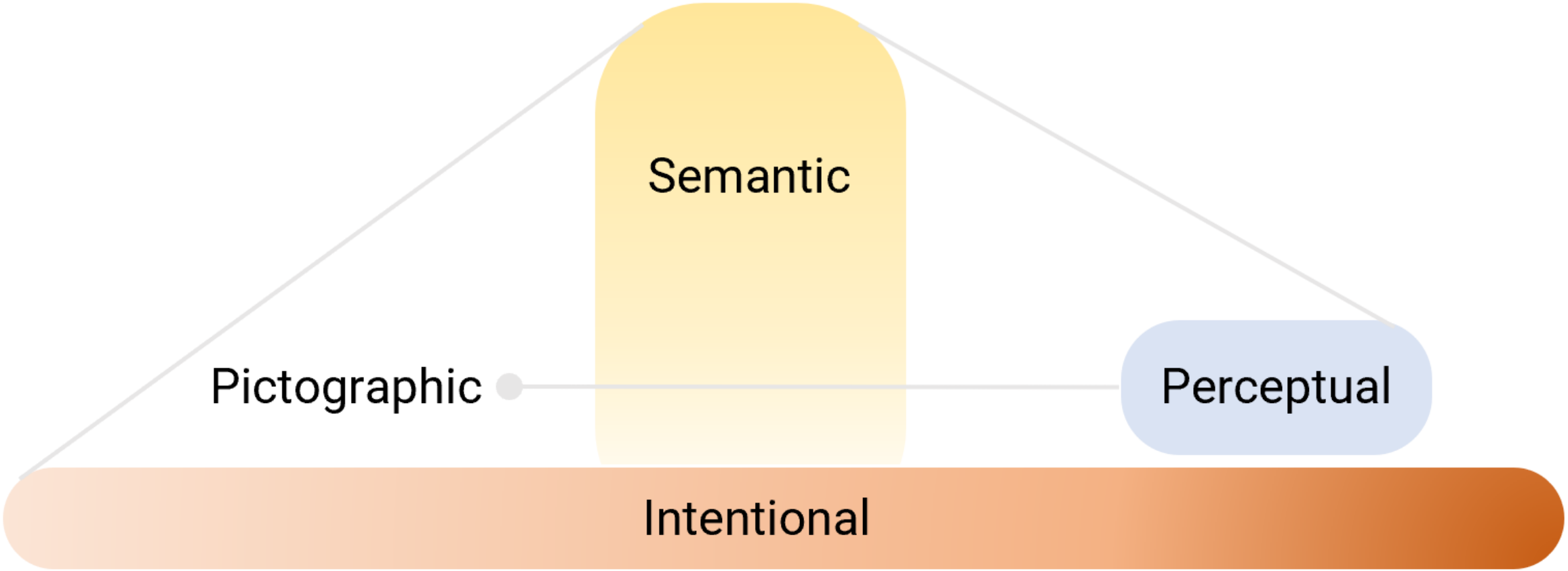
The Role of Functional Aesthetics in Visual Analysis

Vidya Setlur

Tableau Research

Functional aesthetics

Functional aesthetics is the concept of combining perception, semantics, and intent to function together as a whole, creating beauty in meaningful design.


Semantic
Pictographic
Perceptual
Intentional

Talk outline

- Role of perception in seeing and understanding data
- Semantics in visual analysis
- Understanding intent
- Bringing it all together

Talk outline

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		Central	East	South	West
Coffee	Amaretto	$5,104	$1,010		-$1,224
	Colombian	$8,525	$27,256	$8,767	$11,256
	Decaf Irish Cream	$9,635	$2,726	$2,935	-$1,307
	Total	$23,264	$30,992	$11,702	$8,725
Espresso	Caffe Latte			$3,873	$7,502
	Caffe Mocha	$14,642	-$6,232	$5,202	$4,066
	Decaf Espresso	$8,859	$2,411	$5,930	$12,302
	Regular Espresso		$10,065		
	Total	$23,501	$6,244	$15,005	$23,870
Herbal Tea	Chamomile	$14,435	$764	$3,178	$8,854
	Lemon	$6,253	$7,902	$2,593	$13,121
	Mint	$4,069	-$2,243		$4,328
	Total	$24,757	$6,423	$5,771	$26,303
Tea	Darjeeling	$10,769	$6,500		$11,784
	Earl Grey	$10,334	$3,404		$10,426
	Green Tea	$1,227	$5,654		-$7,112
	Total	$22,330	$15,558		$15,098

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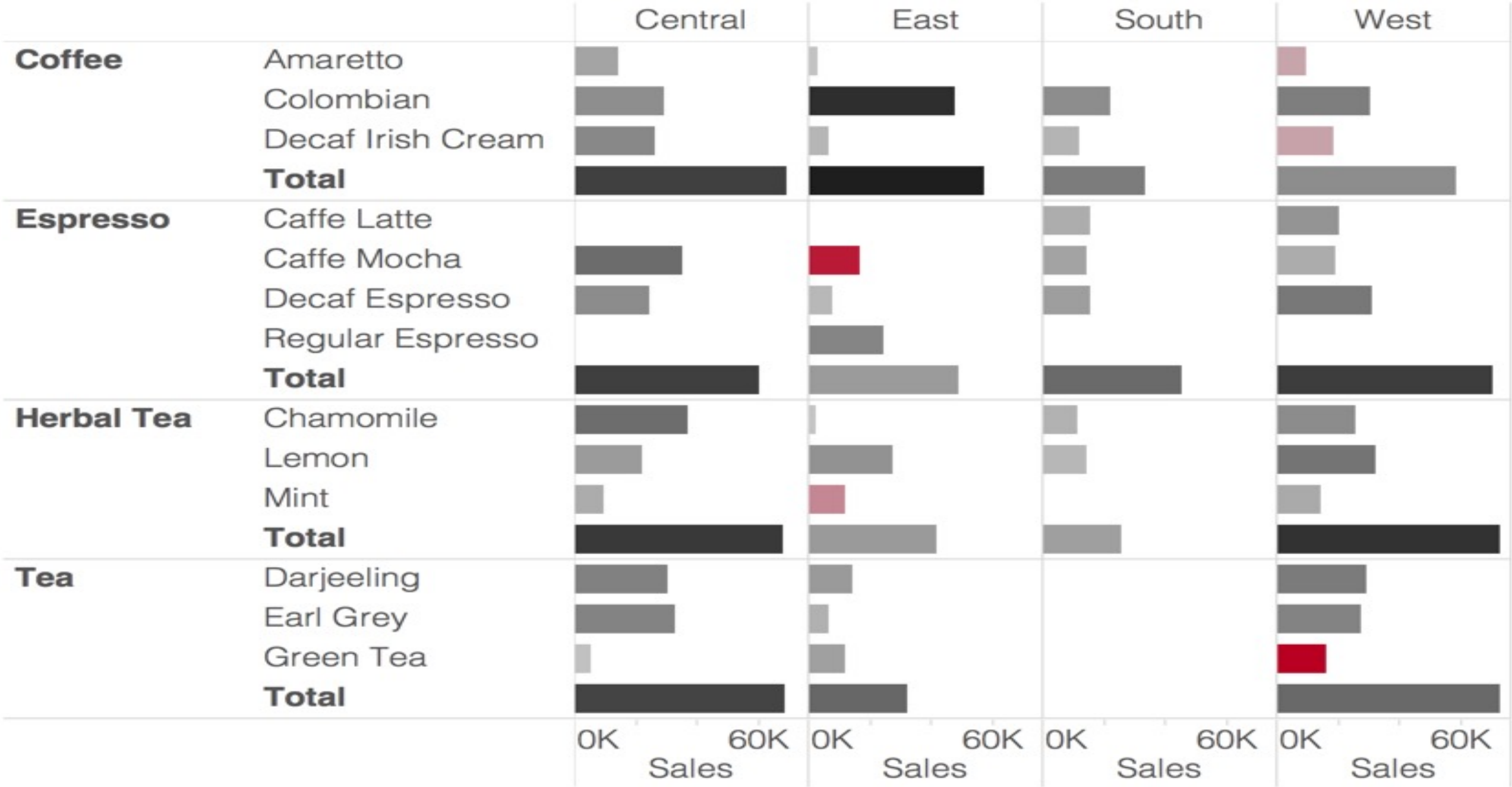
Central
East
South
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Coffee
Amaretto
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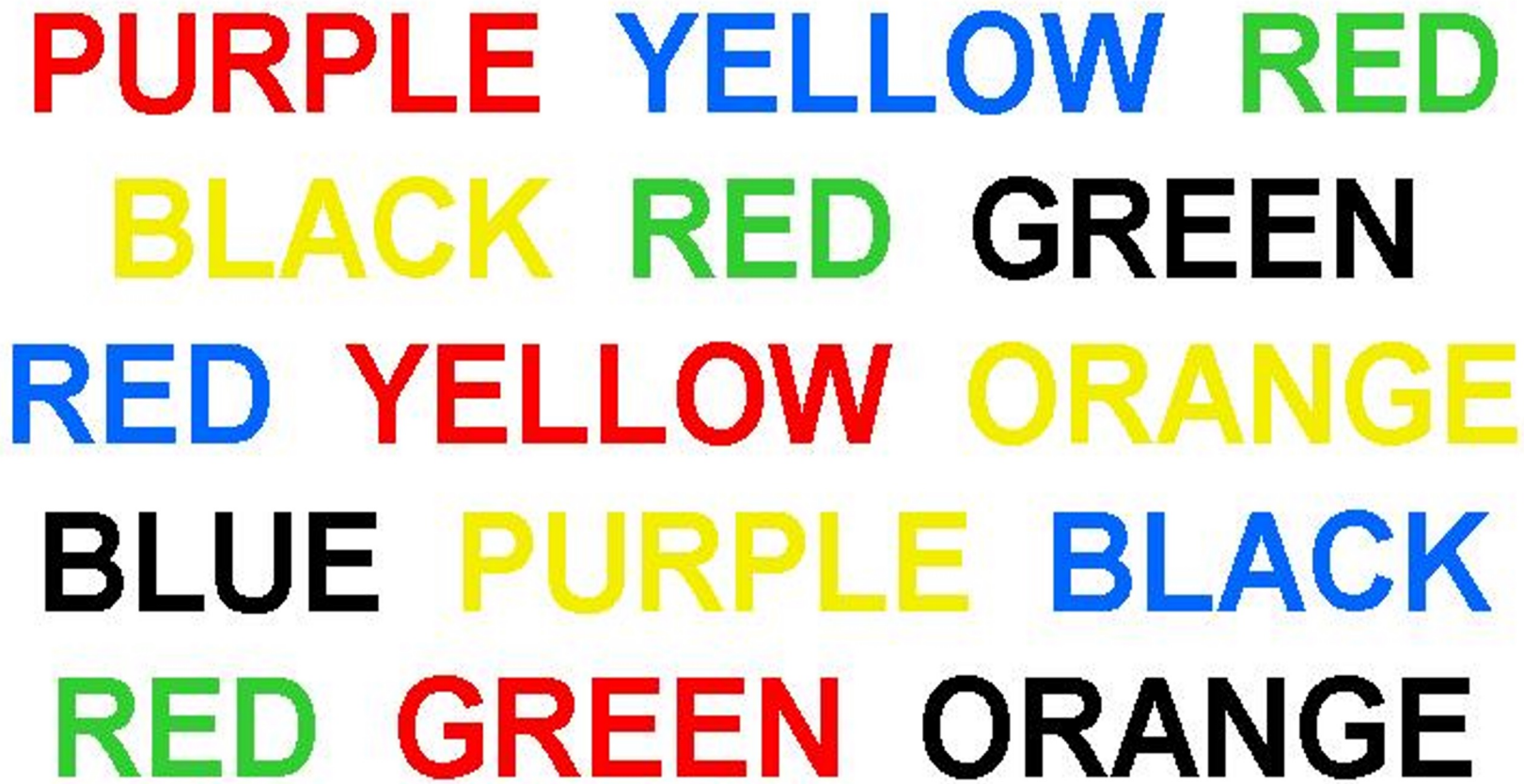
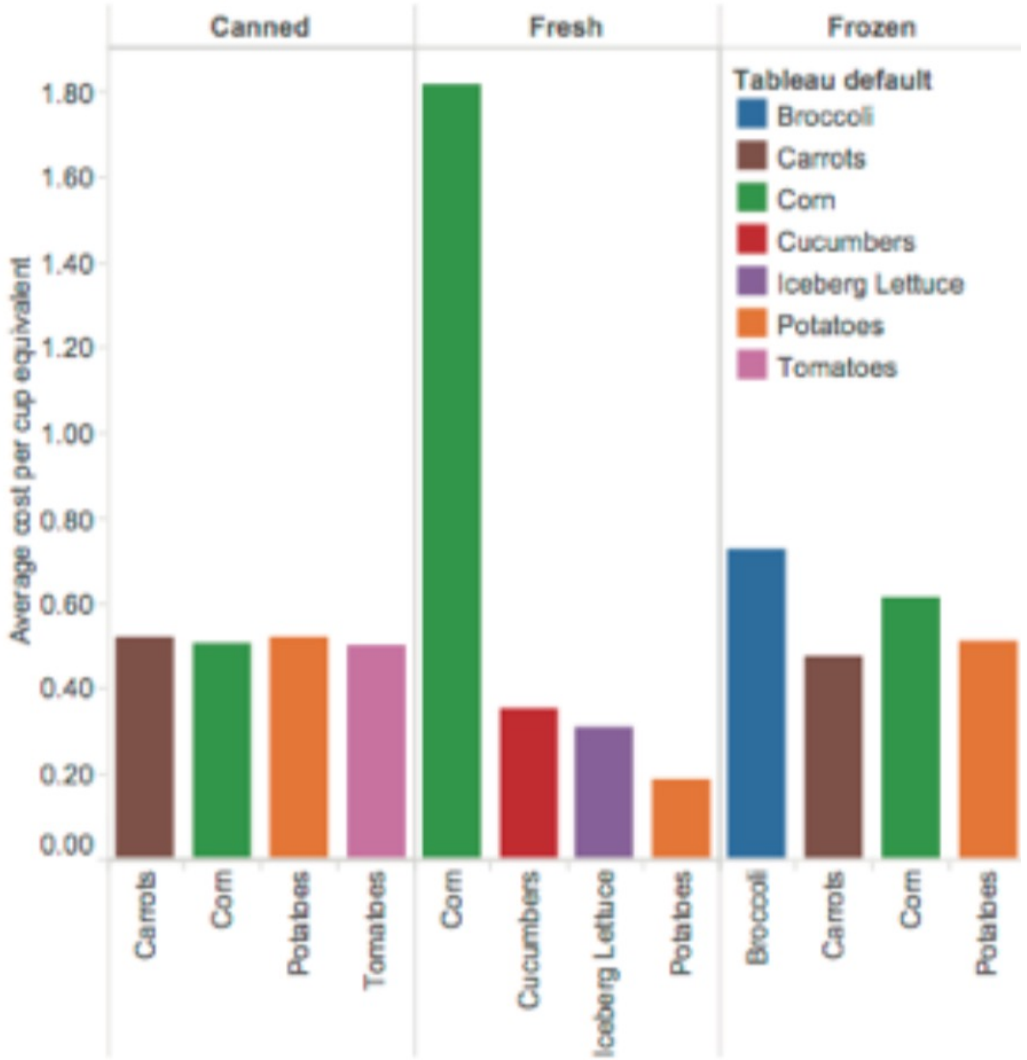
Caffe Mocha
Decaf Espresso
Regular Espresso
Total
Herbal Tea
Chamomile
Lemon
Mint
Total
Tea
Darjeeling
Earl Grey
Green Tea
Total
0K
60K
Sales

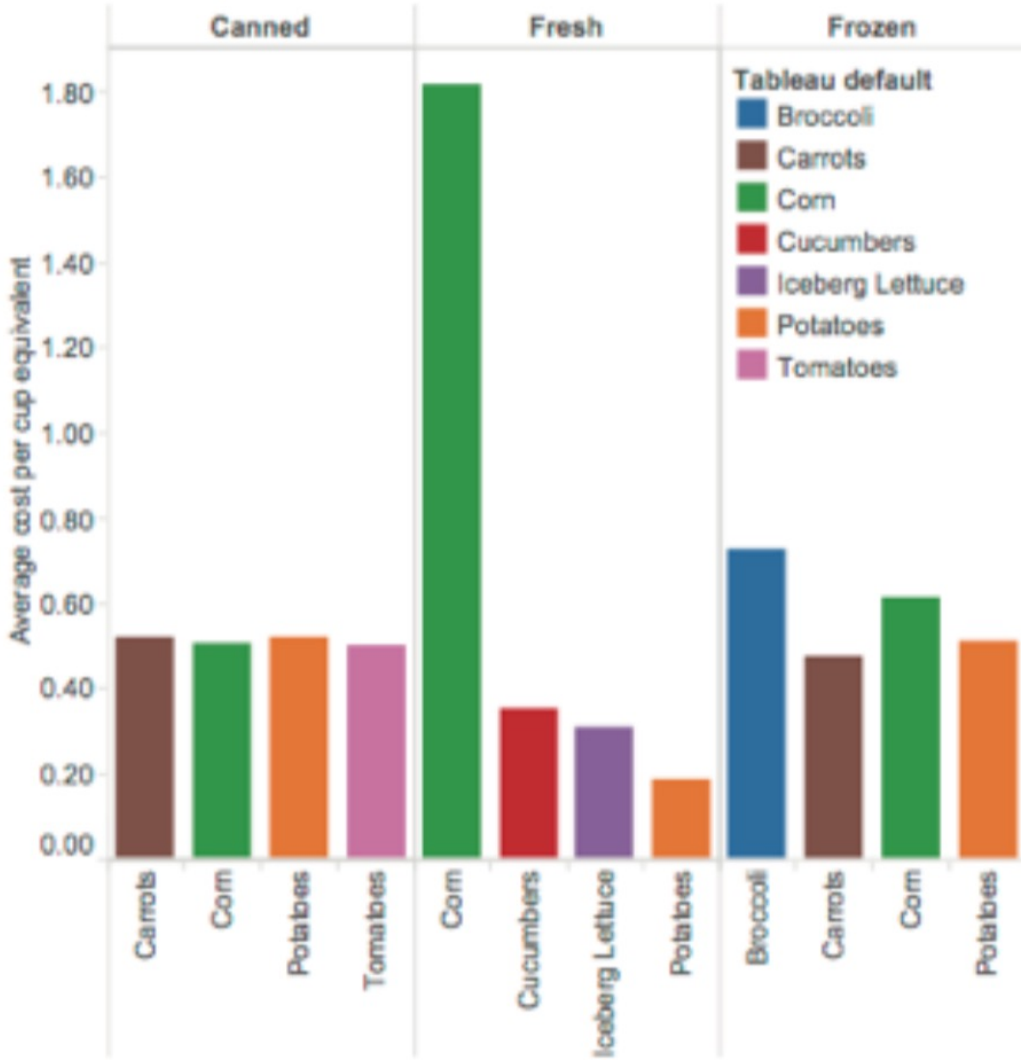
Say the color, not the word

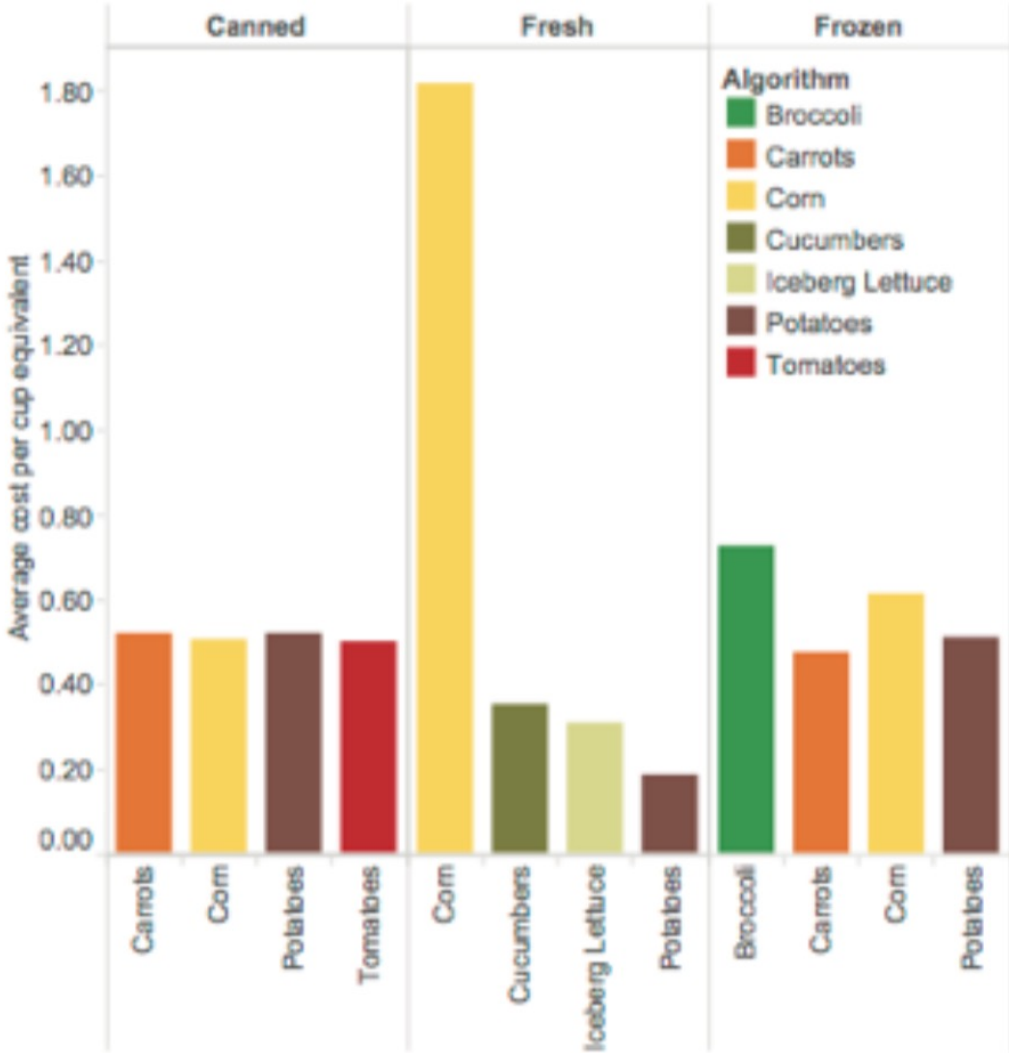


Default colors



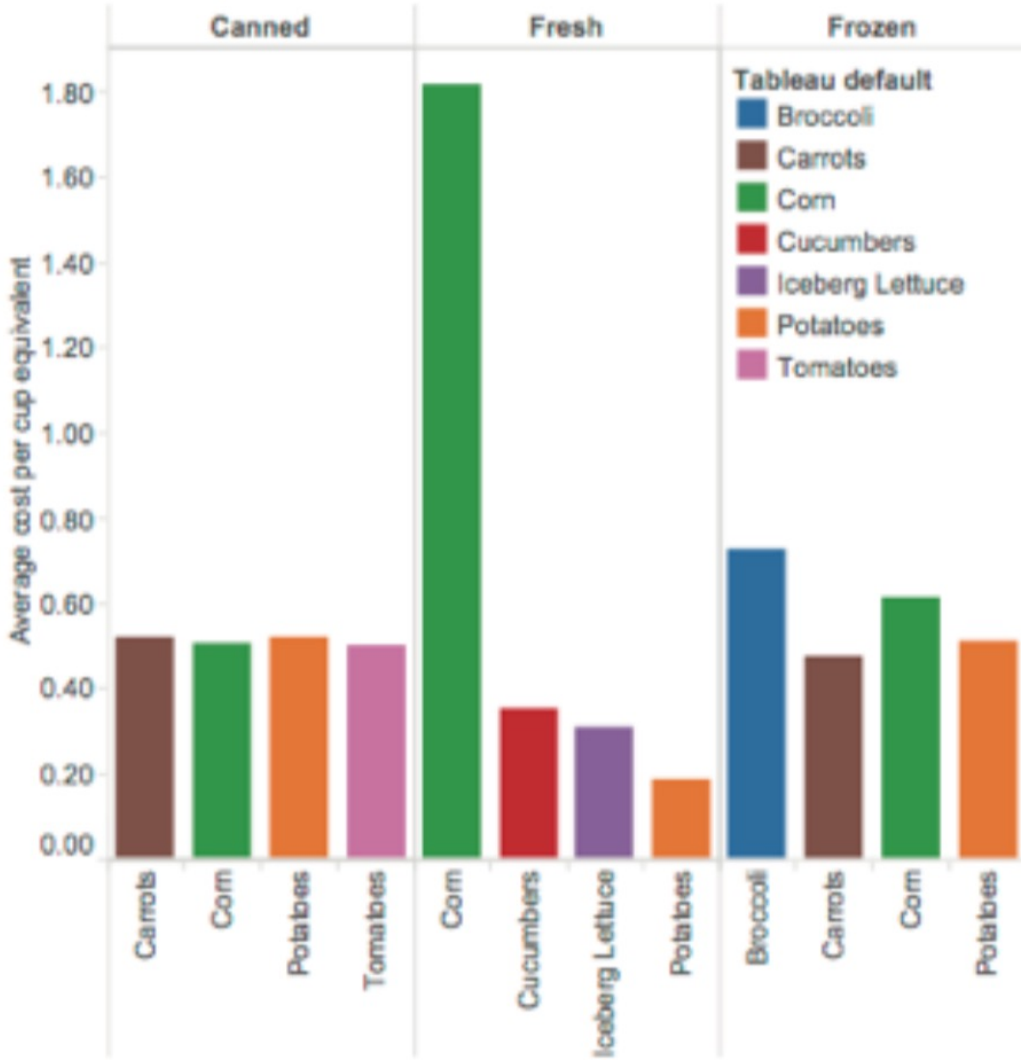
Semantically resonant colors

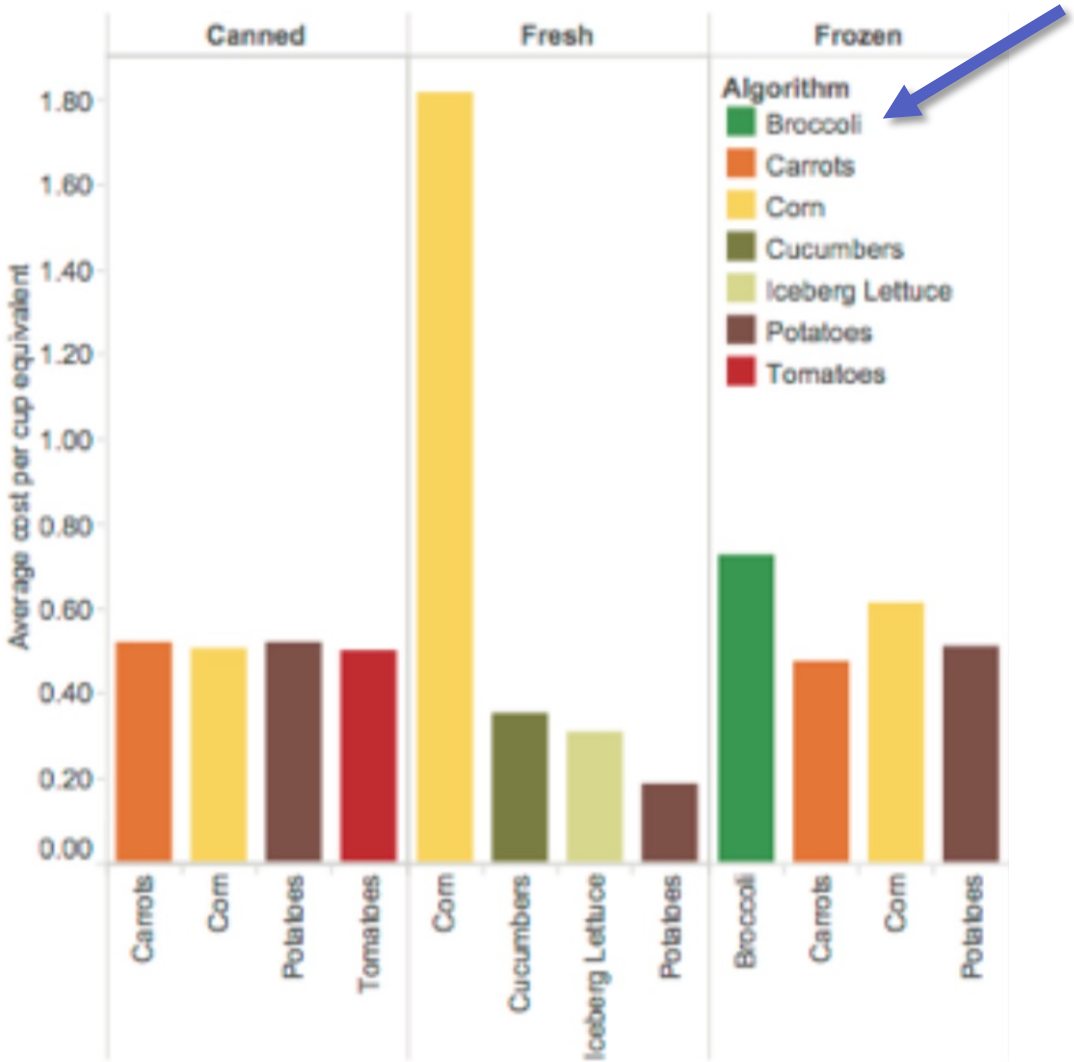




A Linguistic Approach to Categorical Color Assignment for Data Visualization, IEEE Vis 2015

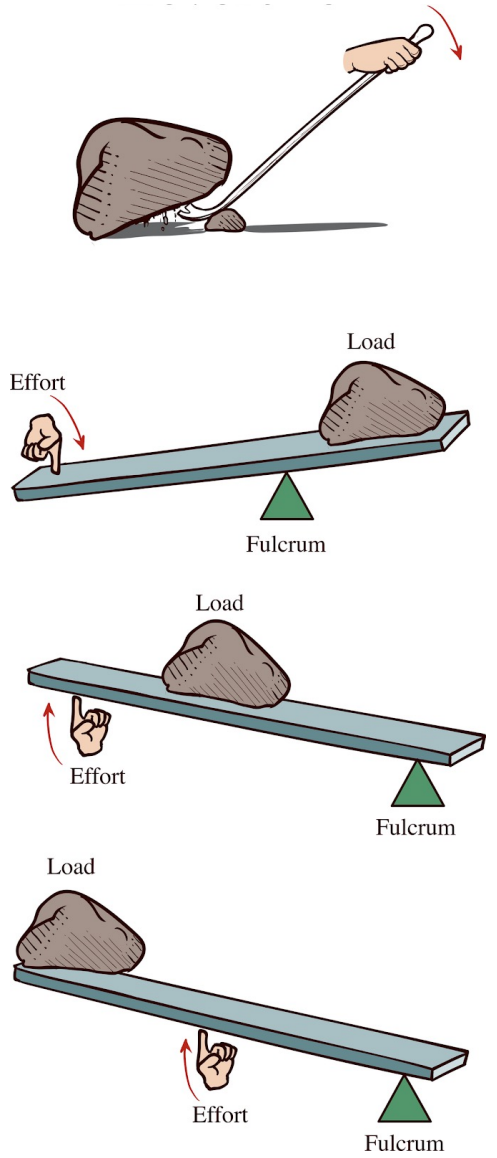
Semantically resonant colors



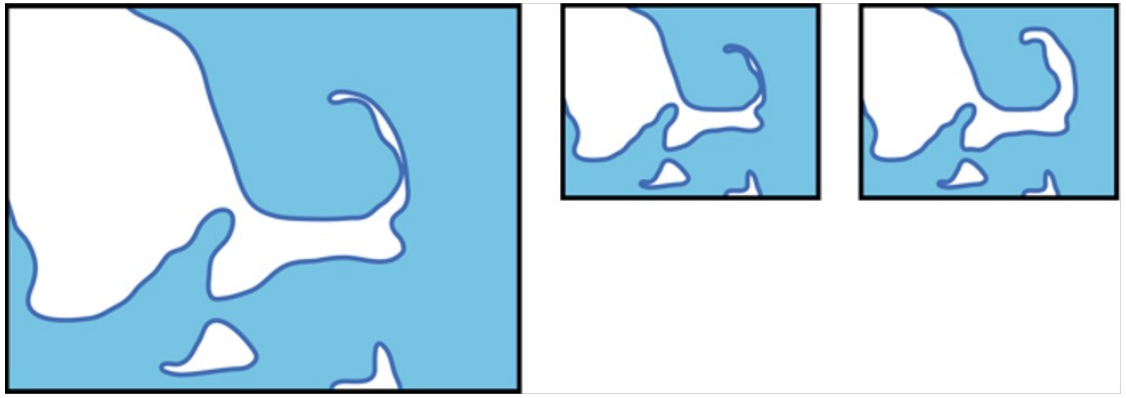


Diagramming the world

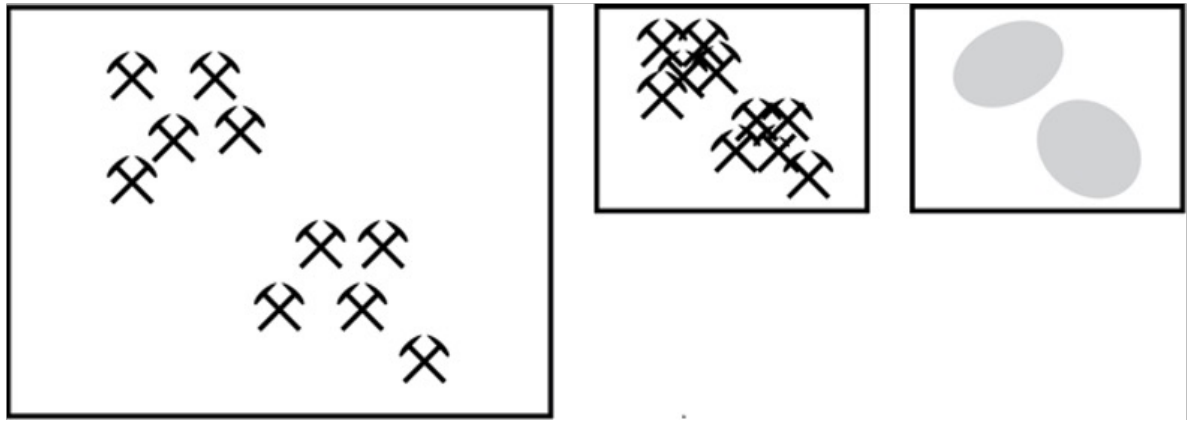
Diagramming the world



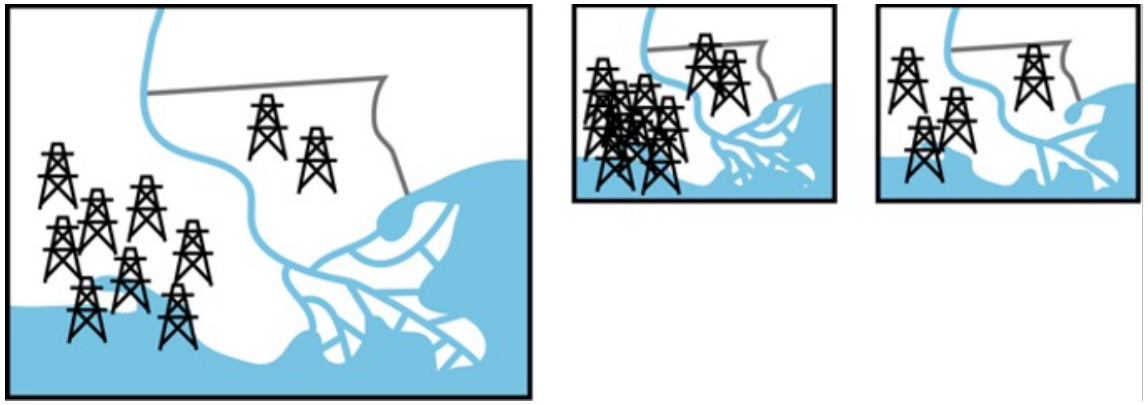
Generalizing information



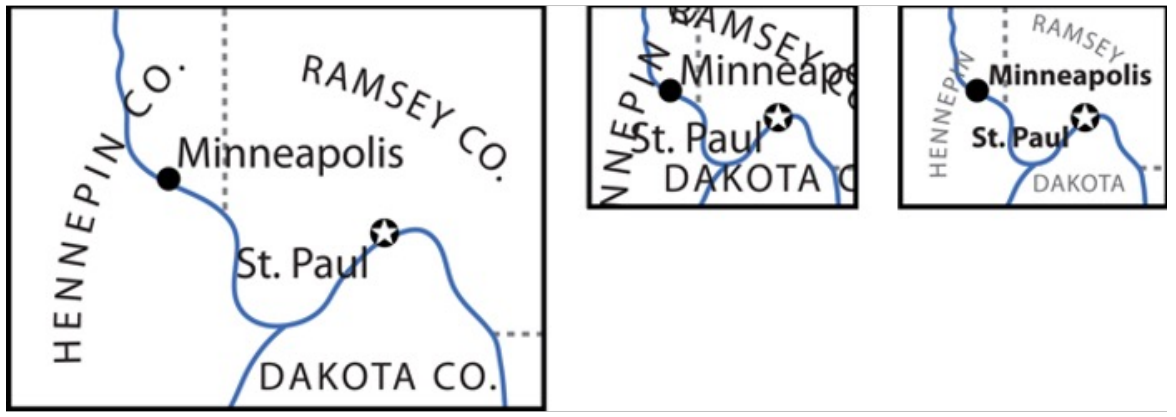
Exaggeration



Aggregation

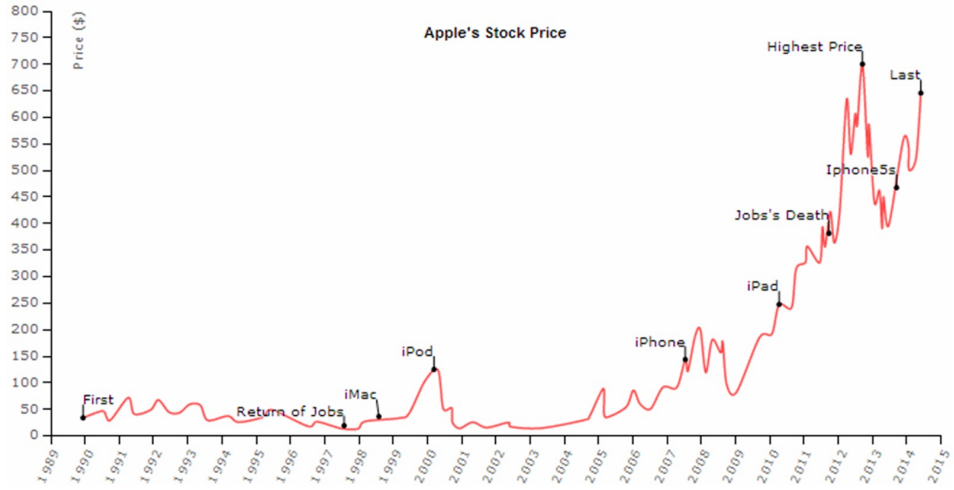


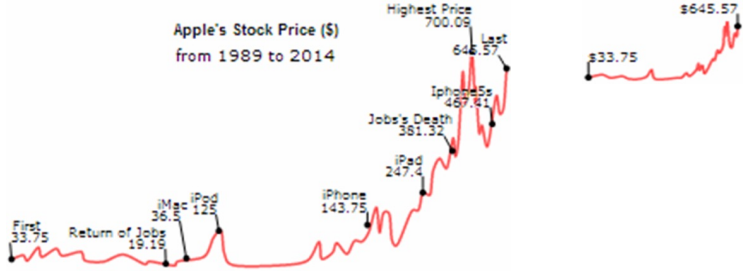
Typification



Label prominence

Generalizing information





Semantic Resizing of Charts Through Generalization: A Case Study with Line Charts, IEEE Vis 2021

Key takeaways

Representation is context, task, and data specific.

Emphasize the most important elements while still representing the view in the most faithful and recognizable way.

The level of detail in the view must outweigh the insignificance of items that are deemphasized.

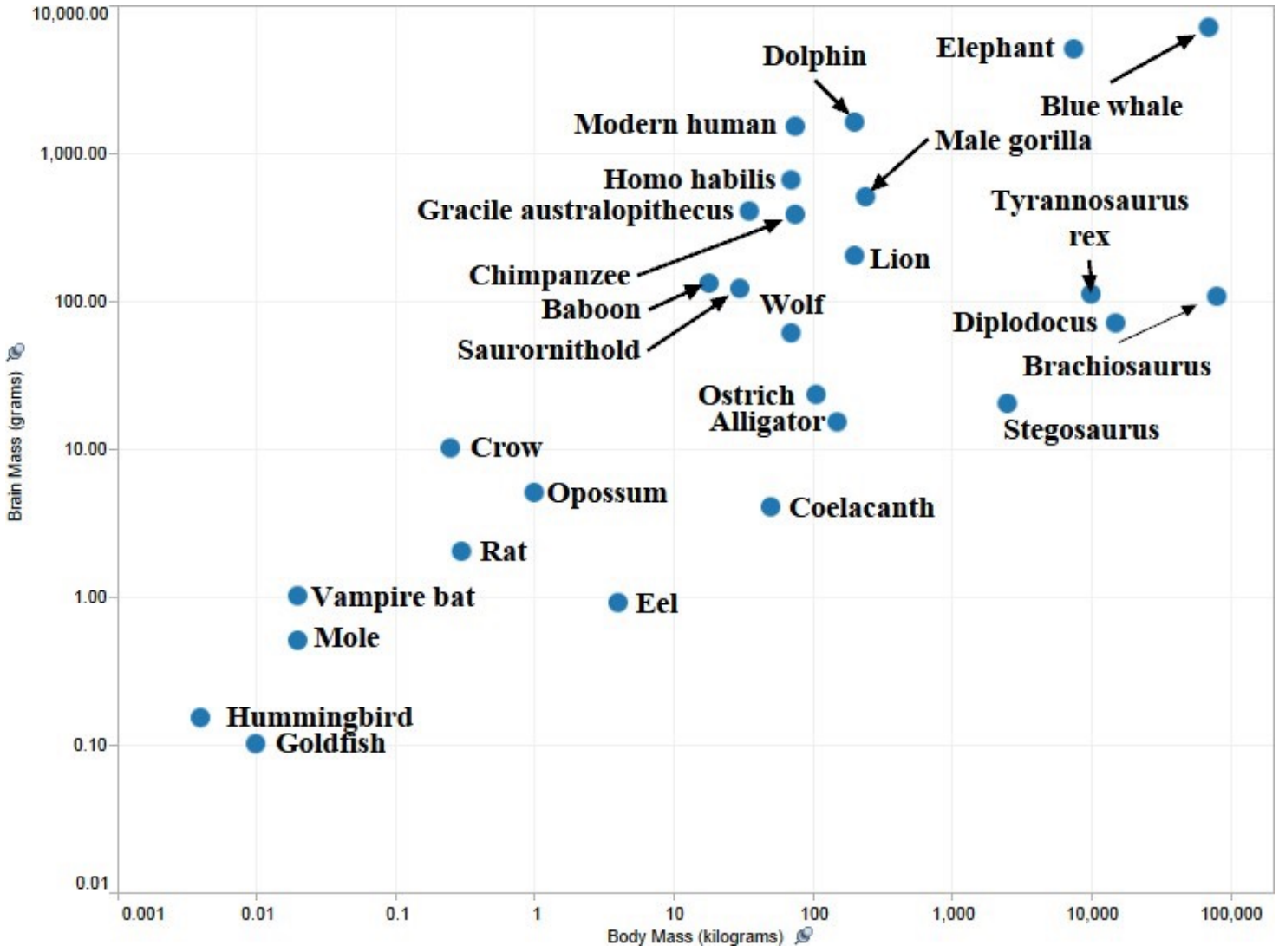
Talk outline

- Role of perception in seeing and understanding data
- Semantics in visual analysis
- Understanding intent
- Bringing it all together

People seek meaning

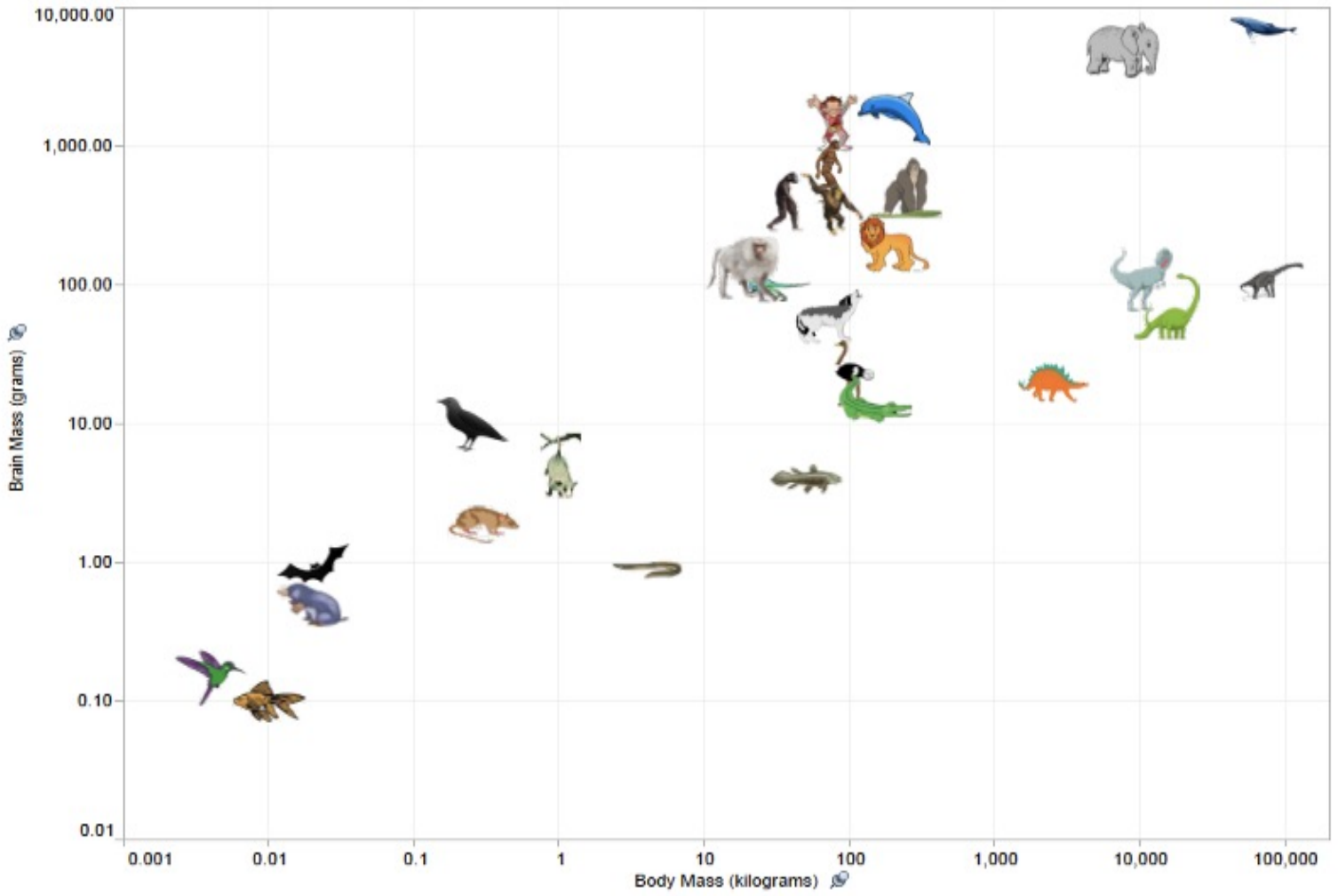
Symbols to convey meaning

Charts are inherently abstract



Adding icon encodings

Automatic Generation of Semantic Icon Encodings for Visualizations, ACM CHI 2014



Help people see and understand their data

data

visualization

Help people see and understand their data

data

visualization

connect clean integrate transform calculate analyze author visualize collaborate share tell stories

Parsing dates

Date as text string

Name Abc	Birthday Abc	Gold Stars #
Claire	1-3-07	18
Donny	4-15-08	9
Sam	10-3-07	22
Trent	7-11-07	25
Agatha	8-3-08	11
Geraldine	2-7-09	3

Date as “Date”

Name Abc	Birthday 📅	Gold Stars #
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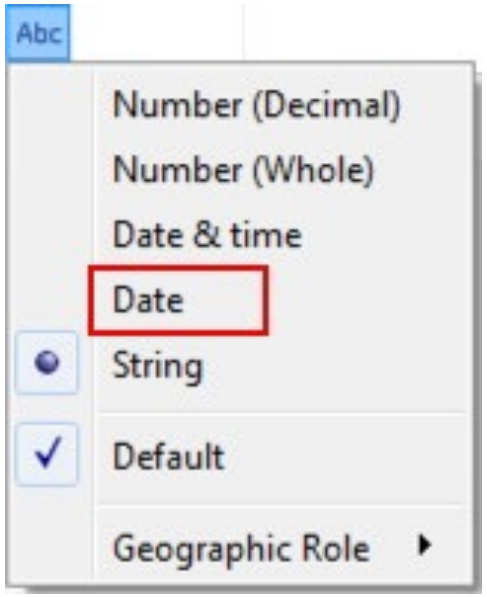

Does Anybody Really Know What Time It Is? Automating the Extraction of Date Scalars. Tableau Research White Paper, 2018.

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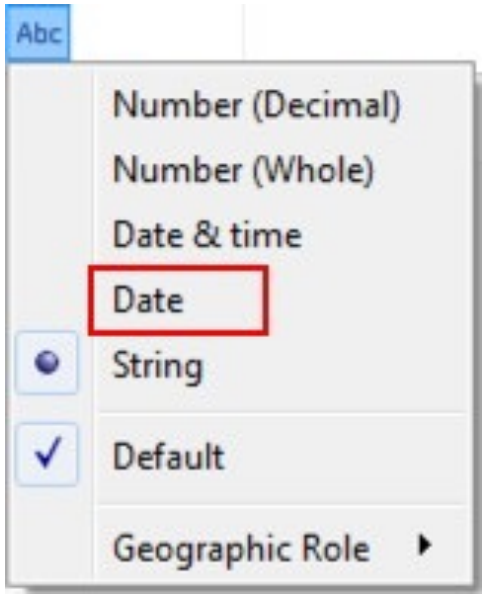


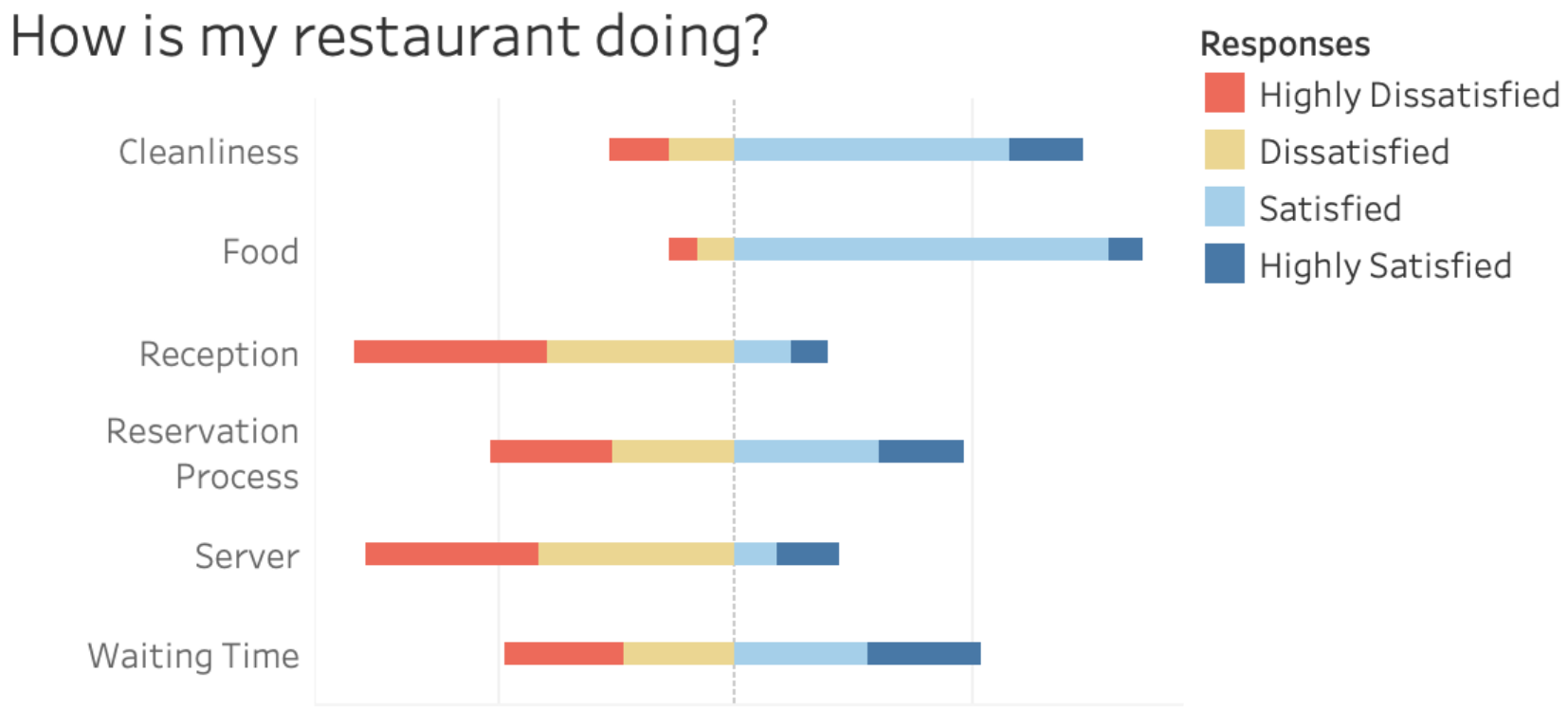
Does Anybody Really Know What Time It Is? Automating the Extraction of Date Scalars. Tableau Research White Paper, 2018.

Semantic joins

Country	Sales	Users
BR	1,418	75,000
CN	4,995	432,000
DE	1,445	126,000
GB	1,719	41,045
IN	1,421	205,869
JP	2,535	115,000
MX	755	123,650
RU	1,370	12,533
US	9,125	235,455

Country	Internet users	Adoption rate
Brazil	99,350,744	45.20%
China	568,192,065	34.60%
Germany	56,286,824	87.74%
India	245,289,322	18.50%
Japan	100,456,980	65.10%
Nigeria	45,787,000	28.53%
Russia	65,849,001	48.00%
United Kingdom	78,572,984	89.92%
United States	289,547,750	91.30%

Semantic sort



Location semantics

Why and where are semantics important?

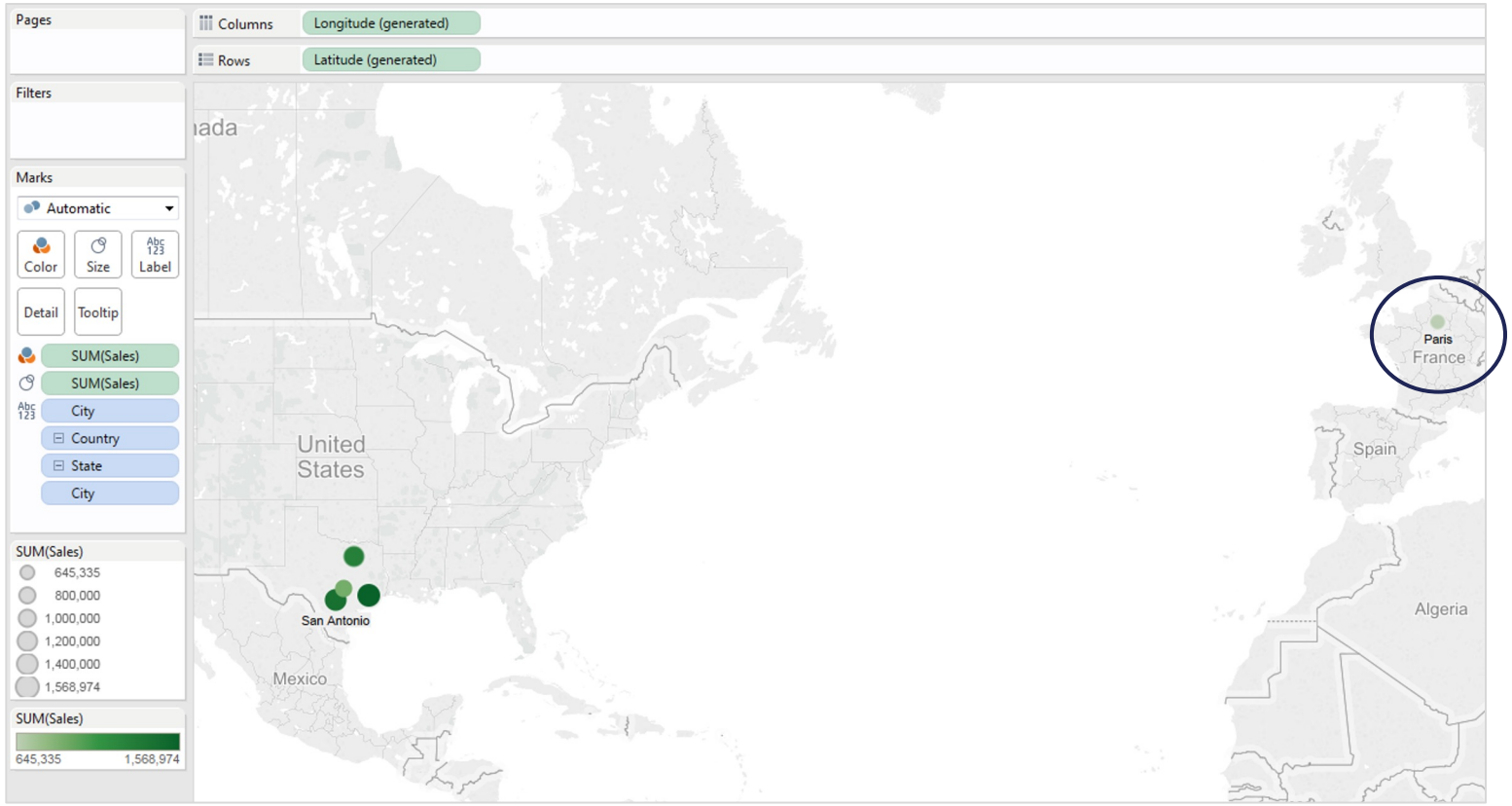
I have some sales data and need a map

City	Sales
Houston	1568974
San Antonio	1436697
Dallas	1281047
Austin	912791
Paris	645335

Location semantics

Is this what I was looking for?

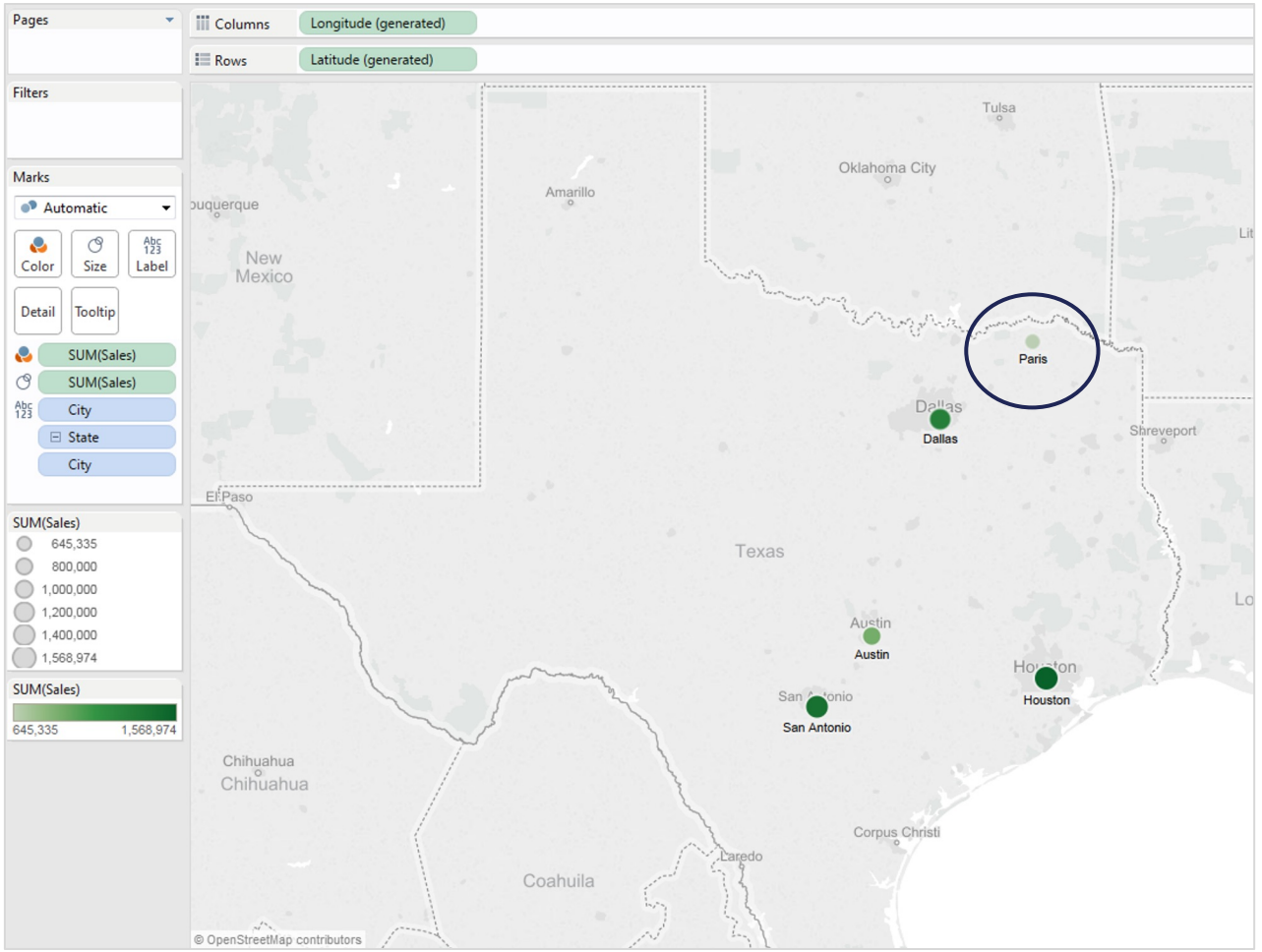
City	Sales
Houston	1568974
San Antonio	1436697
Dallas	1281047
Austin	912791
Paris	645335



Location semantics

Is this better?

City	Sales
Houston	1568974
San Antonio	1436697
Dallas	1281047
Austin	912791
Paris	645335



Data enrichment

Datetime	Price	Latitude	Longitude	area	#beds	openhouse_time
1/4/20	600000	38.8977	77.0365	5320	3	3:00 PM
...	...	...	...	...	...	...

Data enrichment

Expensive: adjective; entailing great expense; **very high priced**; costly.

Datetime	Price	Latitude	Longitude	area	#beds	openhouse_time
1/4/20	600000	38.8977	77.0365	5320	3	3:00 PM
...	...	...	...	...	...	...

Data enrichment

Large: adjective; ample in dimensions, quantity, or number.
Having much size or **extent**, capacity, scope, length, breadth etc., or relatively being of more than

Area: noun; a **measure** of the **extent** of a surface it is measured in square units.

Datetime	Price	Latitude	Longitude	area	#beds	openhouse_time
1/4/20	600000	38.8977	77.0365	5320	3	3:00 PM
…	…	…	…	…	…	…

Key takeaways

Applying semantics to data conveys recognizable meaning to make sense of it.

NLP and AI techniques bridge between the worlds of machine language and human language in the context of data analysis.

By balancing the perception and semantics, we can encourage deeper, clearer, and better conversations with the data.

Talk outline

- Role of perception in seeing and understanding data
- Semantics in visual analysis
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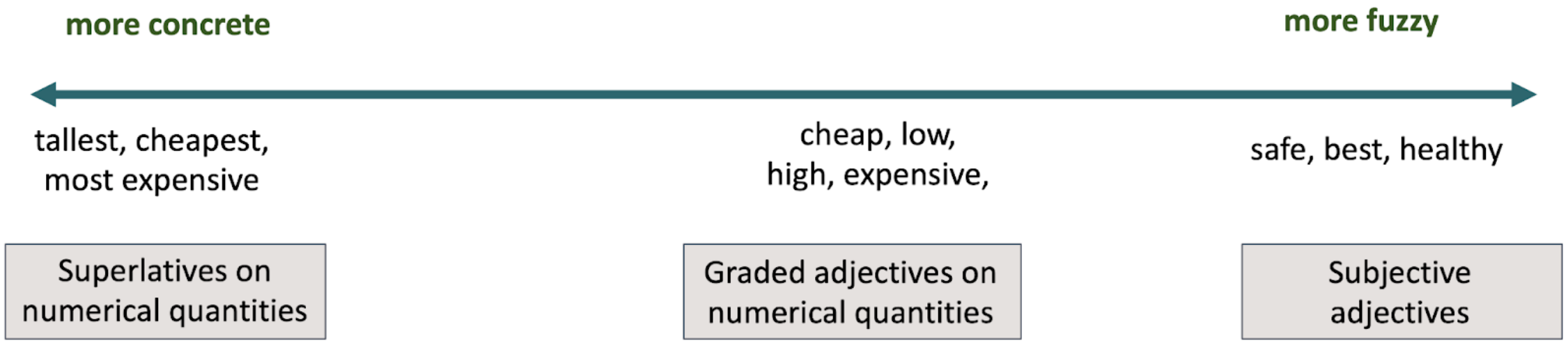
Analytical intent

The goal that a user focuses on when either performing targeted or more open-ended data exploration and discovery.

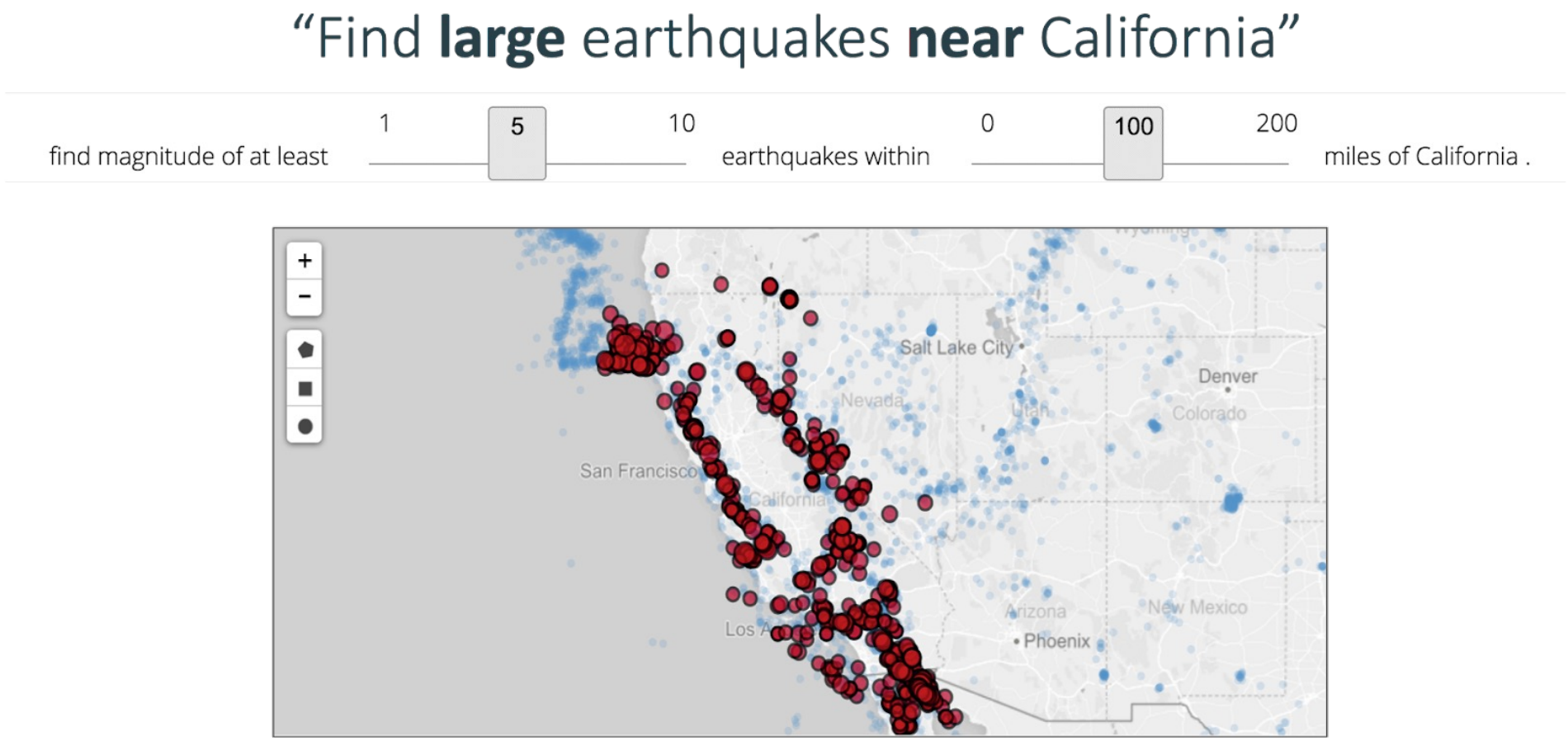
A user can express their analytical intent in a system in a variety of ways –

- Pick attributes and choose a chart type
- Expressed through natural language

Vagueness and ambiguity



Supporting an analytical conversation

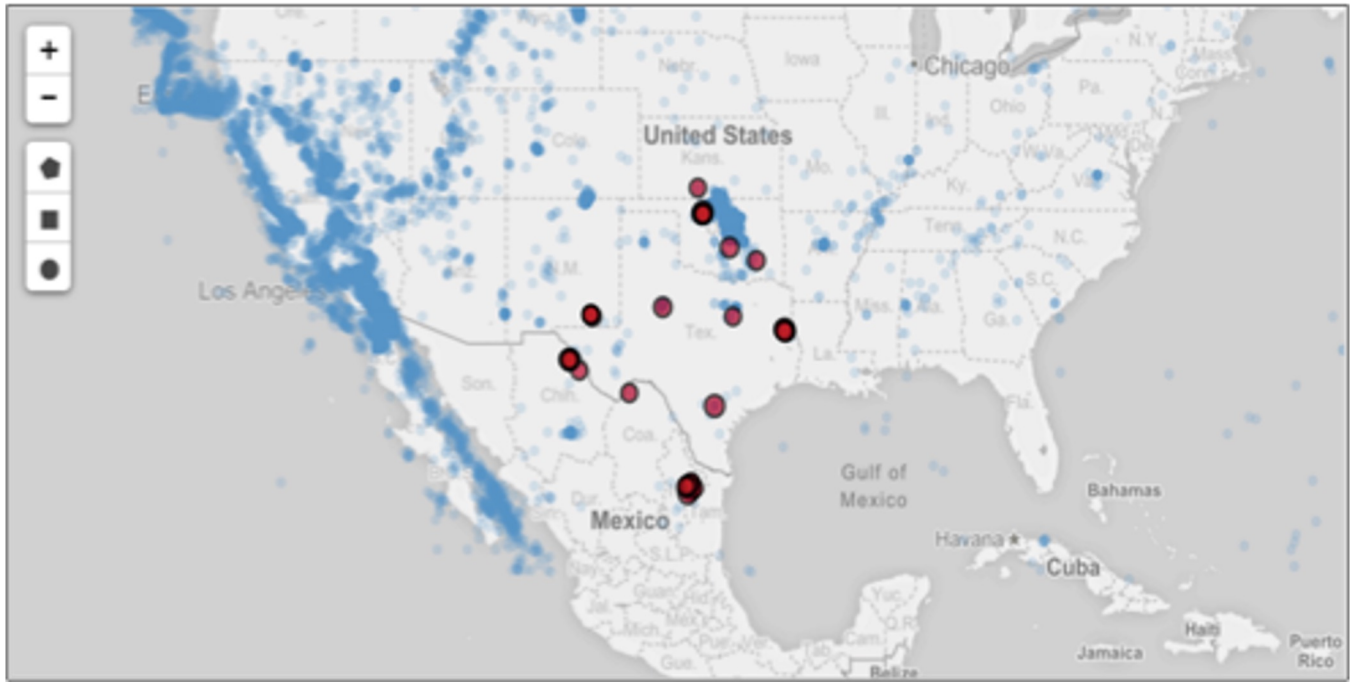


Eviza: A Natural Language Interface for Visual Analysis, UIST 2016

Supporting an analytical conversation

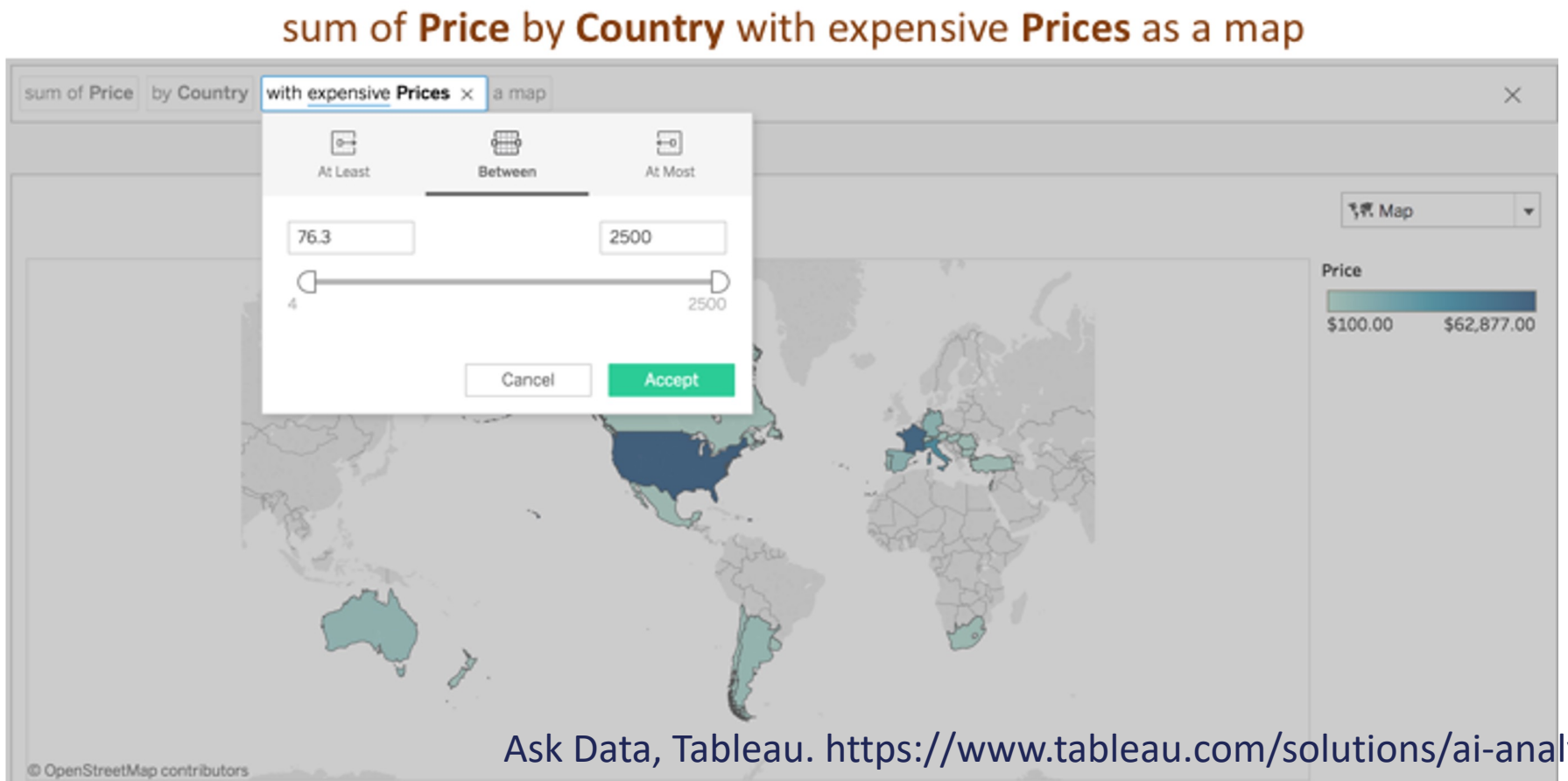
"Find large earthquakes near California"

"How about near Texas"



Infer, repair, and refine

"where are the expensive wines?"



Ask Data, Tableau. https://www.tableau.com/solutions/ai-analytics/augmented-analytics

Using external knowledge

WolframAlpha What would you like to know about?

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Related changes
Upload file
Special pages
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Wikidata item

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Portal:Current events

From Wikipedia, the free encyclopedia

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Topics in the news

- In the Battle of Mosul, the **Great Mosque of al-Nuri** is destroyed.
- In Saudi Arabia, **Mohammad bin Salman** is appointed Crown Prince after the king deposes Muhammad bin Nayef.
- **A vehicle driven into pedestrians** near the Finsbury Park Mosque *(pictured)*, London, injures at least 10 people.
- In golf, Brooks Koepka wins the **U.S. Open**.
- In cricket, the ICC Champions Trophy concludes with Pakistan defeating India in **the final**.

Ongoing: Battle of Raqqa
Recent deaths: Con Sciacca · Otto Warmbier · Tim Hague · Baldwin Lonsdale

Finsbury Park Mosque

June 22, 2017 (Thursday)

edit history watch

June 21, 2017 (Wednesday)

edit history watch

Armed conflicts and attacks

- Moro conflict
  - Maute rebels storm a school in Pigcawayan, North Cotabato, Philippines, and take civilians hostage. (*The Sydney Morning Herald*)
- Iraqi Civil War (2014–present)
  - Battle of Mosul (2016–present)

Time: 07:22 UTC | **Day**: 22 June | Purge

<<	June 2017					>>
S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

More June 2017 events...

about:

N SIZES »
ng size equivalents
8
g size to a specified system
the french equivalent ring size to ring size
hoe size equivalents
men's size 5 shoe
oe size to a specified system
n's size 11 shoe in Japanese size
G NEEDLE SIZES »
ation about knitting needle sizes
needle size 8
tting needle

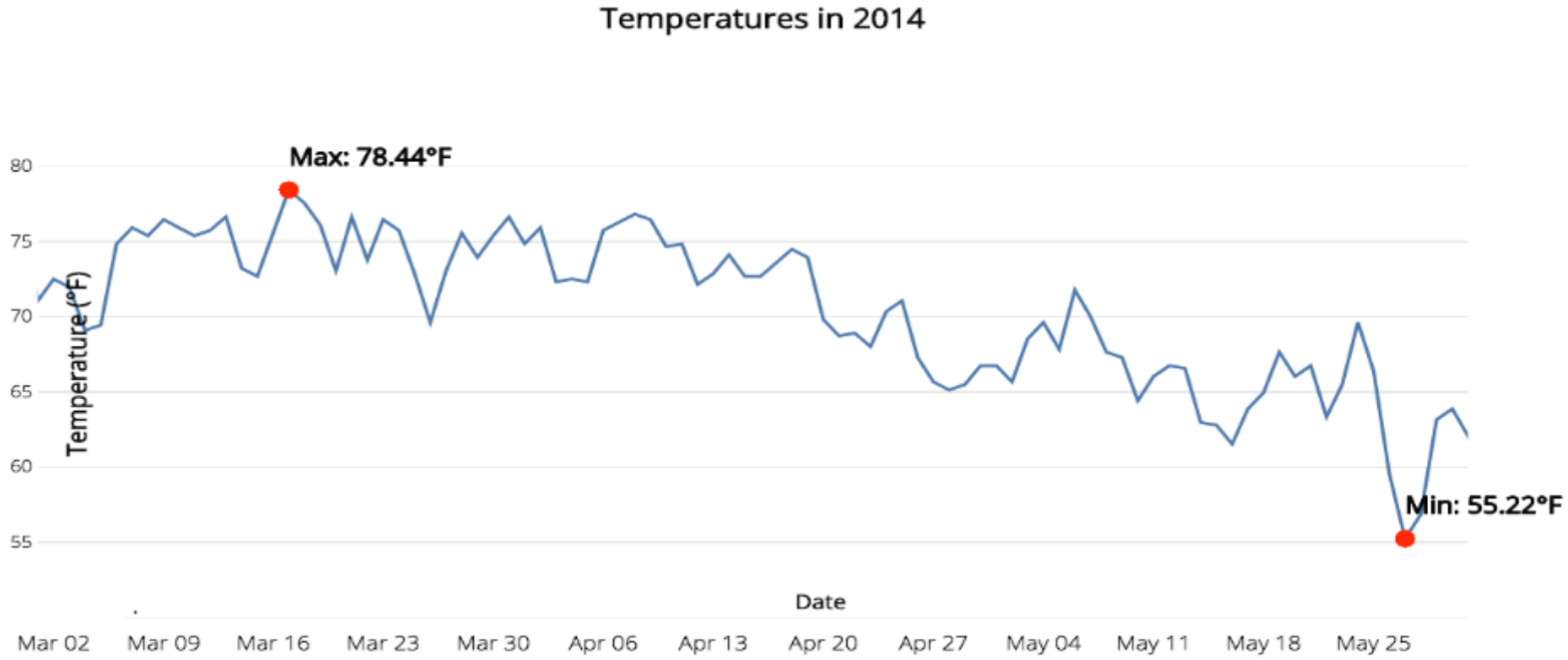
“highest and lowest temperatures in **Fahrenheit** over **fall**”

“highest and lowest temperatures in **Fahrenheit** over **fall**”

Units
(and how to convert to)

(March 1, May 31)
in the Southern hemisphere

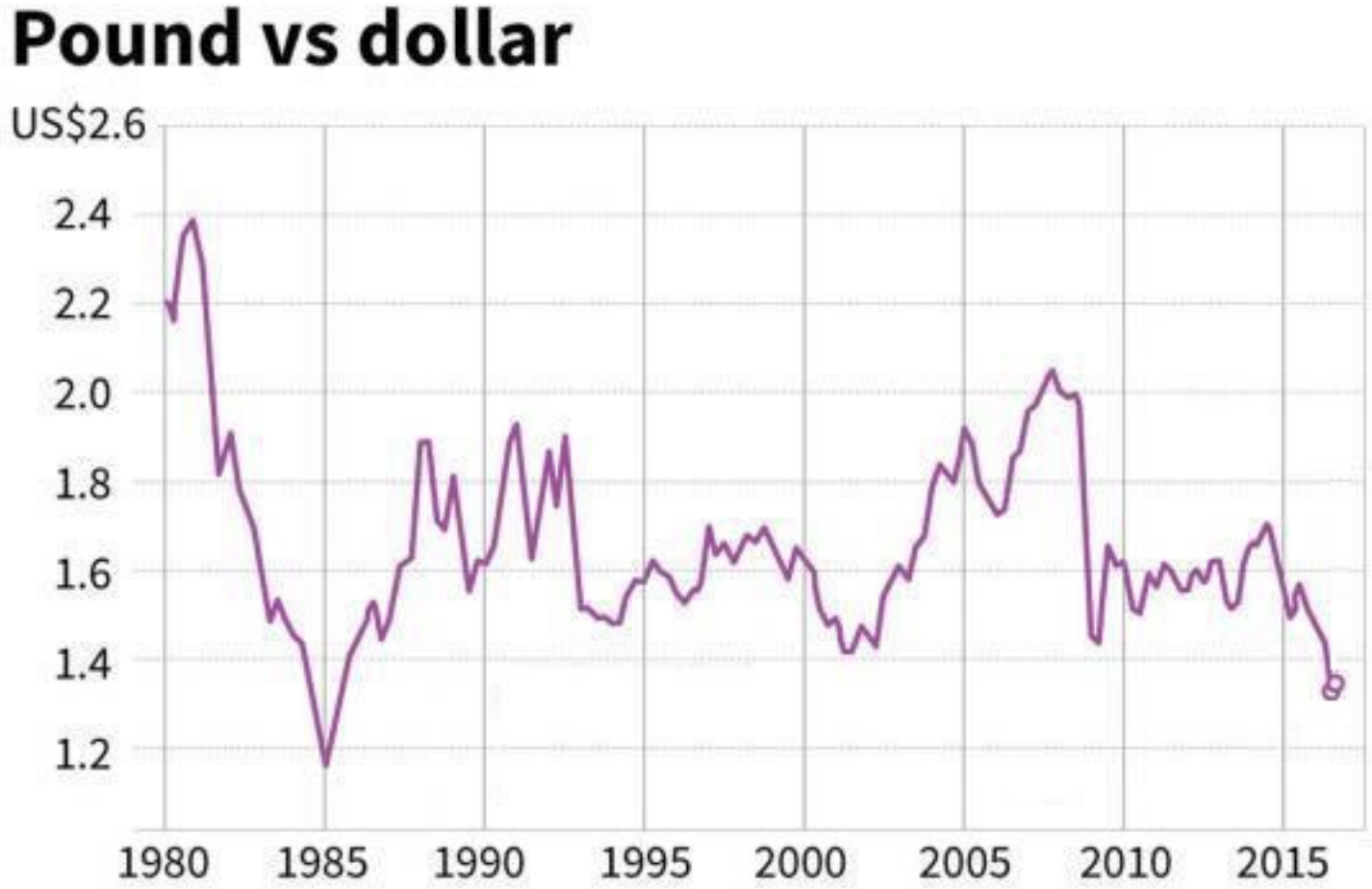
“highest and lowest temperatures in **Fahrenheit** over **fall**”



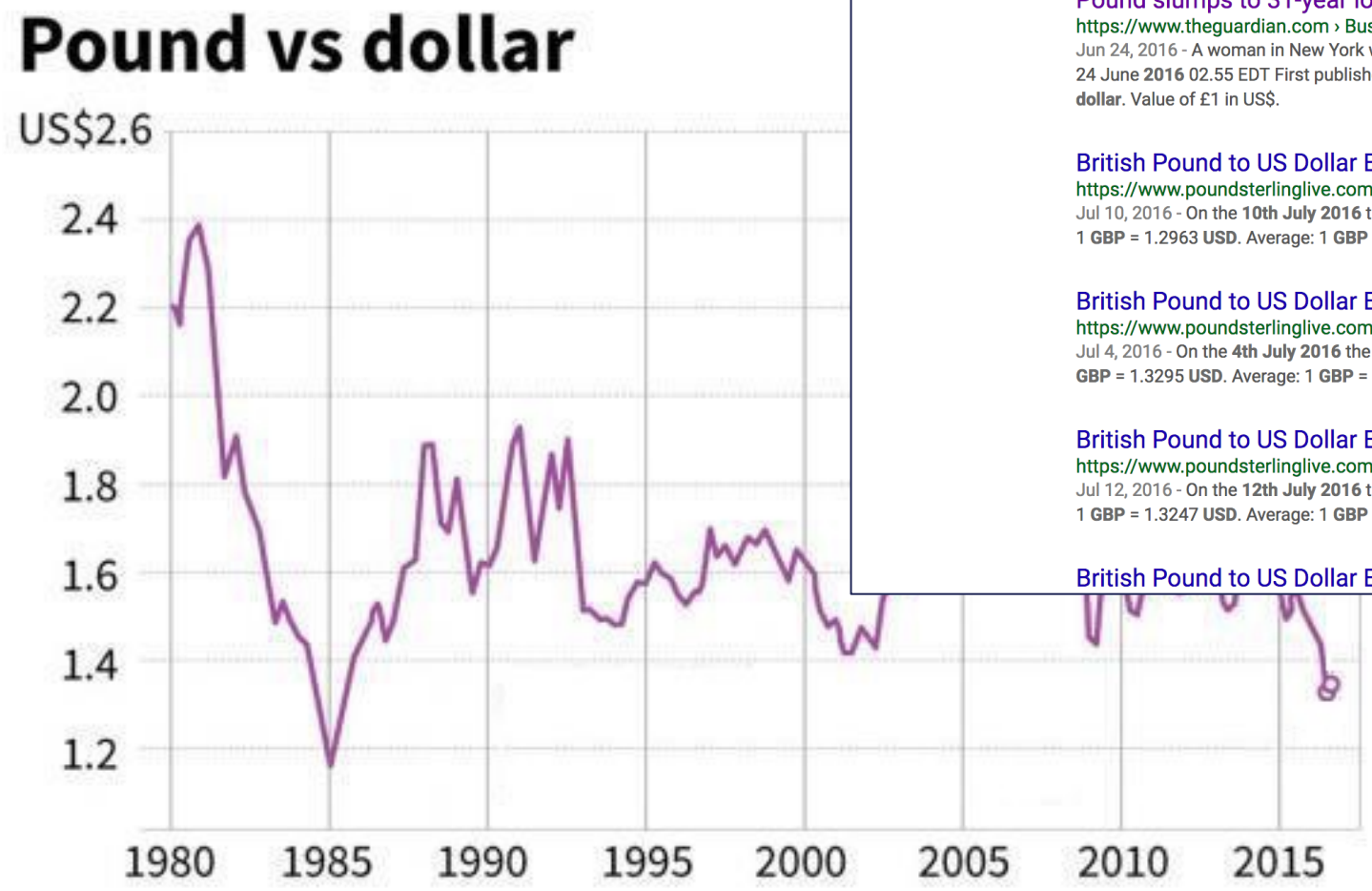
highest and lowest temperatures in Fahrenheit over seasons in Southern Hemisphere

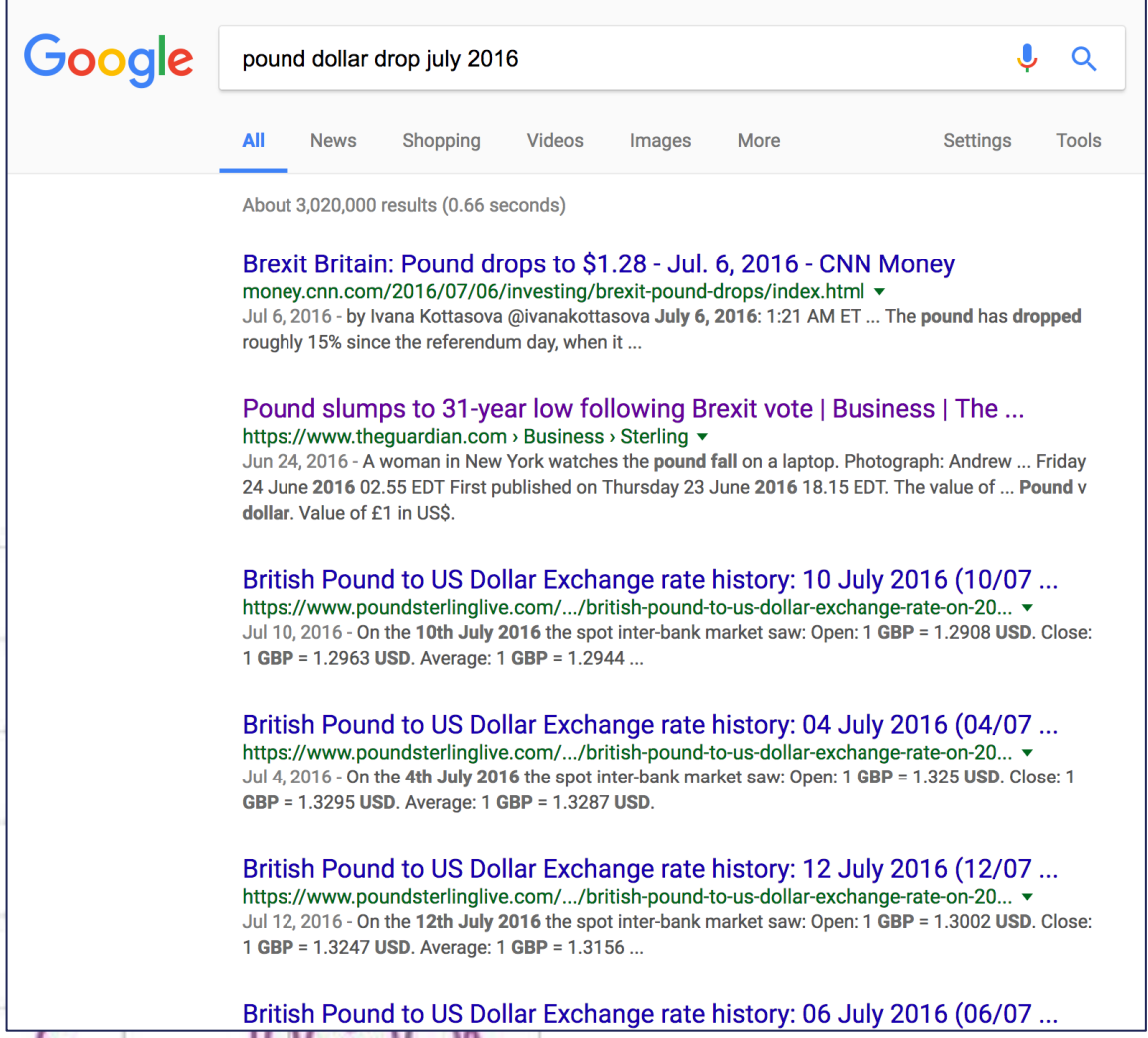
fall is from 03/01/2014 to 05/31/2014 fall .

“what is the drop in july 2016?”



“what is the drop in

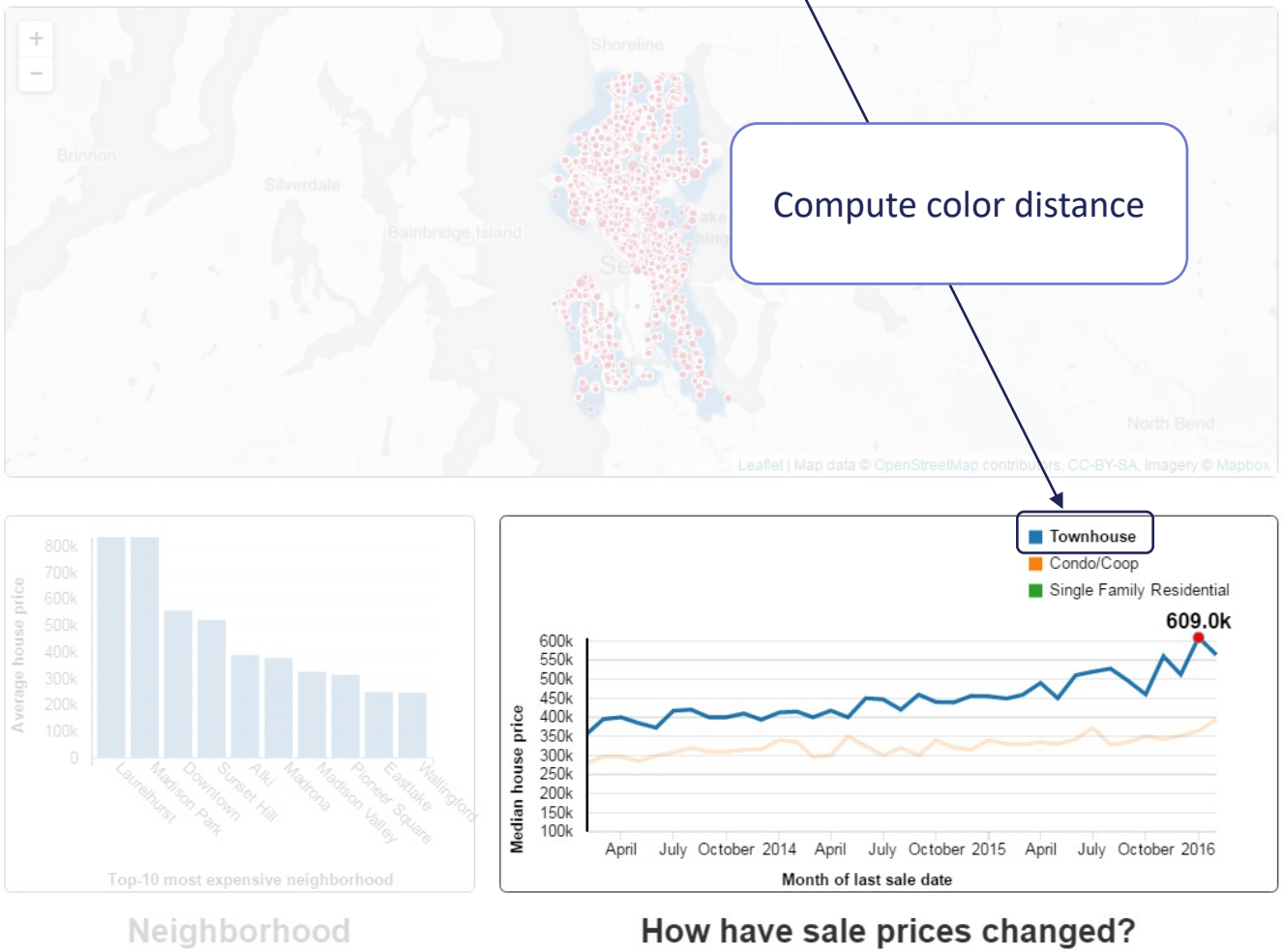




“what is the drop in july 2016?”

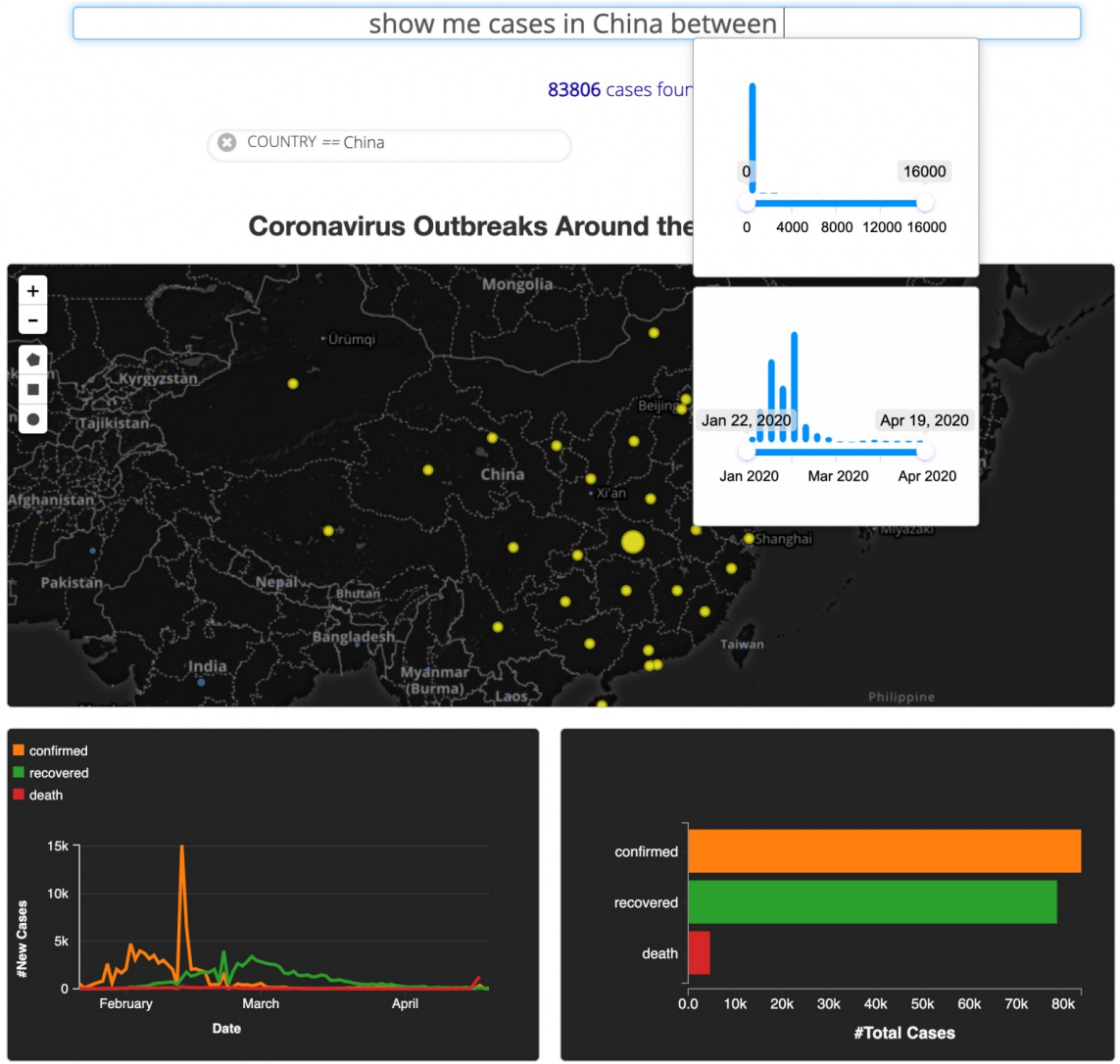
Conversing with a dashboard

Query: *what's the **spike** in that **blue** **line**?*



Scaffolding conversation

Sneak Pique: Exploring Autocompletion as a Data Discovery Scaffold for Supporting Visual Analysis, UIST 2020



“The medium is the message” – Marshall McLuhan

Participant
Hi @cha(t)bot

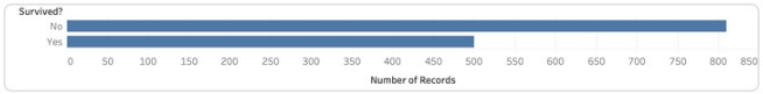
cha(t)bot APP 11:49 PM
Hi, I am an Analytical Cha(t)bot. Ask a question about the Titanic dataset

Here are the attributes in the dataset - (111 kB)

Dimensions & Measures	Description and Example Values
Number of Passengers	Number of passenger records in dataset
Age	Age in years ranging from 0.17 to 80
Age (bin)	Age in 5 year bins
Class	Cabin class [1, 2, 3]
Fare	Fare ranging from $0 to $512.33
Fare (bin)	Fare in $25 bins
Family aboard?	Was family was aboard or not [Yes, No]
Sex	Sex of passenger [male, female]
Survived?	Whether the passenger survived or not [Yes, No]
%survived	Computes the percent of survived passengers

Participant
show me those who survived and did not survive

cha(t)bot APP 11:50 PM
Here are the passengers who survived and did not survive -

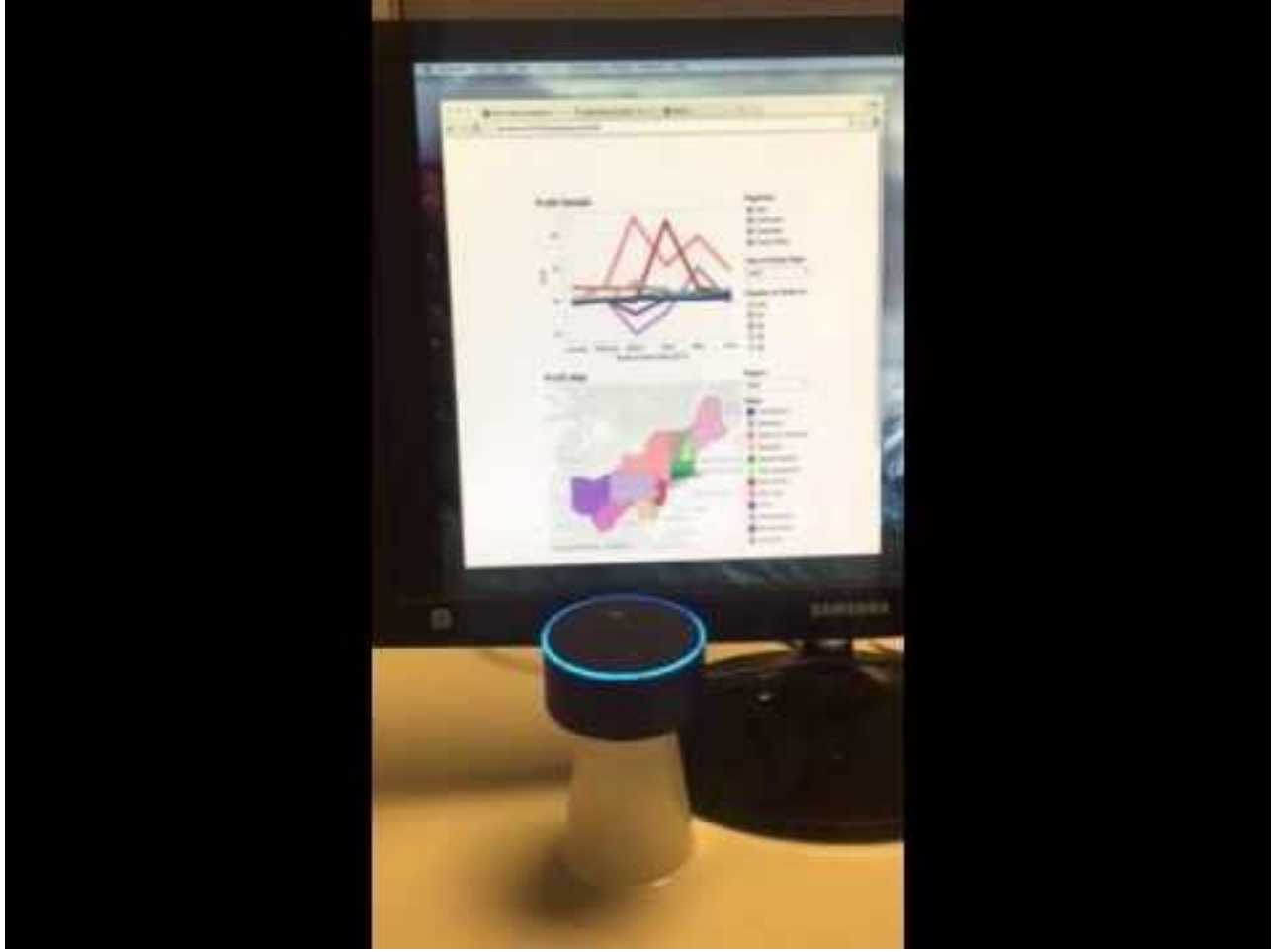


Use the options below to filter

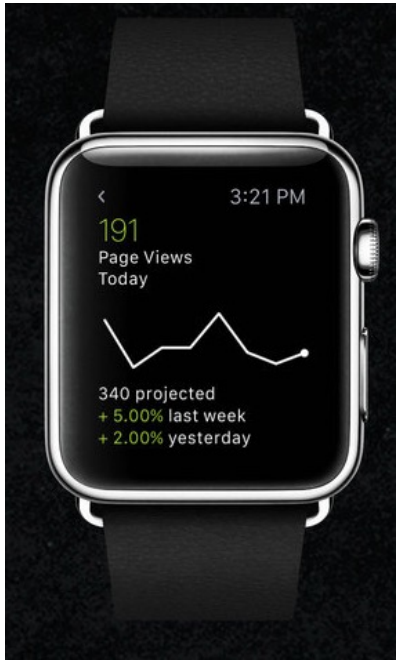
Survived

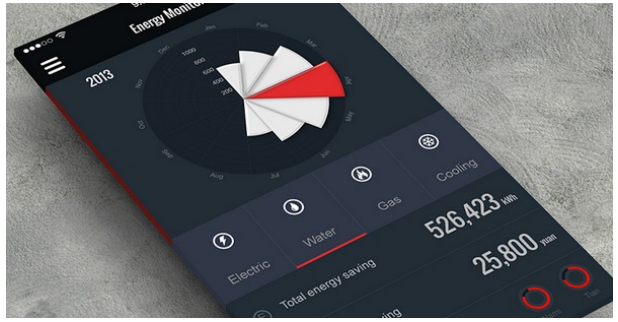
The number of passengers who survived is 500.

Analytical chatbots



"Hey Tableau, give me the summary of the day"





Touch-screen interaction

Data metrics based on natural language utterances

Key takeaways

Provide affordances for a user to understand, repair, refine, and disambiguate concepts.

Scaffolds support intent and they depend on the medium.

Pragmatics, data, and the medium need to work together to support a cooperative conversation.

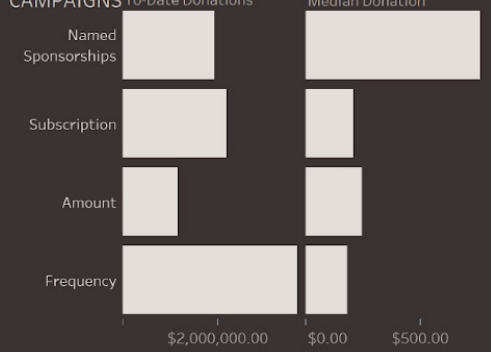
Talk outline

- Role of perception in seeing and understanding data
- Semantics in visual analysis
- Understanding intent
- Bringing it all together

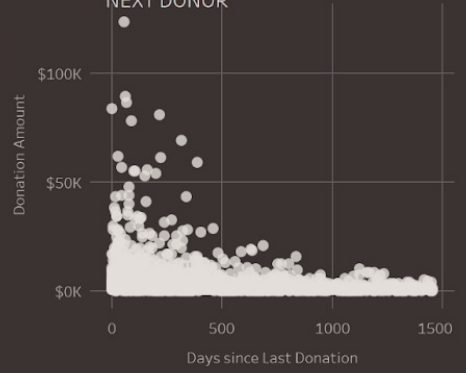
DONATION DRIVE

Sample data | Data current to 12/31/2014

CAMPAIGNS To-Date Donations | Median Donation

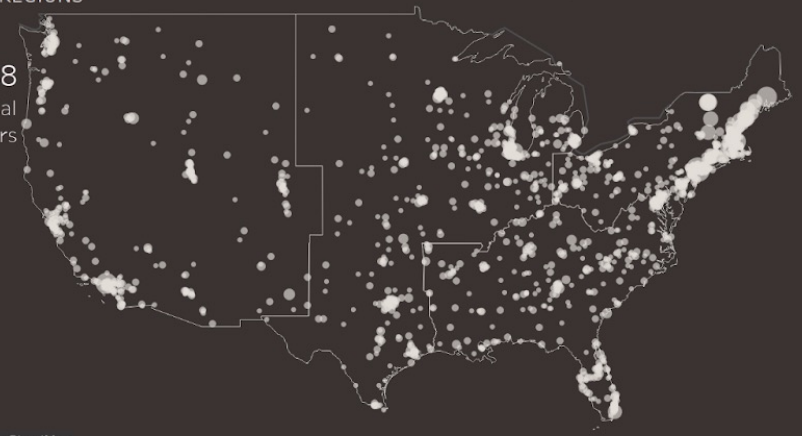


NEXT DONOR



CITIES AND REGIONS

38 potential donors



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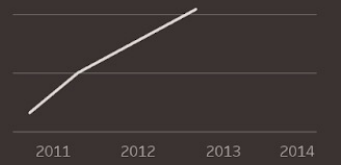
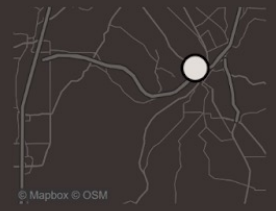
Deborah Paul

Last Donation: **9/4/2012**
15 months ago

(614) 867-5309





123 Fake Data Lane
West Linn, Oregon
97068

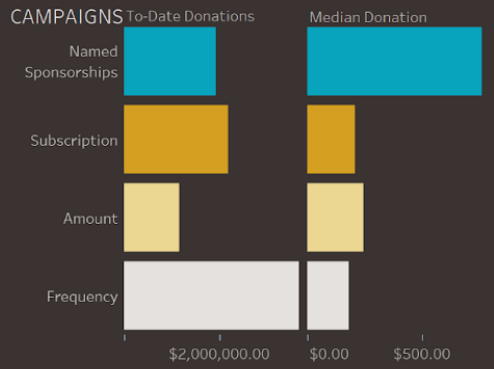
RECOMMENDED OPTIONS

COLLECT DONATION

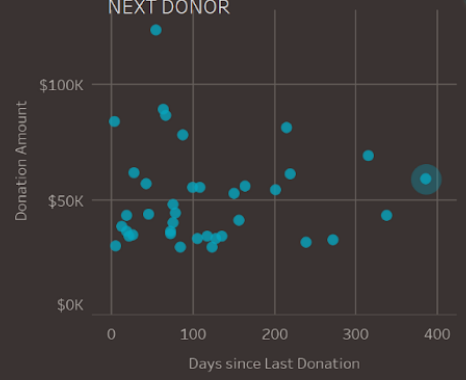
DONATION DRIVE

Sample data | Data current to 12/31/2014

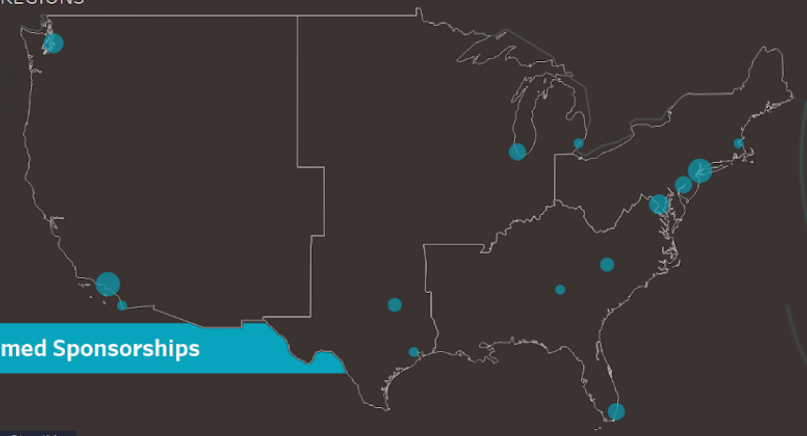
CAMPAIGNS



NEXT DONOR



CITIES AND REGIONS



Named Sponsorships

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Kim Weiss

Last Donation: **12/10/2012**
12 months ago

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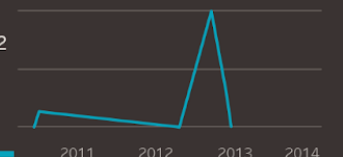
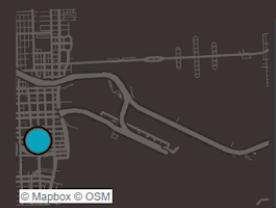
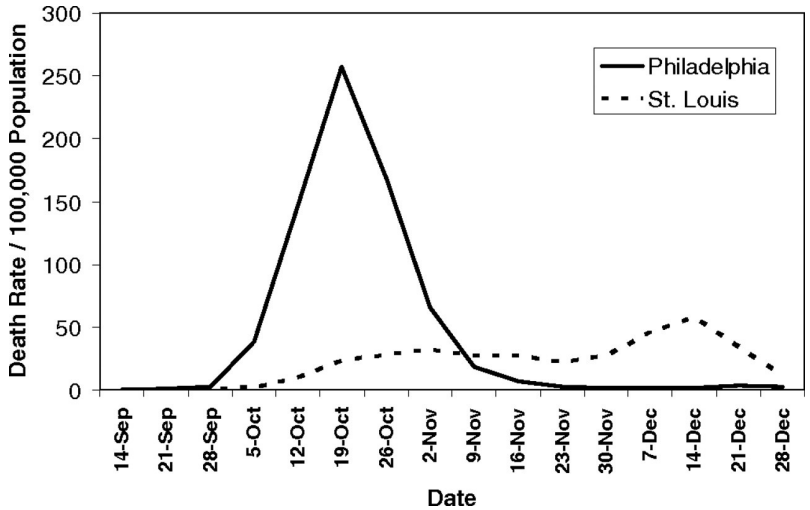




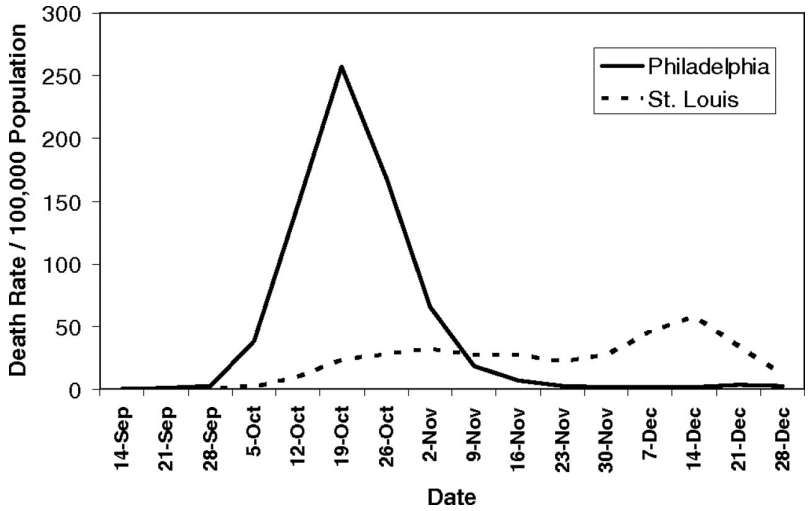
123 Fake Data Lane
Miami, Florida
33132

RECOMMENDED OPTIONS

COLLECT DONATION



Flatten the curve



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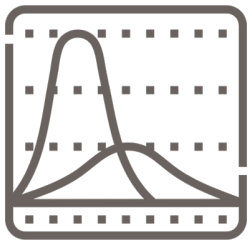
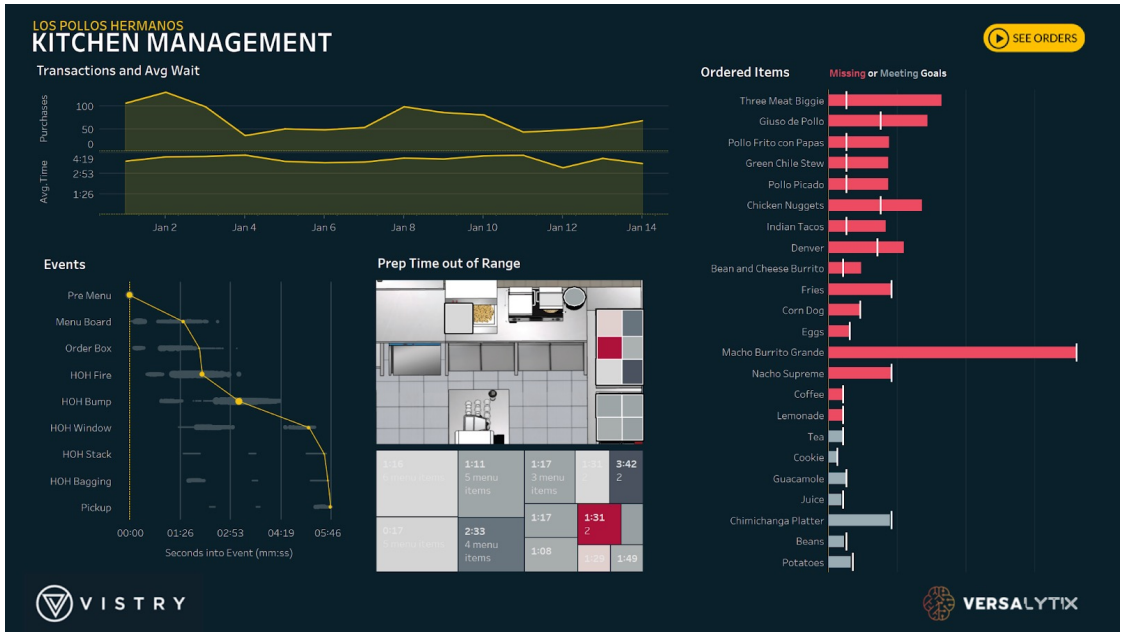
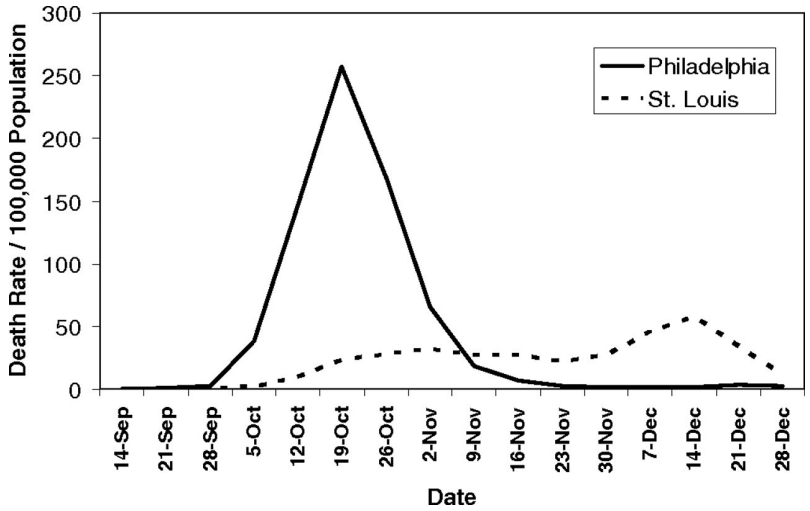
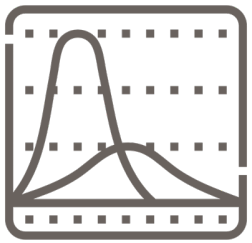




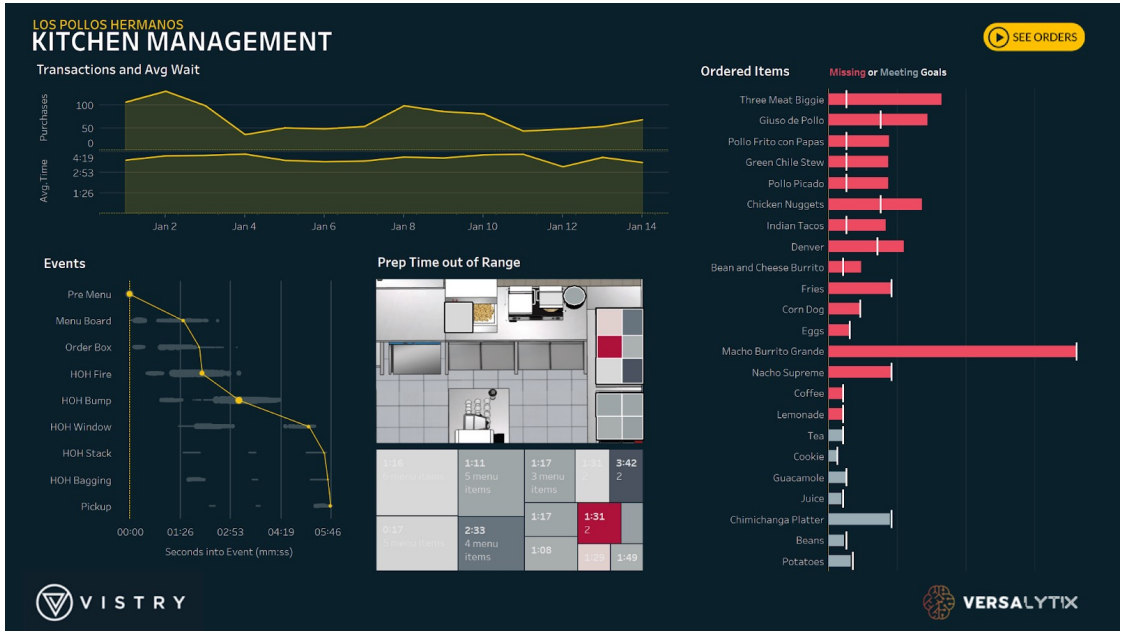
New domains





Flatten the curve

Data ubiquity



New domains

Thanks!

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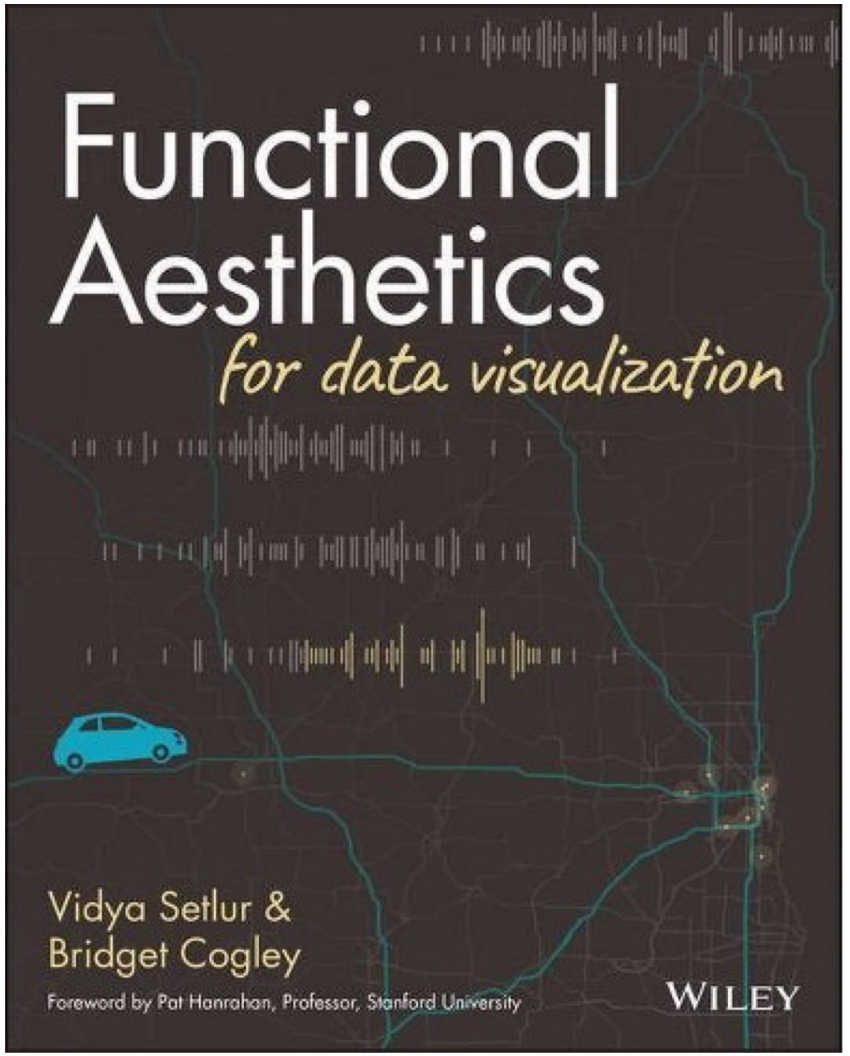
vsetlur@tableau.com

@vsetlur



Book coming out on Sept 21.
https://www.functionalaestheticsbook.com