Storytelling with data

09 | **Foundations of interactive data-driven, visual design**
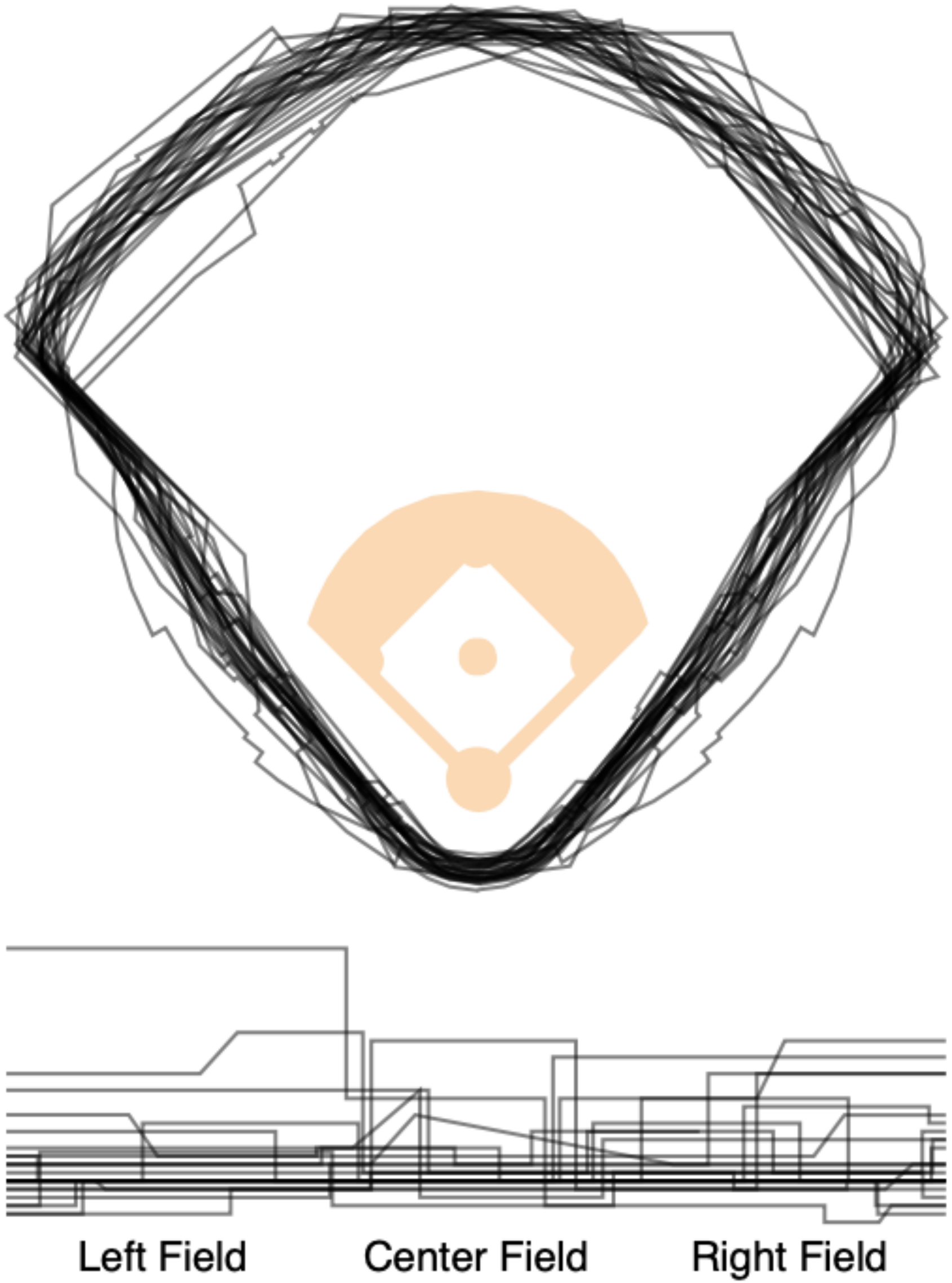
Scott Spencer | Columbia University

Write **memo** pitching idea
to **Chief Analytics Officer**

Present **critique** of exemplary
information graphic

Build **interactive graphics** for
Chief Marketing Officer to
explore project and insights

Write **critique** of
peer presentation

YOU
ARE
HERE

FINAL

FINAL

DRAFT
FINAL

FINAL

DRAFT
FINAL

DRAFT
FINAL

DRAFT
FINAL

Ideate a **data analytics project**
addressing problem or
opportunity for **your audience**

Write a **project proposal** to
Chief Analytics Officer

Create **information graphics** of
project and insights for an
External Audience

Present **project** and **insights**
to **Chief Executive Officer**

CONDUCT DATA ANALYSIS

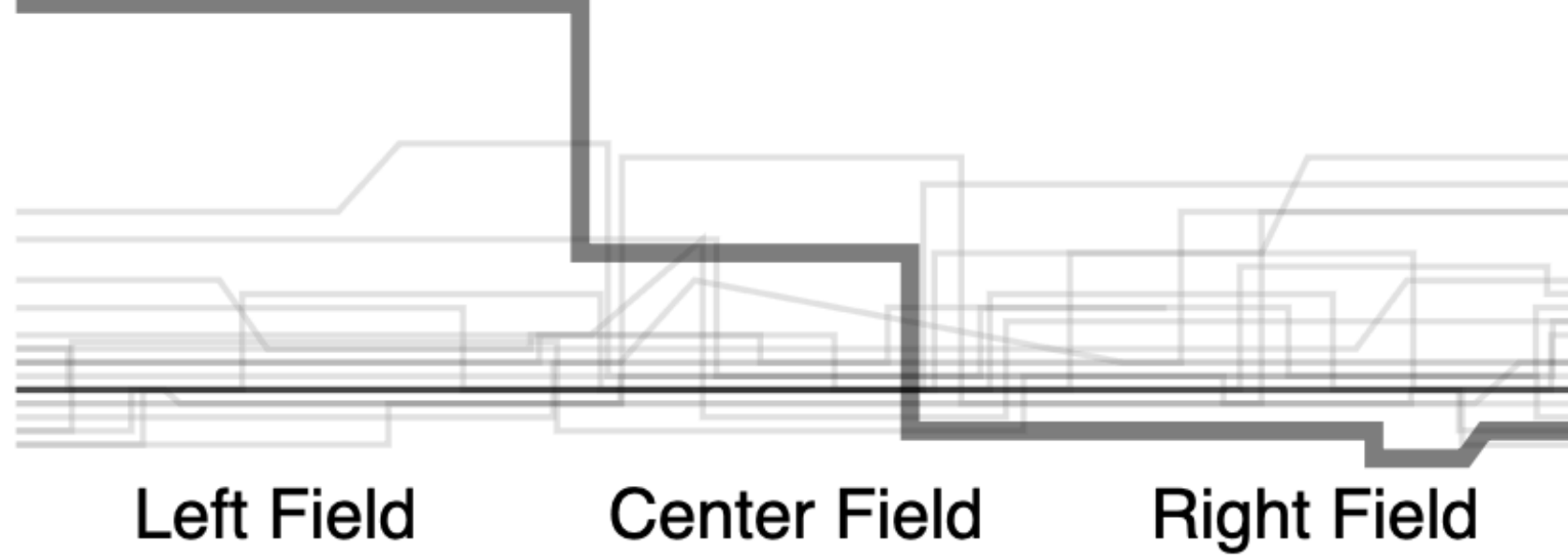**note! — all design concepts for <u>static</u>** *data-driven,* *visual narratives* **apply to i<u>nt</u>er<u>a</u>cti<u>ve</u>** *graphics*

examples of interaction with data-driven, visuals

Left Field   Center Field   Right Field

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

Left Field   Center Field   Right Field

Left Field   Center Field   Right Field
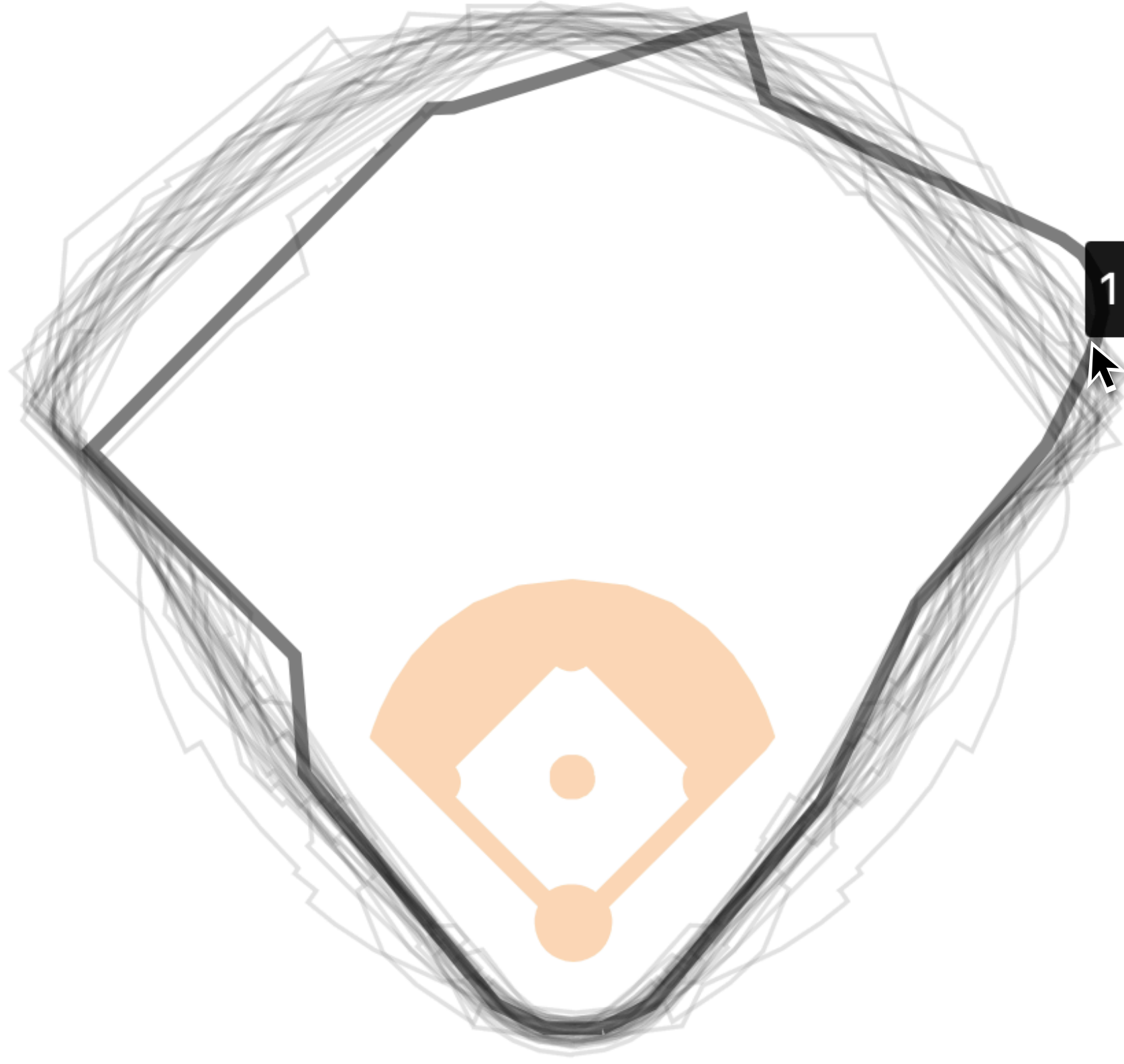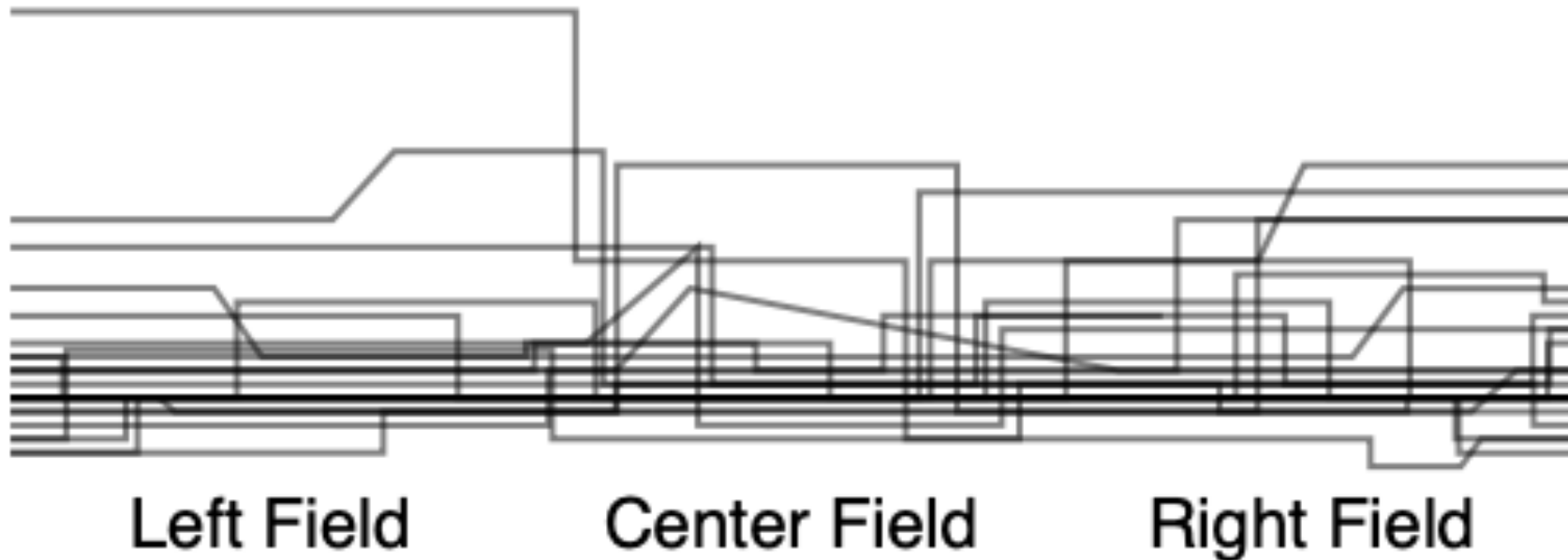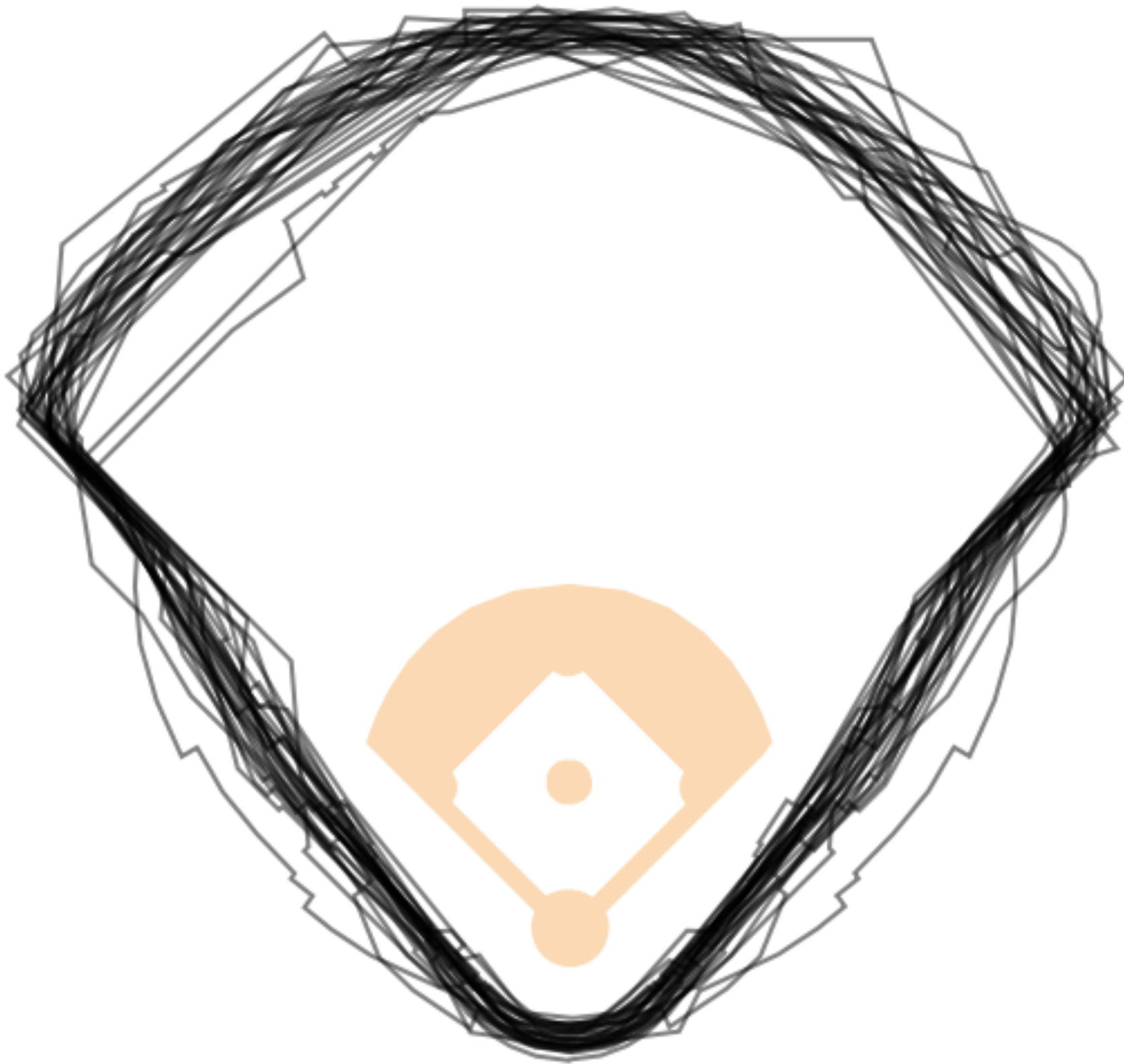
Spencer, Scott. Sec. 1.1.1.2 "Understanding data requires context." In *Data in Wonderland*. 2021. https://ssp3nc3r.github.io/data_in_wonderland/#understanding-data-requires-context.

What's Really Warming the World?

By Eric Roston 🐦 and Blacki Migliozzi 🐦 | June 24, 2015

Skeptics of manmade climate change offer various natural causes to explain why the Earth has warmed 1.4 degrees Fahrenheit since 1880. But can these account for the planet's rising temperature? Scroll down to see how much different factors, both natural and industrial, contribute to global warming, based on findings from NASA's Goddard Institute for Space Studies.

1880-2014

This line shows the measured, or "observed," land-ocean temperature
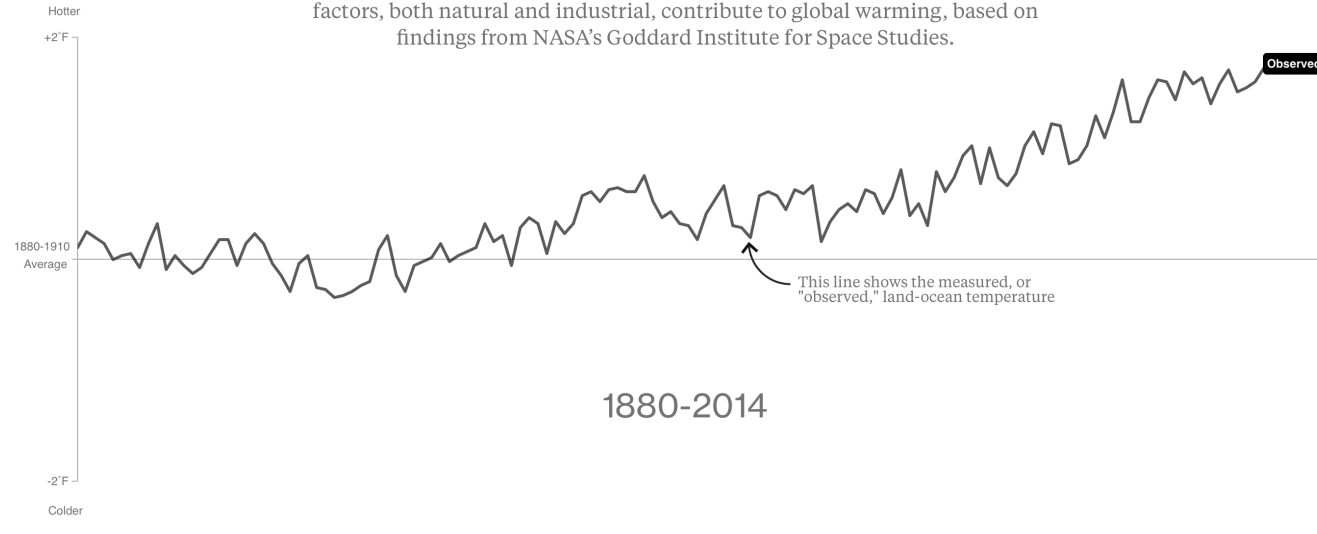
So If It's Not Nature, Is It Deforestation?

Humans have cut, plowed, and paved more than half the Earth's land surface. Dark forests are yielding to lighter patches, which reflect more sunlight—and have a slight cooling effect.

1880-2005
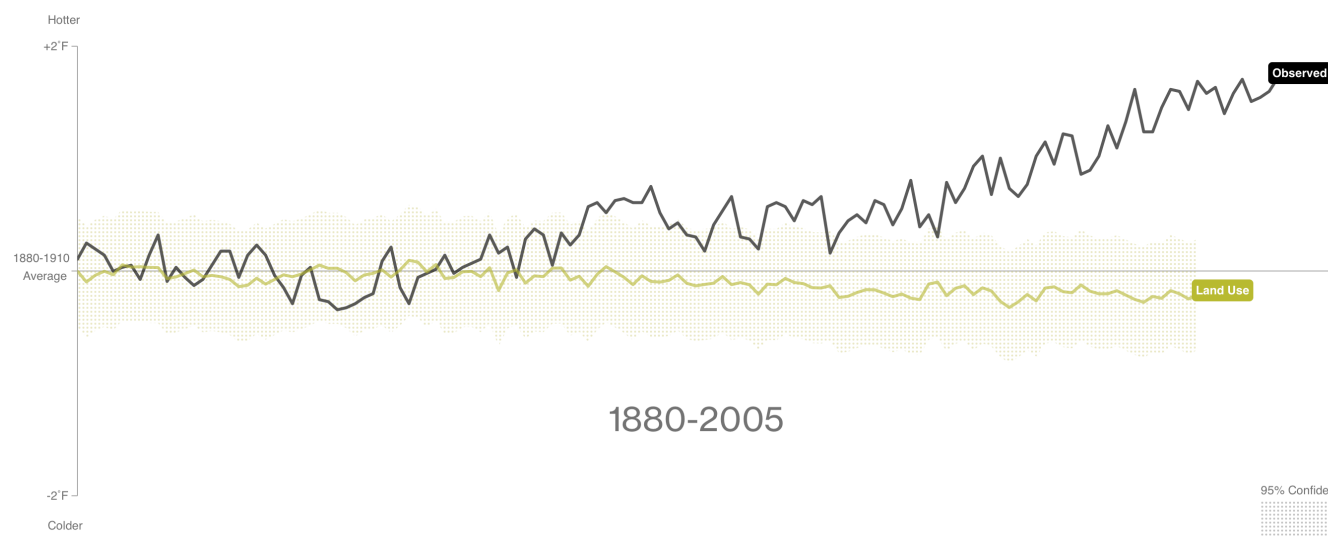
Is It the Earth's Orbit?

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.

1880-2005

This band shows where temperatures fall in 95% of climate simulations
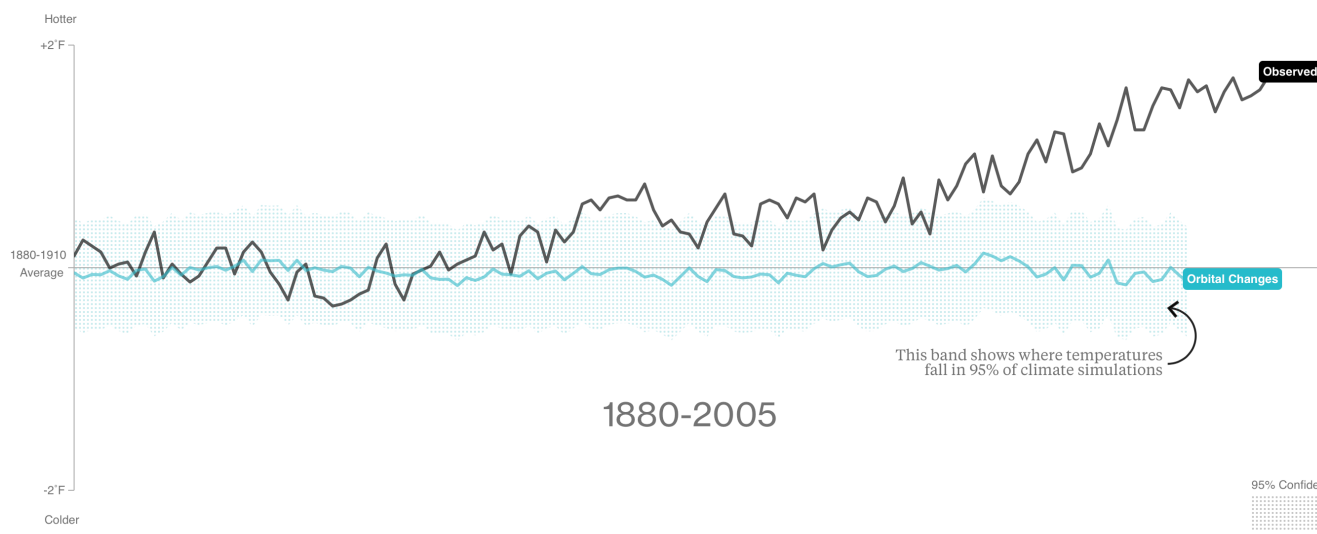
Or Ozone Pollution?

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.

1880-2005
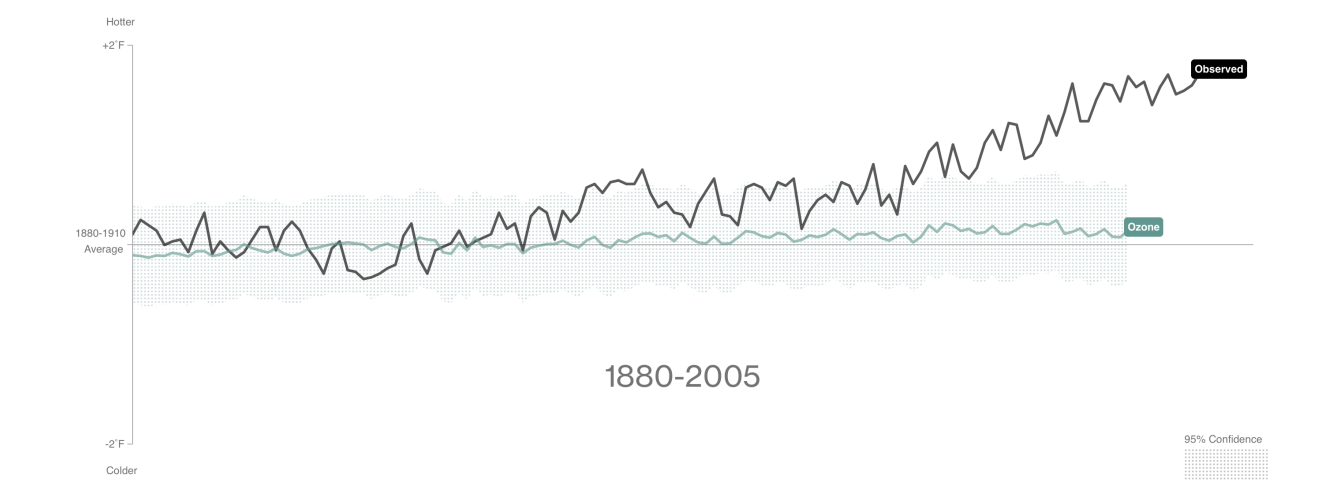
Is It the Sun?

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

1880-2005
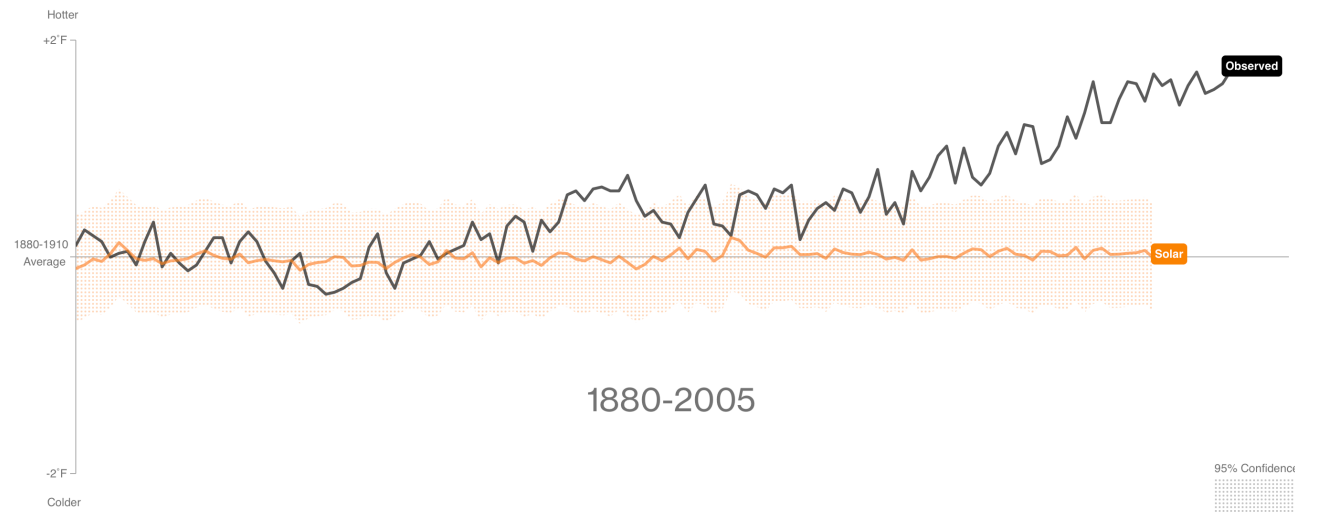
No, It Really Is Greenhouse Gases.

Atmospheric CO_2 levels are 40 percent higher than they were in 1750. The green line shows the influence of greenhouse gas emissions. It's no contest.

1880-2005
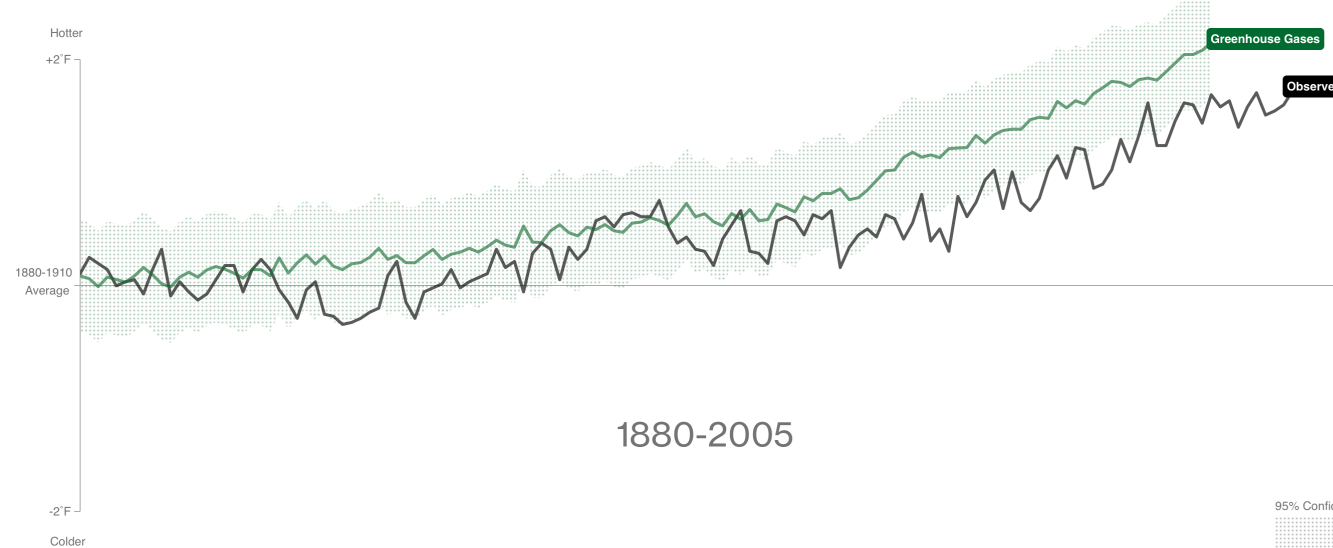
Roston, Eric, and Blacki Migliozzi. "What's Really Warming the World?" Bloomberg, June 24, 2015, Businessweek edition. https://www.bloomberg.com/graphics/2015-whats-warming-the-world/.

A 3-D View of a Chart That Predicts
The Economic Future: The Yield Curve

By **GREGOR AISCH** and **AMANDA COX**   MARCH 18, 2015

Back   Next

Yield curve 101

The yield curve shows how much it costs the federal government to borrow money for a given amount of time, revealing the relationship between long- and short-term interest rates.
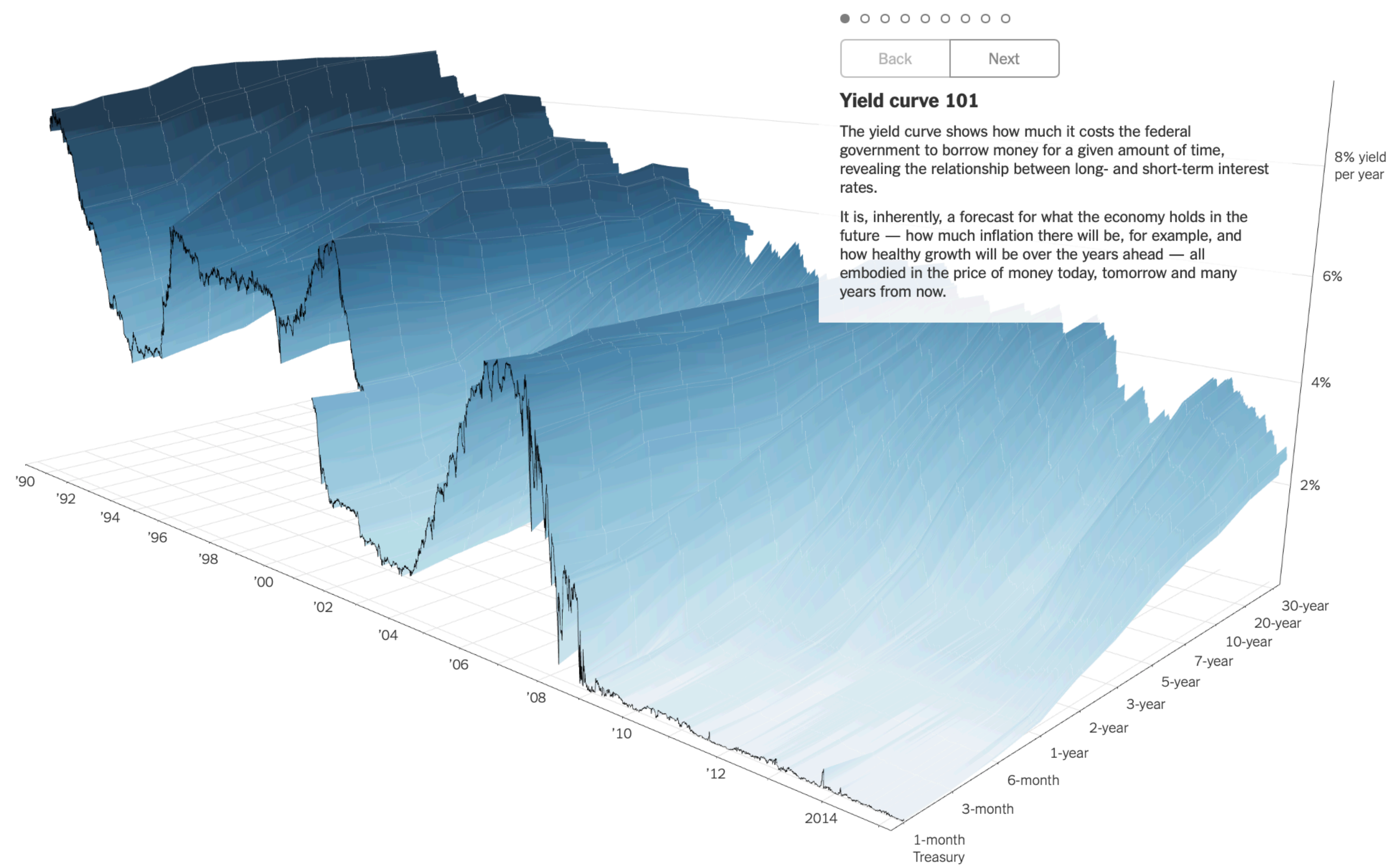
It is, inherently, a forecast for what the economy holds in the future — how much inflation there will be, for example, and how healthy growth will be over the years ahead — all embodied in the price of money today, tomorrow and many years from now.

Sources: Treasury Department; Bundesbank; Thomson Reuters

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.

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.

$259,000 ⊗

EQUIVALENT RENT

$1,207

$259K
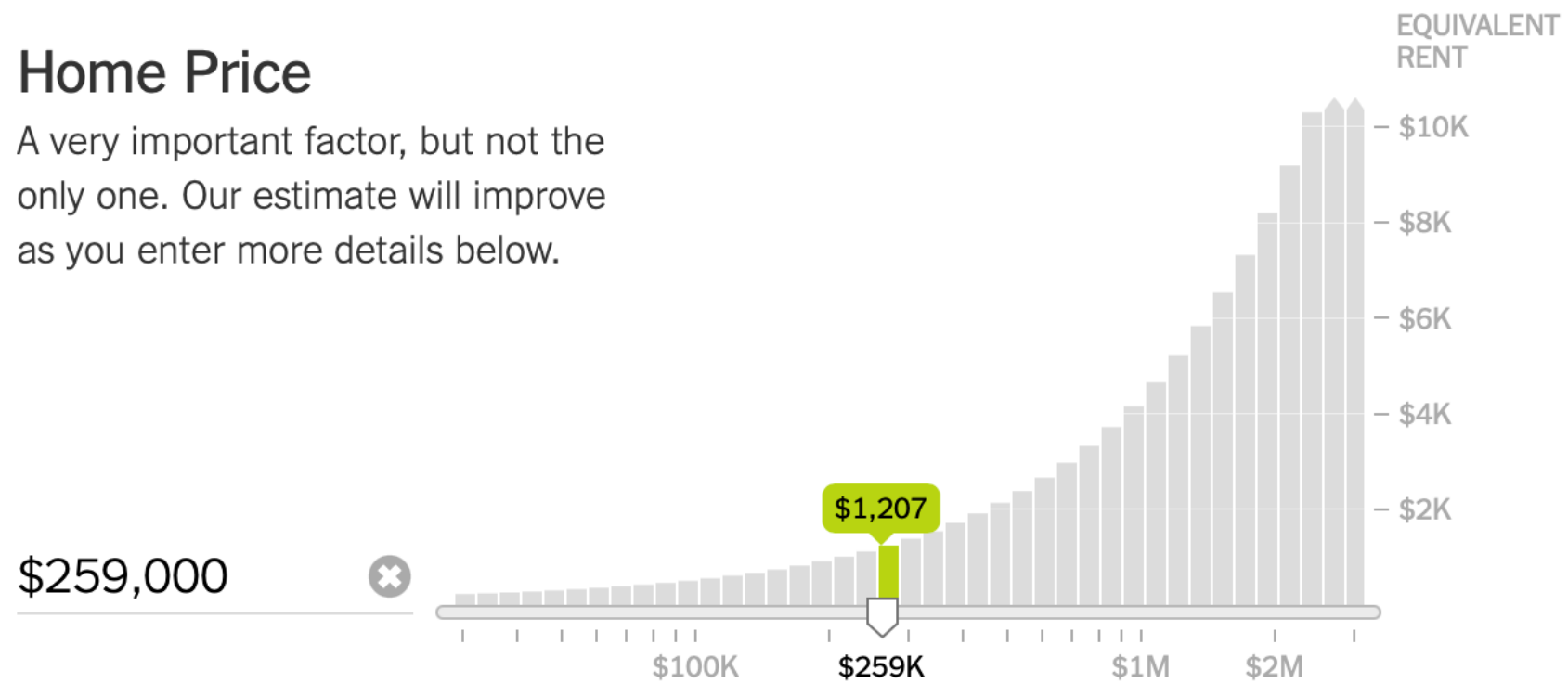
If you can rent a similar home for less than ...

$1,207 PER MONTH

... then renting is better.

Costs after **4 years**	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.

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.

4 years ⊗

EQUIV. RENT

$1,207

Bostock, Mike, Shan Carter, and Archie Tse. "Is It Better to Rent or Buy?"
The New York Times. May 21, 2014, Online edition, sec. The Upshot.
https://www.nytimes.com/interactive/2014/upshot/buy-rent-calculator.html.

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

back, next, zoom

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?

¯_(ツ)_/¯

text entry

responsive graphics

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/
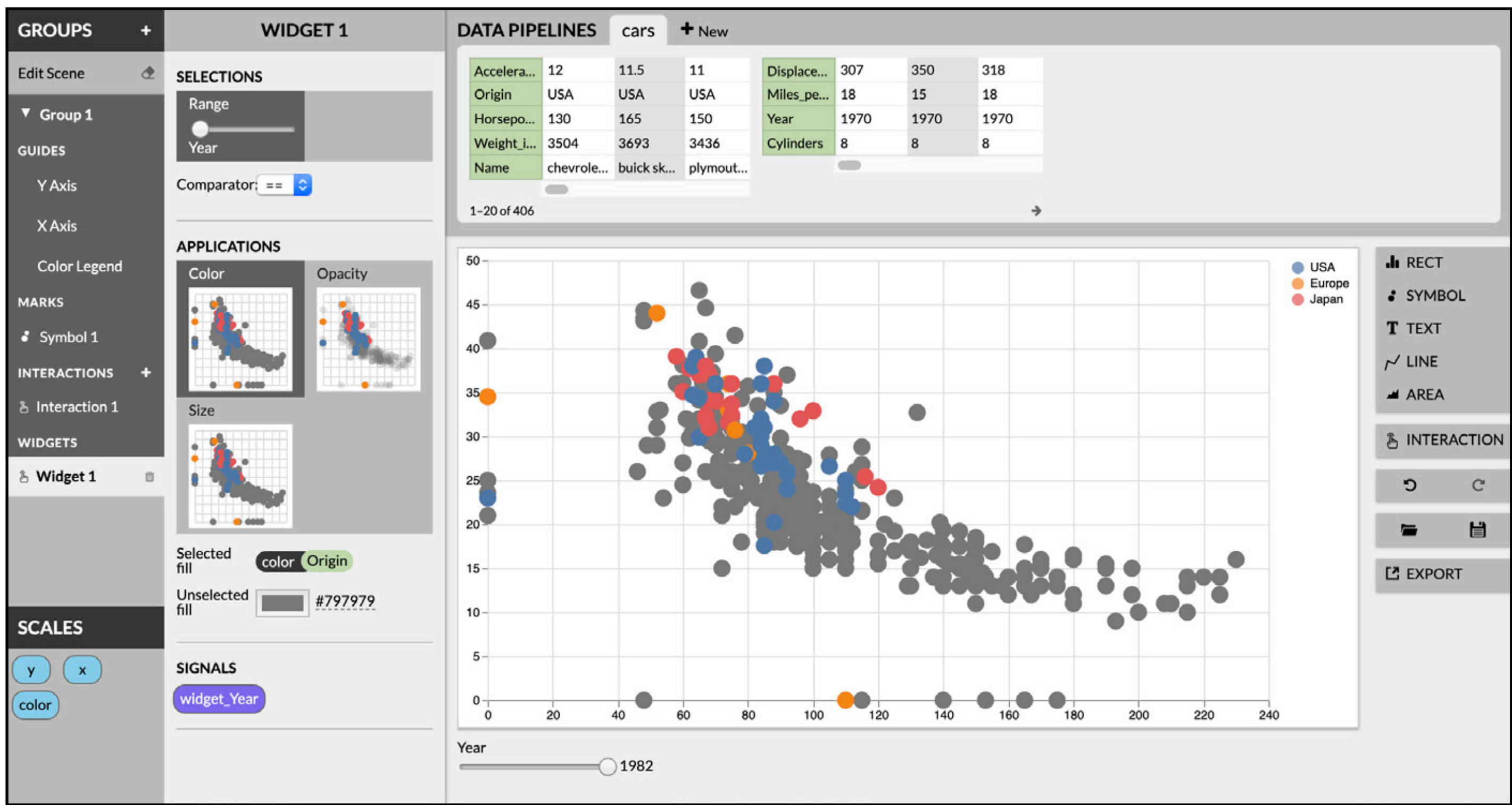
Zong, Jonathan, Dhiraj Barnwal, Rupayan Neogy, and Arvind Satyanarayan. "Lyra 2: Designing Interactive Visualizations by Demonstration." *IEEE Transactions on Visualization and Computer Graphics* 27, no. 2 (February 2021): 304–14. https://doi.org/10.1109/TVCG.2020.3030367.
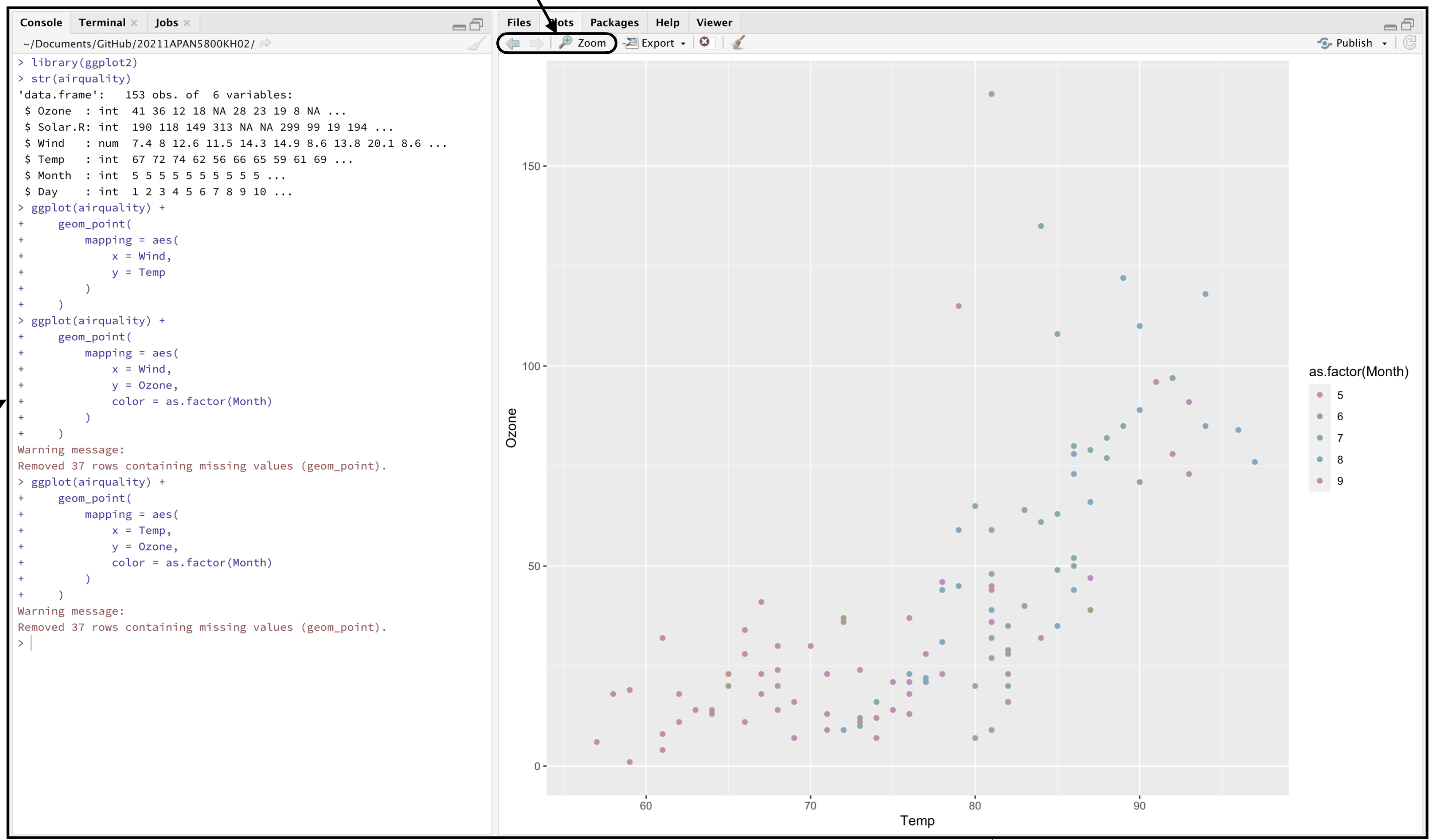
RStudio is a *web browser application* with a *graphical user interface*. We can "*interact*" with it by **entering** text (code), **clicking** buttons, etc. In *response*, RStudio *changes the view of the data graphic* we see. Is this an interactive graphic?

¯_(ツ)_/¯

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
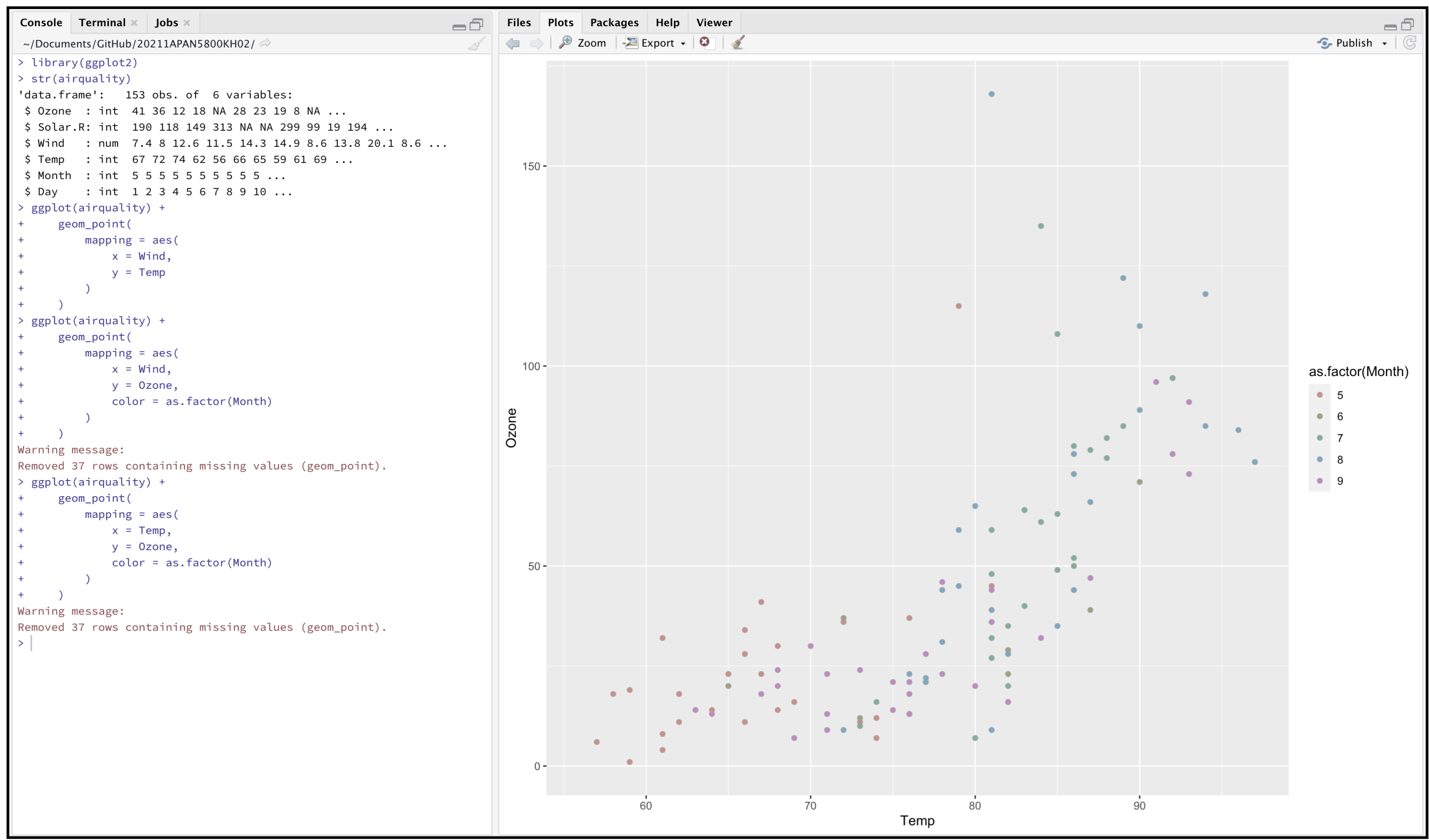
why we interact with data-driven visuals

"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*
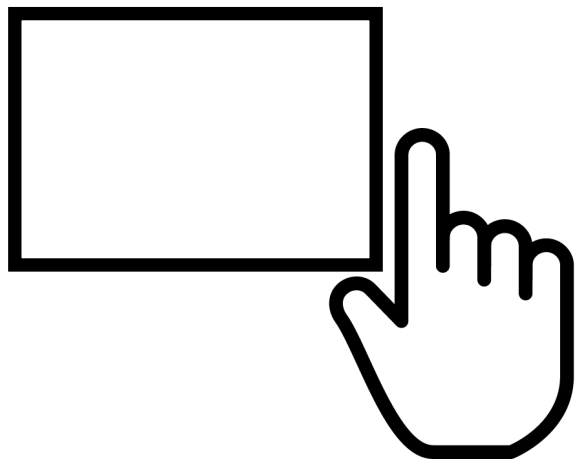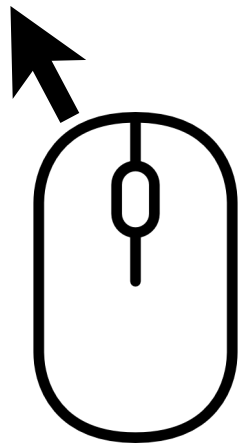
POINTING, HOVERING

SCROLLING
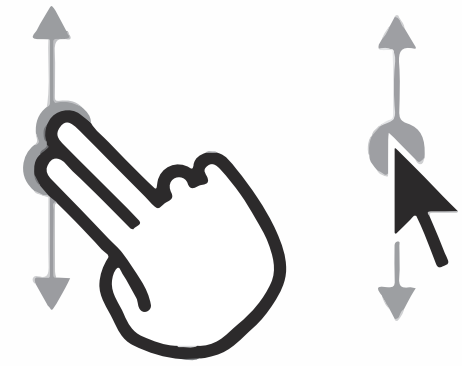
CLICKING
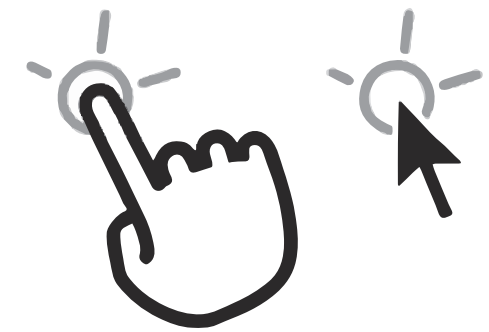
PRESSING
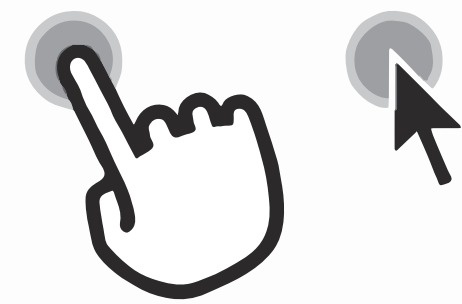
DRAGGING
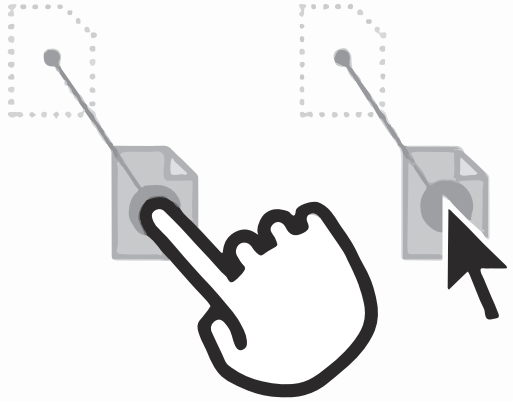
SWIPING

PINCHING, SPREADING

ROTATING

OR
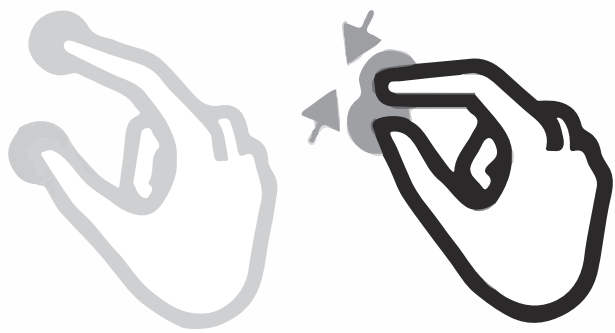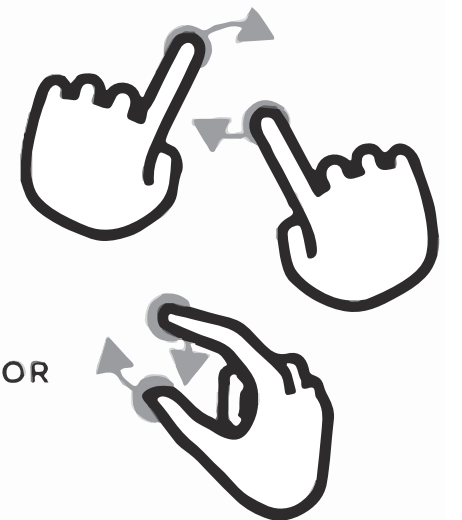
GESTURES WITH MULTIPLE FINGERS
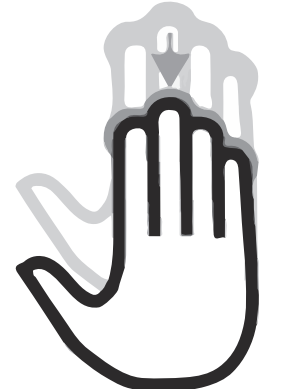
how we interact, **our *actions* can trigger *events* on *elements* like *widgets* or *directly on data encodings***

CLICKING
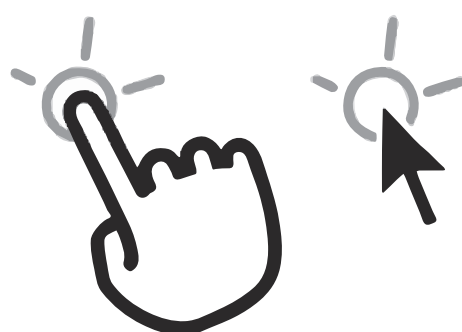
DRAGGING
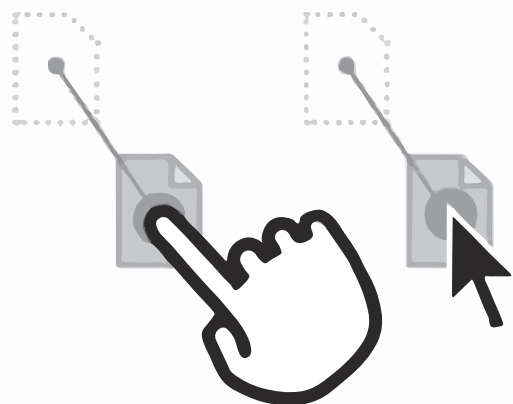
text entry   button   radio-button
group   drop-down
list   direct selection of
data encodings   slider   range bars   selecting group
of encodings

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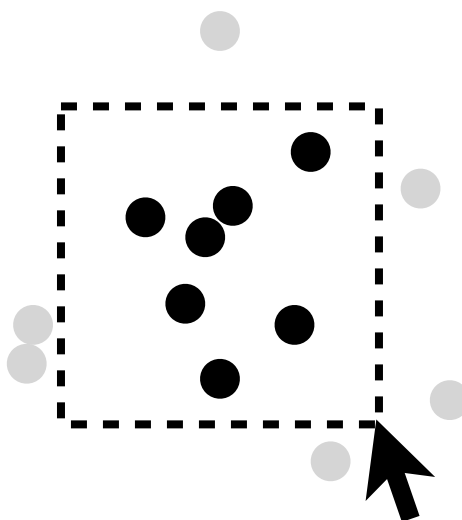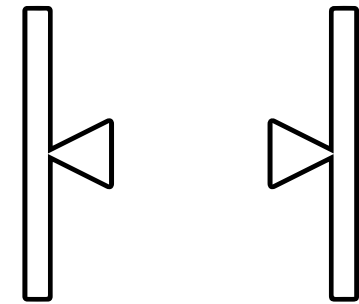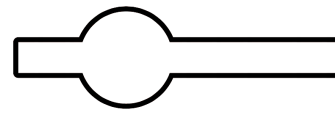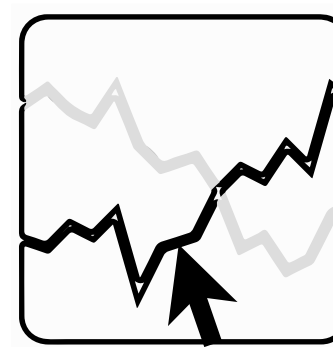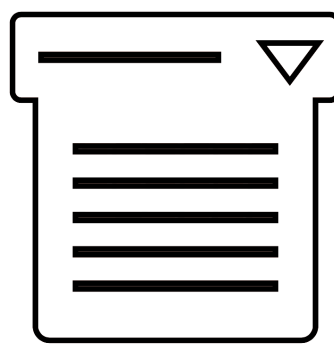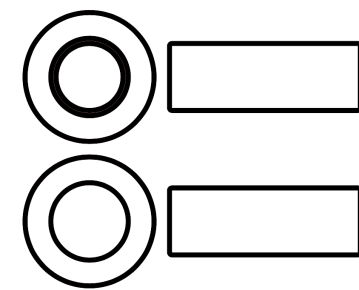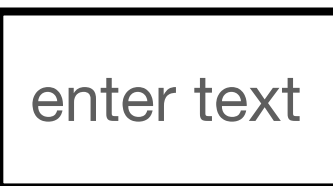
… **where the elements *listen* to events and *react* by changing data or attributes to responsive visual encodings.**

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 revisitation, review, and sharing

Annotate patterns to document findings

Share views and annotations to enable collaboration

Guide users through analysis tasks or stories

Twenty-five years ago,

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

— Ben Shneiderman, Computer Scientist, 1996.

10,744

Suggesting importance, **cumulative citations** to Ben's mantra keep rising.

819
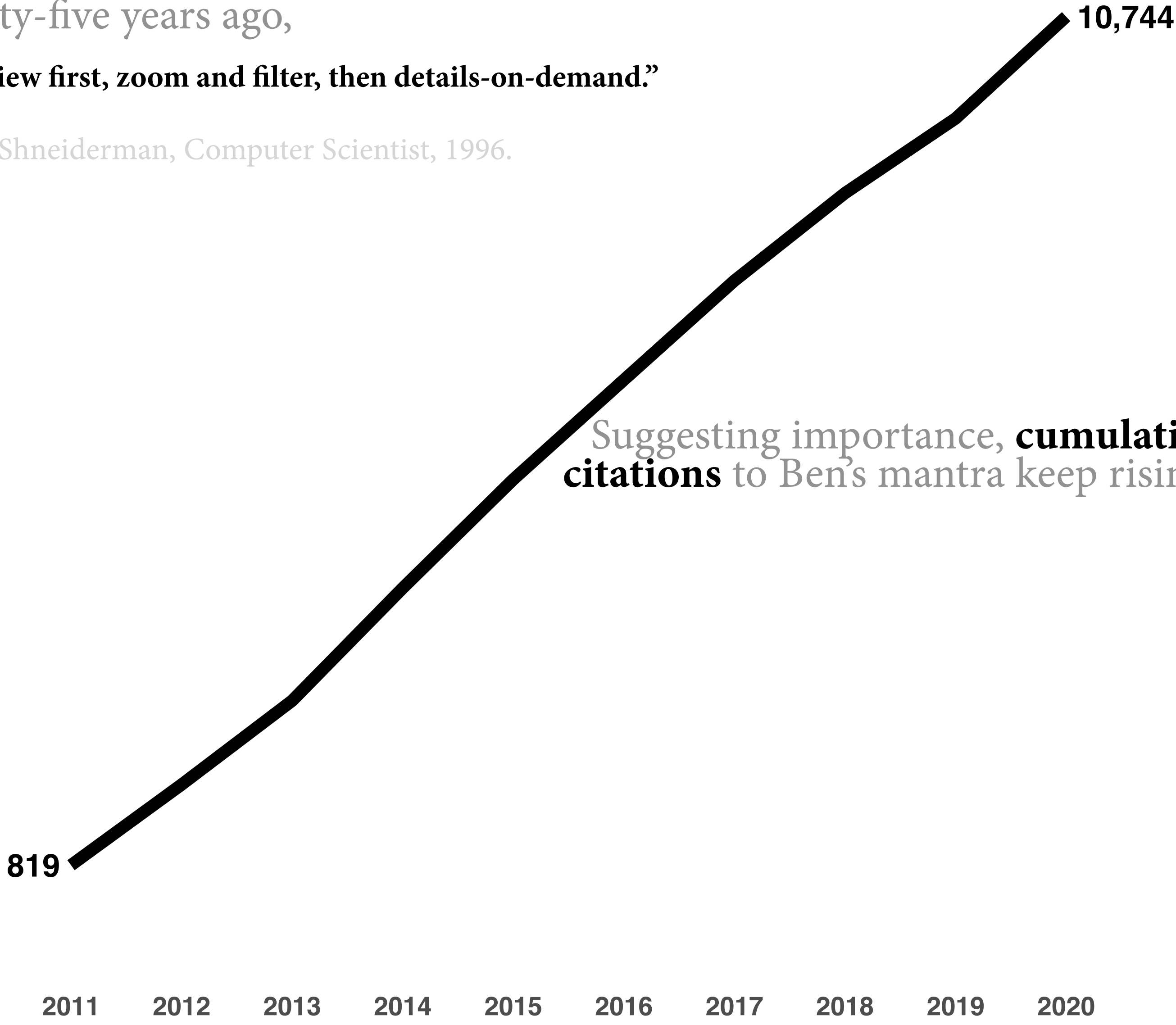
"Gain an ***overview*** of the entire collection."

"***Zoom*** in on items of interest. ***Filter*** out uninteresting items"

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

2011   2012   2013   2014   2015   2016   2017   2018   2019   2020

Source: IEEE repository.

overview first, **what's an *overview*?**

Back to Results | Next »

Help on Dictionary Entry | Print | Save | Email | Cite

overview, *n.*

Text size: A A

View as: Outline | Full entry

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

Pronunciation: ? Brit. ▶/ˈəʊvəvju:/, U.S. ▶/ˈoʊvərˌvju/

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*?

THE

ORIGIN OF SPECIES

BY MEANS OF NATURAL SELECTION,

OR THE

PRESERVATION OF FAVOURED RACES IN THE STRUGGLE FOR LIFE.

BY CHARLES DARWIN, M.A., F.R.S., &c.

SIXTH EDITION, WITH ADDITIONS AND CORRECTIONS.

(*ELEVENTH THOUSAND.*)

LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1872.

The right of Translation is reserved.

CONTENTS.

CHAPTER I.

VARIATION UNDER DOMESTICATION.

Causes of Variability — Effects of Habit and the use or disuse of Parts — Correlated Variation — Inheritance — Character of Domestic Varieties — Difficulty of distinguishing between Varieties and Species — Origin of Domestic Varieties from one or more Species — Domestic Pigeons, their Differences and Origin — Principles of Selection, anciently followed, their Effects — Methodical and Unconscious Selection — Unknown Origin of our Domestic Productions — Circumstances favourable to Man's power of Selection 5–32

CHAPTER II.

VARIATION UNDER NATURE.

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STRUGGLE FOR EXISTENCE.

Its bearing on natural selection — The term used in a wide sense — Geometrical ratio of increase — Rapid increase of naturalised animals and plants — Nature of the checks to increase — Competition universal — Effects of climate — Protection from the number of individuals — Complex relations of all animals and plants throughout nature — Struggle for life most severe between individuals and varieties of the same species: often severe between species of the same genus — The relation of organism to organism the most important of all relations 48–61

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

Page 1 (left)

ORIGIN OF SPECIES.

INTRODUCTION.

WHEN on board H.M.S. 'Beagle,' as naturalist, I was much struck with certain facts in the distribution of the organic beings inhabiting South América, and in the geological relations of the present to the past inhabitants of that continent. These facts, as will be seen in the latter chapters of this volume, seemed to throw some light on the origin of species—that mystery of mysteries, as it has been called by one of our greatest philosophers. On my return home, it occurred to me, in 1837, that something might perhaps be made out on this question by patiently accumulating and reflecting on all sorts of facts which could possibly have any bearing on it. After five years' work I allowed myself to speculate on the subject, and drew up some short notes; these I enlarged in 1844 into a sketch of the conclusions, which then seemed to me probable: from that period to the present day I have steadily pursued the same object. I hope that I may be excused for entering on these personal details, as I give them to show that I have not been hasty in coming to a decision.

My work is now (1859) nearly finished; but as it will take me many more years to complete it, and as my health is far from strong, I have been urged to publish this Abstract. I have more especially been induced to do this, as Mr. Wallace, who is now studying the natural history of the Malay archipelago, has arrived at almost exactly the same general conclusions that I have on the origin of species. In 1858 he sent me a memoir on this subject, with a request that I would forward it to Sir Charles Lyell, who sent it to the Linnean Society, and it is published in the third volume of the Journal of that Society. Sir C. Lyell and Dr. Hooker, who both knew of my work—the latter having read my sketch of 1844—honoured me by thinking it advisable to publish, with Mr. Wallace's excellent memoir, some brief extracts from my manuscripts.

This Abstract, which I now publish, must necessarily be imperfect. I cannot here give references and authorities for my

B

Page 2 (middle)

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

Page 3 (right)

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 lineal 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.

— Darwin, Charles. *The Origin of Species By Means of Natural Selection.*
6th Edition. London: John Murray, Albemarle Street, 1872.

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

Reset | Pause | Slow | Fast

I   II   III   IV   V   VI   VII   VIII   IX   X   XI   XII   XIII   XIV   XV

First Edition (1859) ■ Second Edition (1860) ■ Third Edition (1861) ■ Fourth Edition (1866) ■ Fifth Edition (1869) ■ Sixth Edition (1872)

— Fry, Ben. "The Preservation of Favoured Traces." Commercial. *Fathom Information Design*. Accessed March 16, 2021. https://fathom.info/traces/.

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

"A vis idiom that provides **an <u>*overview*</u> is intended to give the user a <u>broad</u>**

<u>**awareness of the entire information space**</u>. A common goal in

overview design is to <u>**show all items in the dataset simultaneously**</u>,

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

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

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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
	...

For the past six springs, New Yorkers pedaled past colorful blossoms on their way to work, home, or just cruising.

Yet, some cruisers wearied whilst scouting a docking station [•]. And some on foot languished curbside without saddle to straddle.

Empty and **full** docking stations sprout like dandelions under the sun and moon, shown in 10 minute increments. Availability waxes and wanes by time and place.

A ride against the flow is a joy ride for us all.

Angles of full-empty docking indicators mark **time** of problem.

Demand for bikes generally peaked around 9AM, after sunrise, and again at 7PM, in the dark.

Ride against the flow

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**

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without any need for navigation to pan or scroll. Overviews help the user **find**
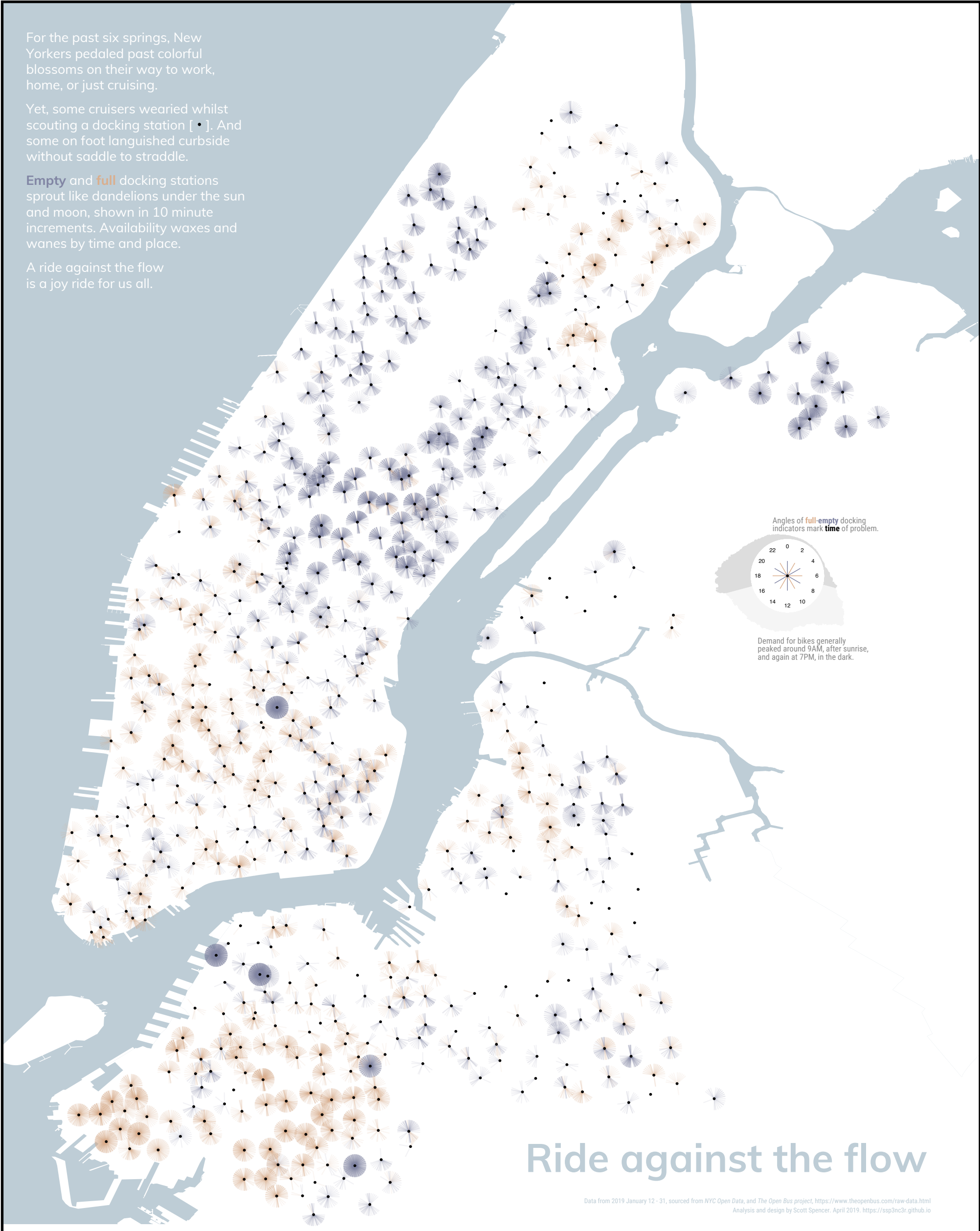
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What?! — But some datasets have *many* variables! How can we show high-dimensional space in a single view?

"**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.

Overview is

- an awareness of
  - the content
  - the structure
  - the changes

  of an information space

- acquired by
  - pre-attentive cues
  - information reception
  - active creation

  - when initiating a task
  - throughout a task

- useful for
  - monitoring
  - navigating
  - exploring
  - understanding
  - planning

  with
  - good performance
  - subjective satisfaction

- provided by a
  - geometrically shrunken
  - semantically shrunken

  - static visualization
 - dynamic visualization
  - manipulable visualization

— 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, *zoom* and filter? *details-on-demand*? — example using pointing, hovering ▶

Reset Pause Slow Fast

I II III IV V VI VII VIII IX X XI XII XIII XIV XV

relation to man's power of selection. But the expression often used by Mr. Herbert Spencer of the Survival of the Fittest is more accurate, and is sometimes equally convenient. We have seen that man by selection can certainly produce great
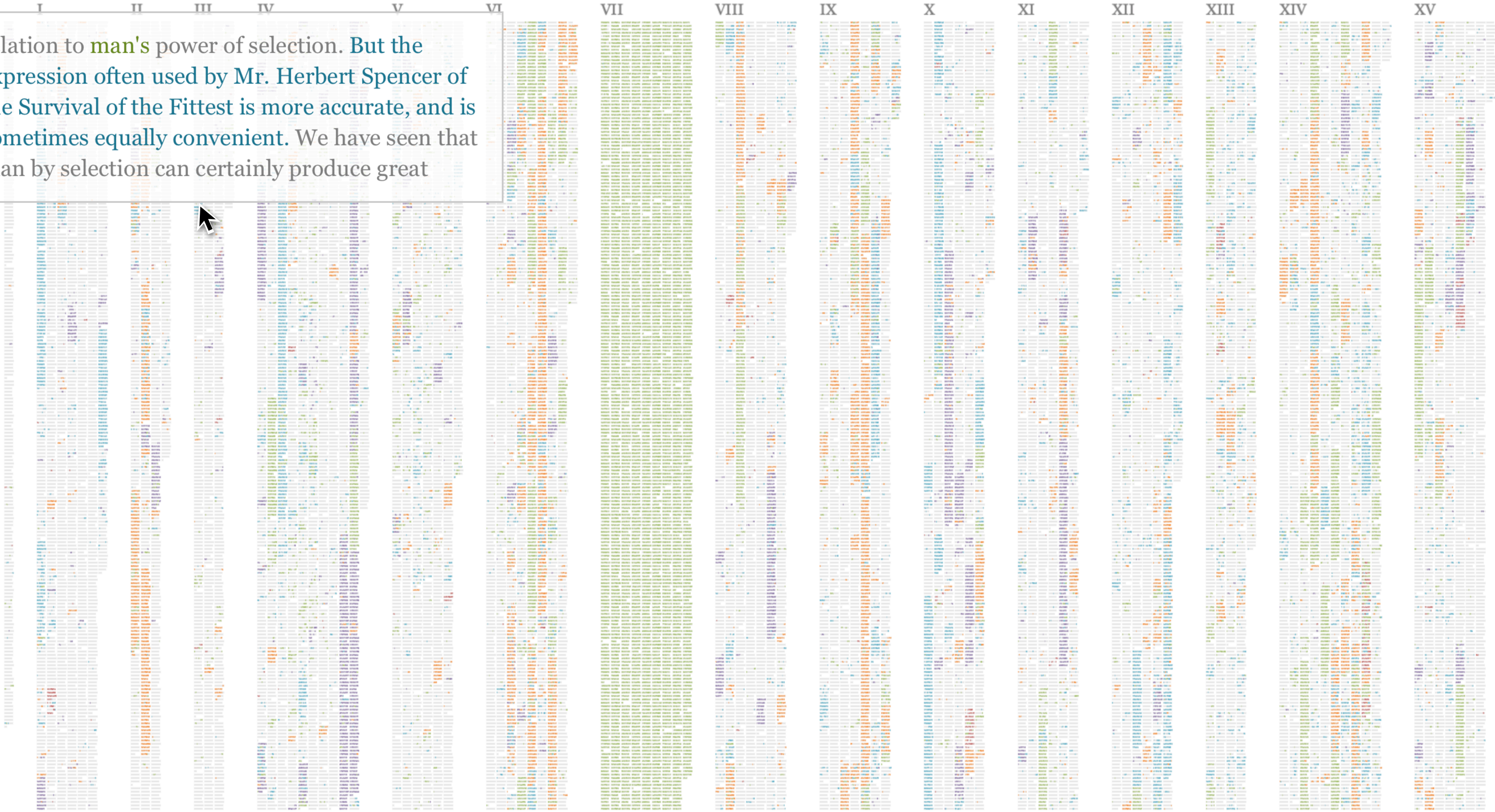
First Edition (1859) Second Edition (1860) Third Edition (1861) Fourth Edition (1866) Fifth Edition (1869) Sixth Edition (1872)

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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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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.
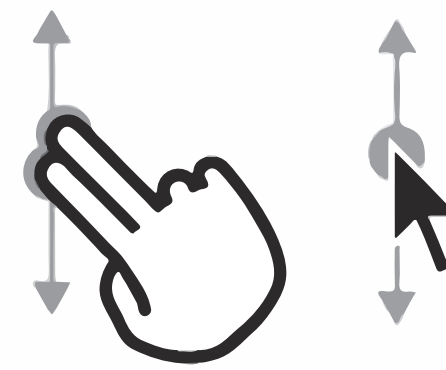
Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aenean faucibus elementum arcu, sed scelerisque metus rhoncus vel. Mauris dapibus nisi a quam rutrum, ut efficitur neque ullamcorper. Nullam tincidunt enim quis ligula maximus commodo. Aenean sapien lorem, bibendum et tincidunt sed, imperdiet nec 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.

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

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anything other than scroll, something spectacular has to happen."

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

**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

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