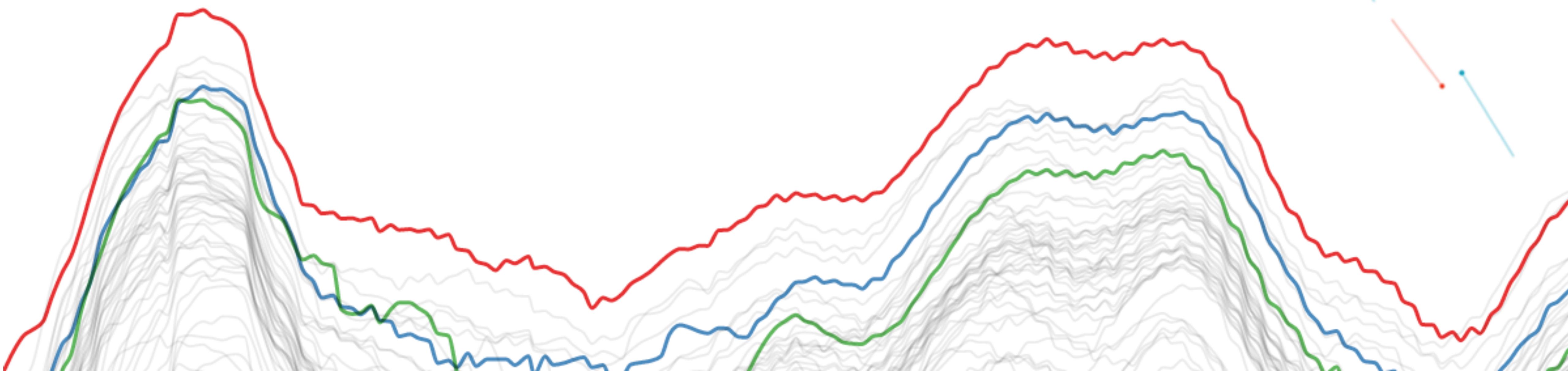


Visualización de la información

Fernando Becerra

f.becerra@udd.cl | [@fdo_becerra](https://twitter.com/fdo_becerra) | www.fernandobecerra.com

Magíster en Data Science, Universidad del Desarrollo

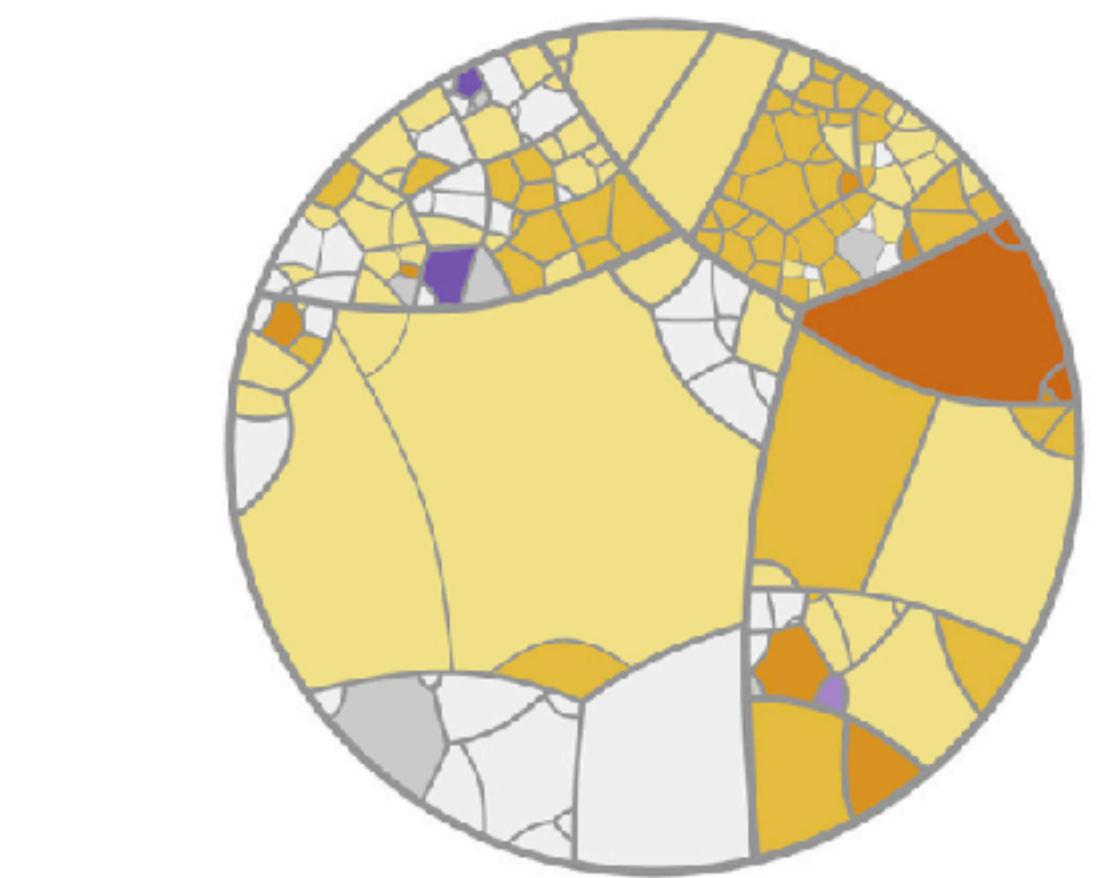


¿QUIÉN SOY?

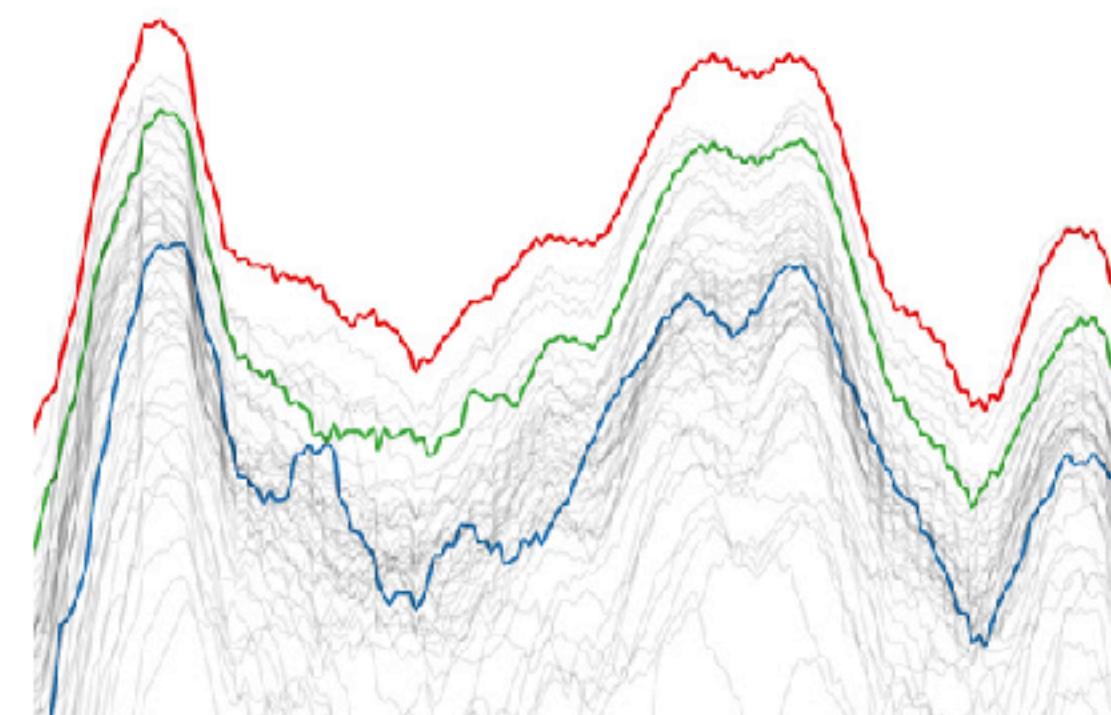
FERNANDO BECERRA

DATA ANALYSIS + VISUALIZATION

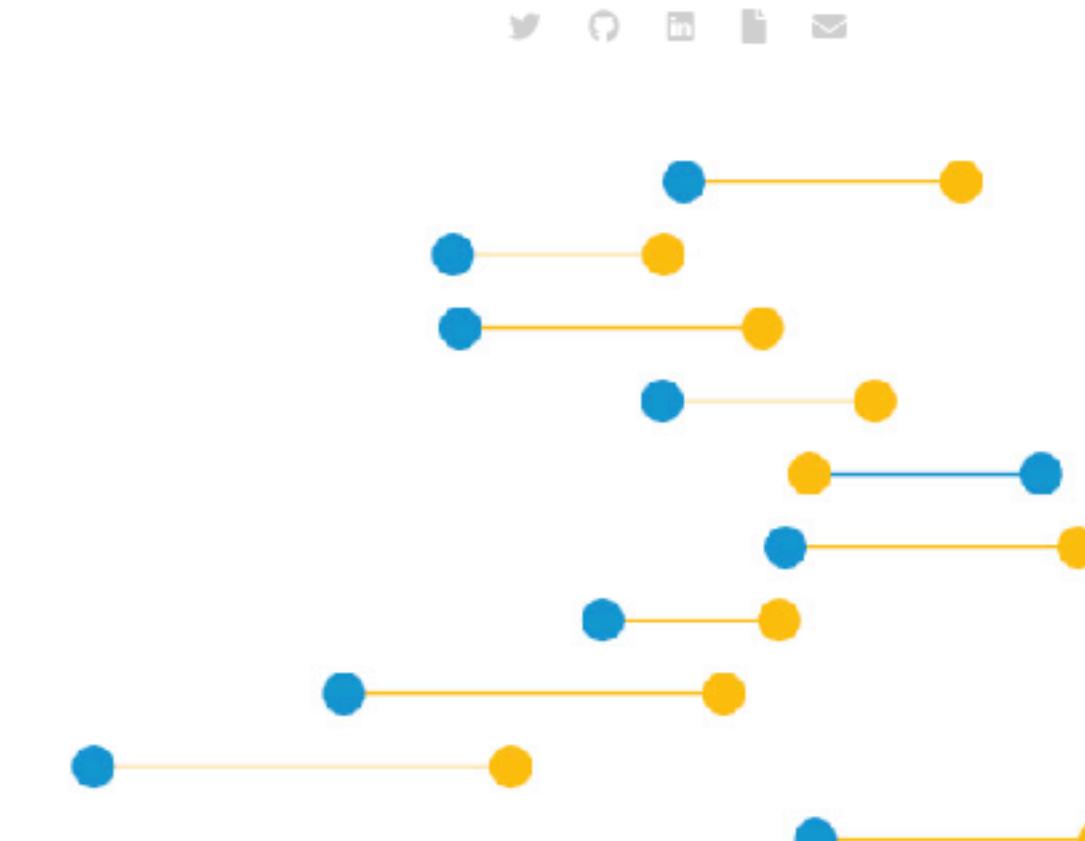
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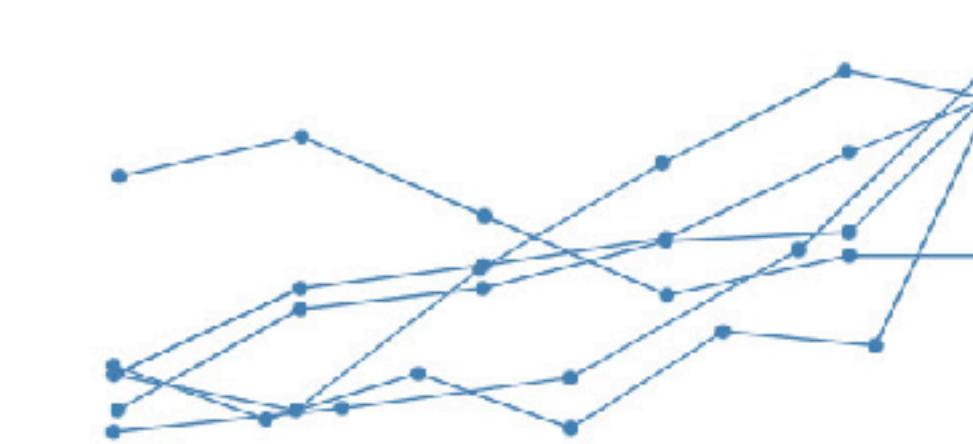
D3JS INTERACTIVE DATAVIZ
Inflation for Americans at each age
How does inflation affect Americans at different ages?



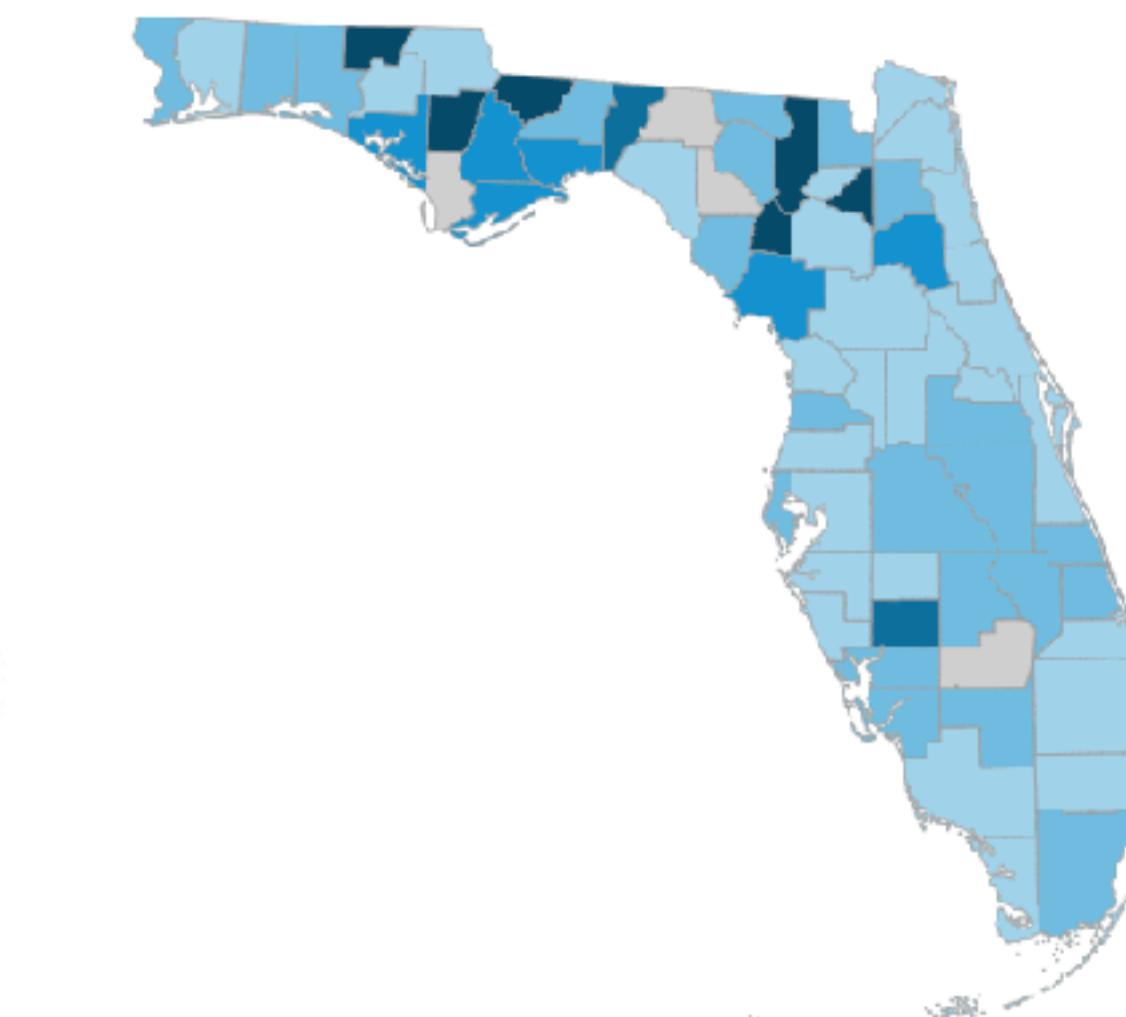
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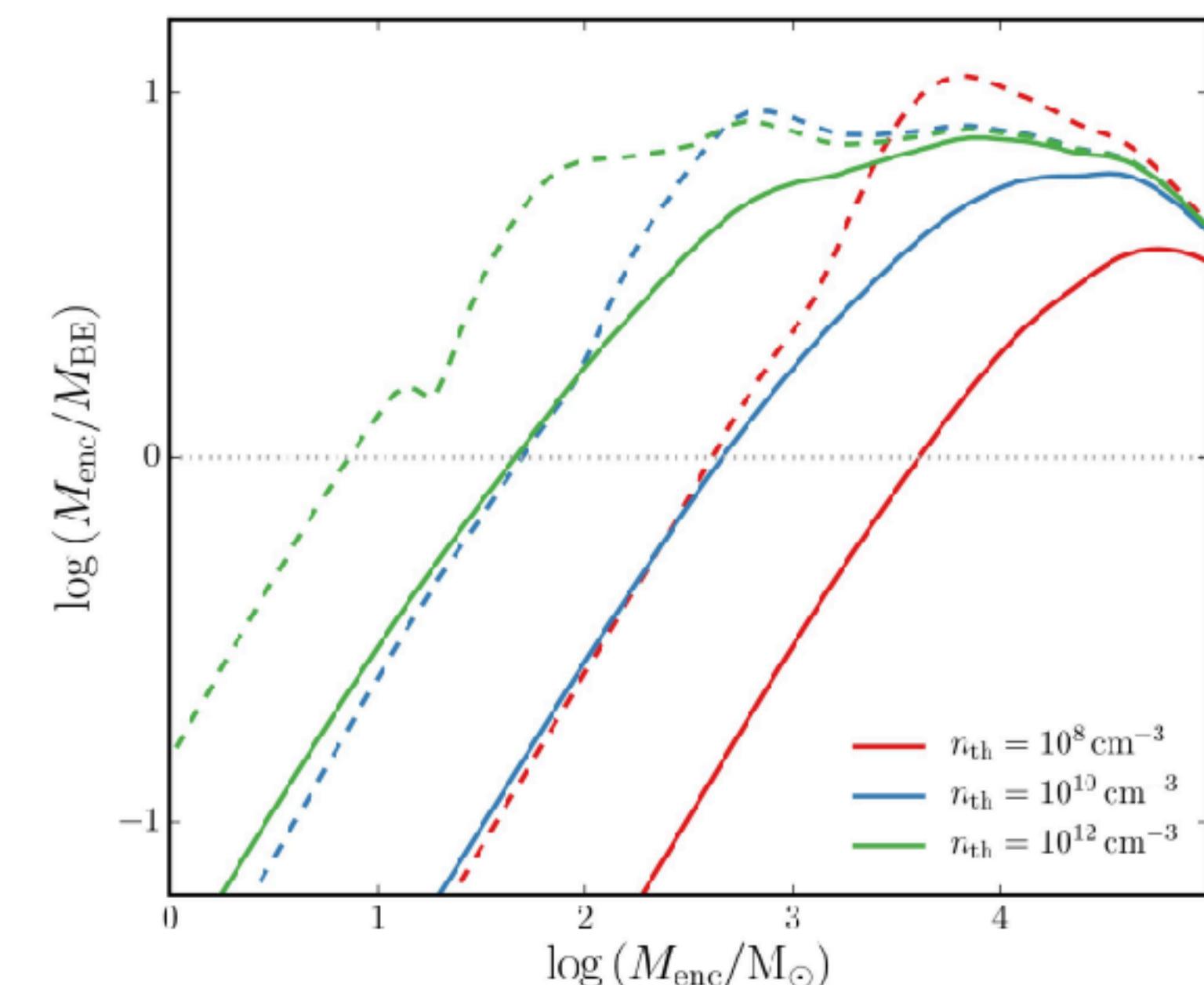
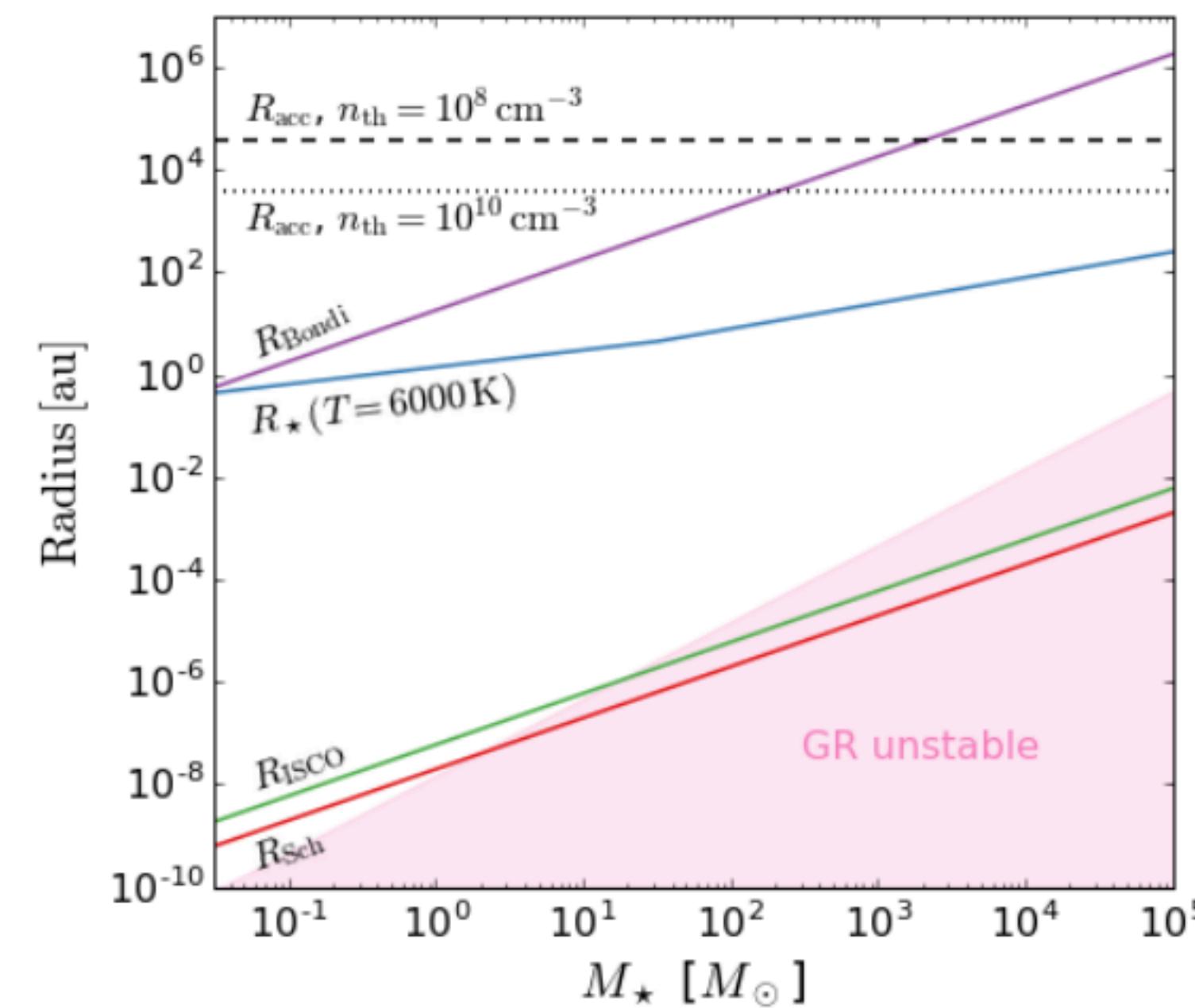
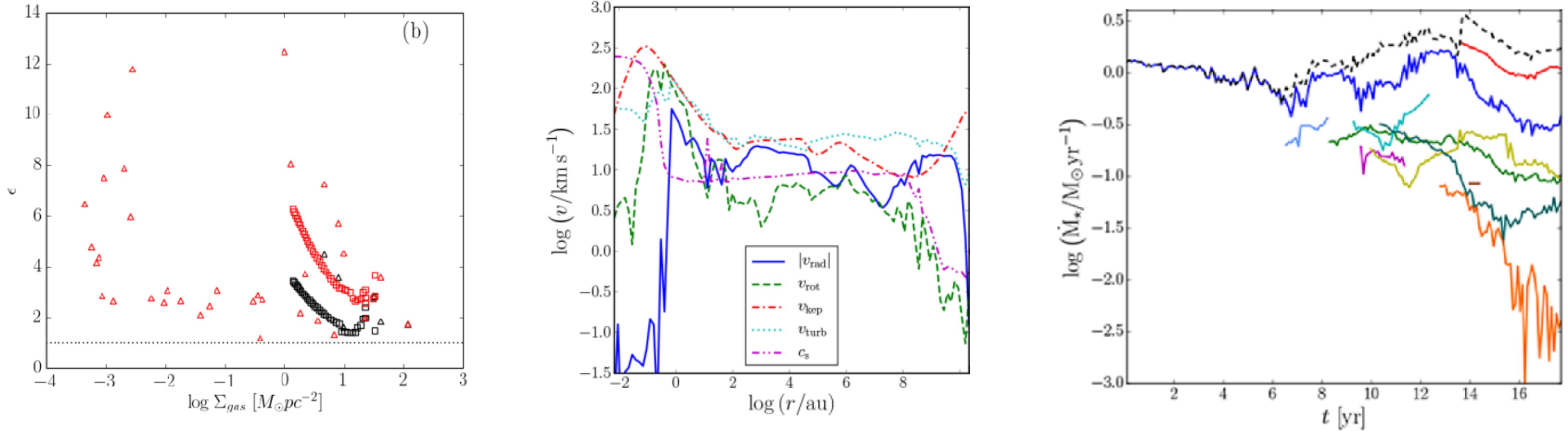
D3JS INTERACTIVE DATAVIZ
Beyond education outcomes
How equitably distributed are educational resources?

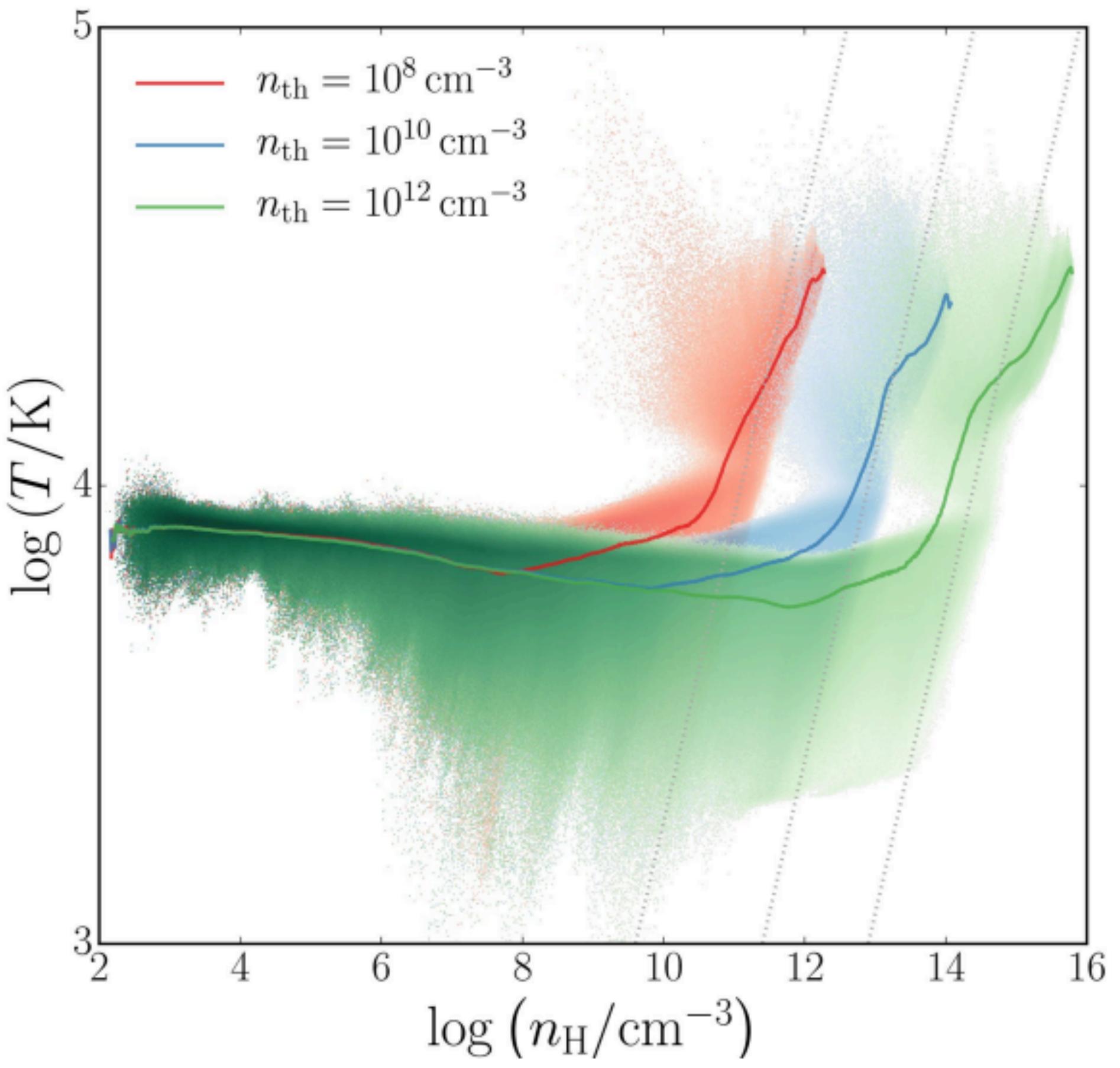
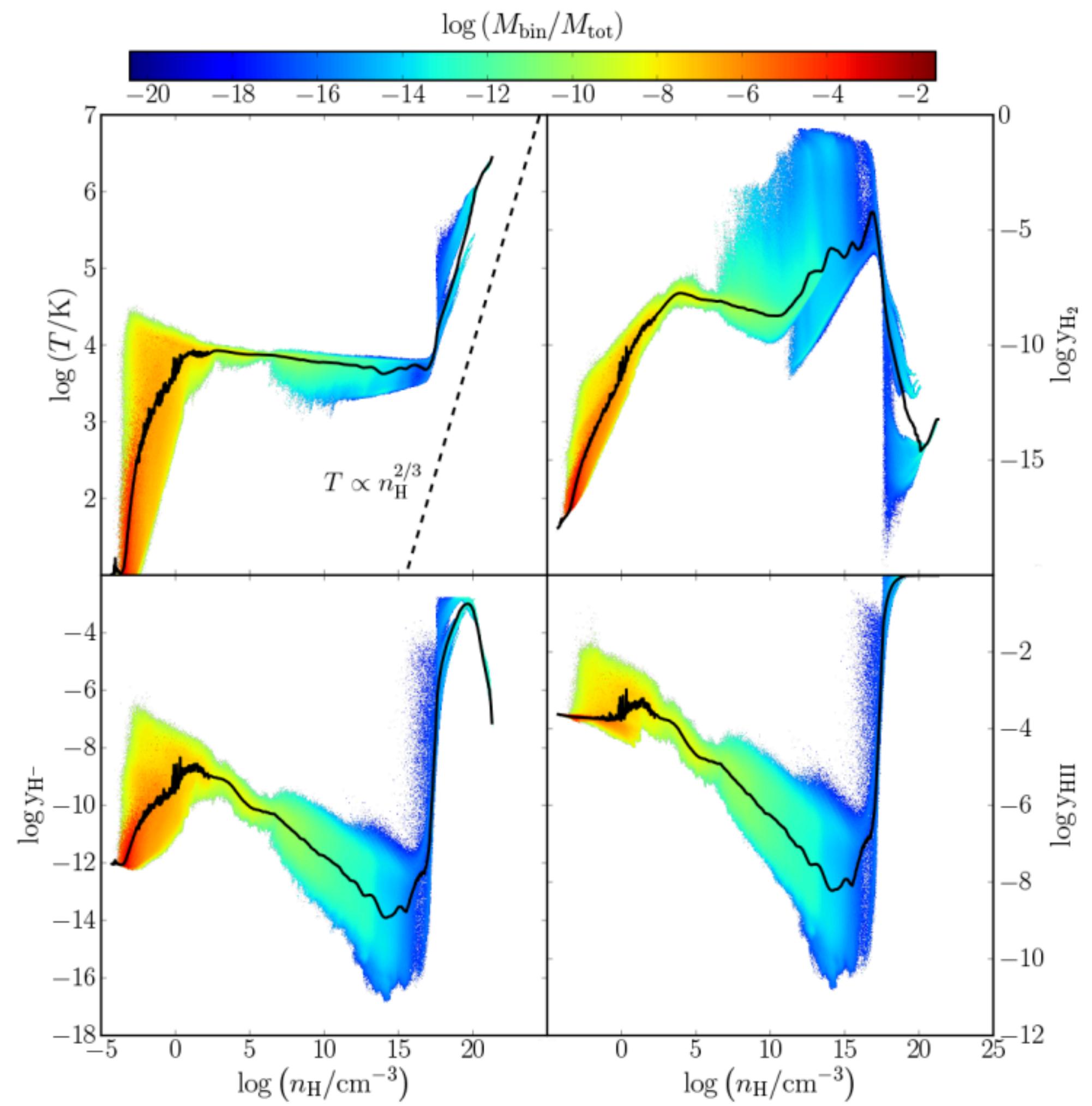


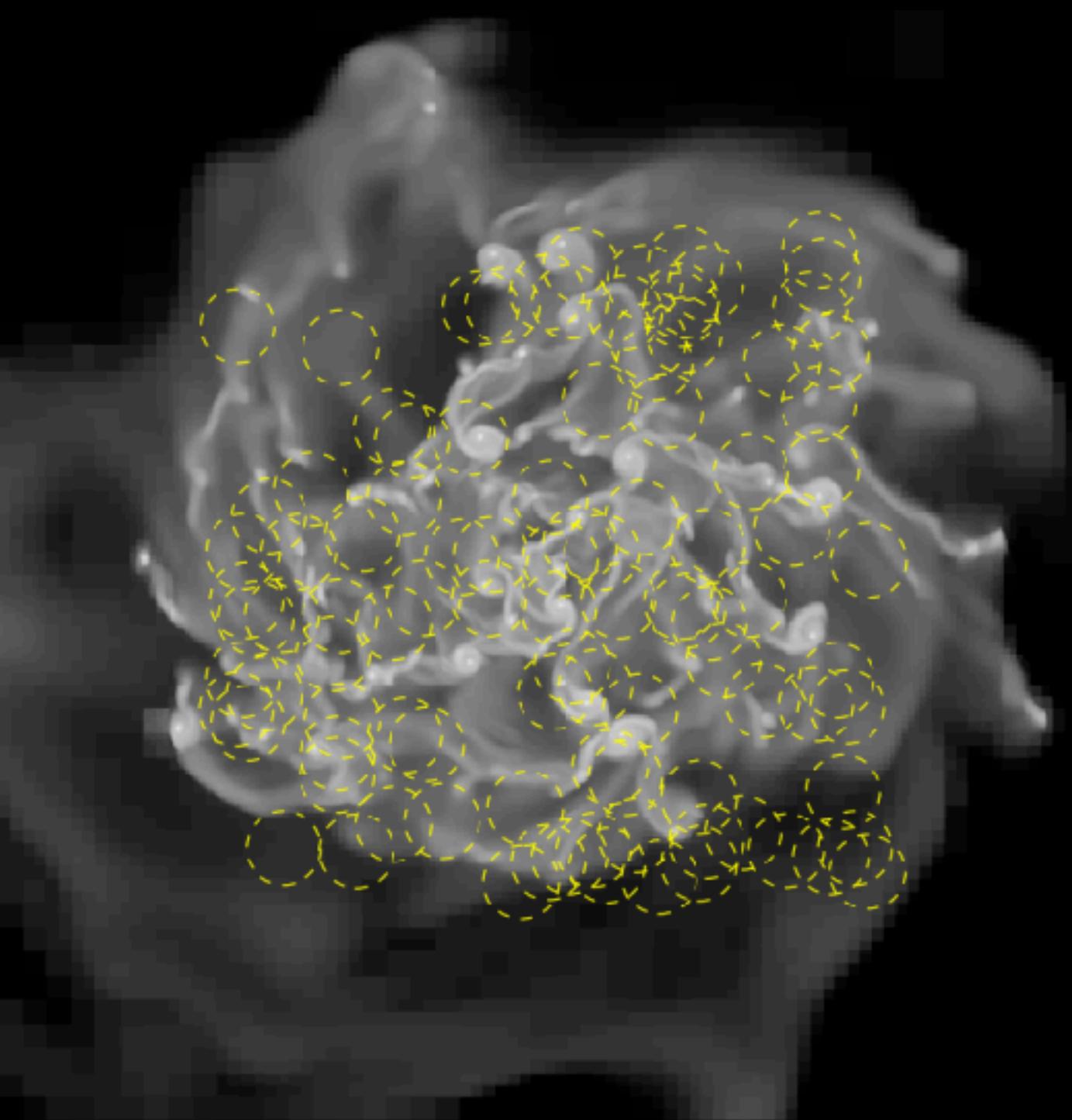
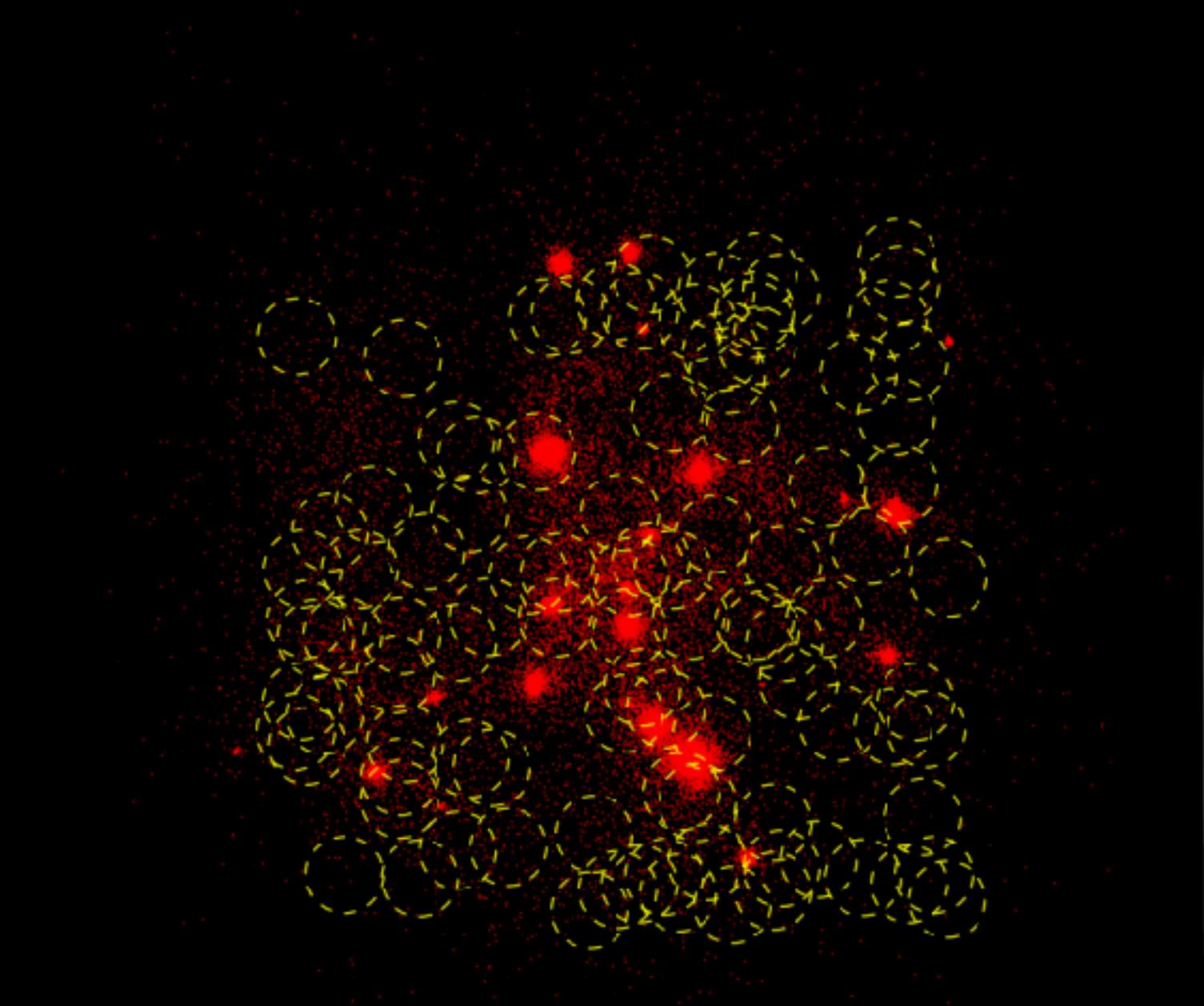
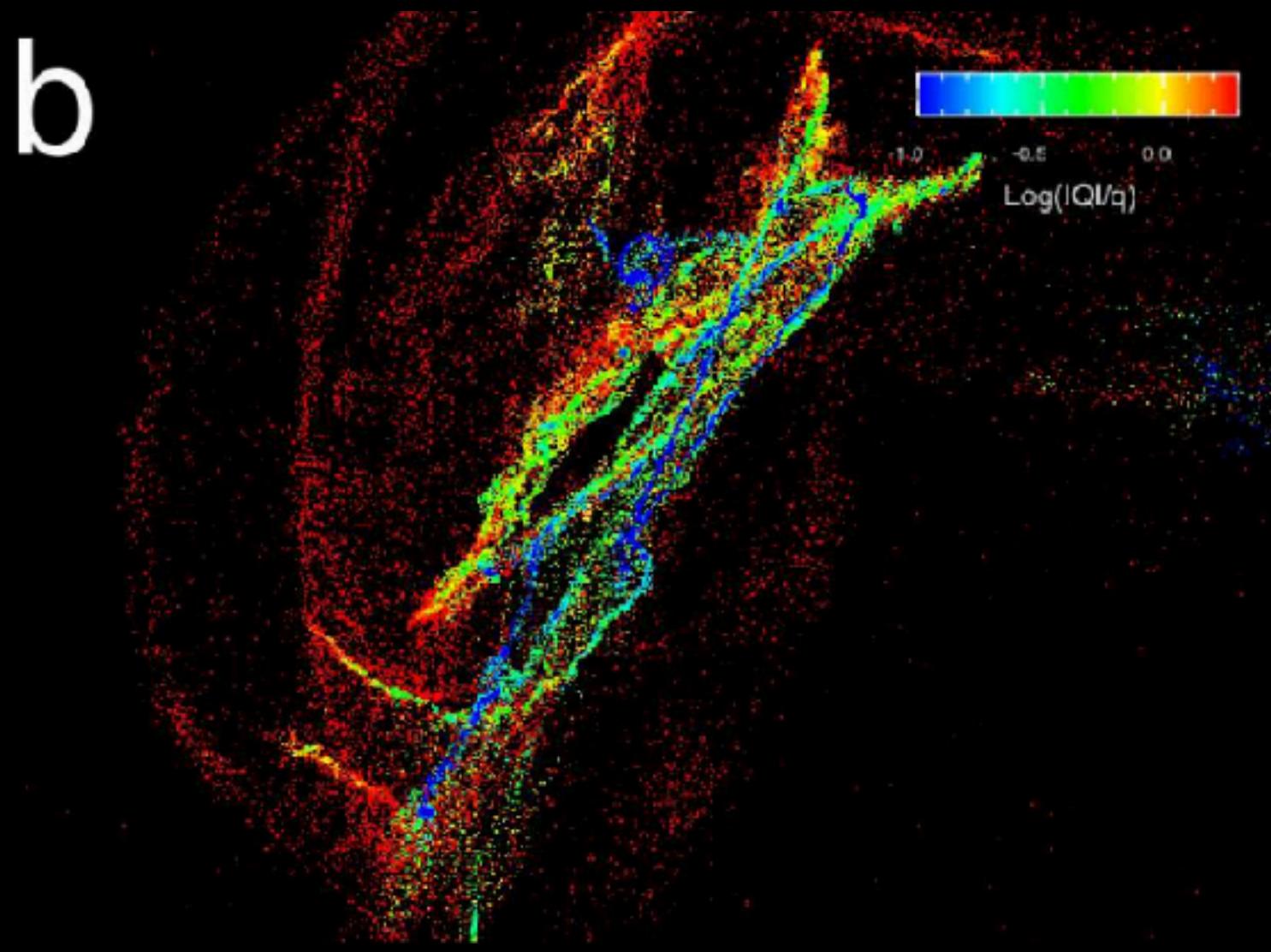
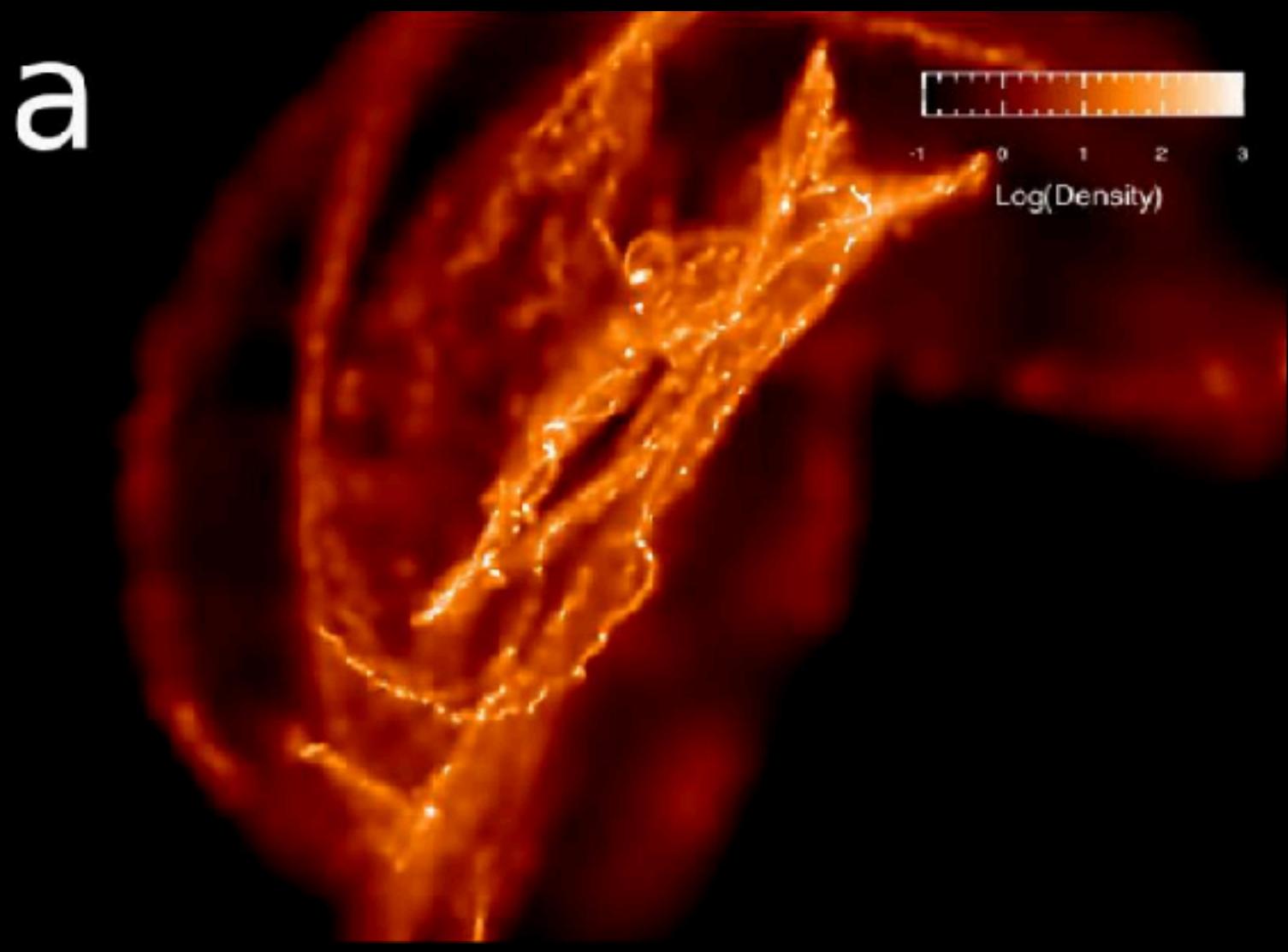
D3JS INTERACTIVE DATAVIZ
Giving dashboard
A snapshot of the many ways Americans give

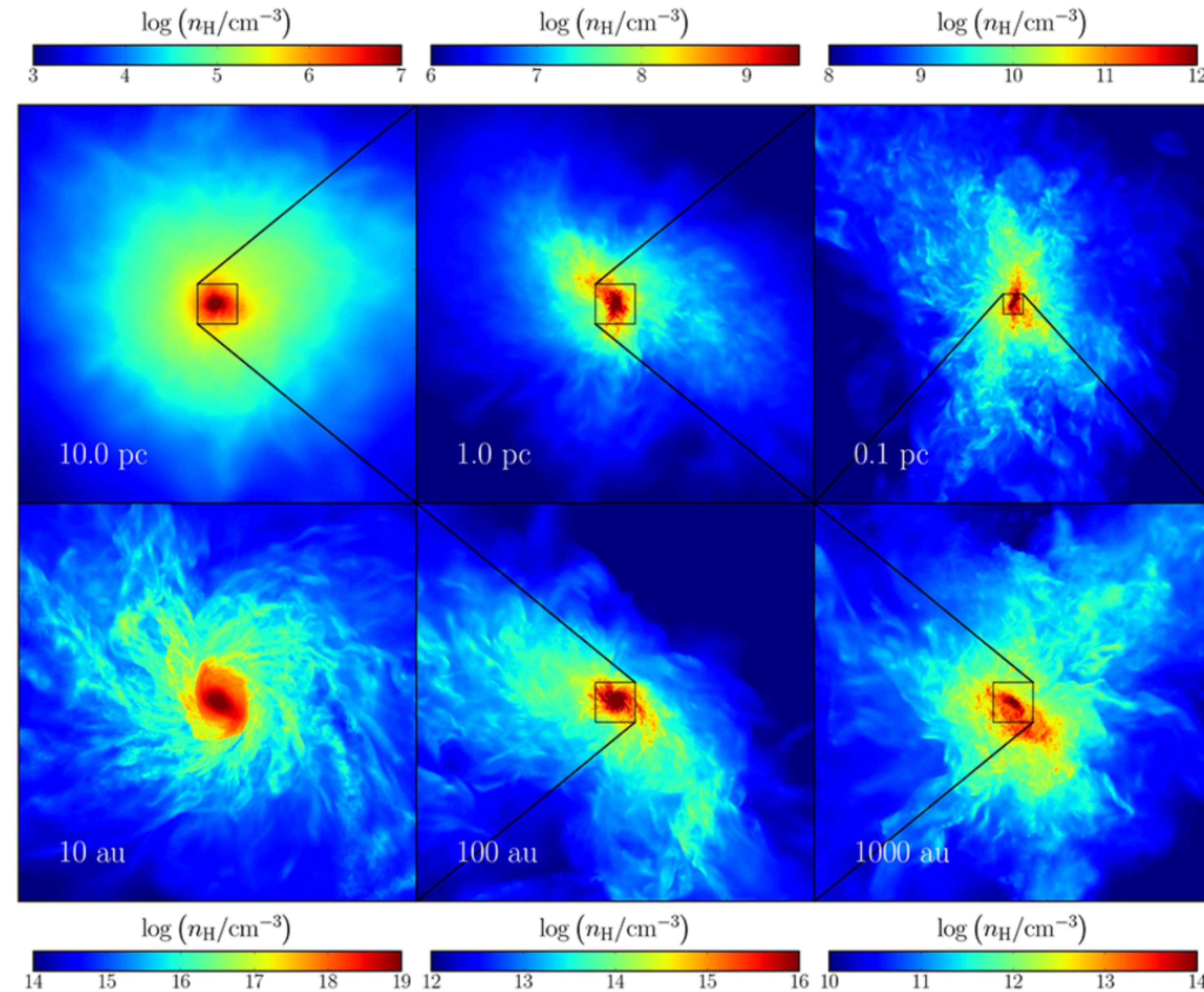


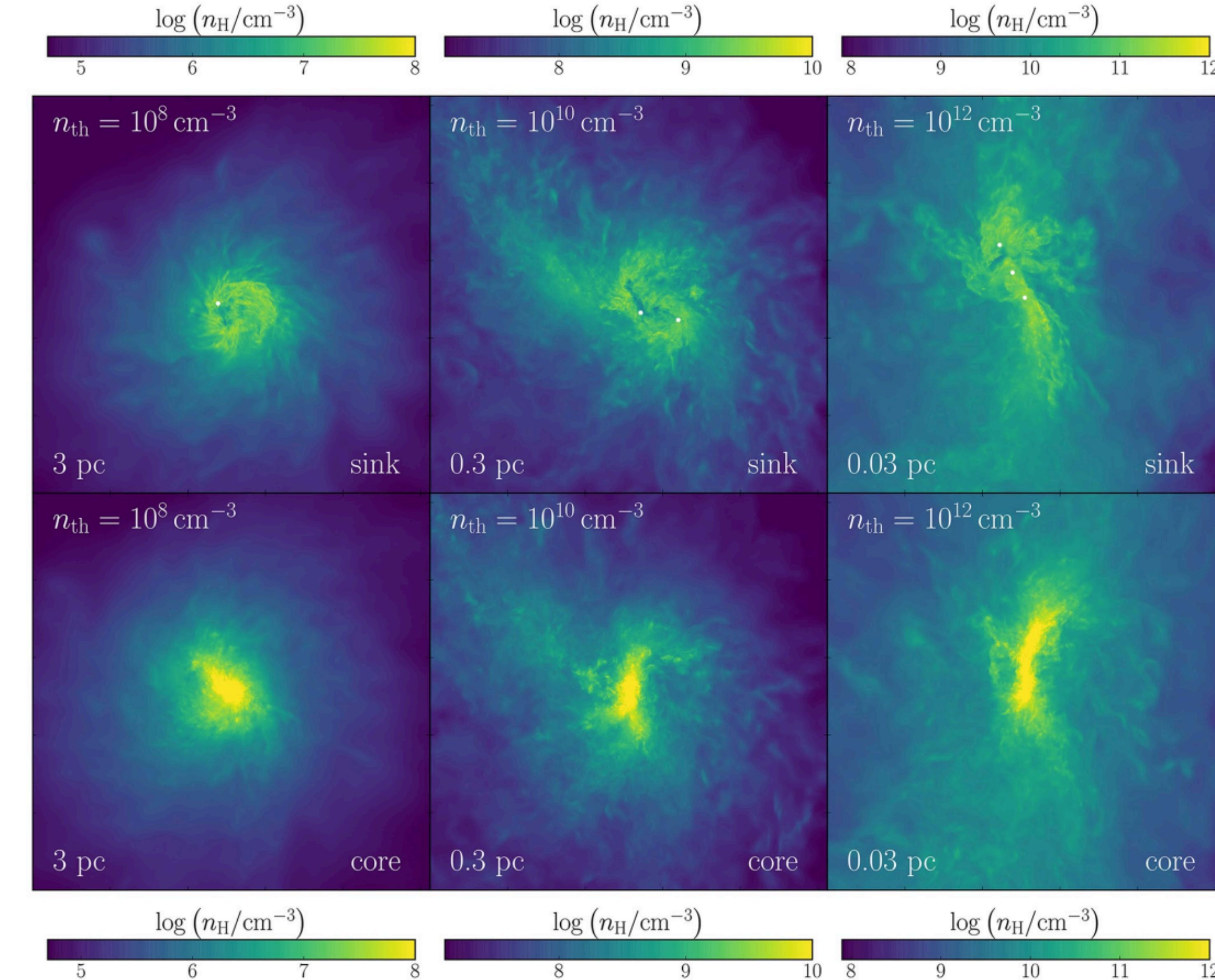
D3JS INTERACTIVE DATAVIZ
The leaky pipeline of advanced placement test taking
<https://www.fernandobecerra.com/>
The gap between AP class enrollment and AP test taking

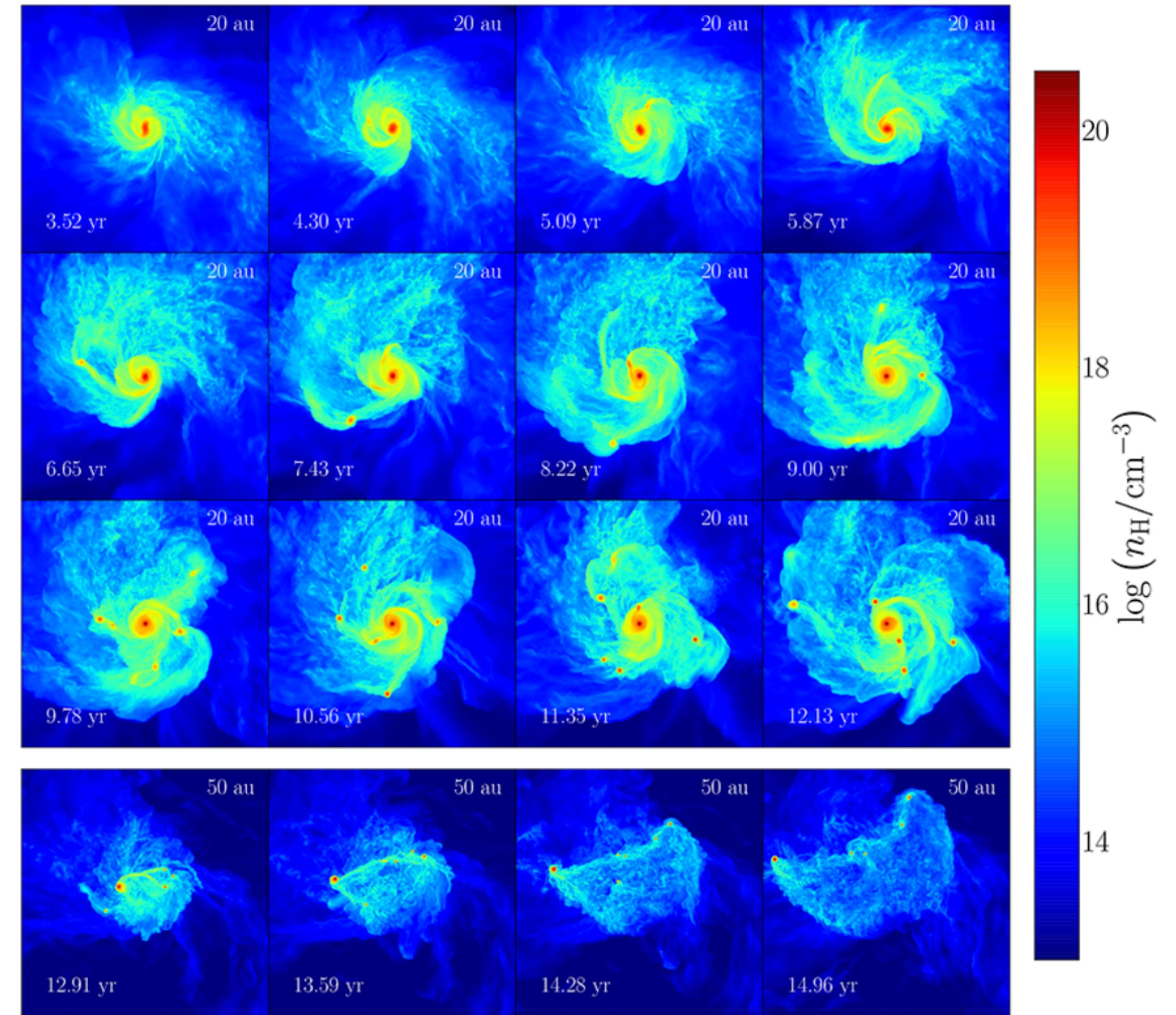








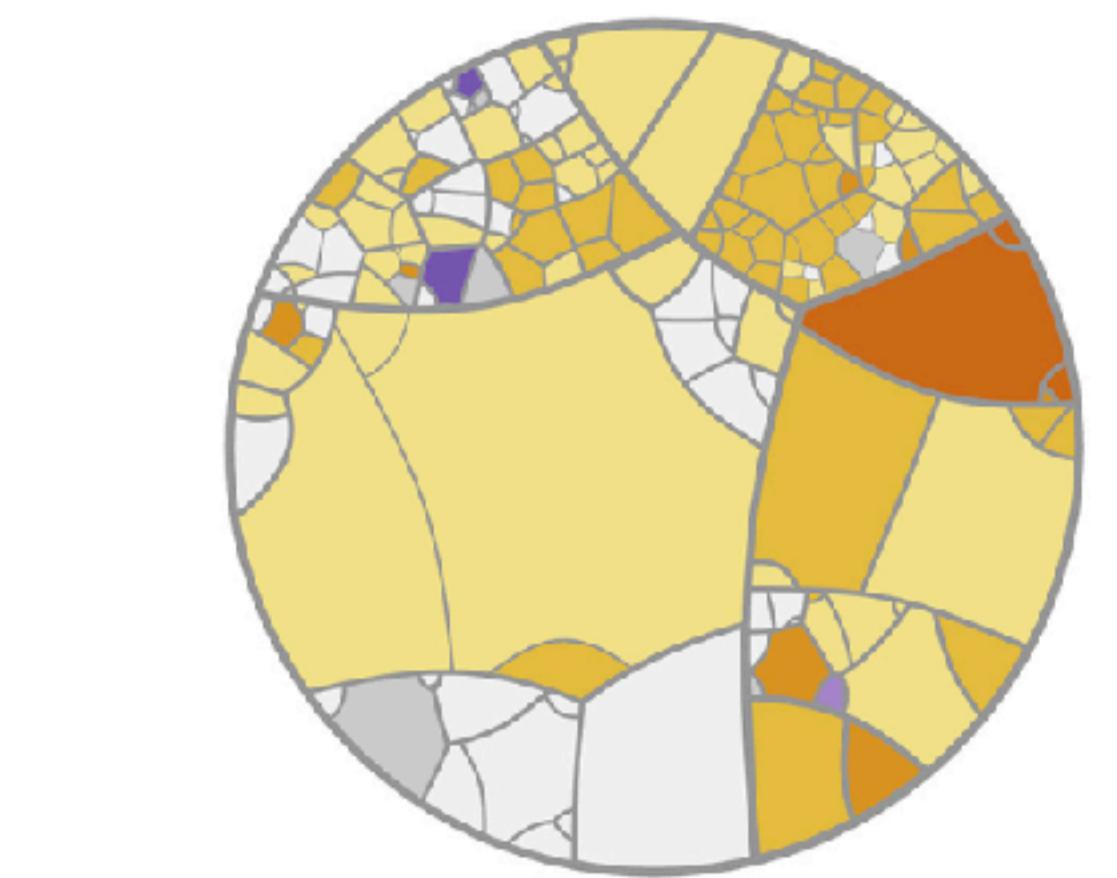




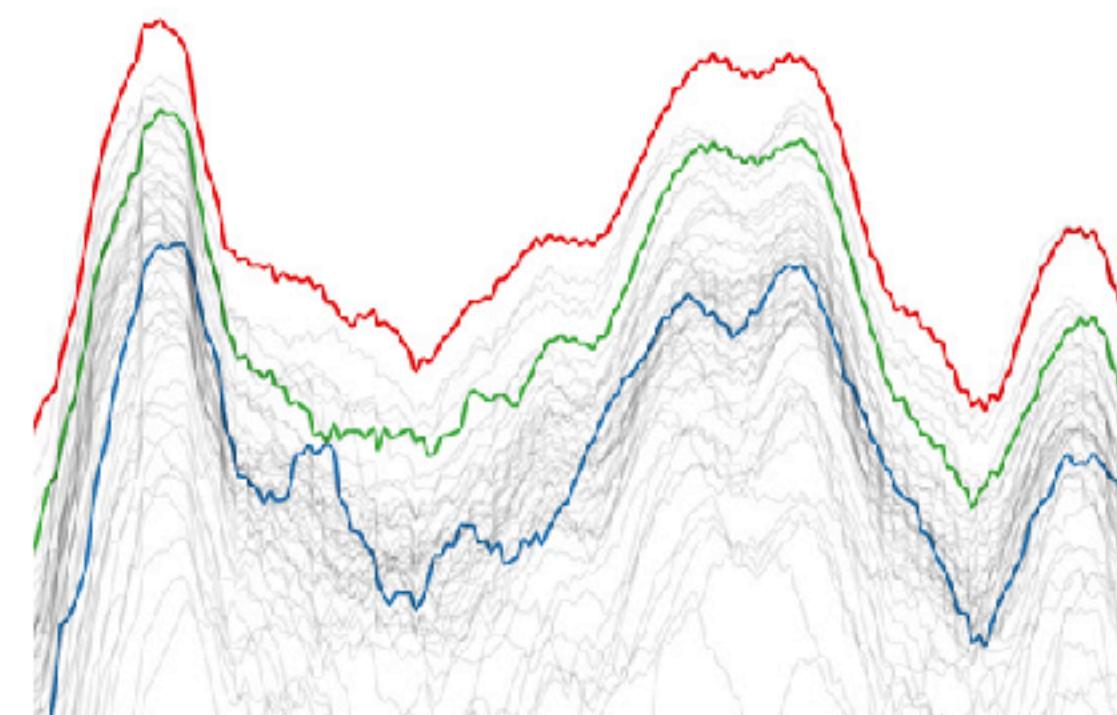
FERNANDO BECERRA

DATA ANALYSIS + VISUALIZATION

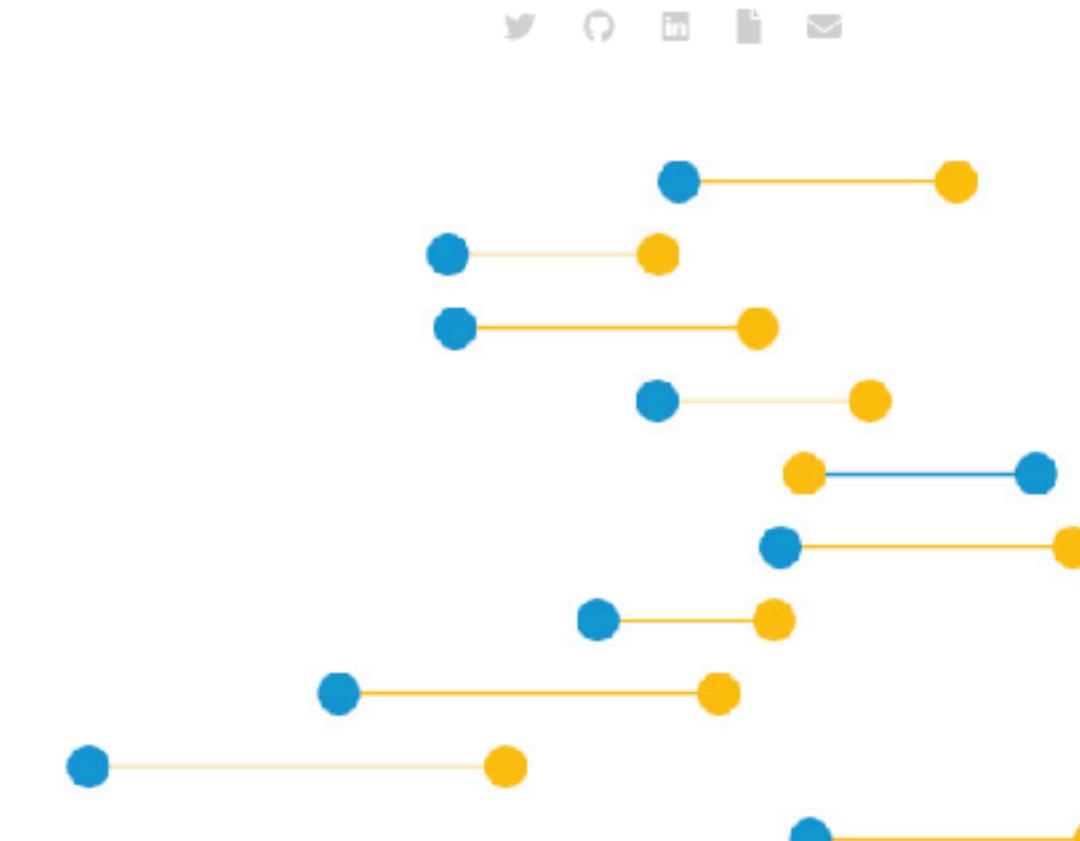
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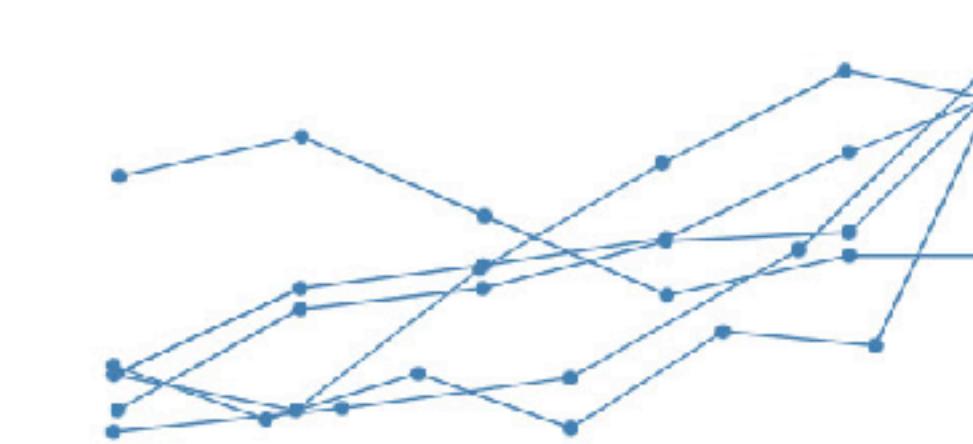
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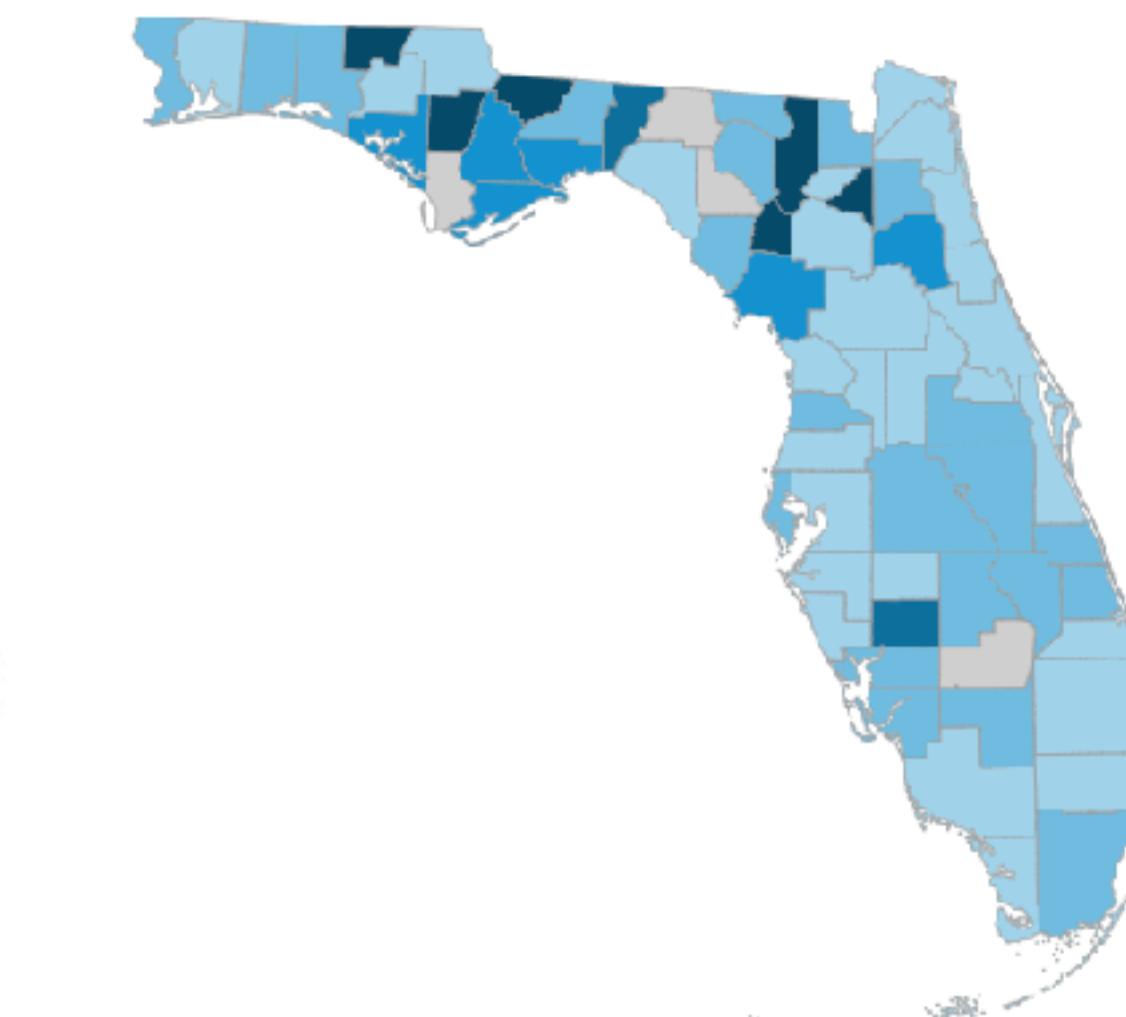
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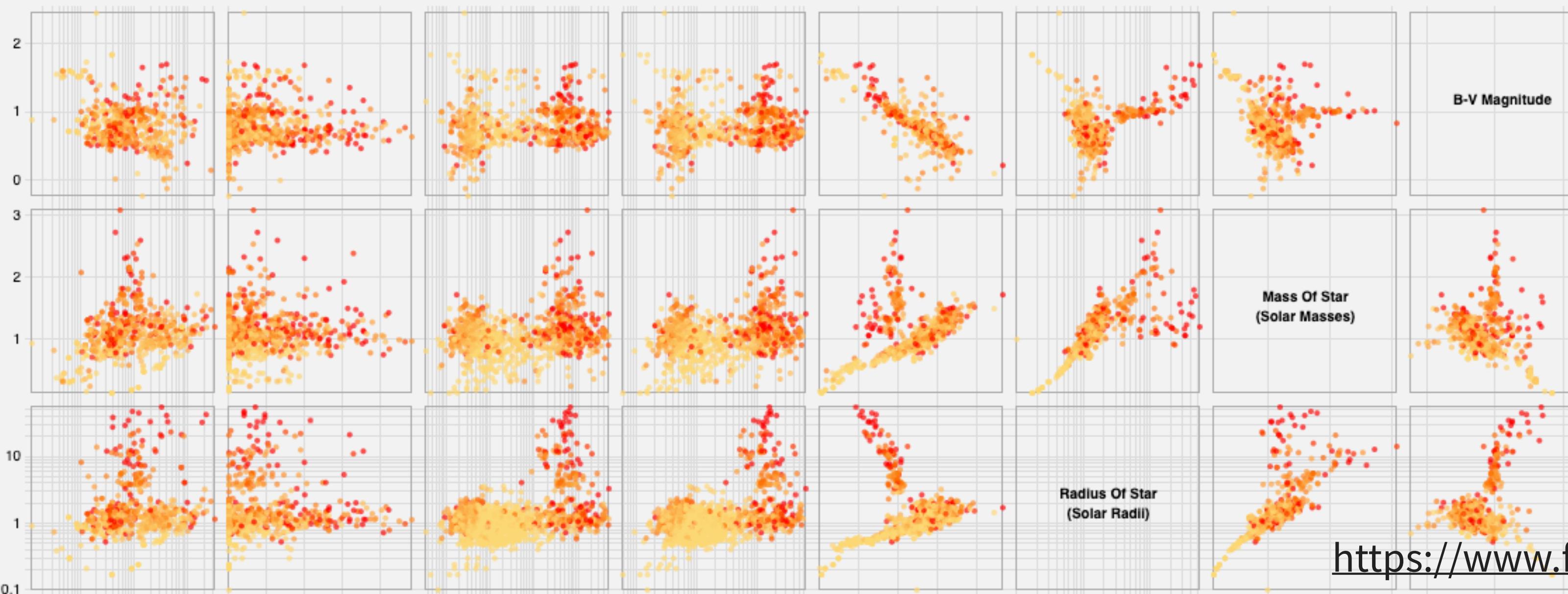
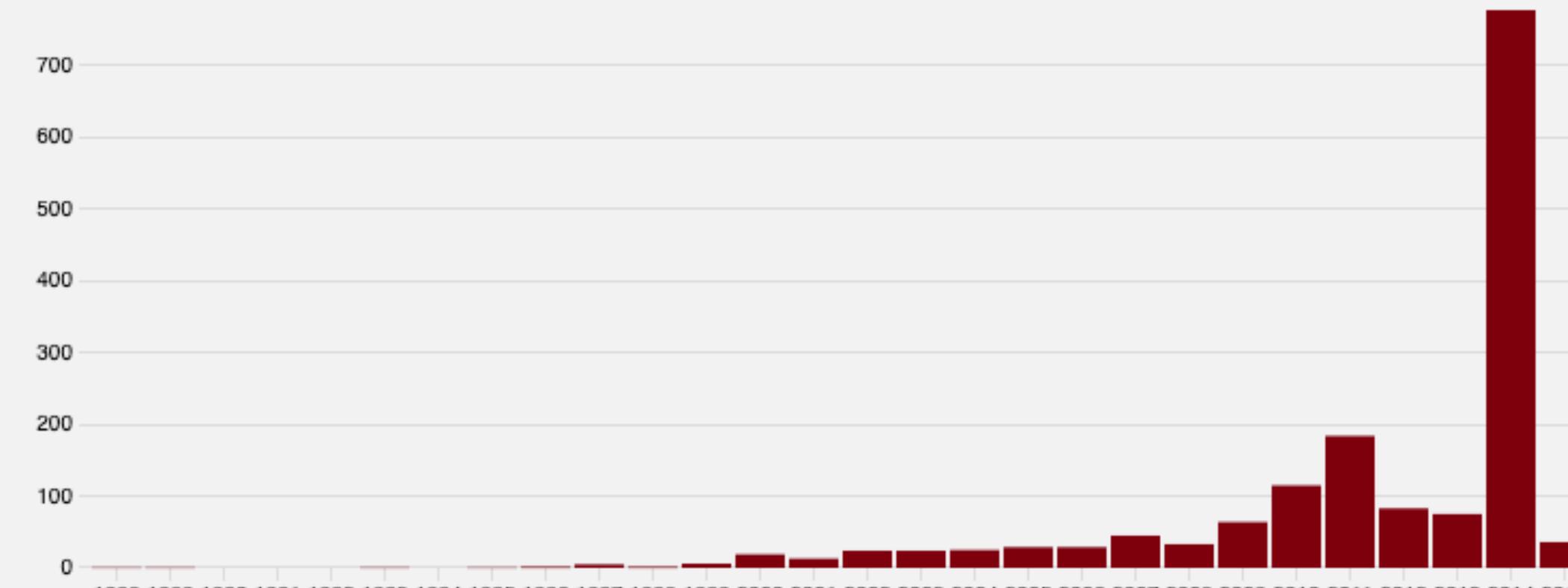
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Ex²: Exoplanets Explorer

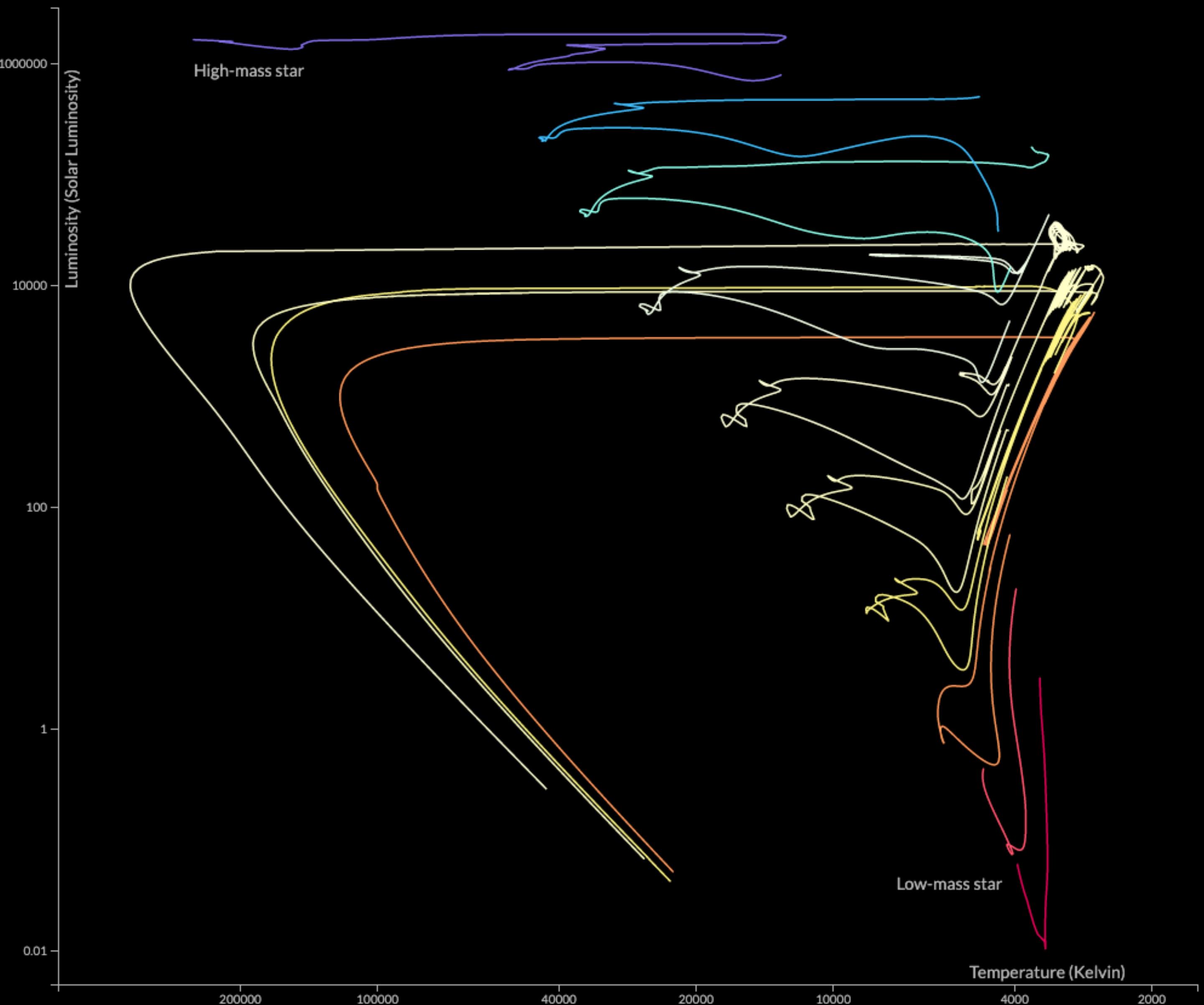
A visualization by [Fernando Becerra](#)

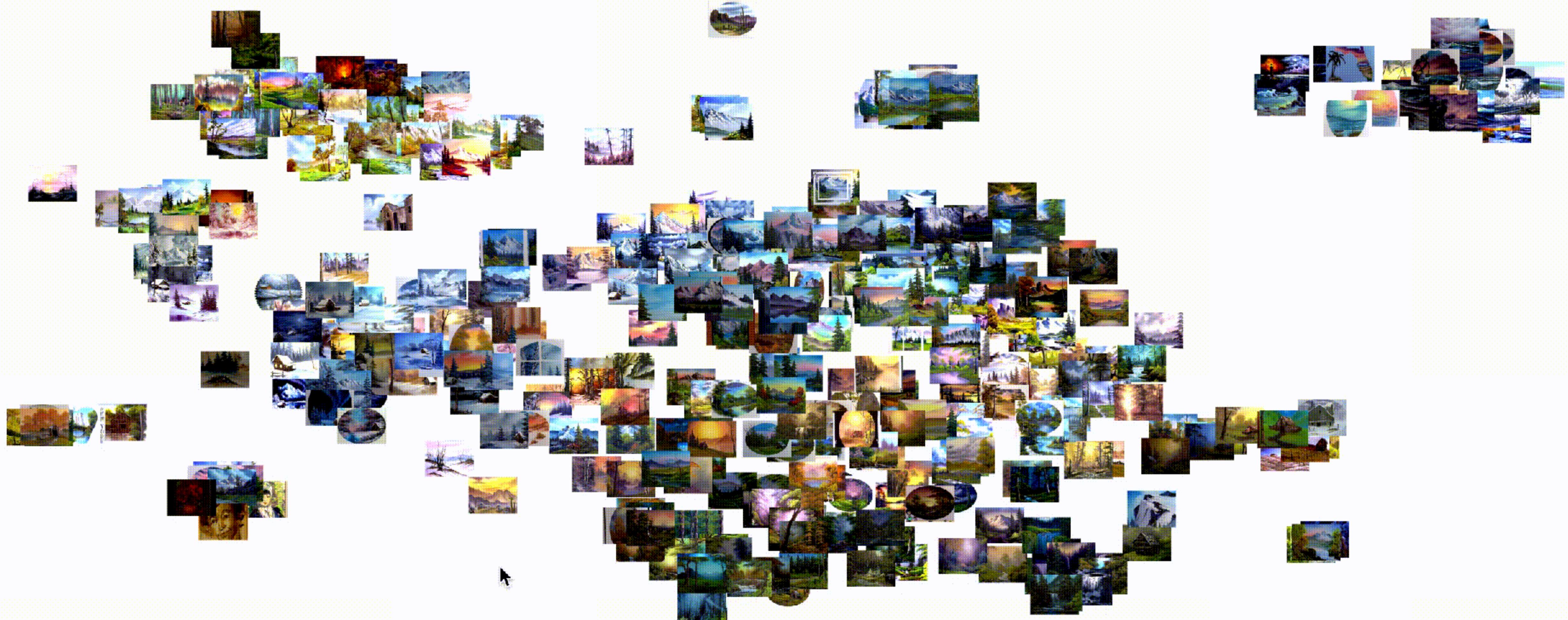
Exoplanets are planets orbiting a star beyond our Solar System. They have been discovered since 1988, but most of the first discoveries were huge gas giants orbiting close to their parent star. The launch of the [Kepler Space Telescope](#) opened a new window using a technique called the "transit" method, which allowed astronomers to confirm more than 1,000 exoplanets spanning a wide range of properties.

This visualization tool is intended to explore different exoplanets characteristics. The histogram on the right shows the number of planets discovered by year. Each bar is clickable, which will select the objects discovered that year and highlight them on the scatter plots below. These plots are color-coded by planet mass and include a brush tool to select and explore the properties of a subset of exoplanets across multiple panels.



Different types of stars show similar trends and behaviors when placed on the HR-diagram, and we can make use of that fact to draw some physical meaning and intuition.





PALETTE

barn beach bridge bushes cabin clouds fence flowers fog framed grass guest hills lake
mountains night ocean palm trees path river rocks snow steve ross sun trees waterfall

PICTORIAL ELEMENTS

Visualizador de datos Covid-19 en Chile

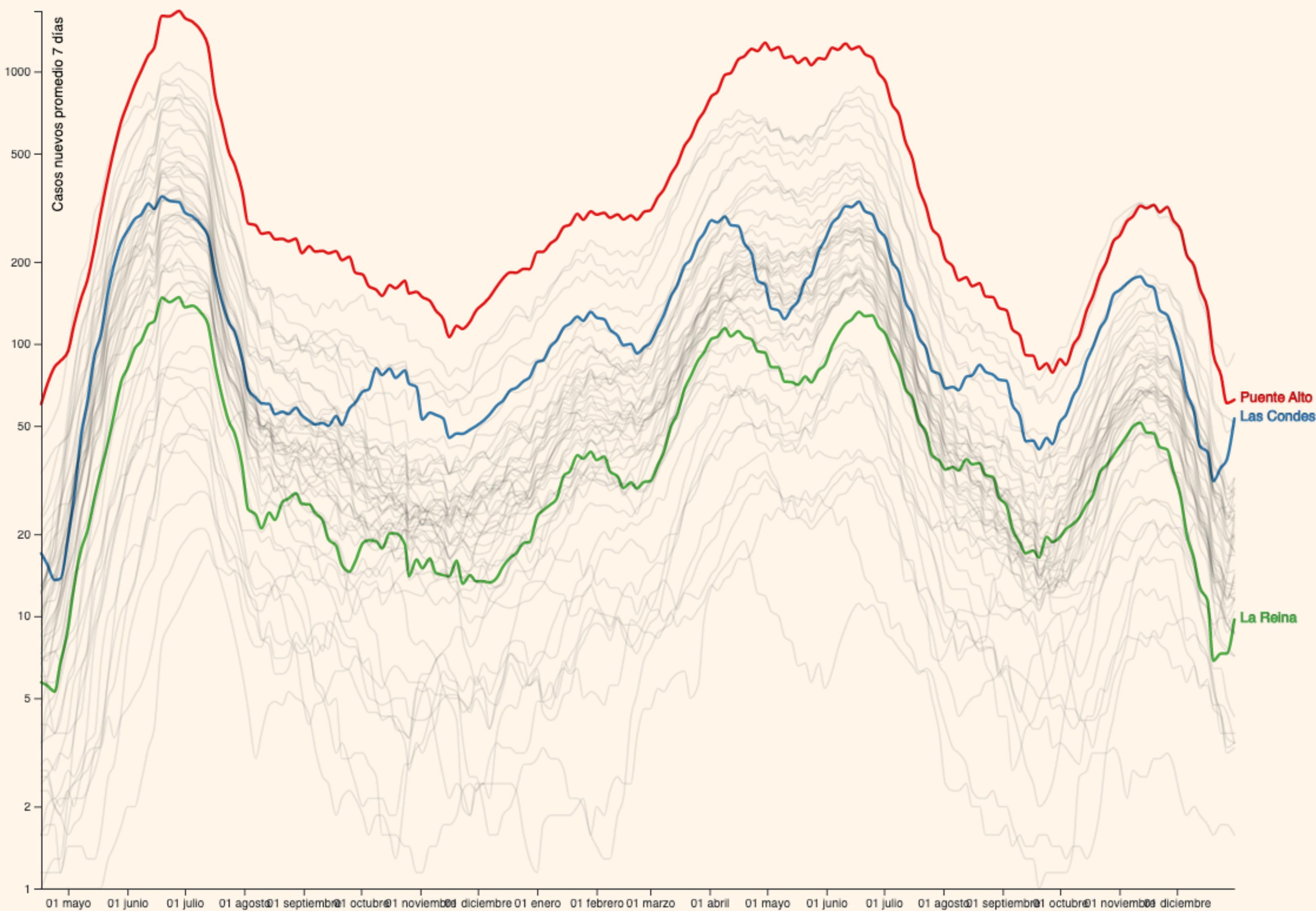
El gráfico a la derecha muestra el número de **casos** ▾
nuevos ▾ **promedio 7 días** ▾ **en**
Metropolitana ▾ **por comuna** ▾ **en escala** **logarítmica** ▾

* Base de datos del Ministerio de Ciencias hasta el 31 de diciembre* Sólo se muestran las comunas con más de 50 casos.

También puedes seleccionar hasta 7 comunas para destacar en el gráfico

Buscar comuna... 

Puente Alto  Las Condes  La Reina 



<https://www.fernandobecerra.com/covid19chile/>

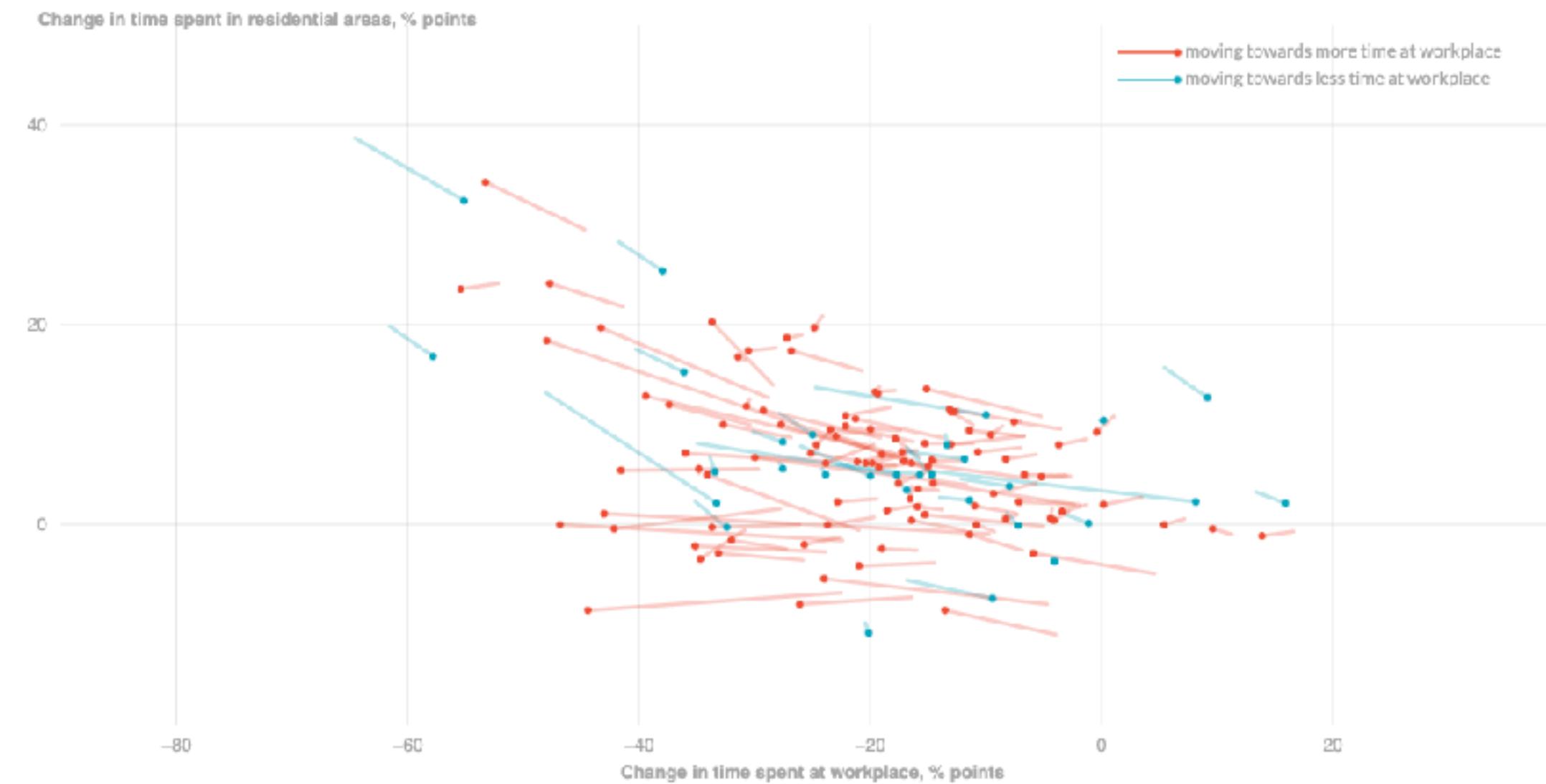
Creado por Fernando Becerra. Comentarios y sugerencias en   

Holidays, not lockdowns, drive more people to stay home

After the initial full lockdown in March 2020, Christmas and Easter have driven the highest decline in time spent at work on average.

Change in time spent at workplace v change in time spent in residential areas

Week of May 01, 2021



Since the beginning of the pandemic governments have been enforcing lockdowns to keep people at home and control the spread of the virus. For most families, it is hard to stop working without appropriate economic incentives, and, eventually, are forced to go back to their workplaces as soon as the lockdown is over. The key to finding a way of forcing people staying home while getting paid might be more familiar than what you think and it is (un)surprisingly effective: holidays.

Data from Google's COVID-19 mobility reports show that the initial global lockdown of March 2020 dropped the time spent at workplaces more than 45% on average, compared to January 2020. Two months later countries started going back to normal, but since then they have been going back and forth between closing down and reopening again. Spikes in new cases drive governments to decree lockdowns, but as soon as restrictions are lifted people return to work and create an increase in time spent going back to the beginning of the cycle.

<https://www.fernandobecerra.com/covid-mobility/>

Research has shown that experienced teachers are more effective than inexperienced teachers, and [addressing these inequities](#) can improve reading and math test scores.

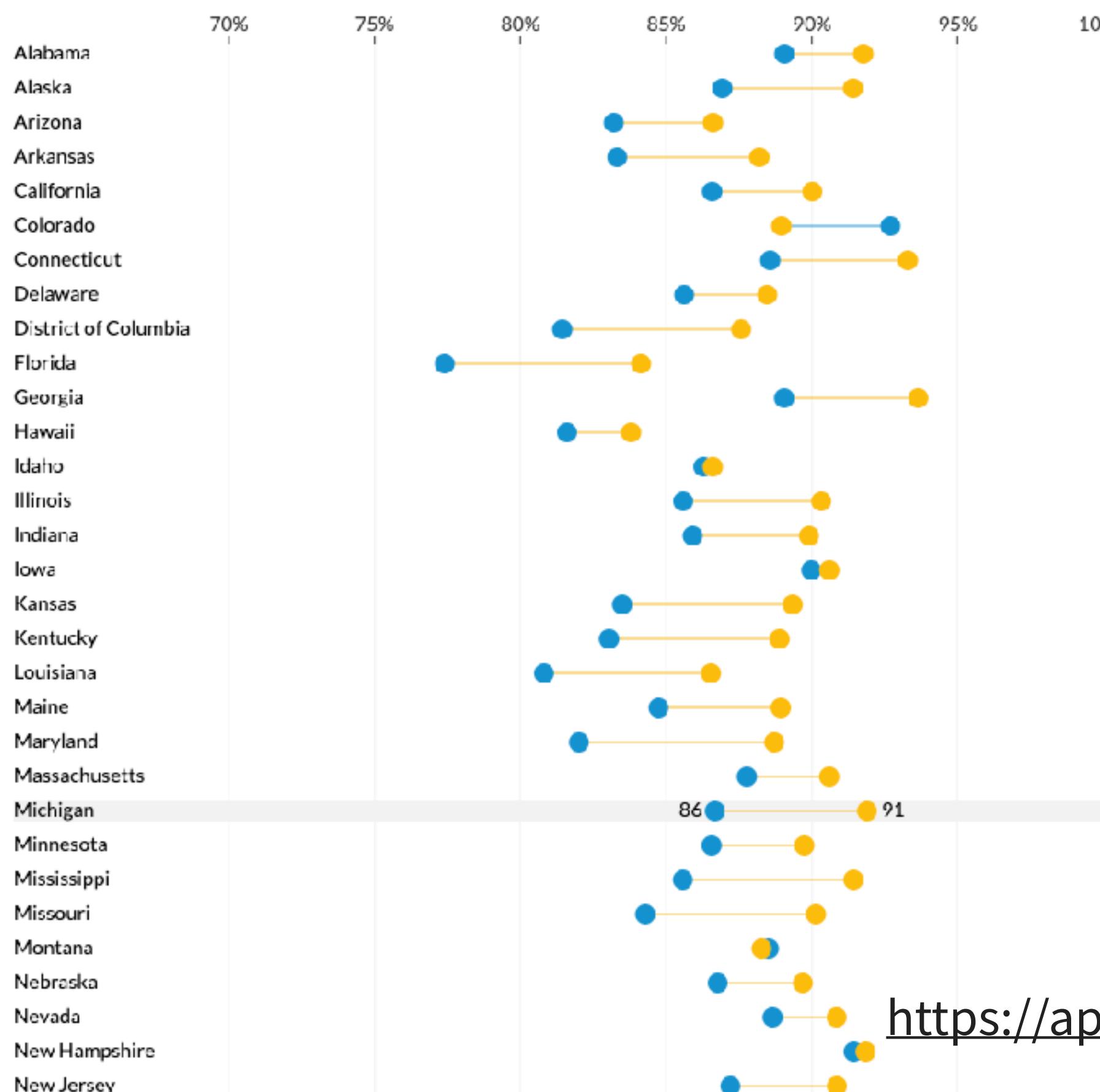
Below, we display the share of teachers who have more than two years of experience in students' schools.

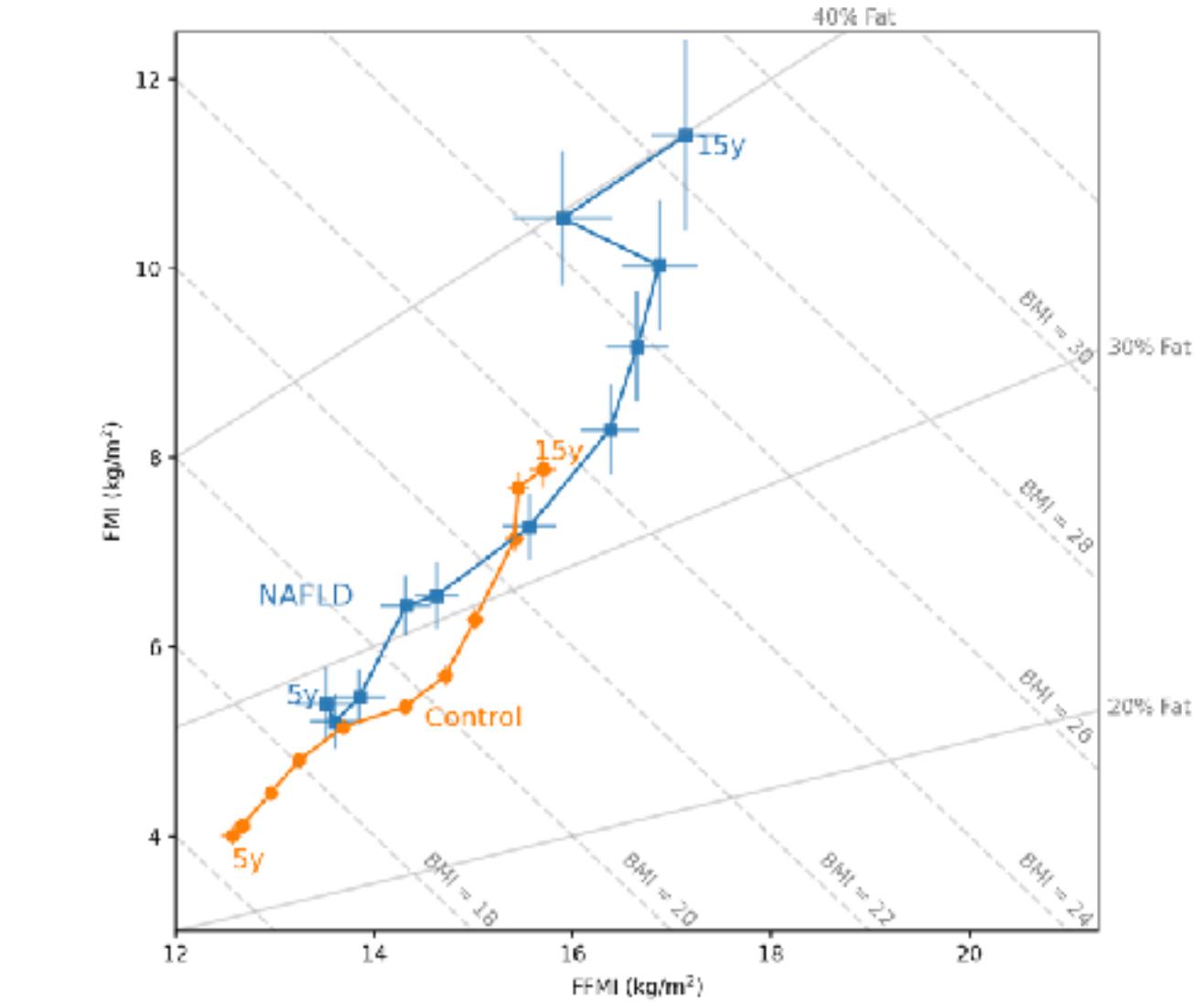
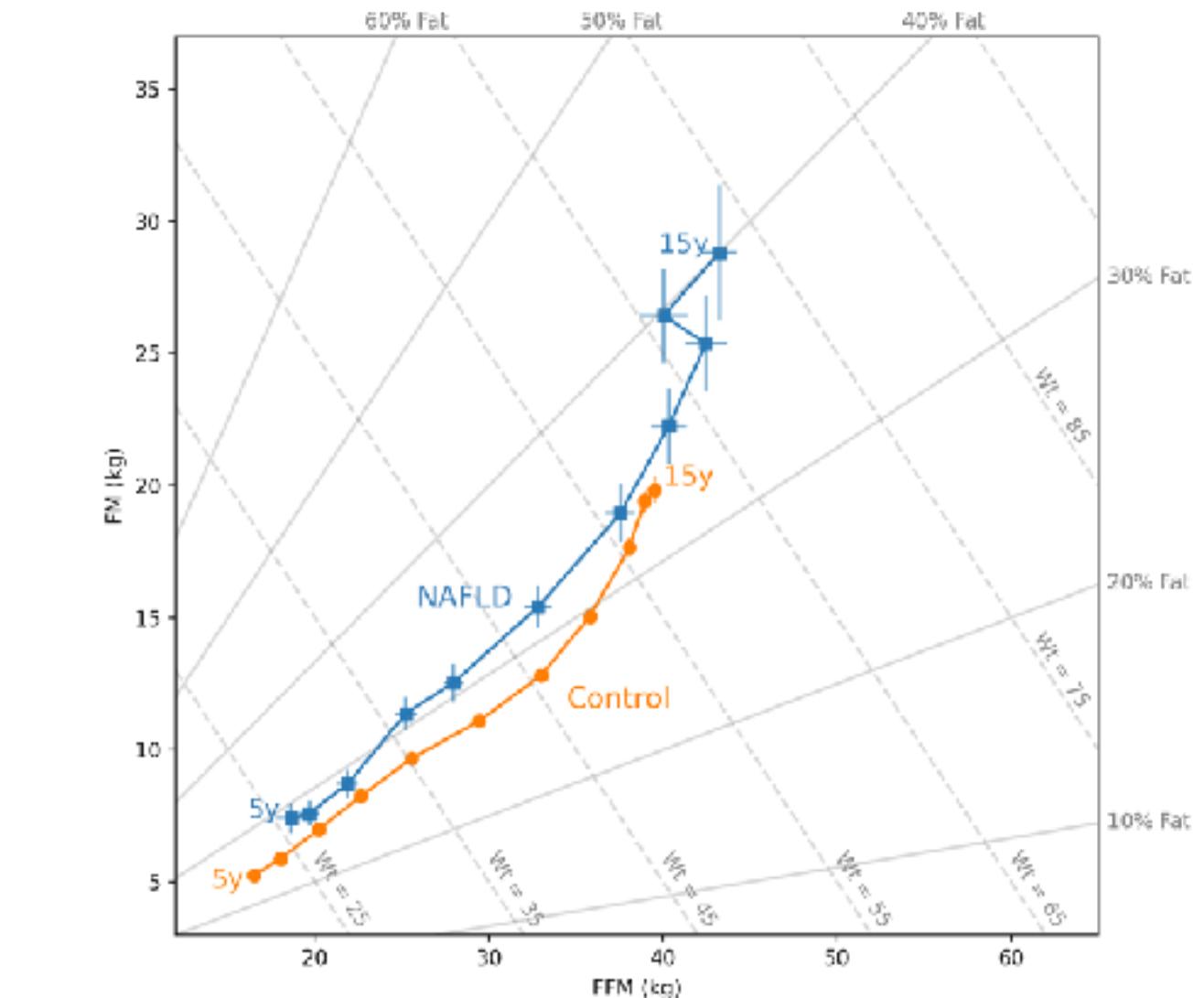
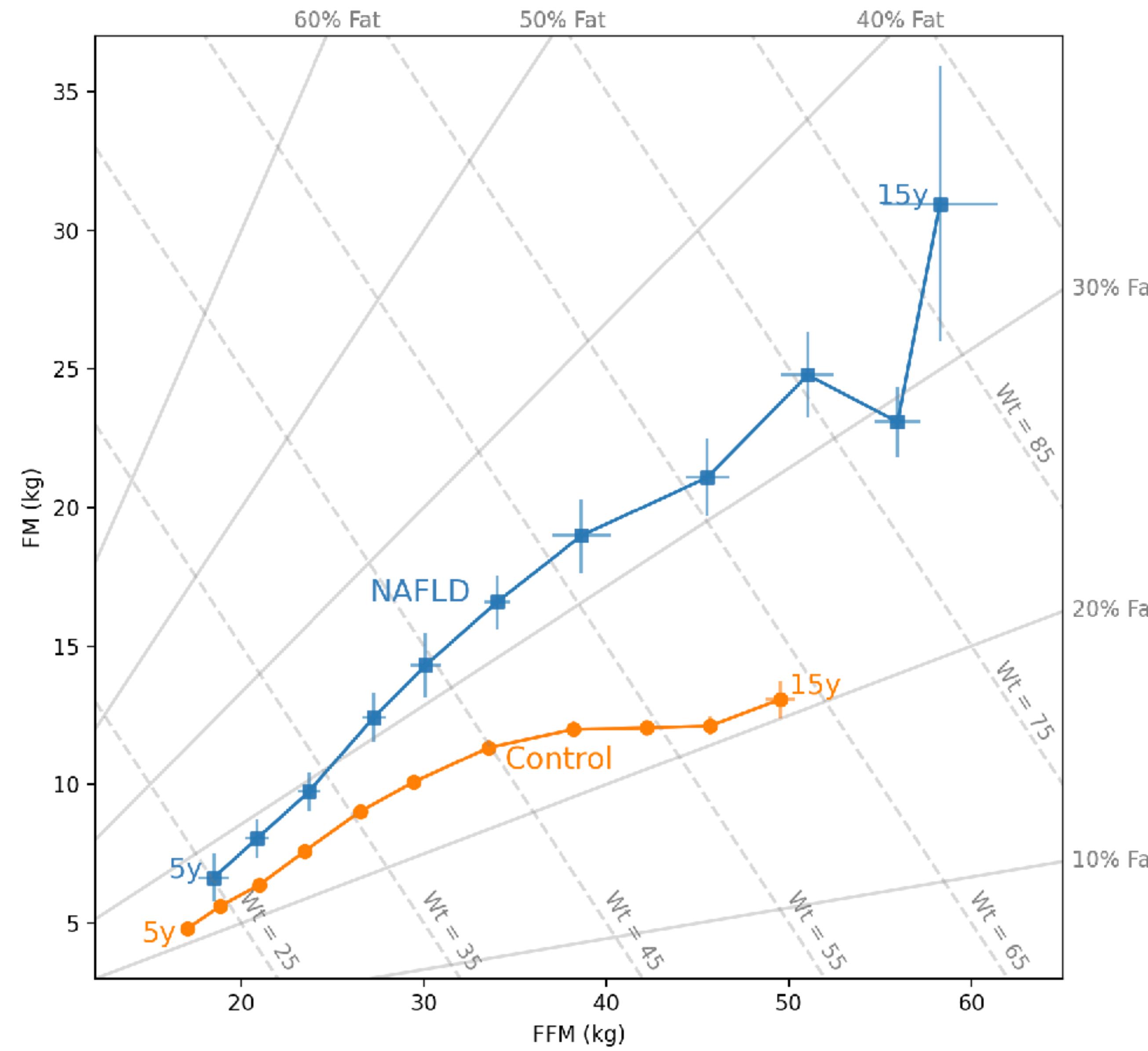
Show gap between ● Black students and ● White students

Mouse over a state to explore data by school district

Average share of teachers with more than two years of experience

EXPAND SCALE ON SORT BY GAP OFF





EL CURSO

Objetivos

1. Entender los conceptos fundamentales dentro del campo de visualización de información
2. Aprender las técnicas y mejores prácticas para diseñar una visualización de datos
3. Desarrollar un pensamiento crítico frente a los gráficos que se ocupan día a día
4. Crear e implementar visualizaciones de datos en Python
5. Usar la visualización de datos como una forma de comunicar y contar una historia

Proyecto Final

1. Grupos de 3 ó 4 personas.
2. Tres opciones:
 - i. Infografía
 - ii. Notebook explicativo
 - iii. Dashboard
3. Más detalles (y la rúbrica) la próxima semana

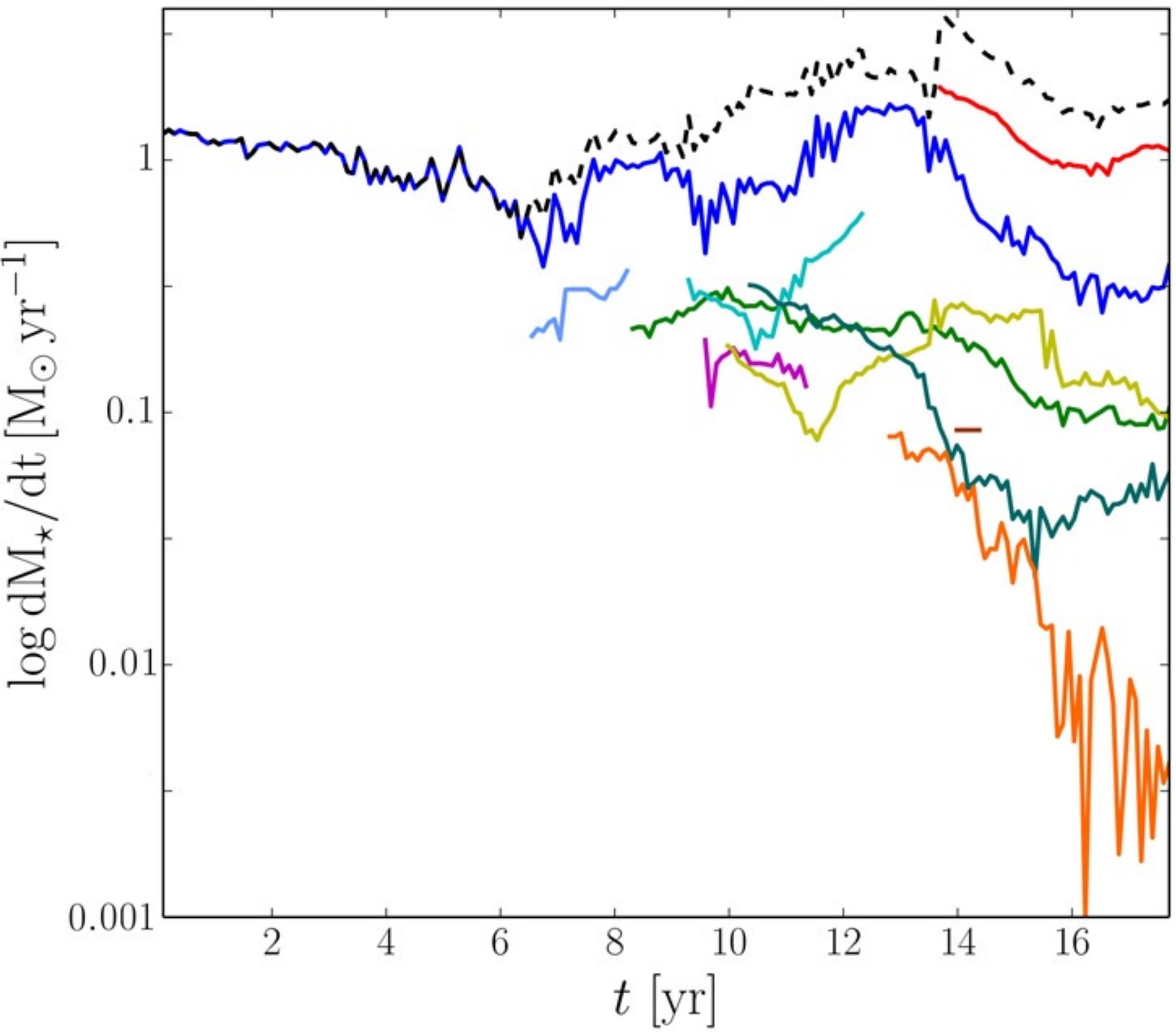
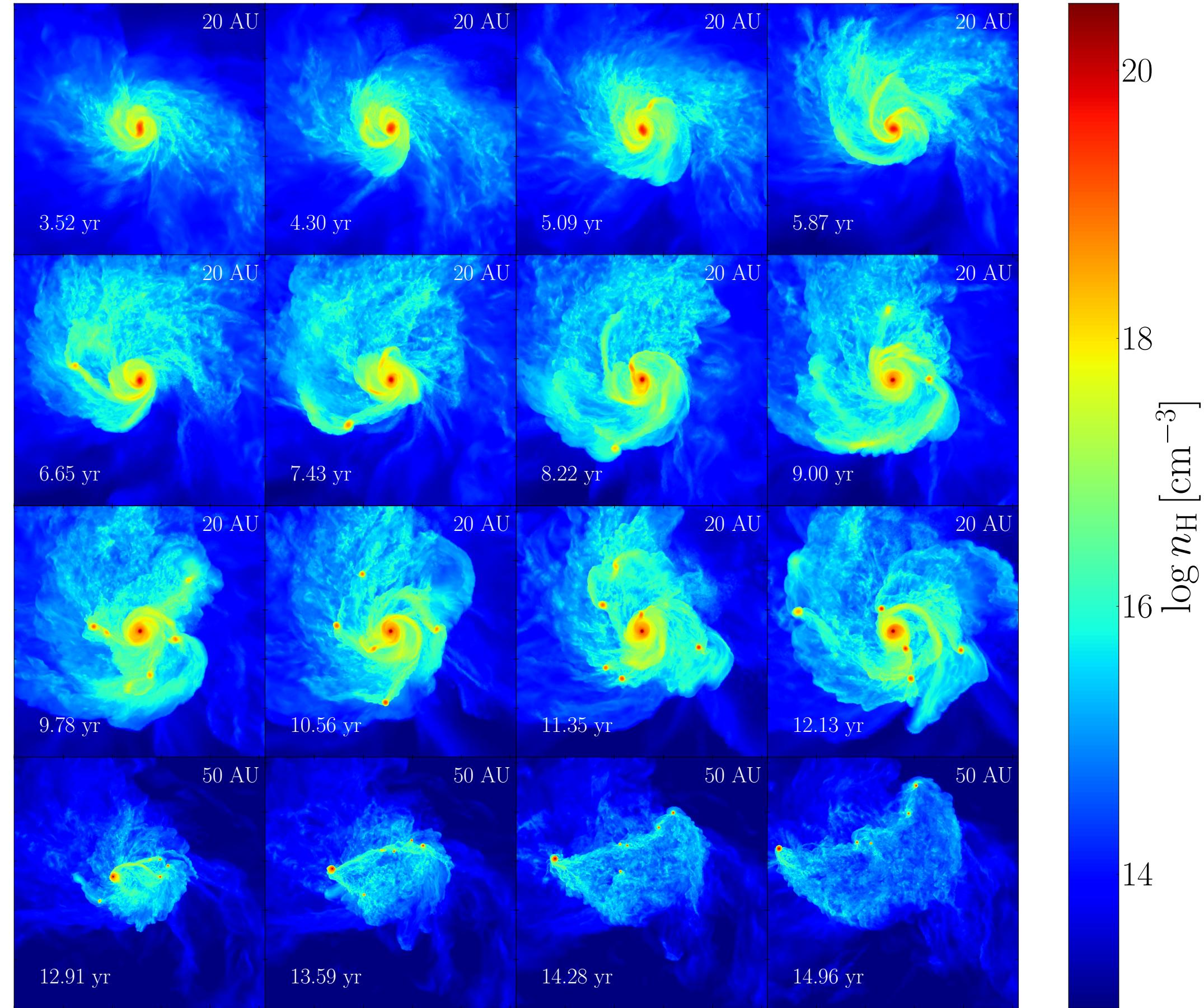
¿DUDAS?

Visualización de datos

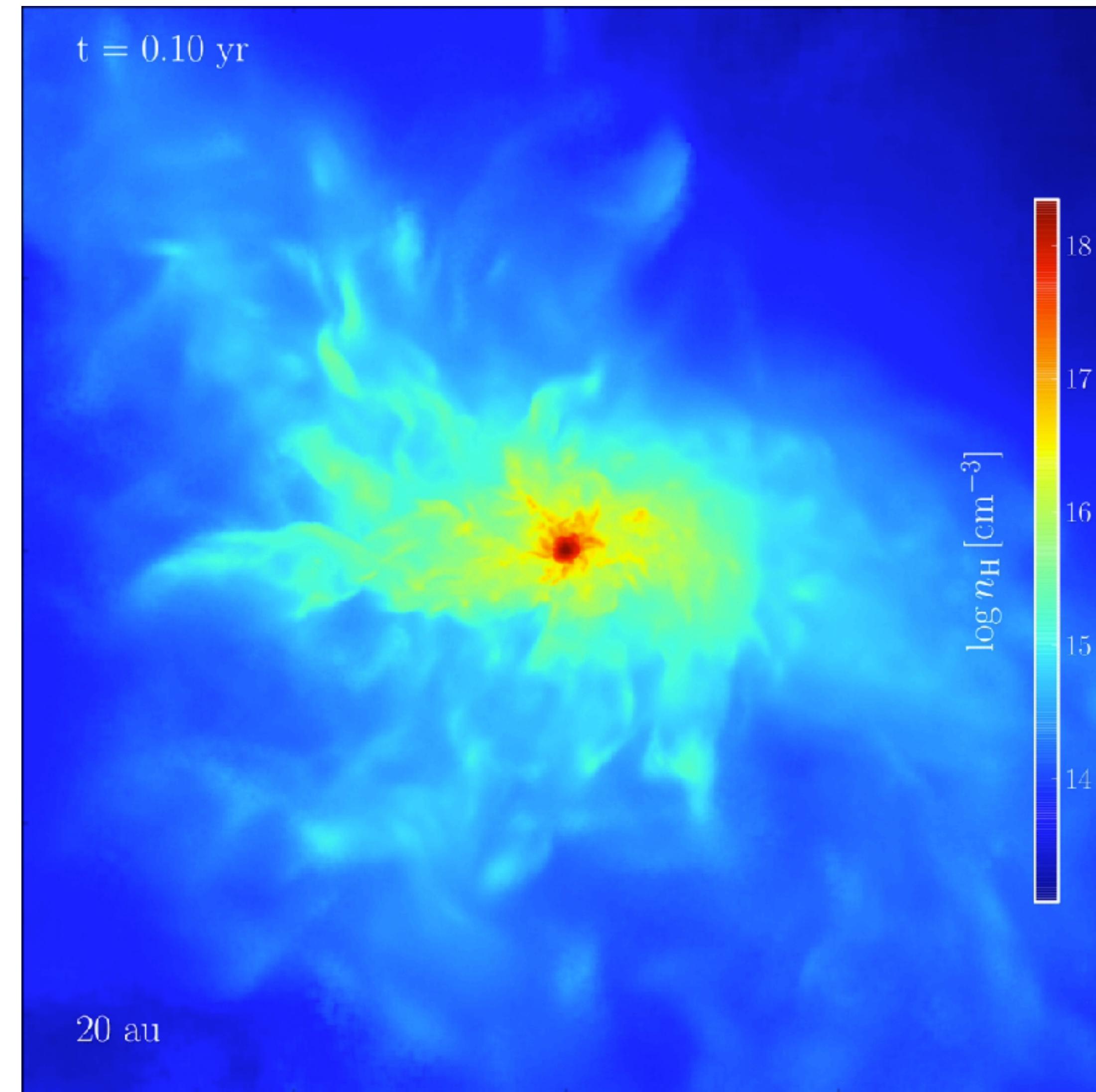
Visualización

1. Formación de imágenes mentales de forma visual
2. El acto o proceso de interpretar en términos visuales o poner en forma visible para transmitir información a través de la representación gráfica de los datos

Transmitir información a través de la representación gráfica de los datos

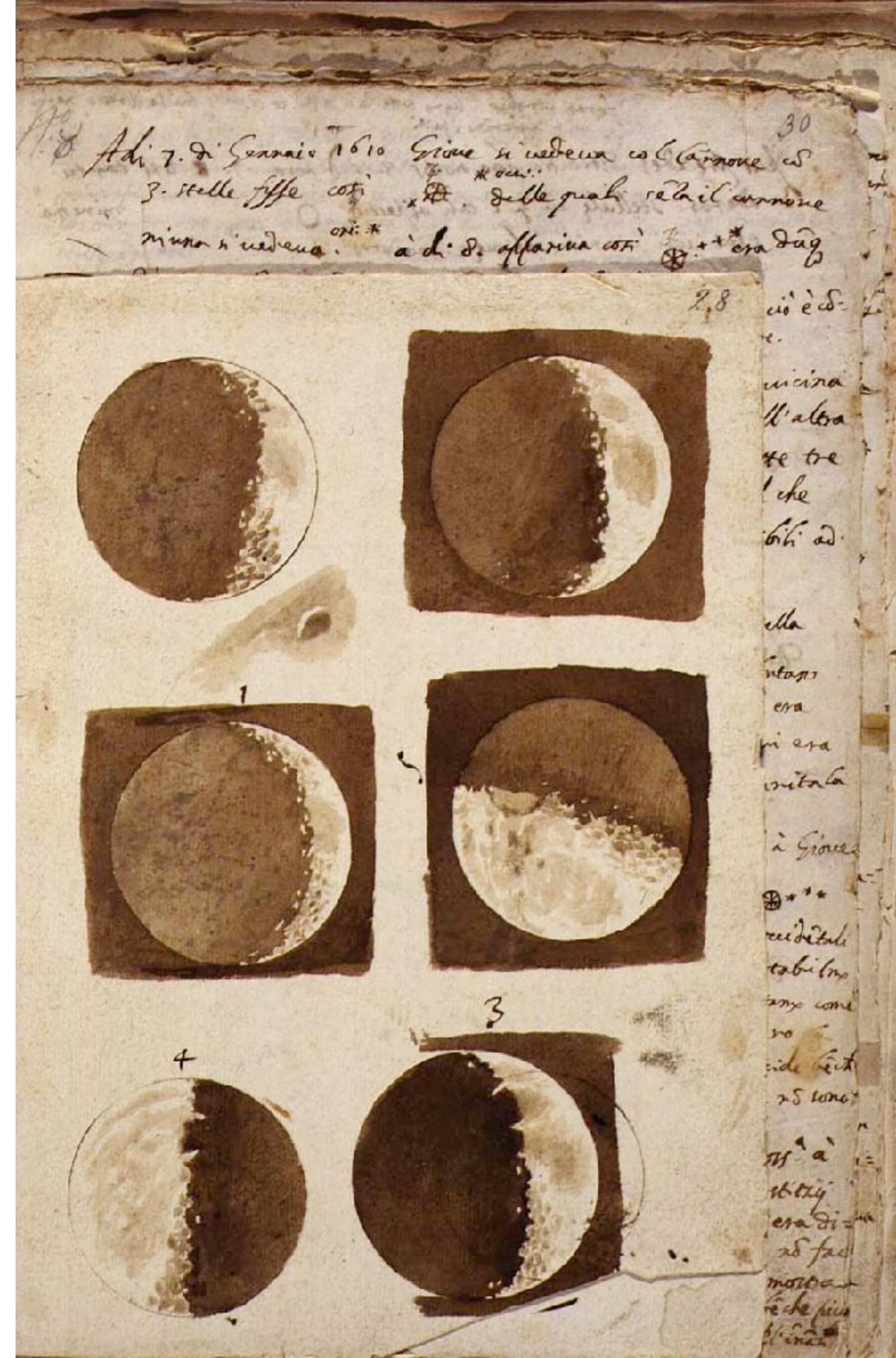


Transmitir información a través de la representación gráfica de los datos

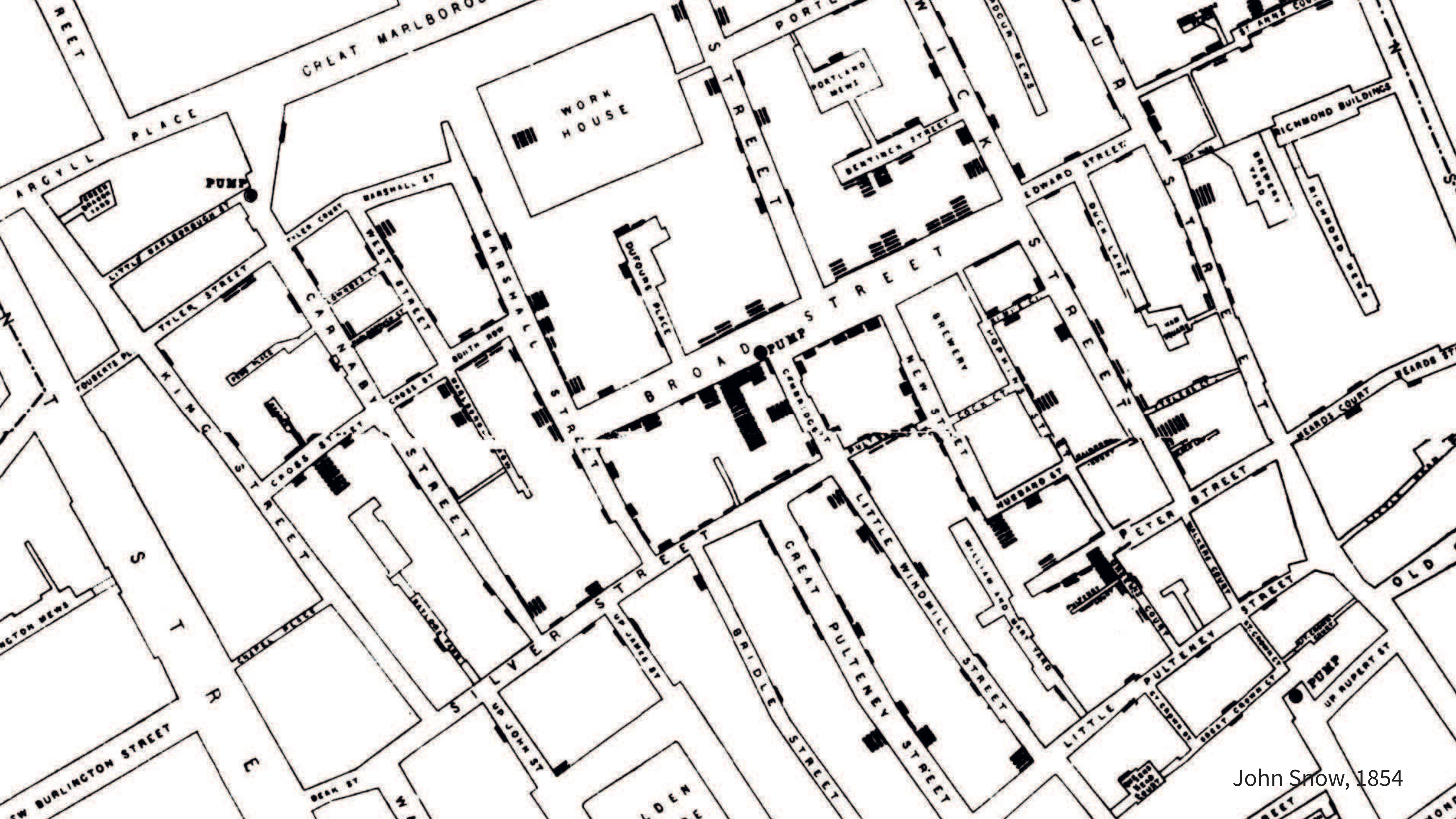


Objetivos de la visualización

- 1. Guardar o grabar información**
- 2. Analizar (explorar) datos**
- 3. Comunicar (explicar) a otr@s**



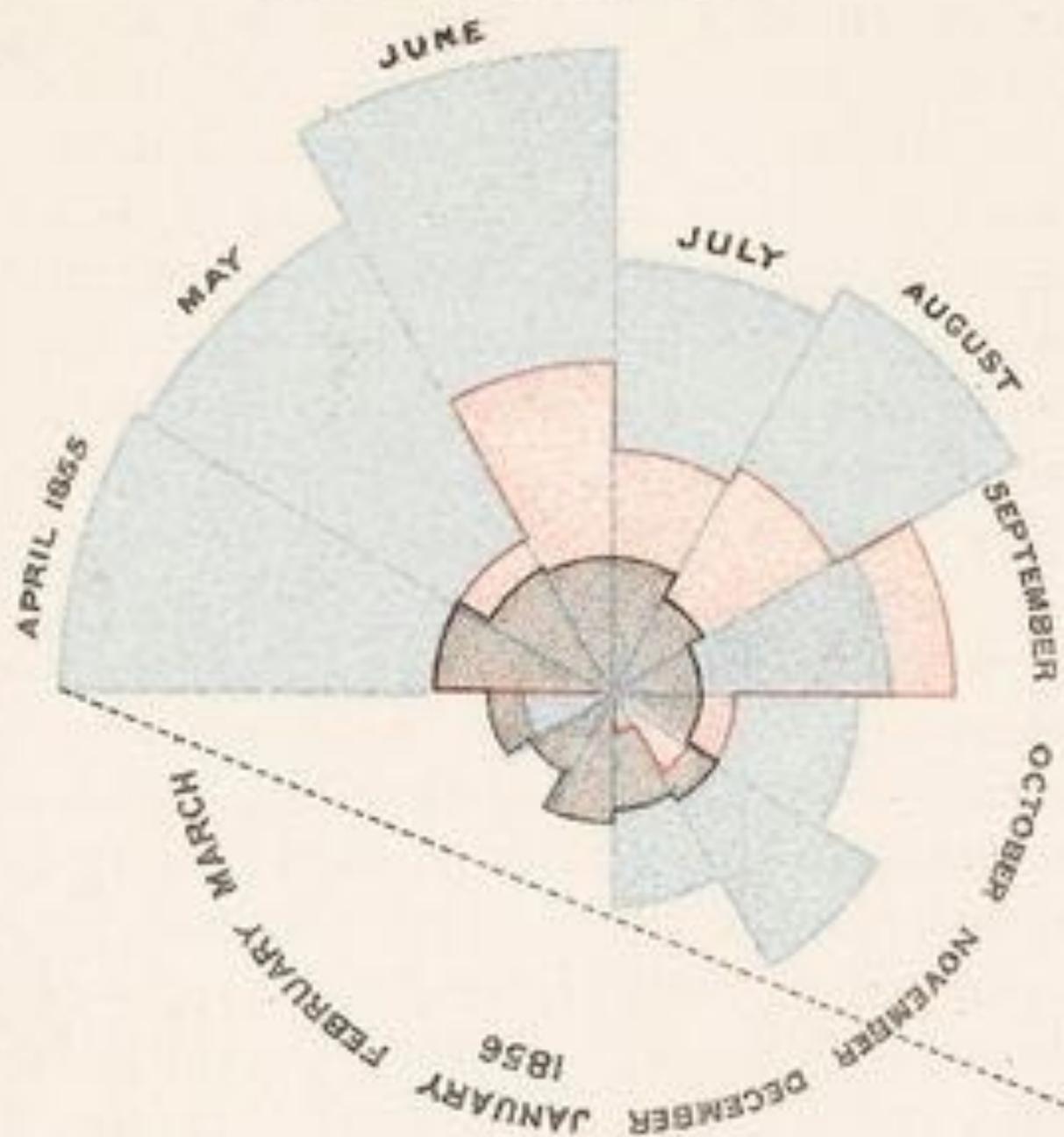
Galileo Galilei, 1610



John Snow, 1854

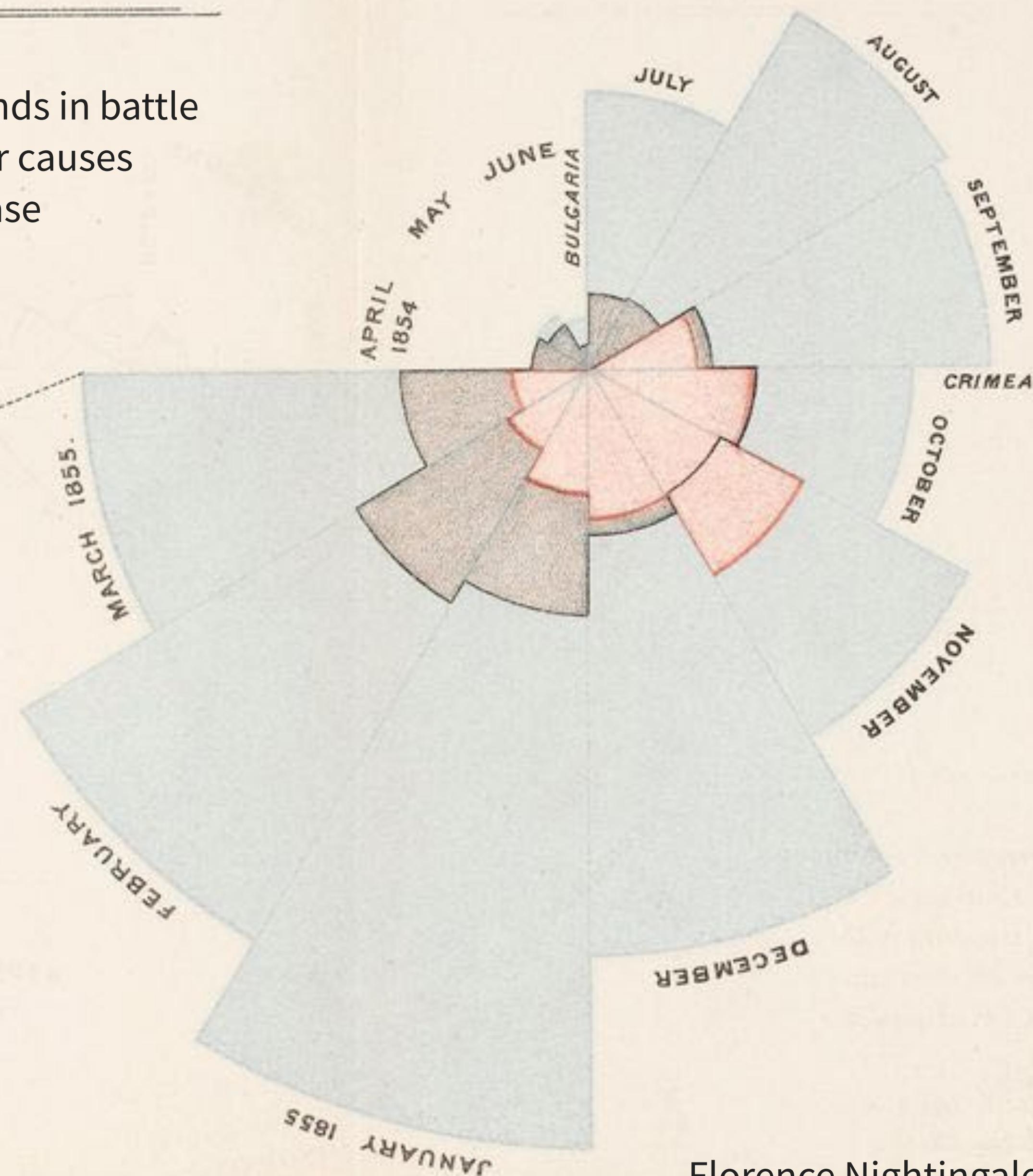
DIAGRAM OF THE CAUSES OF MORTALITY
IN THE ARMY IN THE EAST.

2.
APRIL 1855 TO MARCH 1856.



■ Wounds in battle
 Other causes
 Disease

1.
APRIL 1854 TO MARCH 1855.



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 1855, the blue coincides with the black.

The entire areas may be compared by following the blue, the red & the black lines enclosing them.

Florence Nightingale, 1856

Carte Figurative des pertes successives en hommes de l'Armée Française dans la Campagne de Russie 1812-1813.
Dessinée par M. Minard, Inspecteur Général des Ponts et Chaussées en retraite

Paris, le 20 Novembre 1869

Les nombres d'hommes perdus sont représentés par les largures des zones colorées à raison d'un millimètre pour dix mille hommes; ils sont de plus écrits en trèves des zones. Le rouge désigne les hommes qui ont été en Russie; le noir ceux qui en sortent. — Les renseignements qui ont servi à dessiner la carte ont été puisés dans les ouvrages de M. M. Chiers, de Segur, de Fezenac, de Chambray et le journal médical de Jacob, pharmacien de l'Armée depuis le 28 Octobre.

Pour mieux faire juger à l'œil la diminution de l'armée, j'ai supposé que les corps du Prince Sébastien et du Maréchal Davout, qui avaient été détachés sur Minsk et Mohilow et qui rejoignirent Orosba en Wilcisk, avaient toujours marché avec l'armée.

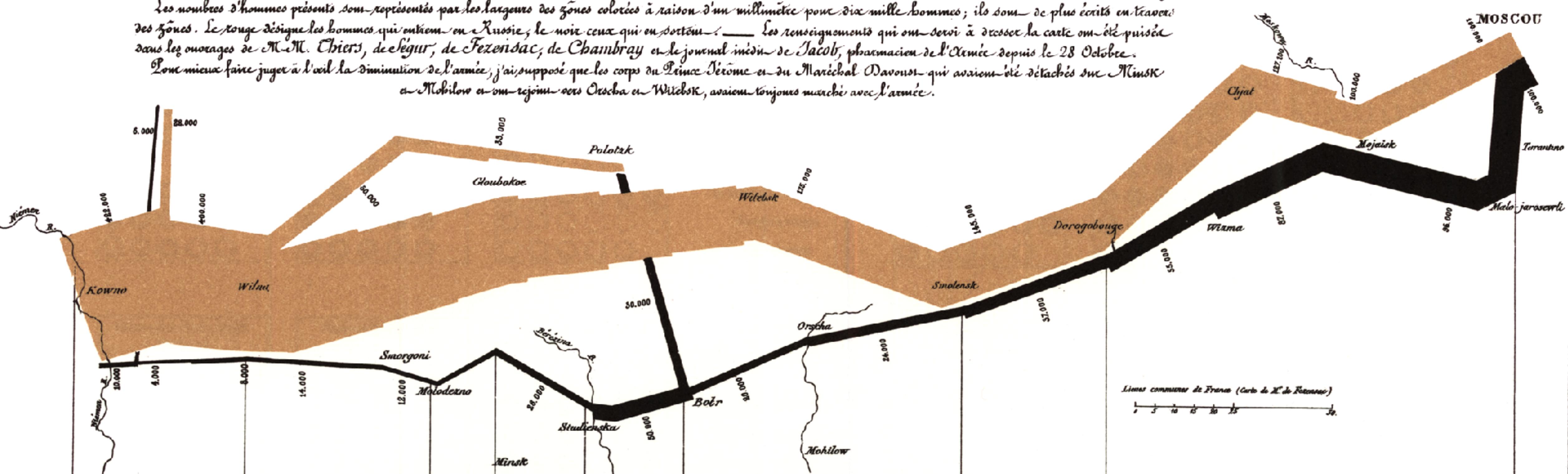
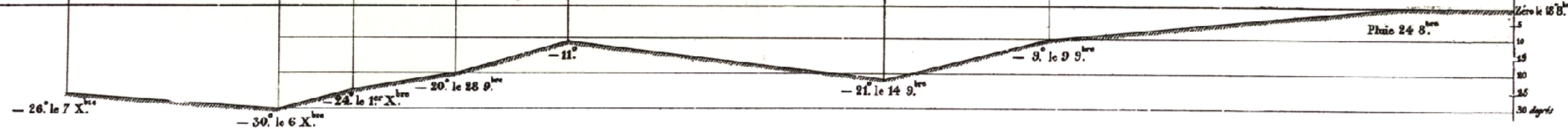


TABLEAU GRAPHIQUE de la température en degrés du thermomètre de Réaumur au dessous de zéro.

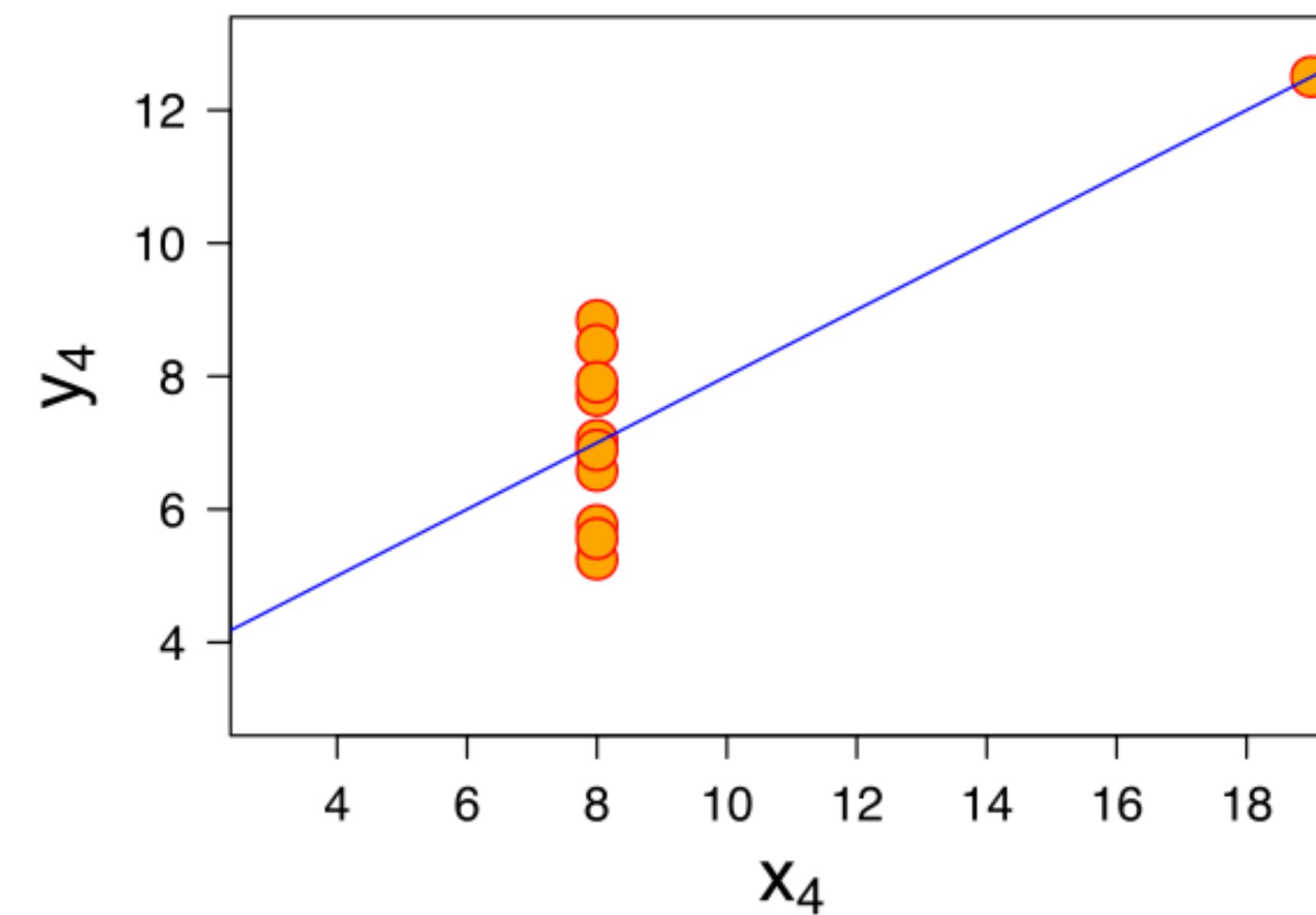
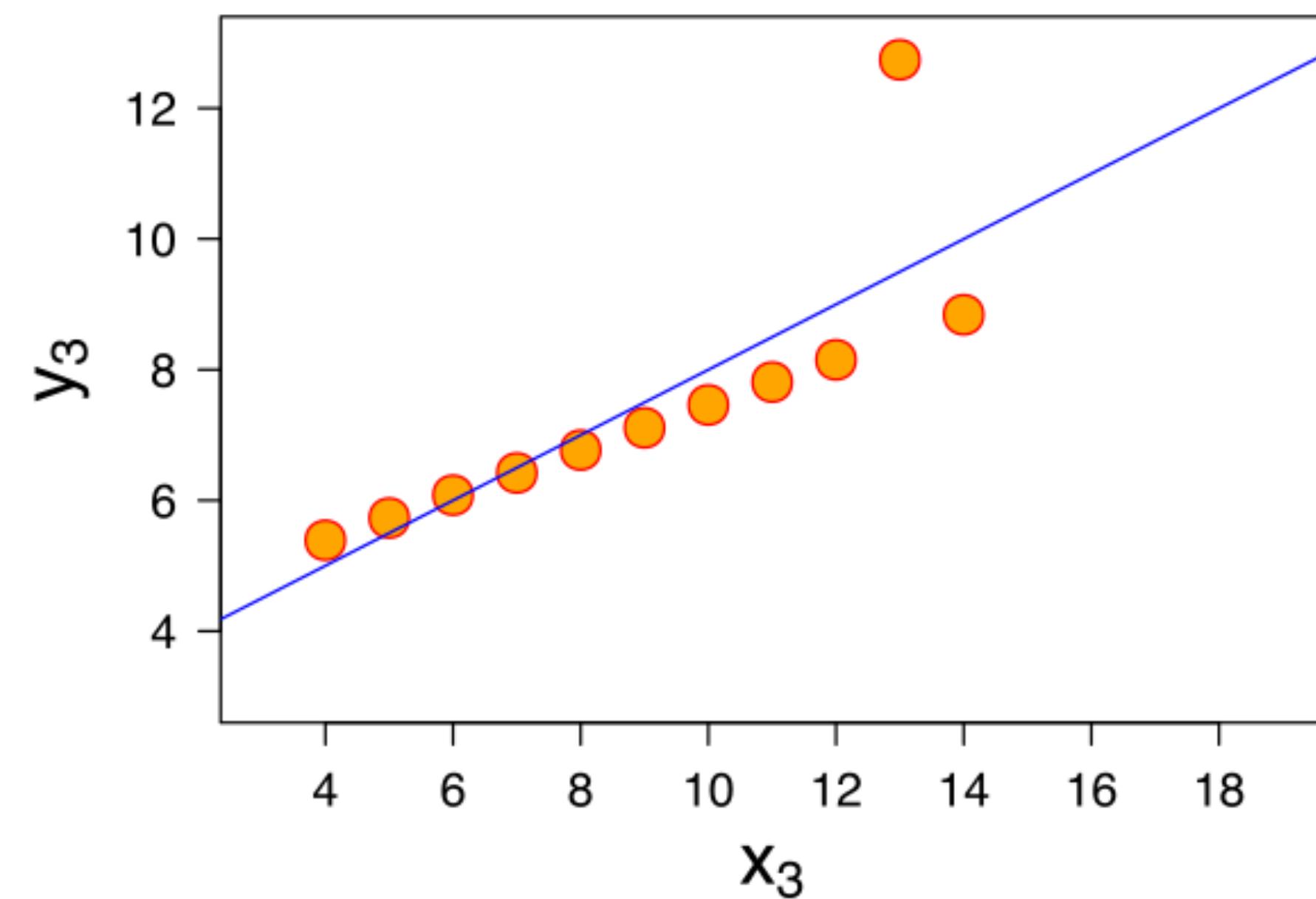
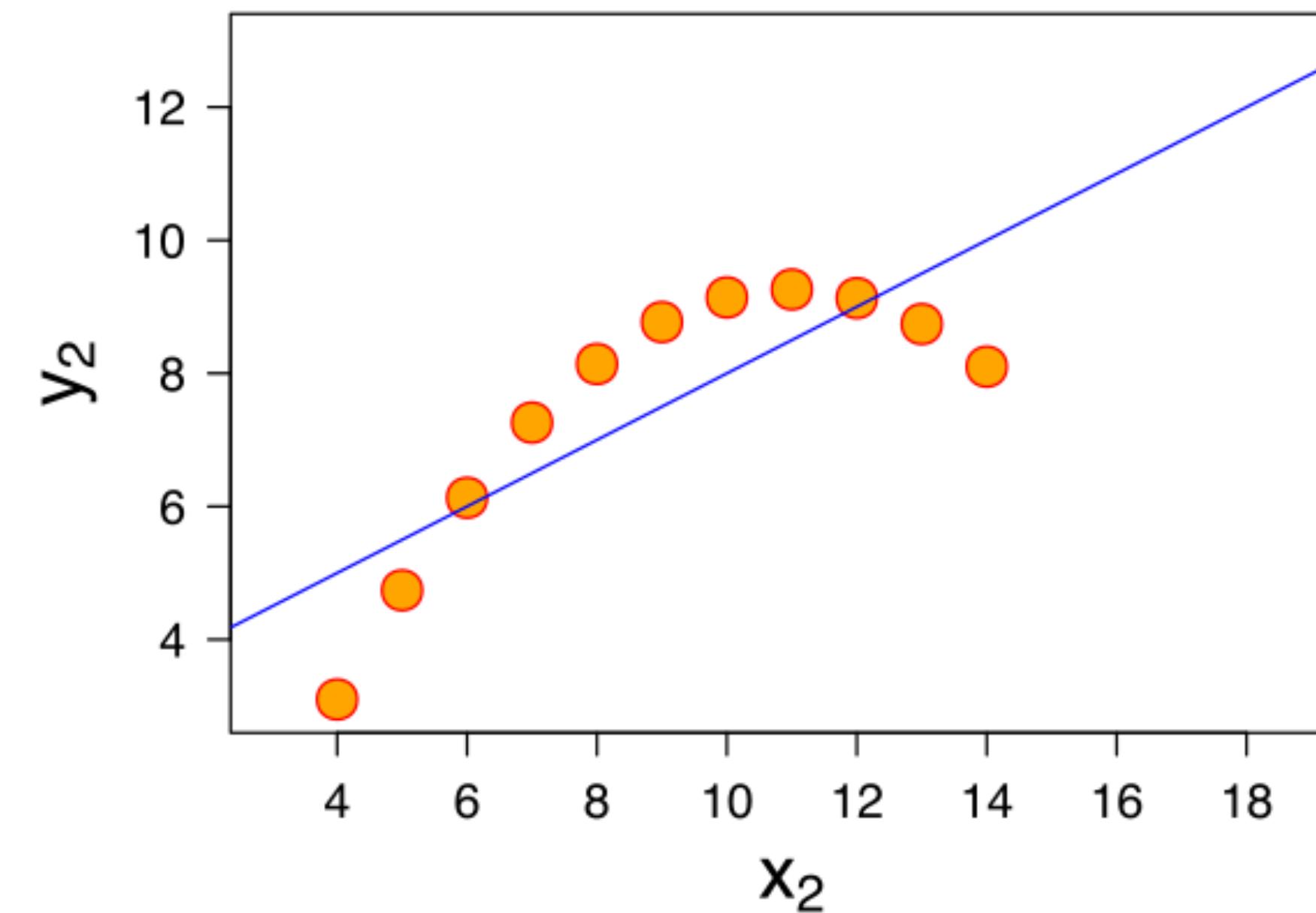
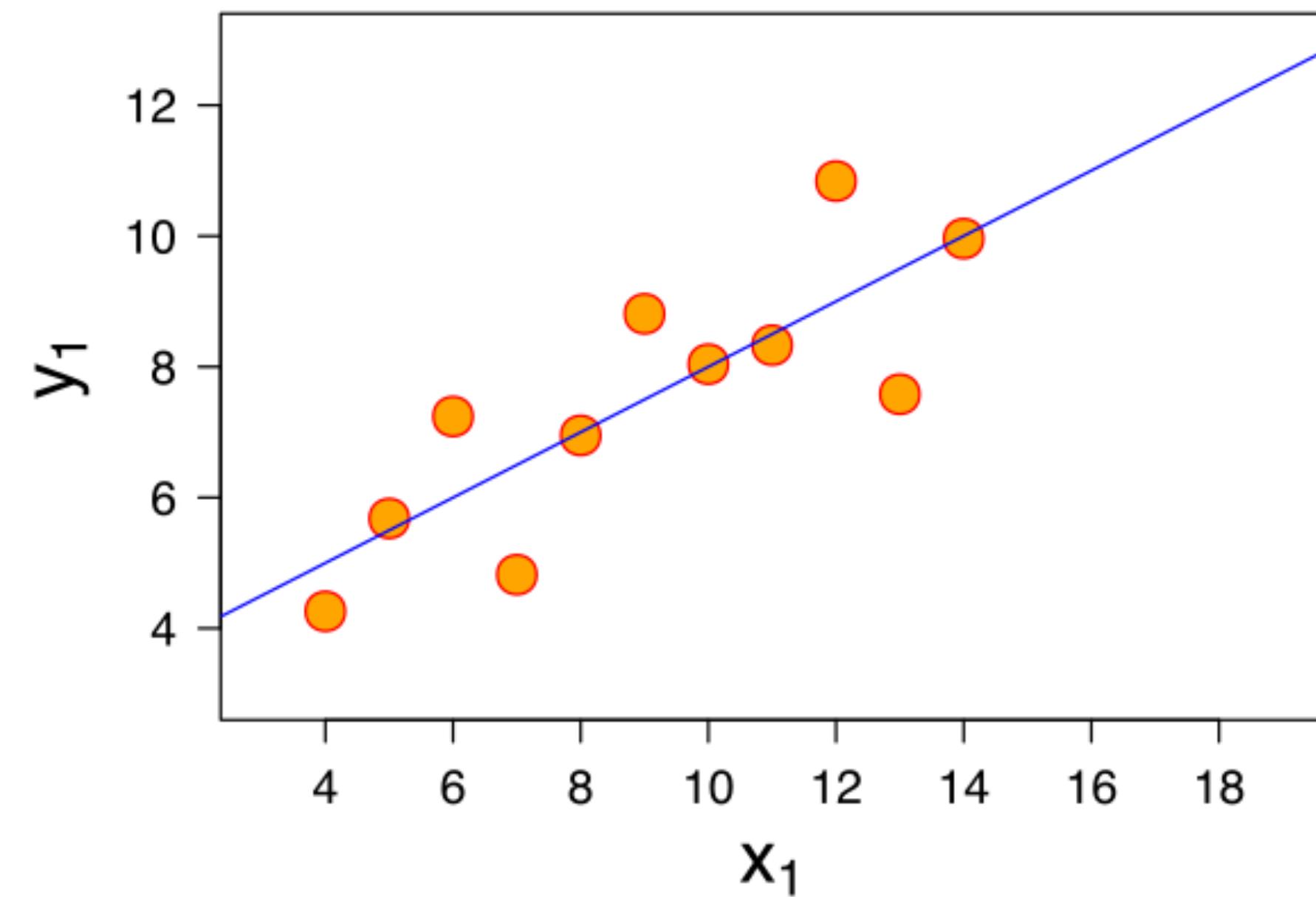
Les cosaques passent au galop
le Niemen gelé.



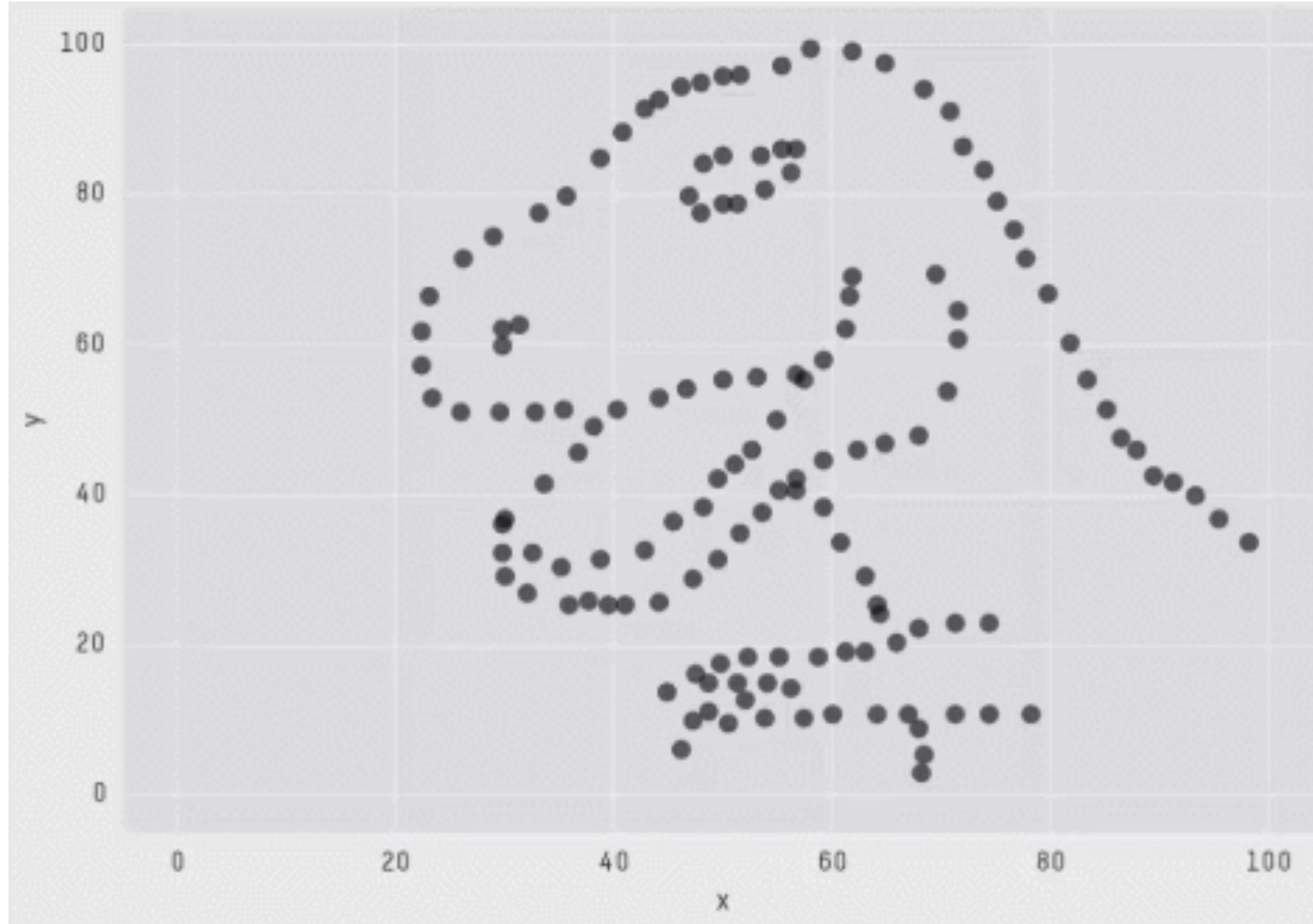
¿Por qué visualizar los datos?

	Set A		Set B		Set C		Set D	
	X	Y	X	Y	X	Y	X	Y
0	10	8.04	10	9.14	10	7.46	8	6.58
1	8	6.95	8	8.14	8	6.77	8	5.76
2	13	7.58	13	8.74	13	12.74	8	7.71
3	9	8.81	9	8.77	9	7.11	8	8.84
4	11	8.33	11	9.26	11	7.81	8	8.47
5	14	9.96	14	8.10	14	8.84	8	7.04
6	6	7.24	6	6.13	6	6.08	8	5.25
7	4	4.26	4	3.10	4	5.39	19	12.50
8	12	10.84	12	9.13	12	8.15	8	5.56
9	7	4.82	7	7.26	7	6.42	8	7.91
10	5	5.68	5	4.74	5	5.73	8	6.89
mean	9.00	7.50	9.00	7.50	9.00	7.50	9.00	7.50
std	3.32	2.03	3.32	2.03	3.32	2.03	3.32	2.03
corr	0.82		0.82		0.82		0.82	
lin. reg.	$y = 3.00 + 0.500x$		$y = 3.00 + 0.500x$		$y = 3.00 + 0.500x$		$y = 3.00 + 0.500x$	

Anscombe, 1973



Anscombe, 1973



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

Diseño

Actividad

Crea al menos 3 formas de visualizar estas dos cantidades:

42

23



42
23
•
•
→ 23
42

Fijación de diseño

Adherencia ciega a un conjunto de ideas o conceptos

1. writing, number notation

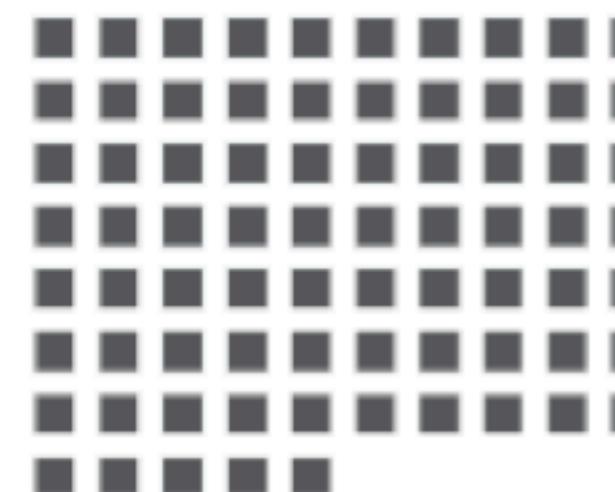
75, 37

a

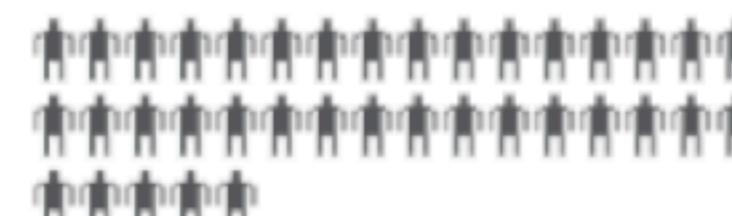
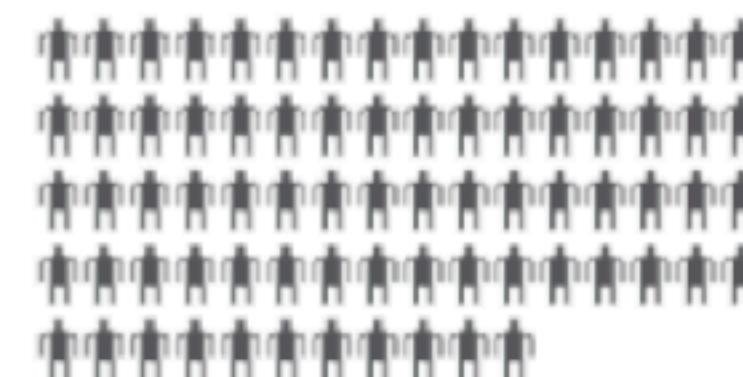
b



2. squares



3. repeated icon



4. hundreds, tens, units, decimals...

represented by squares



5. bars



a



b



6. line graph

28. gray tones



29. color scale



30.

geometric proportions

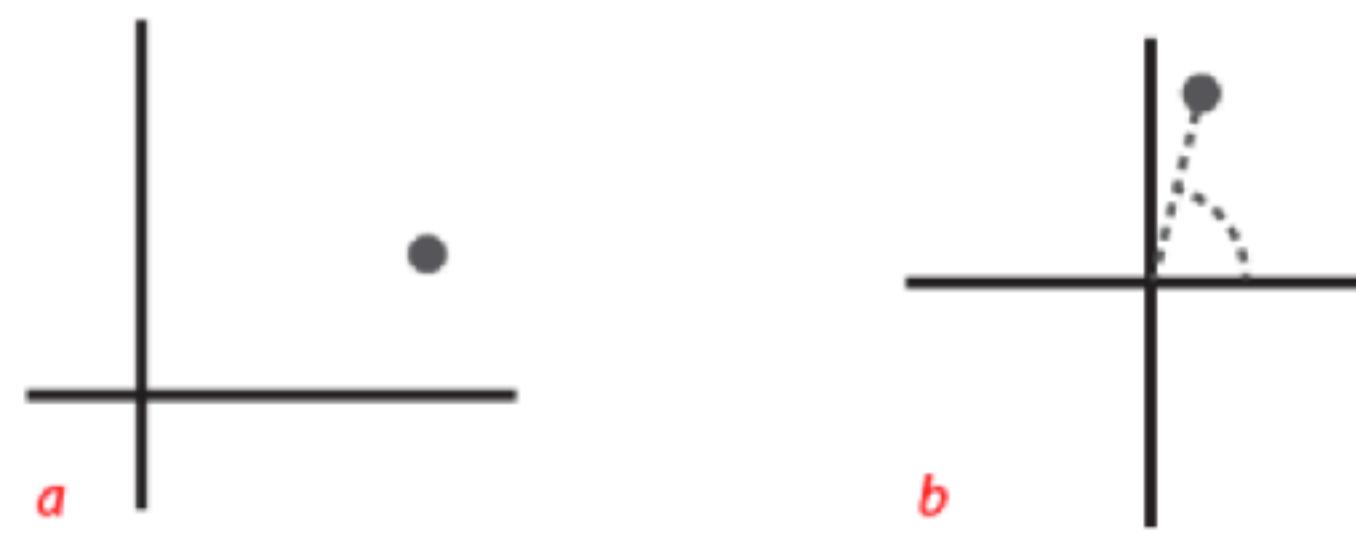


31. horizontal/vertical proportions



Useful if the first value represents a horizontal distance, and the second value a vertical one.

32. coordinates



a cartesian and *b* polar

34. geographic coordinates

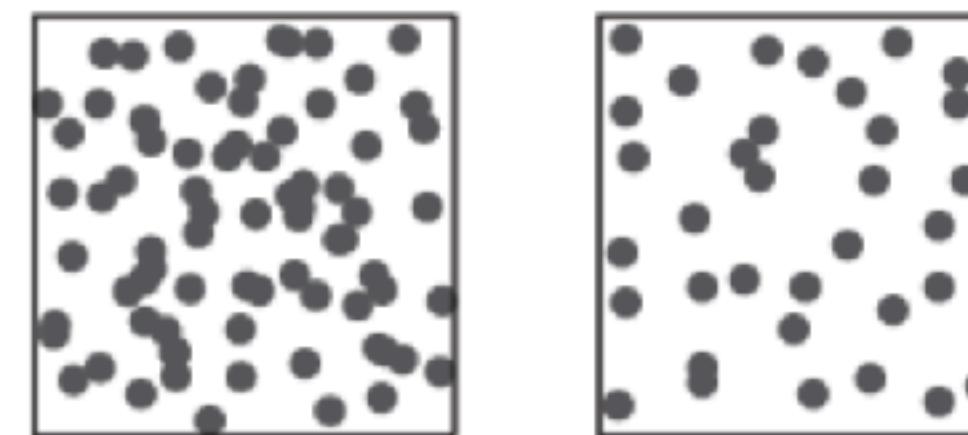


a longitude, latitude *b* latitude, longitude

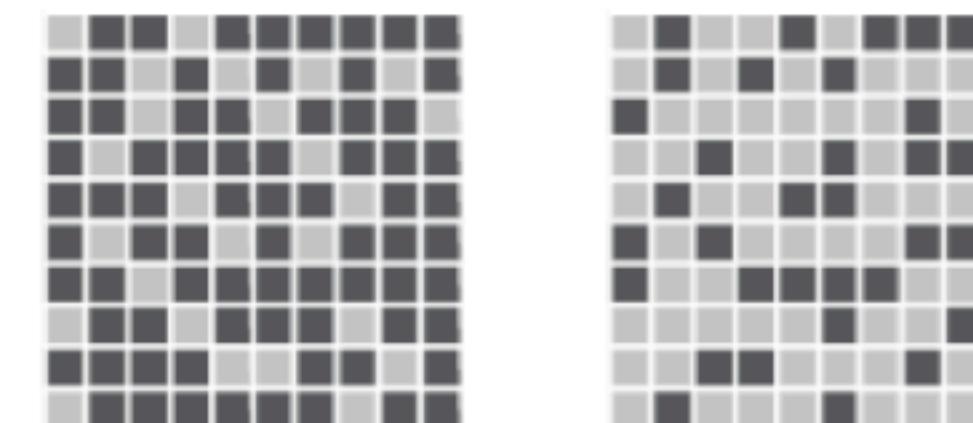
35. values associated to countries



36. density

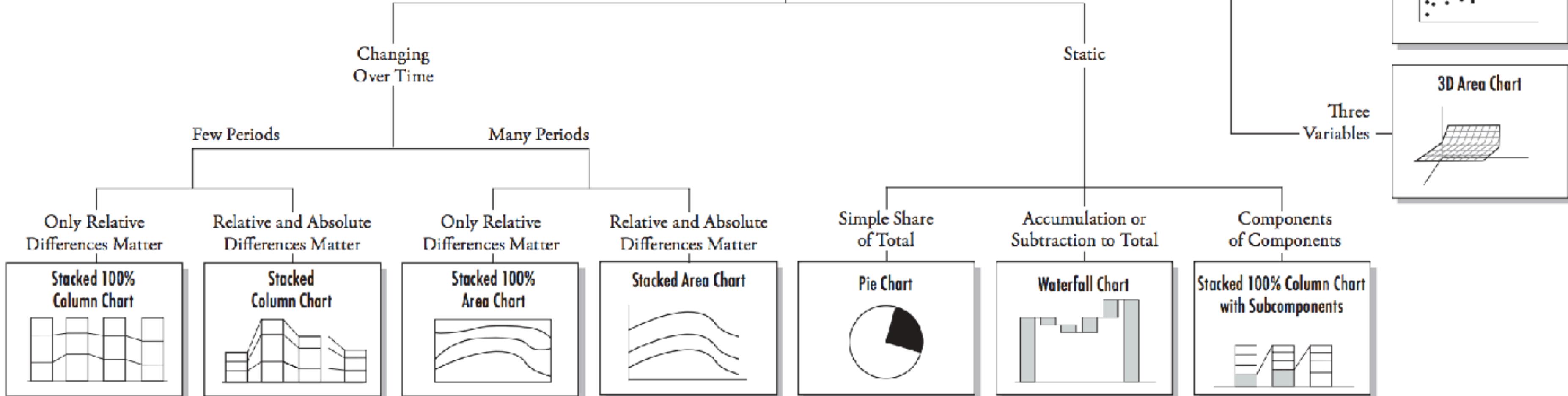
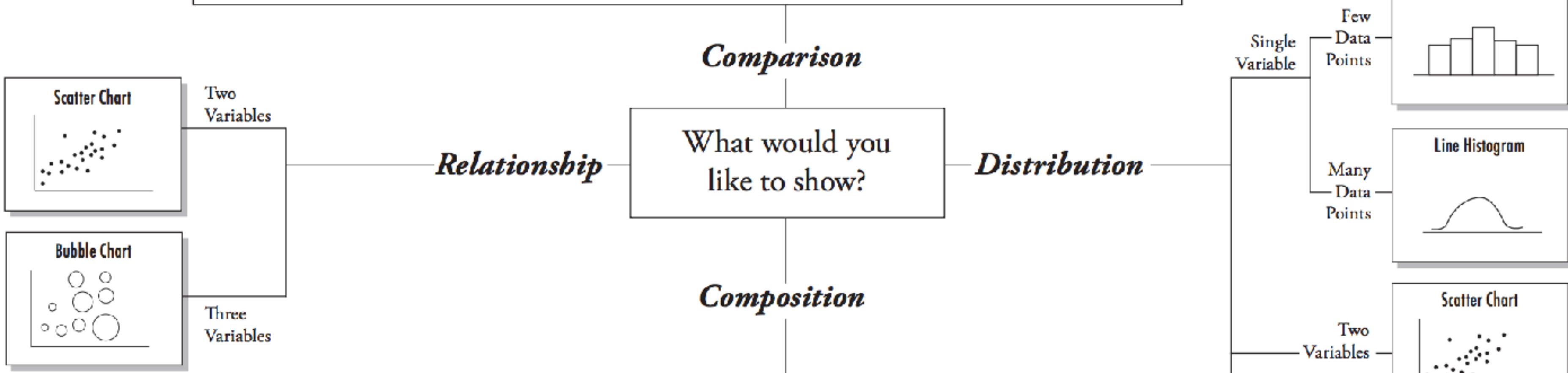
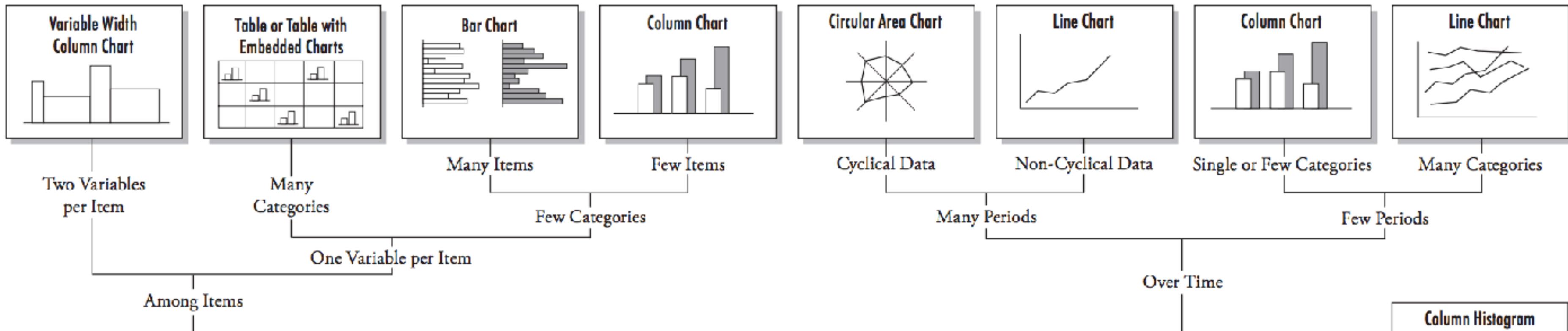


37. percentages / density



Combination of 12 and 36.

Tipos de gráficos



Visual vocabulary

Designing with data

There are so many ways to visualise data - how do we know which one to pick? Use the categories across the top to decide which data relationship is most important in your story, then look at the different types of chart within the category to form some initial ideas about what might work best. This list is not meant to be exhaustive, nor a wizard, but is a useful starting point for making informative and meaningful data visualisations.

© FT graphic: Alan Smith; Data: Campbell, Ian, Boff, Ira, Bacon, Graham, Burdett, Billy, Deneberg, Fawcett, David, Hiltz, James, Gaha, Implied by the Financial Times, licensed by Ian Schlesinger and Kavita Bhambhani.



ft.com/vocabulary

Deviation

Emphasise variations (+/-) from a fixed reference point. Typically the reference point is zero, but it can be a target or an average. Can also be used to show outliers (positive/negative).

Example FT uses:
Trade surplus/deficit, climate change

Correlation

Show the relationship between two or more variables. Be mindful that unless you tell them otherwise, many readers will assume the relationships you show them to be causal (i.e. one causes the other).

Example FT uses:
Wealth distribution, income tables, constituency election results

Ranking

Use when an item's position in an ordered list is more important than its absolute or relative value. Don't be afraid to highlight the points of interest.

Example FT uses:
Income distribution, population, age/decile distribution, revealing inequality

Distribution

Show where values fall in a dataset and how often they occur. The shape (or 'skew') of a distribution can be a revealing way of highlighting the lack of uniformity or equality in the data.

Example FT uses:
Income distribution, population, age/decile distribution, revealing inequality

Change over Time

Give time comparisons. These can be short (month-to-month) or long (decades). Use this to see how different countries have changed over time. Consider how the context of the chart and the current time period is important to provide context for the data.

Example FT uses:
Share price movements, economic time series, sectoral changes in a market

Magnitude

Show how big something is. These can be relative (just being able to see the difference), absolute (to see the size of something). Use this to show a year-over-year, month-over-month, dollars or people's rather than a calculated rate or per cent.

Example FT uses:
Financial budget, company structures, national election results

Part-to-whole

Aspire from isolating just one aspect of movement between two or more states or conditions. These might be logical sequences or geographical locations.

Example FT uses:
Population density, refugee flows, location of disaster risk, impact, catchment areas, variation in election results

Spatial

Show the whereabouts and intensity of movement between two or more states or conditions. These might be logical sequences or geographical locations.

Example FT uses:
Movement of funds, trade, migrants, location information, relationships, QSRs

Flow

Show the whereabouts and intensity of movement between two or more states or conditions. These might be logical sequences or geographical locations.

Example FT uses:
Population density, refugee flows, location of disaster risk, impact, catchment areas, variation in election results

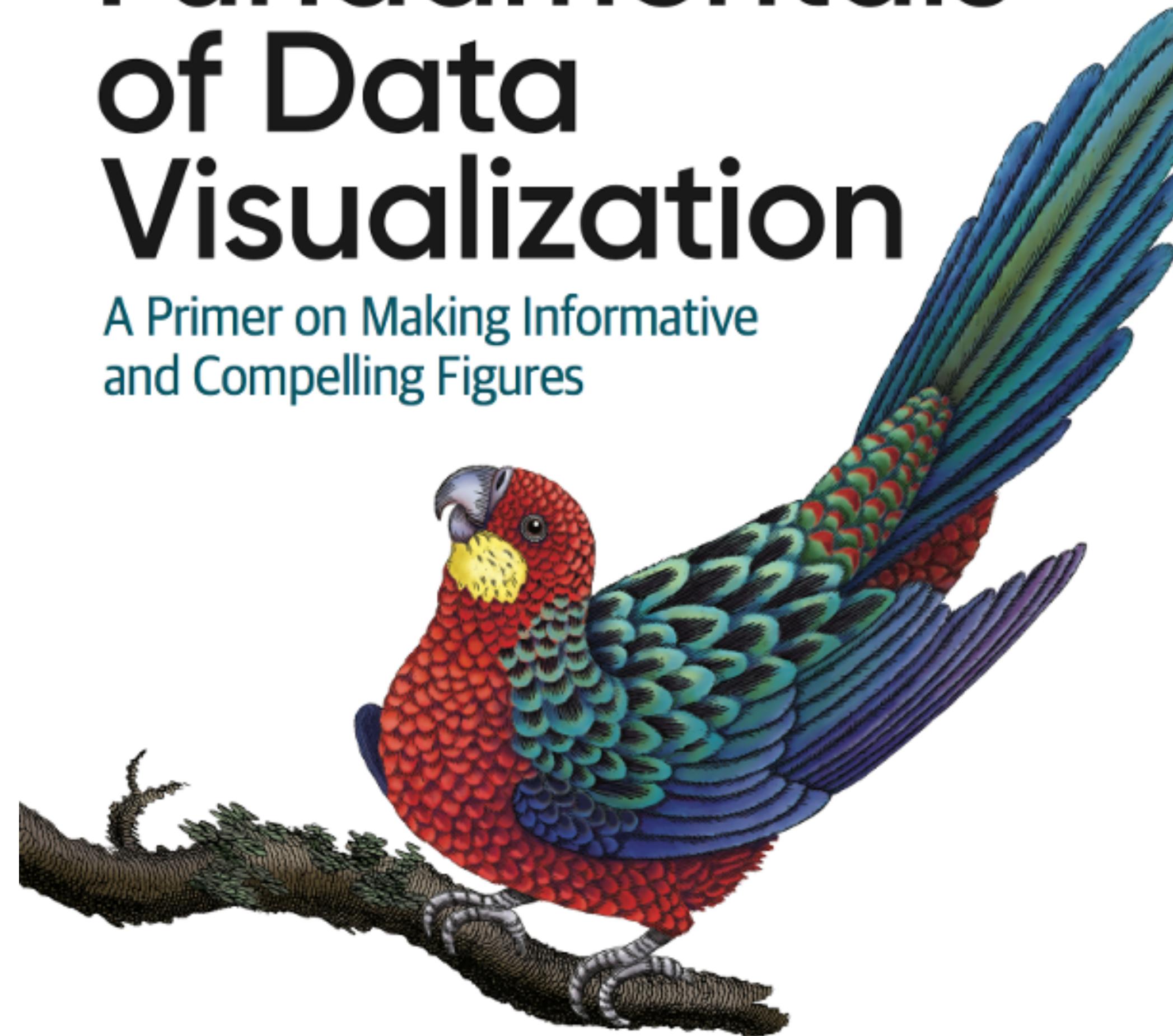


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O'REILLY®

Fundamentals of Data Visualization

A Primer on Making Informative
and Compelling Figures



Claus O. Wilke

<https://clauswilke.com/dataviz/>

Principios de diseño

Edward Tufte - Principios de diseño

1. Integridad gráfica
2. El factor mentira
3. Maximiza el radio datos/tinta
4. Evita basura gráfica

OBAMACARE ENROLLMENT

7,066,000

6,000,000

AS OF
MARCH 27

MARCH 31
GOAL

SOURCE: HHS



channel

mediamatters.org

IE IN SECOND PLACE WITH \$26.5 MIL, WHILE "MUPP DOW FUT 16,325.00

JOB LOSS BY QUARTER



FOX
NEWS
.COM

SOURCE: BLS

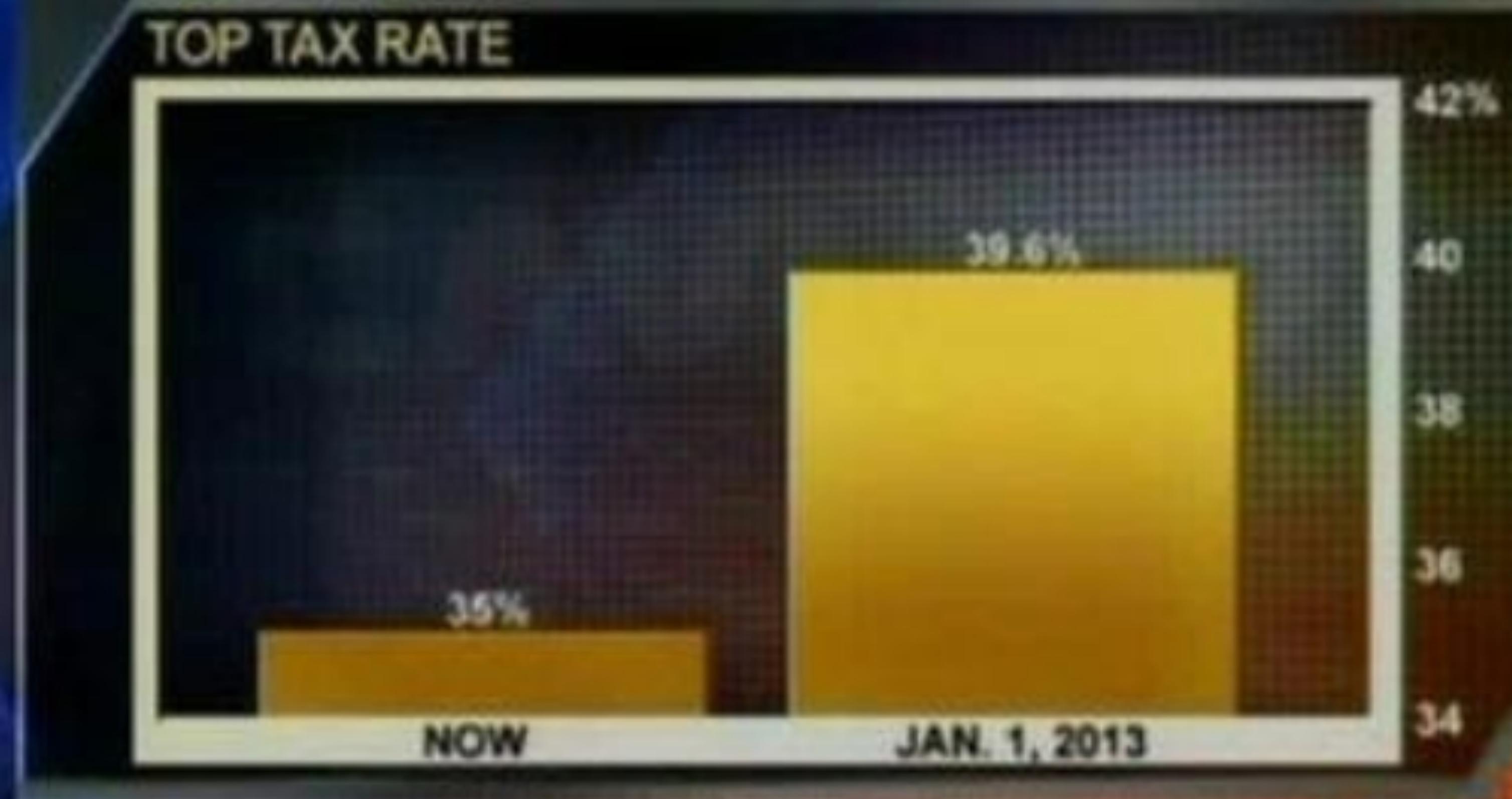
AMERICA'S
NEWSROOM

N FAIRFAX, VA... BYRD WAS ADMITTED TO THE HOSPITAL

S&P 3.08

IF BUSH TAX CUTS EXPIRE

TOP TAX RATE



8:01 p ET

FOX
BUSINESS

TOP STORIES

TECHNOLOGY

CONSUMER

WITH THE JUSTICE DEPARTMENT AND ACQUIRES FULL T

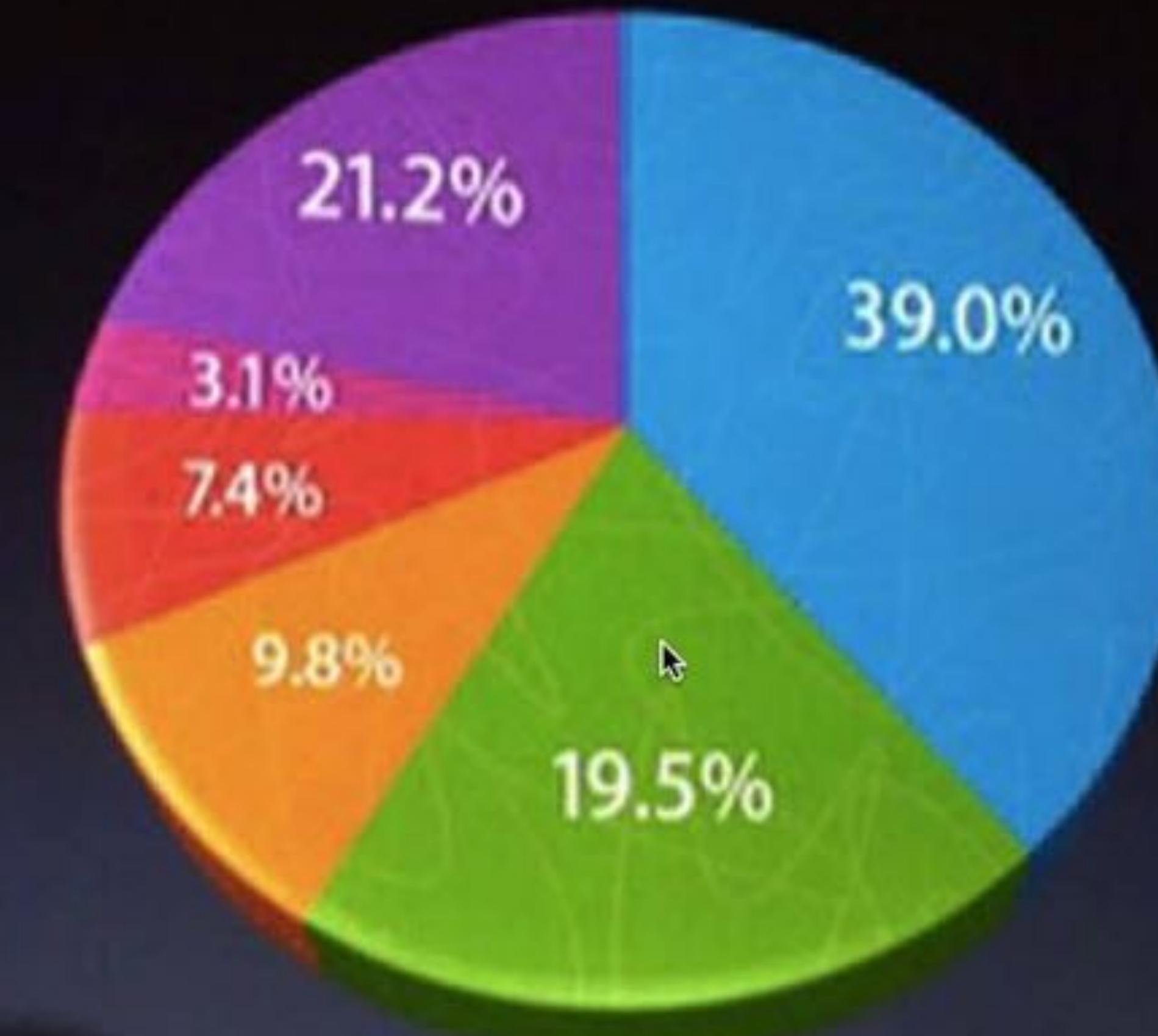
DOW 13008.68 ▲ 64.33

S&P 1379.32 ▲ 5.98

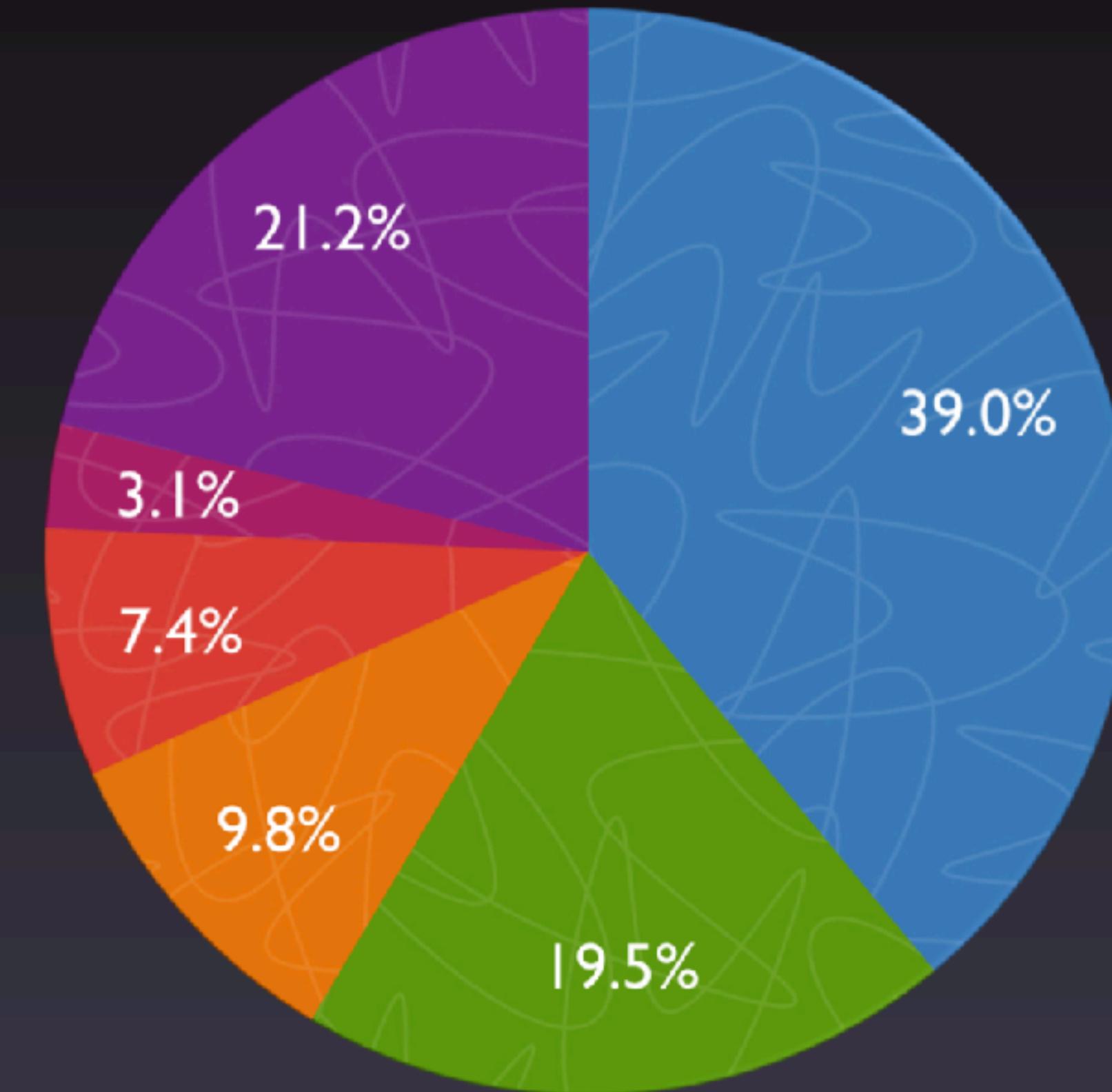
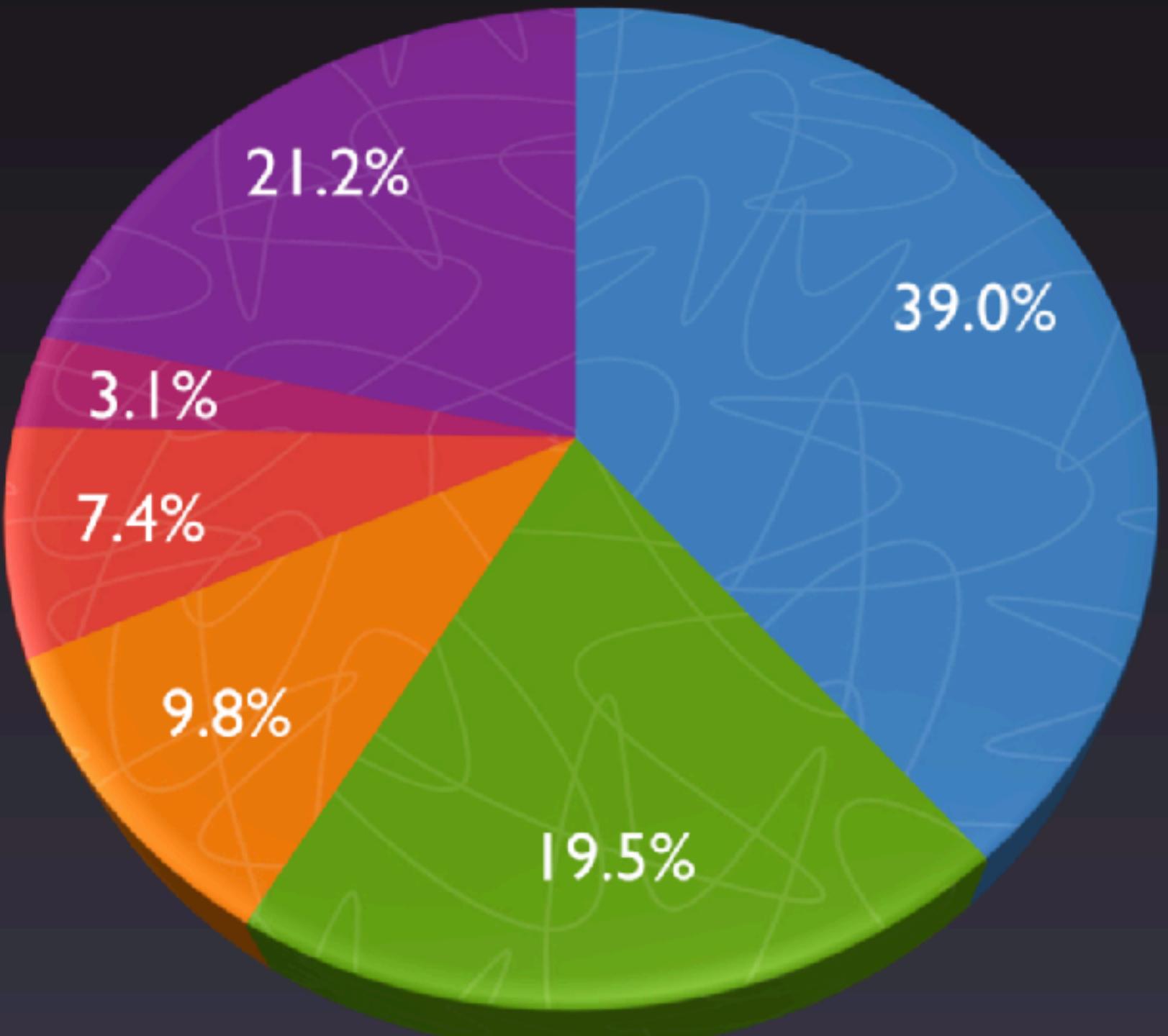
NASDAQ 2939.52 ▲ 6.32

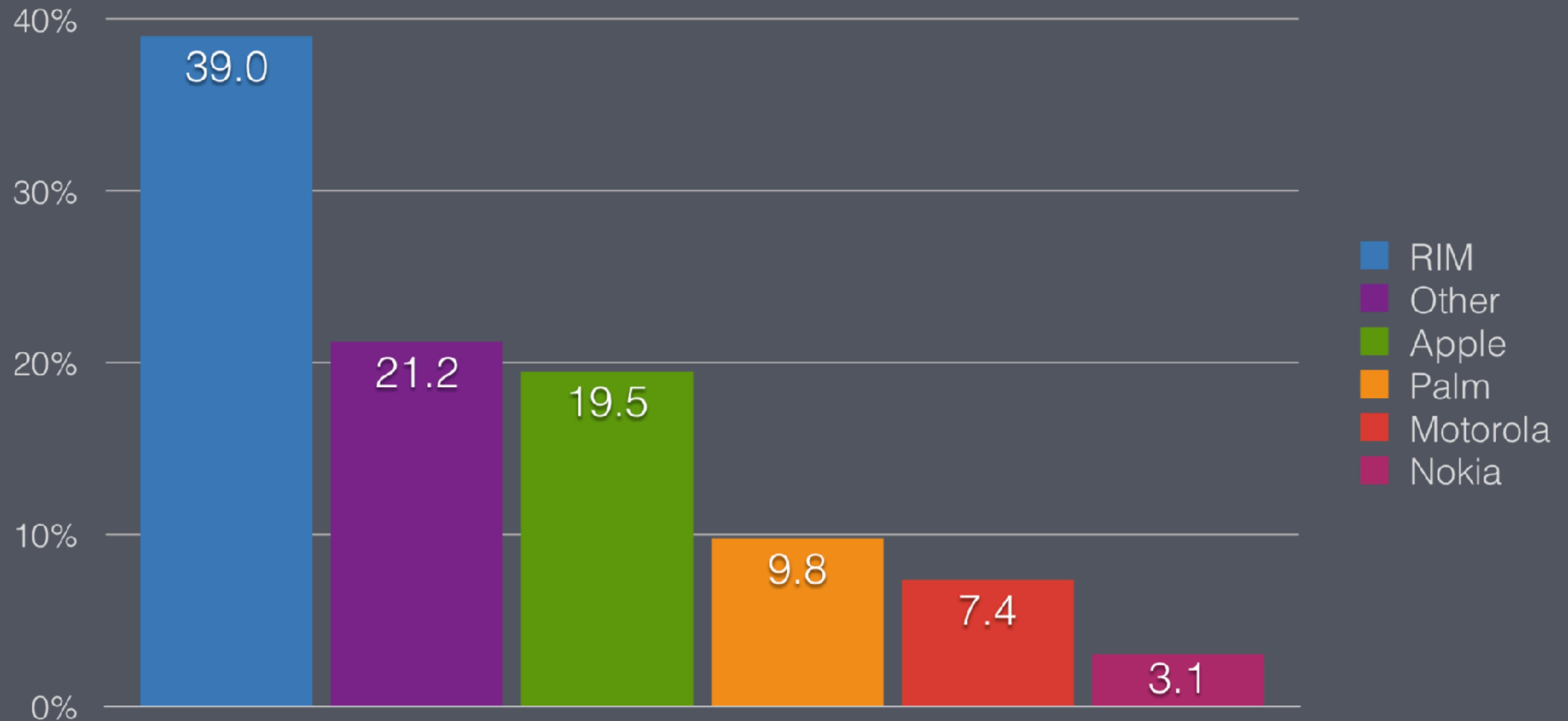
U.S. SmartPhone Marketshare

- RIM
- Apple
- Palm
- Motorola
- Nokia
- Other



- RIM
- Apple
- Palm
- Motorola
- Nokia
- Other





DELINCUENCIA

Victimas violentas (Personas victimizadas por delitos en 12 meses)

30,7%

2010

22,8%

2013

27,3%

2016





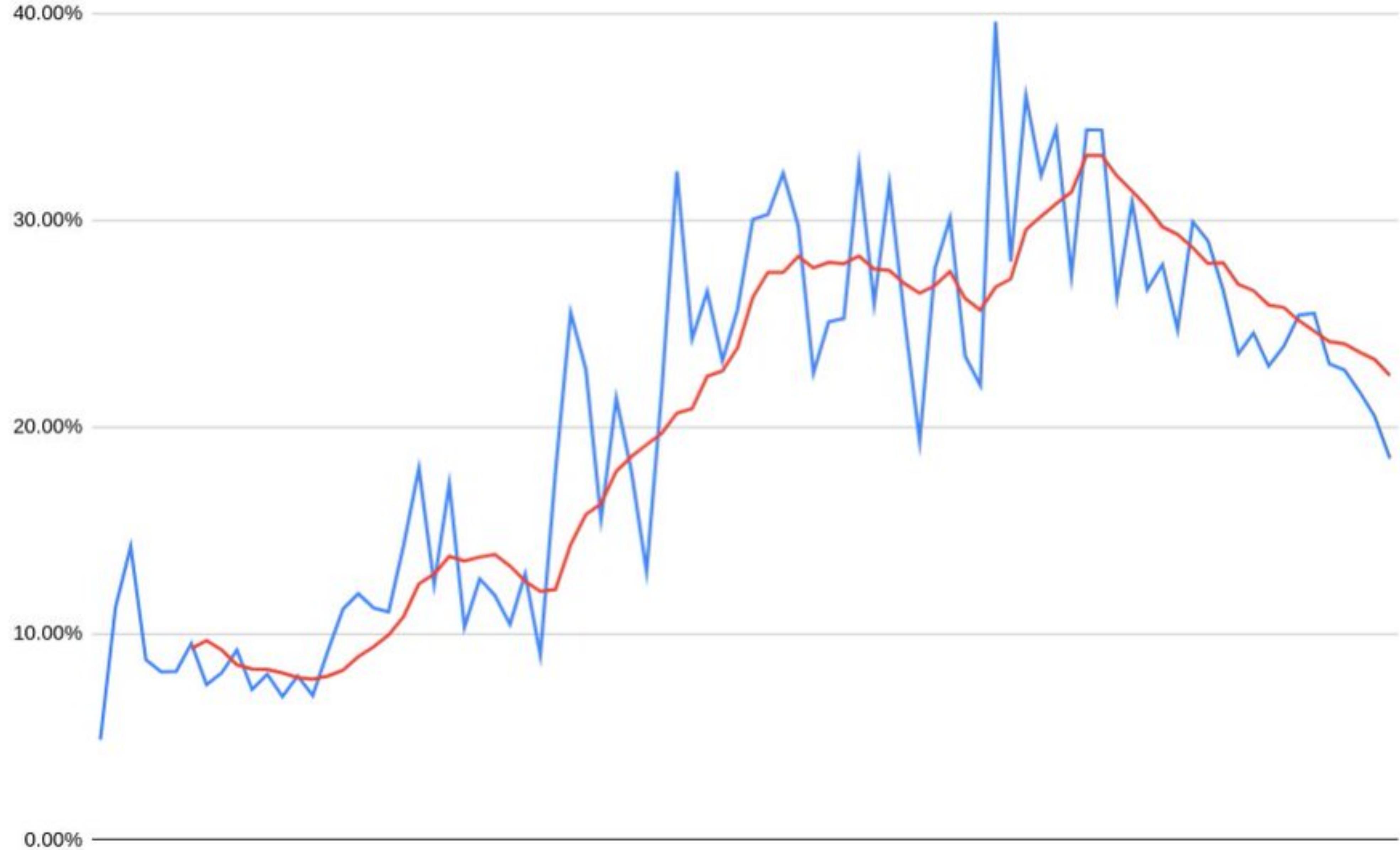
Tasa de Positividad Nacional



www.gob.cl/coronavirus

NUEVO BALANCE DE COVID-19 EN CHILE

T13 10:47 SANTIAGO 6° 13°

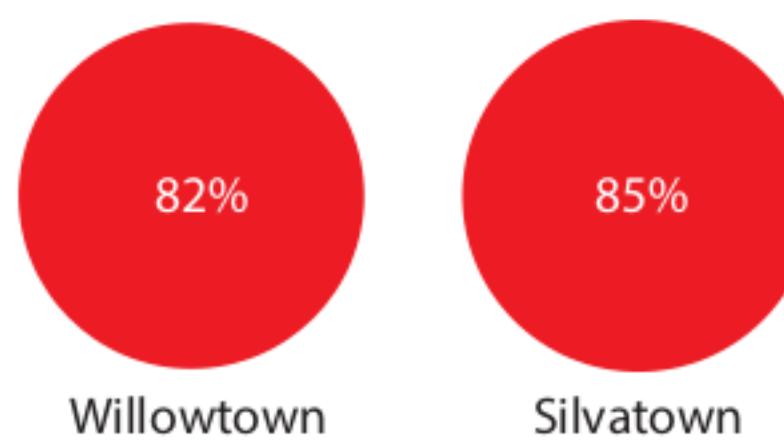


Correct versions

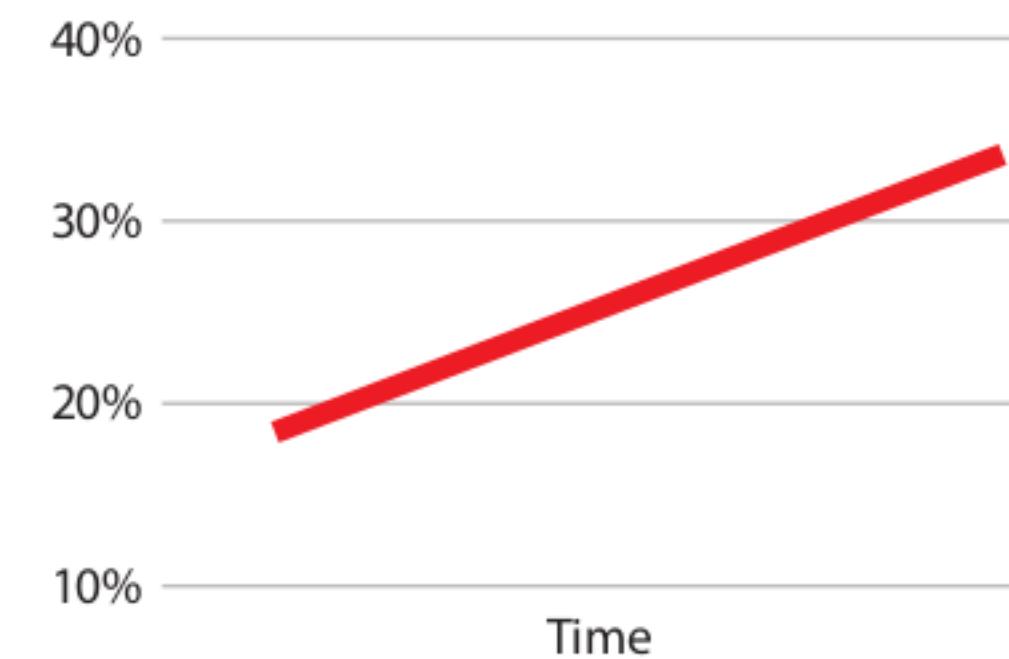
Percentage of population with access to safe drinking water



Percentage of population with access to safe drinking water

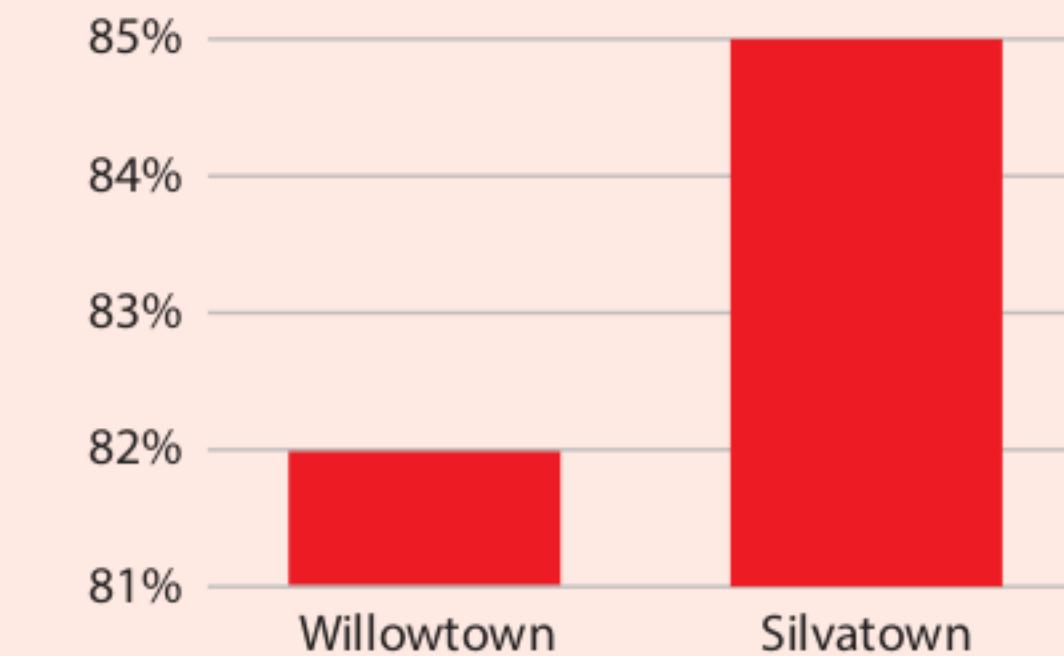


Access to safe drinking water by minority ethnic group



Deceptive versions

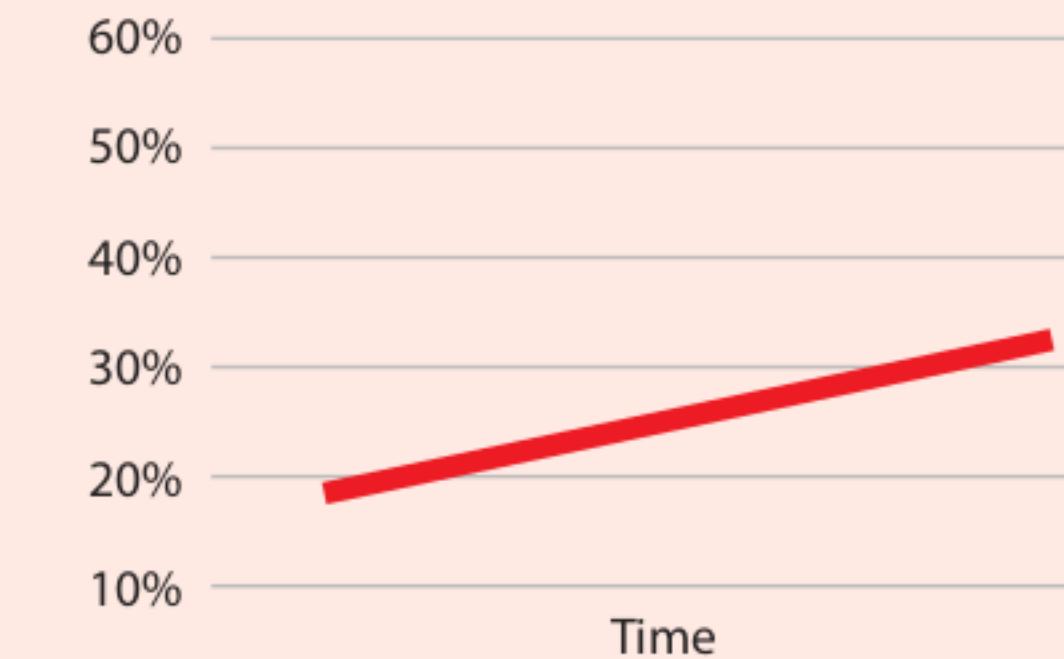
Percentage of population with access to safe drinking water



Percentage of population with access to safe drinking water



Access to safe drinking water by minority ethnic group



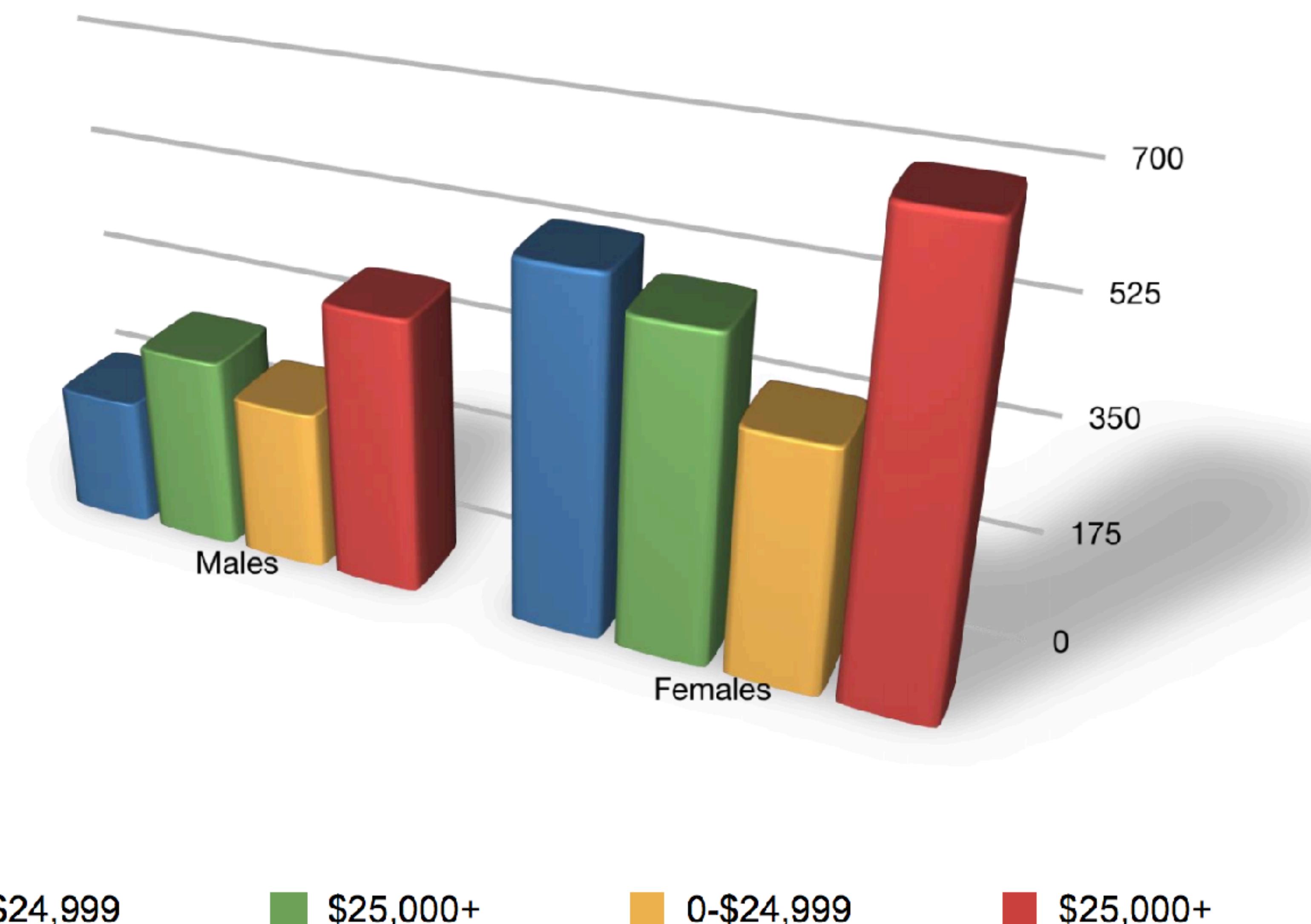
How Charts Lie



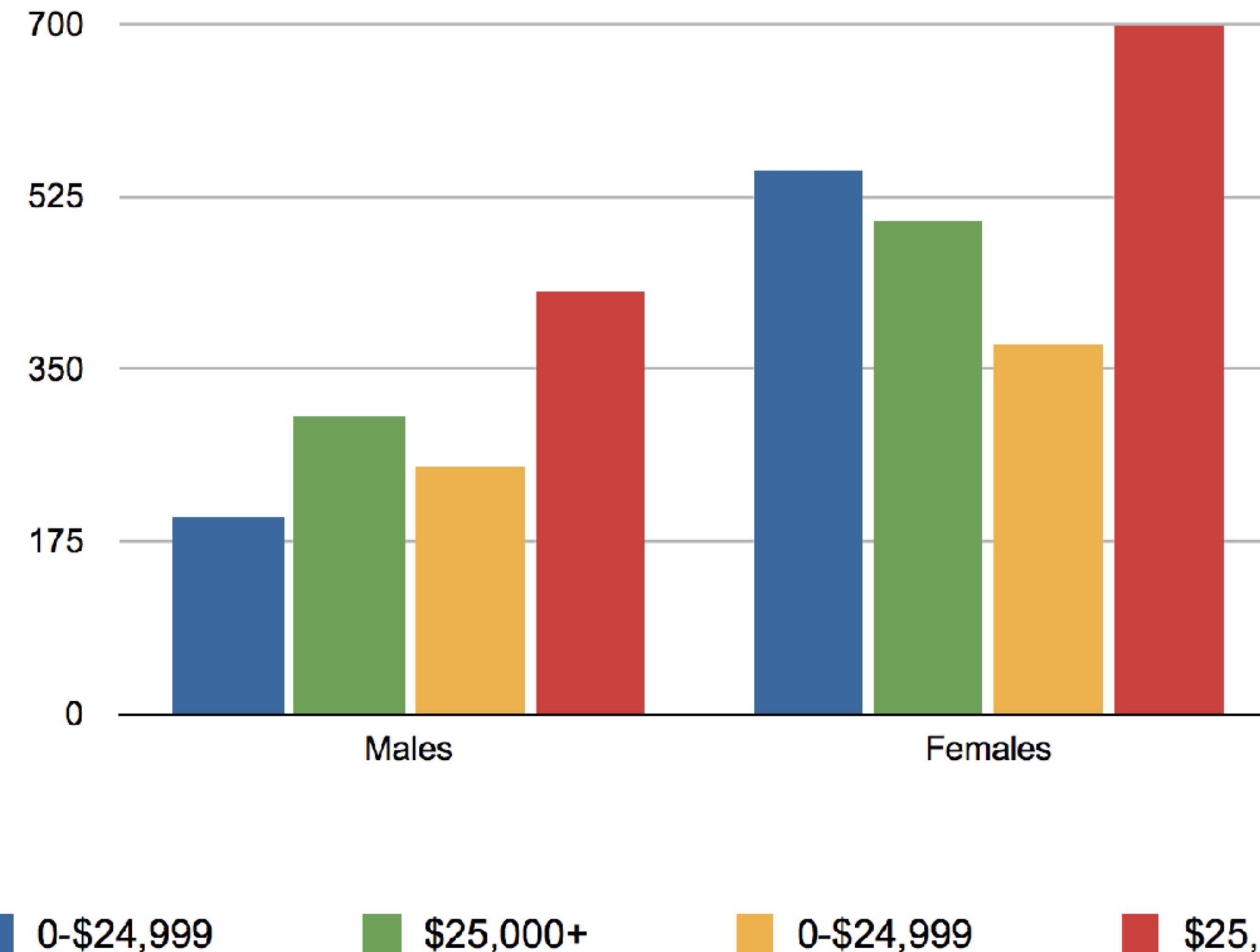
Getting Smarter about
Visual Information

Alberto Cairo

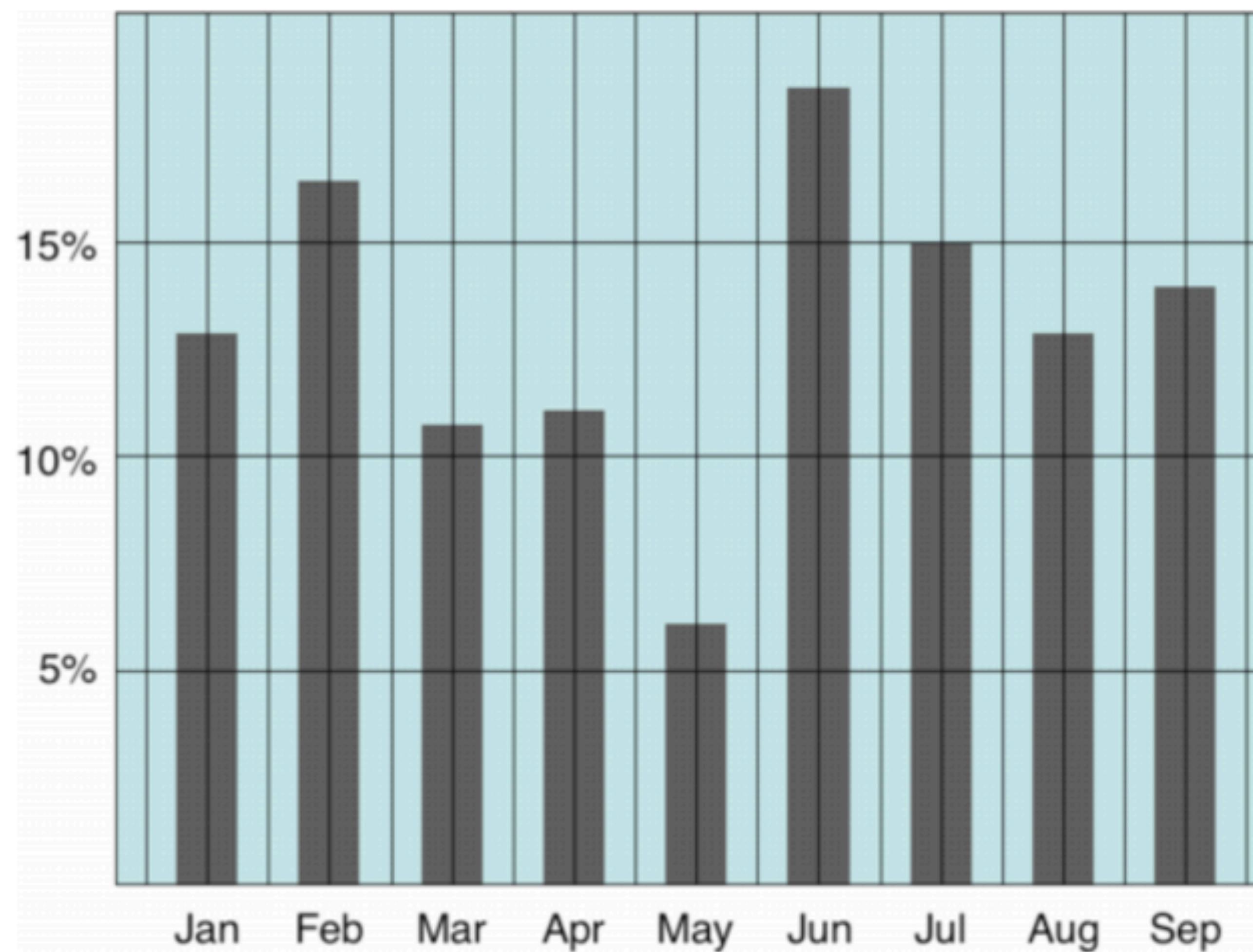
Radio datos/tinta = Tinta en datos / Tinta total usada en el gráfico



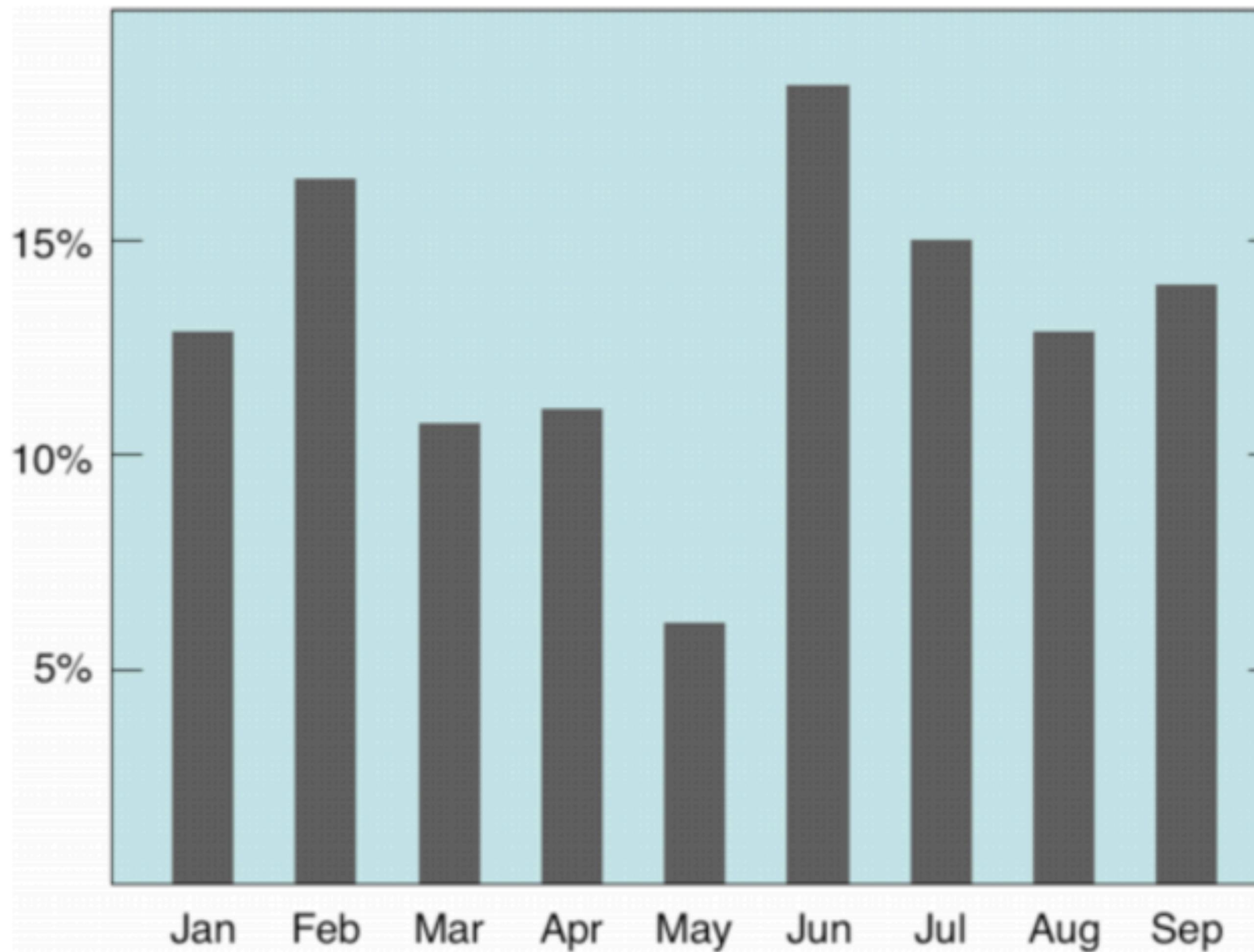
Radio datos/tinta = Tinta en datos / Tinta total usada en el gráfico



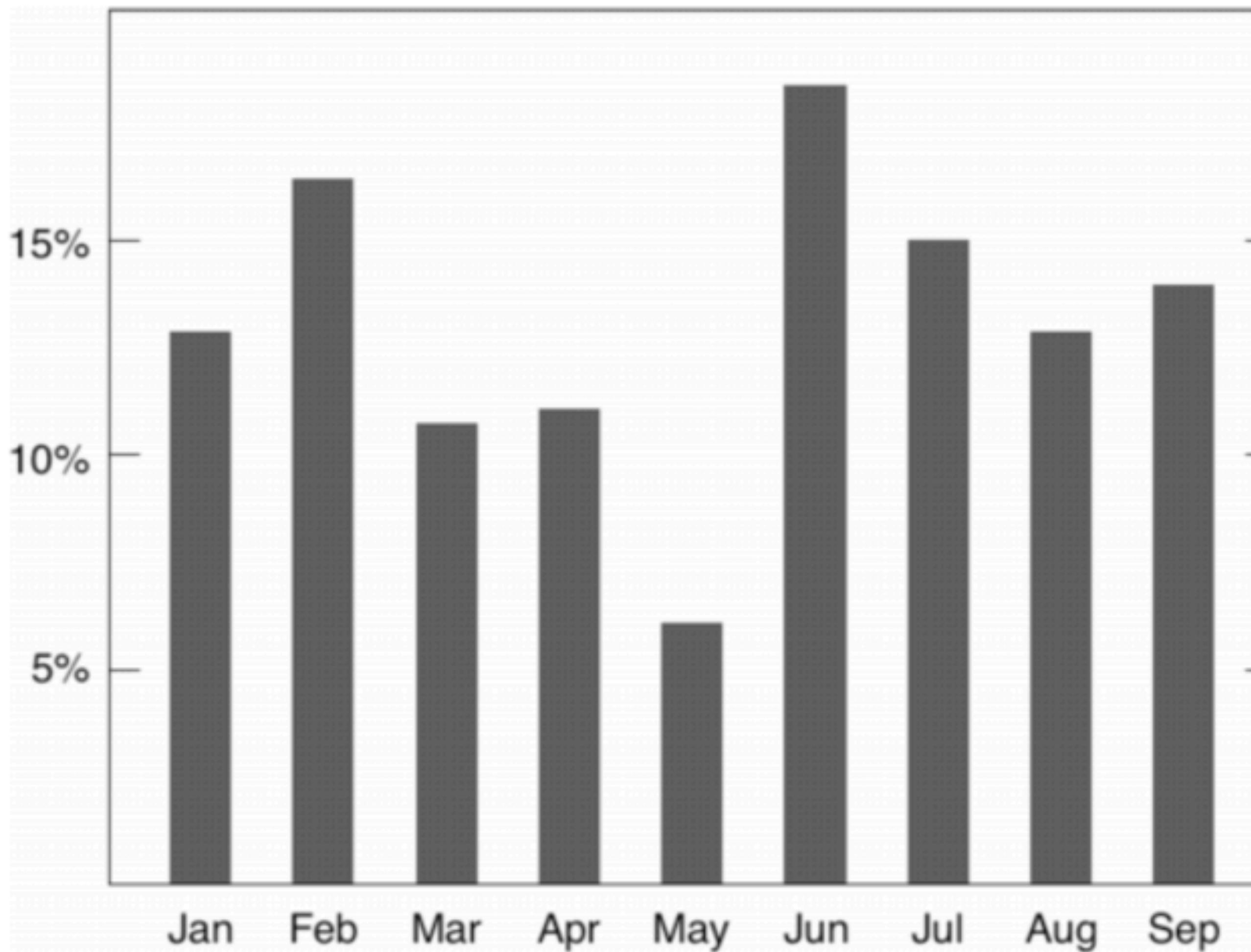
Evita basura gráfica



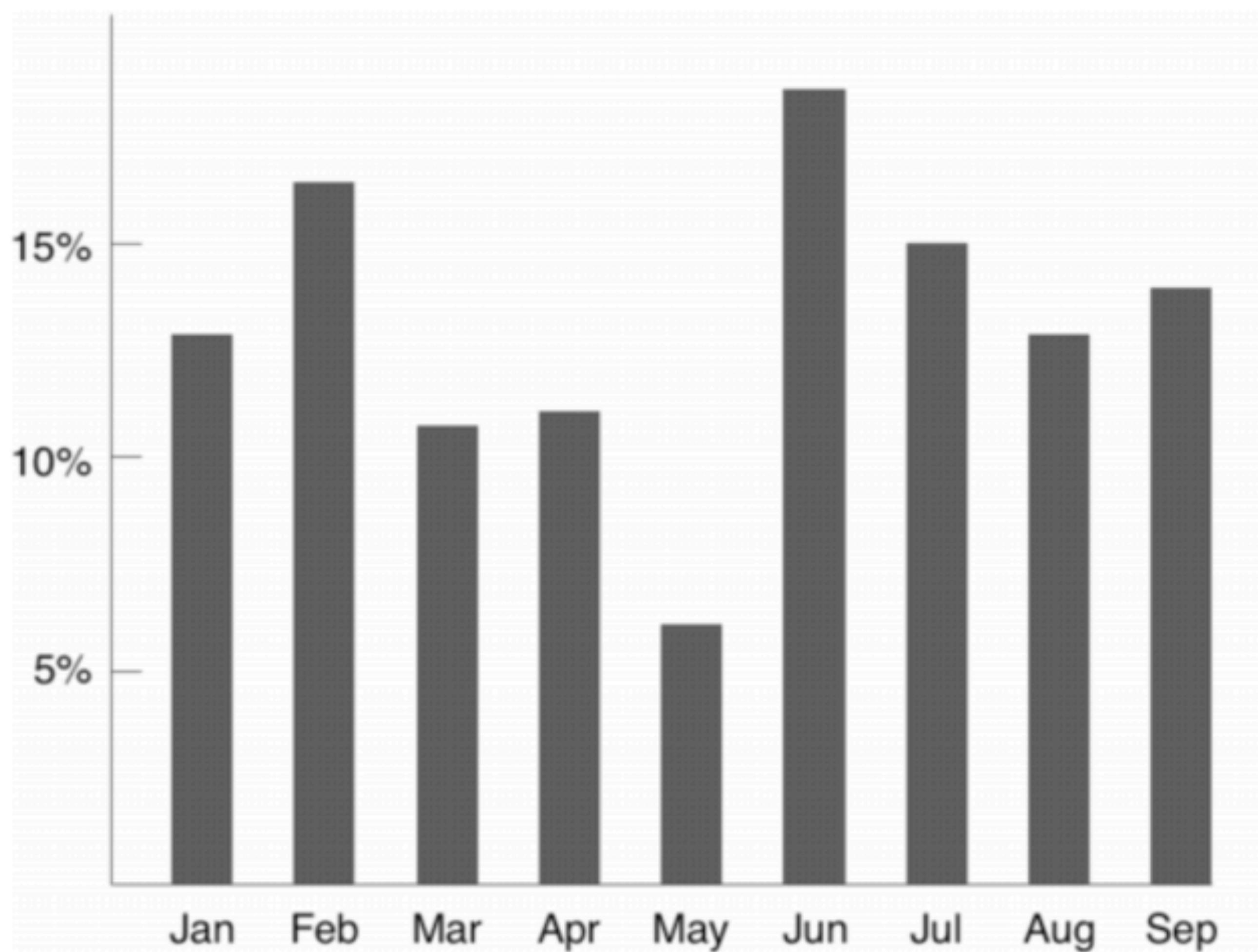
Evita basura gráfica



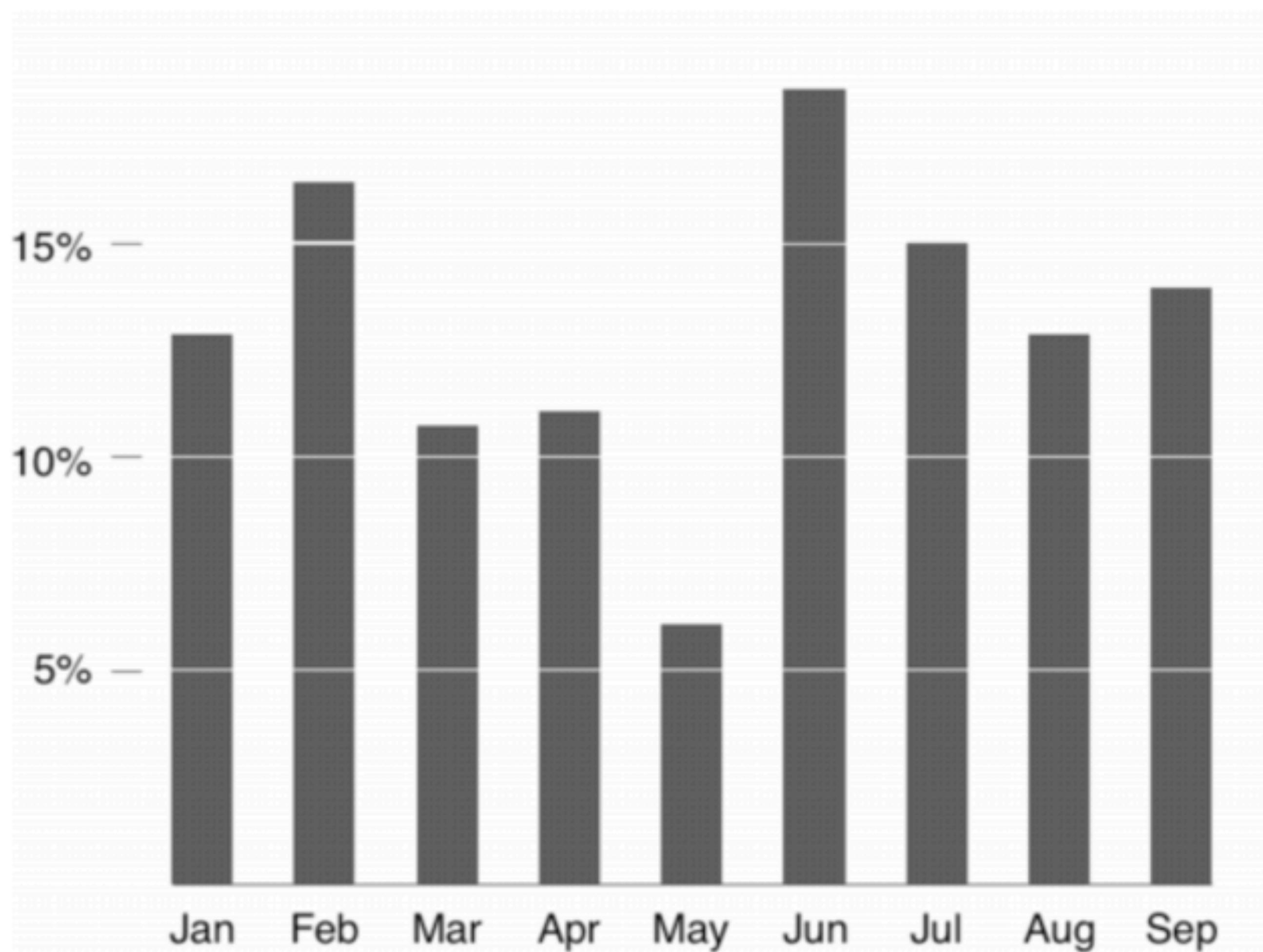
Evita basura gráfica



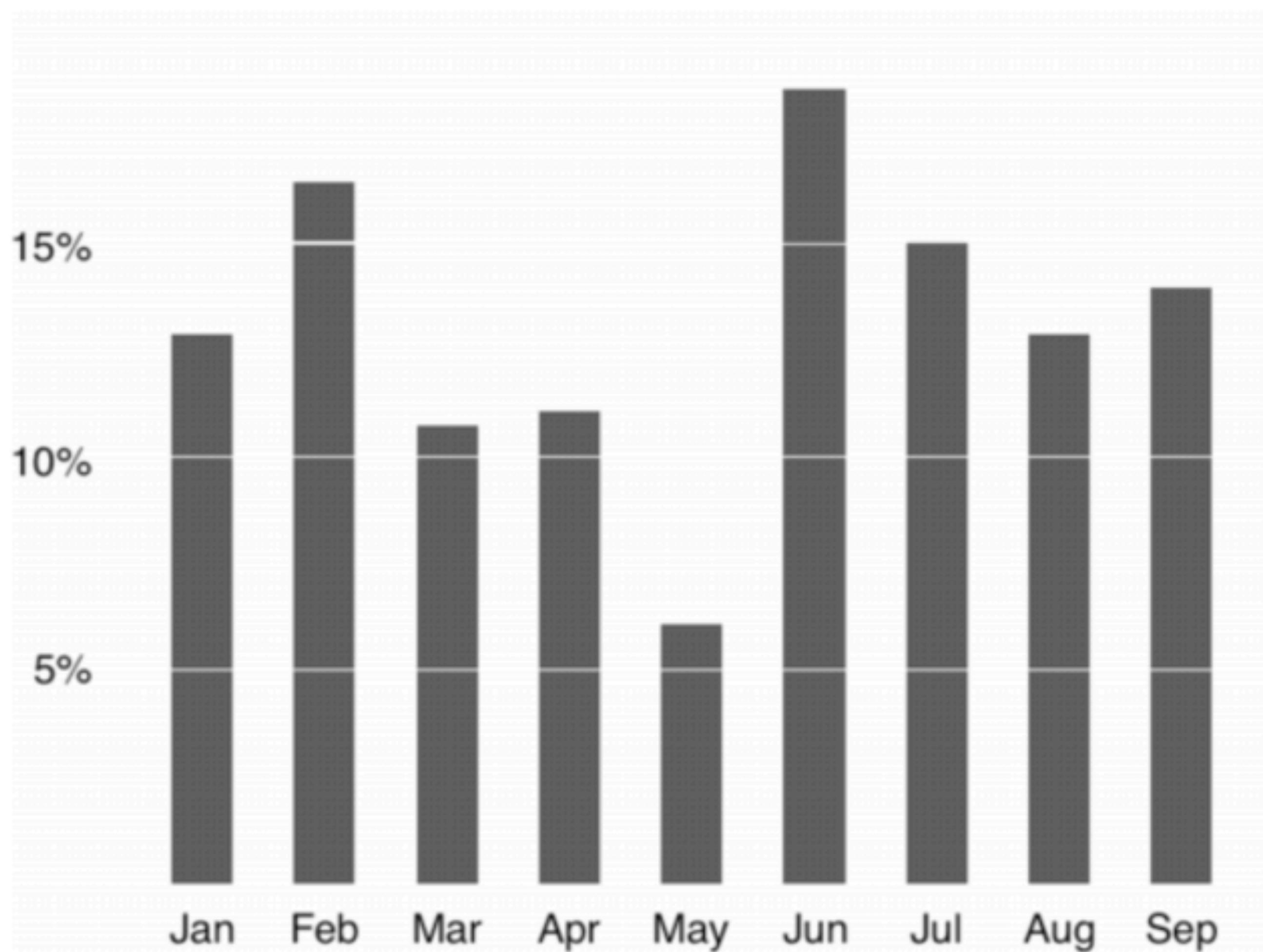
Evita basura gráfica



Evita basura gráfica



Evita basura gráfica

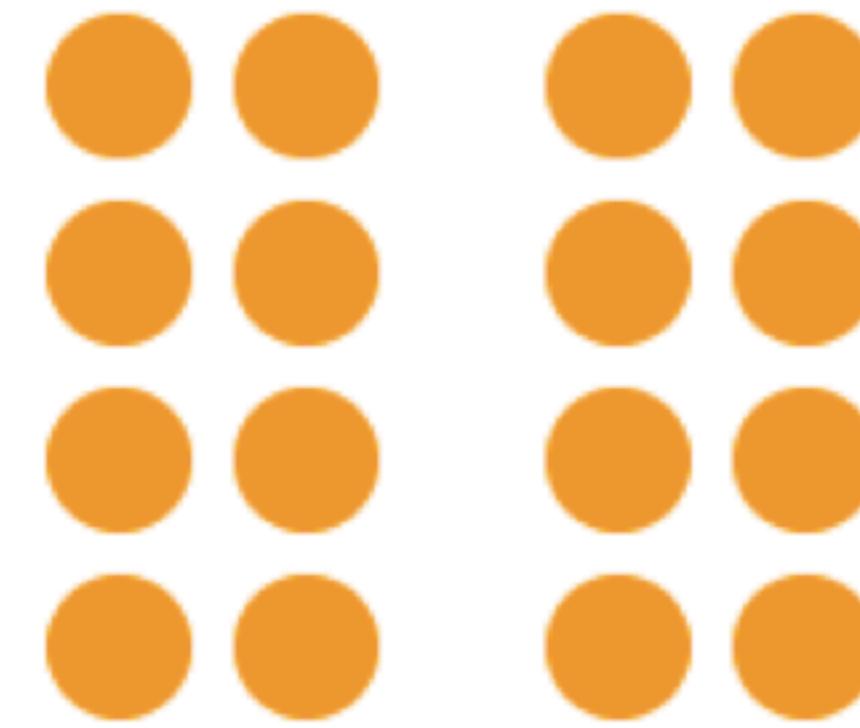
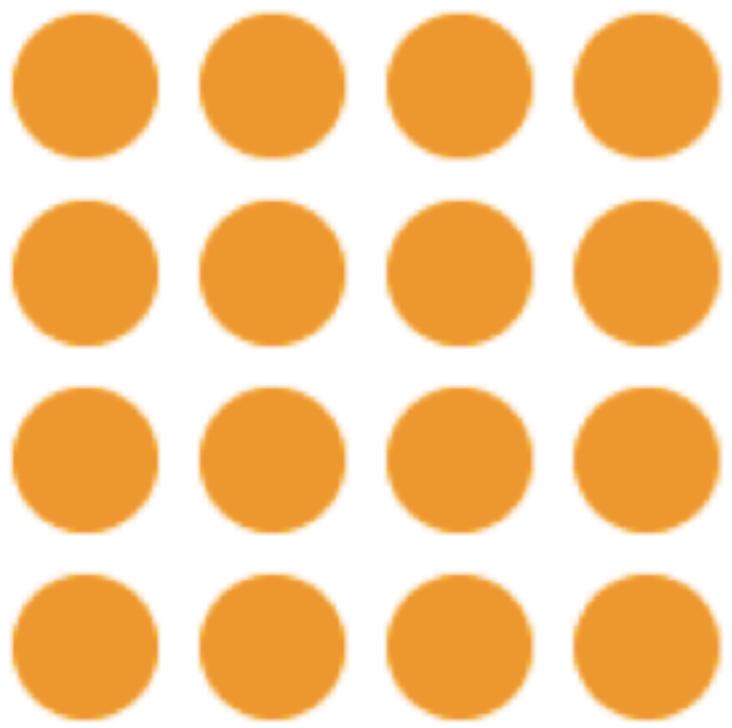


Principios de Gestalt

Principios de Gestalt

1. Proximidad
2. Similitud
3. Conexión
4. Encierro

Proximidad

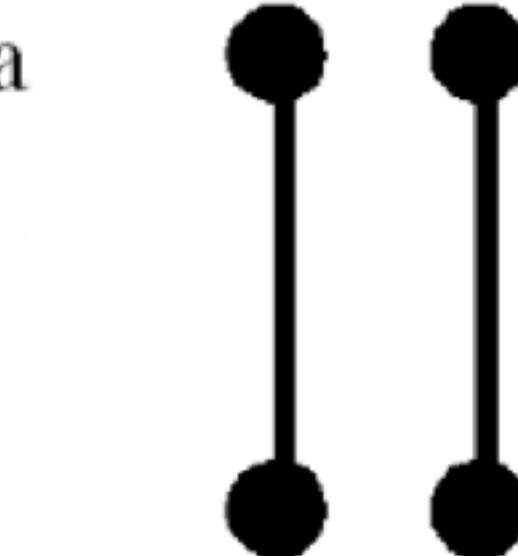


Similitud

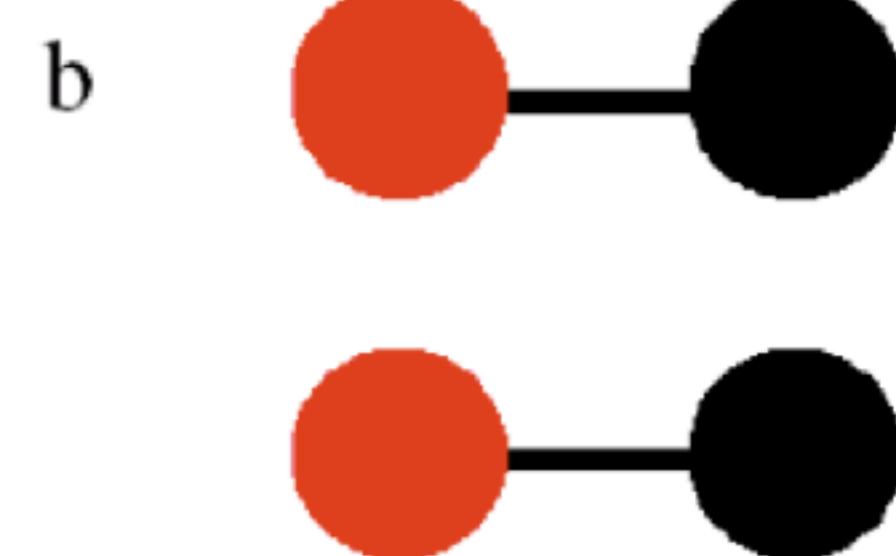
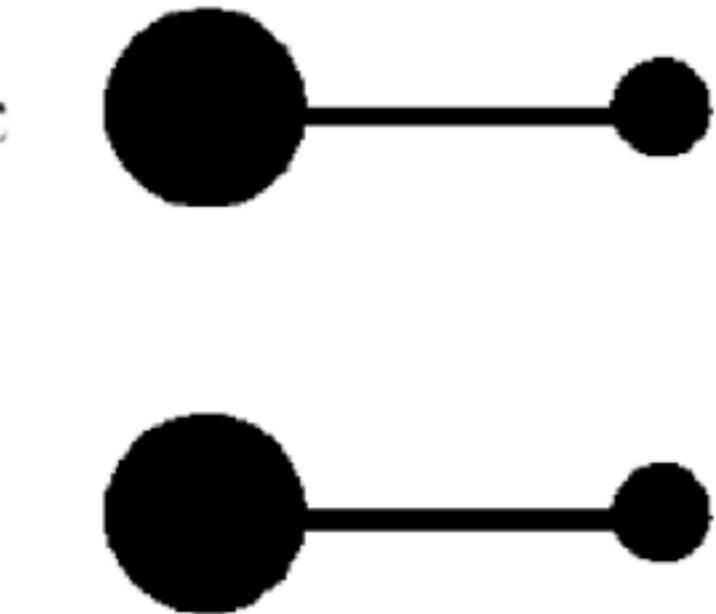


Conexión

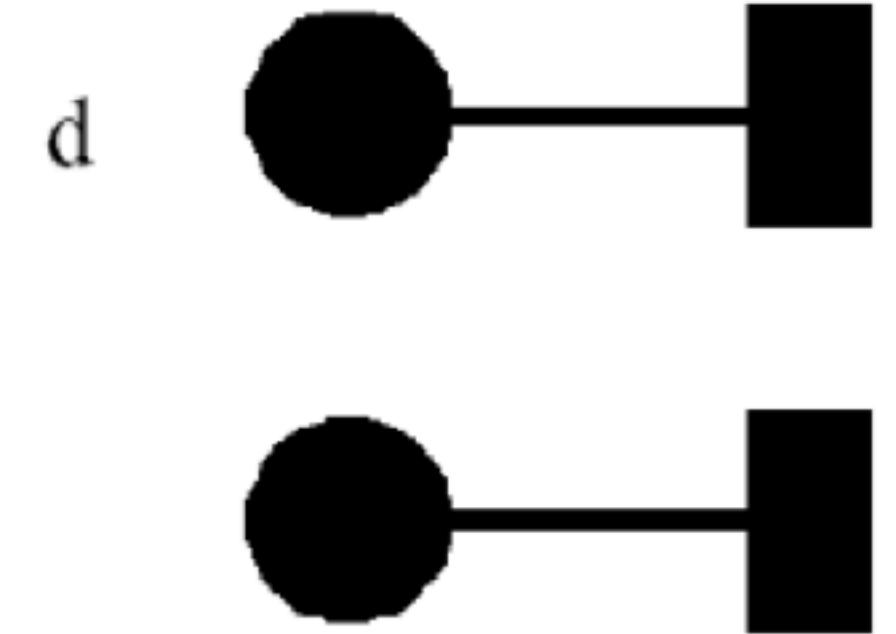
Proximity



Size



Color



Shape

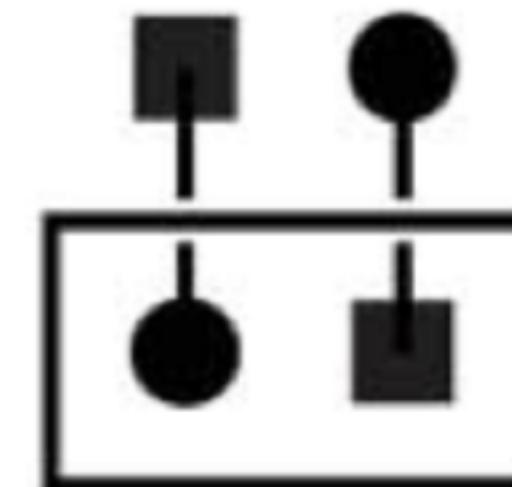
Encierro



Similarity



Connection



Enclosure

Show gap between

Black students

and

White students

Mouse over a state to explore data by school district

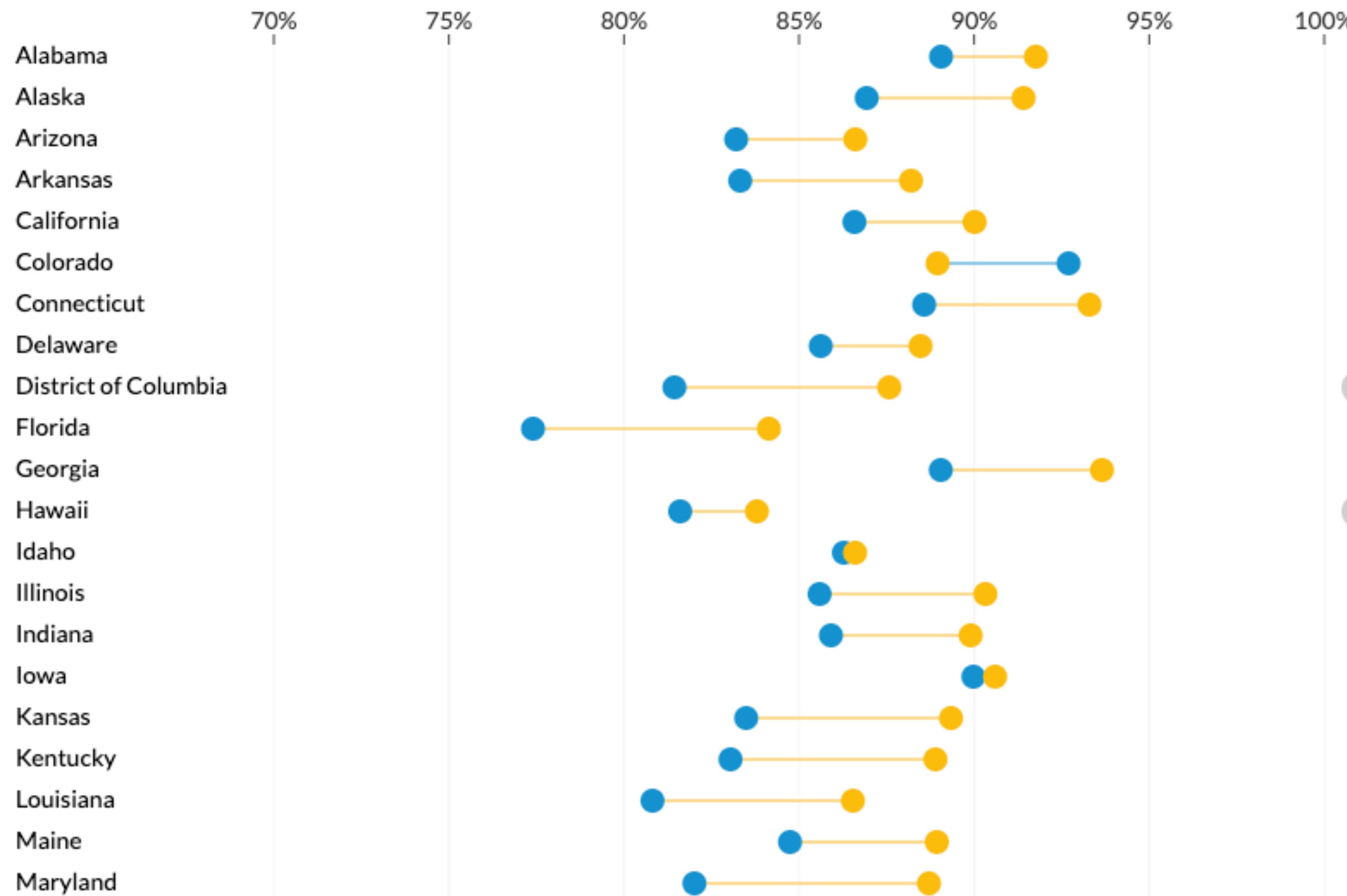
Average share of teachers with more than two years
of experience

EXPAND SCALE

ON

SORT BY GAP

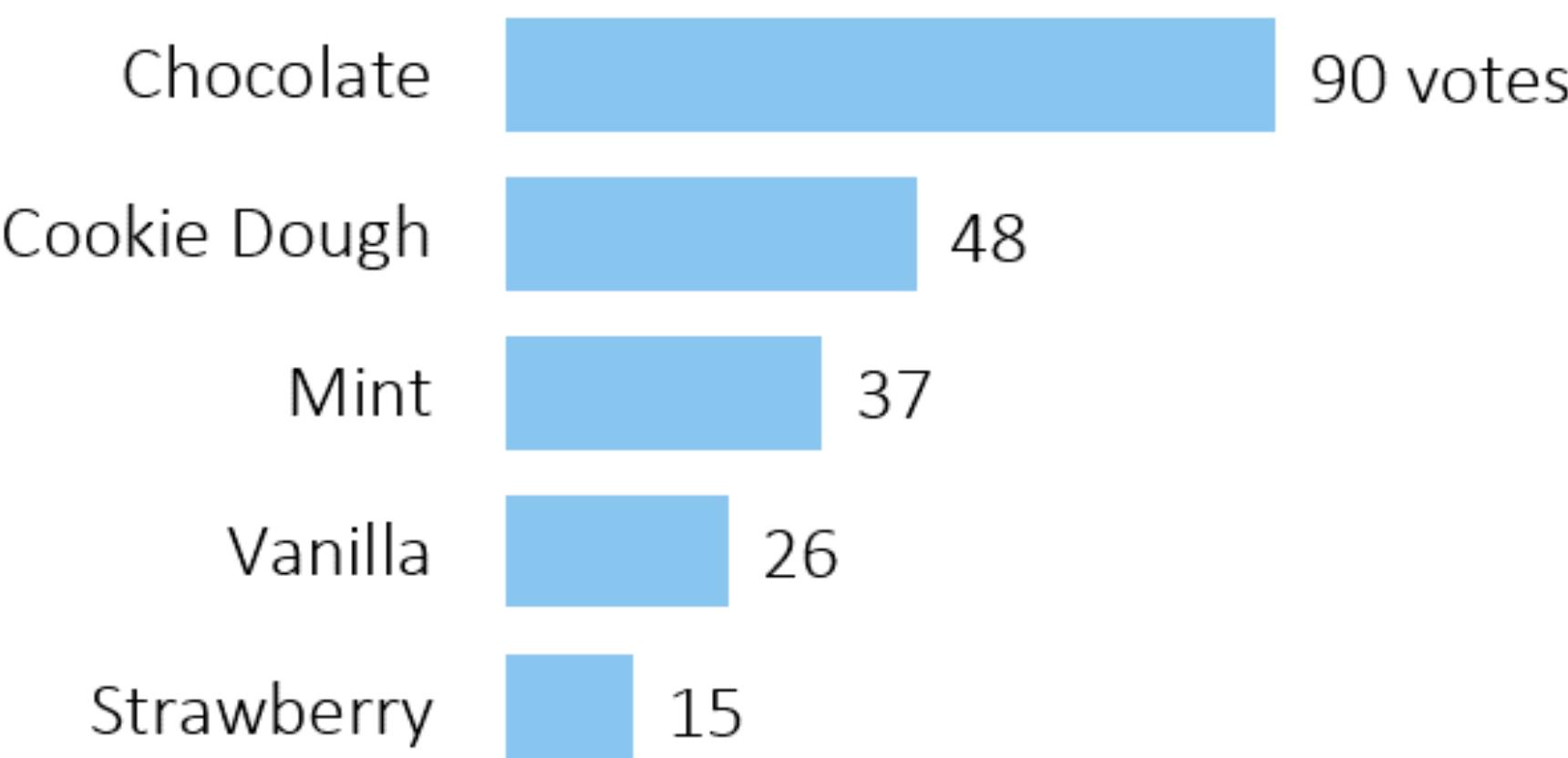
OFF



Mensaje

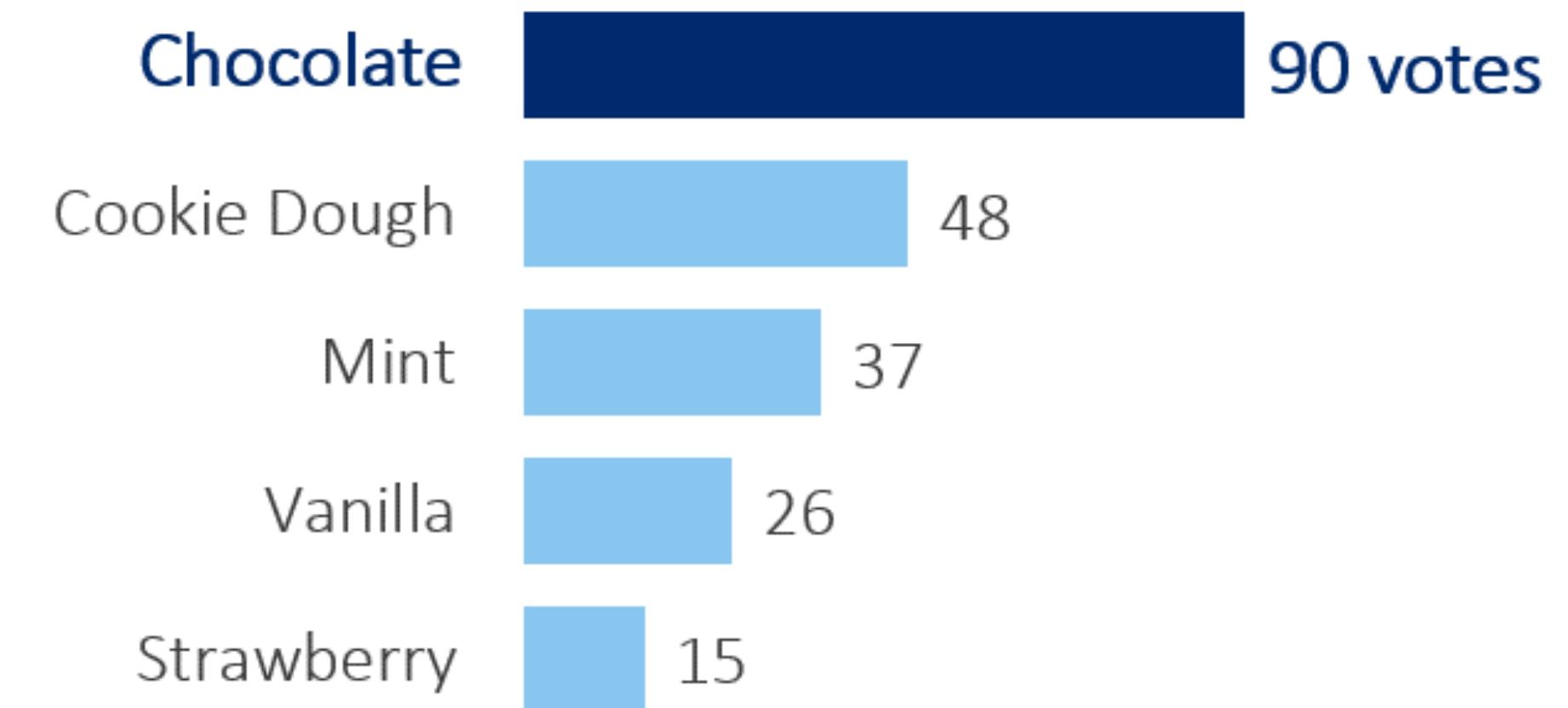
Título descriptivo y saturación

Ice cream flavor preferences based on 2014 survey of elementary school students (n=216)



or

Chocolate was most popular flavor
among elementary students surveyed



Source: 2014 survey of elementary school students (n=216)

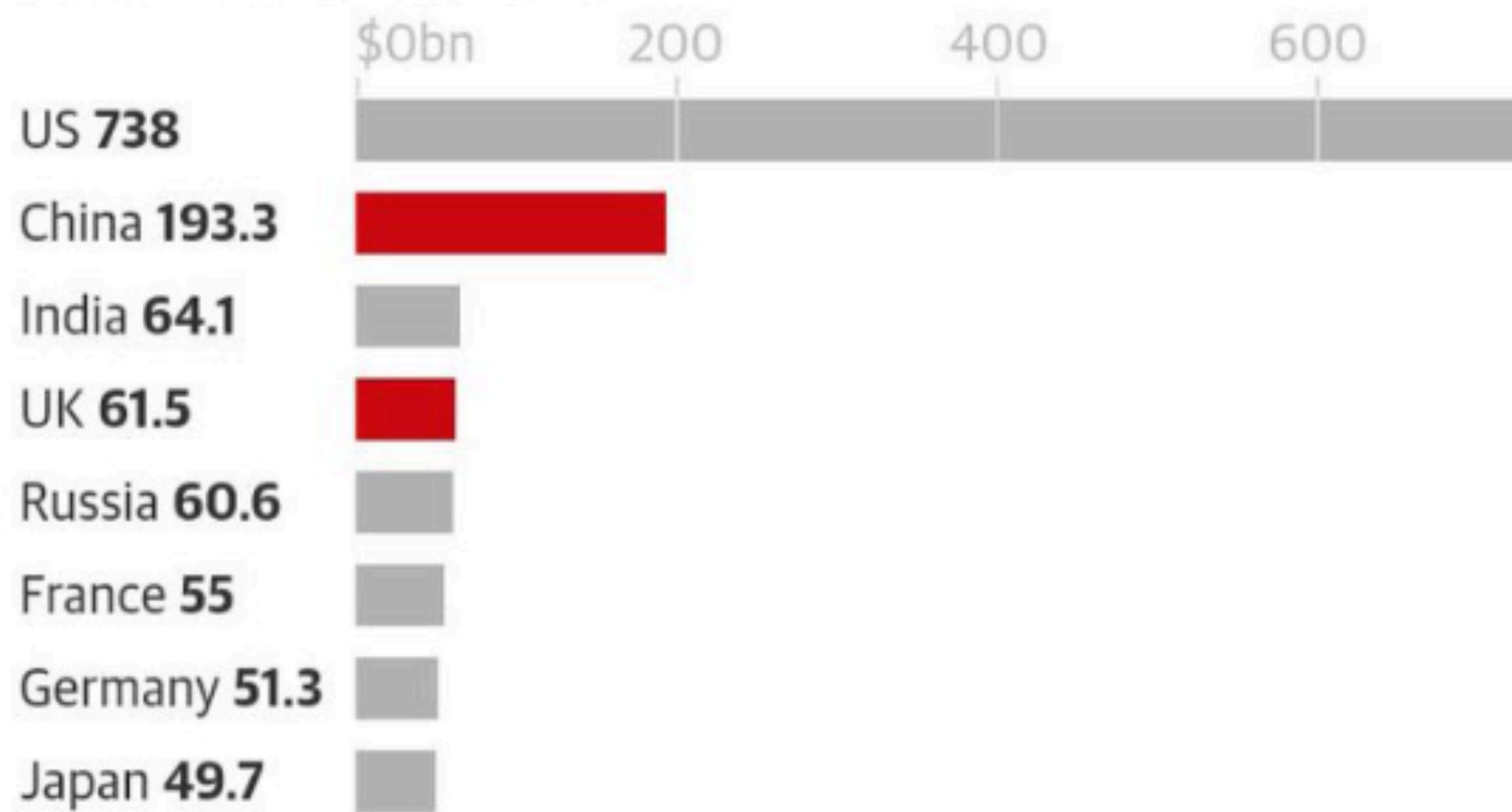


Mac
@GoodPoliticGuy

...

yea that's the main thing I noticed too

China's defence budget in 2020 was three times that of the UK



Guardian graphic | Source: IISS, the Military Balance 2021

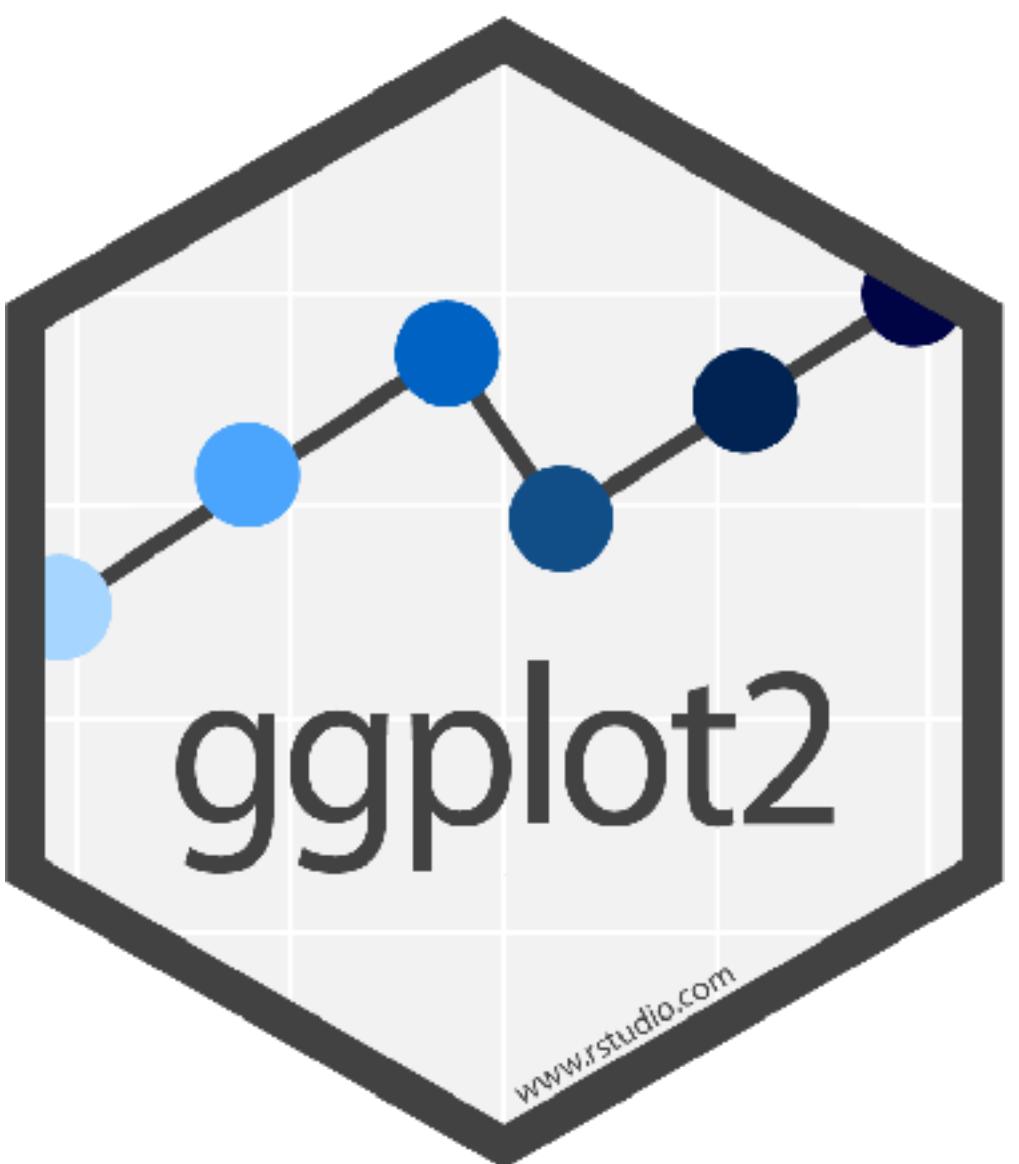
2:53 PM · Sep 20, 2021 · Twitter for iPhone

25.6K Retweets **958** Quote Tweets **254.7K** Likes

Herramientas

Datawrapper

RAWGraphs



Flourish





Power BI

+ tableau



Análisis y procesamiento



Visualización



Dashboard



Visualización = Historia



LIFE IN A BOX

Planets in the box have the right atmospheric pressure and the right temperature to keep surface water in a liquid state. In our solar system Earth and Mars are in the box, Venus and Mercury outside. The cold gas giants are literally off the chart.

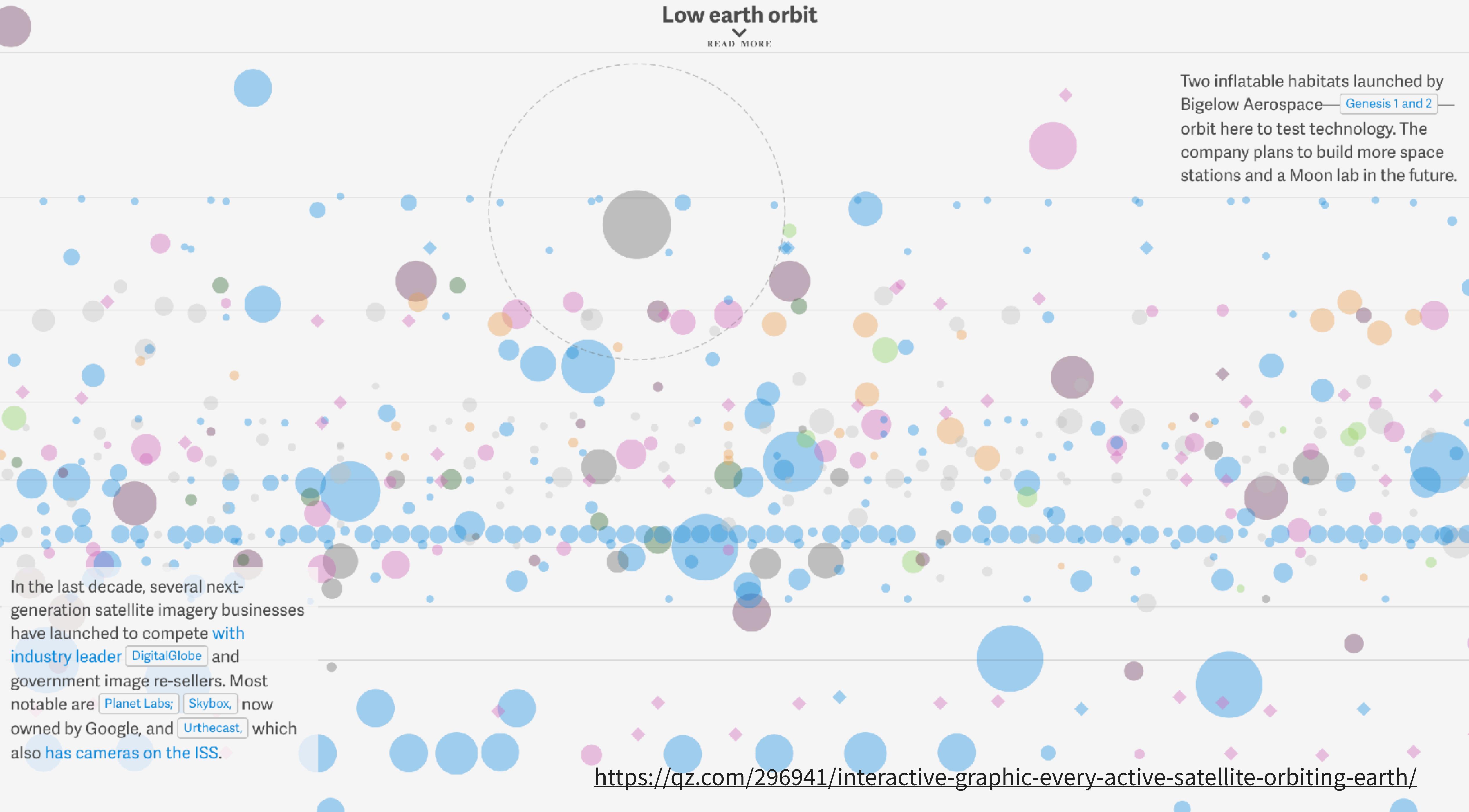
The logarithmic scale used initially here allows for an easier comparison of the exoplanets. The linear scale shows how shallow the habitability zone is.

<https://www.nationalgeographic.com/astrobio.../goldilocks-worlds/>

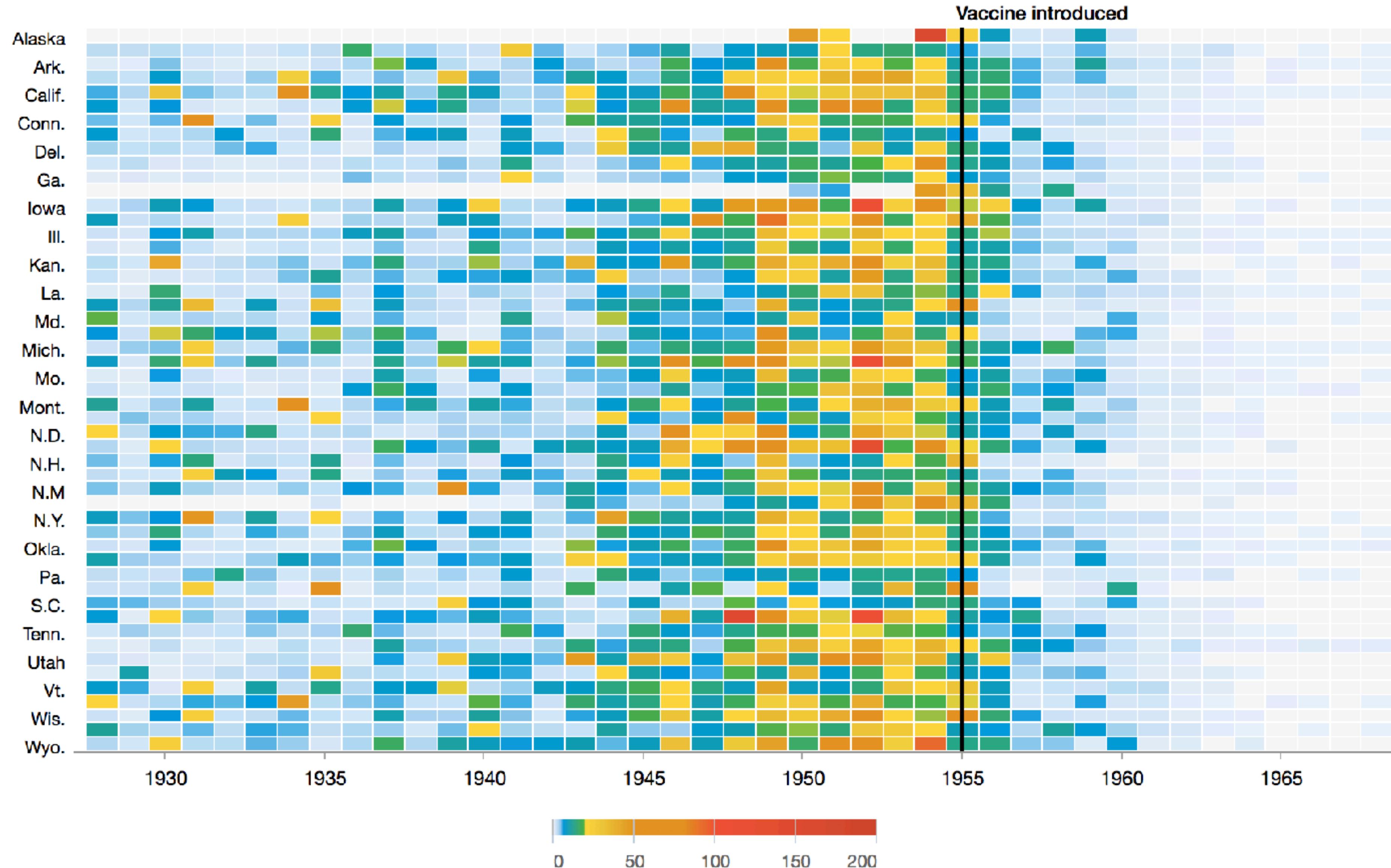
Low earth orbit

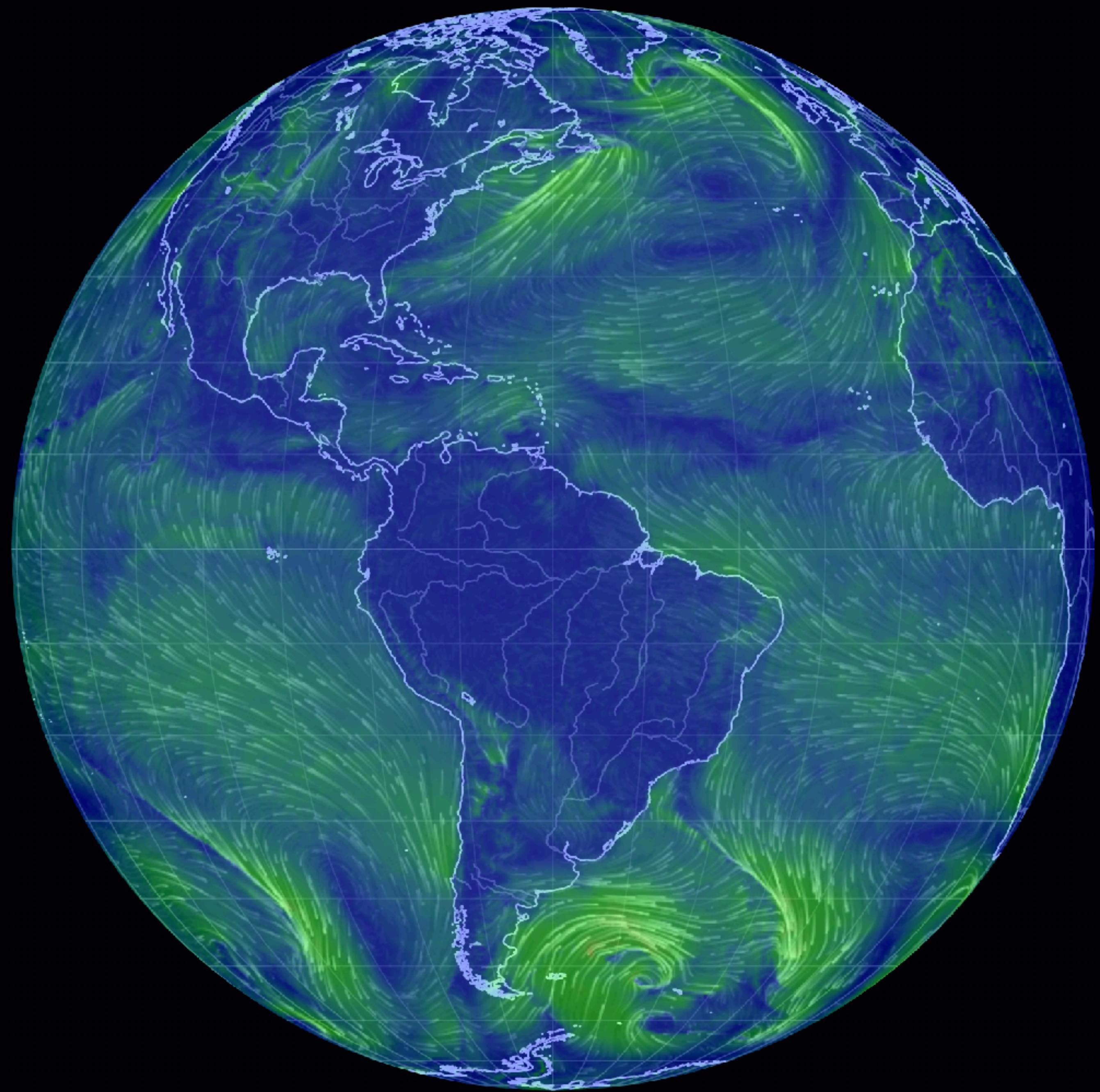
READ MORE

Two inflatable habitats launched by Bigelow Aerospace—[Genesis 1 and 2](#)—orbit here to test technology. The company plans to build more space stations and a Moon lab in the future.



Polio

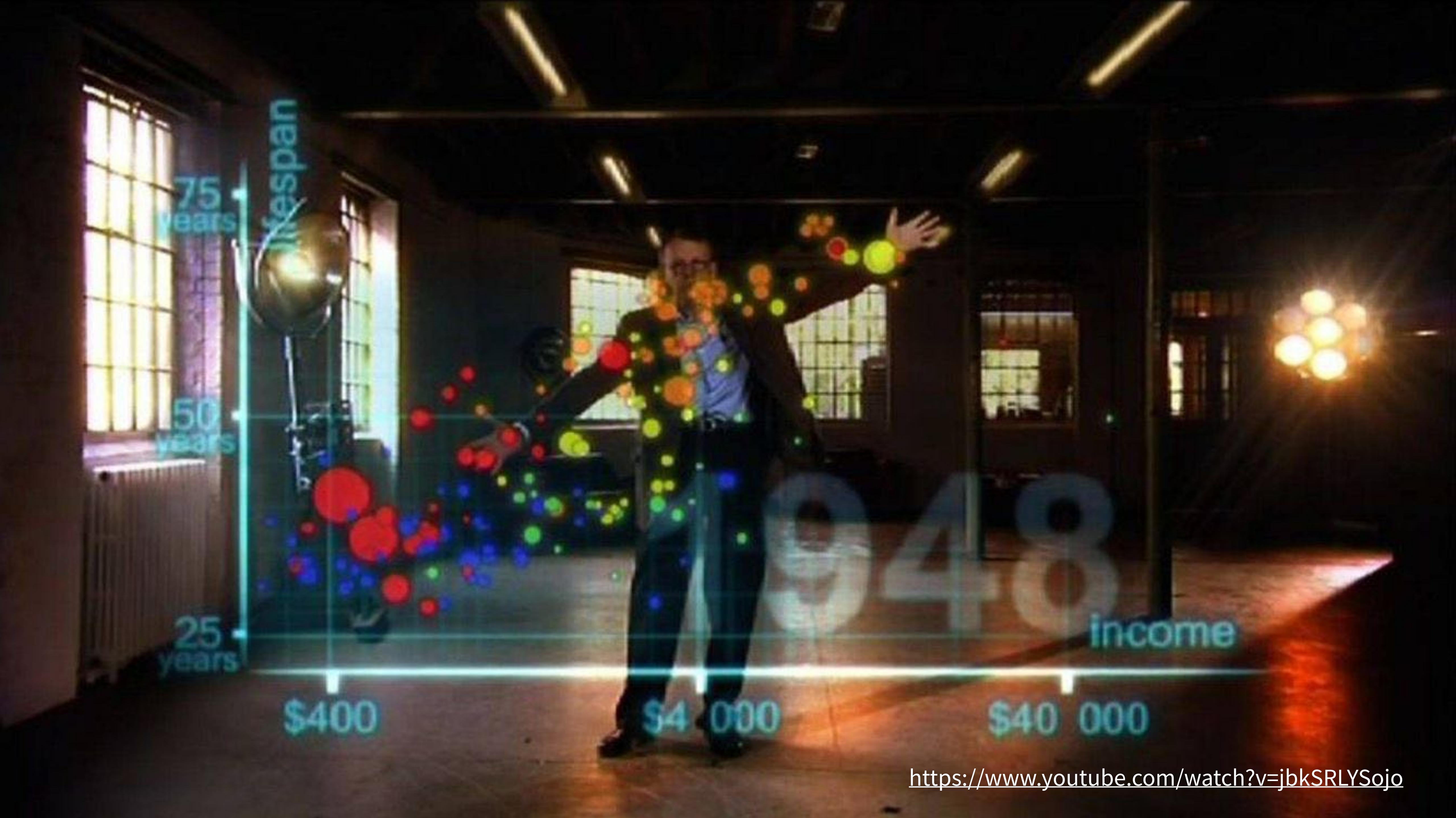




earth =

community
<https://earth.nullschool.net>

Pausa



<https://www.youtube.com/watch?v=jbkSRLYSoj>

The Python Graph Gallery



Welcome to the Python Graph Gallery, a collection of hundreds of charts made with [Python](#). Charts are organized in about 40 sections and always come with their associated reproducible code. They are mostly made with [Matplotlib](#) and [Seaborn](#) but other library like [Plotly](#) are sometimes used. If you're new to python, this [online course](#) can be a good starting point.

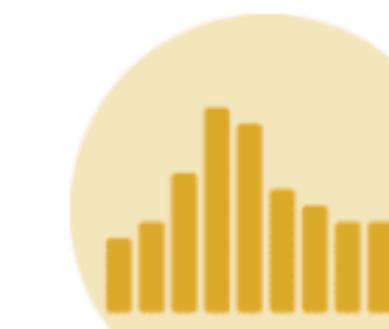
Distribution



Violin



Density



Histogram



Boxplot



Ridgeline

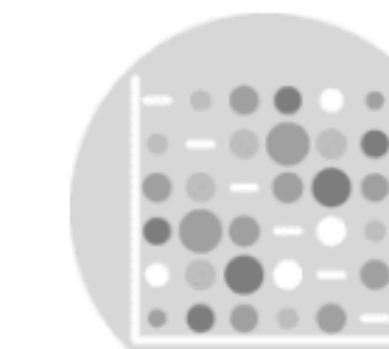
Correlation



Scatterplot



Heatmap



Correlogram



Bubble

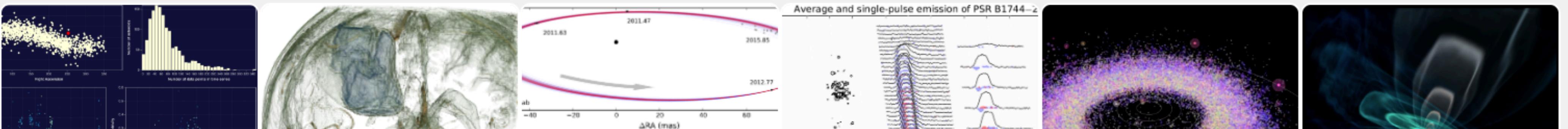
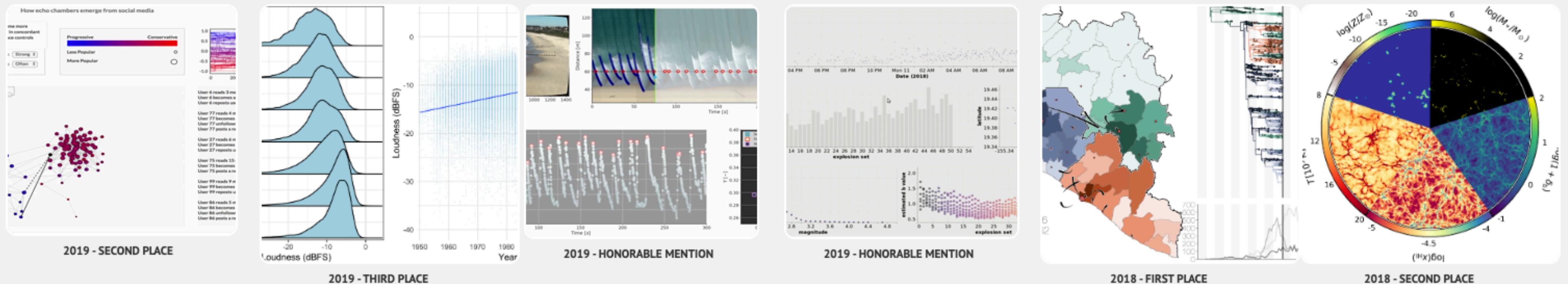
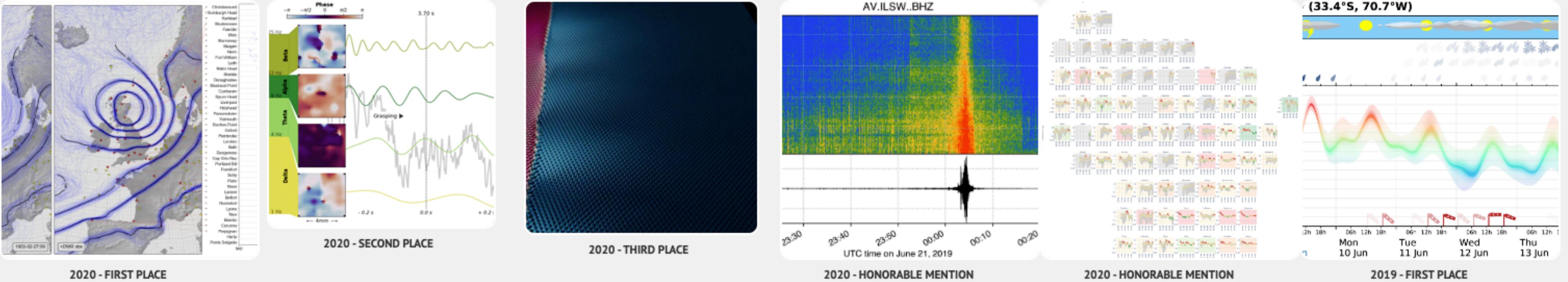


Connected Scatter



2D Density

Gallery



matplotlib

Cheat sheet
Version 3.5.0

Quick start

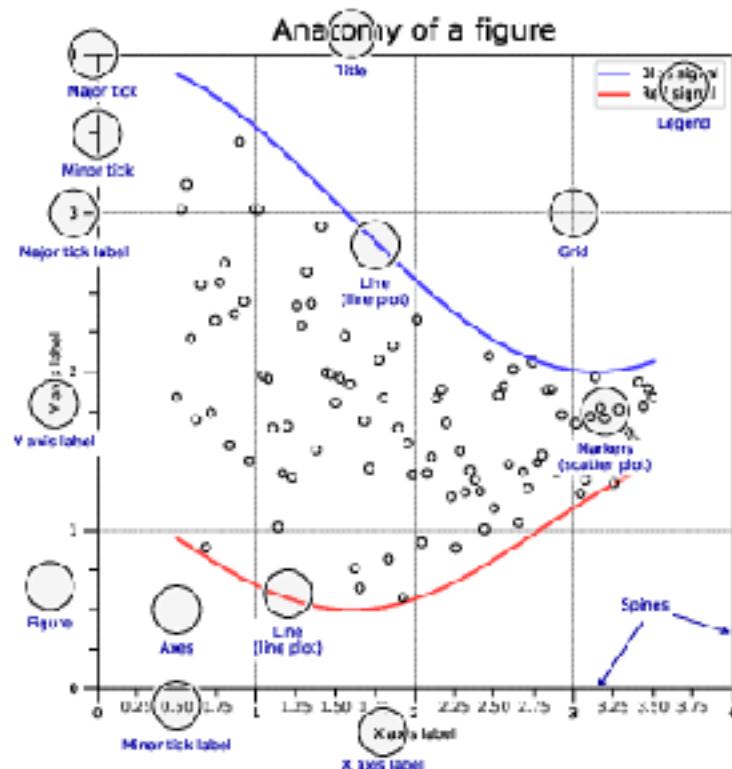
```
import numpy as np
import matplotlib as mp
import matplotlib.pyplot as plt

X = np.linspace(0, 2*np.pi, 100)
Y = np.cos(X)

fig, ax = plt.subplots()
ax.plot(X, Y, color='green')

fig.savefig("figure.pdf")
fig.show()
```

Anatomy of a figure



Subplots layout

```
subplot[s](rows,cols,...)
fig, axs = plt.subplots(3, 3)

G = gridspec(rows,cols,...)
ax = G[0,:]

ax.inset_axes(extent)

d = make_axes_locatable(ax)
ax = d.new_horizontal('10%')
```

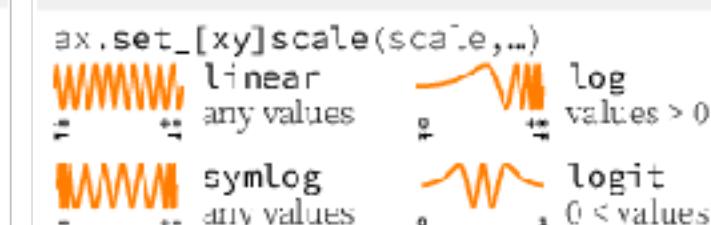
Getting help

- [matplotlib.org](#)
- [github.com/matplotlib/matplotlib/issues](#)
- [discourse.matplotlib.org](#)
- [stackoverflow.com/questions/tagged/matplotlib](#)
- [gitter.im/matplotlib](#)
- [twitter.com/matplotlib](#)
- [Matplotlib users mailing list](#)

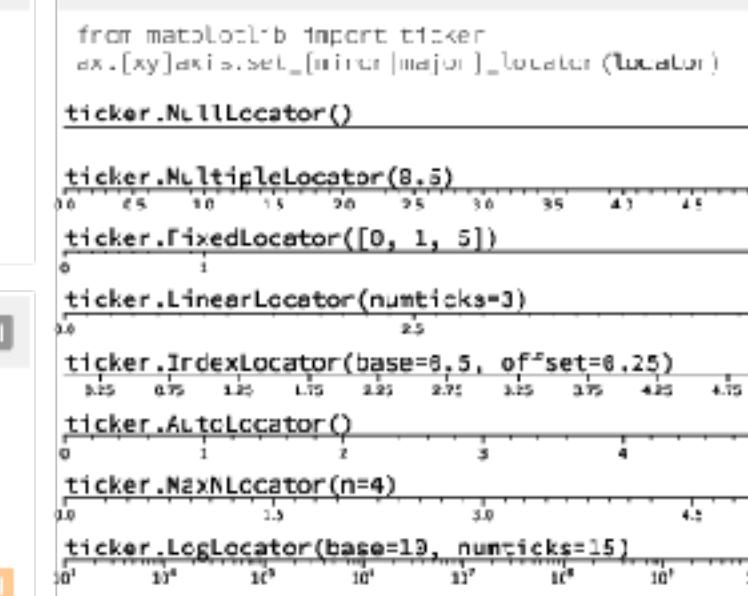
Basic plots



Scales



Tick locators



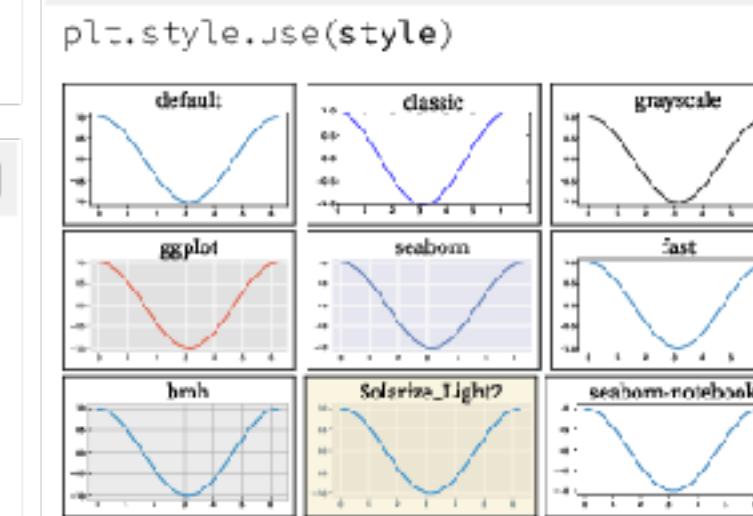
Animation

```
import matplotlib.animation as mpla

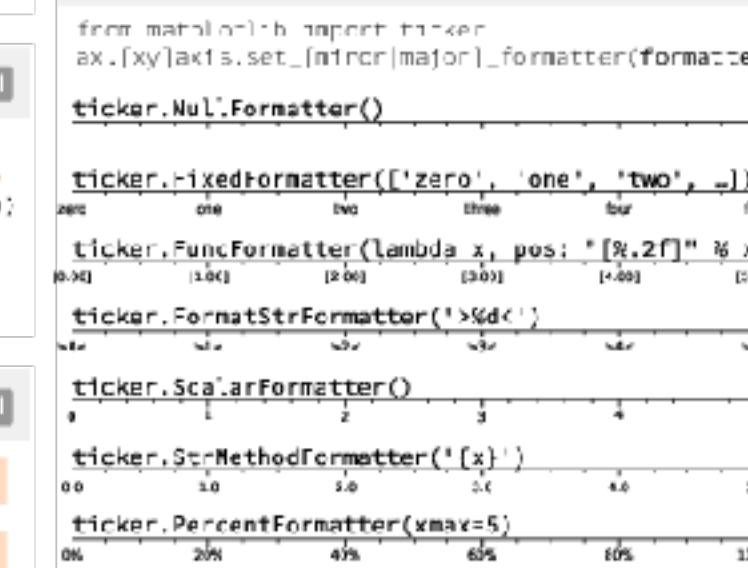
T = np.linspace(0, 2*np.pi, 100)
S = np.sin(T)
line, = plt.plot(T, S)

def animate(i):
    line.set_ydata(np.sin(T-i/50))
anim = mpla.FuncAnimation(
    plt.gcf(), animate, interval=5)
plt.show()
```

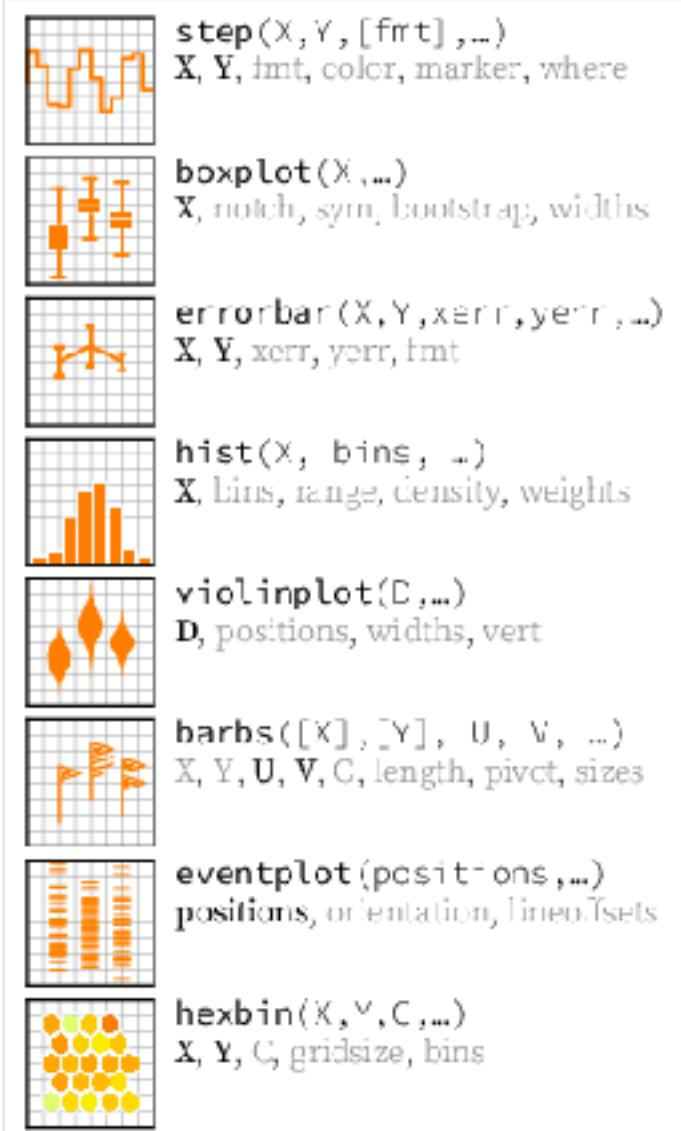
Styles



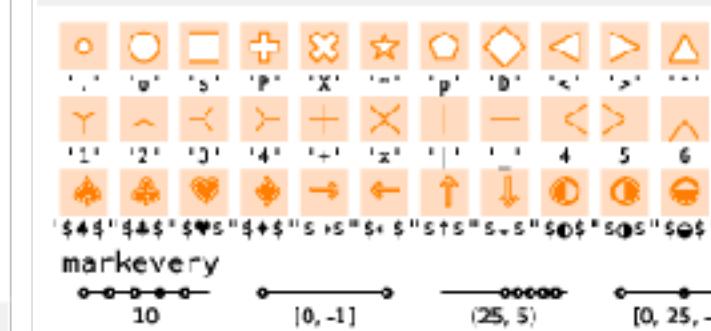
Tick formatters



Advanced plots



Markers



Colors

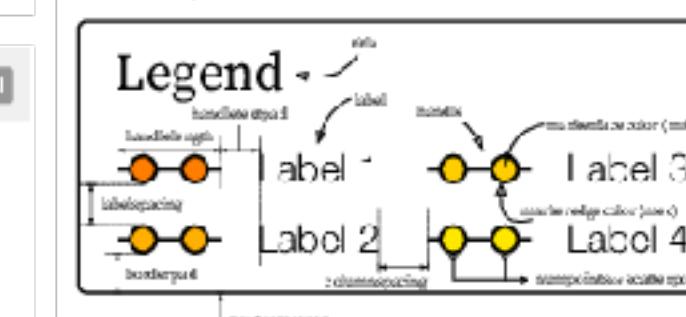


Colormaps

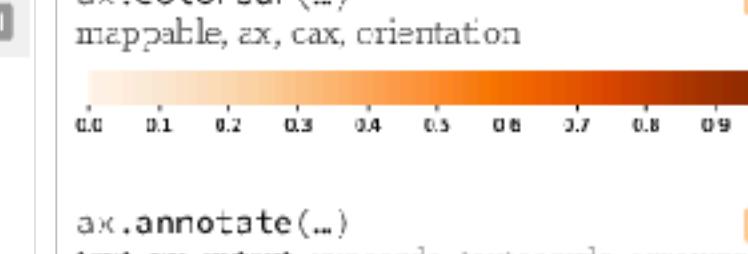


Ornaments

```
ax.legend(...)
handles, labels, loc, title, frameon
```



Legend



Text

```
text(x,y, text,...)
text, xy, xytext, textcoords, arrowprops
```



Event handling

```
fig, ax = plt.subplots()
def on_click(event):
    print(event)
fig.canvas.mpl_connect(
    'button_press_event', on_click)
```

Quick reminder

```
ax.grid()
ax.set_xylim(vmin, vmax)
ax.set_xylabel(label)
ax.set_xticks(ticks, [labels])
ax.set_yticks(ticks, [labels])
ax.set_title(title)
ax.tick_params(width=10, ...)
ax.set_axis_on/off()
```

```
fig.suptitle(title)
fig.tight_layout()
plt.gcf(), plt.gca()
mpl.rc('axes', linewidth=1, ...)
[fig|ax].patch.set_alpha(0)
text,r'$\frac{-e^{i\pi}}{2^n}$'
```

Keyboard shortcuts

ctrl+s	Save	ctrl+w	Close plot
-	Reset view	f	Fullscreen 0/1
-	View forward	b	View back
p	Pan view	o	Zoom to rect
x	X pan/zoom	y	Y pan/zoom
g	Minor grid 0/1	c	Major grid 0/1
-	X axis log/linear	l	Y axis log/linear

Ten simple rules

1. Know Your Audience
2. Identify Your Message
3. Adapt the Figure
4. Captions Are Not Optional
5. Do Not Trust the Defaults
6. Use Color Effectively
7. Do Not Mislead the Reader
8. Avoid "Chartjunk"
9. Get the Right Tools

Visualización en Python