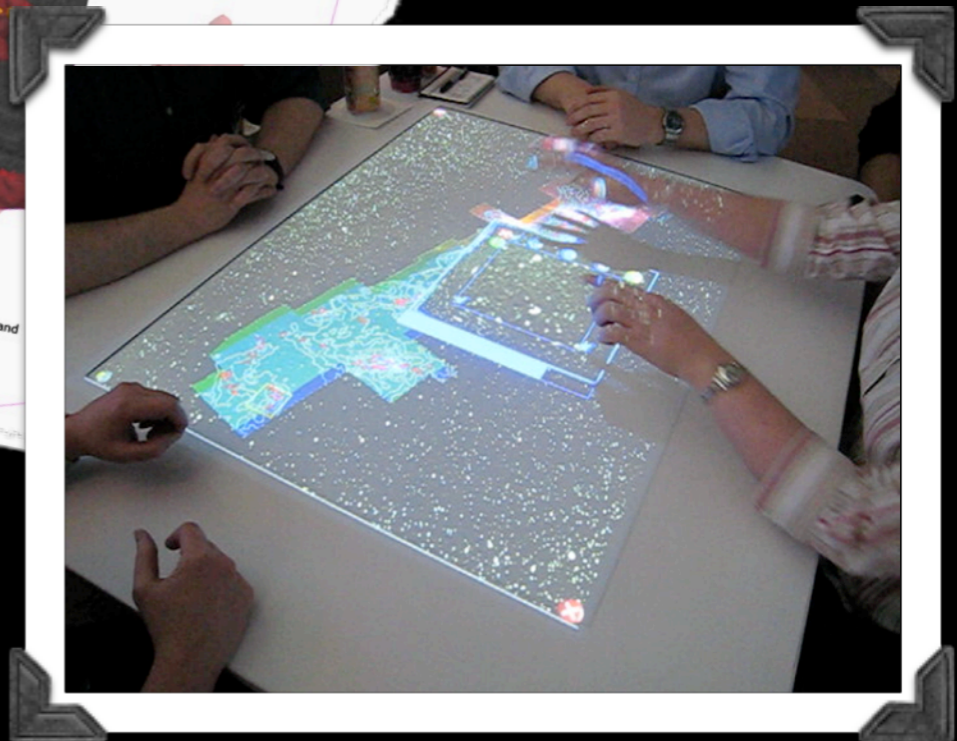
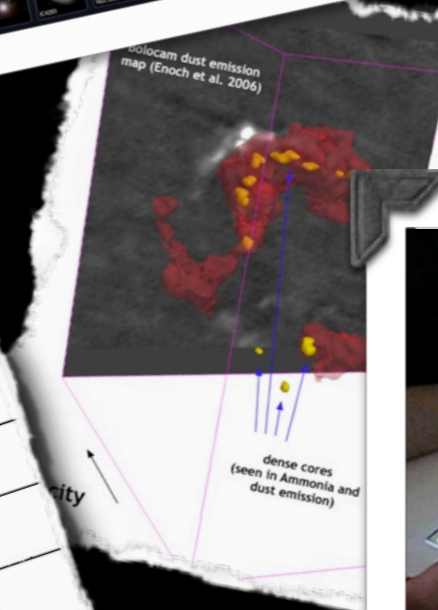
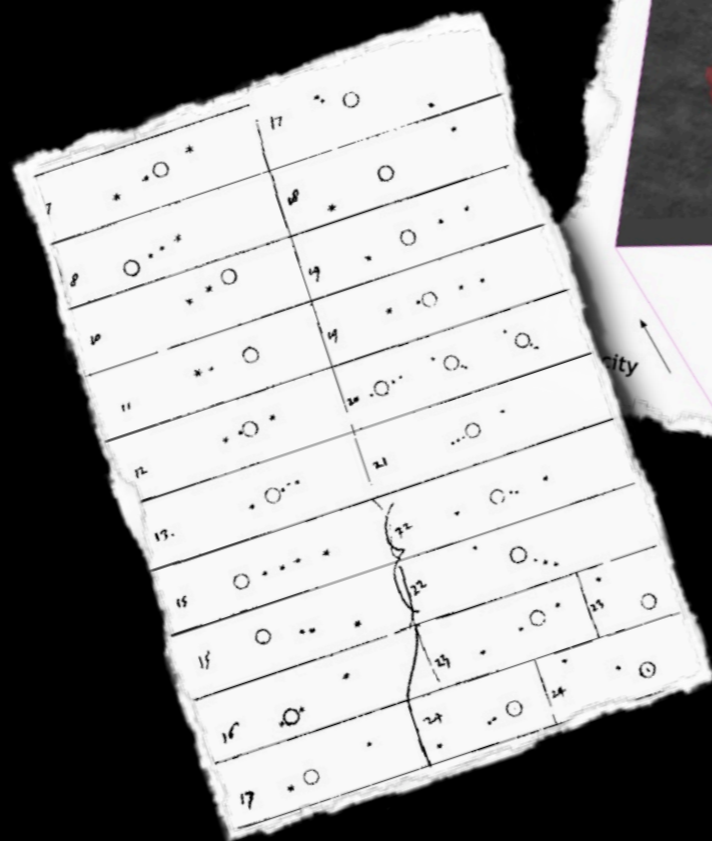
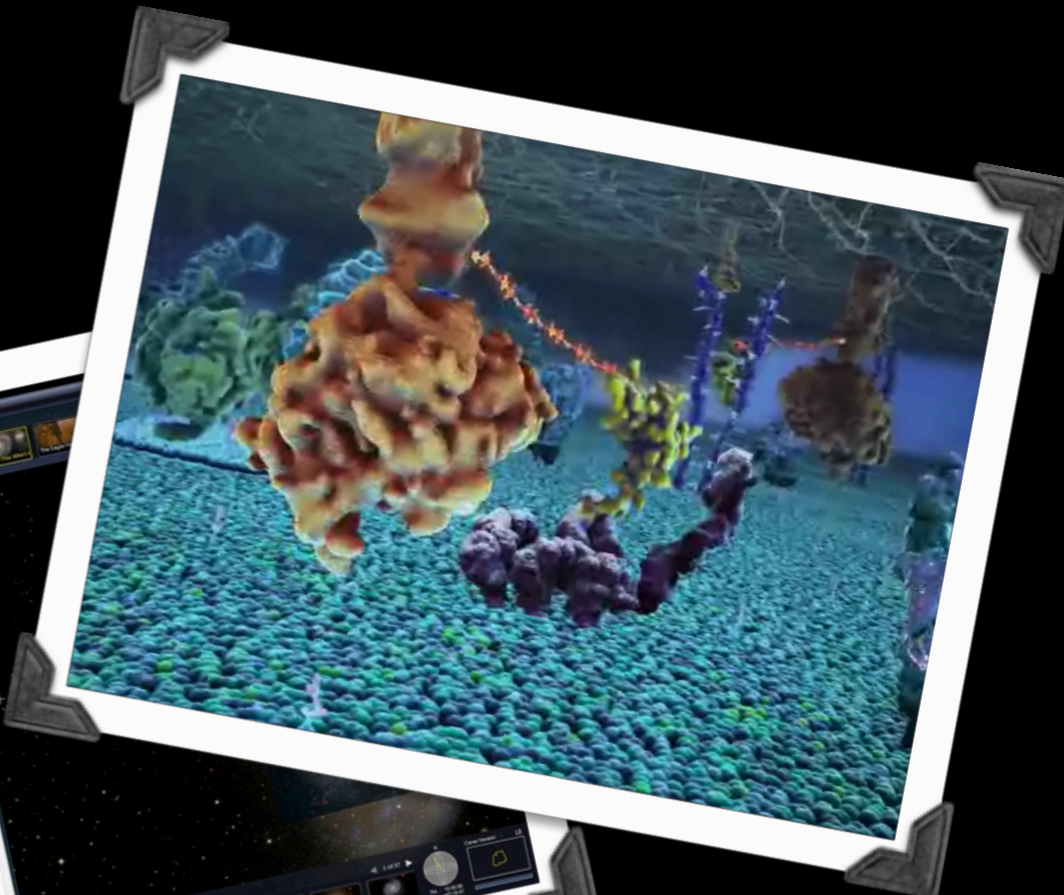
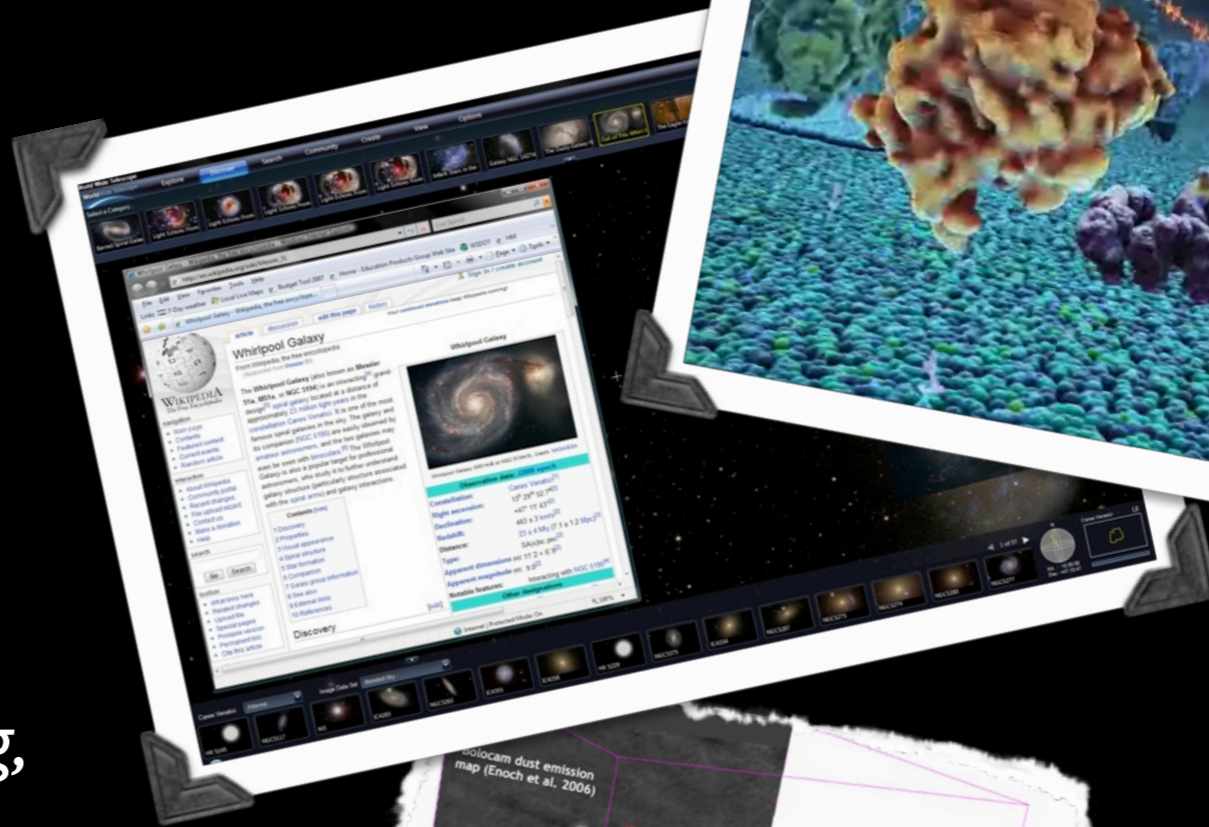


Seeing Science

Alyssa A. Goodman

Professor of Astronomy
& Founding Director of the
Initiative in Innovative Computing,
Harvard University

Scholar-in-Residence,
WGBH Boston





Who am I?

...my interest(s) in "Seeing Science"...

Astronomy

COMPLETE Home Page
http://www.cfa.harvard.edu/COMPLETE/

COMPLETE The COordinated Molecular Probe Line Extinction Thermal Emission Survey of Star Forming Regions

- Data
- Results
- Projects
- People
- Learn
- Restricted

Project Description

The COordinated Molecular Probe Line Extinction Thermal Emission Survey of Star Forming Regions (COMPLETE) provides a range of data complementary to the Spitzer Legacy Program "From Molecular Cores to Planet Forming Disks" (c2d) for the Perseus, Ophiuchus and Serpens regions. In combination with the Spitzer observations, COMPLETE will allow for detailed analysis and understanding of the physics of star formation on scales from 500 A.U. to 10 pc.

Phase I, which is now complete, provides fully sampled, arcminute resolution observations of the density and velocity structure of the three regions, comprising: extinction maps derived from the Two Micron All Sky Survey (2MASS) near-infrared data using the NICER algorithm; extinction and temperature maps derived from IRAS 60 and 100um emission; HI maps of atomic gas; 12CO and 13CO maps of molecular gas; and submillimeter continuum images of emission from dust in dense cores.

Click on the "Data" button to the left to access this data.

Phase II (which is still ongoing) uses targeted source lists based on the Phase I data, as it is (still) not feasible to cover every dense star-forming peak at high resolution. Phase II includes high-sensitivity near-IR imaging (for high resolution extinction mapping), mm-continuum imaging with MAMBO on IRAM and high-resolution observations of dense gas tracers such as N₂H⁺. These data are being released as they are validated.

COMPLETE Postdoc, 2007

Referencing Data from the COMPLETE Survey

COMPLETE data are non-proprietary. Please reference Ridge, N.A. et al., "The COMPLETE Survey of Star Forming Regions: Phase I Data", 2006. AJ. 131. 2921 as

Scientific Computing

Initiative in Innovative Computing (IIC) | Harvard University
http://iic.harvard.edu/

home about the iic research education people events employment reaching the iic

iic Initiative in Innovative Computing at Harvard

ABOUT US
Mission of the IIC
The Initiative in Innovative Computing (IIC) is an interdisciplinary research and development center at Harvard dedicated to using innovative computing tools to accelerate discovery across all of the scientific disciplines. The IIC's researchers work in close collaboration with scientists and engineers in other fields, fostering a two-way collaborative flow of ideas and inventions between basic science and computer science, academia and industry, professional staff and faculty, teachers and students. The IIC trains the next generation of creative and computationally capable scientists, and communicates with the public at large about the value of computing in science and the science it enables.
Read more the IIC and our strategic role and how to contact us.

FEATURE
Astronomical Medicine
The goal of the Astronomical Medicine project is to make the specific modifications to existing medical imaging programs that enable their use in astronomical research. In particular, two software packages (3D Slicer and OsiriX) are being modified and used on data from the COMPLETE Survey of Star-Forming Regions, in order to characterize the physical nature of gas that forms new stars in our Galaxy.
Watch the movie and find out more about the Astronomical Medicine project at the IIC.

NEWS & EVENTS
Application Deadline Extended for Graduate Research Fellowships in Computational Science
The IIC is pleased to announce the inauguration of new graduate research fellowships in Computational Science at Harvard. GSAS faculty whose research projects address challenges that span science and computing are invited to nominate Ph.D. candidates as IIC Computational Science Research Fellows. The application deadline has now been extended by two weeks.
Read more... Previous news

UPCOMING EVENT
"IIC Colloquium"
Feb 4, 2009 4:00pm
Tamara Munzner, University of British Columbia
More events

© 2008 President and Fellows of Harvard College
IIC Basecamp login

Teaching

Homepage § Quantitative Reasoning 46
http://my.harvard.edu/icb.do?keyword=&RSS

my.harvard Welcome, Alyssa Goodman logout

Quantitative Reasoning 46
COURSE SITE ADMIN MODIFY THIS PAGE

This site is from a previous offering of this course. Click here to find current course sites on my.harvard.

Announcements
There are currently no announcements.

Course Information
Quantitative Reasoning 46 : The Visual Display of Information: The Art of Numbers
Harvard College/GSAS: 9479
Spring 2007-2008
Alyssa A. Goodman
Location: Science Center E
Meeting Time: Tu, Th, 1-2:30, and a weekly section to be arranged.
Exam Group: 15,16
This course focuses on the insight into quantitative information offered by graphs, tables, charts, maps, and other illustrations. We analyze which of these tools are best for communicating what kinds of data, and why. Ideas about causality, approximation, statistical significance, credibility, and dimensionality will be addressed by analyzing real data and their display. The data will be drawn from medical, astronomical, social-science, aerospace, financial, and geographic examples. Approximately one-quarter of the course will focus on web and live presentations of data. Much of the course's philosophy is based on the work of Edward Tufte.

Emailbag
You may view an email by clicking on its subject.

Subject	Sender	Date Sent
Subject	Sender	Date Sent

Note: Due to University privacy policies this topic is available only to members of the class list.

GapMinder
GAPMINDER HOME

Relative Strengths



Pattern Recognition
Creativity



Calculations



“Interocularity”

(see work of John Tukey)

“Image and Meaning”

(see work of Felice Frankel,
and imageandmeaning.org)

Seeing Science

Data • Dimensions • Display

What...

...is easier now than before?

fast computation, animation, 3D

...was easier before than now?

craftsmanship

...should be easier in the future?

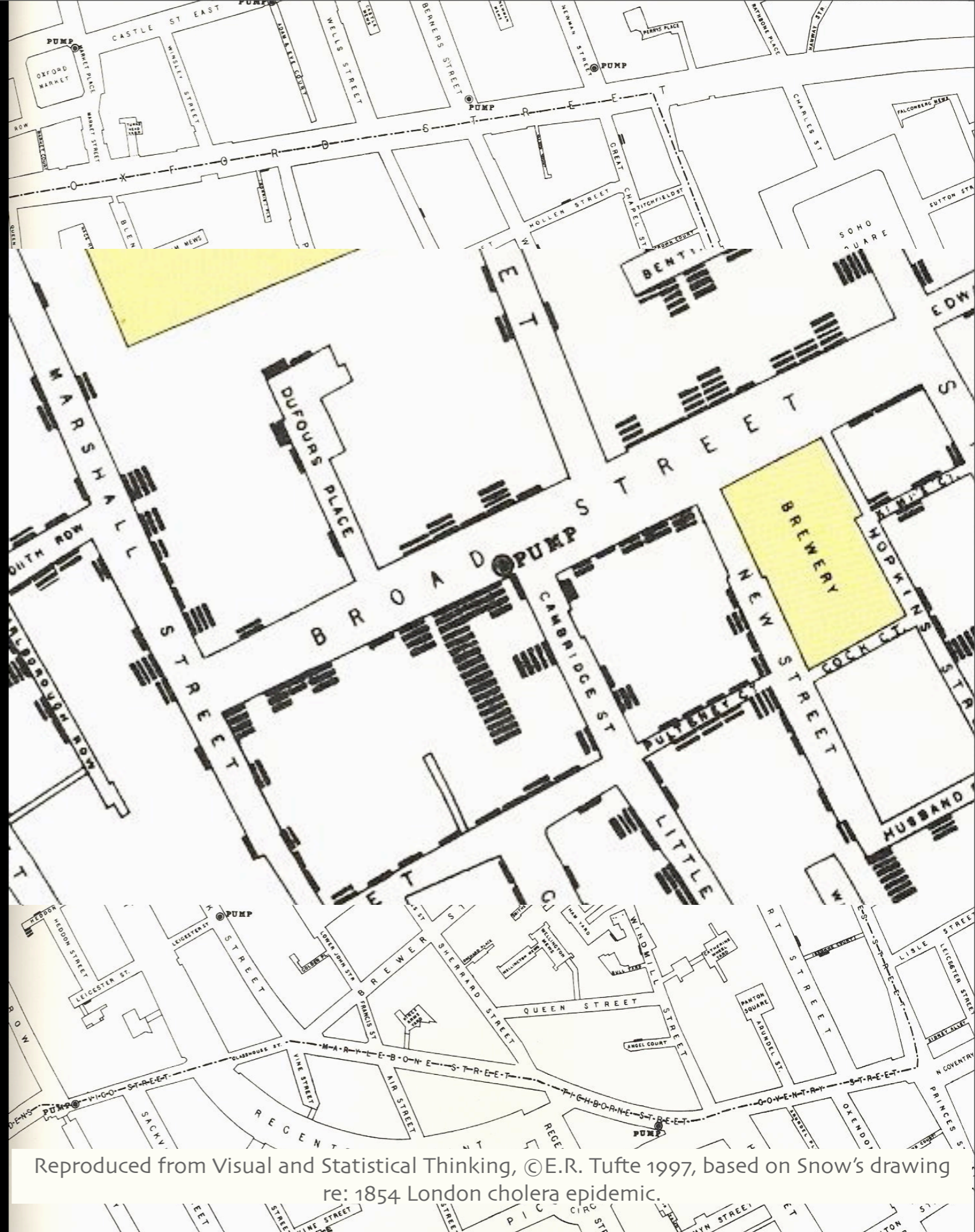
modular craftsmanship

Craftsmanship (in 1854)

Displaying
“high-dimensional” data

with

“multi-functioning
graphical elements”



What Computers *Can* Let us Craft

Elements...

✓ Maps

✓ Tables

✗ Graphs

✓ Charts

✓ Illustrations

✓ Combinations

Live Scoreboard | Celtics.com

SCOREBOARD

DEN	116	WAS	72	POR	97	PHI	46	MIL	34	DAL	26-11	LAL	25-11
CHA	119	BOS	79	NJN	70	SAS	52	UTA	34	SAC	14-21	SEA	9-27
FINAL		2-34	4th	0:50	4th	Halftime	5:36	2nd	10:00		10:00		

COURTSIDE LIVE

19-16 STANDINGS

Fouls Full :20
1 4 0

02:46

1	2	3	4	OT	T
18	17	24	13		72
18	19	26	16		79

Fouls Full :20
1 3 1

30-5 STANDINGS

COURTSIDE LIVE | BOX SCORE | PLAY-BY-PLAY | Highlights | Watch the Game | Listen to the Game

WAS SELECT: ○ ALL ● ACTIVE 5

PLAYER NAME	PTS	REB	RST	F
<input type="checkbox"/> Daniels, Antonio	7	2	8	0
<input checked="" type="checkbox"/> Stevenson, DeSha	11	3	4	2
<input checked="" type="checkbox"/> Jamison, Antawn	18	10	0	3
<input checked="" type="checkbox"/> Butler, Caron	14	3	1	3
<input checked="" type="checkbox"/> Haywood, Brenda	12	5	0	3
<input type="checkbox"/> Blatche, Andray	3	5	0	3
<input checked="" type="checkbox"/> Mason, Roger	3	1	1	5
<input type="checkbox"/> Songaila, Darius	2	1	1	2
<input type="checkbox"/> Young, Nick	2	0	0	0
<input type="checkbox"/> Pecherou, Oleksiy	0	1	0	0
<input type="checkbox"/> Arenas, Gilbert				
<input type="checkbox"/> McGuire, Dominic				

BOS SELECT: ○ ALL ● ACTIVE 5

PLAYER NAME	PTS	REB	RST	F
<input type="checkbox"/> Rondo, Rajon	4	2	2	2
<input checked="" type="checkbox"/> Allen, Roy	16	6	3	2
<input checked="" type="checkbox"/> Garnett, Kevin	21	6	6	3
<input checked="" type="checkbox"/> Pierce, Paul	16	4	2	3
<input type="checkbox"/> Perkins, Kendrick	9	3	1	3
<input checked="" type="checkbox"/> House, Eddie	5	6	3	1
<input type="checkbox"/> Allen, Tony	4	4	0	0
<input type="checkbox"/> Davis, Glen	1	0	0	2
<input checked="" type="checkbox"/> Posey, James	3	2	0	2
<input type="checkbox"/> Pollard, Scot				
<input type="checkbox"/> Scalabrino, Brian				
<input type="checkbox"/> Powe, Leon				

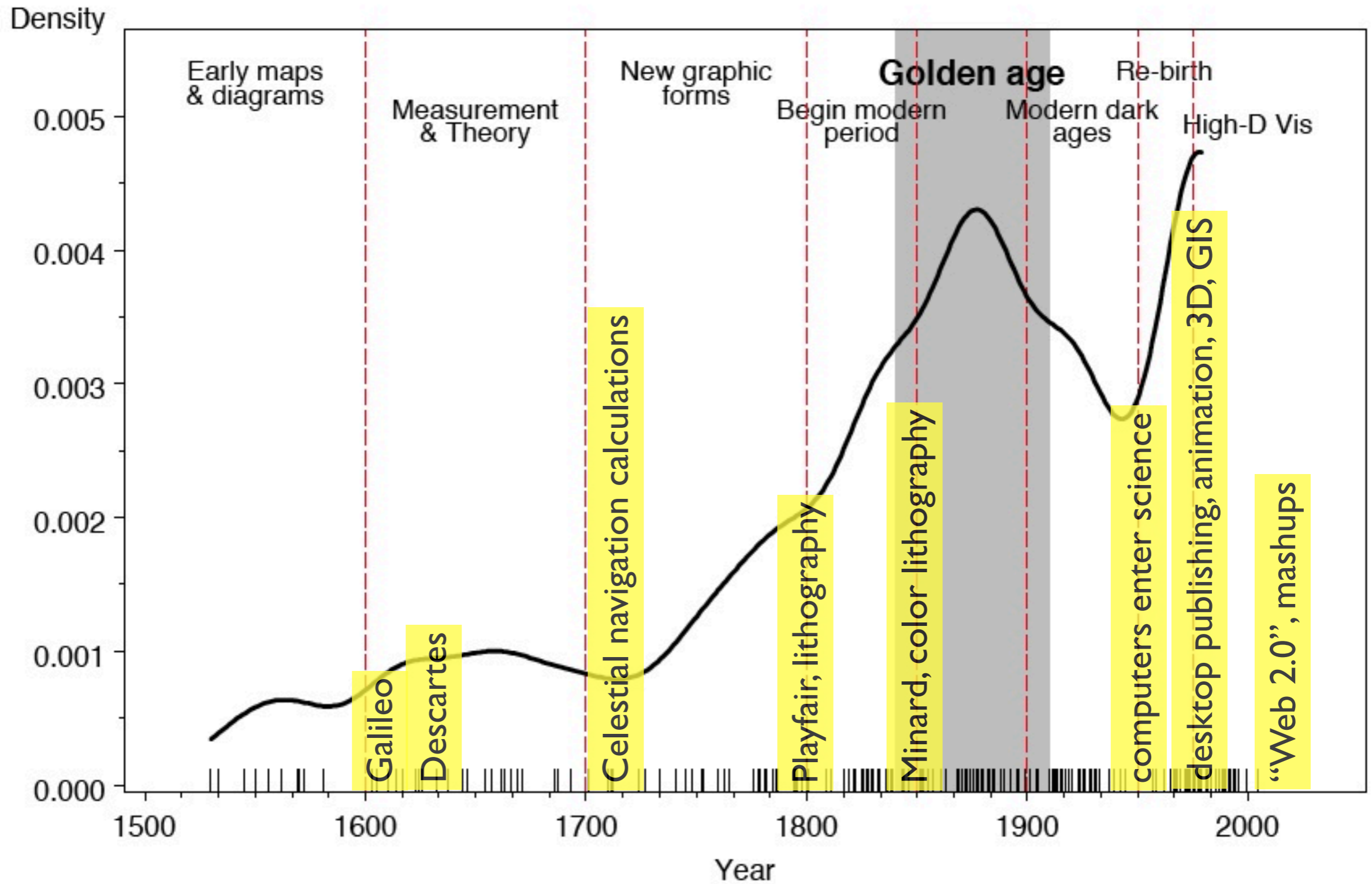
TD Banknorth GARDEN

WIZARDS

CELTICS

WAS show: ● made shots ✓ X missed shots ✓ BOS show: ● made shots ✓ X missed shots ✓

Milestones: Time course of developments



adapted from Friendly, "The Golden Age of Statistical Graphics," *Statistical Science*, in press (2008)

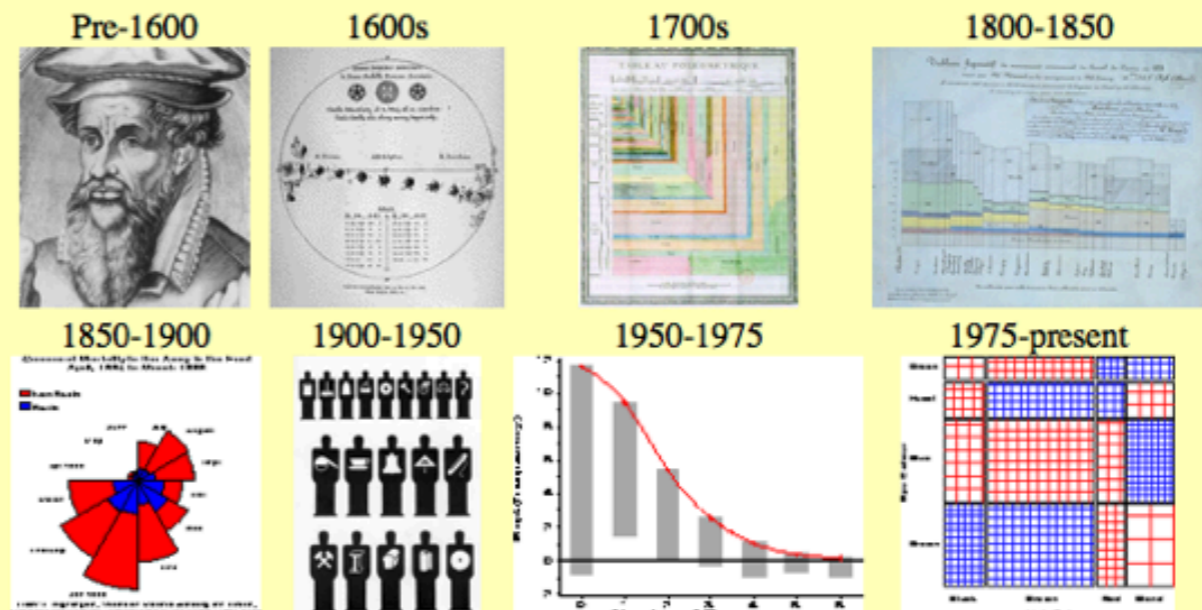
The Milestones Project (Friendly & Denis)

Milestones in the history of thematic cartography, statistical graphics, and data visualization

http://www.math.yorku.ca/SCS/Gallery/milestone/index.html

Milestones in the History of Thematic Cartography, Statistical Graphics, and Data Visualization

An illustrated chronology of innovations by Michael Friendly and Daniel J. Denis



Up: [Gallery](#) [Introduction](#) [Related](#) [References](#) [Term Index](#) [Category XRef](#)

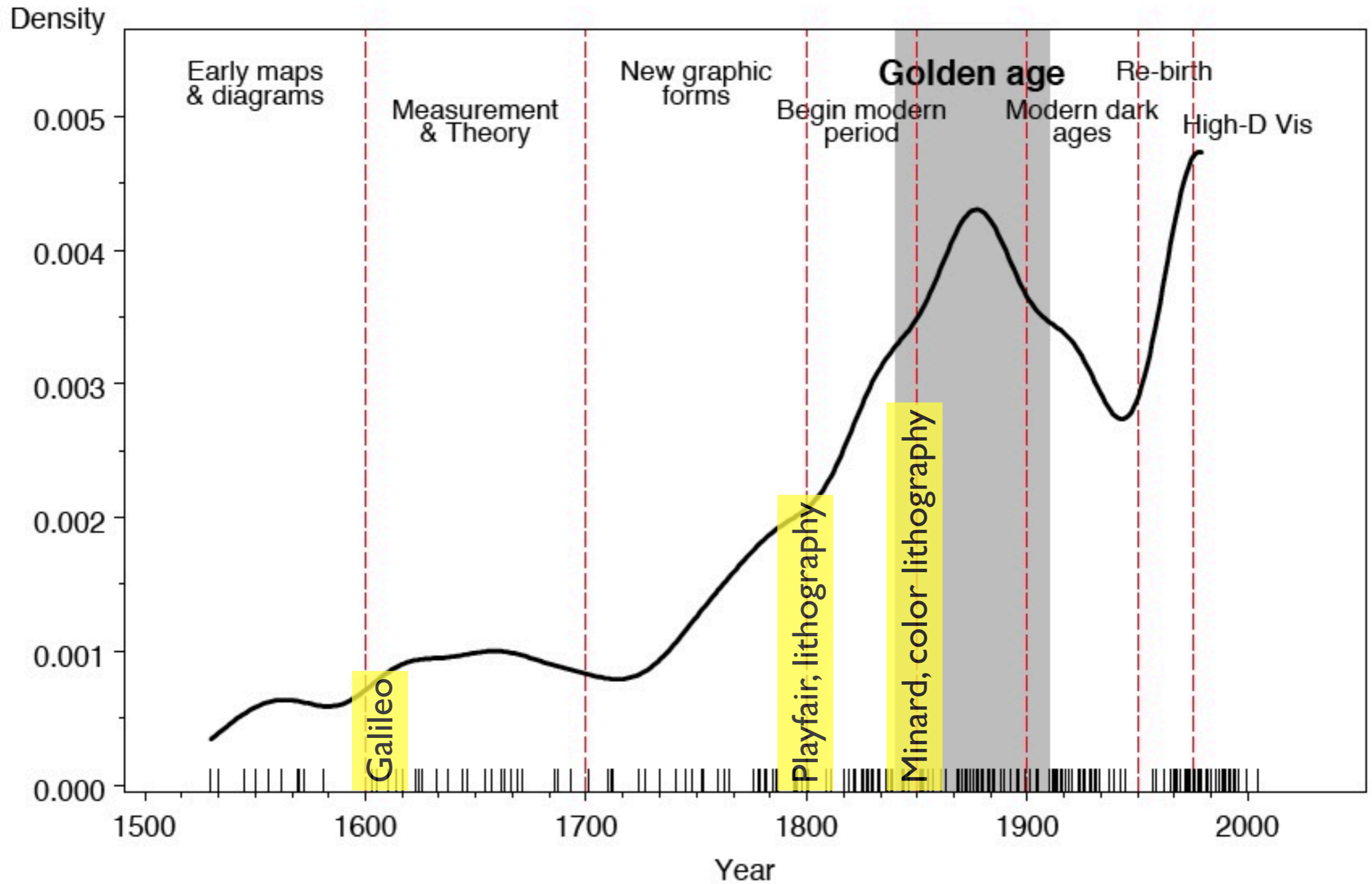
[Pre-1600](#) [1600s](#) [1700s](#) [1800+](#) [1850+](#) [1900+](#) [1950+](#) [1975+](#)

Related information:

- **Citations:** References to information or images obtained from this web site should be cited as follows: Friendly, M. & Denis, D. J. (2001). *Milestones in the history of thematic cartography, statistical graphics, and data visualization*. Web document, <http://www.math.yorku.ca/SCS/Gallery/milestone/>. Accessed: Thu, 16 Oct 2008 15:28:13 GMT
- **PDF version:** [This document in PDF form](#), with active links.
- **Other publications:**
 - [Chapter on the Milestone Project](#) in C. Weihs and W. Gaul (eds.), *Classification-- The Ubiquitous Challenge, Handbook of Computational Statistics: Data Visualization*, Springer, 2005.
 - [A Brief History of Data Visualization](#) in C. Chen, W. Hardle and A. Unwin (eds.), *Handbook of Computational Statistics: Data Visualization*, Vol III, Springer, 2007.
- **Visual brochures** designed by Mario Kanno
 - [Milestones in the History of Data Visualization](#)
 - [Marcos na História da Visualização de Dados](#) (Brazilian Portuguese)
- **Images** from the JSM 2002 Technical Poster Session [Thanks to Andy Mauromoustakos!]:
 - [Image1](#) (864 x 648; 123K);
 - [Image2](#) (864 x 648; 124K).

This web version is dedicated to [Arthur H. Robinson](#) (1915-2004), who inspired and encouraged our interest; to Antoine de Falguerolles, who initiated it, and to *les Chevaliers des Album de Statistique Graphique*, who supported it with interest, enthusiasm, and resources. In particular, Gilles Palsky, Antoine de Falguerolles, Antony Unwin and Ruddy Ostermann contributed important images and background information. This work is supported by the National Sciences and Engineering Research Council of Canada, Grant OGP0138748.

Milestones: Time course of developments



adapted from Friendly, "The Golden Age of Statistical Graphics," *Statistical Science*, in press (2008)

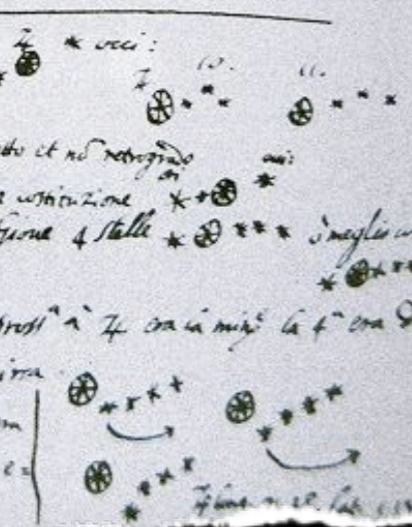
Galileo Galilei (1564-1642)

Sec^{mo} Principe.

Galileo Galilei, Humilis^s Servus della Ser.^{ma} V.^a inuigilanti
 do assiduam, et de ogni spirito se essere no solo satisfatto
 alvario che non della stessa di Matematico nelle sue
 Dio di Padova,

Inuere diuere determinate di presentare al Sec^{mo} Principe
 l'occhio et di essere di giuramento inestimabile di ogni
 negozio et in irea marittima o terreste stimo di tenere per
 che nuovo artificio ne l'ingegno segeto et solo a disposizione
 di l'occhio di l'occhio conato dalle piu uolte speculazioni di
 propri, bottna na l'vantaggio di scoprire Legni et Vele dell' inimico
 di Val hore et piu di tempo prima di egli se sopra noi et distinguendo
 il numero et la qualita dei Vasselli giudicare le sue forze
 ballastarsi alla caccia al combattimento o alla fuga, o pure essi
 nella campagna aperta vedere et particolarmente distinguere ogni suo
 moto et propriamente.

Adi 7. di gennaio
 Giove si uide usti
Adi 8. usti
 4 stelle ora d'ing diretto et no retrogrado
Adi 12. si uide in tale uisione
 Il 13 si uide usti in Giove 4 stelle
Adi 14. di agosto
 Il 15 stelle in pressi a 4 ora in migi la 4^a ora di =
 stante dalla 3^a di doppio la ora
 Lo spazio delle 3 stelle non om
 maggiore del diametro di 7 et c =
 ora in linea retta.



7	* * ○ *	17	* ○
8	○ * * *	18	* ○
10	* * ○	19	* ○ * *
11	* * ○	19	* ○ * *
12	* ○ *	20	○ ○ ○ ○ ○
13	* ○ * *	21	... ○ *
15	○ * * * *	22	* ○ .. *
15	○ * * *	22	○ .. *
16	○ * *	23	* ○ *
17	* ○ *	24	* ○ *
		24	* ○ *

SIDERIUS NUNCIUS

On the third, at the seventh hour, the stars were arranged in this
 quence. The eastern one was 1 minute, 30 seconds from Jupiter
 the closest western one 2 minutes; and the other western one wa

East * ○ * * West

10 minutes removed from this one. They were absolutely on the
 same straight line and of equal magnitude.

On the fourth, at the second hour, there were four stars around
 Jupiter, two to the east and two to the west, and arranged precise

East * * ○ * * West

on a straight line, as in the adjoining figure. The easternmost wa
 distant 3 minutes from the next one, while this one was 40 second
 from Jupiter; Jupiter was 4 minutes from the nearest western one
 and this one 6 minutes from the westernmost one. Their magnitude,
 ere nearly equal; the one closest to Jupiter appeared a little smaller
 than the rest. But at the seventh hour the eastern stars were only
 10 seconds apart. Jupiter was 2 minutes from the nearer eastern

East ** ○ * * West

one, while he was 4 minutes from the next western one, and this
 one was 3 minutes from the westernmost one. They were all equal
 and extended on the same straight line along the ecliptic.

On the fifth, the sky was cloudy.

On the sixth, only two stars appeared flanking Jupiter, as is seen

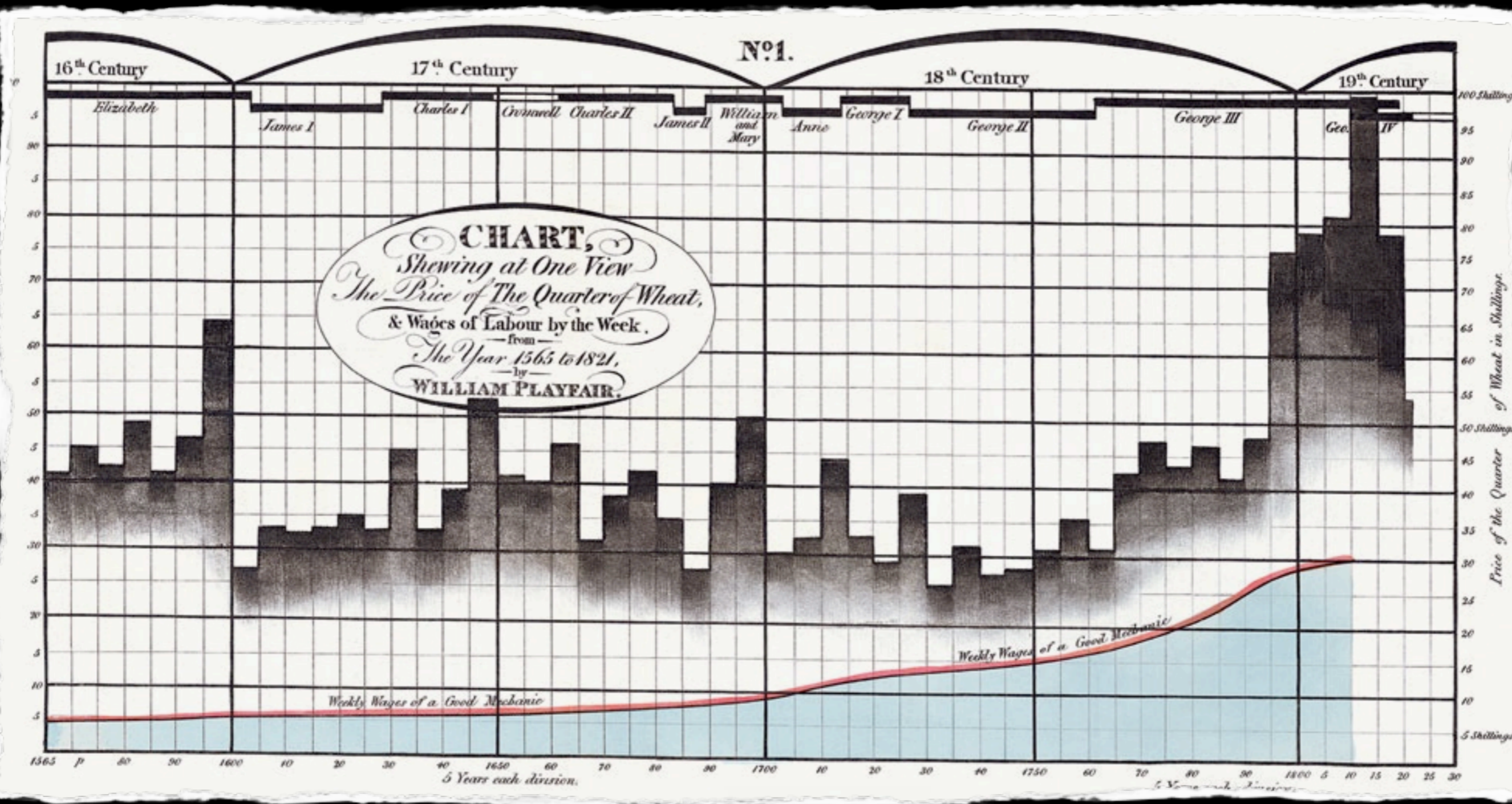
East * ○ * West

in the adjoining figure. The eastern one was 2 minutes and the
 western one 3 minutes from Jupiter. They were on the same straight
 line with Jupiter and equal in magnitude.

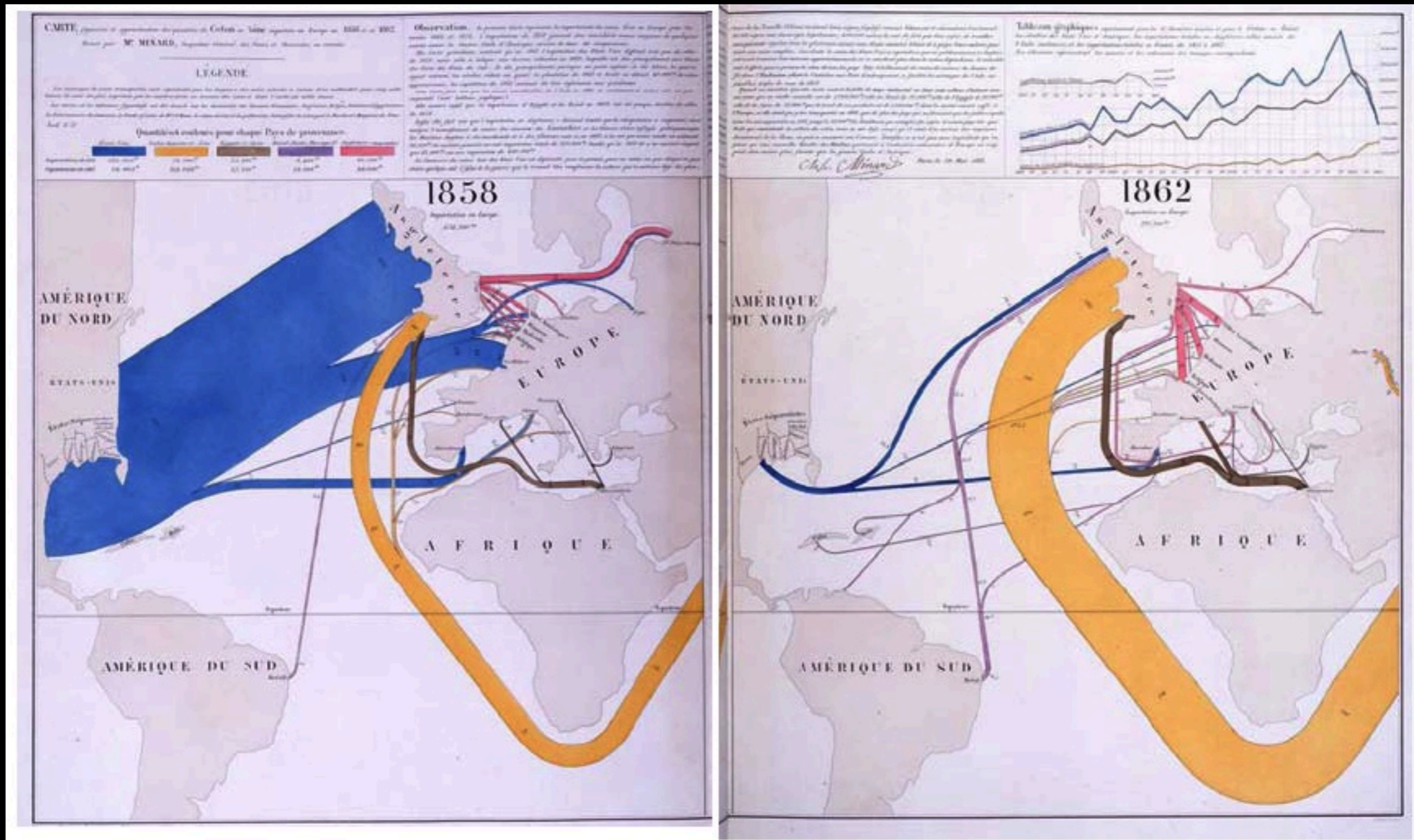
On the seventh, two stars stood near Jupiter, both to the east

Notes for & re-productions of Siderius Nuncijs

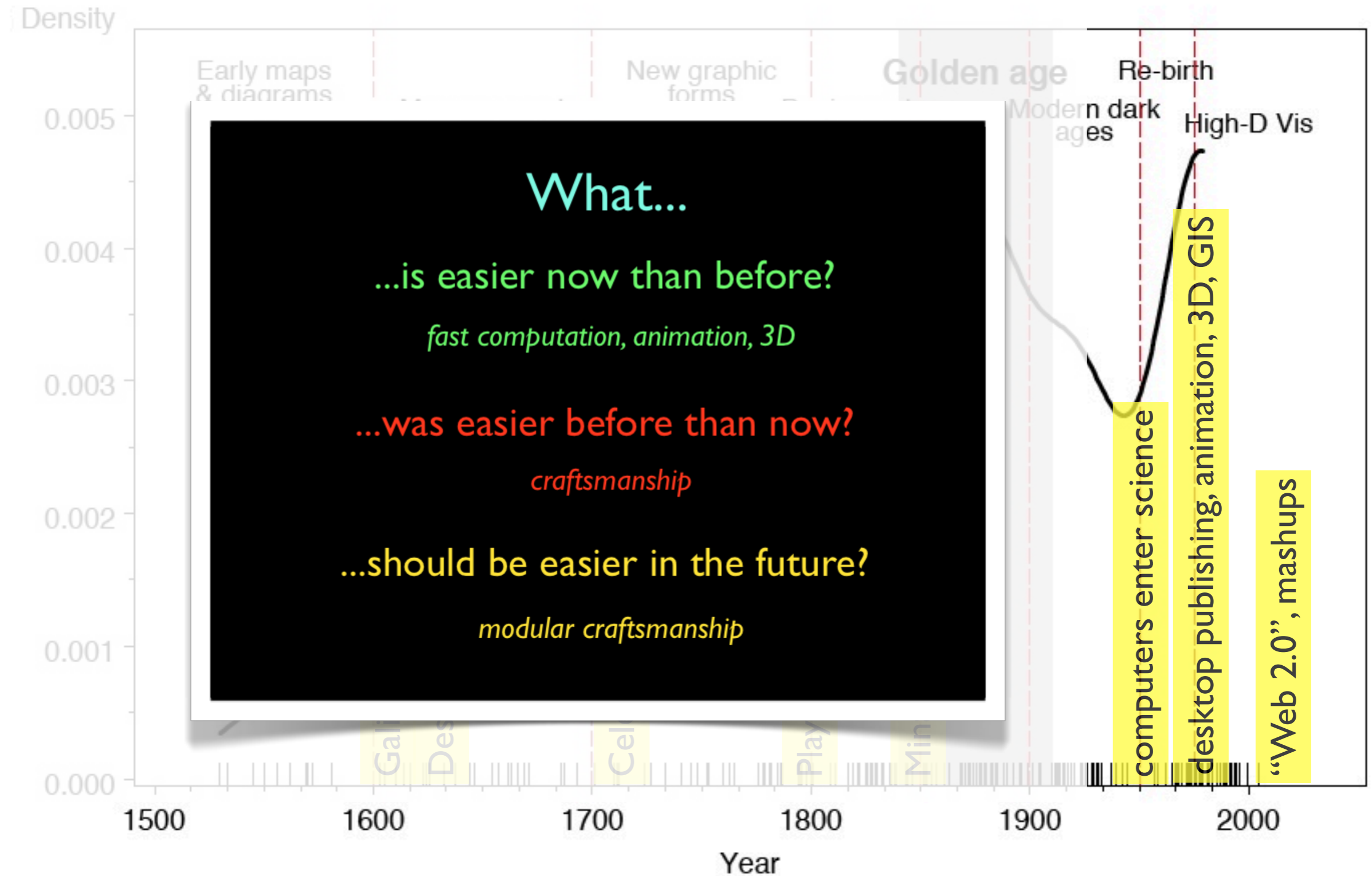
William Playfair (1759-1823)



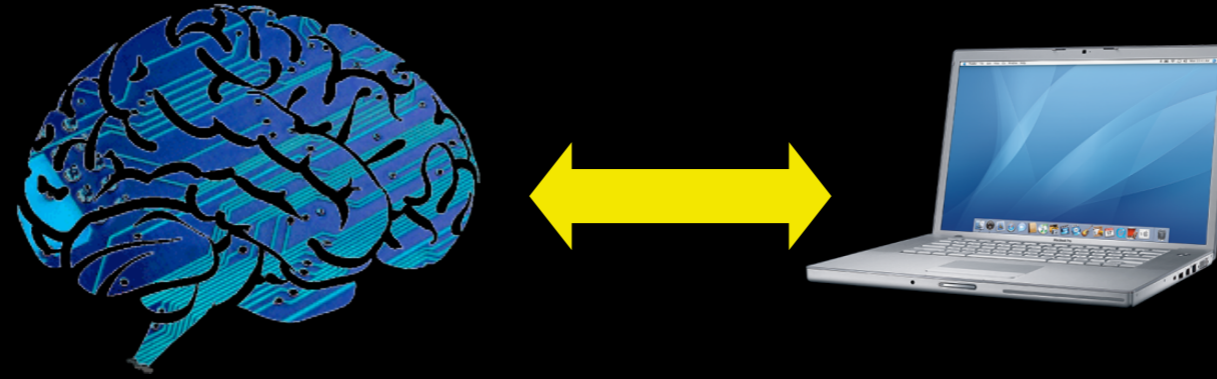
Charles Joseph Minard, in color (1781-1870)



Milestones: Time course of developments



adapted from Friendly, "The Golden Age of Statistical Graphics," *Statistical Science*, in press (2008)



Data Reduction

Data Display

Context (e.g. journals + online data)

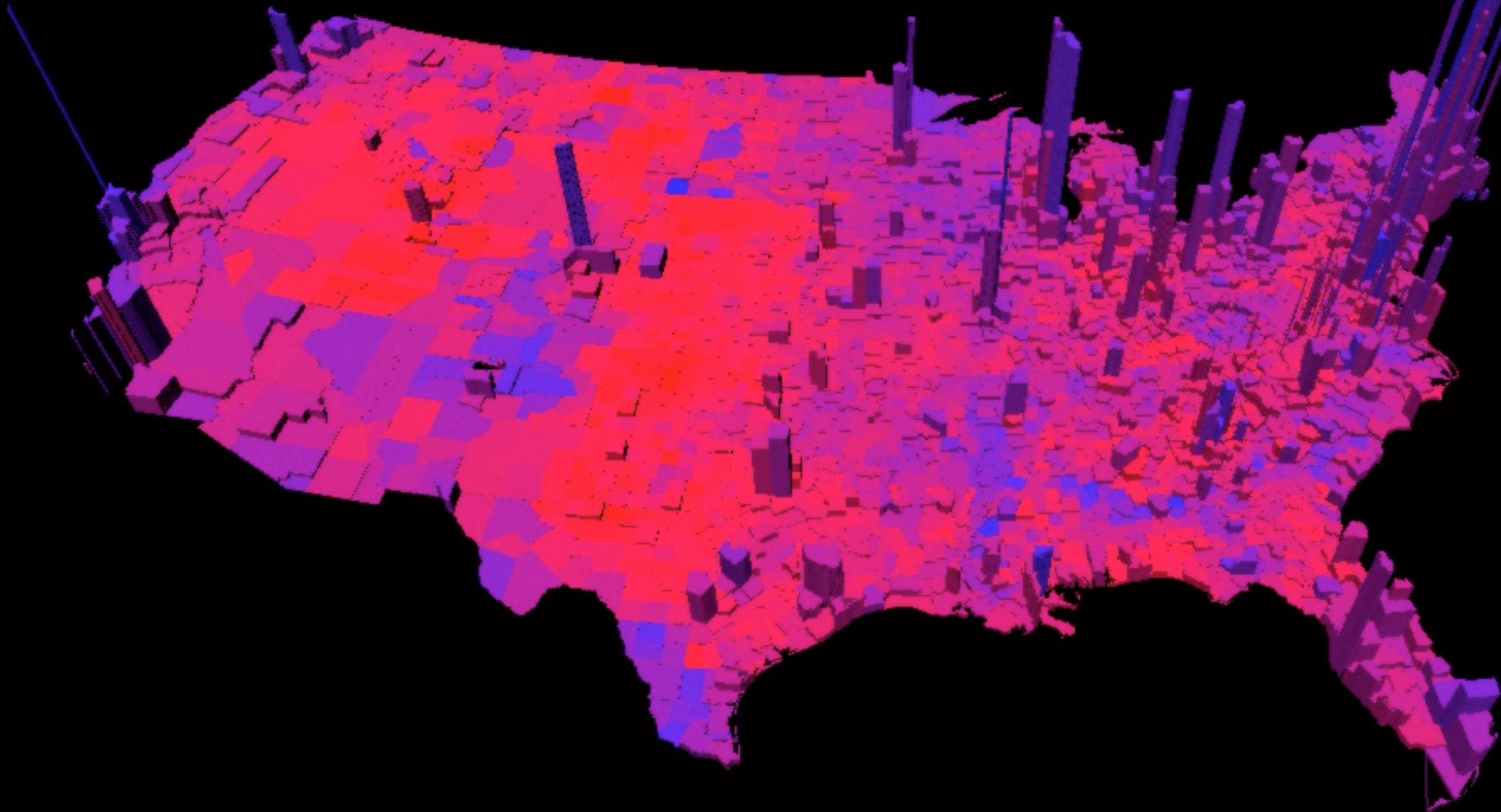
Simulation Design

Statistics Design

Data Exploration (Visualization)

Data • Dimensions • Display

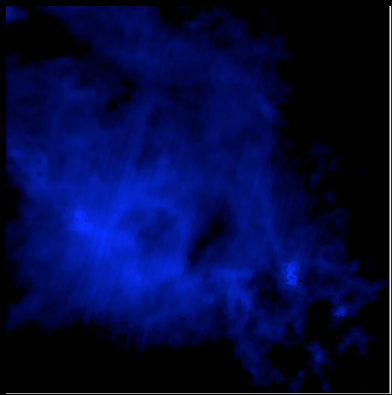
“High-dimensional” or “Multivariate” Data and High(er) Dimensional Displays



*This map **displays** 2 quantities as a function of 2 spatial dimensions.
...Is that 4 dimensions?*

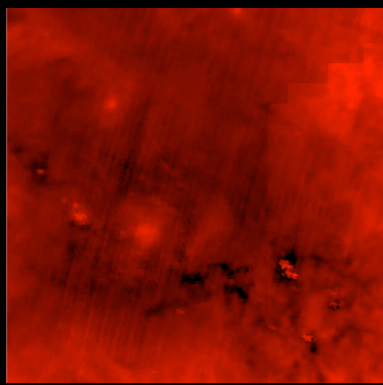
Note: Computers make this Easy

Column
Density

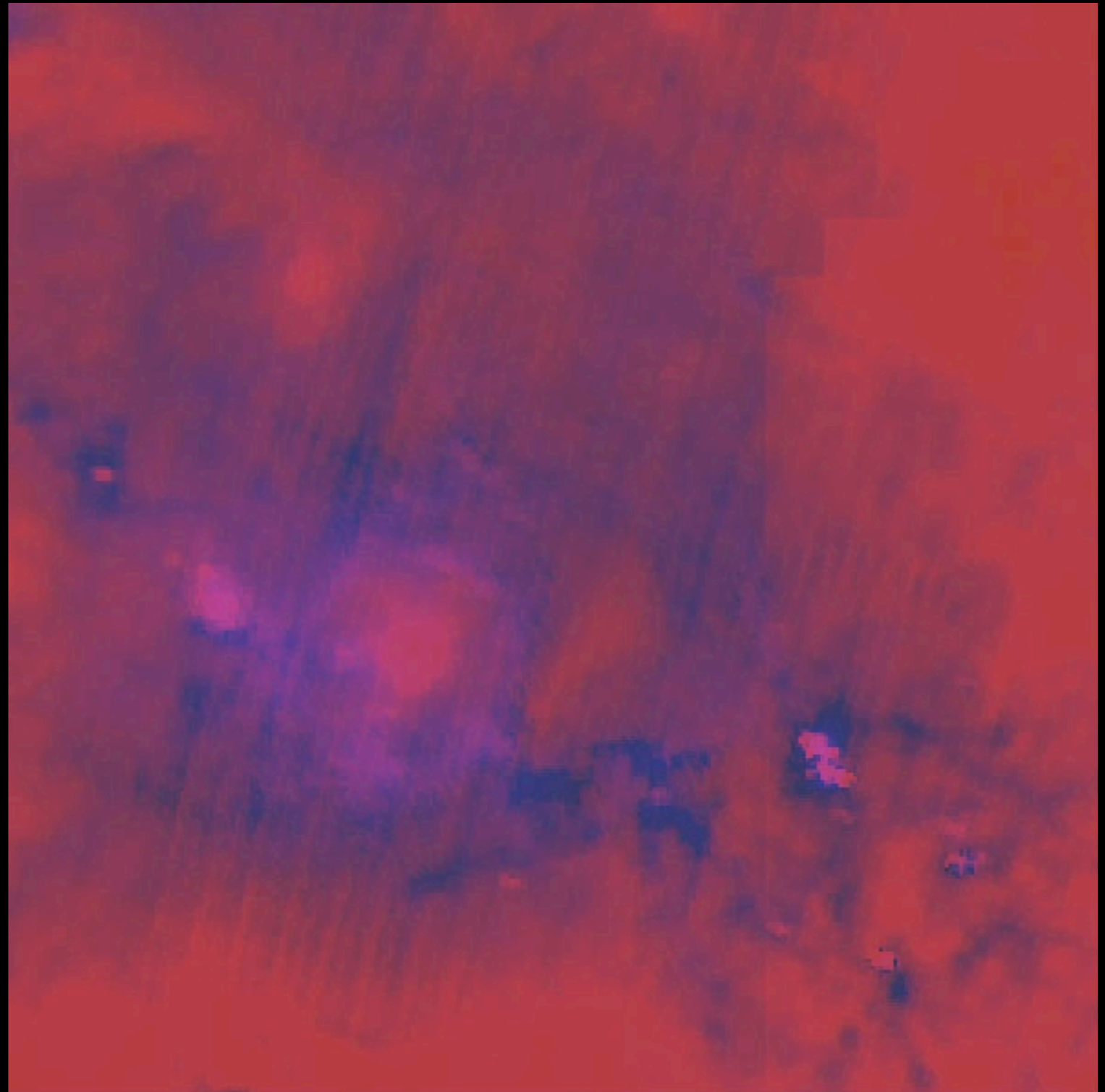


+

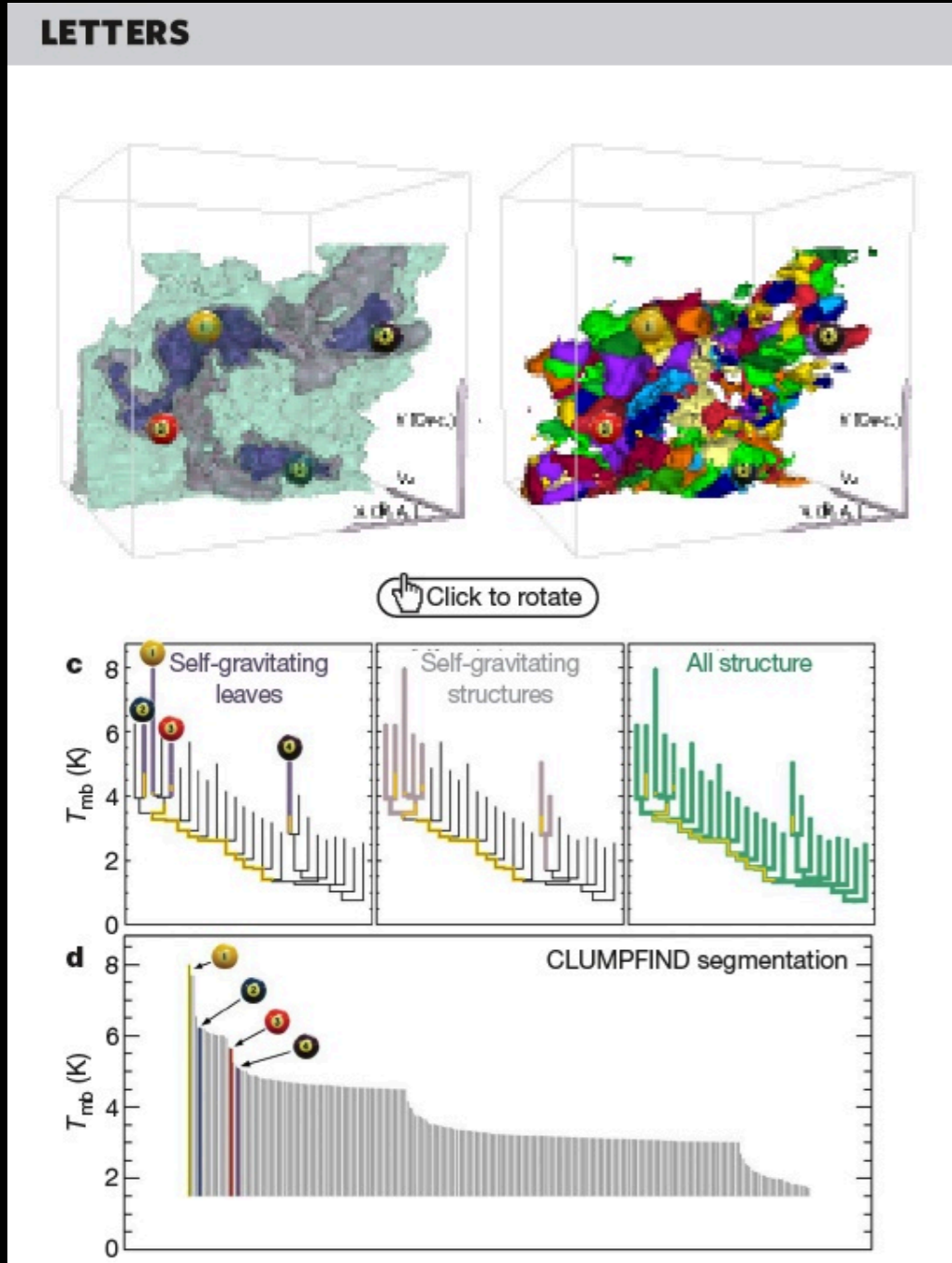
Temperature



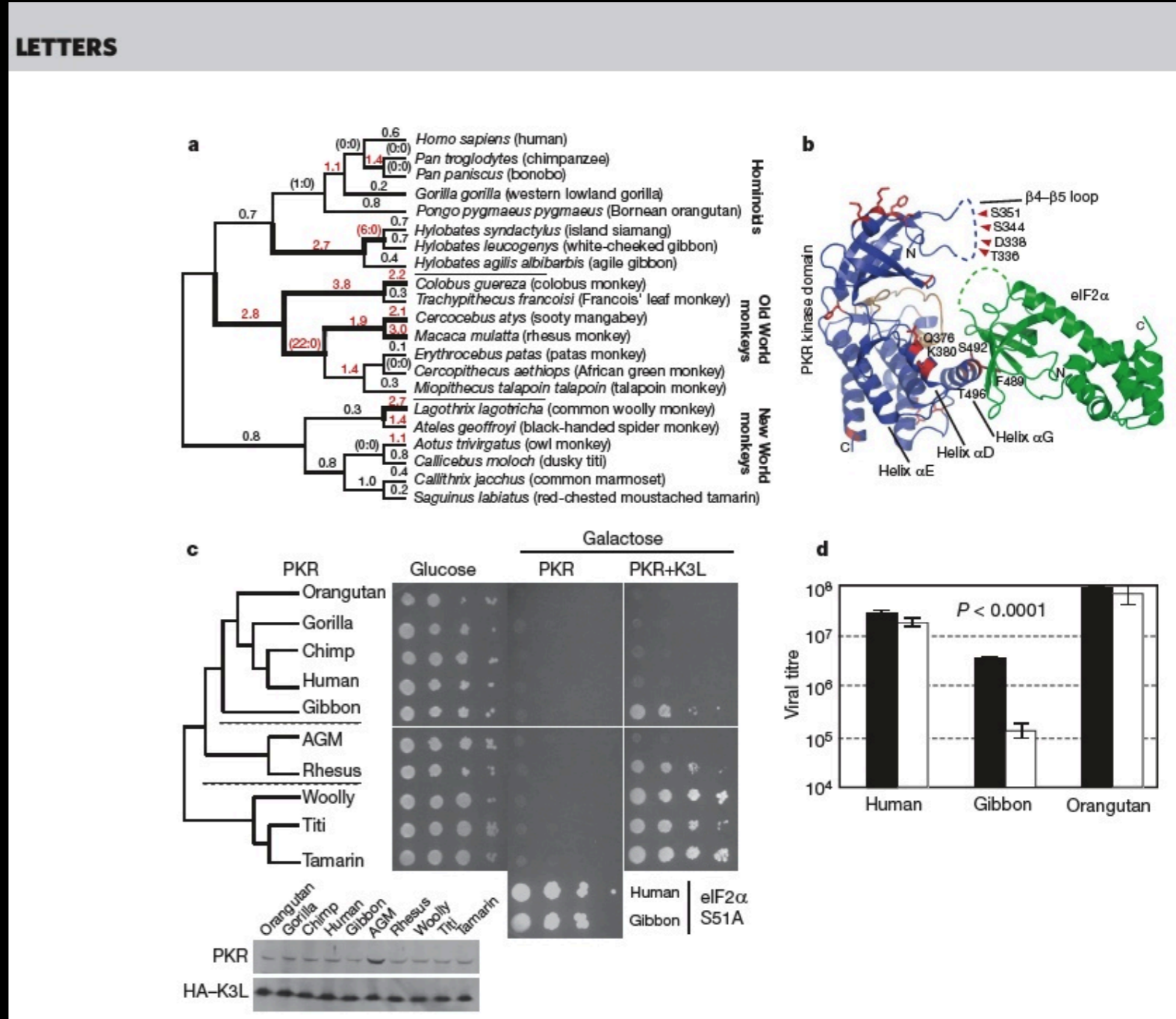
=



“High-dimensional” or “Multivariate” Data (Astronomy=Biology)



Goodman et al. *Nature*, 2009



Elde et al. *Nature*, 2008

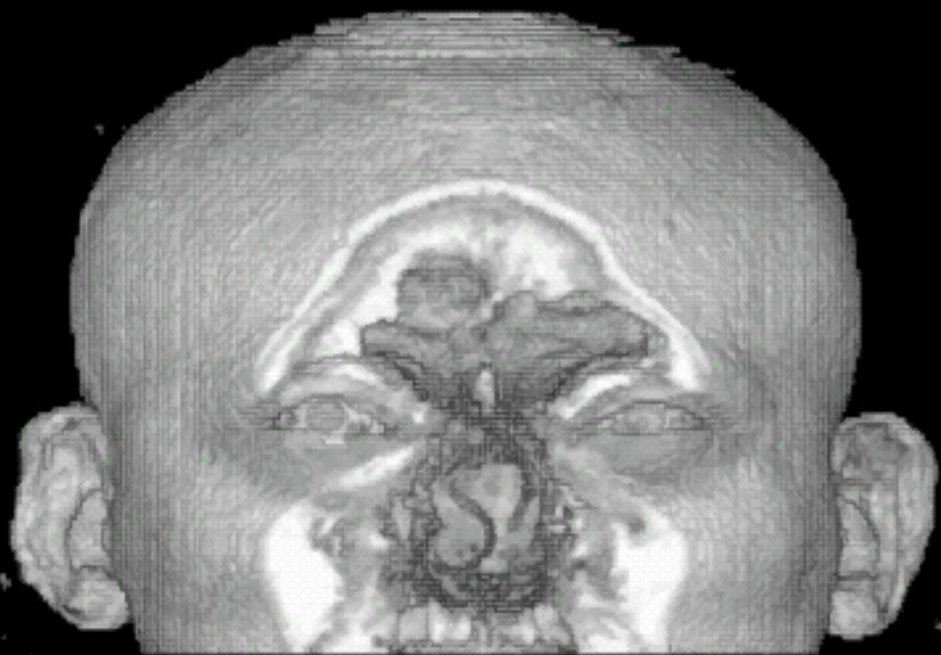
What about Animation?



How many dimensions at once?

Can/should time (animation) substitute for dimensions?

"KEITH"



"PERSEUS"



"z" is depth into head

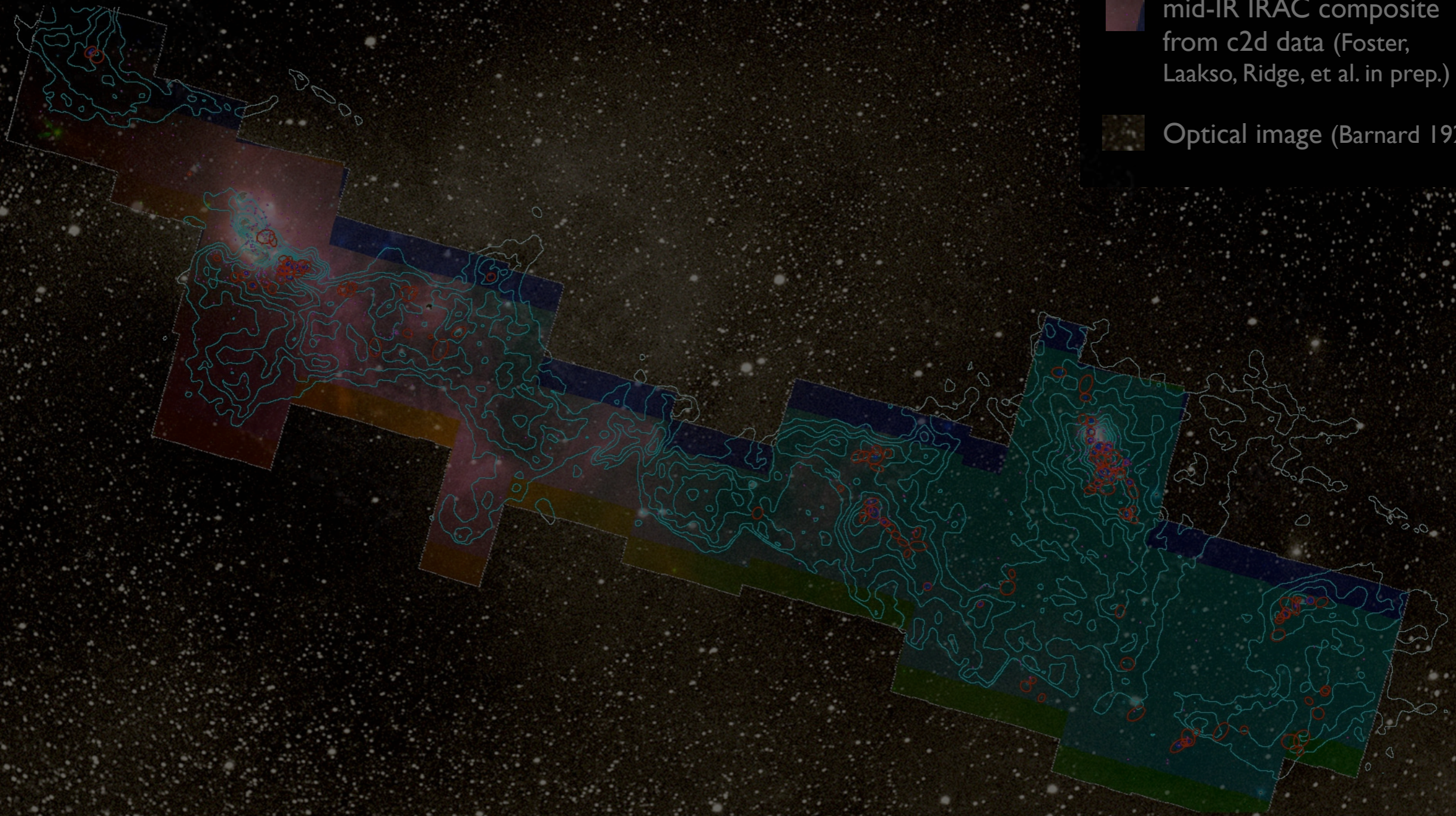
"z" is line-of-sight velocity

(This kind of "series of 2D slices view" is known in the Viz as "the grand tour")

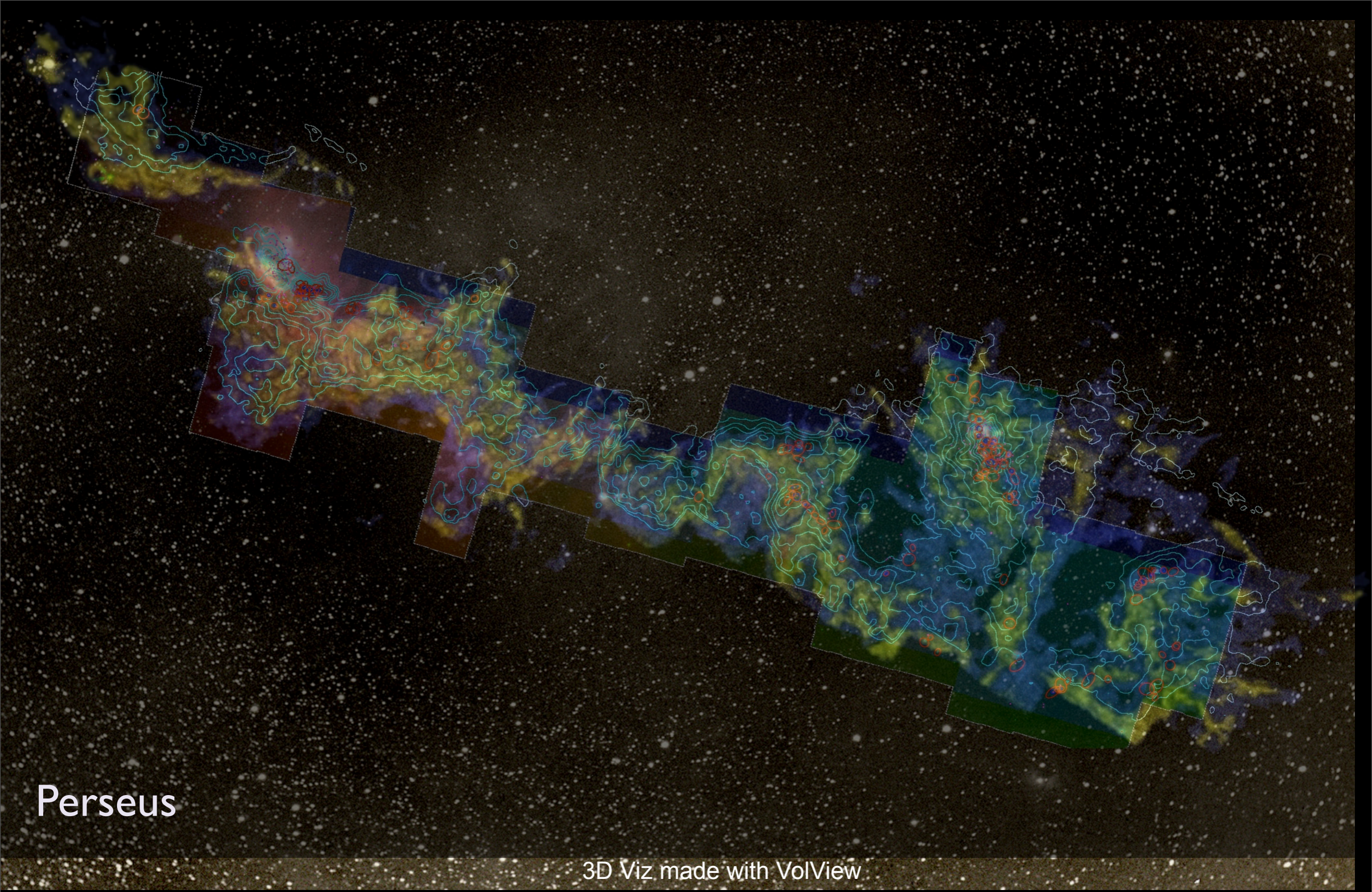
COMPLETE Perseus

Image size: 1305 x 733
VL: 63 WW: 127

-  mm peak (Enoch et al. 2006)
-  sub-mm peak (Hatchell et al. 2005, Kirk et al. 2006)
-  ^{13}CO (Ridge et al. 2006)
-  mid-IR IRAC composite from c2d data (Foster, Laakso, Ridge, et al. in prep.)
-  Optical image (Barnard 1927)



m: 17249
Zoom: 227% Angle: 0



Perseus

3D Viz made with VolView

AstronomicalMedicine@iig

COMPLETE

What...

...is easier now than before?

fast computation, animation, 3D

...was easier before than now?

craftsmanship

...should be easier in the future?

modular craftsmanship

The “Easier” Future: Modular Craftsmanship

The Future we can see from “now”...

“live” interaction with data (DataDesk, WWT)
(scripts *only when useful*)

more display modes available (3D PDF, touch tables/walls, stereo+)

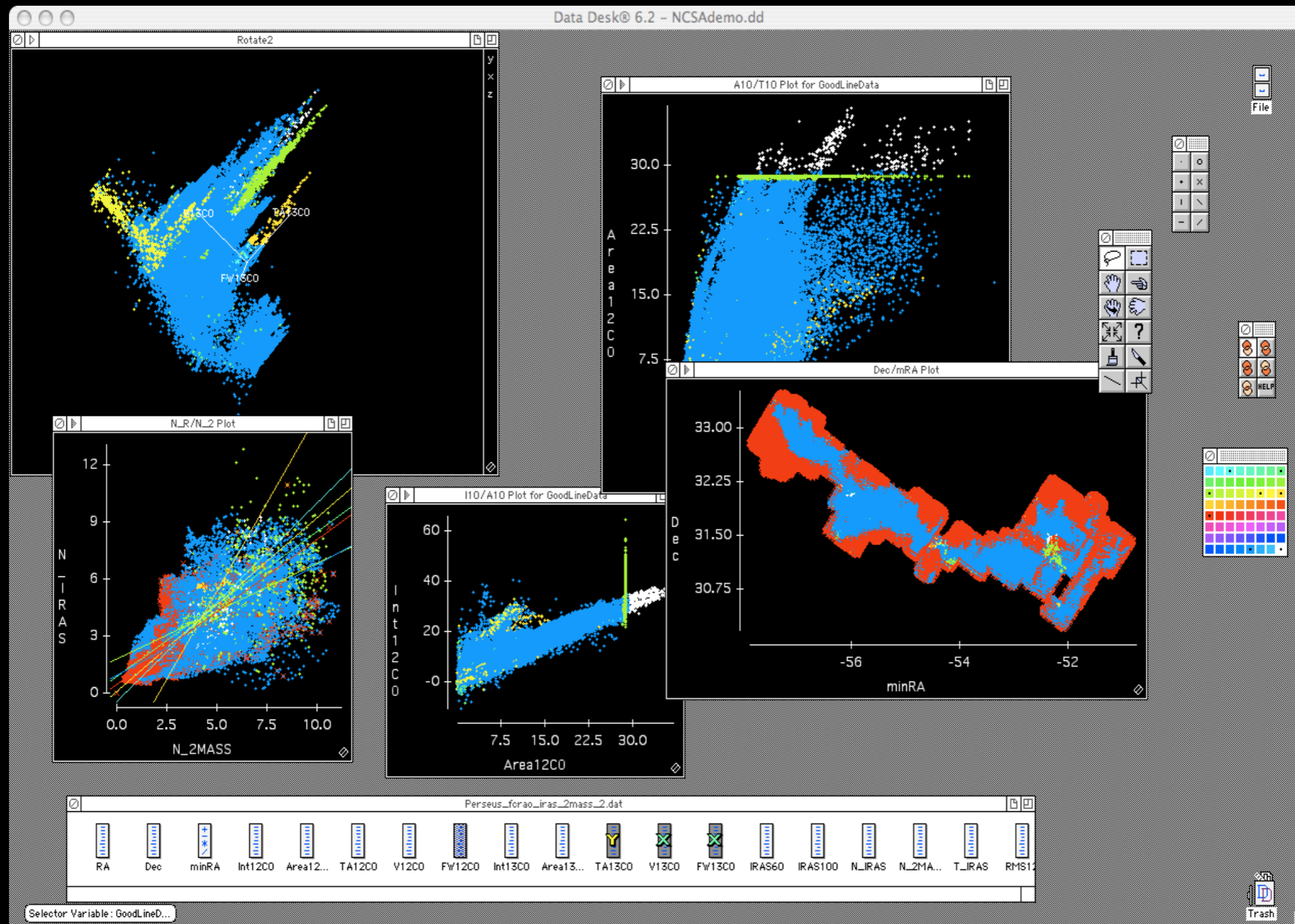
re-usable tools/mashups (Many Eyes, UFOmaps.com)

Unsolved Questions...

(feasibility of) templates/language (e.g. Grammar of Graphics)

improved graphical representation of uncertainty

“Data Desk”



If only **DataDesk** were >2D...??

Mirage (Bell Labs)

Tasks

Task	Status	Message
SDSSDR2-I-SIAP-RA_9.89...	Completed	Done.
SDSSDR2-JPG-SIAP-RA_9...	Completed	Done.
SDSSDR2-R-SIAP-RA_9.8...	Completed	Done.
SDSSDR2-U-SIAP-RA_9.8...	Completed	Done.
SDSSDR2-Z-SIAP-RA_9.8...	Completed	Done.
Loading SDSS-DR2-RA_9...	Completed	Loaded 1 datasets.

Console Options Help

/tmp/SDSS-DR2-RA_9.895-Dec_0.86-Radius_0.25_Resource0_Tab

File Image Scale Color Data/Axes

fpC-003325-r6-0174.fit.gz x0.25

(9.88868, 1.01311) (1686, 479) 1115.0

File Image Scale Color Data/Axes

aspx?ra=9.895&dec=0.86&height=512&width=512&scale=3.5 x1.0

(282, 223) (3, 7, 6)

z

	U	G	
587731187282019071	24.18713	24.20689	23.07292
588015510347318143	25.97617	23.60485	22.97292
587731187281953508	21.4283	20.91666	21.97292
587731187282018784	23.57881	22.82347	22.97292
587731187282018888	23.81209	22.60126	21.97292
587731187281953860	19.15922	17.97867	29.97292
587731187282084911	23.8728	25.90358	23.97292
587731187281887870	25.03652	22.63719	21.97292
588015510347513898	25.59181	23.56613	21.97292
587731187281888417	24.52932	25.09906	29.97292
587731187818823841	21.79988	20.83762	20.97292
587731187818824258	24.73024	22.97165	22.97292

cf. Avizo (Mercury Systems); some aspects of GenePattern; Taverna...

3D PDF

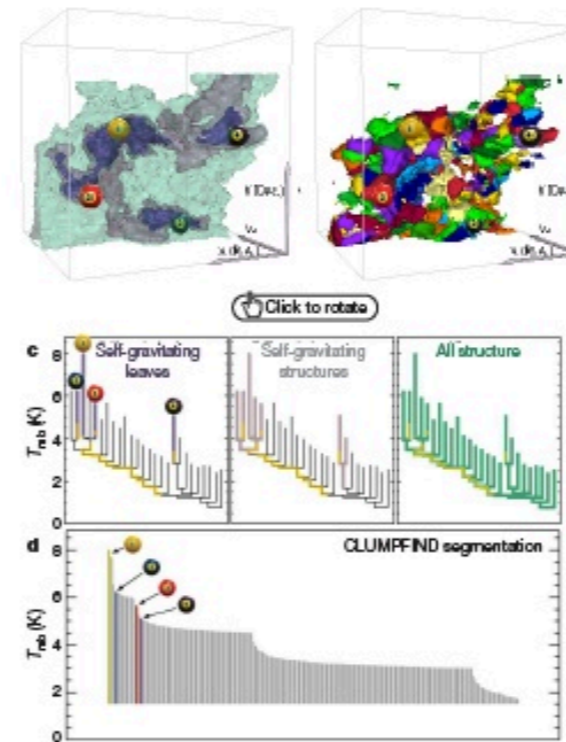


Figure 2 | Comparison of the 'dendrogram' and 'CLUMPFIND' feature-identification algorithms as applied to ¹³CO emission from the L1448 region of Perseus. **a**, 3D visualization of the surfaces indicated by colours in the dendrogram shown in **c**. Purple illustrates the smallest scale self-gravitating structures in the region corresponding to the leaves of the dendrogram; pink shows the smallest surfaces that contain distinct self-gravitating leaves within them; and green corresponds to the surface in the data cube containing all the significant emission. Dendrogram branches corresponding to self-gravitating objects have been highlighted in yellow over the range of T_{mb} (main-beam temperature) test-level values for which the virial parameter is less than 2. The x - y locations of the four 'self-gravitating' leaves labelled with billiard balls are the same as those shown in Fig. 1. The 3D visualizations show position-position-velocity (p - p - v) space. RA, right ascension; dec., declination. For comparison with the ability of dendrograms (**c**) to track hierarchical structure, **d** shows a pseudo-dendrogram of the CLUMPFIND segmentation (**b**), with the same four labels used in Fig. 1 and in **a**. As 'clumps' are not allowed to belong to larger structures, each pseudo-branch in **d** is simply a series of lines connecting the maximum emission value in each clump to the threshold value. A very large number of clumps appears in **b** because of the sensitivity of CLUMPFIND to noise and small-scale structure in the data. In the online PDF version, the 3D cubes (**a** and **b**) can be rotated to any orientation, and surfaces can be turned on and off (interaction requires Adobe Acrobat version 7.0.8 or higher). In the printed version, the front face of each 3D cube (the 'home' view in Fig. 1, and velocity with respect to the Local Standard of Rest increases from front (-0.5 km s^{-1}) to back (8 km s^{-1})).

data, CLUMPFIND typically finds features on a limited range of scales, above but close to the physical resolution of the data, and its results can be overly dependent on input parameters. By tuning CLUMPFIND's two free parameters, the same molecular-line data set⁶ can be used to show either that the frequency distribution of clump mass is the same as the initial mass function of stars or that it follows the much shallower mass function associated with large-scale molecular clouds (Supplementary Fig. 1).

Four years ago, we published a paper in *Nature* titled 'Self-gravitating structures' where we proposed a new method for identifying self-gravitating structures in 3D data cubes.

using 2D maps of column density. With this early 2D work as inspiration, we have developed a structure-identification algorithm that abstracts the hierarchical structure of a 3D (p - p - v) data cube into an easily visualized representation called a 'dendrogram'¹⁰. Although well developed in other data-intensive fields^{11,12}, it is curious that the application of tree methodologies so far in astrophysics has been rare, and almost exclusively within the area of galaxy evolution, where 'merger trees' are being used with increasing frequency¹³.

Figure 3 and its legend explain the construction of dendrograms schematically. The dendrogram quantifies how and where local maxima of emission merge with each other, and its implementation is explained in Supplementary Methods. Critically, the dendrogram is determined almost entirely by the data itself, and it has negligible sensitivity to algorithm parameters. To make graphical presentation possible on paper and 2D screens, we 'flatten' the dendrograms of 3D data (see Fig. 3 and its legend), by sorting their 'branches' to not cross, which eliminates dimensional information on the x axis while preserving all information about connectivity and hierarchy. Numbered 'billiard ball' labels in the figures let the reader match features between a 2D map (Fig. 1), an interactive 3D map (Fig. 2a online) and a sorted dendrogram (Fig. 2c).

A dendrogram of a spectral-line data cube allows for the estimation of key physical properties associated with volumes bounded by isosurfaces, such as radius (R), velocity dispersion (σ_v) and luminosity (L). The volumes can have any shape, and in other work¹⁴ we focus on the significance of the especially elongated features seen in L1448 (Fig. 2a). The luminosity is an approximate proxy for mass, such that $M_{\text{gas}} = X_{13\text{CO}} L_{13\text{CO}}$, where $X_{13\text{CO}} = 8.0 \times 10^{20} \text{ cm}^2 \text{ K}^{-1} \text{ km}^{-1} \text{ s}$ (ref. 15; see Supplementary Methods and Supplementary Fig. 2). The derived values for size, mass and velocity dispersion can then be used to estimate the role of self-gravity at each point in the hierarchy, via calculation of an 'observed' virial parameter, $\alpha_{\text{obs}} = 5\sigma_v^2 R / GM_{\text{gas}}$. In principle, extended portions of the tree (Fig. 2, yellow highlighting) where $\alpha_{\text{obs}} < 2$ (where gravitational energy is comparable to or larger than kinetic energy) correspond to regions of p - p - v space where self-gravity is significant. As α_{obs} only represents the ratio of kinetic energy to gravitational energy at one point in time, and does not explicitly capture external over-pressure and/or magnetic fields⁶, its measured value should only be used as a guide to the longevity (boundedness) of any particular feature.

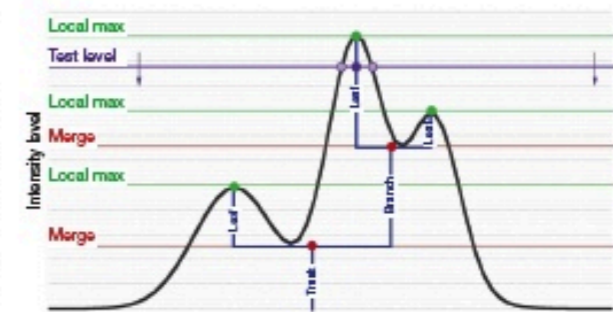


Figure 3 | Schematic illustration of the dendrogram process. Shown is the construction of a dendrogram from a hypothetical one-dimensional emission profile (black). The dendrogram (blue) can be constructed by 'dropping' a test constant emission level (purple) from above in tiny steps (exaggerated in size here, light lines) until all the local maxima and mergers are found, and connected as shown. The intersection of a test level with the emission is a set of points (for example the light purple dots) in one dimension, a planar curve in two dimensions, and an isosurface in three dimensions. The dendrogram of 3D data shown in Fig. 2c is the direct analogue of the tree shown here, only constructed from 'isosurface' rather than 'point' intersections. It has been sorted and flattened to a 2D representation in order to be usefully representing dendrograms for 3D data cubes would

embargoed until 1/1/09

Off the desktop

IIC Member login



Initiative in Innovative Computing at Harvard

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scientists' discovery room lab (sdr lab)

Lead investigators
Chia Shen (IIC), Hanspeter Pfister (SEAS/IIC) and Robert Lue (FAS/Molecular and Cellular Biology)

Project staff
Michael Horn, Hao Jiang and Meekal Bajaj

Description

The Scientists' Discovery Room (SDR) is a next-generation visual digital laboratory for science discovery, collaborative learning and education. Our research focuses on experimenting with new modalities of human-computer interaction and visualization, to create a new genre of navigation, exploration and detailed analyses in multi-dimensional information spaces. All projects in SDR are in close collaboration with domain scientists and educators.



CThru, currently a collaborative endeavor with Molecular and Cellular Biology faculty, aims to develop a self-guided educational environment. In CThru, we examine methods for constructing interactive video-based educational modules. Using the animation "The Inner Life of the Cell" as a testbed, CThru addresses research issues of embedding interactive visible objects, extensive multimedia information and manipulatable 3D models within a video flow for self-explanatory learning, replacing sequential video viewing with the experience of exploring and manipulating in a multi-dimensional information space.

INVOLV is a generalizable multi-user interactive visualization framework for large hierarchical data sets. In this project, we address the visual layout of both the primary data representation and the overlay of alternate structures of the same data. Our first case study is the visualization of life on earth based on the Encyclopedia of Life (www.eol.org). We address the challenge of allowing free-form exploration of more than 1.2 million named species while communicating issues of biodiversity and phylogeny. The current visualization, designed for biodiversity science education settings, combines a Voronoi Treemap tessellation (see photo) with innovative human-computer interaction designs to support collaborative exploration and learning.

Slideshow: Tabletop Computers *Continued* By Meredith Ringel Morris

First Published December 2008

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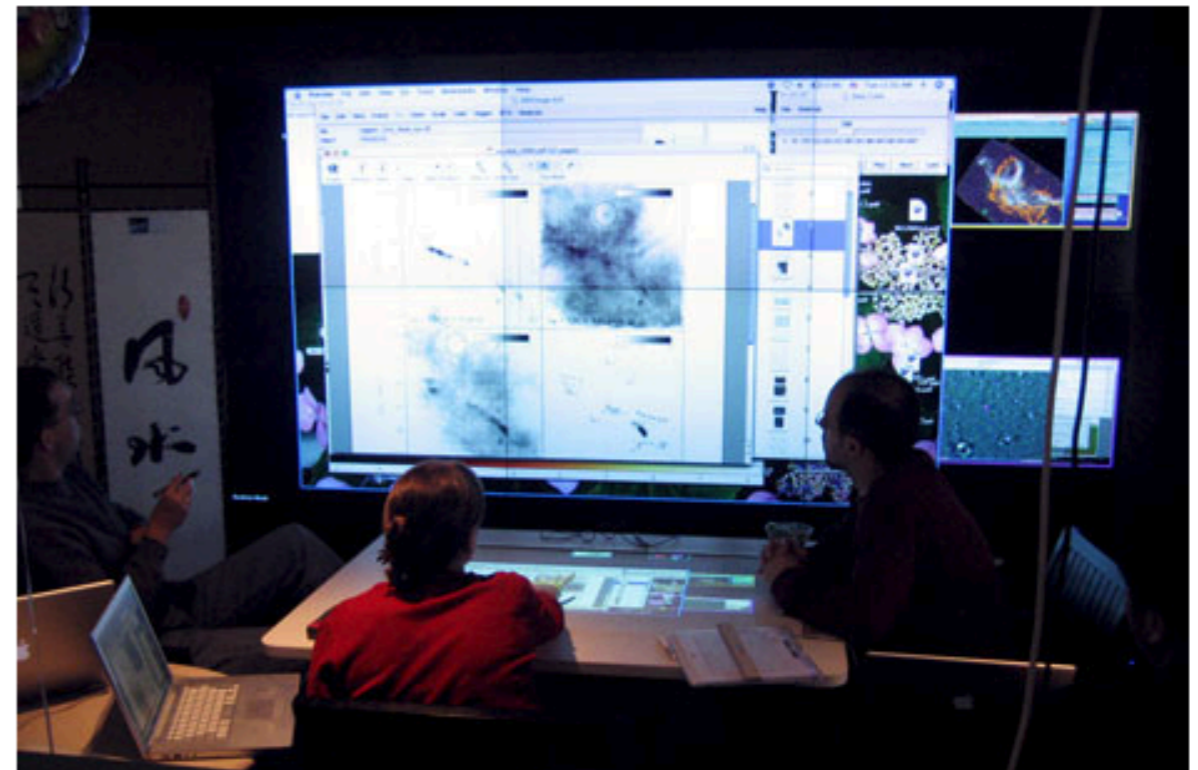


PHOTO: HAO JIANG, DANIEL WIGDOR, CLIFTON FORLINES, AND CHIA SHEN

UBITABLE: Users can interact with surface computers through auxiliary devices, such as laptops, phones, and PDAs. The display on the auxiliary device can convey private or sensitive content to a single user, while group-appropriate content can appear on the tabletop display. Chia Shen and her colleagues at Mitsubishi Electric Research Laboratories, in Cambridge, Mass., have explored auxiliary interactions with surface computers in their UbiTable project, in which two people with laptops collaborate over a tabletop display. Recently, Shen expanded the UbiTable into an interactive room called the WeSpace. People can share data on their laptops with other people in the room, using both a table and a large display wall. Here, three Harvard University astrophysicists discuss radio and IR spectrum images using the WeSpace.

The Scientists' Discovery Room: Version 0.01



movie courtesy Daniel Wigdor, taken at MERL, Kendall Square, Cambridge



The Baby Name Wizard's NameVoyager

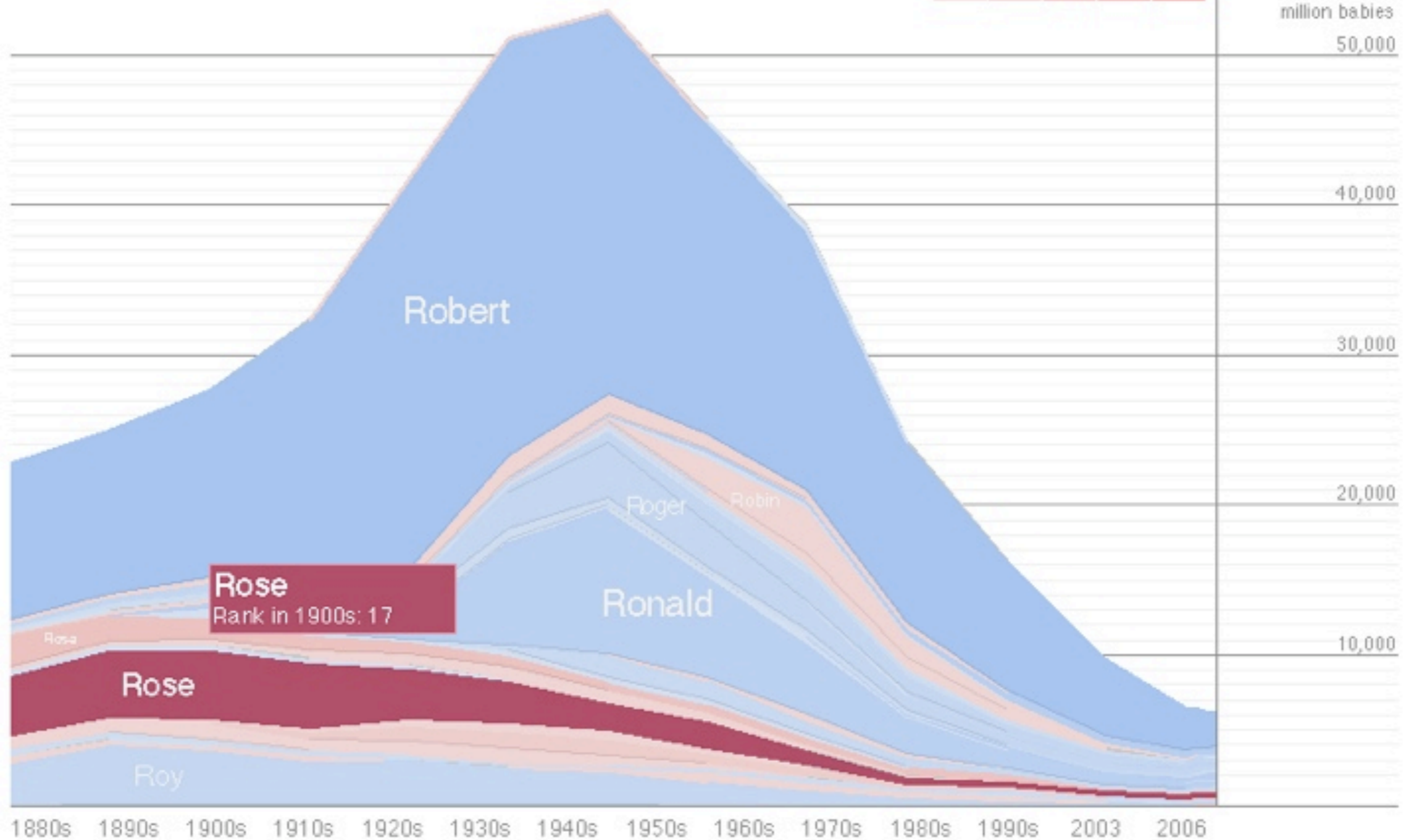
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> RO

boys girls both

2005 rank, boys	1000	500	100	25	1
girls	1000	500	100	25	1

Names starting with "RO", per million babies
50,000



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Data Viz at its Best: Baby Name Wizard's Name Voyager from Martin Wattenberg

Many Eyes: Martin Wattenberg & Fernanda Viegas (IBM)

Many Eyes

http://manyyeyes.alphaworks.ibm.com/manyyeyes/

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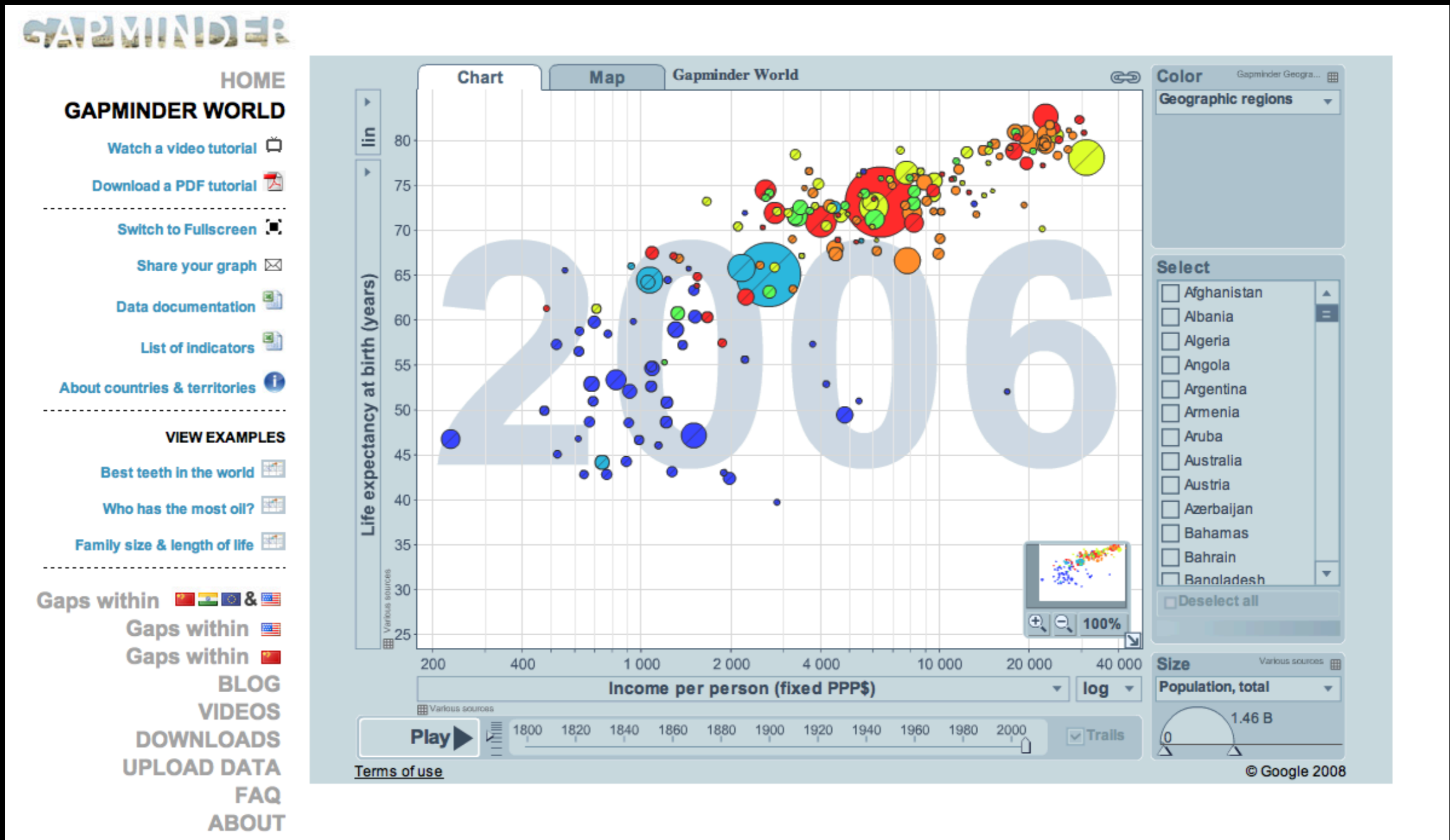
many eyes beta
 for shared visualization and discovery

WORDLE!
 debuts on many eyes

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Gapminder:

Re-usable, interactive graphical tools



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8,629.68

+64.59 (0.75%)
Dec 12 - Close

Open: 8,563.10
High: 8,682.57
Low: 8,347.81
Vol: 270.62M

Mkt Cap: -
52Wk High: 13,990.65
52Wk Low: 7,882.51
Avg Vol: 318.63M

P/E: -
F P/E: -
Beta: -
EPS: -
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Yield: -
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Tip: You can drag the chart.

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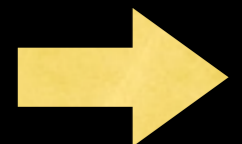
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Mashups, Resource Hubs, APIs



More on re-usability

Exemplar mashup c. 2006

UFO Maps Sighting reports, as they happen. [Comments?](#)

July Year: 2006

Map Satellite Hybrid

Norfolk, MA • Jul 1st 2006 12:00:00 AM

It was a ball of opal or white with a little pink and green sheen to it. Not metal....

[Read full report](#)

Re-usable, standard interaction tools

“Social” (community) tags & data

Portals to deeper information

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Massive online data repository

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Gauges

By Google

Each numeric value is shown as a gauge.

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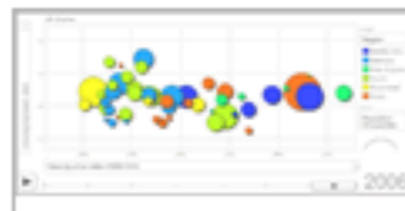


Interactive Time Series Chart

By Google

An interactive time series line chart like the one used in Google Finance. The first column contains dates and the second column contains values.

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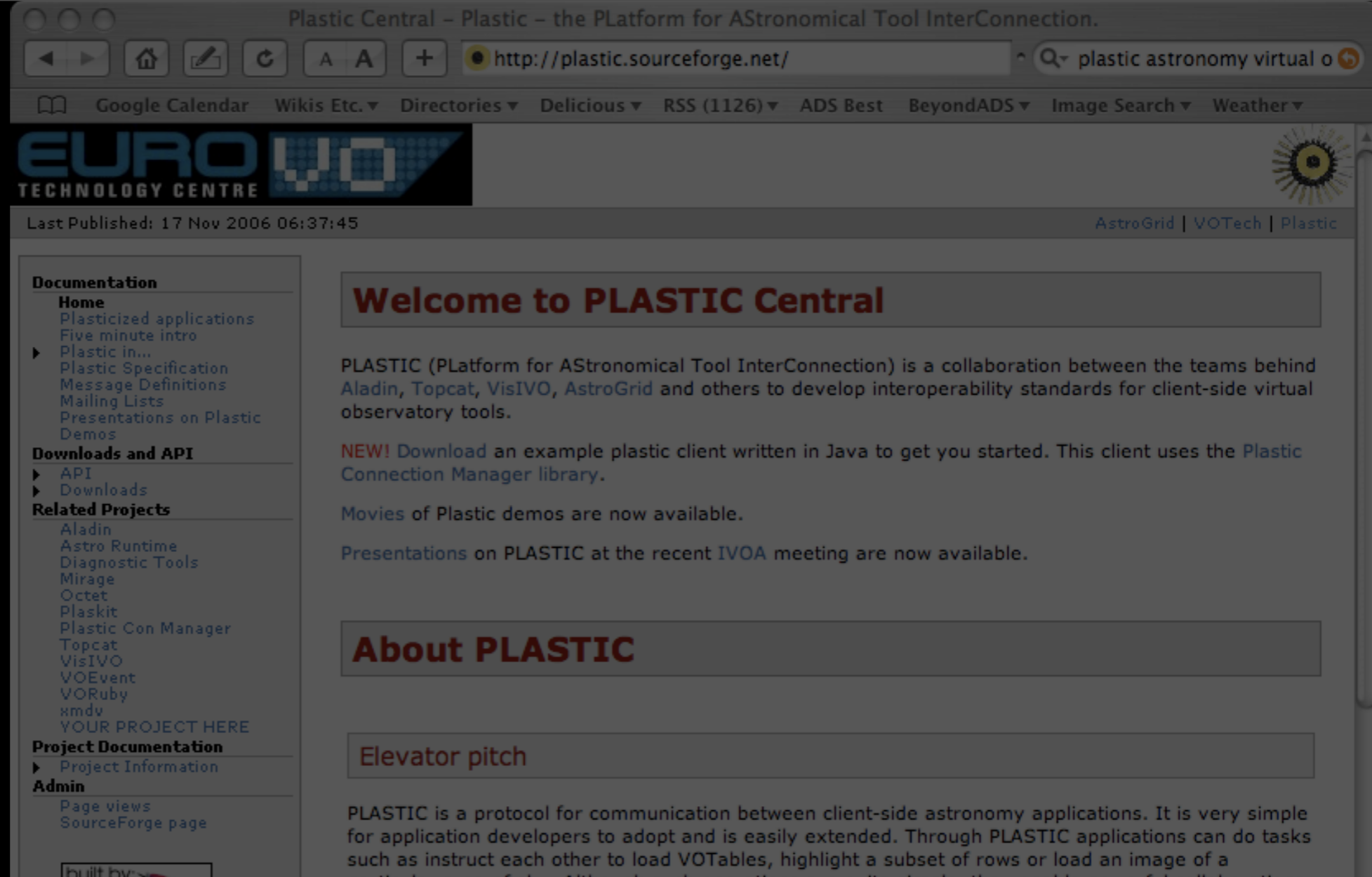
Motion Chart

By Google

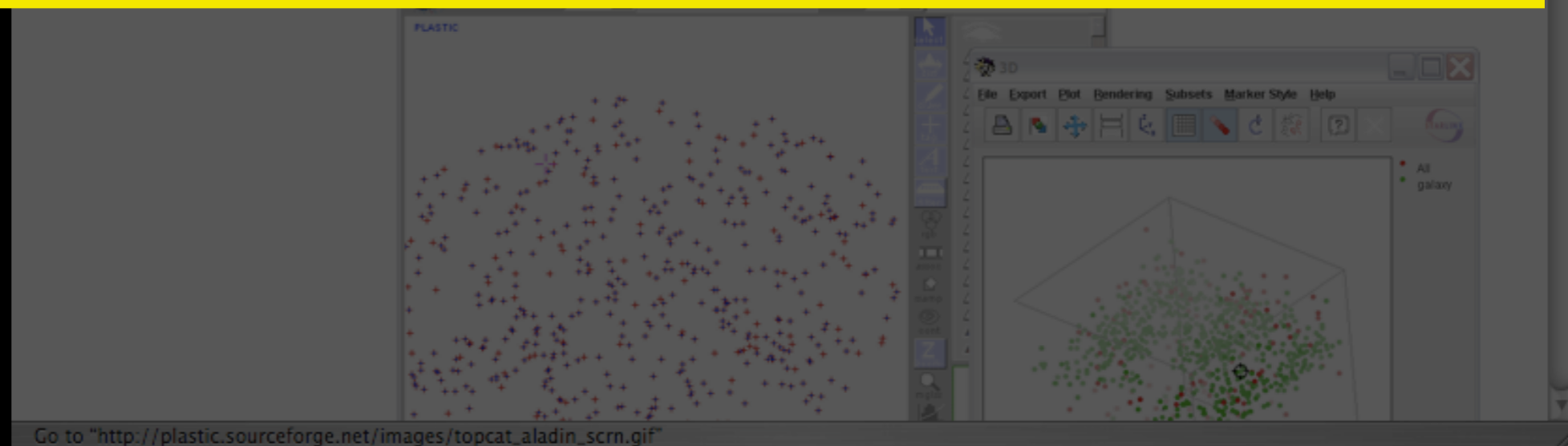
A dynamic flash based chart to explore several indicators over time. Required columns: bubble name, time and 2 columns of numeric values. Optional columns: Numeric values or categories.

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“PLASTIC” (SAMP)



between tools. The philosophy is that the astronomer should have a suite of interoperating tools at his disposal, each of which does **one thing well** and which can be composed according to his particular needs



What...

...is easier now than before?

fast computation, animation, 3D

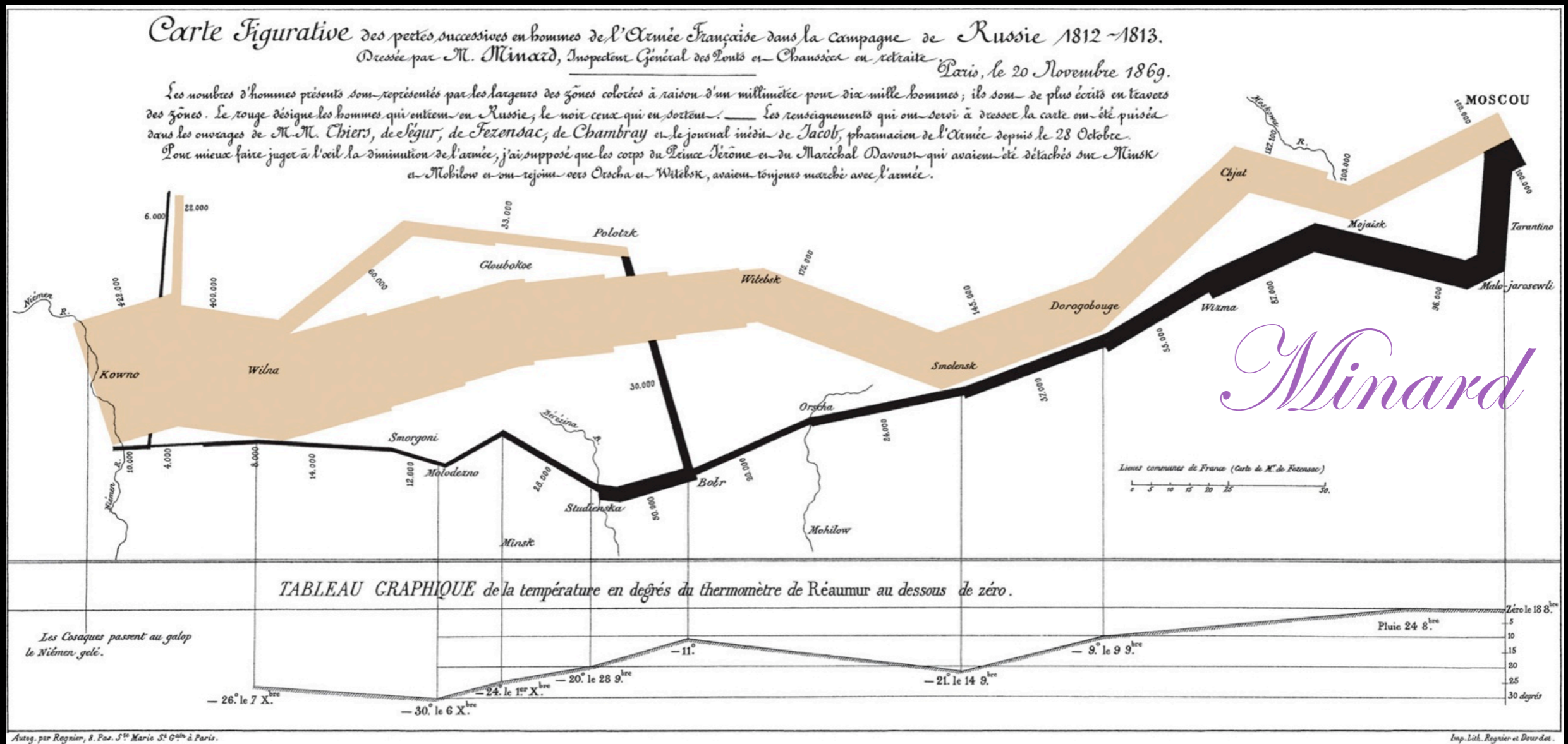
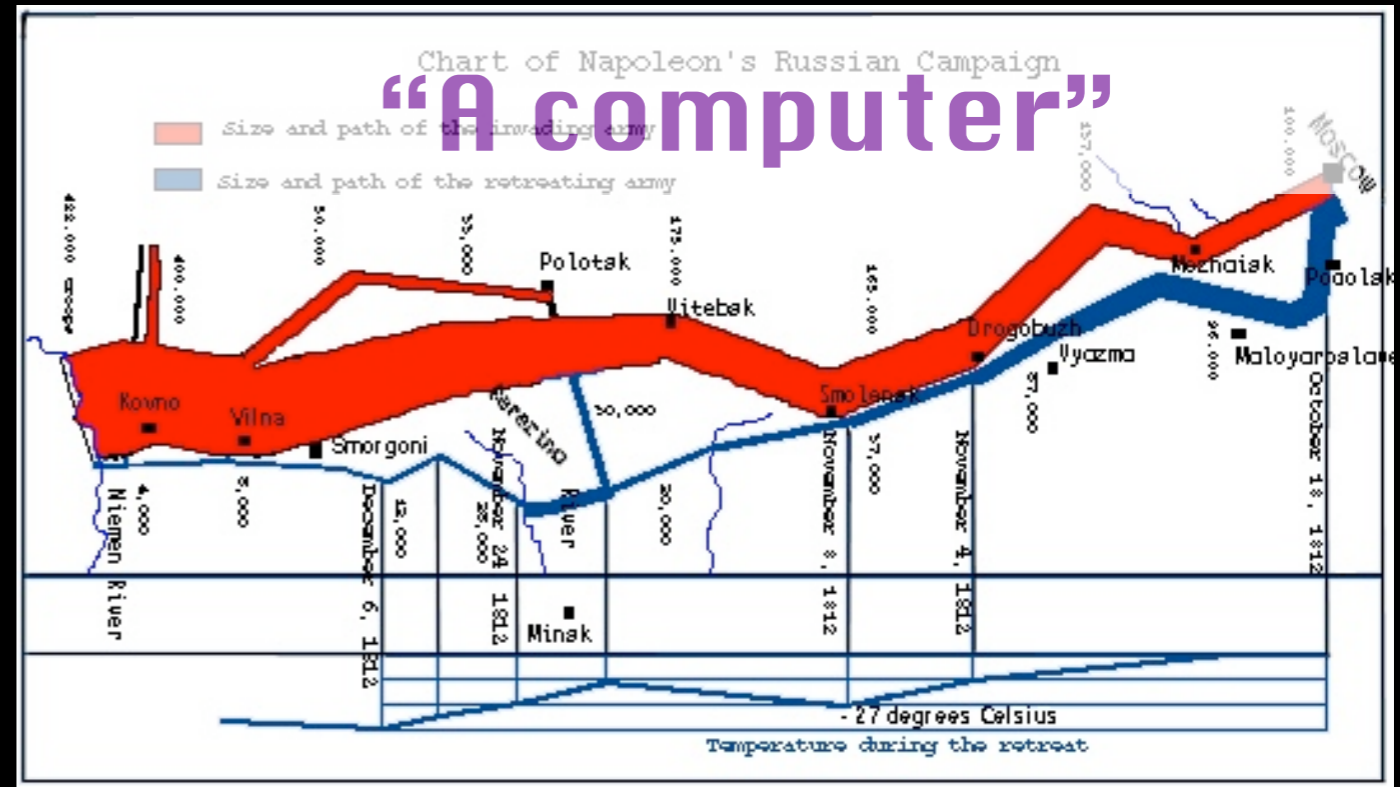
...was easier before than now?

craftsmanship

...should be easier in the future?

modular craftsmanship

Are we held back by confining tools?



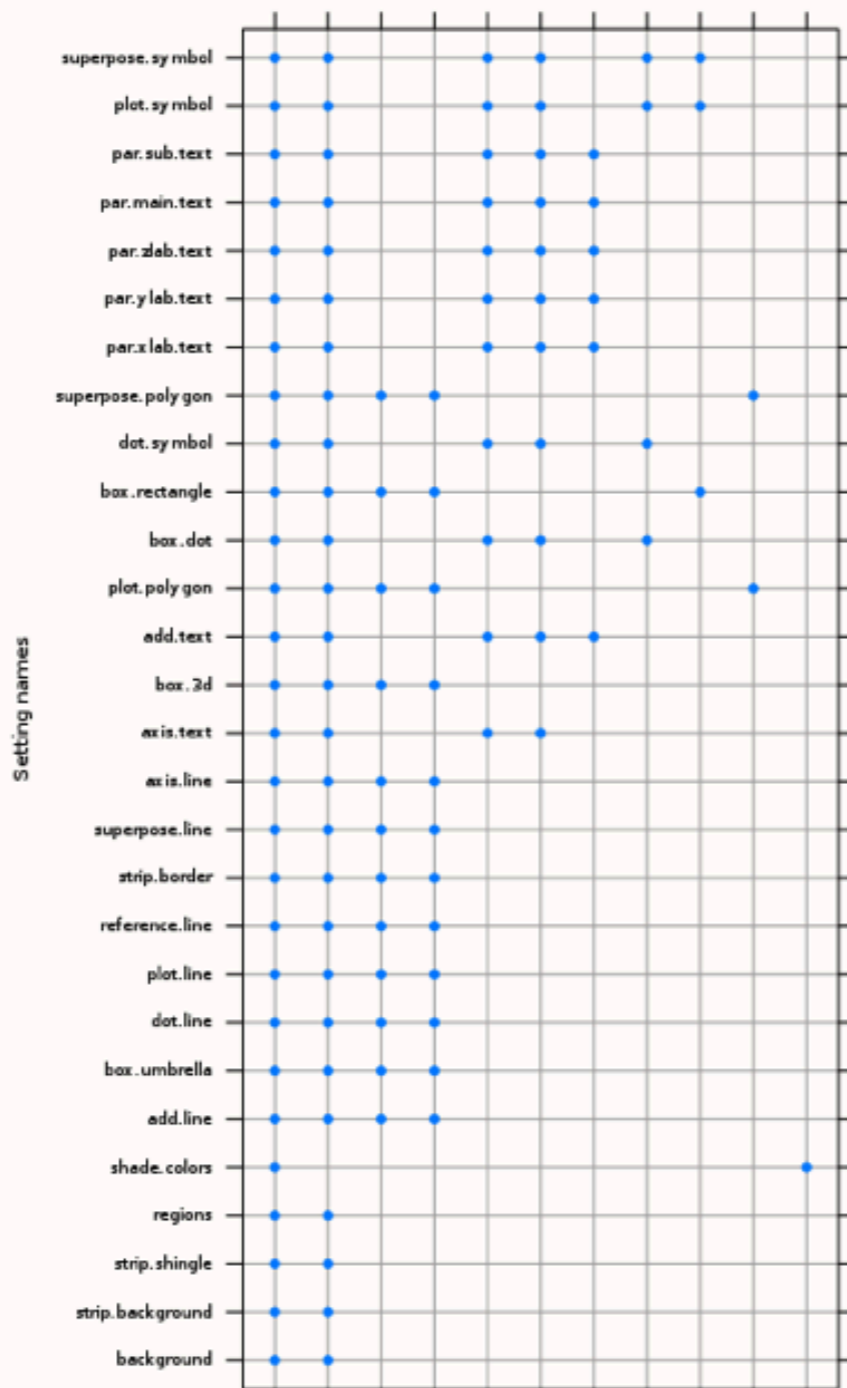
Lattice: Multivariate Data Visualization with R - Figures and Code

Black and White Theme **Default Color Theme** Classic Gray Theme

- Chapter 1
- Chapter 2
- Chapter 3
- Chapter 4
- Chapter 5
- Chapter 6
- Chapter 7**
- Figure 7.1
- Figure 7.2
- Figure 7.3**
- Figure 7.4
- Chapter 8
- Chapter 9
- Chapter 10
- Chapter 11
- Chapter 12
- Chapter 13
- Chapter 14

- Extracts
- Errata
- Reviews

Figure 7.3



```
## Chapter 7
vad.plot <-
  dotplot(reorder(Var2, Freq) ~ Freq | Var1,
    data = as.data.frame.table(VADeaths),
    origin = 0, type = c("p", "h"),
    main = "Death Rates in Virginia - 1940",
    xlab = "Number of deaths per 100")

## Figure 7.1
vad.plot

dot.line.settings <- trellis.par.get("dot.line")
str(dot.line.settings)
dot.line.settings$col <- "transparent"
trellis.par.set("dot.line", dot.line.settings)
plot.line.settings <- trellis.par.get("plot.line")
str(plot.line.settings)
plot.line.settings$lwd <- 2
trellis.par.set("plot.line", plot.line.settings)

## Figure 7.2
vad.plot

panel.dotline <-
function(x, y,
  col = dot.symbol$col, pch = dot.symbol$pch,
  cex = dot.symbol$cex, alpha = dot.symbol$alpha,
  col.line = plot.line$col, lty = plot.line$lty,
  lwd = plot.line$lwd, alpha.line = plot.line$alpha,
  ...)
{
  dot.symbol <- trellis.par.get("dot.symbol")
  plot.line <- trellis.par.get("plot.line")
  panel.segments(0, y, x, y, col = col.line, lty = lty,
    lwd = lwd, alpha = alpha.line)
  panel.points(x, y, col = col, pch = pch, cex = cex, alpha = alpha)
}
trellis.par.set(dot.line = dot.line.settings,
  plot.line = plot.line.settings)
trellis.par.set(dot.line = list(col = "transparent"),
  plot.line = list(lwd = 2))
trellis.par.set(list(dot.line = list(col = "transparent"),
  plot.line = list(lwd = 2)))

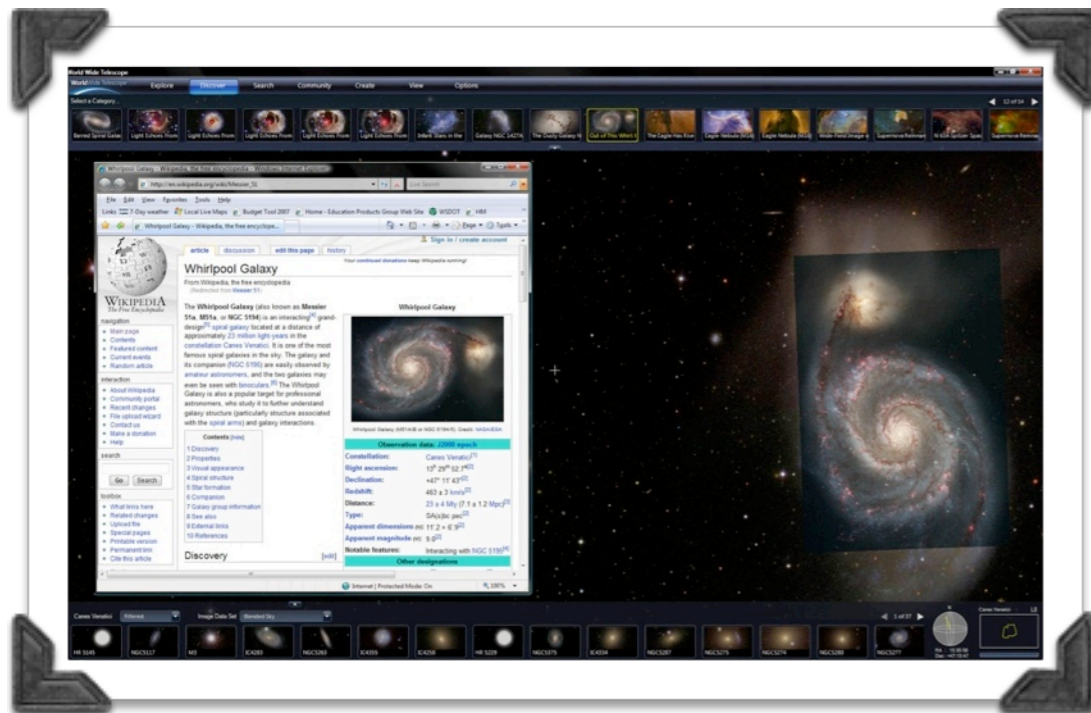
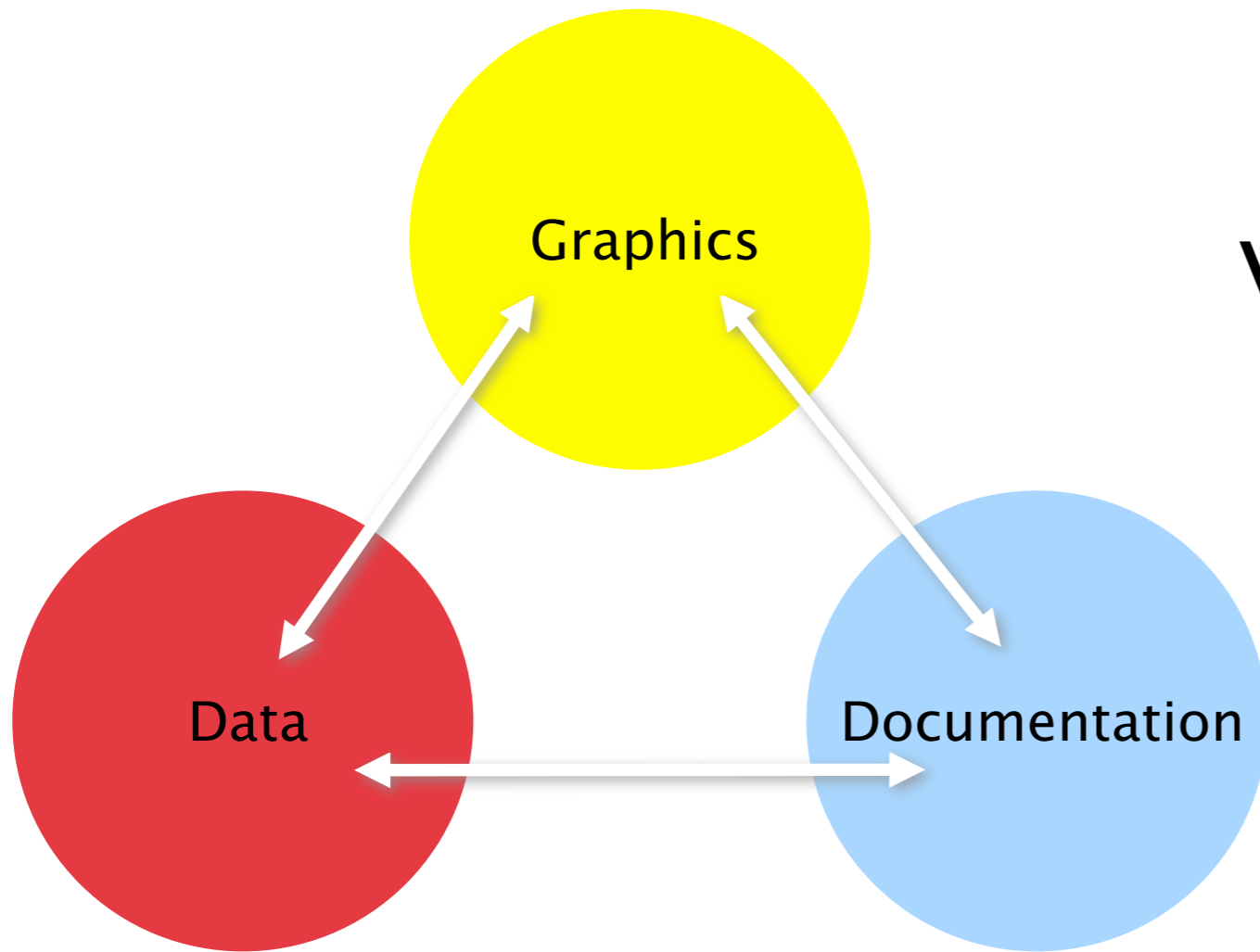
## Figure 7.2 (alternative)
update(vad.plot,
  par.settings = list(dot.line = list(col = "transparent"),
    plot.line = list(lwd = 2)))

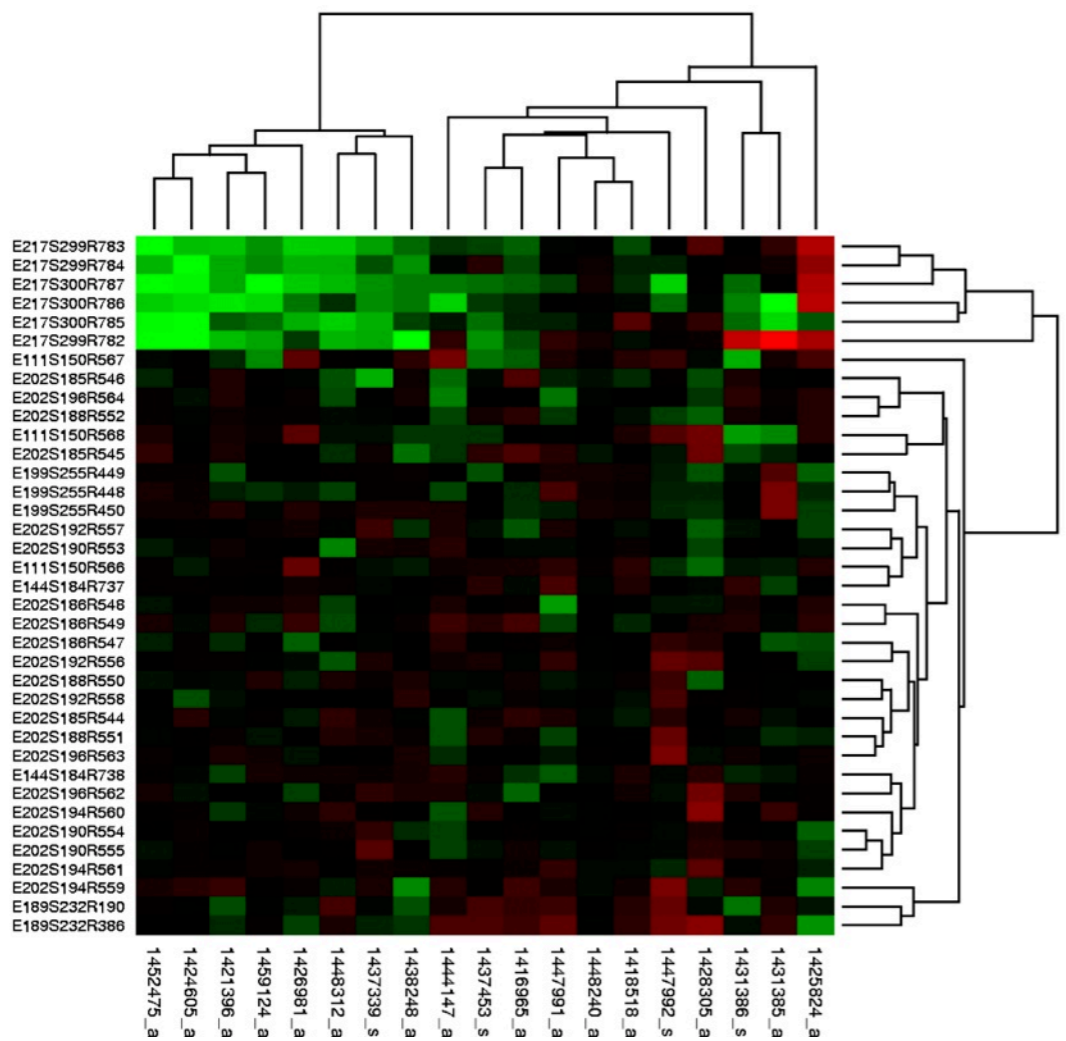
tp <- trellis.par.get()
unusual <-
  c("grid.pars", "fontsize", "clip",
    "axis.components",
    "layout.heights", "layout.widths")
for (u in unusual) tp[[u]] <- NULL
names.tp <- lapply(tp, names)
unames <- sort(unique(unlist(names.tp)))
ans <- matrix(0, nrow = length(names.tp), ncol = length(unames))
```

we must do better....

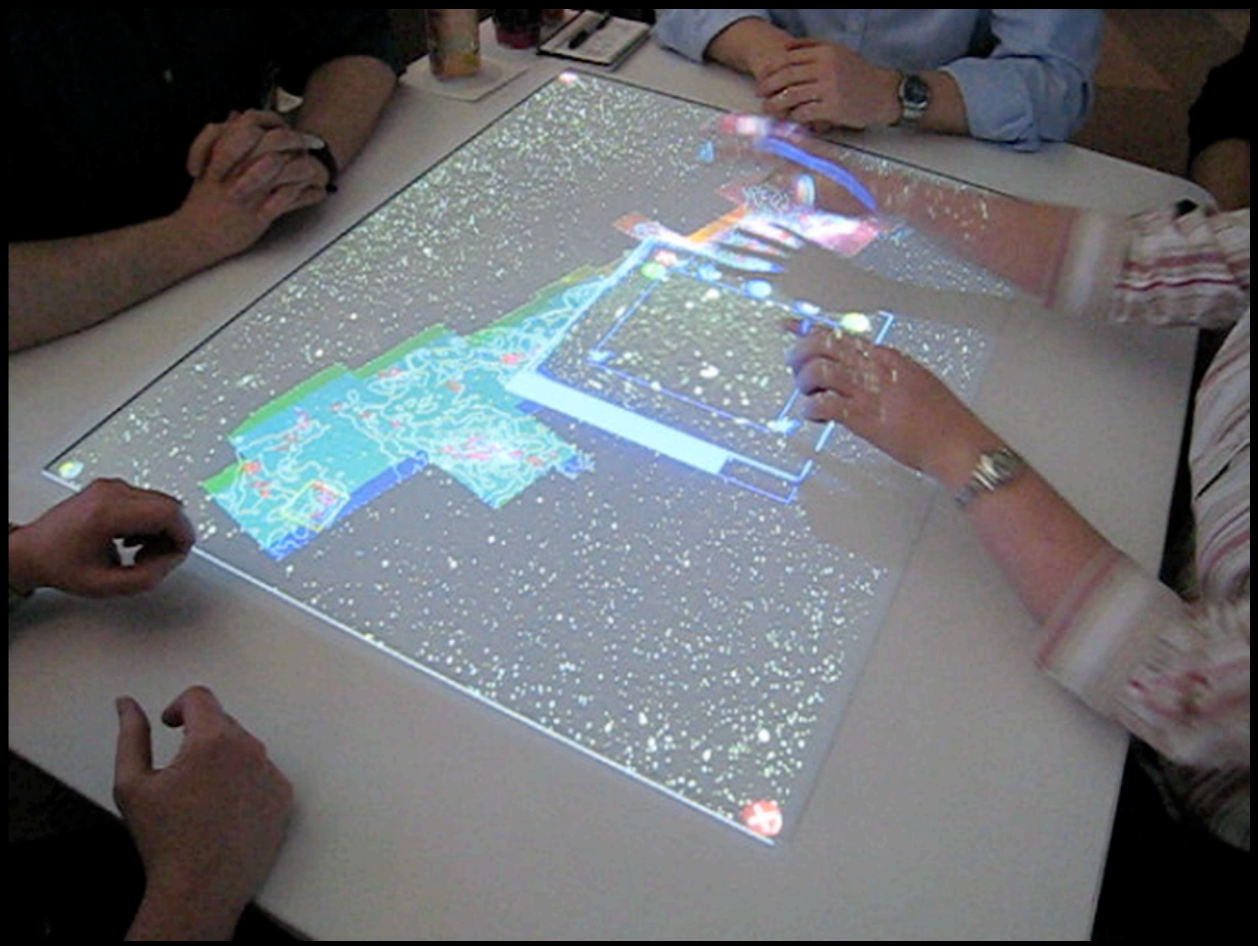
The Future, Now

World Wide Telescope (ask for a demo...)





Seeing



Science

