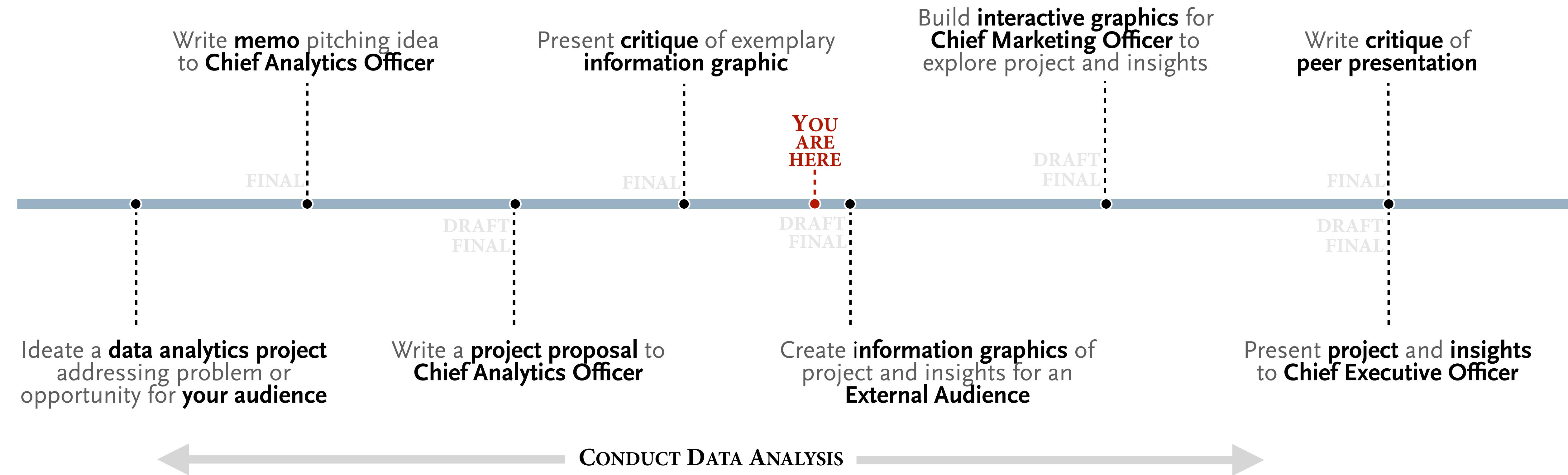


Storytelling with data

09 | Foundations of interactive data-driven, visual design

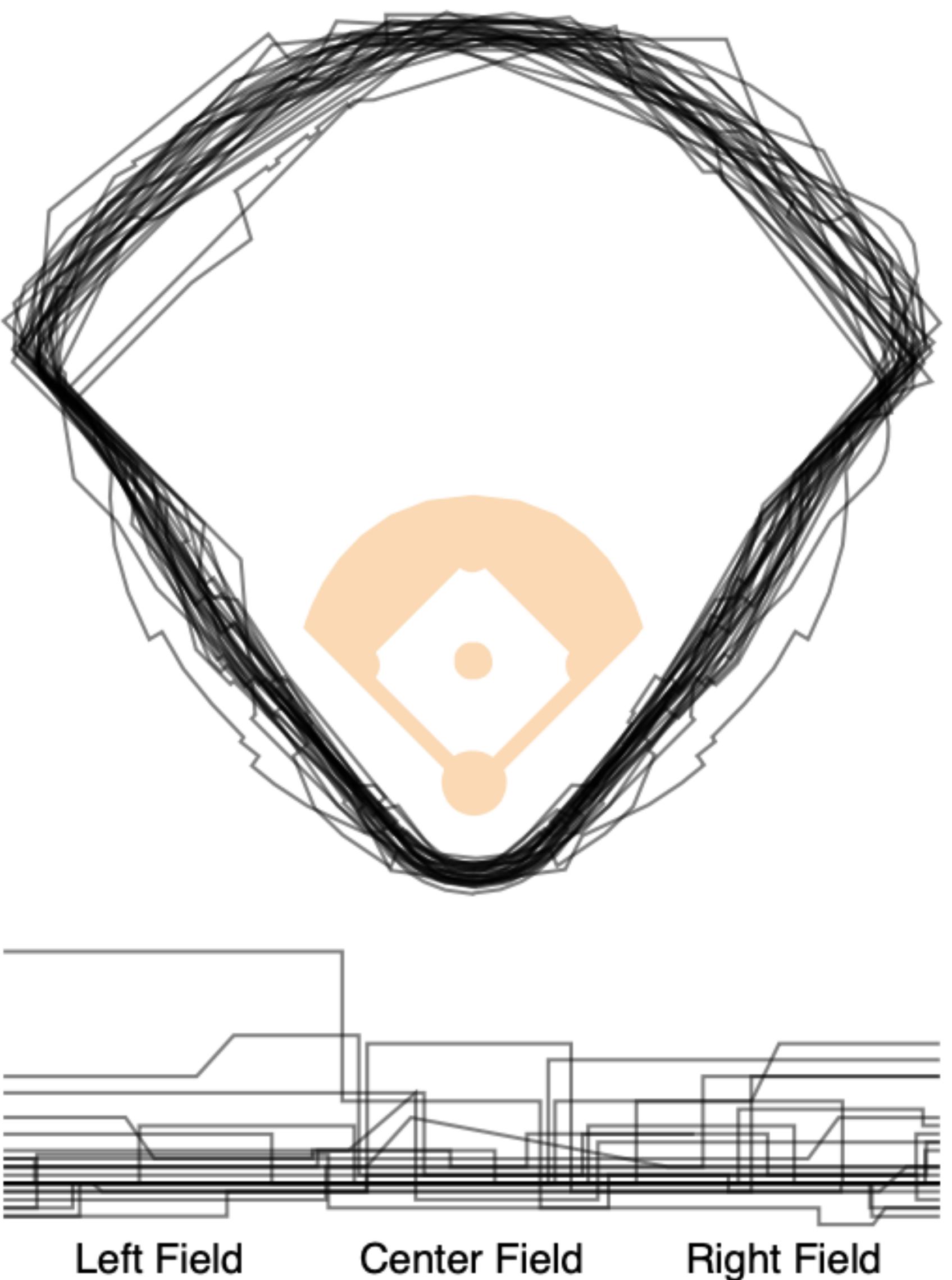
course overview | main course deliverables



note! — all design concepts for static *data-driven, visual narratives* apply to interactive *graphics*

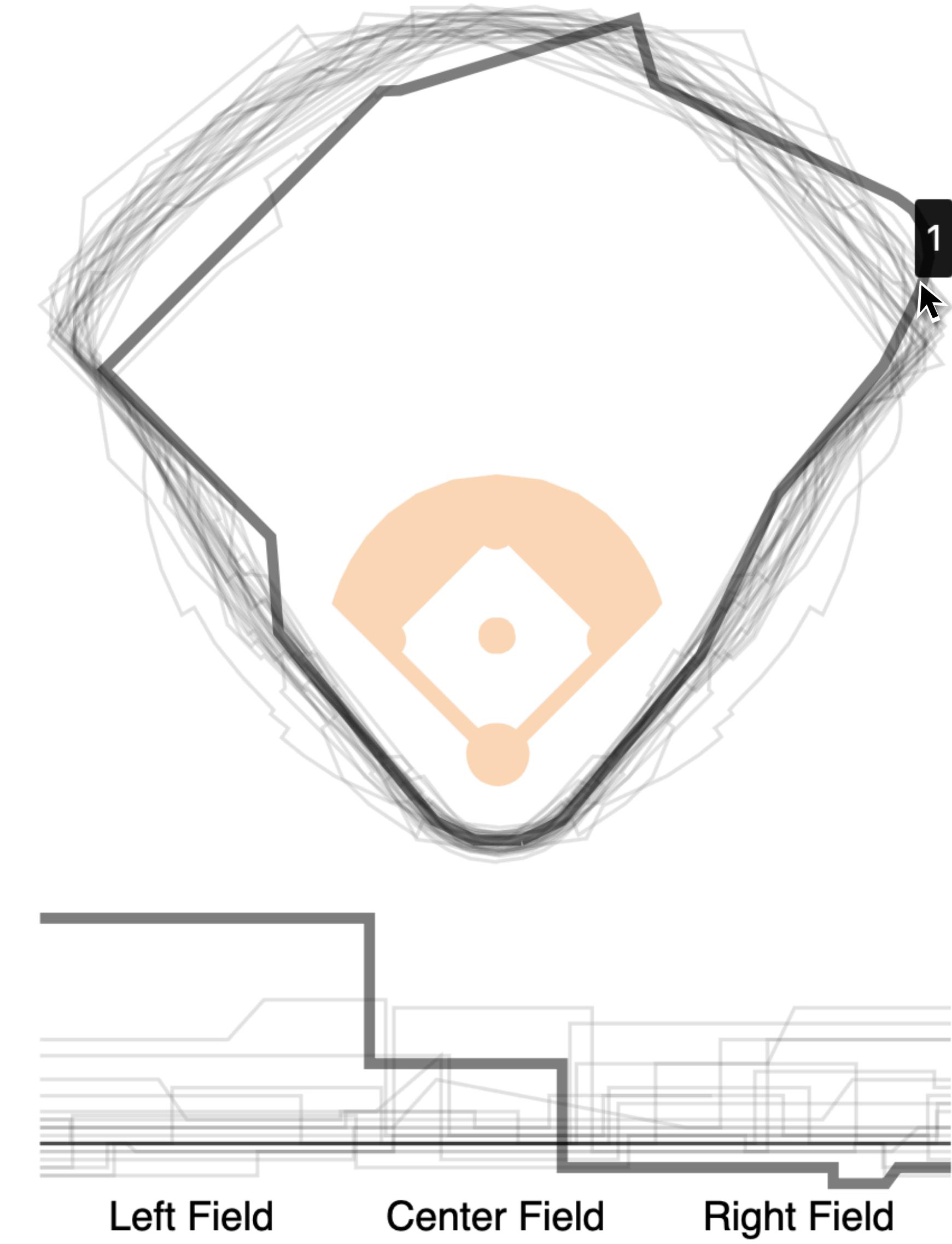
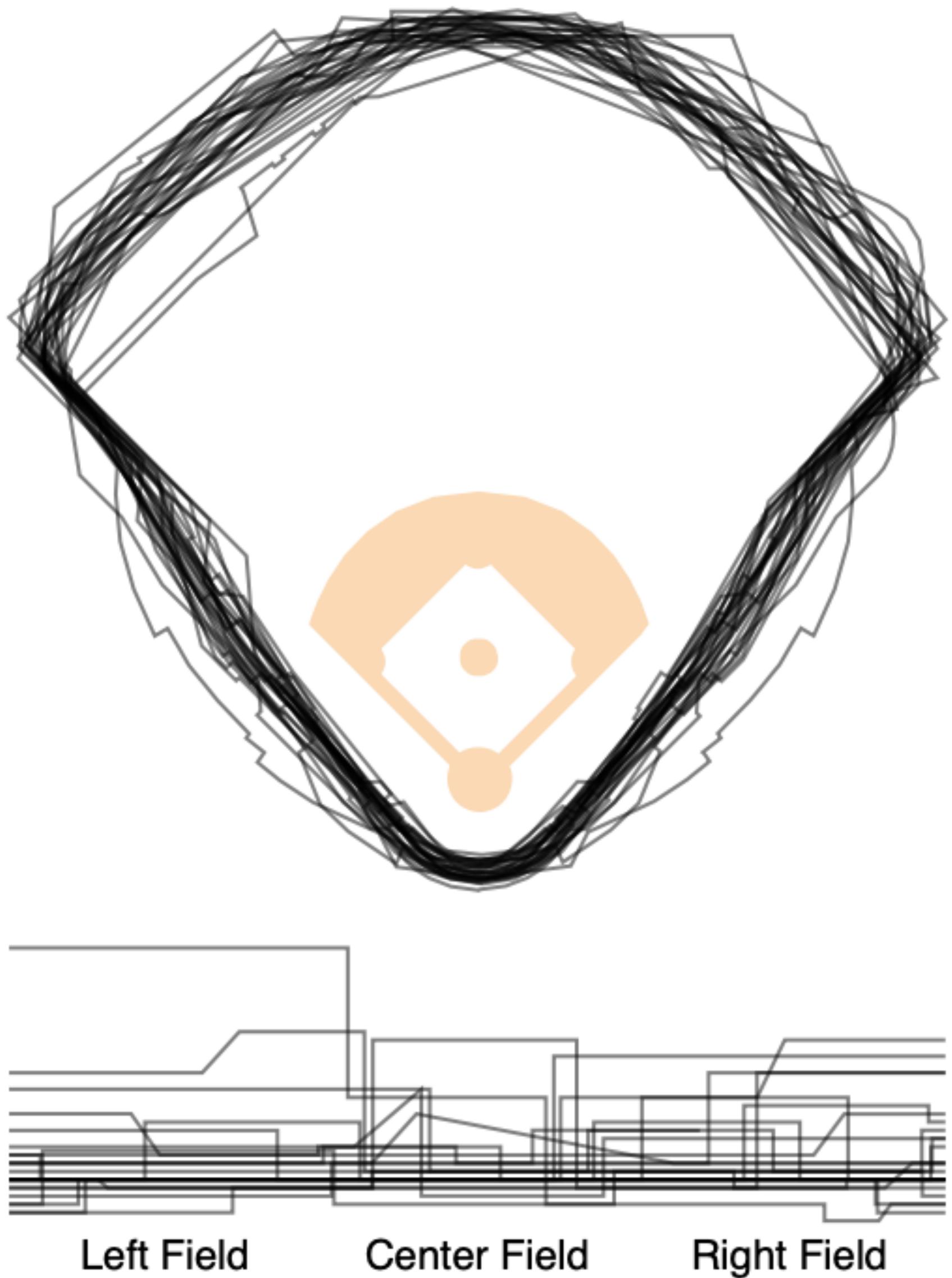
examples of interaction with data-driven, visuals

examples of interaction, follow the citation to the original, interactive version



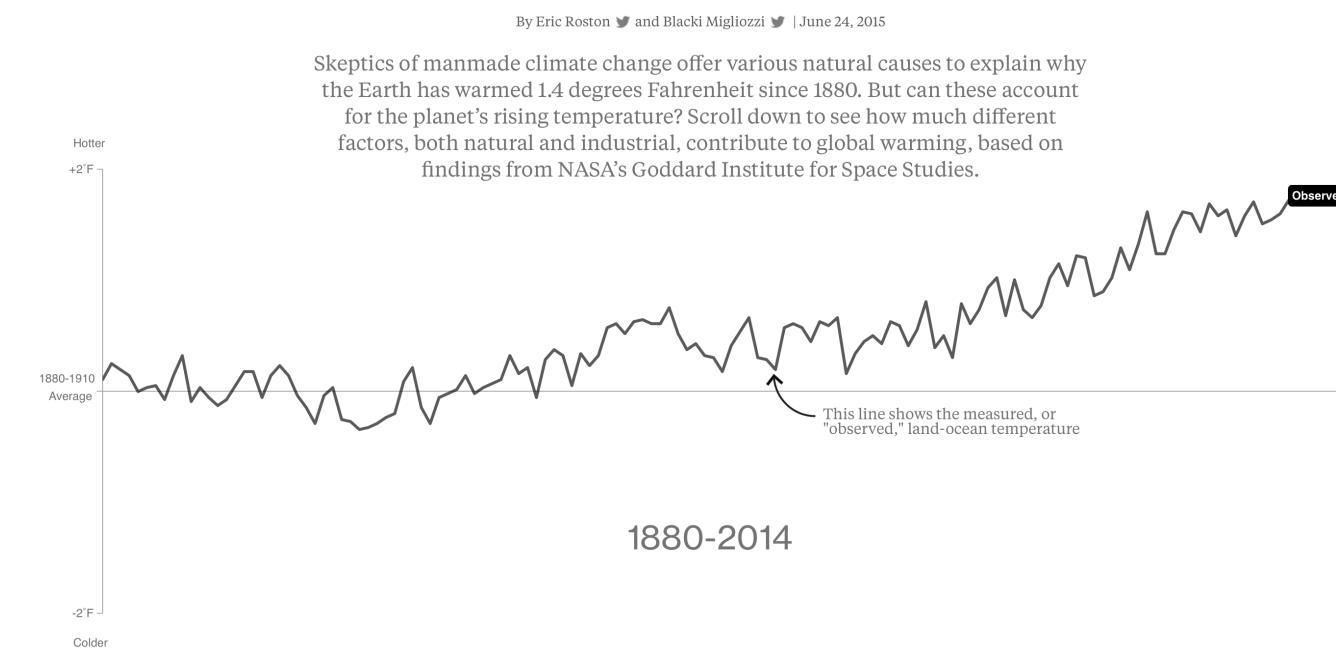
Spencer, Scott. Sec. 1.1.1.2 “Understanding data requires context.” In *Data in Wonderland*. 2021. https://ssp3nc3r.github.io/data_in_wonderland/#understanding-data-requires-context.

examples of interaction, follow the citation to the original, interactive version

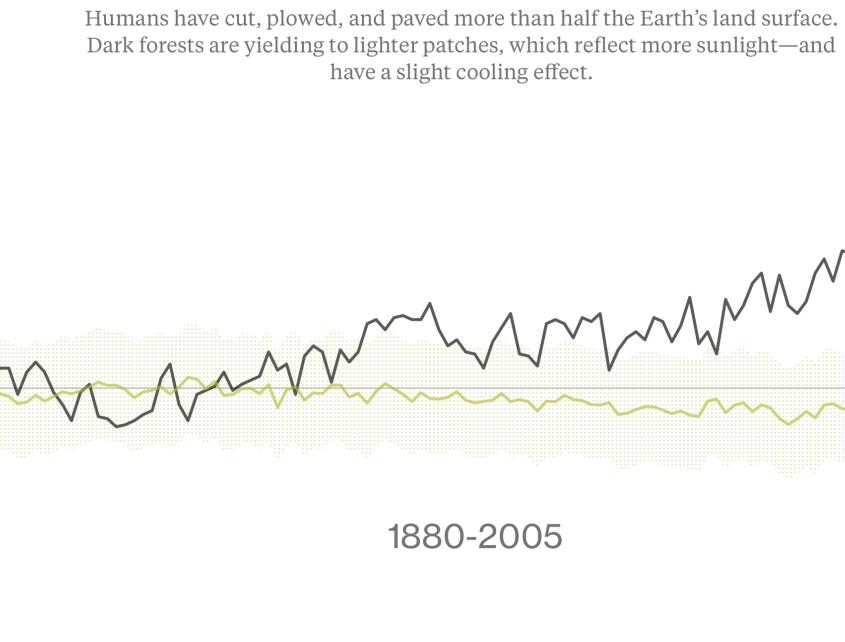


examples of interaction, follow the citation to the original, interactive version

What's Really Warming the World?

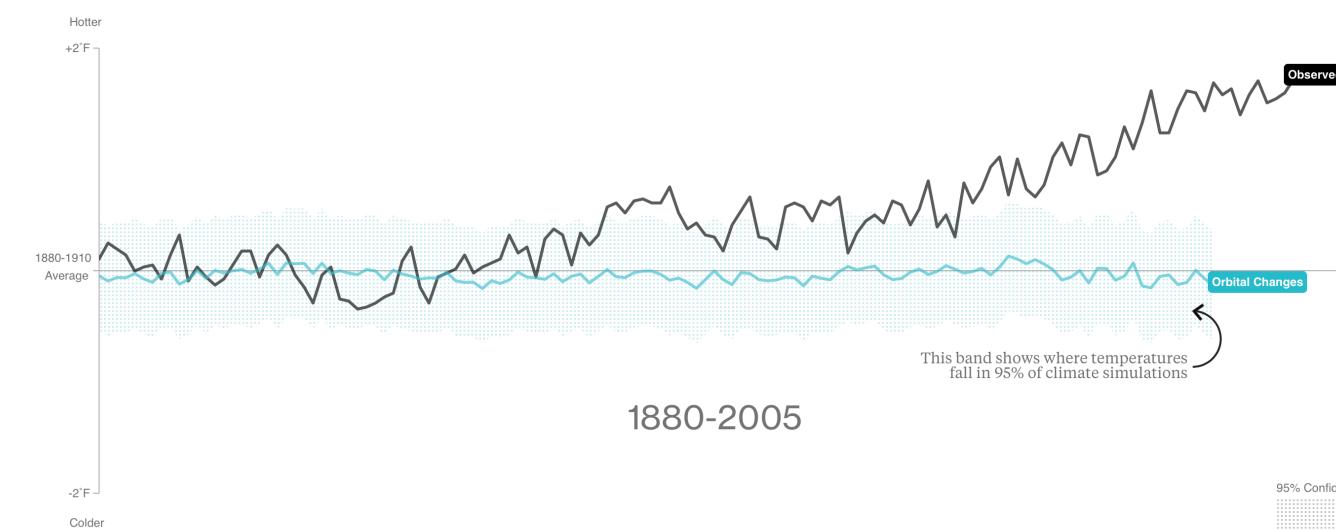


So If It's Not Nature, Is It Deforestation?



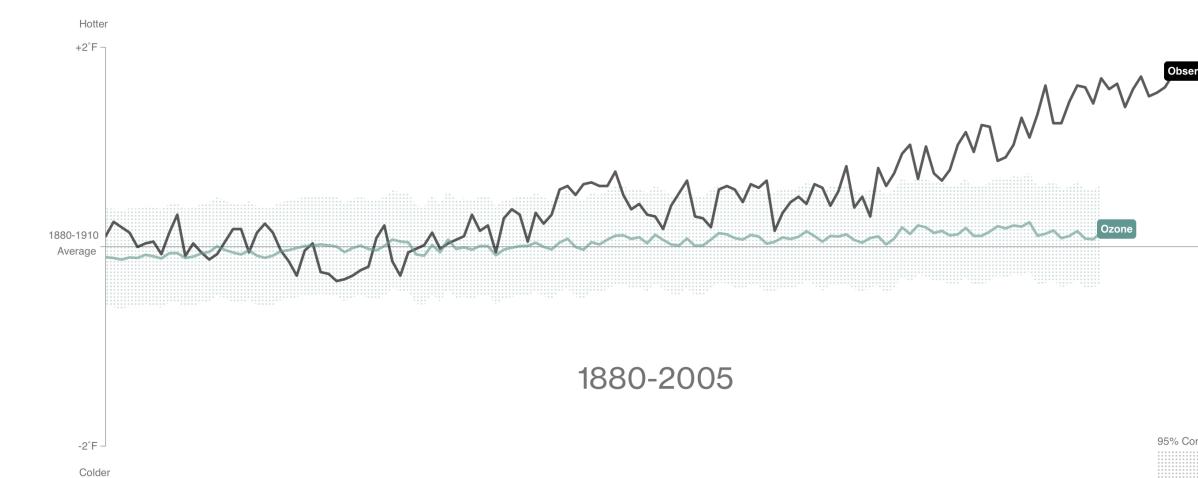
Is It the Earth's Orbit?

The Earth wobbles on its axis, and its tilt and orbit change over many thousands of years, pushing the climate into and out of ice ages. Yet the influence of orbital changes on the planet's temperature over 125 years has been negligible.



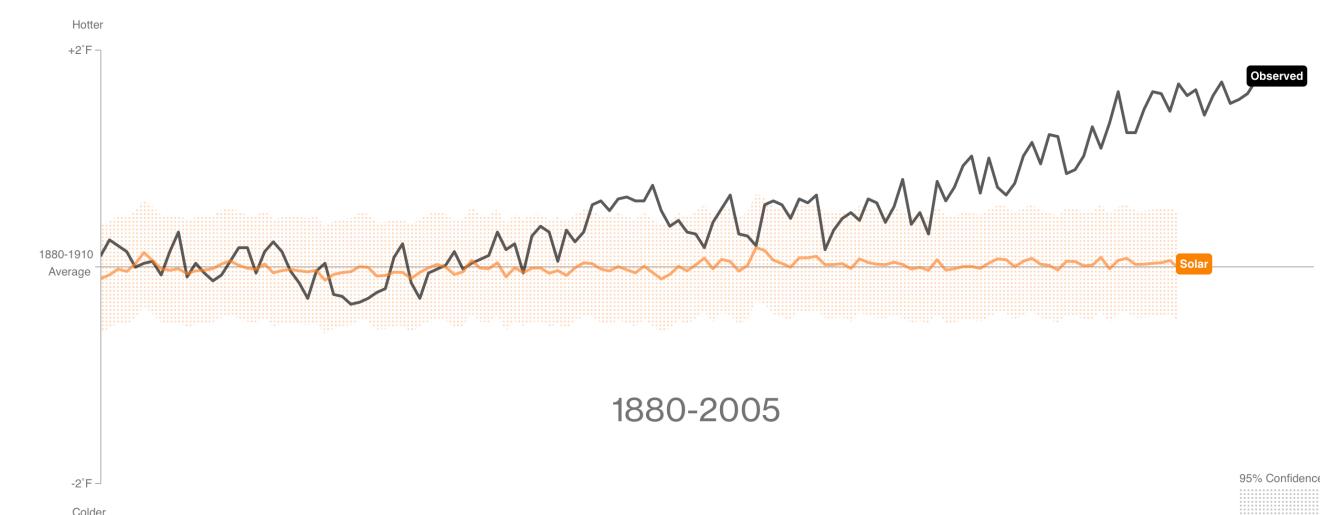
Or Ozone Pollution?

Natural ozone high in the atmosphere blocks harmful sunlight and cools things slightly. Closer to Earth, ozone is created by pollution and traps heat, making the climate a little bit hotter. What's the overall effect? Not much.



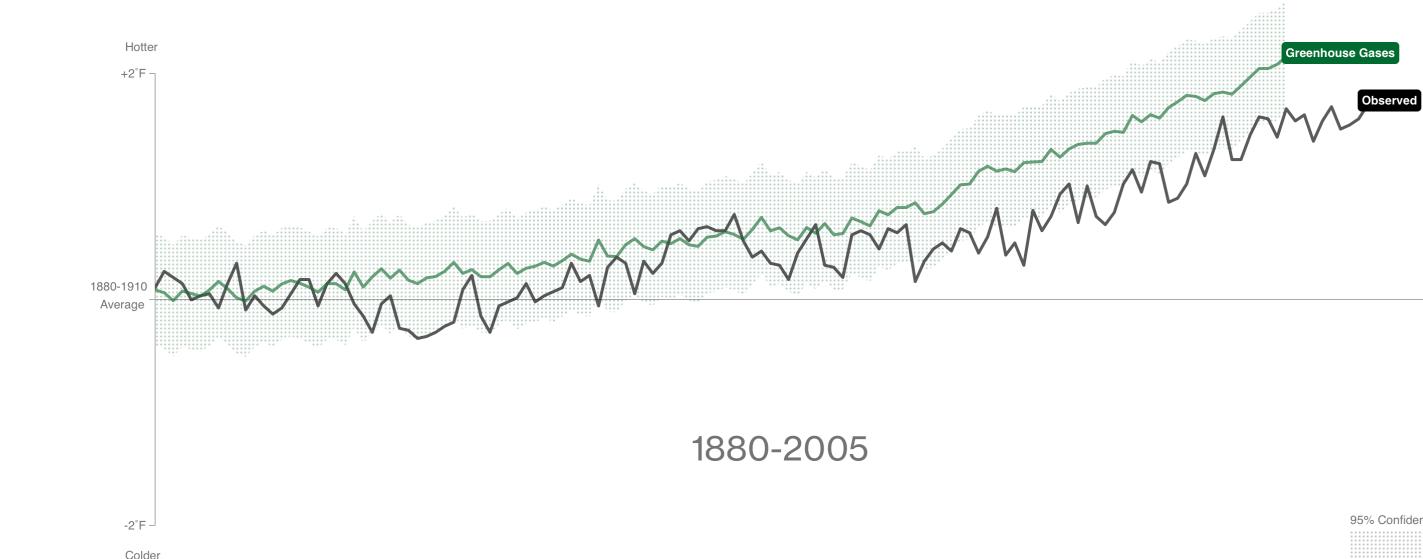
Is It the Sun?

The sun's temperature varies over decades and centuries. These changes have had little effect on the Earth's overall climate.

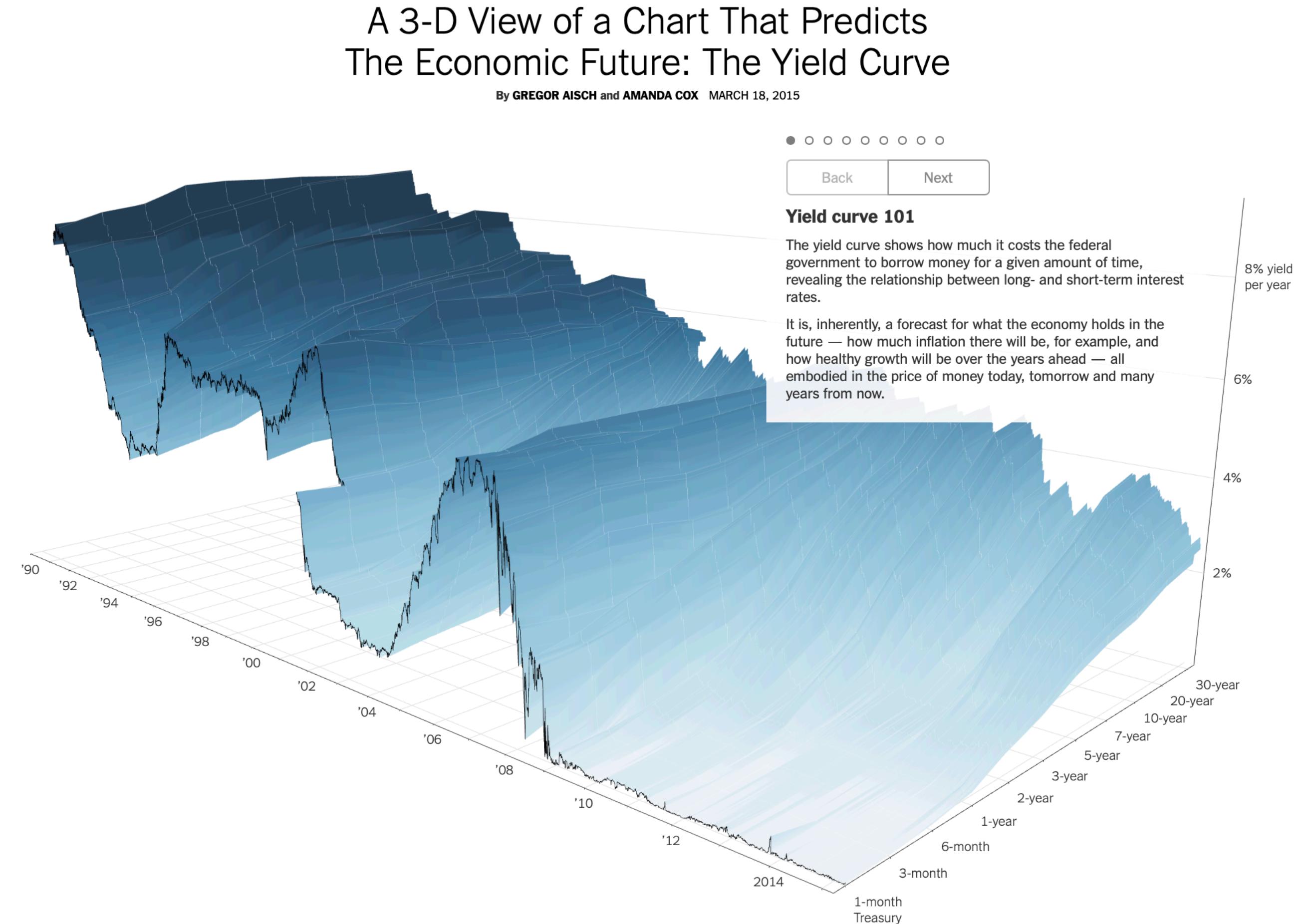


No, It Really Is Greenhouse Gases.

Atmospheric CO₂ levels are 40 percent higher than they were in 1750. The green line shows the influence of greenhouse gas emissions. It's no contest.



examples of interaction, follow the citation to the original, interactive version



Aisch, Gregor, and Amanda Cox. "A 3-D View of a Chart That Predicts The Economic Future: The Yield Curve." *The New York Times*. March 18, 2015, Online edition, sec. The Upshot. <https://www.nytimes.com/interactive/2015/03/19/upshot/3d-yield-curve-economic-growth.html>

examples of interaction, follow the citation to the original, interactive version

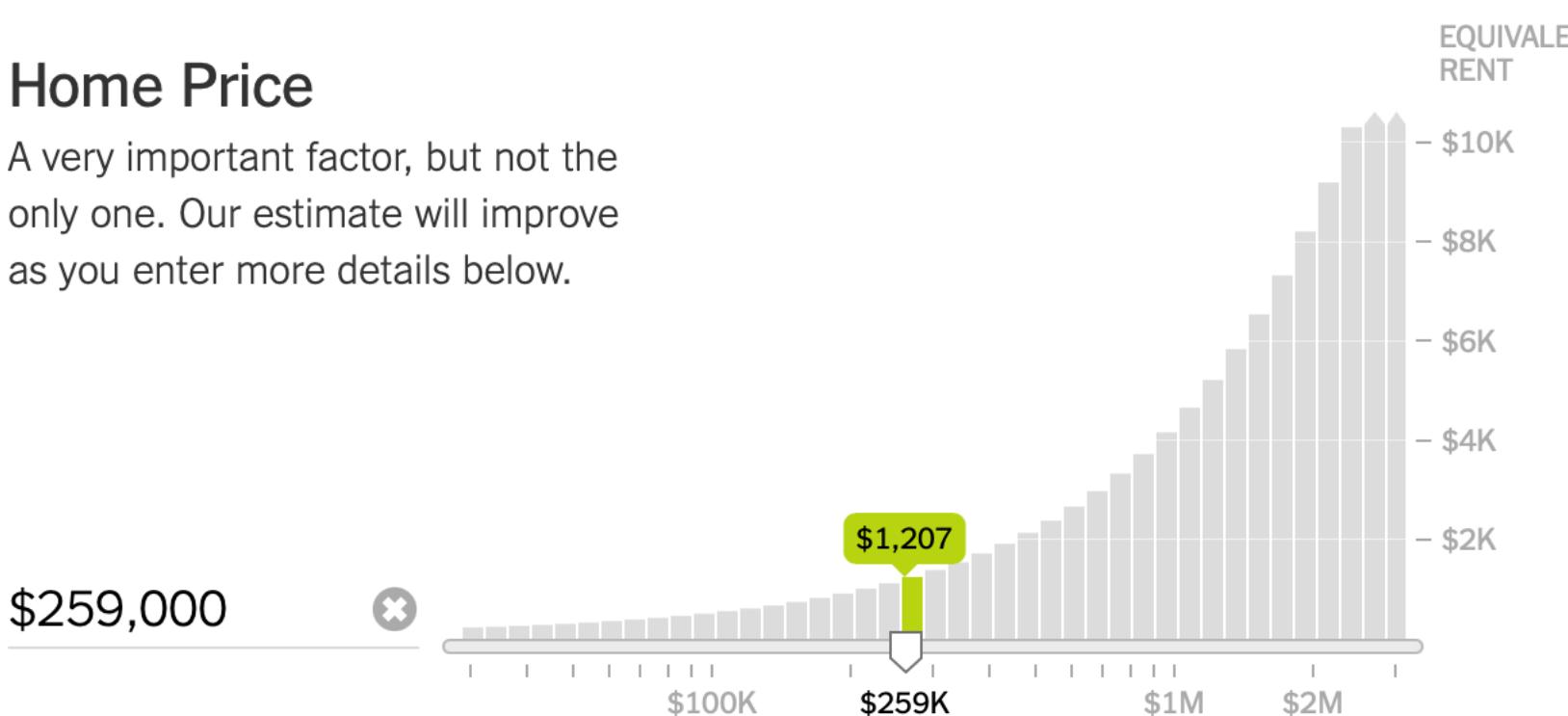
Is It Better to Rent or Buy?

By MIKE BOSTOCK, SHAN CARTER and ARCHIE TSE

The choice between buying a home and renting one is among the biggest financial decisions that many adults make. But the costs of buying are more varied and complicated than for renting, making it hard to tell which is a better deal. To help you answer this question, our calculator takes the most important costs associated with buying a house and computes the equivalent monthly rent. [RELATED ARTICLE](#)

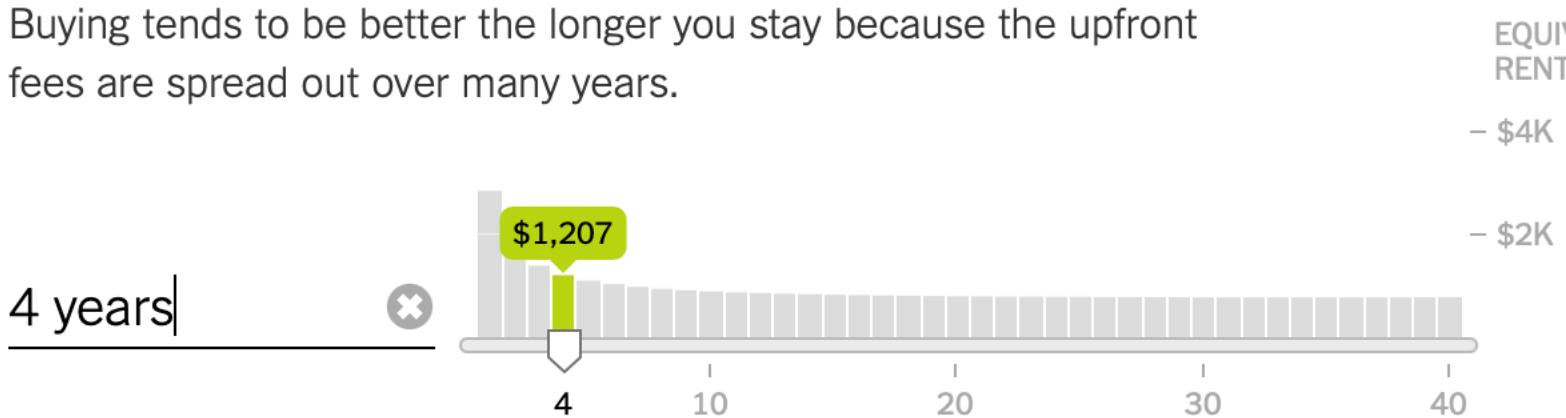
Home Price

A very important factor, but not the only one. Our estimate will improve as you enter more details below.



How Long Do You Plan to Stay?

Buying tends to be better the longer you stay because the upfront fees are spread out over many years.



If you can rent a similar home for less than ...

\$1,207 PER MONTH

... then renting is better.

	Rent	Buy
Initial costs	\$1,207	\$62,160
Recurring costs	\$60,919	\$72,559
Opportunity costs	\$3,284	\$12,639
Net proceeds	-\$1,207	-\$83,154
Total	\$64,204	\$64,204

How to Read the Charts Charts that are relatively flat indicate factors that are not particularly important to the outcome. Conversely, the factors that have steep slopes have a large impact.

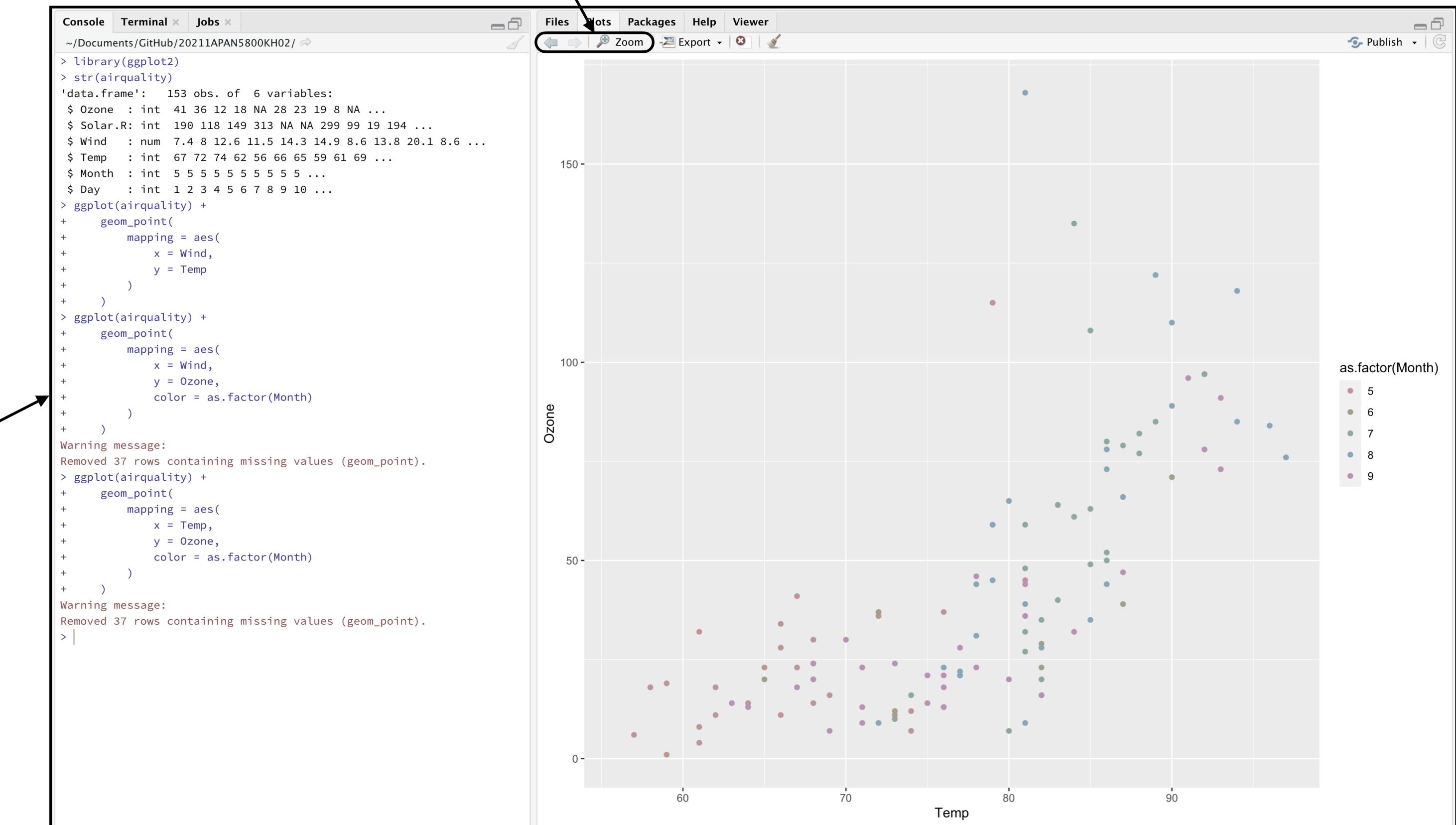
examples of interaction, we can make interactive graphics in RStudio; but is RStudio some kind of interactive graphic?

RStudio is a *web browser application* with a *graphical user interface*. We can “*interact*” with it by **entering** text (code), **clicking** buttons, etc. In *response*, RStudio *changes the view of the data graphic* we see. Is this an interactive graphic?

-\(_\text{U}\) /-

text entry

back, next, zoom



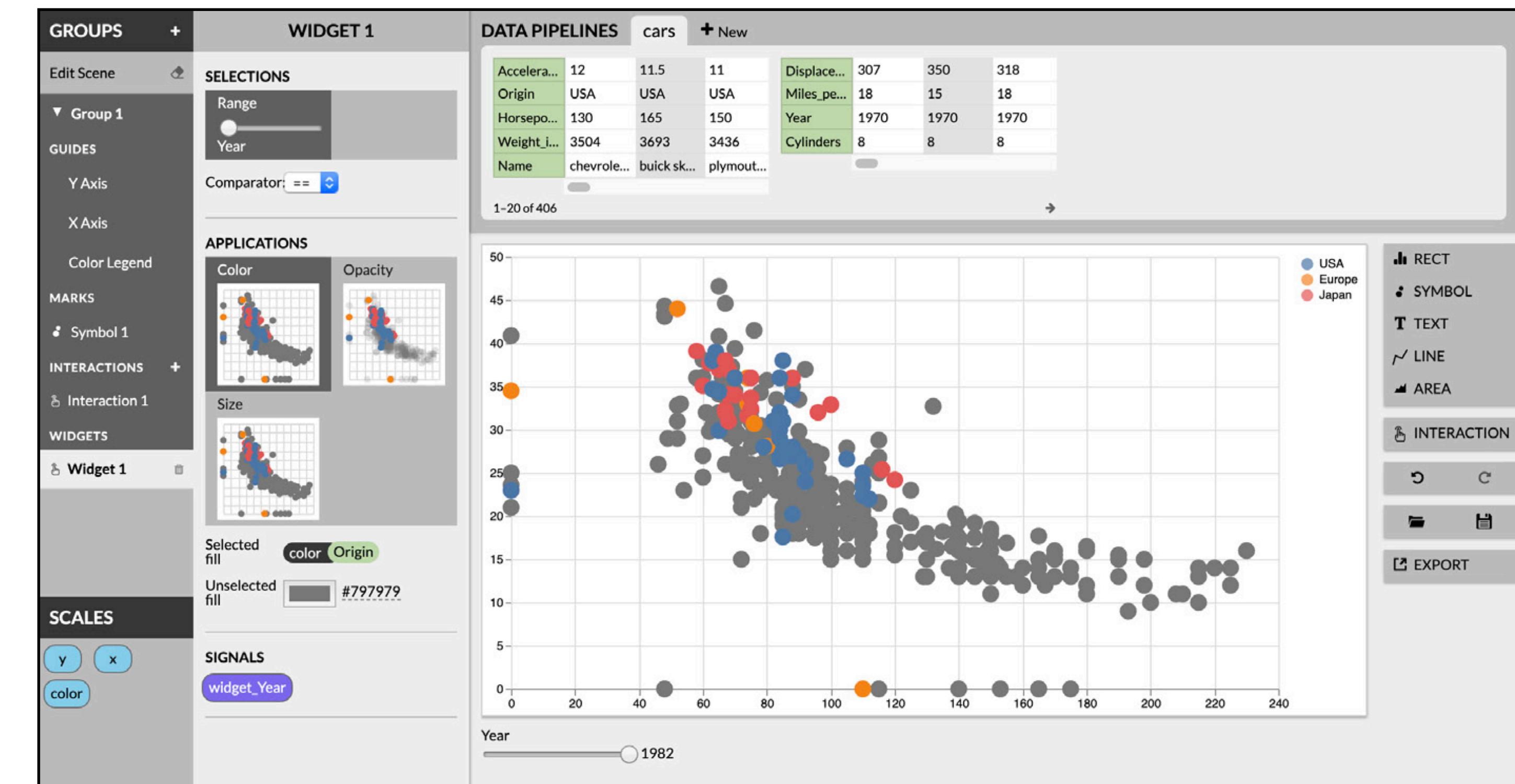
responsive graphics

examples of interaction, we can make interactive graphics in Lyra2; but is Lyra2 some kind of interactive graphic?

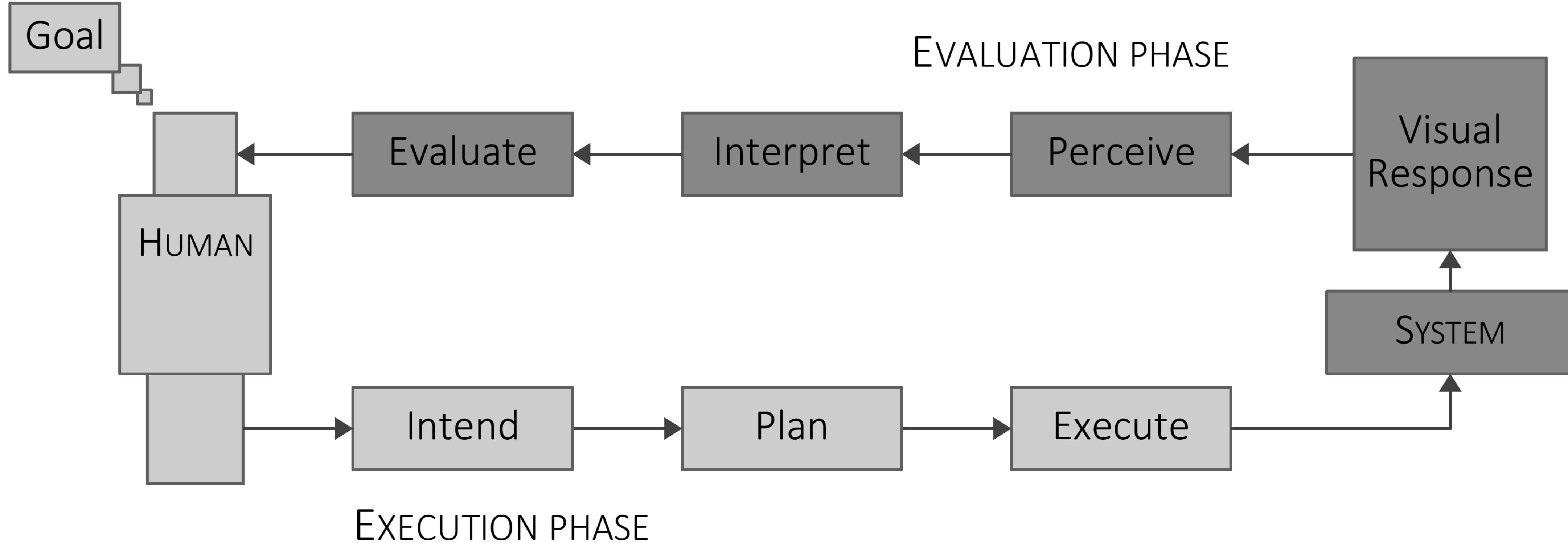
Lyra2 is a *web browser application* with a *graphical user interface*. We can “*interact*” with it by **dragging** and **dropping**, **clicking** buttons, similar to Tableau but free, open-source, and based on the powerful Vega / D3 javascript languages. In *response*, Lyra2 *changes the view of the data graphic* we see. Is this an interactive graphic?

-_(ツ)_/-

<http://vega.github.io/lyra/>



how we interact, what's interactivity? — “human in the loop” of executing and evaluating

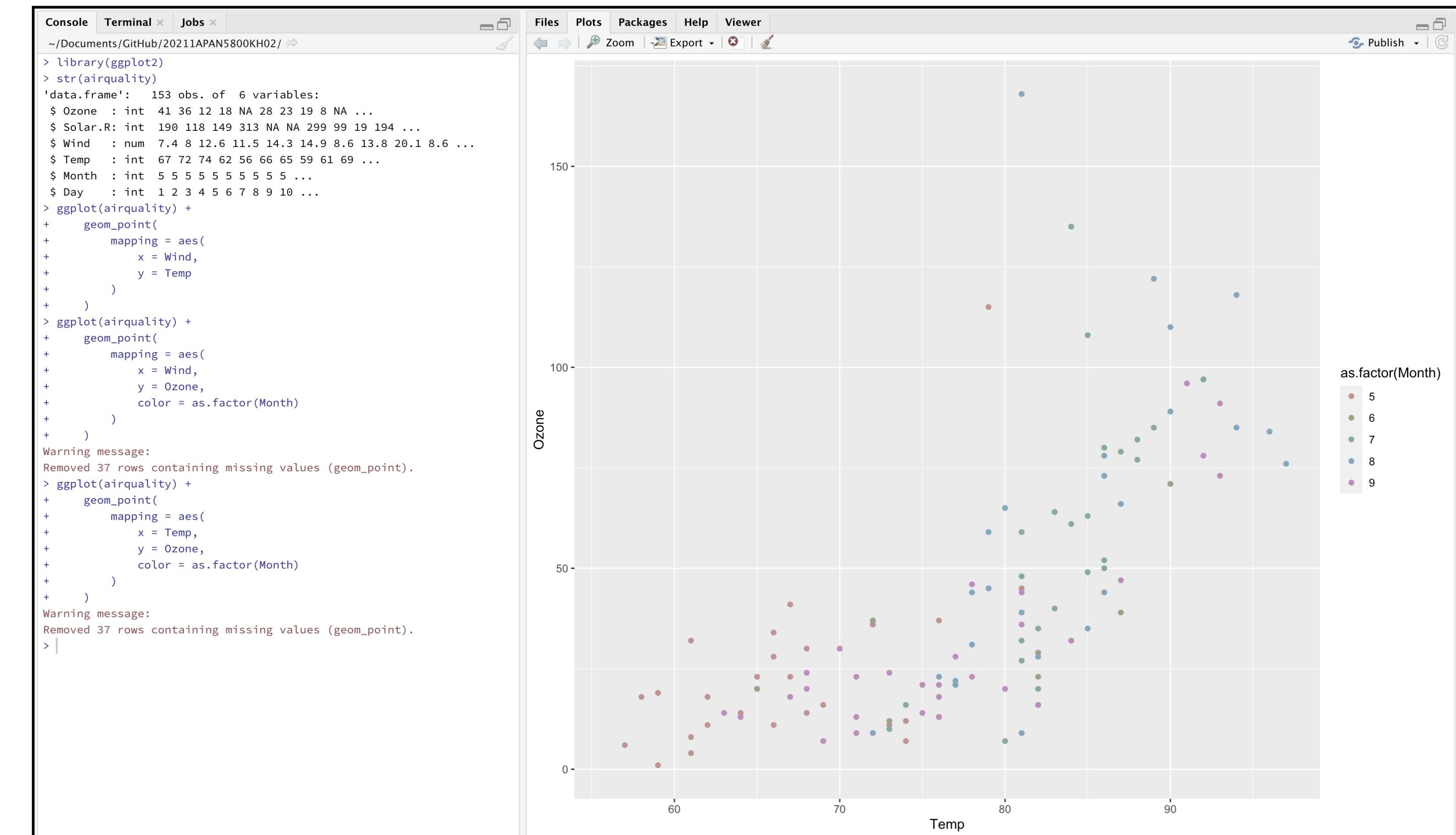


examples of interaction, we can make interactive graphics in RStudio; but is RStudio some kind of interactive graphic?

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directness	interaction	example
-	source code editing	c++ / graphics.h
↔	scripting commands	r / rstudio / ggplot2
	graphical interface	buttons, sliders, text boxes
↓	direct manipulation	graphical element touched by pointer directed with mouse or trackpad
+	direct touch	graphical element touched by finger on screen



***why* we interact with data-driven visuals**

why we interact, reveal all the relationships

“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 himself.”

— Jaques Bertin, 1981

why we interact, typical goals in interaction with data visuals

Mark something as **interesting**

Show me **something else**

Show me a **different arrangement**

Show me a **different representation**

Show me more or less **detail**

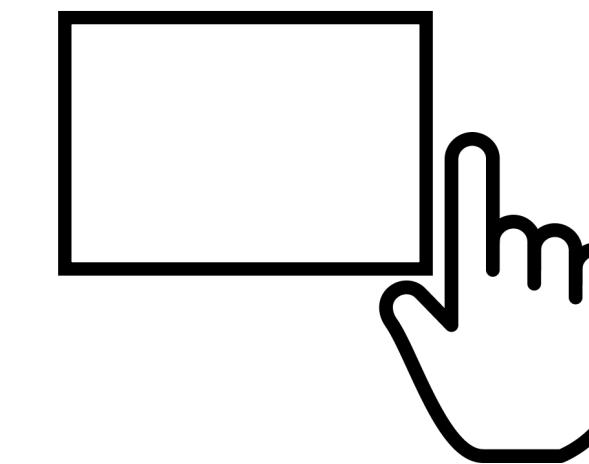
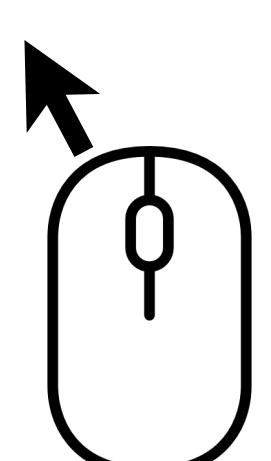
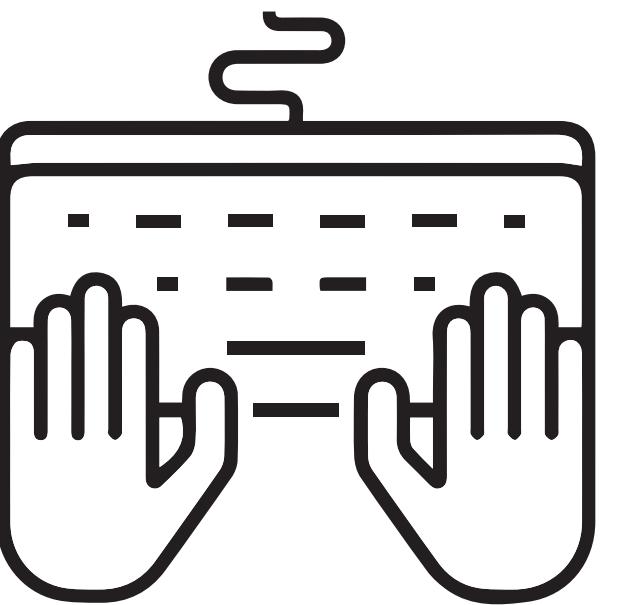
Show me something **conditionally**

Show me **related** things

Let me go back to **where I've been**

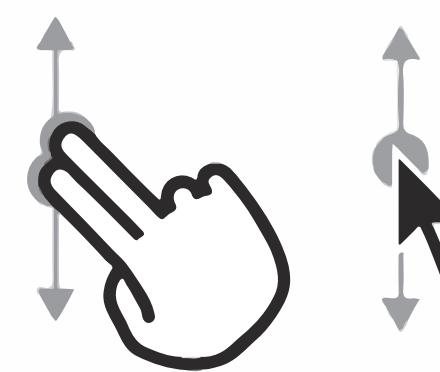
how we interact with data-driven visuals

how we interact, common *interfaces* and *actions*

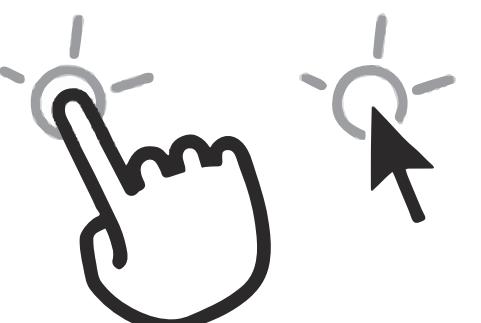


POINTING, HOVERING

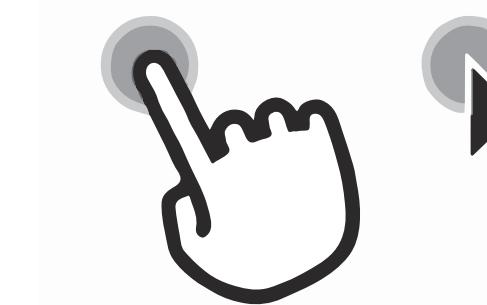
SCROLLING



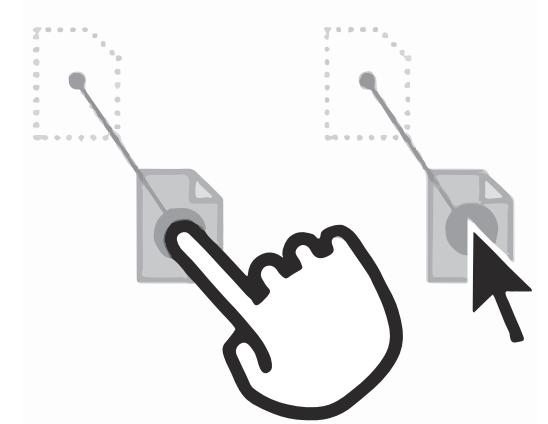
CLICKING



PRESSING



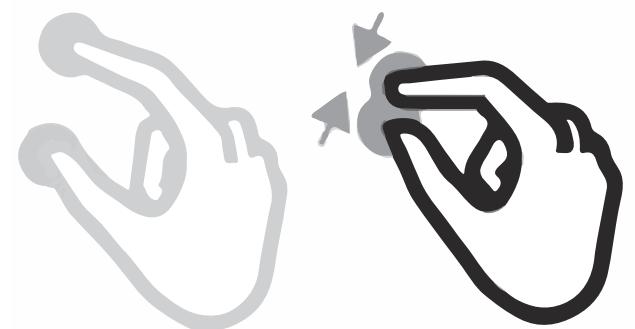
DRAGGING



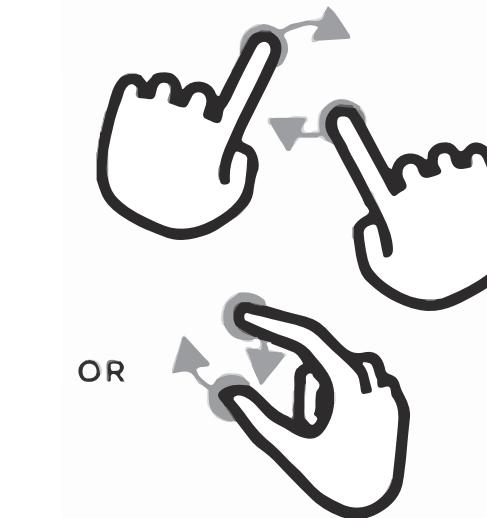
SWIPING



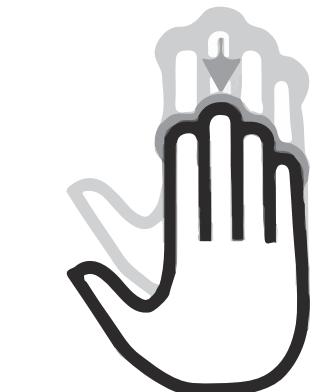
PINCHING, SPREADING



ROTATING

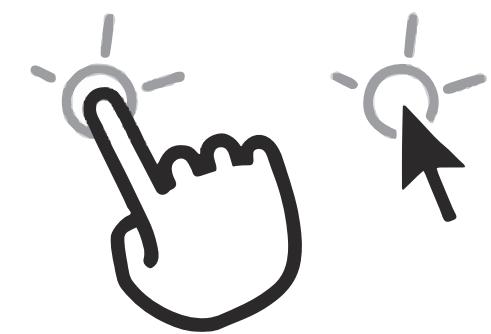


GESTURES WITH
MULTIPLE FINGERS

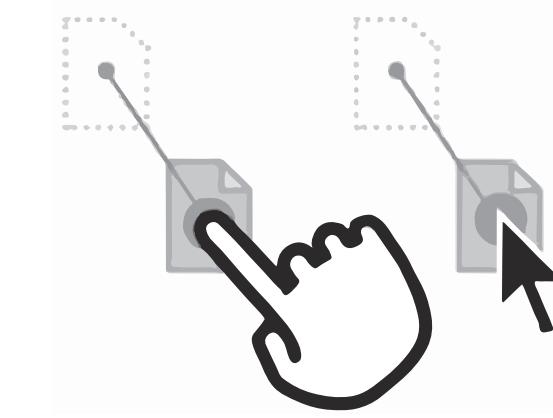


how we interact, our *actions* can trigger *events* on elements like *widgets* or directly on *data encodings*

CLICKING



DRAGGING



text entry

button

radio-button
group

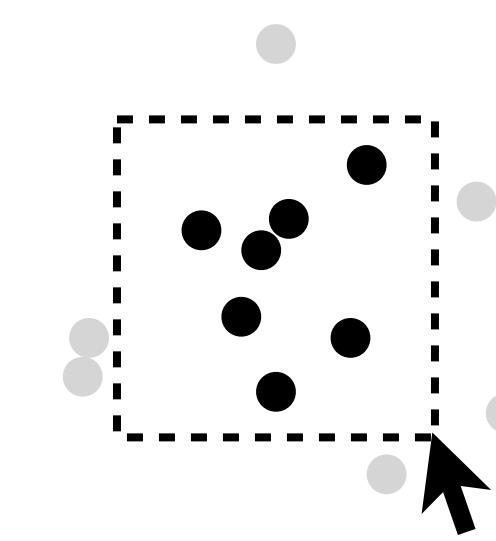
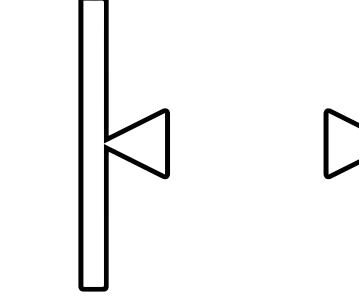
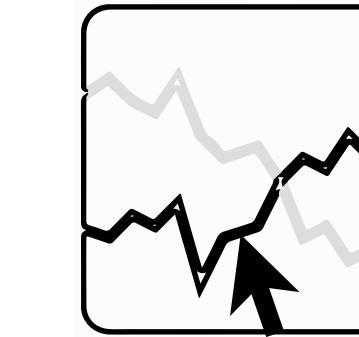
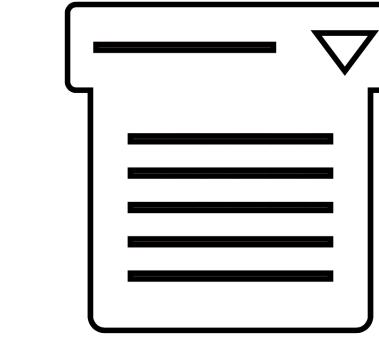
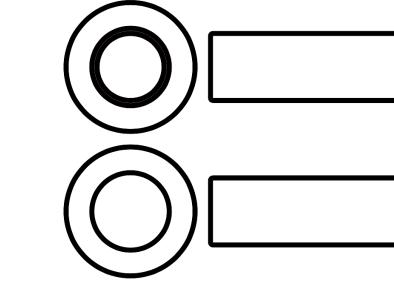
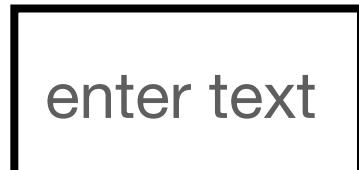
drop-down
list

direct selection of
data encodings

slider

range bars

selecting group
of encodings



... where the elements *listen* to events and *react* by changing data or attributes to responsive visual encodings.

how we interact, common visualization and manipulation *tasks*

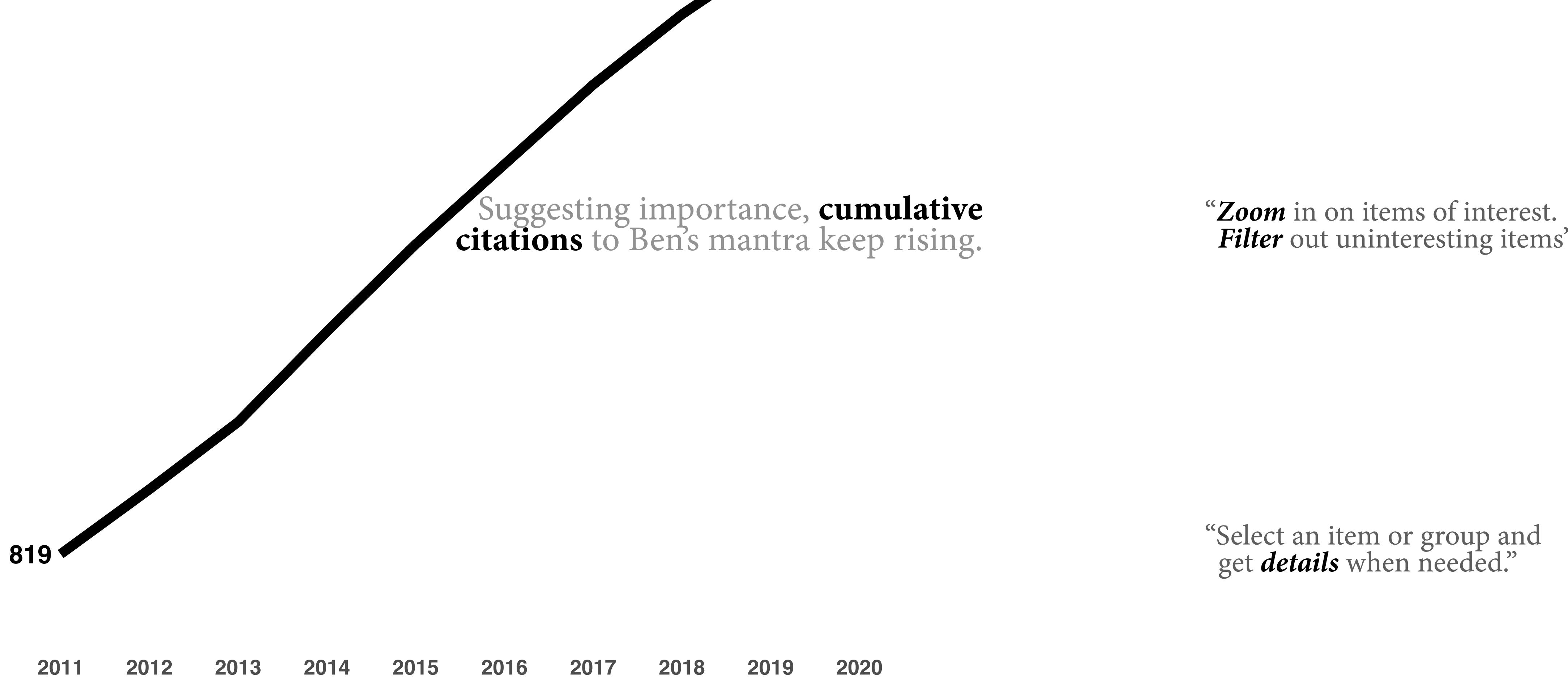
Data and view specification	Visualize data by choosing visual encodings Filter out data to focus on relevant items Sort items to expose patterns Derive values of models from source data
View manipulation	Select items to highlight, filter, or manipulate Navigate to examine high-level patterns and low-level detail Coordinate views for linked exploration Organize multiple windows and workspaces
Process and provenance	Record analysis histories for revisit, review, and sharing Annotate patterns to document findings Share views and annotations to enable collaboration Guide users through analysis tasks or stories

how we interact, ordering interactions, one approach — *overview first, zoom and filter, then details-on-demand*

Twenty-five years ago,

“Overview first, zoom and filter, then details-on-demand.”

— Ben Shneiderman, Computer Scientist, 1996.



“Gain an **overview** of the entire collection.”

“**Zoom** in on items of interest. **Filter** out uninteresting items”

“Select an item or group and get **details** when needed.”

Source: IEEE repository.

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scott.spencer@columbia.edu

overview first, what's an *overview*?

OED Oxford English Dictionary
The definitive record of the English language

Quick search:
Lost for Words? [A](#)

Back to Results | Next » Help on Dictionary Entry | Print | Save | Email | Cite

overview, n.

View as: Outline | Full entry

Text size: [A](#) [A](#)

Quotations: Show all | Hide all Keywords: On | Off

Pronunciation: [?] Brit. /'əʊvəvju:/, U.S. /'ouvərvju:/

Forms: see OVER- prefix and VIEW *n.*

Frequency (in current use):

Origin: Formed within English, by conversion. Etymon: OVERVIEW *v.*

Etymology: < OVERVIEW *v.*

†1. Inspection; overseeing, supervision. *Obsolete.*

Thesaurus »

1598 W. SHAKESPEARE *Love's Labour's Lost* iv. iii. 173 Too bitter is thy iest. Are we betrayed thus to thy ouer-view?

1644 W. LAUD Wks. (1854) IV. 242 The business of leaving the care of these books and the overview of them to my chaplains.

(Hide quotations)

2. Originally U.S. A general survey; a comprehensive review of facts or ideas; a concise statement or outline of a subject. Also: a broad or overall view of a subject.

Thesaurus »

Categories »

1916 *Jrnl. Philos., Psychol. & Sci. Methods* 13 471 An overview of the field of behavior under the following heads.

1934 *Jrnl. Philos. Sci.* 1 474 Having thus given, in organismic terms, a brief over-view of the nature and content of thought, we may now consider for a moment its logical aspect.

1944 *Mind* 53 276 According to the jacket..the purpose of this book is to present 'an overview of present-day philosophical trends'.

1969 M. CRICHTON *Andromeda Strain* v. 44 A scientist with a conscience, an overview, an appreciation of the significance of events.

1975 A. S. MISKIMIN *Renaissance Chaucer* viii. 230 In an overview such as this, many questions will be begged.

1993 A. TOFFLER & H. TOFFLER *War & Anti-war* xvi. 141 In a preliminary overview of what they call 'cyberwar', they touch on broad strategic questions.

(Hide quotations)

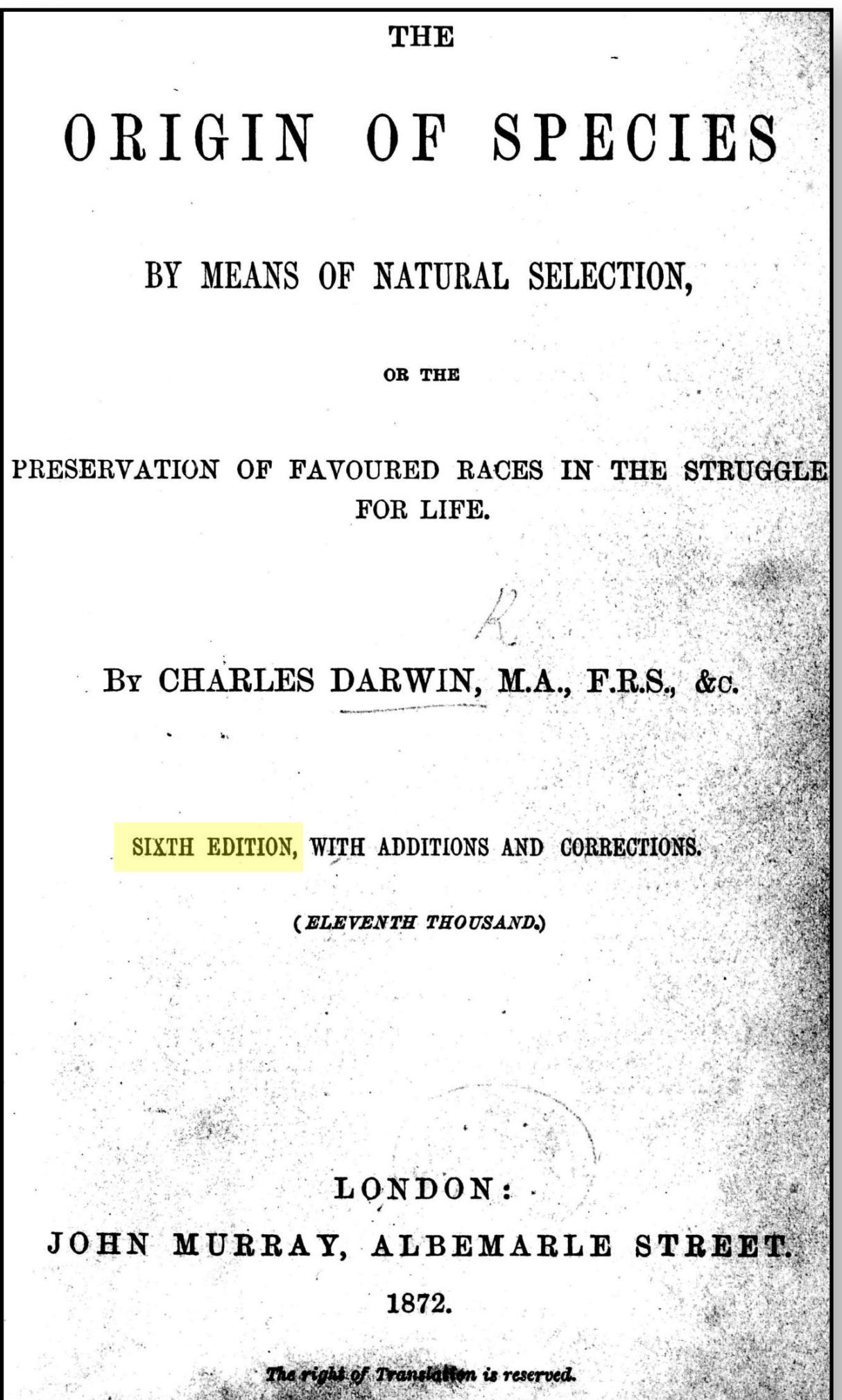
3. A view from above. Cf. OVERVIEW *v.* 2.

1980 *Hunting Ann.* 1981 29/3 We didn't have a tree stand so I picked a little grassy knoll that allowed me a fairly good overview of the riverbottom.

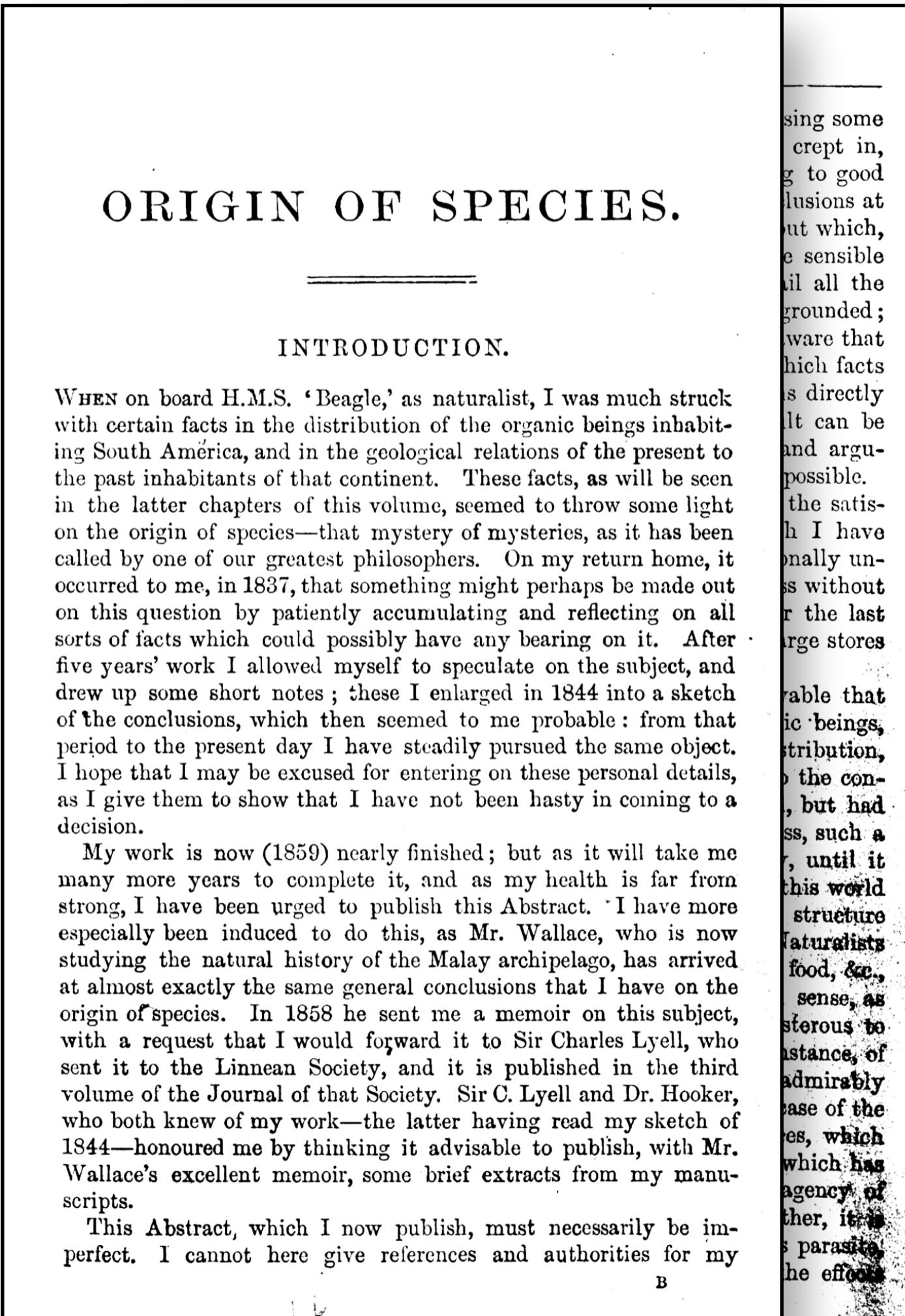
1992 *Zoo Life* Winter 103/1 New African Panorama brings you face to face with giraffes and an exciting overview of the 13-acre African plains.

(Hide quotations)

overview first, can a book's *table of contents* be an *overview*?



overview first, can a book's *introduction* be an overview?



Introduction. 3

of external conditions, or of habit, or of the volition of the plant itself.

It is, therefore, of the highest importance to gain a clear insight into the means of modification and coadaptation. At the commencement of my observations it seemed to me probable that a careful study of domesticated animals and of cultivated plants would offer the best chance of making out this obscure problem. Nor have I been disappointed; in this and in all other perplexing cases I have invariably found that our knowledge, imperfect though it be, of variation under domestication, afforded the best and safest clue. I may venture to express my conviction of the high value of such studies, although they have been very commonly neglected by naturalists.

From these considerations, I shall devote the first chapter of this Abstract to Variation under Domestication. We shall thus see that a large amount of hereditary modification is at least possible; and, what is equally or more important, we shall see how great is the power of man in accumulating by his Selection successive slight variations. I will then pass on to the variability of species in a state of nature; but I shall, unfortunately, be compelled to treat this subject far too briefly, as it can be treated properly only by giving long catalogues of facts. We shall, however, be enabled to discuss what circumstances are most favourable to variation. In the next chapter the Struggle for Existence amongst all organic beings throughout the world, which inevitably follows from the high geometrical ratio of their increase, will be considered. This is the doctrine of Malthus, applied to the whole animal and vegetable kingdoms. As many more individuals of each species are born than can possibly survive; and as, consequently, there is a frequently recurring struggle for existence, it follows that any being, if it vary however slightly in any manner profitable to itself, under the complex and sometimes varying conditions of life, will have a better chance of surviving, and thus be naturally selected. From the strong principle of inheritance, any selected variety will tend to propagate its new and modified form.

This fundamental subject of Natural Selection will be treated at some length in the fourth chapter; and we shall then see how Natural Selection almost inevitably causes much Extinction of the less improved forms of life, and leads to what I have called Divergence of Character. In the next chapter I shall discuss the complex and little known laws of variation. In the five succeeding chapters, the most apparent and gravest difficulties in accepting the theory will be given: namely, first, the difficulties of transitions, or how a

B 2

4

Introduction.

simple being or a simple organ can be changed and perfected into a highly developed being or into an elaborately constructed organ; secondly, the subject of Instinct, or the mental powers of animals; thirdly, Hybridism, or the infertility of species and the fertility of varieties when intercrossed; and fourthly, the imperfection of the Geological Record. In the next chapter I shall consider the geological succession of organic beings throughout time; in the twelfth and thirteenth, their geographical distribution throughout space; in the fourteenth, their classification or mutual affinities, both when mature and in an embryonic condition. In the last chapter I shall give a brief recapitulation of the whole work, and a few concluding remarks.

No one ought to feel surprise at much remaining as yet unexplained in regard to the origin of species and varieties, if he make due allowance for our profound ignorance in regard to the mutual relations of the many beings which live around us. Who can explain why one species ranges widely and is very numerous, and why another allied species has a narrow range and is rare? Yet these relations are of the highest importance, for they determine the present welfare, and, as I believe, the future success and modification of every inhabitant of this world. Still less do we know of the mutual relations of the innumerable inhabitants of the world during the many past geological epochs in its history. Although much remains obscure, and will long remain obscure, I can entertain no doubt, after the most deliberate study and dispassionate judgment of which I am capable, that the view which most naturalists until recently entertained, and which I formerly entertained—namely, that each species has been independently created—is erroneous. I am fully convinced that species are not immutable; but that those belonging to what are called the same genera are more closely related to each other, and are the descendants of some other and generally extinct species, in the same manner as the acknowledged varieties of any one species are the descendants of that species. Furthermore, I am convinced that Natural Selection has been the most important, but not the exclusive, means of modification.

overview first, can a single view of every word in a book, color-coded by date added to edition, be an *overview*?

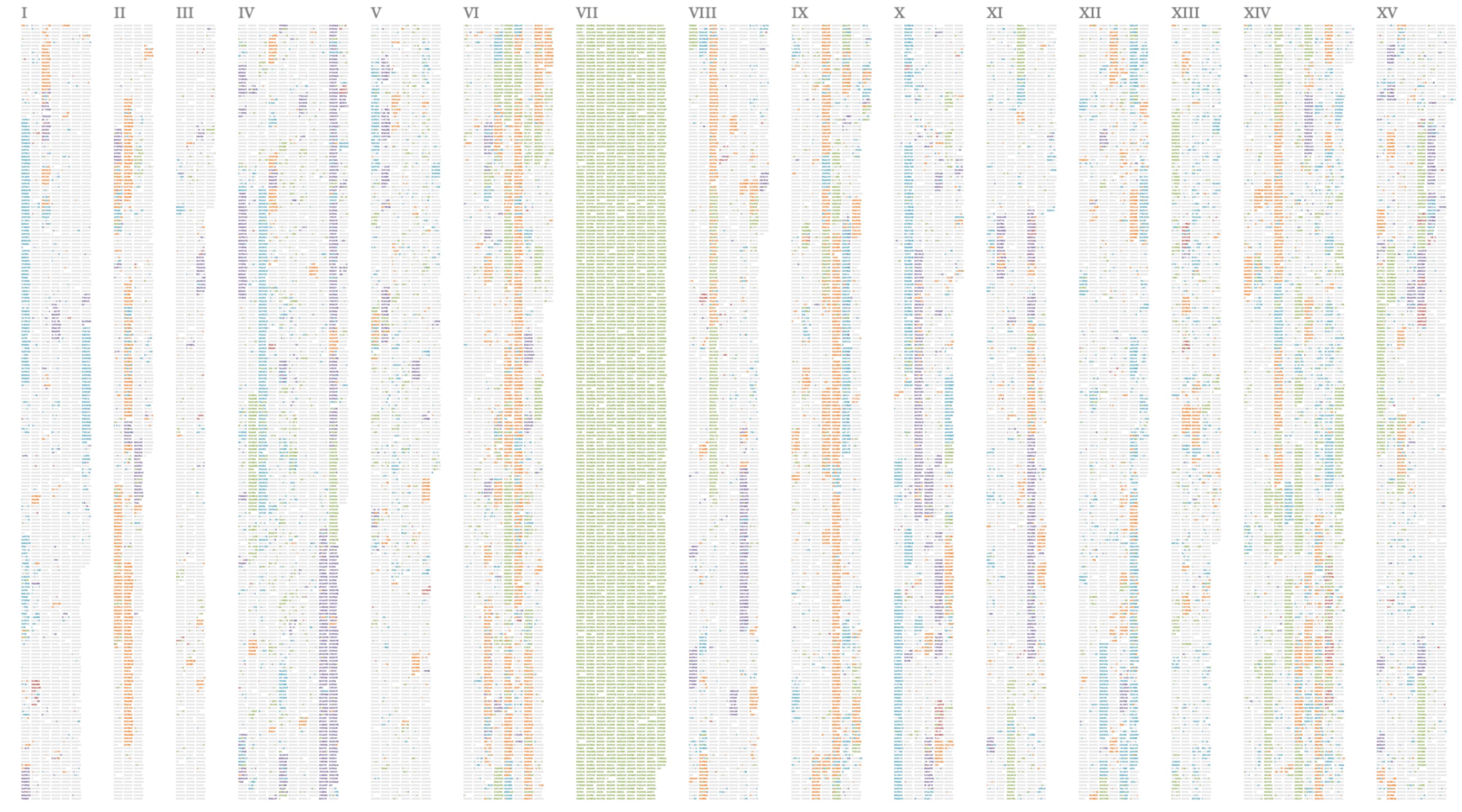
ON THE ORIGIN OF SPECIES *The Preservation of Favoured Traces*

Reset

Pause

Slow

Fast



First Edition (1859)

Second Edition (1860)

Third Edition (1861)

Fourth Edition (1866)

Fifth Edition (1869)

Sixth Edition (1872)

how we interact, what's an *overview*, what should it do?

“A vis idiom that provides **an *overview*** is intended to give the user a **broad**

awareness of the entire information space. A common goal in

overview design is to **show all items in the dataset simultaneously**,

without any need for navigation to pan or scroll. Overviews help the user **find**

regions where further investigation in more detail might be productive.”

— Tamara Munzner, professor of computer
science, visualization researcher, 2014

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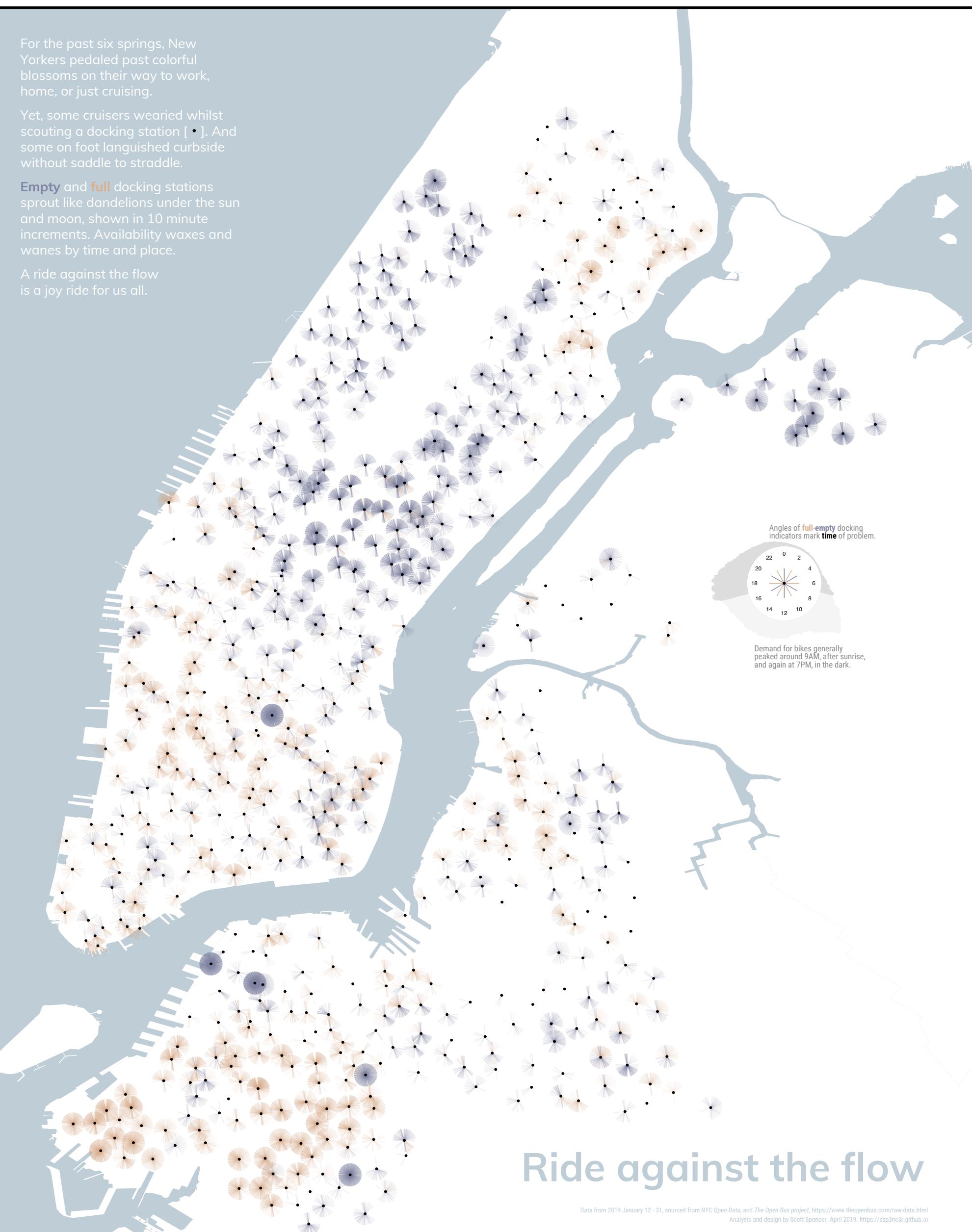
— Tamara Munzner, professor of computer
science, visualization researcher, 2014

What?! — But some datasets have *many variables!* How
can we show high-dimensional space in a single view?

how we interact, what's an *overview*, what should it do?

Variables with measured observations in our example Citi Bike dataset

shown	not shown
geographic boundaries	station id
station latitude	number bikes station, date, time
station longitude	number spaces station, date, time
station empty	ride number
station full	sex rider
time of day empty	birthdate rider
time of day full	subscriber rider
average rate rides time	temperature date, time, location
sunrise time	humidity date, time, location
sunset time	rain date, time, location
	wind speed date, time, location
	wind direction date, time, location
	traffic rate date, time, location
	subway entrances location
	...



how we interact, what's an *overview*, what should it do?

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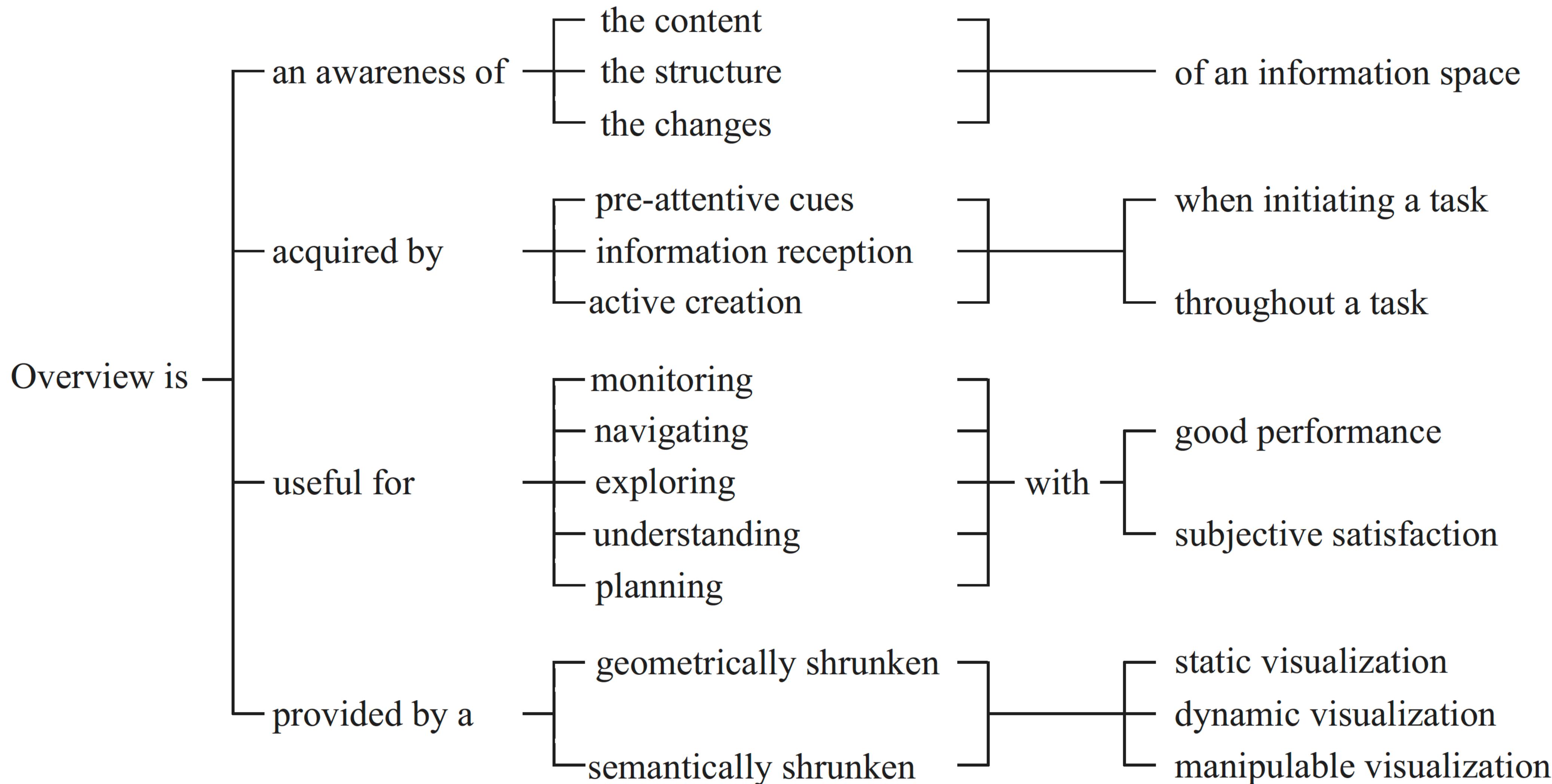
— Tamara Munzner, professor of computer science, visualization researcher, 2014

What?! — But some datasets have *many variables!* How can we show high-dimensional space in a single view?

“**What constitutes an *overview* of an information space may differ depending on whether the task is a monitoring task, a navigation task, a planning task, or the user has some other focus.**”

— Hornbæk, Kasper, and Morten Hertzum. “The Notion of Overview in Information Visualization.” *International Journal of Human-Computer Studies* 69, no. 7–8 (July 2011): 509–25. <https://doi.org/10.1016/j.ijhcs.2011.02.007>.

how we interact, what's an *overview*, what should it do?



how we interact, *zoom* and filter? *details-on-demand?* — example using pointing, hovering

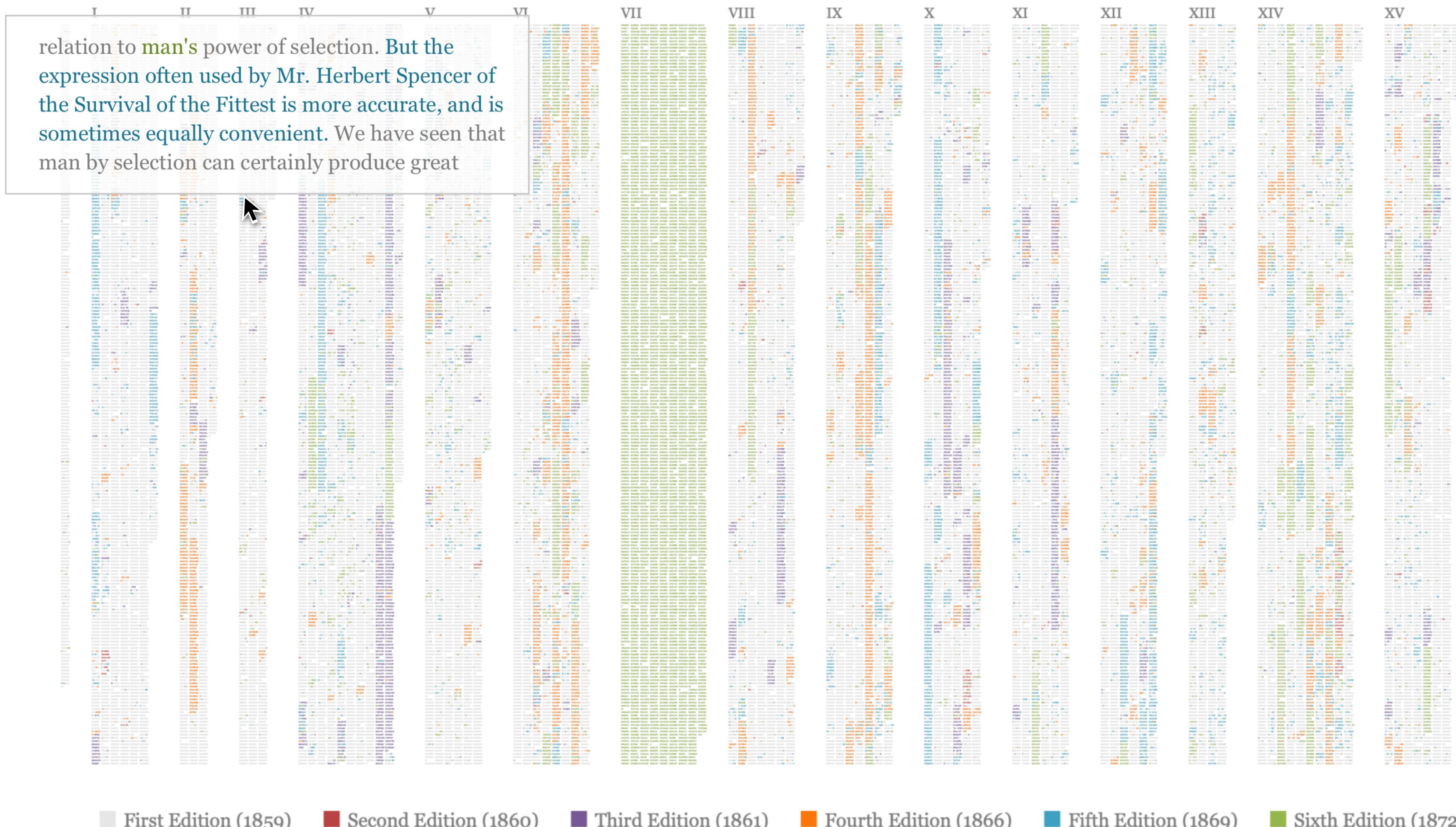
ON THE ORIGIN OF SPECIES *The Preservation of Favoured Traces*

Reset

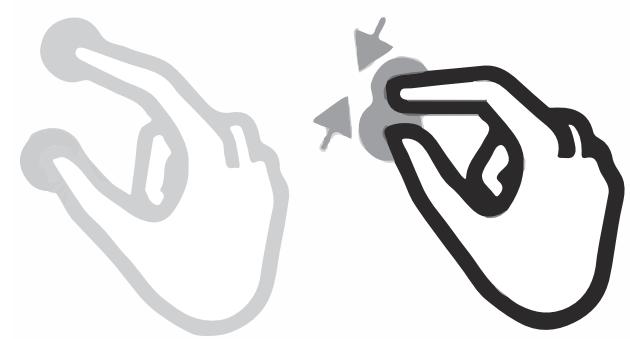
Pause

Slow

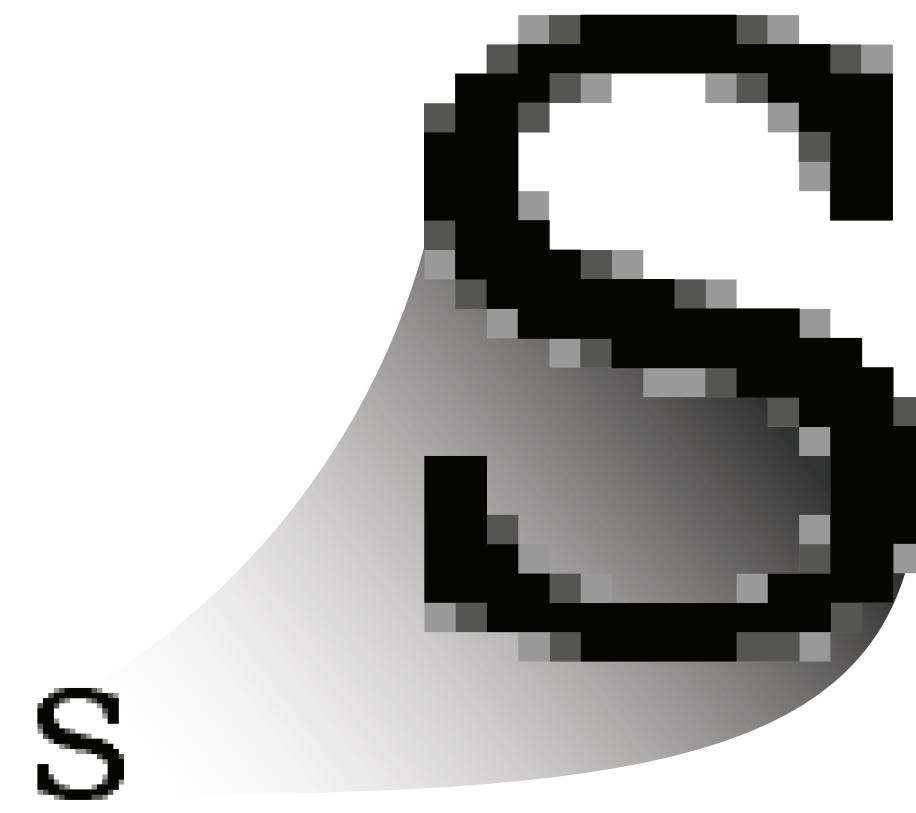
Fast



how we interact, on zooming (e.g.



) — *raster* and *vector* graphics



how we interact, which actions should we link to zooming, filtering, and showing details?

Twenty-five years ago,

“Overview first, zoom and filter, then details-on-demand.”

— Ben Shneiderman, Computer Scientist, 1996.

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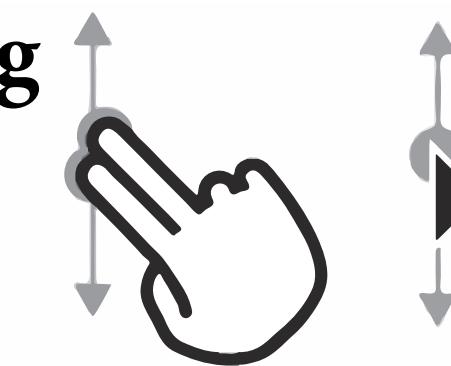
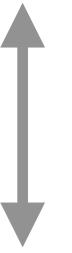
— Ben Shneiderman, Computer Scientist, 1996.

Recently,

“Readers just want to scroll. . . . If you make the reader click or do anything other than scroll, something spectacular has to happen.”

— Archie Tse, Deputy Graphics Director, The New York Times, 2016.

how we interact, “scrollytelling” — an abstract example based on scrolling



Mauris dapibus nisi a quam rutrum, ut efficitur neque ullamcorper. Nullam tincidunt enim quis ligula maximus commodo. Aenean sapien lorem, bibendum et tincidunt sed, imperdiet nec odio.

Fusce egestas aliquet tortor, vitae aliquet dolor varius faucibus. Duis aliquet in lorem dictum maximus. Fusce a orci felis. Cras porttitor facilisis nisi in dapibus. As the reader scrolls, this text narrates and describes the graphic to the right. Integer maximus tristique lorem, vel imperdiet ante mollis id.

Suspendisse at purus molestie, iaculis mi eget, pulvinar orci. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Morbi convallis tellus tortor.

Morbi tincidunt lacus et justo sodales, ut tempor nibh molestie. Integer metus nisl, suscipit eu pretium malesuada, sagittis at purus. Class aptent taciti sociosqu ad litora torquent per conubia nostra, per inceptos himenaeos. Sed ultrices placerat imperdiet. Nulla faucibus tincidunt rutrum. Etiam ut ante velit.



This section, which may be a data graphic, **stays in place** while the **text to the left scrolls** up or down.

But you can **change this graphic** as you scroll based on an anchor in the document and you can do things like **add or remove layers** within this graphic.

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Interactivity lets readers dig deeper, explore more views of data, and re-build trust through transparency.

“Knowing that the majority of readers doesn’t click buttons does not mean you shouldn’t use any buttons. Knowing that many many people will ignore your tooltips doesn’t mean you shouldn’t use any tooltips. All it means is that **you should not hide important content behind interactions**” like “mak[ing] the user click or hover to see it.”

— Gregor Aisch. CIO, Datawrapper, 2017.

**group work on your
data-driven, visual narrative**

resources

References

Spencer, Scott. Sec. 3 In *Data in Wonderland*. 2021. https://ssp3nc3r.github.io/data_in_wonderland.

Aisch, Gregor. “In Defense of Interactive Graphics.” *Vis4.Net* (blog), March 13, 2017. <https://www.vis4.net/blog/2017/03/in-defense-of-interactive-graphics/>.

Bertin, Jacques. *Graphics and Graphic Information-Processing*. Berlin ; New York: de Gruyter, 1981.

Goldenberg, Russell. *Scrollama.js*. Sticky Side Example. Github repository. Last accessed 2021 March 13. <https://russellgoldenberg.github.io/scrollama/sticky-side/>.

Heer, Jeffrey, and Ben Shneiderman. 2012. “Interactive Dynamics for Visual Analysis: A Taxonomy of Tools That Support the Fluent and Flexible Use of Visualizations.” *Queue* 10 (2): 30–55. <https://doi.org/10.1145/2133416.2146416>.

Hohman, Fred, Matthew Conlen, Jeffrey Heer, and Duen Chau. 2020. “Communicating with Interactive Articles.” *Distill* 5 (9): 10.23915/distill.00028. <https://doi.org/10.23915/distill.00028>.

Hornbæk, Kasper, and Morten Hertzum. “The Notion of Overview in Information Visualization.” *International Journal of Human-Computer Studies* 69, no. 7–8 (July 2011): 509–25. <https://doi.org/10.1016/j.ijhcs.2011.02.007>.

Munzner, Tamara. “Manipulate View,” “Facet into Multiple Views,” “Reduce Items and Attributes,” and “Embed: Focus + Context.” In *Visualization Analysis and Design*. CRC Press, 2014.

Pike, William A., John Stasko, Remco Chang, and Theresa A. O’Connell. “The Science of Interaction.” *Information Visualization* 8, no. 4 (January 2009): 263–74. <https://doi.org/10.1057/ivs.2009.22>.

Satyanarayan, Arvind, Kanit Wongsuphasawat, and Jeffrey Heer. “Declarative Interaction Design for Data Visualization.” In *The 27th Annual ACM Symposium*, 669–78. New York, New York, USA: ACM Press, 2014. <https://doi.org/10.1145/2642918.2647360>.

Shneiderman, Ben. 1996. “The Eyes Have It: A Task by Data Type Taxonomy for Information Visualizations.” In Proceedings 1996 IEEE Symposium on Visual Languages, 336–43. Boulder, CO, USA: IEEE Comput. Soc. Press. <https://doi.org/10.1109/VL.1996.545307>.

Shneiderman, Ben, Catherine Plaisant, Maxine Cohen, Steven M. Jacobs, and Niklas Elmqvist. *Designing the User Interface: Strategies for Effective Human-Computer Interaction*. Sixth Edition. Boston: Pearson, 2017.

Tominski, Christian, and Heidrun Schumann. “Chapter 4. Interacting with Visualizations.” In *Interactive Visual Data Analysis*, 1st ed. Boca Raton: CRC Press, 2020.

Tse, Archie. “Why we are doing fewer interactives.” Presentation. *Malofiej Conference*. 2016. Visuals: <https://github.com/archietse/malofiej-2016/blob/master/tse-malofiej-2016-slides.pdf>

Yi, Ji Soo, youn ah Kang, John T Stasko, and Julie A Jacko. 2007. “Toward a Deeper Understanding of the Role of Interaction in Information Visualization.” *IEEE* 13 (6): 1224–31.