DATAVIS 10½
A PRACTICAL BRIEF INTRO TO DATA VISUALIZATION

PERE-PAU VÁZQUEZ – VIRVIG GROUP – UPC

OUTLINE

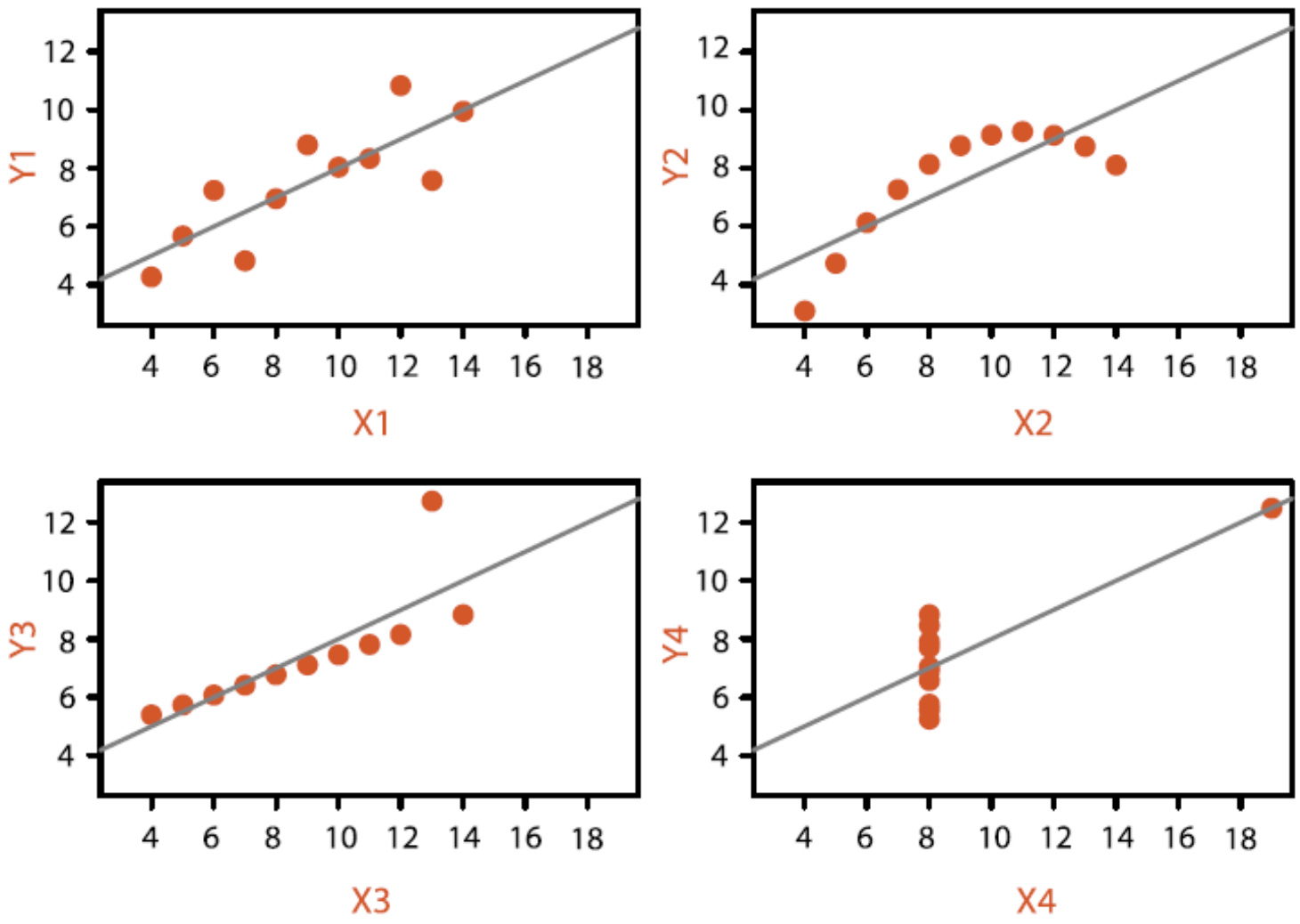
- Introduction to Visualization (concepts, goals, history…)
- Dos and don’ts of data visualization (and why it matters)
- Basic charts (purpose and implementation)
- Compound and interactive charts (how to implement multiple views)
- Further reading

NUMBERS ARE NOT ENOUGH

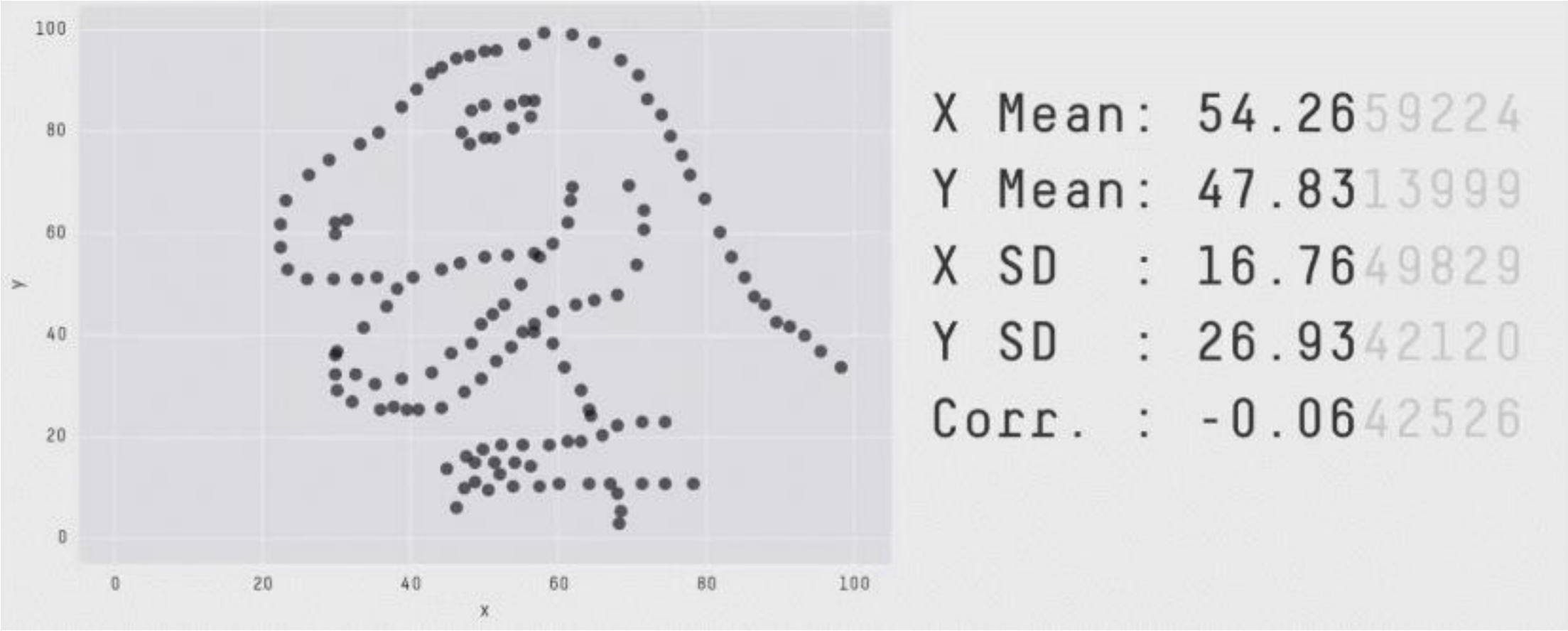
Anscombe's Quartet: Raw Data

	1		2		3		4	
	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	9.0	7.5	9.0	7.5	9.0	7.5	9.0	7.5
Variance	10.0	3.75	10.0	3.75	10.0	3.75	10.0	3.75
Correlation	0.816		0.816		0.816		0.816	

NUMBERS ARE NOT ENOUGH



NUMBERS ARE NOT ENOUGH



WHAT IS VISUALIZATION?

“...make both calculations and graphs.
Both sorts of output should be studied;
each will contribute to understanding.”

F. J. Anscombe, 1973

WHAT IS VISUALIZATION?

“Computer-based visualization systems provide
visual representations of datasets
designed to help people
carry out tasks more effectively.”

Tamara Munzner, 2016

WHAT IS VISUALIZATION?

"Computer-based visualization systems provide
visual representations of **datasets**
designed to **help people**
carry out **tasks** more effectively."

Tamara Munzner, 2016

WHAT IS VISUALIZATION?

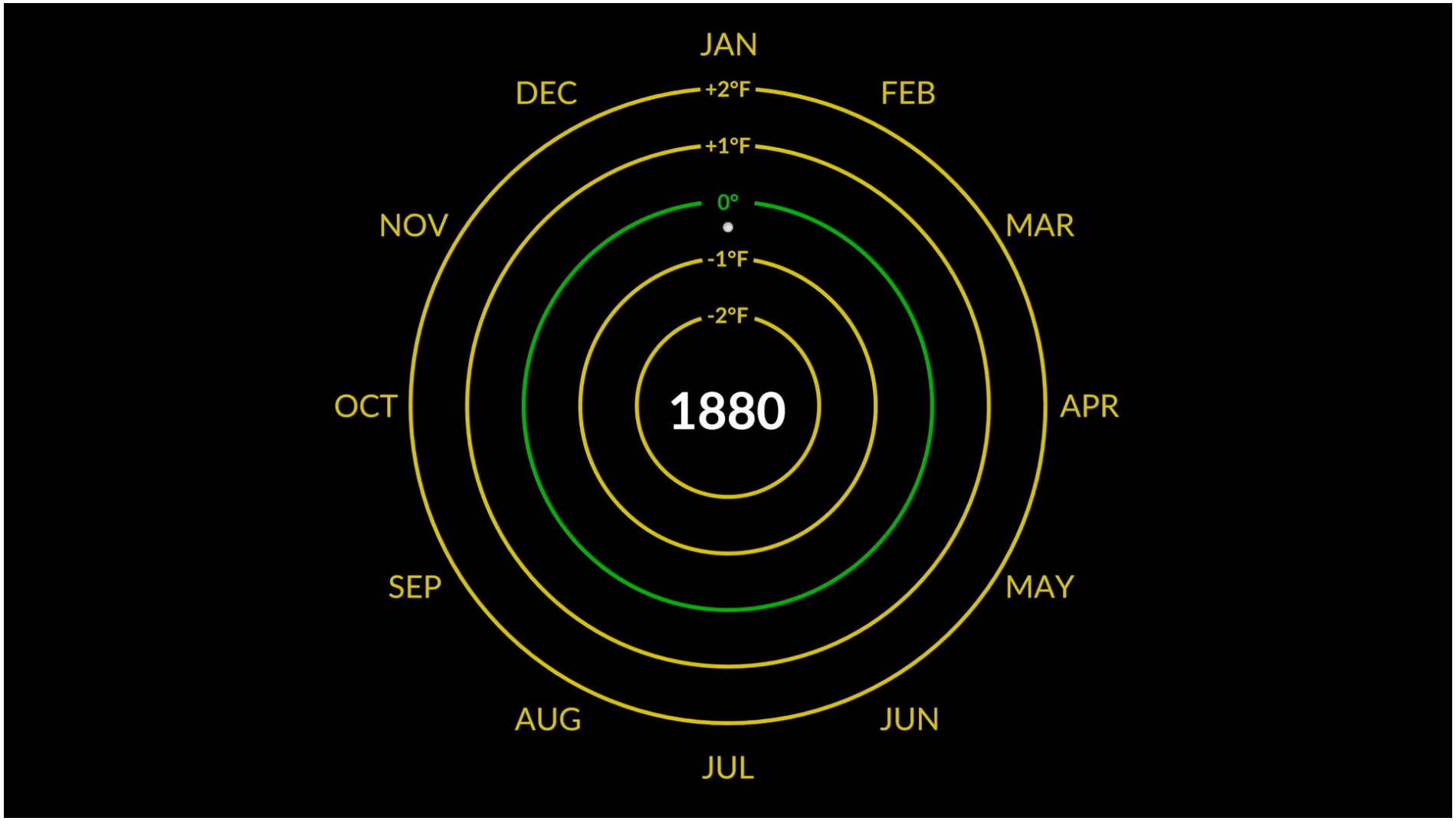
“A graphic is not ‘drawn’ once and for all; it is ‘constructed’ and reconstructed until it reveals all the relationships constituted by the interplay of the data. The best graphic operations are those carried out by the decision-maker themself.”

Jacques Bertin

TODAY'S CONTENTS

- Organization
  - Do's and don'ts
    - Slides
  - Basic concepts
    - Slides
  - Visualization techniques
    - Using Altair
  - Multiple Views & Interaction
    - Slides + Altair

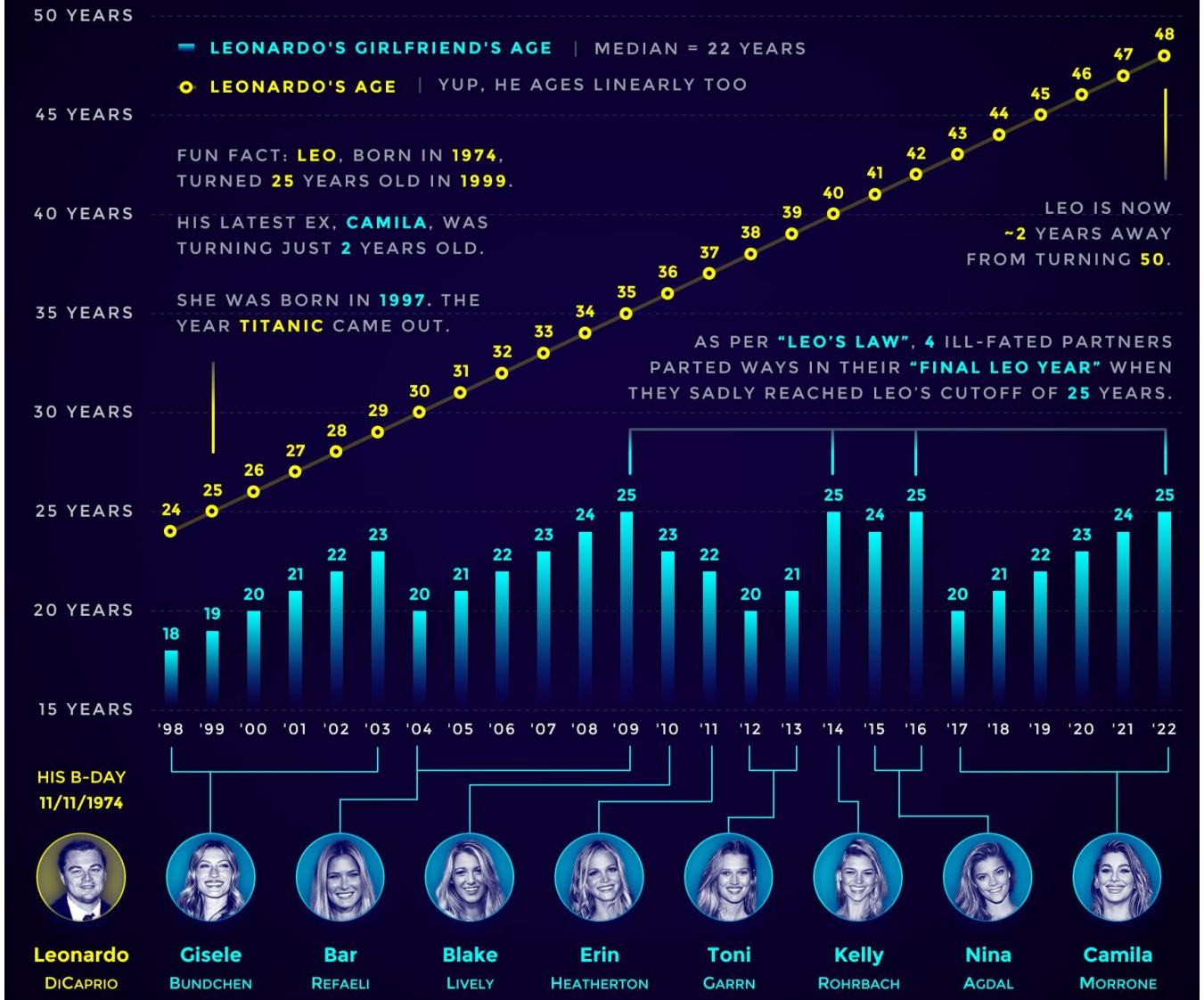
EXAMPLES



https://climate.nasa.gov/climate_resources/300/video-climate-spiral/

LEONARDO DICAPRIO REFUSES TO DATE A WOMAN HIS AGE

HE GETS **OLDER**, THEY STAY THE **SAME AGE**. LEO'S PUSHING **50** NOW BUT STICKS TO DATING WOMEN **≤25**.



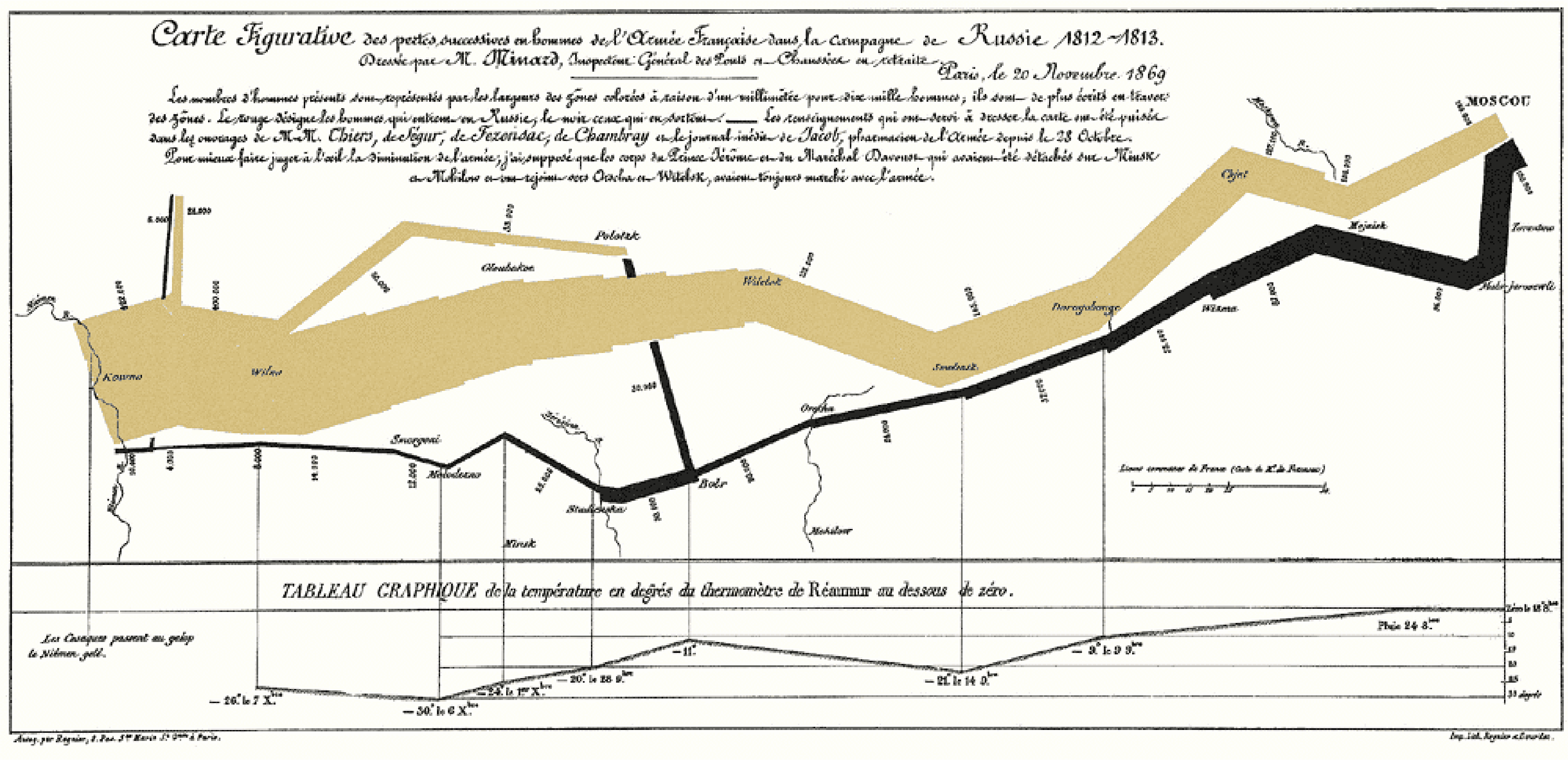
Ricky Gervais at the 2020 Golden Globes: *Once Upon a Time in Hollywood* is nearly three hours long. Leonardo DiCaprio attended the premiere, and by the end, his date was too old for him. Even Prince Andrew's like, "Come on, Leo, mate. You're nearly 50, son."

https://digg.com/data-viz/link/leonardo-di-caprio-dating-history-25-year-old-girlfriends-visualized-YjMeIPkdLJ

HISTORY

Inka’s narrative Khipus contain histories and numerical data

HISTORY



Carte Figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812–1813.
TABLEAU GRAPHIQUE de la température en degrés du thermomètre de Réaumur au dessous de zéro.
MOSCOU

HISTORY

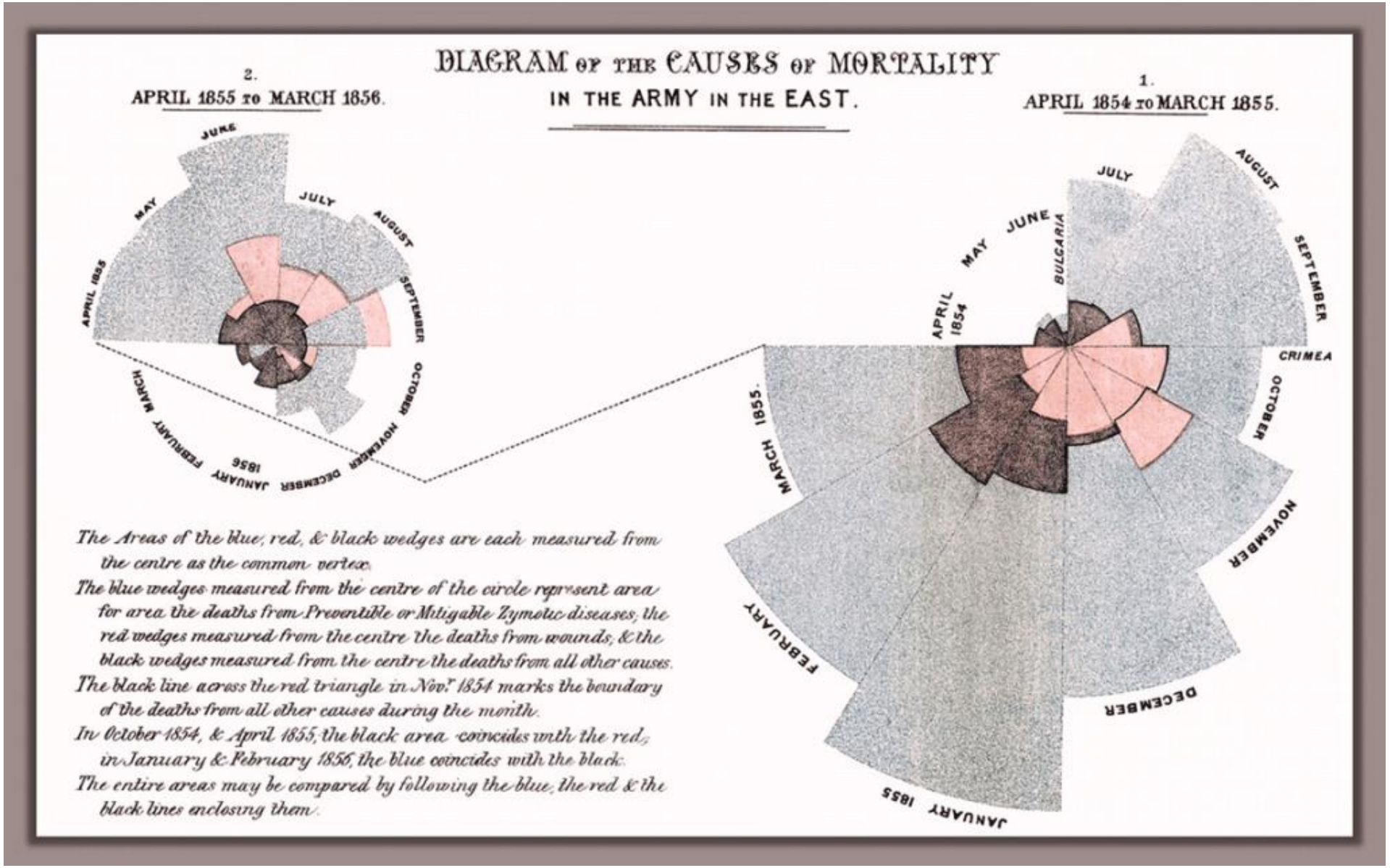


DIAGRAM OF THE CAUSES OF MORTALITY
IN THE ARMY IN THE EAST.
2.
APRIL 1855 TO MARCH 1856.
1.
APRIL 1854 TO MARCH 1855.
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
JANUARY 1856
FEBRUARY
MARCH
APRIL 1855
MAY
JULY
AUGUST
SEPTEMBER
CRIMEA
OCTOBER
NOVEMBER
DECEMBER
JANUARY 1855
FEBRUARY
MARCH 1855.
APRIL 1854
MAY
JUNE
BULGARIA
The Areas of the blue, red, & black wedges are each measured from the centre as the common vertex.
The blue wedges measured from the centre of the circle represent area for area the deaths from Preventible or Mitigable Zymotic diseases, the red wedges measured from the centre the deaths from wounds, & the black wedges measured from the centre the deaths from all other causes.
The black line across the red triangle in Nov.r 1854 marks the boundary of the deaths from all other causes during the month.
In October 1854, & April 1855, the black area coincides with the red, in January & February 1856, the blue coincides with the black.
The entire areas may be compared by following the blue, the red & the black lines enclosing them.

HISTORY

- Cholera epidemic in London 1854

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  - John Snow

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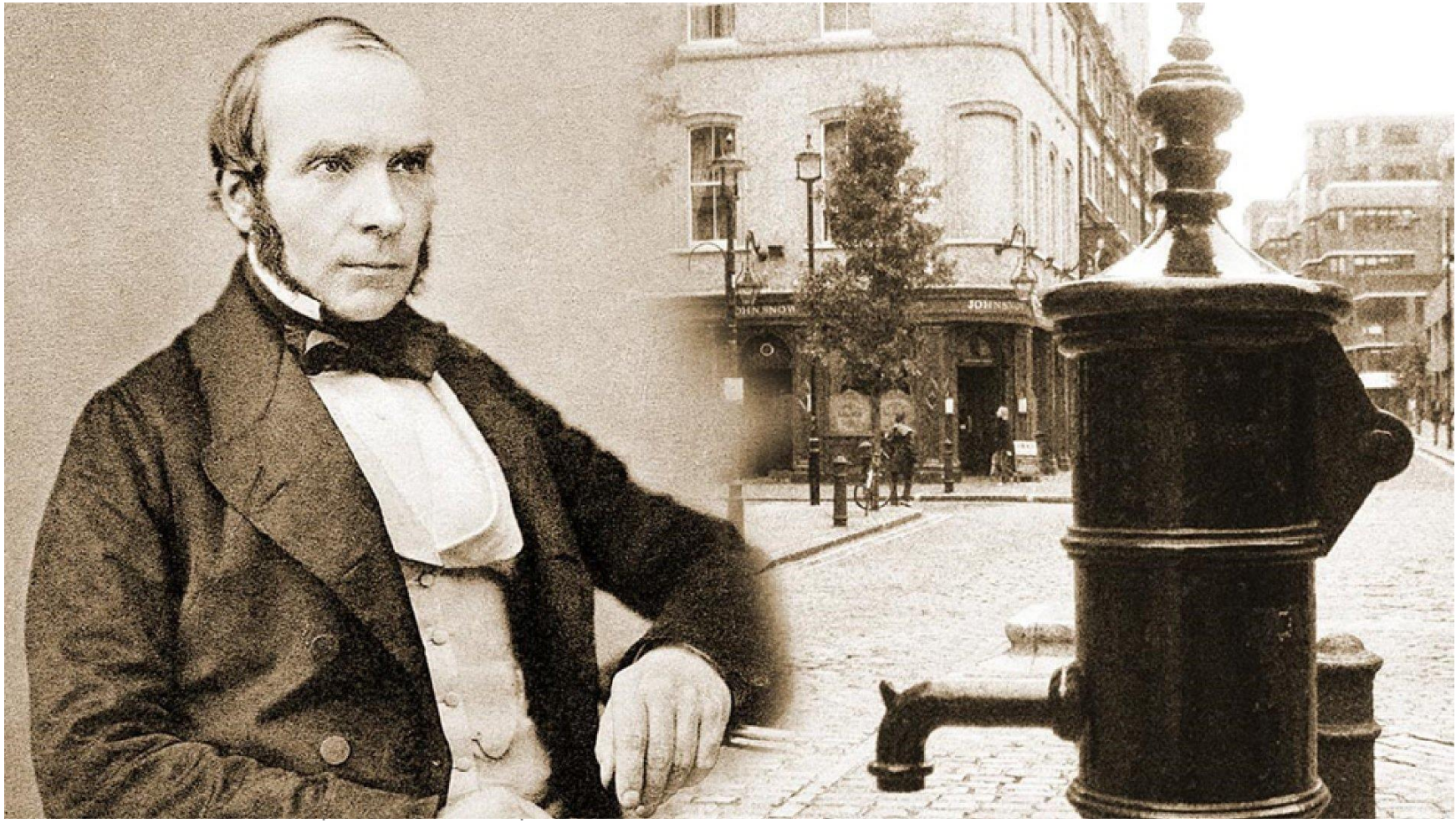


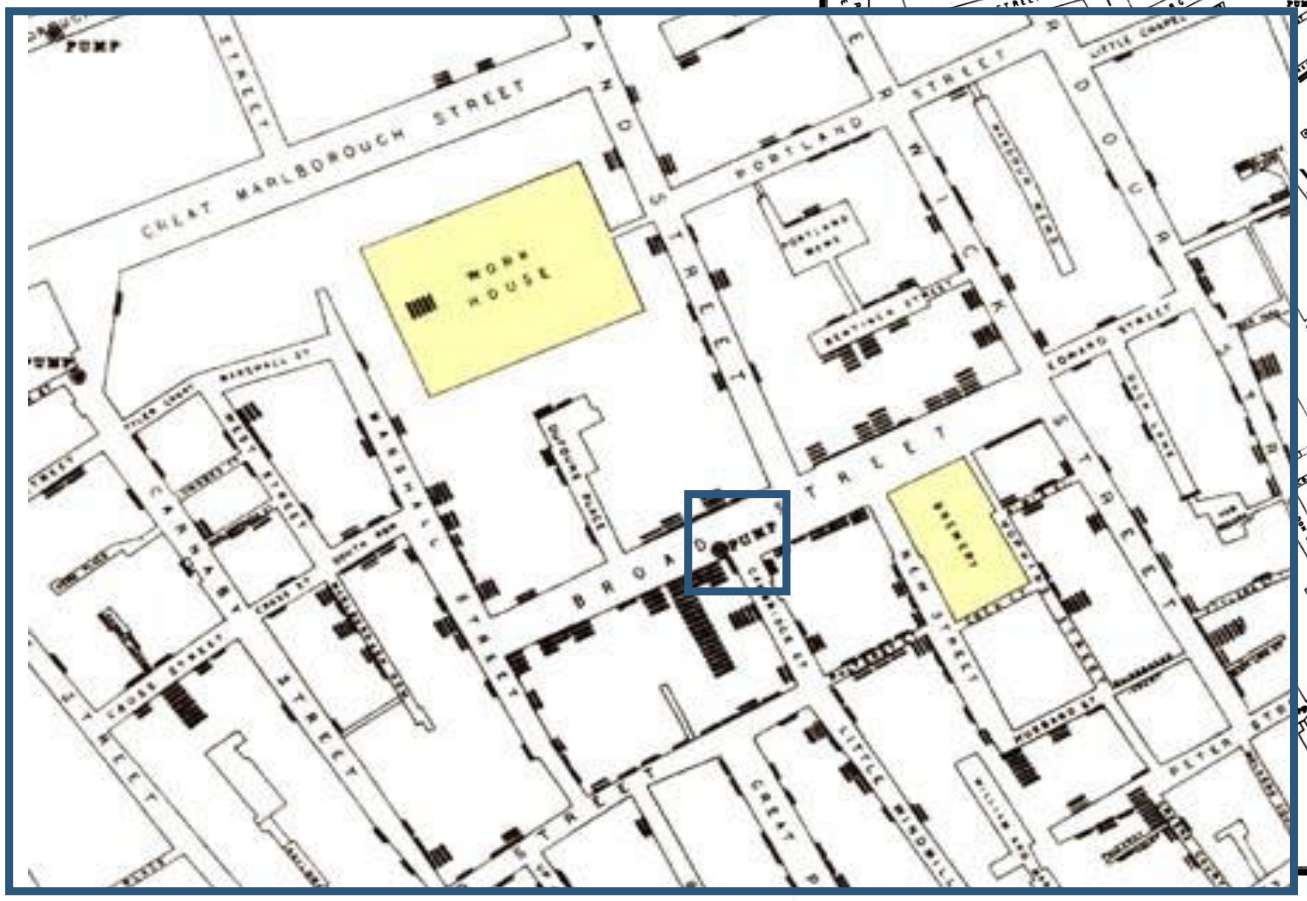
HISTORY

- Cholera epidemic in London 1854
  - Dr. John Snow was able to trace the source of the cholera outbreak in Soho
  - His findings inspired fundamental changes in the water and waste systems in London

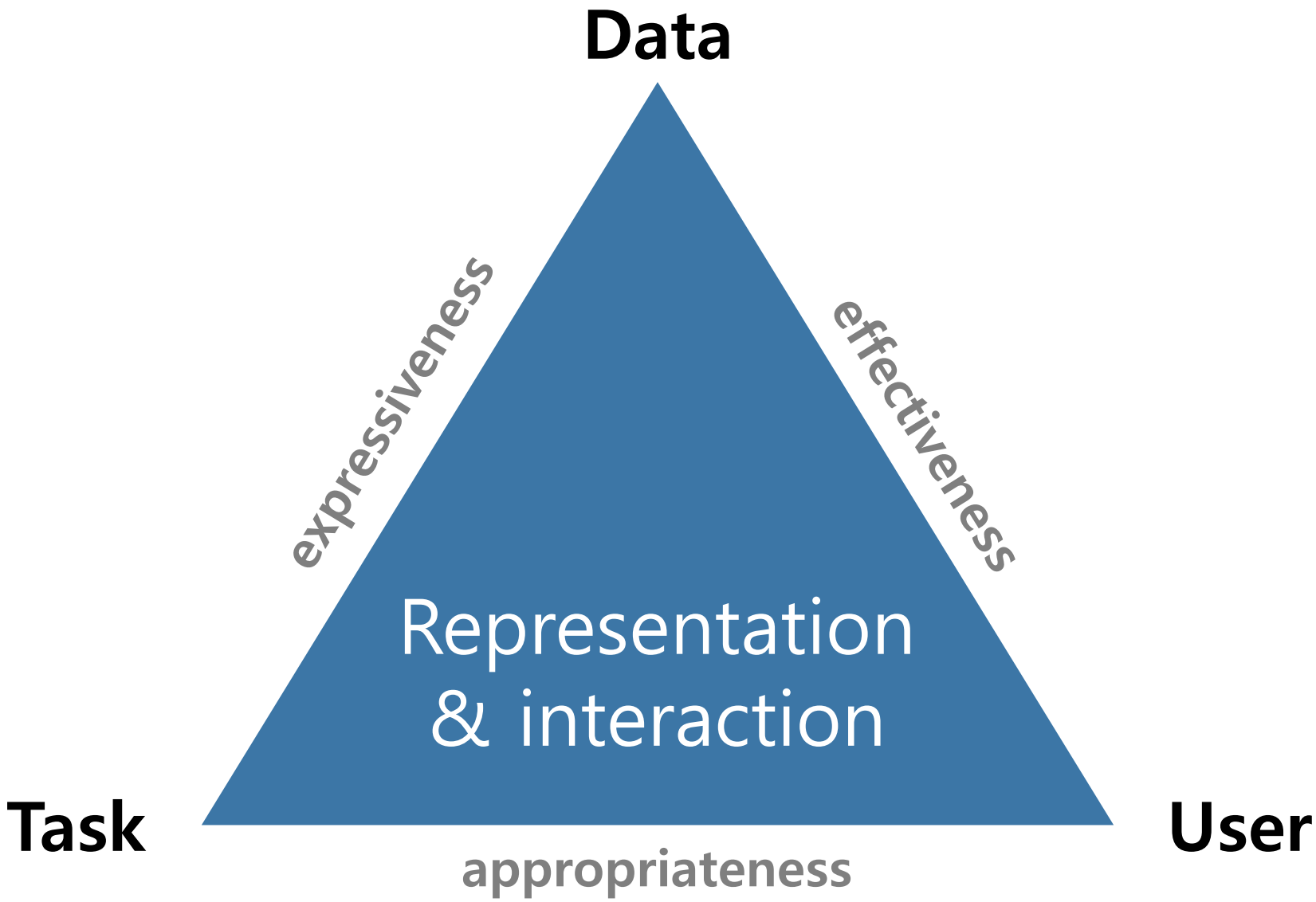
  - He is considered one of the fathers of modern epidemiology

INTRODUCTION

- Drawing by John Snow



DATA, TASKS, USERS



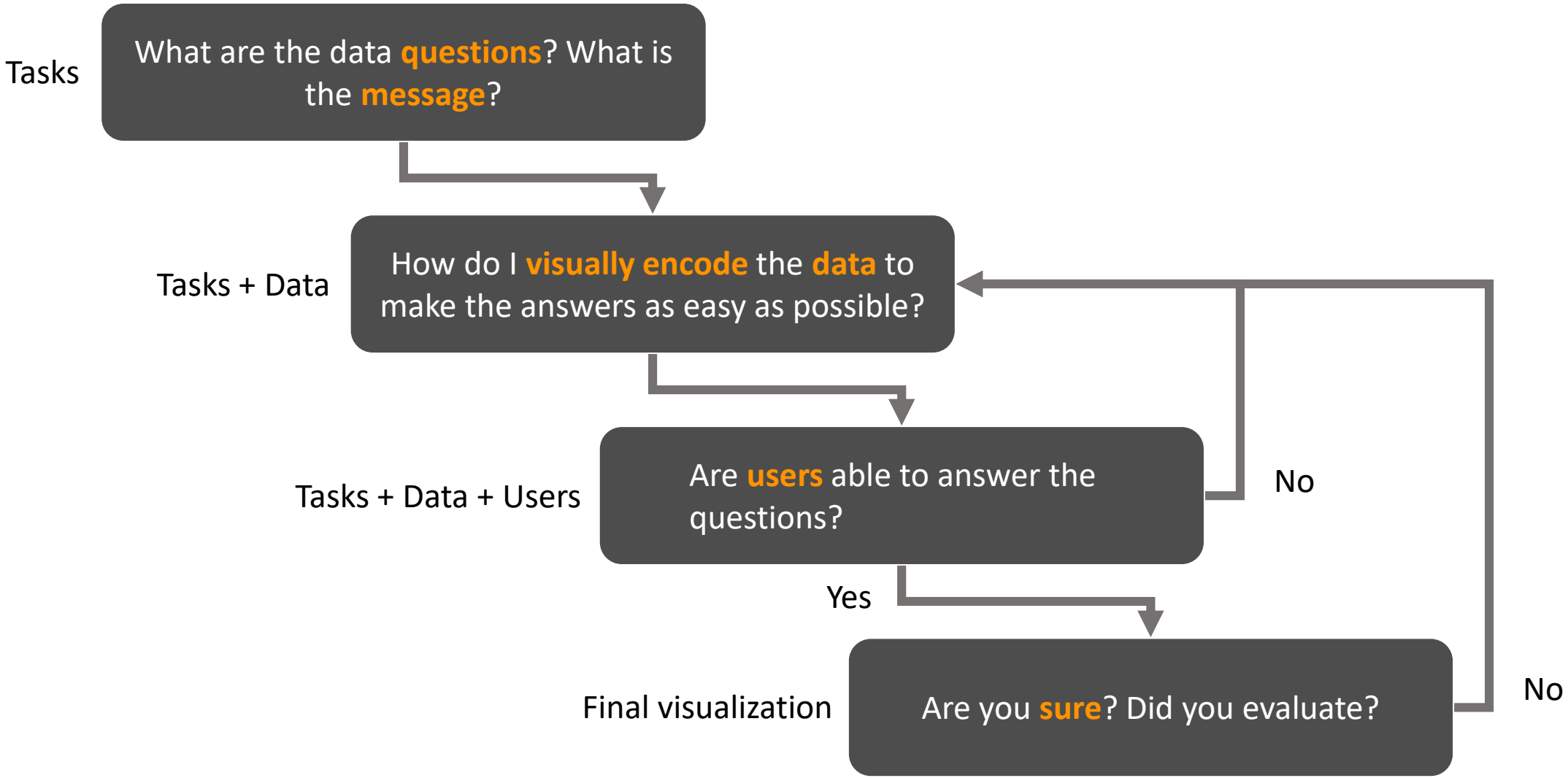
DATA, TASKS, USERS

- *Expressiveness:* Show exactly **the information in the data**
  - Nothing more and nothing less

- *Effectiveness:* Take into account the **cognitive capabilities** of the human visual system, and
  - the task, application background, and other context-related information…

- *Appropriateness:* Cost-value ratio that assesses the benefit of the visualization process with respect to achieving the task
  - Mainly **time** (computation) and **space** (screen-space) efficiency

DATA, TASKS, USERS



DATA, TASKS, USERS

- **Data** types
  - *Nominal* (unordered set of names)
    - Examples: Car manufacturers and countries
    - Only test for inequality is possible
  - *Ordinal* (ordered set of non-measureable data)
    - Examples: days of the week and rating scales
    - Tests for equality and “direction” (<,>,=, ≠)
  - *Quantitative* (measured or simulated data)
    - Examples: physical measurements of height, weight, length
    - Full set of arithmetic operations possible

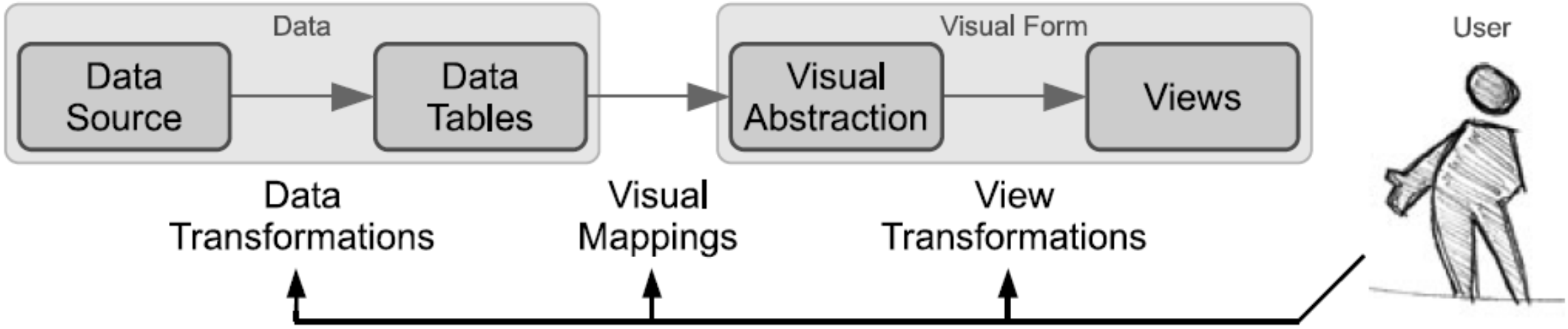
DATA, TASKS, USERS

- **Data** structure

Structure	Examples
1-dimensional	Alphabetic lists, source code, texts/documents
2-dimensional	Planar or map data, photos
3-dimensional	Molecules, human body, buildings
Temporal	{start, finish}, e.g., medical records, project management, historical presentations
Multi-dimensional	N attributes -> points in n-dimensional space, e.g., relational databases
Tree	Hierarchies or tree structures, e.g., file directories, business organizations
Network	Connected as graphs, e.g., communications networks, social networks

VISUALIZATION PIPELINE

- The visualization pipeline is dynamic (Aigner et al., 2011)



THE VISUALIZATION MANTRA

Schneiderman’s Mantra

1. Overview first
2. Zoom and filter
3. Then Details on Demand

THE VISUALIZATION MANTRA

Schneiderman’s Mantra

1. Overview first: Provide **big picture** of the data, no details
2. Zoom and filter
3. Then Details on Demand

THE VISUALIZATION MANTRA

Schneiderman's Mantra

1. *Overview first: Provide big picture of the data, no details*
2. Zoom and filter: Focus on a **particular area** of the data
3. Then Details on Demand

THE VISUALIZATION MANTRA

Schneiderman's Mantra

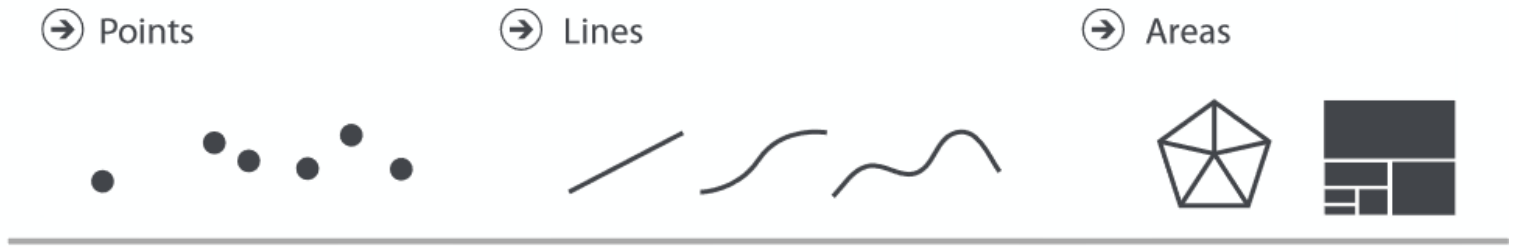
1. *Overview first: Provide big picture of the data, no details*
2. *Zoom and filter: Focus on a particular area of the data*
3. Then Details on Demand: Only when requested, **details of single data items**

MARKS AND VISUAL VARIABLES

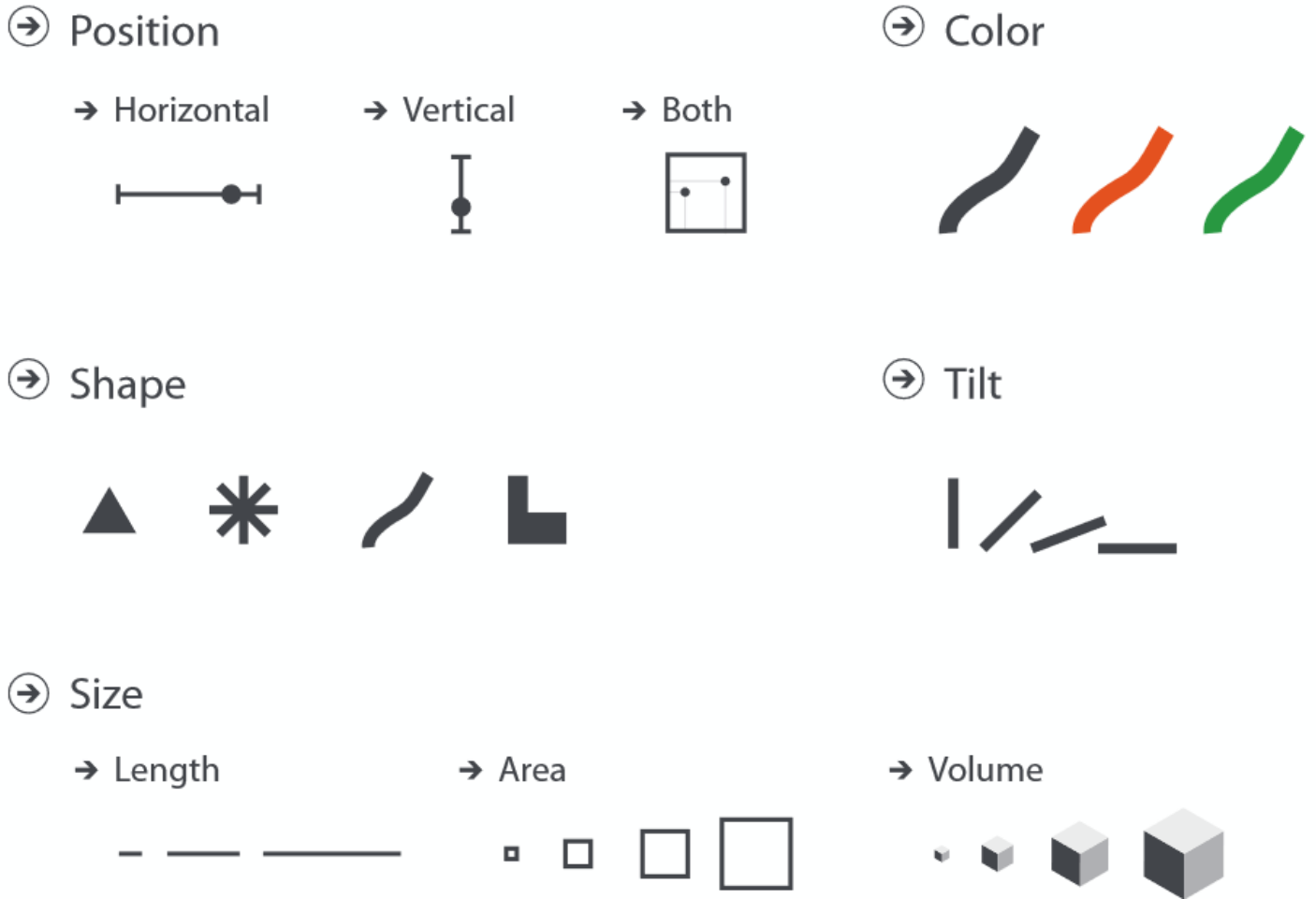
- Marks:
  - Geometric primitives
- Visual channels:
  - Control appearance of marks
  - Can redundantly code with multiple channels

MARKS AND VISUAL VARIABLES

Marks



Visual channels



MARKS

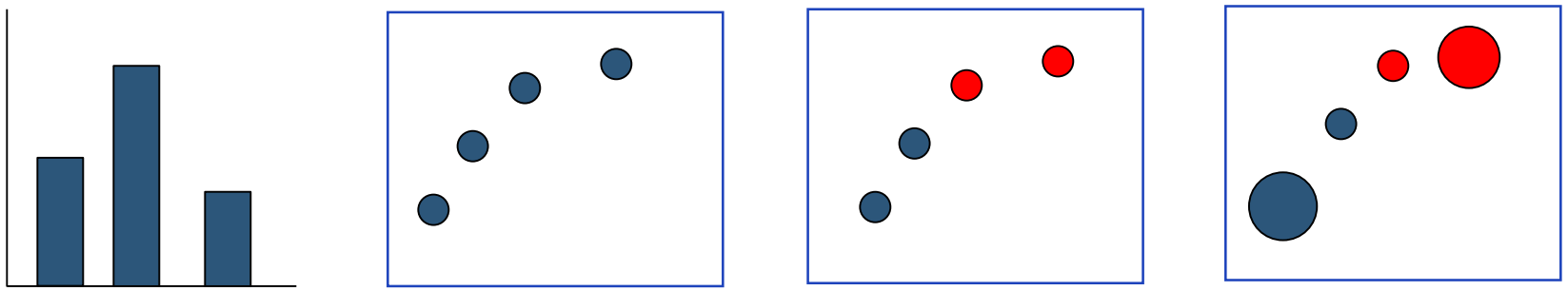
- **Points:** Location on the plane that has no theoretical length or area
  - Signification independent on the size and character of the mark

- **Lines:** Phenomenon on the plane which has a measurable length but no area
  - Independent of the width and other mark characteristics

- **Areas:** Something on the plane that has measurable size
  - Signification applies to the entire area covered by the visible mark

MARKS AND VISUAL CHANNELS

- Designing a visualization implies selecting a combination of marks and channels showing abstract data dimensions



Channel	Vertical pos.	Vertical pos. Horizontal pos.	Vertical pos. Horizontal pos. Color	Vertical pos. Horizontal pos. Color Size
Mark	Line	Point	Point	point

VISUAL VARIABLES. PERCEPTION

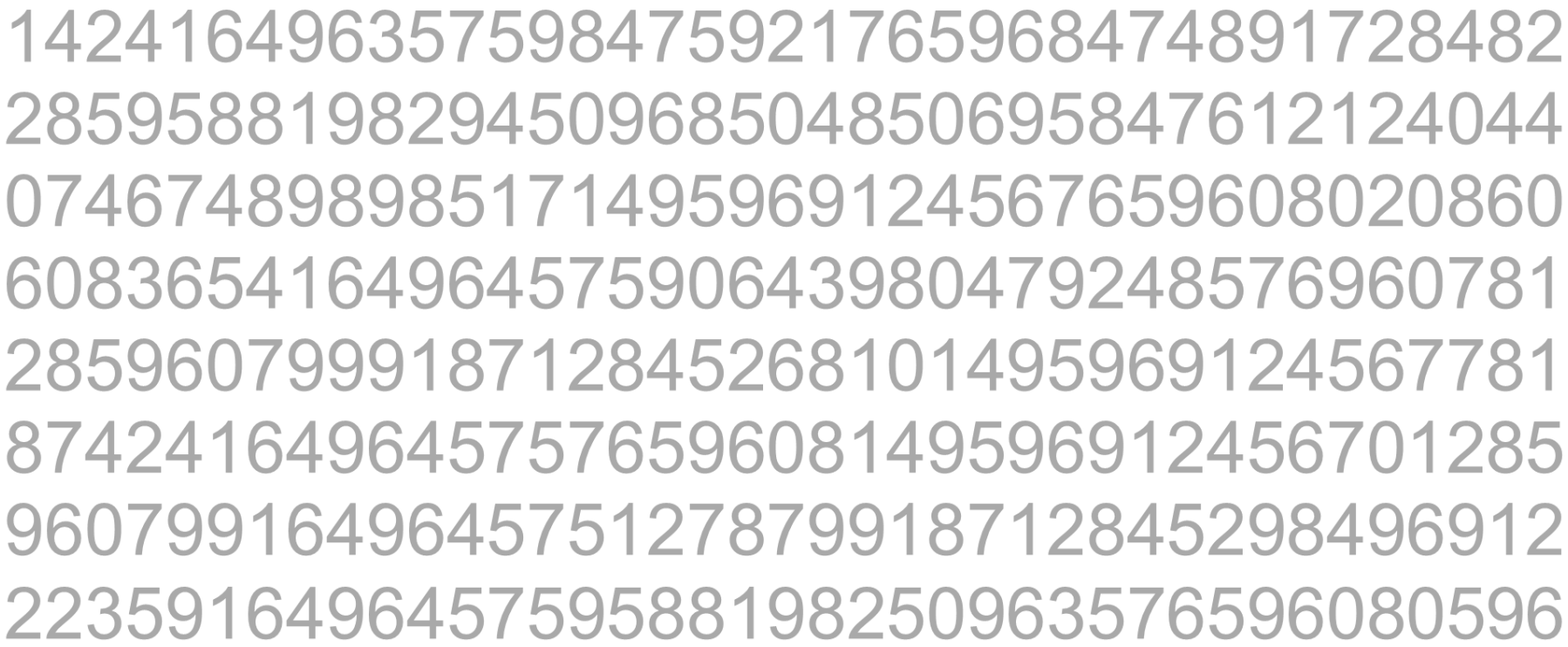
- Not everything is perceived equally:
  - Preattentive variables
  - Layouts

VISUAL VARIABLES. PERCEPTION. PREATTENTIVE VARIABLES

- A limited set of basic visual properties are processed ***preattentively***
  - Information that “pops out”
  - Parallel processing by the low-level visual system (Stage 1 in the model)
  - Occurs prior to conscious attention
  - Important for designing effective visualizations
    - What features can be perceived rapidly?
    - Which properties are good discriminators?
    - What can mislead viewers?
    - How to design information such that it pops out?

VISUAL VARIABLES. PERCEPTION. PREATTENTIVE VARIABLES

- Example: Find the 3s



VISUAL VARIABLES. PERCEPTION. PREATTENTIVE VARIABLES

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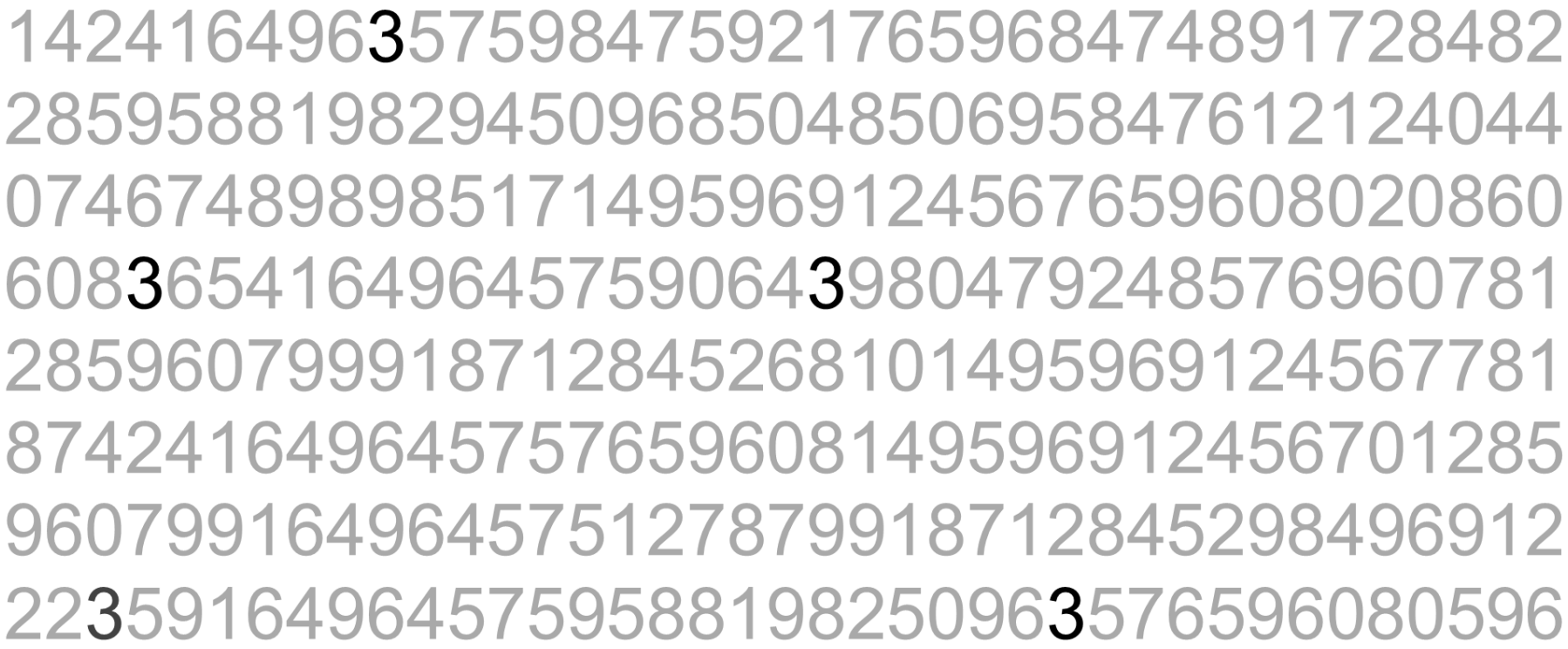
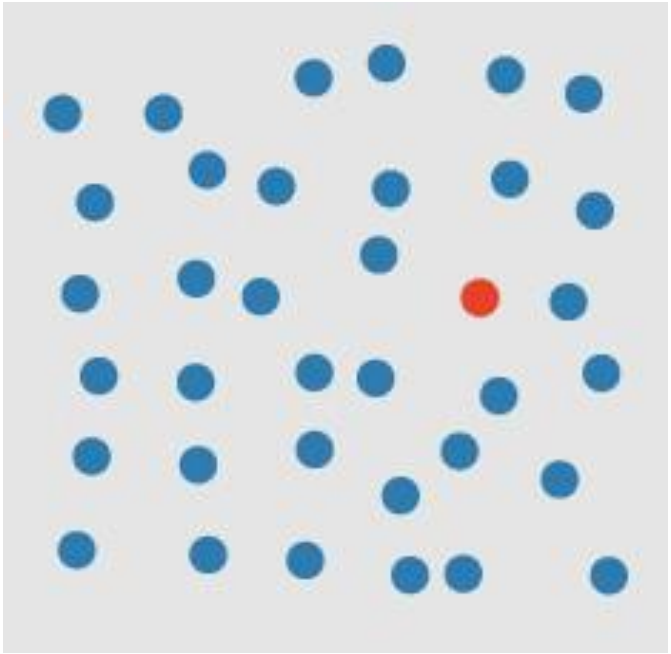
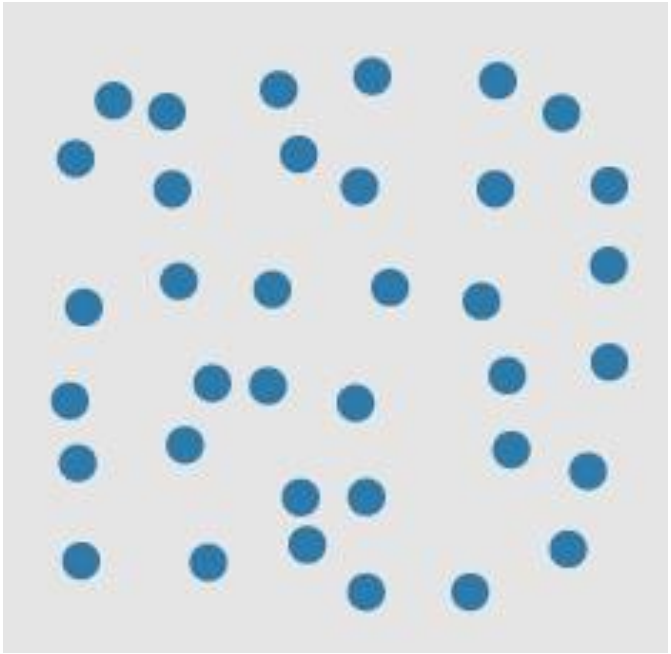


VISUAL VARIABLES. PERCEPTION. PREATTENTIVE VARIABLES

- Is there a red circle present in the image?





Images taken from http://www.csc.ncsu.edu/faculty/healey/PP/index.html

VISUAL VARIABLES. PERCEPTION. PREATTENTIVE VARIABLES

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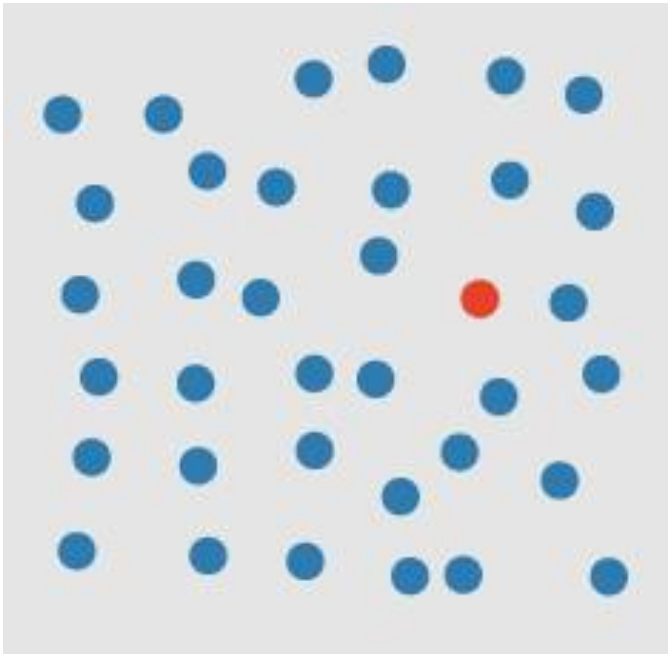
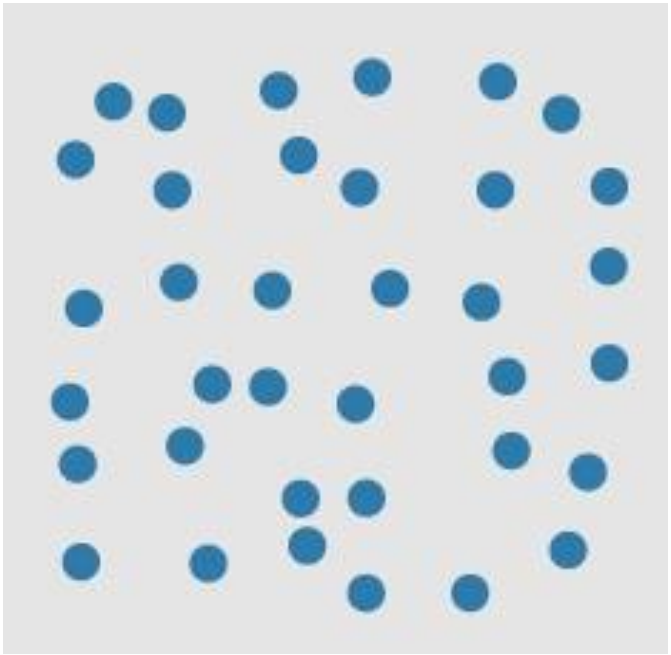




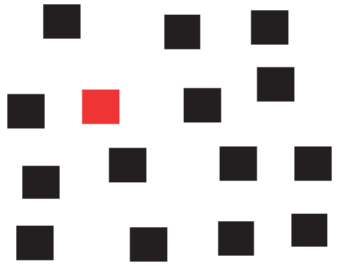
Color is preattentively processed!

Images taken from http://www.csc.ncsu.edu/faculty/healey/PP/index.html

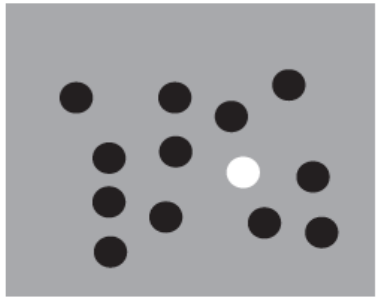
VISUAL VARIABLES. PERCEPTION. PREATTENTIVE VARIABLES

Color

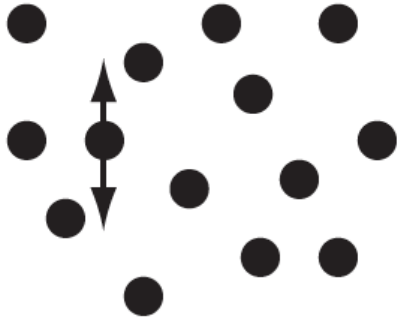
hue



lightness



Motion



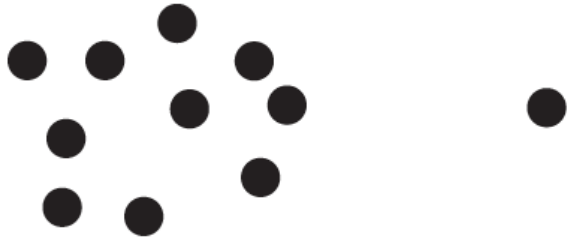
Elementary shape

size

elongation

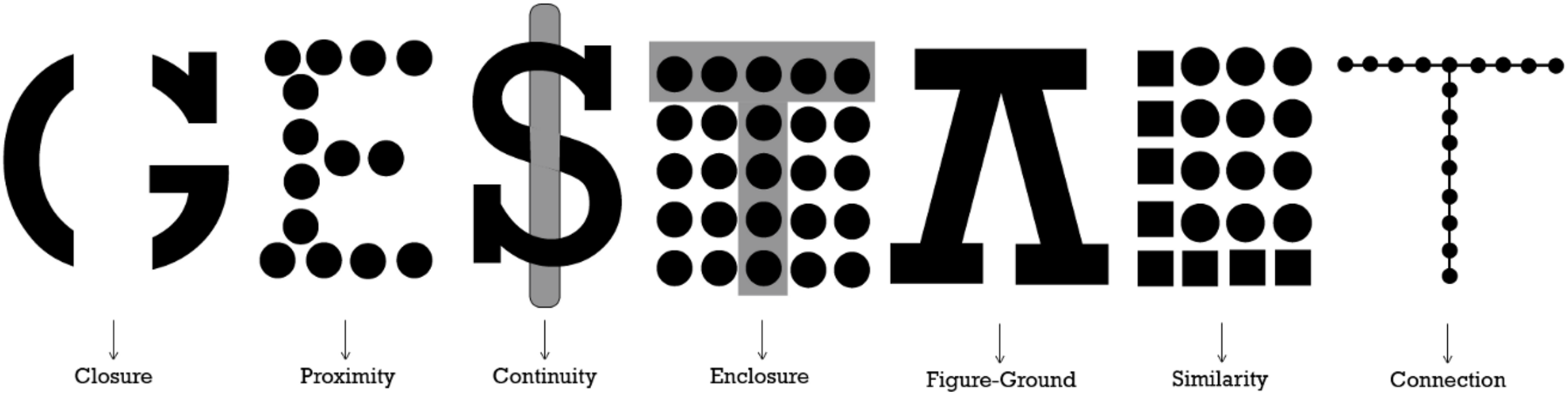
orientation

Spatial grouping

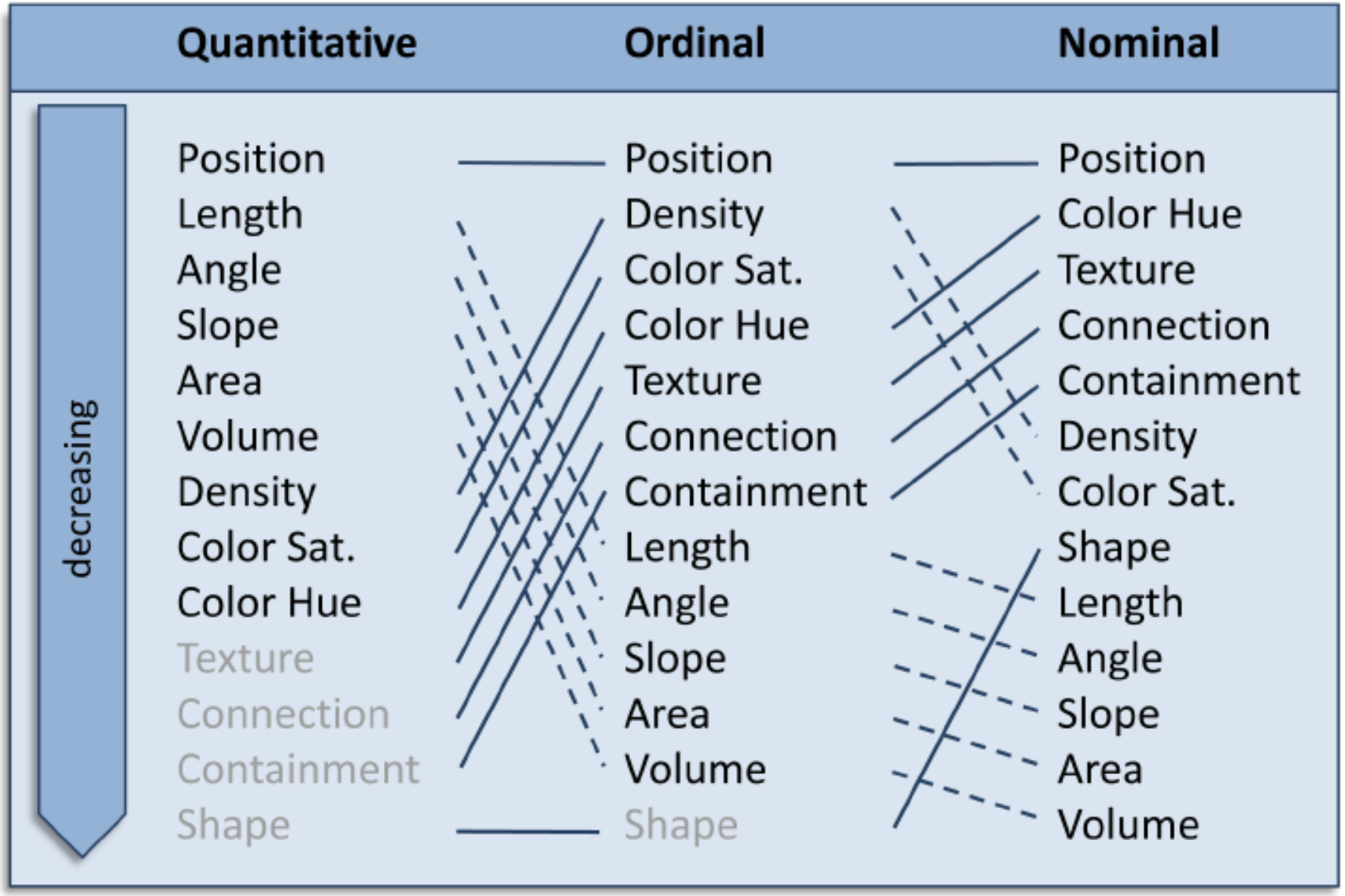


C. Ware, Information Visualization. Perception for design, 2013

VISUAL VARIABLES. PERCEPTION. LAYOUTS

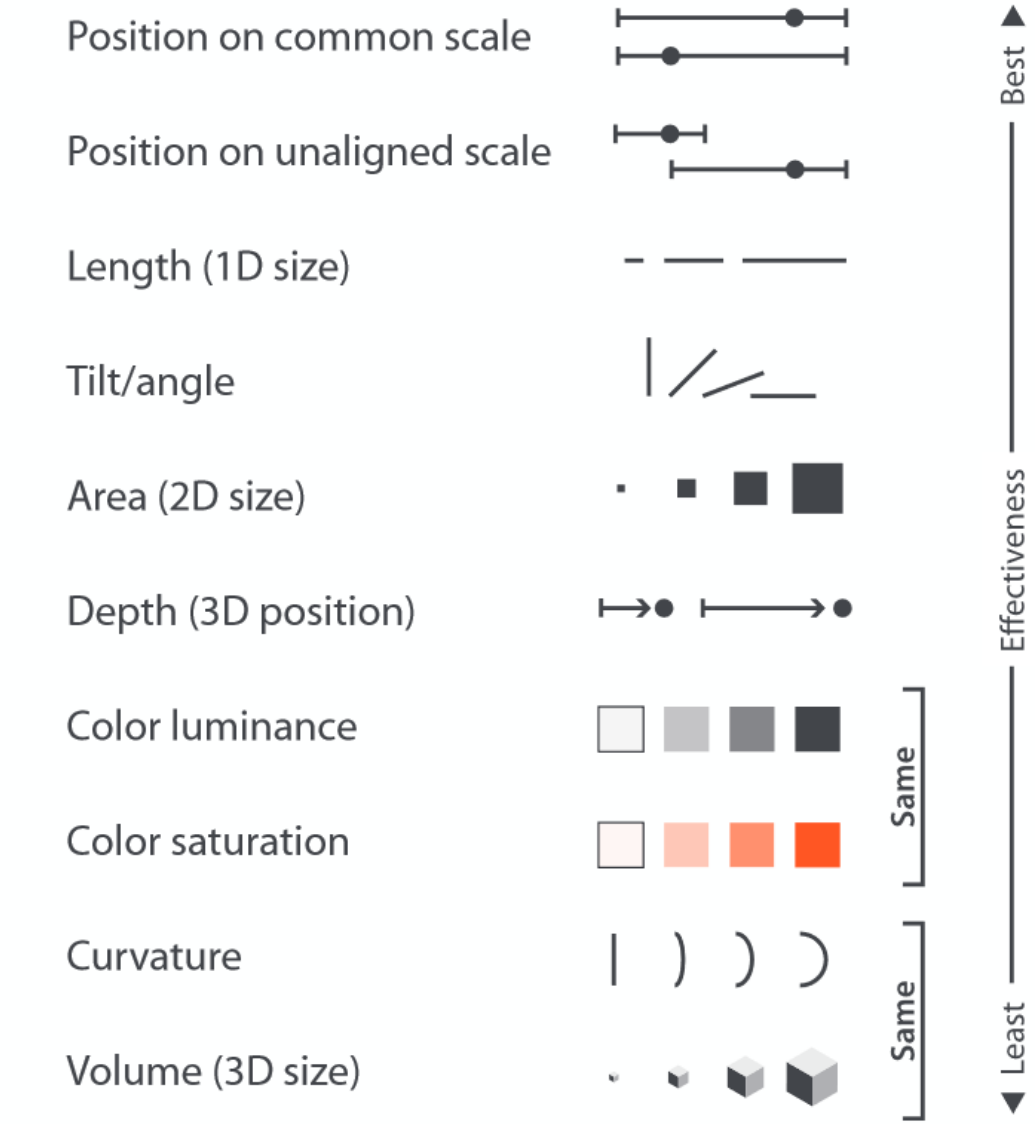


VISUAL VARIABLES. PERCEPTION



MARKS AND VISUAL VARIABLES

Magnitude Channels: Ordered Attributes



Identity Channels: Categorical Attributes

- expressiveness principle
  - match channel and data characteristics
- effectiveness principle
  - encode most important attributes with highest ranked channels

OUTLINE

- Introduction to Visualization (concepts, goals, history…)
- **Dos and don’ts of data visualization (and why it matters)**
- Basic charts (purpose and implementation) – In altair
- Compound and interactive charts (how to implement multiple views) – In altair
- Further reading

DO'S AND DON'TS

Very general principle:

strive to give **your viewer**

the **greatest number** of **useful ideas**

in the **shortest time**

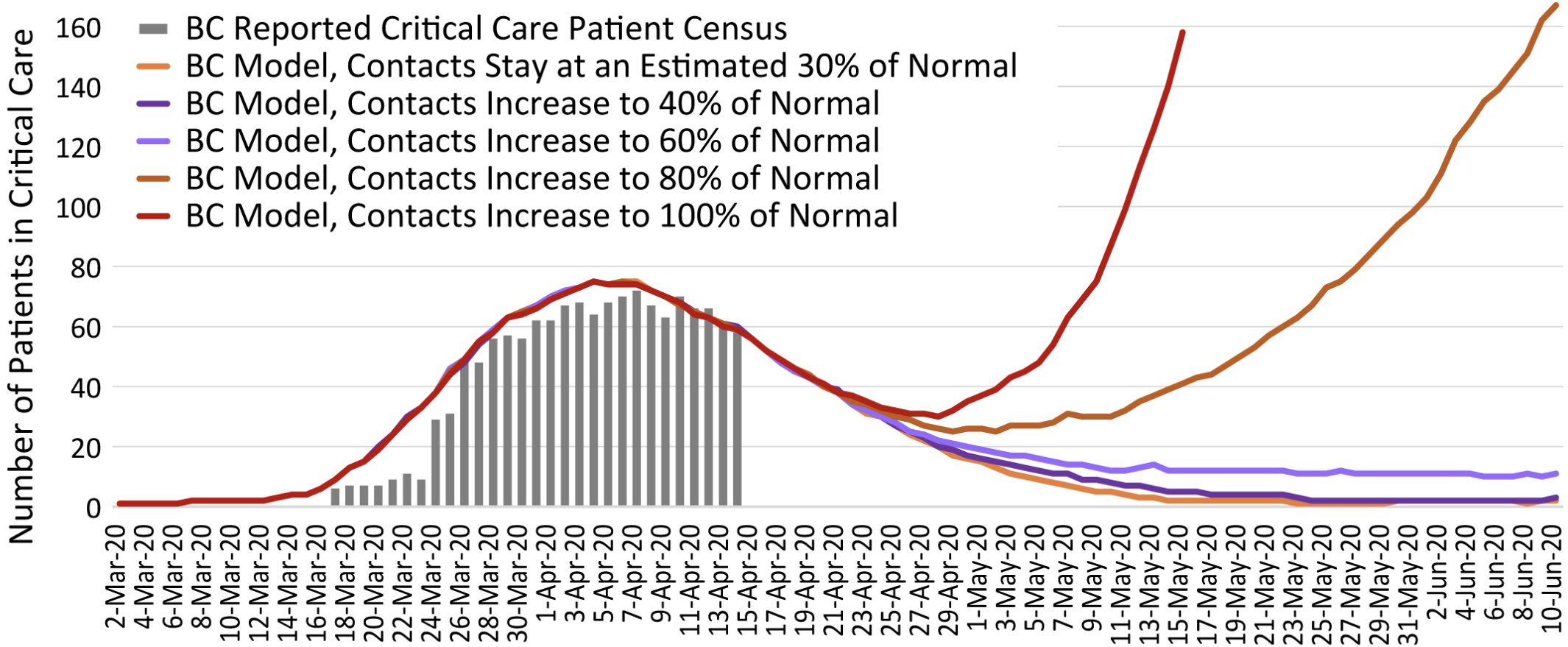
with the **least ink**

in the **smallest space**

Tufte, E. The Visual Display of Quantitative Information (Graphic Press, Cheshire, Connecticut, USA, 2007).

EXPLAIN YOUR DATA

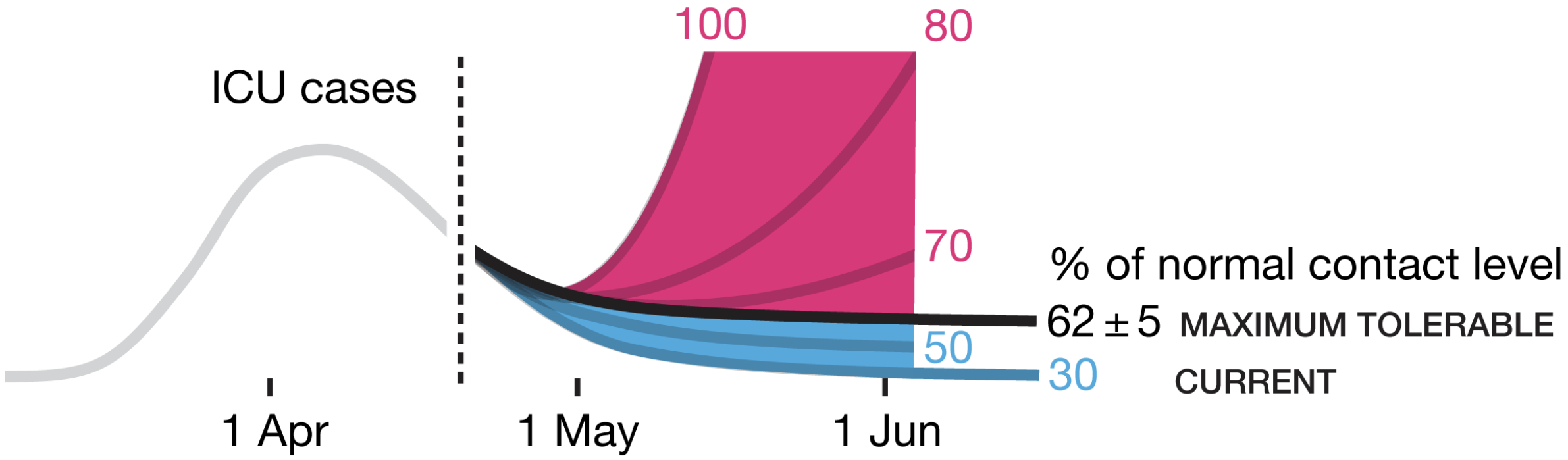
Example: critical care implications of dynamic model in BC's context



BCCDC http://www.bccdc.ca/health-info/diseases-conditions/covid-19/modelling-projections

EXPLAIN YOUR DATA

Critical care admission rate remains acceptable if restrictions are relaxed up to 60% of normal



http://mkweb.bcgsc.ca/the-covid-charts/

SATISFY YOUR AUDIENCE, NOT YOURSELF

Influence of data display formats on physician investigators' decisions to stop clinical trials: prospective trial with repeated measures

Linda S Elting, Charles G Martin, Scott B Cantor, Edward B Rubenstein

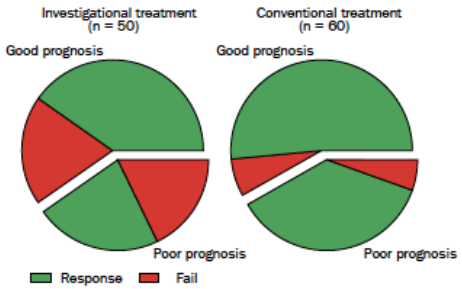
"...eight voiced considerable contempt for the [icon] display."

"... icon displays were often preferred by nurses, students, ... but were considered unacceptable by physicians."

table

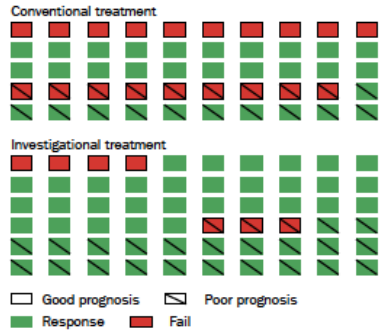
	Conventional treatment		Investigational treatment	
	Total no	% Fail	Total no	% Fail
Good prognosis	30	30	35	11
Poor prognosis	20	45	25	12
Total	50	38	60	12

pie chart



bar graph

icon graph



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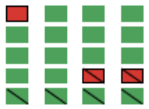
	% accuracy	% preference
	82	0
30 30 35 11 20 45 25 12 50 38 60 12	68	62
	56	24
	56	14

KEEP DATA LEGIBLE

- The resolving power of the eye is approximately 50 cycles per degree (*see next slide*).
  - This limits us from distinguishing features smaller than 0.1 mm at a reading distance of 30 cm.
  - Larger features must be used to maintain legibility and comprehension. 1 point = 1/72 inch = 0.0353 cm

KEEP DATA LEGIBLE

- Cycles per degree (aka **acuity**):
  - Spatial resolving capacity of the visual system
  - Ability of the eye to see fine detail
  - Refers to the highest resolution we can see with the fovea
- Each cycle represents an element we can see isolated:
  - Commonly taken as a line pair: a black and white strokes together

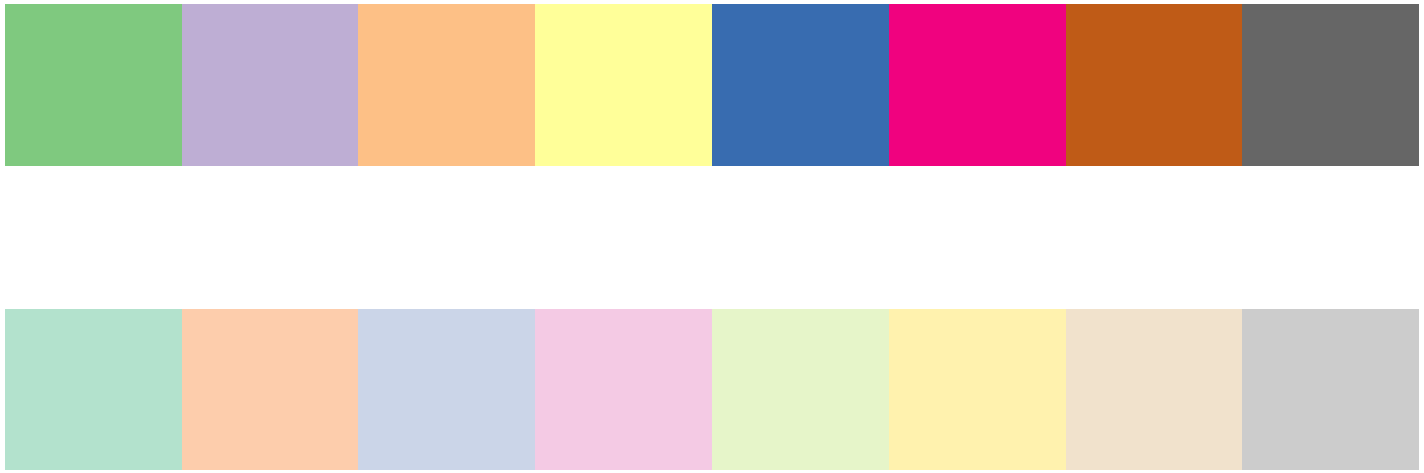
- Other acuity limits: https://entokey.com/visual-acuity-2/

USE COLOR WISELY

- Four types of use of color in vis:
  - To distinguish
  - To encode values
  - To highlight

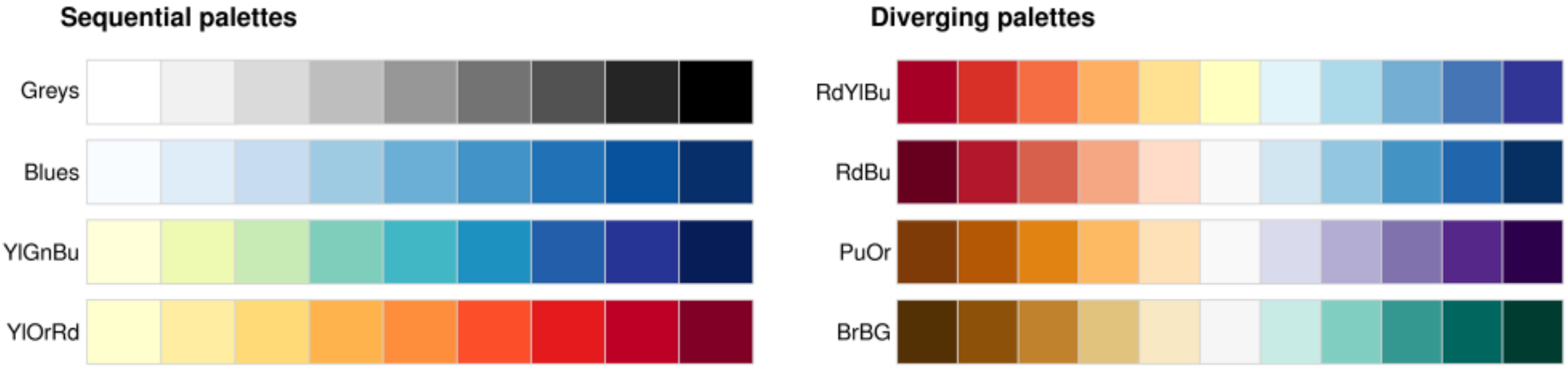
USE COLOR WISELY

- Four types of use of color in vis:
  - To distinguish: categorical data



USE COLOR WISELY

- Four types of use of color in vis:
  - To encode values. Quanitative data



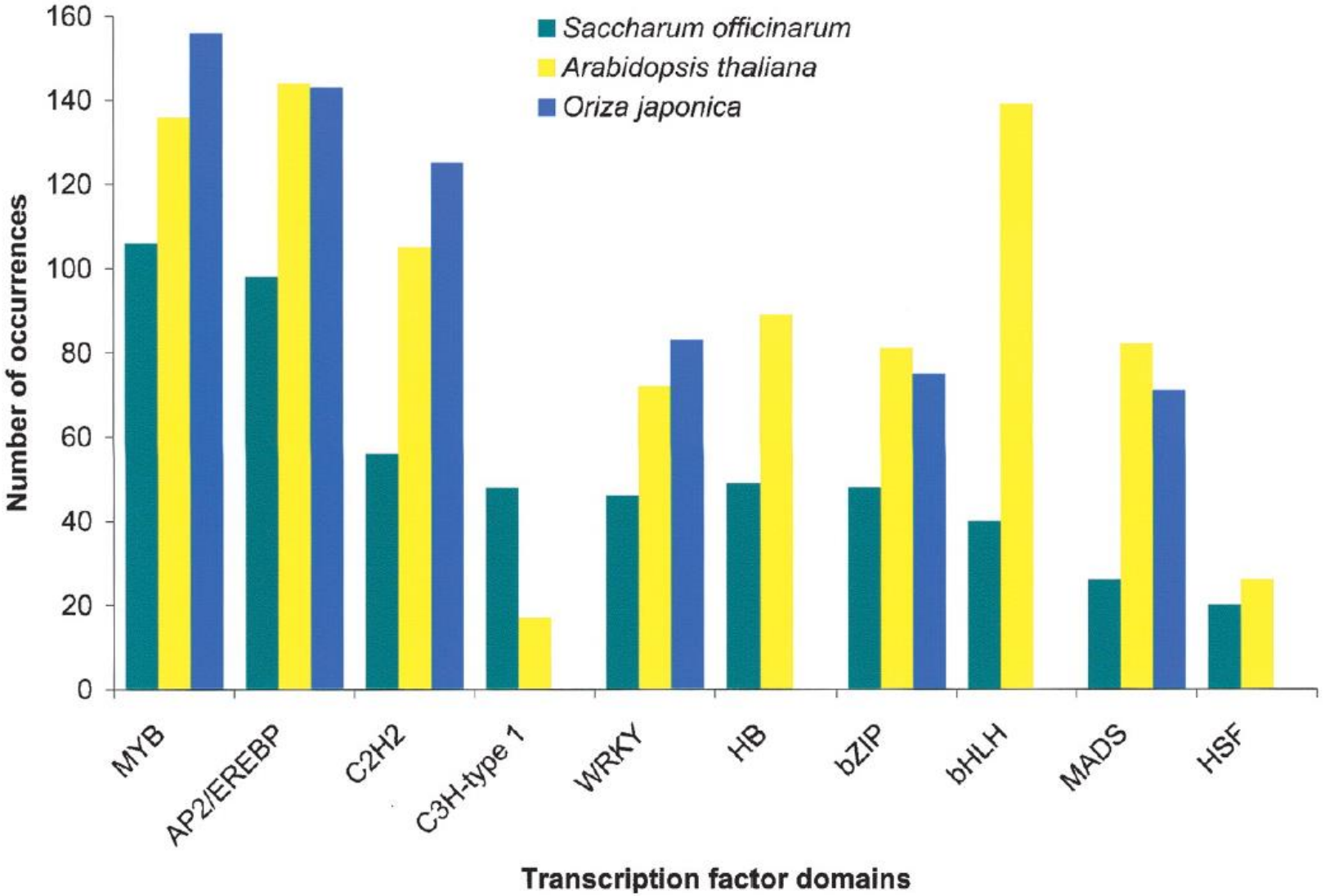
https://betterfigures.org/2015/06/23/picking-a-colour-scale-for-scientific-graphics/

USE COLOR WISELY

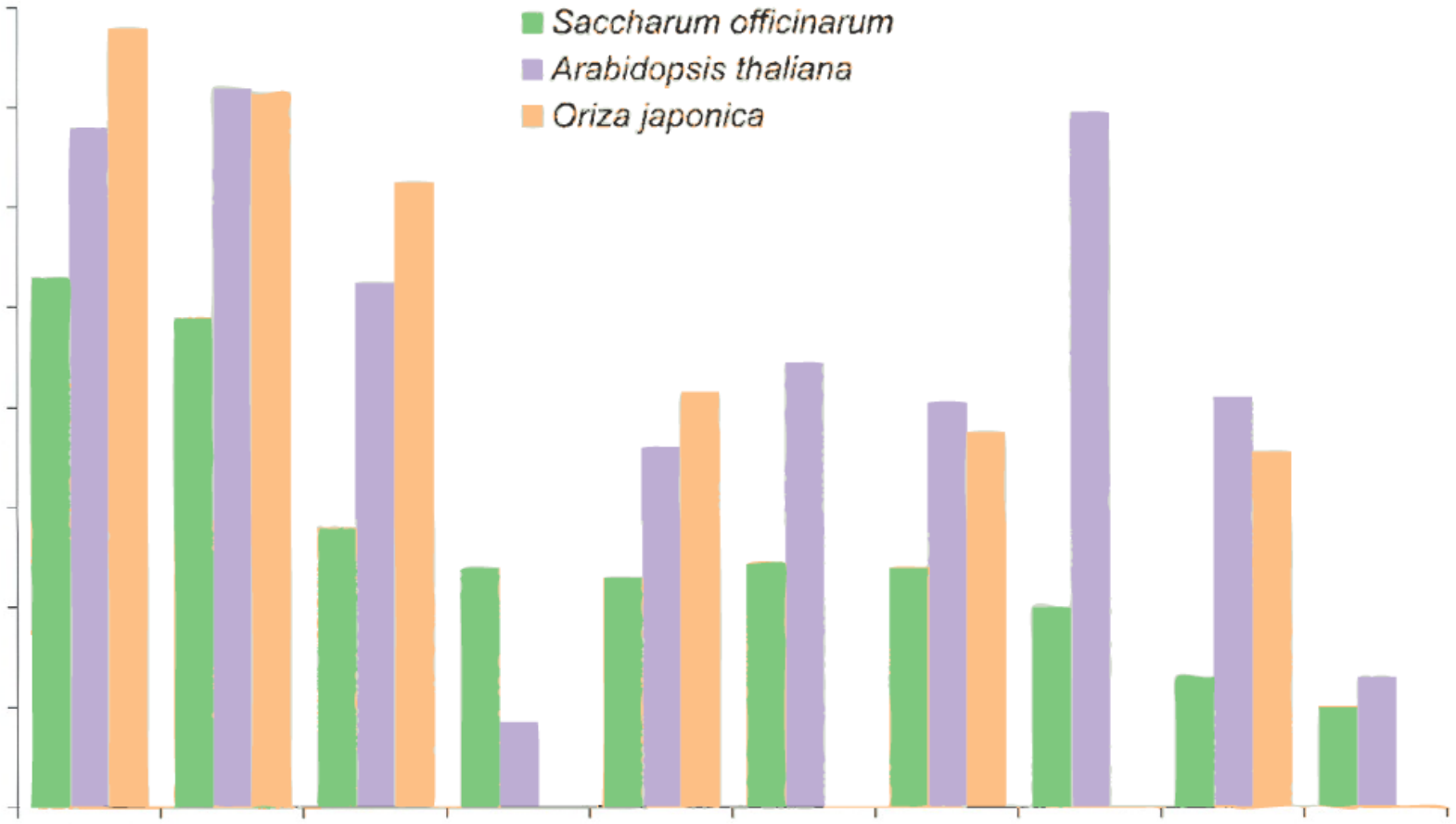
- Four types of use of color in vis:
  - To highlight elements/values

https://betterfigures.org/2015/06/23/picking-a-colour-scale-for-scientific-graphics/

USE COLOR WISELY



USE COLOR WISELY



BREWER QUALITATIVE 3-COLOR PALETTES

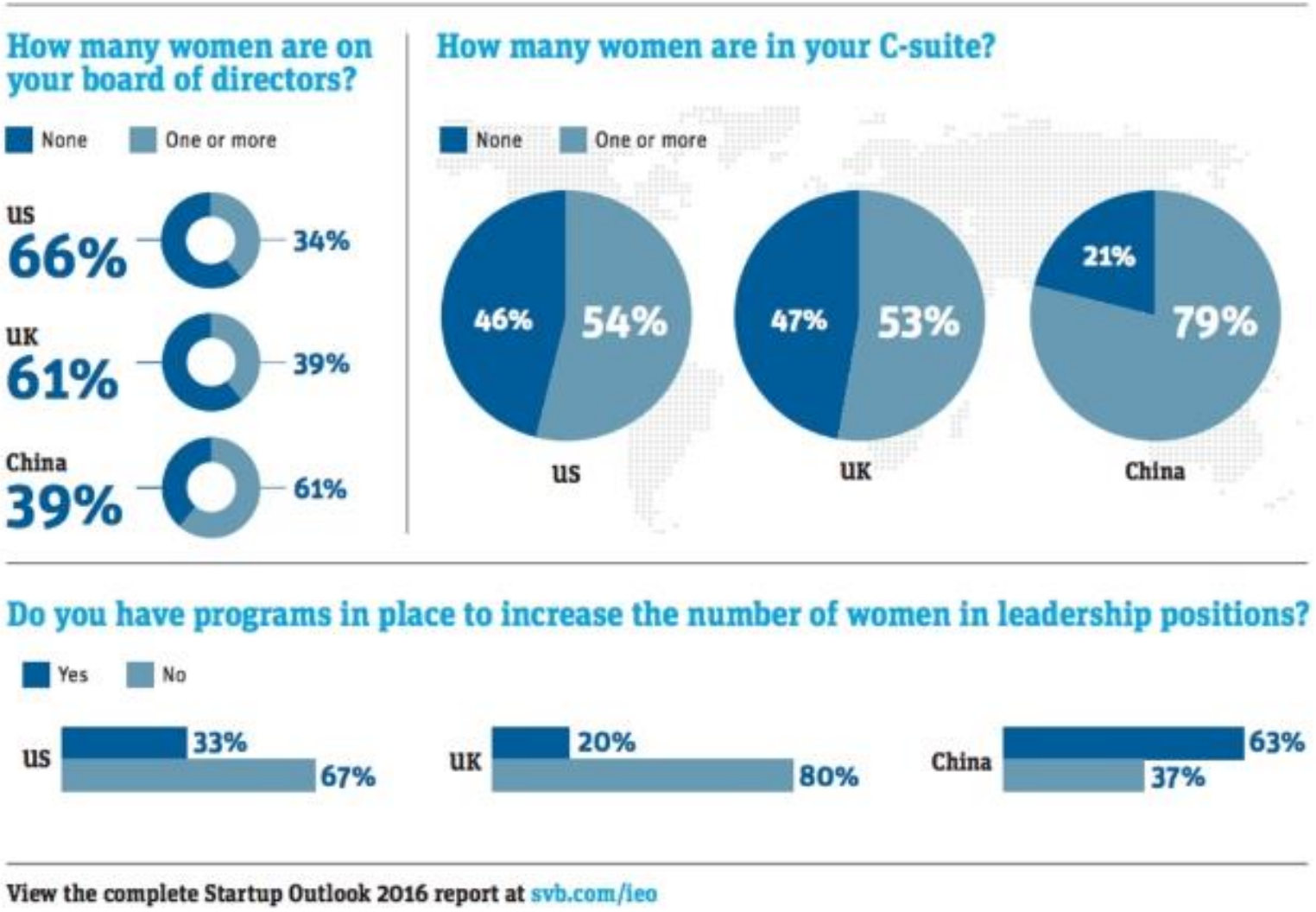
ACCENT PASTEL 1 SET 2

WWW.COLORBREWER.ORG

USE COLOR WISELY

- General approach:
  - Design everything using neutral colors
    - Neutral can be light grey, corporate color…
  - Use color to highlight
    - Message
    - Takeaway
    - Region of interest

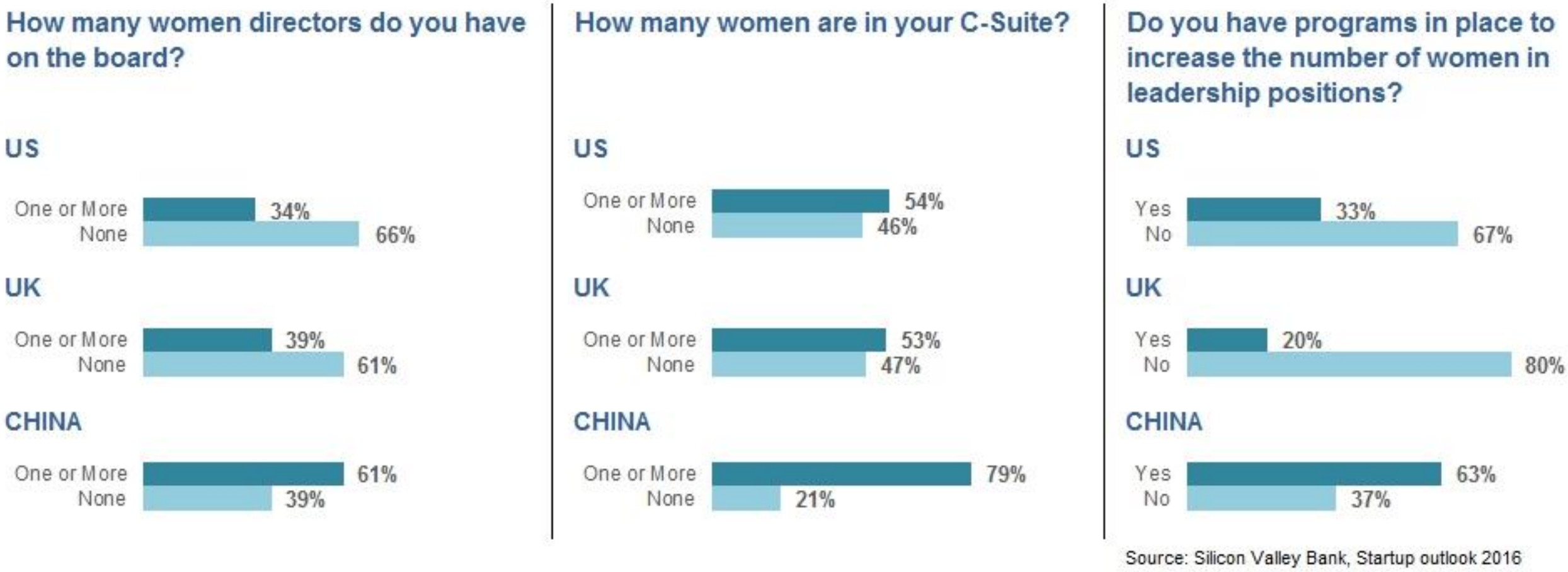
BE CONSISTENT



https://www.fastcompany.com/4011394/china-beats-the-u-s-when-it-comes-to-female-startup-leaders

BE CONSISTENT

China leads when it comes to female startup leaders with 79% of Chinese startups having one or more women in the C-Suite



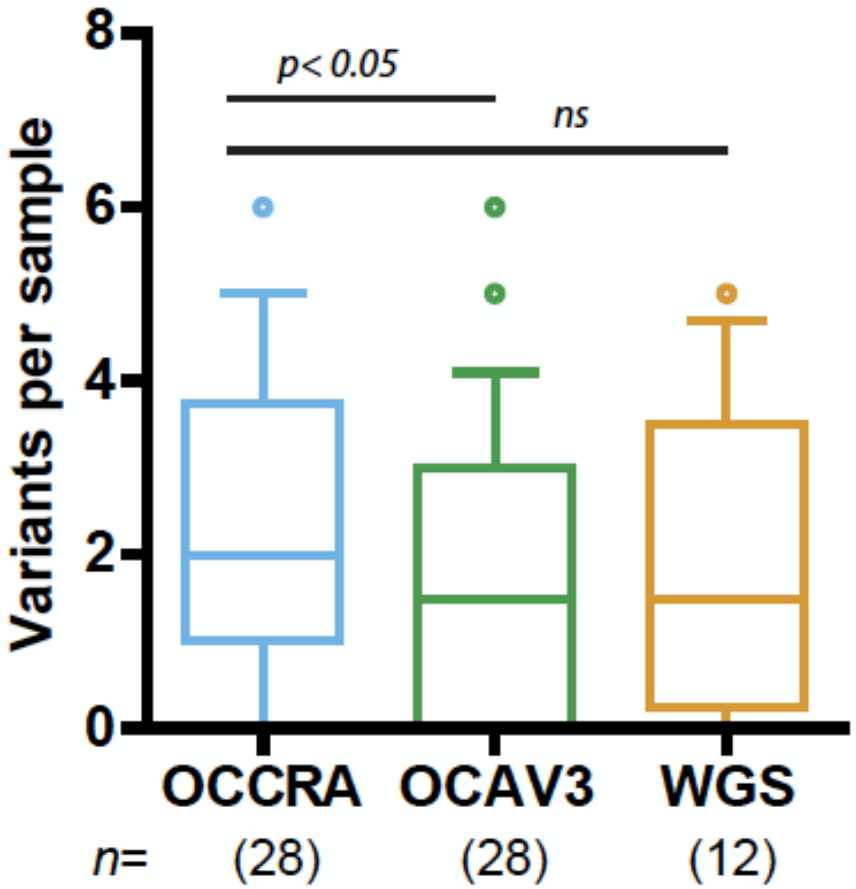
https://daydreamingnumbers.com/blog/consistency-in-charts/

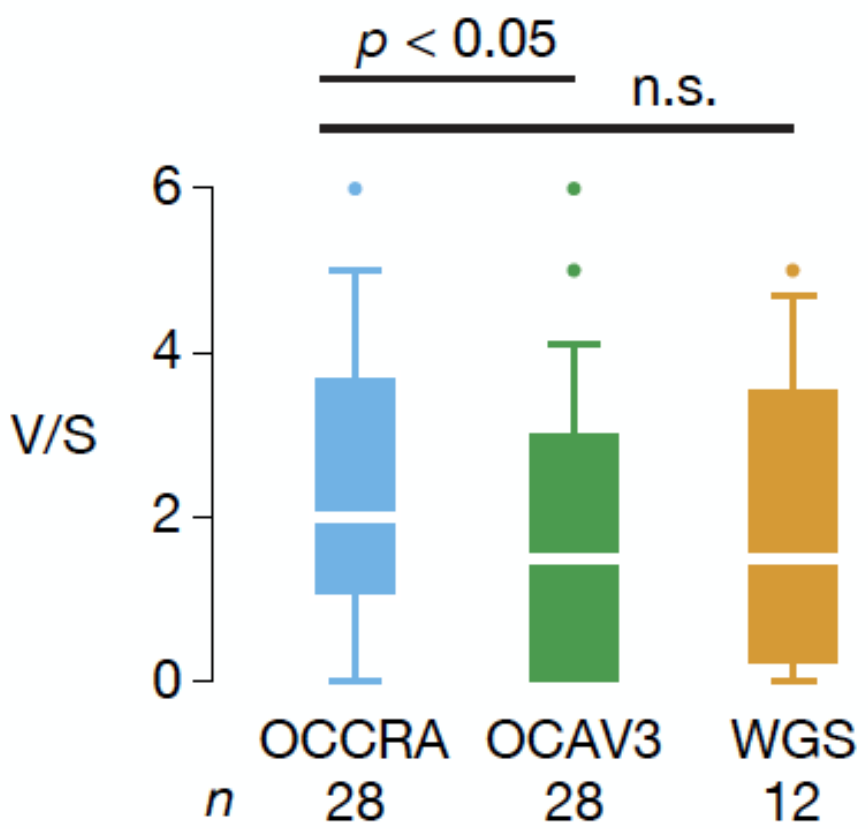
EMPHASIZE THE MESSAGE/DATA

- Match the pertinence of an object with its visual salience
  - Which also means removing salience of non-important elements

- Apply visual organization Gestalt principles

EMPHASIZE THE MESSAGE/DATA



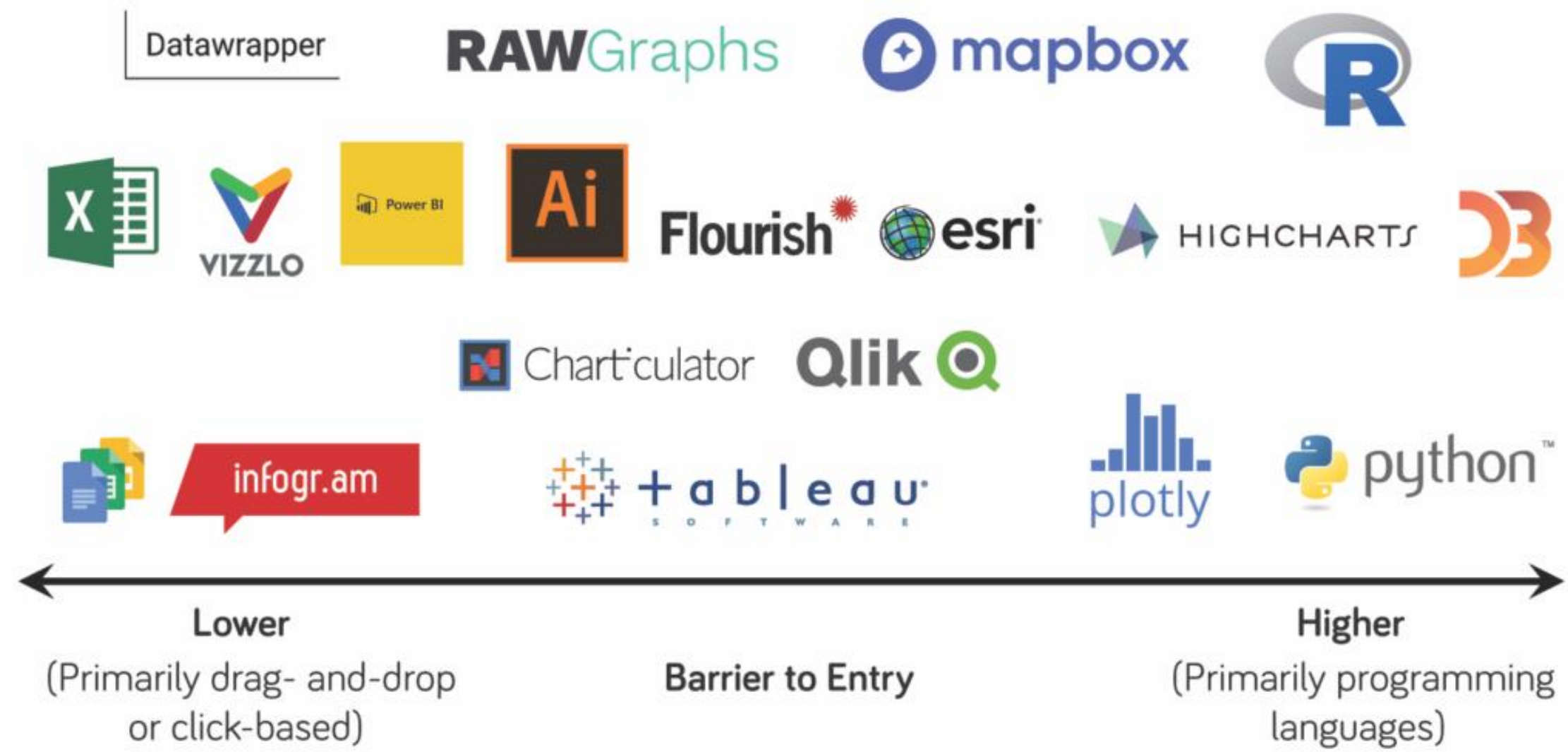


LET'S PRACTICE!!!

- Different ways to achieve this
  - Out-of-the box software
  - Libraries
    - Different amount of programming

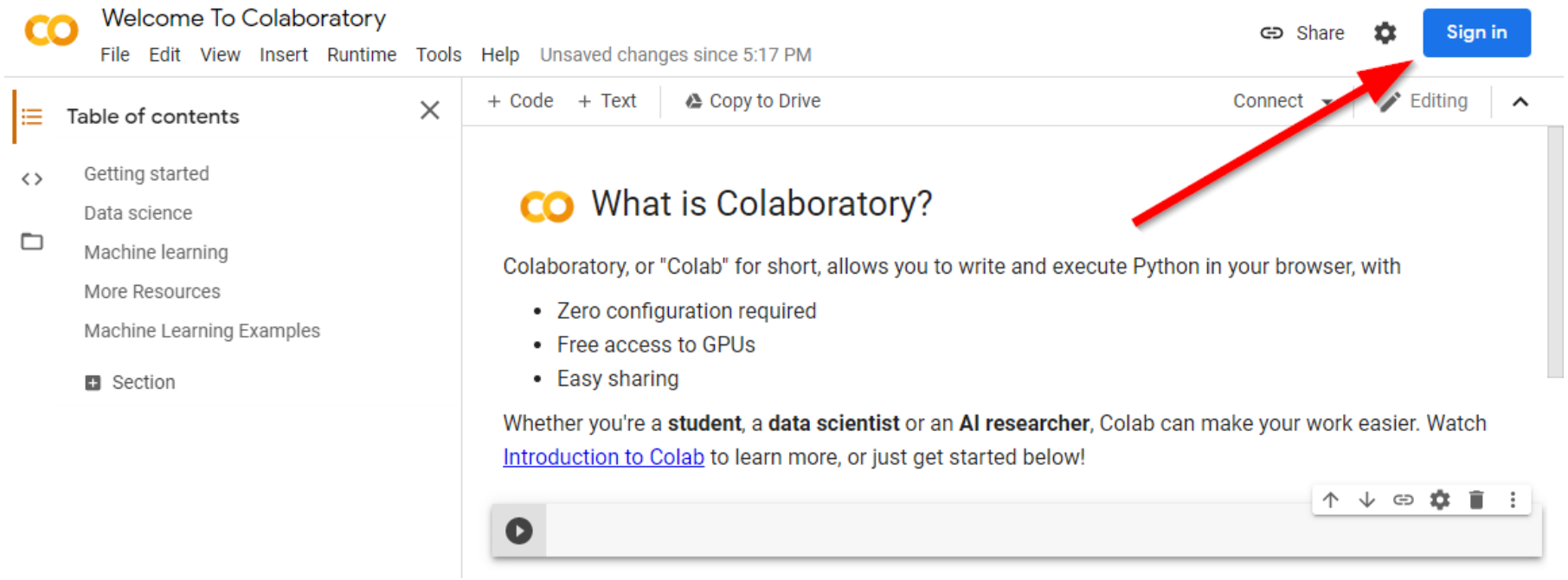
Tufte, E. The Visual Display of Quantitative Information (Graphic Press, Cheshire, Connecticut, USA, 2007).

LET'S PRACTICE LIBRARIES & SOFTWARE



GOOGLE COLAB

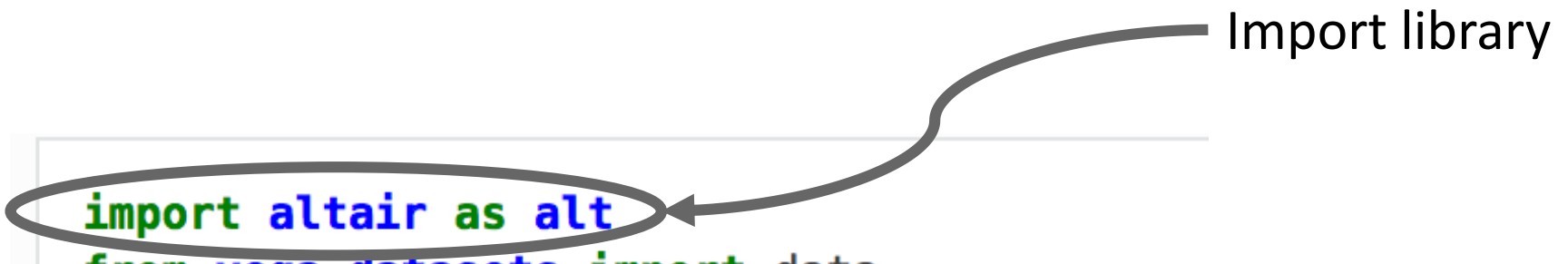
- Sign-in



GOOGLE COLAB

- Download and upload this notebook:
  - https://www.cs.upc.edu/~ppau/notebook.ipynb

ALTAIR




```
import altair as alt
from vega_datasets import data
url = data.cars.url

alt.Chart(url).mark_point().encode(
    x='Horsepower:Q',
    y='Miles_per_Gallon:Q'
)
```

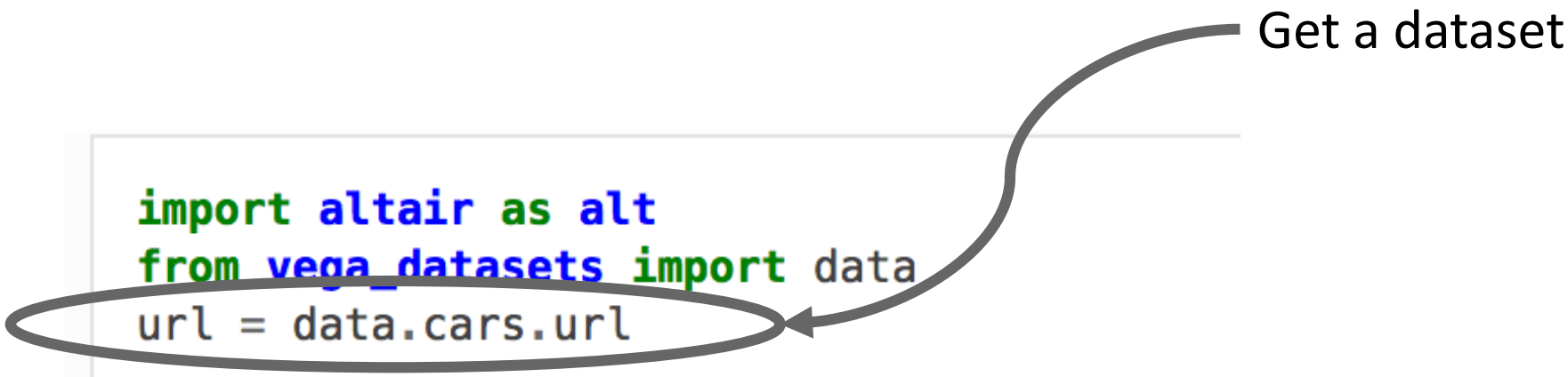
ALTAIR

Import package with datasets

```
import altair as alt
from vega_datasets import data
url = data.cars.url

alt.Chart(url).mark_point().encode(
    x='Horsepower:Q',
    y='Miles_per_Gallon:Q'
)
```

ALTAIR




```
import altair as alt
from vega_datasets import data
url = data.cars.url

alt.Chart(url).mark_point().encode(
    x='Horsepower:Q',
    y='Miles_per_Gallon:Q'
)
```

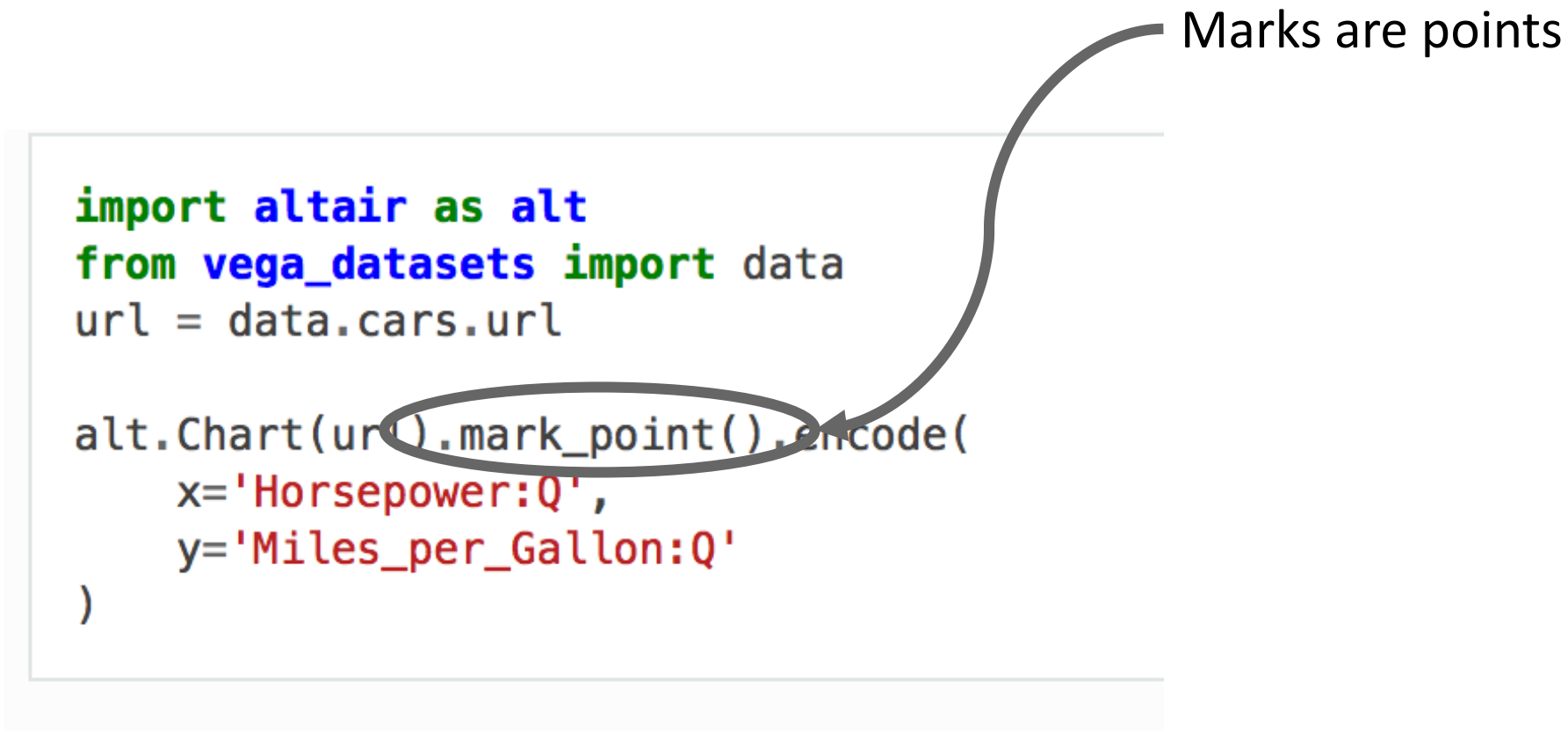
ALTAIR

Define a chart with the data

```
import altair as alt
from vega_datasets import data
url = data.cars.url

alt.Chart(url).mark_point().encode(
    x='Horsepower:Q',
    y='Miles_per_Gallon:Q'
)
```

ALTAIR


Marks are points
import altair as alt
from vega_datasets import data
url = data.cars.url
alt.Chart(url).mark_point().encode(
x='Horsepower:Q',
y='Miles_per_Gallon:Q'
)

ALTAIR

```
import altair as alt
from vega_datasets import data
url = data.cars.url

alt.Chart(url).mark_point().encode(
    x='Horsepower:Q',
    y='Miles_per_Gallon:Q'
)
```

X axis will encode the Horsepower variable

ALTAIR

```
import altair as alt
from vega_datasets import data
url = data.cars.url

alt.Chart(url).mark_point().encode(
    x='Horsepower:Q',
    y='Miles_per_Gallon:Q'
)
```

Y axis will encode the Miles_per_Gallon variable

MULTIPLE VIEWS

- Often information too complex for a single view
  - Show multiple views side by side
    - Different views of the data
  - Not merely isolated separate views
    - Mighty tools which show **data relationships**

- **Single view:** combination of a set of data together with specifications on how to display this data

MULTIPLE VIEWS

- Advantages:
  - **Eyes Beat Memory**: two simultaneous views have lower cognitive load than remembering previous view
  - Facilitate data understanding
    - Comparison
    - Show details
  - Facilitate data exploration
    - Show focus + context
    - Different data + same encoding

MULTIPLE VIEWS

- Challenges:
  - Real-estate trade-off: popup view vs. static side-by-side
  - Alternative: Single view that is changed through interaction (filtering, aggregation, navigation)
  - Choosing the most adequate implementation:
    - Visual representation selection
    - Data reduction
    - Design adequate interaction methods

MULTIPLE VIEWS

- Coordinated views
  - Further step that adds linked interactions
  - Boosts expressivity
  - Increases exploration possibilities

MULTIPLE VIEWS

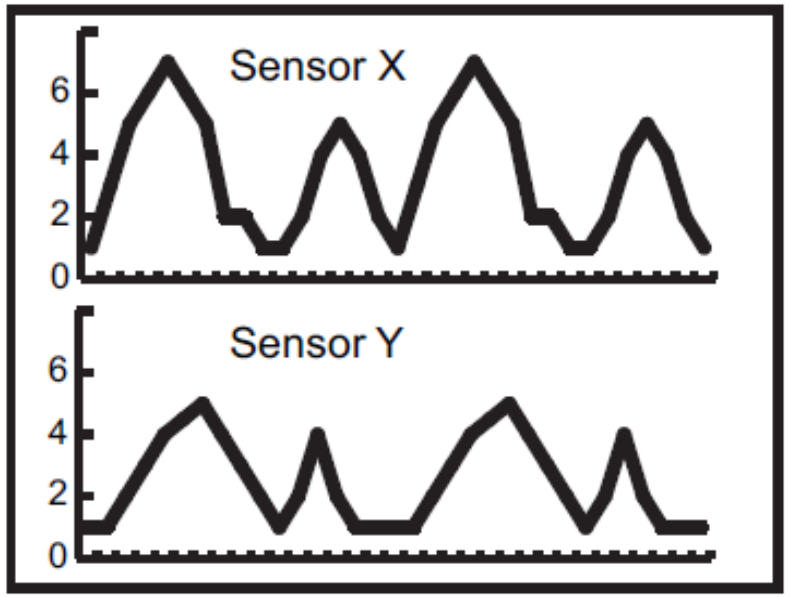
- Visual representation selection. Decisions:
  - Is all the data shared in both representations?
  - Which representation for each view?
  - How do we partition data?
- Answers linked to each other

- Multiple views approaches: Juxtaposition, superposition, and explicit encoding

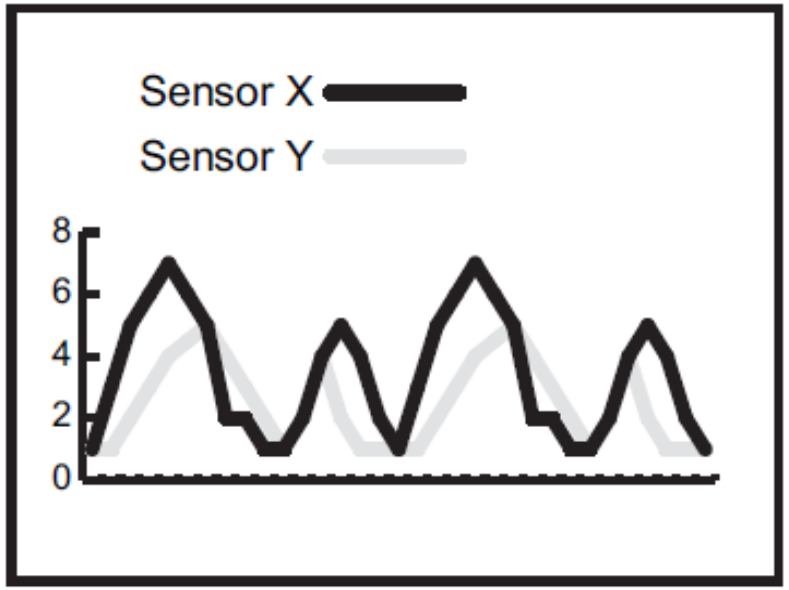
MULTIPLE VIEWS

- Multiple views layouts (aka ***facet***, ***multiform***):

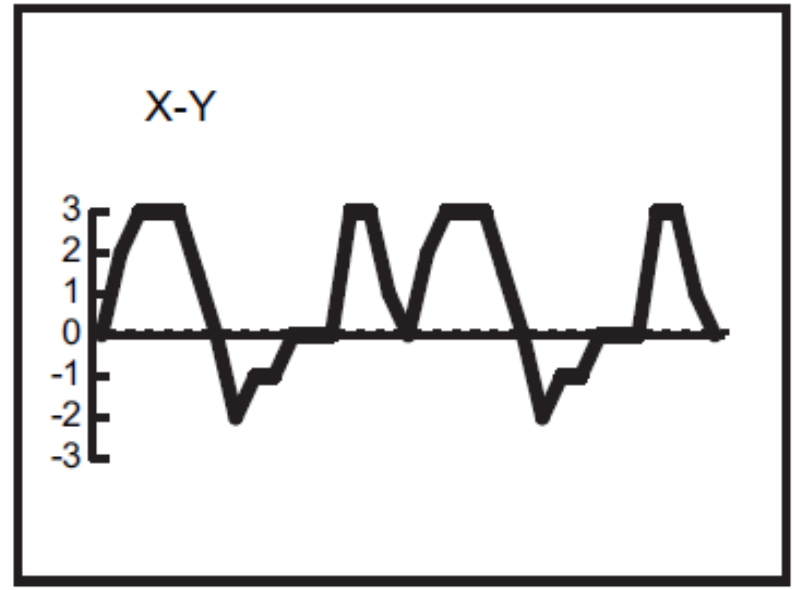
Juxtaposition



Superposition



Explicit encoding: difference



MULTIPLE VIEWS

- Juxtaposition. Why?
  - Comparing two views that are simultaneously visible is relatively easy
    - Move our eyes back and forth
  - Alternative: change over time: comparing current state to its previous state requires users to consult their working memory

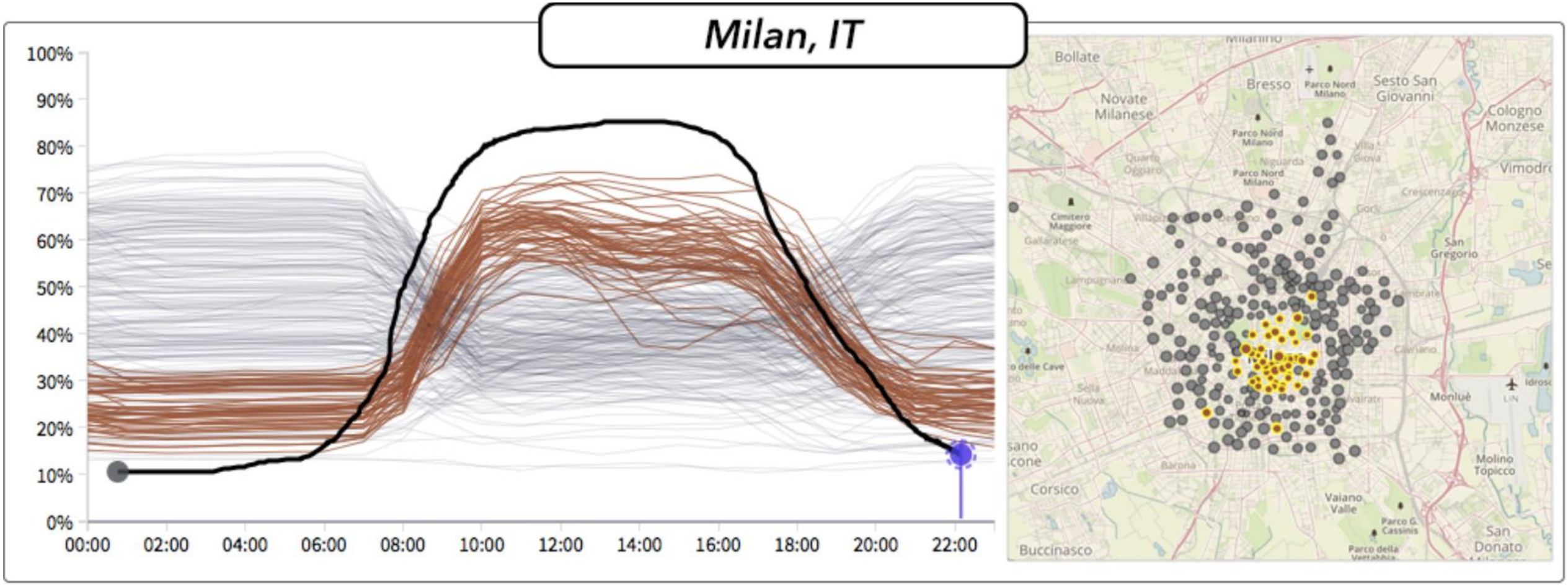
MULTIPLE VIEWS

- Juxtaposition. Design choices
  - Which channels are shared
  - How much of the data is shared
  - How/if the navigation is synchronized
  - … but also when to show them, how to arrange, which attributes used to split the data, how many regions…

MULTIPLE VIEWS

- Juxtaposition. How?
  - Uniform design: Same representation, different data
  - Multiform design: Different encoding, same data
    - Can support more tasks
    - Need coordinating views with linked highlighting
- Juxtaposition. Shortcomings:
  - Larger display area required (e.g. 2x)
  - Trade-off between display area and working memory
    - Typically can encode more layers than superimposing

MULTIPLE VIEWS



MULTIPLE VIEWS

- Superposition:
  - Use of multiple layers over the same space
- Layer: set of objects spread out over a region
  - Spatially intermixed with objects that are not part of the visual layer
  - Each set of objects in each layer visually distinguishable from objects in other layers at a perceptual level

MULTIPLE VIEWS

- Superposition. Why?
  - Does not require more space
  - Can use the whole view
  - May reduce eye movement required to compare

MULTIPLE VIEWS

- Superposition. Design choices
  - How many layers?
    - More limited than when using juxtaposition
  - How are layers perceptually distinguished?
  - How to partition items into layers?
  - Are layers static? Or are they constructed dynamically in response to user interaction?

MULTIPLE VIEWS

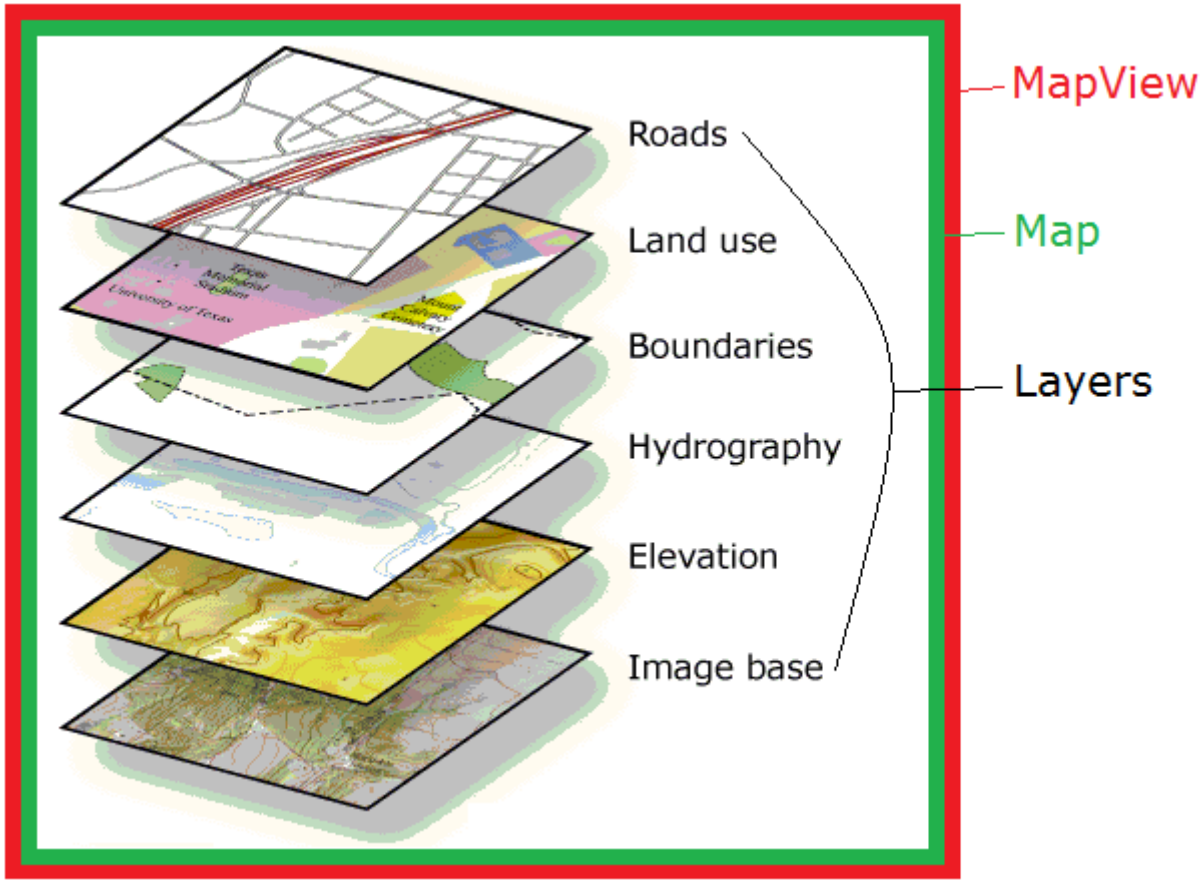
- Superposition. How?
  - Make different and non overlapping range of the visual channels active in the encoding
    - E.g. foreground and background
  - Number of distinguishable layers limited if they contain a substantial number of area marks
    - Two layers is achievable, three with careful design
    - Multiple layers only if few marks in each

MULTIPLE VIEWS

- Superposition. Static layers
  - All layers displayed simultaneously
  - Requires selective direction of visual attention

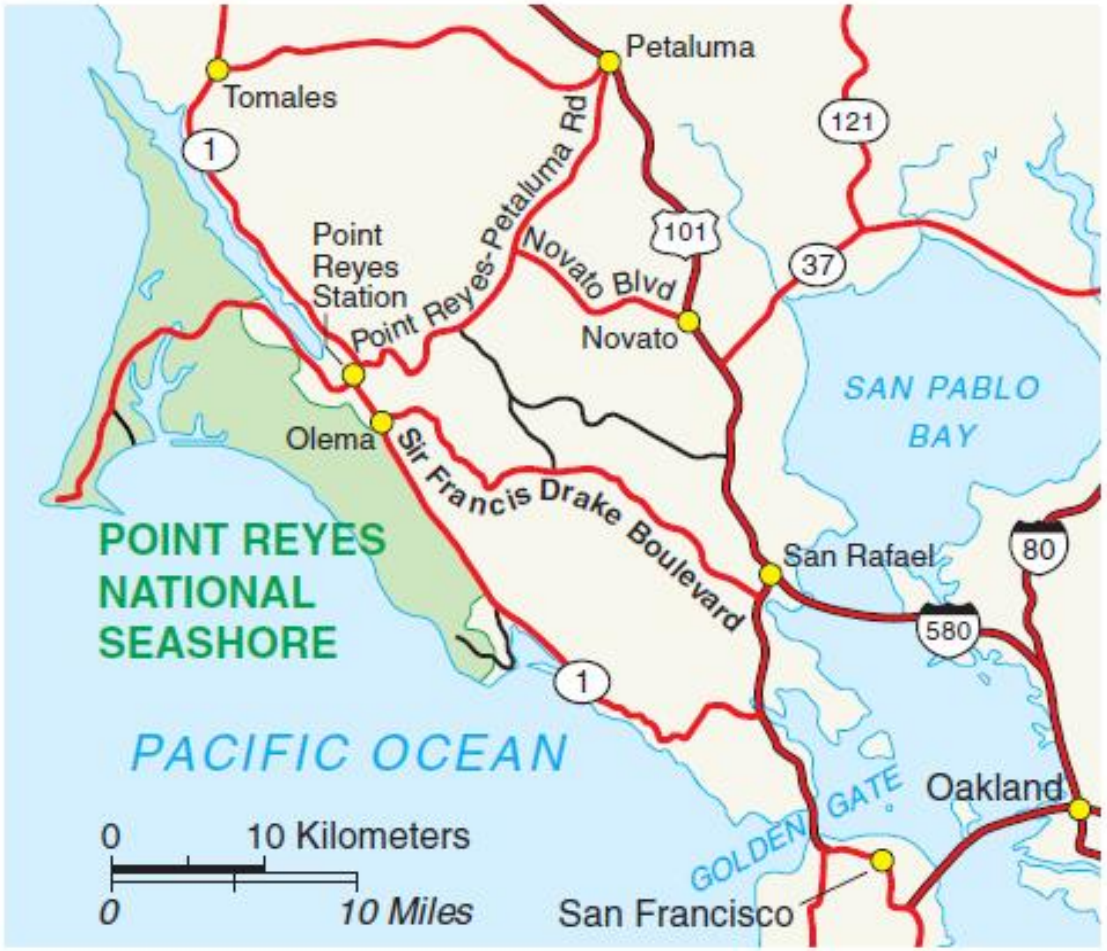
MULTIPLE VIEWS

- Superposition. Static layers



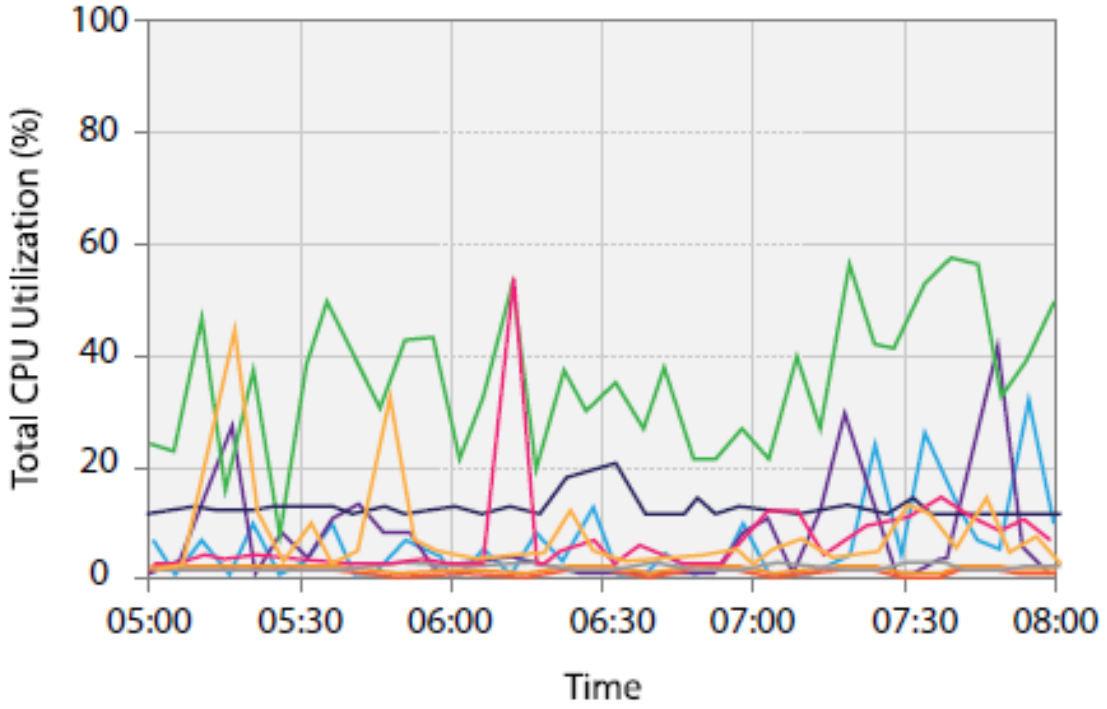
MULTIPLE VIEWS

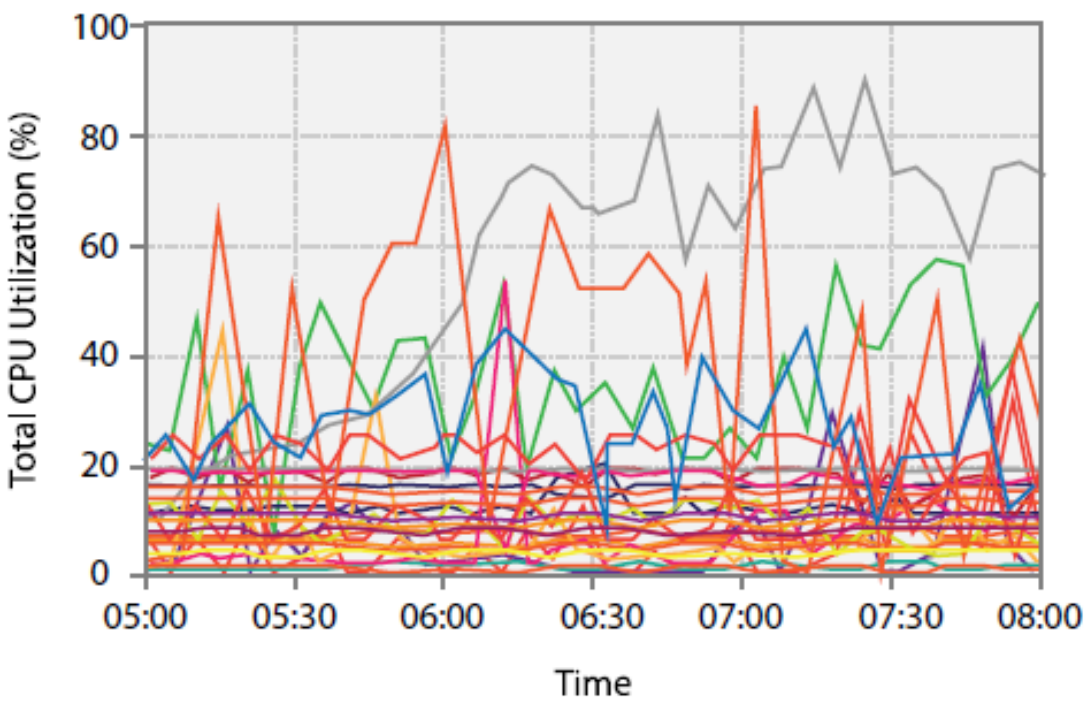
- Superposition. Static layers



MULTIPLE VIEWS

- Superposition. Static layers.
  - Line charts: up to a dozen lines



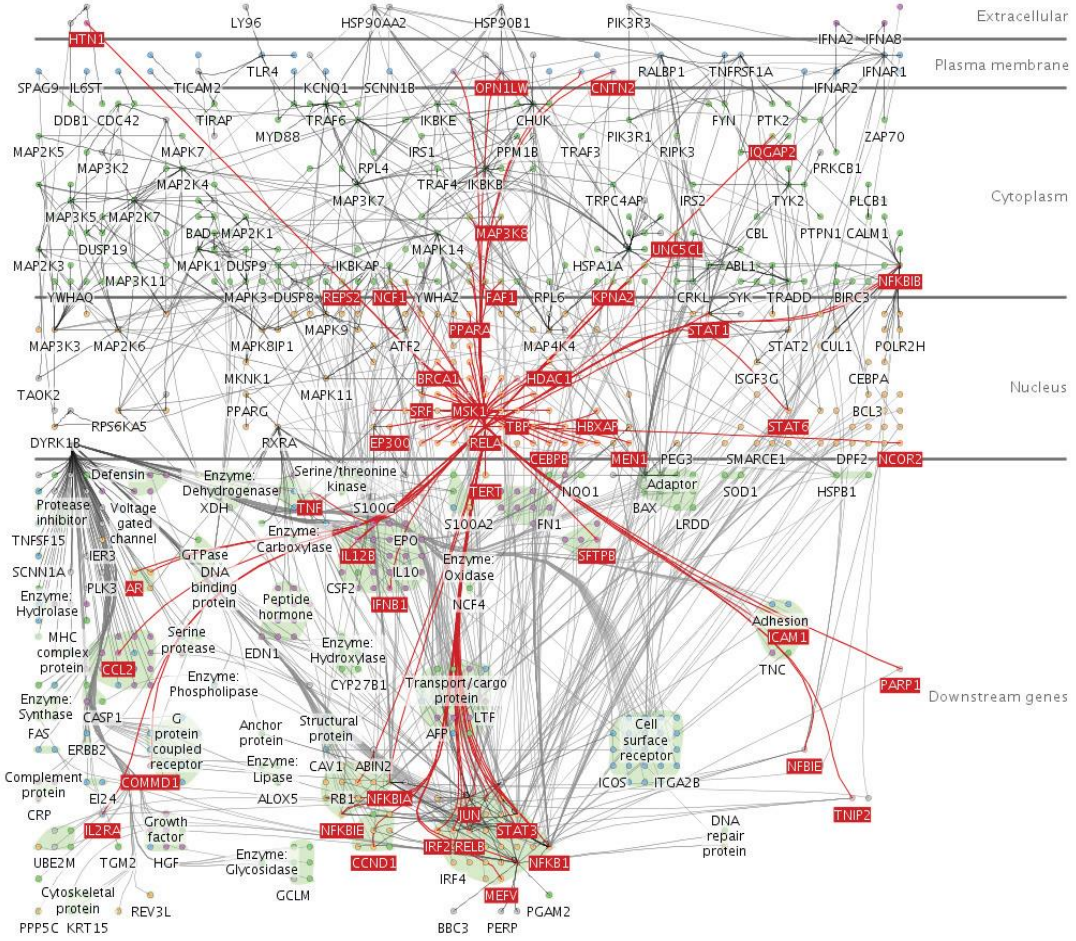


MULTIPLE VIEWS

- Superposition. Dynamic layers:
  - A layer with different salience is constructed interactively
    - Typically in response to user interaction
  - Can have a huge number of different layers
    - Not displayed simultaneously
    - Built on the fly

MULTIPLE VIEWS

- Superposition. Dynamic layers



MULTIPLE VIEWS

- Difference encoding:
  - Two or more layers with different layers of information combined
    - Only the difference: Different visual encoding
    - Original + difference: Original encoding for the data to compare and another visual cue for the difference
  - Many encoding variants

MULTIPLE VIEWS

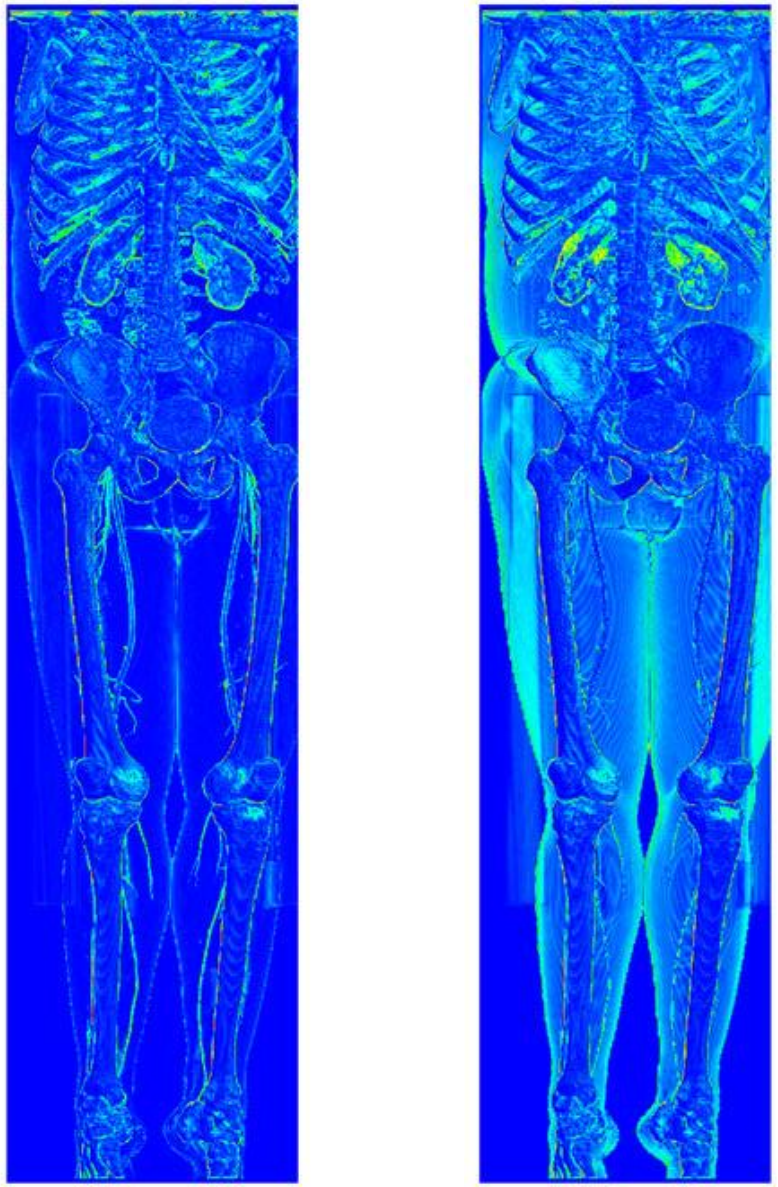
Original

Algorithm 1

Algorithm 2

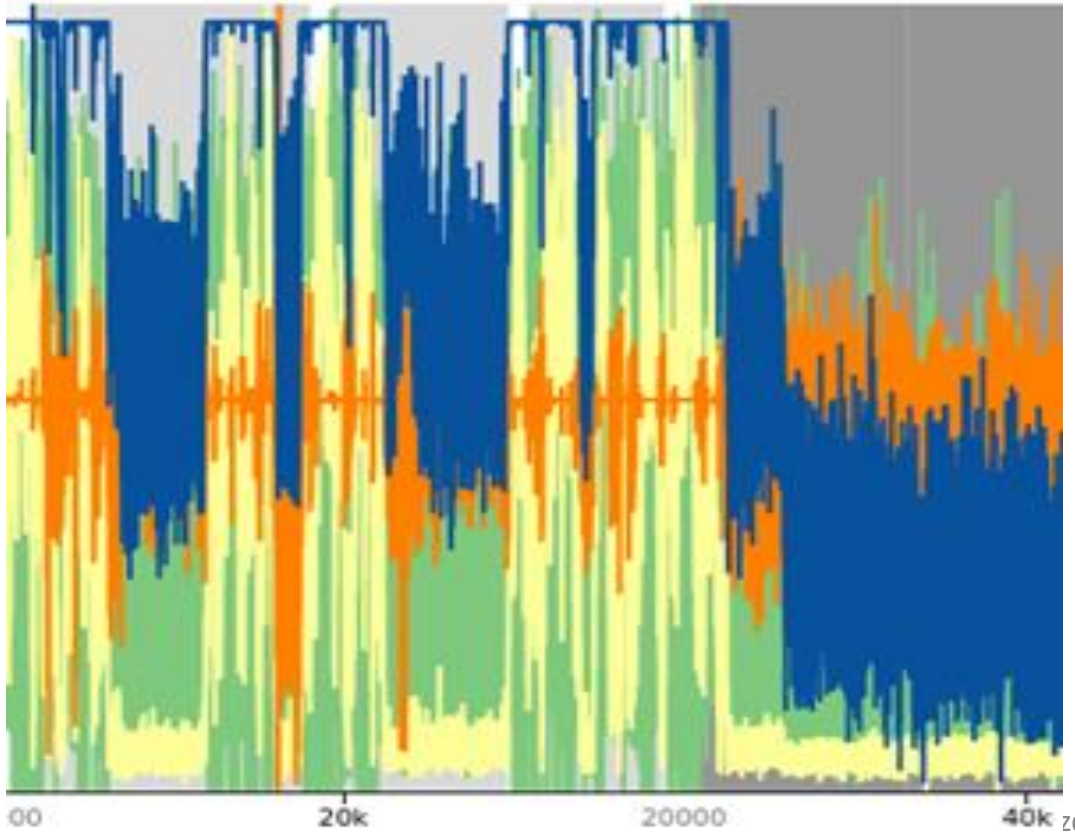
MULTIPLE VIEWS

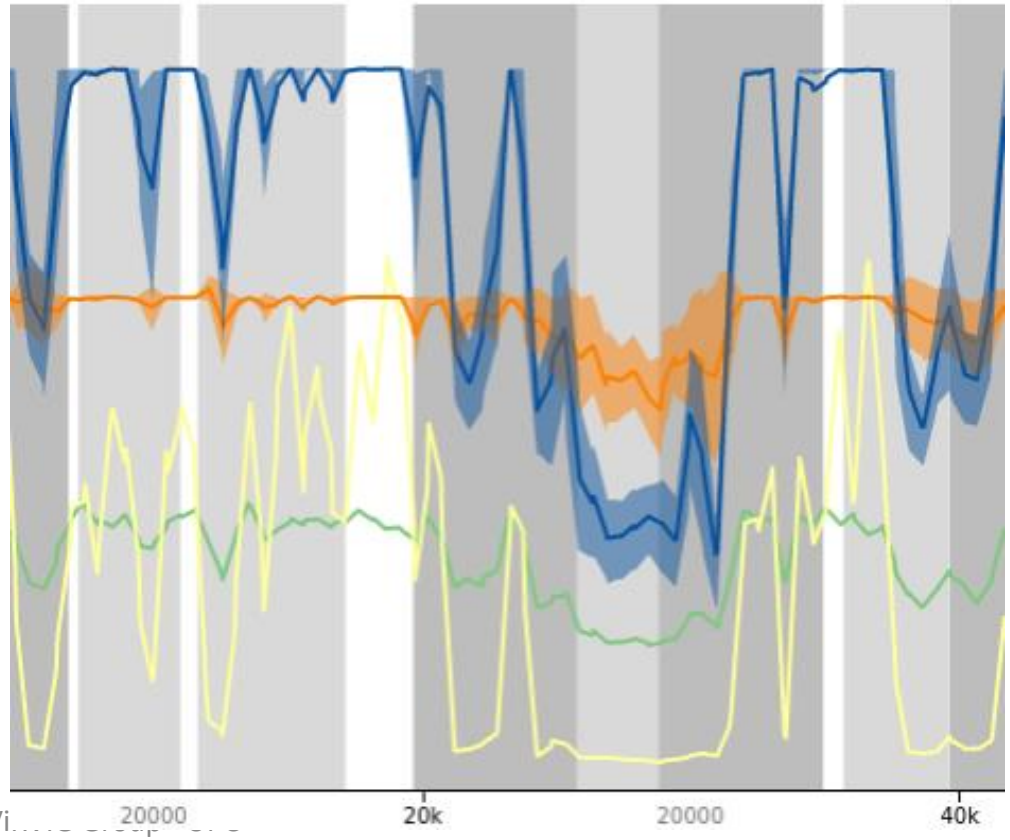
- Difference images:
  - Difference encoding
    - Similar regions: cold color (blue)
    - Different regions: warmer colors
      - Warmer → larger difference



MULTIPLE VIEWS

- Difference encoding: only differences (Tukey's fences) + average





INTERACTION

- Interaction
  - Problem:
    - You have a lot of data (& attributes) to understand
  - Do you?
    - Pack all the data into one complex representation
    - Spread the data into multiple coordinated views
    - ***Use interaction to reveal different subsets of the data***

INTERACTION

- Interaction
  - “The effectiveness of information visualization hinges on two things: its ability to clearly and accurately represent information and our ability to interact with it to figure out what the information means.”

    S. Few, *Now you see it*

- Two key aspects of data visualization
  - Representation
  - Interaction
    - Interaction is Vital
      - Engage in a dialog with your data

INTERACTION

- Why interact?
  1. Select
  2. Explore
  3. Reconfigure
  4. Encode
  5. Abstract/Elaborate
  6. Filter
  7. Connect

MULTIPLE VIEWS. INTERACTION

- Effective exploration comes from **coordinating/linking** views
  - Different names: *linked views*, *multiple views*, *coordinated views*, *coordinated multiple views*, and *coupled views*
- Linkage:
  - Actions in one view are somehow propagated to other views

MULTIPLE VIEWS. INTERACTION

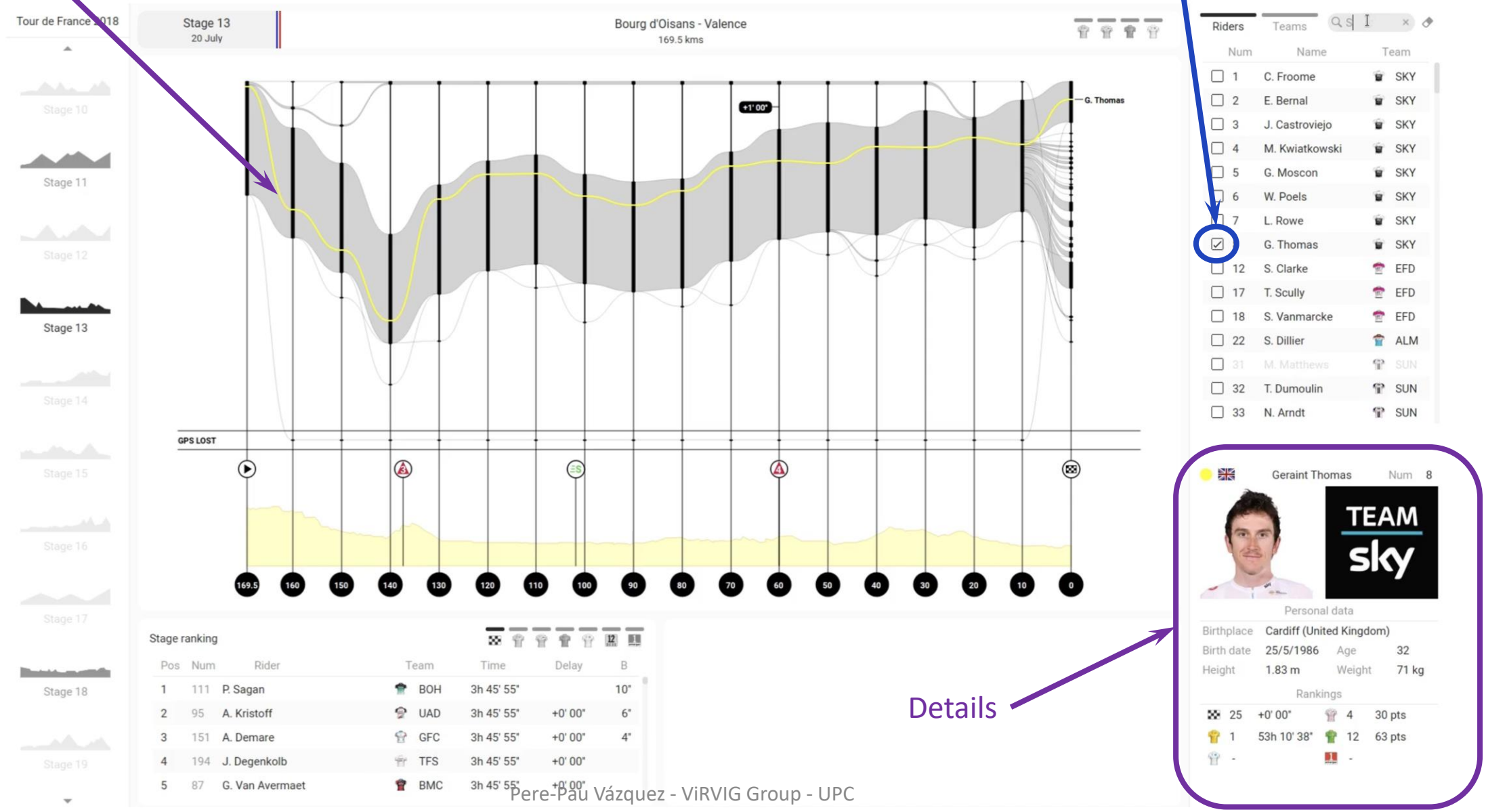
- Linking choices
  - Linked highlighting:
    - Highlighting / brushing – items selected in one view selected in all others
  - Linked navigation:
    - View parameters change through the interaction with other views

MULTIPLE VIEWS. INTERACTION

- Linked highlighting:
  - Unleashes the full power of linked views. One of the most common forms of linking
    - items that are interactively selected in one view are immediately highlighted in all other views using in the same highlight color
      - also called **brushing** or **cross-filtering**
  - Special case of a shared visual encoding in the color channel

Highlighted ranking along the stage

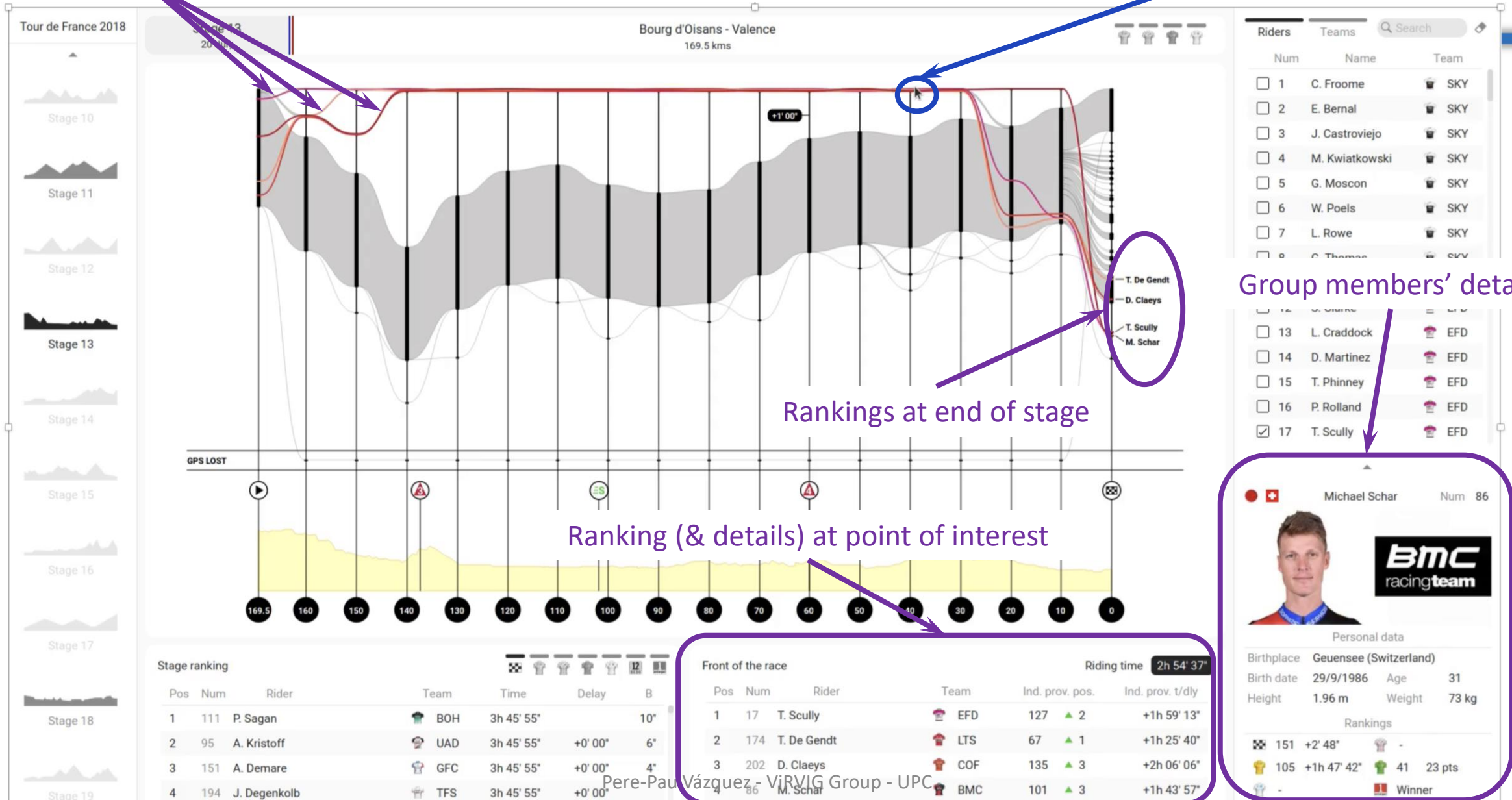
Selection



Details

Highlighted ranking positions along the stage

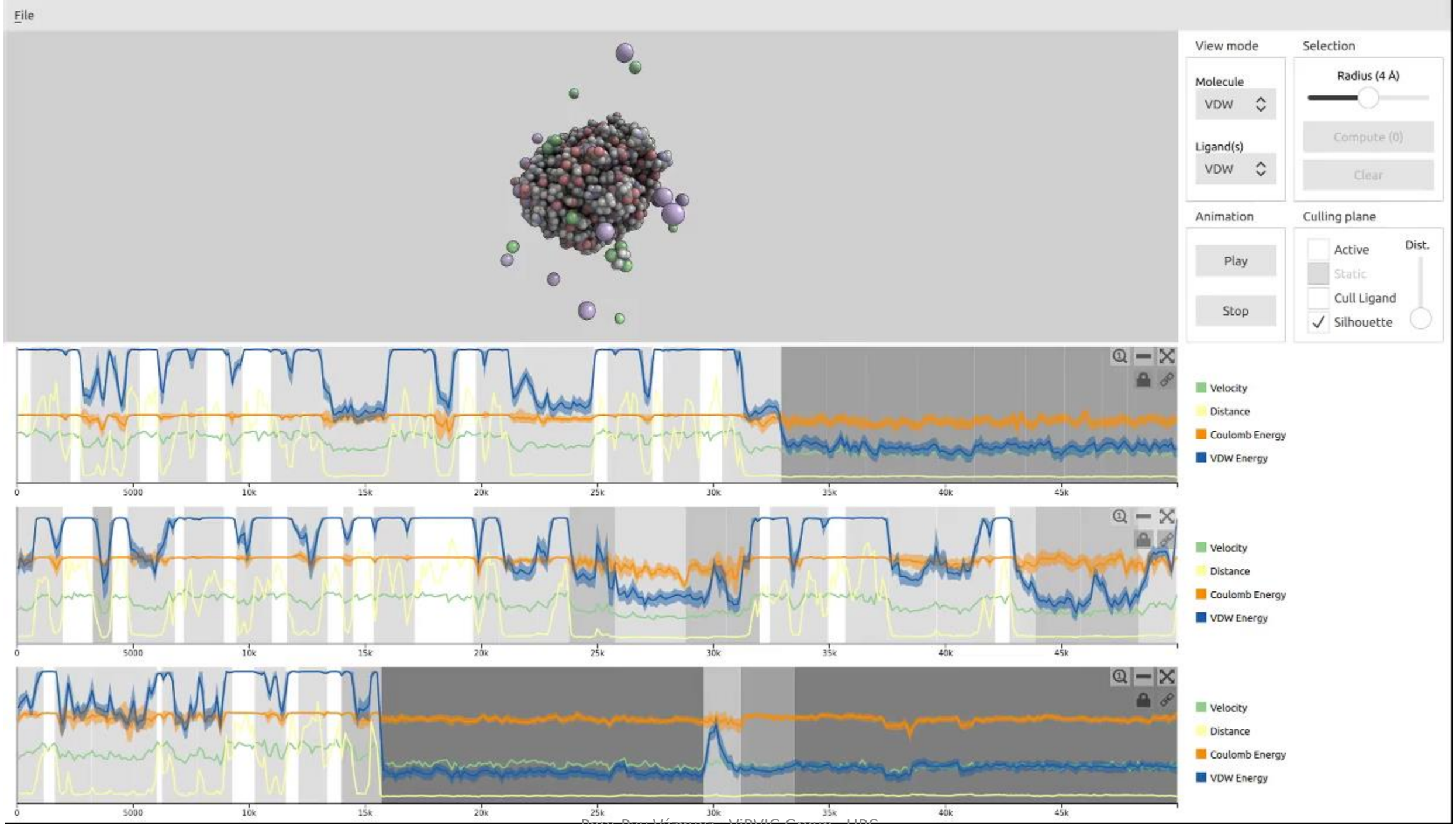
Group selection



Rankings at end of stage

Group members' details

Ranking (& details) at point of interest


File
View mode
Molecule
VDW
Ligand(s)
VDW
Selection
Radius (4 Å)
Compute (0)
Clear
Animation
Play
Stop
Culling plane
Active
Static
Cull Ligand
Silhouette
Dist.
Velocity
Distance
Coulomb Energy
VDW Energy
0
5000
10k
15k
20k
25k
30k
35k
40k
45k

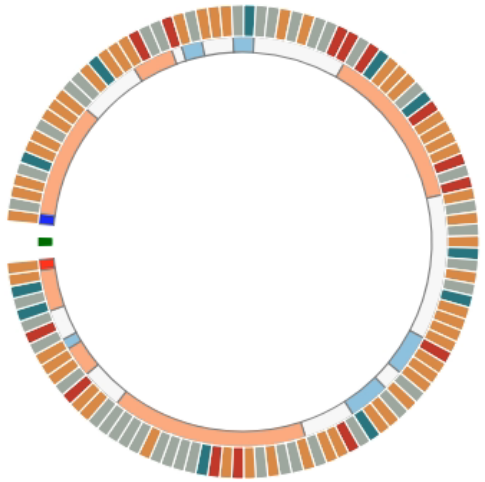
Visual Analysis of Protein-Ligand Interactions

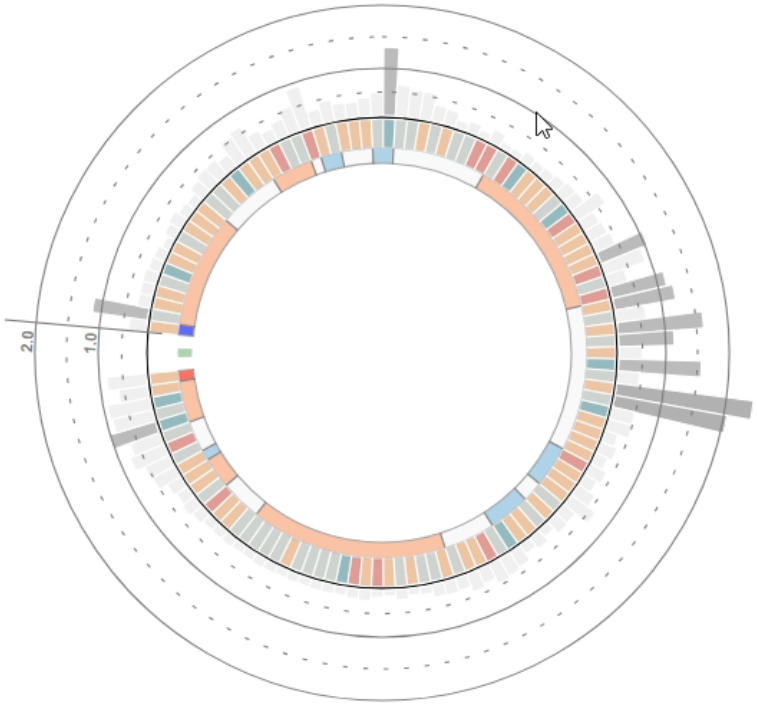
Residues ▾

RMSF ▾

SER, THR, ASN, GLN, CYS, TYR, MET, TRP
ALA, ILE, LEU, PHE, VAL, PRO, GLY
LYS, ARG, HIS
ASP, GLU

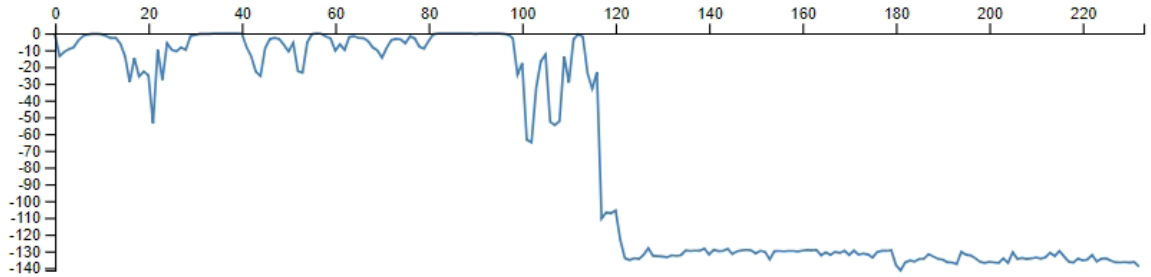
Alpha-helix
Beta-sheet
None





≥1.5Å
≥0.75Å and <1.5Å
<0.75Å

Frame 0



FURTHER READING

- Information Visualization: Perception for Design, 3rd edition, Colin Ware, Morgan Kaufmann, 2013
- Tamara Munzner's: Visualization Analysis and Design, AK Peters, 2014.
- Color Basics for Creating Visualizations. Theresa-Marie Rhyne: https://www.youtube.com/watch?v=RiG1Rn0Acn0
- Jon Schwabish's "One chart at a time" Youtube series: https://www.youtube.com/watch?v=gFFj22kjlZk
- https://public.tableau.com/es-es/s/gallery/visual-vocabulary
- Visual Vocabulary Financial Times: https://github.com/ft-interactive/chart-doctor/tree/master/visual-vocabulary
- Claus Wilke Data Visualization free book: https://clauswilke.com/dataviz

DATAVIS 10½
A PRACTICAL BRIEF INTRO TO DATA VISUALIZATION

PERE-PAU VÁZQUEZ – VIRVIG GROUP – UPC