

CSC2537 / STA2555

INFORMATION VISUALISATION

Fanny CHEVALIER

ABOUT ME ...

Assistant Professor in CS and Stats
Formerly Research Scientist at Inria

Work in:

- HCI
- Data Visualization
- Visual Analytics
-



<http://fannycchevalier.net>

COURSE OBJECTIVES

After following this course, you will be able to:

- **know** the scientific foundation of Infovis;
- **critique** work in visualization;
- **analyze** data sets using visualization techniques;
- **build** visualizations that convey information and ideas;
- **evaluate** a visualization technique;

PURPLE **YELLOW** **RED**
BLACK **RED** **GREEN**
RED **YELLOW** **ORANGE**
BLUE **PURPLE** **BLACK**
RED **GREEN** **ORANGE**

ASSIGNMENTS

50%

 Research Project

20%

 Paper commentaries

30%

 Leading class discussion

<https://csc2537-visualization.github.io>

GUEST SPEAKERS



Richard BRATH



Justin MATEJKĀ



SCHEDULE

Date	Class	Assignment	book/icon
8 Jan.	Introduction (Lecture)	--	--
15 Jan.	Fundaments of visualization (Lecture)	📝 Commentary #1 due	book
22 Jan.	Guest seminar: Richard Brath	📝 Commentary #2 due 👤 Paper selection form due.	book
29 Jan.	Exploratory Data Analysis	🧩 Project abstract due	book/icon
5 Feb.	Graphs & Networks	--	book/icon
12 Feb.	Project mid-term reviews	🧩 Presentation in class	
19 Feb.	READING WEEK: No class	--	--
26 Feb.	Interaction & Animation	📝 Commentary #3 due	book/icon
5 Mar.	Evaluation & Review	📝 Commentary #4 due	book/icon
12 Mar.	Understanding The Viewer	📝 Commentary #5 due	book/icon
19 Mar.	Visualization Beyond the Desktop	--	book/icon
25 Mar.	Guest seminar: Justin Matejka	--	--
2 Apr.	Project Final Presentation	🧩 Project: Presentation in class	--
15 Apr.	--	🧩 Project: Final report due	--

<https://csc2537-visualization.github.io>

Foreword
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Introduction
ooooooooooooooo

Foundation of Information Visualization
ooooooooooooooo

Wrap up
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INTRODUCTION

WHY VISUALIZATION?

The
Economist

A special report on managing information | February 27th 2010

Special Report | Data, data everywhere

Information has gone from scarce to superabundant. That brings huge new benefits, says Kenneth Cukier (interviewed here)—but also big headaches

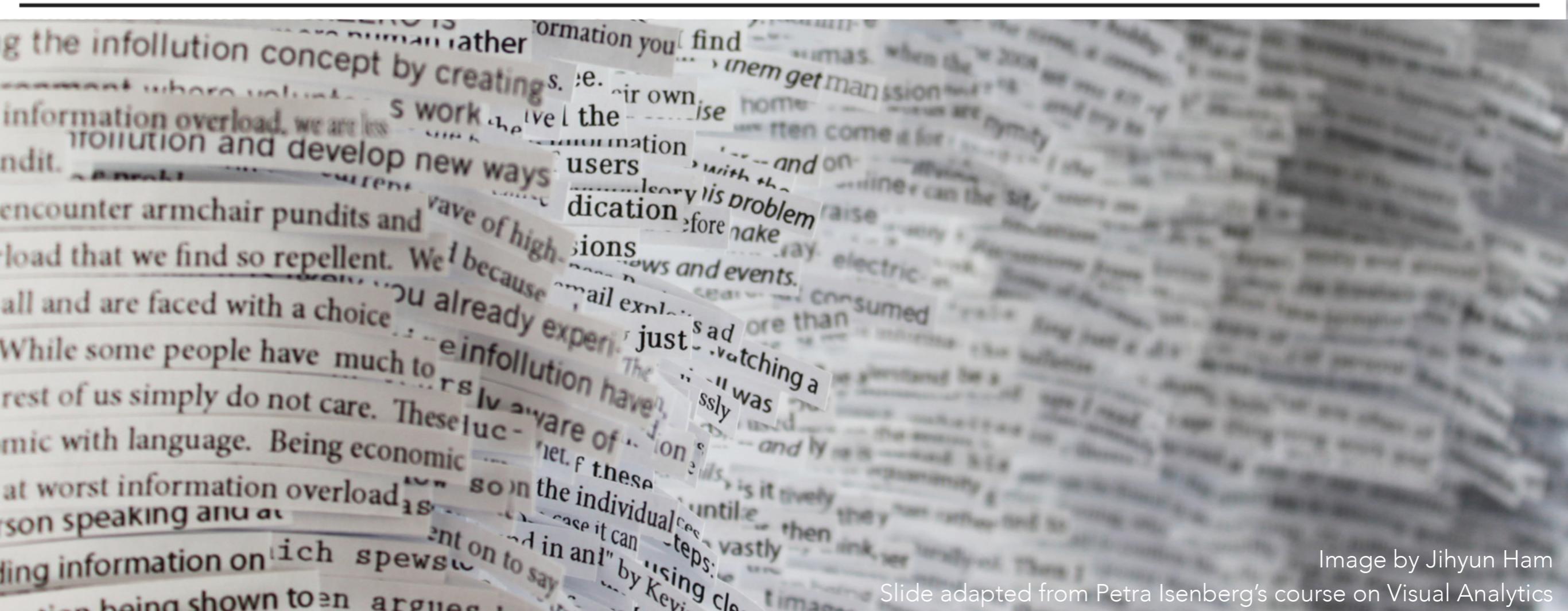
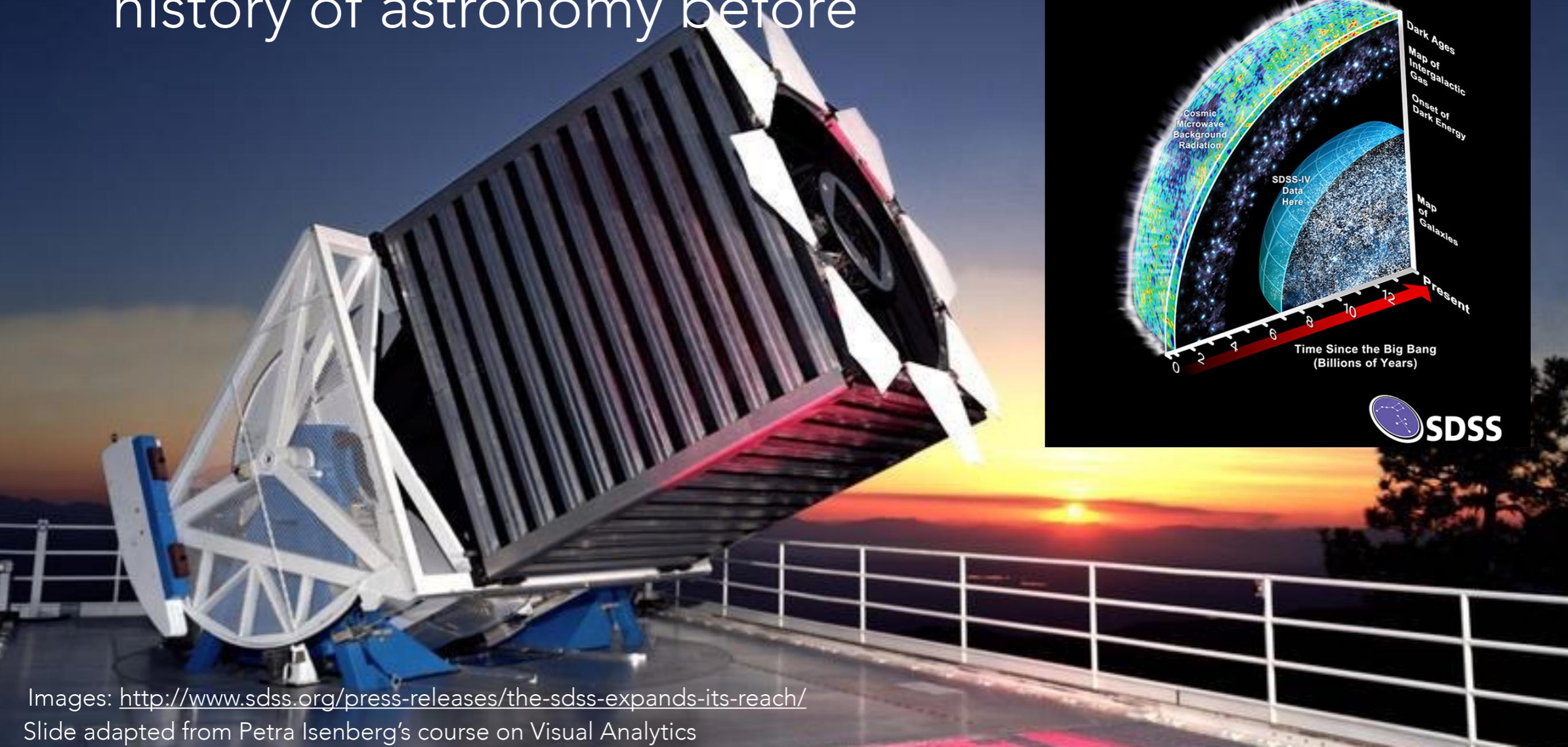


Image by Jihyun Ham

Slide adapted from Petra Isenberg's course on Visual Analytics

SLOAN DIGITAL SKY SURVEY

- started in 2000 <http://www.sdss.org/>
- in first weeks, collected more data than entire history of astronomy before



WALMART

- 1 million customer transactions per hour
- likely has information on >145 million Americans [1]



Image: <http://saultonline.com/2016/06/walmart-canada-to-stop-accepting-visa/>

[1] http://centerformediajustice.org/wp-content/uploads/2014/06/WALMART_PRIVACY_.pdf

Slide adapted from Petra Isenberg's course on Visual Analytics

AND MUCH MORE...

- Youtube users upload more than 100 hours of new video every minute
<https://youtube.googleblog.com/2013/05/heres-to-eight-great-years.html>
- Facebook has currently on average 1.13 billion active users daily
<http://newsroom.fb.com/company-info/>
- the Library of Congress adds 12,000 items to their collection every day
<https://www.loc.gov/about/fascinating-facts/>

CHALLENGES

- data != useful information
- you want insights

Analysis is needed

MAKING SENSE OF DATA

How can we ...

- effectively access to the information?
- understand the data structure?
- make comparisons?
- make decisions?
- discover new insights?
- communicate to others?
- convince?
- ...

Anascombe's Quartet

I		II		III		IV	
x	y	x	y	x	y	x	y
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71
9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25
4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50
12.0	10.84	12.0	9.13	12.0	8.15	8.0	5.56
7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91
5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.89

STATISTICAL ANALYSIS

suggests that all datasets are equivalent w.r.t. some metrics

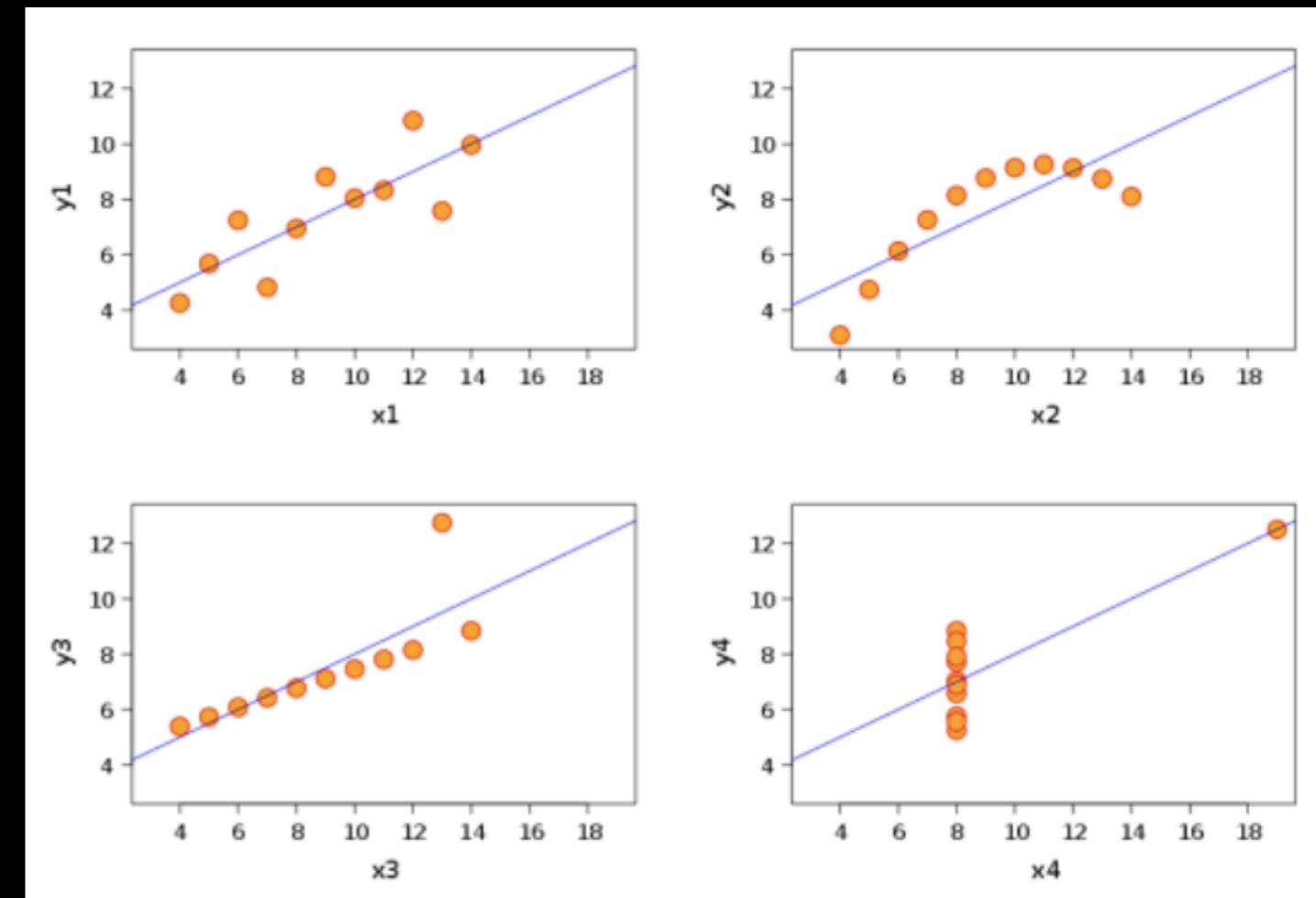
I		II		III		IV	
x	y	x	y	x	y	x	y
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71
9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25
4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50
12.0	10.84	12.0	9.13	12.0	8.15	8.0	5.56
7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91
5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.89

Mean of x	9
Sample variance of x	11
Mean of y	7.50
Sample variance of y	4.12
Correlation between x and y	0.816
Linear regression line	$y = 3.00 + 0.500x$

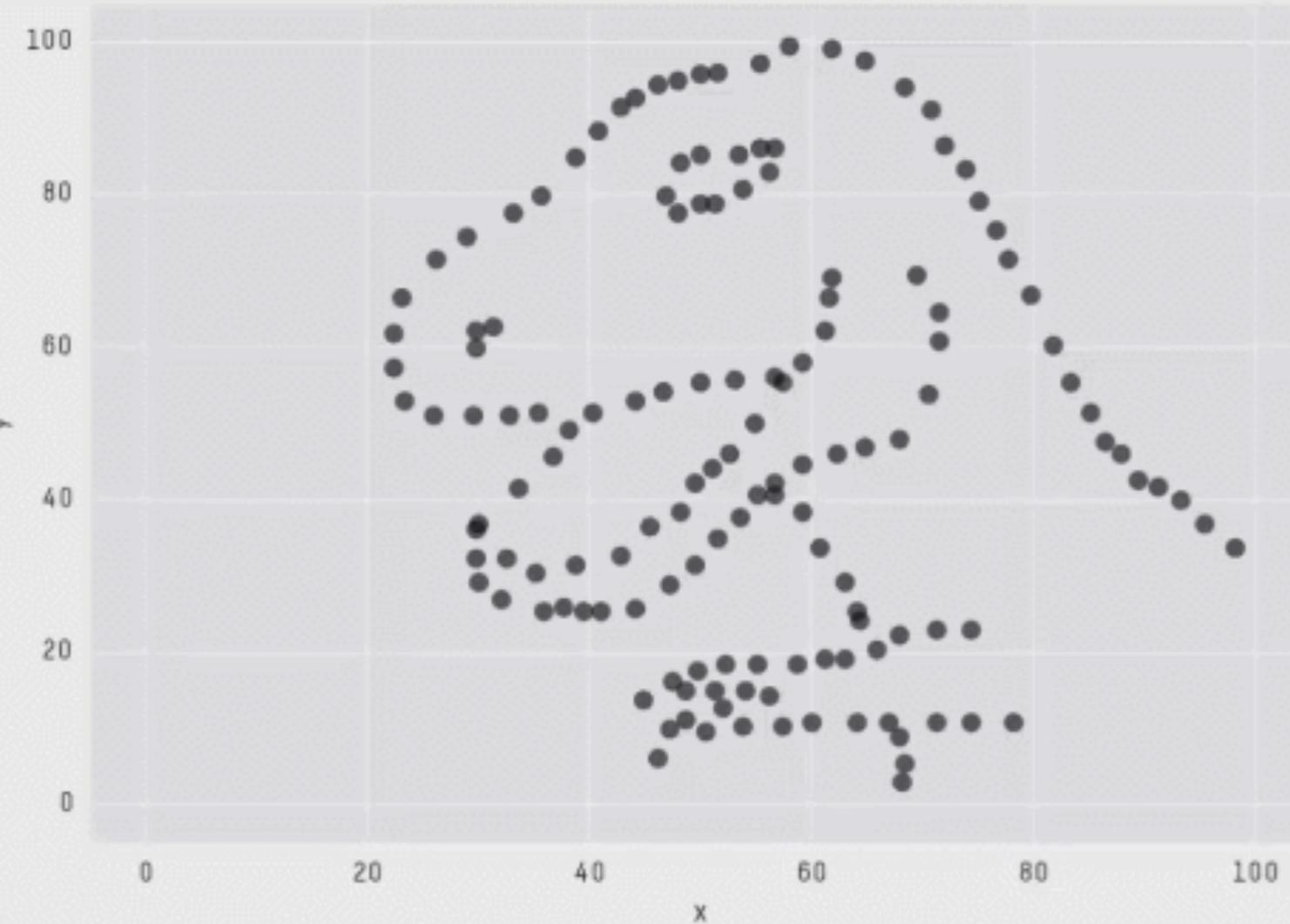
VISUALIZATION

the visual representations tell a complete different story...

I		II		III		IV	
x	y	x	y	x	y	x	y
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71
9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25
4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50
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7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91
5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.89

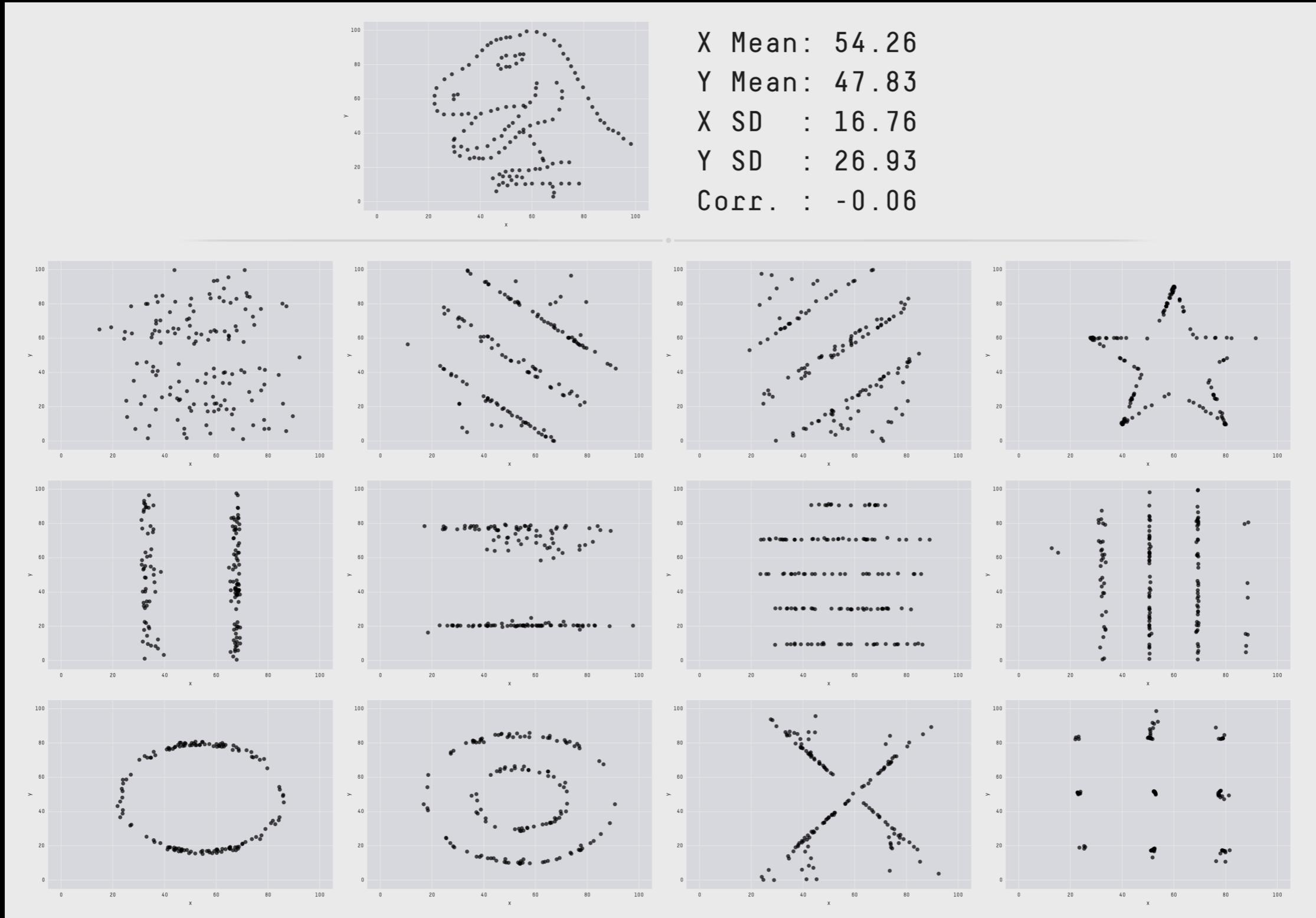


DATASAURUS DOZEN

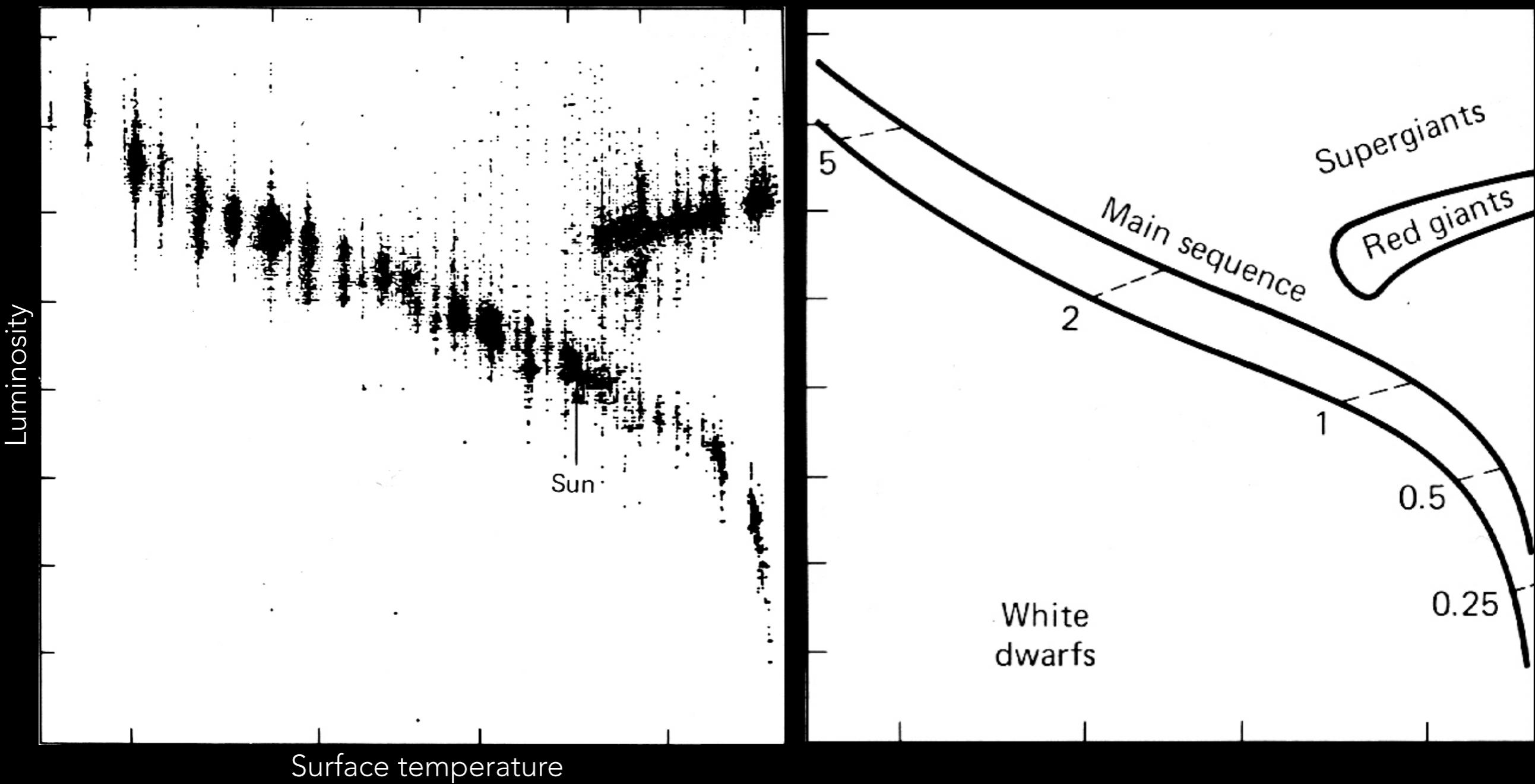


X Mean: 54.2659224
Y Mean: 47.8313999
X SD : 16.7649829
Y SD : 26.9342120
Corr. : -0.0642526

DATASAURUS DOZEN



AUTOMATIC ABSTRACTION CAPABILITY



Hertzsprung Russell Diagram and its interpretation

WHY VISUAL REPRESENTATIONS?

- **Vision** is the sense with the **highest bandwidth** ($\approx 100\text{MB/s}$, then ears $<100\text{b/s}$);
- **Vision extends** memory and cognition
- people **think visually**

HUMAN IN THE LOOP

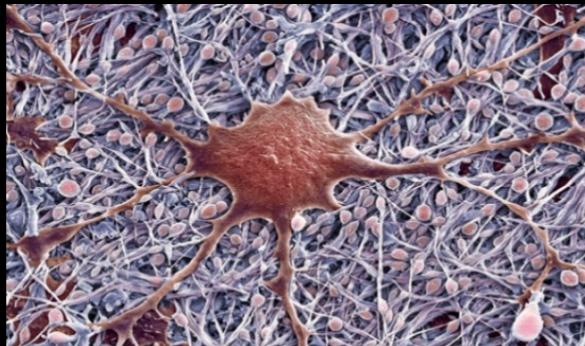
- it is sometimes dangerous to rely on purely automated analyses
- **human judgment** and **intervention** often needed
 - for: background information, flexible analysis (unintended directions), creativity
 - because: data can be incomplete, inconsistent, or deceptive

EXAMPLE APPLICATIONS



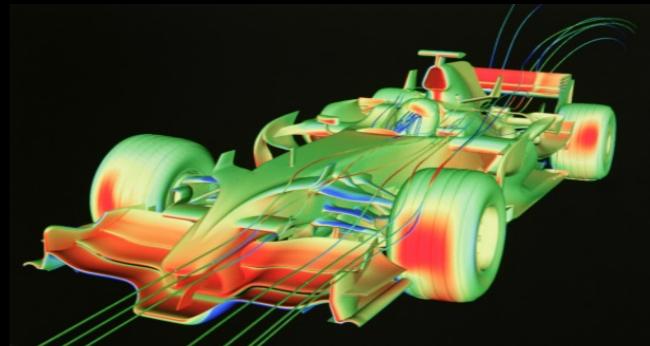
MEDICINE

Digital Health Records



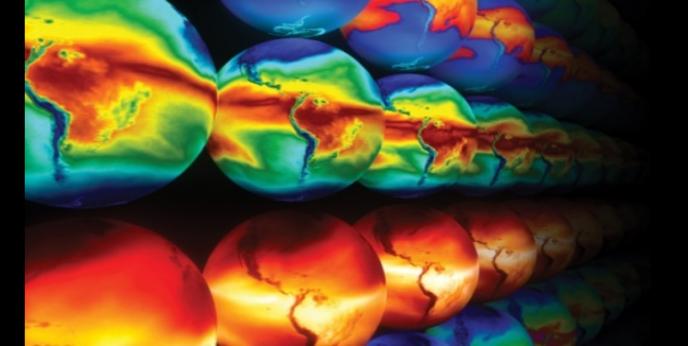
BIOLOGY

Connectomics



ENGINEERING

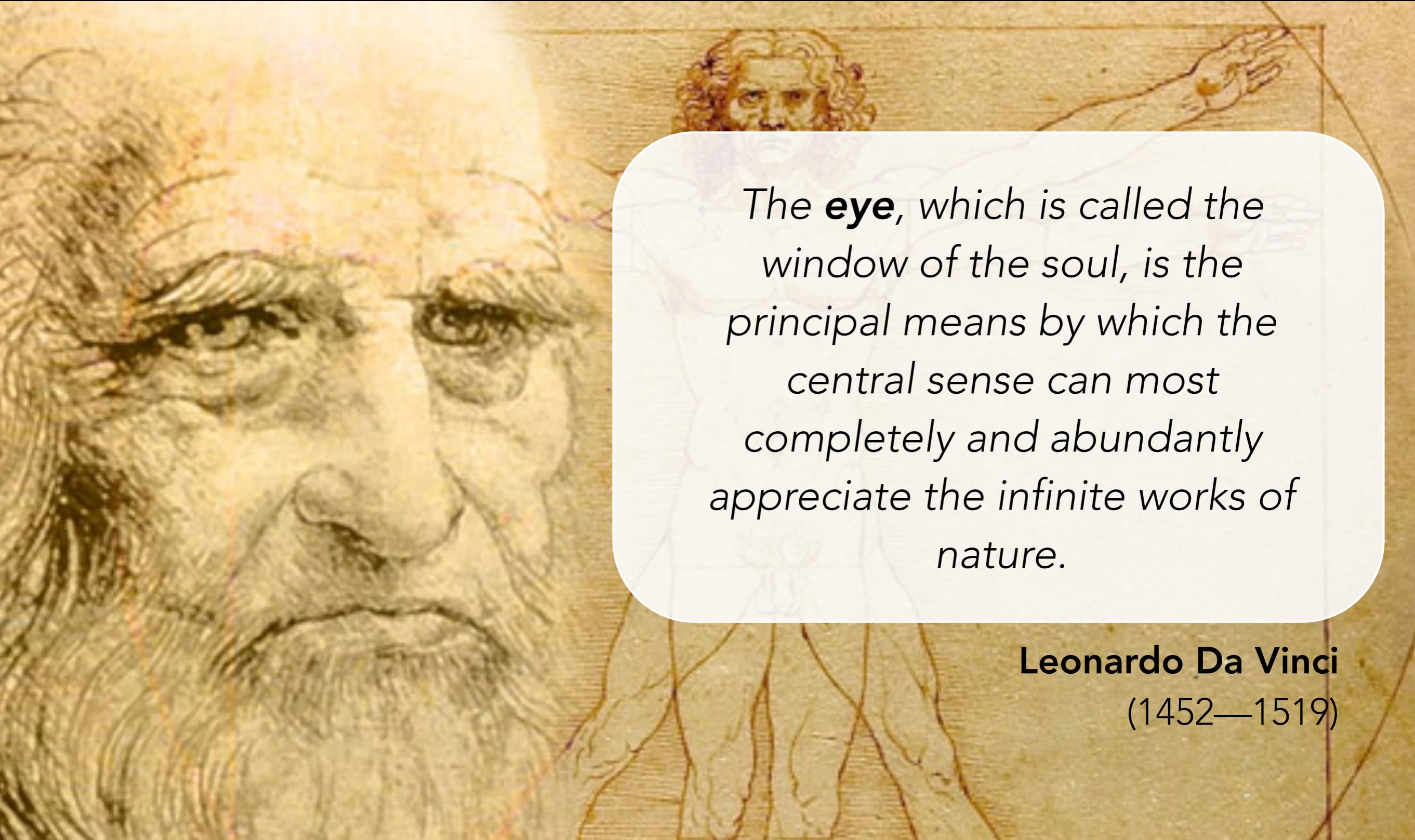
Large CFD Simulations



EARTH SCIENCES

Global Climate Models

And many more...



*The **eye**, which is called the window of the soul, is the principal means by which the central sense can most completely and abundantly appreciate the infinite works of nature.*

Leonardo Da Vinci
(1452—1519)

"A PICTURE IS WORTH A THOUSAND WORDS"

(Anonymous, 1911)

百聞不如一見

"One hundred rumors are not comparable to one look."

An Old Chinese Inscription



Napoleon Bonaparte (18xx)

"Un petit dessin vaut mieux qu'un long discours"

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FOUNDATION OF INFORMATION VISUALISATION DEFINITION & HISTORICAL EXAMPLES

WHAT IS VISUALIZATION?



1. The representation of an object, situation, or set of information as a chart or other image.

2. The formation of a mental image of something.

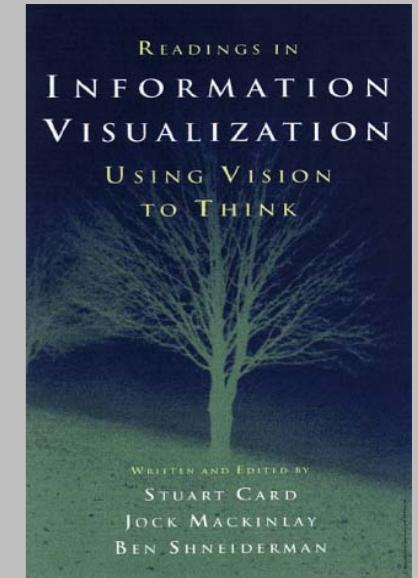
INFORMATION VISUALIZATION : Infovis

- Design **visual representations**
- Concerns **abstract data**
- Includes **interaction**

Official definition:

The use of computer-supported, interactive, visual representations of abstract data to amplify cognition.

[Card Mackinlay & Shneiderman, 1998]



Involves many fields:

- **graphics** (millenniums of history)
- **cognitive psychology** (centuries of history)
- **Human-computer interaction** (decades of history)

SCIENTIFIC VISUALIZATION : SciViz

Visualization of data sets captured from real world,
having a **given spatialization**.

Key differences with Information Visualization:

- concern data with a physical existence in the world
- limited set of application domains
- smaller design space

VISUAL ANALYTICS

Visual Analytics combines **automated analysis** techniques with **interactive visualizations** for an effective understanding, reasoning and decision making on the basis of **very large and complex data** sets.

Key differences with Information Visualization:

- involves automated data mining, information retrieval, data retrieval

WHY VISUAL REPRESENTATIONS?

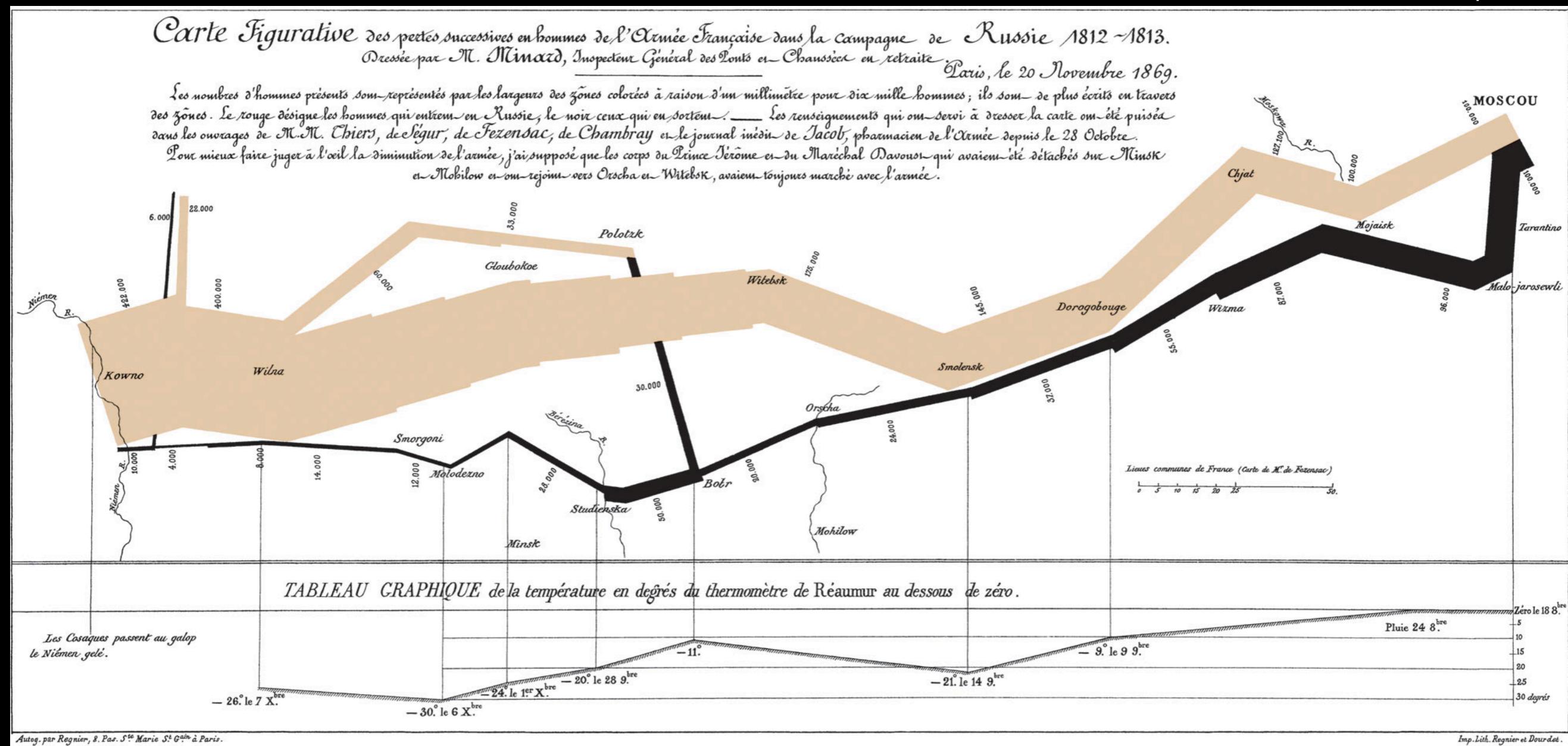
- **Vision** is the sense with the **highest bandwidth** ($\approx 100\text{MB/s}$, then ears $<100\text{b/s}$);
- **Vision extends** memory and cognition
 - people **think visually**

VISUAL THINKING: NAPOLEON'S MOSCOW MARCH

Qualified by Edward Tufte as the best statistical representation ever.



Charles Minard, 1869



More about this: The Visual Display of Quantitative Information (Tufte)

VISUAL THINKING: BROAD STREET CHOLERA OUTBREAK (1854)

“The most terrible outbreak of cholera which ever occurred in the kingdom”

– John Snow

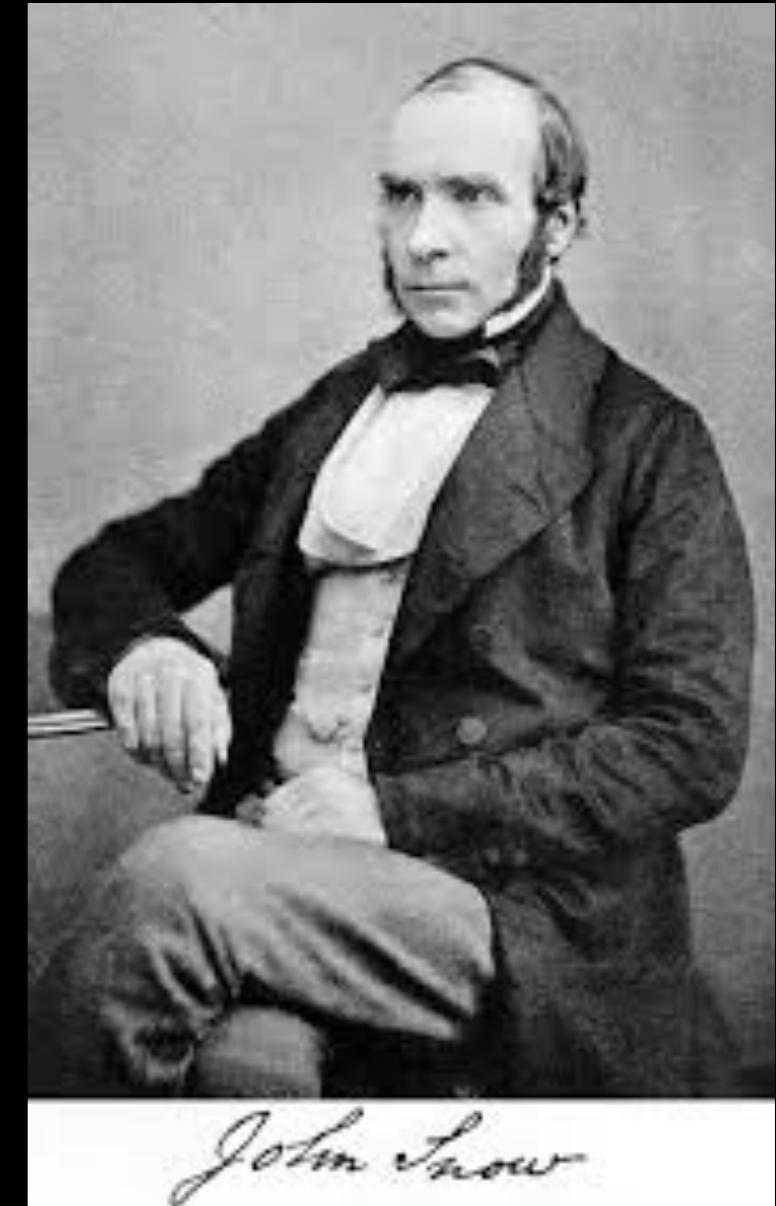
Major cholera outbreak in London in 1854

- 127 deaths within 3 days, close to Broad Street
- 616 deaths within 30 days

Dr. John Snow was the first to make the link between contaminated water pumps and the disease propagation

How did he do?

- Talked to local residents
- Hypothesized water pumps as potential source
- Used annotated maps to illustrate his theory
- Convinced authorities to condemn pumps



VISUAL THINKING: BROAD STREET CHOLERA OUTBREAK (1854)



More about this: The Visual Display of Quantitative Information (Tufte)

VISUAL THINKING: CHALLENGER SPACE SHUTTLE (1986)



Source: Space Shuttle Challenger Disaster, Wikipedia

VISUAL THINKING: CHALLENGER SPACE SHUTTLE (1986)



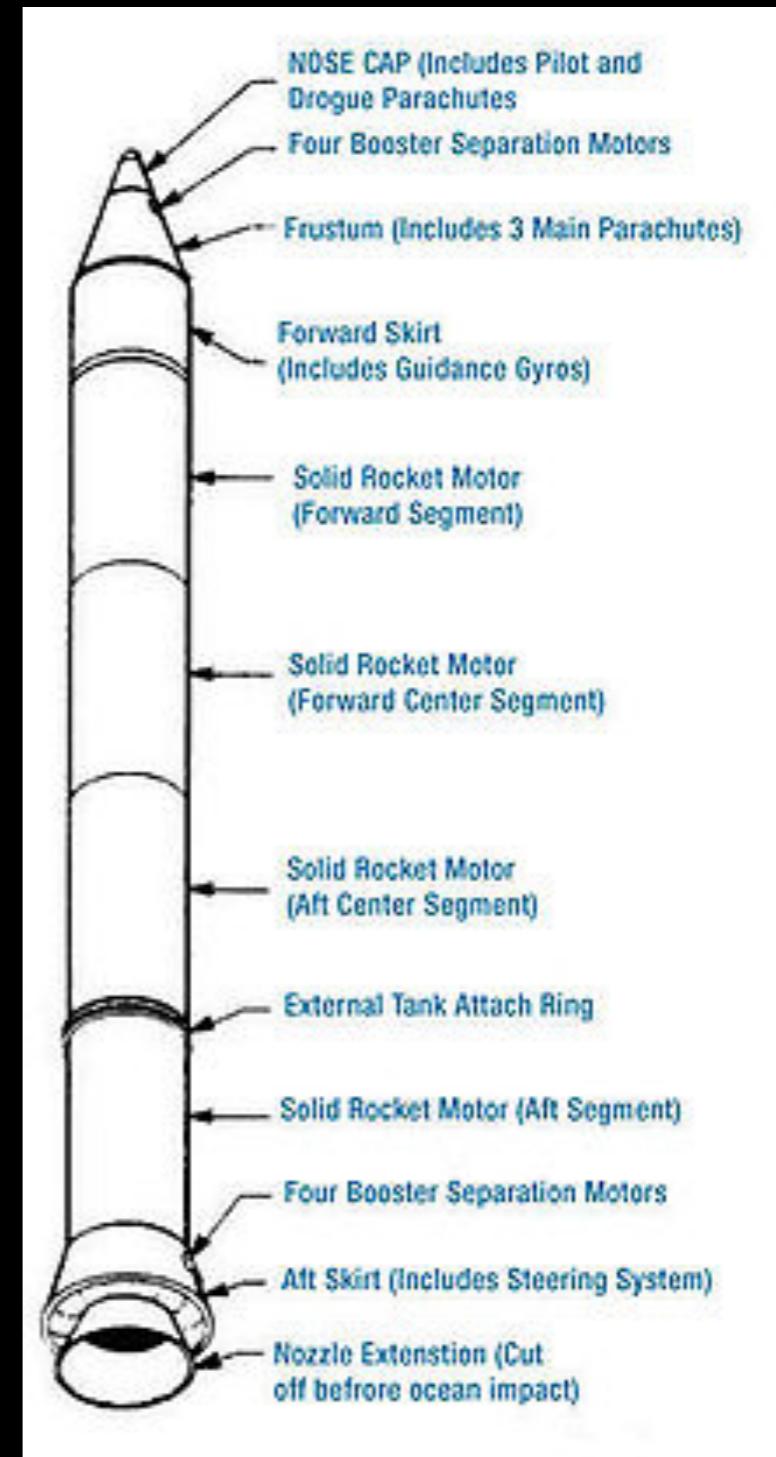
ice on the launch tower, hours before
Challenger launch

7 crew members died during the explosion

The disaster could have been avoided

- Weather forecast for Jan. 28th announced exceptionally cold morning, with temperatures close to -0.5°C
- Morton Thiokol engineers, in charge of the solid rocket booster (SRB), were concerned about low temperatures
- Engineers feared the effect of low temperature on the joint resistance

Solid rocket booster provides thrust during the first two minutes of flight space shuttle



VISUAL THINKING: CHALLENGER SPACE SHUTTLE (1986)

HISTORY OF O-RING DAMAGE ON SRM FIELD JOINTS								
JET	SRM No.	Cross Sectional View			Top View		Clocking Location (deg)	
		Erosion Depth (in.)	Perimeter Affected (deg)	Nominal Dia. (in.)	Length Of Max Erosion (in.)	Total Heat Affected Length (in.)	Clock	
61A	22A	None	None	0.280	None	None	36° -- 66°	
61A LH Center Field**	22A	NONE	NONE	0.280	NONE	NONE	338°-18°	
61A LH CENTER FIELD**	22A	NONE	NONE	0.280	NONE	NONE	338°-18°	
51C	15A	0.010	154.0	0.280	4.25	5.25	163	
51C LH Forward Field**	15B	0.038	130.0	0.280	12.50	58.75	354	
51C RH Center Field (prim)***	15B	None	45.0	0.280	None	29.50	354	
51C RH Center Field (sec)***	15B	None	45.0	0.280	None	29.50	354	
41D RH Forward Field	13B	0.026	110.0	0.280	3.00	None	275	
41C LH Aft Field*	11A	None	None	0.280	None	None	--	
41B LH Forward Field	10A	0.040	217.0	0.280	3.00	14.50	351	
STS-2 RH Aft Field	2B	0.053	116.0	0.280	--	--	90	

*Hot gas path detected in putty. Indication of heat on O-ring, but no damage.
**Soot behind primary O-ring.
***Soot behind primary O-ring, heat affected secondary O-ring.

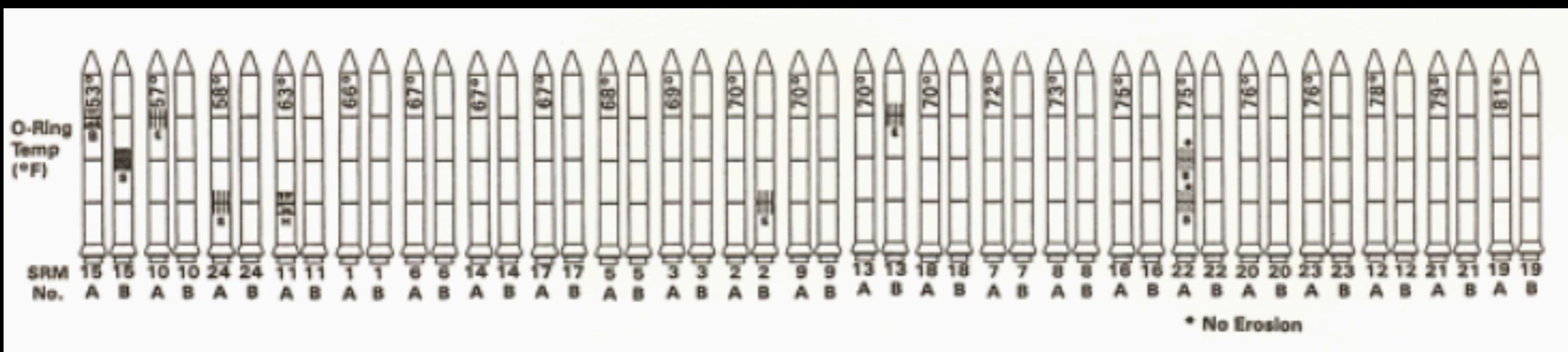
Clocking location of leak check port - 0 deg.

OTHER SRM-15 FIELD JOINTS HAD NO BLOWHOLES IN PUTTY AND NO SOOT NEAR OR BEYOND THE PRIMARY O-RING.

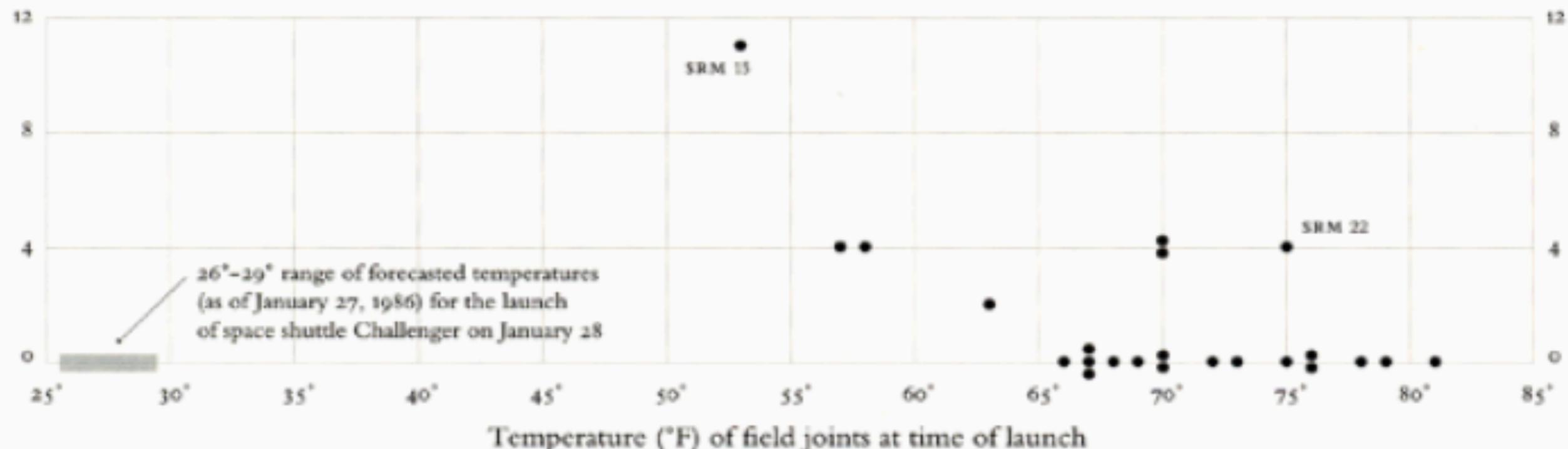
SRM-22 FORWARD FIELD JOINT HAD PUTTY PATH TO PRIMARY O-RING, BUT NO O-RING EROSION AND NO SOOT BLOWBY. OTHER SRM-22 FIELD JOINTS HAD NO BLOWHOLES IN PUTTY.

BLOW BY HISTORY	MOTOR	MBT	AMB	O-RING	WIND
SRM-15 WORST BLOW-BY	DM-1	68	36	47	10 MPH
○ 2 CASE JONES (80°), (110°) <u>Arc</u>	DM-2	76	45	52	10 MPH
○ MUCH WORSE VISUALLY THAN SRM-22	DM-3	72.5	40	48	10 MPH
SRM-12 BLOW-BY	DM-4	76	48	51	10 MPH
○ 2 CASE JOINTS (30-40°)	SRM-15	52	64	53	10 MPH
SRM-13A, 15, 16A, 18, 23A 24A	SRM-22	77	78	75	10 MPH
○ NOZZLE Blow-by	SRM-25	55	26	29	10 MPH
				27	25 MPH

VISUAL THINKING: CHALLENGER SPACE SHUTTLE (1986)

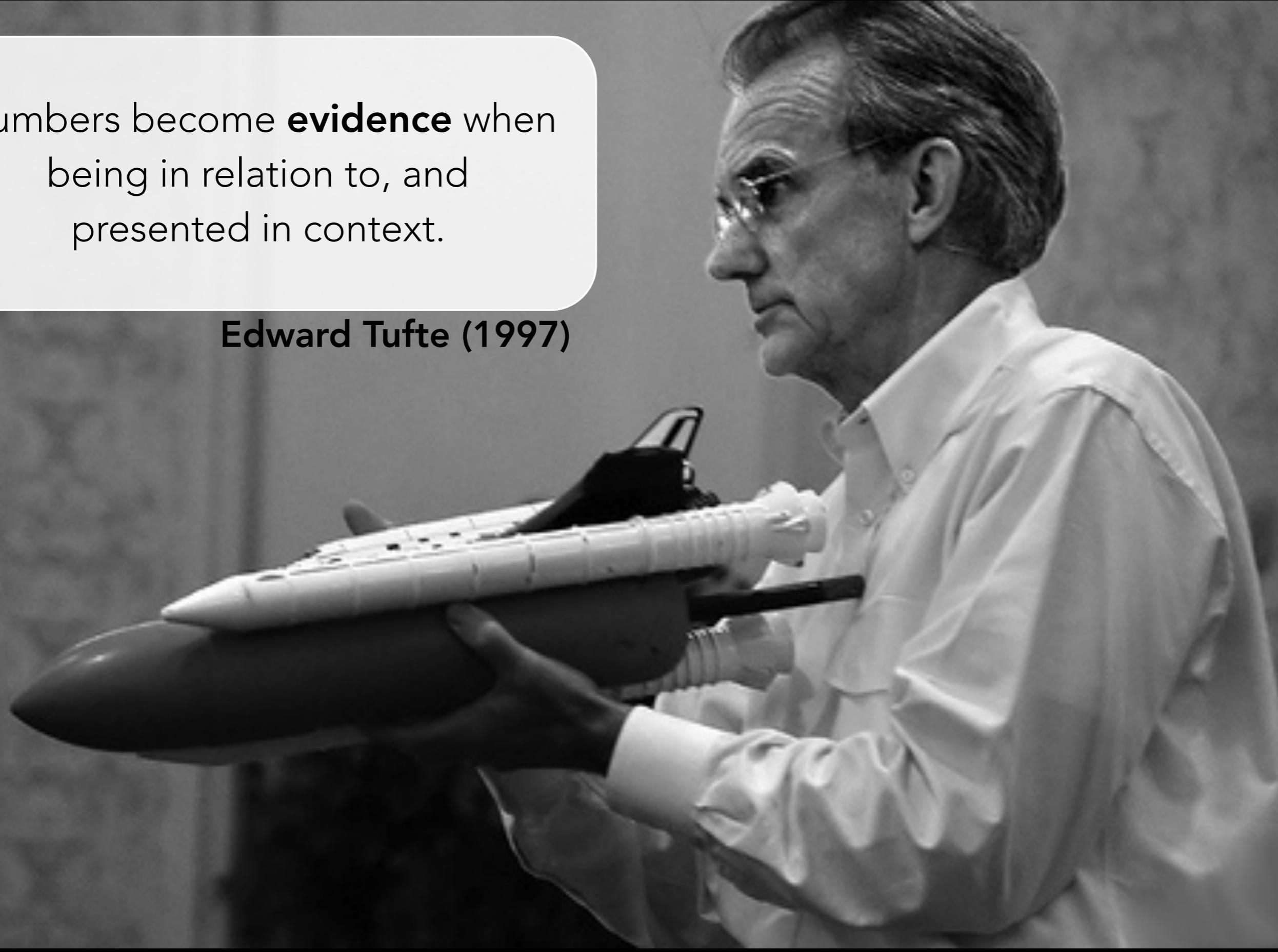


O-ring damage index, each launch



Numbers become **evidence** when
being in relation to, and
presented in context.

Edward Tufte (1997)



CHALLENGES

data

- quantity (e.g. large and streaming data)
- quality of data is often low
- dealing with uncertainty in the data

CHALLENGES

human perception and reasoning

- understanding and supporting how humans perceive and reason about data
- create representations that are fair to the data
- create interfaces that are meaningful, clear, effective, and efficient

CHALLENGES

evaluation

- develop methods to compare novel techniques / tools to existing ones
- assess how good (effective, efficient, etc.) a technique / tool is
 - very difficult for measures other than time & error, e.g. how many insights a technique / tool generates

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WRAP UP

THIS IS A SEMINAR-BASED COURSE

- We will pick a theme every week and go over representative papers in the area.
- Available papers and themes and a schedule is on the course webpage.
- **You will lead a class discussion** for one such paper at one such session (choices due 22 Jan.).

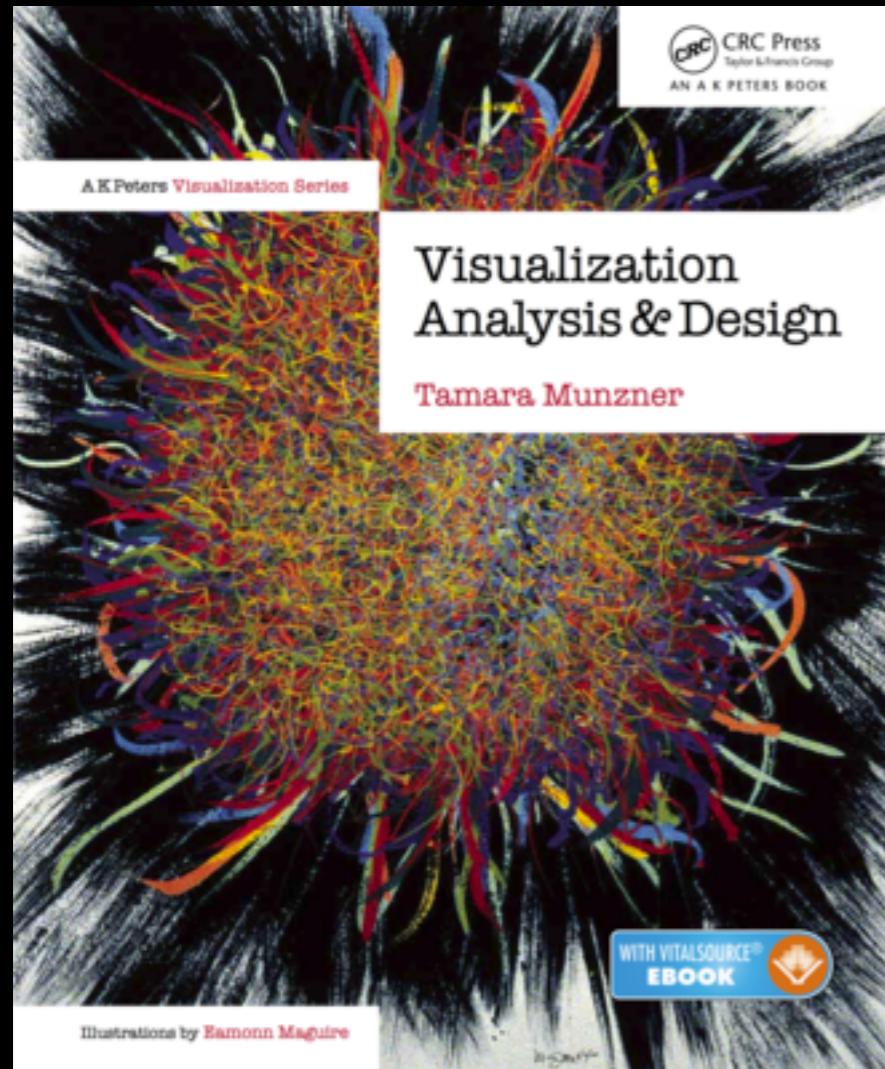
PAPER COMMENTARIES

- **You will write a paper commentary** (i.e. critique) for five papers as indicated in the course schedule.
- Each critique is worth 5 points. We will drop the lowest grade.
- Commentaries are worth 20% of your final grade.

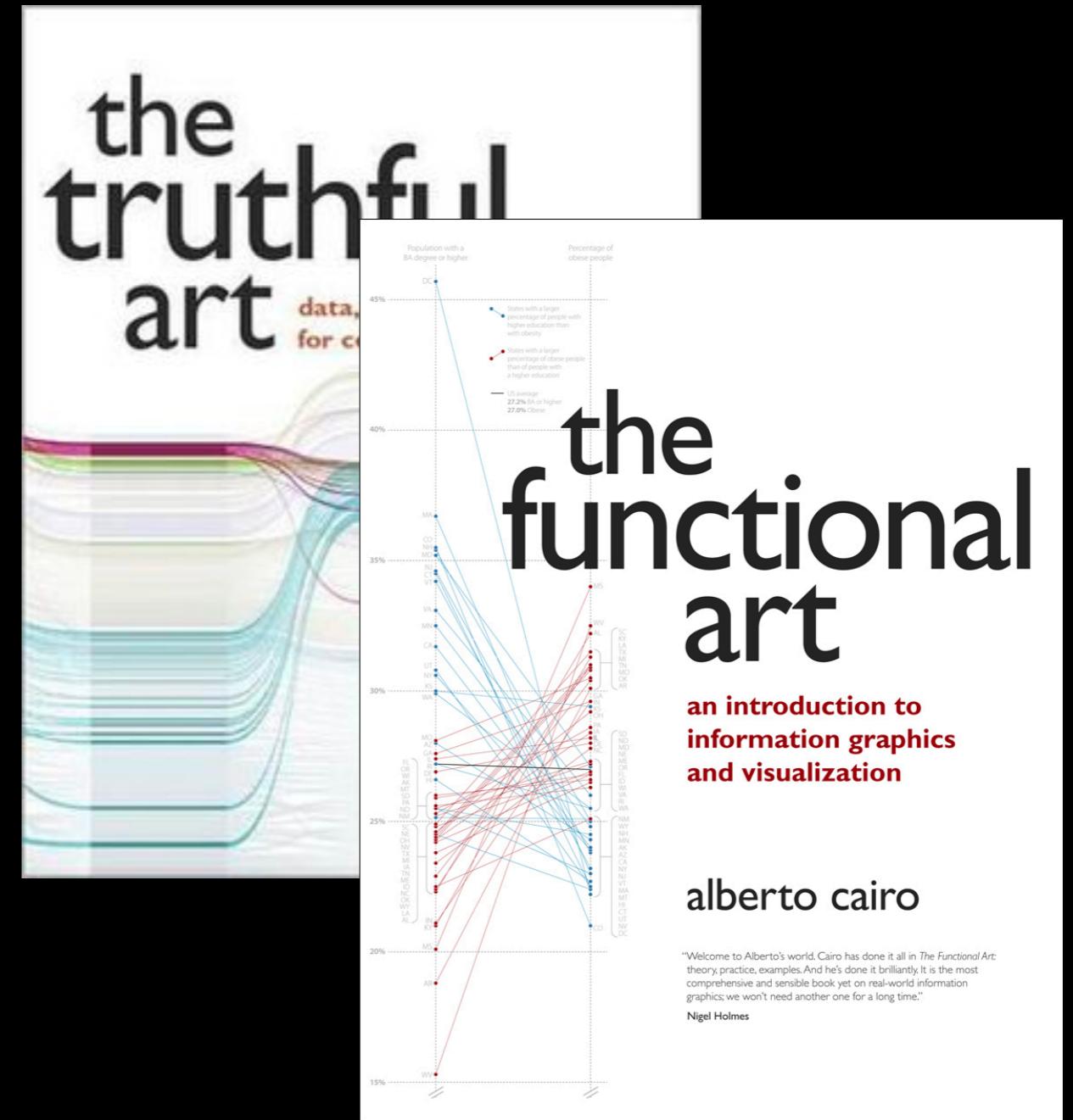
RESEARCH PROJECT

- You will complete a class research project, in groups of two people.
- The project is worth 50% of your final grade.
- Several milestones (see course website).

RESOURCES



Munzner's Visualization
Analysis & Design



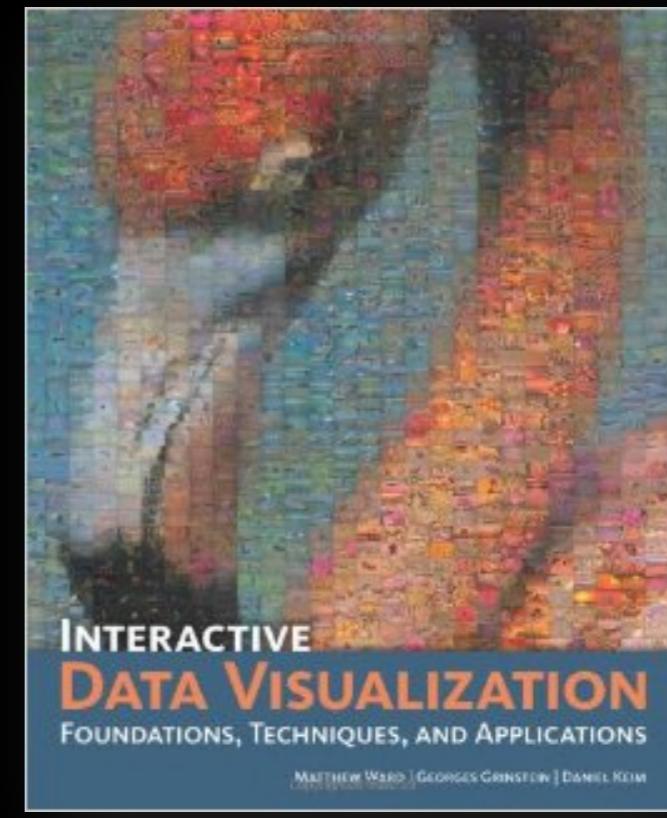
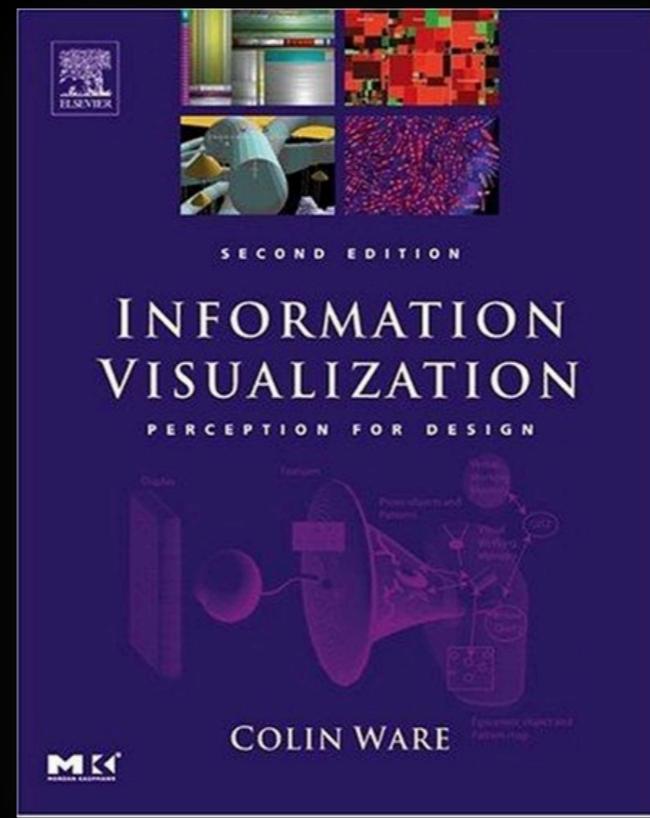
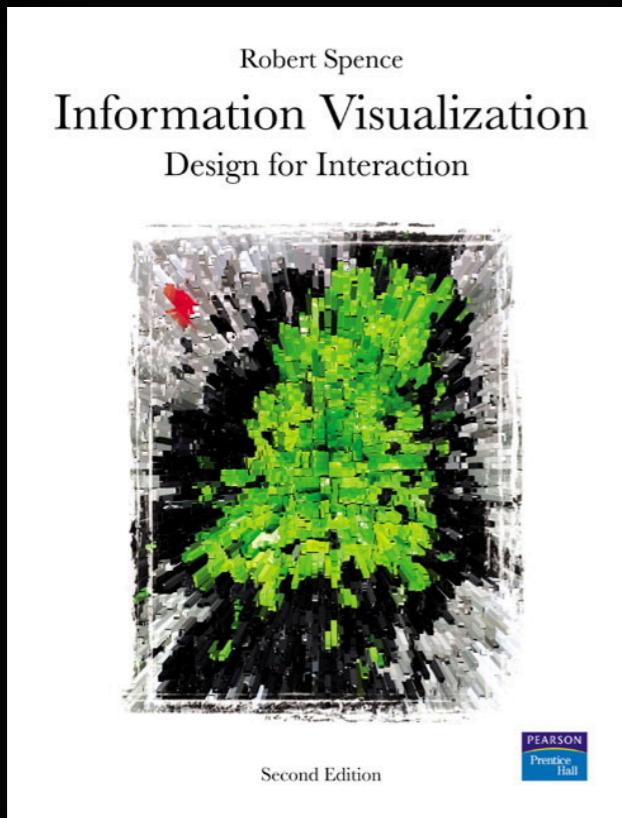
Alberto Cairo's
The functional art; The truthful art

RESOURCES

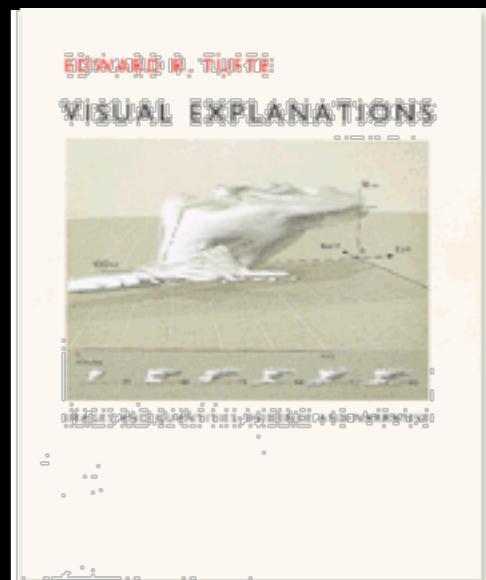
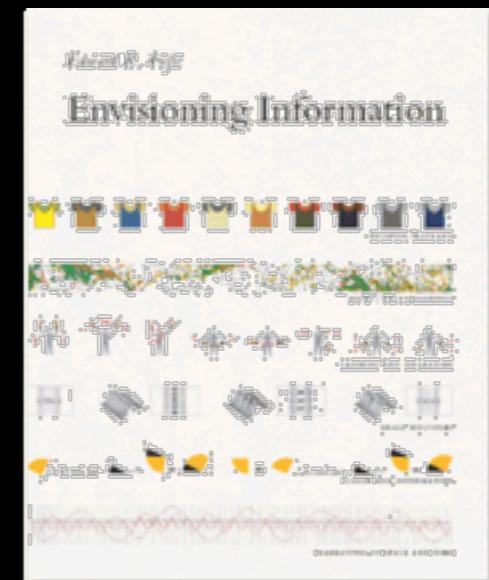
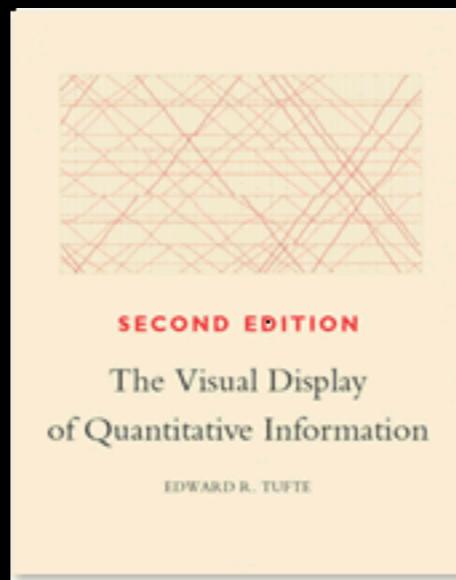
Blogs

<http://flowingdata.com/>
<http://felliinlovewithdata.com/>
<http://eagereyes.org/>
<http://infosthetics.com/>

Books



Tufte's collection



LEADING A CLASS DISCUSSION GUIDELINES AND PAPER SELECTION



LEADING A CLASS DISCUSSION

25-minute discussion

The goal is **not** to do a mere presentation of what the paper is about. The goal is to **lead a critical discussion** about a scientific paper in class.

Think about it this way...

What will the audience understand at the end of class that they may not have at the beginning? Decide on 3-4 key ideas from the readings that you would like the students to understand deeply, and structure your discussion strategy around that.

LEADING A CLASS DISCUSSION

Should I stick solely to the content of the given paper?

NO!

You should extend to related research and resources

You should share your critical thoughts and reflection

Shall we all read the papers **before** the presentation?

Highly recommended

Shall we all read the papers **after** the presentation?

Mandatory!

LEADING A CLASS DISCUSSION

29 JAN.

EXPLORATORY DATA ANALYSIS

Project: Abstract due. (See [Project..](#))

Overview and basics of exploratory data analysis

Students-moderated discussion

 Readings

 Comm.

 Disc.

[Polaris: A System for Query, Analysis and Visualization of Multi-dimensional Relational Databases](#)

--

 (1)

(Stolte and Hanrahan, TVCG 2002)

[Voyager: Exploratory Analysis via Faceted Browsing of Visualization Recommendations](#)

--

 (2)

(Kanit Wongsuphasawat et al., TVCG 2016)

[Integrating Statistics and Visualization: Case Studies of Gaining Clarity during Exploratory Data Analysis](#)

--

 (3)

(Perer and Shneiderman, CHI 2008)

LEADING A CLASS DISCUSSION

Indicate your choice in the following table. You need to select *at least* one paper for each of the top choices, and *at most* ten papers as "I would rather not present" / "I can't present" combined. *

RESEARCH PROJECT
PROSPECTIVE PROJECTS



PROJECT

Completed in groups of two

It is expected that you explore and discuss

- Related work
- Analysis of domain, tasks, design goals
- Design & execution
- (Evaluation)
- Implications for visualization design



PROJECT MILESTONES

DUE 29 JAN. Project Abstract (5 pts)

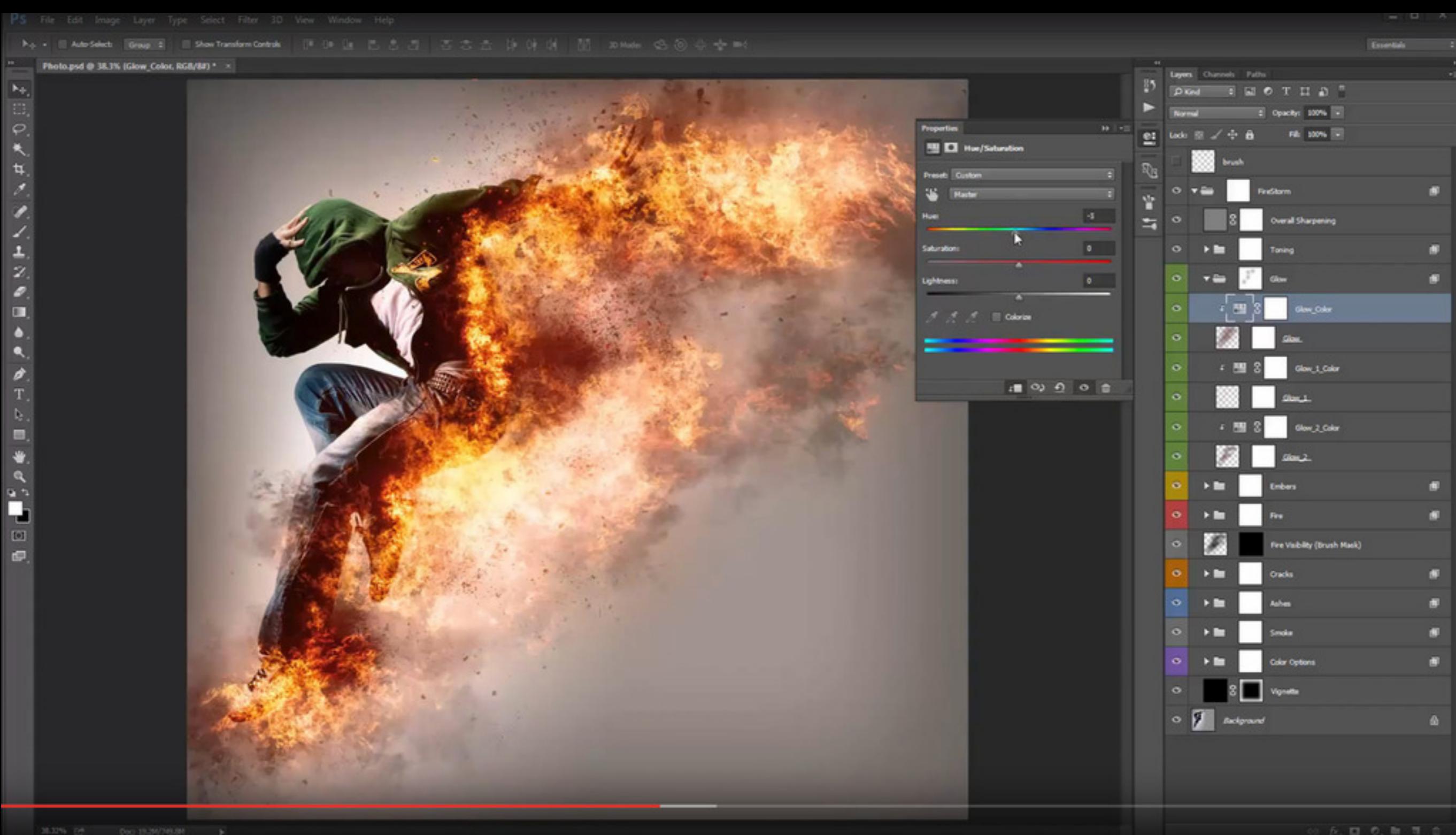
DUE 12 FEB. Mid-term review (10 pts)

DUE 2 APR. Project presentation (25 pts)

DUE 15 APR. Research report (10 pts)



PIXEL HISTORY / LAYERS



ANIMATED TRANSITIONS OF THE INTERNET

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<h1><font size=10 color="#FFFFFF>Gliimpse:</font></h1>

<h2>
<font face="Courier New" color="#FFFFFF> what you gliimpse is |</font>
</h2>

</center>
<br><br><br><br>
<br><br><br>

<p align=right>
<font size=4 face="Helvetica" color=99CCFF> <b><i>Pierre Dragicevic</i></b>
</font><br>
<font face="Helvetica" color=6699CC> INRIA </font><br><br>
<font size=4 face="Helvetica" color=99CCFF> <b><i>Stéphane Huot</i></b>
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<font face="Helvetica" color=6699CC> LRI - Université Paris-Sud & CNRS, INRIA
</font><br><br>
<font size=4 face="Helvetica" color=99CCFF> <b><i>Fanny Chevalier </i></b>
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<font face="Helvetica" color=6699CC> OCAD University </font>
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VISUALIZATION LITERACY



STATISTICAL LITERACY

Conditional probability

Explained Visually

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By [Victor Powell](#)

A conditional probability is the probability of an event, given some other event has already occurred. In the below example, there are two possible events that can occur. A ball falling could either hit the red shelf (we'll call this event A) or hit the blue shelf (we'll call this event B) or both.

If we know the statistics of these events across the entire population and then were to be given a single ball and told "this ball hit the red shelf (event A), what's the probability it also hit the blue shelf (event B)?" we could answer this question by providing the conditional probability of B given that A occurred or $P(B|A)$.

$$P(B|A) = \frac{P(A|B)P(B)}{P(A)}.$$

$P(A) = 0.200$ or 20.0%



$P(B) = 0.200$ or 20.0%



$P(A \cap B) = 0.100$ or 10.0%

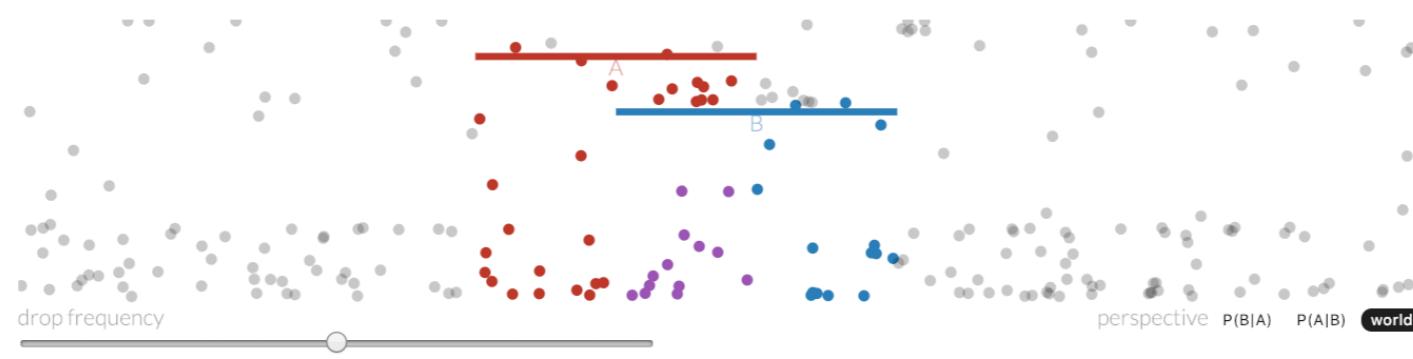


$P(B|A) = 0.500$ or 50.0%

If we have a ball and we know it hit the red shelf, there's a 50.0% chance it also hit the blue shelf.

$P(A|B) = 0.500$ or 50.0%

If we have a ball and we know it hit the blue shelf, there's a 50.0% chance it also hit the red shelf.



<http://setosa.io/ev/conditional-probability/>

STATISTICAL LITERACY

≡ Seeing Theory

English ▾

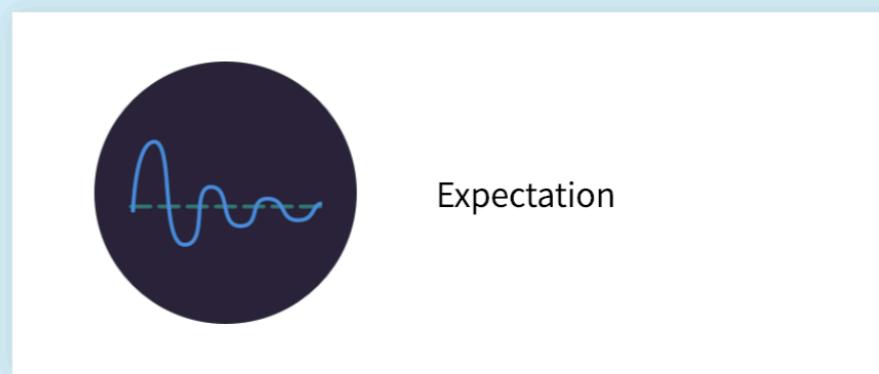
Chapter 1

Basic Probability

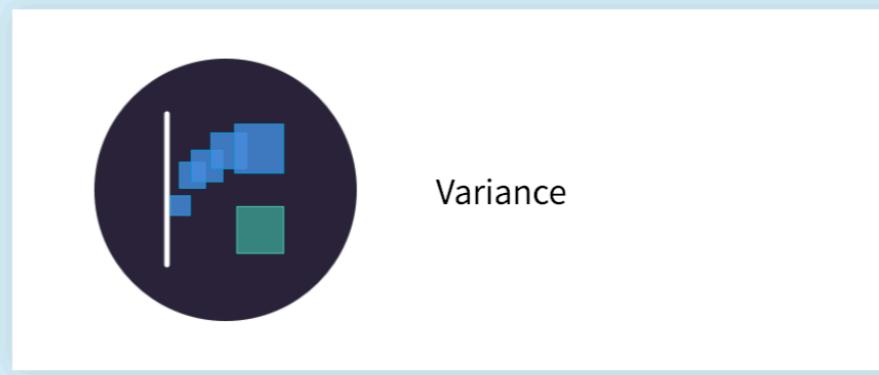
This chapter is an introduction to the basic concepts of probability theory.



Chance Events



Expectation



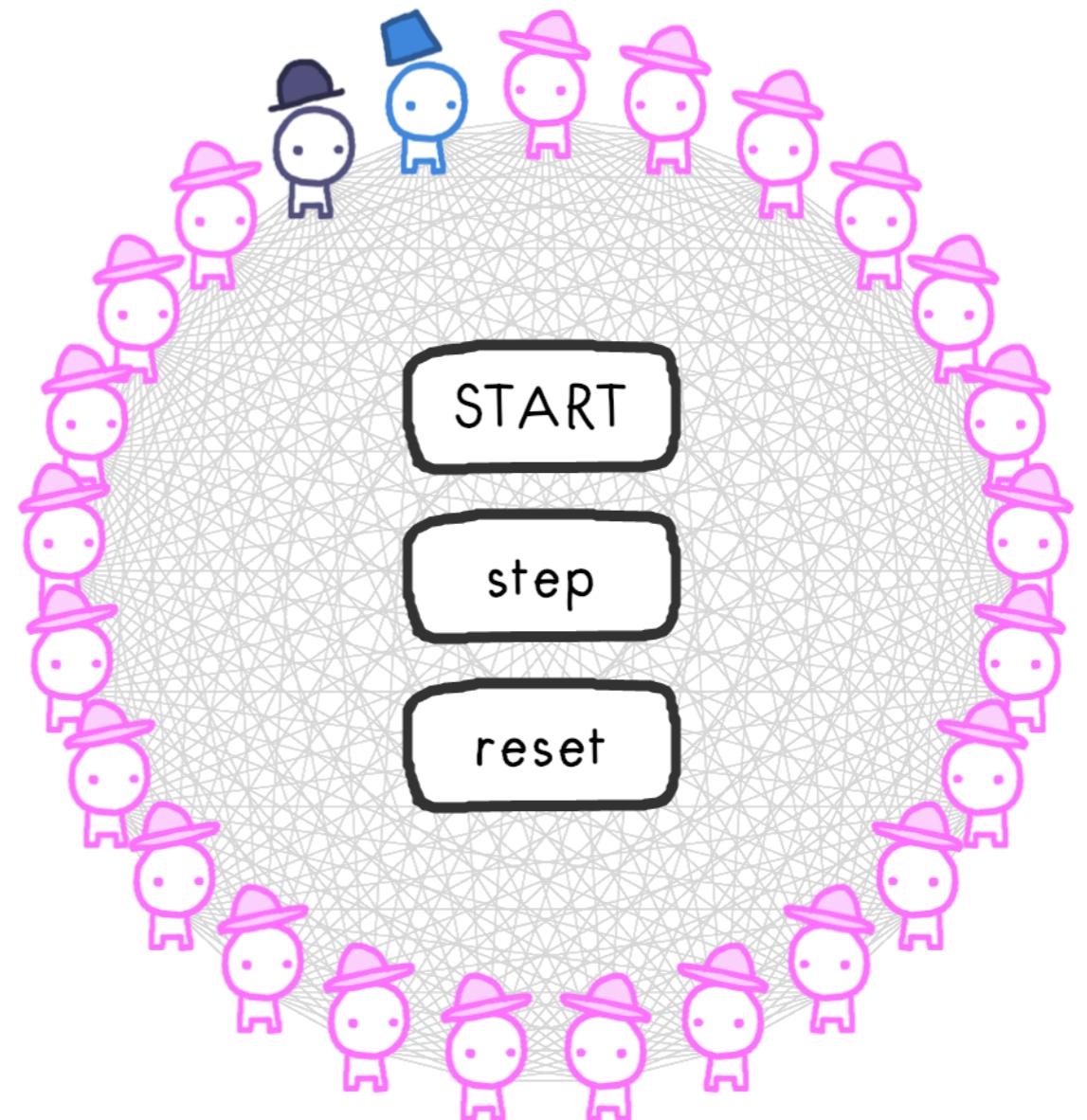
Variance

<https://seeing-theory.brown.edu/>

EXPLORABLE EXPLANATIONS

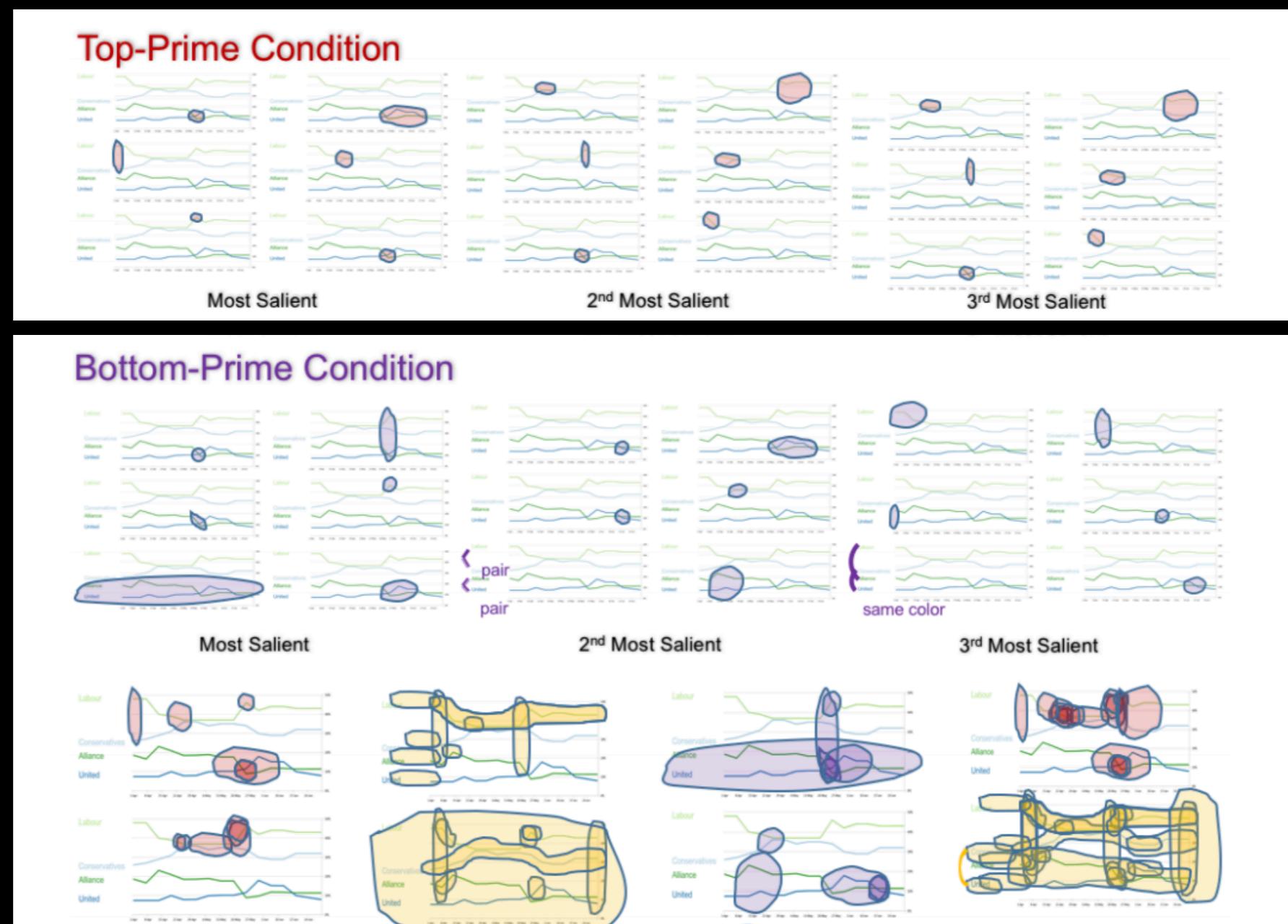
Before everything goes to heck, let's start with something nice! Here's a world filled entirely with **Always Cooperates**, except for one **Always Cheat** and one **Copycat**.

Use the buttons on the right to **START** the sim, go through it **step-by-step**, or **reset** it. →



PERCEPTION/COGNITION EXPERIMENTS

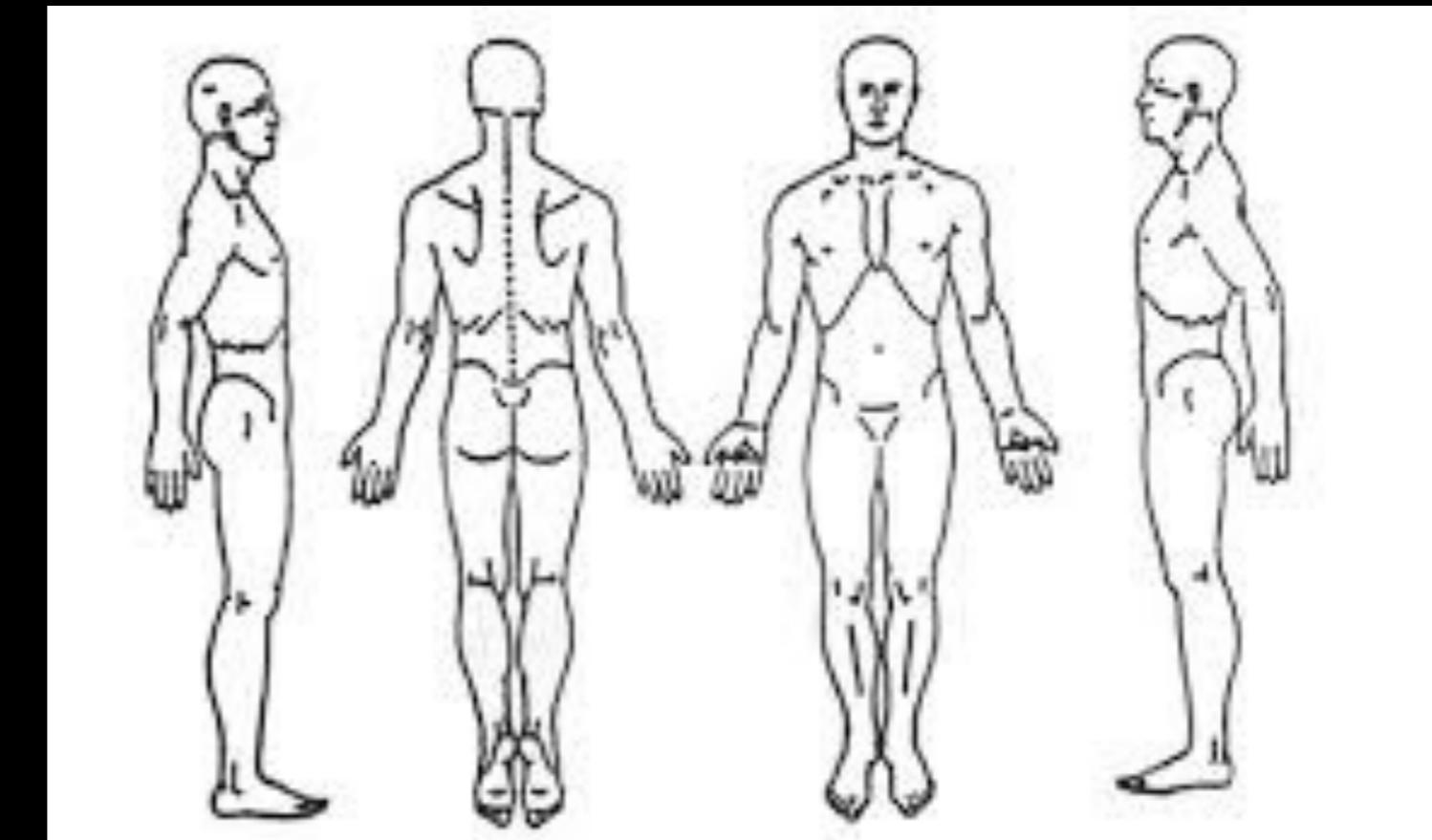
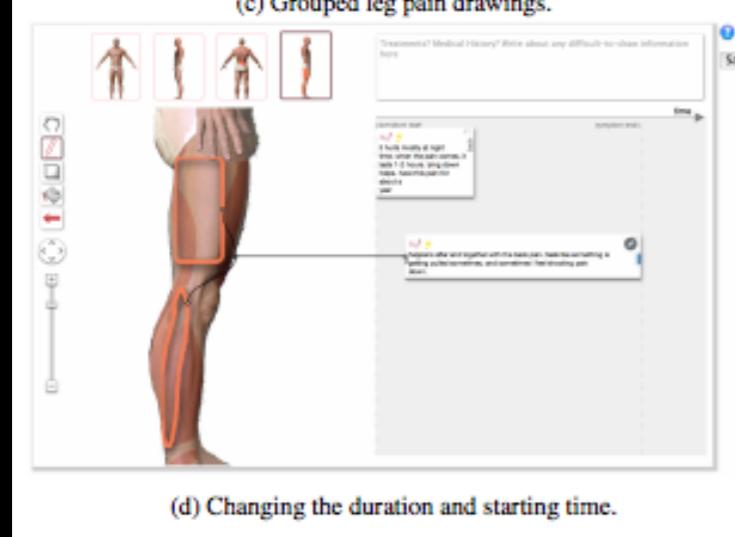
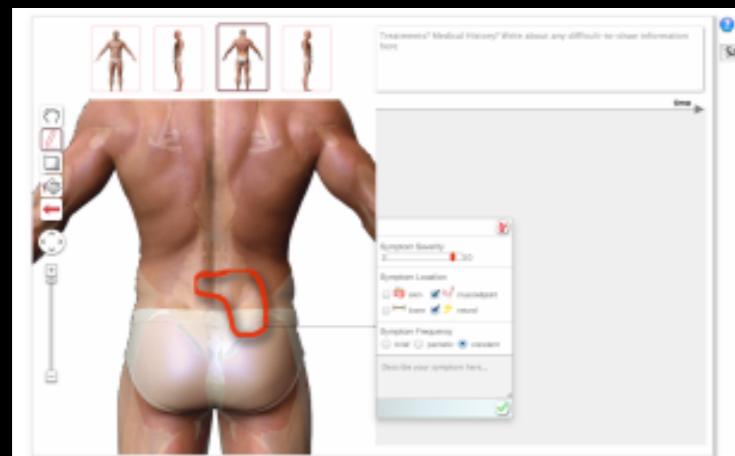
The Curse of Knowledge in Visual Data Communication



(SKETCH-BASED) TOOL FOR AUTHORING ANIMATED VISUAL TRANSITIONS



PATIENT-PHYSICIAN COMMUNICATION



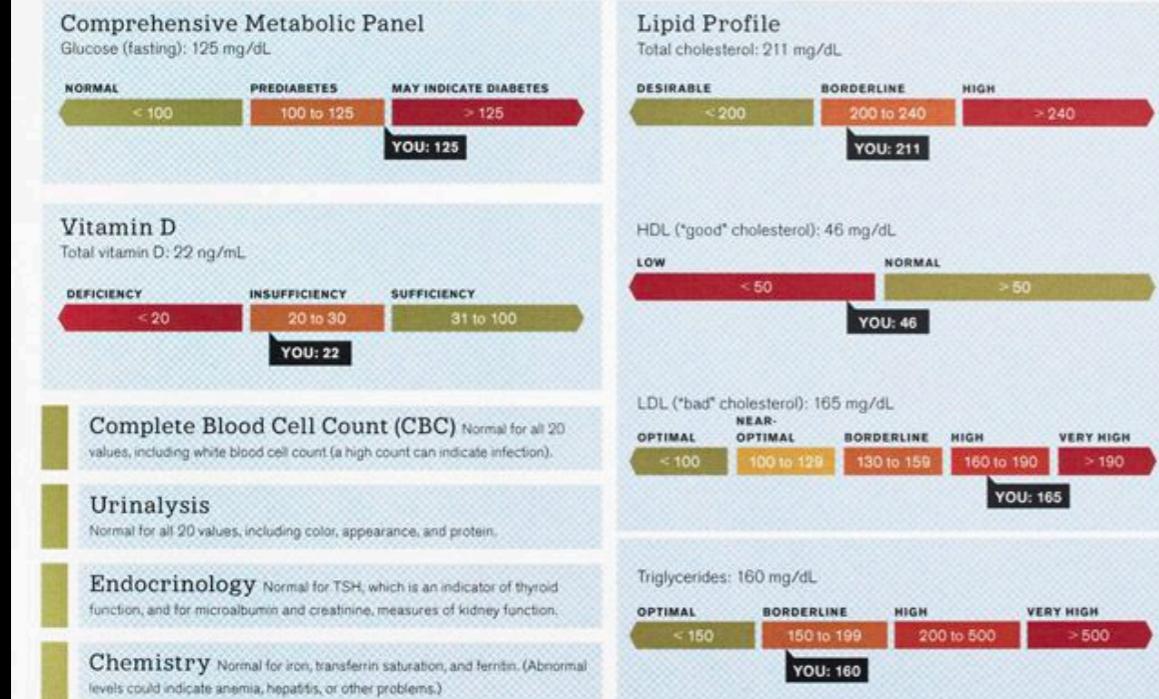
PATIENT-PHYSICIAN COMMUNICATION

Your Test Results

PATIENT: Cora Peterson

GENDER: Female COLLECTED: November 13, 2010, 8:40 a.m.
 AGE: 41 RECEIVED: November 13, 2010, 8:12 p.m.
 DOB: August 12, 1969 ORDERED BY: Dr. Pico Duval

RESULTS:



WHAT DO YOUR RESULTS MEAN?

- ELEVATED GLUCOSE:** The relatively high amount of sugar in your blood is typical of a patient with prediabetes, which can double your risk for heart disease, depending on other risk factors. See diabetes.org for more information.
- ELEVATED CHOLESTEROL:** Your relatively high cholesterol (a waxy substance produced in the liver) may also increase your risk of heart disease, depending on other risk factors. See heart.org for more information.
- LOWER LEVELS OF VITAMIN D:** Your results suggest insufficient vitamin D, which promotes bone density and immune-system function. Women who fit your profile can become deficient within five months if no action is taken. Vitamin D deficiency may increase your risk for osteoporosis, high blood pressure, and certain cancers.

WHAT CAN YOU DO?

- CONSIDER YOUR LIFESTYLE.** If you are inactive, overweight, and/or a smoker, your risk for diabetes and heart disease rises. Exercising regularly (30 minutes/day) and reducing your weight by 5 to 10 percent lowers your risk of diabetes by 58 percent.
- ADDRESS OTHER RISK FACTORS FOR DIABETES AND HEART DISEASE.** Dietary changes, like reducing alcohol consumption and increasing fruit and vegetable intake, can decrease your cholesterol and triglyceride levels.
- ASK YOUR DOCTOR ABOUT REDUCING YOUR HEART DISEASE RISK.** Medications like statins can lower cholesterol and delay the onset of heart disease. Calculate your risk at hp2010.nihbihn.net/atpsi/calculator.asp.
- CONSIDER LIFESTYLE CHANGES TO CORRECT VITAMIN D INSUFFICIENCY.** These include diet, vitamin D supplements, and more exposure to sunlight.

Your results at a glance:

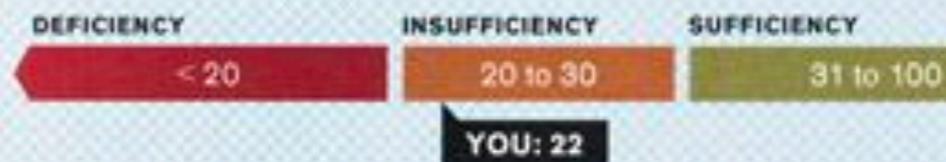
- YOUR GLUCOSE LEVELS ARE TOO HIGH, WHICH INDICATES PREDIABETES.
- YOUR VITAMIN D LEVEL IS TOO LOW.
- YOUR CHOLESTEROL LEVELS ARE BORDERLINE HIGH.
- YOUR KIDNEY, LIVER, AND THYROID FUNCTION ARE ALL NORMAL.

Questions?

Contact the physician who ordered this test for further interpretation of the results:
DR. PICO DUVAL
 (212) 555-5253

Vitamin D

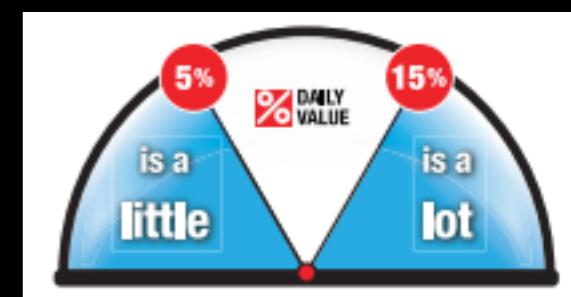
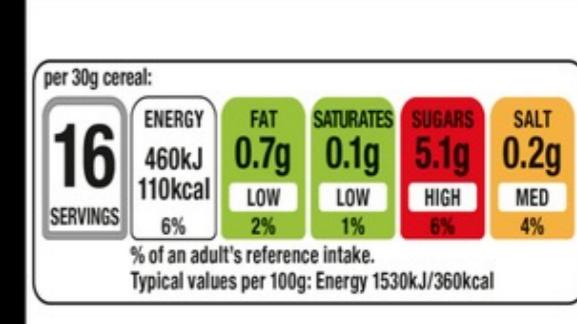
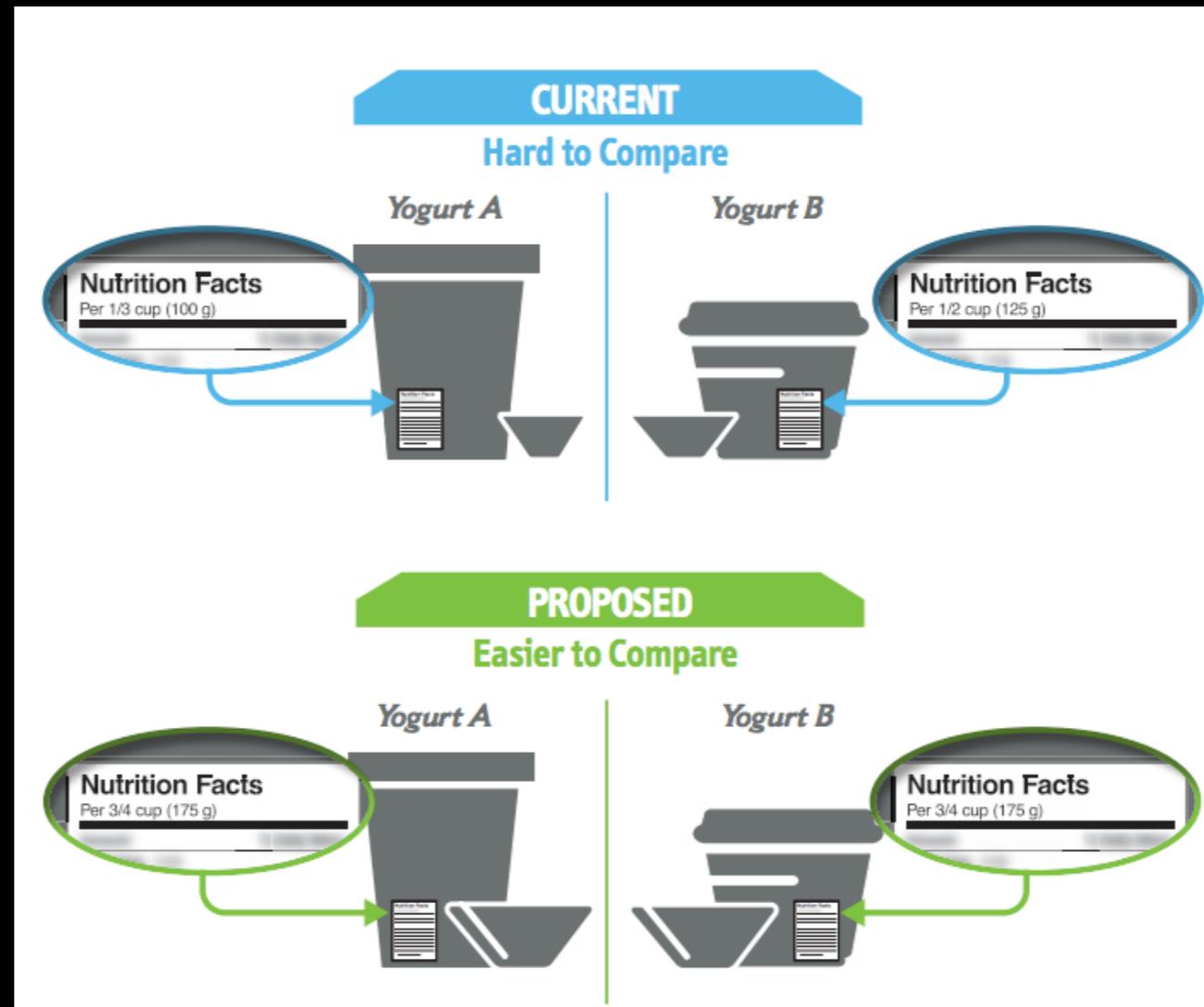
Total vitamin D: 22 ng/mL



FOOD & NUTRITION

Cracker B

Nutrition Facts	
Per 4 crackers (20 g)	
Amount	% Daily Value
Calories 85	
Fat 2 g	3 %
Saturated 0.3 g + Trans 0 g	2 %
Cholesterol 0 mg	
Sodium 90 mg	4 %
Carbohydrate 15 g	5 %
Fibre 3 g	12 %
Sugars 1 g	
Protein 2 g	
Vitamin A 0 %	Vitamin C 0 %
Calcium 2 %	Iron 7 %





PROSPECTIVE PROJECT X

VAST CHALLENGES



Visual Analytics
Community
DISCOVERY THROUGH COLLABORATION AND SHARING

HOME CONTENTS COMMUNITIES OUR MEMBERS LINKS

Username: Password: Log in [I forgot my password.](#) [Register](#)

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VAST Challenge

The Visual Analytics Science and Technology (VAST) Challenge is an annual contest with the goal of advancing the field of visual analytics through competition. The VAST Challenge is designed to help researchers understand how their software would be used in a novel analytic task and determine if their data transformations, visualizations, and interactions would be beneficial for particular analytic tasks. VAST Challenge problems provide researchers with realistic tasks and data sets for evaluating their software, as well as an opportunity to advance the field by solving more complex problems.

Researchers and software providers have repeatedly used the data sets from throughout the life of the VAST Challenge as benchmarks to demonstrate and test the capabilities of their systems. The ground truth embedded in the data sets has helped researchers evaluate and strengthen the utility of their visualizations.

Challenge Archive

- [VAST Challenge 2015 "Mayhem at DinoFun World"](#)
- [VAST Challenge 2014 "The Kronos Incident"](#)
- [VAST Challenge 2013 "Three Mini-Challenges"](#)
- [VAST Challenge 2012 "BANKWORLD"](#)
- [2011 - 2013 VAST Cyber Challenges](#)
- 2011: <http://hcil2.cs.umd.edu/newvarepository/benchmarks.php#VAST2011> Epidemic Spread and Computer Networks
- 2010: <http://hcil2.cs.umd.edu/newvarepository/benchmarks.php#VAST2010> Illegal Arms and Virus Pandemic
- 2009: <http://hcil2.cs.umd.edu/newvarepository/benchmarks.php#VAST2009> Trouble at the Embassy
- 2008: <http://www.cs.umd.edu/hcil/VASTchallenge08/> "The Paraiso Movement"
- 2007: <http://www.cs.umd.edu/hcil/VASTcontest07/> "Blue Iguanodon"
- 2006: <http://www.cs.umd.edu/hcil/VASTcontest06/> "A tale of Alderwood"