Storytelling with data

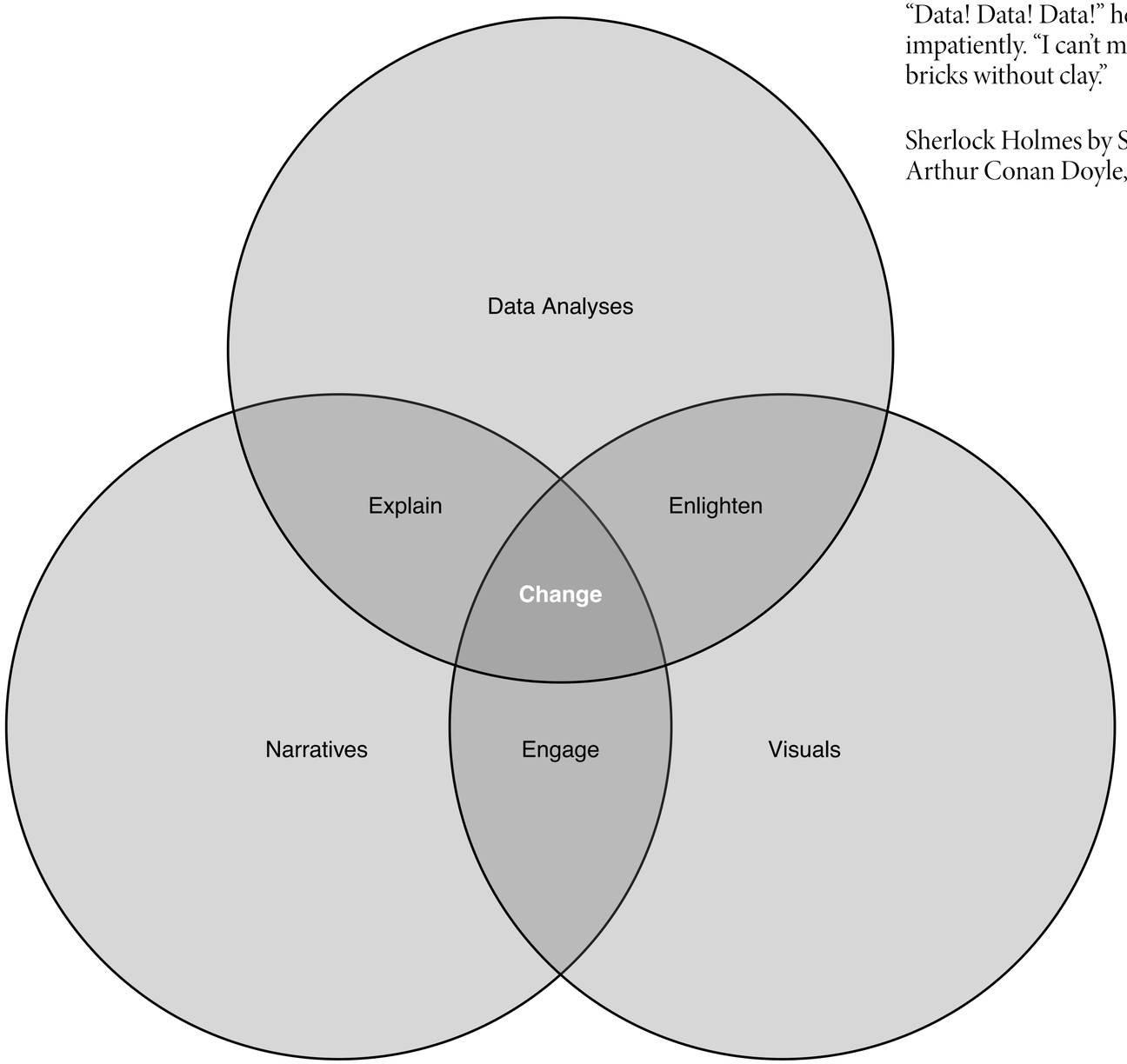
09 | Foundations of interactive data-driven, visual design

Scott Spencer | Columbia University

course overview, learn to drive change using data visuals and narrative

"Data! Data! Data!" he cried impatiently. "I can't make bricks without clay."

Sherlock Holmes by Sir Arthur Conan Doyle, *author*



No one ever made a decision because of a number. They need a story.

Daniel Kahneman, *psychologist, behavioral economist, and author*

The greatest value of a picture is when it forces us to notice what we never expected to see.

John W Tukey, *mathematician*

general course deliverable timeline

Individual Work

For learning data visualization
and written narrative techniques

Group work

For building graphics and narrative
into interactive communications

Sept 30	Oct 14	Oct 28	Nov 18	Nov 18	Dec 11	Dec 13
Homework 1 graphics 10%	Homework 2 graphics 10%	Homework 3 writing 10%	Homework 4 graphics 10%	Proposal 15%	Interactive Communication 20%	Multimodal communication 15%
Participation 10%						

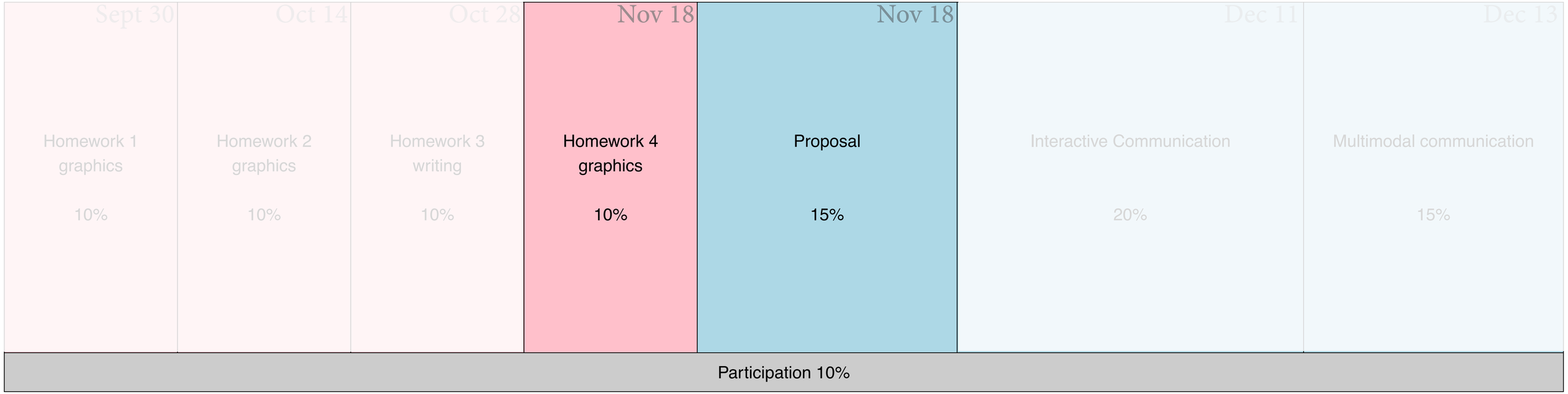
next deliverables, individual homework three and group proposal

Individual Work

For learning data visualization
and written narrative techniques

Group work

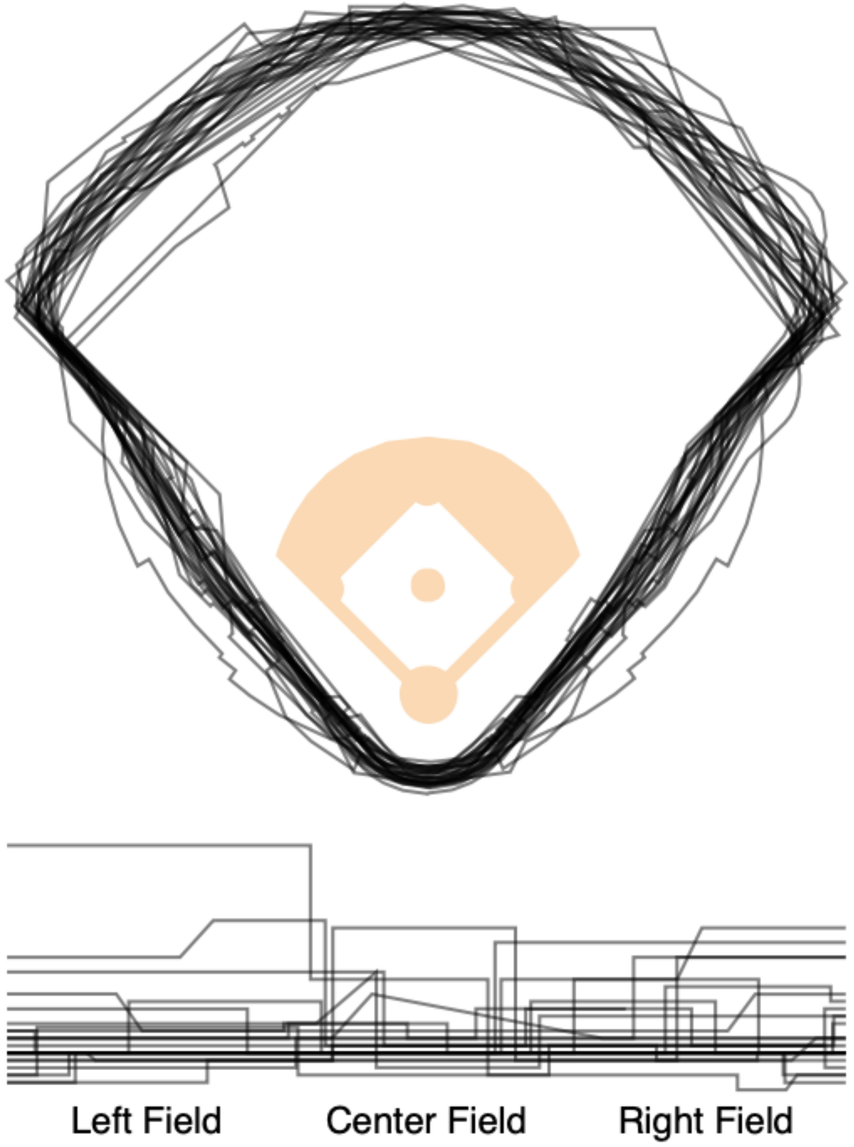
For building graphics and narrative
into interactive communications



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

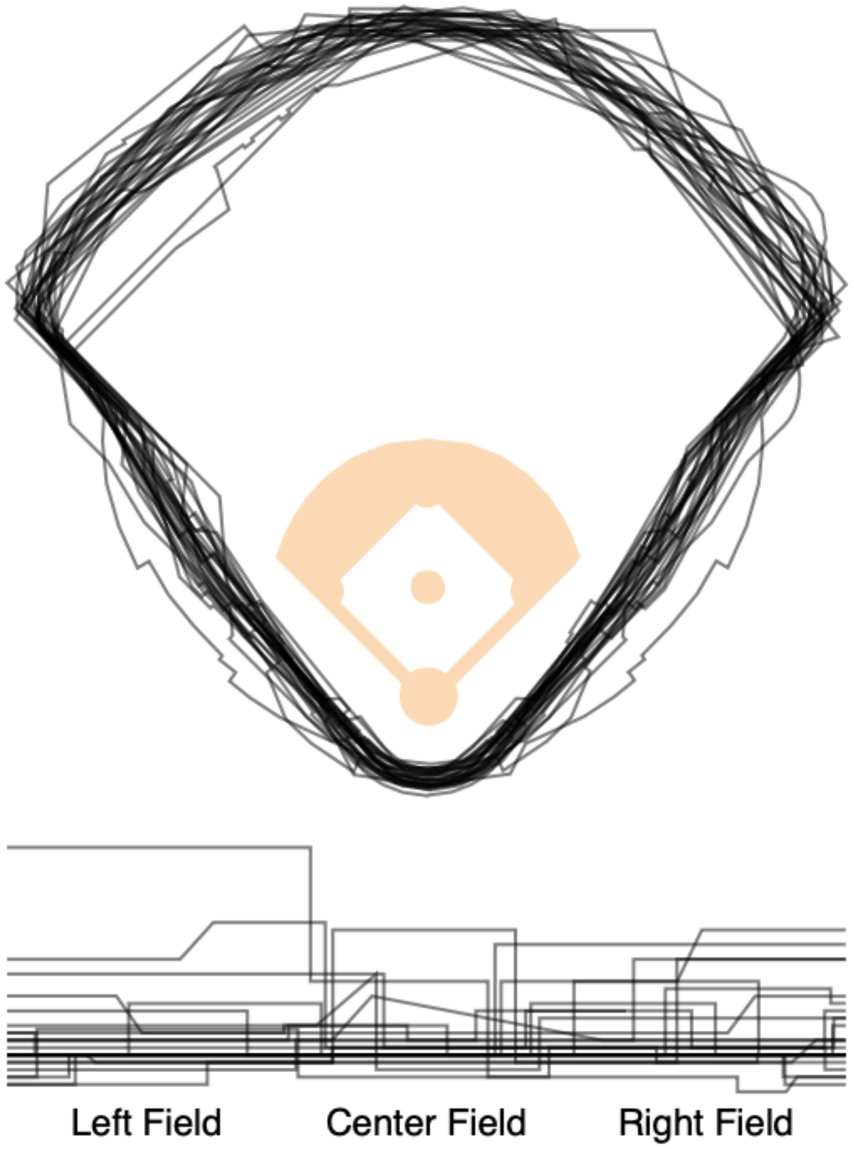
***examples* of interaction with data-driven, visuals**

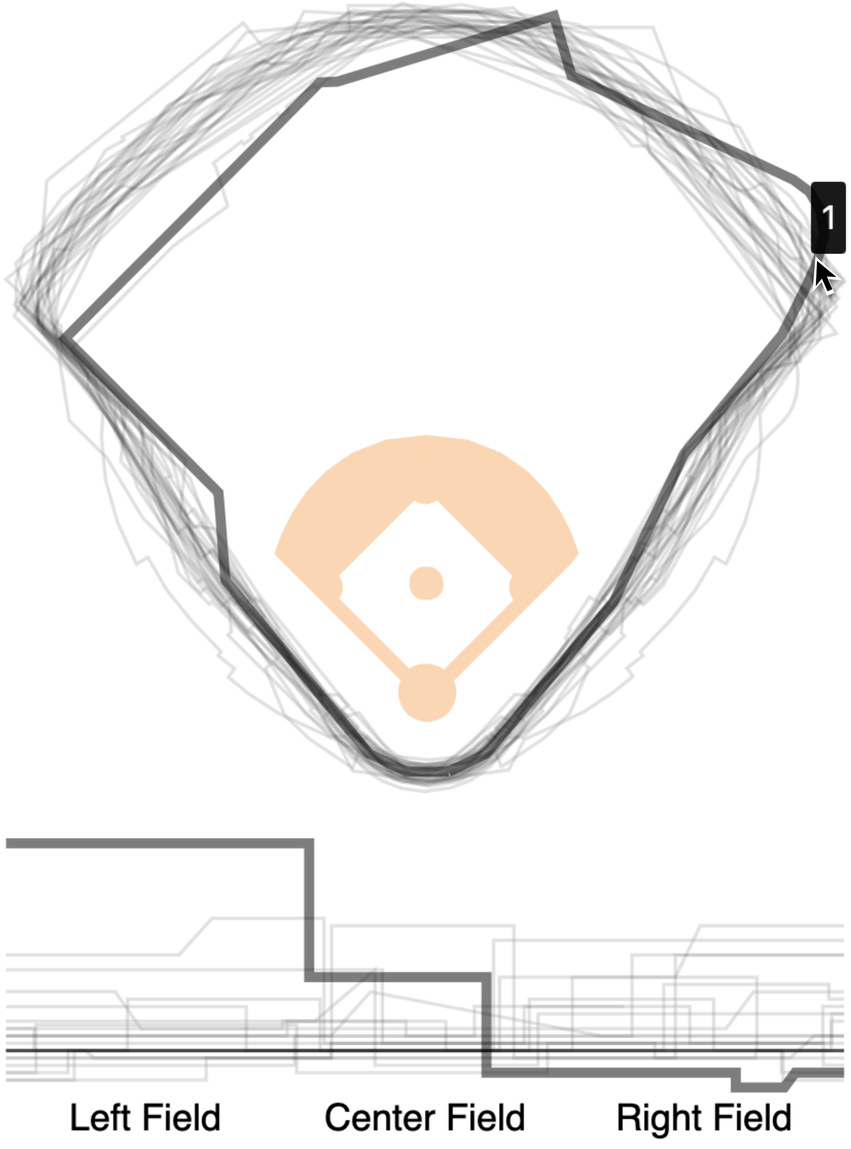
examples of interaction, follow the citation to the original, interactive version



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**





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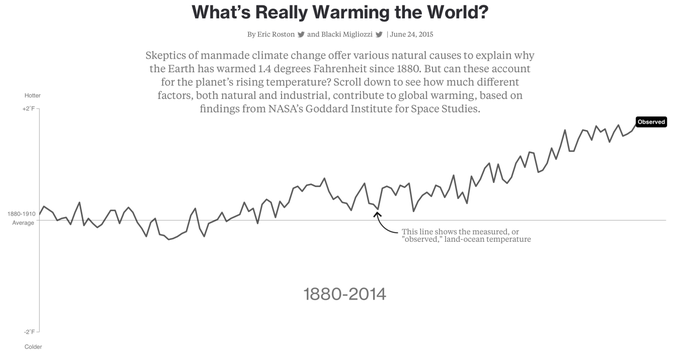

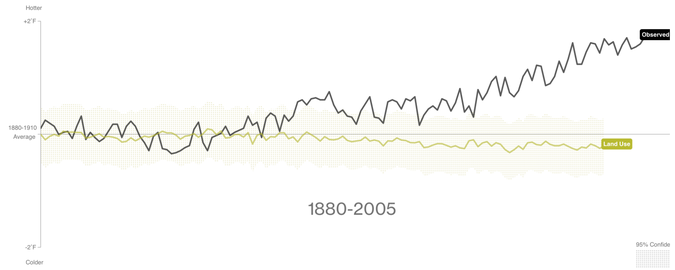

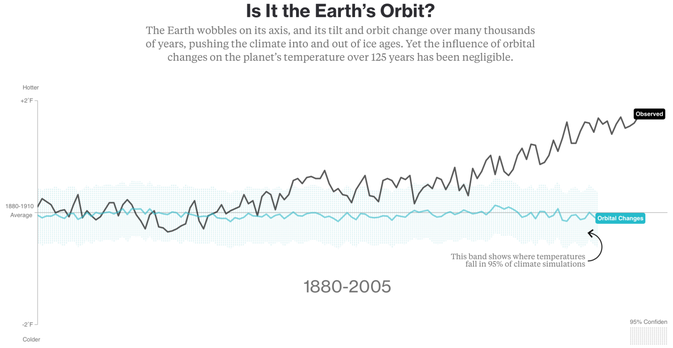

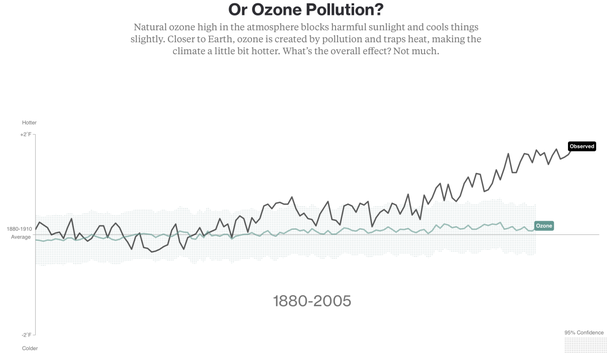

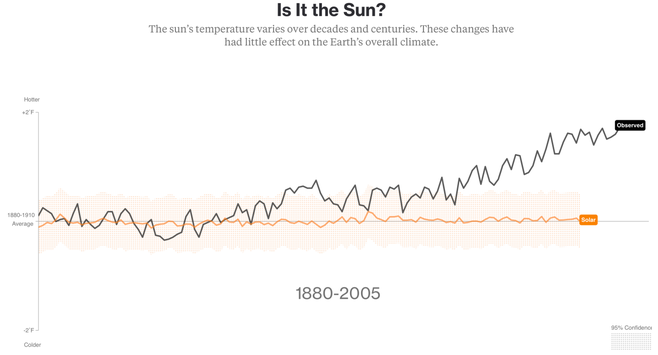

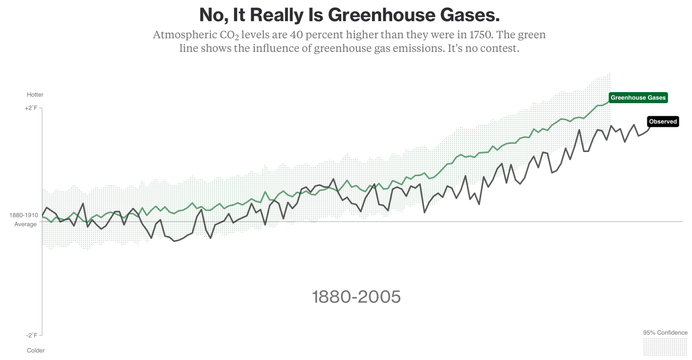

Roston, Eric, and Blacki Migliozzi. "What's Really Warming the World?" Bloomberg, June 24, 2015, Businessweek edition. https://www.bloomberg.com/graphics/2015-whats-warming-the-world/.

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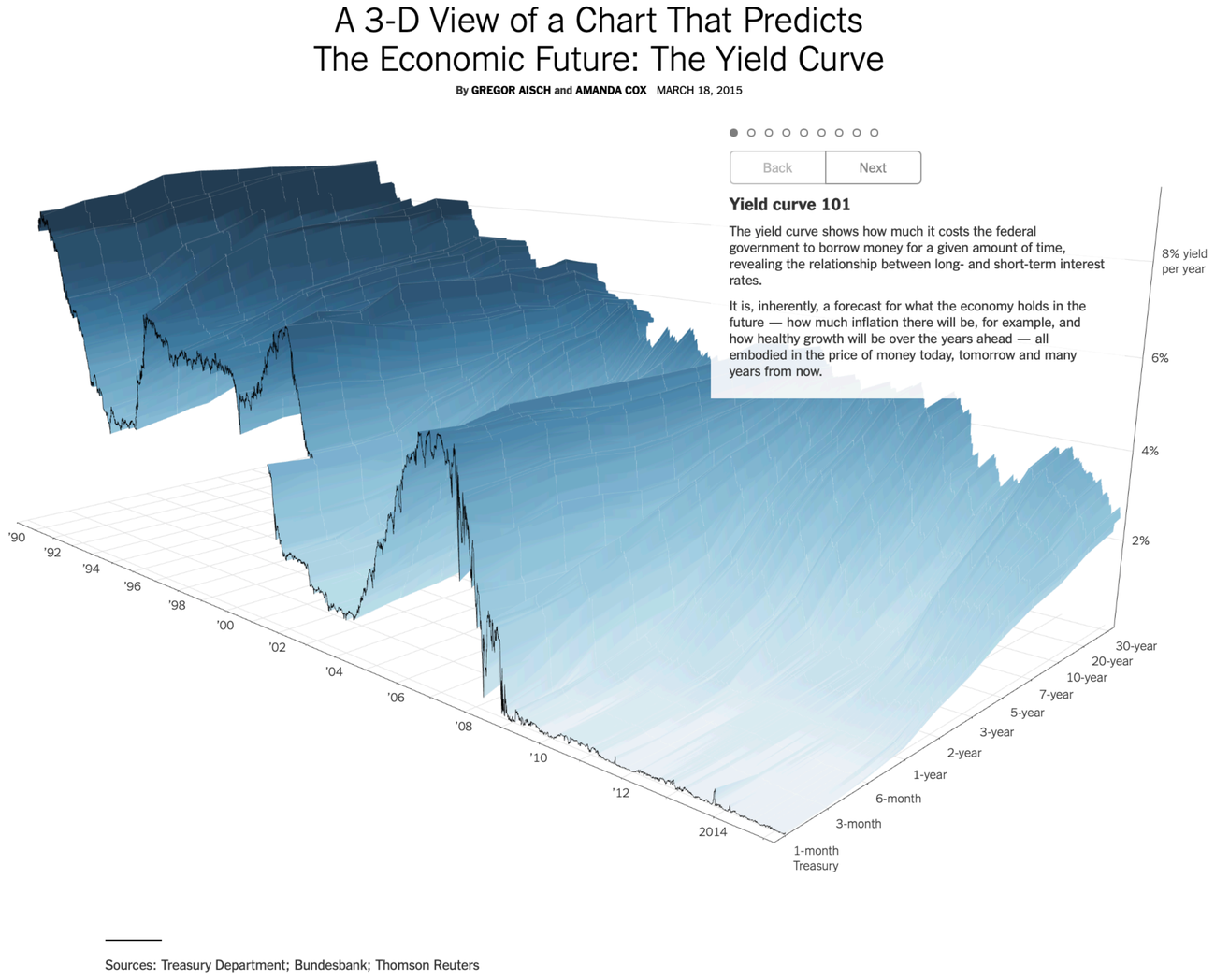
examples of interaction, follow the citation to the original, interactive version



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.

Is It Better to Rent or Buy?

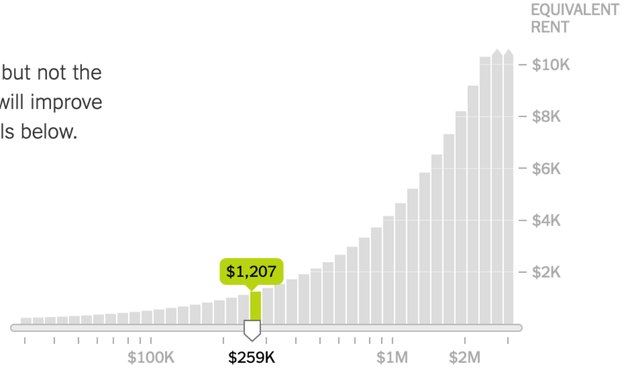
By MIKE BOSTOCK, SHAN CARTER and ARCHIE TSE

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.

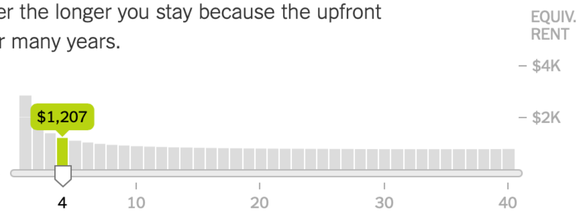
$259,000



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



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.

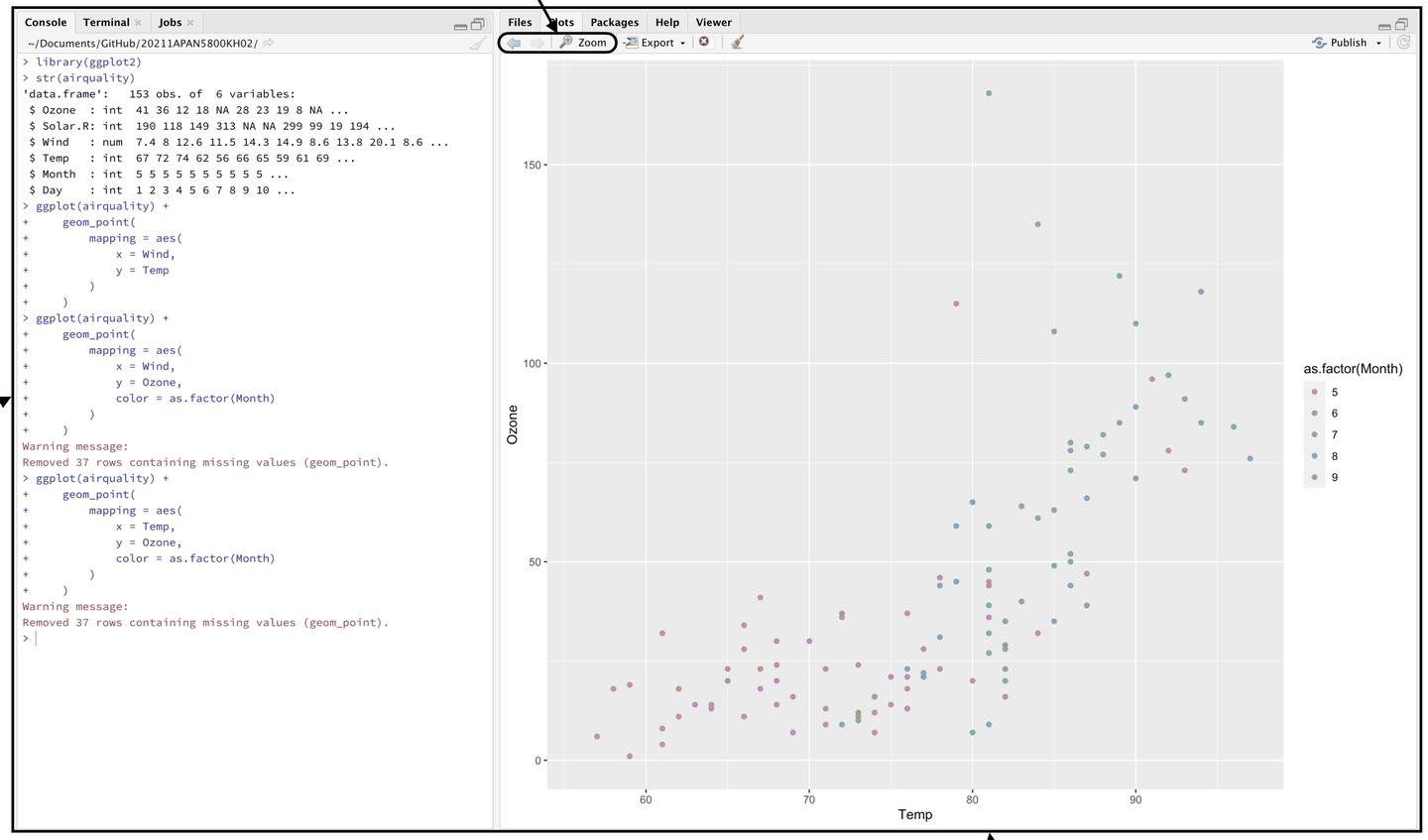
Bostock, Mike, Shan Carter, and Archie Tse. "Is It Better to Rent or Buy?" *The New York Times*. May 21, 2014, Online edition, sec. The Upshot. https://www.nytimes.com/interactive/2014/upshot/buy-rent-calculator.html.

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

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)_/¯

https://www.rstudio.com/products/rstudio/

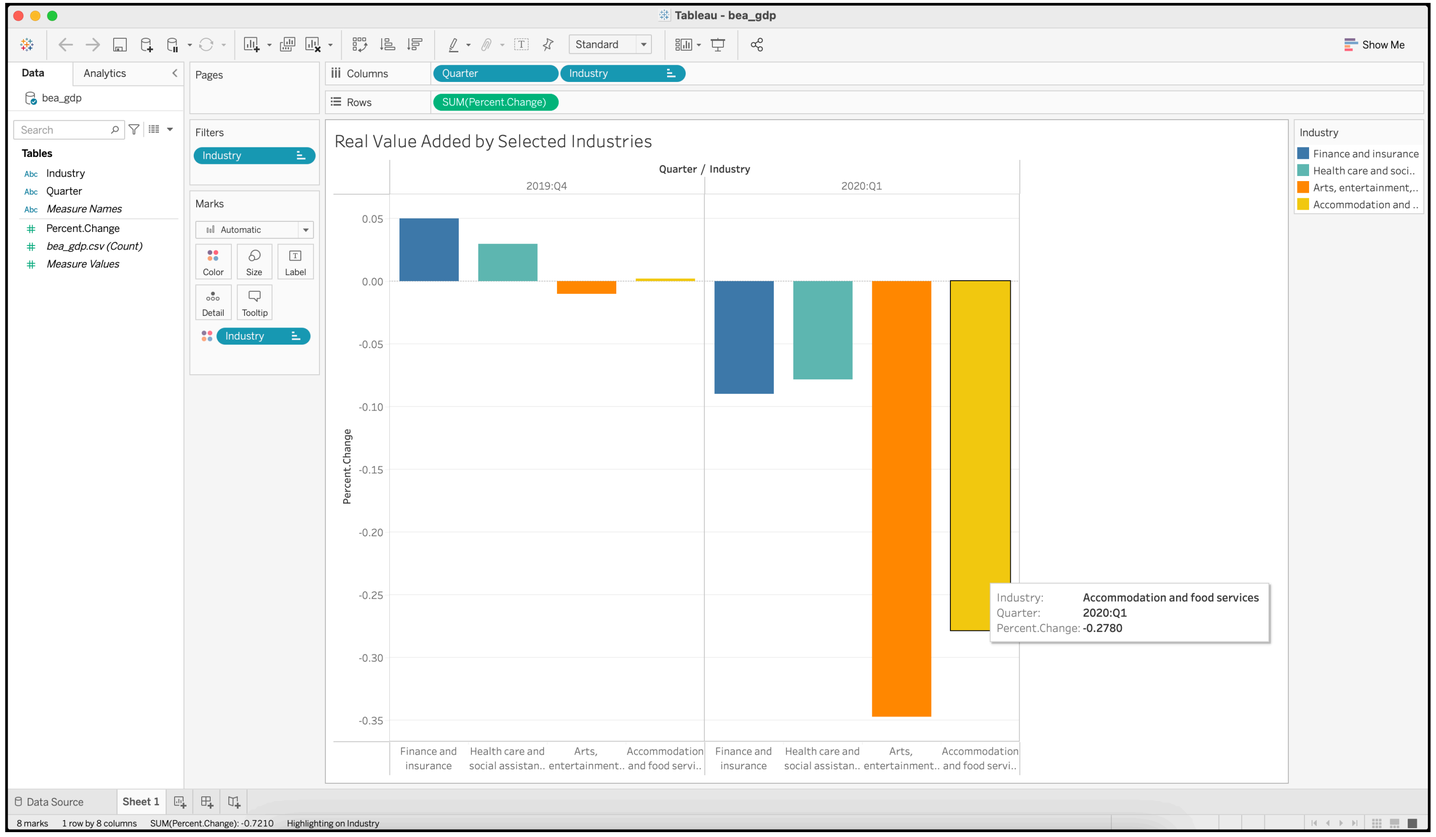


examples of interaction, we can make interactive graphics in Tableau; but is Tableau some kind of interactive graphic?

Tableau is a software *application* with a *graphical user interface*. We can "***interact***" with it by ***dragging*** and ***dropping***, ***clicking*** buttons. In ***response***, Tableau ***changes the view of the data graphic*** we see. Is Tableau an interactive graphic?

¯_(ツ)_/¯

https://www.tableau.com/products/desktop



Sleeper, Ryan. *Innovative Tableau: 100 More Tips, Tutorials, and Strategies*, 2020;
Practical Tableau: 100 Tips, Tutorials, and Strategies from a Tableau Zen Master, 2018.

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

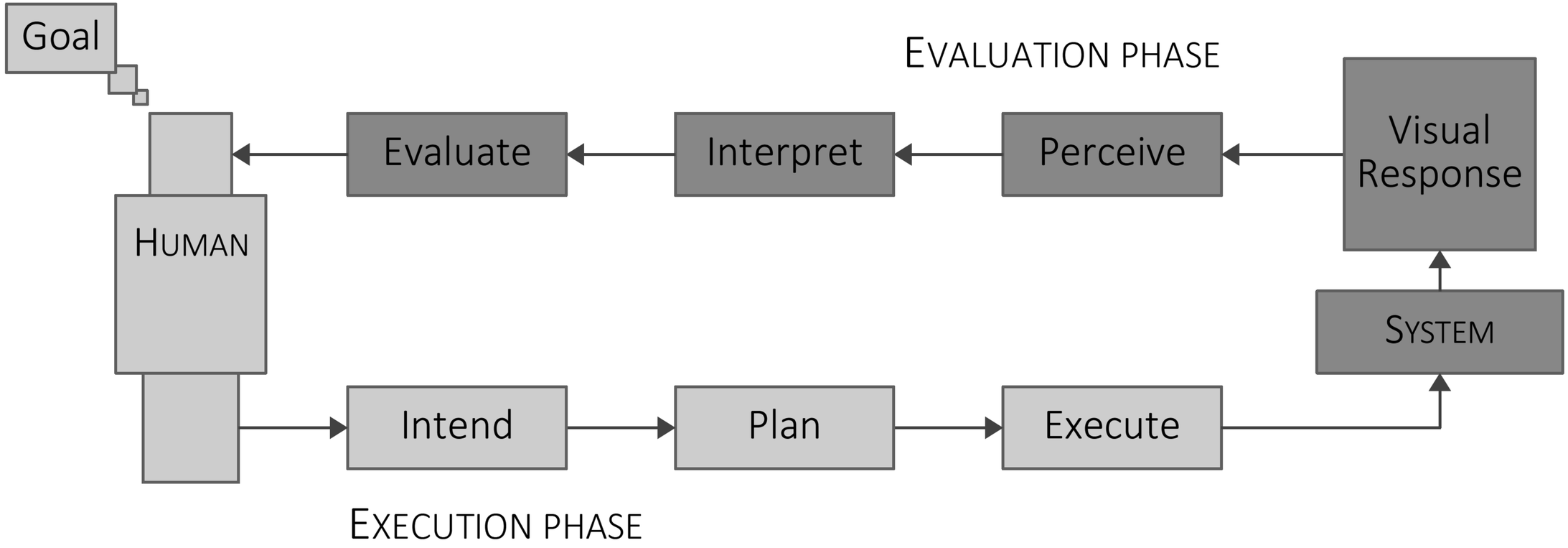
Lyra2 is a *web browser application* with a *graphical user interface*. We can "***interact***" with it by ***dragging*** and ***dropping***, ***clicking*** buttons, similar to Tableau but free, open-source, and based on the powerful **Vega / D3 javascript** languages. In ***response***, Lyra2 ***changes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

¯_(ツ)_/¯

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

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.

 what's interactivity? — "human in the loop" of executing and evaluating



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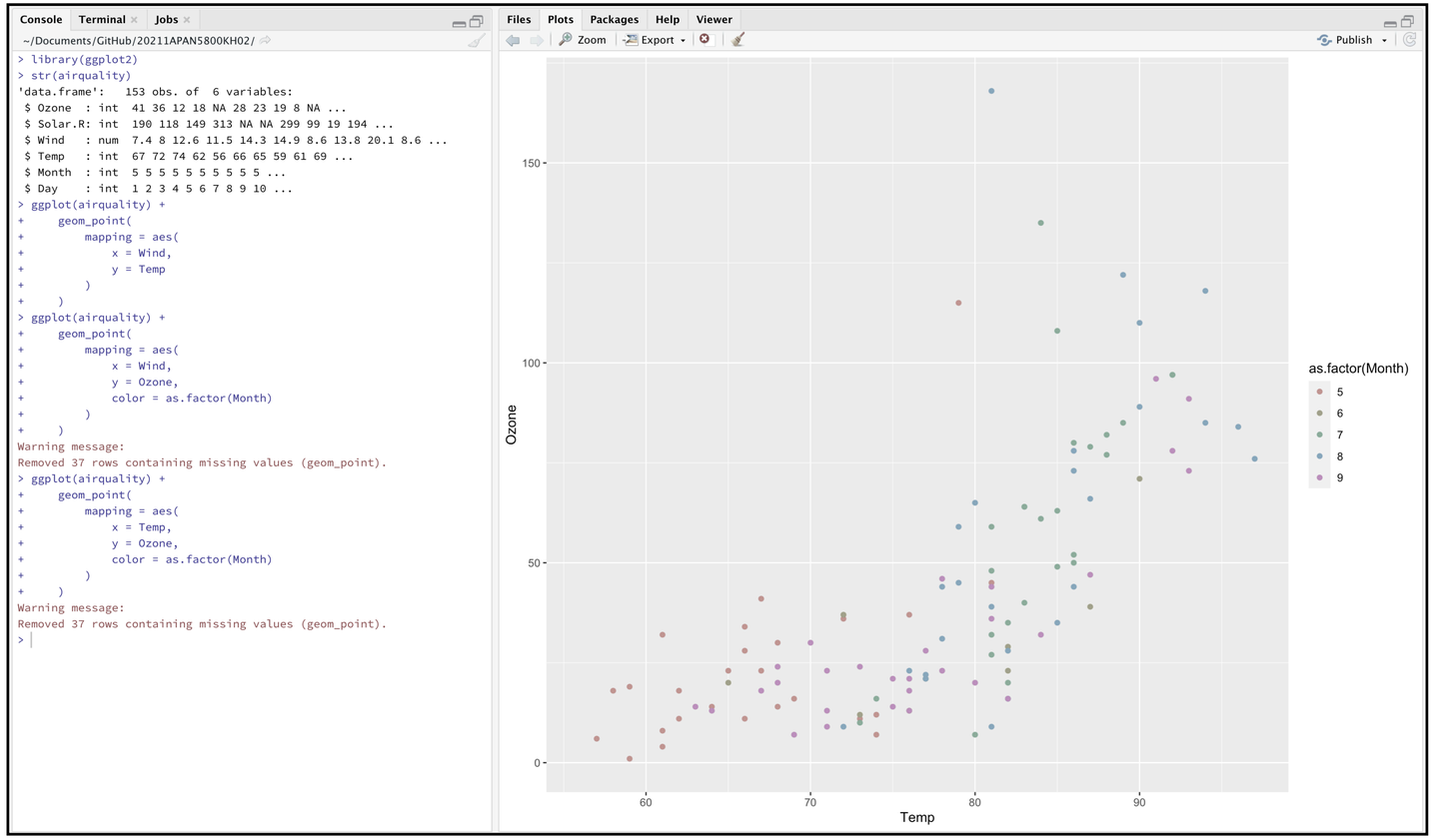
¯_(ツ)_/¯

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**, *Semiology of Graphics*

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**

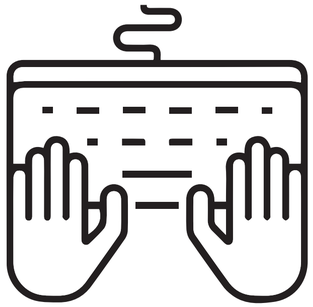
Show me something **conditionally**

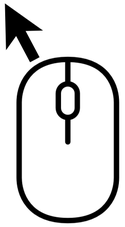
Show me **related** things

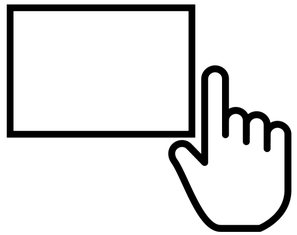
Let me go back to **where I've been**

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

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

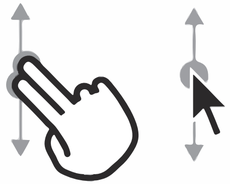




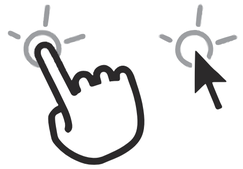


POINTING, HOVERING

SCROLLING

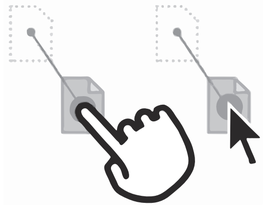


CLICKING



PRESSING

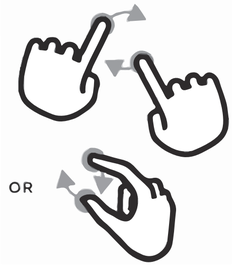
DRAGGING



SWIPING

PINCHING, SPREADING

ROTATING



GESTURES WITH MULTIPLE FINGERS

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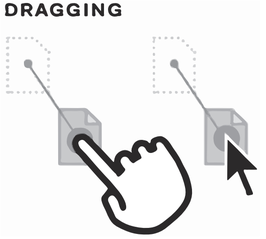
how we interact, **our *actions* can trigger *events* on *elements* like *widgets* or *directly on data encodings***

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

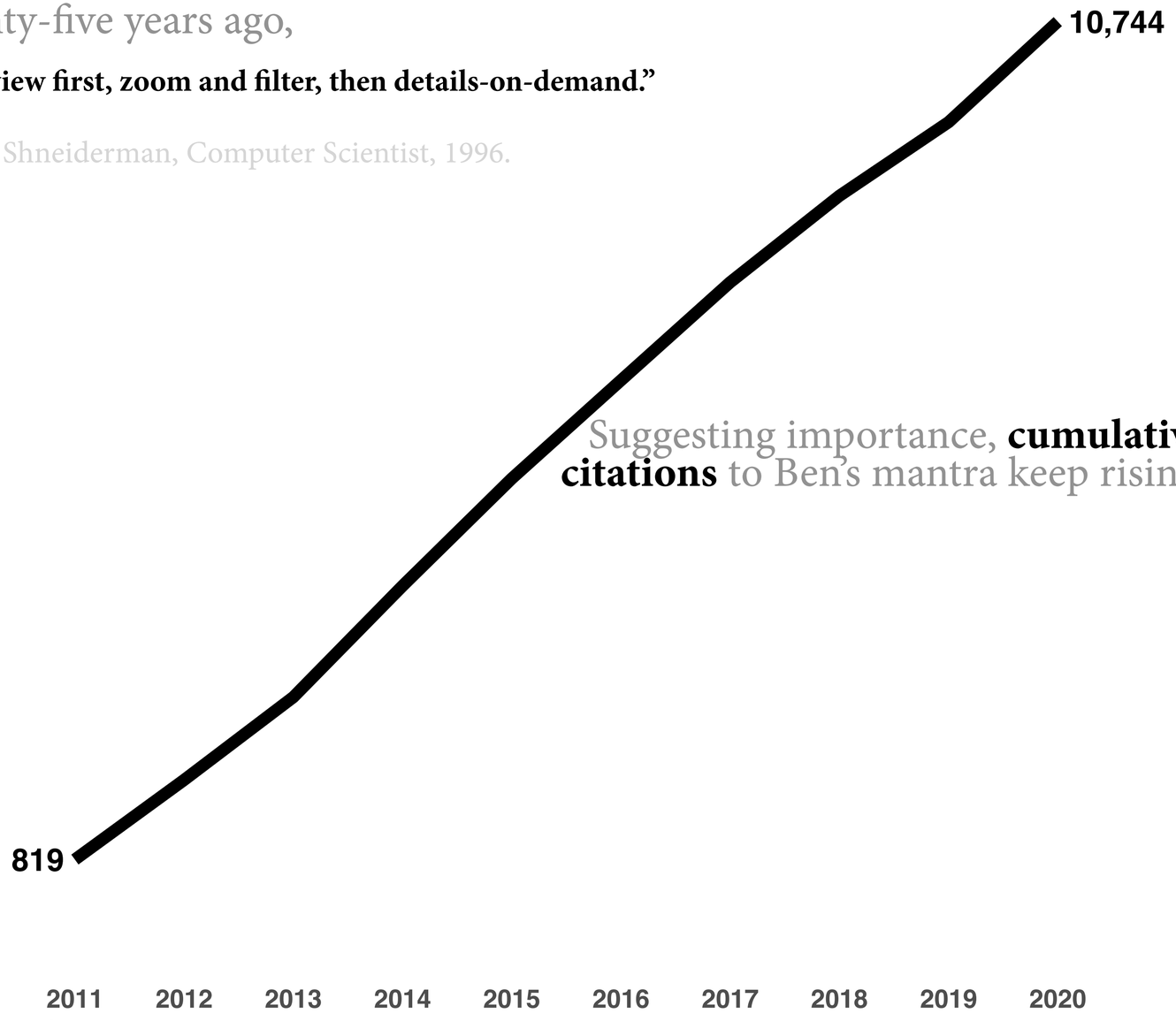
Process and provenance

- **Record** analysis histories for 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.



Source: IEEE repository.

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

“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.”

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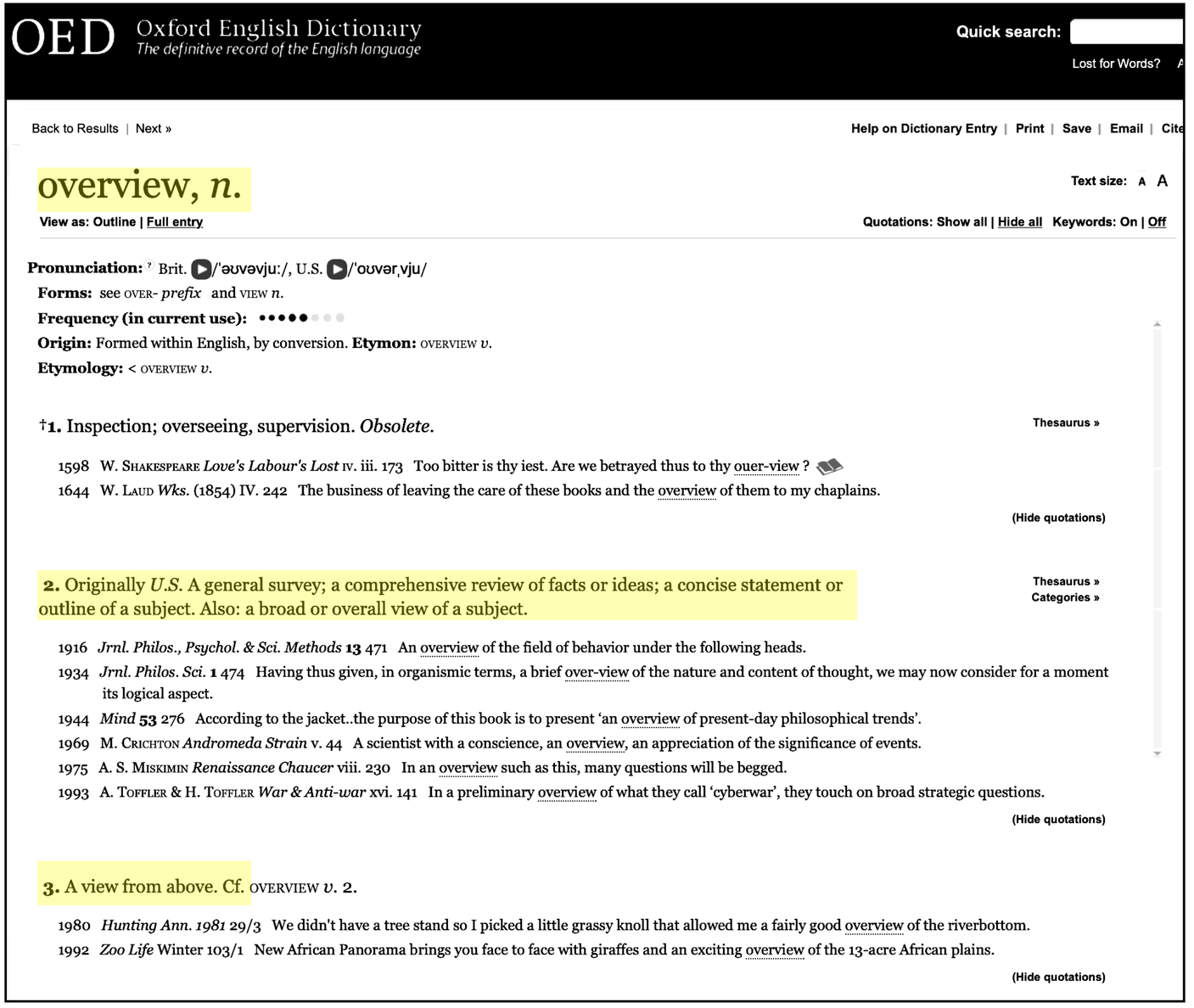
overview first, what's an *overview*?



OED Oxford English Dictionary
The definitive record of the English language

Quick search: Lost for Words?

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. /ˈəʊvəvjuː/, U.S. /ˈoʊvərˌvju/

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

Frequency (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)

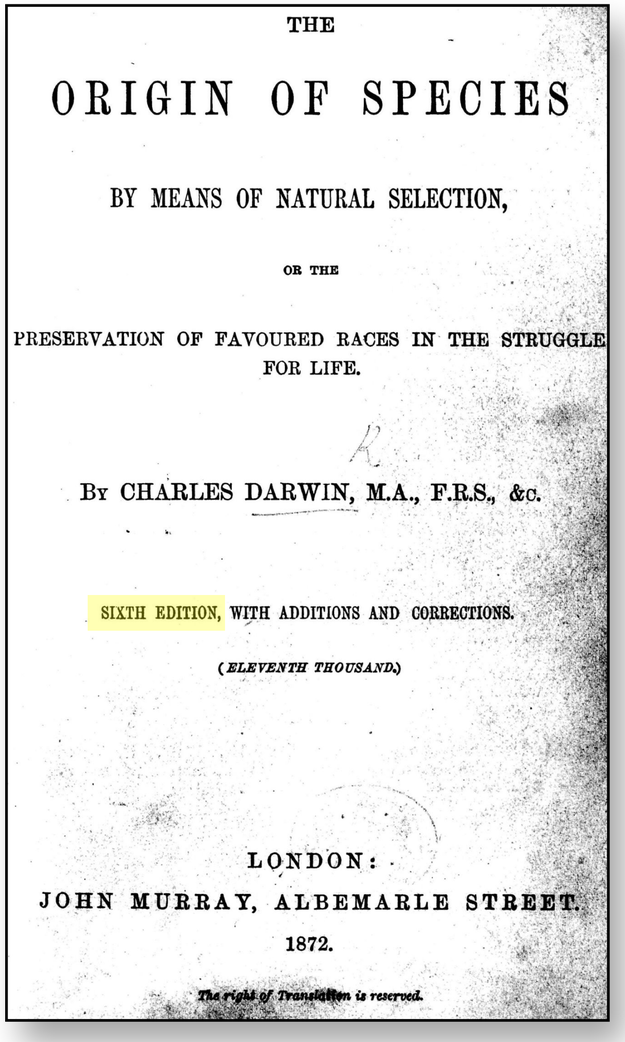
3. A view from above. Cf. OVERVIEW *v.* **2.**

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.

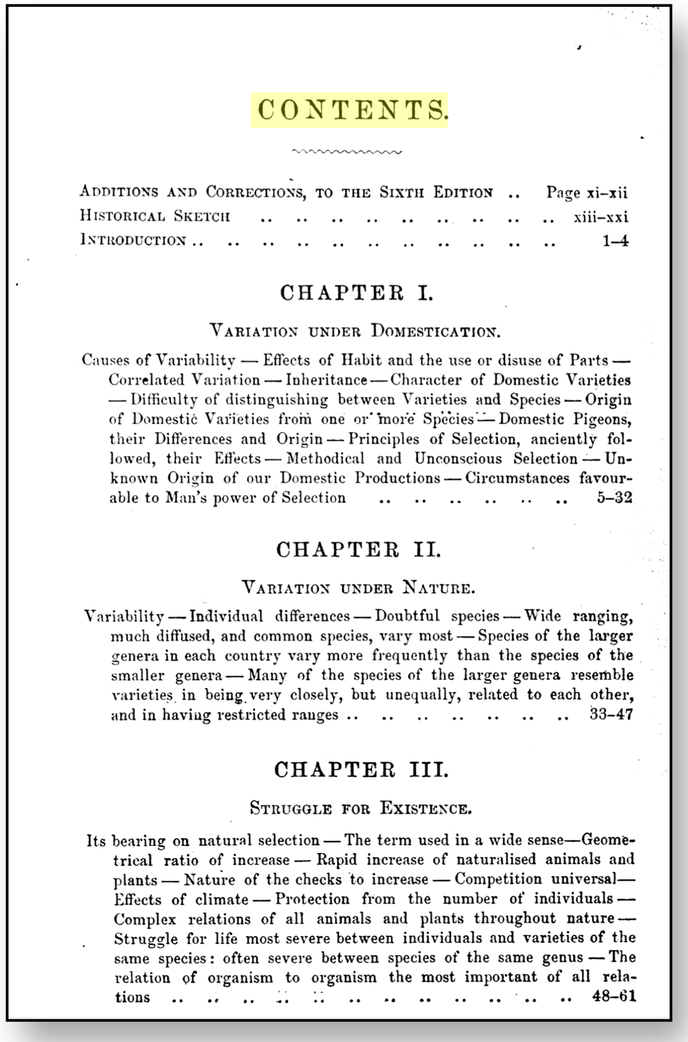
By CHARLES DARWIN, M.A., F.R.S., &c.

SIXTH EDITION, WITH ADDITIONS AND CORRECTIONS.

(*ELEVENTH THOUSAND.*)

LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1872.

The right of Translation is reserved.



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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

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

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

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 America, 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

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

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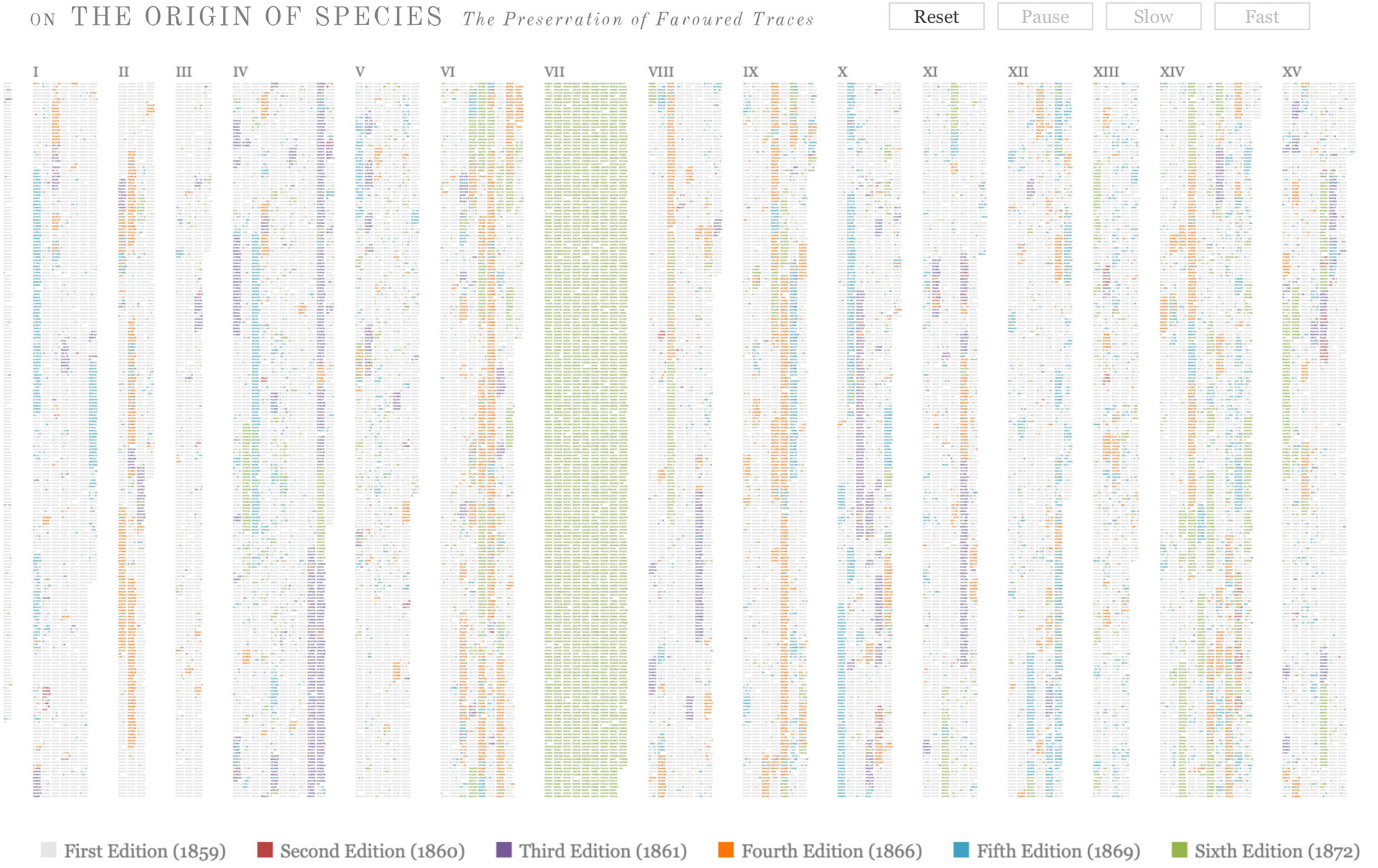
overview first, can a single view of every word in a book, color-coded by date added to edition, be an *overview*?



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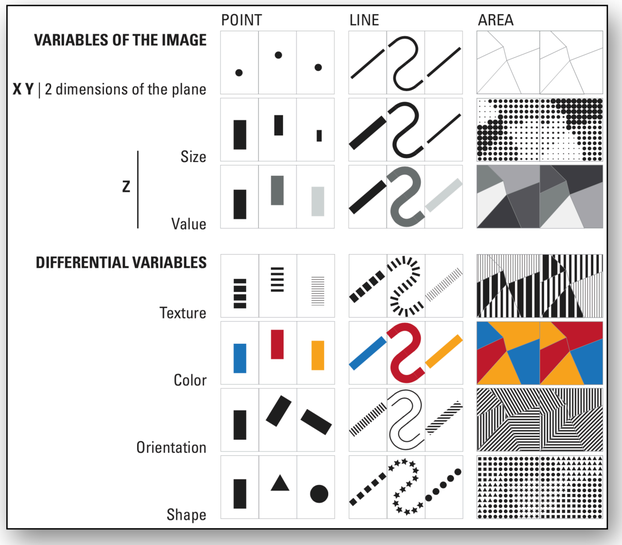
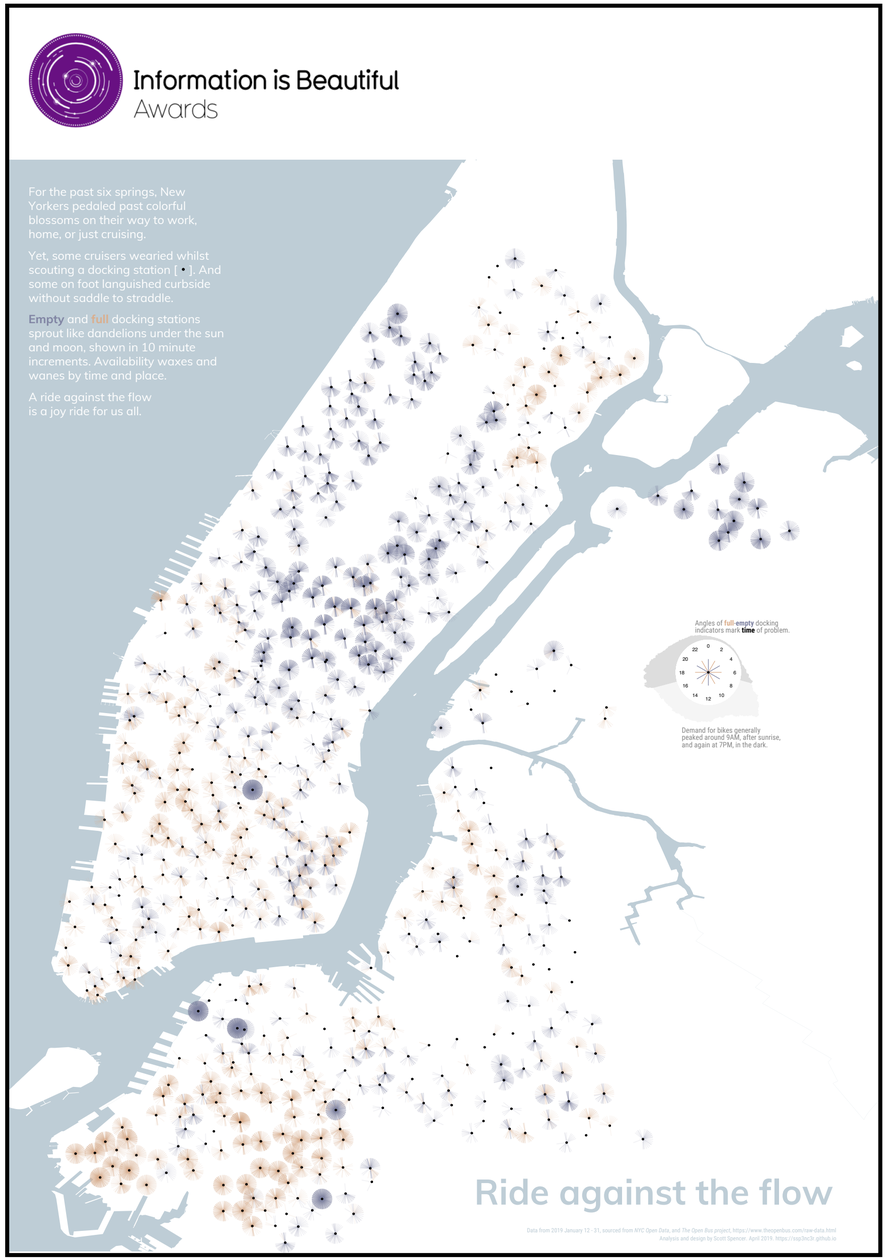
What?! — But some datasets have *many* variables! How can we show high-dimensional space in a single view?

how we interact, what's an *overview*, what should it do? — CitiBike example, measured and *some* available variables

shown	available, 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?

"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**."

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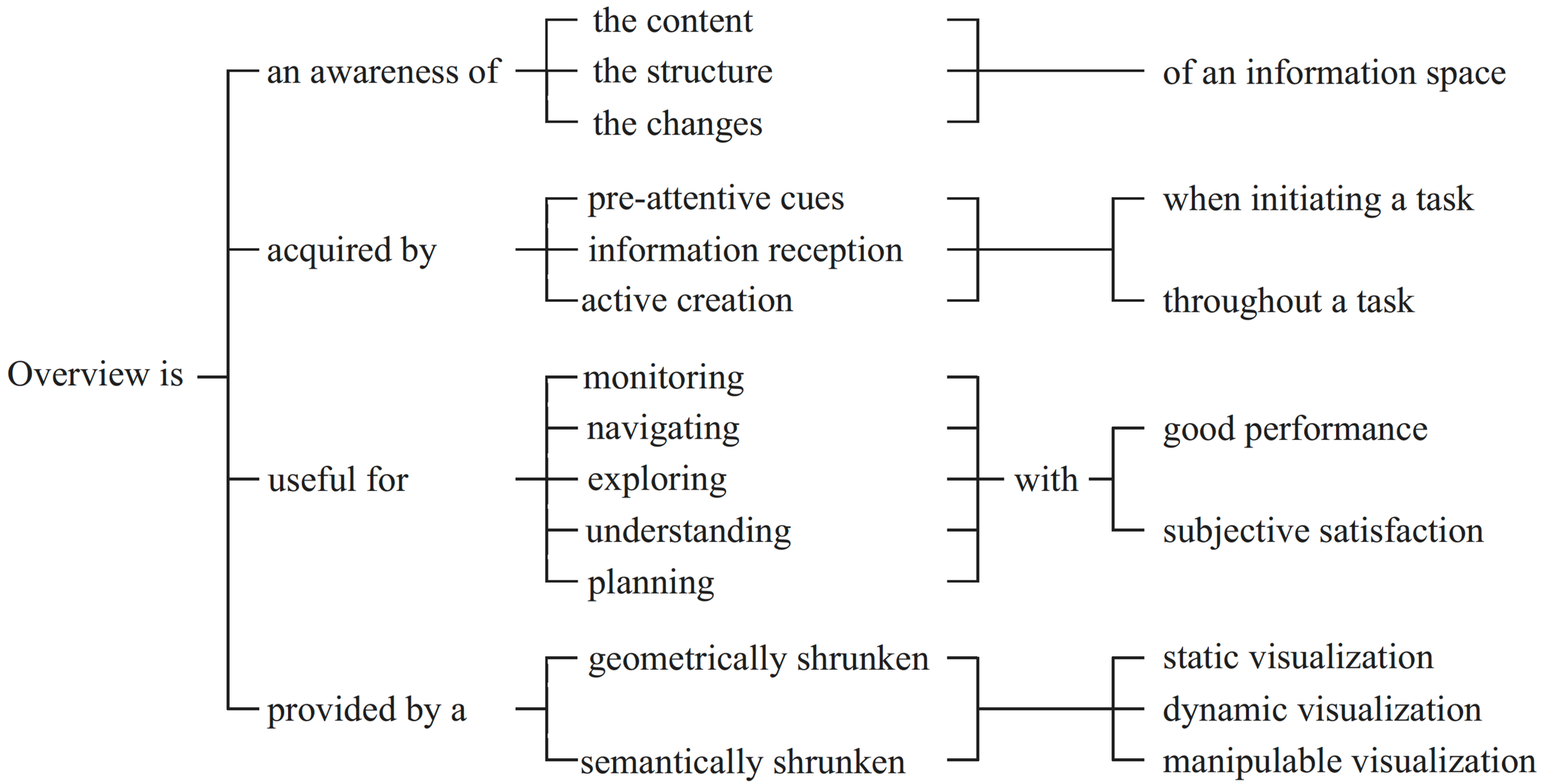
What?! — But some datasets have *many* variables! How can we show high-dimensional space in a single view?

"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."

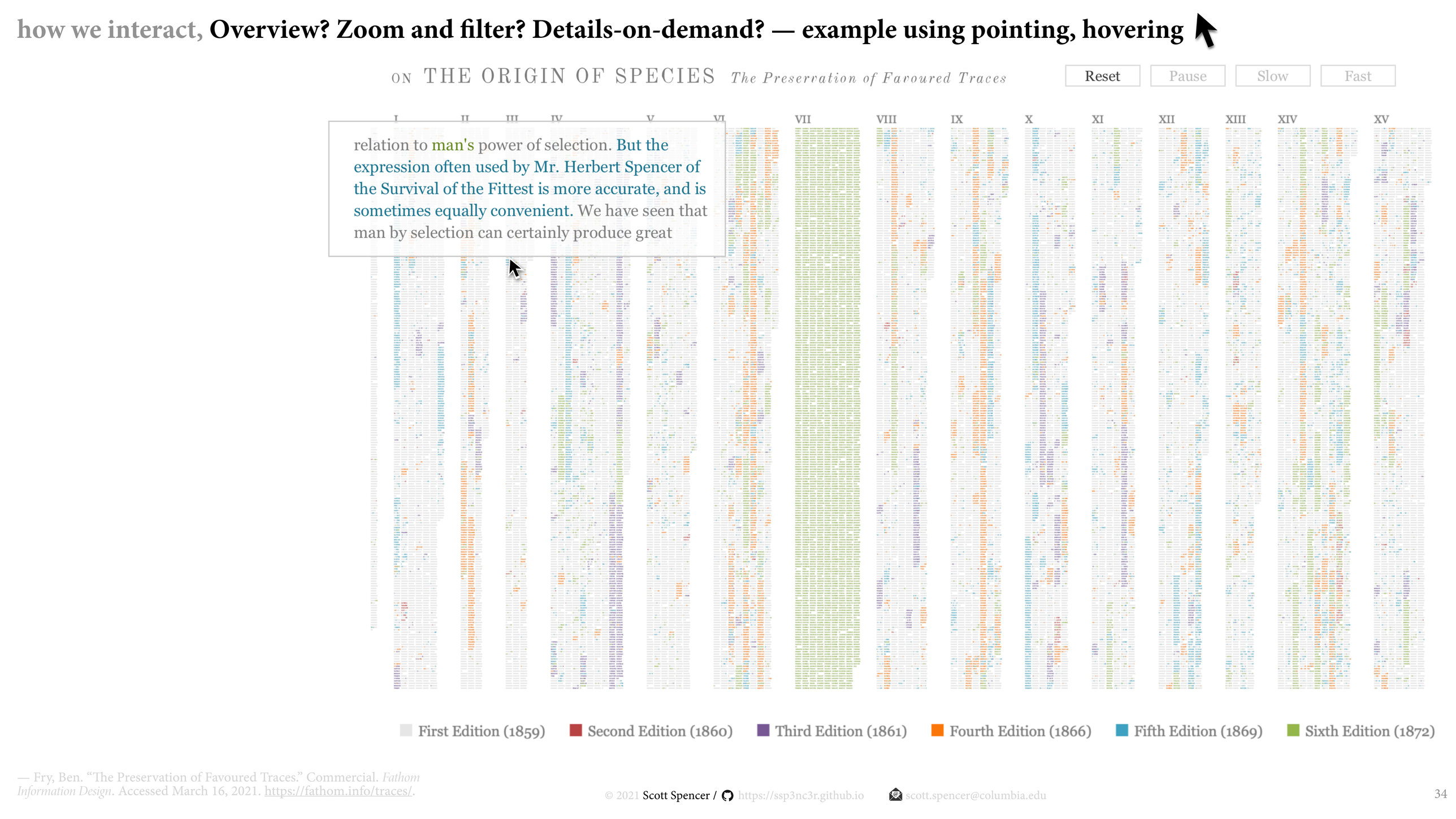
— Hornbæk, Kasper, and Morten Hertzum. "The Notion of Overview in Information Visualization." *International Journal of Human-Computer Studies* 69, no. 7–8 (July 2011): 509–25. https://doi.org/10.1016/j.ijhcs.2011.02.007.

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



— 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, Overview? Zoom and filter? Details-on-demand? — example using pointing, hovering



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

how we interact, Overview? Zoom and filter? Details-on-demand? — example using pointing, hovering, clicking

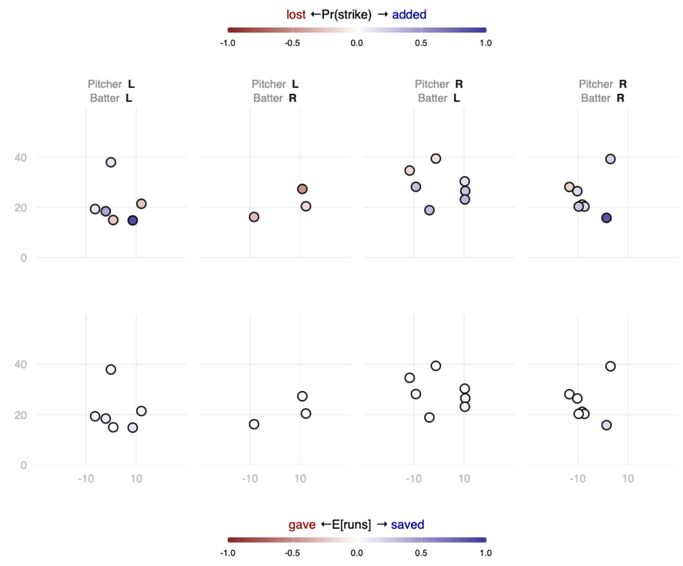
Explorable differences between umpire calls and modeled probabilities of strikes

Below, we can explore the percentage difference between the umpire calls and modeled probabilities of those calls, with corresponding video footage. Circles ○ in the **top row** represent called pitches (ball, strike) and lightness of the color represent how close [8] our *modeled* strike probability was to the *actual* call {0, 1} for each handedness (throw-stand) matchup `{LL,LR,RL,RR}`.

Of note, the graphics below only show pitches where the differences of called **ball** or **strike** from modeled probability of strikes exceed ± 0.10.

Circles ○ in the **bottom row** represent the corresponding estimate of *runs saved* from that variation.

Hovering a pointer over a circle ○ links ○—○ pitches in top and bottom rows, and provides more details of the play in a tooltip. **Clicking** a pitch loads its game video:



Clicking one of the above observed pitches loads its video:

Explorable differences between umpire calls and modeled probabilities of strikes

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variation.

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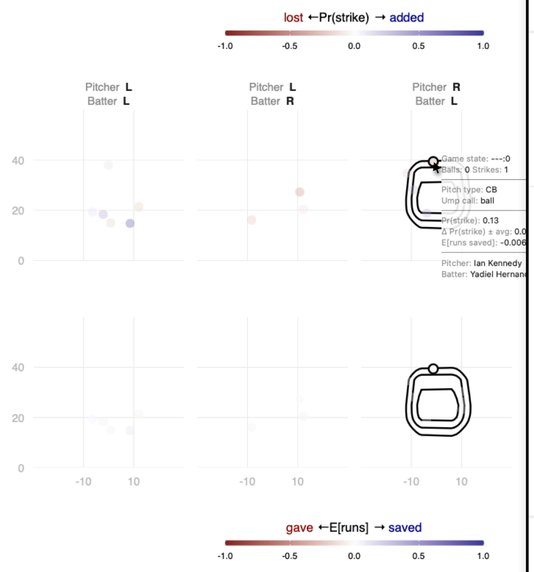
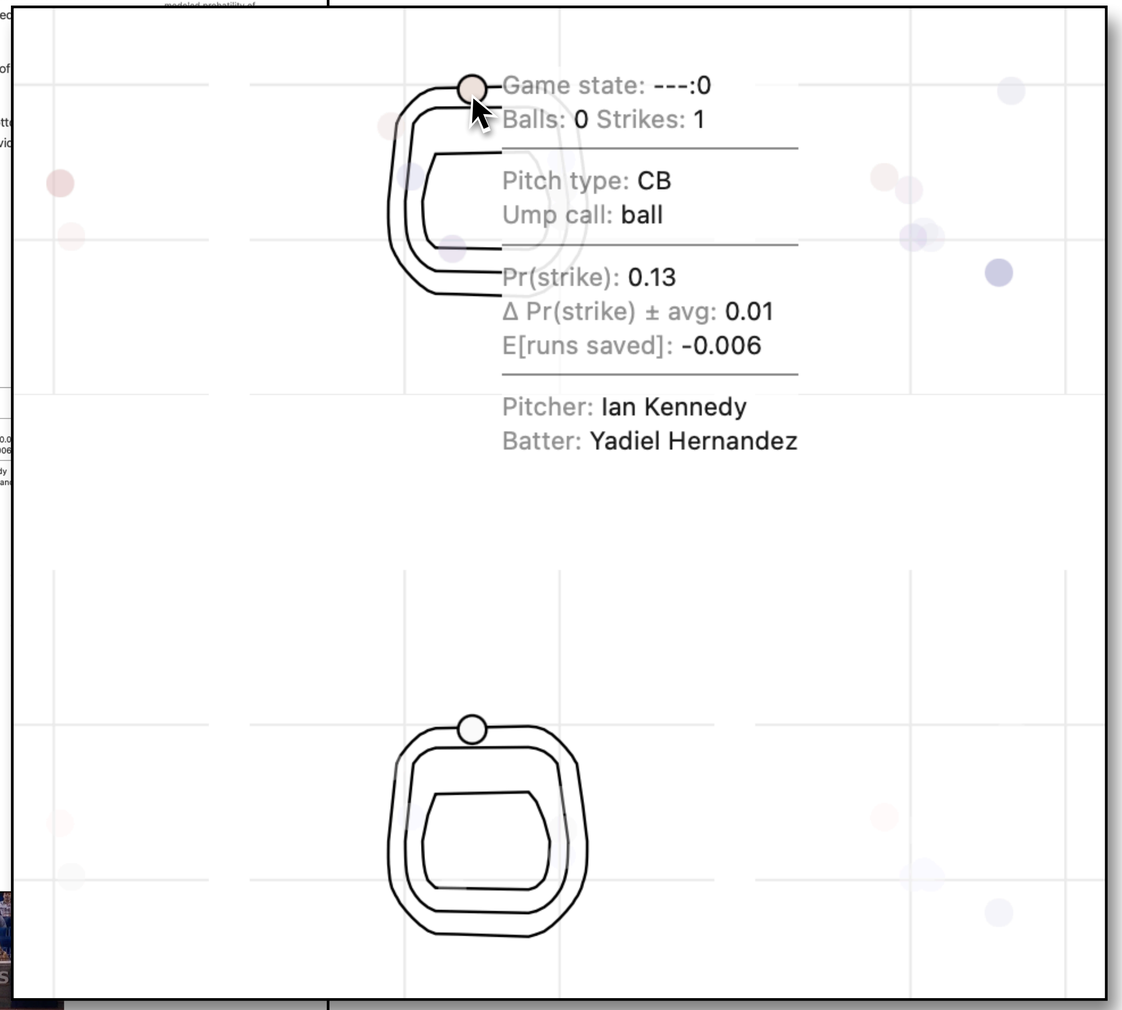
more details of the play in a tooltip. **Clicking** a pitch loads its game vi



Clicking one of the above observed pitches loads its video:



how we interact, on zooming (*e.g.*) — *raster* and *vector* graphics

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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.

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

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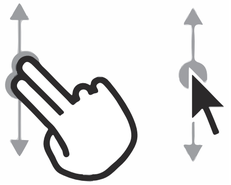
Recently,

“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.

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



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

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“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.

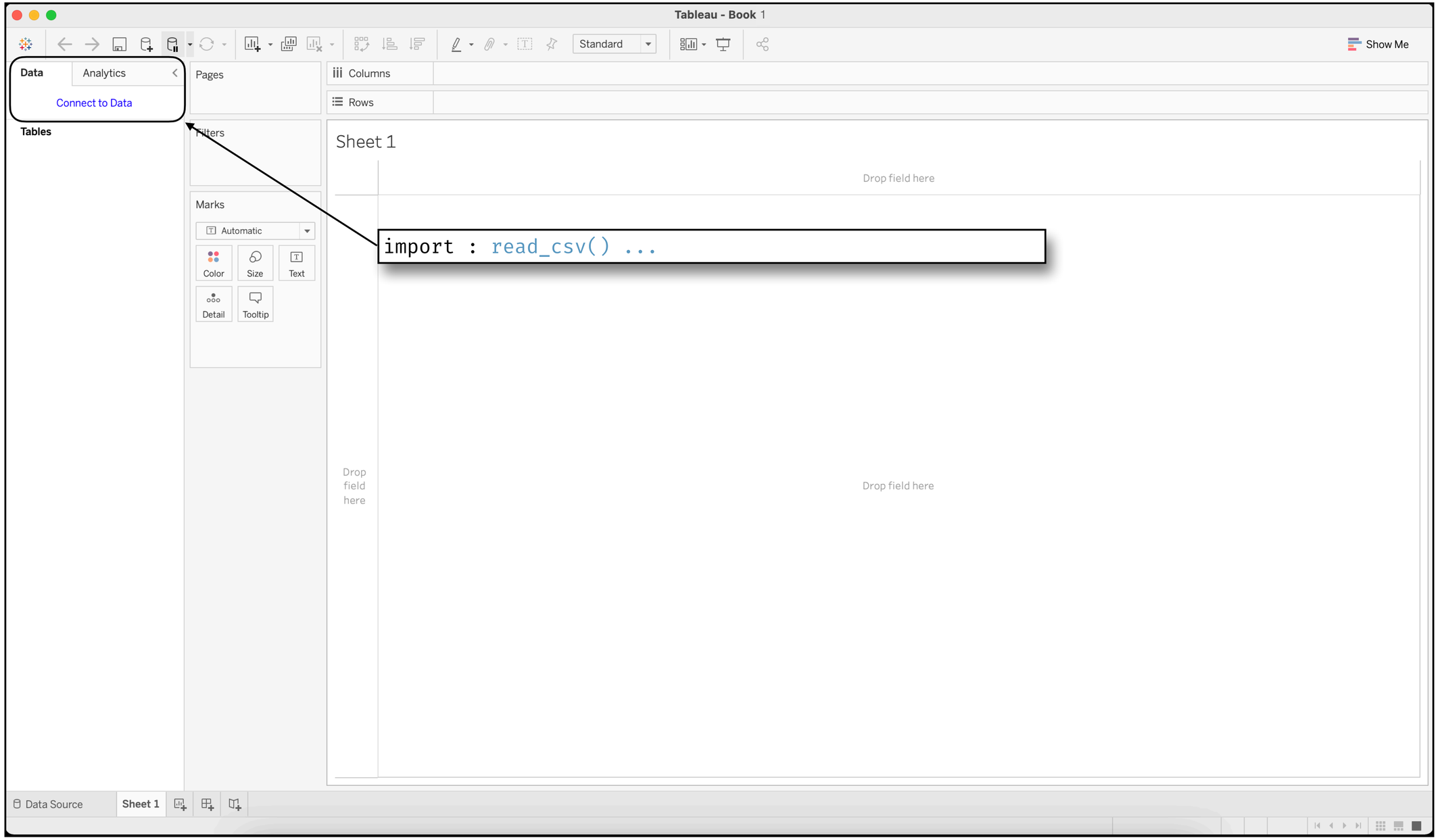
Interactivity lets readers dig deeper, explore more views of data, and re-build trust through transparency.

“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.”

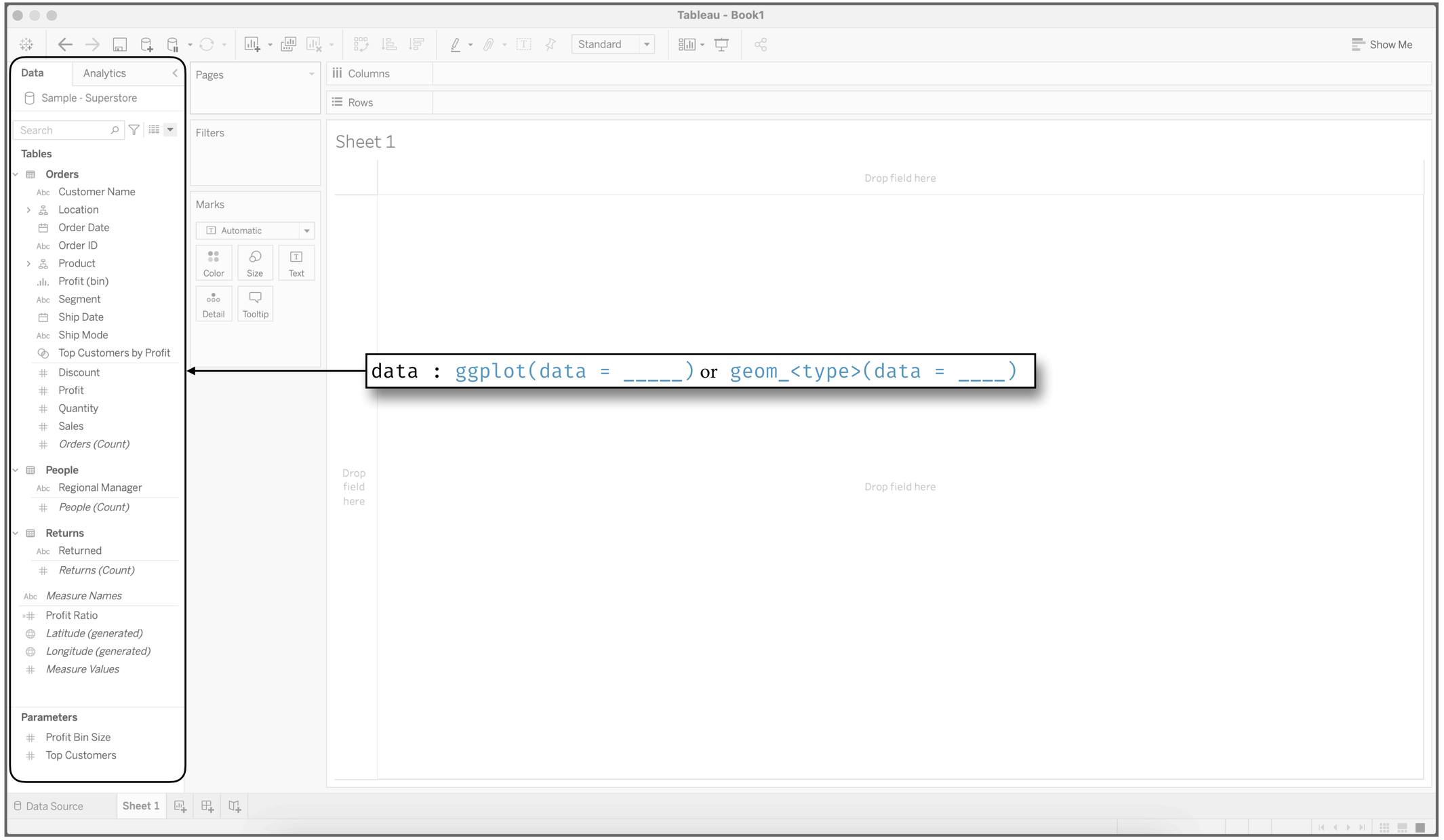
— Gregor Aisch. CIO, Datawrapper, 2017.

(limited) grammar of graphics functions mapped to Tableau — introduction & use case

basics of Tableau, Tableau mapped to grammar of graphics functions (ggplot2 + tidyverse)



basics of Tableau, Tableau mapped to grammar of graphics functions (ggplot2 + tidyverse)



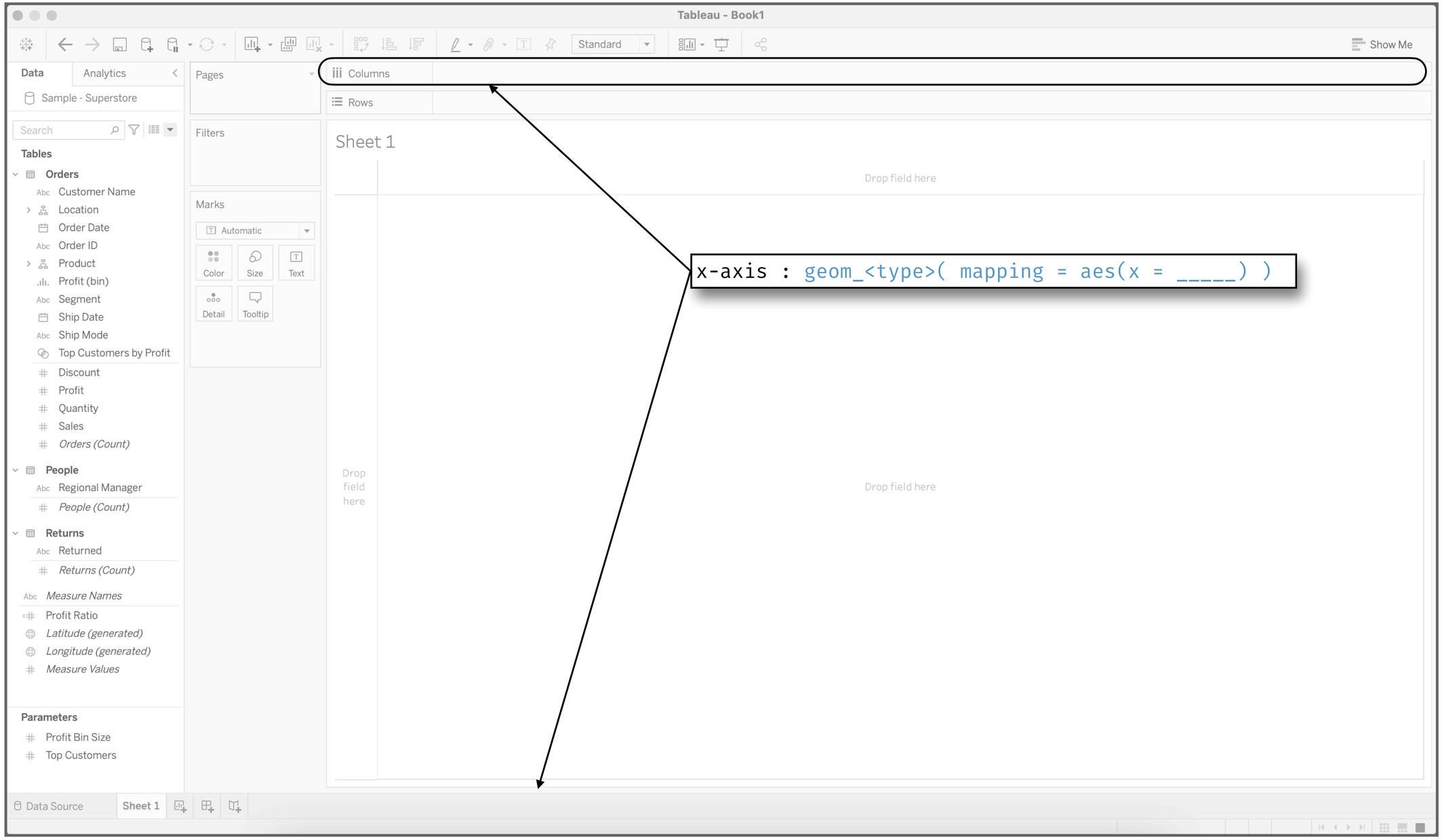


Tableau - Book1
Standard
Show Me
Data
Analytics
Sample - Superstore
Search
Tables
Orders
Customer Name
Location
Order Date
Order ID
Product
Profit (bin)
Segment
Ship Date
Ship Mode
Top Customers by Profit
Discount
Profit
Quantity
Sales
Orders (Count)
People
Regional Manager
People (Count)
Returns
Returned
Returns (Count)
Measure Names
Profit Ratio
Latitude (generated)
Longitude (generated)
Measure Values
Parameters
Profit Bin Size
Top Customers
Pages
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Marks
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Columns
Rows
Sheet 1
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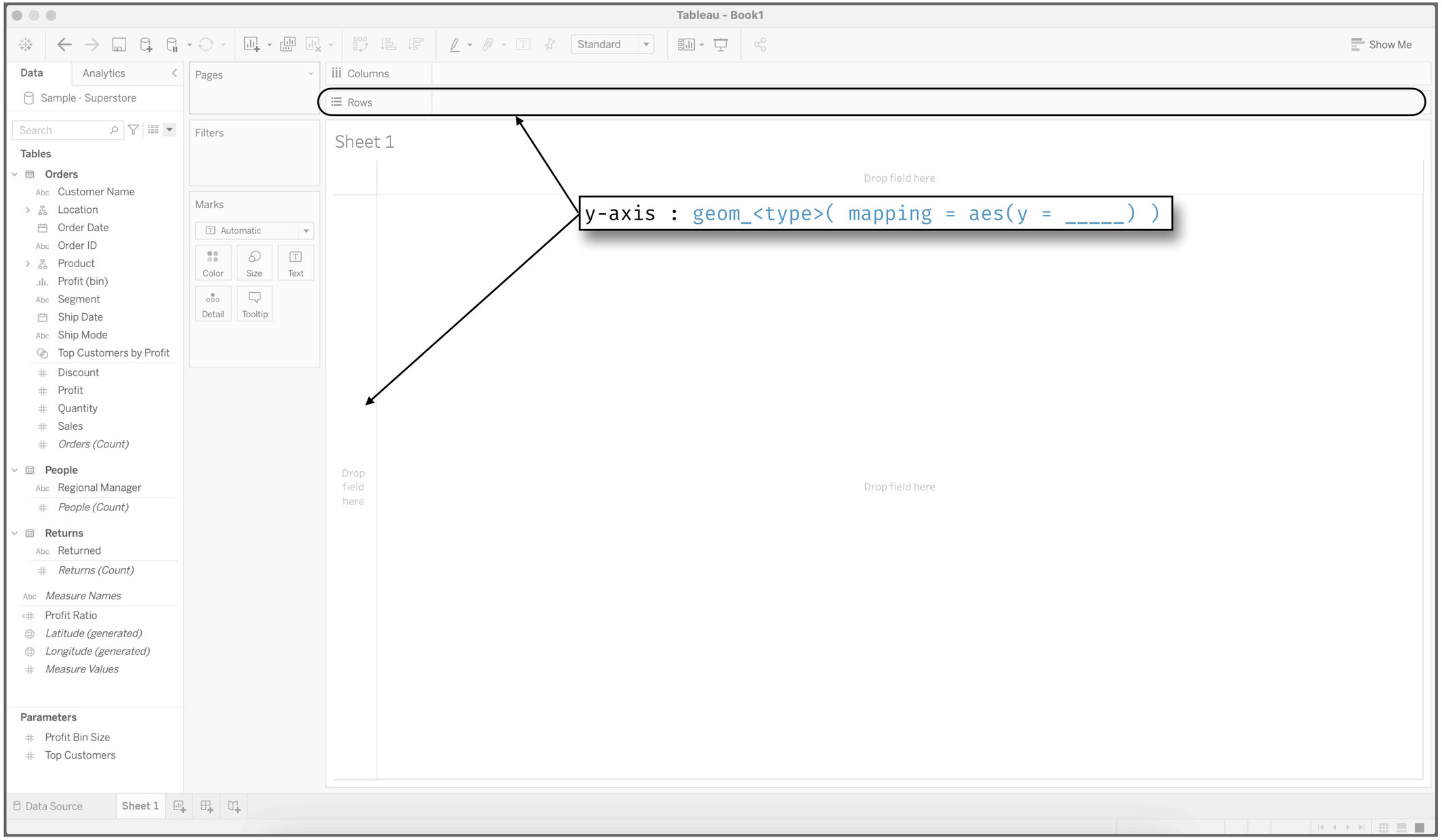
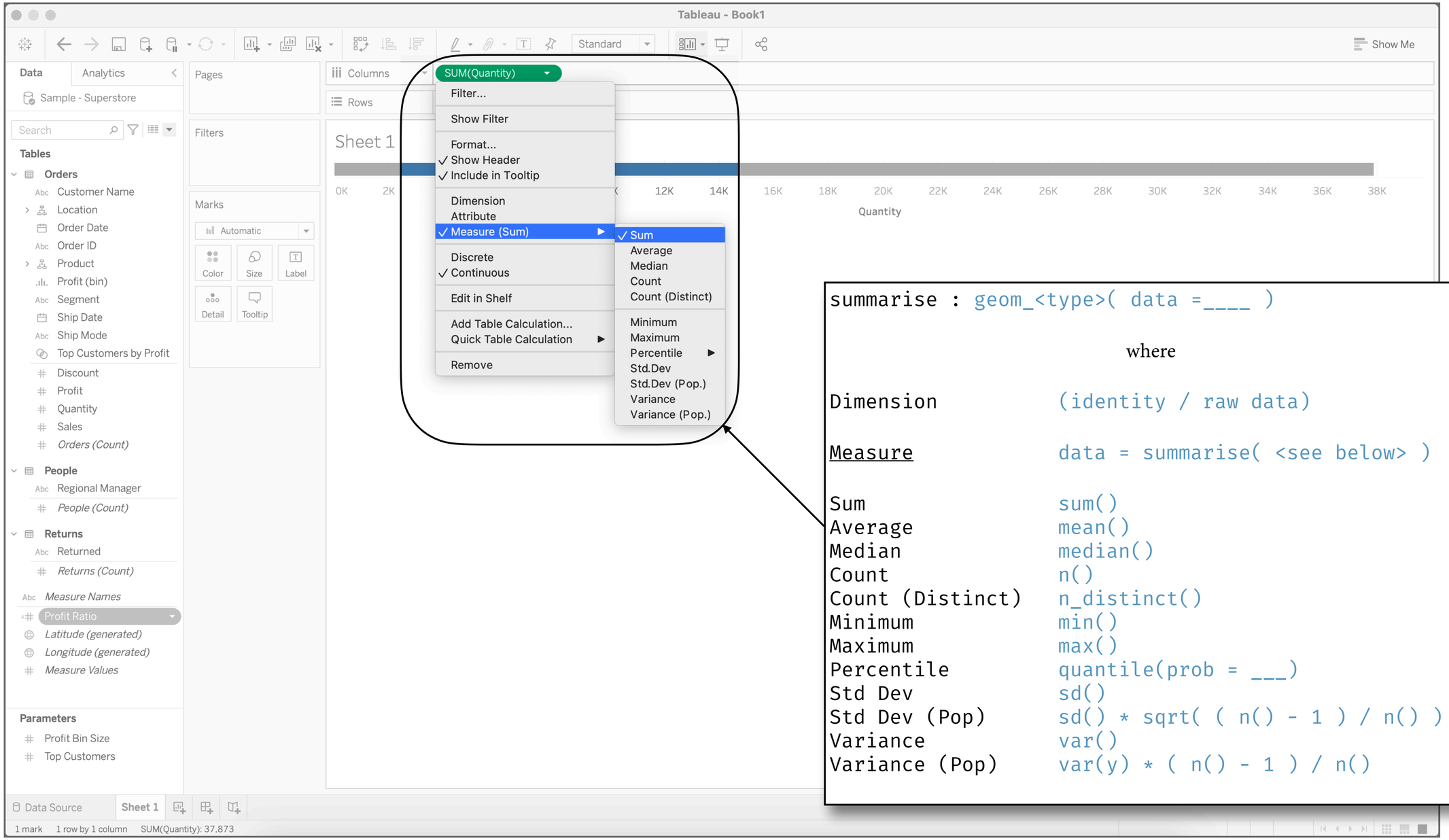
Drop field here
x-axis : geom_<type>(mapping = aes(x = _____))
Data Source
Sheet 1

basics of Tableau, Tableau mapped to grammar of graphics functions (ggplot2 + tidyverse)



basics of Tableau, Tableau mapped to grammar of graphics functions (ggplot2 + tidyverse)



summarise : geom_<type>(data =____)

where

Dimension	(identity / raw data)
Measure	data = summarise(<see below>)
Sum	sum()
Average	mean()
Median	median()
Count	n()
Count (Distinct)	n_distinct()
Minimum	min()
Maximum	max()
Percentile	quantile(prob = ___)
Std Dev	sd()
Std Dev (Pop)	sd() * sqrt((n() - 1) / n())
Variance	var()
Variance (Pop)	var(y) * (n() - 1) / n()

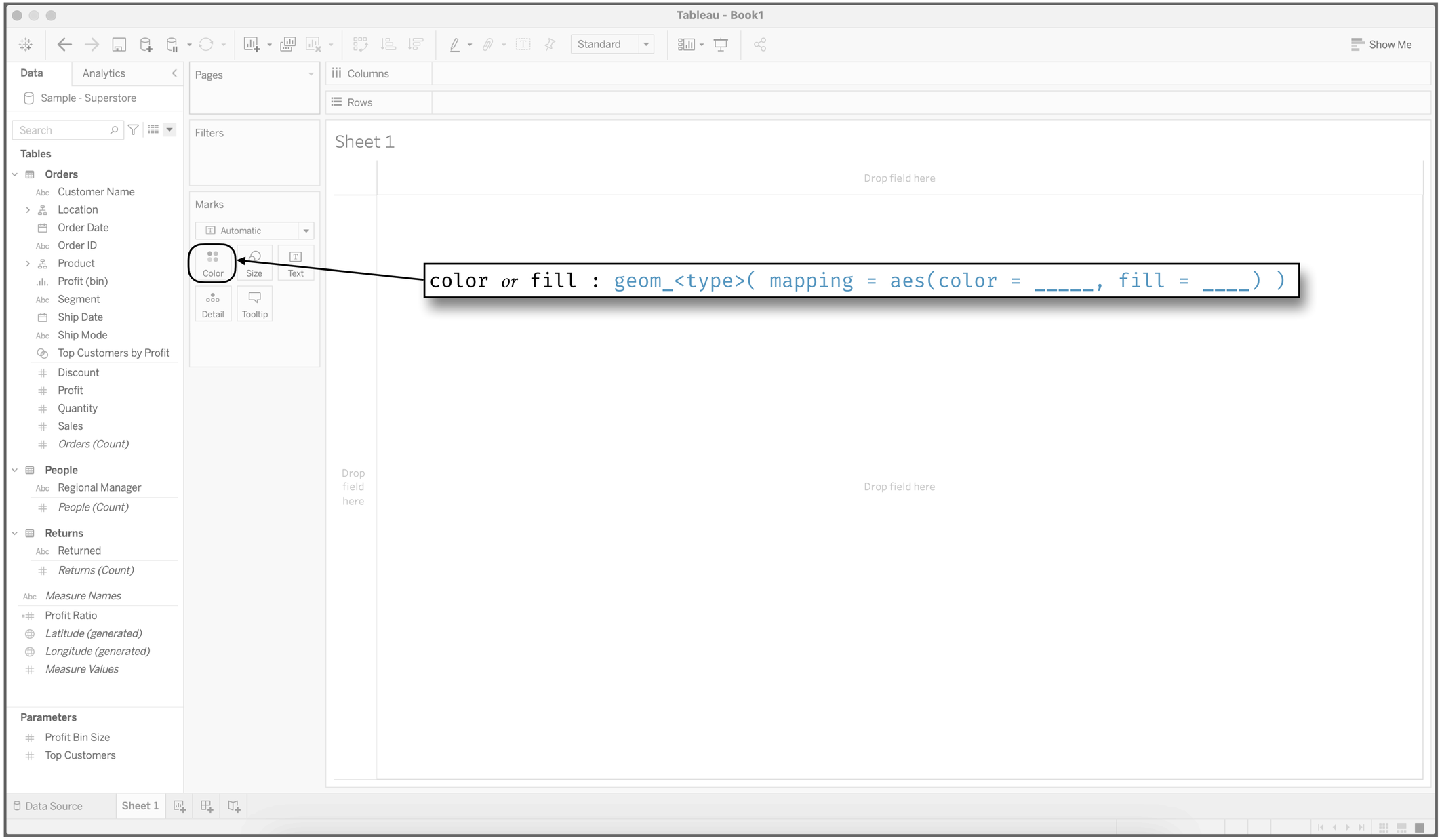


Tableau - Book1
Standard
Show Me
Data
Analytics
Sample - Superstore
Search
Tables
Orders
Customer Name
Location
Order Date
Order ID
Product
Profit (bin)
Segment
Ship Date
Ship Mode
Top Customers by Profit
Discount
Profit
Quantity
Sales
Orders (Count)
People
Regional Manager
People (Count)
Returns
Returned
Returns (Count)
Measure Names
Profit Ratio
Latitude (generated)
Longitude (generated)
Measure Values
Parameters
Profit Bin Size
Top Customers
Pages
Filters
Marks
Automatic
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Sheet 1
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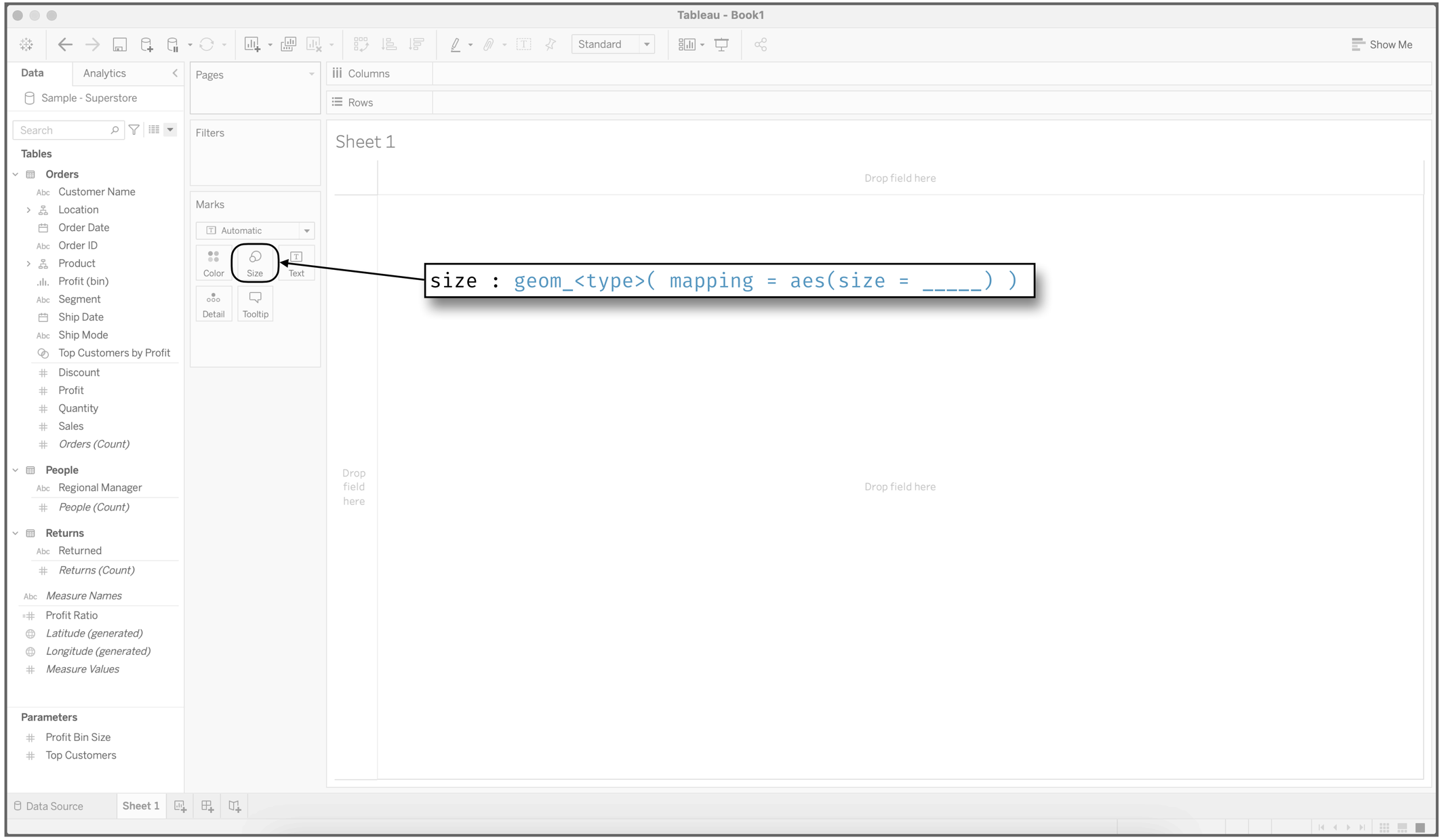
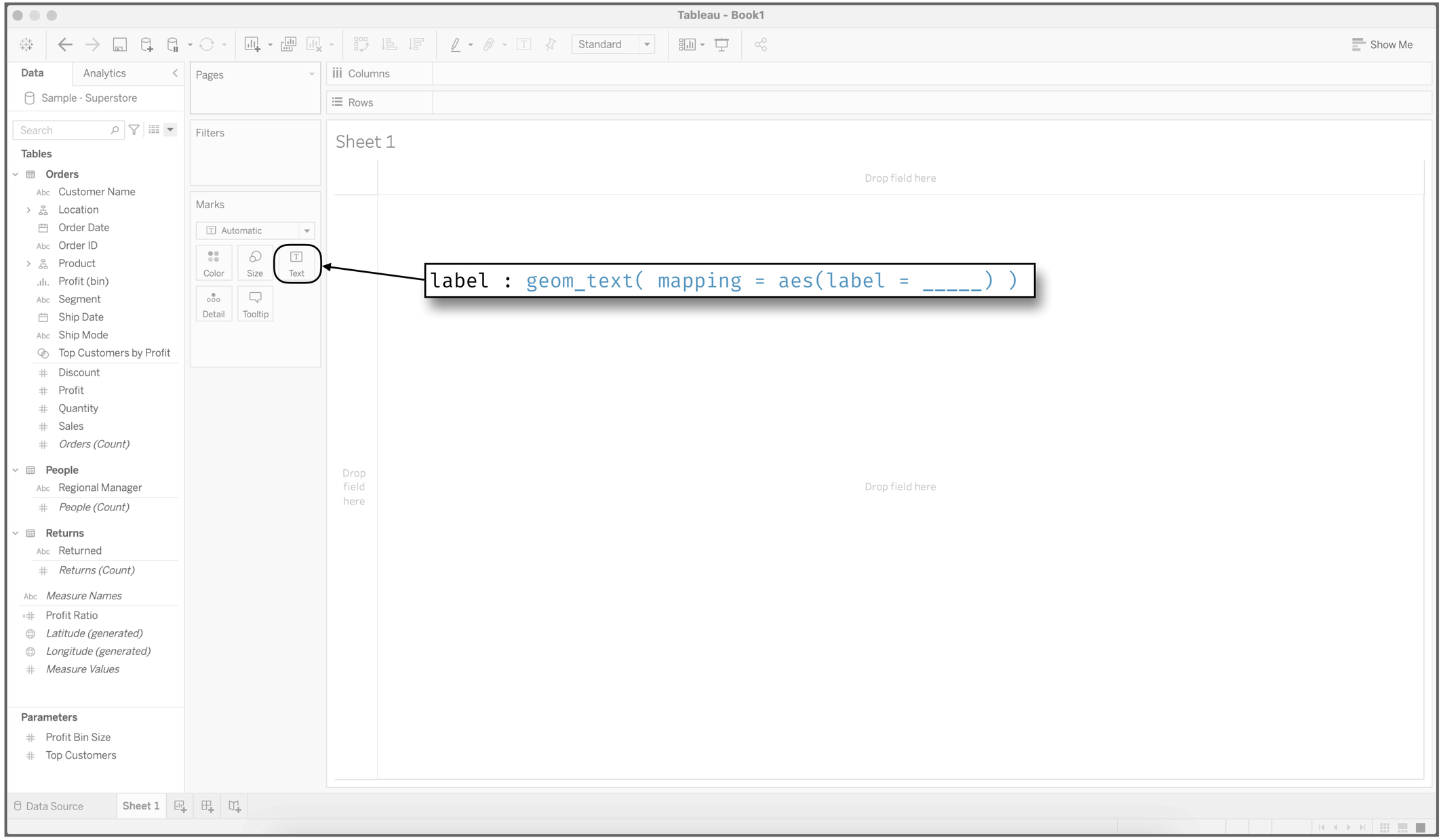
color or fill : geom_<type>(mapping = aes(color = _____, fill = ____))
Data Source
Sheet 1

basics of Tableau, Tableau mapped to grammar of graphics functions (ggplot2 + tidyverse)



basics of Tableau, Tableau mapped to grammar of graphics functions (ggplot2 + tidyverse)



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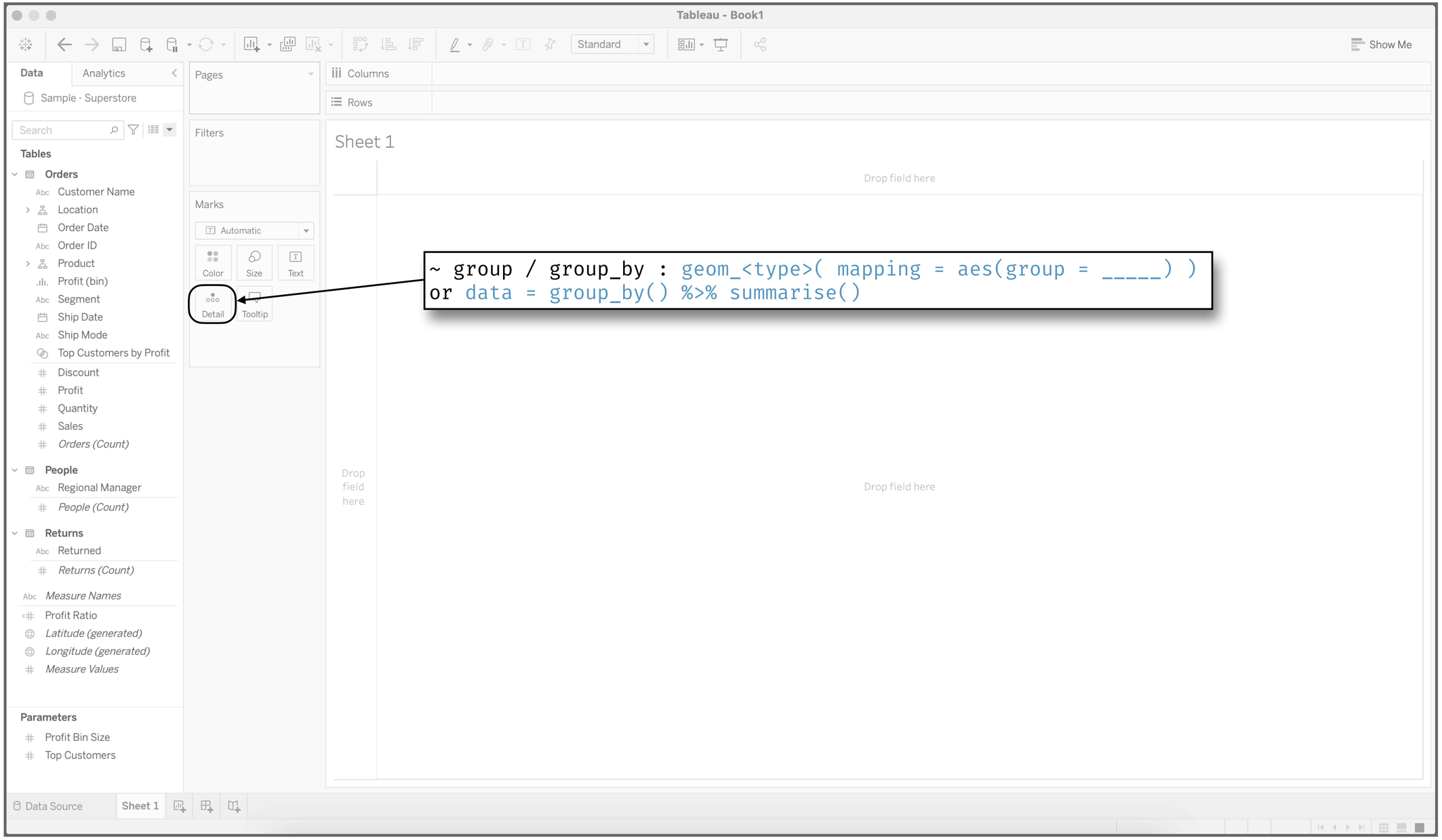


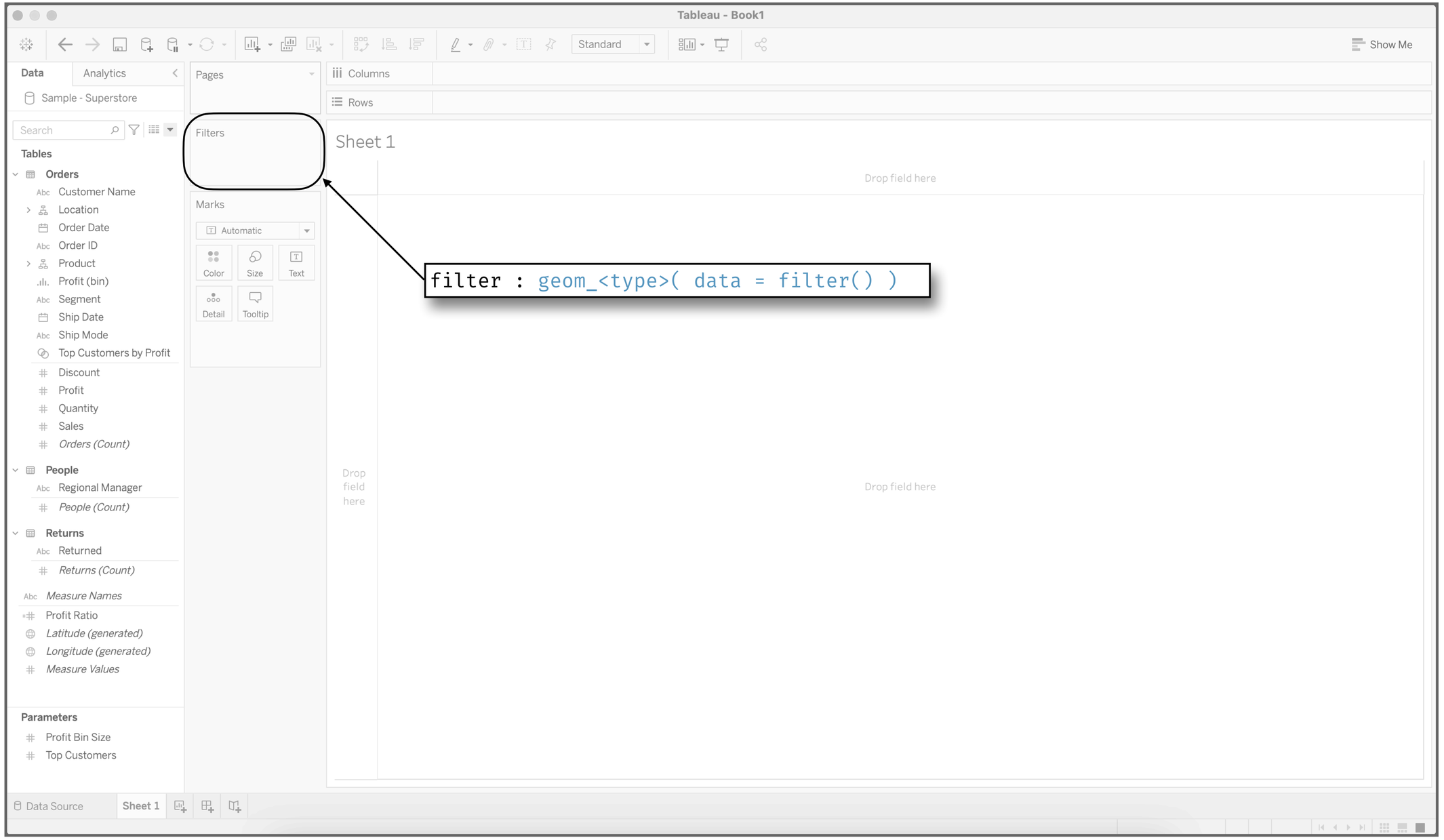
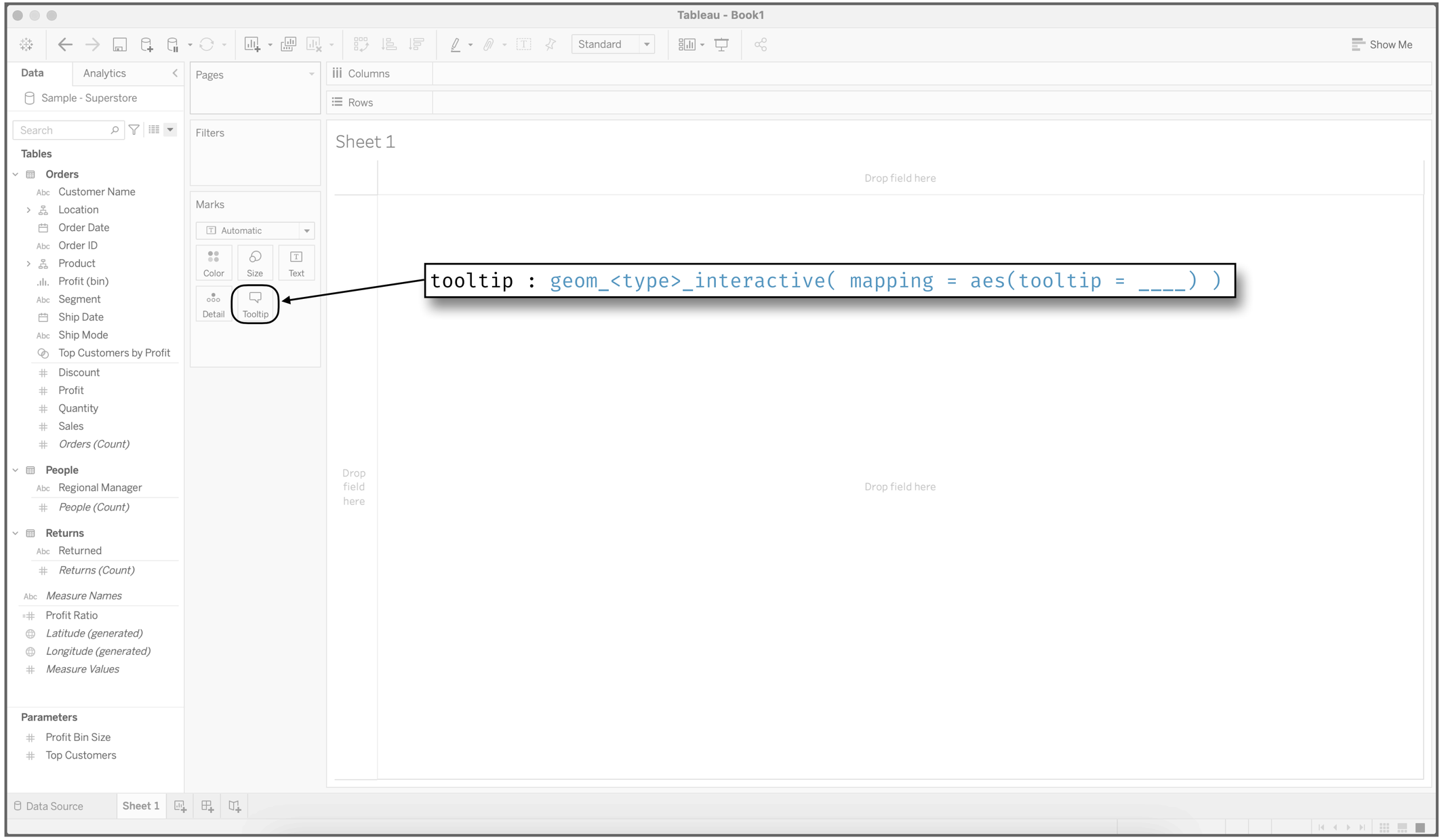
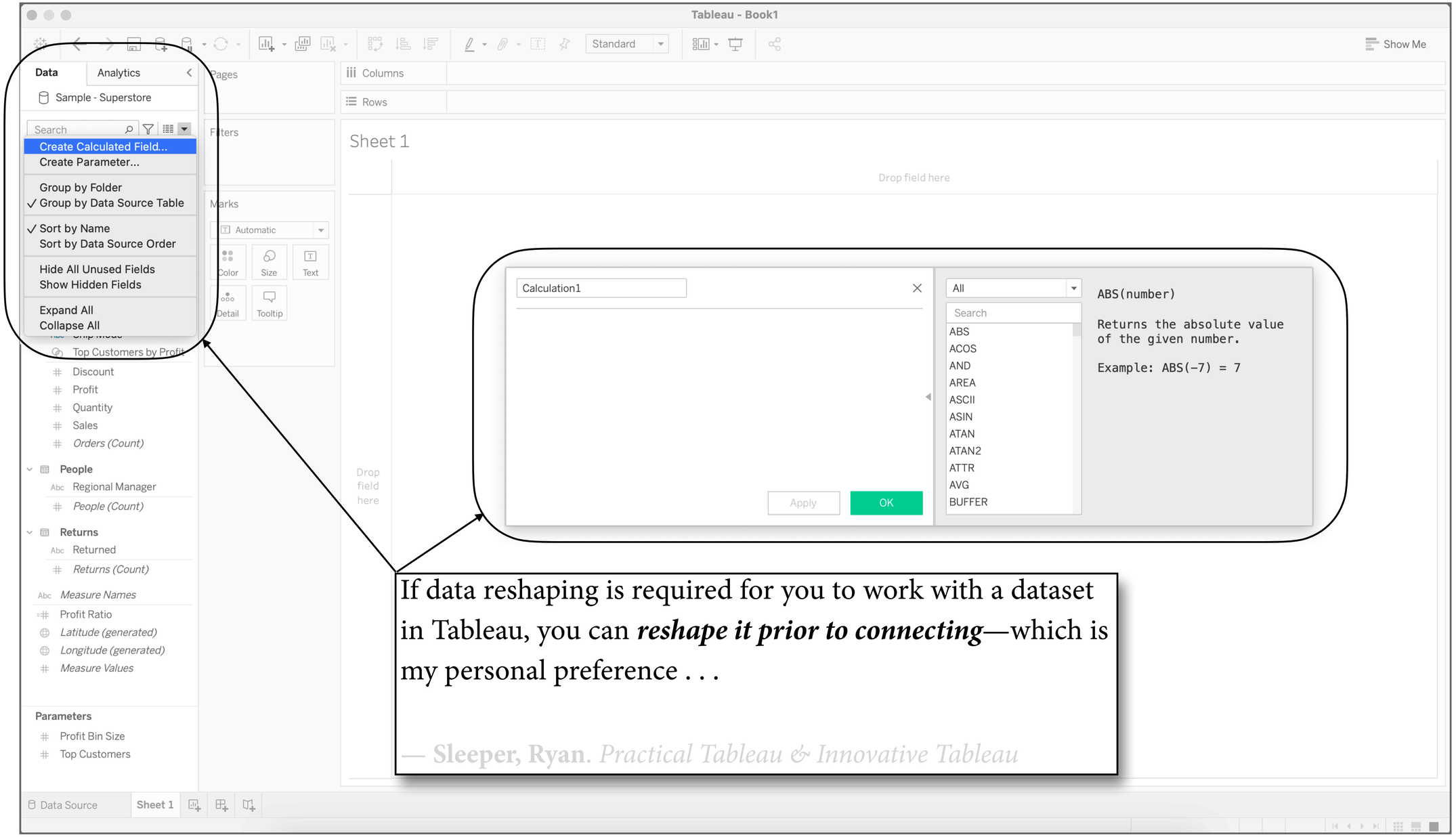


Tableau - Book1
Standard
Show Me
Data
Analytics
Sample - Superstore
Search
Tables
Orders
Customer Name
Location
Order Date
Order ID
Product
Profit (bin)
Segment
Ship Date
Ship Mode
Top Customers by Profit
Discount
Profit
Quantity
Sales
Orders (Count)
People
Regional Manager
People (Count)
Returns
Returned
Returns (Count)
Measure Names
Profit Ratio
Latitude (generated)
Longitude (generated)
Measure Values
Parameters
Profit Bin Size
Top Customers
Pages
Filters
Marks
Automatic
Color
Size
Text
Detail
Tooltip
Columns
Rows
Sheet 1
Drop field here
Drop field here
Drop field here
filter : geom_<type>(data = filter())
Data Source
Sheet 1

basics of Tableau, Tableau mapped to grammar of interactive graphics functions (ggplot2 + tidyverse + ggiraph)



basics of Tableau, beyond basic aggregations, transformations are generally impractical in Tableau (use R, Python, SQL, . . .)



If data reshaping is required for you to work with a dataset in Tableau, you can ***reshape it prior to connecting***—which is my personal preference . . .

— **Sleeper, Ryan.** *Practical Tableau & Innovative Tableau*

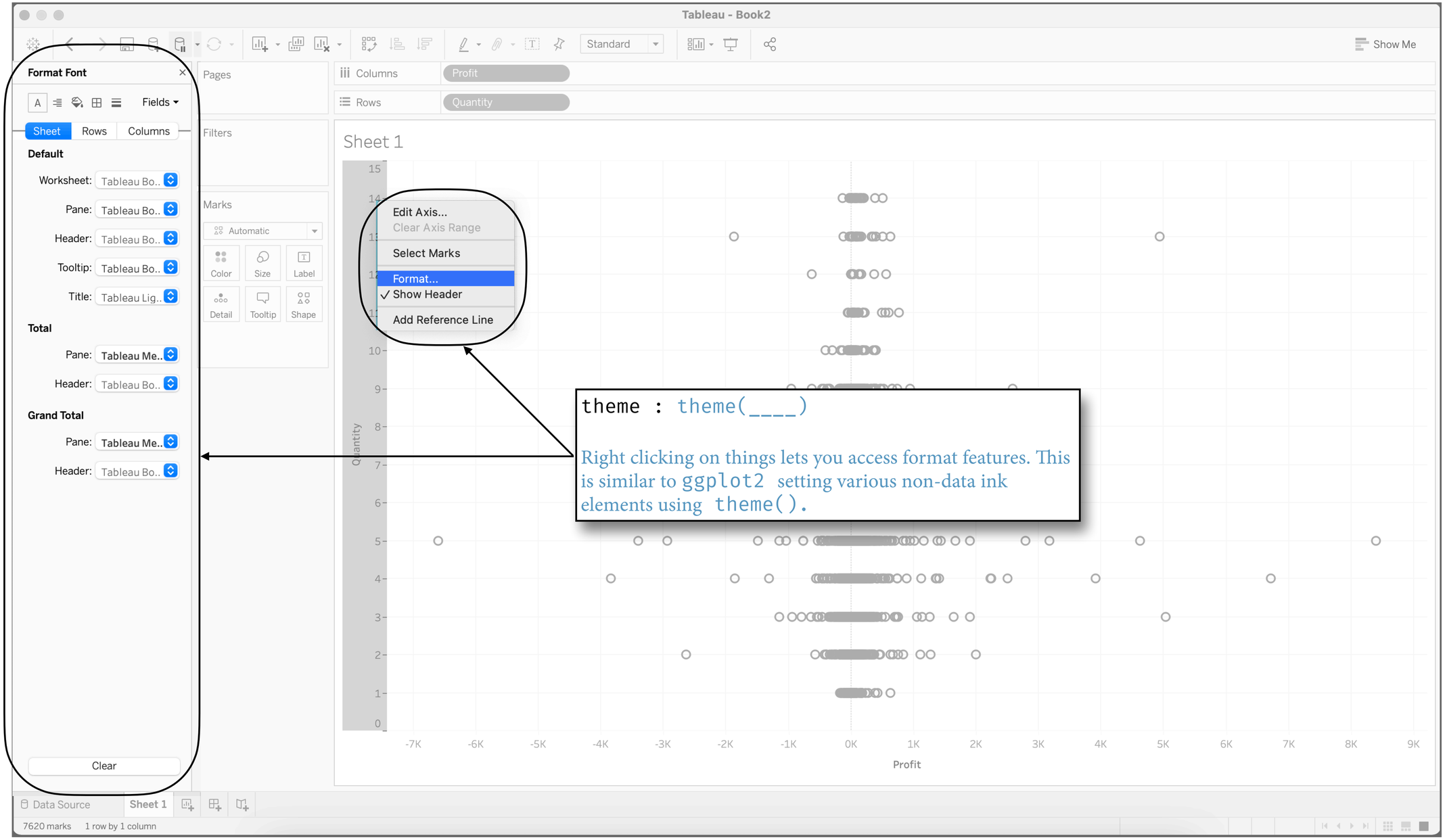


Tableau - Book2
Format Font
Fields
Sheet
Rows
Columns
Default
Worksheet:
Pane:
Header:
Tooltip:
Title:
Total
Pane:
Header:
Grand Total
Pane:
Header:
Clear
Pages
Filters
Marks
Automatic
Color
Size
Label
Detail
Tooltip
Shape
Columns
Profit
Rows
Quantity
Sheet 1
Edit Axis...
Clear Axis Range
Select Marks
Format...
Show Header
Add Reference Line
Quantity
Profit
Data Source
Sheet 1
7620 marks
1 row by 1 column
theme : theme(____)
Right clicking on things lets you access format features. This is similar to ggplot2 setting various non-data ink elements using theme().

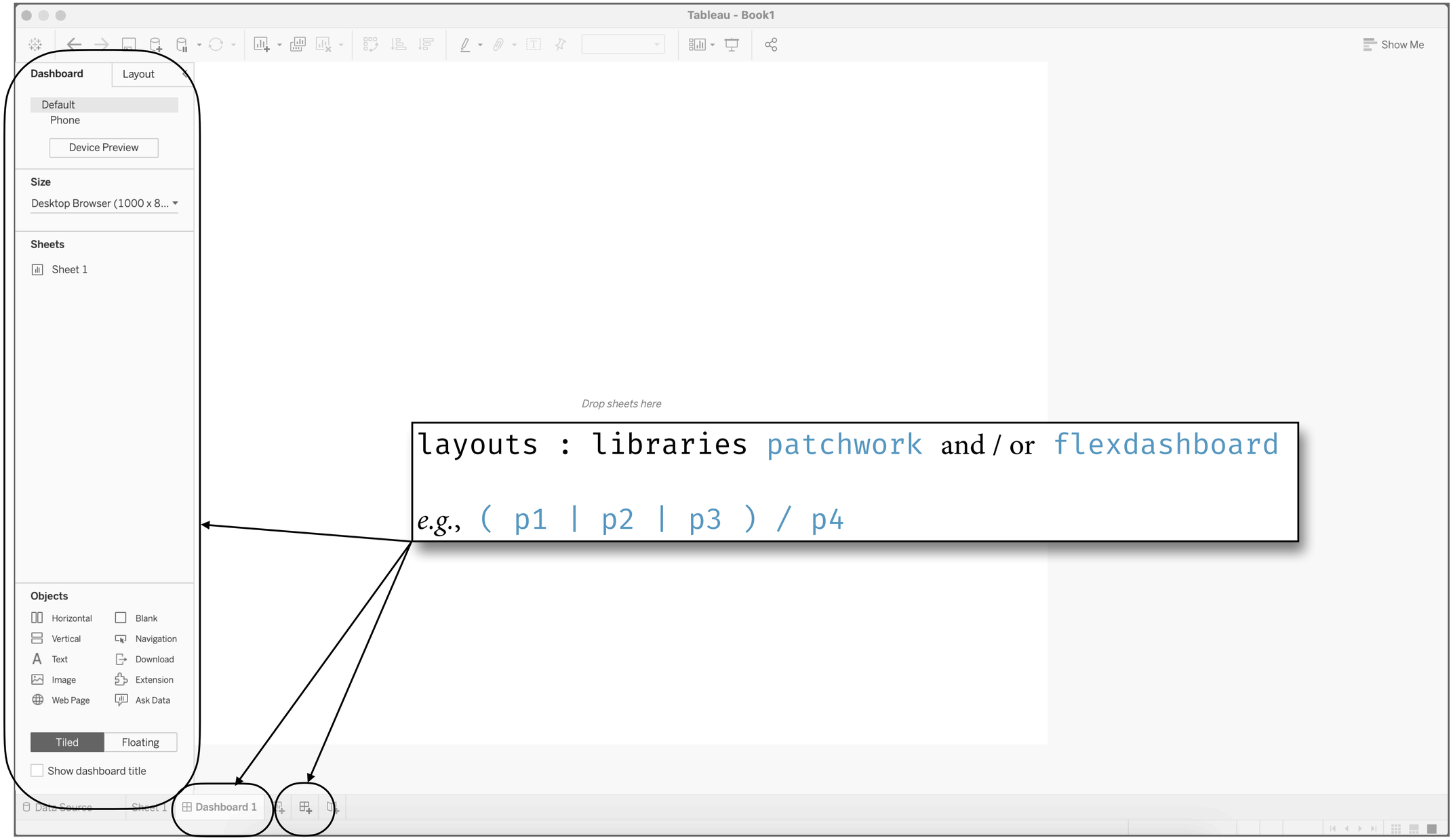
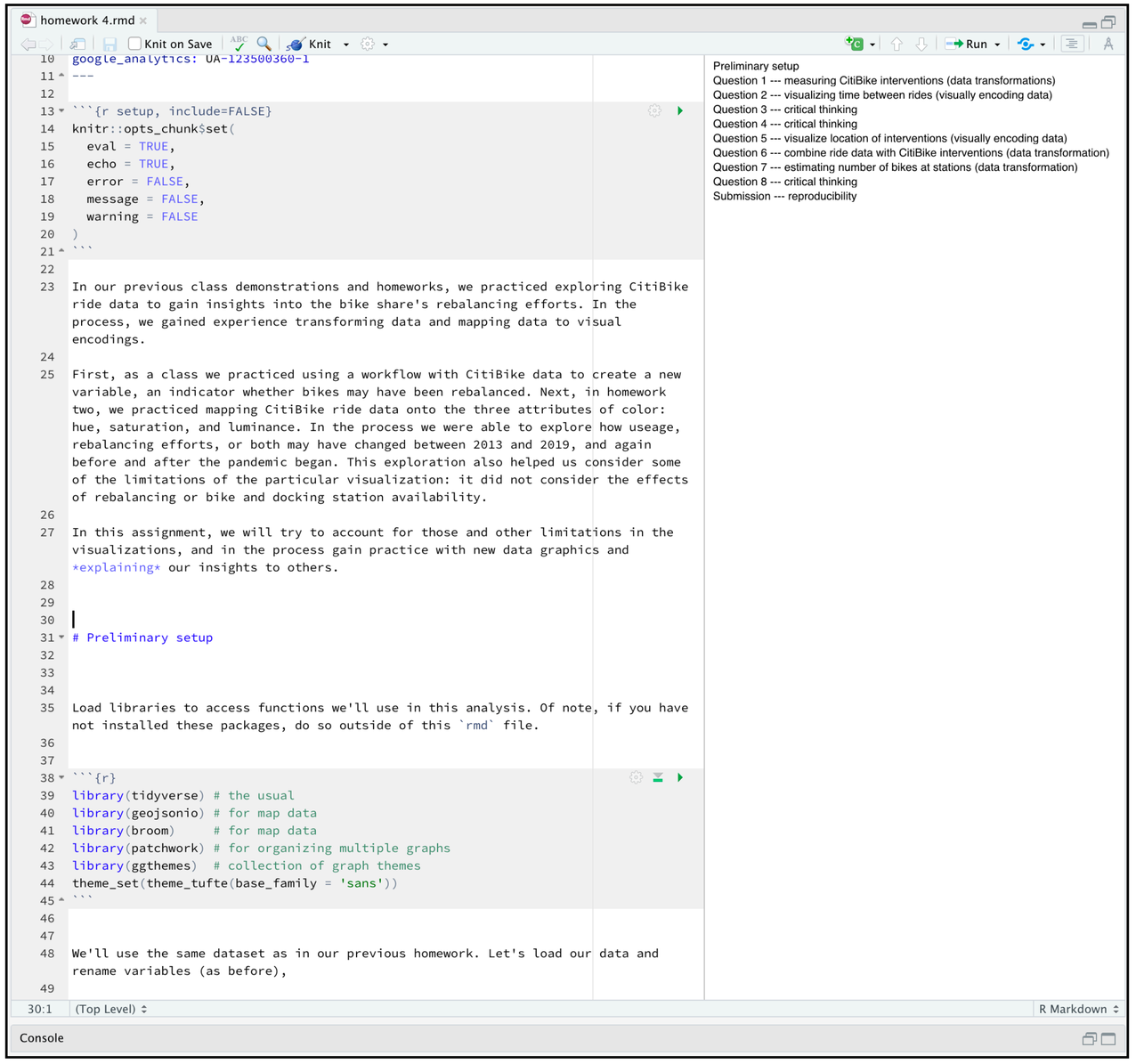


Tableau - Book1
Show Me
Dashboard
Layout
Default
Phone
Device Preview
Size
Desktop Browser (1000 x 8...
Sheets
Sheet 1
Drop sheets here
Objects
Horizontal
Blank
Vertical
Navigation
Text
Download
Image
Extension
Web Page
Ask Data
Tiled
Floating
Show dashboard title
Data Source
Sheet 1
Dashboard 1
layouts : libraries patchwork and / or flexdashboard
e.g., (p1 | p2 | p3) / p4

individual homework four check-in | graphics
practice with Citi Bike rebalancing study

individual homework four check-in, **questions?**



group project check-in | proposals

resources

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