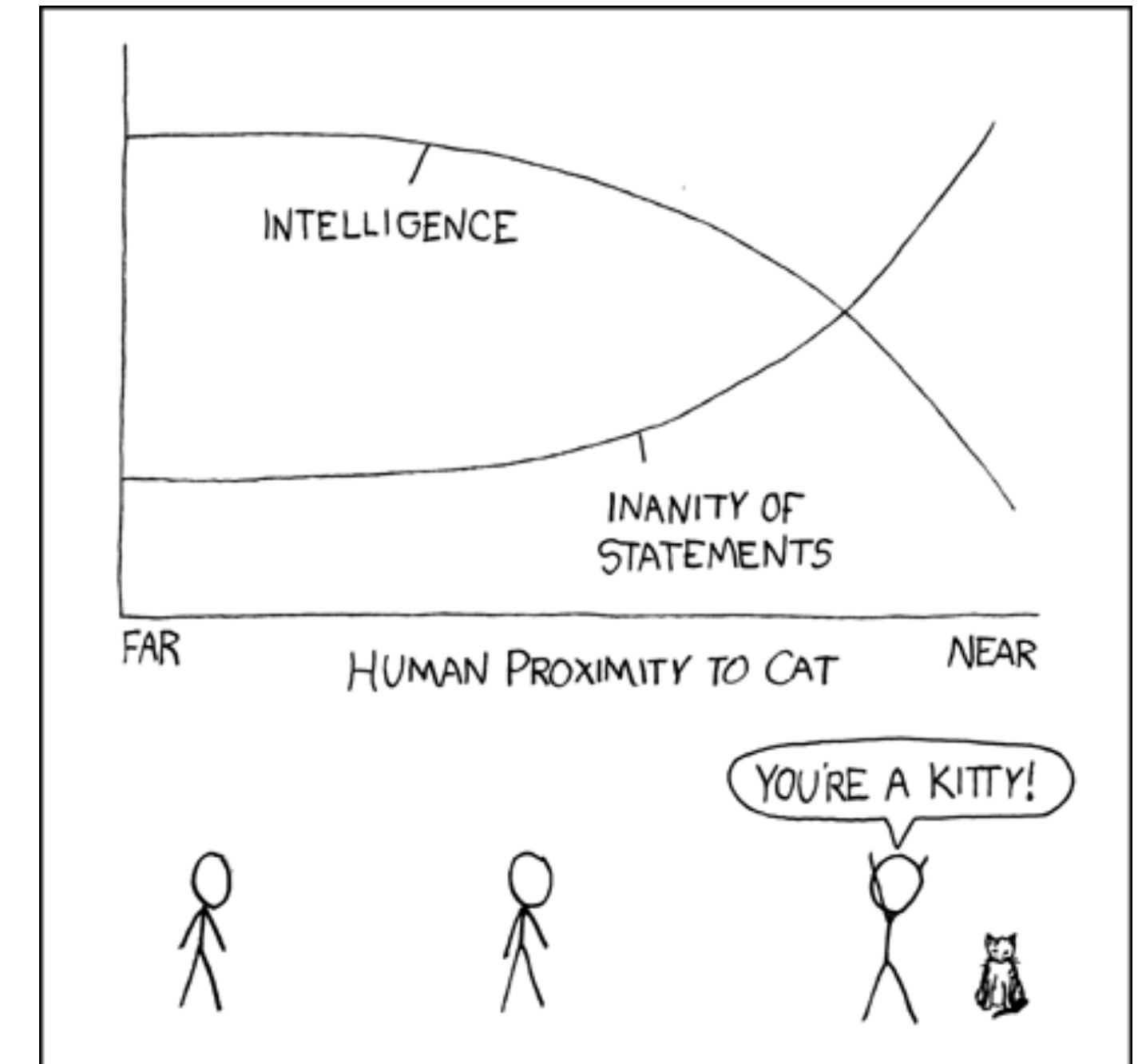


# CS-5630 / CS-6630

## Visualization

Alexander Lex  
[alex@sci.utah.edu](mailto:alex@sci.utah.edu)



**visualization**

**pictures**

***The purpose of computing is insight, not numbers.***

**- Richard Wesley Hamming**

**- Card, Mackinlay, Shneiderman**

**Banana**

***M. acuminata***

**Date**

***P. dactylifera***

**Cress**

***Arabidopsis thaliana***

**Rice**

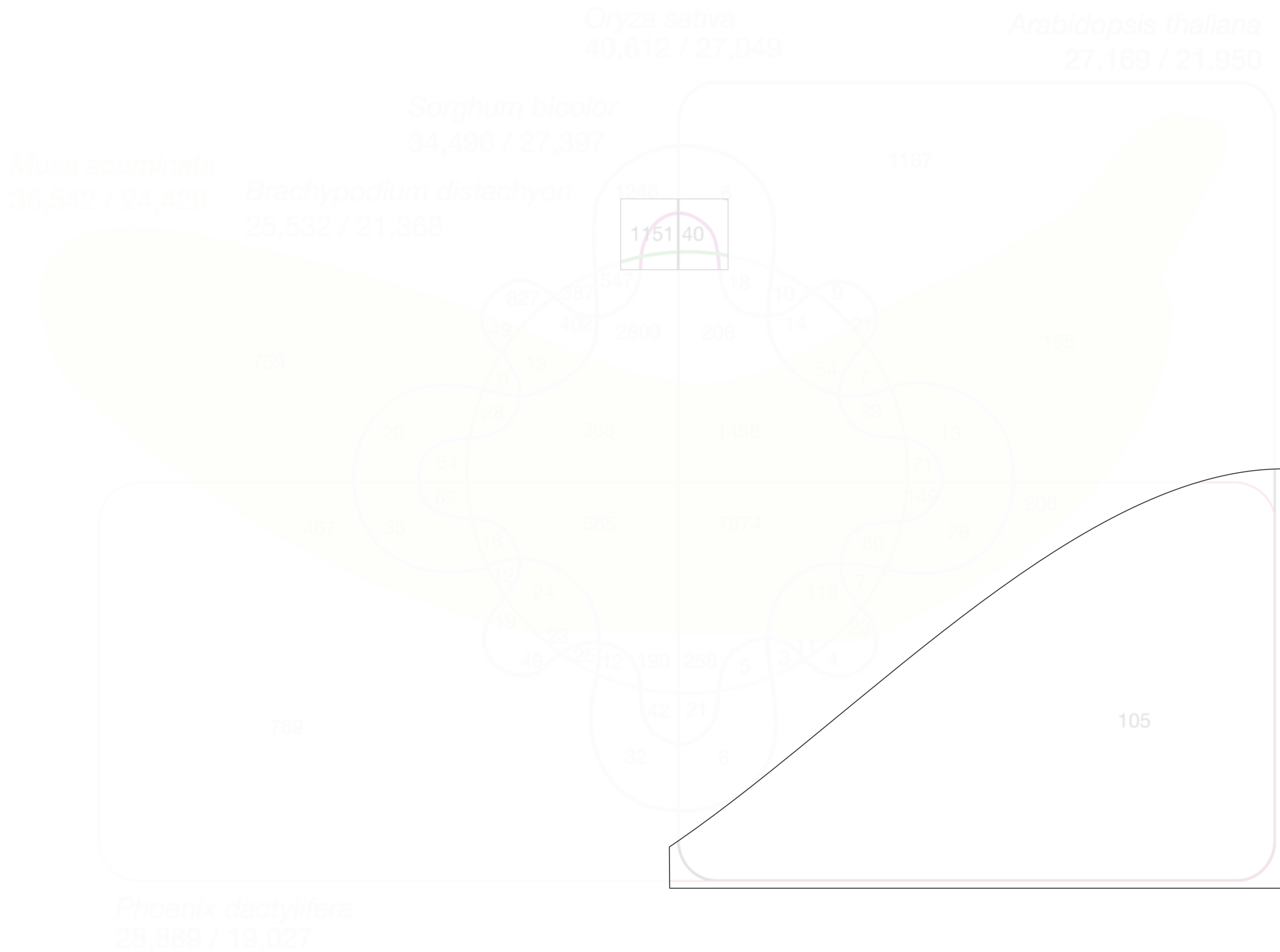
***Oryza sativa***

**Sorghum**

***Sorghum bicolor***

**Brome**

***Brachypodium distachyon***



[D'Hont et al., Nature, 2012]



vi · su · al · i · za · tion

1. Formation of mental visual images
2. The act or process of interpreting in visual terms or of putting into visible form

# Visualization Definition

Visualization is the process that **transforms** (abstract) **data** into **interactive graphical representations** for the purpose of **exploration, confirmation, or presentation.**

**Good  
Data  
Visualization**

- ... makes data **accessible****
- ... combines strengths of **humans and computers****
- ... enables **insight****
- ... **communicates****

# Visualization

“Visualization is really about external cognition, that is, how resources outside the mind can be used to boost the cognitive capabilities of the mind.”



Stuart Card



# Why Visualize?

To inform humans: Communication

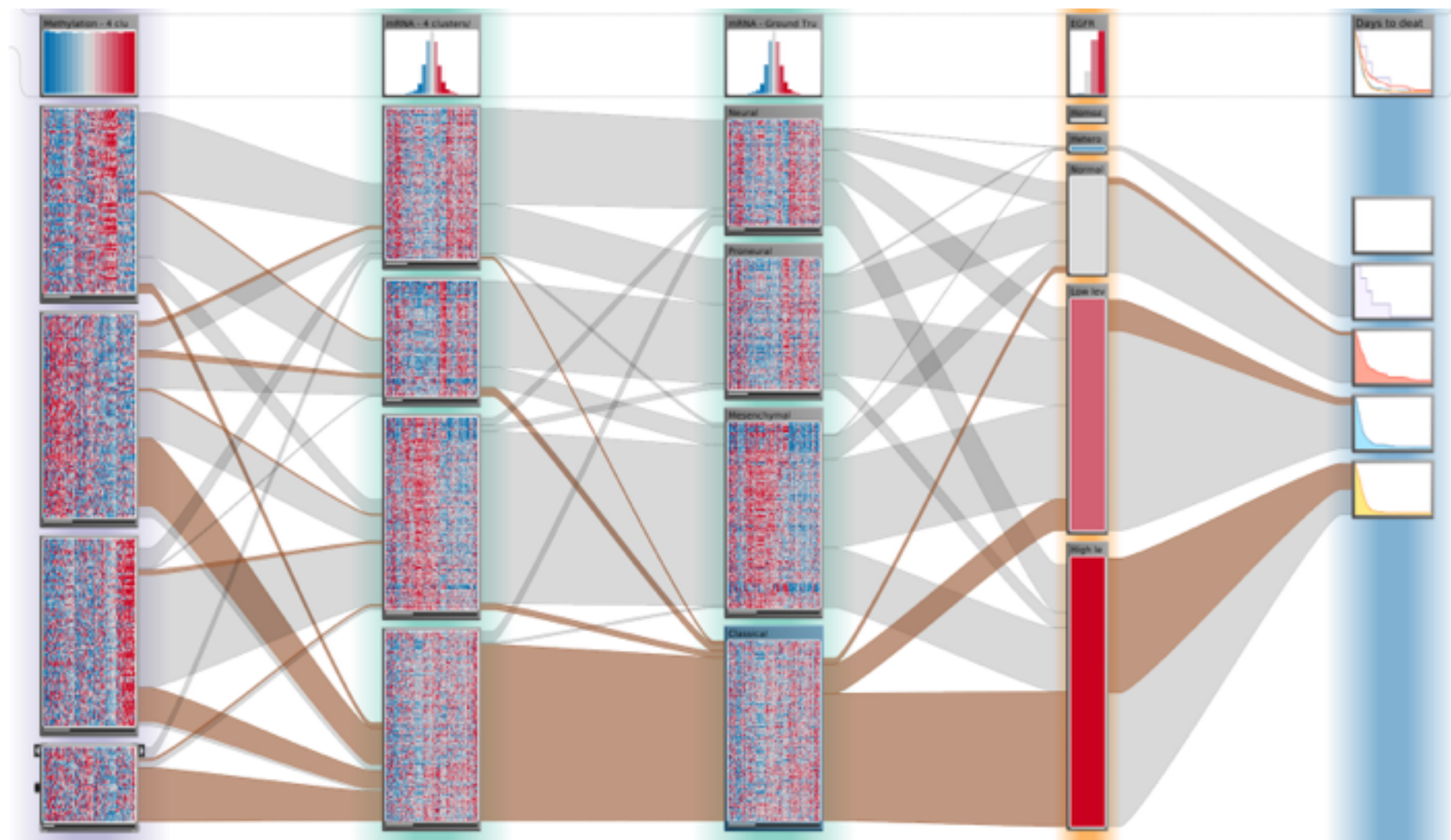
*How is ahead in the election polls?*

When questions are not well  
defined: Exploration

*What is the structure of a terrorist network?*

*Which drug can help patient X?*

# Purpose of Visualization

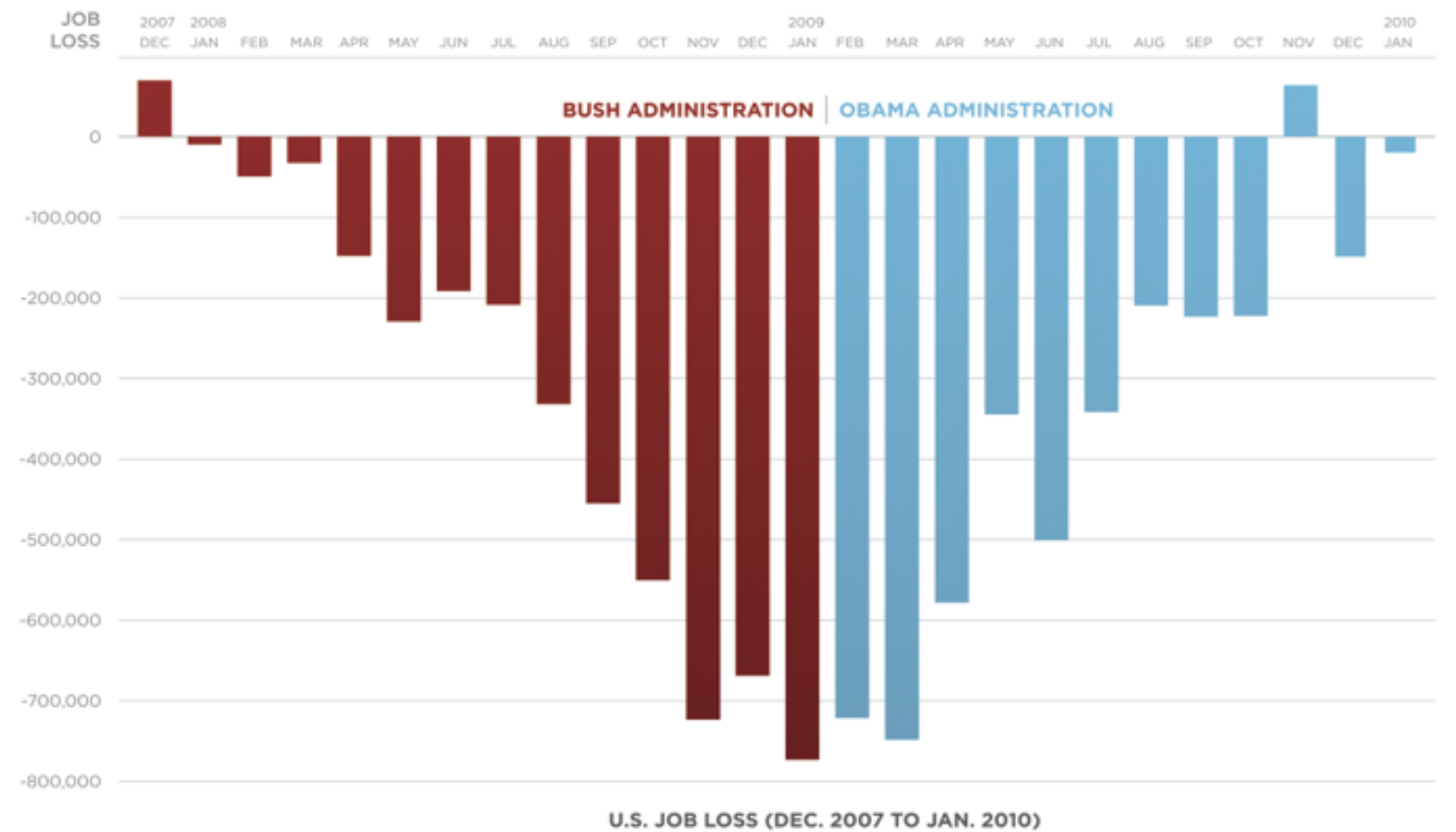


Open Exploration

Confirmation

Communication

[Obama Administration]

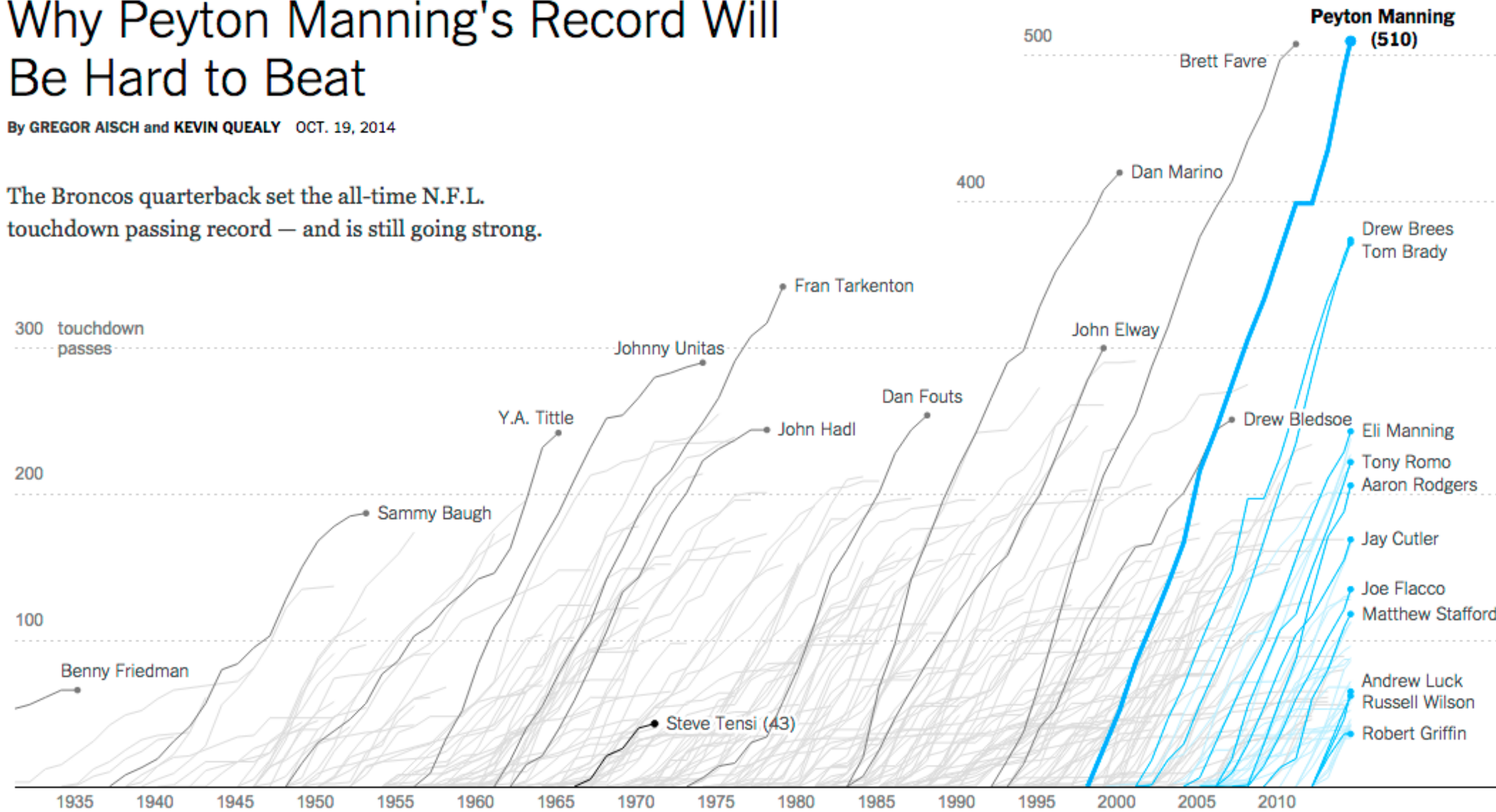


# Example Communication

## Why Peyton Manning's Record Will Be Hard to Beat

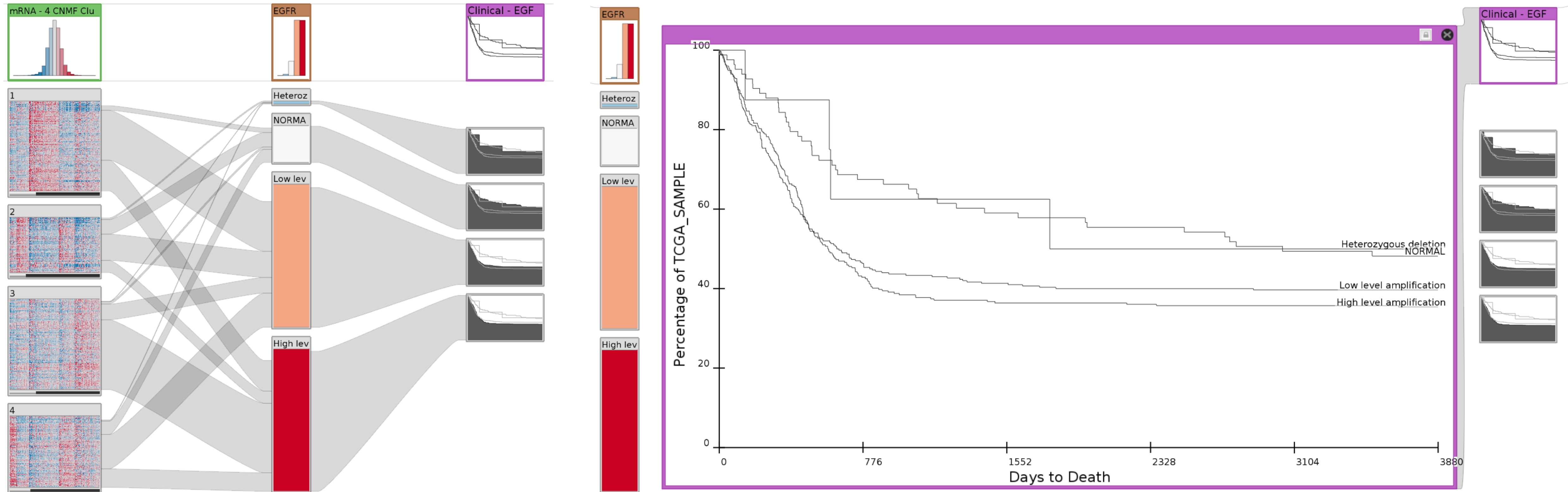
By GREGOR AISCH and KEVIN QUEALY OCT. 19, 2014

The Broncos quarterback set the all-time N.F.L. touchdown passing record — and is still going strong.



[New York Times]

# Example Exploration: Cancer Subtypes



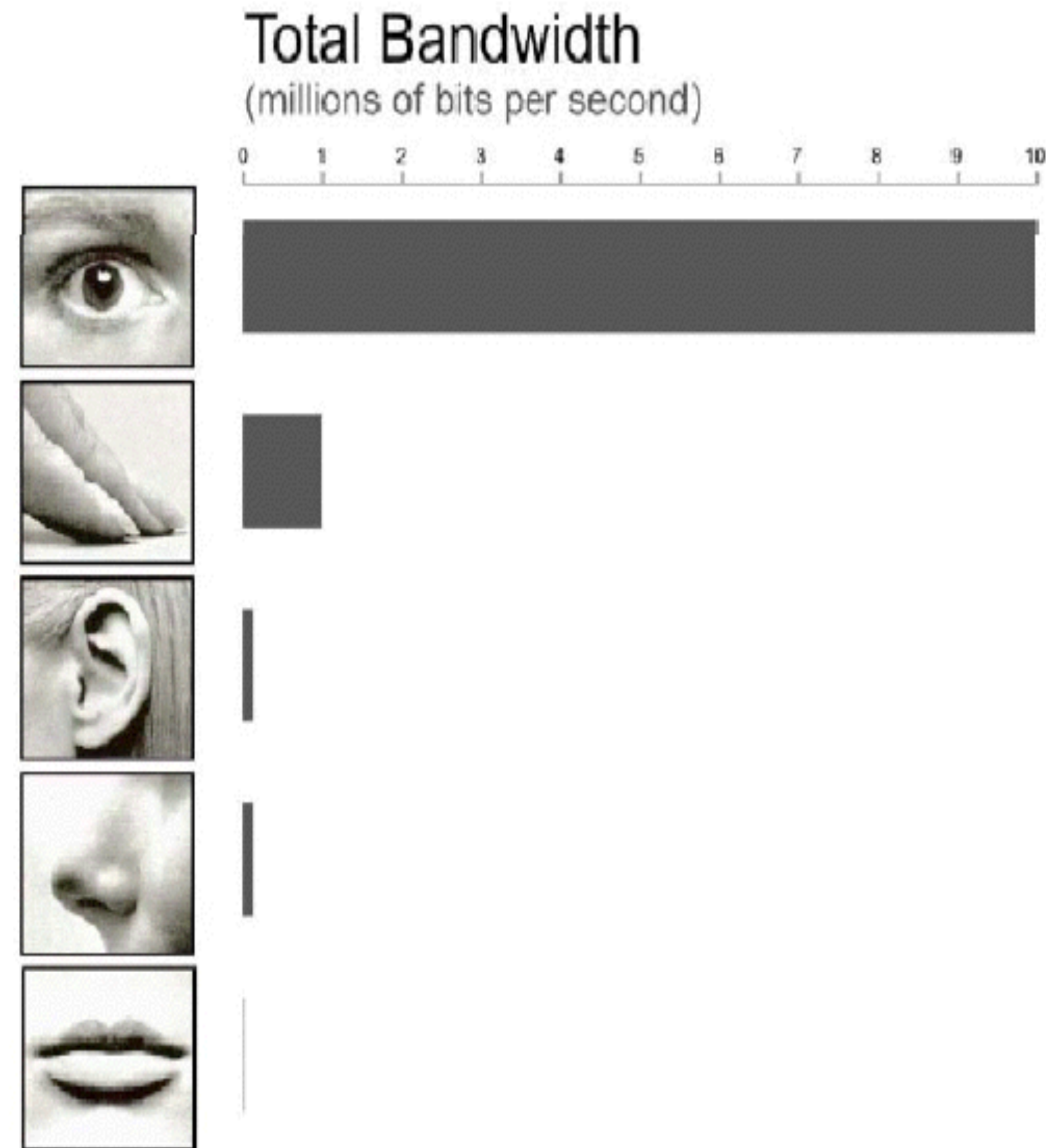
# Why Graphics?

Figures are **richer**; provide more information with less clutter and in less space.

Figures provide the *gestalt* effect: they give an overview; **make structure more visible**.

Figures are **more accessible**, easier to understand, **faster to grasp**, more comprehensible, **more memorable**, more fun, and less formal.

list adapted from: [Stasko et al. 1998]



for city's main public hospital was a wreck, and the city's public-housing projects were shuttered.

Campanella then switched to an identically constructed map, only this time based on 2010 census data, and in bits and pieces on the screen there was a simple and arresting picture of what Katrina meant. In the neighborhoods that were once a dense black, many of the little squares had thinned and turned gray. The sharp lines that once separated the teapot from Central City were now blurry: the white areas of the city were pushing north, into the vacuum left by the exodus. The Bywater was graying, as it gentrified still further. "Before Katrina, an American Community Survey estimate of New Orleans Parish population was four hundred and fifty-five thousand, and about sixty-eight per cent black," Campanella said. "Now the latest estimate is three hundred and eighty-four thousand, and it's about

# When not to visualize?

# When to automate?

Well defined question on well-defined dataset

*Which gene is most frequently mutated in this set of patients?*

*What is the current unemployment rate?*

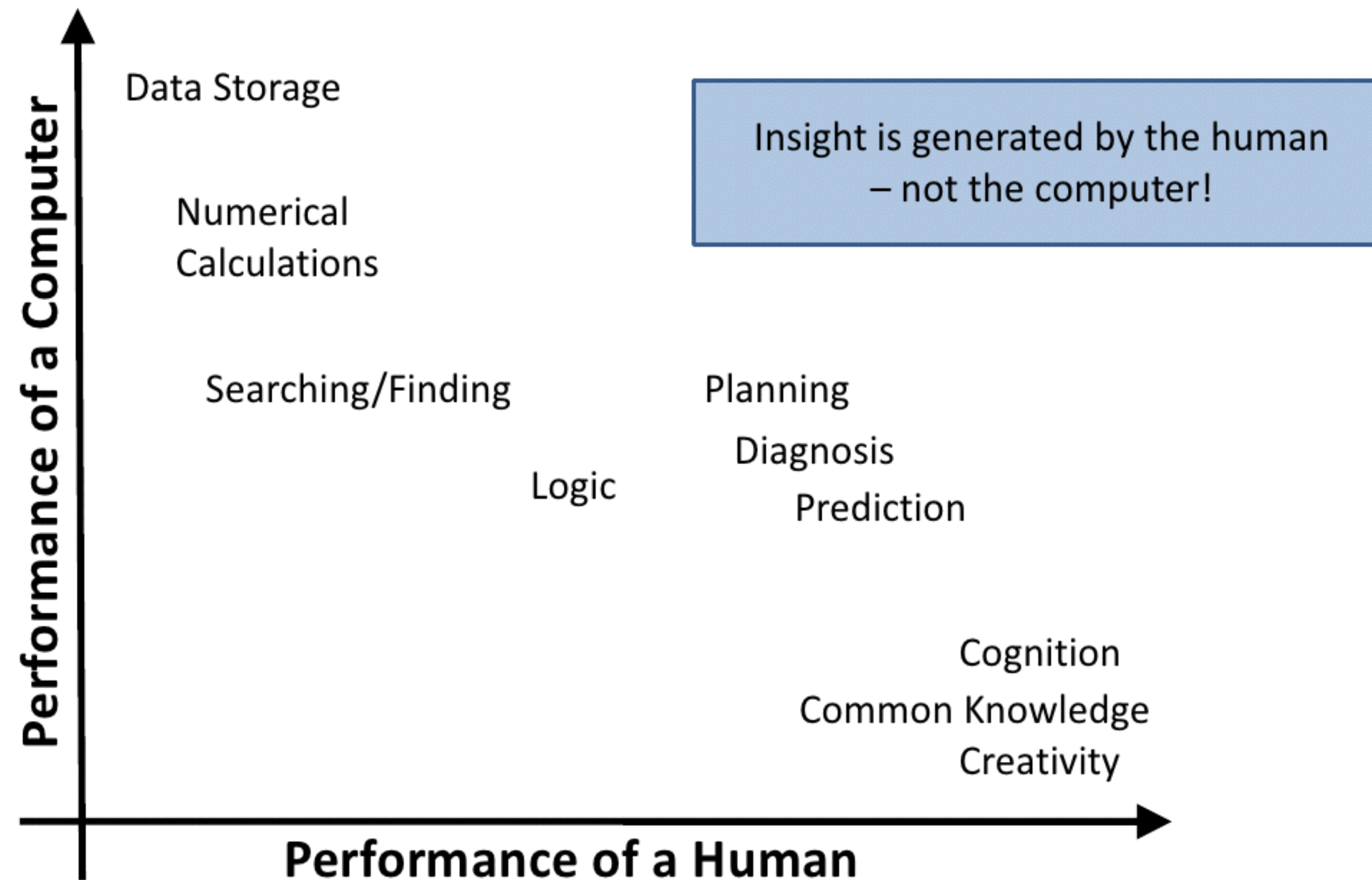
Decisions needed in minimal time

*High frequency stock market trading: which stock to buy/sell?*

*Manufacturing: is bottle broken?*



# The Ability Matrix





# Why Use Computers?

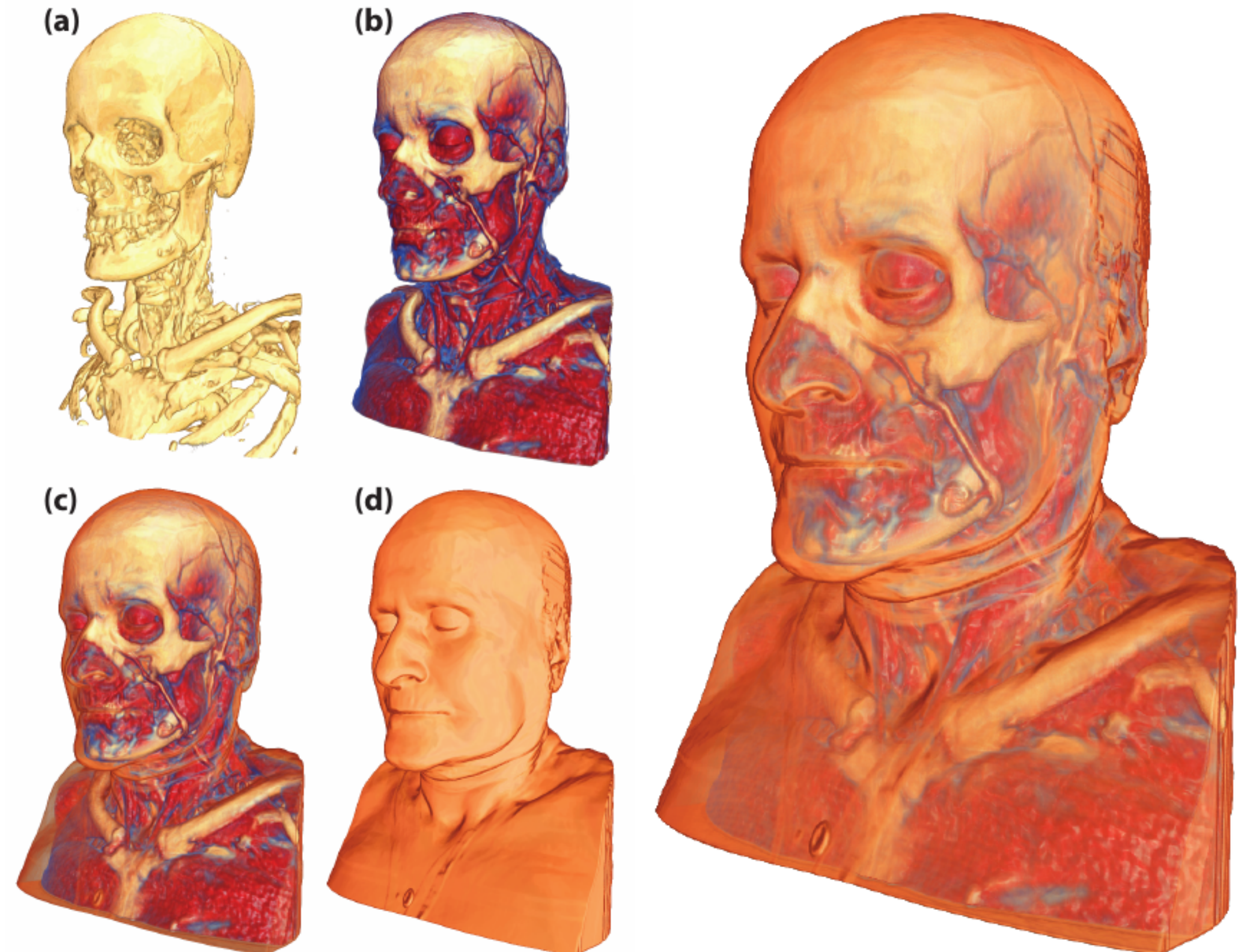
## Scale

Drawing by hand (or Illustrator)

infeasible

inflexible (updates!)

How to draw an MRI scan?



[Bruckner 2007]

# Why Use Computers?

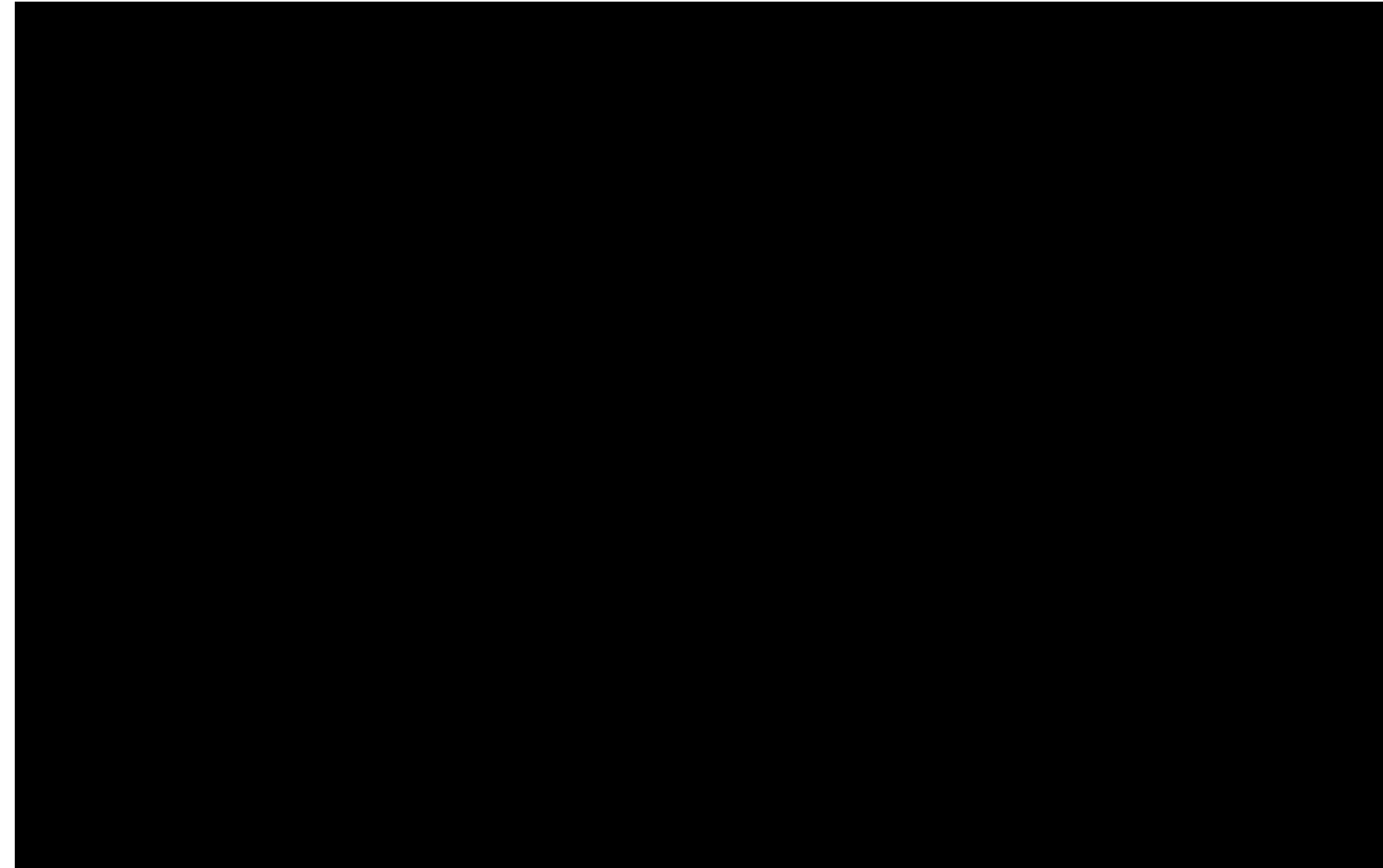
## Interaction

*Interaction* allows to “drill down” into data

## Integration

Integration with algorithms

Make visualization part of a data analysis pipeline



# Why User Computers?

## Efficiency

Re-use charts / methods for  
different datasets

## Quality

Precise data driven rendering

## Storytelling

Use time

# Tell Stories

[New York Times]



# Why not just use Statistics?

I		II		III		IV	
x	y	x	y	x	y	x	y
10	8.0	10	9.1	10	7.4	8	6.5
8	6.9	8	8.1	8	6.7	8	5.7
13	7.5	13	8.7	13	12.	8	7.7
9	8.8	9	8.7	9	7.1	8	8.8
11	8.3	11	9.2	11	7.8	8	8.4
14	9.9	14	8.1	14	8.8	8	7.0
6	7.2	6	6.1	6	6.0	8	5.2
4	4.2	4	3.1	4	5.3	19	12.
12	10.	12	9.1	12	8.1	8	5.5
7	4.8	7	7.2	7	6.4	8	7.9
5	5.						6.8

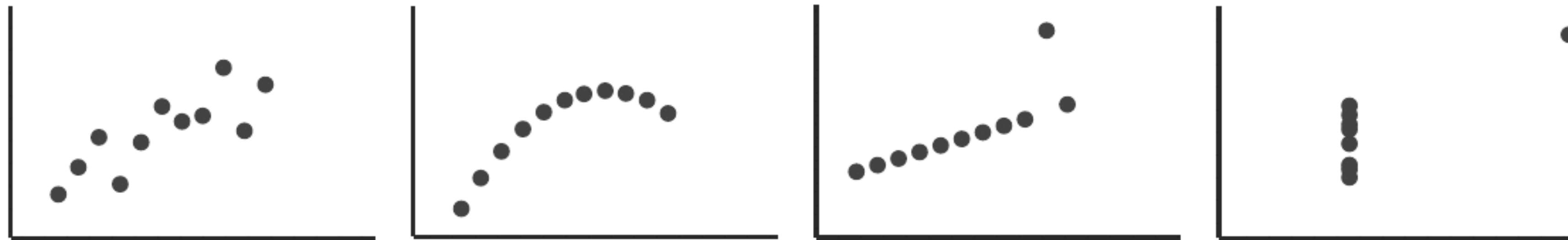
**Mean x: 9 y: 7.50**

**Variance x: 11 y: 4.122**

**Correlation x - y: 0.816**

**Linear regression:  $y = 3.00 + 0.500x$**

# Anscombe's Quartett



**Mean x: 9 y: 7.50**

**Variance x: 11 y: 4.122**

**Correlation x - y: 0.816**

**Linear regression:  $y = 3.00 + 0.500x$**

**Data**

# Visualization in the Data Science Process

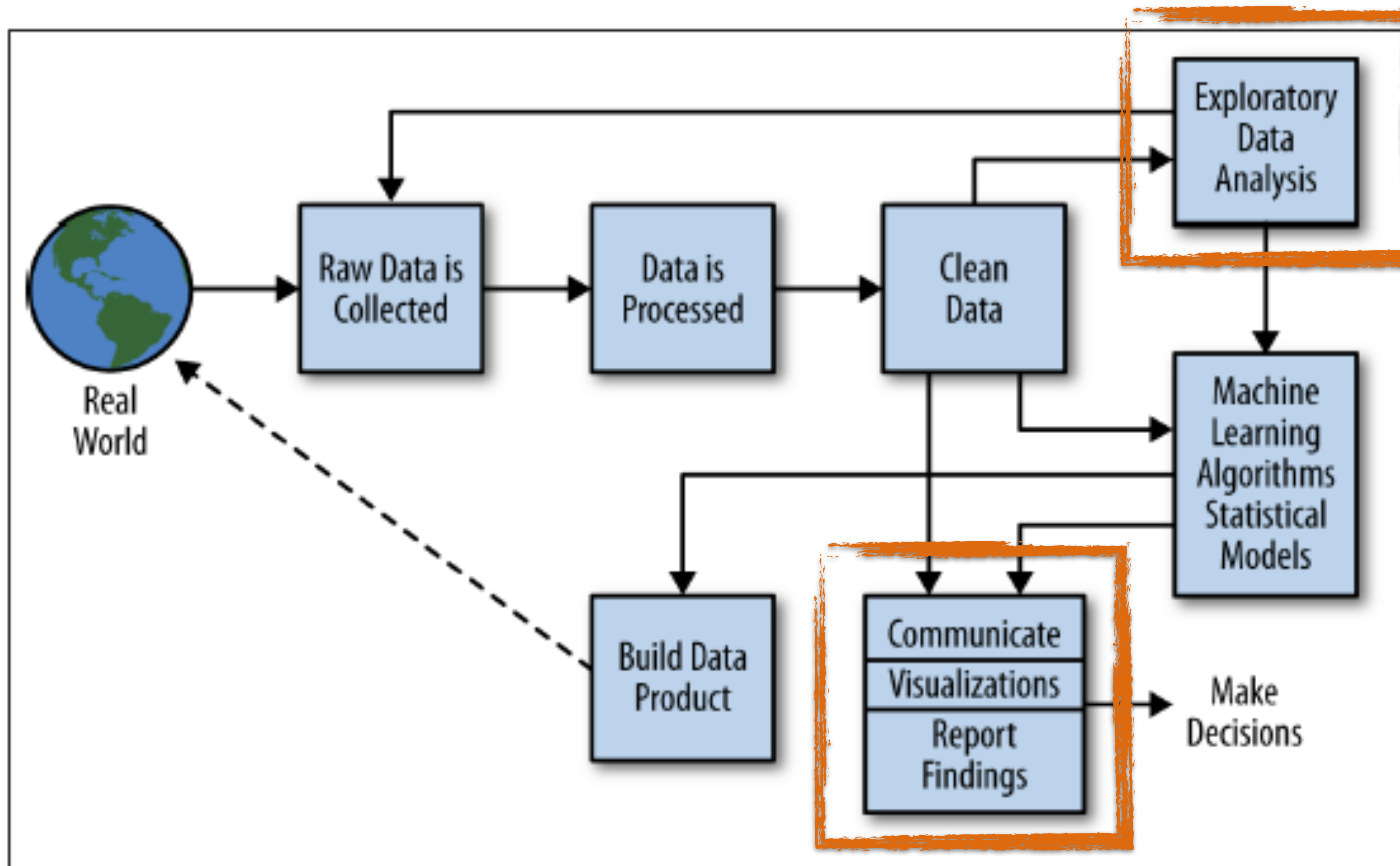


Figure 2-2. The data science process



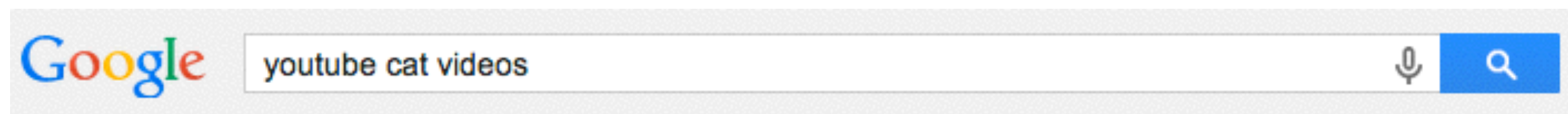
# Big Data

2010: 1,200 exabytes, largely unstructured

Google stores ~10 exabytes (2013)

Hard disk industry ships ~8 exabytes/year

15 Exabytes in Punch Cards:  
4.5 km over New England



Web Videos Shopping Images News More Search tools

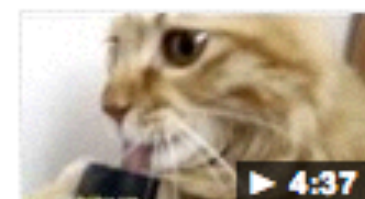
About 593,000,000 results (0.44 seconds)

[TOP 10 BEST CAT VIDEOS OF ALL TIME! - YouTube](#)



[www.youtube.com/watch?v=...](http://www.youtube.com/watch?v=...) YouTube  
Sep 6, 2012 - Uploaded by WatchTheDaily  
We've scoured the internet and found the cutest and funniest cat videos of all time. Any we missed? Let us ...

[The World's Most Funny Cat Videos 2013 - YouTube](#)



[www.youtube.com/watch?v=Ak...](http://www.youtube.com/watch?v=Ak...) YouTube  
Aug 15, 2013 - Uploaded by papiaanifails  
FREE Cat Tree Construction Manual : <http://tinyurl.com/ovp252j>  
Funniest Dog Videos <https://www.youtube.com> ...

In one second on the Internet there are...



# Example: Personal Data



**Timeline**

2016 June 29

Wednesday, June 29, 2016

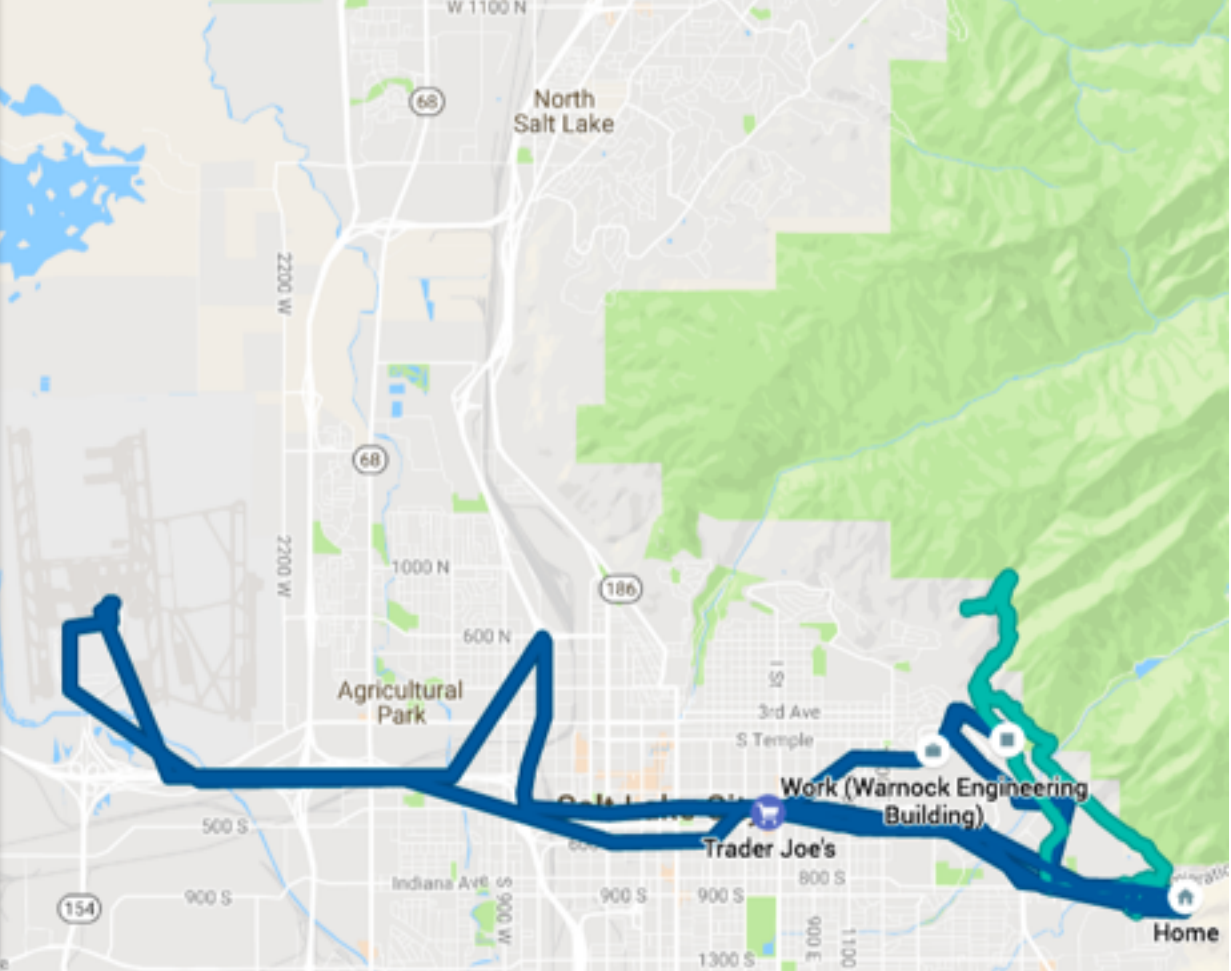
36.6 mi 1h 59m  
11.4 mi 1h 48m  
0.2 mi 11m

**Home ?** 8:51 AM  
3125 Kennedy Dr, Salt Lake City, UT 84108

**Driving - 3.4 mi** 18 mins

**Work (Warnock Engineering Bu...)** 9:09 AM - 12:42 PM  
72 Central Campus Dr, Salt Lake City, UT 84112

**20 S 2030 E ?** 1:01 PM - 3:01 PM



**Google My Activity**

Bundle view

Item view

Delete activity by

Other Google activity

Activity controls

My Account

Help

Search

Filter by date & product

Only you can see this data. Google protects your privacy and security. [Learn more](#)

**Today**

Some activity may not appear yet

ITEMS 123

CHROME SEARCH ANDROID IMAGE SEARCH NOW

**STRAVA** Dashboard Training Explore Challenges

Go Premium

**Alexander Lex - Ride**

8:54 AM on Saturday, August 20, 2016

**Wasatch Crest Trail**

40.7 km 2:34:29 442m  
Distance Moving Time Elevation

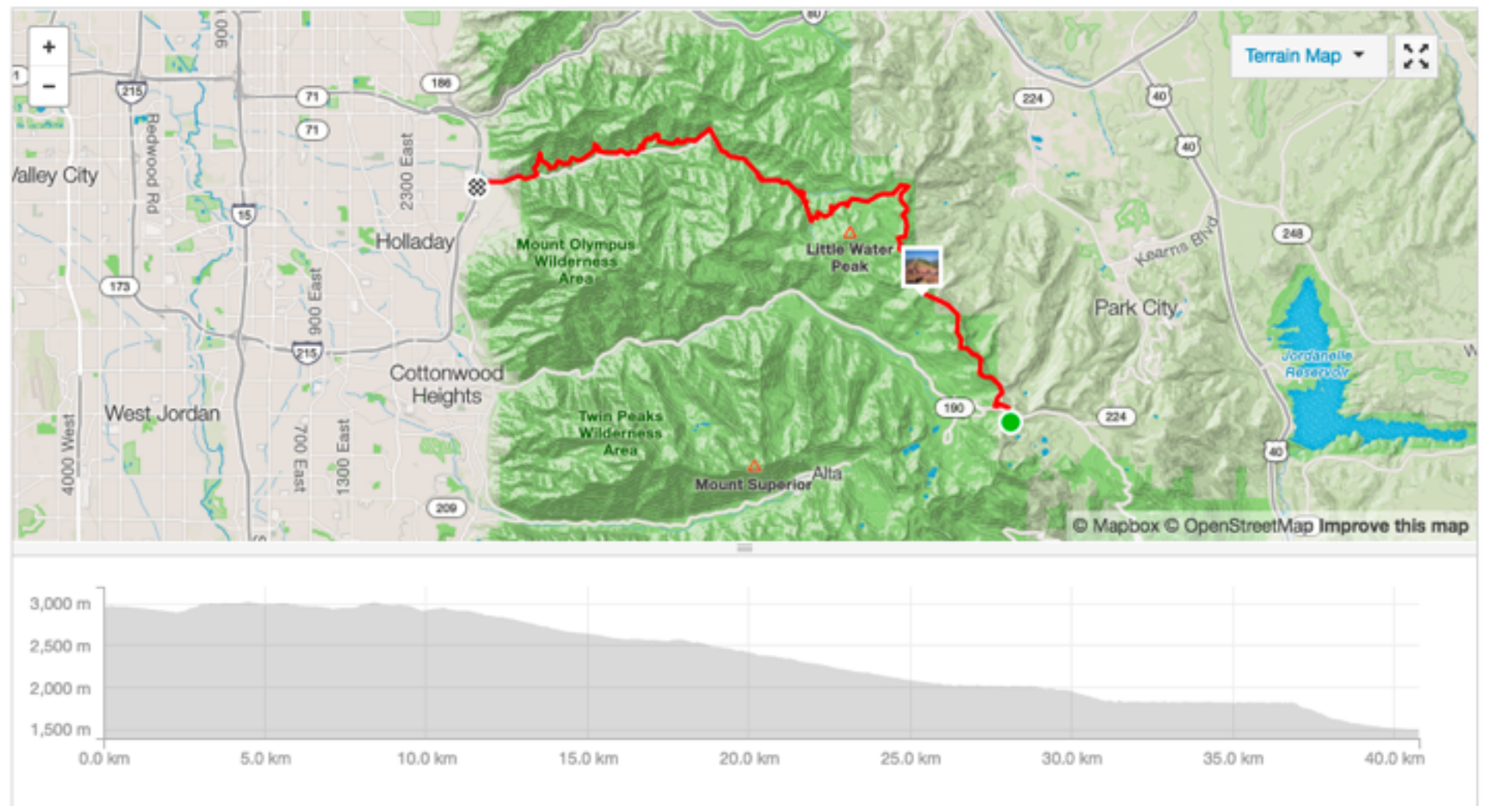
148w 1,372 kJ  
Estimated Avg Power Energy Output

	Avg	Max
Speed	15.8km/h	74.2km/h
Elapsed Time	3:30:52	

Device: [Strava Android App](#) Bike: —

**TOP RESULTS**

- PR on [rattlesnake dh](#) (6:39)
- PR on [Church Fork to Bottom of Rattlesnake](#) (18:45)
- PR on [Elbow to Birch](#) (16:13)



# Big Data in Science and Engineering

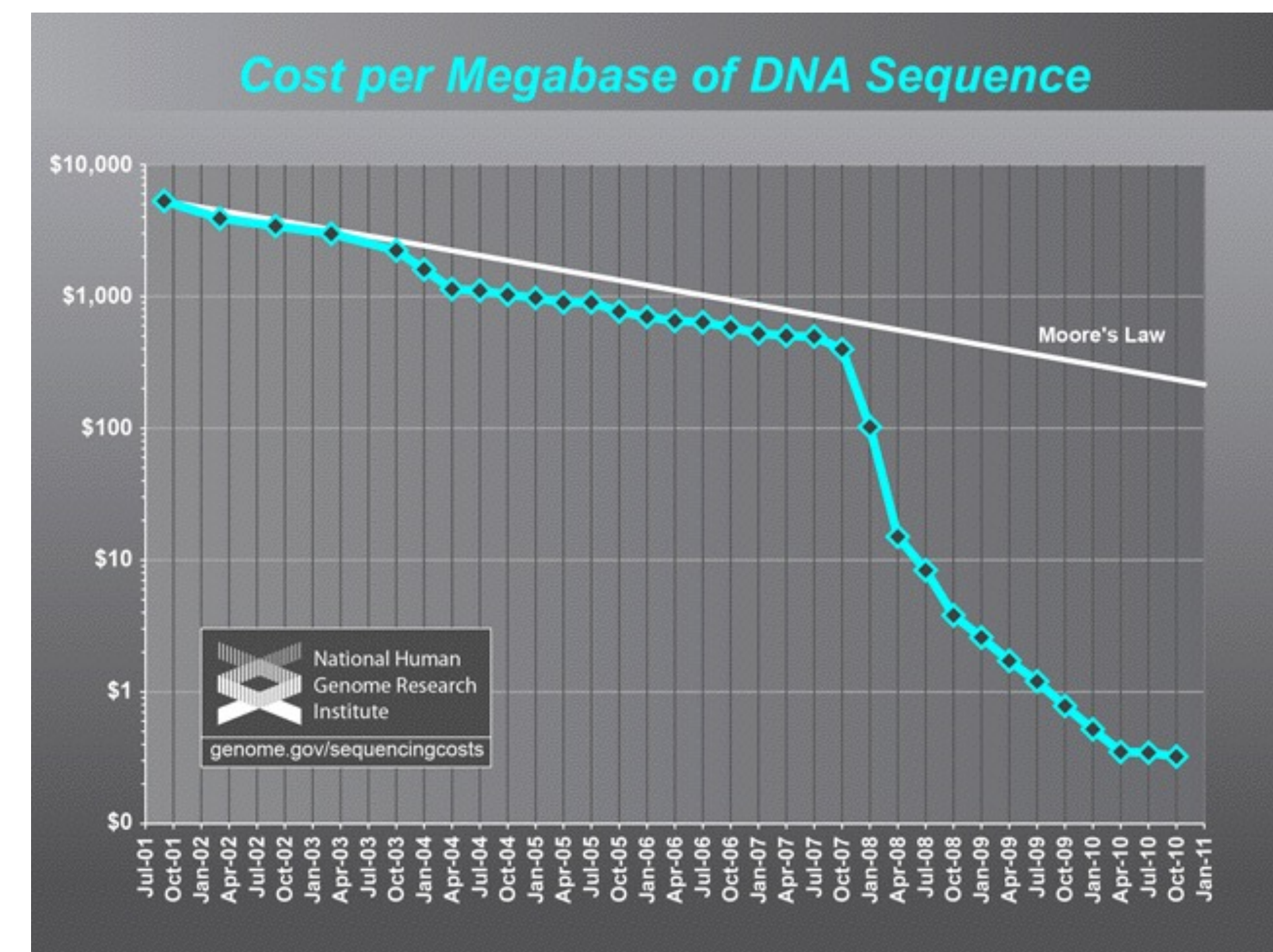
“Big Data” hasn’t just transformed industry!

It’s also transformed science and engineering. Cheap sensors (e.g. imaging) have changed the way science and engineering are done.

Examples:

- Large physics experiments and observations
- Cheaper and automated genome sequencing
- Smart buildings / cities (blyncsy)
- Geophysical imaging

Controversy: Hypothesis or data driven methods



# Example: CERN Large Hadron Collider Data

CERN has publicly released over 300TB of data: [CERN Open Data Portal](#)

## How much is that?

- At 15 GB of storage a piece, you'd need 20,000 Gmail accounts to store the whole shebang. If you wanted to send that much data at the max attachment size of 25 MB, it would take you 12 million emails.
- A DVD-R holds 4.7 GB. You'd need 63,830 of them to hold 300 TB.
- Your Blu-ray collection wouldn't need to expand quite so much. 6,000 discs ought to hold it.
- It takes Pandora about a day and a half to burn through a gig of mobile data. So if the CERN data was an album, you could stream it in just over 1,230 years.
- At 350 MB per hour for 4K video streaming, so if the CERN data was a 4K movie it'd probably be about 857,142 hours, or about 98 years long.
- But it ain't no thing compared to what the National Security Agency works with. Going by 2013 figures the agency released, the NSA's various activities "touch" 300 TB of data every 15 minutes or so

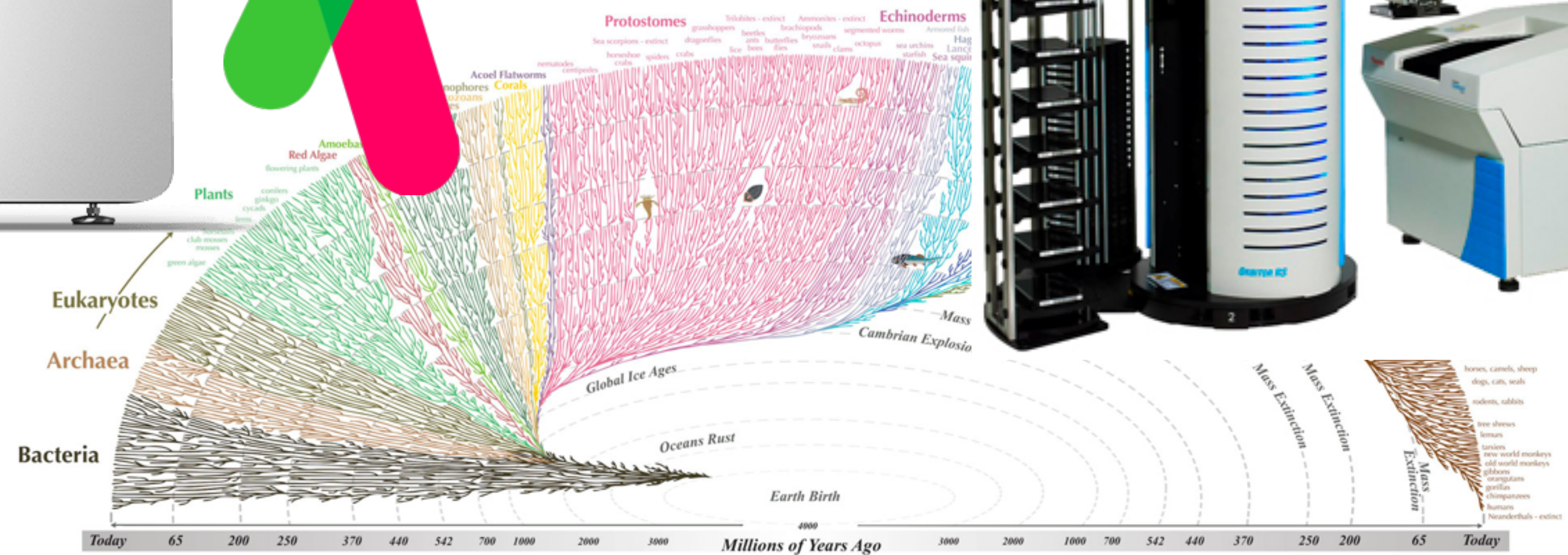
([Popular Mechanics Article](#))

# Example: Genomics



23andMe

Example TCGA: 1 Petabyte



All the major and many of the minor living branches of life are shown on this diagram, but only a few of those that have gone extinct are shown. Example: Dinosaurs - extinct

# NSA Utah Data Center (Bluffdale, Utah)

Storage Capacity?

estimates vary, but Forbes magazine estimates 12 exabytes (12,000 petabytes or 12 million terabytes)



“The ability to take data—to be able to **understand** it, to **process** it, to **extract value** from it, to **visualize** it, to **communicate** it—that’s going to be a hugely important skill in the next decades, ... because now we really do have **essentially free and ubiquitous data.**”

Hal Varian, Google’s Chief Economist  
The McKinsey Quarterly, Jan 2009



# How did we get here?

A bit of history

# “It is things that make us smart”

Donald A. Norman



15 a

**E** In terra pax hominibus bonae voluntatis. **Quidiam** re...

**D**omine deus rex caelestis deus pater omnipotens. **Virginitas** **Es** pater **alm**

**D**omine deus agnus dei

maie uirginis marie. **Dea** mundi. **Et** tolli peccata mundi

30 The first Book of

describe the circle  $AEH$ ; and let  $DA$  be produced to the point  $G$  in the circumference thereof. Then  $AG = CB$ .

For  $DG = DE$ , and  $DA = DC$ . Wherefore  $AG = CE = BC = AG$ . Which was to be done.

The joining of the point  $A$  within or without the line  $BC$  varies the cases; but the construction, and the demonstration, are every where alike.

Q.E.D.

The line  $AG$  might be taken with a pair of compasses; but the so doing answers to no postulate, as Ptolemy well intimates.

**PROP. III.**

Two right lines,  $A$  and  $B$ , being given, from the greater  $B$  cut away the right line  $BE$  equal to the lesser  $A$ .

At the point  $B$  draw the right line  $BD = A$ . The circle described from the center  $B$  in the distance of  $BD$  shall cut off  $BE = BD = A = BE$ . Which was to be done.

**PROP. IV.**

If two triangles  $BAC$ ,  $EDF$ , have two sides of the one  $BA$ ,  $AC$  equal to two sides of the other  $ED$ ,  $DF$ ; and also the contained angle  $B$  equal to the angle  $E$ , the third sides  $BC$ ,  $EF$  shall be equal; and also the angles  $C$ ,  $F$  shall be equal; and also the angles  $A$ ,  $D$  shall be equal.

**EUCLIDE'S ELEMENTS.**

31

and  $AC = DF$  and have the angle  $A$  equal to the angle  $D$  contained under the equal sides they shall have the base  $BC$  equal to the base  $EF$ ; and the triangles  $BAC$  shall be equal to the triangles  $EDF$ ; and the remaining angles  $C$ ,  $F$ , each to each, and the remaining angles  $A$ ,  $D$ , each to each, shall be equal.

If the point  $D$  be applied to the point  $A$ , and the right line  $DE$  fall upon the right line  $AB$ , the point  $E$  shall fall upon  $B$ , because  $DE = AB$ ; also the right line  $DF$  shall fall upon  $AC$ , because the angle  $A = D$ ; moreover the point  $F$  shall fall upon the point  $C$ , because  $AC = DF$ . Therefore the right lines  $EF$ ,  $BC$  shall agree, because they have the same terms, & so consequently are equal. Wherefore the triangles  $BAC$ ,  $EDF$ , and the angles  $C$ ,  $F$ , as also the angles  $A$ ,  $D$ , do agree; and are equal, which was to be demonstrated.

**PROP. V.**

The angles  $ABC$ ,  $ACB$  at the base of an isosceles triangle  $ABC$ , are equal one to the other; and if the equal sides  $AB$ ,  $AC$  be produced, the angles  $CBD$ ,  $BCE$ , under the base, shall be equal one to the other.

Take  $AE = AD$ , and join  $CE$ ,  $BD$ , and  $BE$ .

Because, in the triangles  $ACD$ ,  $ABE$  are  $AC = AB$  and  $AE = AD$ , and the angle  $A$  common to them both; therefore the angle  $AEC = ADB$ ; and the angle  $AEB = ADC$ ; and the base  $BE = CE$ ; also  $BC = BC$ . Therefore in the triangles  $BEC$ ,  $BCD$  shall be the angle  $ECB = DCB$ , which was to be done. Also therefore the angle  $EBC = DCB$ ; but the angle  $AEB = ADC$ ; therefore the angle  $ABC = ACB$ , which was to be done.

**I**ncipit scripturae sanctorum per anni certissimi. **I**n isto sancti Saturnini martyris. **Oratio.**

Eus qui non deum Saturnini martyris tui concedis natalicio presertim: non tribue meritis adiuvare. **Per dominum nostrum. Amen.**

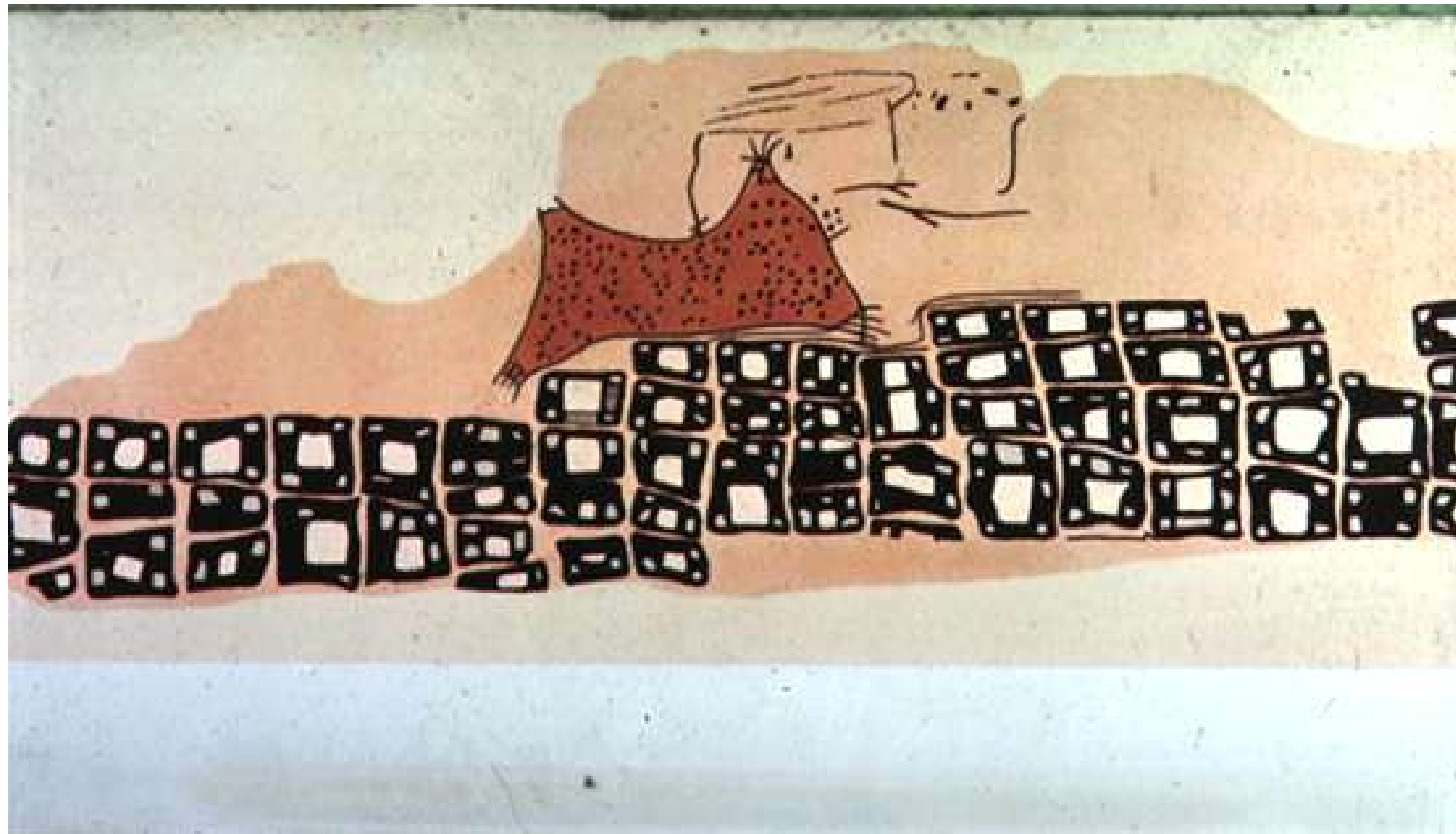
**R**ome natale sacrum Saturnini martyris et senis: et sicut via comitibus maximiano. Et quo primo iter alios servas dei caritati sunt ad fodendam harenas ad faciendam thermas vicentianam. Quorum unum sibi presertim: cum interrogasset idem maximianus quomodo vocaretur: respondit: Ego peccator: sicut servus servorum domini nostri iesu christi. Et in eius post alia diceret maximianus: aut sacrificia deo hercultant carnis tuae cremato: respondit: Ego quidem semper hoc optavi: veritate si meritis: invero coenam desiderata accepta.

**M**aximianus igitur laudato. **Actus secunda** perfectio missas est in custodiam decem et

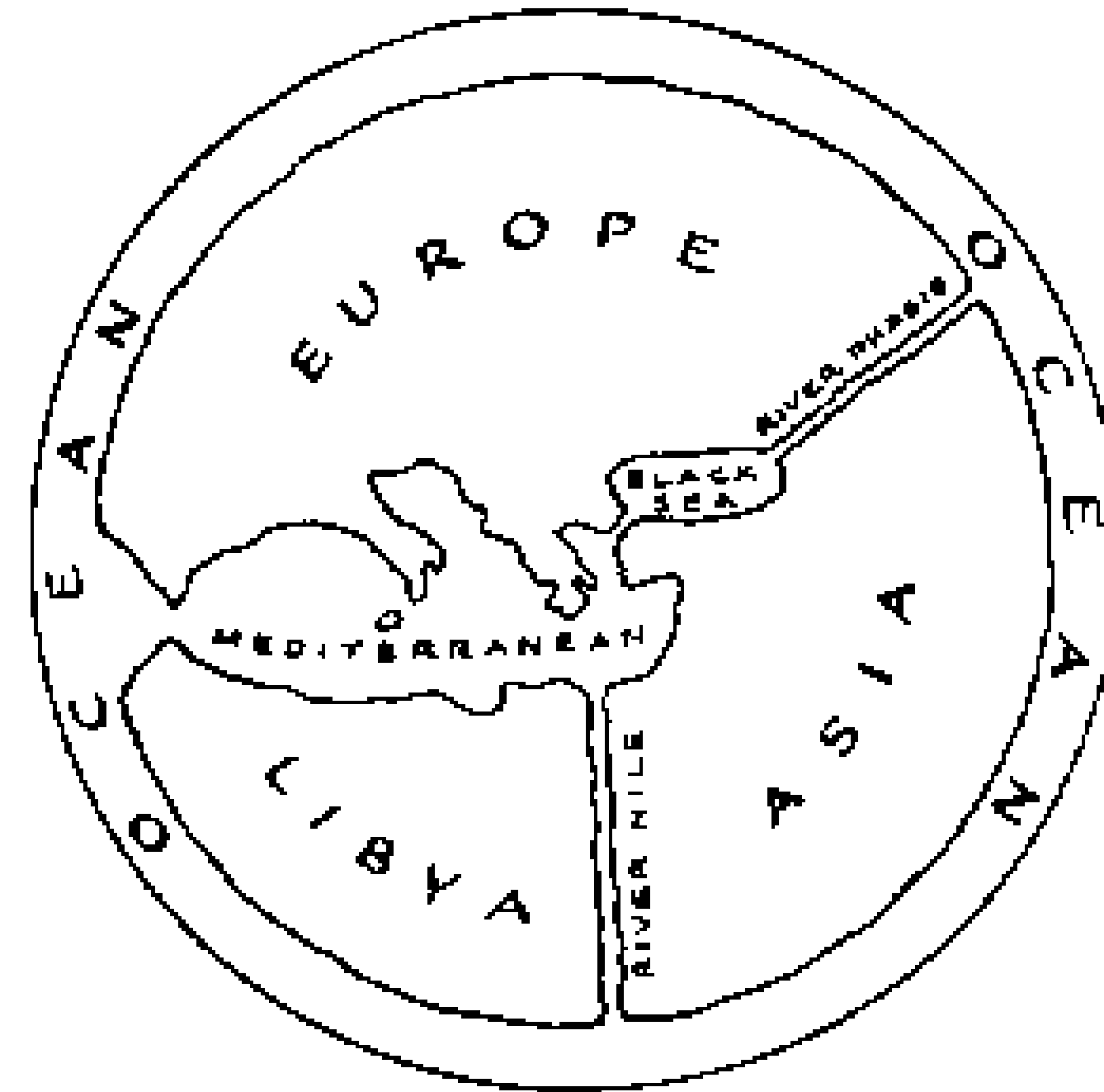
**E**cce ego miras piscatore: milio dicit dicit: piscantem esse. **Luc. 6.**

**M**ocavit iesus discipulos suos et egit. **xij. et ipse quos ipse luc. 6.**

# Record



Konya town map, Turkey, c. 6200 BC

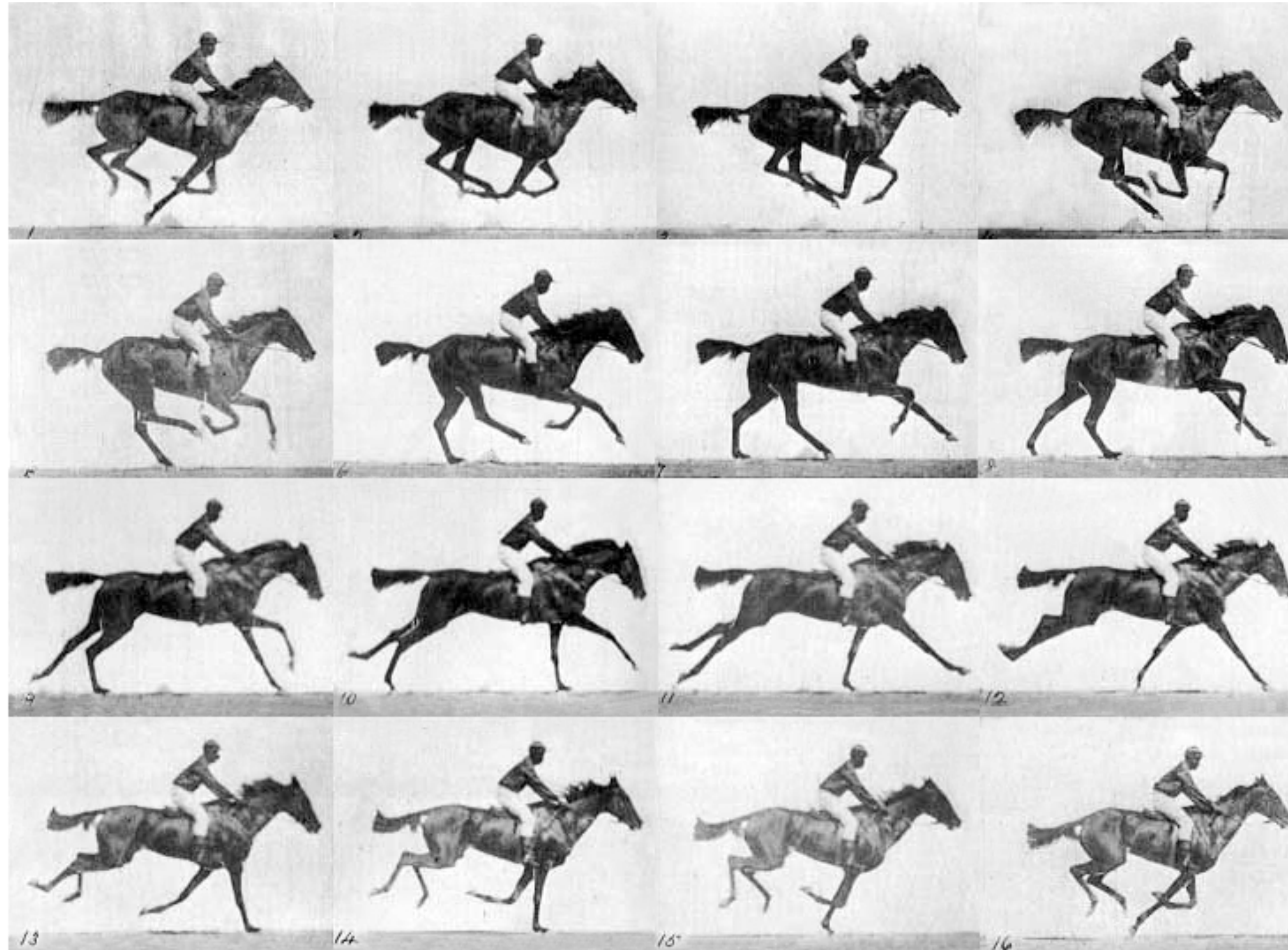


Anaximander's Map of the World

Anaximander of Miletus, c. 550 BC

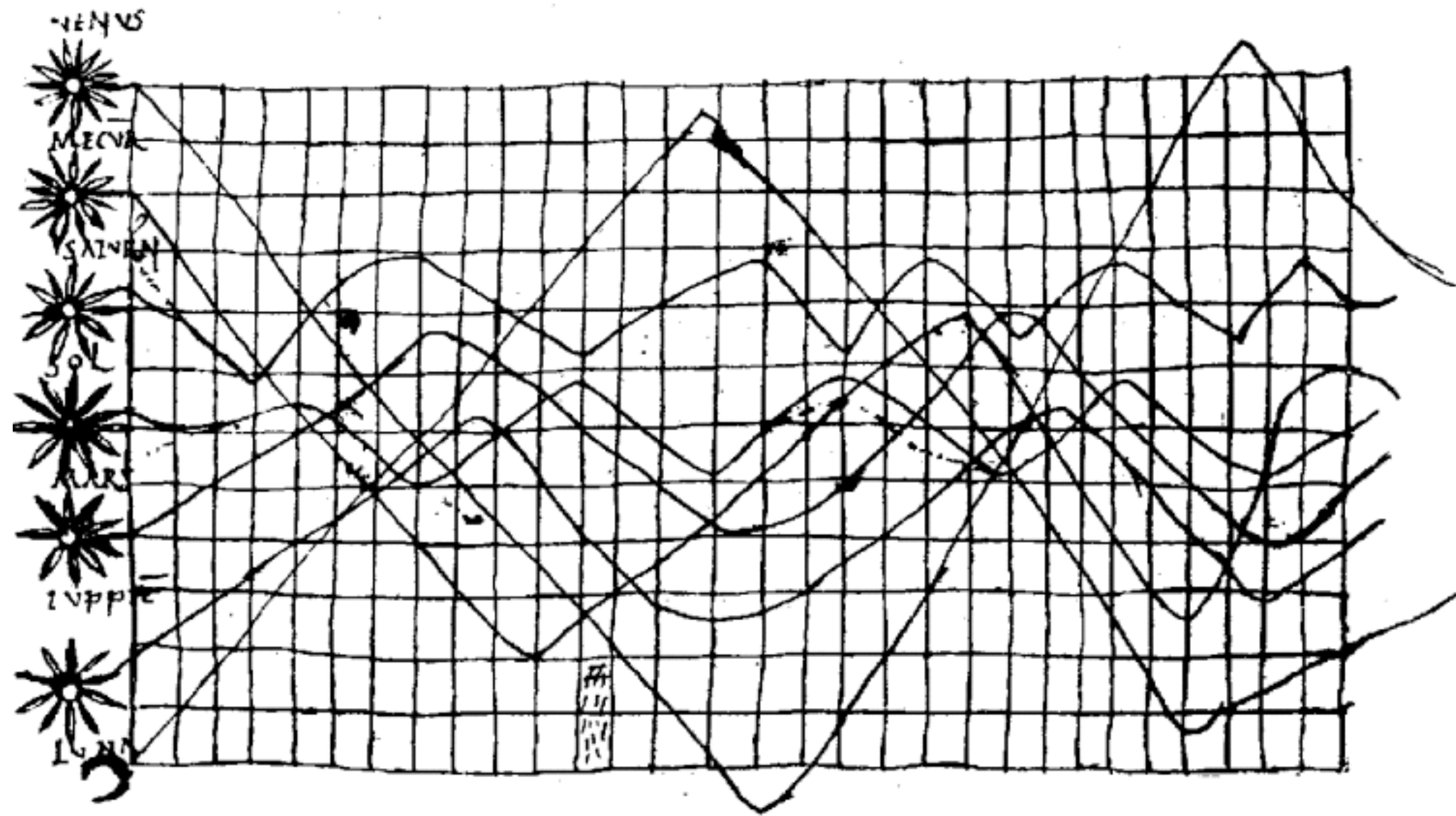


# Record

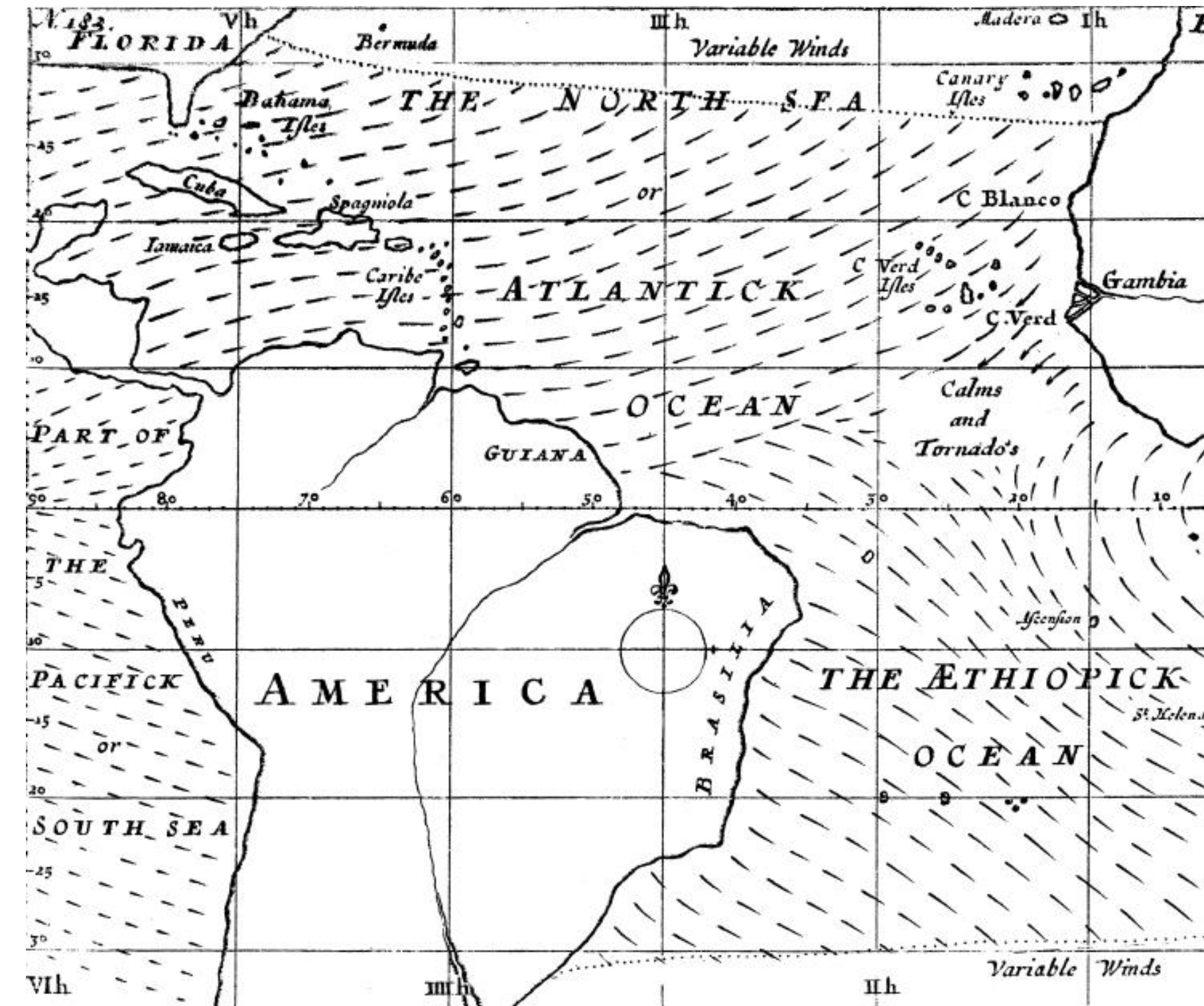


E. J. Muybridge, 1878

# Analyze



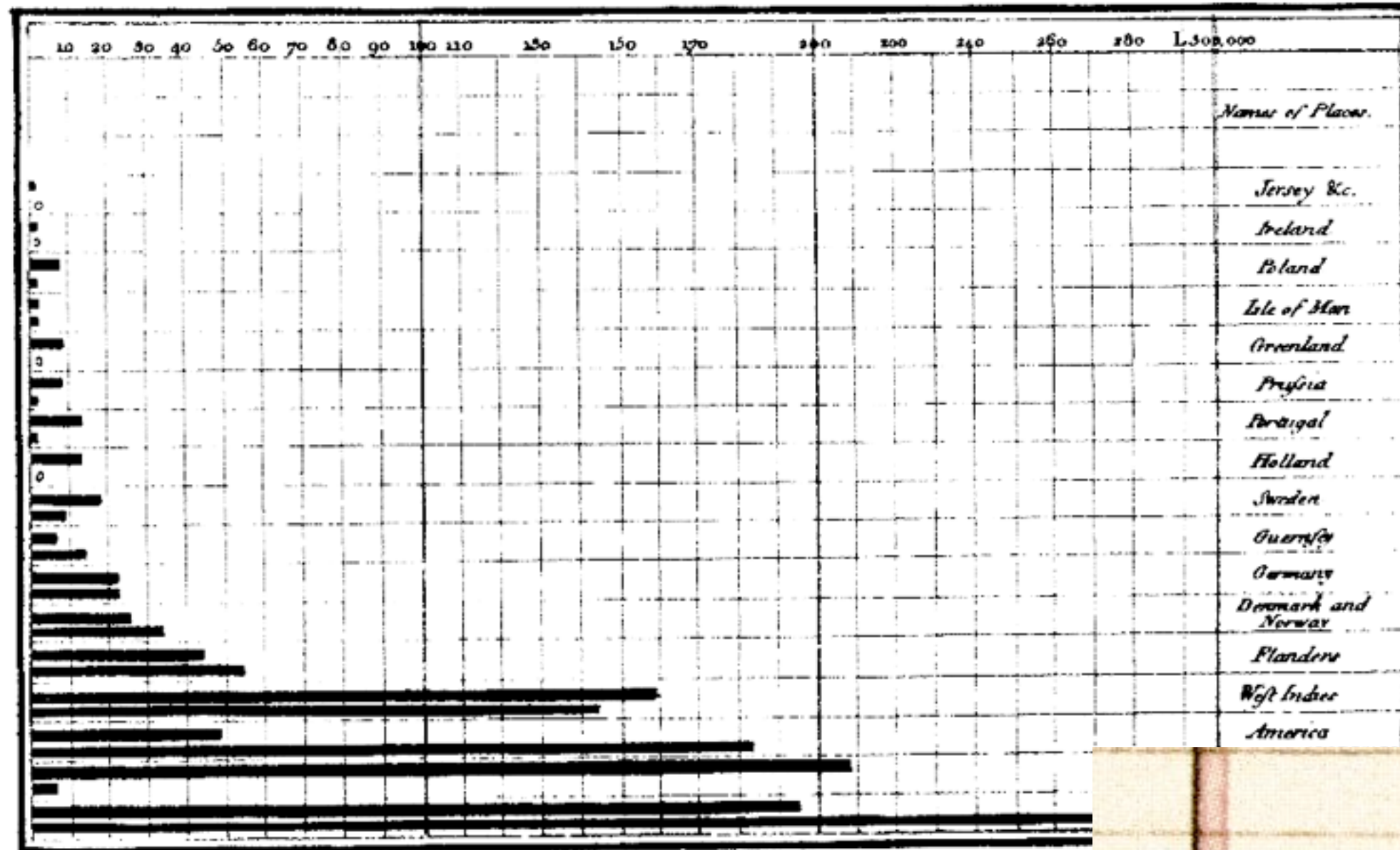
Planetary Movement Diagram, c. 950



Halley's Wind Map, 1686

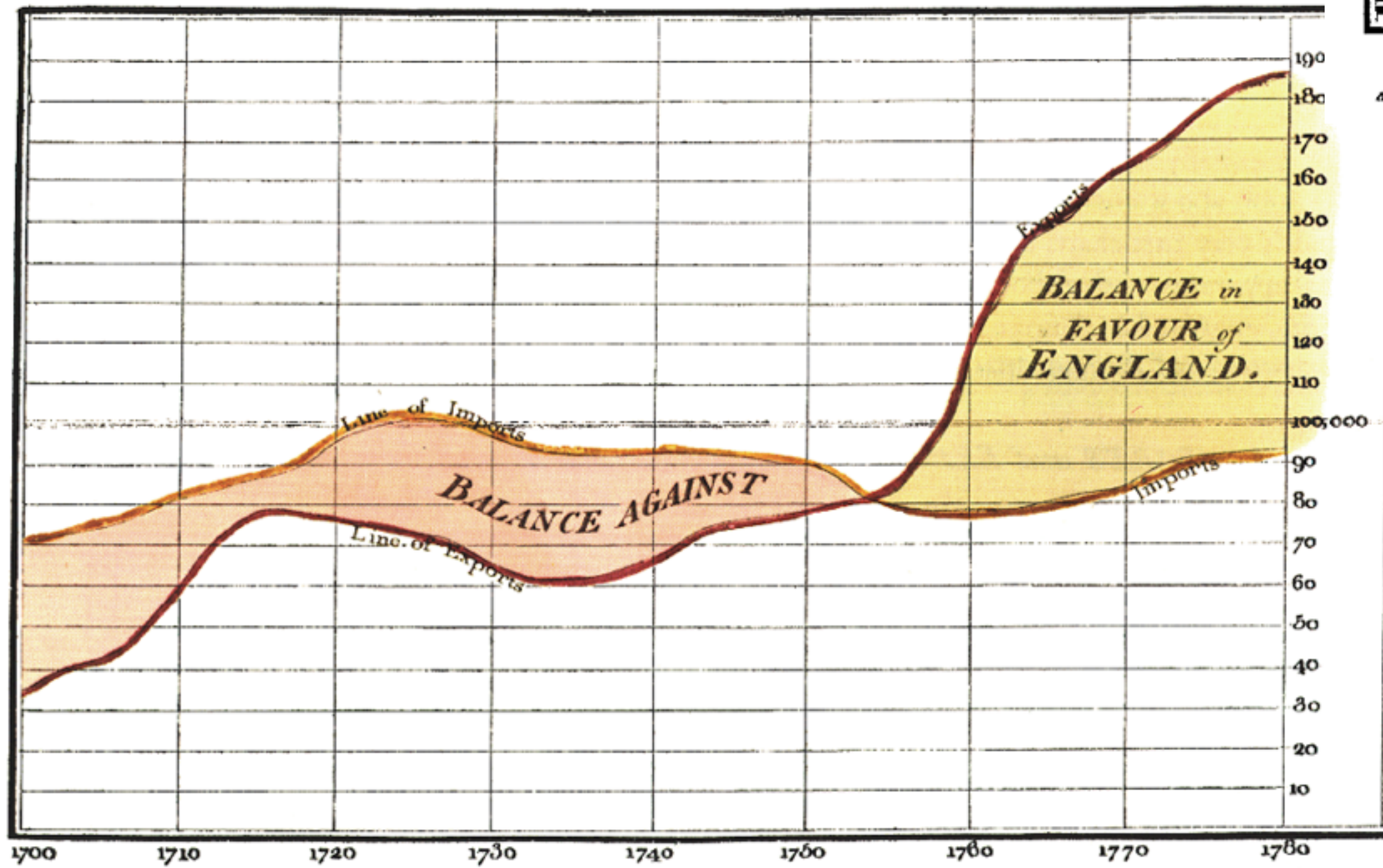
# Analyze

Exports and Imports of SCOTLAND to and from different parts for one Year from Christmas 1780 to Christmas 1781.

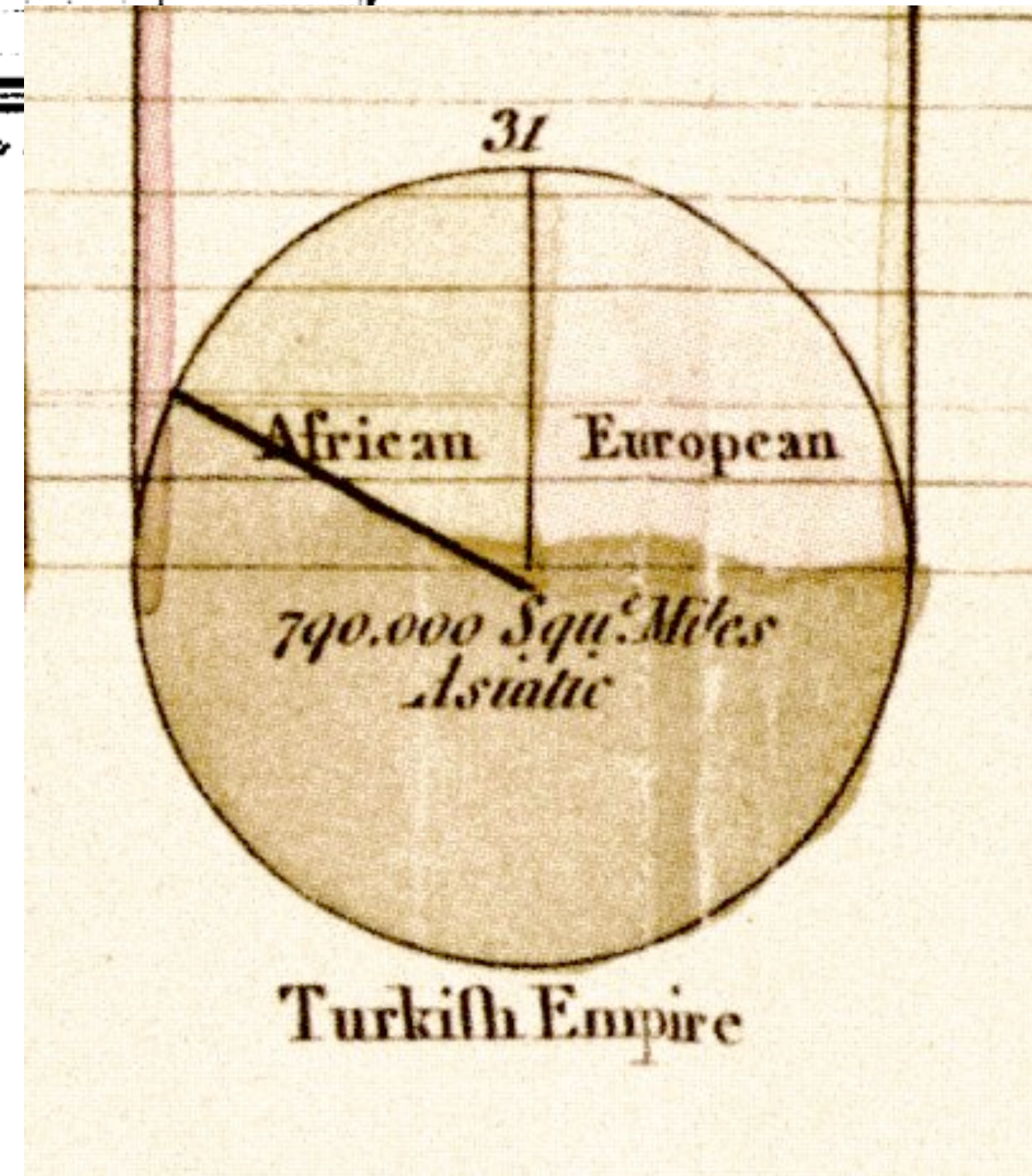


The upright divisions are Ten Thousand Pounds each. The Black Lines are Exports published in the Act passed June 7<sup>th</sup> 1781 by W. Playfair

Exports and Imports to and from DENMARK & NORWAY from 1700 to 1780.



W. Playfair, 1786



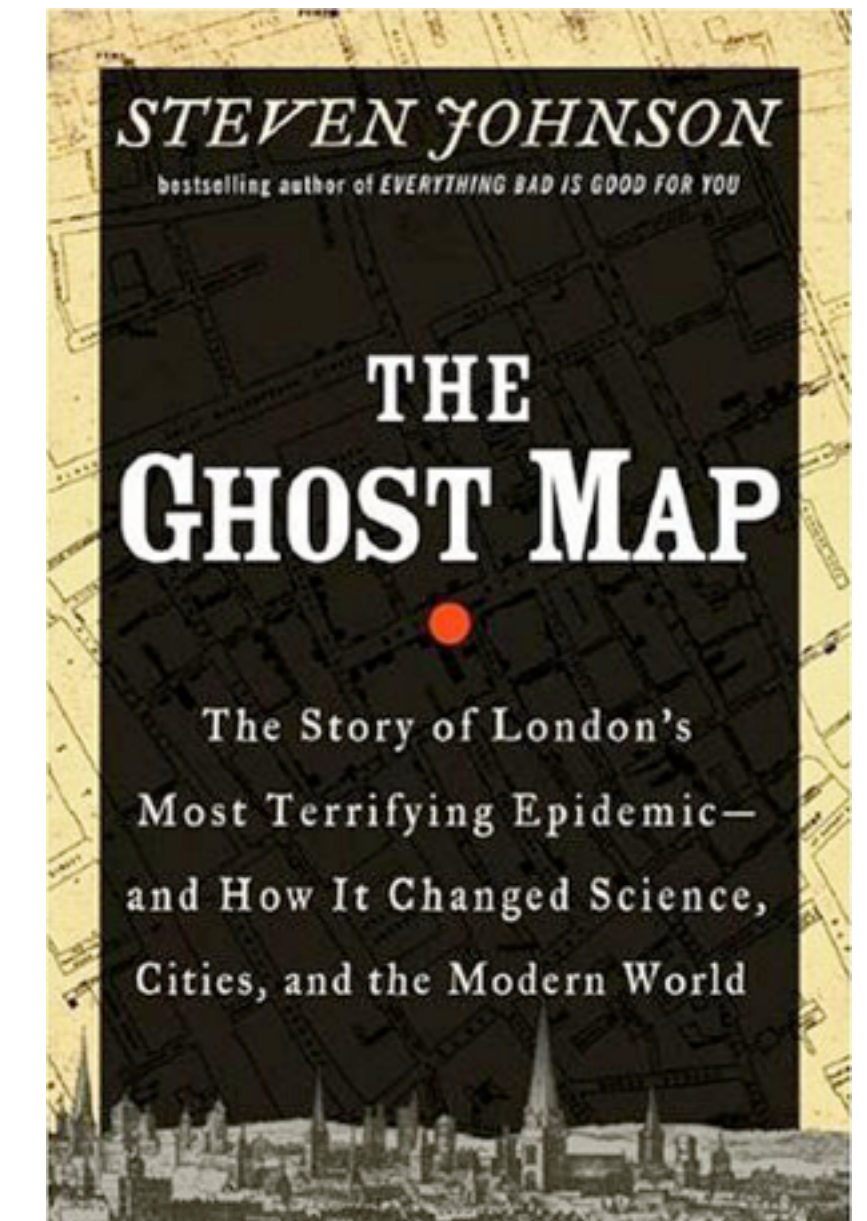
W. Playfair, 1801



# Find Patterns

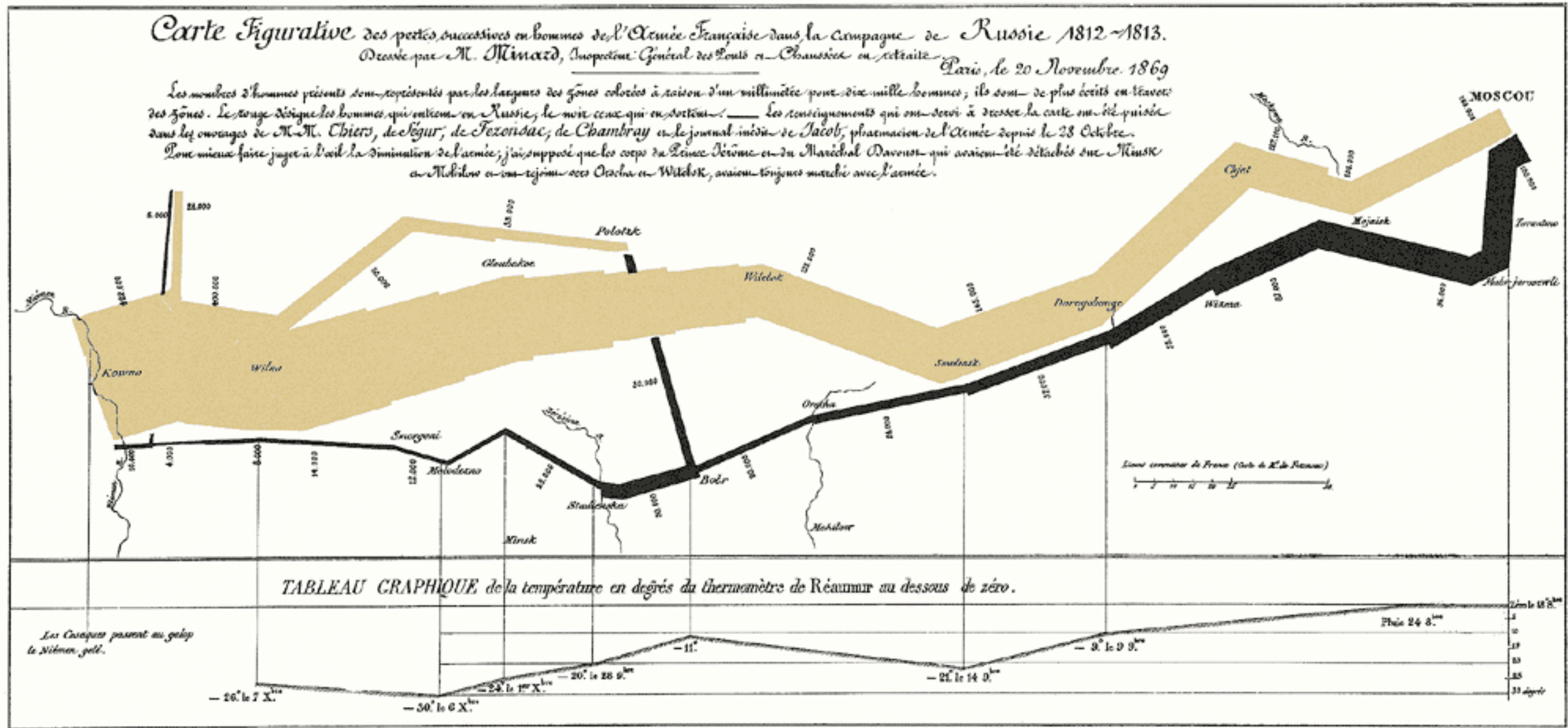


John Snow, 1854



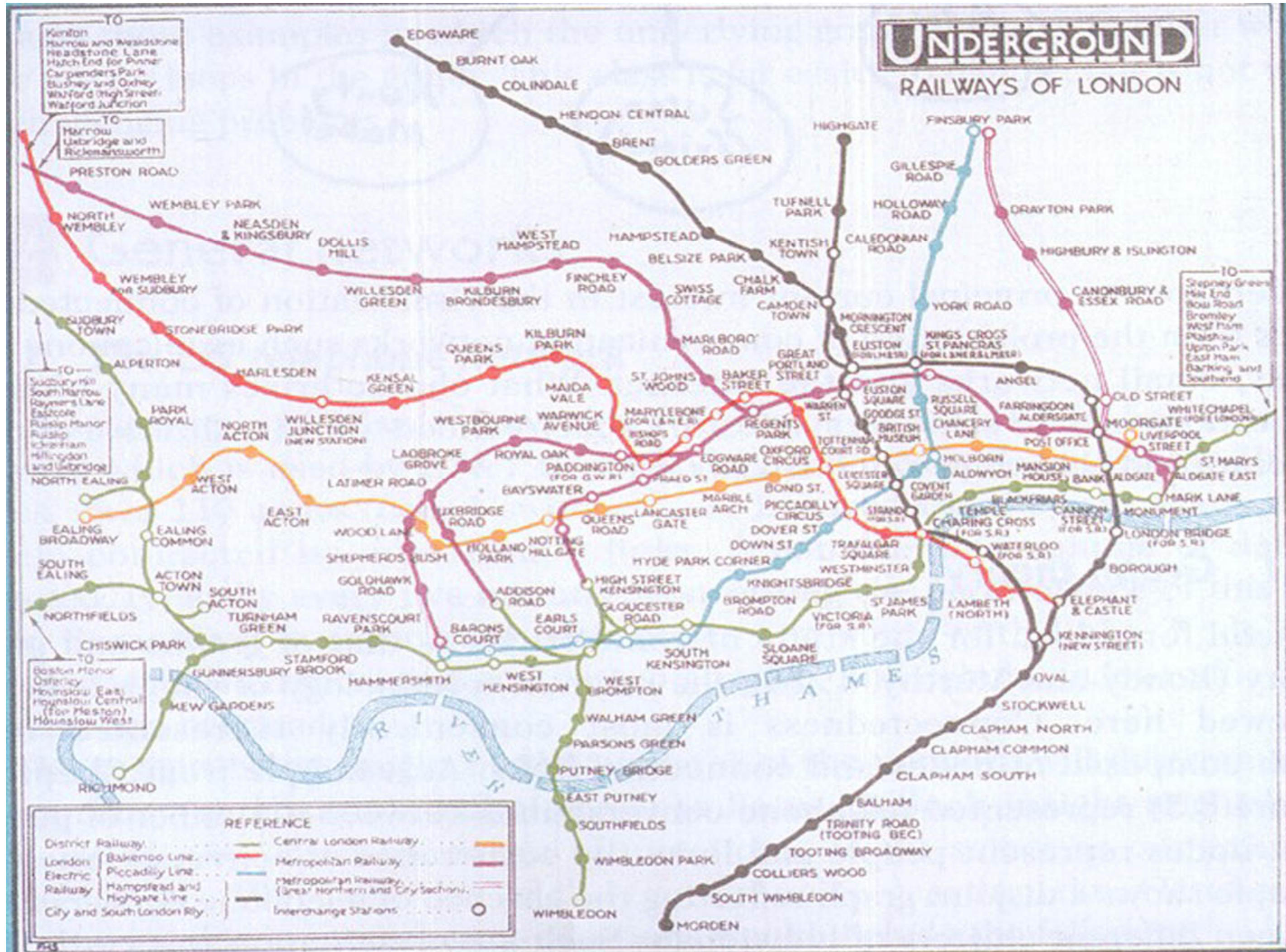
E. Tufte, Visual Explanations, 1997

# Communicate



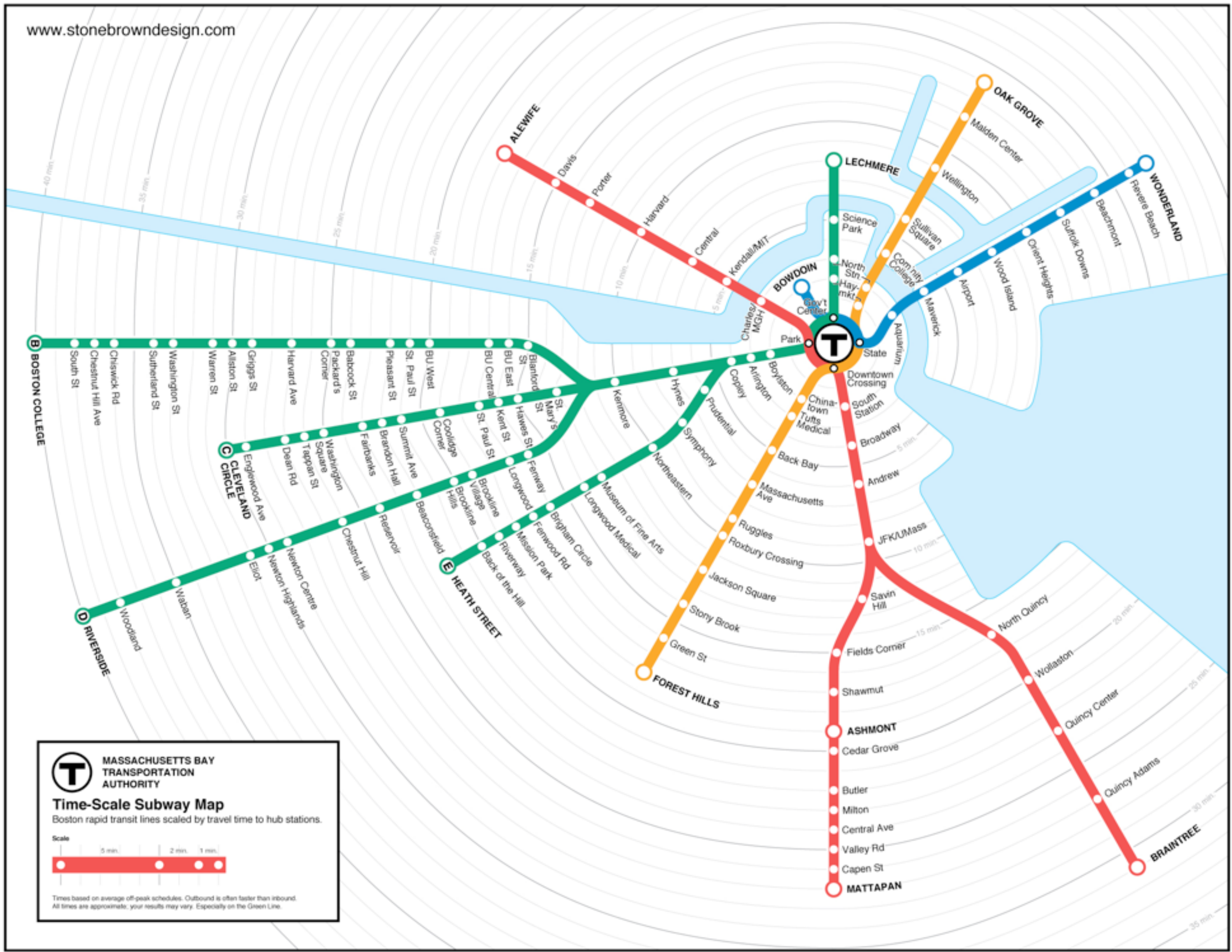
C.J. Minard, 1869

# Communicate



London Subway Map, 1927





**T** MASSACHUSETTS BAY  
TRANSPORTATION  
AUTHORITY

**Time-Scale Subway Map**  
Boston rapid transit lines scaled by travel time to hub stations.

Scale

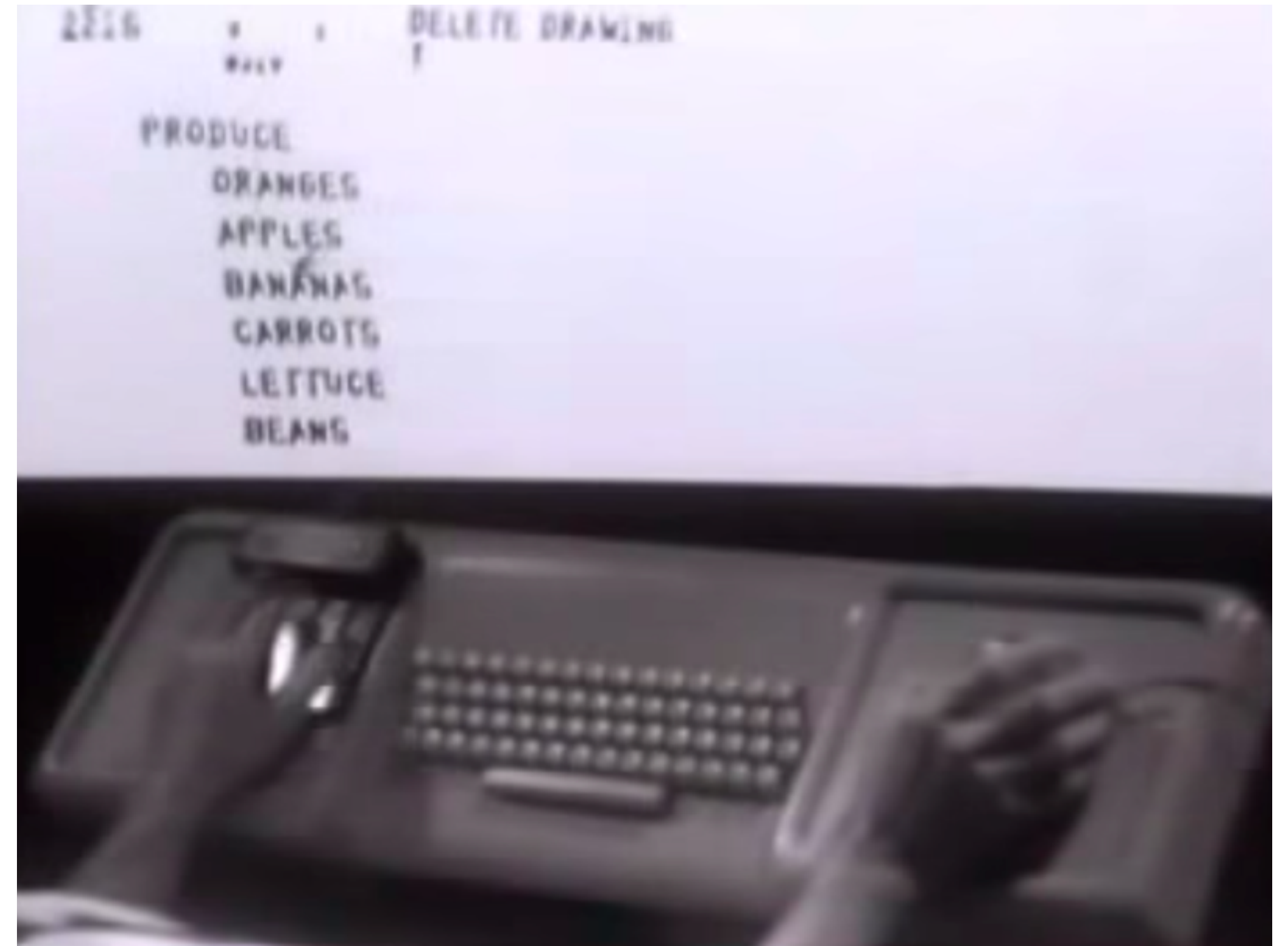
5 min. 2 min. 1 min.

Times based on average off-peak schedules. Outbound is often faster than inbound.  
All times are approximate; your results may vary. Especially on the Green Line.

# Interact



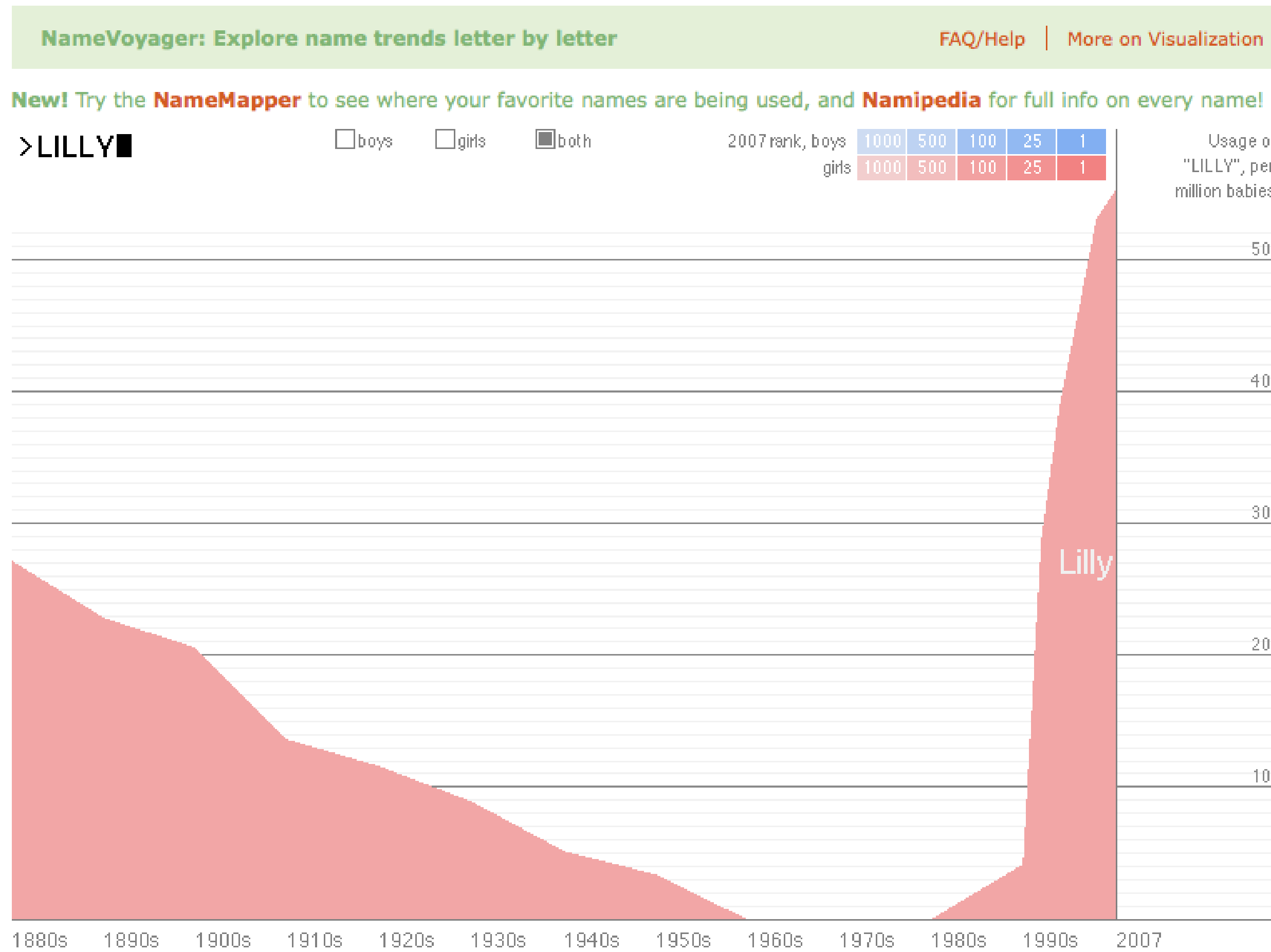
Ivan Sutherland, Sketchpad, 1963



Doug Engelbart, 1968

# Modern Examples

# Analyze



M. Wattenberg, 2005



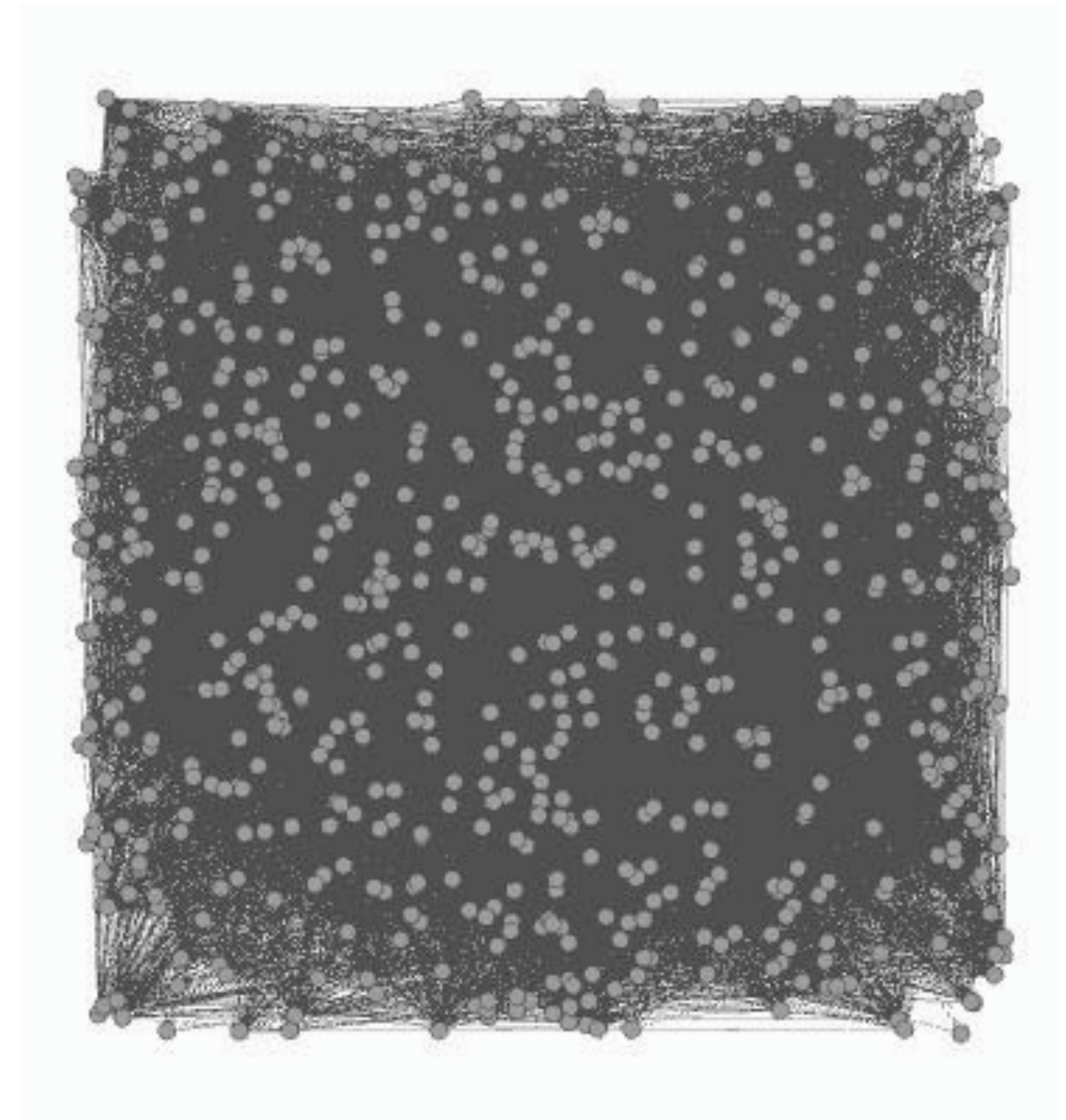
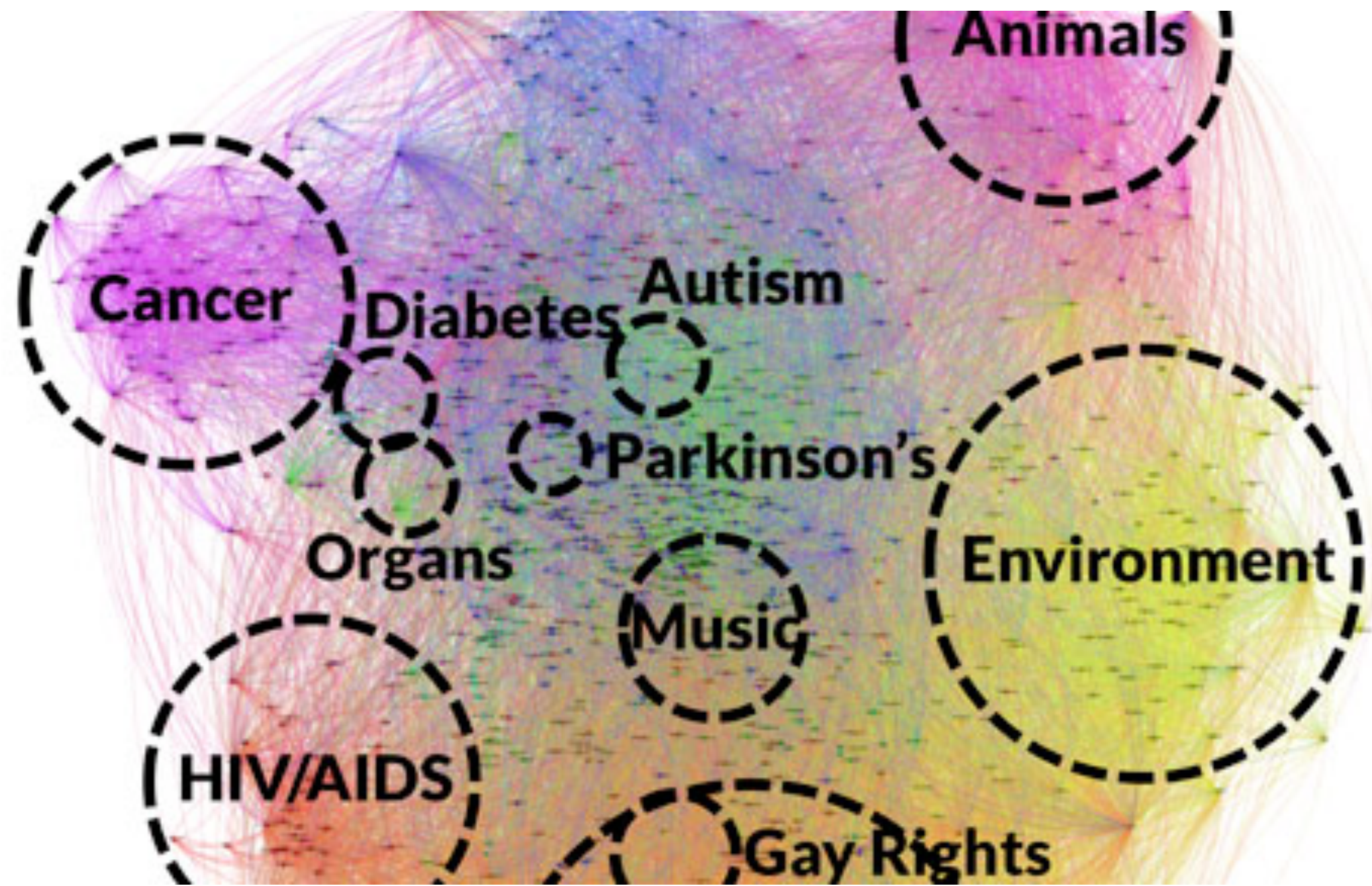
# Communicate



Hans Rosling, TED 2006

**It's about Humans!**

# Not everything that can be drawn can be read!



# Limits of Cognition



Daniel J. Simons and Daniel T. Levin, Failure to detect changes to people during a real world interaction, 1998

**Who is CS-5630 / CS-6630?**

# Alexander Lex

[@alexander\\_lex](https://twitter.com/alexander_lex)  
<http://alexander-lex.net>



Assistant Professor, Computer Science

Before that: Lecturer, Postdoctoral Fellow, Harvard

PhD in Computer Science, Graz University of Technology





# visualization design lab



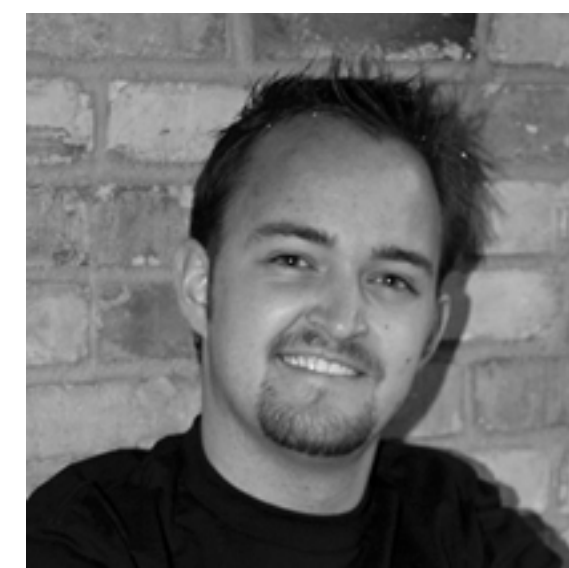
Miriah Meyer



Alexander Lex



Ethan Kerzner



Alex Bigelow



Sean McKenna



Sam Quinan



Nina McCurdy



Jimmy Moore



Sunny Hardasani



Carolina Nobre

<http://vdl.sci.utah.edu/>



# SCI Institute

Scientific Computing and Imaging Institute

Scientific Computing

Biomedical Computing

Scientific Visualization

Information Visualization

Image Analysis





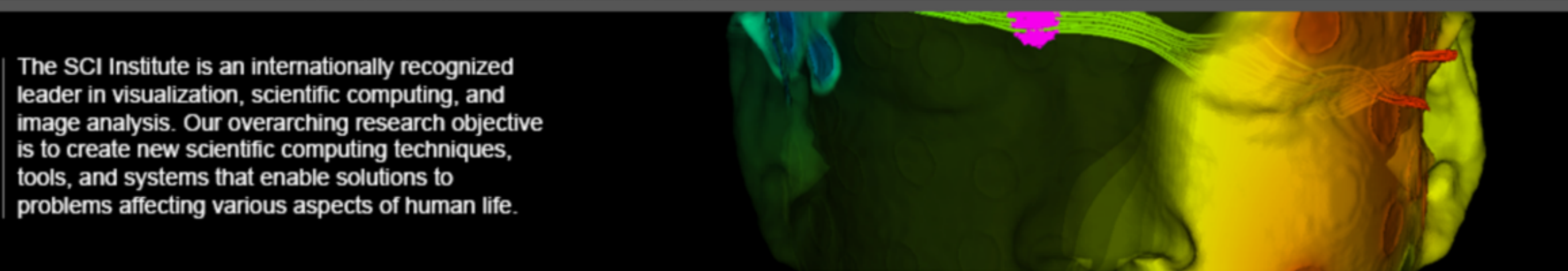
# <http://sci.utah.edu>

[Login](#) [Admin](#)



University of Utah

SCIENTIFIC COMPUTING AND IMAGING INSTITUTE



The SCI Institute is an internationally recognized leader in visualization, scientific computing, and image analysis. Our overarching research objective is to create new scientific computing techniques, tools, and systems that enable solutions to problems affecting various aspects of human life.

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- [Internal](#)

## News from the SCI Institute

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PREV **1** 2 3 4 NEXT



SCIRun 5.0 Released



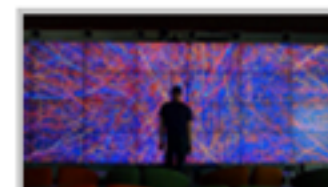
### Seg3D 2.2.0 Now Available

Jul 01, 2015



### SCI Institute welcomes two new Professors in Computer Science and Mathematics

Jun 25, 2015



### Big Scientific Data Made Simple

Jun 23, 2015

## SCI Events

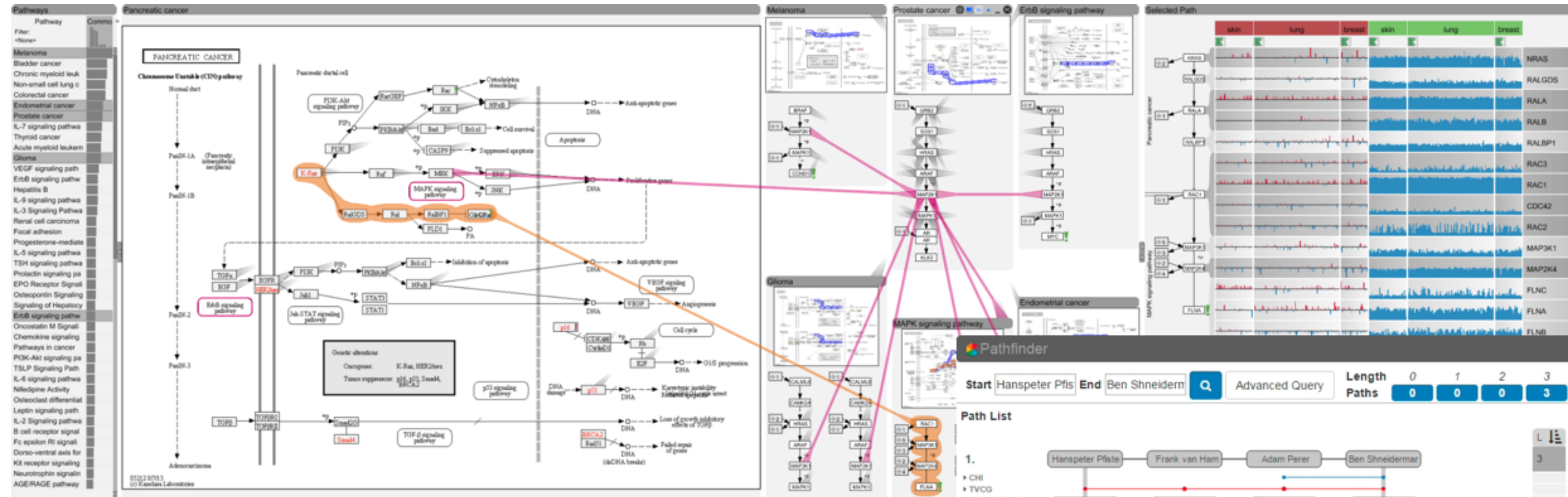
Aug 2015						
S	M	T	W	T	F	S
26	27	28	29	30	31	1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31	1	2	3	4	5

[RSS 2.0](#) [FEED](#)

[View all SCI Events](#)

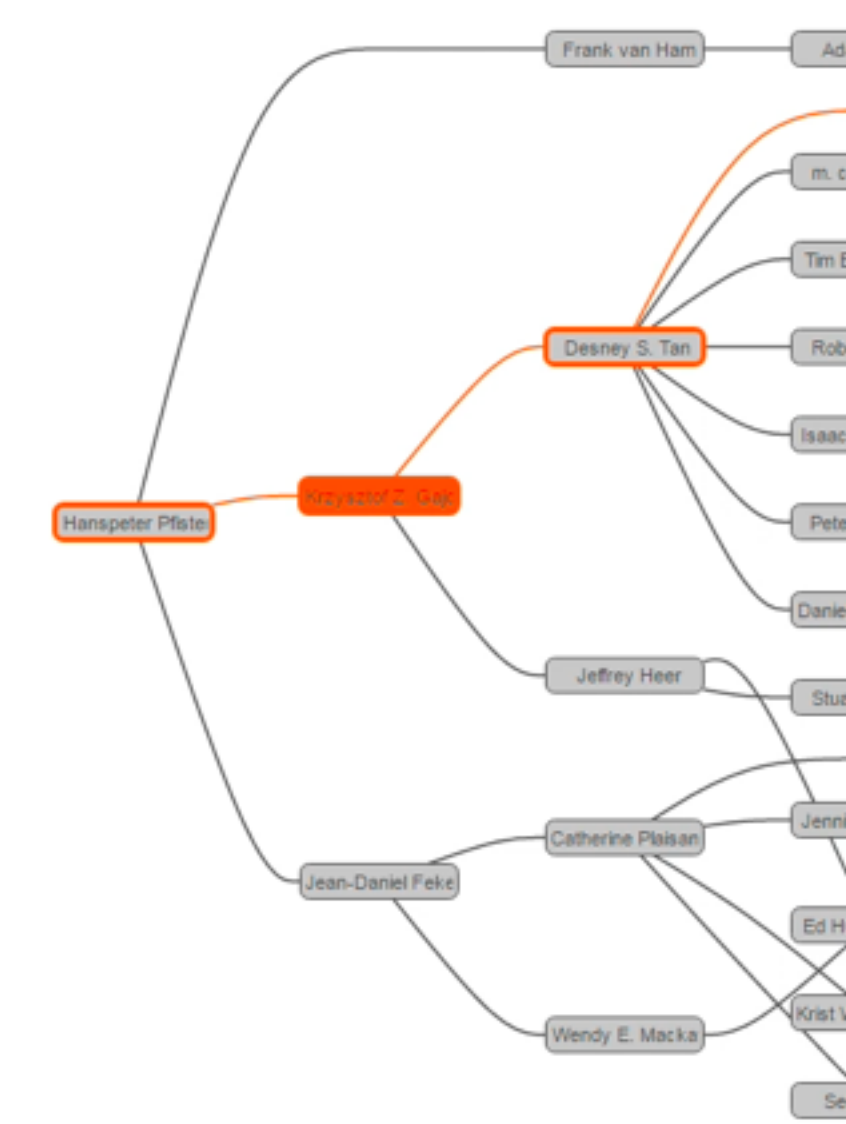
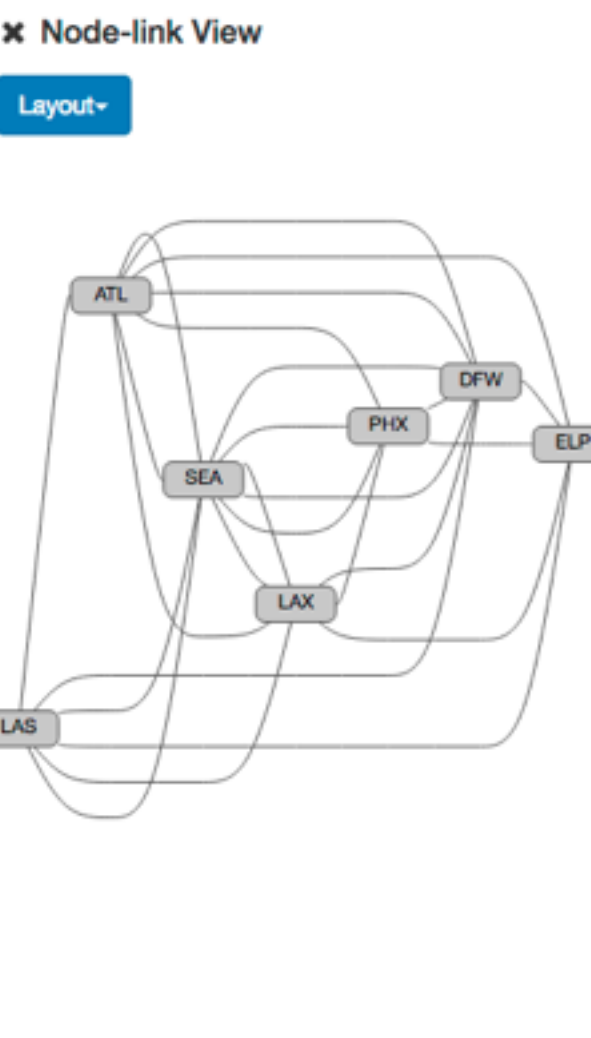
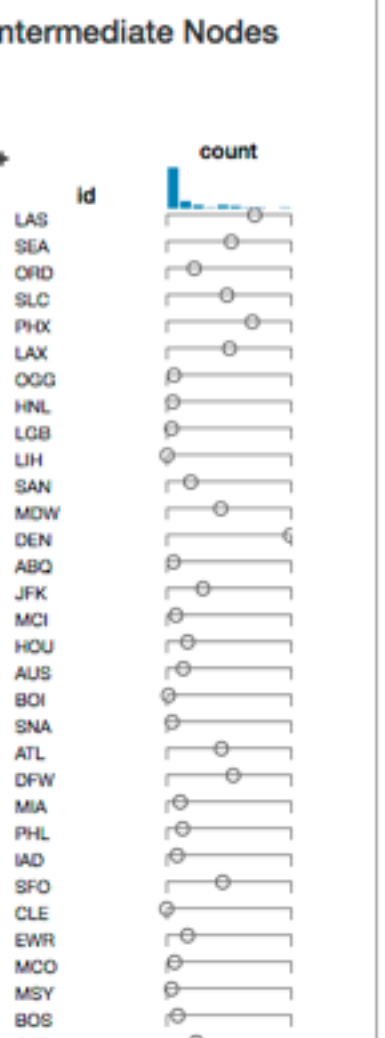
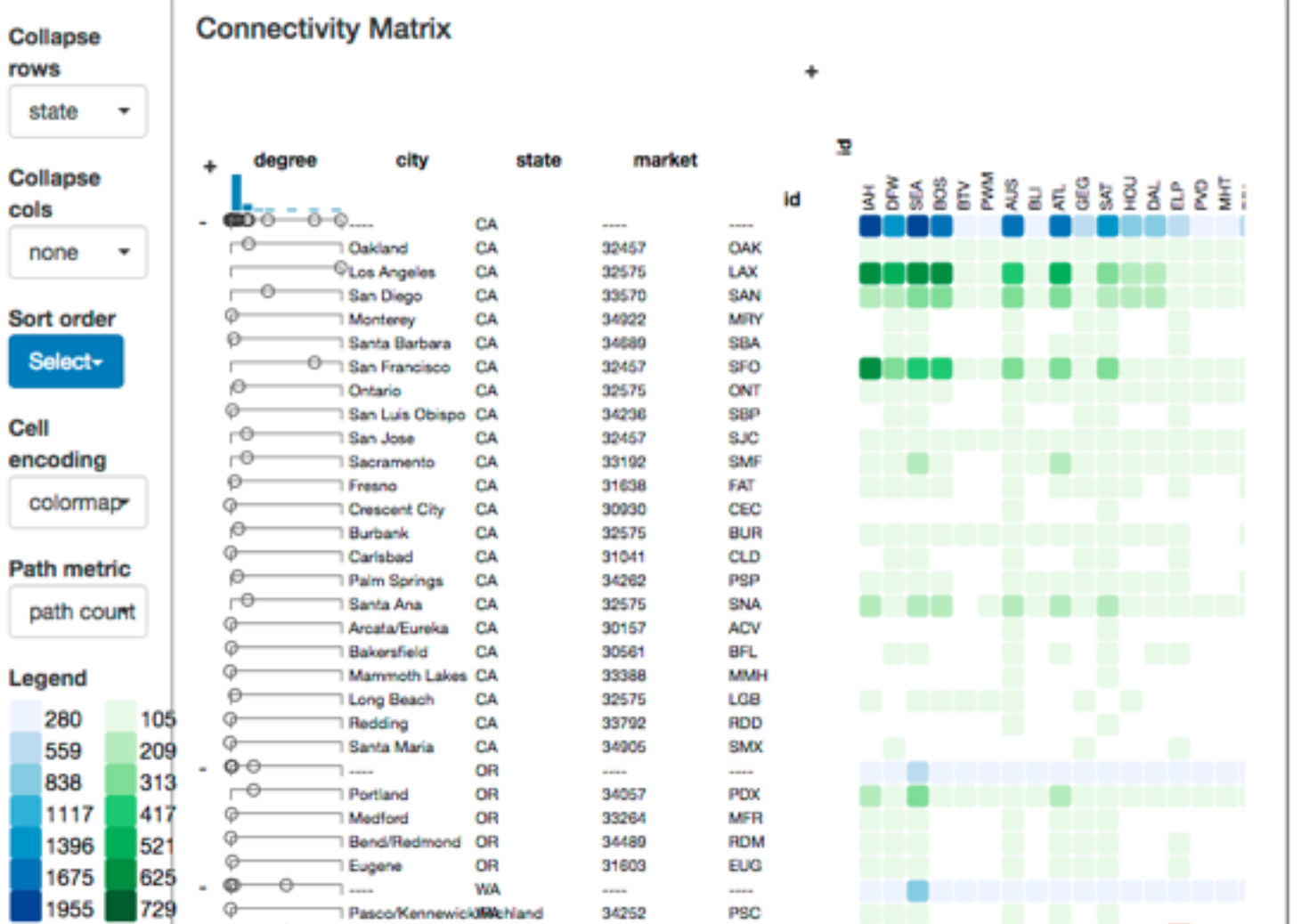
## Upcoming SCI Events

# Large, Multivariate (Biological) Networks

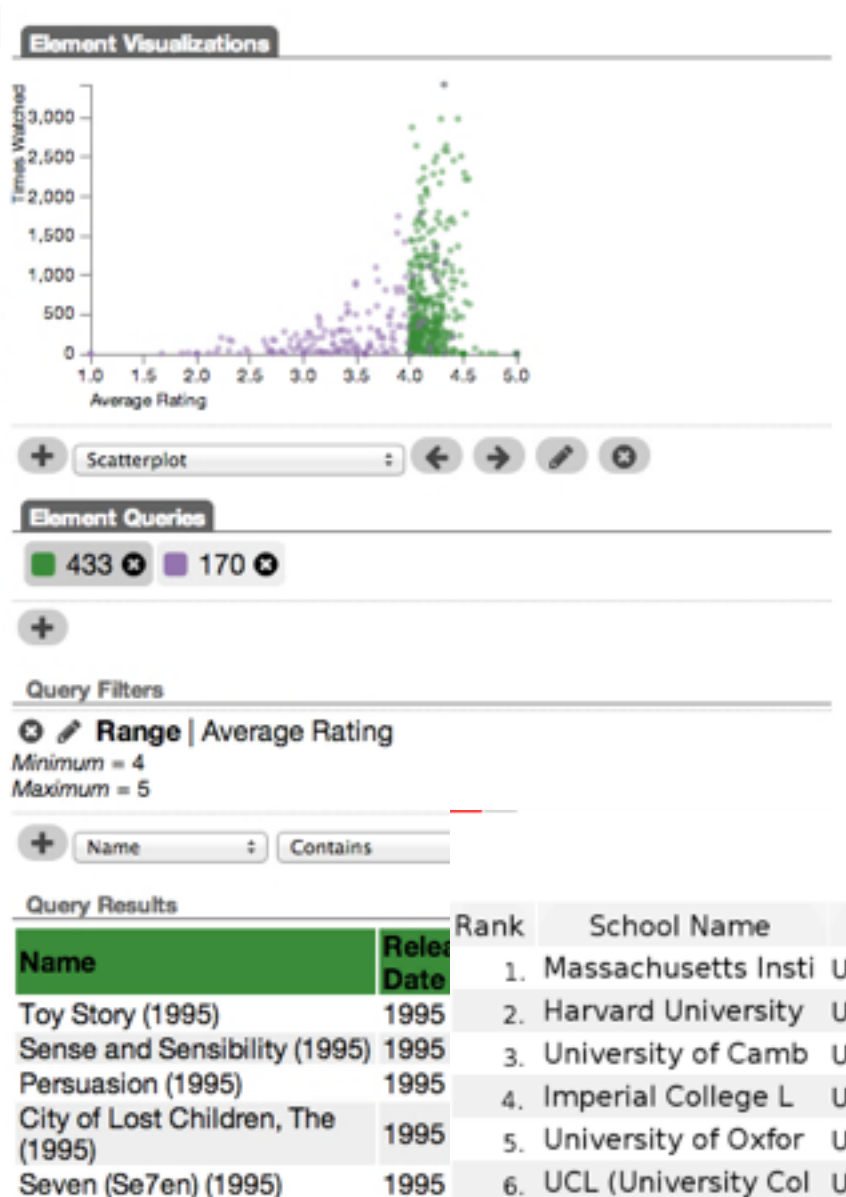
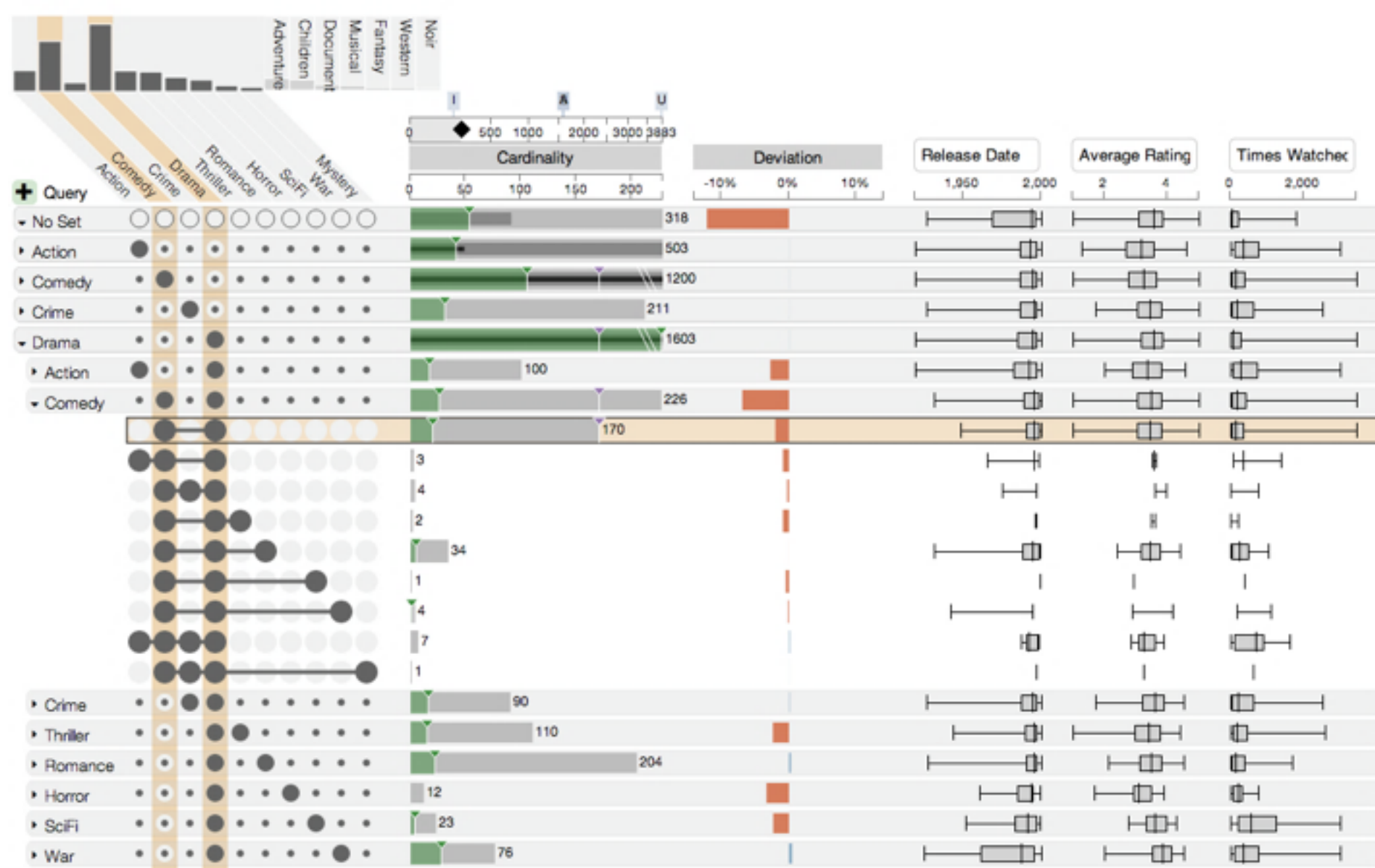


MATCH p = (s)-[x:FLIGHT]->()-[y:FLIGHT]->(t) WHERE s.state in ['CA', 'OR', 'WA'] AND t.state in ['CT', 'ME', 'MA', 'RI', 'NH', 'VT', 'WA', 'TX', 'GA'] AND x.carrier = y.carrier AND x.arr\_time < y.dep\_time

Submit  
Query statistics  
Length 2  
Paths 18389

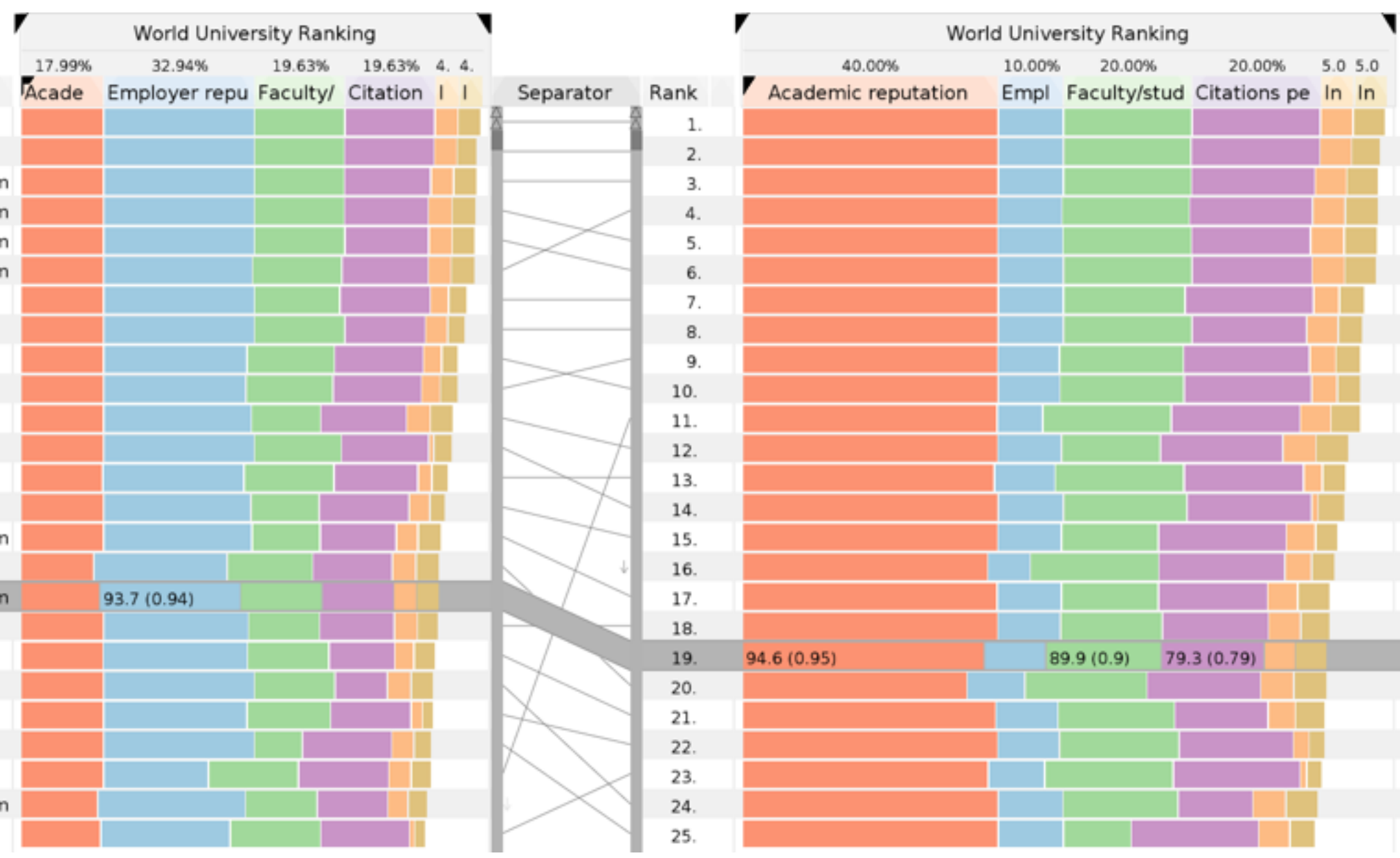


# Multidimensional Data



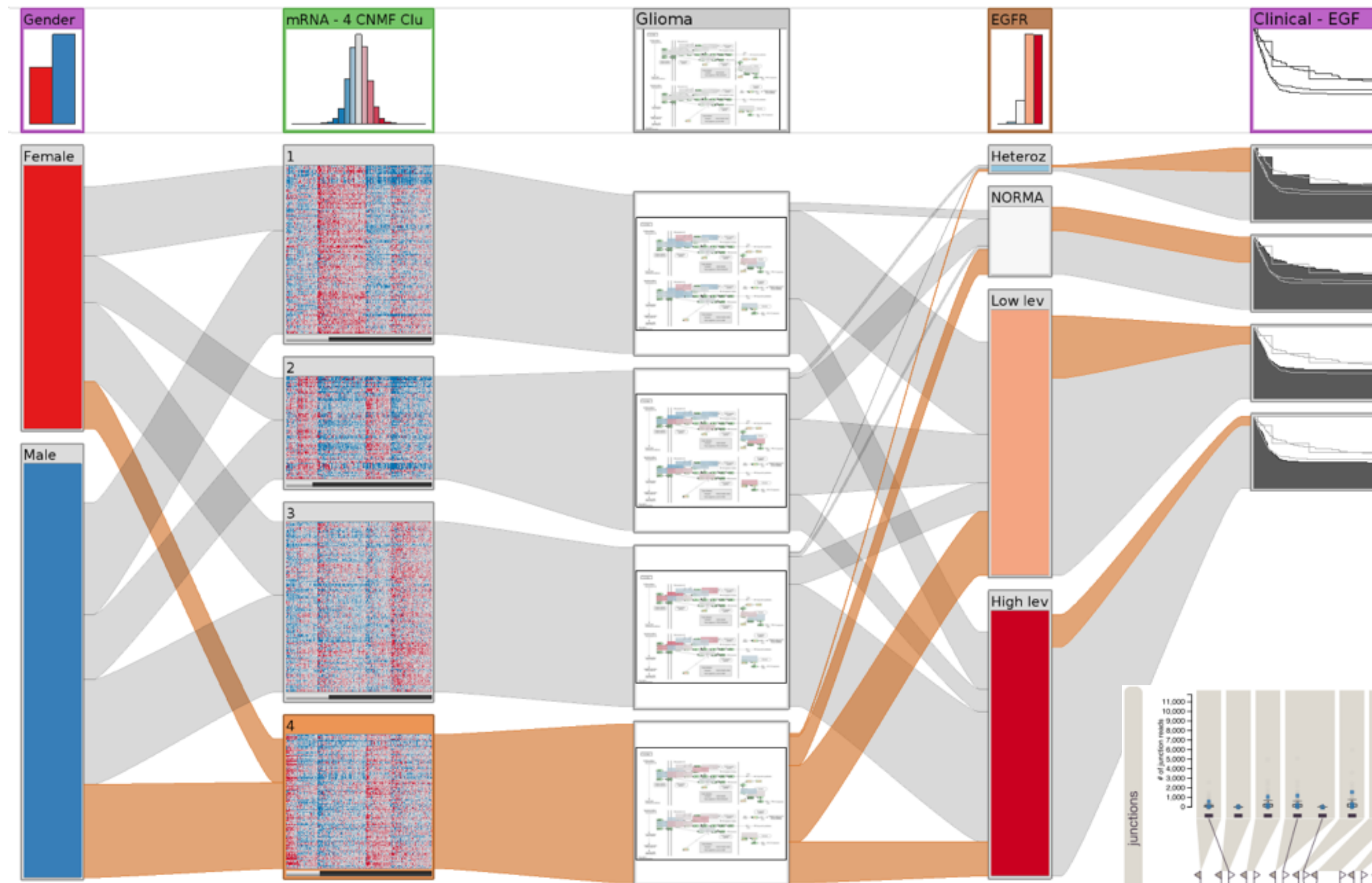
Name	Release Date	Rank	School Name	Country
Toy Story (1995)	1995	1.	Massachusetts Insti	United States
Sense and Sensibility (1995)	1995	2.	Harvard University	United States
Persuasion (1995)	1995	3.	University of Camb	United Kingdom
City of Lost Children, The (1995)	1995	4.	Imperial College L	United Kingdom
Seven (Se7en) (1995)	1995	5.	University of Oxfor	United Kingdom
		6.	UCL (University Col	United Kingdom
		7.	Stanford University	United States
		8.	Yale University	United States
		9.	Princeton Universit	United States
		10.	University of Chica	United States
		11.	ETH Zurich (Swiss F	Switzerland
		12.	Columbia Universit	United States
		13.	University of Penns	United States
		14.	Cornell University	United States
		15.	University of Edinb	United Kingdom
		16.	Ecole Polytechniqu	Switzerland
		17.	King's College Lond	United Kingdom
		18.	University of Toron	Canada
		19.	McGill University	Canada
		20.	National University	Singapore
		21.	University of Michi	United States
		22.	University of Califo	United States
		23.	California Institute	United States
		24.	University of Bristol	United Kingdom
		25.	Duke University	United States

# Multivariate Rankings

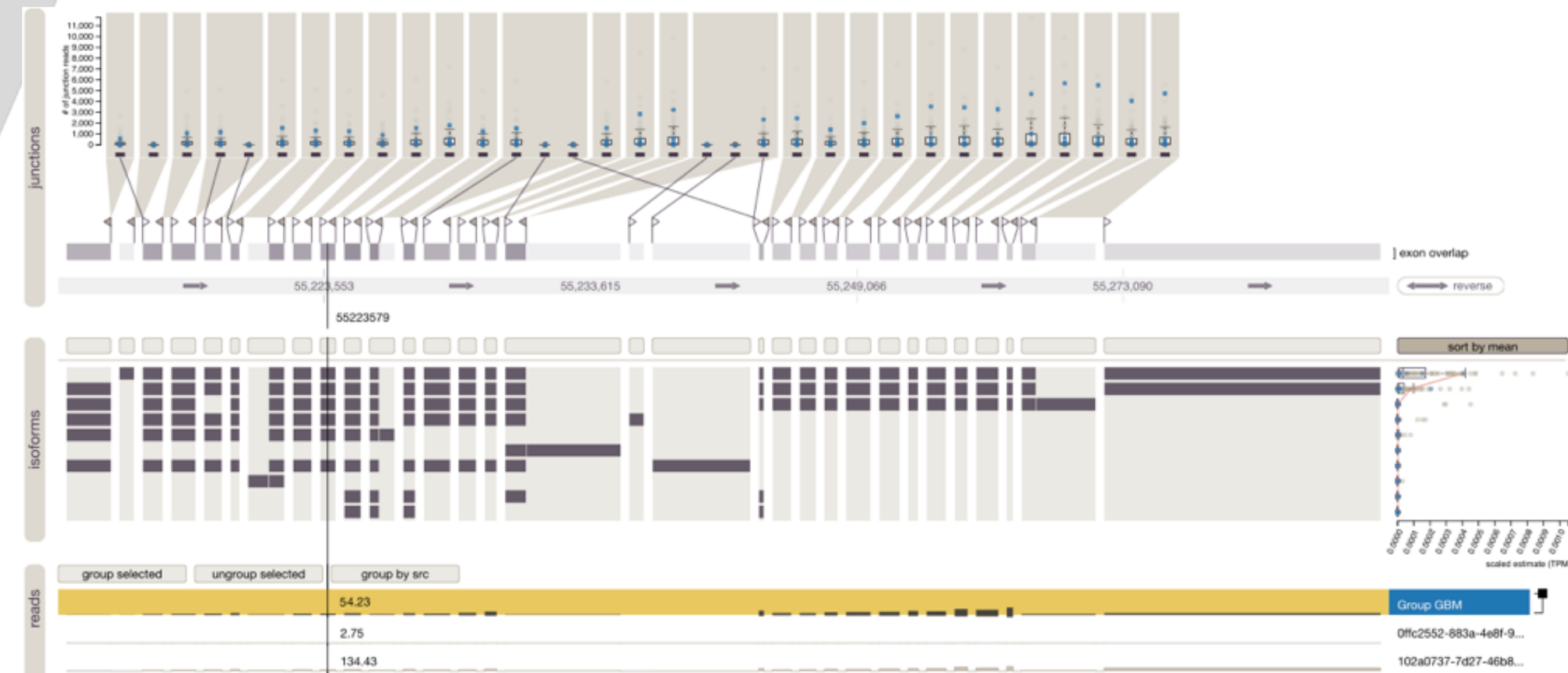


# Set Visualization

# Genomic Data



# Alternative Splicing / mRNA-seq



# Cancer Subtypes / Omics Clustering and Stratification

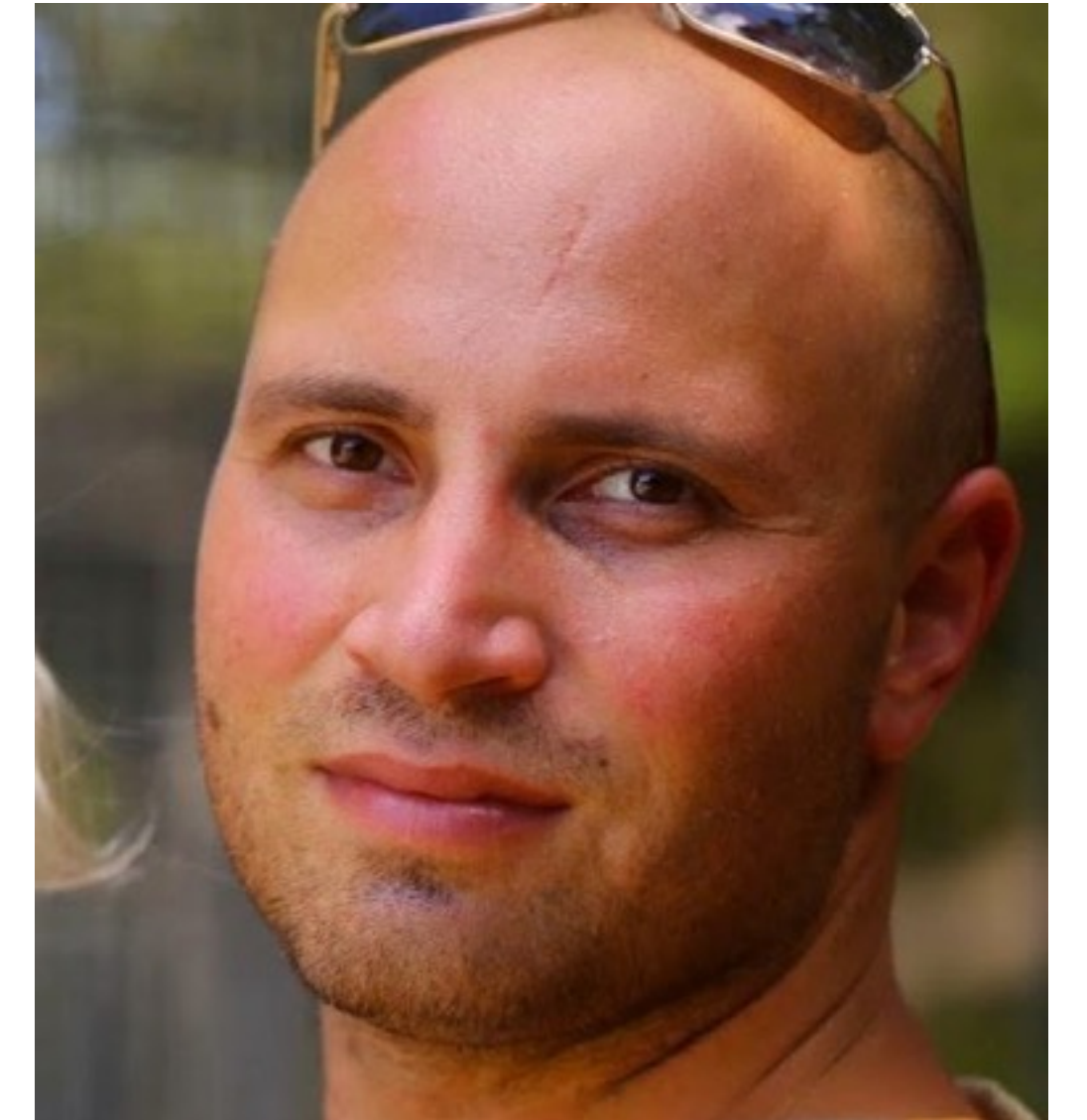
# Aaron Knoll

Guest Lectures on Scientific Visualization

Research Scientist at SCI, SciVis Expert!

PhD from Univ. of Utah

PostDoc at University of Kaiserslautern in  
Germany, and then at Argonne National  
Laboratory



# Course Staff

**Vinitha Yaski**  
*Teaching Assistant*



**Carolina Nobre**  
*Teaching Mentee*



**Yogesh Mishra**  
*Teaching Assistant*

About You

# Structure & Goals



# Course Goals. You will learn:

How to **efficiently visualize data**

**Evaluate** and **critique** visualization designs

**Apply** fundamental principles & techniques

**Design** visual data analysis solutions

**Implement** interactive data visualizations

Web development skills

# Course Components

**Lectures:** introduce theory

**Design Critiques:** develop “an eye” for vis design, critique, learn by example

**Labs:** short coding tutorials, examples

Based on a published script on website

Strongly related to homework assignments

**Homeworks** help practice specific skills

**Final Project** gives you a chance to go through a complete vis project

# Course Components

Theory

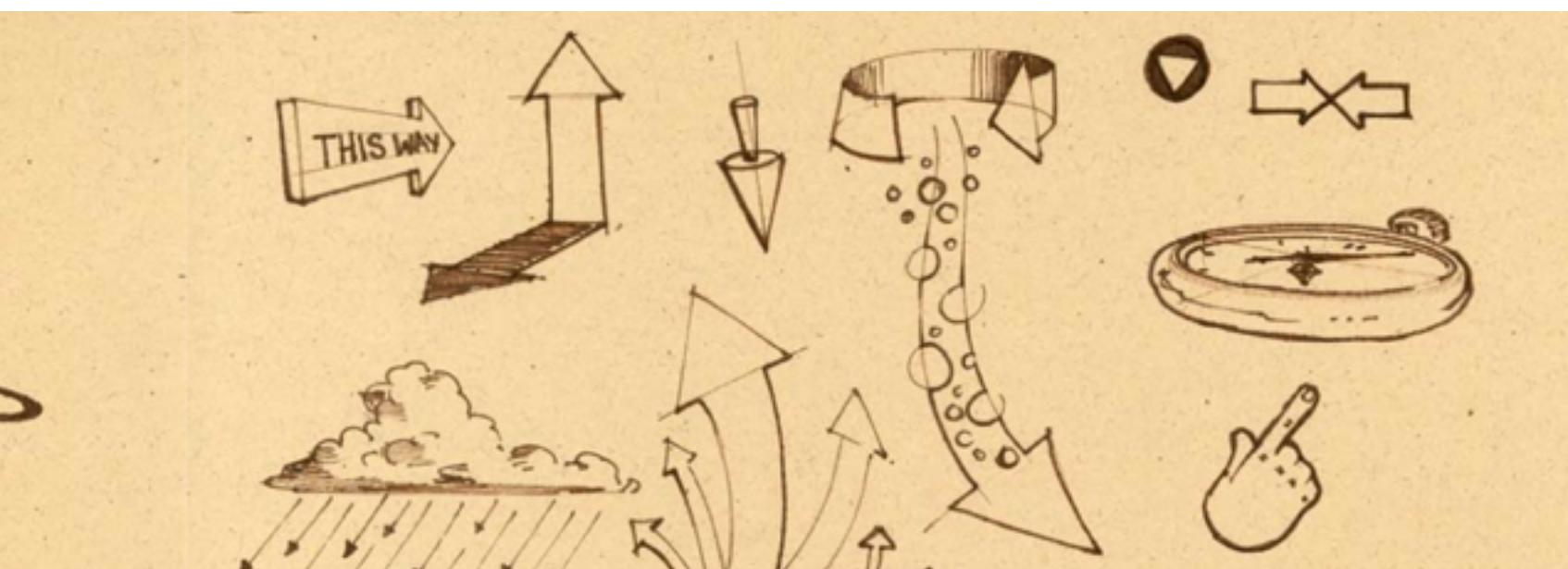
Lecture  
Reading  
Discussion

Design Lecture  
Design Studios

Labs  
D3 reading  
Self-study  
Office hours

Design Skills

Coding Skills



```
<!DOCTYPE html>  
<meta charset="utf-8">  
<style>  
  
text {  
  font: 10px sans-serif;  
}  
  
</style>  
<body>  
<script src="http://d3js.org/d3.v3.min.js"></script>  
</script>
```

# Schedule

**Lectures:** Tuesday and Thursday 2:00-3:20 pm, L101  
WEB

**Online Students:**  
[YouTube Channel](#)

Four Parts:

## I. Technical Foundations

HTML, Javascript, D3

## II. Visualization Fundamentals

Perception, Visual encodings, Design Guidelines,  
Tasks..

## III. Abstract Data Visualization

Tables, Graphs, Maps

## IV. Spatial Data Visualization

Volumes, Surfaces, Flow

## Schedule

### Week 1

#### Lecture 1: Introduction

Tuesday, August 23, 2016

What is visualization? Why is it important? Who are we? Course overview.

Introduction to **Homework 0**.

#### Recommended reading

- [A Tour through the Visualization Zoo](#). Jeffrey Heer, Michael Bostock, Vadim Ogievetsky. Communications of the ACM, 53(6), pp. 59-67, Jun 2010.
- [The Value of Visualization](#). Jarke van Wijk. Proceedings of the IEEE Visualization Conference, pp. 79-86, 2005.

## Part I: Technical Foundations

#### Lecture 2: Version Control and HTML

Thursday, August 25, 2016

Introduction to git. HTML, CSS and the DOM. Selectors, etc.

- [Version Control with git](#)
- [HTML, CSS and SVG](#)

#### Mandatory reading

- [D3 Book, Chapters 1-3](#)
- [VDA Book, Chapter 1](#)

#### Recommended reading

- [Think like a git](#)
- [Understanding git conceptually](#)
- [Fun and insightful talk on git by Linus Torvalds](#)
- [A successful git branching model](#)
- [MDN HTML Elements reference](#)
- [MDN CSS Reference](#)
- [MDN selectors webpage](#)
- [Overview of the Chrome developer tools](#)
- [MDN SVG tutorial](#)

**Homework 0, Introduction due.**

**Friday, Aug. 26, 11:59pm**

# Information <http://dataviscourse.net>

The screenshot shows the header of the Visualization course website. On the left, the title "Visualization" is displayed in a large, bold, black font, with the course numbers "CS-5630 / CS-6630" below it. To the right is the logo for The University of Utah, featuring a red stylized 'U' followed by the text "THE UNIVERSITY OF UTAH". Below the header is a navigation menu with links for "Home", "Syllabus", "Schedule", "Homework", "Project", "Resources", and "Fame".

The main content area features three distinct visualizations:

- UpSet visualization:** A complex chart on the left showing the relationships between various genres (Action, Comedy, Drama, etc.) and their constituent elements. It includes a grid of dots and a bar chart showing the cardinality of each set.
- Wind map:** A map of the United States in the center, where the density of lines represents wind patterns across the country.
- How states have shifted:** A Sankey diagram on the right showing the flow of political affiliations or state shifts over time, with labels for candidates like Obama, McCain, Clinton, and Dole.

Below the visualizations, a red caption reads: "UpSet visualizing intersecting sets | Wind map | How states have shifted".

The amount and complexity of information produced in science, engineering, business, and everyday human activity is increasing at staggering rates. The goal of this course is to expose you to visual representation methods and techniques that increase the understanding of complex data. Good visualizations not only present a visual interpretation of data, but do so by improving comprehension, communication, and decision making.

In this course you will learn about the fundamentals of perception, the theory of visualization, good design practices for

# Communicate

## Canvas

**<https://utah.instructure.com/courses/389965/>**

**Please use forum for all general questions - code, concepts, etc.**

**Only use e-mail for personal inquiries**

## Office Hours

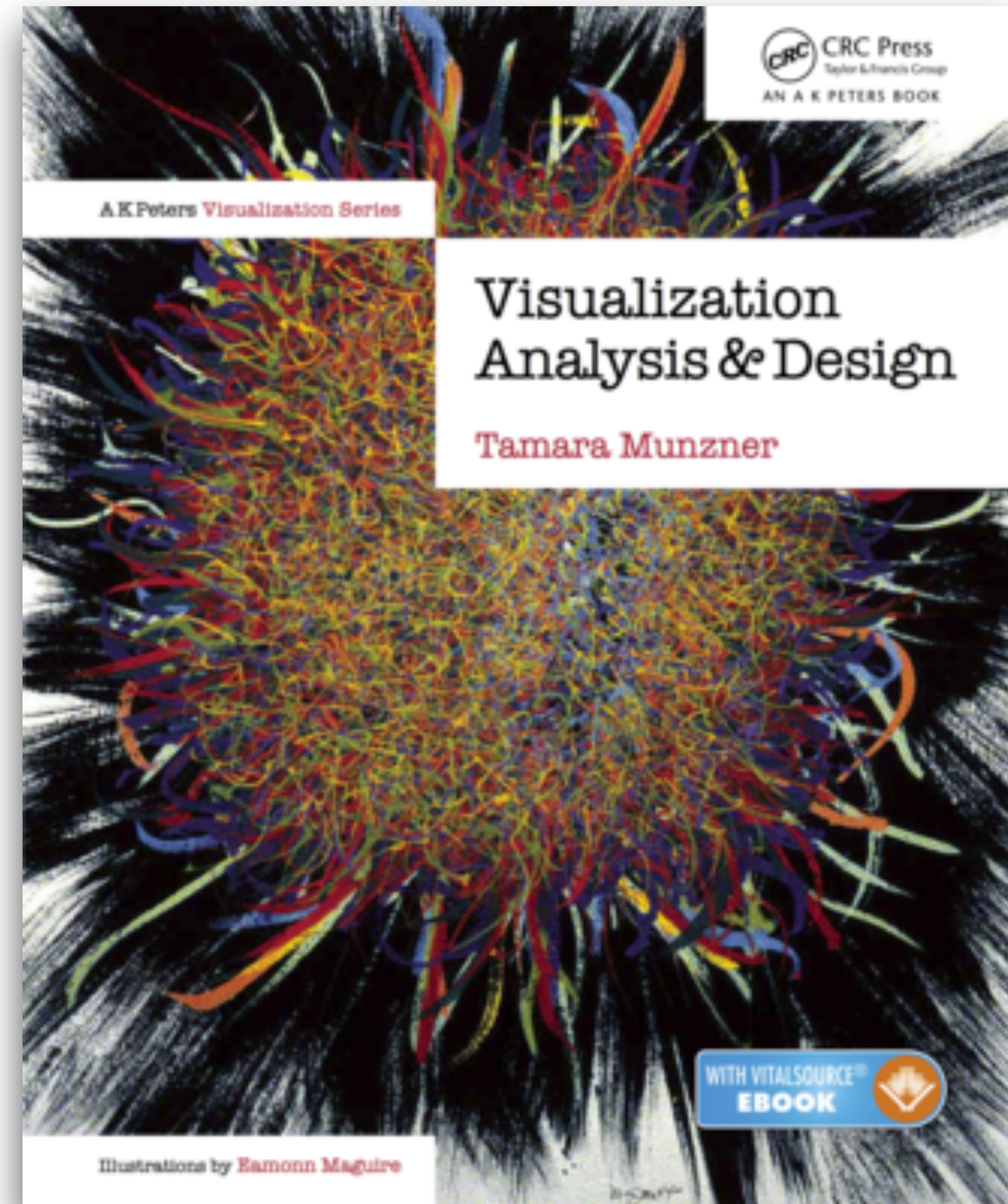
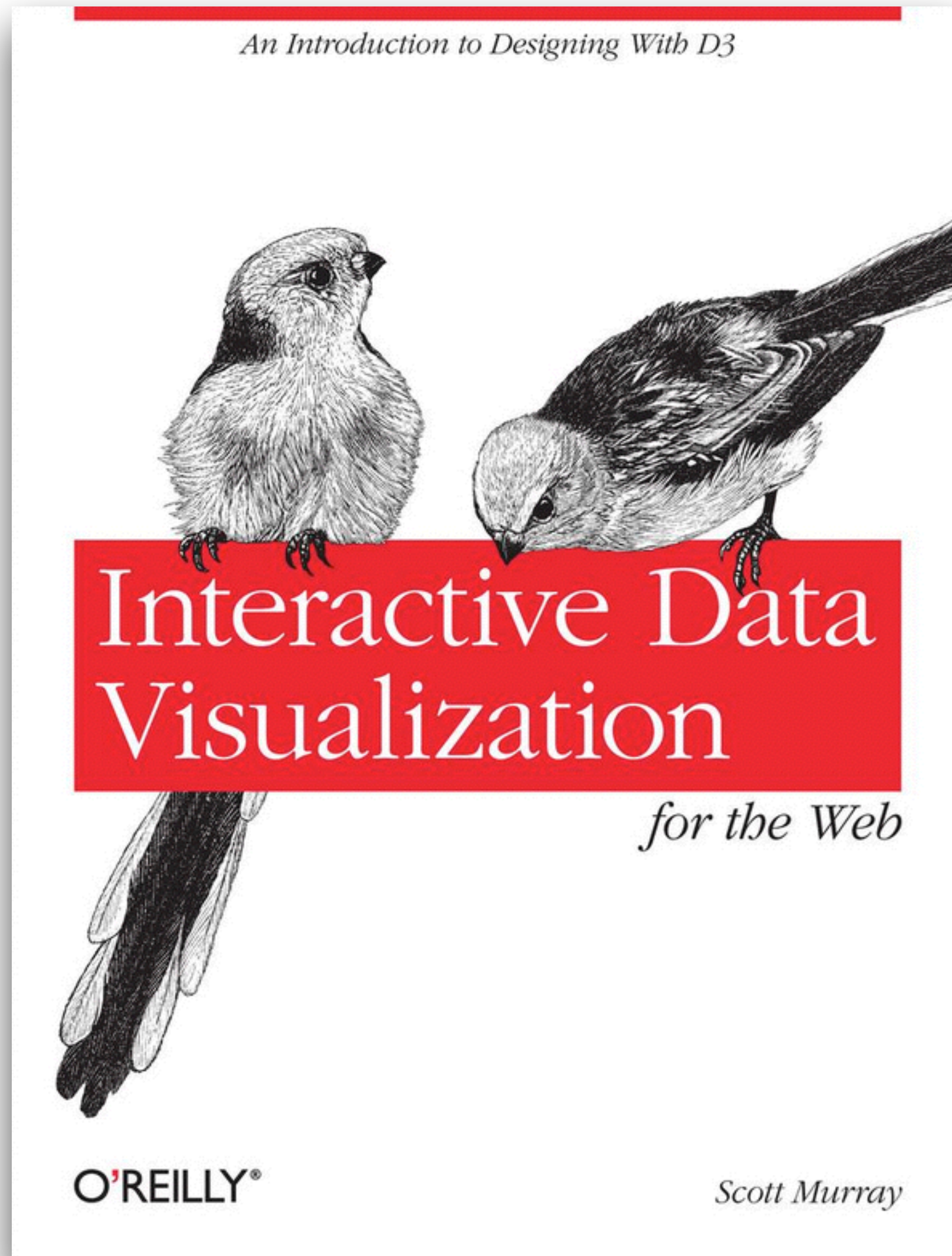
**Alex: Thursday after class**

**TAs: starting next week**

## E-Mail

**[alex@sci.utah.edu](mailto:alex@sci.utah.edu)**

# Required Books



# Programming

## HTML



# JS

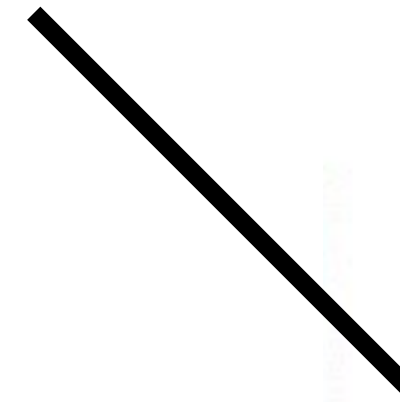


## Data-Driven Documents





Is this course for me ???



# Prerequisites

Programming experience

C, C++, Java, Python, etc.

Willingness to learn new software & tools

This can be time consuming

You will need to build skills by yourself!

Engineering vs Computer Science

**Formalities**

# How are you graded?

7 Homework Assignments: 40%

Varying value, 2%-10%, depending on length/difficult

Start early! Will take long if you don't know JS/D3 yet

Due on Fridays, late days: -10% per day, up to two days.

Final Project: 40%

Teams, two milestones

Exams: 20%

Two exams, one on fundamentals, one on techniques

# Cheating

You are welcome to discuss the course's ideas, material, and homework with others in order to better understand it, but the work you turn in must be your own (or for the project, yours and your teammate's). For example, you must write your own code, design your own visualizations, and critically evaluate the results in your own words. You may not submit the same or similar work to this course that you have submitted or will submit to another. Nor may you provide or make available solutions to homeworks to individuals who take or may take this course in the future.

Will automatically check for plagiarism in all your submissions

# No Device Policy

No Computers, Tablets, Phones in lecture hall

except when used for exercises

Switch off, mute, flight mode

Why?

It's better to take note by hand

Notifications are designed to grab your attention

*Applies to Theory lectures, coding along in technical lectures encouraged*

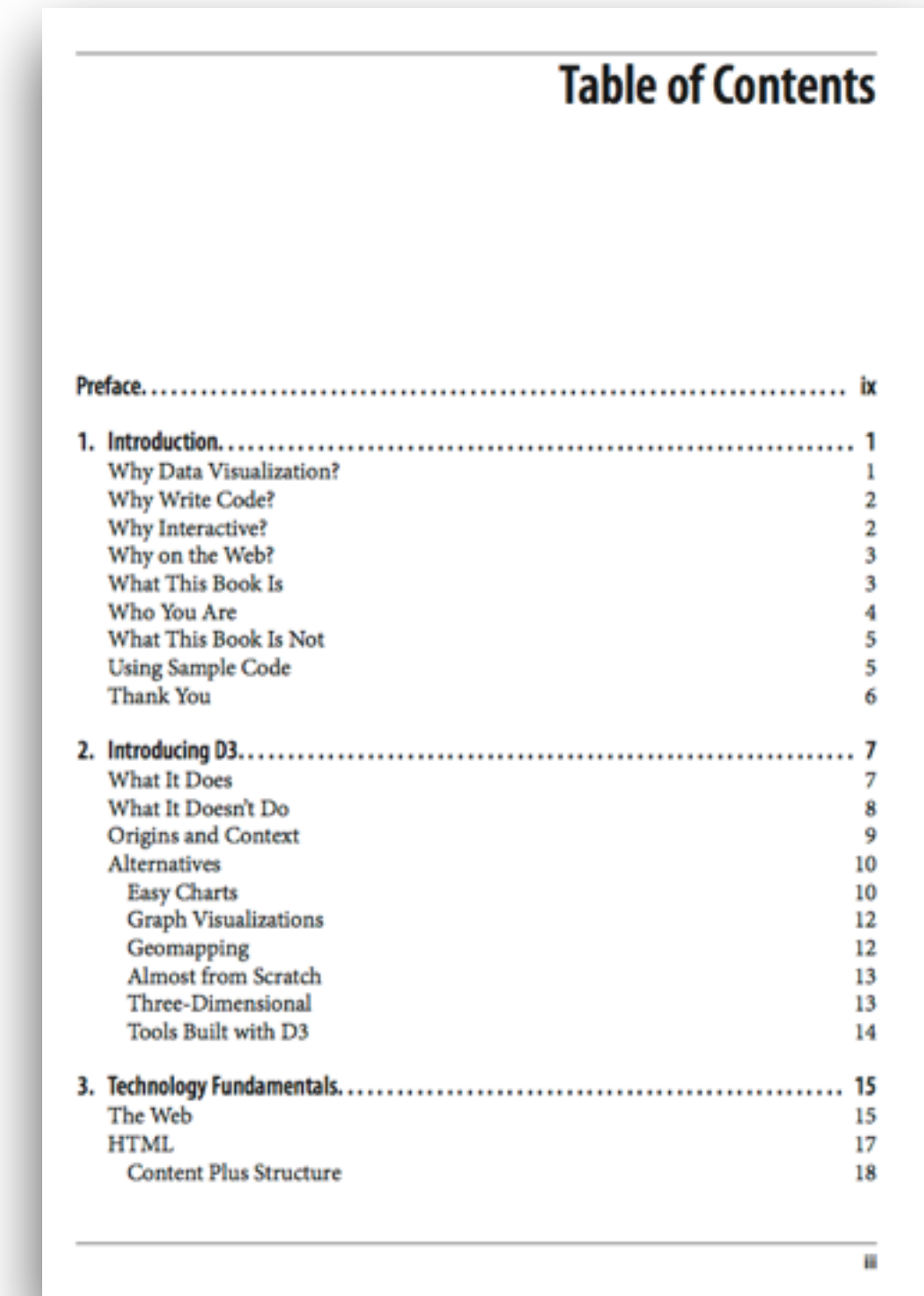
# This Week

HW0, including course survey  
Introduction to Git, HTML, CSS

## Readings

D3 Book, Chapters 1-3

VDA Book, Chapter 1



The image shows a page titled "Table of Contents" from the D3.js book. It lists the following sections and their page numbers:

Preface.....	ix
<b>1. Introduction.....</b>	<b>1</b>
Why Data Visualization?	1
Why Write Code?	2
Why Interactive?	2
Why on the Web?	3
What This Book Is	3
Who You Are	4
What This Book Is Not	5
Using Sample Code	5
Thank You	6
<b>2. Introducing D3.....</b>	<b>7</b>
What It Does	7
What It Doesn't Do	8
Origins and Context	9
Alternatives	10
Easy Charts	10
Graph Visualizations	12
Geomapping	12
Almost from Scratch	13
Three-Dimensional	13
Tools Built with D3	14
<b>3. Technology Fundamentals.....</b>	<b>15</b>
The Web	15
HTML	17
Content Plus Structure	18

iii

# Next Week

HW1 due

More technological foundations

JavaScript, JSON, D3

Office hours start!



<https://github.com/dataviscourse/2016-dataviscourse-homework/>

This screenshot shows the GitHub interface for the repository 'dataviscourse / 2016-dataviscourse-homework'. The repository is currently on the 'master' branch and has 12 commits, 1 branch, 0 releases, and 3 contributors. The most recent commit by 'alexeb' removed a GitHub username sentence. Below the commit history, the README.md file is displayed, containing instructions for cloning and updating the repository.

Repository: **dataviscourse / 2016-dataviscourse-homework**

12 commits | 1 branch | 0 releases | 3 contributors

Branch: master | New pull request | Create new file | Upload files | Find file | Clone or download

alexeb committed on GitHub Removed github username sentence. Latest commit 19c7871 a day ago

- hw0 Removed github username sentence. a day ago
- hw1 minor updates to HW1 4 days ago
- README.md added redame info; wip on hw0 revisions 4 days ago

### README.md

## Homeworks for Utah's Visualization Course 2016

In subfolders in this directory you will find the homeworks for the 2016 version of CS 6630 / CS 5630 - Visualization.

More information can be found on the [course website](#)

We suggest you clone this repository:

```
git clone https://github.com/dataviscourse/2016-dataviscourse-homework
```

To receive updates and add newly released homeworks update youre repository by cd-ing into the 2016-dataviscourse-homework directory and running:

```
git update
```

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