

Lecture 8

Usability + Review

DSCI 532, Data Visualization II

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Overview

- **Usability**
 - How do you know if your interface is easy to use?
- **Review**
 - Top 10 vis tips
- **Inspiration**
 - A few final random thoughts and examples

Usability

User Experience (UX) Design

User experience (UX) design is the process of creating products that provide meaningful and relevant experiences to users

This involves the **design of the entire process** of acquiring and integrating the product, including aspects of **branding, design, usability, and function**

Examples

- How you heard about the product
- The experience of acquiring it
- Unboxing it
- Using it - does it do what you want it to do + is it delightful to use
- Troubleshooting
- Integrating it with other products / services

User Interface (UI) Design

User interface (UI) design is the process of making interfaces in software or computerized devices with a focus on look or style

Compare UI to UX design | Consider a website with movie reviews:

- Imagine the UI for finding a film is beautiful and easy to use
- A user wants to find information about a small independent release
- But the site's database only contains movies from the major studios
- This results in a poor UX

<https://www.interaction-design.org/literature/topics/ui-design>

<https://www.nngroup.com/articles/definition-user-experience>

Usability

Usability is the extent to which a product can be used by specified users to achieve specified goals with **effectiveness**, **efficiency** and **satisfaction** in a specified context of use

<https://www.interaction-design.org/literature/topics/usability>

Usability

Usability is defined by 5 quality components

Learnability

- How easy is it for users to accomplish basic tasks the first time they encounter the design?

Efficiency

- Once users have learned the design, how quickly can they perform tasks?

Memorability

- When users return to the design after a period of not using it, how easily can they reestablish proficiency?

Errors

- How many errors do users make, how severe are these errors, and how easily can they recover from the errors?

Satisfaction

- How pleasant is it to use the design?

How do you test usability?

- **Controlled settings**

- Users' activities are controlled in order to test hypotheses and measure or observe certain behaviours
- Usability tests conducted in a dedicated space (e.g. laboratory)
- Users are selected to reflect the target audience
- Care is taken to avoid bias and influence the users' behaviours in any unintended way
- Data can take many forms (both *qualitative* and *quantitative*):
 - Video
 - Eye-tracking
 - Time per task
 - Number of errors
 - Detailed questionnaires and/or interviews
- **Pro** - good at revealing usability problems and removes many sources of bias
- **Con** - expensive, time-consuming, and poor at capturing real-world context of use

How do you test usability?

- **Natural setting**

- Users are observed using the interface in real-world situations and environments
- Little to no control over the users' behaviour
- The goal is to be unobtrusive and not affect what people are doing
- Data typically takes the form of audio/video recordings and qualitative observations
- **Pro** - good at capturing how people use product in the intended setting
- **Con** - can be difficult to conduct (e.g. need access to these environments, etc.) and unpredictable what people will do

How do you test usability?

- Any setting *not* involving directly observing users
 - Heuristic evaluations
 - User researcher / designer evaluates a detailed prototype by applying their knowledge of typical users together with rules of thumb to identify usability problems
 - Cognitive walkthroughs
 - Define tasks that a user would carry out and then walkthrough these task to evaluate usability
 - <https://www.interaction-design.org/literature/article/how-to-conduct-a-cognitive-walkthrough>
 - Analytics
 - Logging user interactions automatically to reveal patterns of behaviour

How do you test usability?

- **Guerrilla Usability Testing**

- “*the art of pouncing on lone people in cafes and public spaces, [then] quickly filming them whilst they use a website for a couple of minutes*” — designer Martin Belam
- It’s a low-cost method of quickly capturing user feedback by asking people questions about specific areas of a site or application
- Uses a portable device so the test can be conducted anywhere
- Can include capturing screen activity, audio, etc. or just qualitative observation
- Not science, but rather a quick and cheap way to identify key usability problems
- Particularly valuable in early stages of development
- Complemented with more formal methods where needed / available

<https://userbrain.net/blog/7-step-guide-guerrilla-usability-testing-diy-usability-testing-method>

Guerrilla Usability Testing

Step 1 | Come up with a list of tasks

- Write down a list of all important tasks people need to be able to do with your interface
- For example, Facebook's actions would be:
 - Scroll through new posts
 - Update your status
 - Send a private message
 - Upload a photo
 - Add a friend
 - Change your password

<https://userbrain.net/blog/7-step-guide-guerrilla-usability-testing-diy-usability-testing-method>

Step 2 | Prioritize tasks + decide which to test

- Prioritize all items by giving points from 1 to 3 based on how frequently the tasks are performed
- Add
 - 3 points to tasks that most users will do most of the time
 - 2 points if they do it occasionally
 - 1 point if they only perform this task every once in a while
- For example, here's our list for Facebook, prioritized:
 - Scroll through new posts: 3
 - Update your status: 2
 - Send a private message: 1
 - Upload a photo: 2
 - Add a friend: 1
 - Change your password: 1

<https://userbrain.net/blog/7-step-guide-guerrilla-usability-testing-diy-usability-testing-method>

Step 2 | Prioritize tasks + decide which to test

- Don't need to spend a lot of time on your ranking
- Most important is to make sure you find the tasks most people do most of the time
- You can't test everything at once! Focus tests on finding and fixing problems with the most important parts of your interface
- Guerrilla usability testing is about quick results and acting on them immediately
- Select the top 3 tasks for testing. You can test the rest later.

<https://userbrain.net/blog/7-step-guide-guerrilla-usability-testing-diy-usability-testing-method>

Step 3 | Turn your tasks into scenarios

- Scenarios provide the context and description of the test tasks for users
- They are text you will read or give to your users to explain what they should do in your test

<https://userbrain.net/blog/7-step-guide-guerrilla-usability-testing-diy-usability-testing-method>

From Tasks to Scenarios | Example 1

Example 1 | Scroll through new posts

Task

- *Scroll through new posts*

Scenario

- *Scroll through the page to look at new posts*

How could this scenario be better?

- Instead of just describing what to do, give people a reason to do it
- Without any motivation for what they are trying to do, people will literally follow your instructions like a robot and you won't learn anything about usability

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Example 1 | Scroll through new posts

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Example 1 | Scroll through new posts

Task

- *Scroll through new posts*

Scenario (version 2)

- *Look at this page and find out what it's all about*

What is improved about this scenario?

- Allows people to explore the page more naturally
- Just by telling them to look at the page, they will likely try scrolling through the posts

How could this scenario be better?

- Could give them an even more specific goal to focus your test instead of hoping they do what you want

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Example 1 | Scroll through new posts

Task

- *Scroll through new posts*

Scenario (version 3)

- *Imagine this is the first time you're checking Facebook today. Now go and find the first post that was published today*

What is improved about this scenario?

- You have given them a clear goal that will naturally motivate them to use your site

<https://userbrain.net/blog/7-step-guide-guerrilla-usability-testing-diy-usability-testing-method>

From Tasks to Scenarios | Example 2

Example 2 | Update your status

Task

- *Update your status*

Scenario

- *Write a status update and post it to your profile page*

How could this scenario be better?

- Instead of just describing what to do, give people a reason to do it
- Gives too many clues on how to use the site
- People may simply look for the words “status update” and maybe a button labeled “post to profile page” rather than understanding the task

<https://userbrain.net/blog/7-step-guide-guerrilla-usability-testing-diy-usability-testing-method>

Example 2 | Update your status

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Scenario

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Example 2 | Update your status

Task

- *Update your status*

Scenario (version 2)

- *Let your friends know what you're doing by updating your status*

What is improved about this scenario?

- Explains why someone would want to update their status

How could this scenario be better?

- Words “updating your status” could still lead to a word-matching game

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How could this scenario be better?

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Example 2 | Update your status

Task

- *Update your status*

Scenario (version 3)

- *Find a way to let your friends know what you're doing and tell them you're currently testing a website*

What is improved about this scenario?

- You have given them a clear goal that will naturally motivate them to use your site
- Avoids any clues about how to use the interface

<https://userbrain.net/blog/7-step-guide-guerrilla-usability-testing-diy-usability-testing-method>

Summary | Turn your tasks into scenarios

- Provide context and motivation for each task rather than just a description
- Avoid giving clues about how to use your interface
- Keep your scenarios as short as possible and remove unnecessary detail
- Pre-test your scenarios with friends / colleagues

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Step 4 | Combine all three scenarios

For example:

- *Imagine this is the first time you're checking Facebook today. Now go and find the first post that was published today.*
- *Find a way to let your friends know what you're doing and tell them you're currently testing a website.*
- *Last night you were at a party and took some funny pictures and now you're looking for a way to share them so your friends can see them as well.*

Let's try this with your own app

Step 1 - Write three tasks you want to test

Step 2 - Draft scenarios you would give to testers

Step 5 | Start testing

- Guerrilla usability testing is meant to be informal
- You can approach people in your workplace, etc.
- Aim for 3-5 participants
- It can be better if your testers don't know you

<https://userbrain.net/blog/7-step-guide-guerrilla-usability-testing-diy-usability-testing-method>

Step 5 | Start testing

- It's important to tell people that you're testing the interface/prototype not them! Emphasize that they cannot make mistakes.
- Ask them to think out loud
 - "just say what you're looking at, how it affects you, what you expect to happen after every interaction, what you're trying to accomplish, and so on."
- Avoid leading your users; let them figure things out for themselves
 - Best for you to stay silent and try delaying in depth questions until the end
- People are always kinder to your face
 - If they know you've built the tool, they will be more positive
 - Encourage them to be honest and not worry about your feelings

<https://userbrain.net/blog/7-step-guide-guerrilla-usability-testing-diy-usability-testing-method>

Step 6 | Capture testing insights

- Don't try to capture observations during the test
- The goal is to capture the most important issues
 - If you concentrate on observing, you will remember the key points
 - You don't need to remember every small detail in this format
 - If it's a key problem, you will likely see it again!
- When people think aloud, they may struggle to articulate the true problem
 - Think carefully about what they are saying and what they are actually doing to identify the core problem

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Step 6 | Capture testing insights

- Summarize the top three usability issues
- Alternatively, you can record task completion
 - If a user can perform the task quickly and with no trouble, mark it a 3.
 - If a user can perform the task but has some problems, mark it a 2.
 - If a user couldn't perform a task, mark it a 1.

<https://userbrain.net/blog/7-step-guide-guerrilla-usability-testing-diy-usability-testing-method>

Step 6 | Capture testing insights

GUERILLA USABILITY TEMPLATE								
	Upload image TASK 1	Post message TASK 2	Share photo TASK 3	Add a friend TASK 4	Delete a post TASK 5	Change profile TASK 6	Logout TASK 7	Logout TASK 8
Tester 1	3	2	3	3	2	2	3	3
Tester 2	3	3	3	3	3	2	3	3
Tester 3	3	3	3	2	3	1	3	3
Tester 4	3	2	3	3	3	1	2	2
Tester 5	2	2	3	1	1	1	2	1
SUM	14	12	15	12	12	7	13	12

3: User can perform task quickly and with no trouble
2: User can perform task, but has some struggles
1: User can't perform task

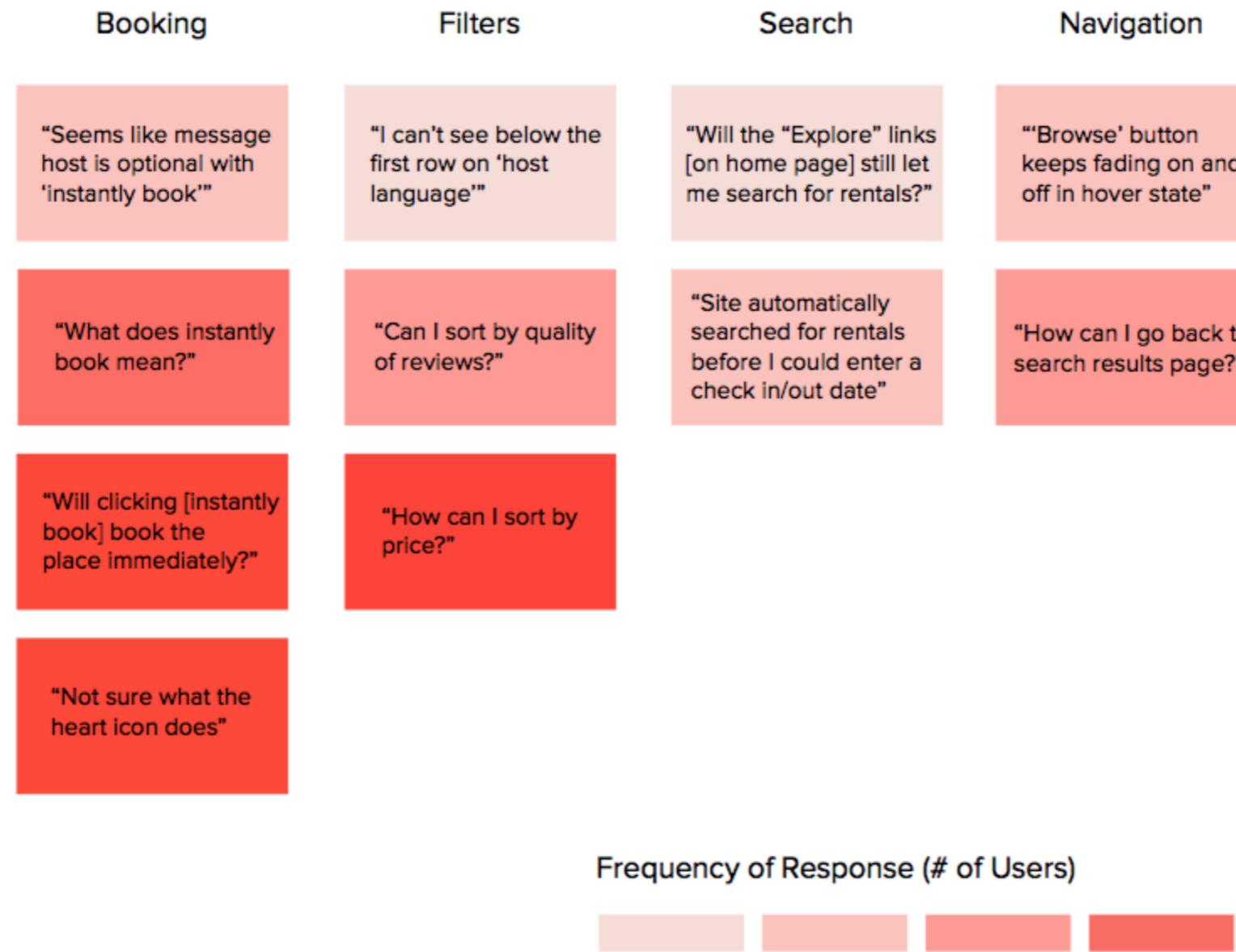
NOTES

3 BIGGEST PROBLEMS

<https://userbrain.net/blog/7-step-guide-guerrilla-usability-testing-diy-usability-testing-method>

Step 6 | Capture testing insights

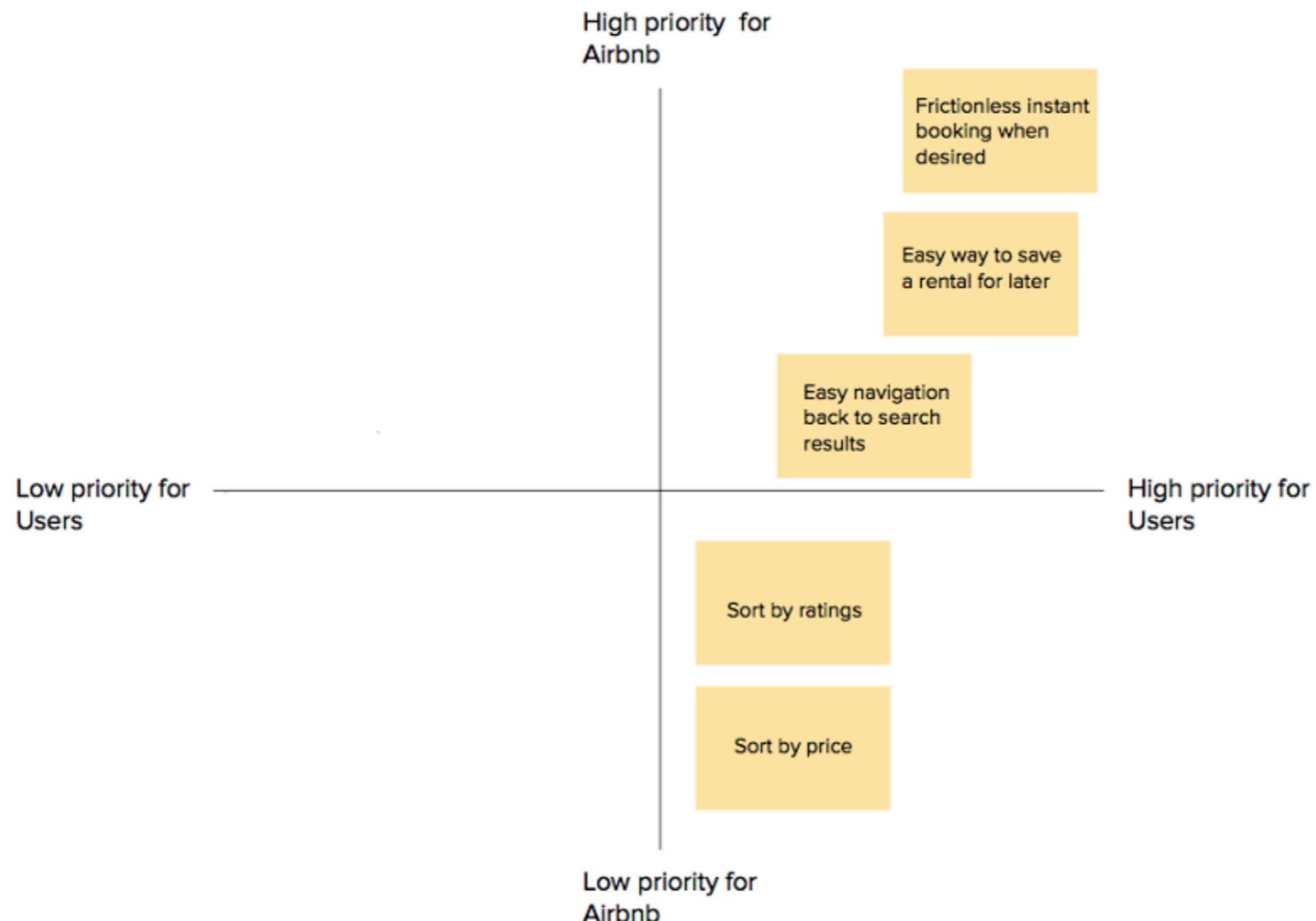
Summarizing feedback



<https://medium.com/interactive-mind/airbnb-guerilla-usability-testing-548b4676d06c>

Step 6 | Capture testing insights

Prioritizing feedback



<https://medium.com/interactive-mind/airbnb-guerilla-usability-testing-548b4676d06c>

Step 7 | Fix your usability issues

- Tackle the largest issues first
- Try to avoid fixing everything at once and talking yourself into a total redesign
- Make testing part of your workflow
 - Test early (even testing a hand-drawn paper prototype can be useful)
 - Test often (create a regular testing cycle)
 - If you don't have time / resources to do the testing yourself, there are usability testing services available by subscription or for fixed fees

<https://userbrain.net/blog/7-step-guide-guerrilla-usability-testing-diy-usability-testing-method>

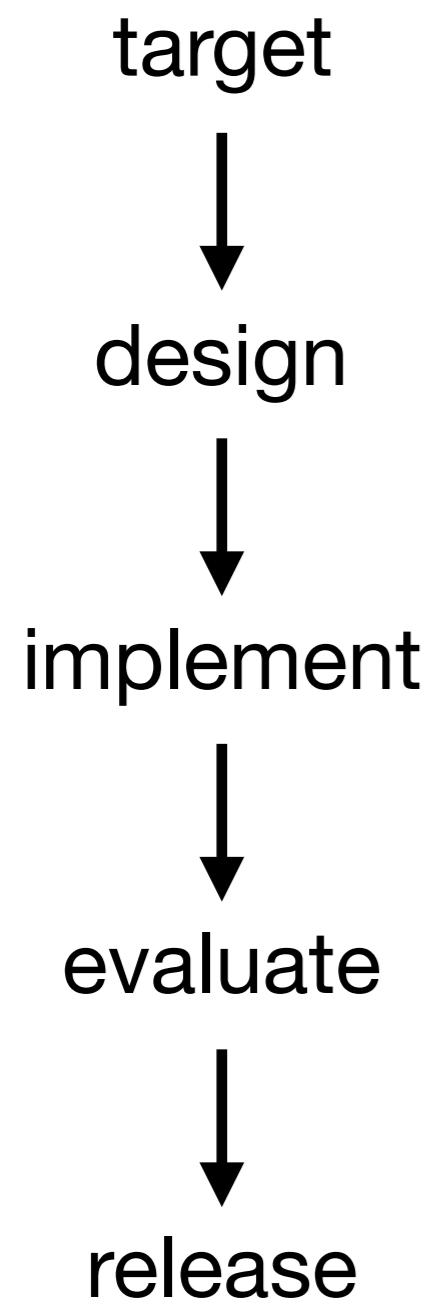
Review

Top 10 vis tips

I

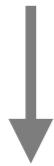
Start with a list of questions
you want to answer with your visualization

Design process



Target

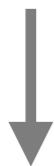
target



design



implement



evaluate



release

What is the purpose of my visualization?

- What am I trying to show?
- What questions am I trying to answer?

Who is my audience?

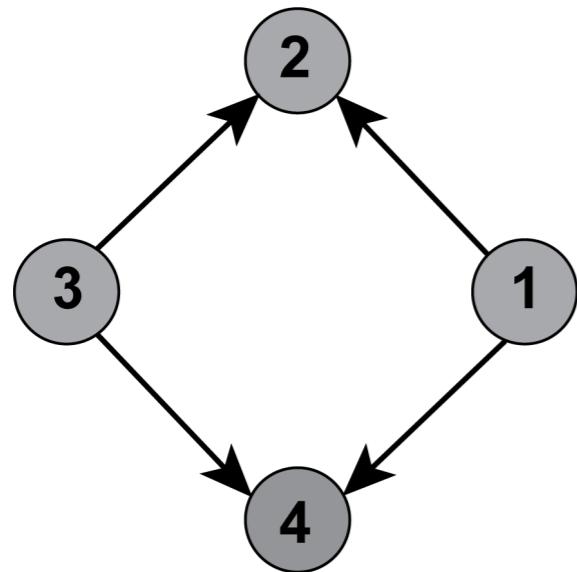
- Is it for me?
- Is it for executive decision makers?
- Is it for data analysts?
- Is it for the general public?

2

Transform your data to serve
your analytical task

Data I have

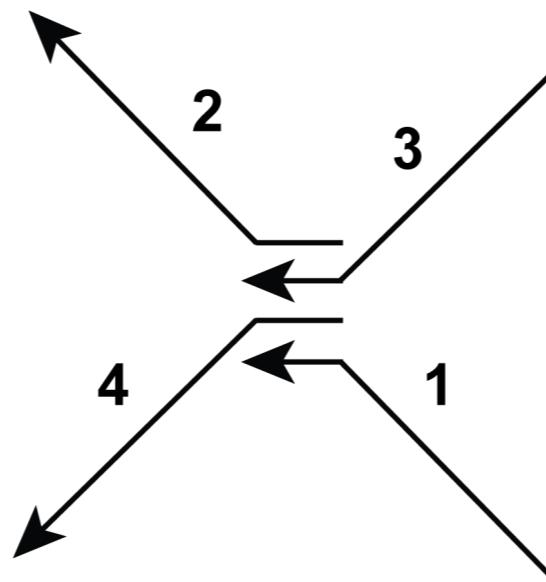
Raw data graph



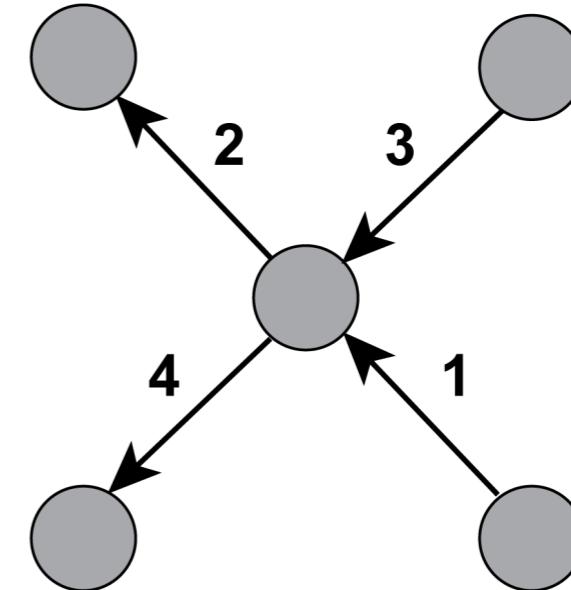
node = sequence
edge = $k-1$ overlap

Data I want to show

DNA sequence



Transformed graph



node = $k-1$ overlap
edge = sequence

3

Consult known guidelines
for choosing your encoding

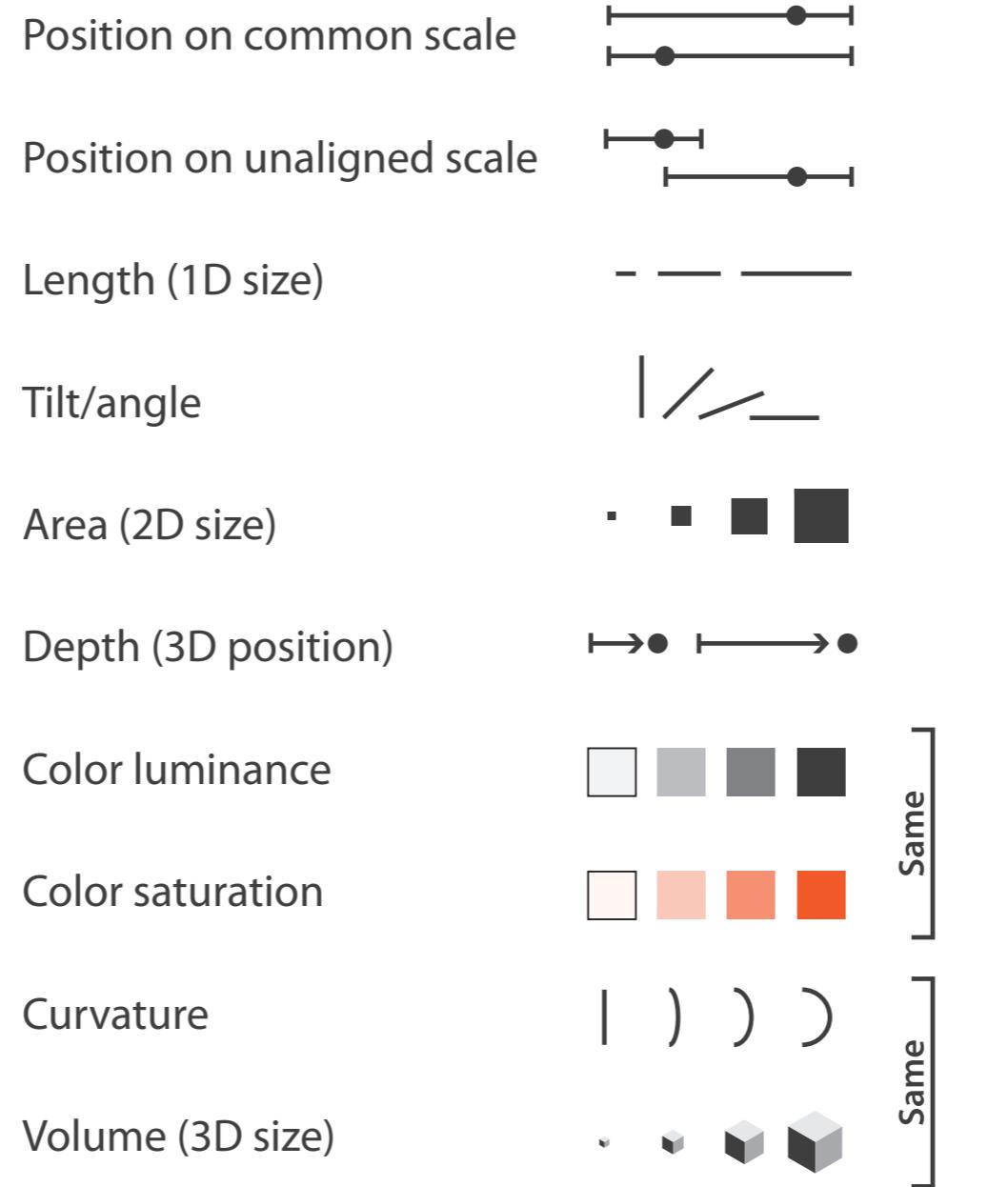


Which encoding should I use?

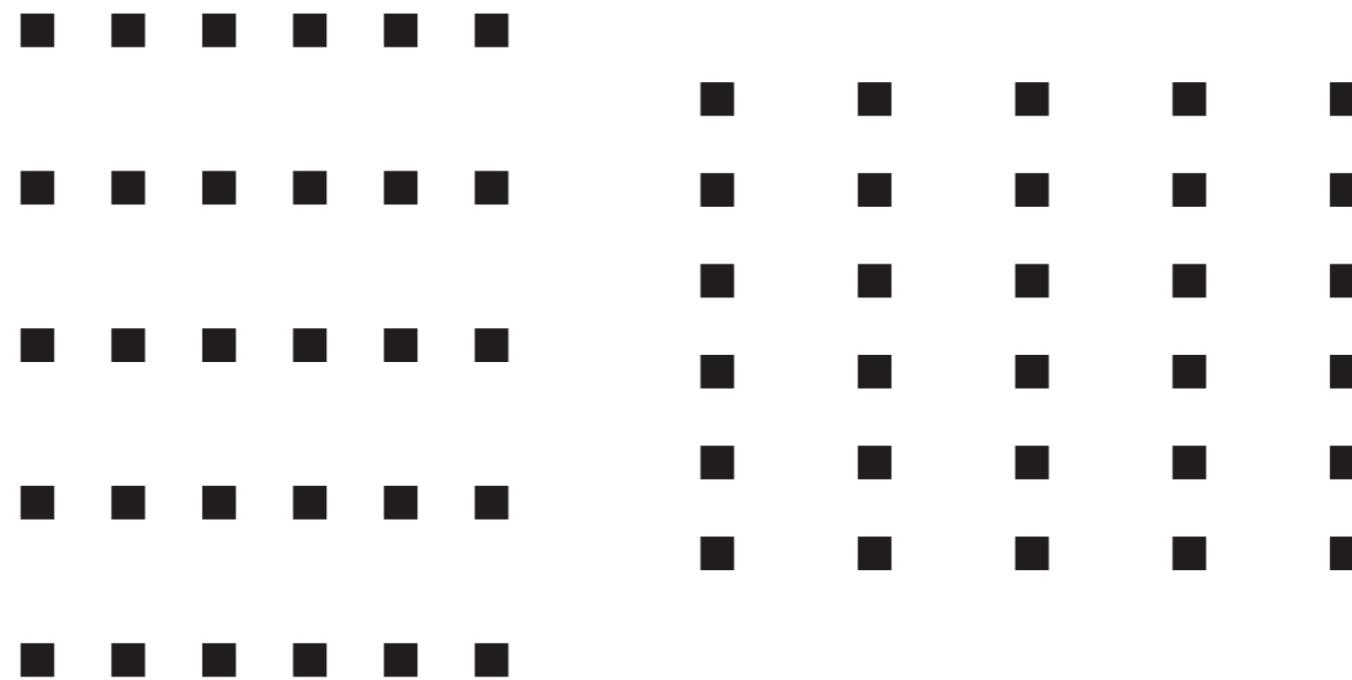
Crowdsourcing Graphical Perception: Using Mechanical Turk to Assess Visualization Design
Heer and Bostock, CHI, 2010

Best practices | Visualizing quantitative values

④ Magnitude Channels: Ordered Attributes



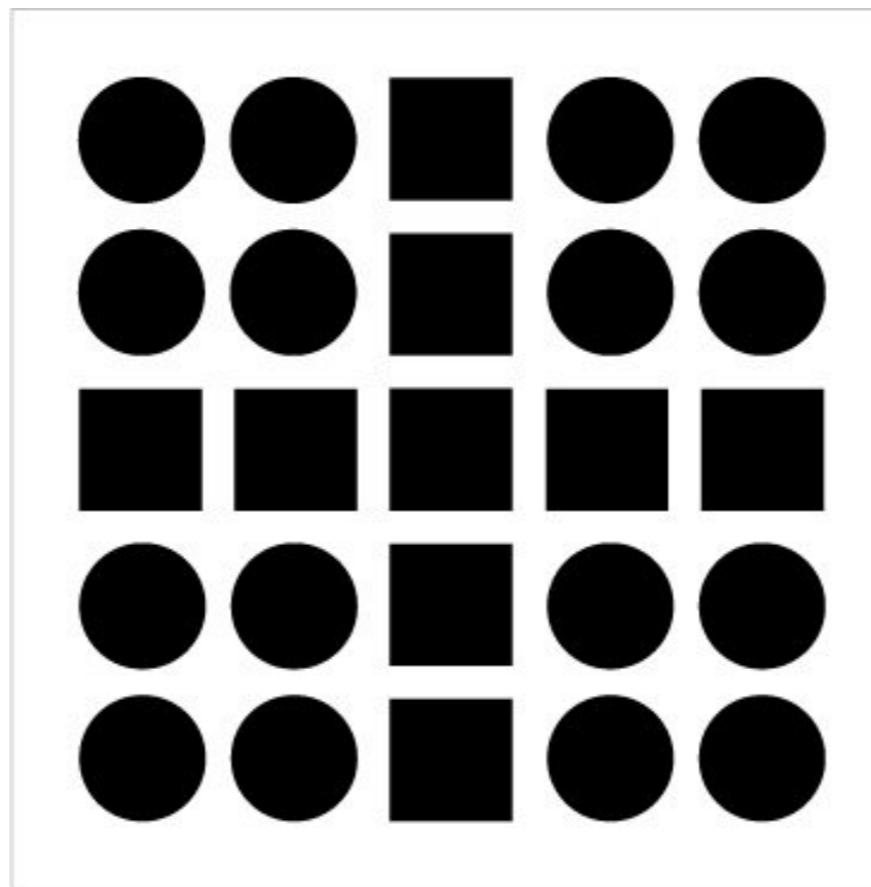
Perceiving Groups | Gestalt Principles



Proximity

Graphic from Bang Wong's Points of View column, Nature Methods, 2010

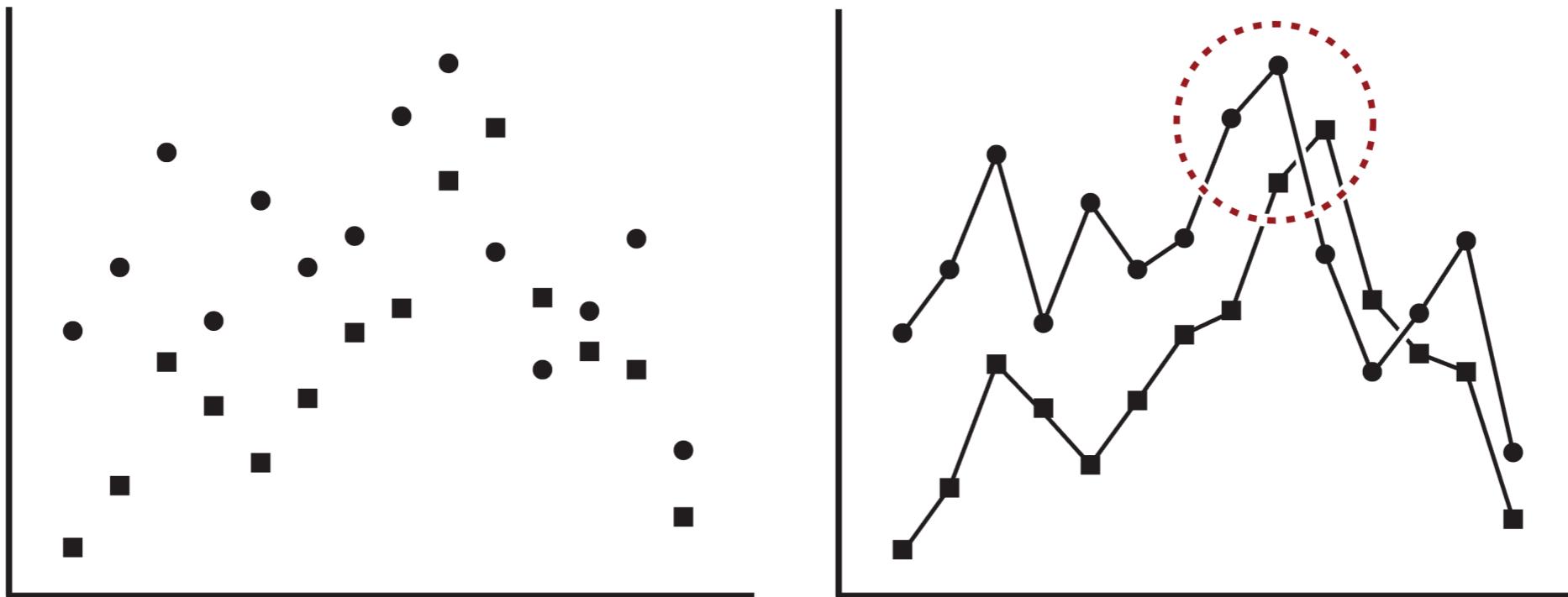
Perceiving Groups | Gestalt Principles



Similarity

Graphic from Bang Wong's Points of View column, Nature Methods, 2010

Perceiving Groups | Gestalt Principles



Connection + Containment

Graphic from Bang Wong's Points of View column, Nature Methods, 2010

Best practices | Visualizing groups

Containment	Best	Marks as Links	Connection
Connection		→ Containment	→ Connection
Proximity		→ Identity Channels: Categorical Attributes	
Similarity		Spatial region	
	Least	Color hue	
		Motion	
		Shape	

The diagram illustrates best practices for visualizing groupings across five levels of effectiveness: Best (Containment), Connection, Proximity, Similarity, and Least (Containment). Each level is associated with specific visualization techniques:

- Containment:** Marks as Links (Containment) and Connection.
- Connection:** Identity Channels: Categorical Attributes (Spatial region, Color hue).
- Proximity:** Motion.
- Similarity:** Shape.

Visual examples for each technique are shown to the right of the descriptions.

4

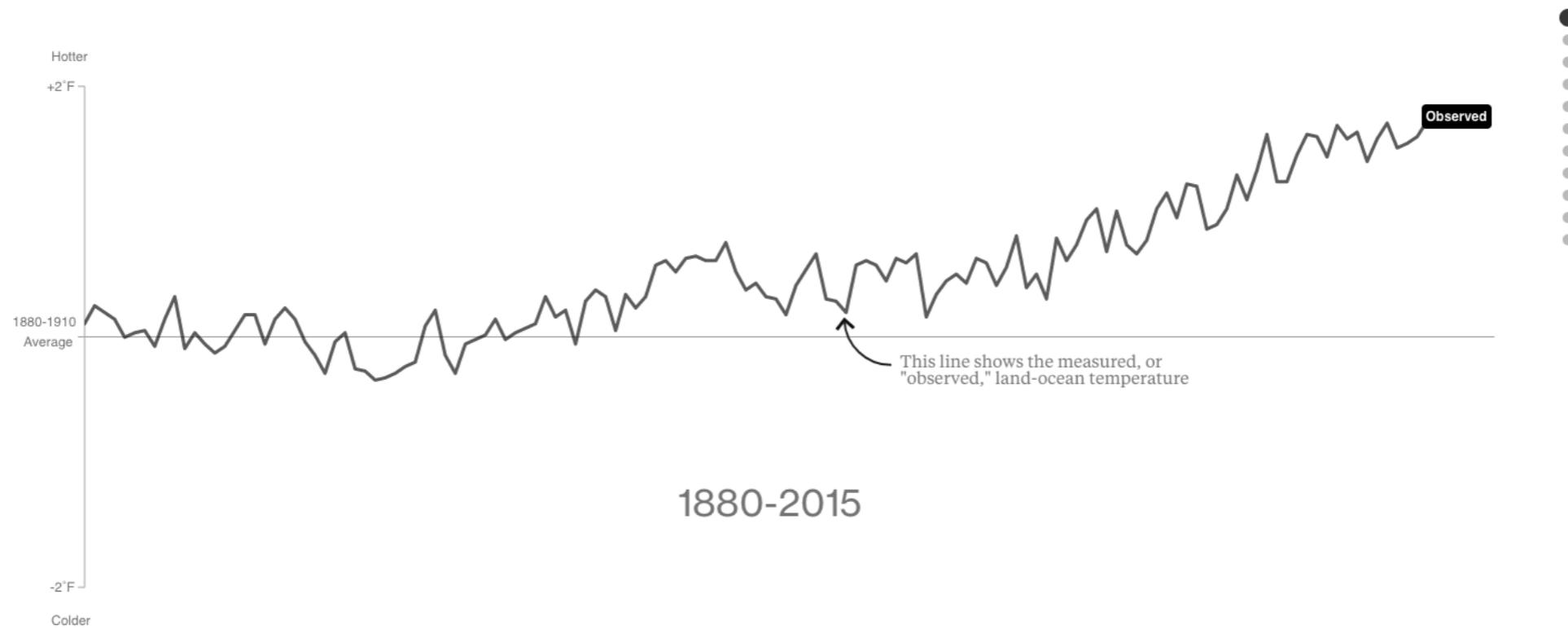
Create clear and concise
titles and axis labels

Consider making your title a question

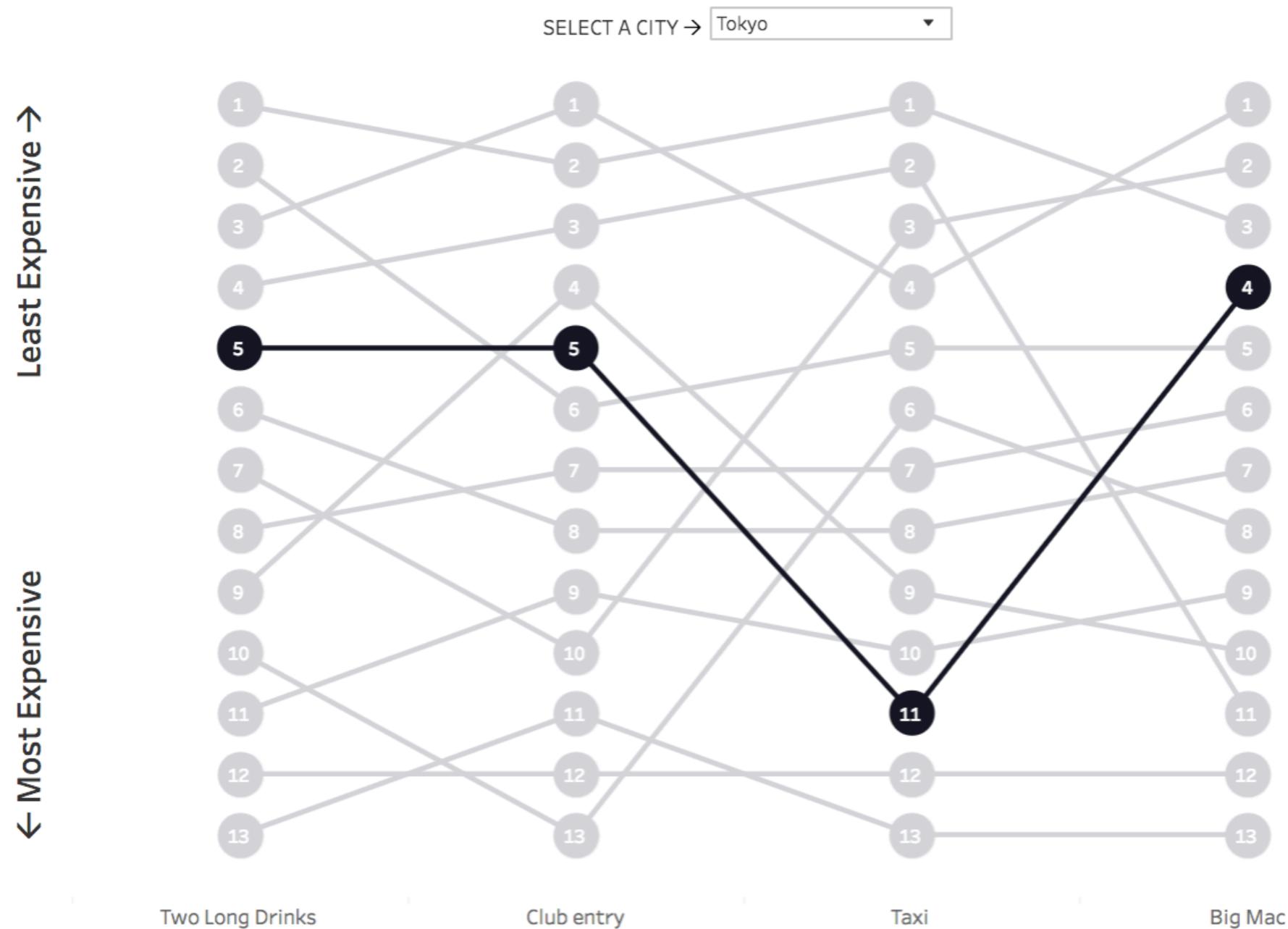
What's Really Warming the World?

By Eric Roston  and Blacki Migliozi  | 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.



How does the cost of a night out rank across a selection of cities?

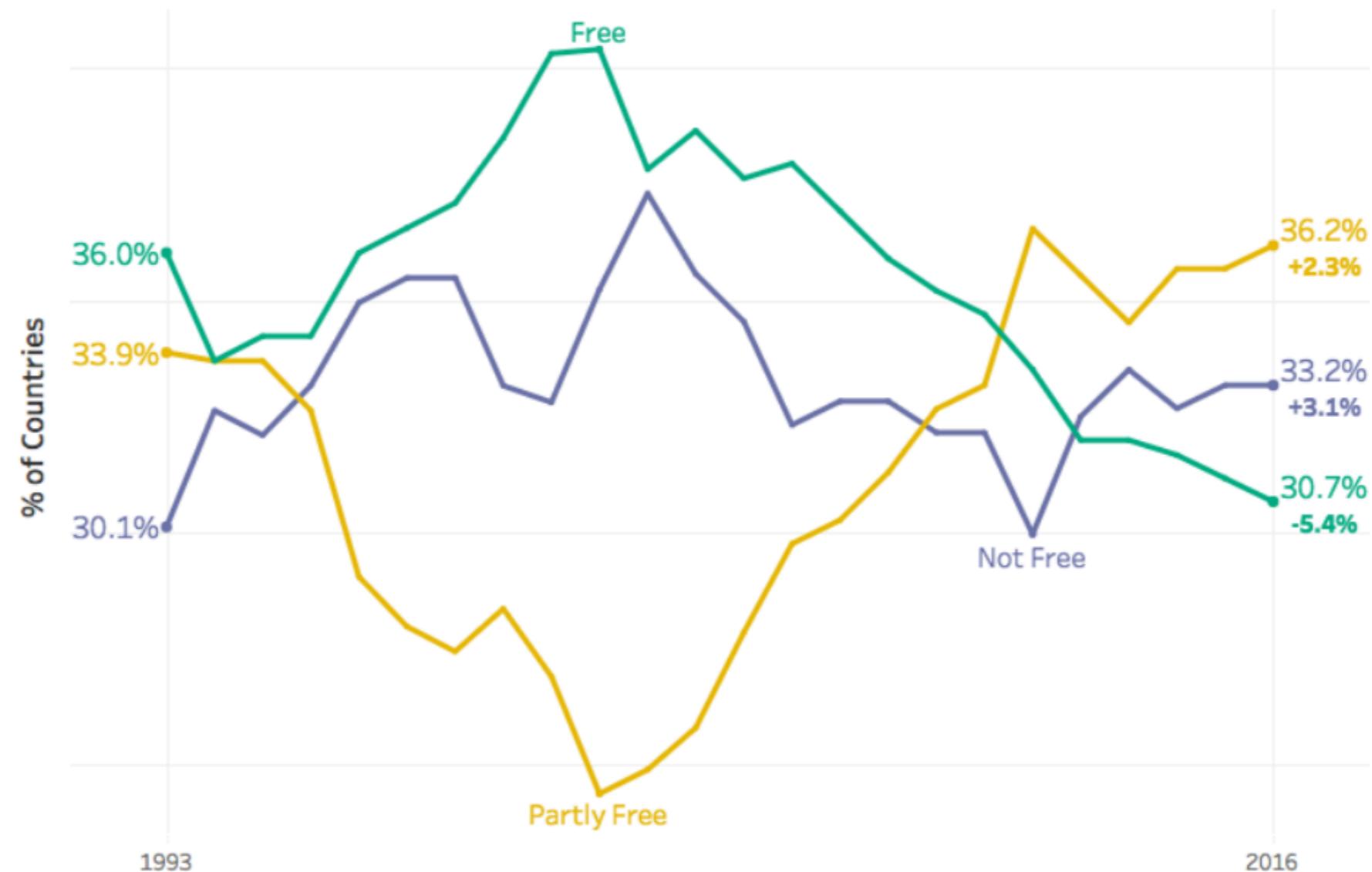


DATA SOURCE: UBS ••• CREATED BY: Andy Kriebel | @VizWizBI

<http://www.vizwiz.com/2018/11/cost-of-night-out.html>

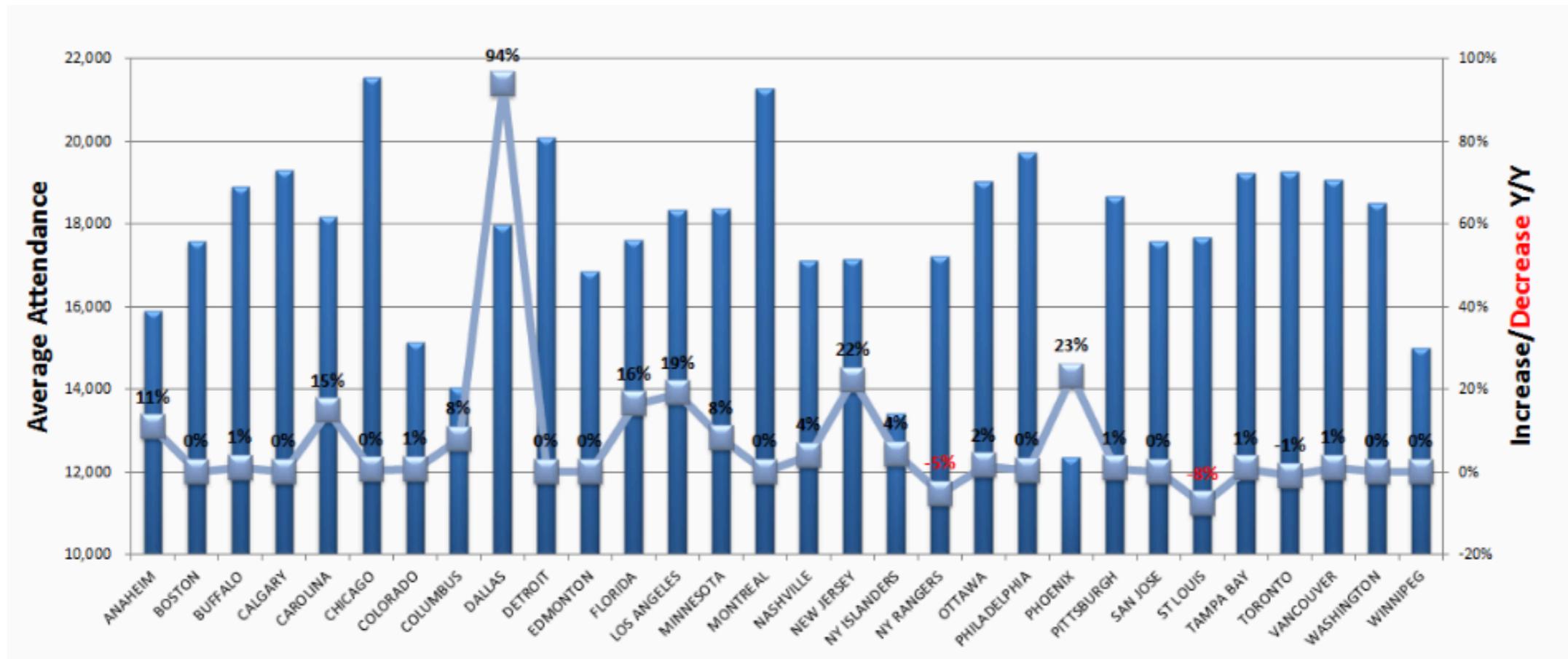
How has Global Press Freedom changed since 1993?

The percentage of countries enjoying a **FREE PRESS** has declined nearly 10% since the peak in 2002.



DATA SOURCE: Freedom House ••• RATING - Free: 0-30 | Partly Free: 31-60 | Not Free: 61-100 ••• CREATED BY: Andy Kriebel | @VizWizBI

Avoid multiple scales on the same axis



<http://www.vizwiz.com/2018/12/nhl-attendance.html>

- Generally, it is better to use two separate plots (small multiples) than to overlay two different scales on the same plot

5

Get it right in black and white

Get it right in black and white



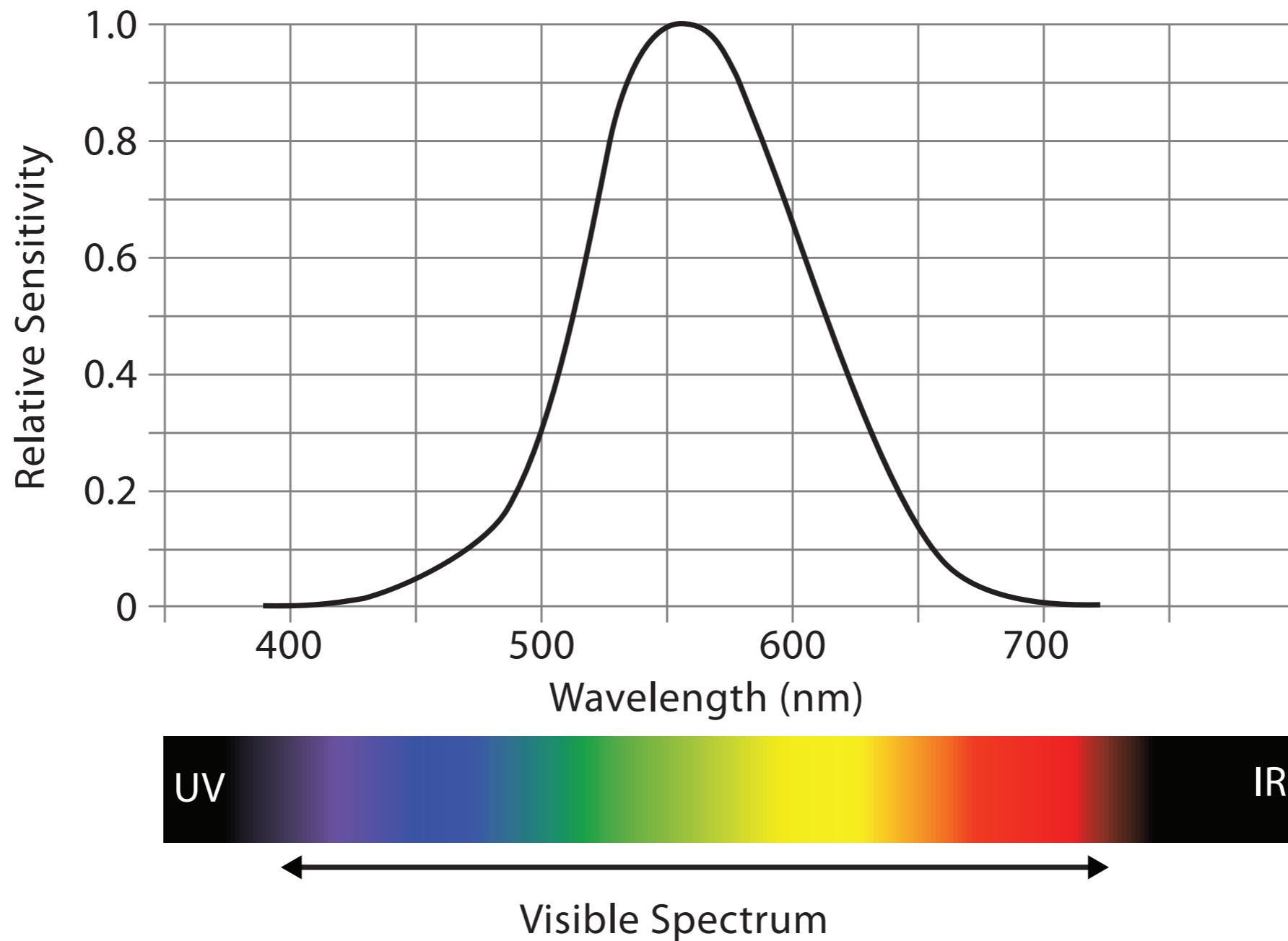
- Adding colour rarely fixes a problematic design
- It can be useful to work out the core structure of your visualizations in black and white
- Colour is a powerful channel and you should save it for the components you want to emphasize

<http://www.stonesc.com/wordpress/2010/03/get-it-right-in-black-and-white/>

6

Use trusted colour palettes

Not all colours are equal



$L^*a^*b^*$ colour space (Lab)

Corners of the RGB
color cube



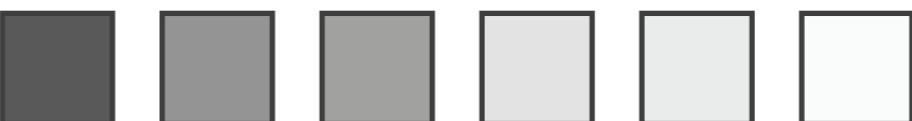
L from HLS
All the same



Luminance values



L^* values



Importance of luminance contrast



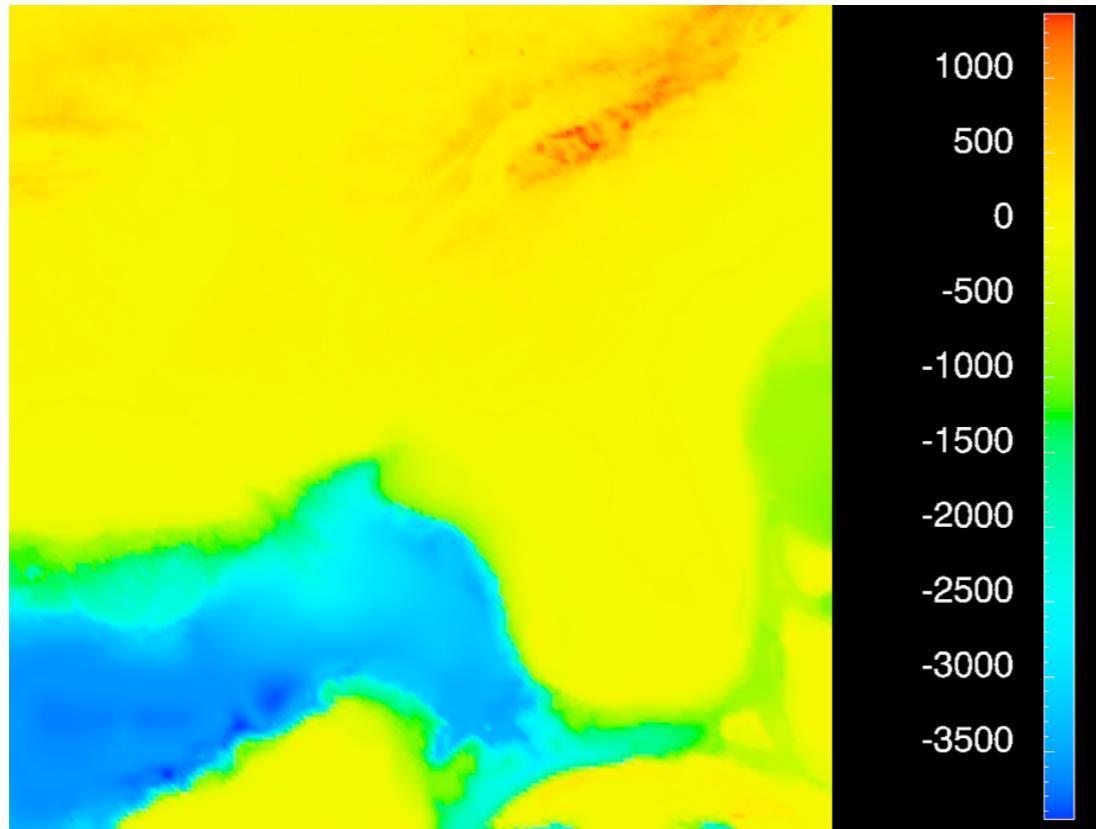
Luminance information



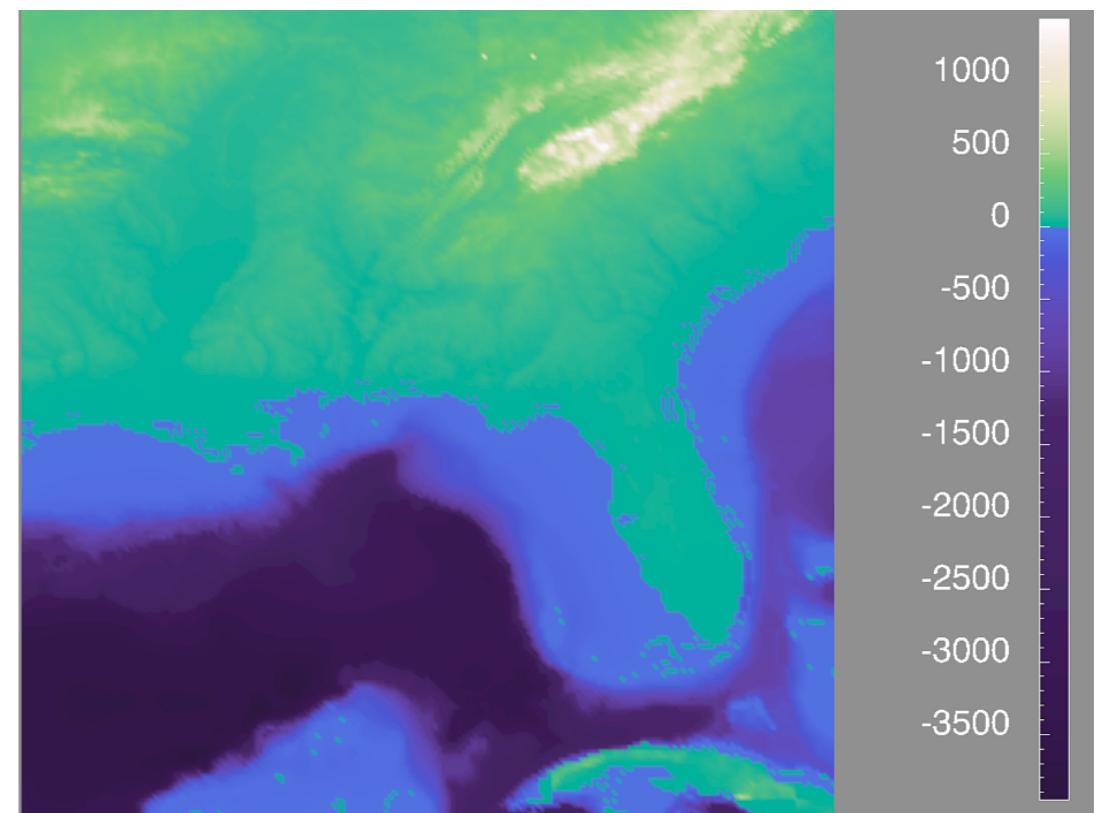
Chroma information



Importance of luminance contrast

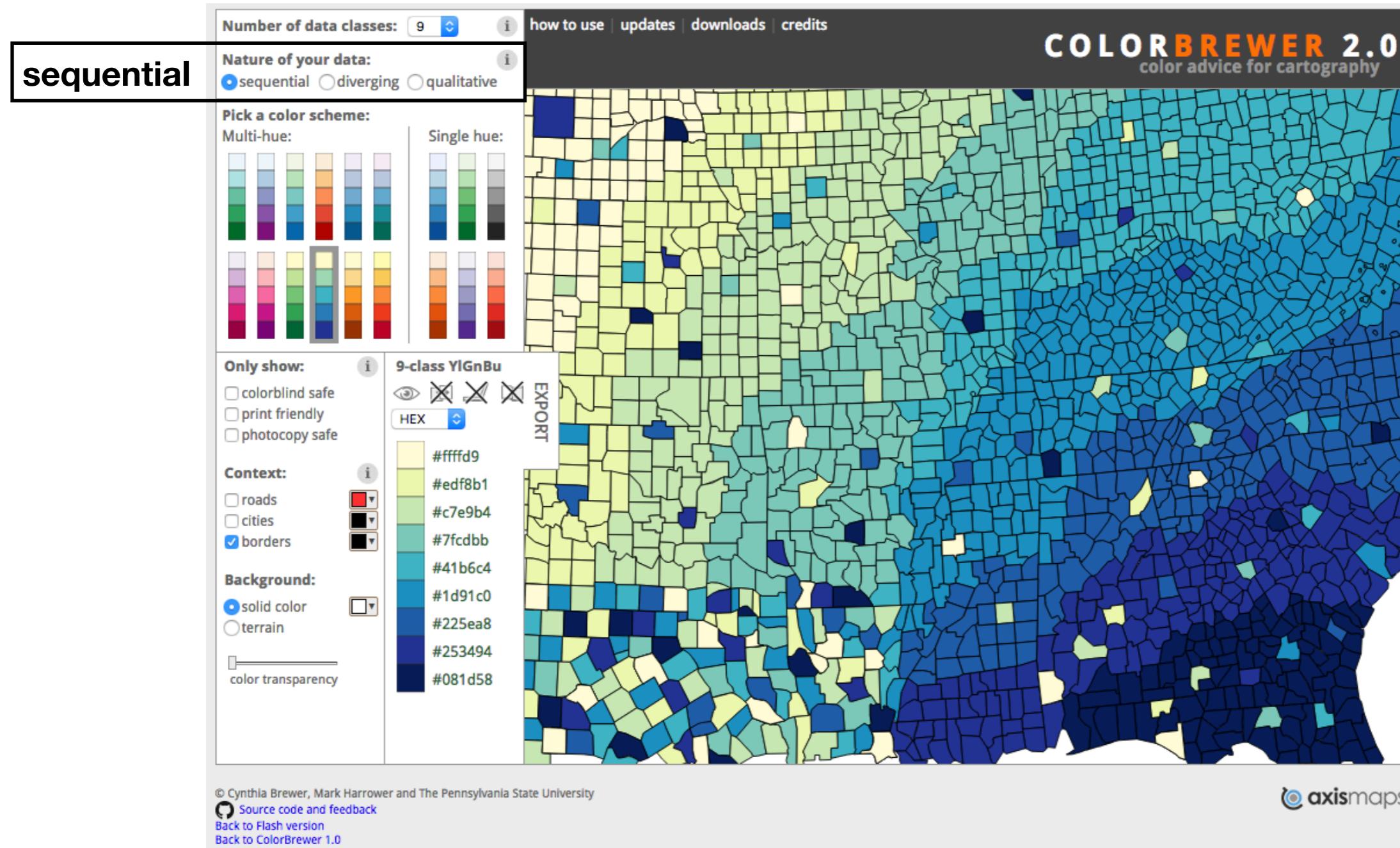


Avoid rainbow colour maps



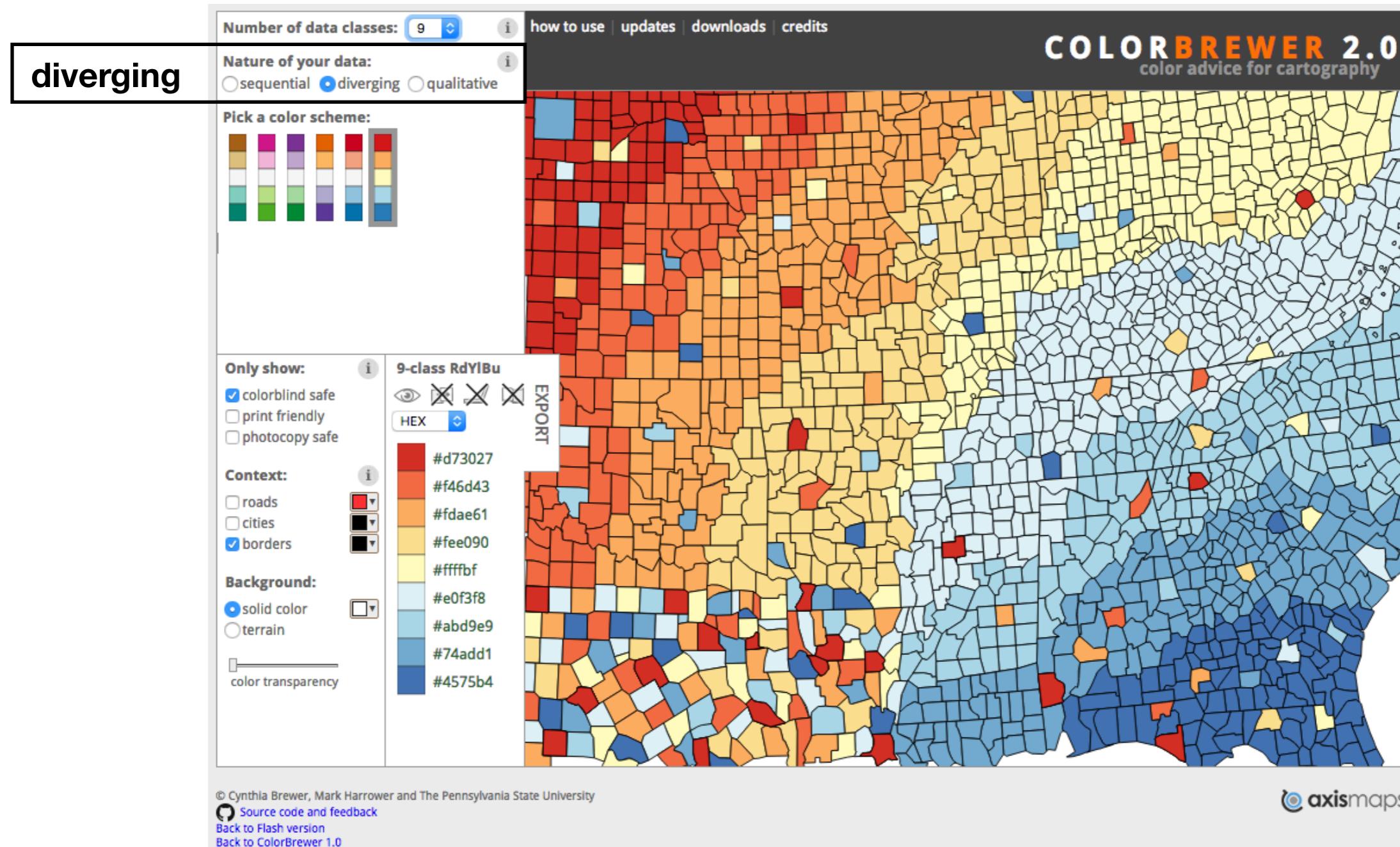
Use monotonically increasing luminance
to provide contrast for revealing detailed structures

Colour Palette Resources | colorbrewer2.org



Hand picked by Cynthia Brewer for their perceptual properties

Colour Palette Resources | colorbrewer2.org



Hand picked by Cynthia Brewer for their perceptual properties

Colour Palette Resources | colorbrewer2.org

qualitative

Number of data classes: 7 how to use | updates | downloads | credits

Nature of your data: sequential diverging qualitative

Pick a color scheme:

Only show:

- colorblind safe
- print friendly
- photocopy safe

Context:

- roads
- cities
- borders

Background:

- solid color
- terrain

color transparency

7-class Paired

EXPORT

#a6cee3
#1f78b4
#b2df8a
#33a02c
#fb9a99
#e31a1c
#fdbf6f

© Cynthia Brewer, Mark Harrower and The Pennsylvania State University
Source code and feedback
Back to Flash version
Back to Color Brewer 1.0

axismaps

Hand picked by Cynthia Brewer for their perceptual properties

Colour Palette Resources | viridis palette



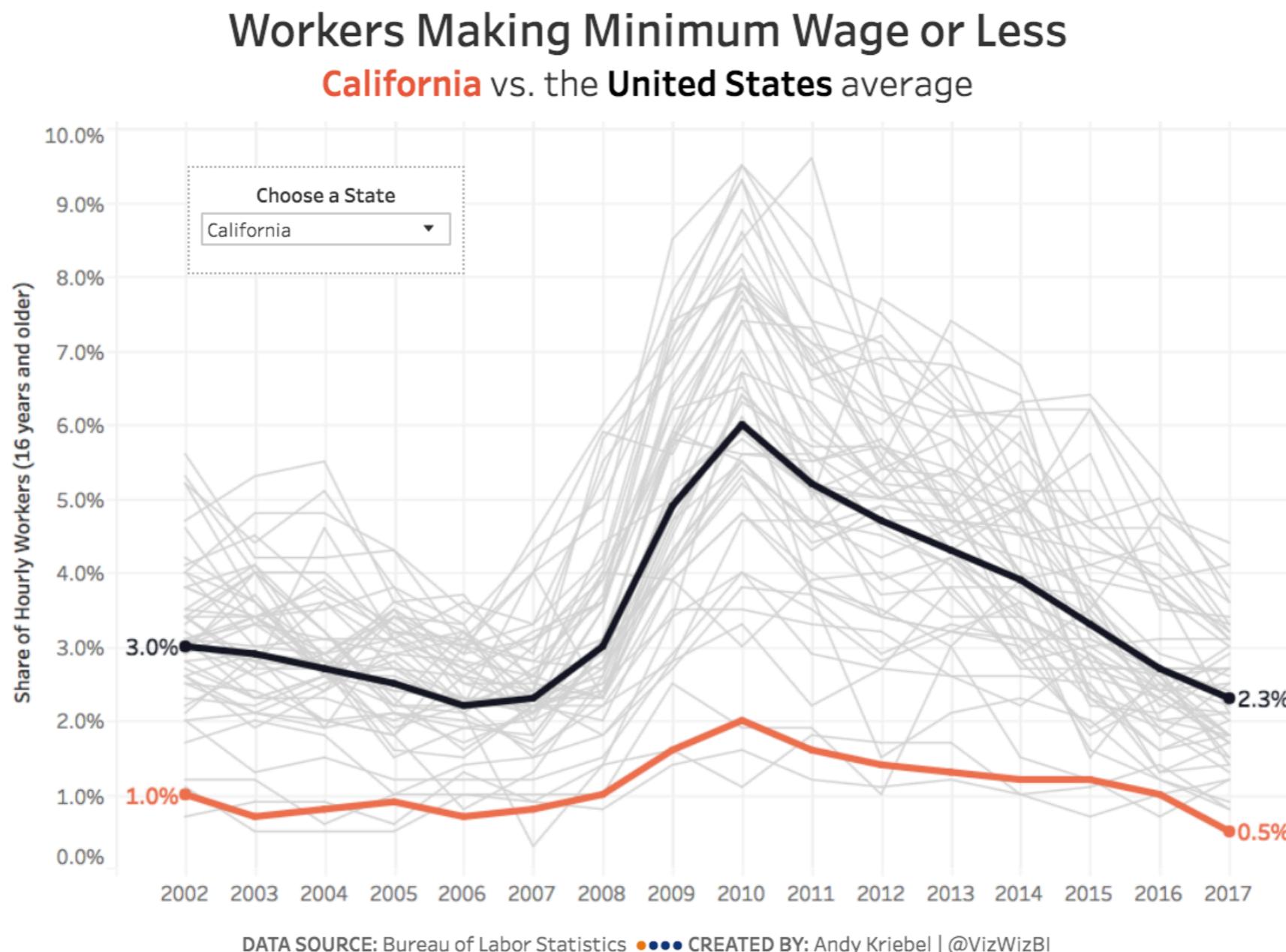
- **Viridis package for R (from matplotlib for python)**
- **Designed to be perceptually uniform**
 - Values close to each other have similar appearing colours
 - Values far away from each other have more different appearing colours

If you create a custom palette, be sure to use a colour blindness simulator | e.g. <http://rehue.net>

7

If the slope of your line is
meaningless, don't use a line

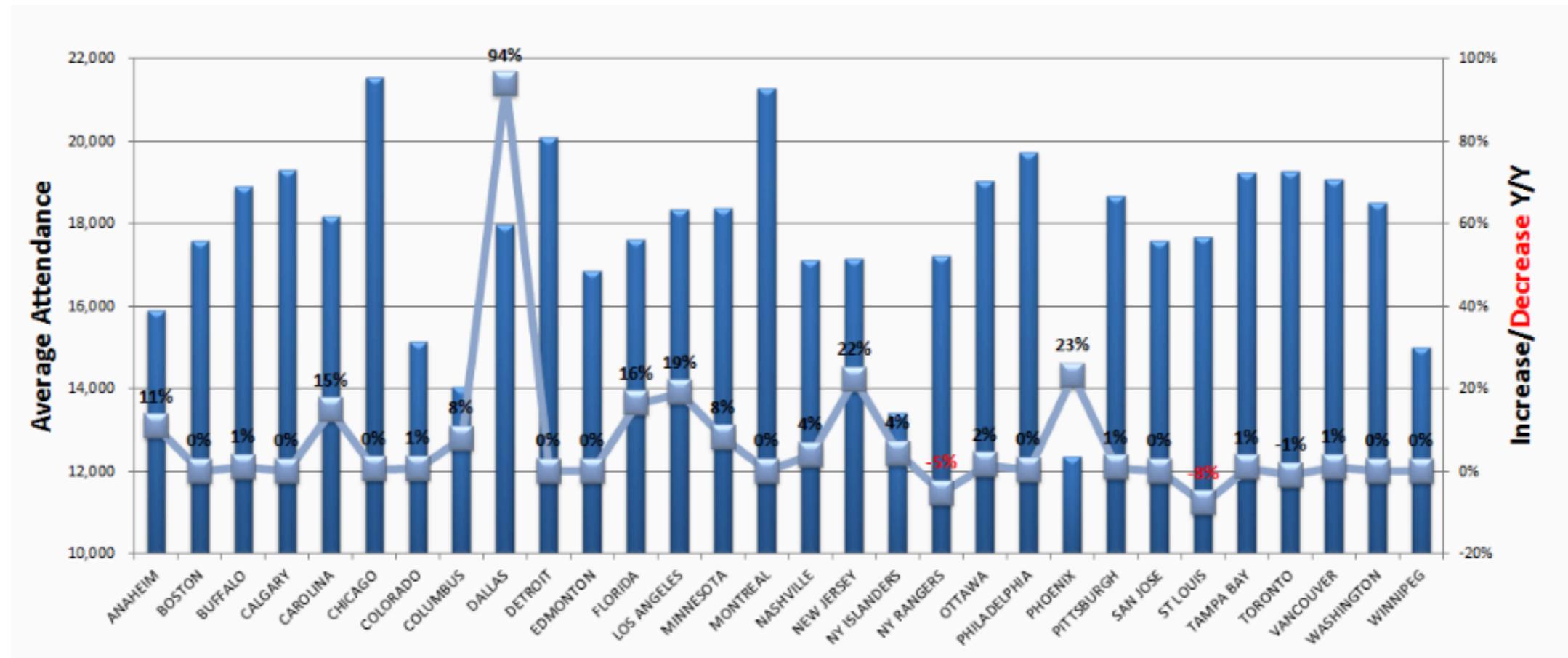
Lines are great for showing trends



— Trend over time —→

<http://www.vizwiz.com/2019/01/minimum->

But use caution in connecting the dots



<http://www.vizwiz.com/2018/12/nhl-attendance.html>

- Connecting points in a plot implies a sequence
 - If the slope of the line graph isn't meaningful, don't use a line
 - Here connecting alphabetically ordered categories doesn't make much sense

8

Follow interaction conventions,
deviate for a reason

Common selection conventions

- **Creating a selection**

- Direct click on the item to select
- One point selected at a time by default
- Click and drag a rectangular selection anywhere on the plot to select points

- **Adding points to the selection**

- Shift or Ctrl (Command on Mac) and click/drag to add points

- **Removing points from the selection**

- Click (or in some cases Ctrl-click) on the selected item to de-select it

- **Clearing the whole selection at once**

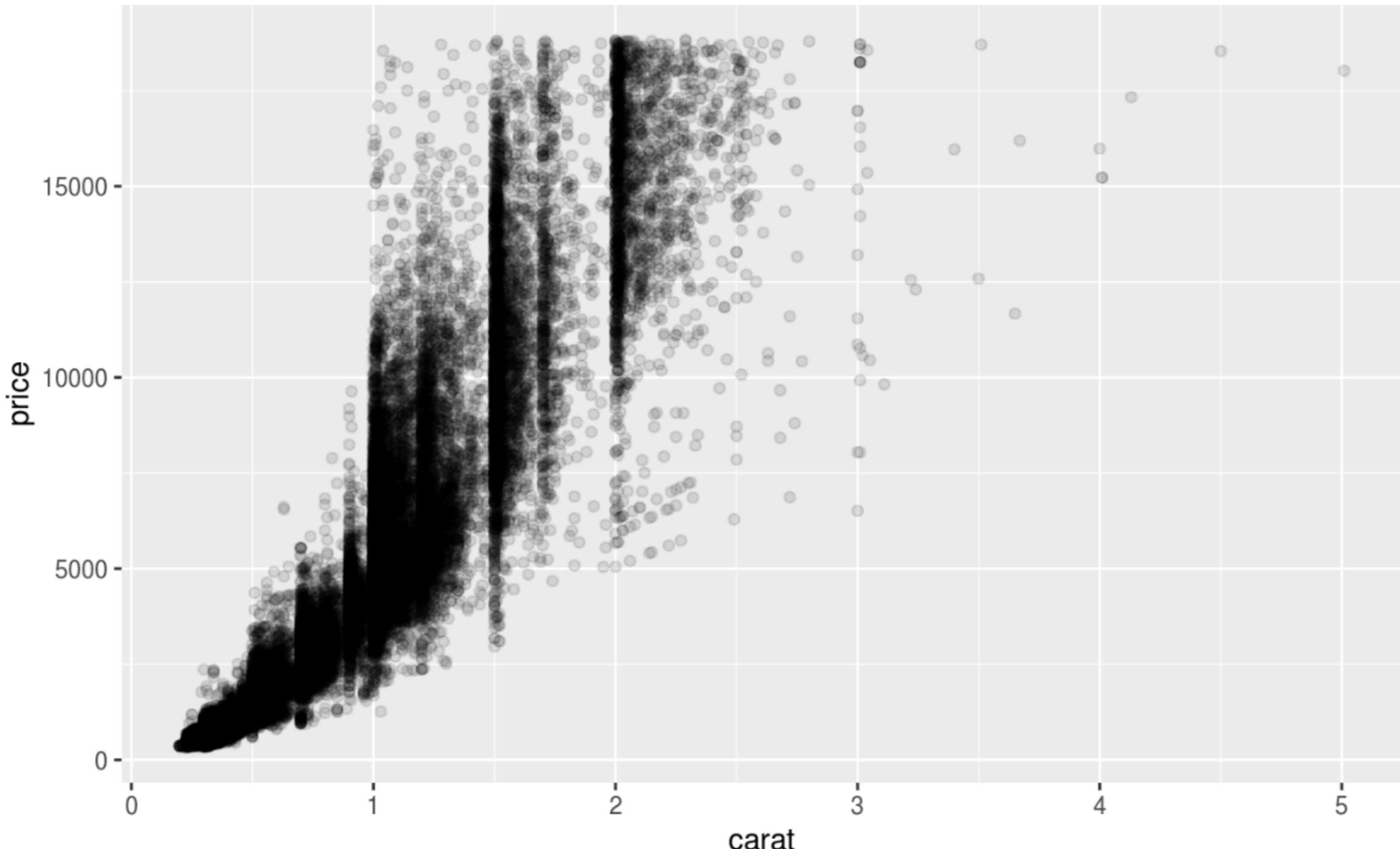
- Click on the background of the plot

9

Bin to conquer over-plotting

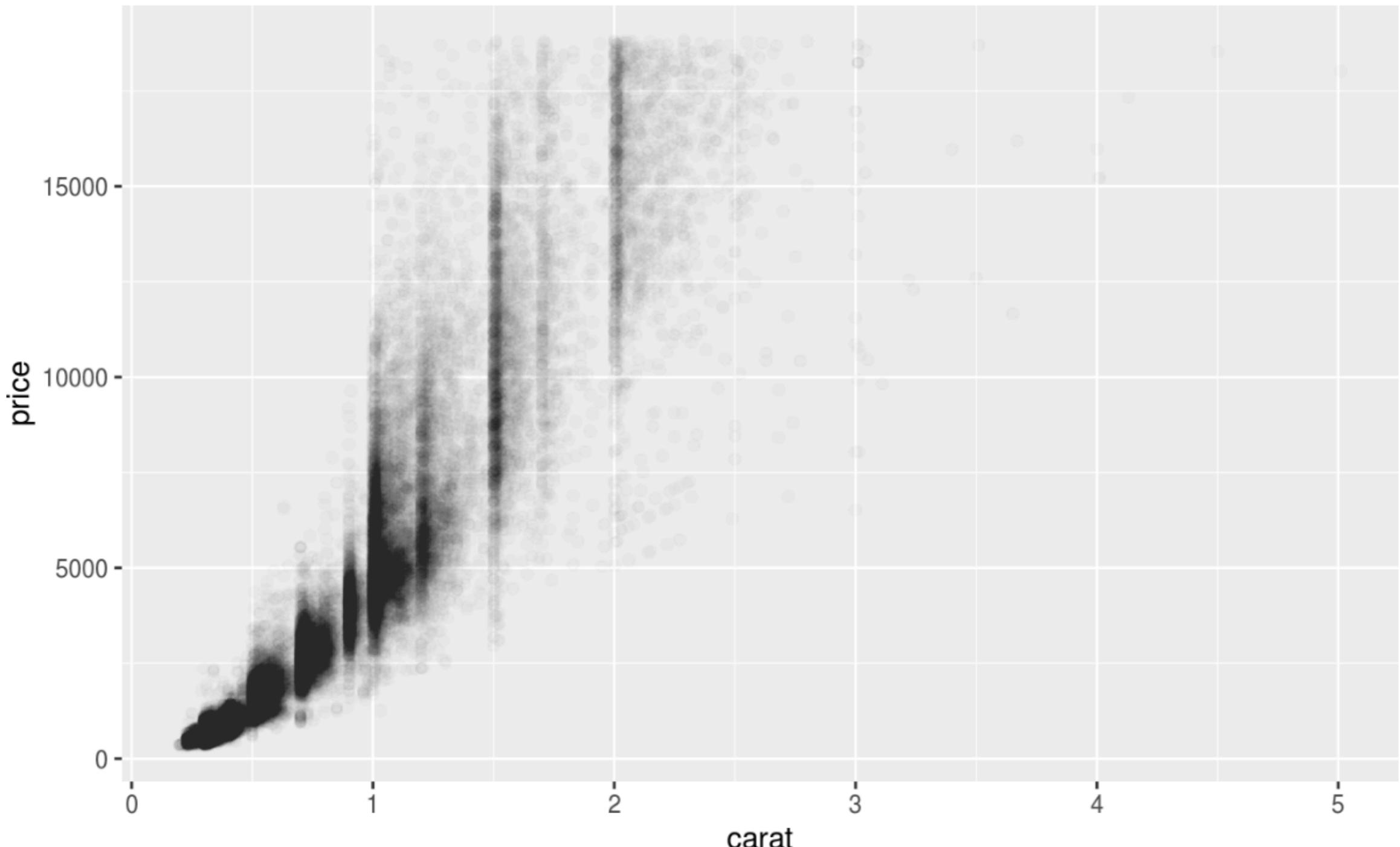
Overplotting

Adding interactive zooming can help



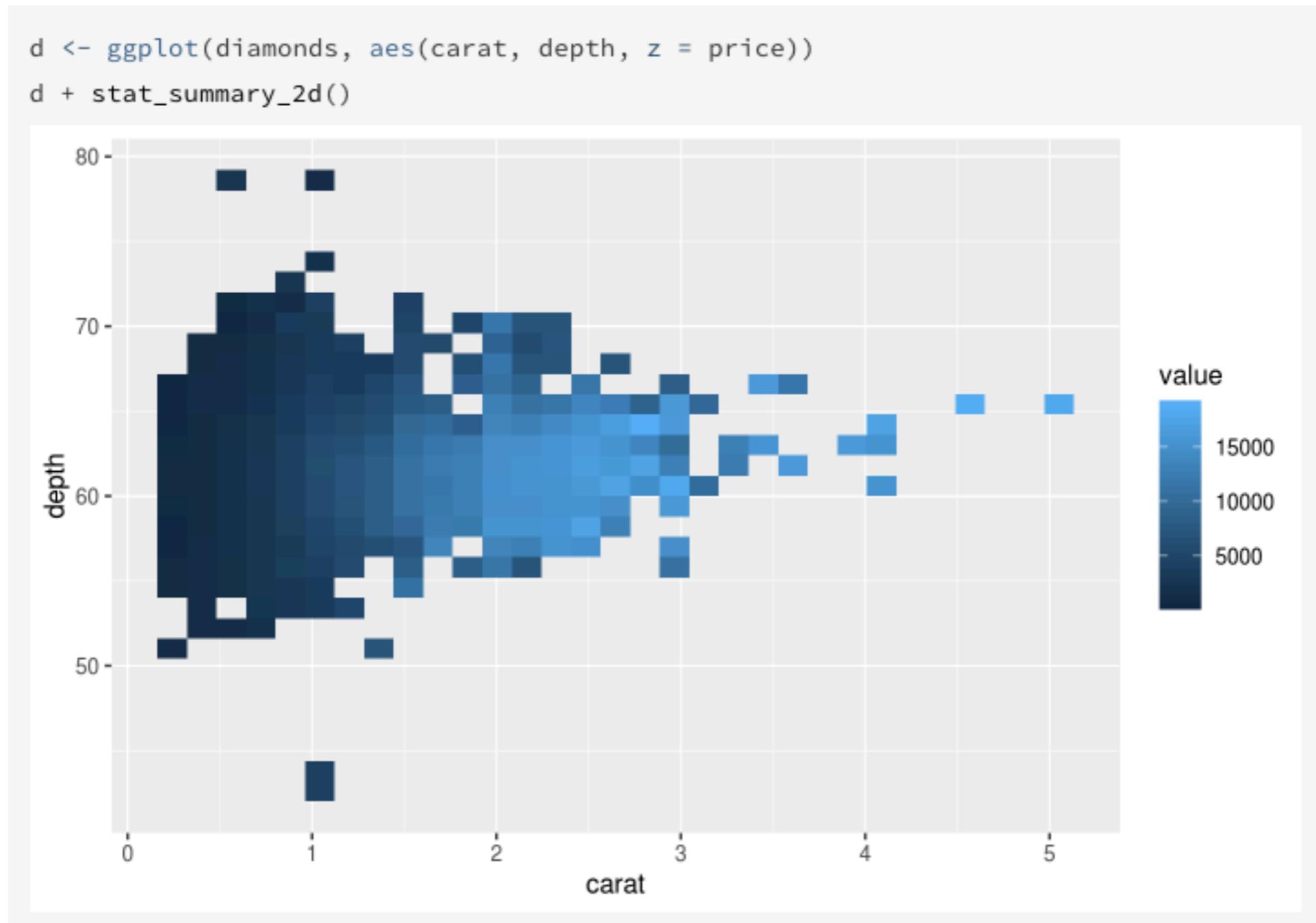
Overplotting

Changing the alpha value can help



Binning | Rectangular binning

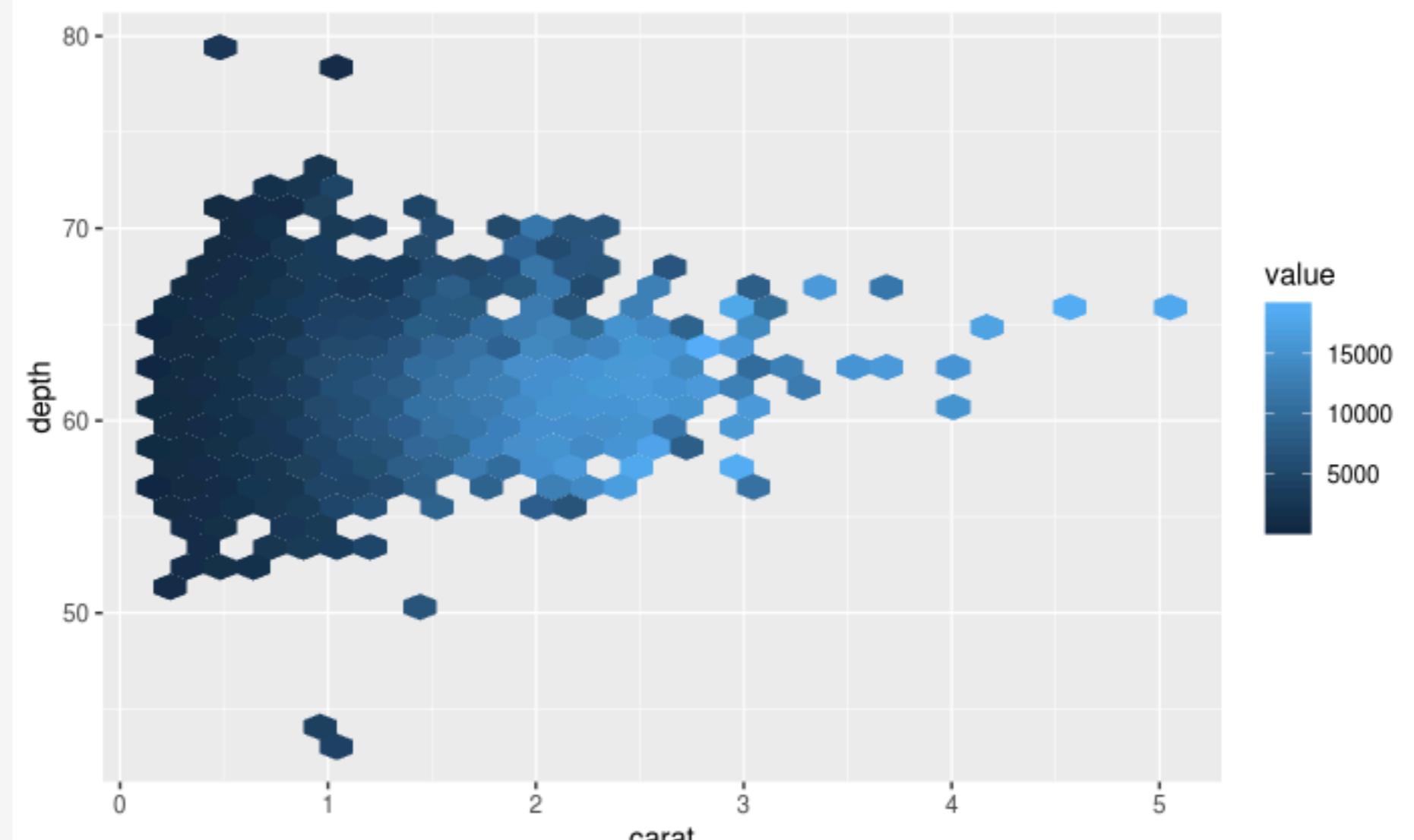
Great solution for large data sets



Binning | Hexagonal binning

Great solution for large data sets

```
if (requireNamespace("hexbin")) {  
  d + stat_summary_hex()  
}
```



10

Pre-compute + cache to
achieve responsiveness

Linked views across different data types

selection: `copy_number = 1`



Montage System
BC Cancer

Denormalized the data

point	range
sample id: DAH177 library id: A32068 type: mutation chrom_number: 3 start: 139290475 end: 139290475 probability: 0.91 ... events: ((type: range, chrom_number: 3 start: 111191194 end: 154780786 copy_number: 3 ...))	sample id: DAH177 library id: A32068 type: segment chrom_number: 3 start: 111191194 end: 154780786 copy_number: 3 ... events: ((type: point, chrom_number: 3 start: 139290475 end: 139290476 probability: 0.91 ...))

- Copy the information about the overlapping points/ ranges into each overlapping item's document
- Exploit search engine's very fast retrieval of terms

Pre-compute / transform data so that query speed is optimized
(design your data store to serve the queries in your interface)

Inspiration

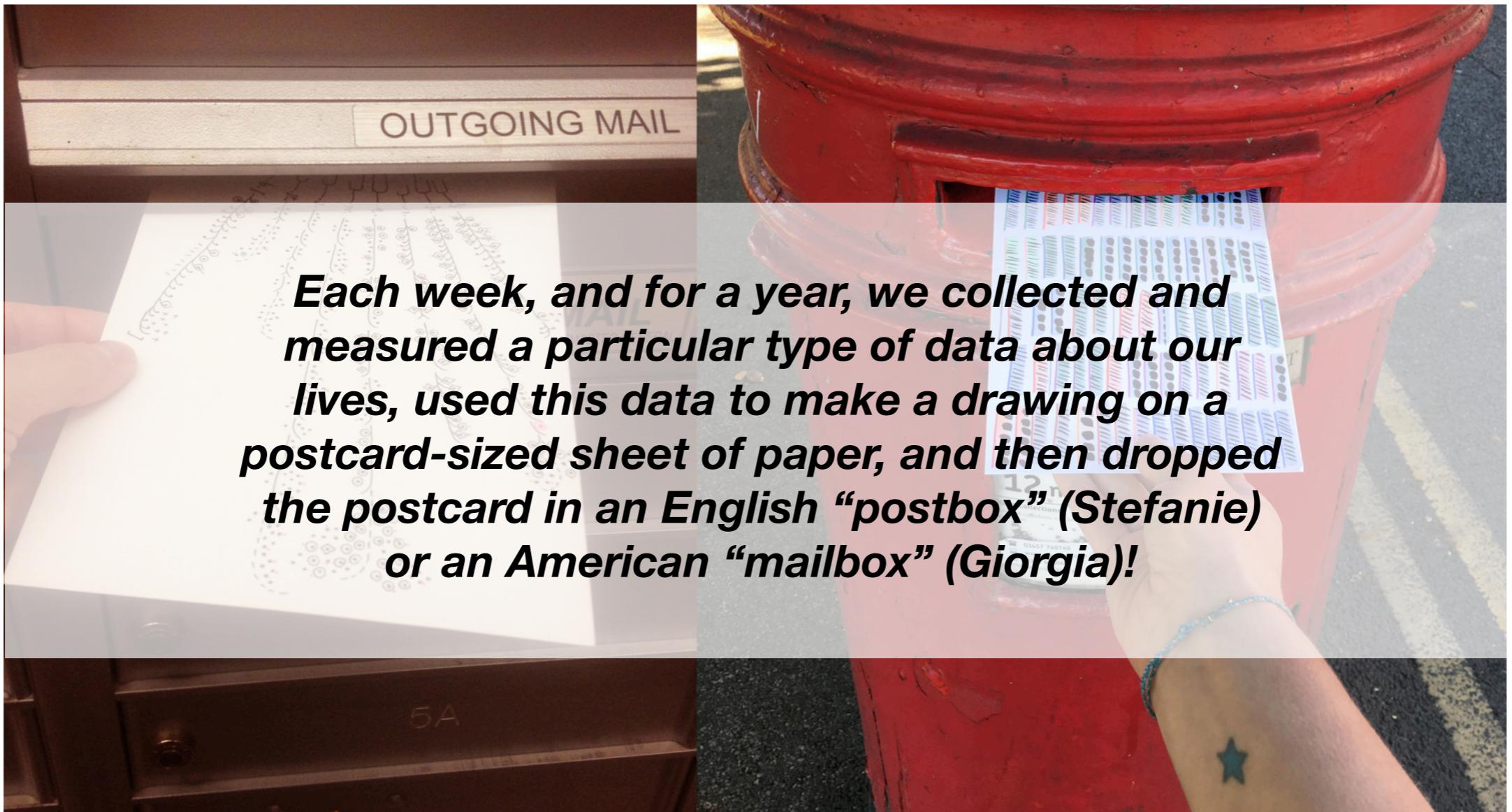
Don't design in a void | Look to examples you like for inspiration

Dear Data



<http://www.dear-data.com>

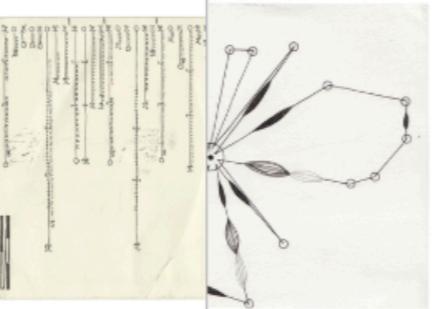
Dear Data



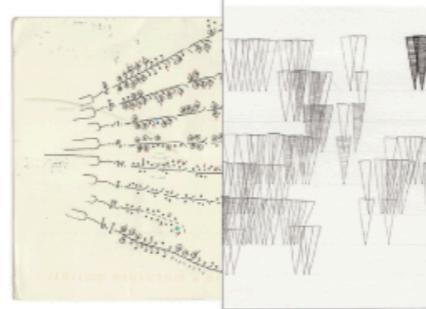
<http://www.dear-data.com>



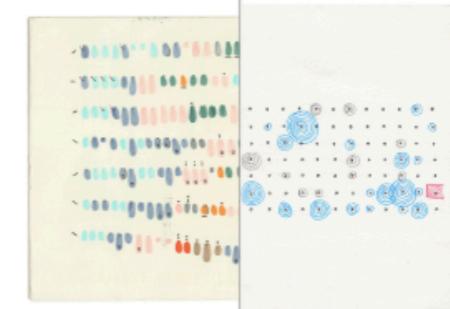
Week 01: A week of clocks



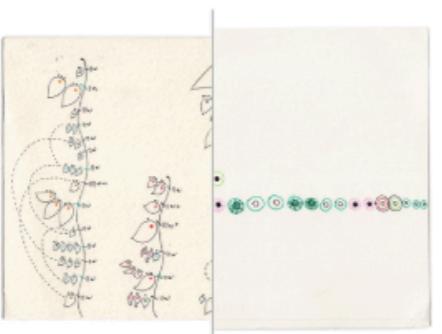
Week 02: A week of public transportation



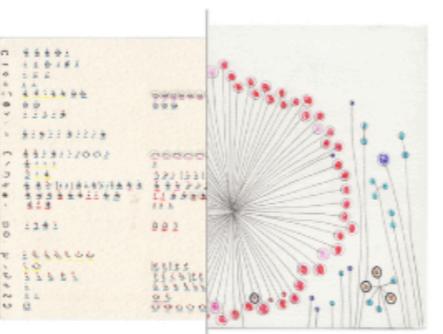
Week 03: A week of thank yous



Week 04: A week of mirrors



Week 05: A week of things we buy



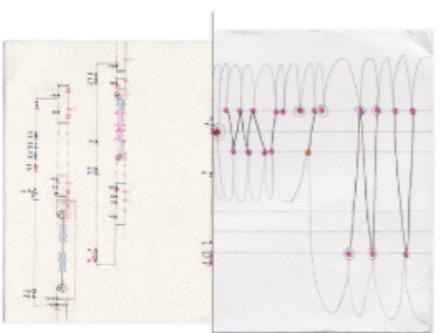
Week 06: A week of physical contacts



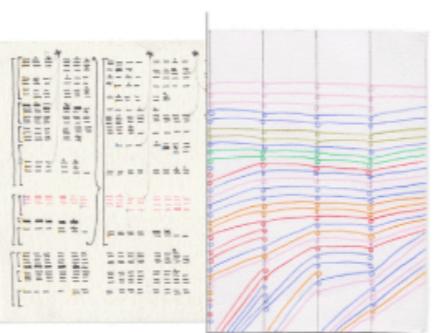
Week 07: A week of complaints



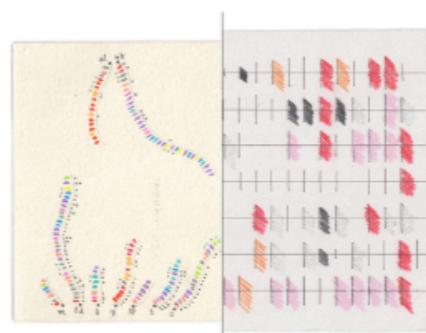
Week 08: A week of phone addiction



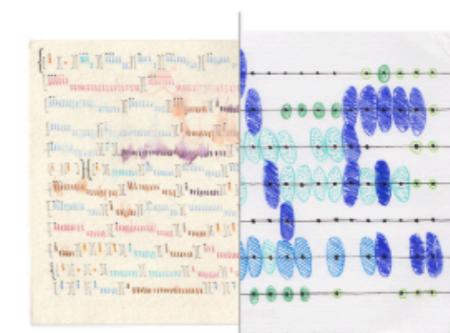
Week 09: A week of Giorgia and Stefanie



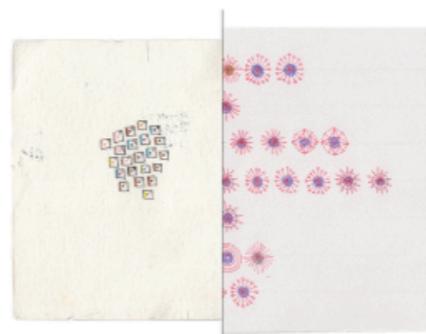
Week 10: A week of to-do lists



Week 11: A week of emotions



Week 12: A week of people



Data is everywhere



<https://support.apple.com/en-us/HT203037>

Data is everywhere



Temperature afghan

Each row represents the observed temperature for that day in the year

<https://www.facebook.com/MeteorologistEllenBacca/photos/a.322769304480787/1201634473260928/?type=3&theater>



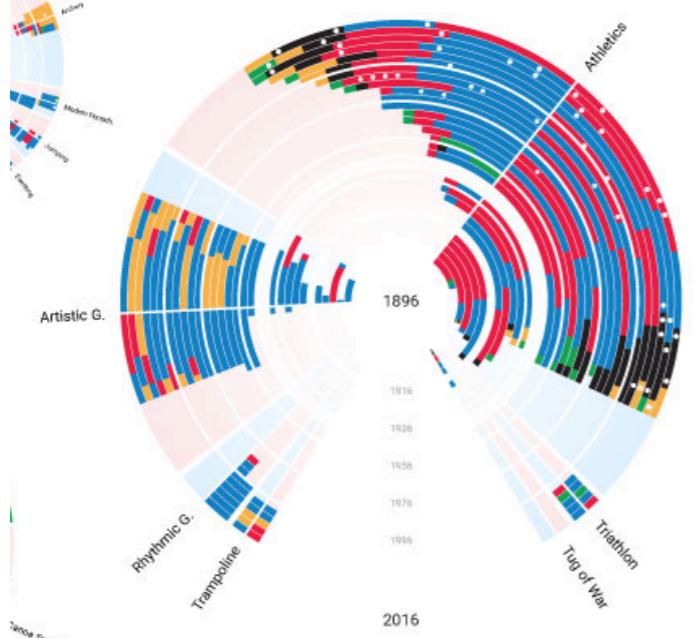
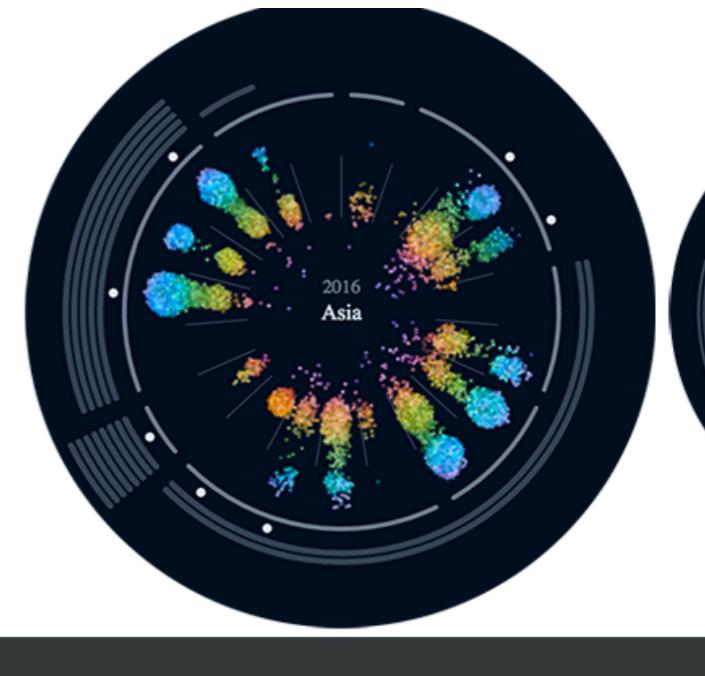
data sketch|es



September Travel

Sharing the travels that we've made
in a visual way

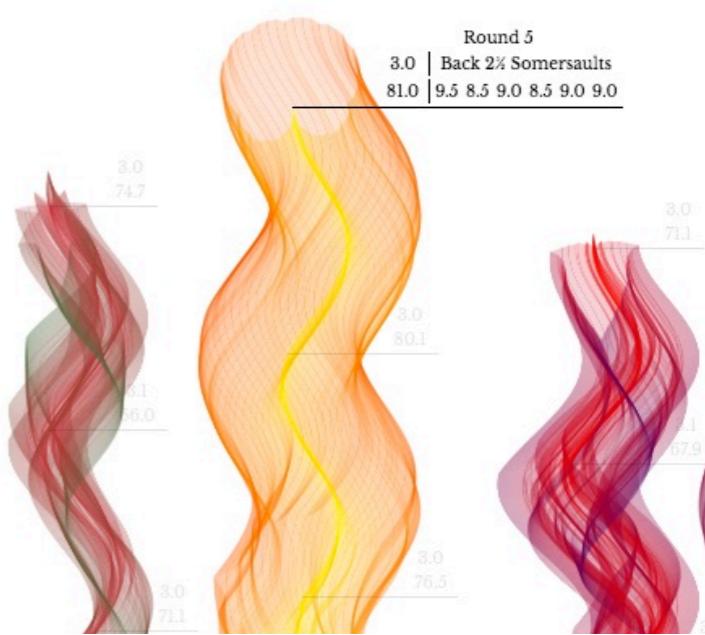
[Read more...](#)



August Olympics

Visualizing that once-every-four-year
festival of sports

[Read more...](#)



Visual designs each month

<http://www.datasketch.es>

Week 1 | Data

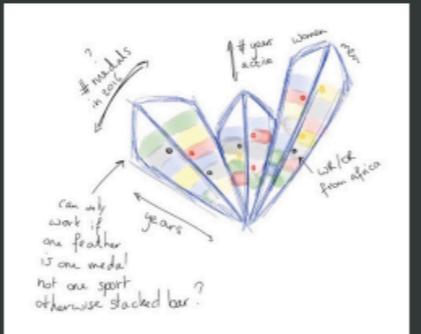
winners or each discipline) in each ring. This turned out to be quite a challenge, but eventually the grouping became something along the lines of: athletics & gymnastics, shooting & horse, wrestling & fighting, cycling & ball sports, and water sports.

Finally, due to the set-up of the chart I created a very specific json from R. I tried to do as many calculations in R and not in JavaScript, because I find it much much easier and straightforward to do in R. About 12 hours of data finding, wrangling, checking and preparing later, I was left with a pretty large json that contained 5146 medal winners in several layers of nesting, ready to be visualized.

You can find a more extensive explanation about what I did & the dataset itself on the [GitHub page of the dataset](#)

week 2 | sketches

By looking at the end result, it might be a bit hard to understand why I'm calling this project the *Olympic Feathers*. Initially I wanted to turn each discipline into a feather shaped slice. But apart from the feather tips not making the final cut I think that the end result is still very similar to my very first sketch.

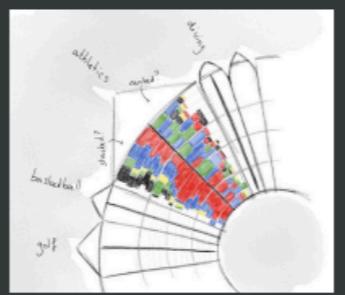


Because Shirley was on vacation for the first 2 weeks of August I asked a colleague from work, Jeroen de Lange our Creative director, if he'd like to help me think out the design some more. It really helped a lot to explain my idea and him asking questions back. That's how I found some issues with my initial simple sketch. For one, a sporting discipline has many events in which a medal can be won so several feathers would get really wide, such as athletics and swimming.

Also, the number of events has changed a lot throughout the years. Therefore, I had to make a choice on what exactly would define 1 medal. Since I was working with circles, in the end it seemed most logical to use the same arc length (i.e. number of degrees) to define one medal. This would create a lot of white space for disciplines in which one edition had tried out a lot of different events. However, I felt that would actually give an interesting insight into the history of the Olympics.



That evening, I sketched out a more detailed version to see how it might look with the new insight I'd gained about the data. I focused on the medals themselves because I wasn't quite sure if they should be ordered in a specific order, so always Americas first, then Asia and so on. Or to ordered them according to which continent won the most medals (for that gender and for that edition). I eventually chose the latter, because again, like the whitespace, it would give an extra level of insight into the data.



After the sketch above, I got to the point where I just had to start coding it out to see how our ideas would work with the data instead of sketching more detailed ideas and guessing about how it would apply to the Olympics data.

week 2 | sketches

The actual data gathering process was absolutely painful: I re-watched all four synchro events and manually entered all of the scores. It wasn't until I had gotten all the data that I found them all on the Rio Olympics website. I threw a bit of a fit over that one 😢

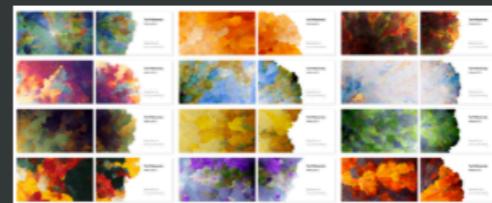
week 2 | sketches

Because of my travels this month, my process was thrown off all over the place. I actually had a sense of what I wanted to do before I even had my data gathered.

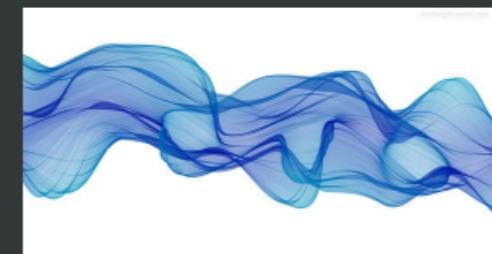
Somewhere in the middle of my trip, Micah tweeted me this beauty:



It was a link to Yuri Vishnevsky's experimentation with algorithmic art in trying to generate a set of unique business cards. Some of them in particular looked like the top-down view after the divers had entered the water, and I knew I wanted to have a similar effect for my visualization:



Yuri didn't provide a link to his code, but did mention a stackexchange challenge where he got his inspiration, and one mention of the term "fractal search algorithm". I latched on to that term, and figured it was as good a place as any to try. And a quick search for "fractal search algorithm javascript" got me to Dan Gries' tutorial for Sweeping Fractal Lines:



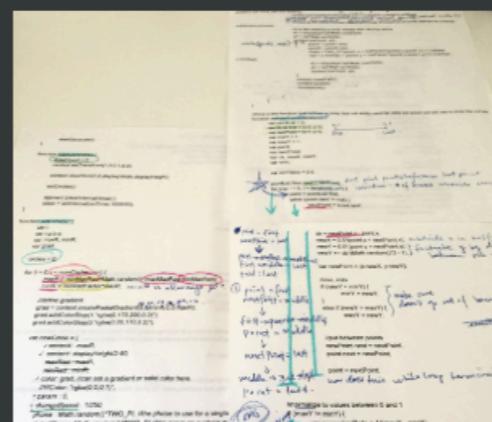
Gorgeous.

And though it wasn't Yuri's water splash, it reminded me of silk flowing through water. It reminded me of ink in water. I thought, if I could make the divers's data look like this - how beautiful would that be?

I had enough ideas (though no sketches) to get right into it as soon as I got back from Asia (with only 1.5 weeks to spare).

week 3 & 4 | code

The first few days was spent just trying to understand Dan's code. At only ~250 lines, it was beautiful in its brevity. As with any piece of code I wanted to understand, I printed out all the lines, and went through them line by line for understanding:



<http://www.datasketch.es>

Thank you