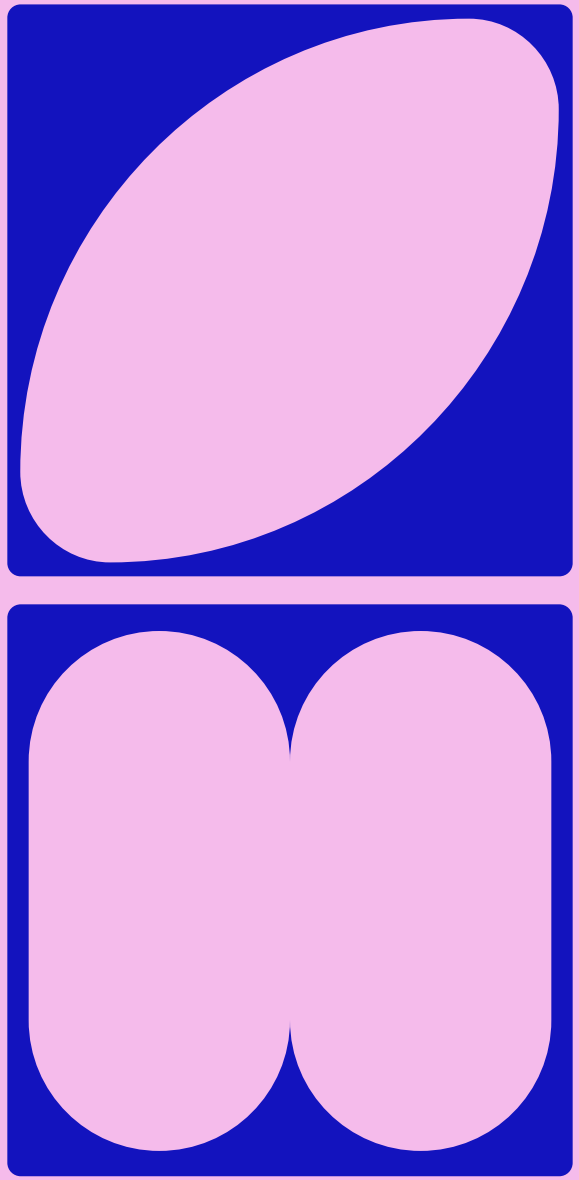
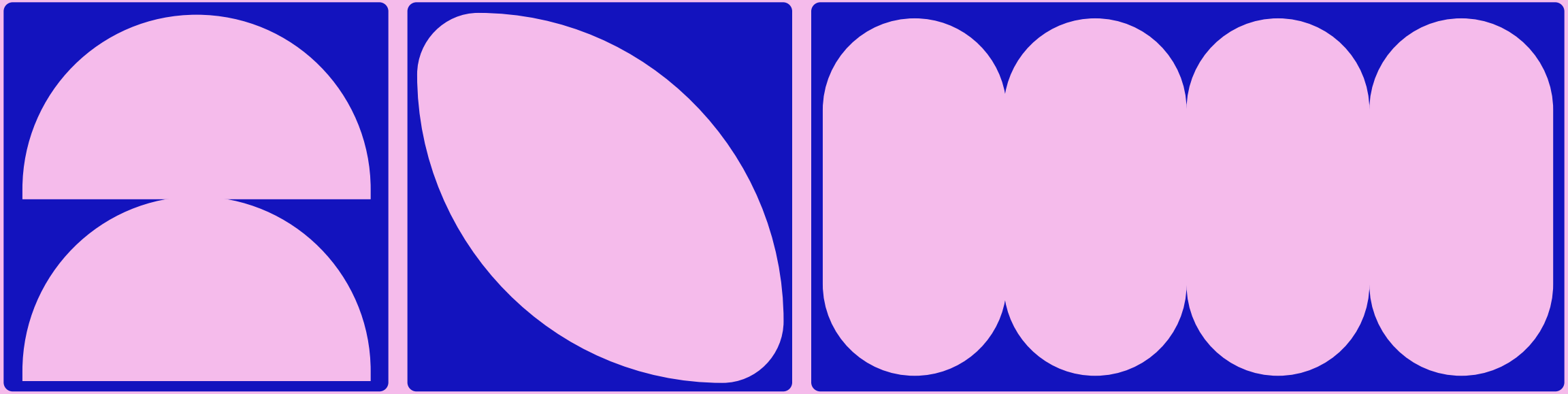
DATA VISUALISATION IN PYTHON

BUILD PUBLICATION-QUALITY PLOTS FOR RESEARCH



Delivered by: Maeve Murphy Quinlan

LOGISTICS/PRACTICALITIES



OVERVIEW

- A friendly, inclusive, enjoyable introduction to the world of data visualisation
- A showcase of what can be done with Python
- Guidance on good practice

- Create publication-ready, polished visualisations
- Understand and apply principles of effective, accessible data visualisation
- Develop reusable plotting workflows with Matplotlib and Seaborn
- Explore the basics of interactive visualisation libraries

BREAKS AT:
11:00 – 10 mins
12:00 – 15 mins

DAY 1 CONTENT: FOUNDATIONS AND CORE SKILLS

TOPICS COVERED

- Visualisation guidance: the basics
- Object Oriented Programming with Matplotlib
- Introducing Seaborn
- Saving out plots

* Content covered may vary depending on group experience and preferences, but breaks listed will stay the same

DAY 2 CONTENT: WORKFLOWS, REFINING, & ADVANCED TOOLS

BREAKS AT:
11:00 – 10 mins
12:00 – 15 mins

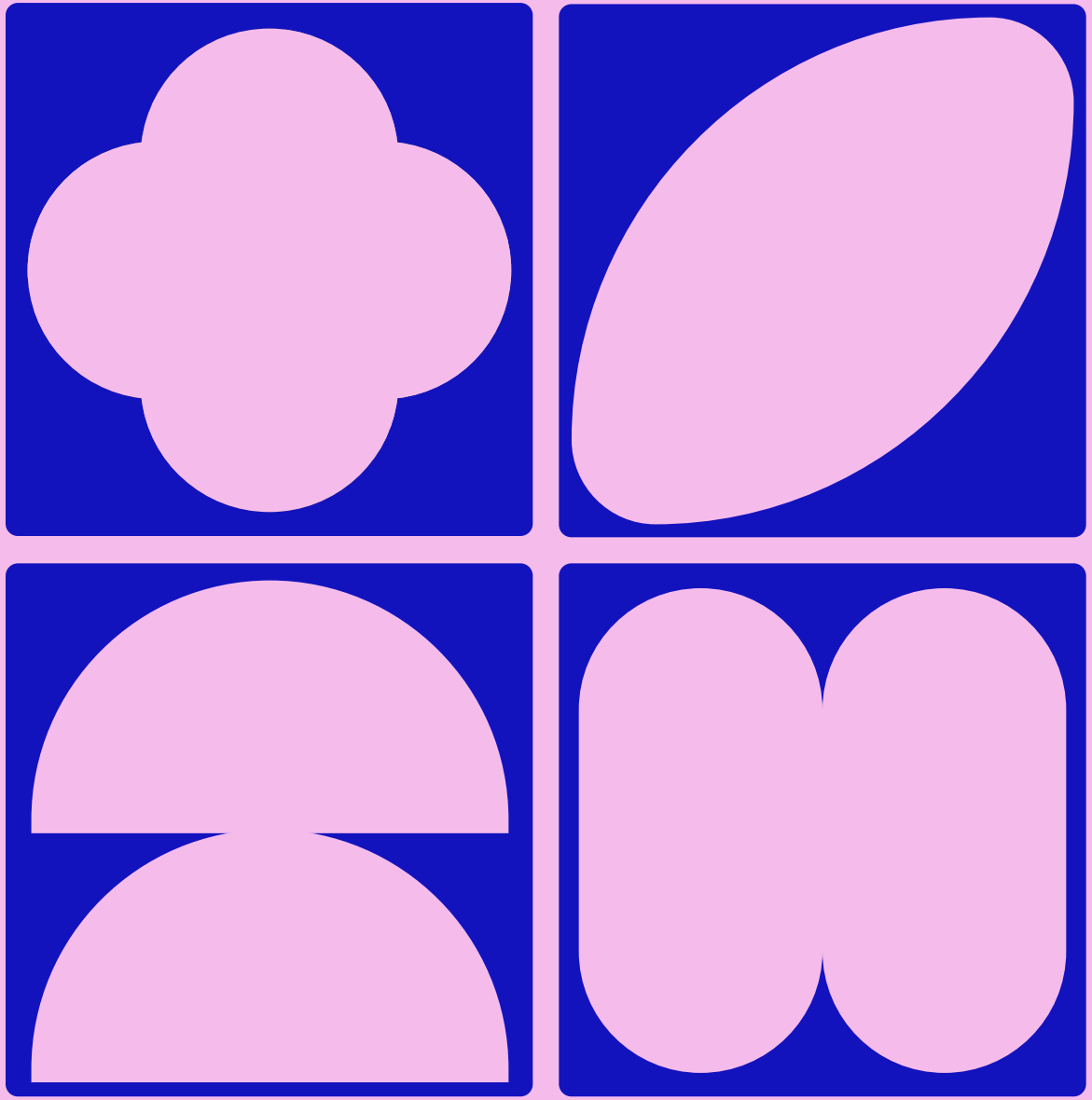
TOPICS COVERED

- Loading in different data files and prepping for plotting (with Pandas)
- Advanced styling and customisation
- Heatmaps
- Customising gridded/faceted plots

* Content covered may vary depending on group experience and preferences, but breaks listed will stay the same

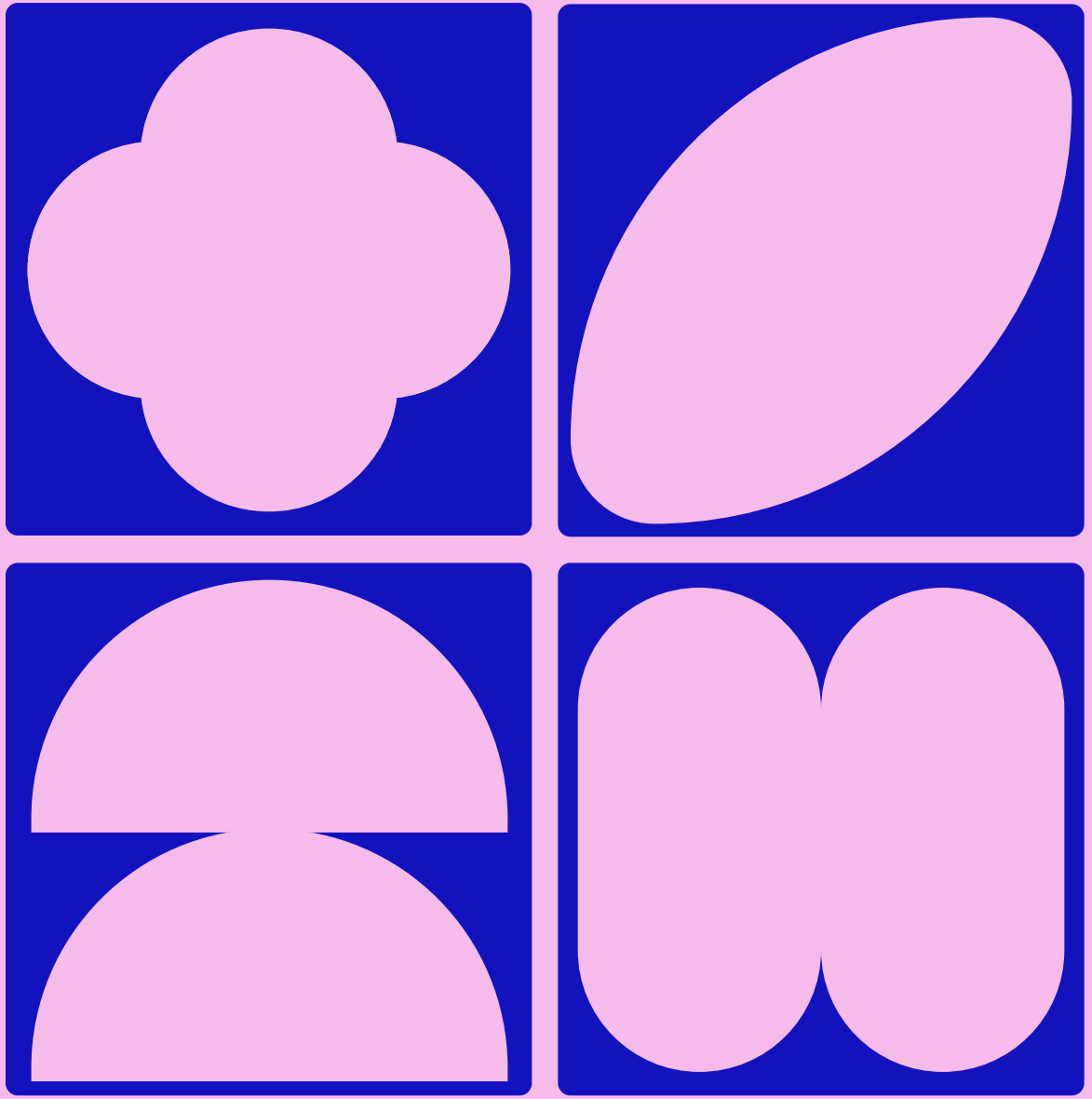
OUR CLASSROOM SETTING

- Learning mindset
  - No such thing as a “silly question”
  - Mistakes help us to learn
  - “I don’t know yet” is a valid answer
- Mutual respect
  - We all bring different expertise and perspectives
  - Pace varies, and that’s ok
- Open communication
  - Let us know if you’re lost; interruptions are welcomed! You can unmute, use the chat, or use the anonymous Q&A in Vevox (we will explain how!)
  - Feedback is welcome: let us know if we are moving too quickly, or if you would like more detail
    - If you’re speeding ahead: relax, enjoy the calm, practice some mindfulness



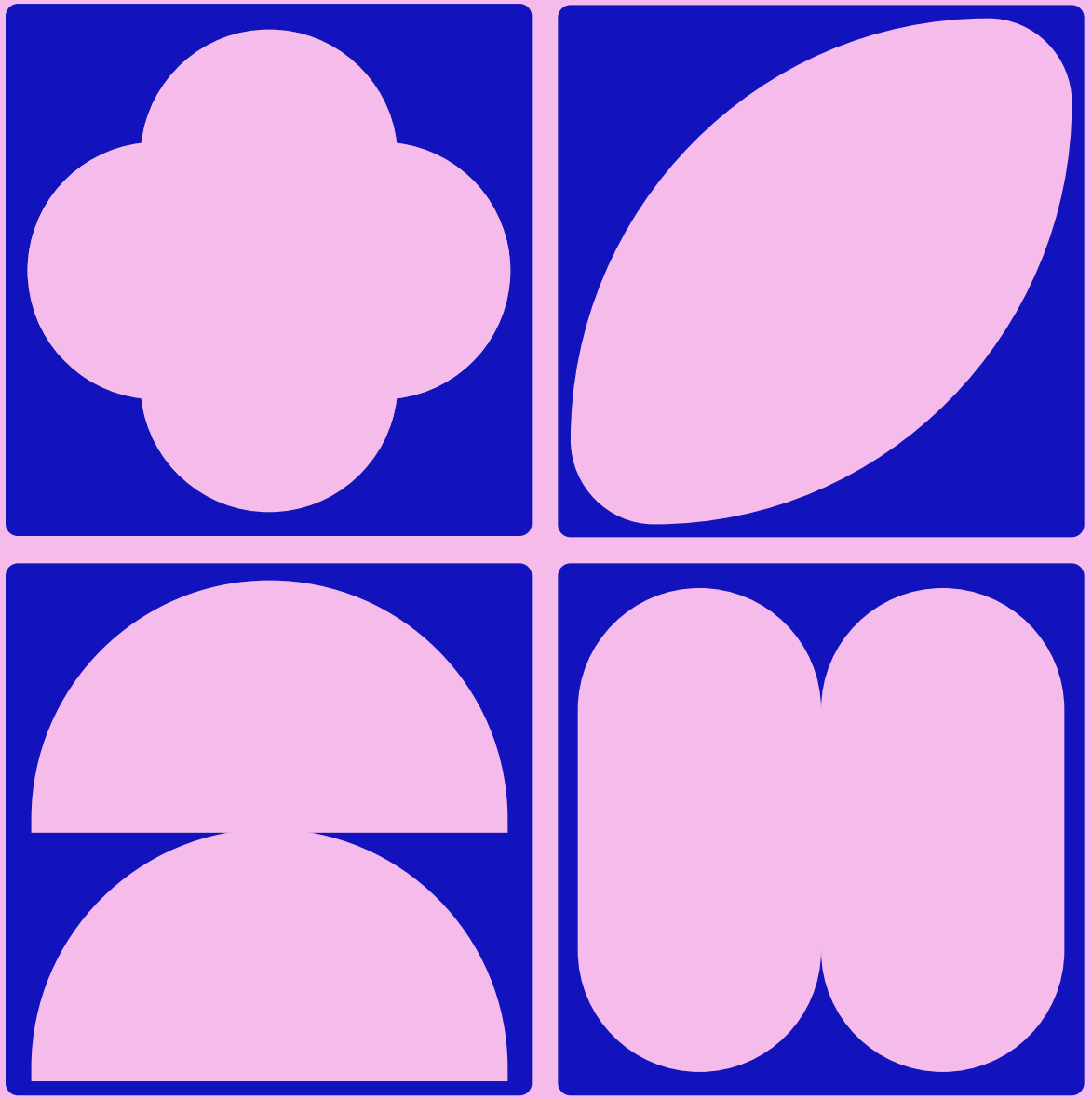
OUR CLASSROOM SETTING

- Active participation
  - Cameras are optional; do whatever makes you feel comfortable
  - The session is not recorded, to encourage more participation
  - Use the chat liberally: questions, comments, jokes, chat are all welcome
  - Try the exercises! Take them slow, try them in your own time if you prefer
- Problem solving
  - Share what works for you and help others
  - It’s ok not to understand immediately



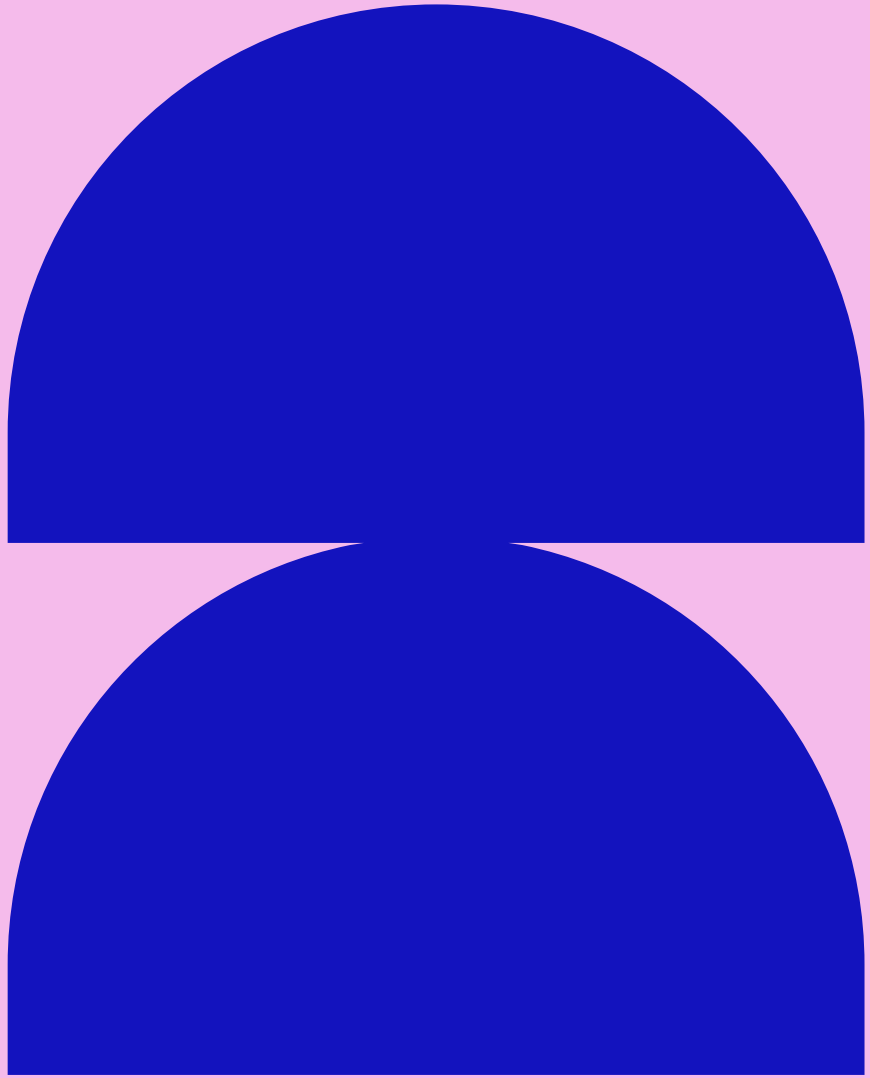
OUR CLASSROOM SETTING

- Take breaks, move away from your screen
- Learning to learn:
  - Learning a programming language is quite different from other topics you may have been taught before
  - Research into how to teach people to code:
    - Middle-class, white, non-disabled, English-as-a-first language, men, with a computer science background: over-represented in foundational research
    - Want to disrupt this with actually effective methods: will introduce these to you to take forward
    - Equity in research computing education



INTERACTIVITY: USING VEVOX

- Online polling:
  - Can join on your laptop, or via your phone
  - Participation will help you learn, but no pressure if it's too many tabs to keep track of!
  - It will be the same link continuously (you can just open it in the background and tab onto it when we are doing an exercise)
- Also has an anonymous Q&A, will stay open over the course of the workshop
- Can also use the Teams chat, we will monitor it for the next week!



JOIN THE VEVOX SESSION

Go to **vevox.app**

Enter the session ID: **142-115-076**

Or scan the QR code

WHAT IS YOUR AREA OF EXPERTISE?

WHAT IS YOUR AREA OF EXPERTISE?

RESULTS SLIDE

Question slide

HOW FAMILIAR/COMFORTABLE ARE YOU WITH EACH OF THE FOLLOWING?

Completely new to it — Very comfortable/familiar

Python

Matplotlib

Seaborn

"Object Oriented Programming" or OOP

Data Visualisation (generally)

HOW FAMILIAR/COMFORTABLE ARE YOU WITH EACH OF THE FOLLOWING?

Completely new to it — Very comfortable/familiar

Python

Matplotlib

Seaborn

"Object Oriented Programming" or OOP

Data Visualisation (generally)

RESULTS SLIDE

WHAT ARE YOU HOPING TO GET OUT OF THIS WORKSHOP?

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RESULTS SLIDE

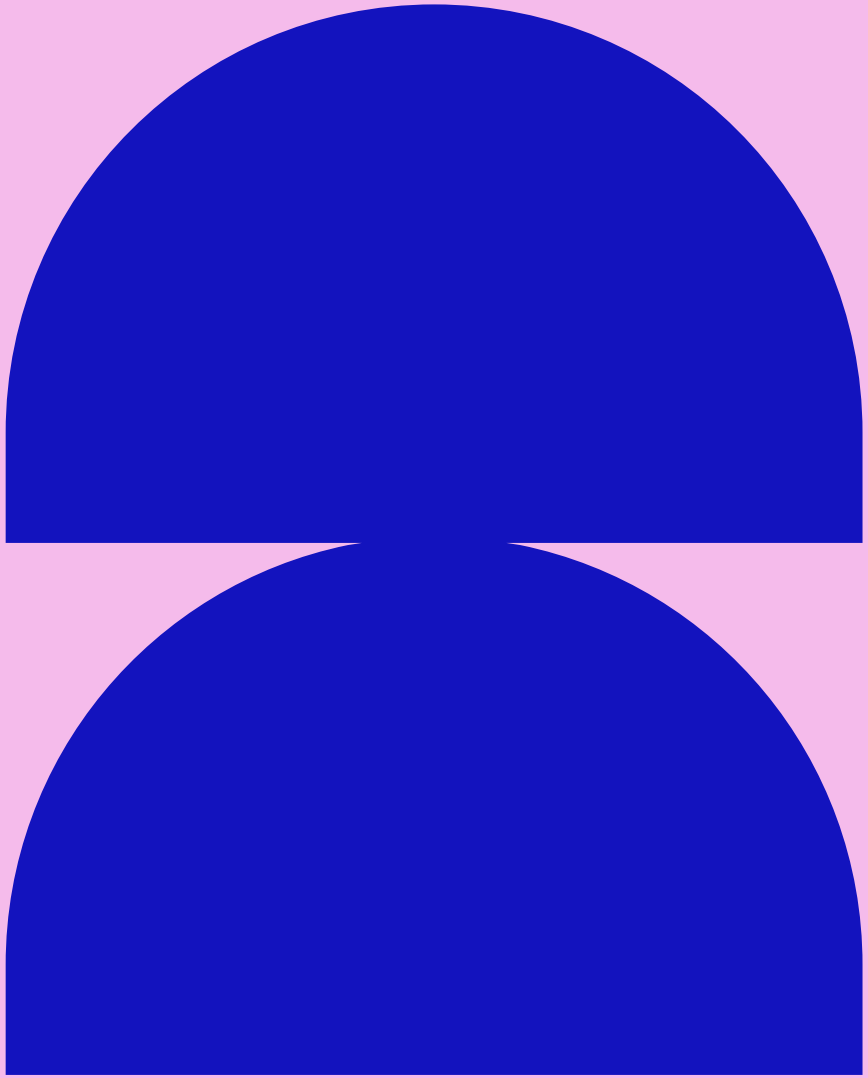
APPROACH: USING THE PRIMM METHOD

- **P** Predict
- **R** Run
- **I** Investigate
- **M** Modify
- **M** Make

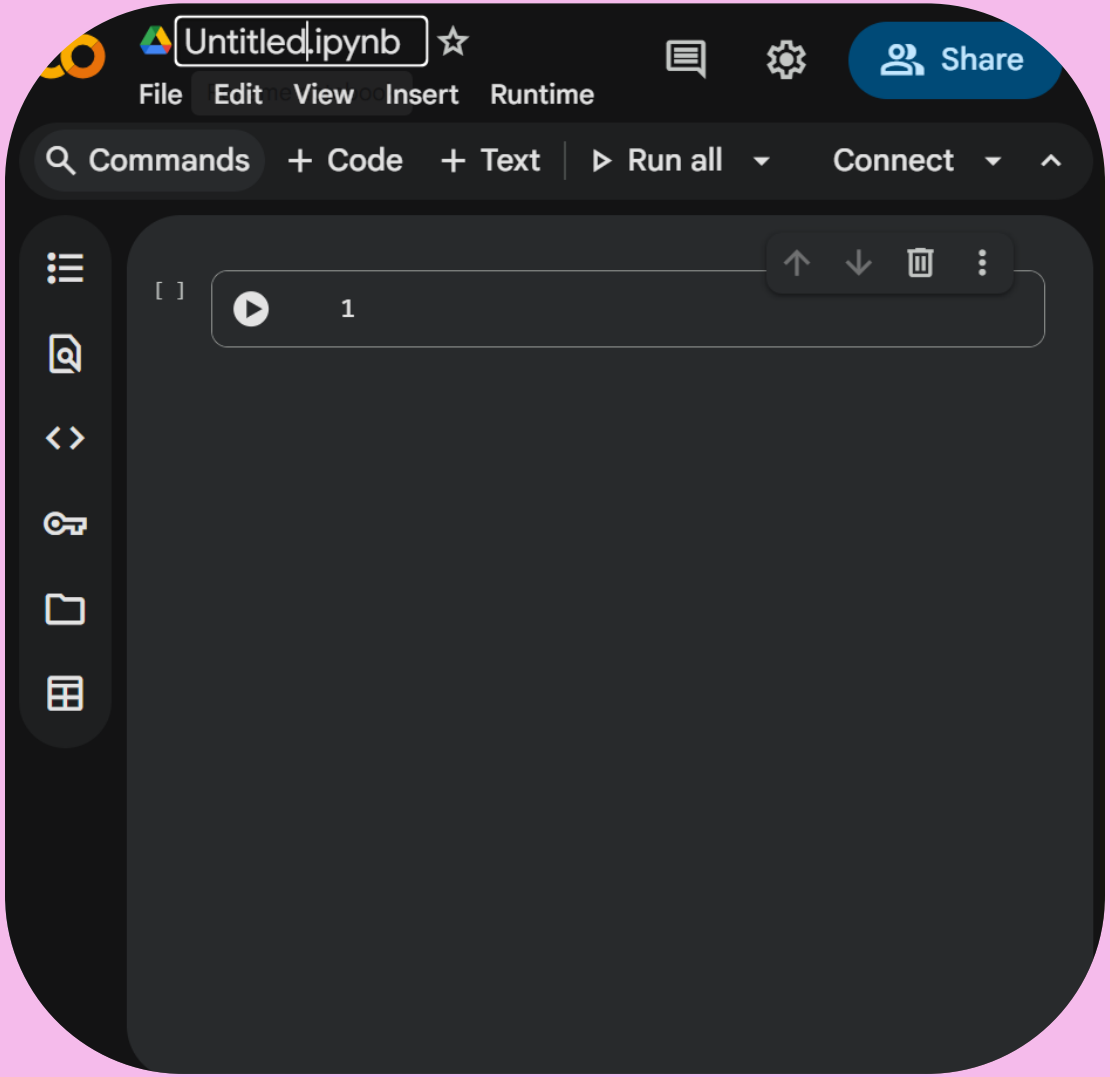
Read more about PRIMM

READ BEFORE YOU WRITE: PREDICT

- Learning how to read or “trace” code is key: novices require a 50% tracing code accuracy before they can independently write code with confidence (Venables et al., 2009)
- Predict what a segment of code will do before you run it:
  - No need to initially figure out *how* it will do that,
  - Just the expected outcome!
  - No pressure – just guess!

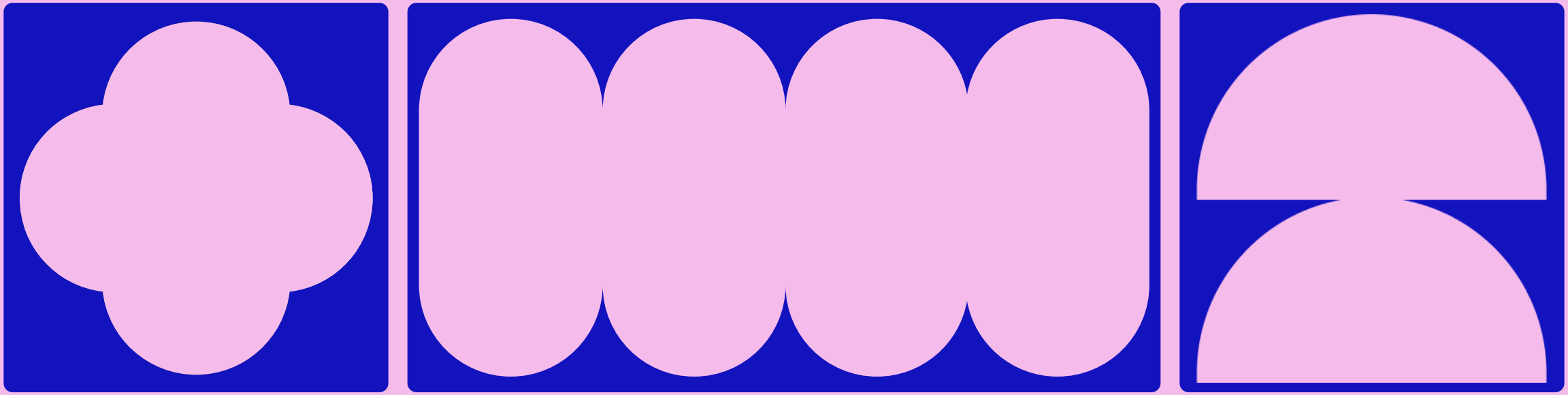


Read more about PRIMM



GOOGLE COLAB

- https://colab.research.google.com/
- You need a Google account
- Free Cloud platform:
  - Runs on a virtual Linux machine
  - No need to install anything locally
- We recommend you install Python on your machine for research, but:
  - The focus of this course is for you to learn about data visualisation
  - Not to focus on installation
- Not using it until after our first break, so you can set up an account then



DATA VISUALISATION

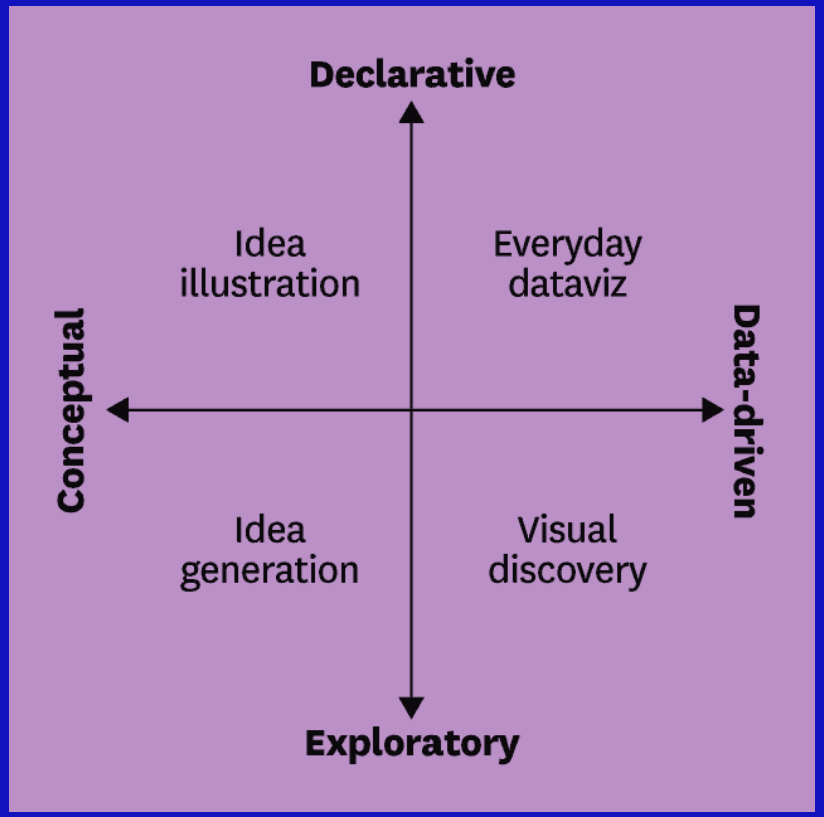
WHAT IS DATA VISUALISATION?

WHAT IS DATA VISUALISATION?

RESULTS SLIDE

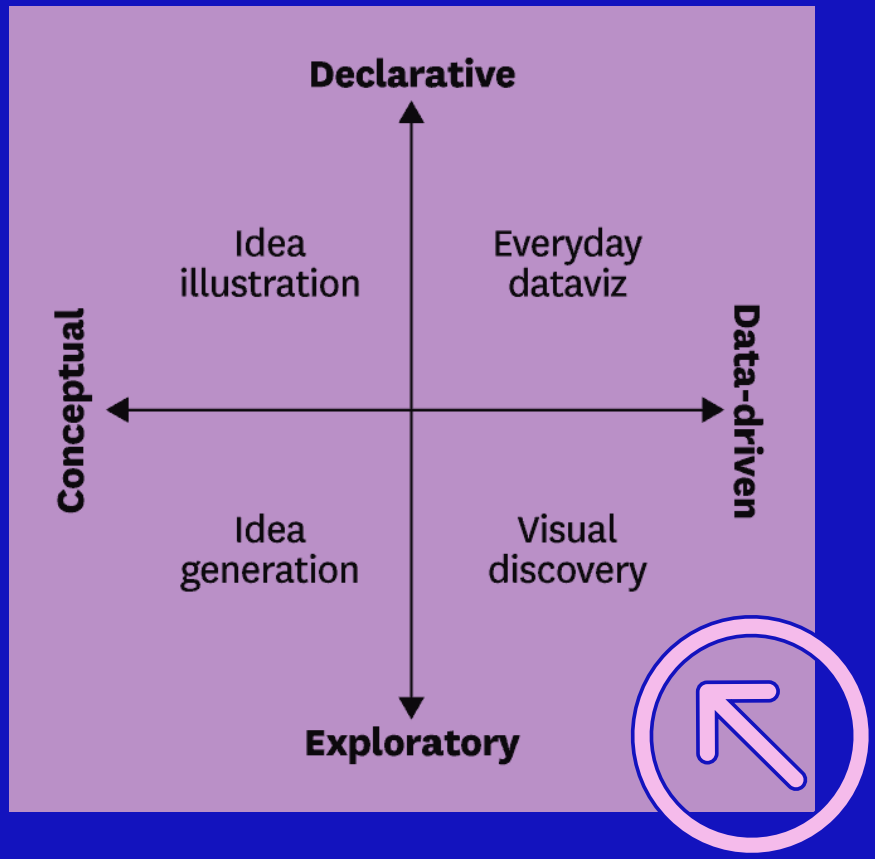
WHAT IS DATA VISUALISATION?

- The “graphical representation of information and data” – Tableau
- A powerful means of communicating information across wide audiences
  - Other researchers in the same/different fields
  - The wider public
  - Policy-makers
- At risk of communicating inaccurate information
  - Intentionally or unintentionally through misleading design choices
  - Due to complexity, causing confusion
  - Due to assumption of the data literacy of the audience
- An art, a science, marketing, persuasion, storytelling, all in one…

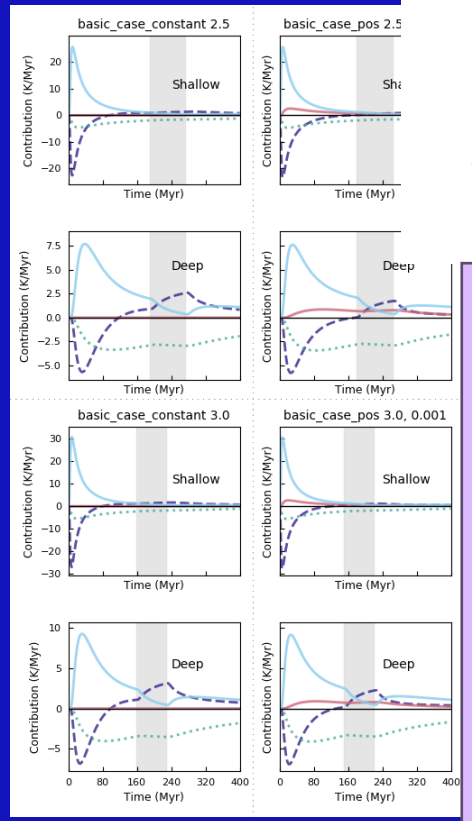


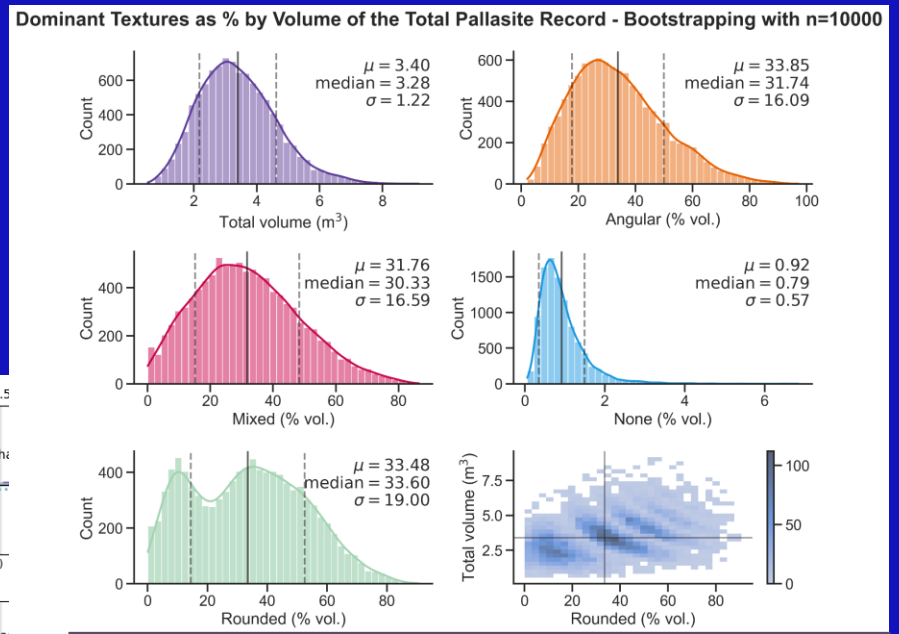
Harvard Business Review

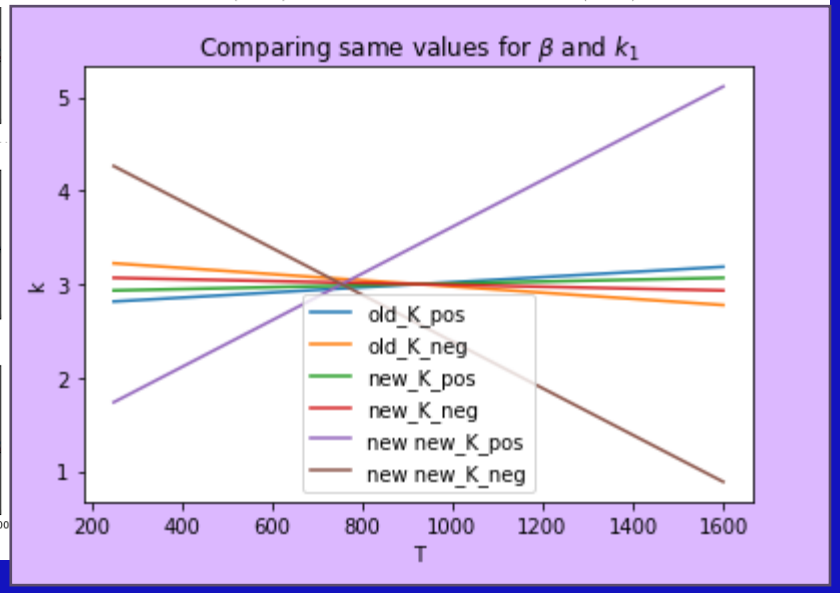
- Conceptual or data-driven?
  - We will mainly be focusing on *data driven* in this course, as Python is best suited to this
- Declaring or exploring something?
  - We will look at both approaches during this course!

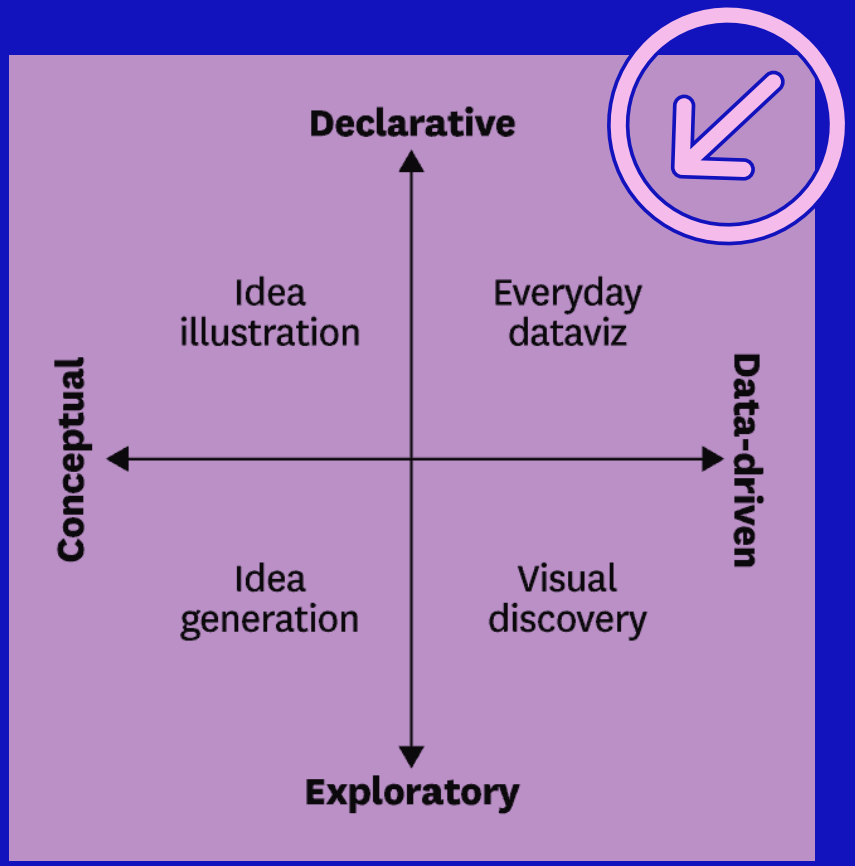

Declarative
Idea illustration
Everyday dataviz
Conceptual
Data-driven
Idea generation
Visual discovery
Exploratory

Often ugly!


basic_case_constant 2.5
basic_case_pos 2.5
Shallow
Deep
basic_case_constant 3.0
basic_case_pos 3.0, 0.001
Contribution (K/Myr)
Time (Myr)


Dominant Textures as % by Volume of the Total Pallasite Record - Bootstrapping with n=10000
μ = 3.40
median = 3.28
σ = 1.22
Total volume (m³)
μ = 33.85
median = 31.74
σ = 16.09
Angular (% vol.)
μ = 31.76
median = 30.33
σ = 16.59
Mixed (% vol.)
μ = 0.92
median = 0.79
σ = 0.57
None (% vol.)
μ = 33.48
median = 33.60
σ = 19.00
Rounded (% vol.)
Total volume (m³)
Rounded (% vol.)
Count


Comparing same values for β and k1
old_K_pos
old_K_neg
new_K_pos
new_K_neg
new new_K_pos
new new_K_neg
k
T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Everyday dataviz
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Visual discovery
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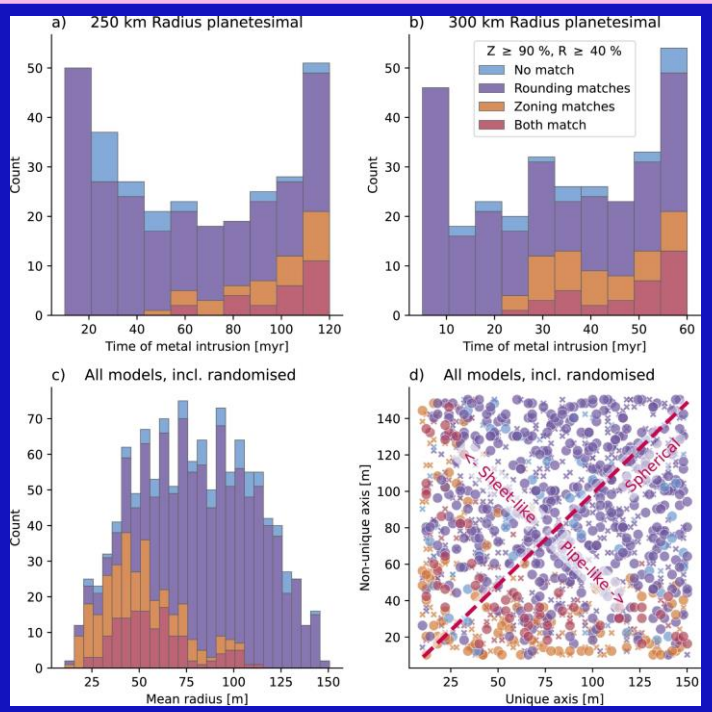
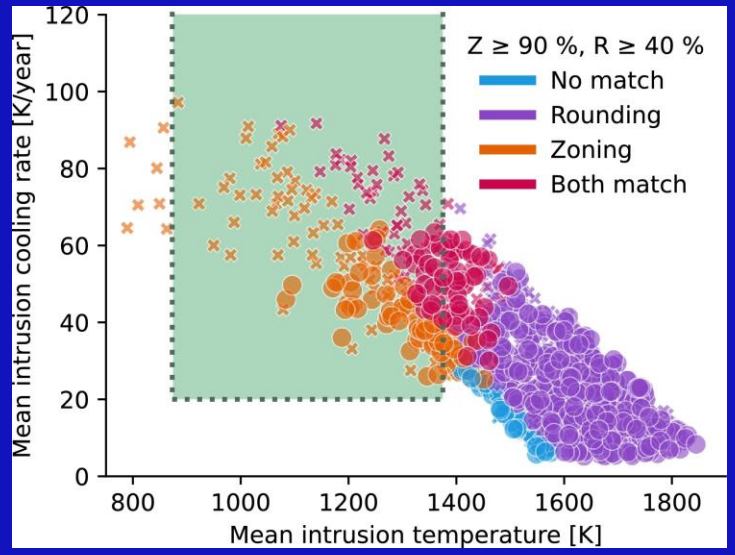
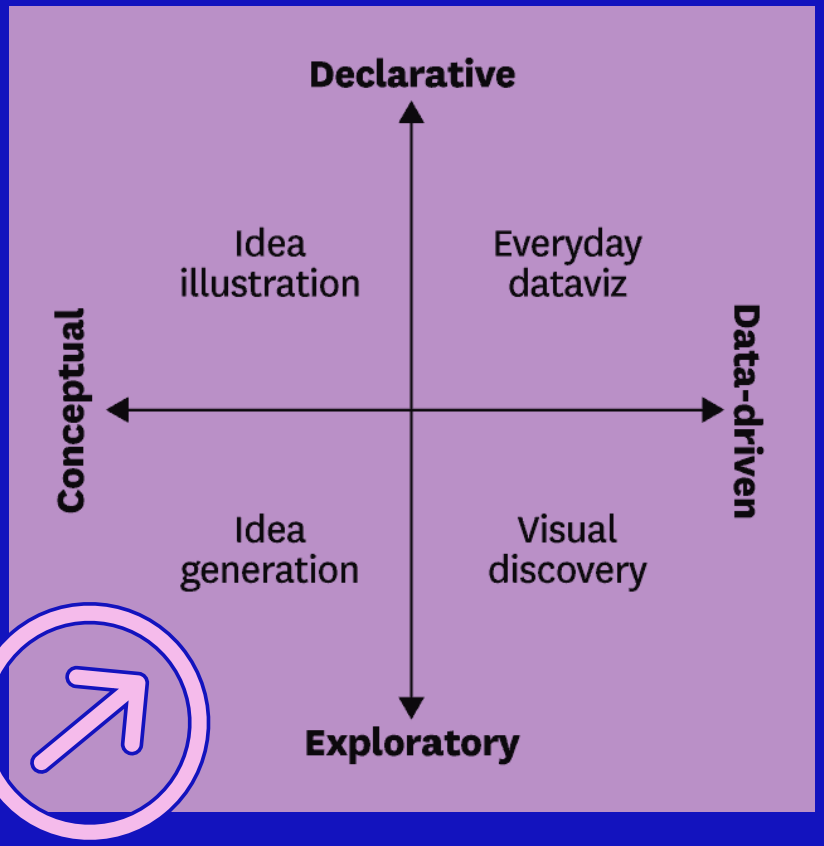

a) 250 km Radius planetesimal
b) 300 km Radius planetesimal
Z ≥ 90 %, R ≥ 40 %
No match
Rounding matches
Zoning matches
Both match
Count
Time of metal intrusion [myr]
c) All models, incl. randomised
d) All models, incl. randomised
Mean radius [m]
Non-unique axis [m]
Unique axis [m]
Sheet-like
Spherical
Pipe-like


Z ≥ 90 %, R ≥ 40 %
No match
Rounding
Zoning
Both match
Mean intrusion cooling rate [K/year]
Mean intrusion temperature [K]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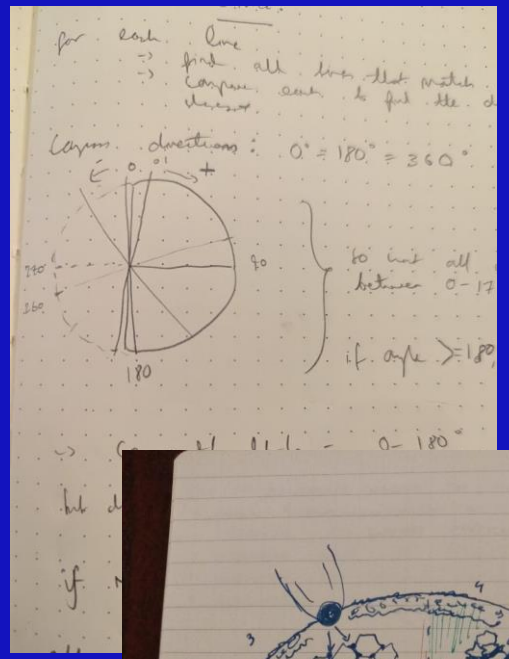
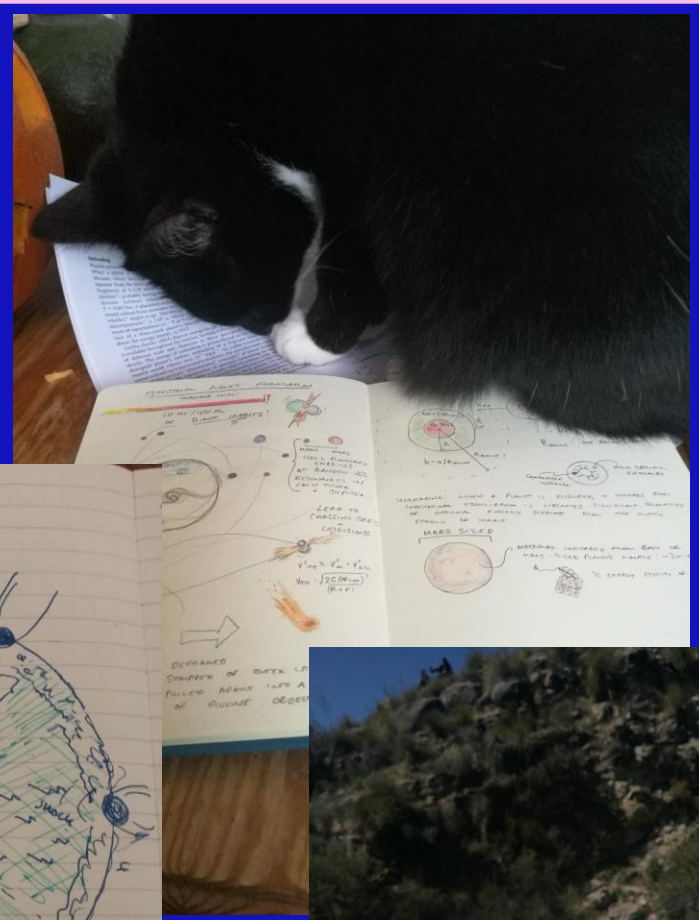
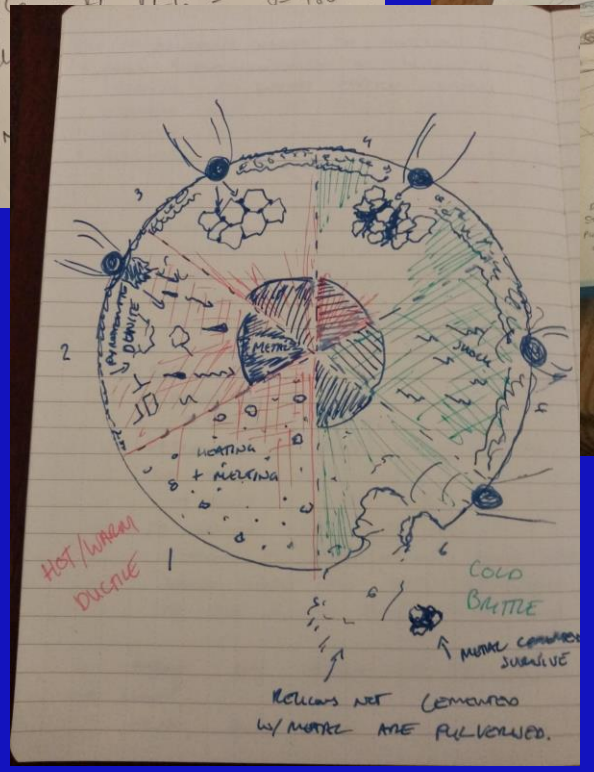
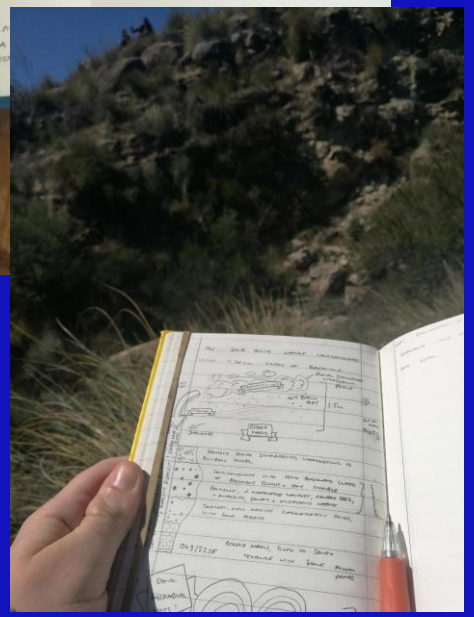
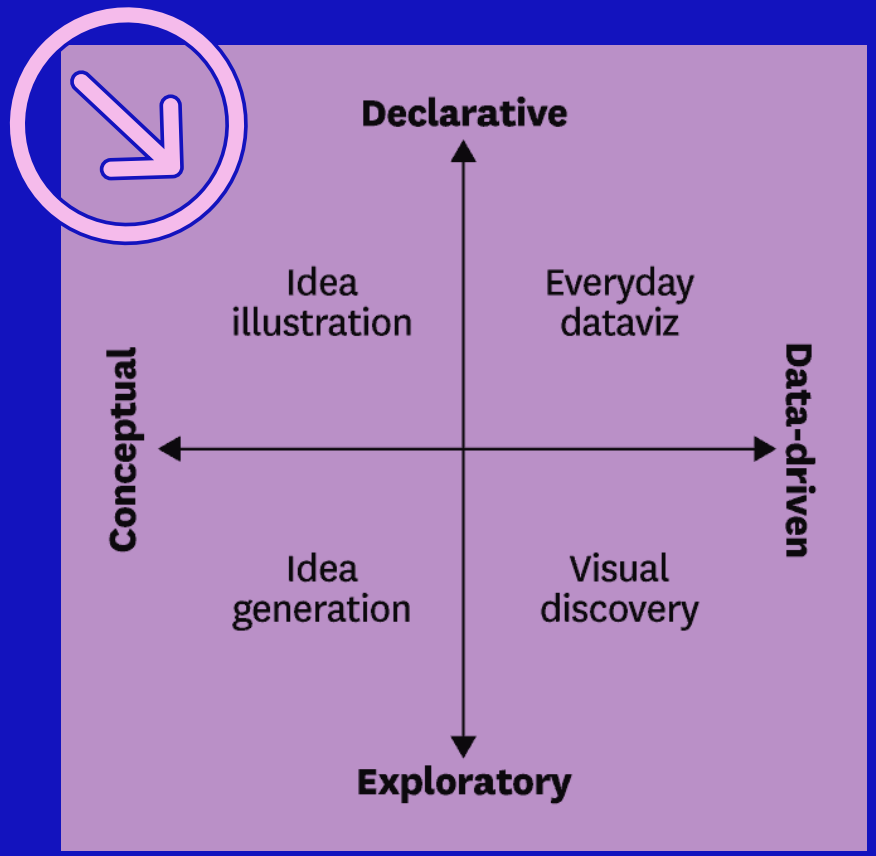
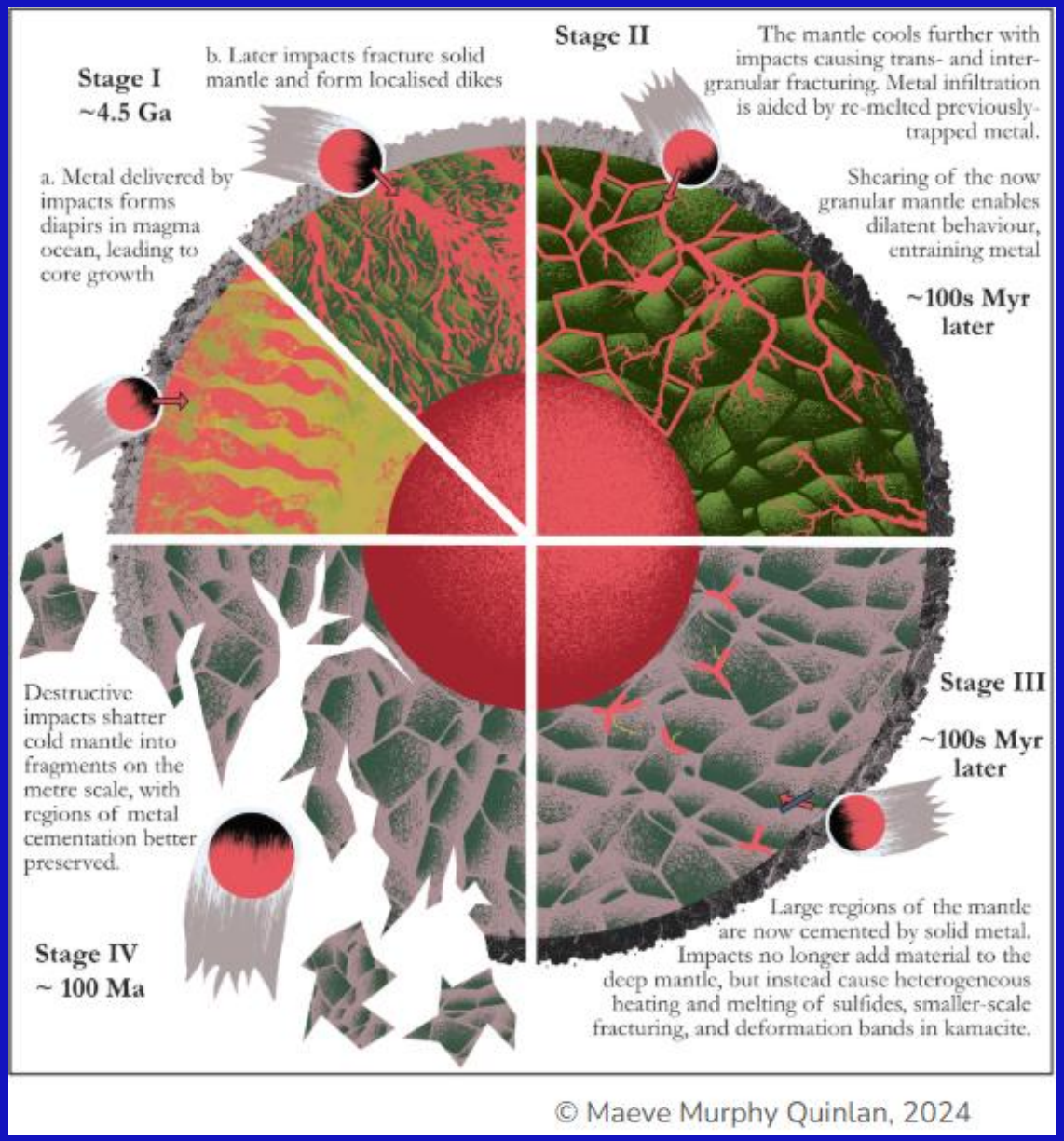












WHAT IS *GOOD* DATA VISUALISATION?

WHAT IS *GOOD* DATA VISUALISATION?

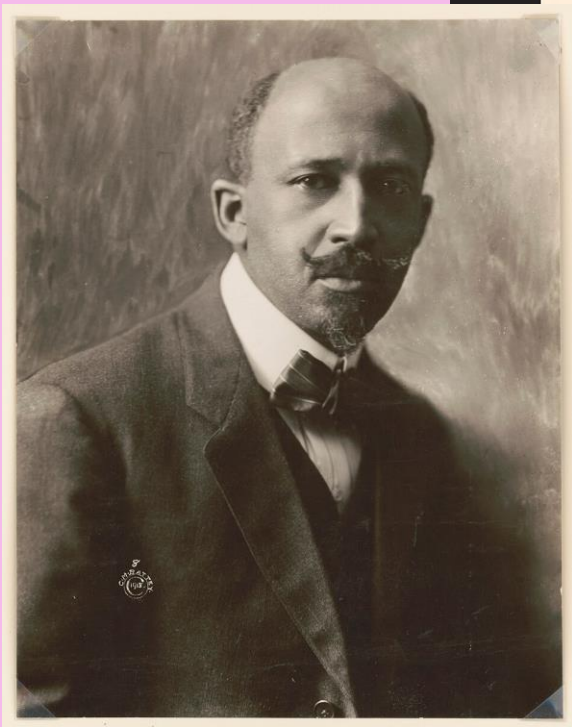
RESULTS SLIDE

WHAT IS “GOOD” DATA VISUALISATION?

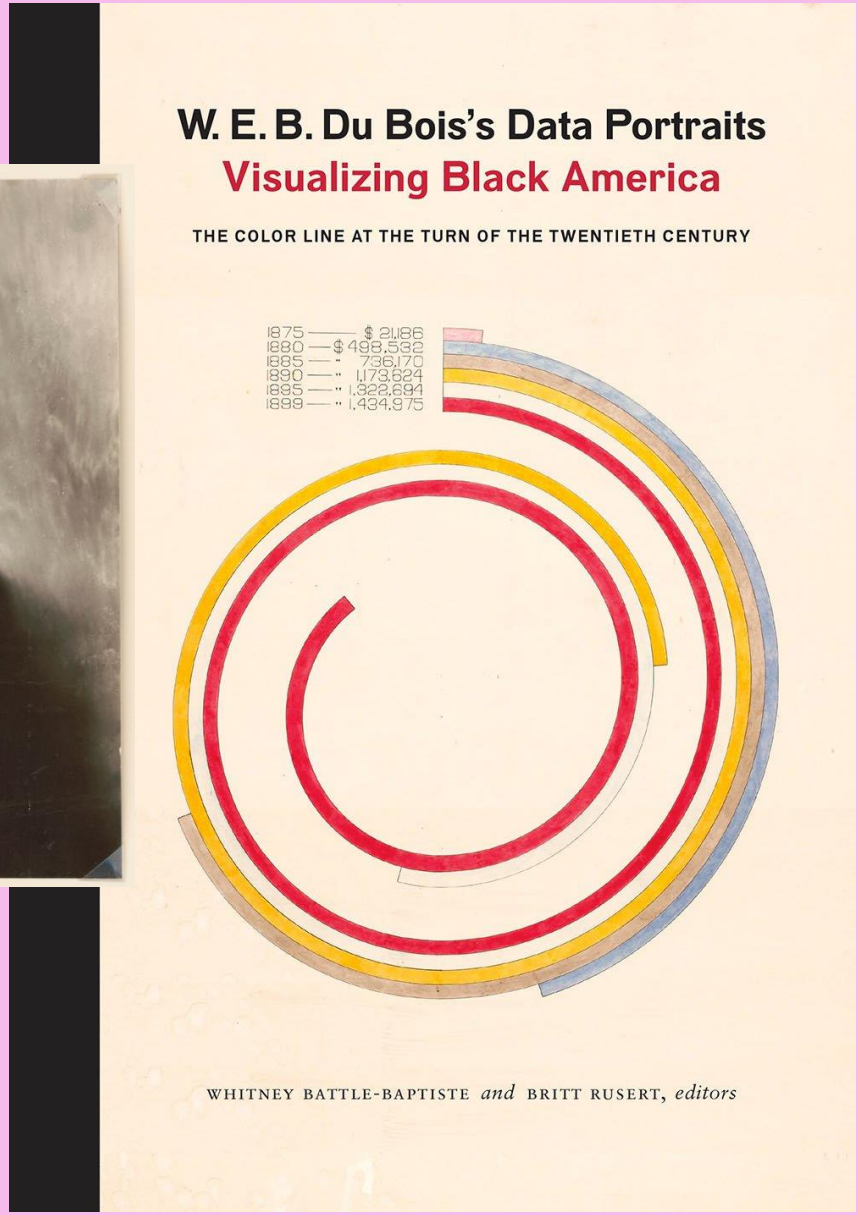
- How do we define “good” data visualisation?
- What is the effect/desired outcome of “good” data visualisation?
  - Communicate meaning, often quite complex meaning
  - To look visually appealing
  - To *not* mislead or misguide, or manipulate (whether intentionally or accidentally)
- “Good” can look different in different contexts:
  - Conference poster
  - Journal article
  - Policy guidance
  - Outreach talk
  - Printed/digital

W.E.B. DU BOIS

- Sociologist, writer, historian, Pan-Africanist civil rights activist; 1868-1963
  - PhD in history from Harvard University
  - Used sociology methodologies to contextualize the historical realities resonating among African-Americans
- “Data Portraits” of African American Life for the 1900 Paris Exposition
- Striking pieces of data visualisation work
  - “Infographic activism”
  - Ink, gouache, watercolour, graphite



Du Bois in 1918, by C. M. Battey

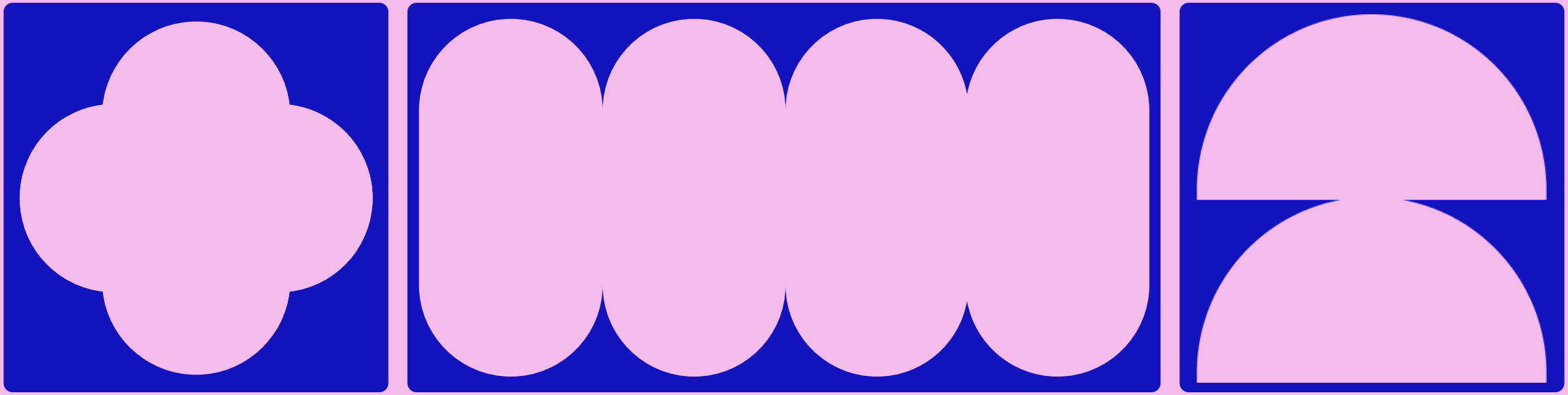


THE DECOLONIAL ATLAS

- Volunteer-run project:
  - “a growing collection of maps which, in some way, help us to challenge our relationships with the land, people, and state”
  - “based on the premise that cartography is not as objective as we’re made to believe”

AuthaGraph projection map (Hajime Narukawa)

Screenshot from the homepage of The Decolonial Atlas

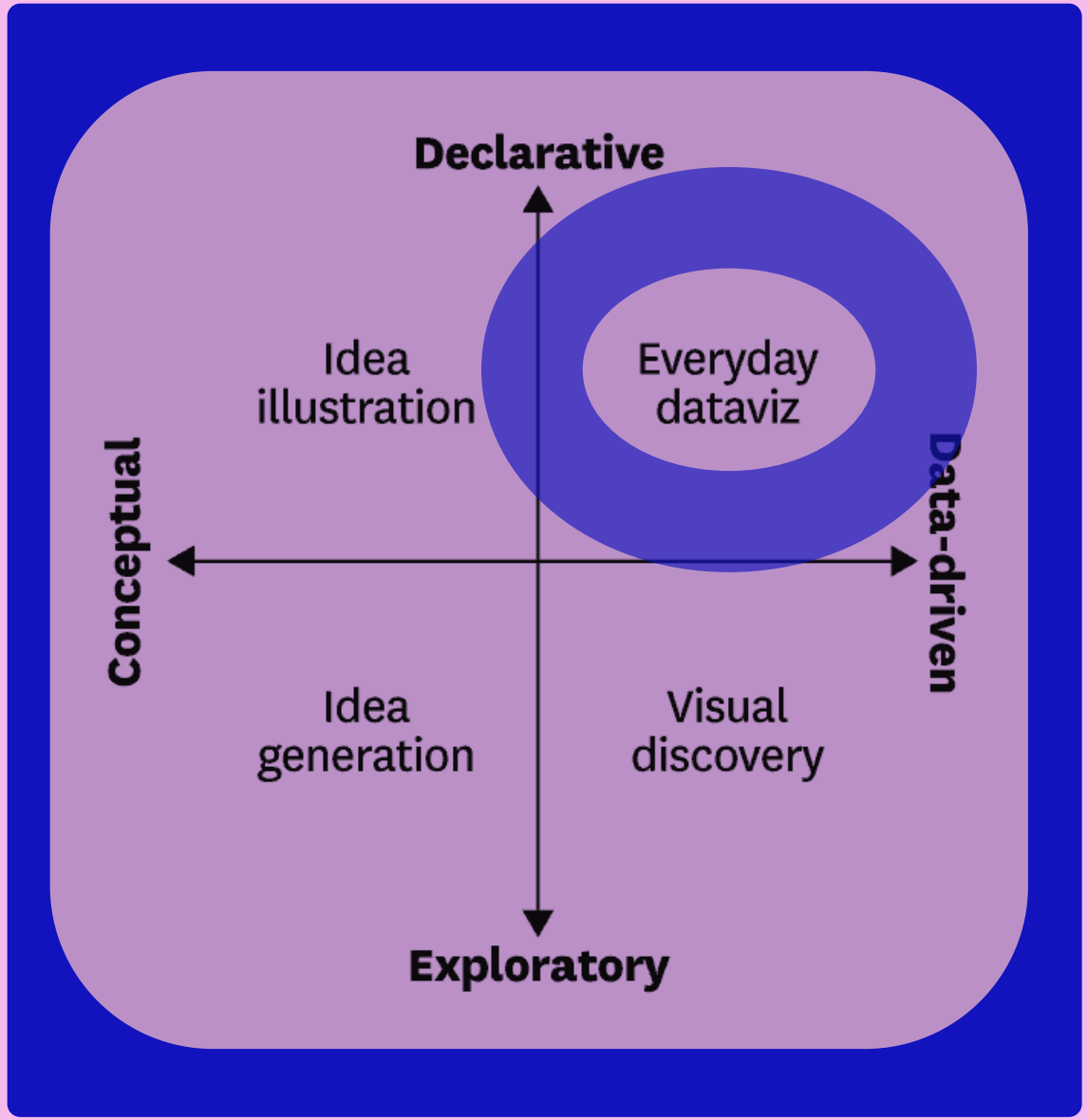


DATA VISUALISATION PRINCIPLES

9 PRINCIPLES

1. Know your audience
2. Diagram first
3. Overall pattern or details?
4. Pick intentional encodings
5. Choose colours carefully
6. Show uncertainty
7. Make it accessible
8. Minimise cognitive load
9. Get opinions

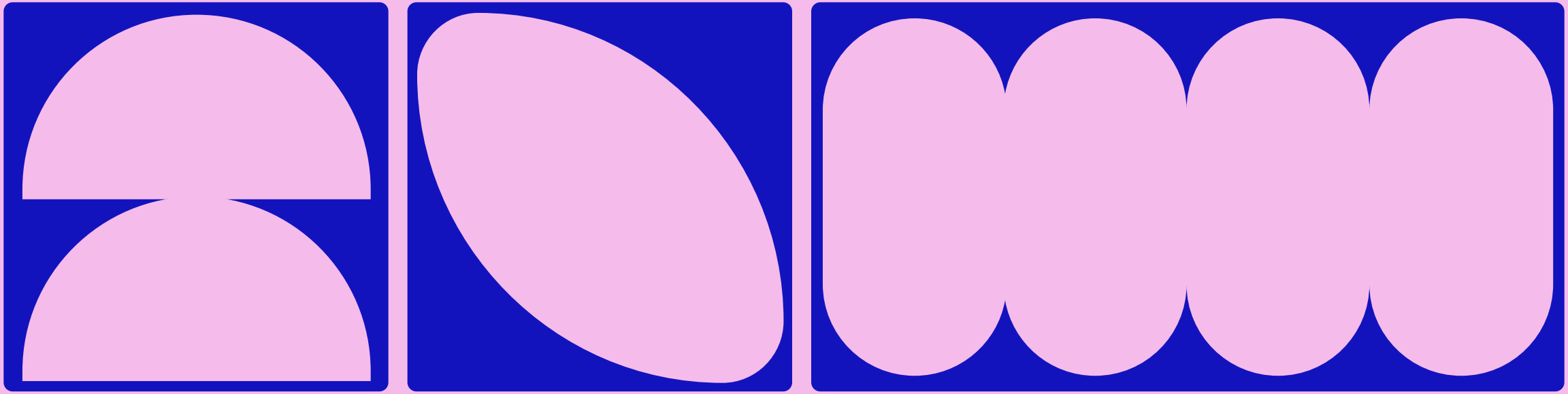
9 PRINCIPLES



9 PRINCIPLES

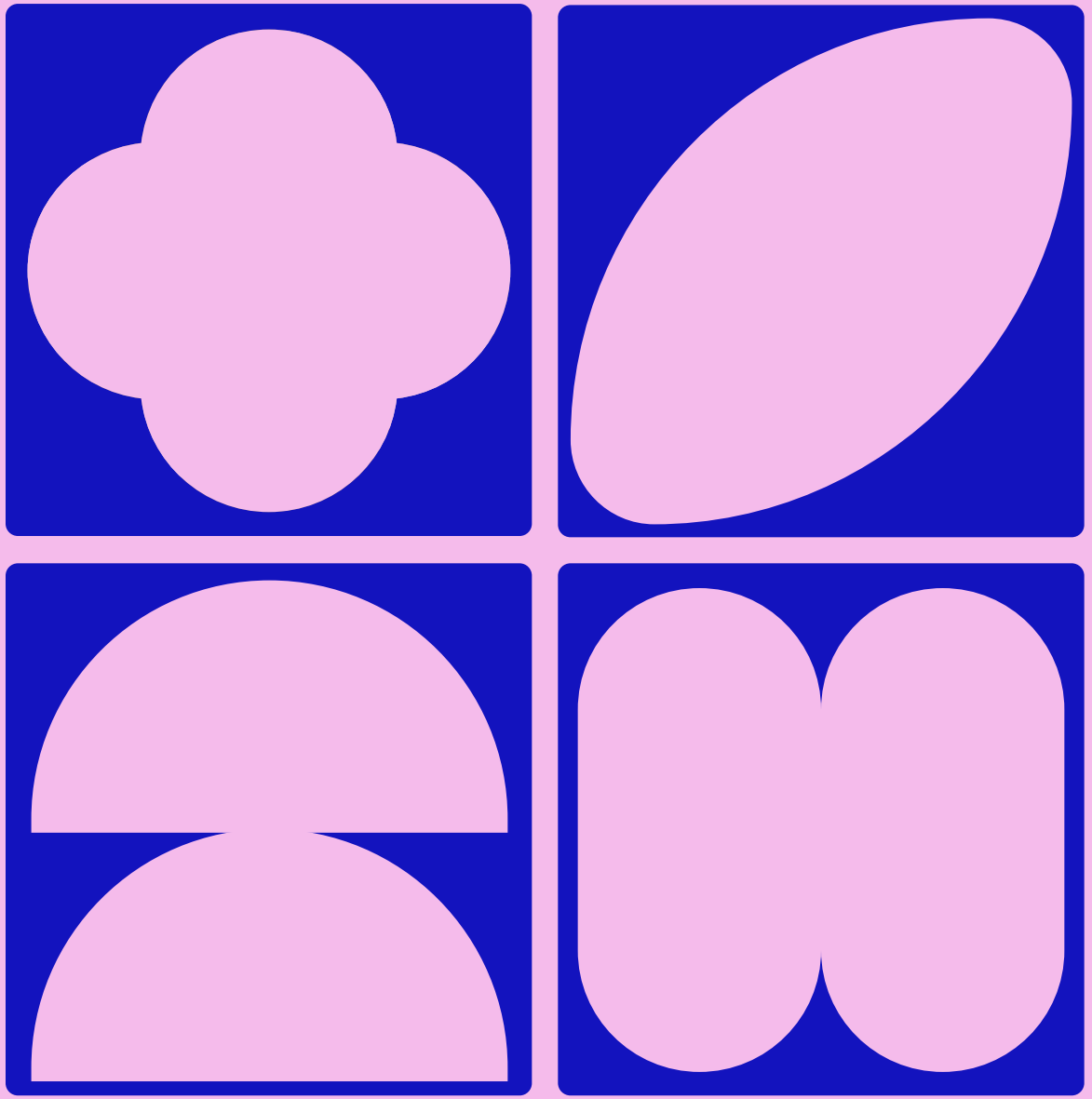
- A Frankenstein’s Monster hodgepodge of different guides:
  - Midway, 2020
  - Kelleher & Wagener, 2011
  - D'Ignazio & Klein, 2020
- Absolutely not set in stone:
  - A guide, not rules

1. KNOW YOUR AUDIENCE



WHO ARE YOU MAKING YOUR DATA VIS FOR?

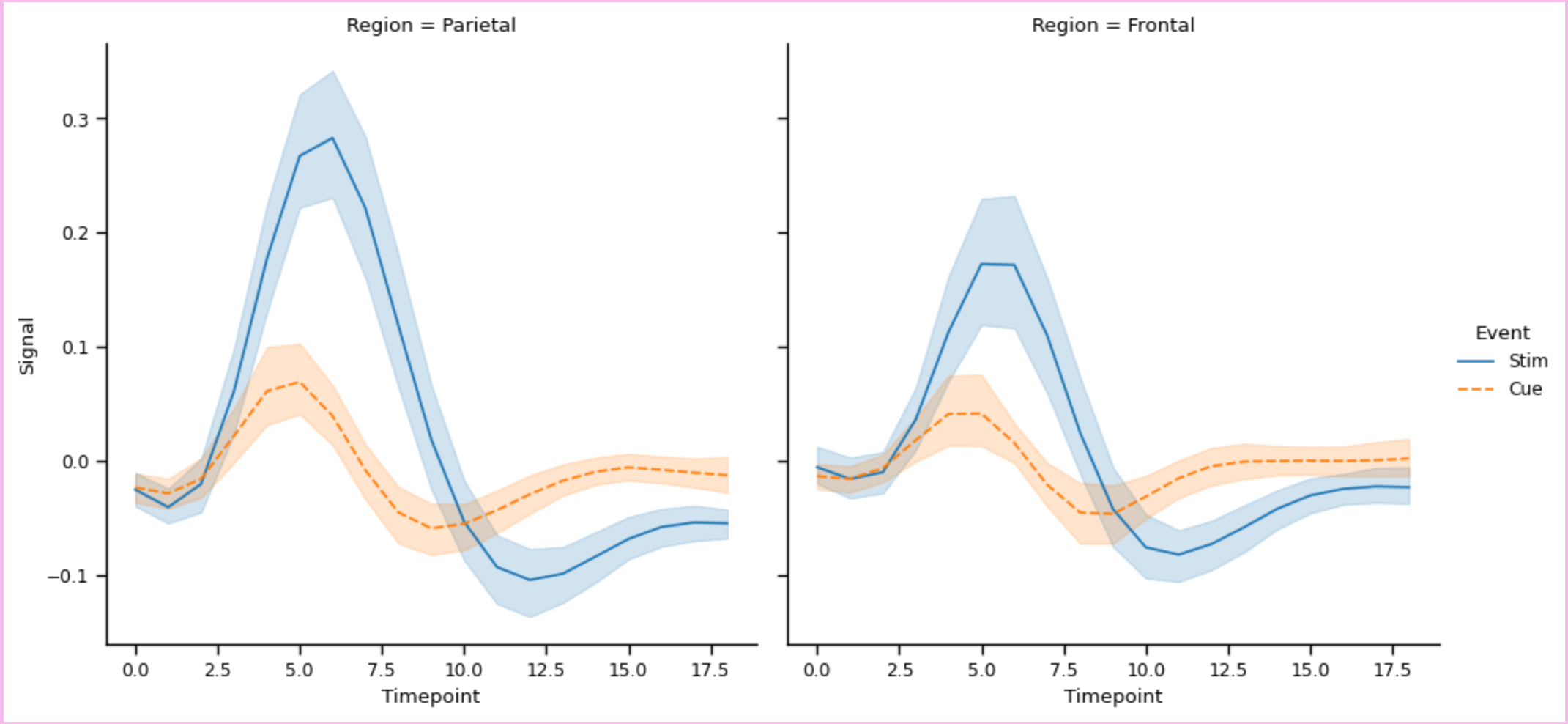
- Who is the audience?
  - Specialists in your field?
  - The general public?
  - Government/policy makers?
- What is the format?
  - Printed
  - Presented (large screen/projector)
  - Digital
- What's the setting?
  - Briefly shown as part of a talk?
  - In a paper for in-depth reading/studying?
  - On a conference poster?

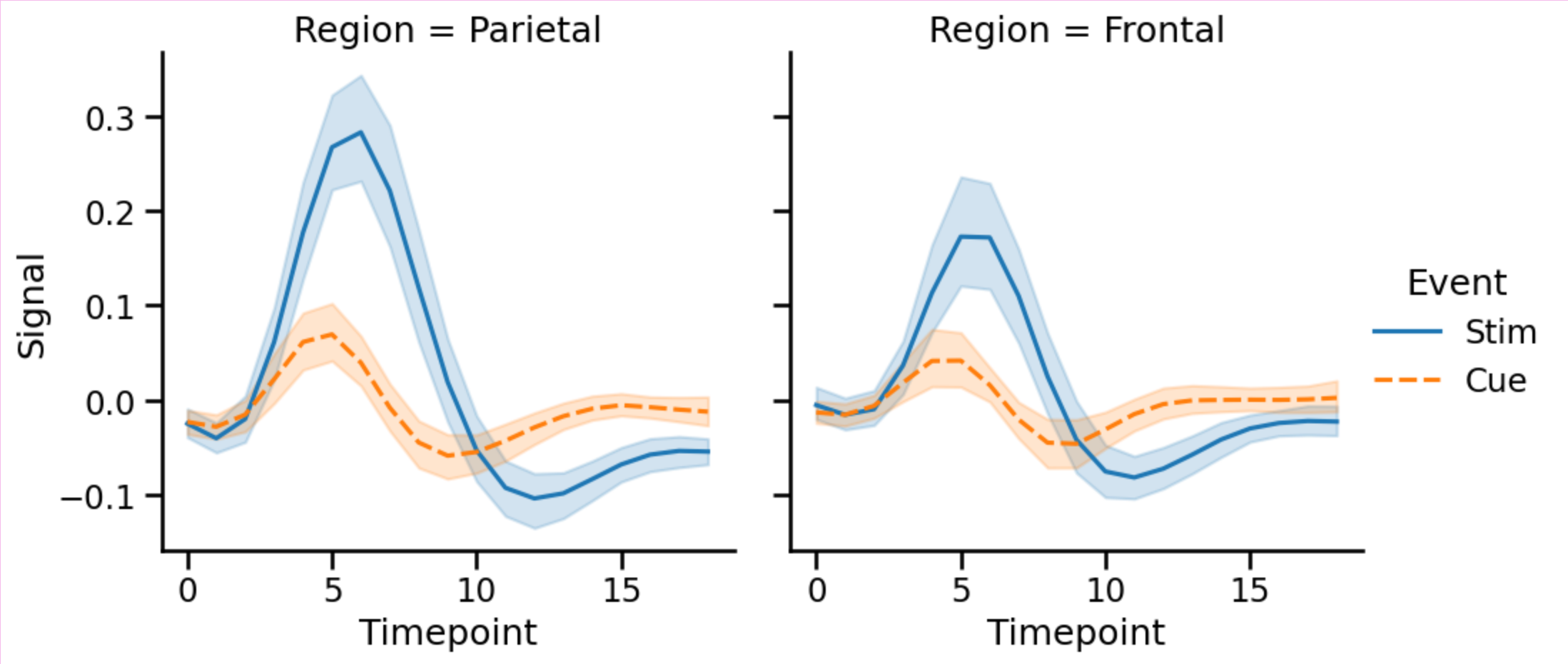


THIS CAN INFLUENCE THE CONCEPT OR DESIGN

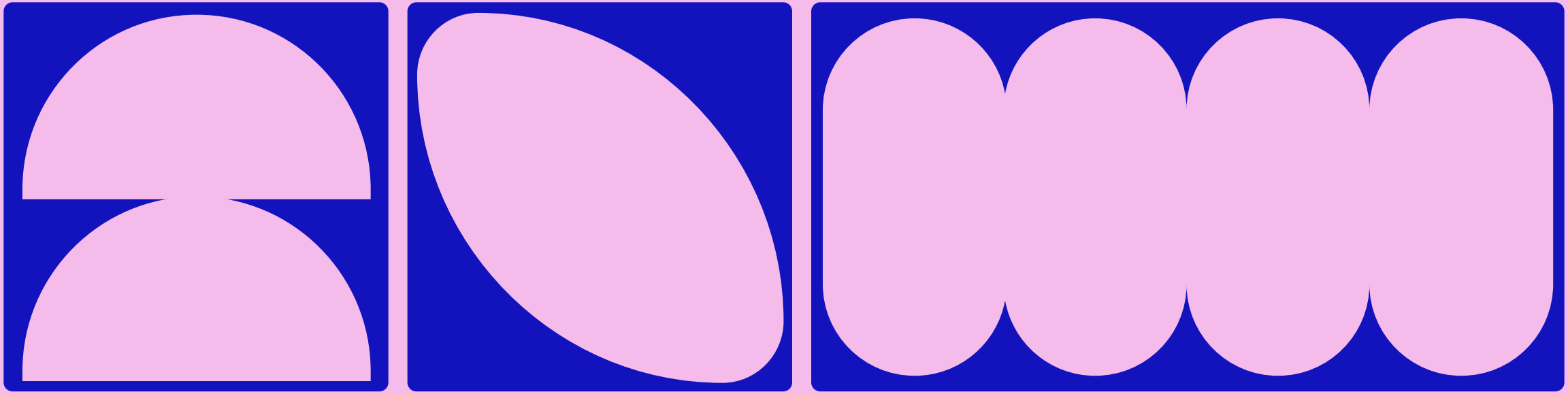
Or the details:

- Font size
- Line thickness
- File format (vector vs. raster)


Region = Parietal
Region = Frontal
Signal
0.3
0.2
0.1
0.0
−0.1
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
Timepoint
Event
Stim
Cue


Region = Parietal
Region = Frontal
Signal
0.3
0.2
0.1
0.0
−0.1
0
5
10
15
Timepoint
Event
Stim
Cue

2. DIAGRAM FIRST



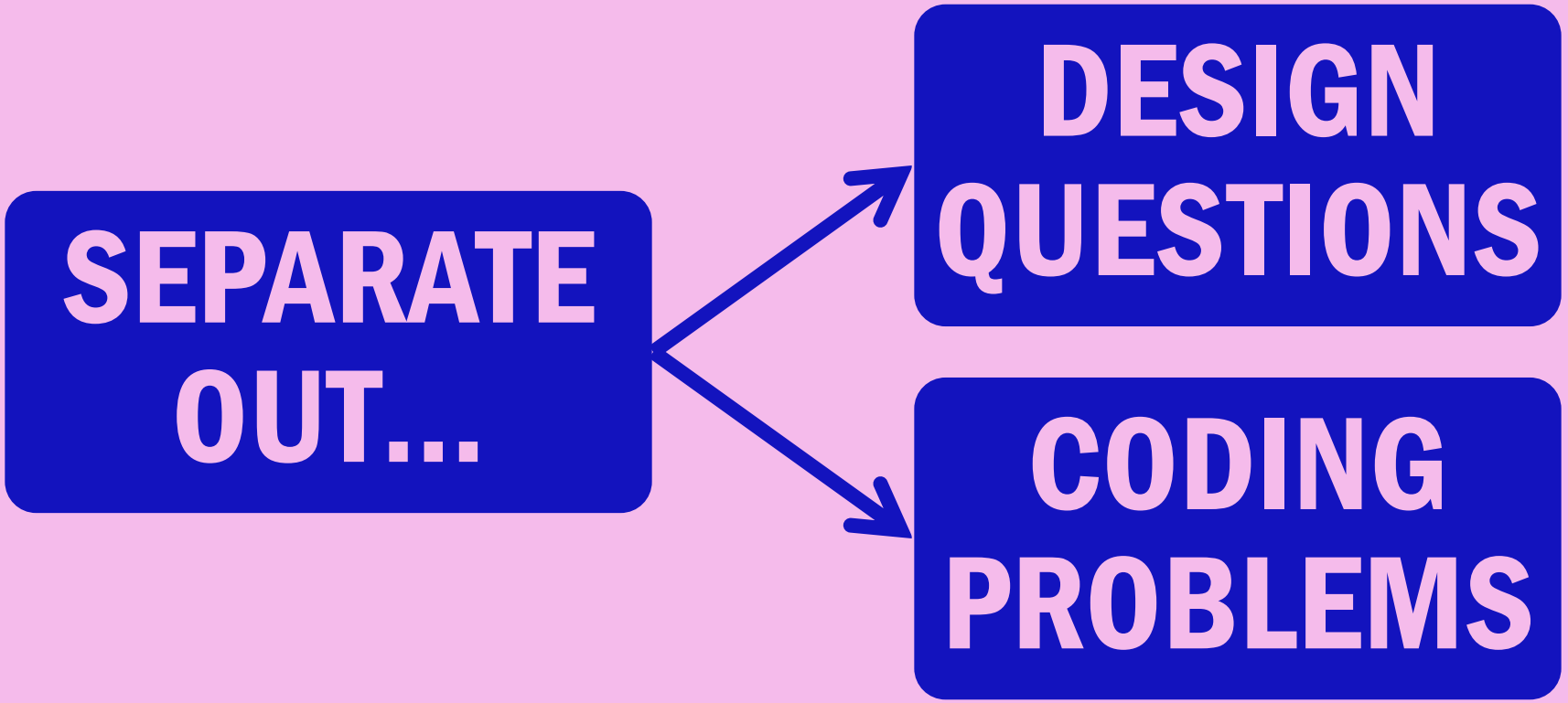
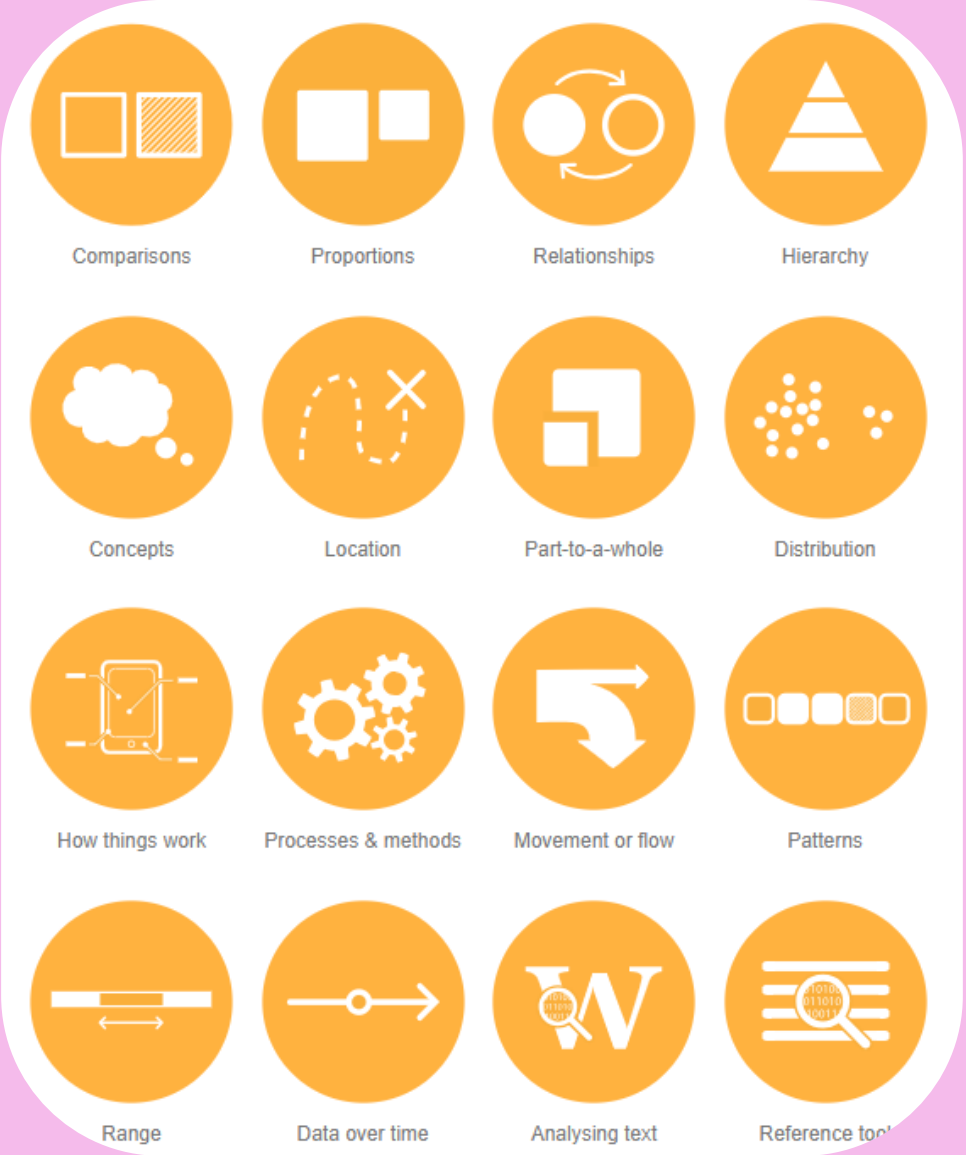

SEPARATE OUT...
DESIGN QUESTIONS
CODING PROBLEMS

DIAGRAM TO HELP YOU FIGURE OUT WHAT CHART TYPE TO USE

- What kind of data are you working with?
  - Timeseries
  - Geospatial
  - Categorical
- What kind of charts are commonly used in your field to display this kind of data?
- What kind of charts are even out there??

- “A friendly guide to choosing a chart type”, *DataWrapper*



Screenshot from DataViz Catalogue

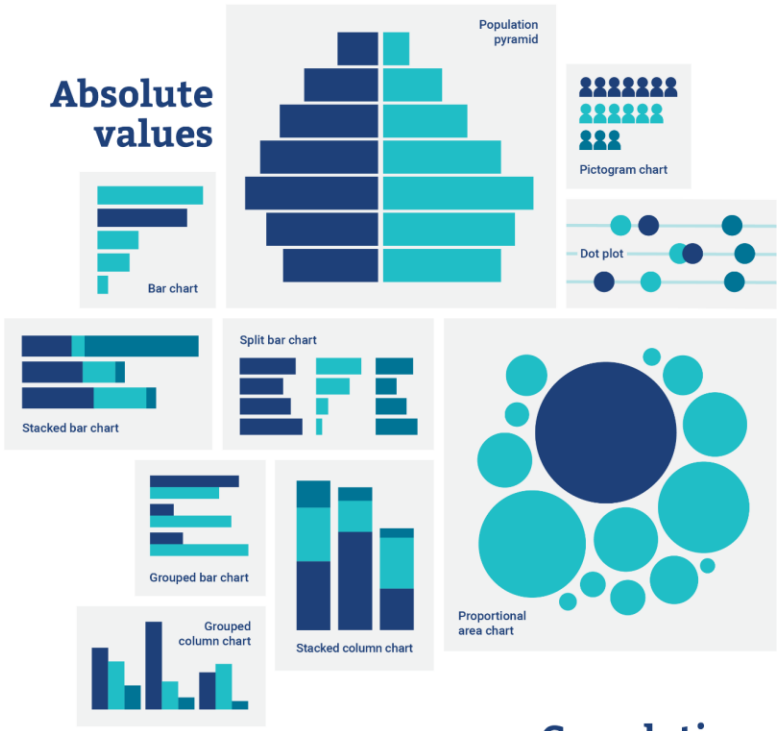
Visualization types

as explained in the article **A friendly guide to choosing a chart type** by Lisa Charlotte Muth on the Datawrapper Blog, June 2025. Find the article here: **datawrapper.de/blog/chart-types-guide**

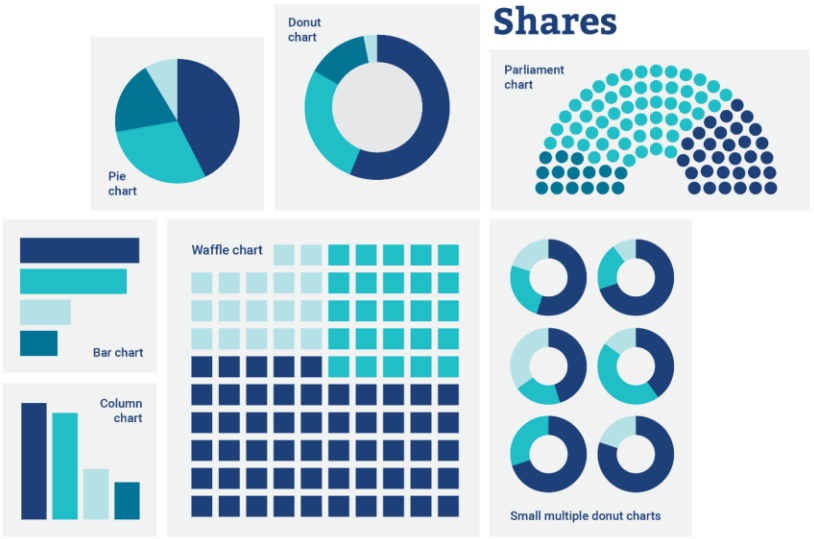
Datawrapper

Developments over time

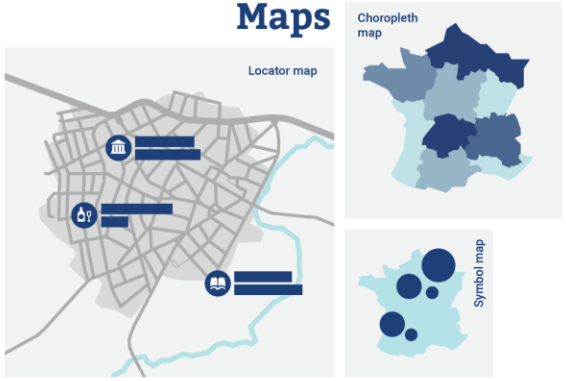
Absolute values



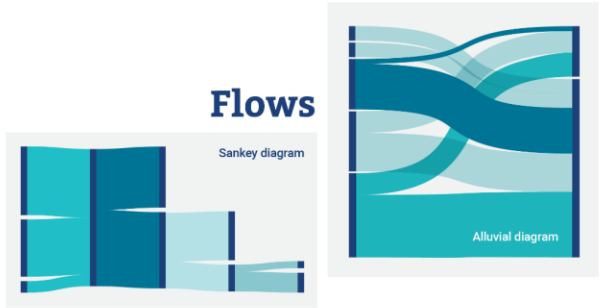
Shares



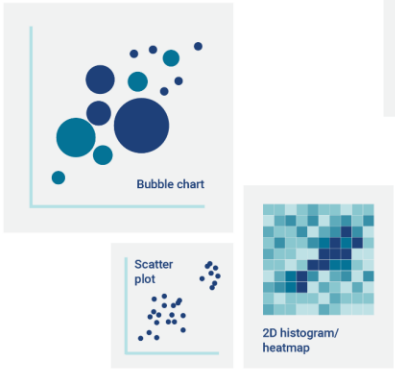
Maps

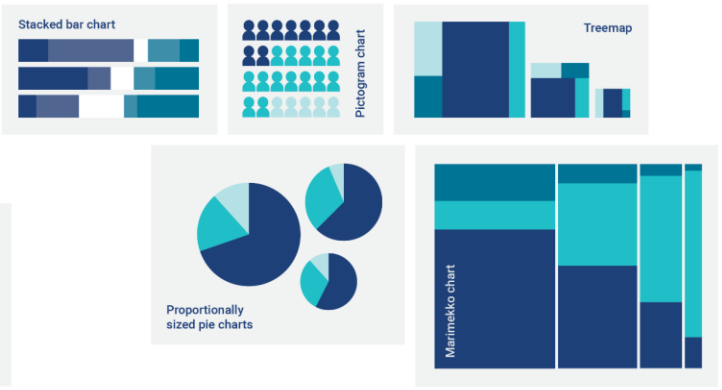


Flows

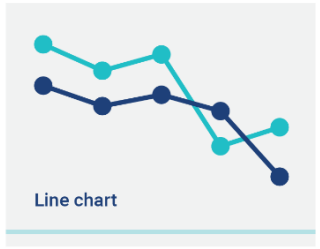


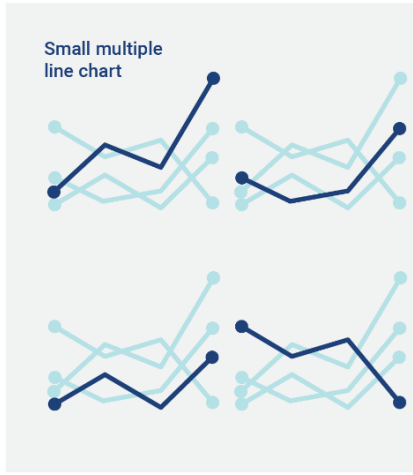
Correlations

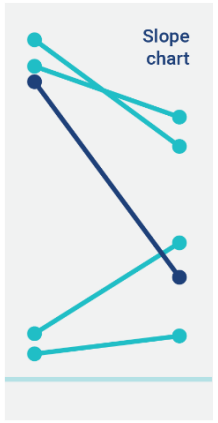


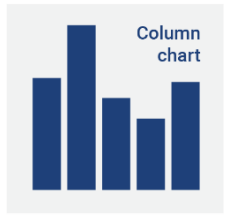


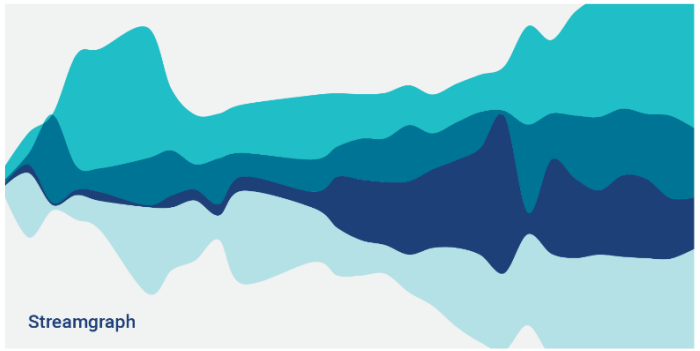
Developments over time

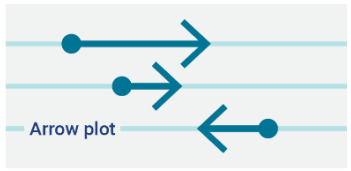




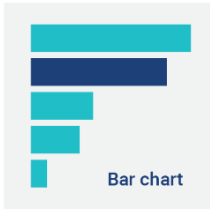


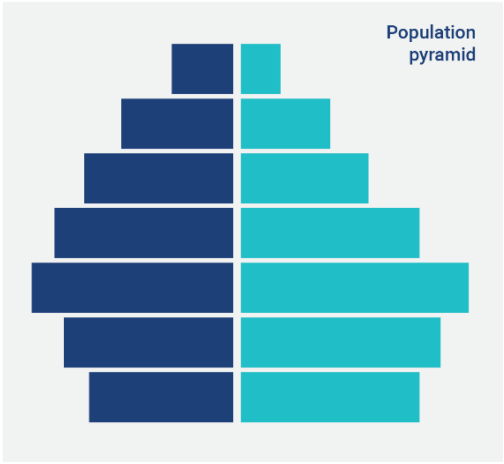


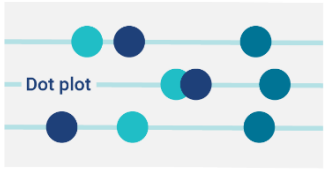


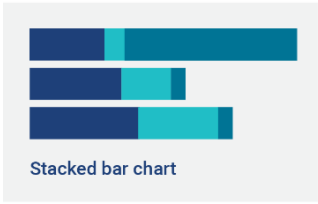


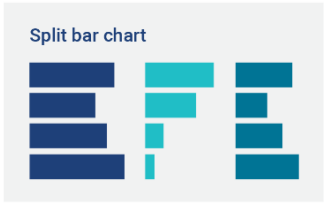
Absolute values

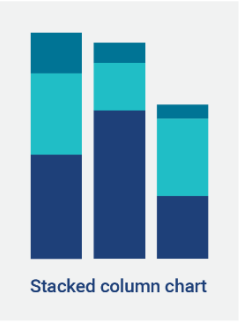


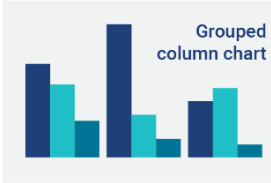


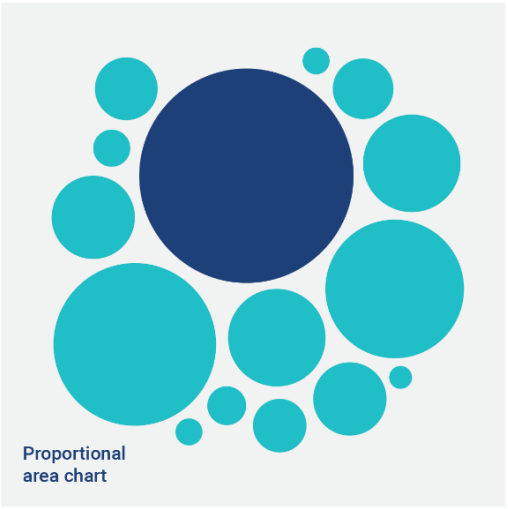




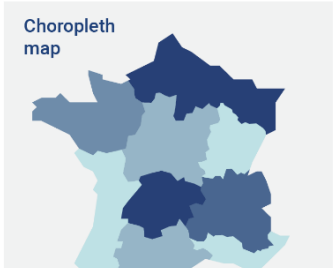








Maps

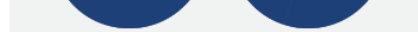


Flows

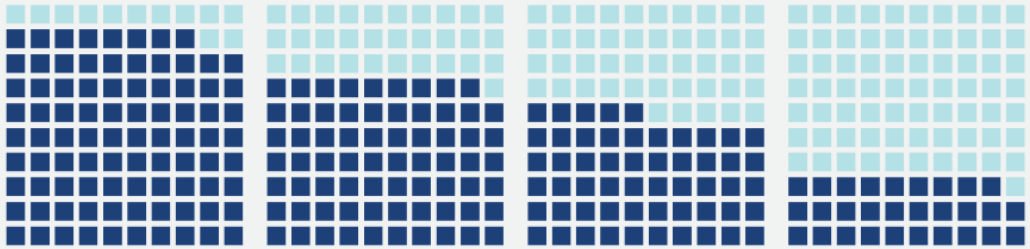
Correlations


Absolute values
Population pyramid
Bar chart
Pictogram chart
Dot plot
Split bar chart
Grouped bar chart
Stacked column chart
Proportional area chart
Grouped column chart
Shares
Donut chart
Pie chart
Parliament chart
Bar chart
Waffle chart
Column chart
Small multiple donut charts
Small multiple waffle charts
Correlations
Stacked bar chart
Pictogram chart
Treemap
Flows

Proportional area chart

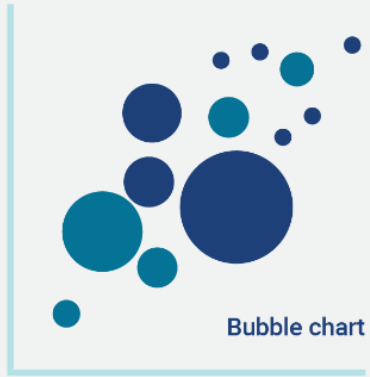


Small multiple donut charts



Small multiple waffle charts

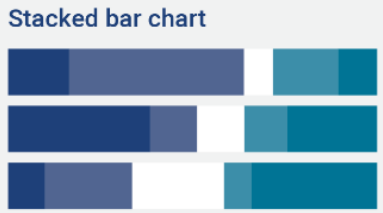
Correlations



Bubble chart

2D histogram/ heatmap

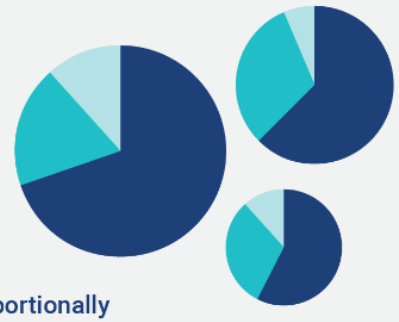
Scatter plot



Stacked bar chart

Pictogram chart

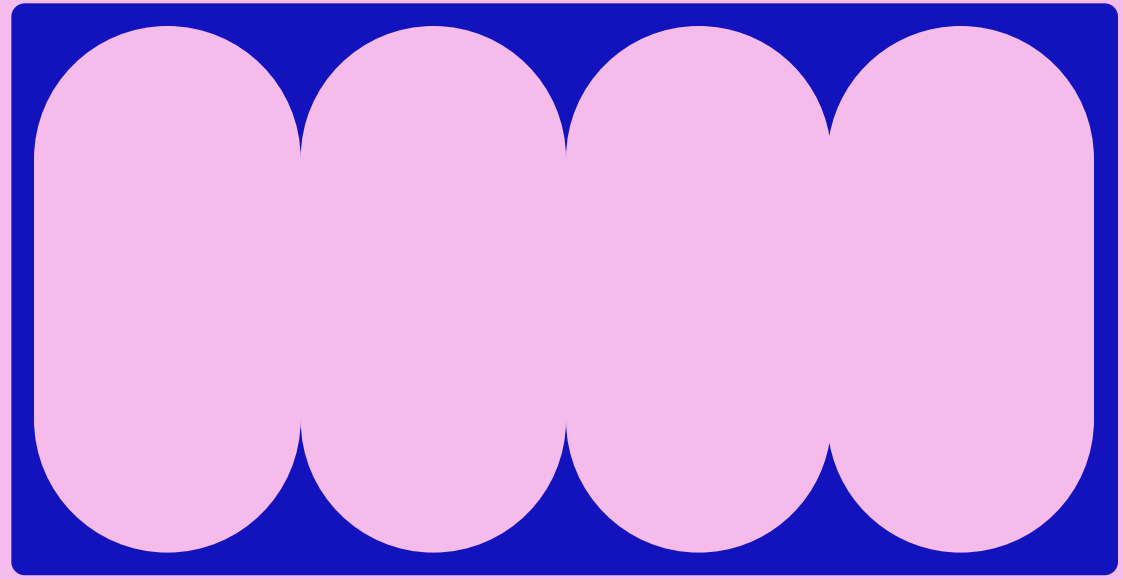
Treemap

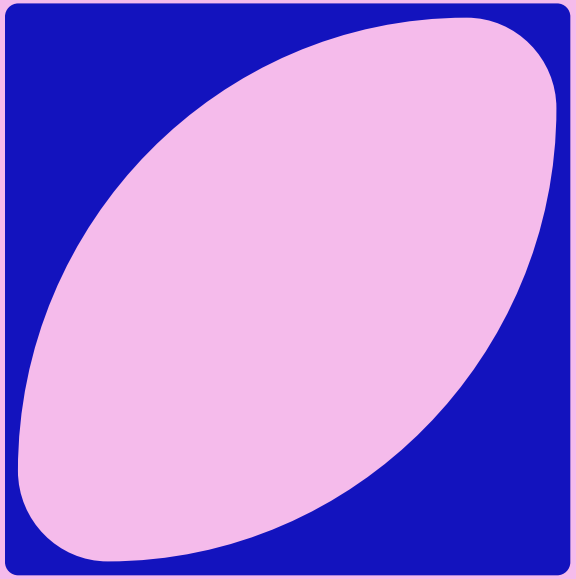


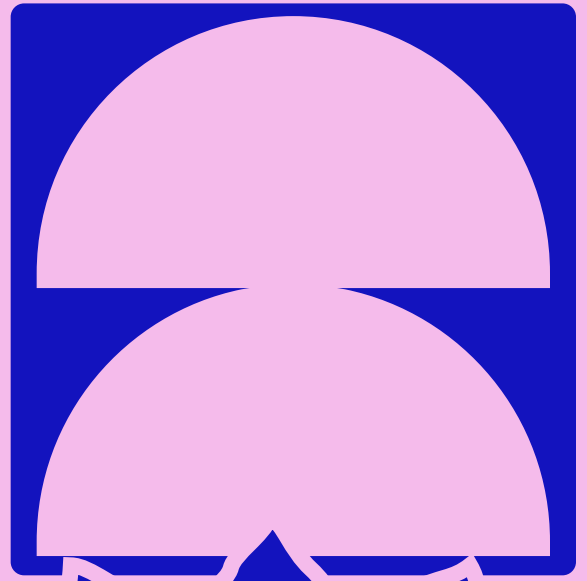
Proportionally sized pie charts

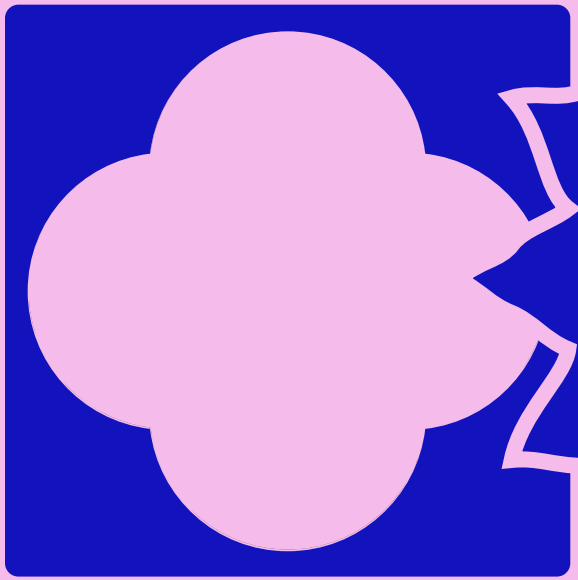
Marimekko chart

SAVE YOURSELF A HEADACHE



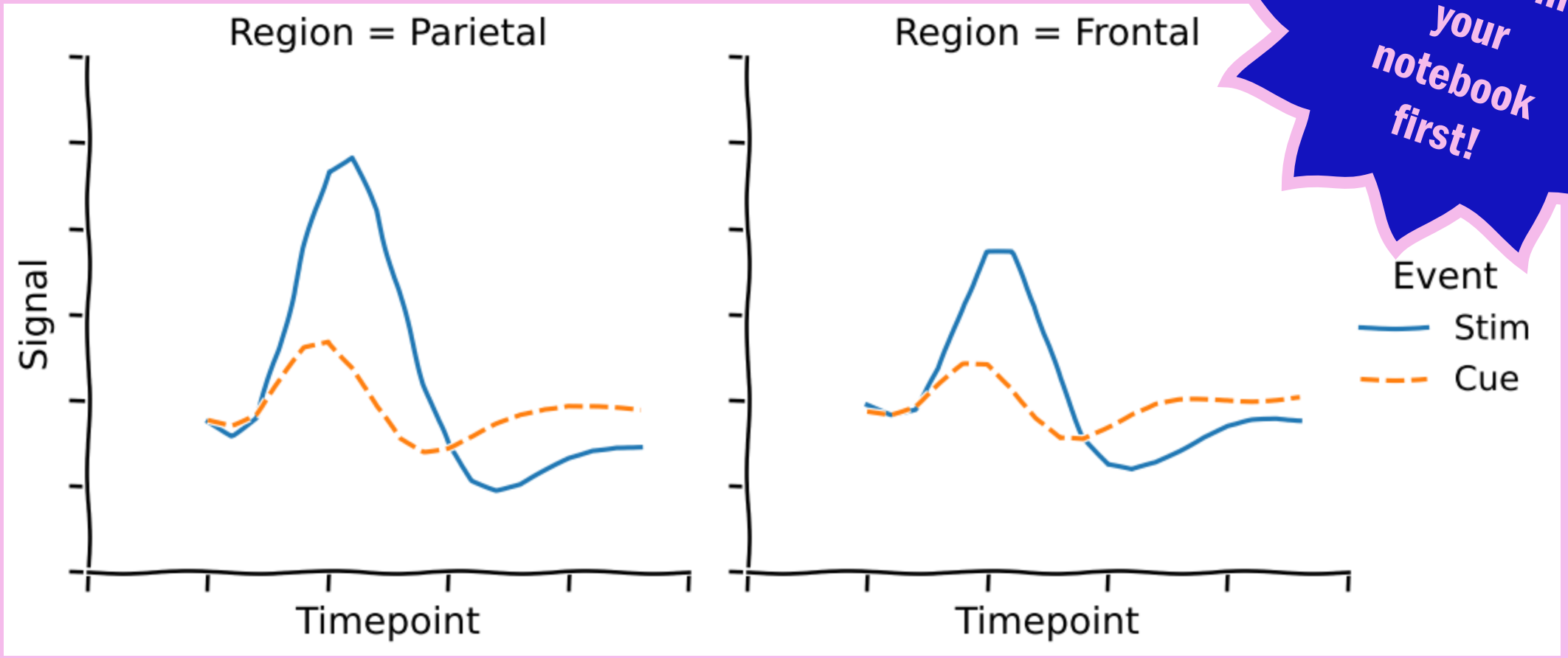




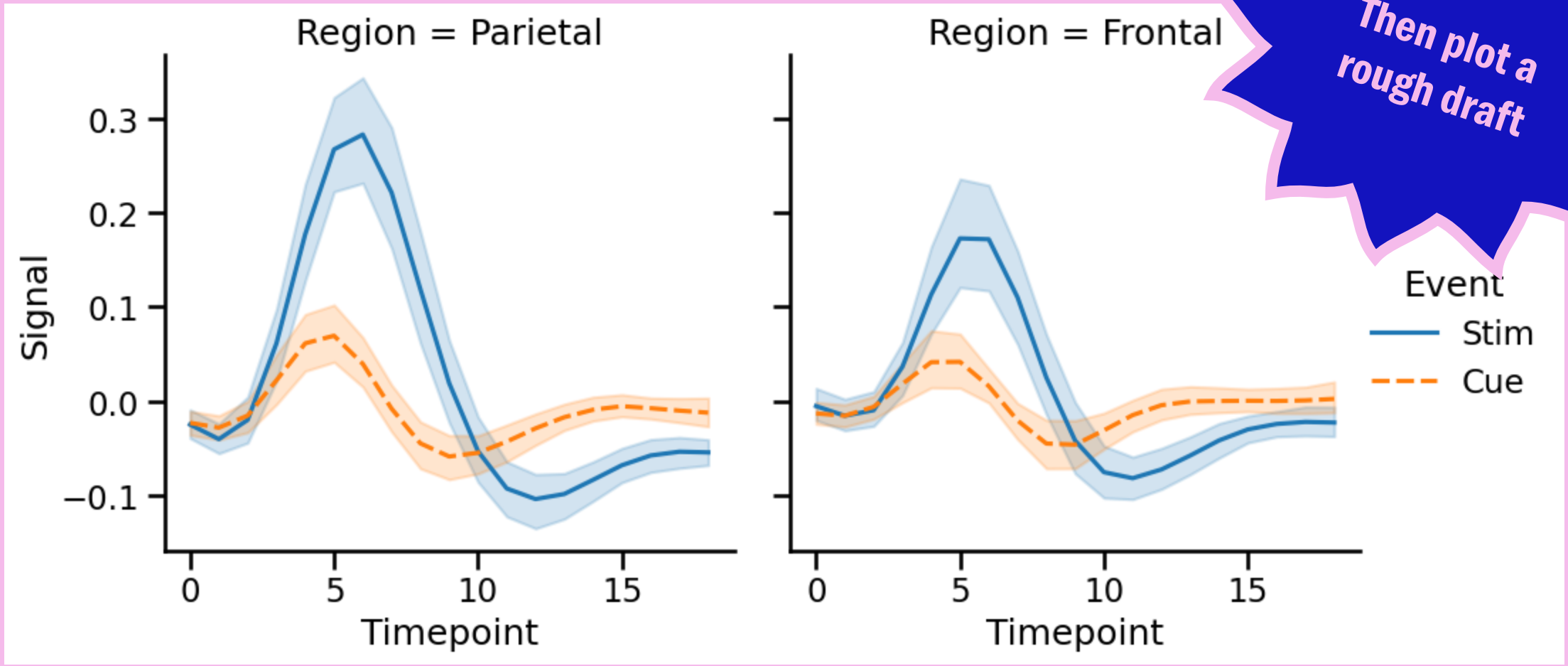


TREAT YOUR FIRST FEW CODED PLOTS AS “SKETCHES” TOO!

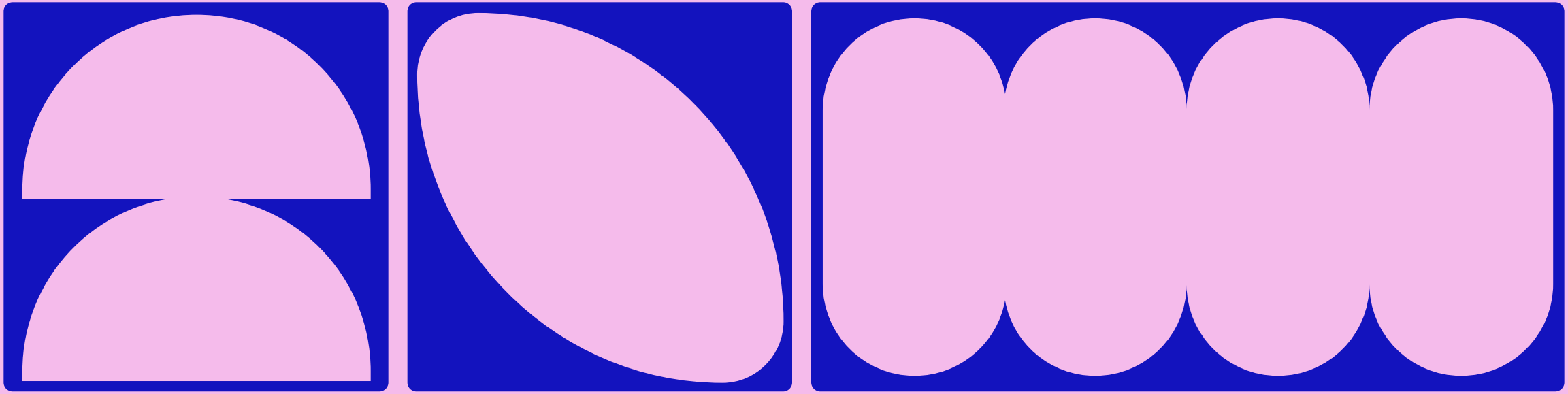
Sketch in your notebook first!



Then plot a rough draft



3. OVERALL PATTERNS OR DETAILS?



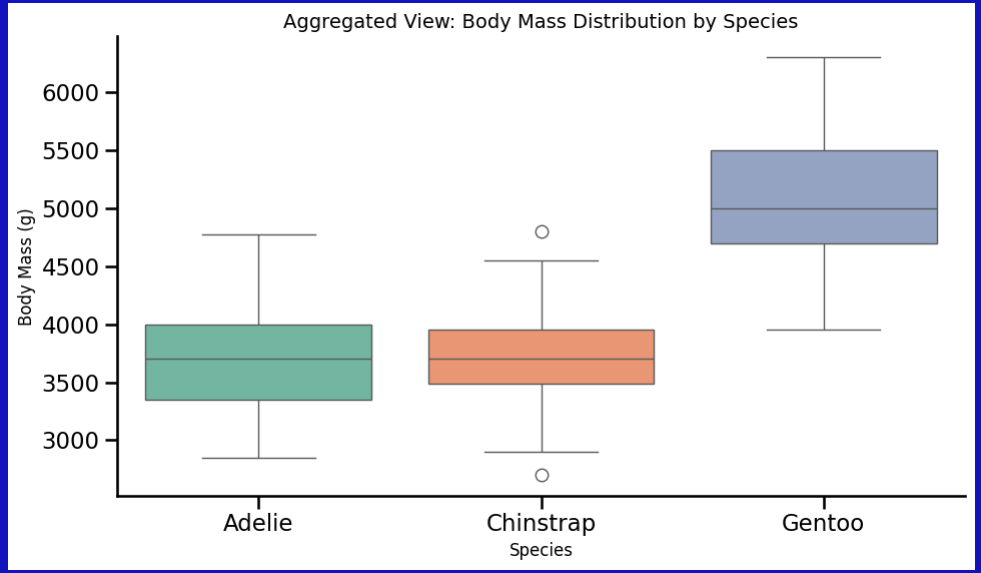
ZOOMED OUT OR IN?

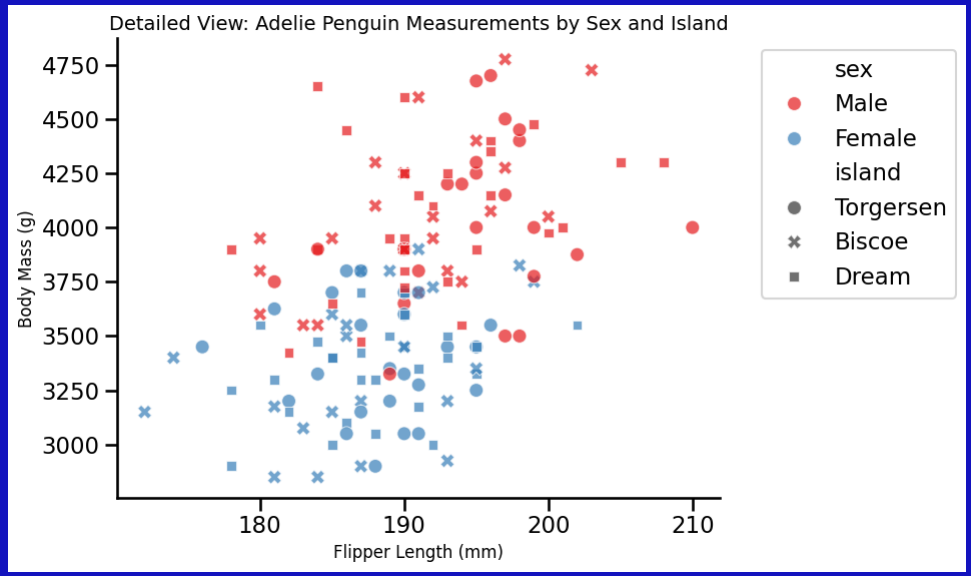
Generally easier to show *either*:

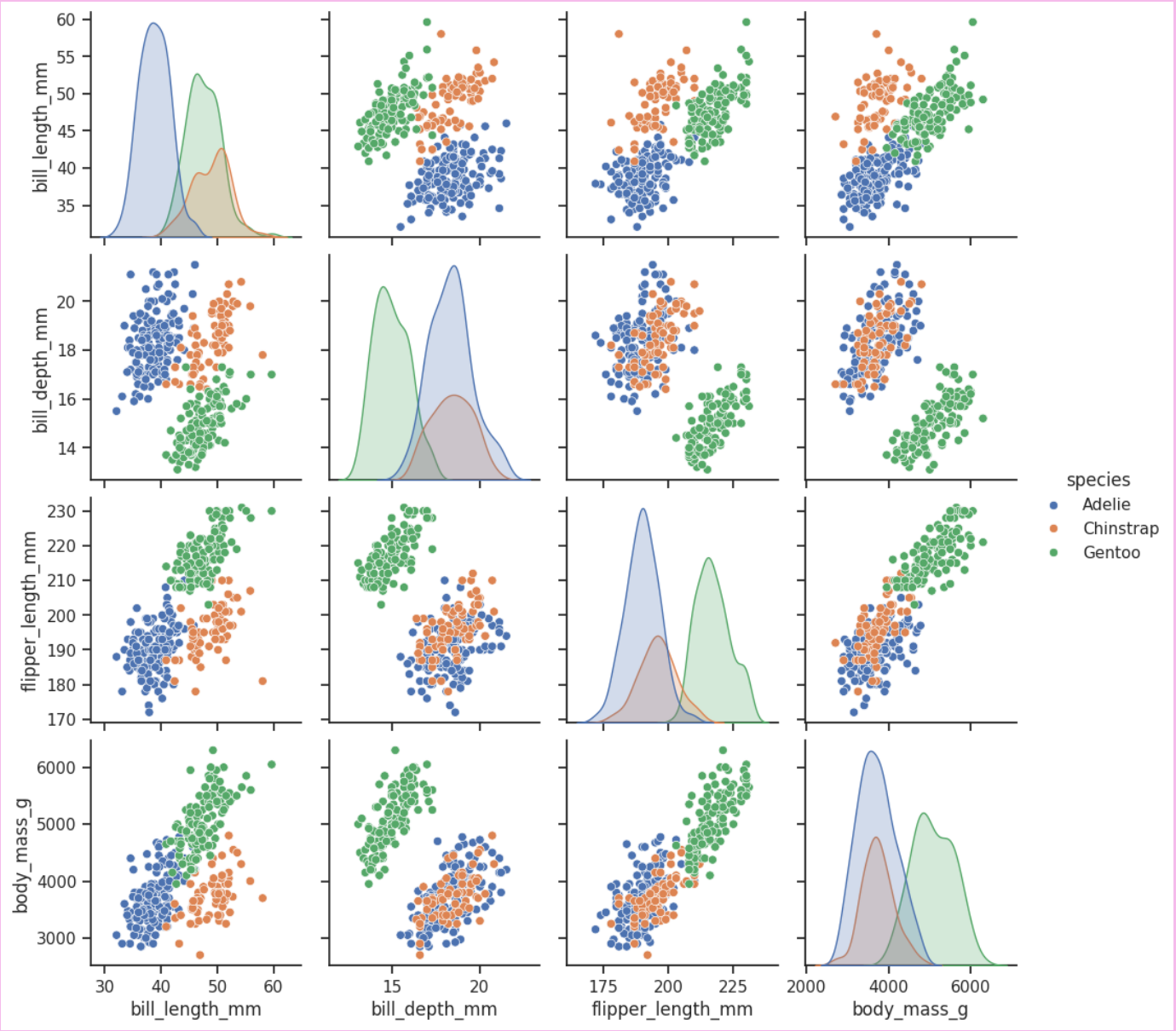
- Zoomed-in, disaggregated, details, *or*
- Zoomed-out, aggregated, large-scale patterns

Can do both in a single plot, but usually a good idea to separate them out!

- Easier to design a “good” visualisation
- Easier to read/understand





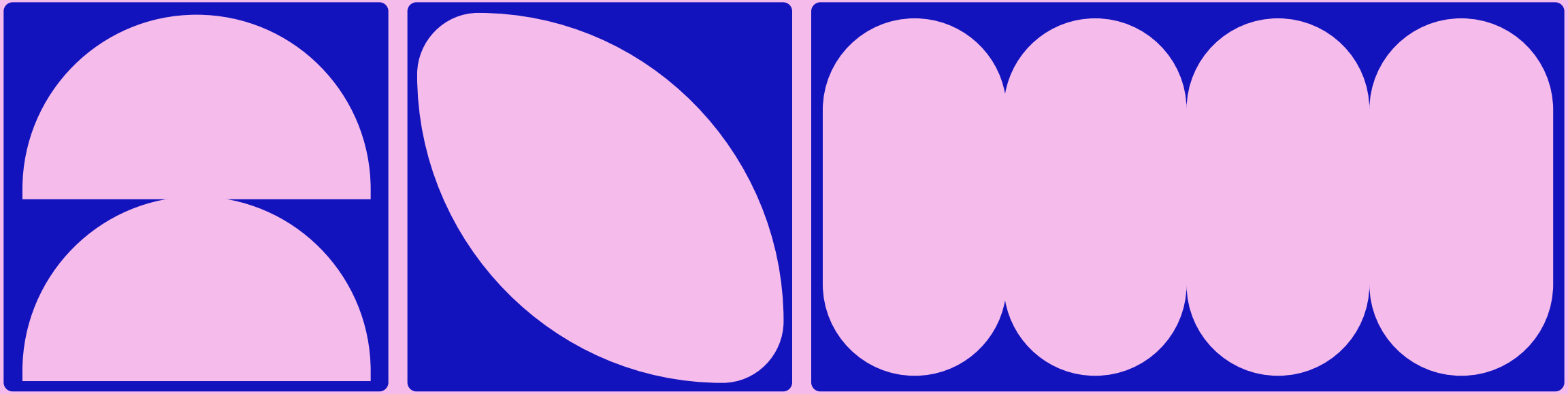


You can try to do both, but it can end up confusing and messy

- Requires intentional planning
- Back to drawing diagrams!!

Experiment with different plot types

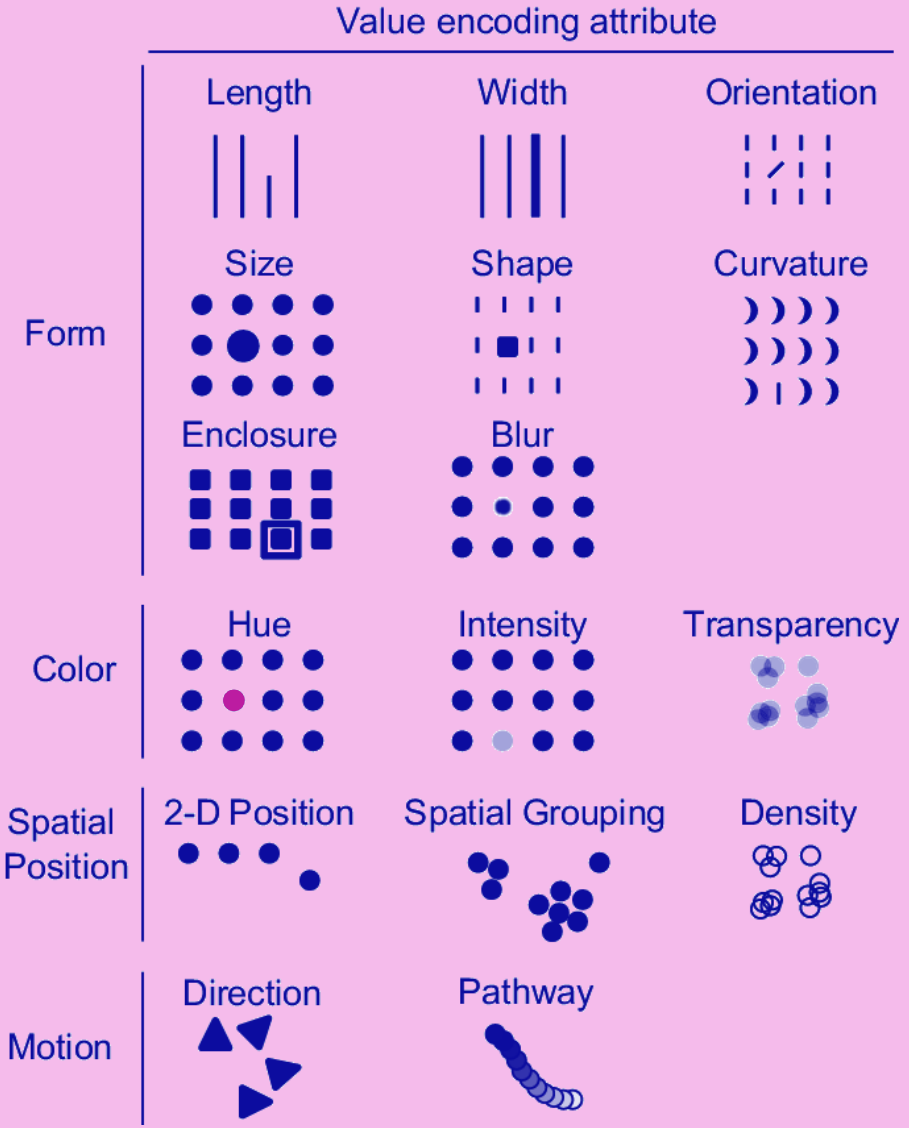
4. PICK INTENTIONAL ENCODINGS



ENCODING

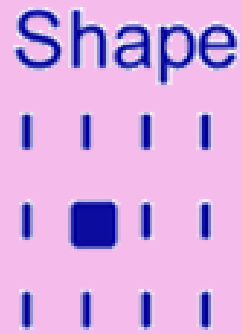
- The mark or shape used to represent the data
- Colour, shape, size, angle

What can different encodings imply?

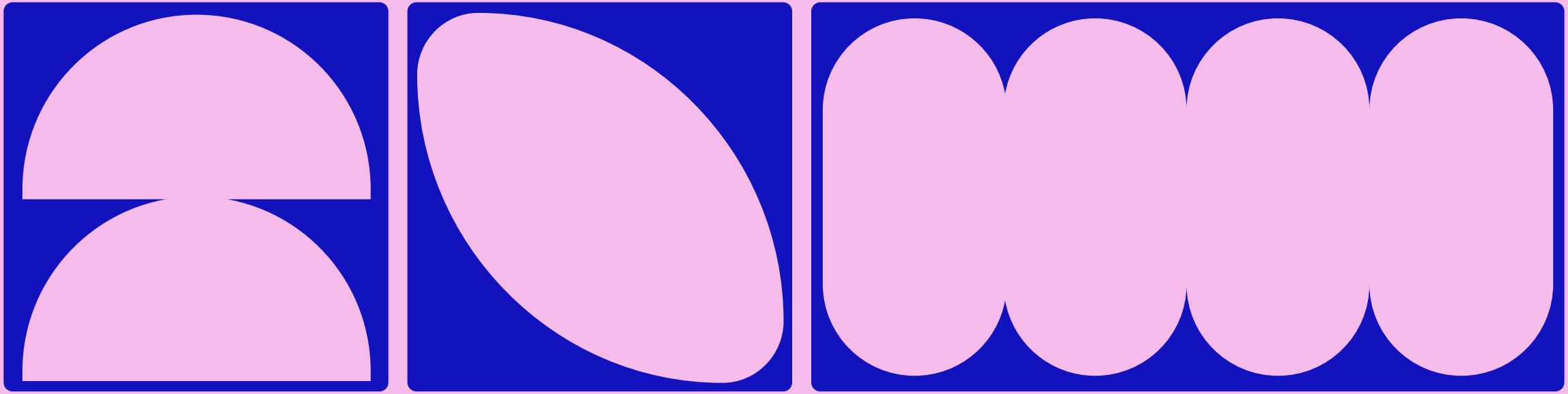


Kelleher & Wagener, 2011

MAY IMPLY ORDERED DATA!

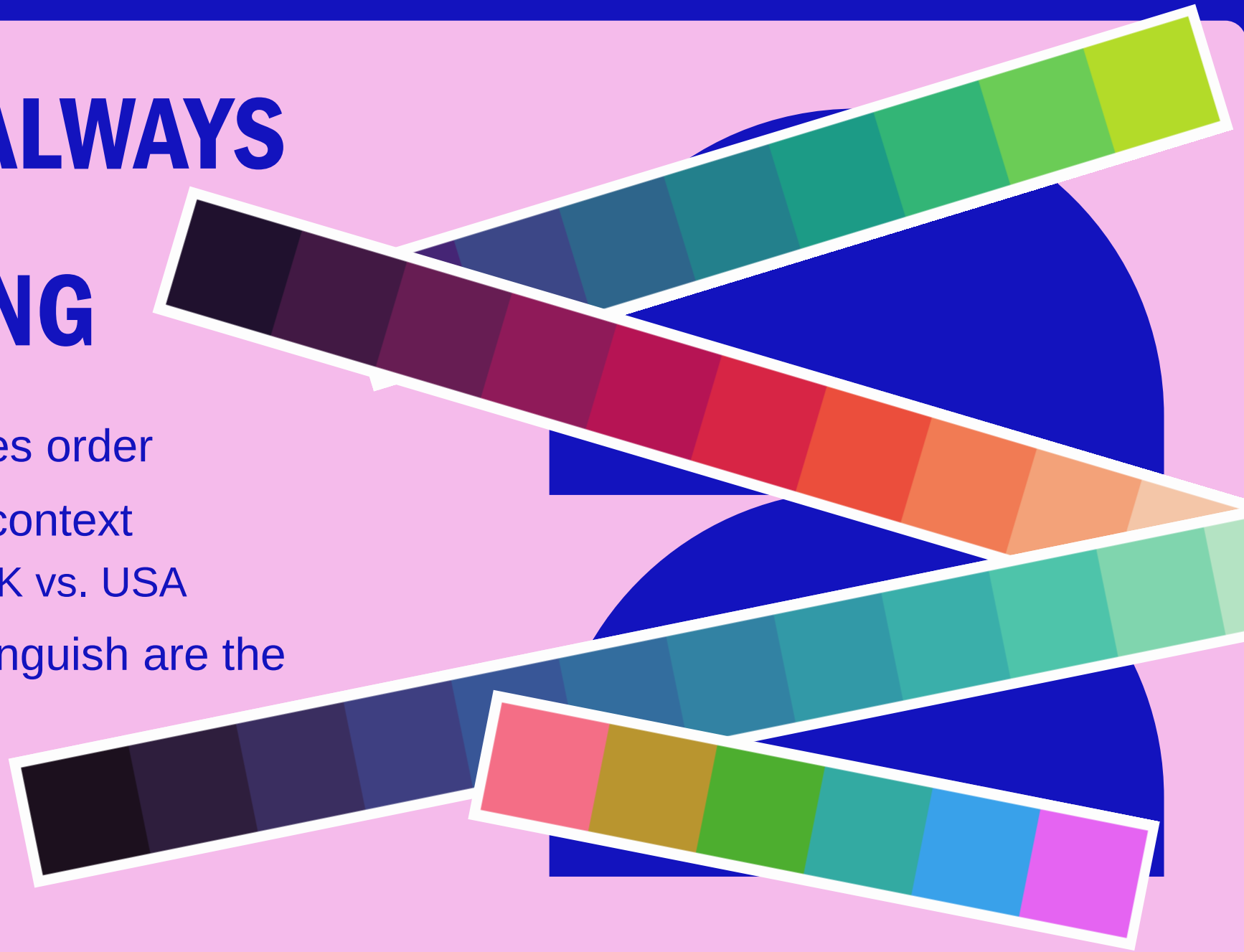


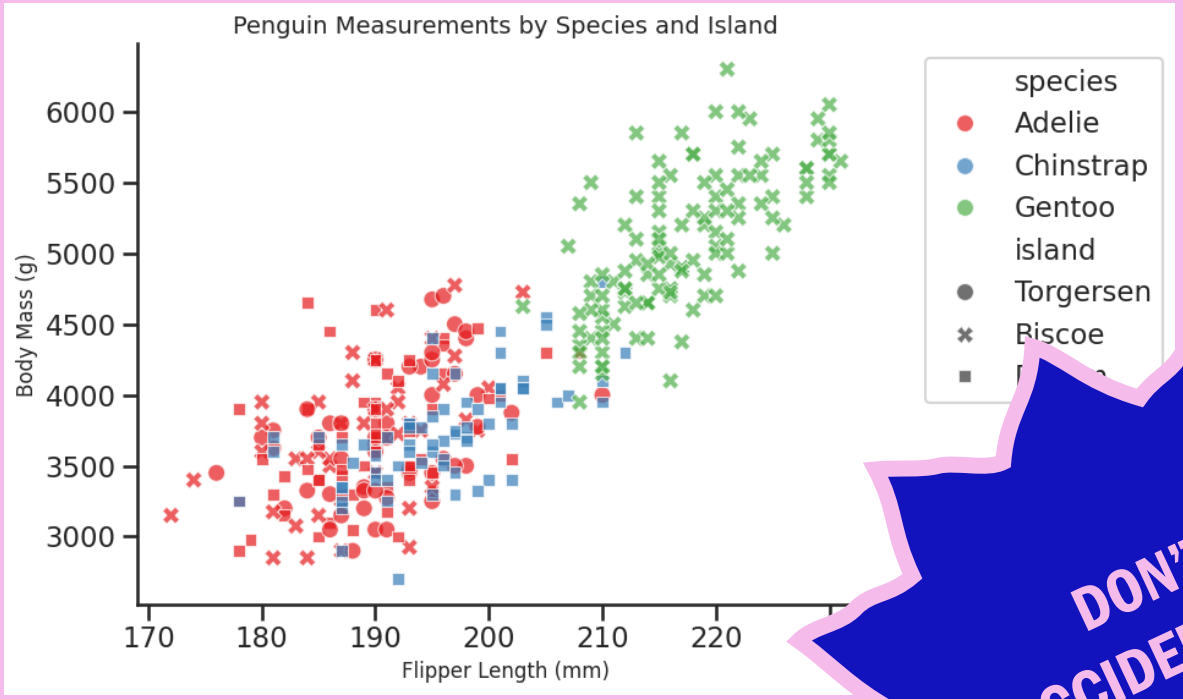
5. CHOOSE COLOURS CAREFULLY

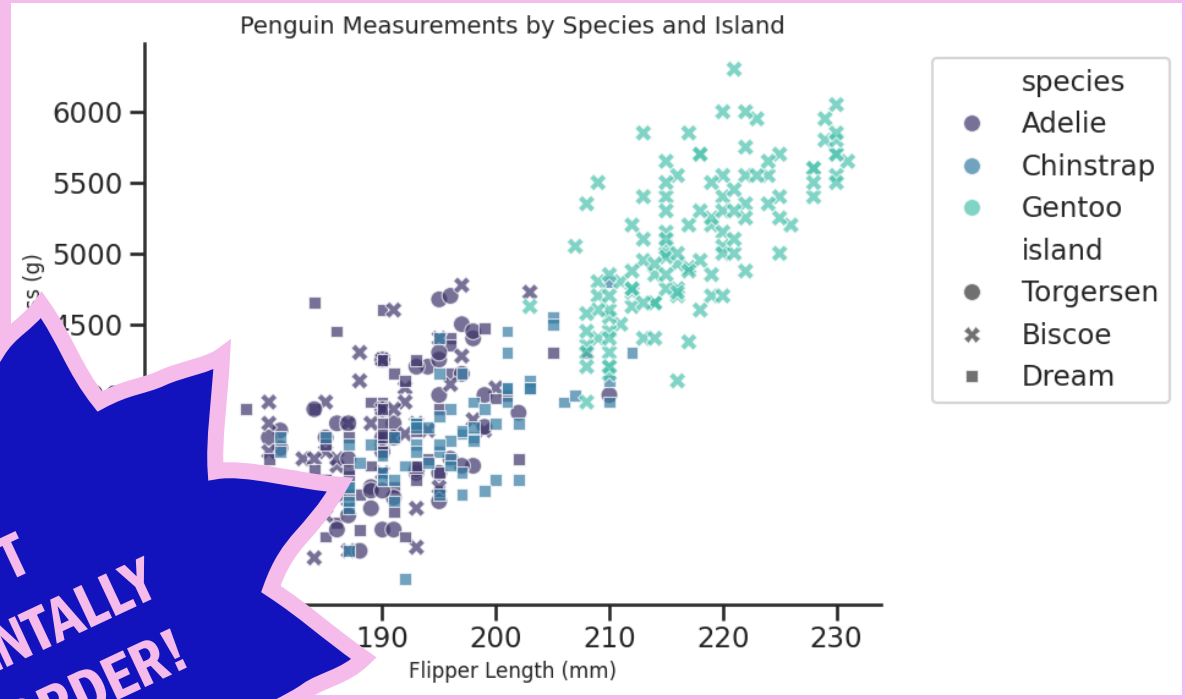


COLOUR ALWAYS MEANS SOMETHING

- Sequential: implies order
- Cultural/political context
  - Blue vs Red in UK vs. USA
- How easy to distinguish are the colours?







DON'T ACCIDENTALLY IMPLY ORDER!

VIZ PALETTE
See your colours in action

By: Elijah Meeks & Susie Lu

Use Chroma.js

Use Colorgorical

Use ColorBrewer

Add

Replace

EDIT

7 Colors

Add

#hex rgb

1 #ffd700
2 #ffb14e
3 #fa8775
4 #ea5f94
5 #cd34b5
6 #9d02d7

Background color: #ffffff

Font color: #000000

COLORS IN ACTION

Charts made with Semiotic

Color Population:

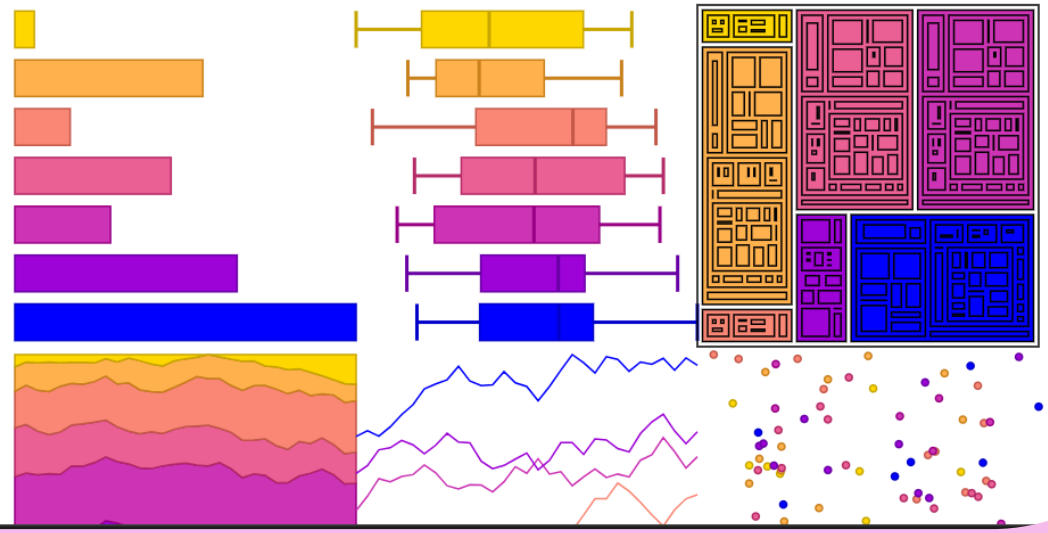
No Color Deficiency - 96% | Deuteranomaly - 2.7% | Protanomaly - 0.66%

Protanopia - 0.59% | Deuteranopia - 0.56% | Greyscale

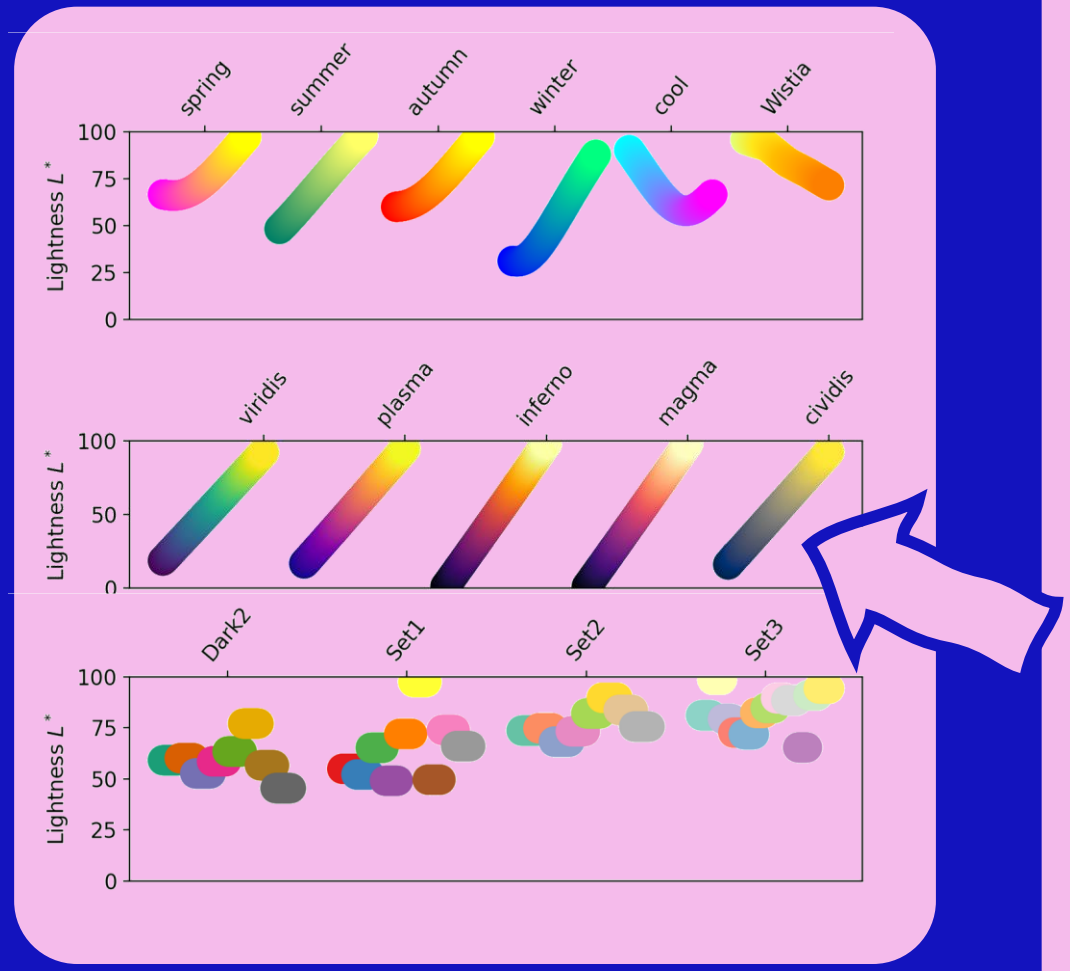
Sample font

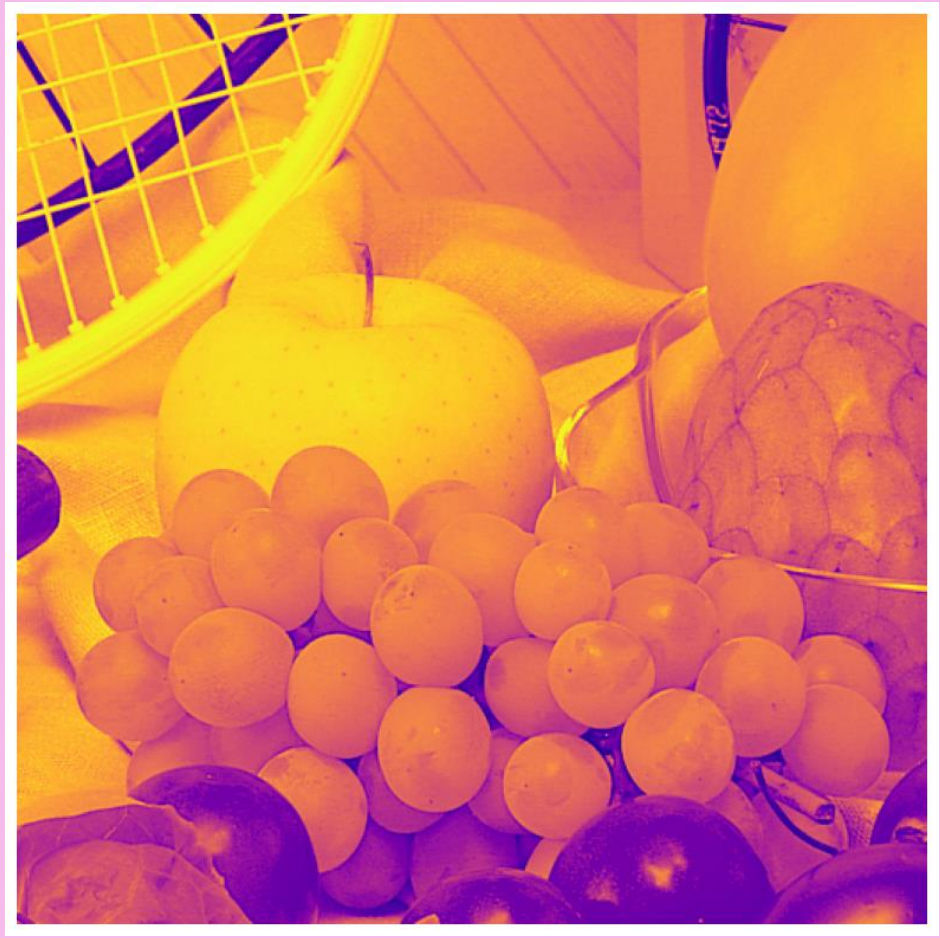
Randomize Data

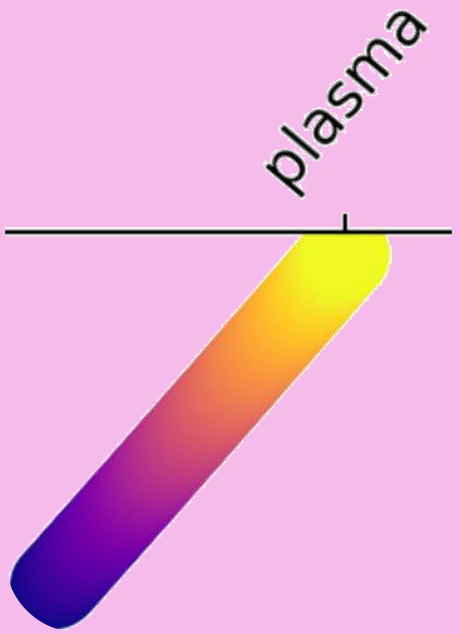
Stroke: Dark None

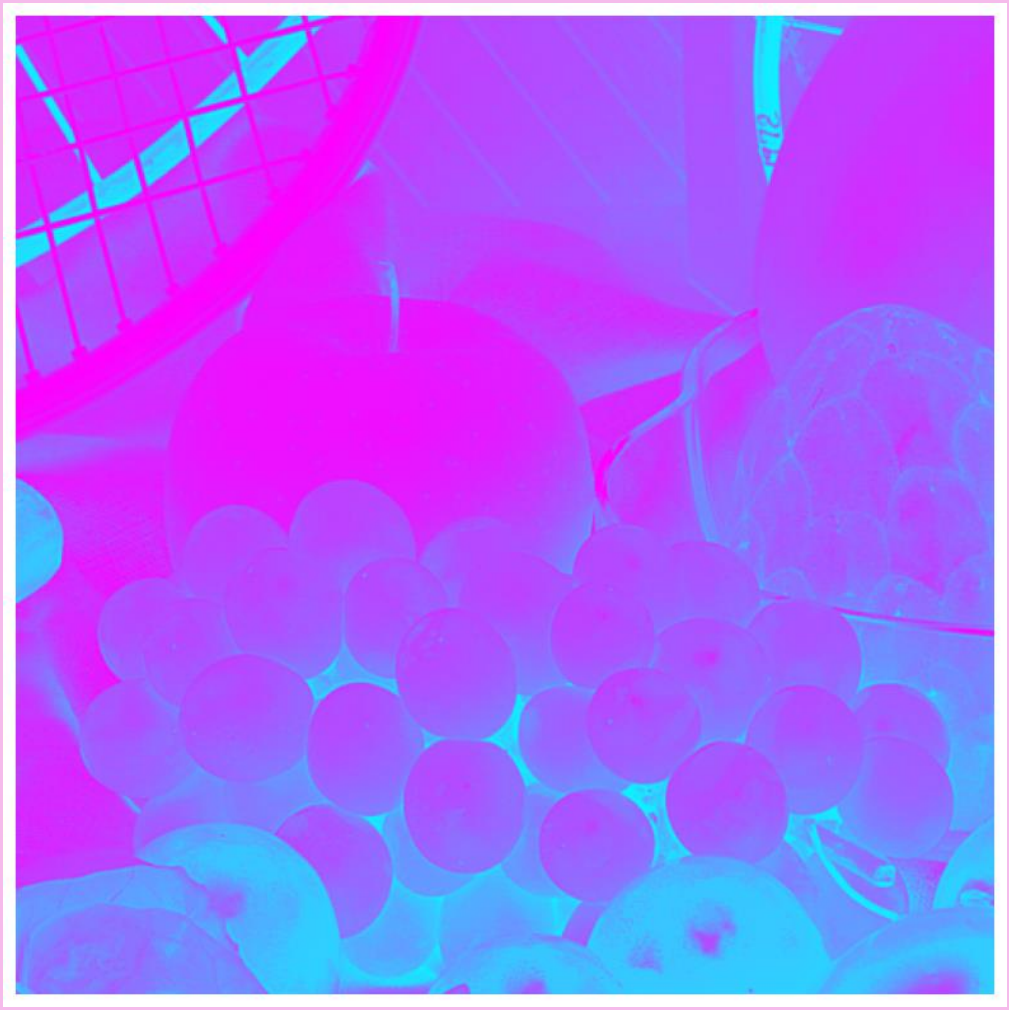


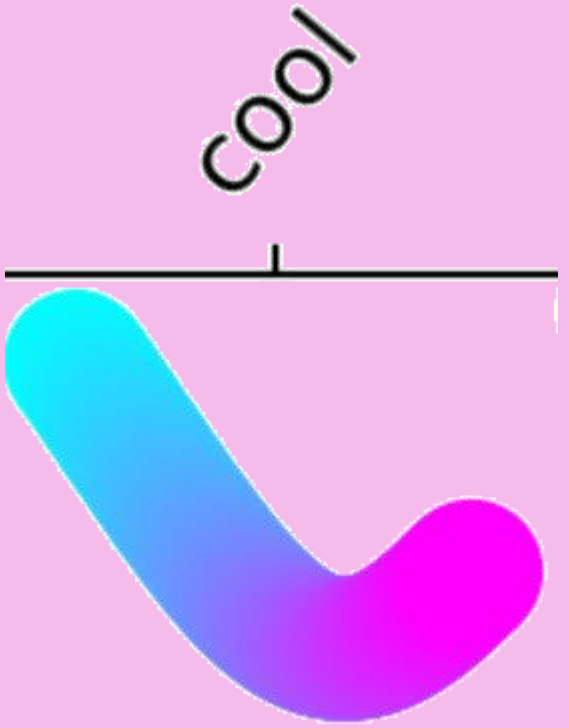
PERCEPTUALLY UNIFORM SEQUENTIAL COLOURMAPS

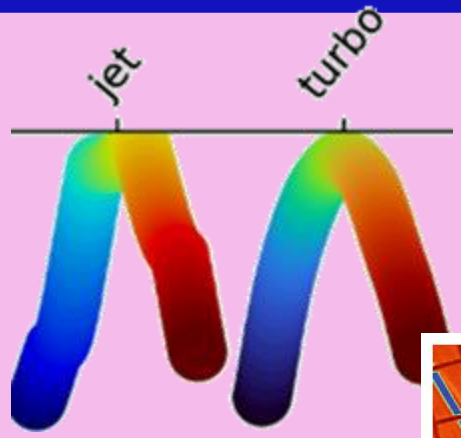


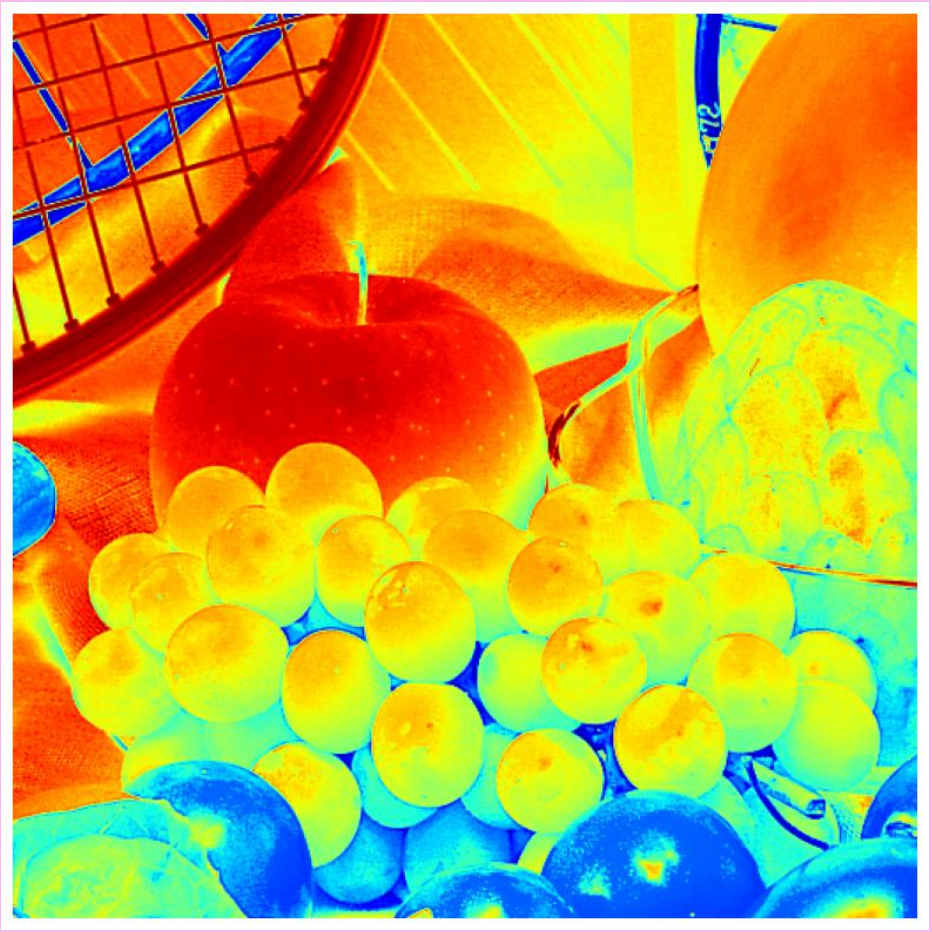


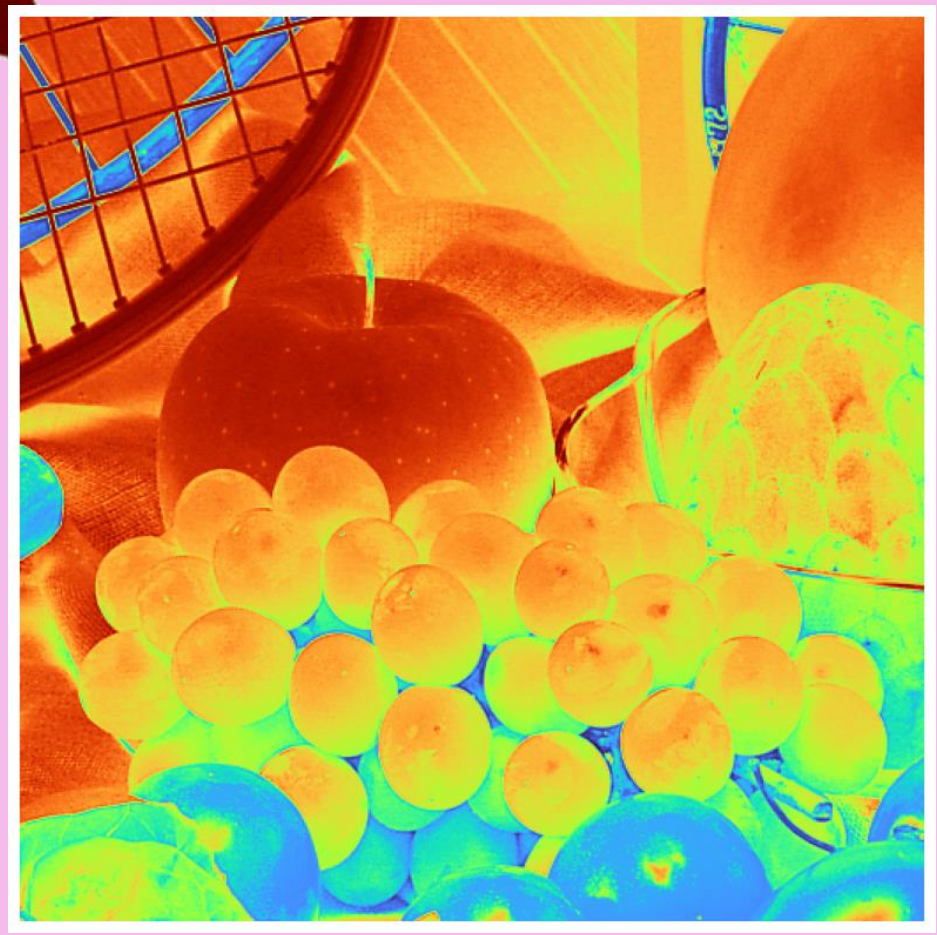

plasma

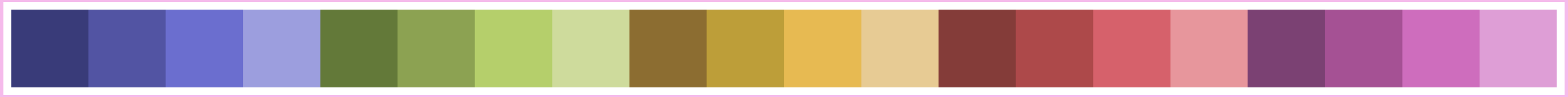



cool


jet
turbo





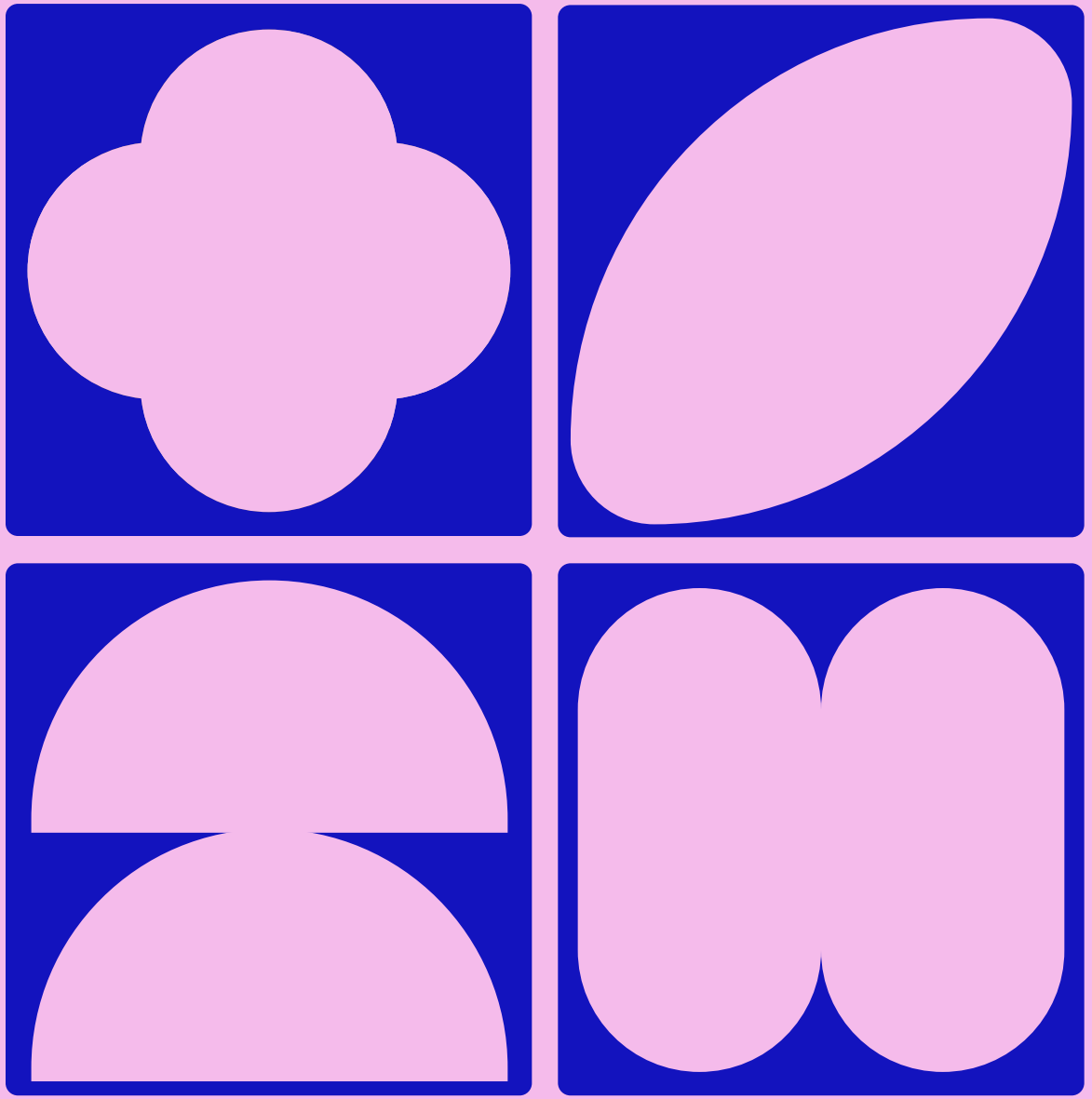


tab20b

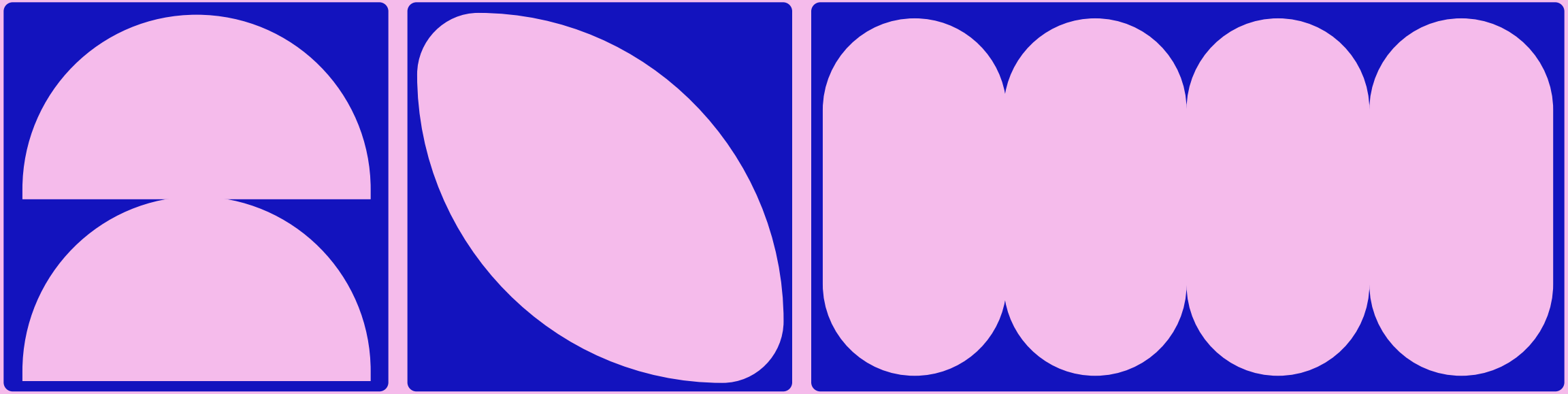
BUILD ON OTHER'S WORK

Some fantastic pre-made palettes:

- IBM Design Language colour palette
- Seaborn colour palettes
- Matplotlib Colourmaps
- "Color Map Advice for Scientific Visualization"



6. SHOW UNCERTAINTY

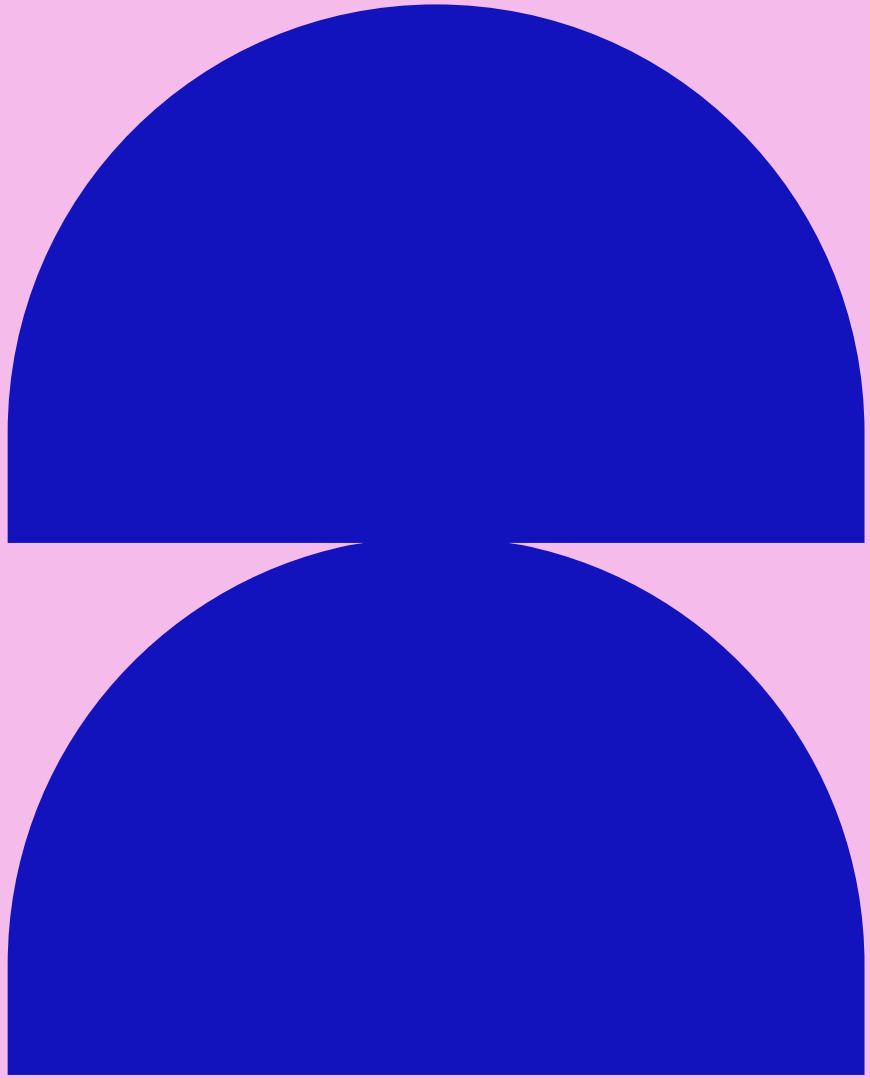


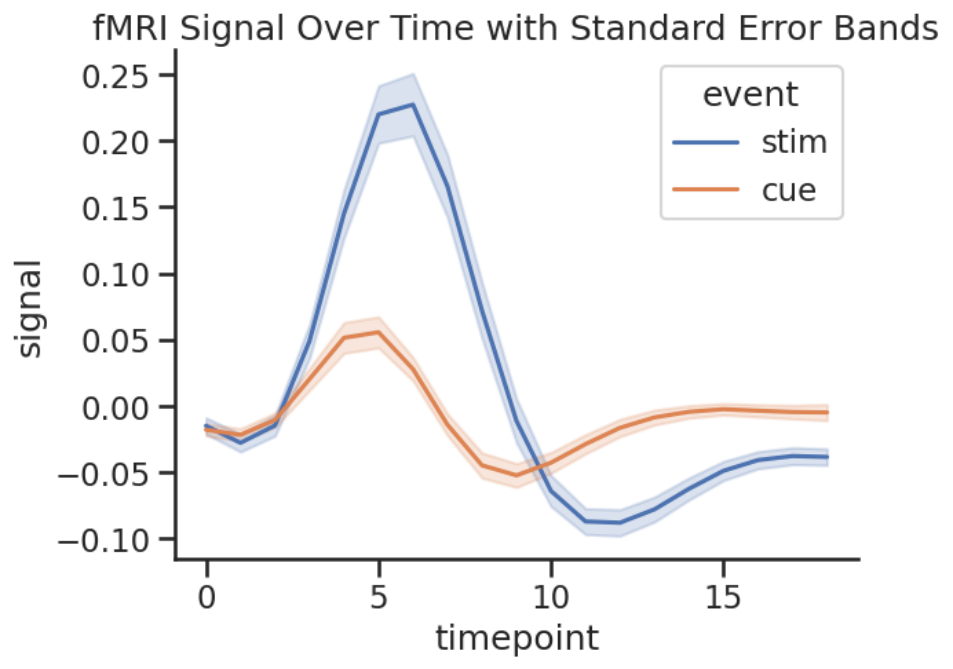
PLOTTING UNCERTAINTY

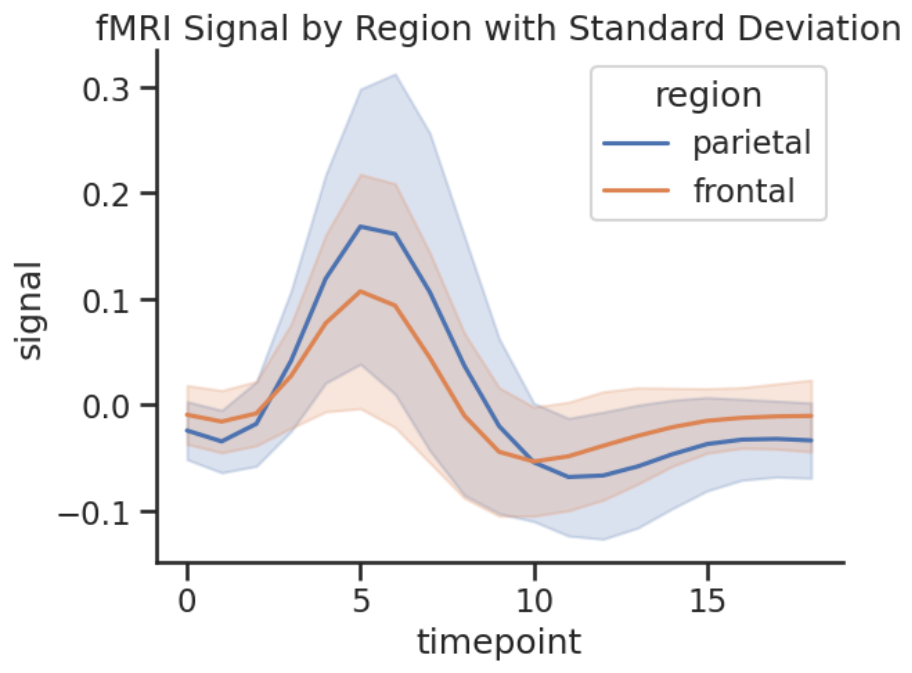
Data is never complete or perfect:

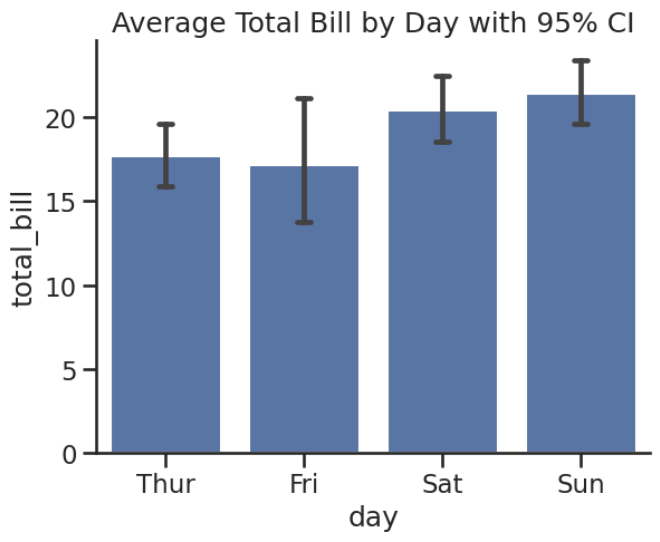
- Make limitations, uncertainty, and data quality visible
- Show confidence intervals, error bars, ranges
- Consider different plot types for statistical measures
- Understand the mental shortcuts people may take when looking at your plot
  - How can they misinterpret uncertainty?

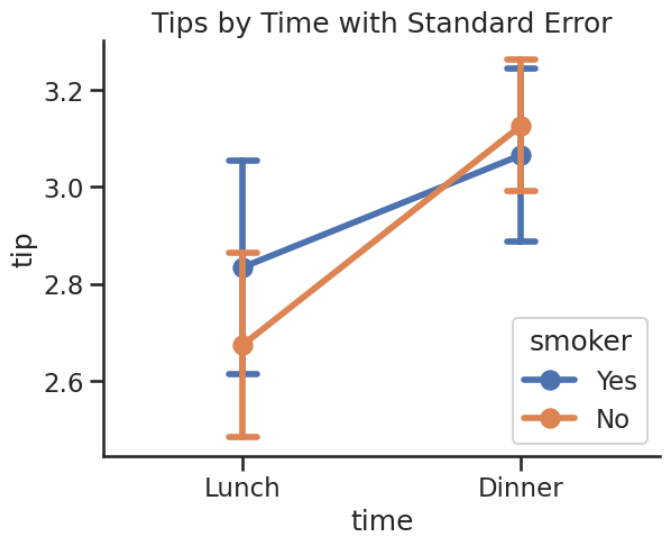
Visualizing uncertainty in Fundamentals of Data Visualization, Wilke, 2019



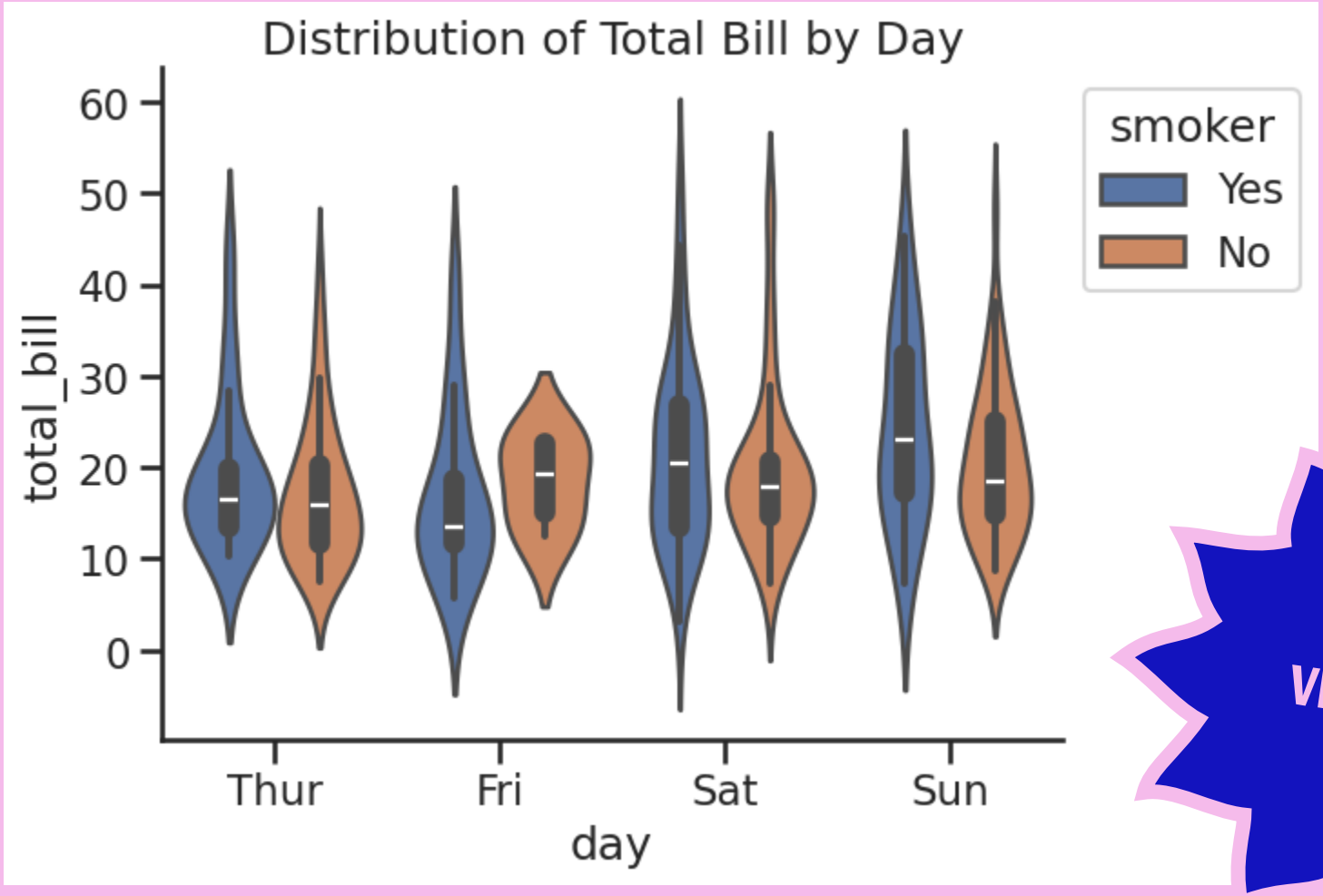






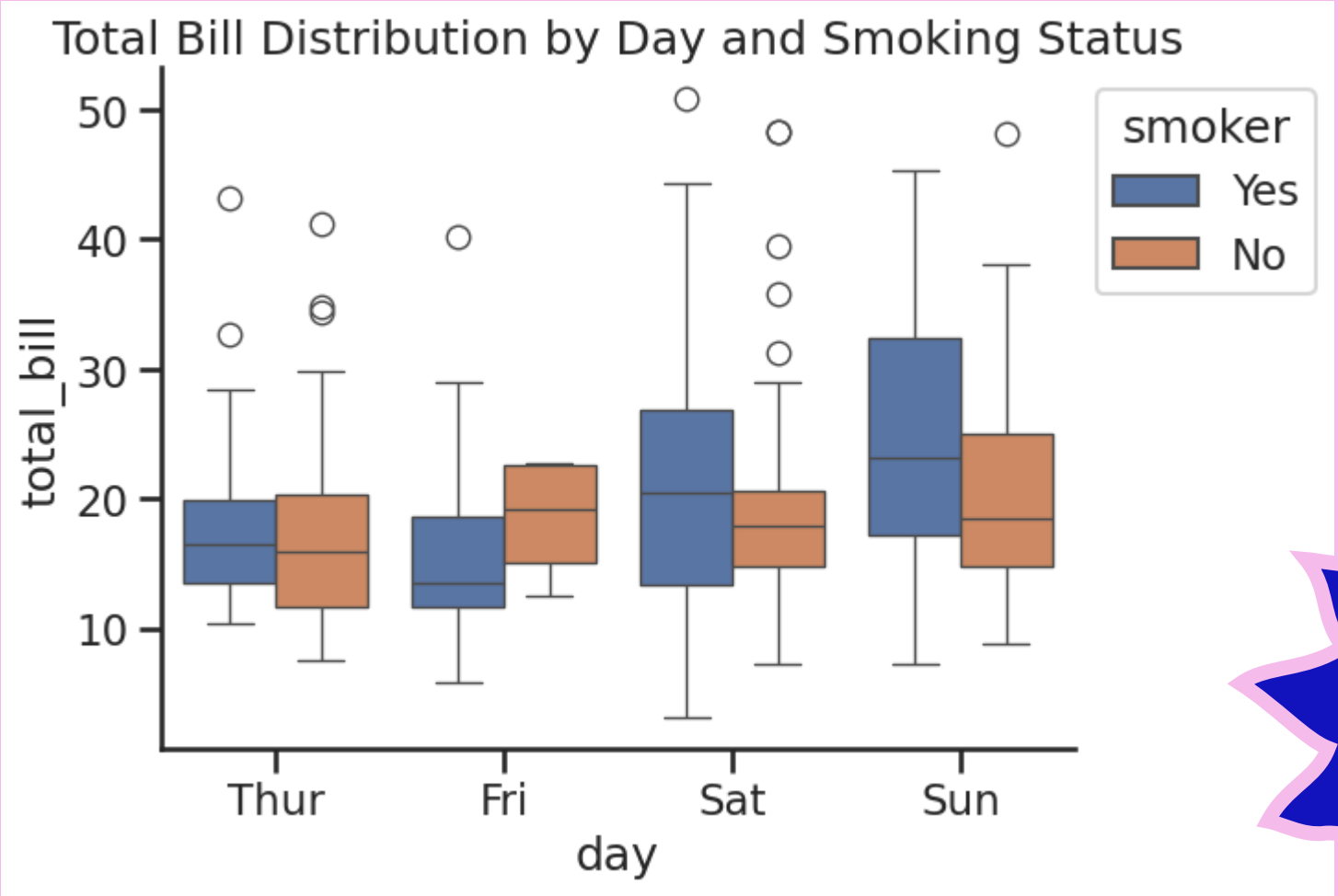


We can use error bars/envelopes to show uncertainty for different plot types



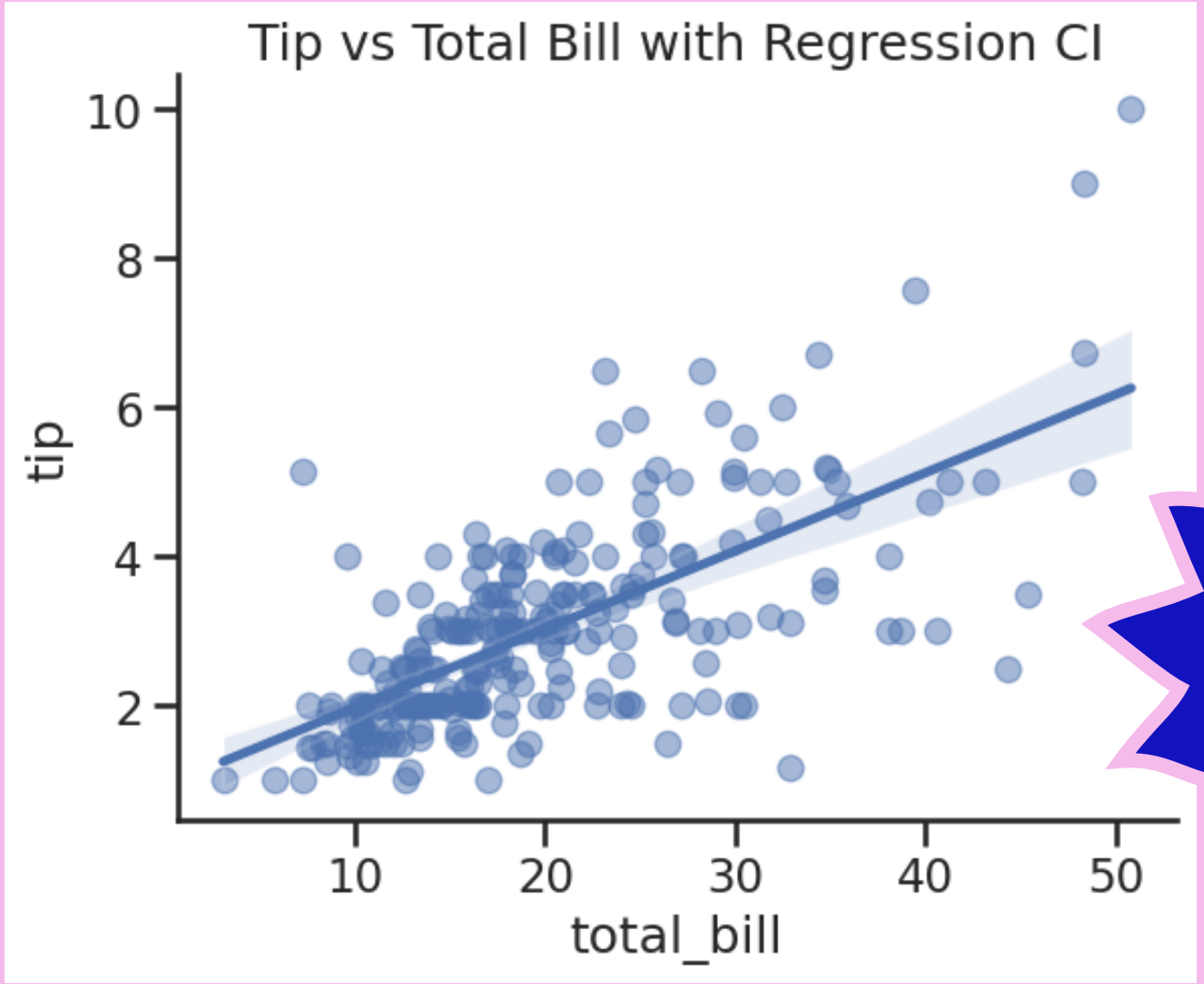
Or we can use a plot specifically designed for uncertainty!

VIOLIN PLOT



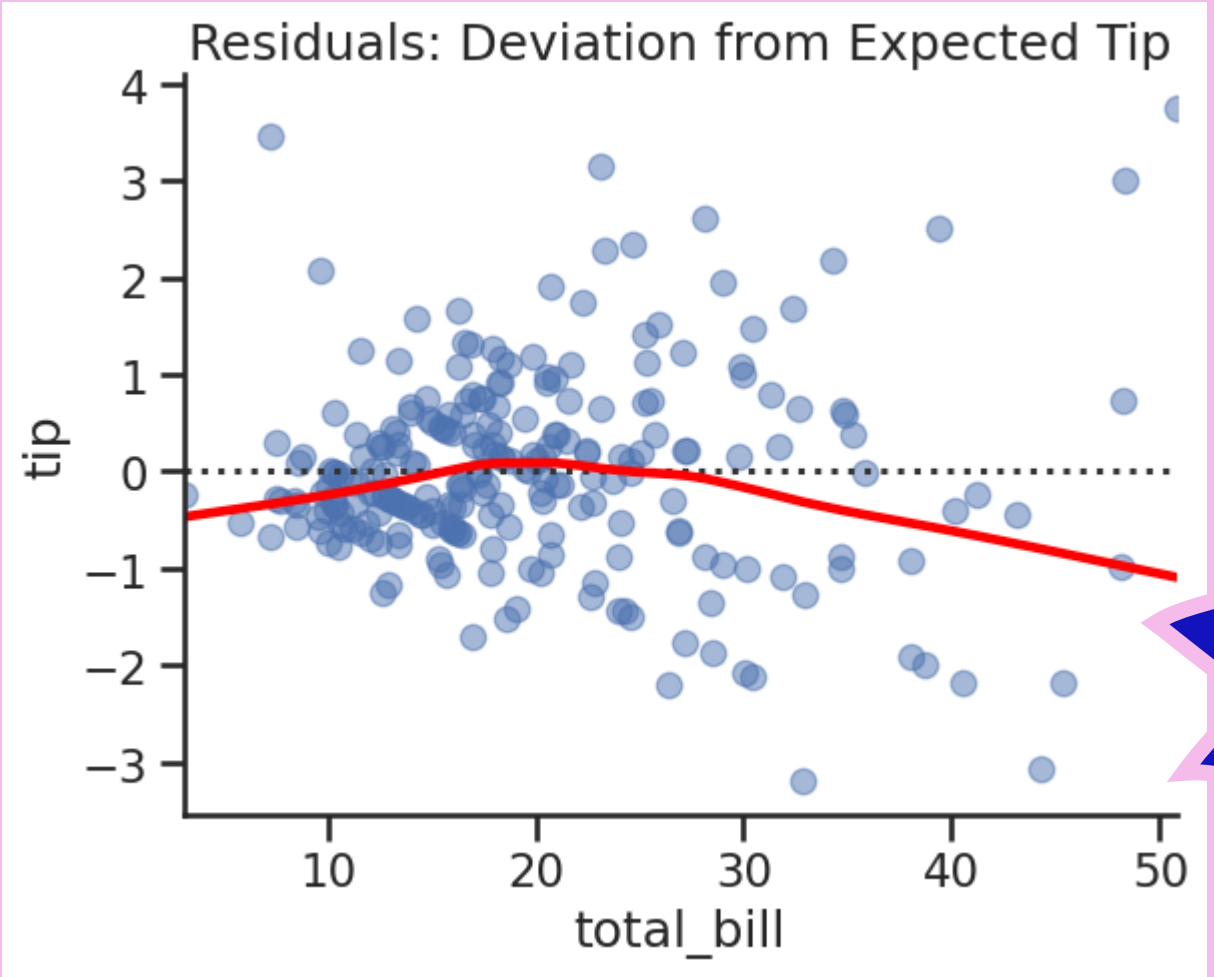
Or we can use a plot specifically designed for uncertainty!

BOX PLOT WITH QUARTILE UNCERTAINTY



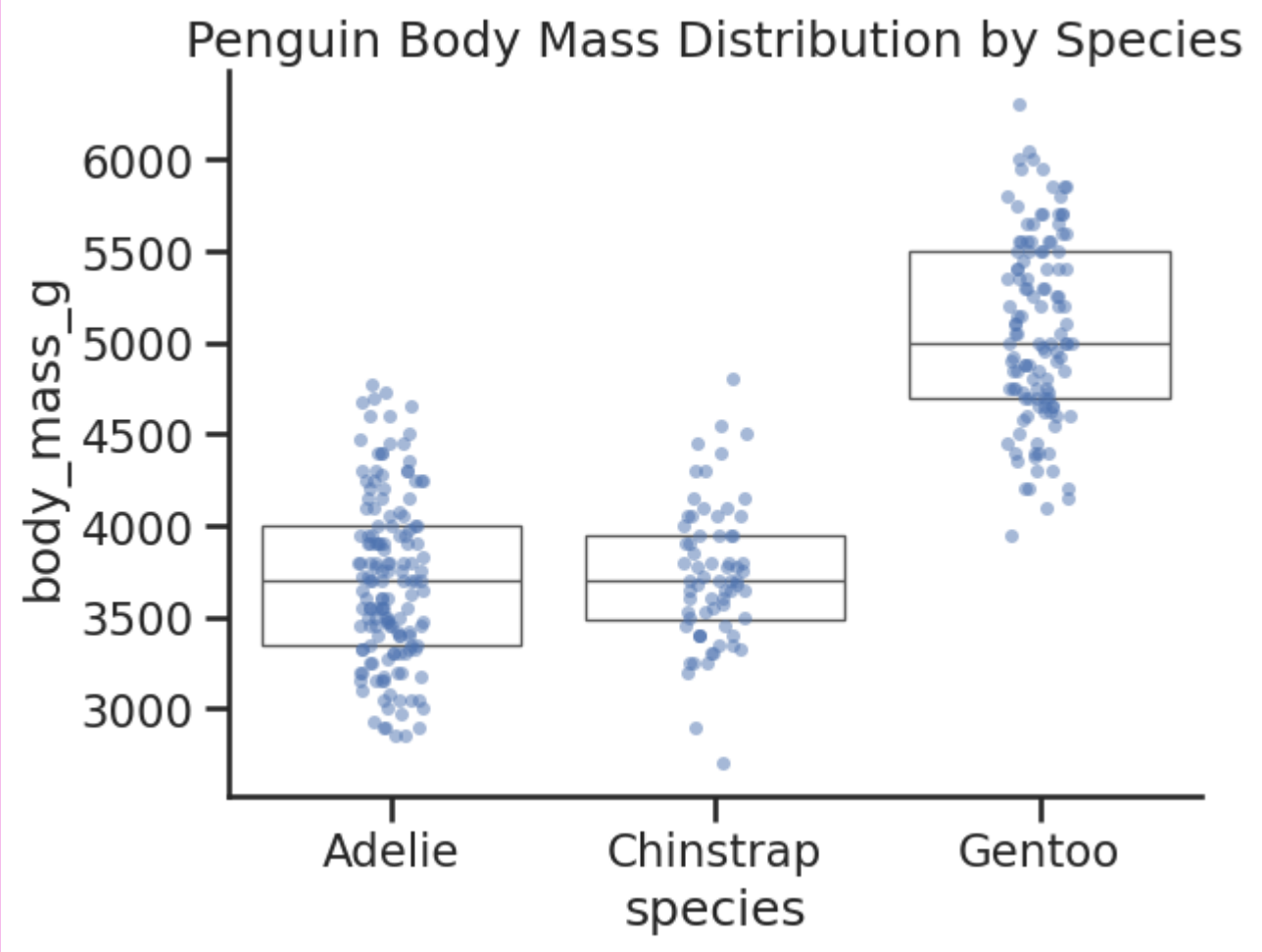
Or we can use a plot specifically designed for uncertainty!

REGRESSION PLOT WITH CONFIDENCE BAND



Or we can use a plot specifically designed for uncertainty!

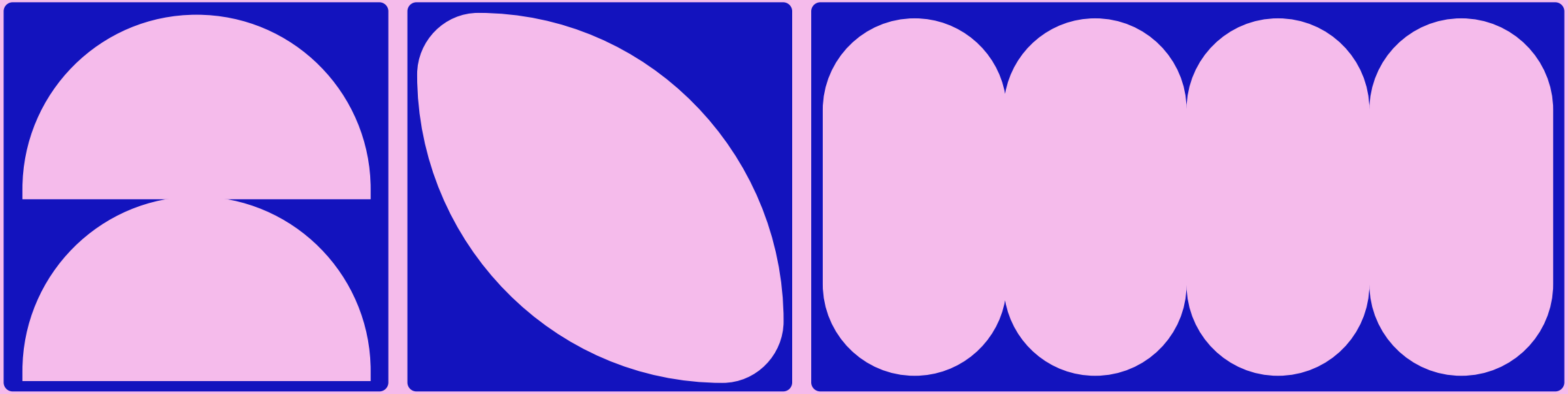
RESIDUAL PLOT SHOWING PREDICTION UNCERTAINTY



Or we can use a plot specifically designed for uncertainty!

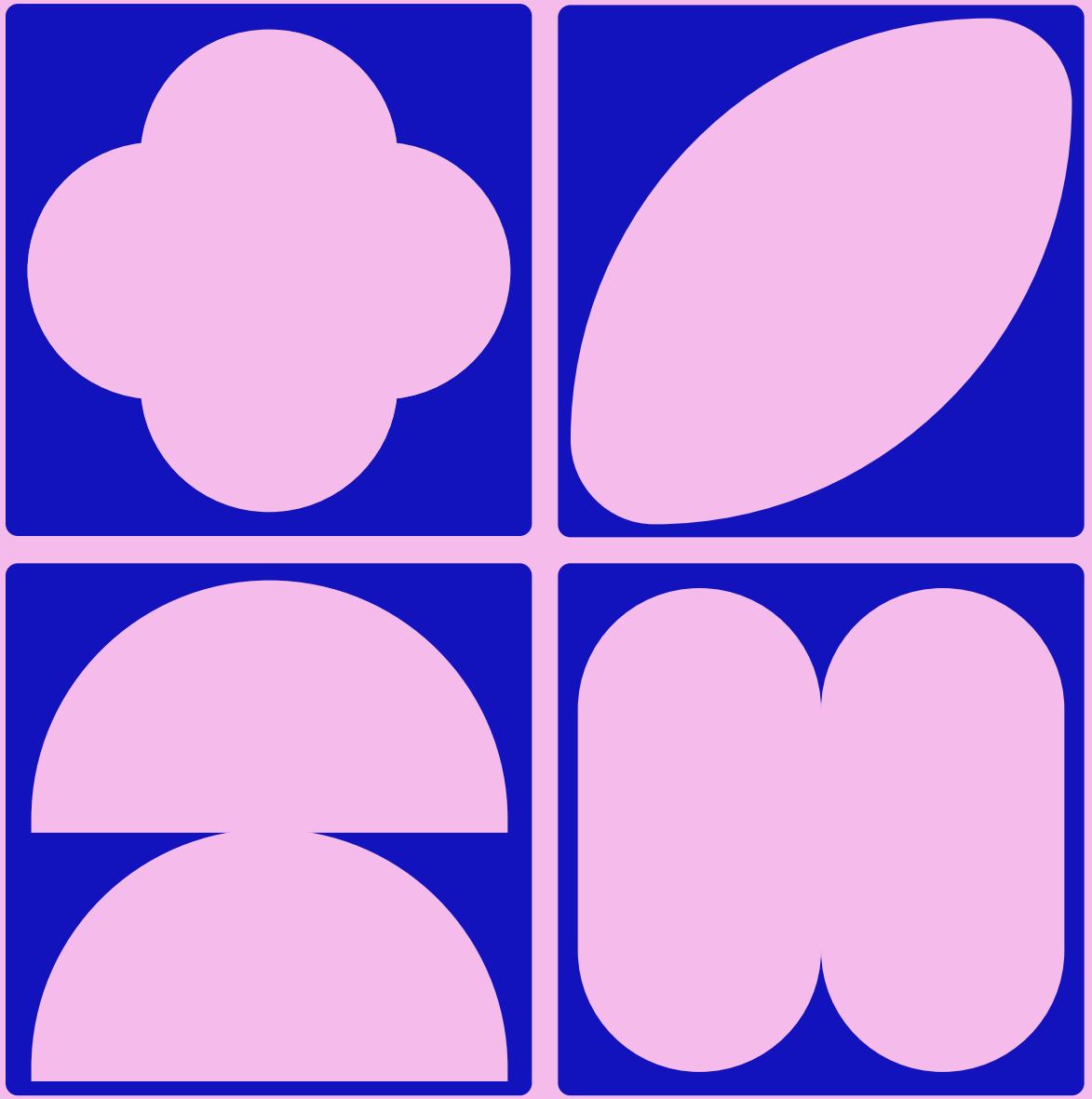
STRIP PLOT WITH BOX PLOT OVERLAY

7. MAKE IT ACCESSIBLE



SPECIFICALLY REFERRING TO ACCESSIBILITY FOR AUDIENCES WITH DISABILITIES

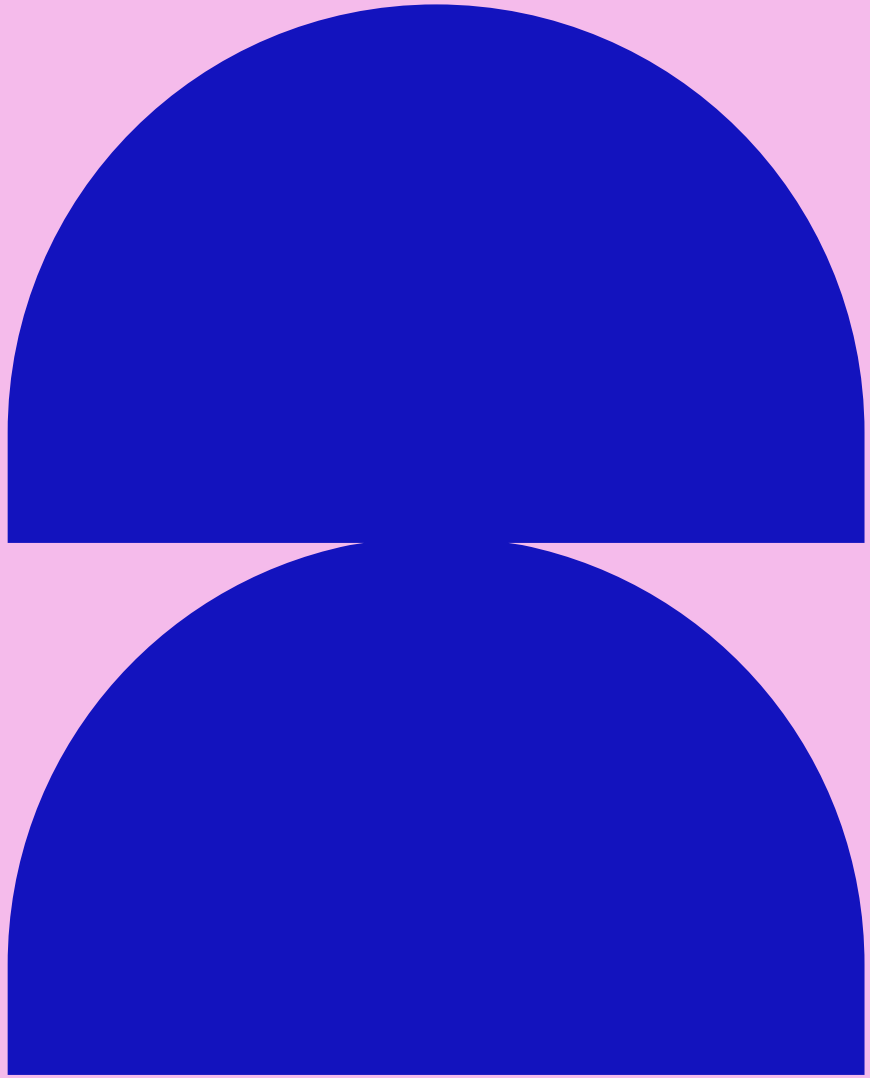
- Are our plots perceivable and understandable?
- How can we use Web Accessibility Guidelines to make sure they are?

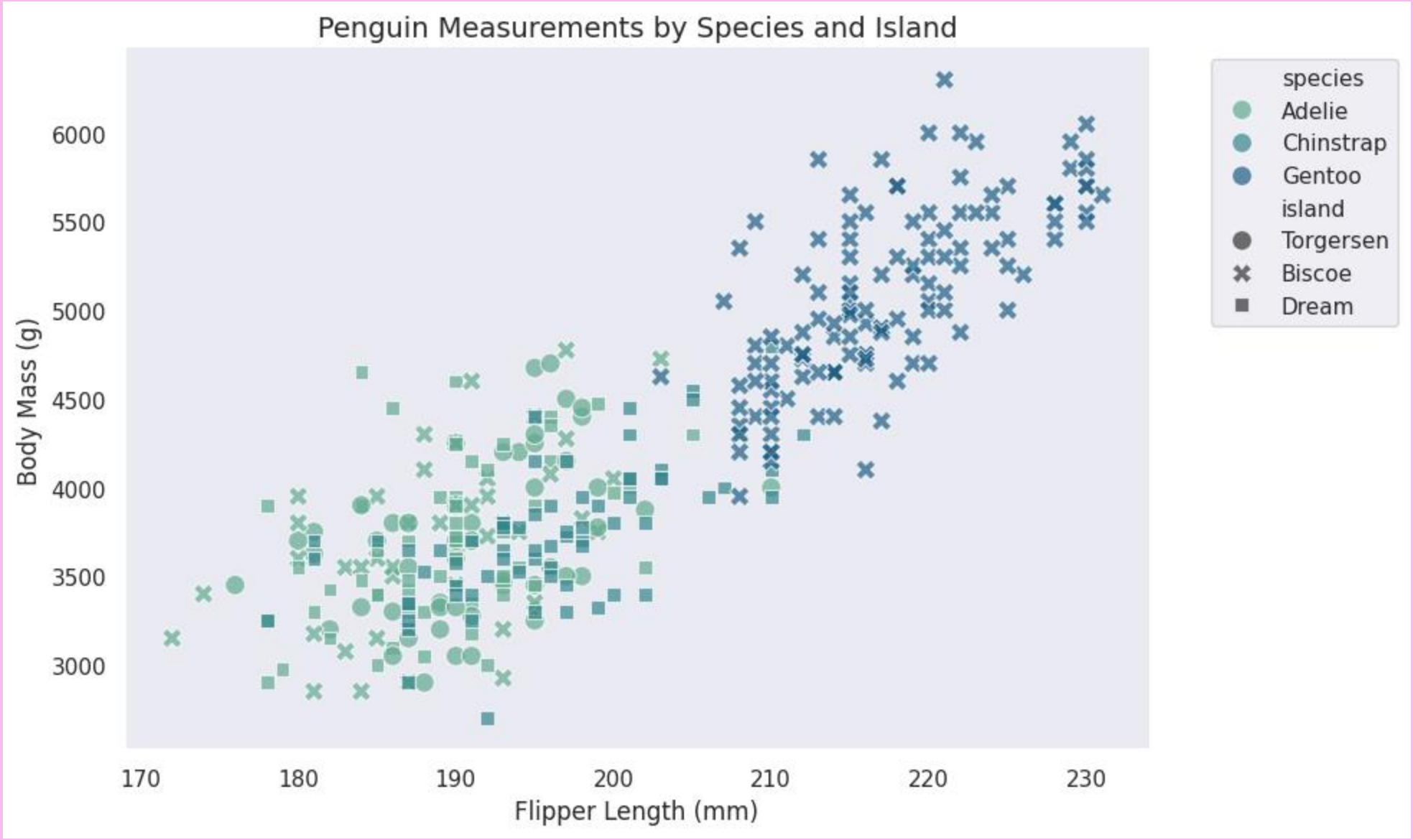


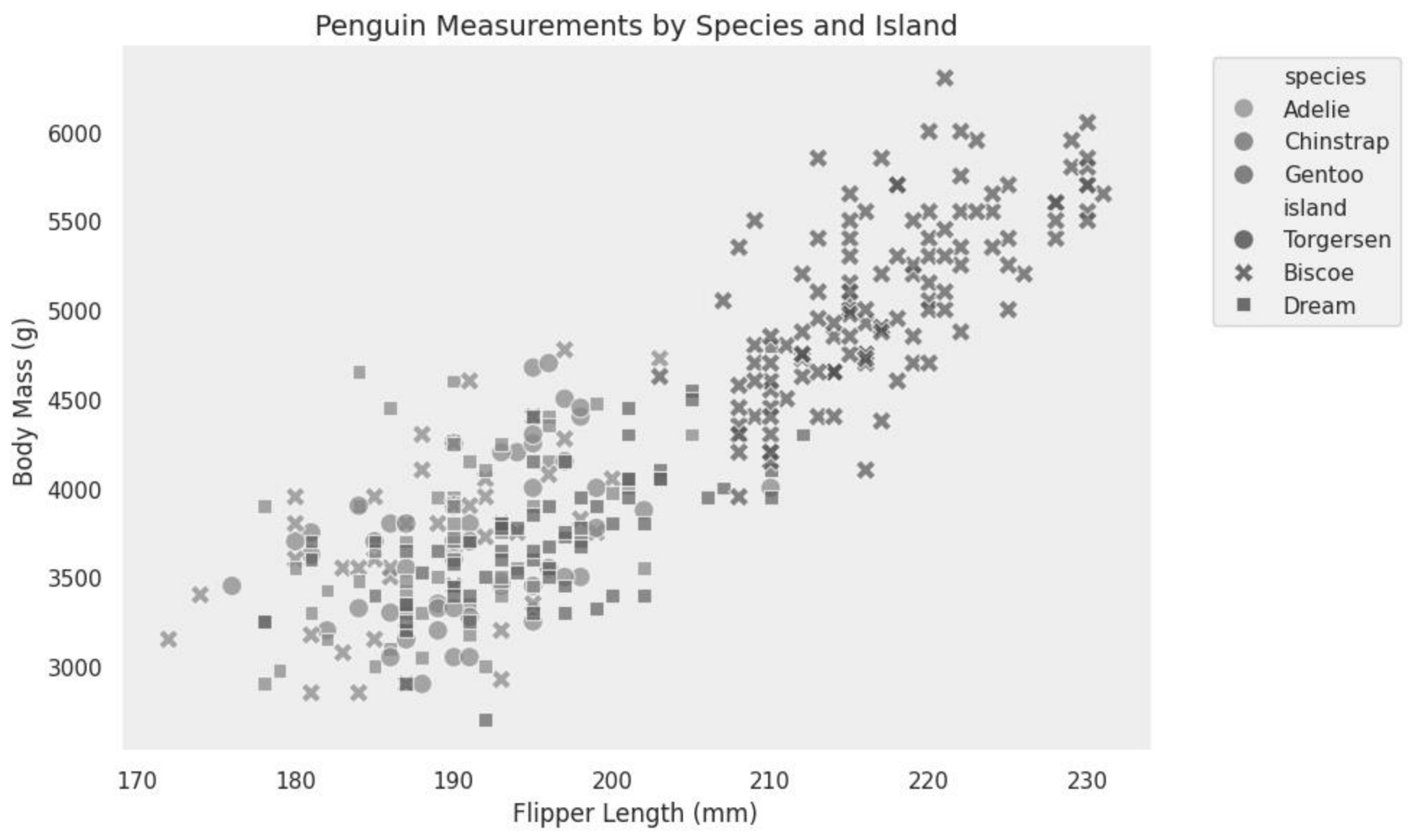
ACCESSIBILITY

- Use high-contrast colours
  - Minimum line thickness
  - Minimum font size/icon size
- Make sure plots are zoomable to 200%
  - Save out as vector graphics or high quality raster
- Choose colourblind-friendly and greyscale friendly colourmaps
- Don’t *only* rely on colour:
  - Shape, line styles
  - Labels and annotations
- Alternative text descriptions of graphics
  - Well-structured data tables
  - Text summary

The Ultimate Checklist for Accessible Data Visualisations, A11Y Collective




Penguin Measurements by Species and Island
Body Mass (g)
6000
5500
5000
4500
4000
3500
3000
170
180
190
200
210
220
230
Flipper Length (mm)
species
Adelie
Chinstrap
Gentoo
island
Torgersen
Biscoe
Dream


Penguin Measurements by Species and Island
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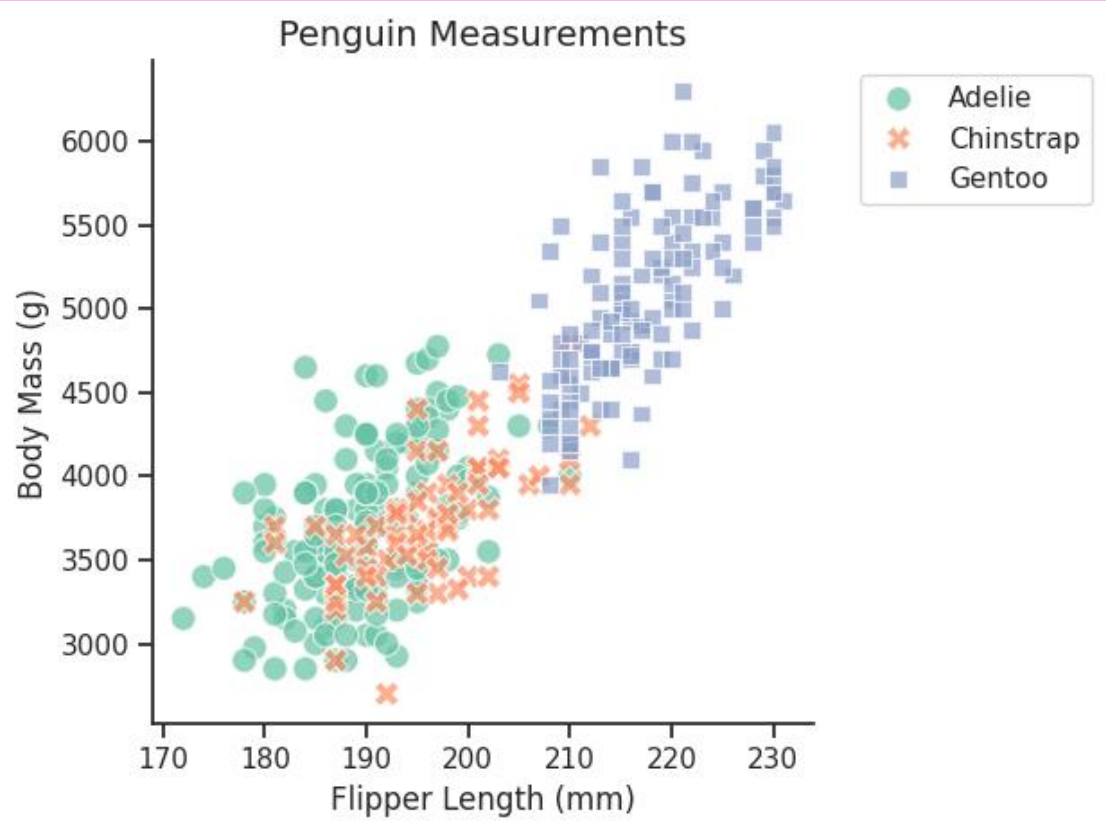
4500
4000
3500
3000
170
180
190
200
210
220
230
Flipper Length (mm)
species
Adelie
Chinstrap
Gentoo
island
Torgersen
Biscoe
Dream


Penguin Measurements
Adelie
Chinstrap
Gentoo
Body Mass (g)
6000
5500
5000
4500
4000
3500
3000
170
180
190
200
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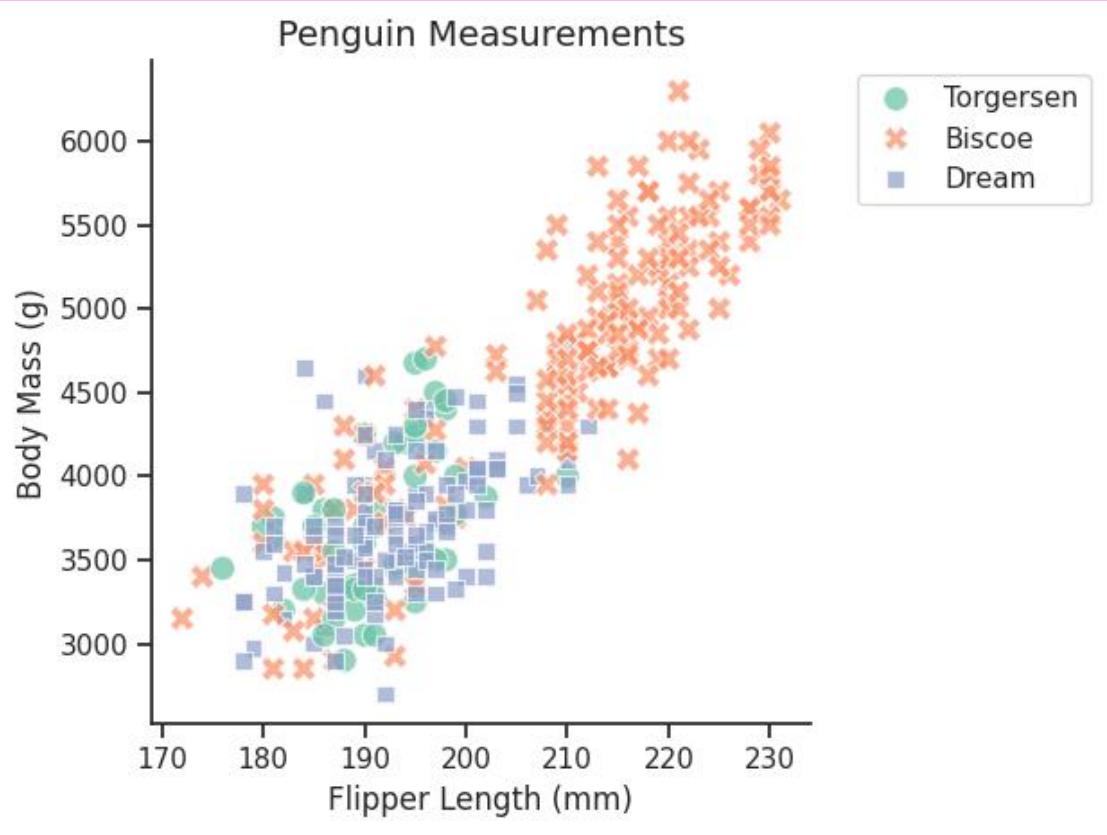
220
230
Flipper Length (mm)


Penguin Measurements
Torgersen
Biscoe
Dream
Body Mass (g)
6000
5500
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4000
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3000
170
180
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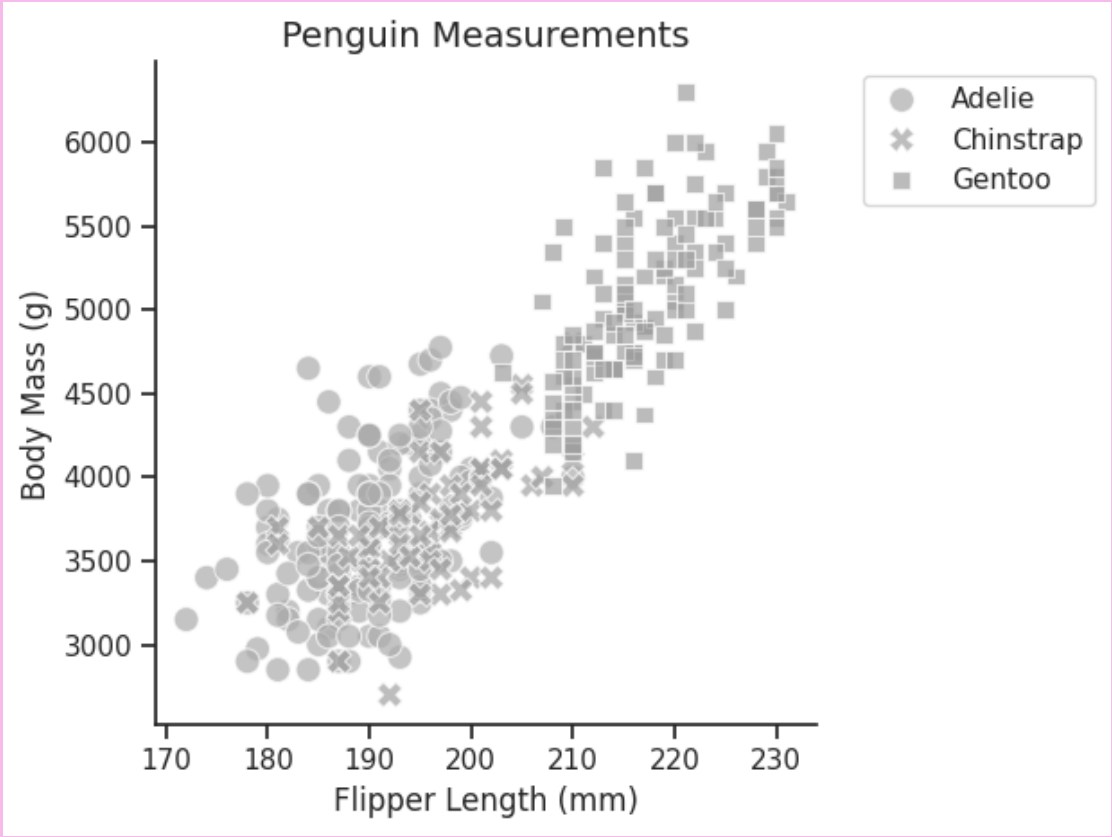
230
Flipper Length (mm)


Penguin Measurements
Adelie
Chinstrap
Gentoo
Body Mass (g)
6000
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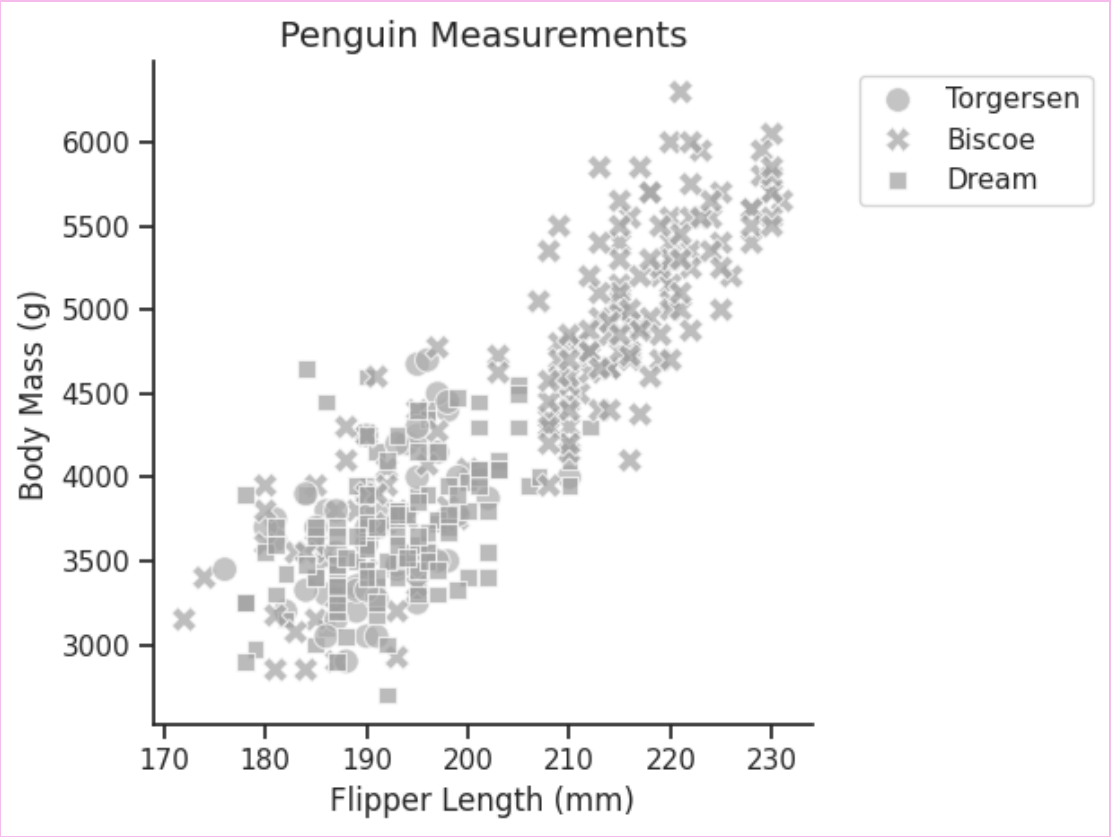
230
Flipper Length (mm)


Penguin Measurements
Torgersen
Biscoe
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Body Mass (g)
6000
5500
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4500
4000
3500
3000
170
180
190
200
210
220
230
Flipper Length (mm)

VIZ PALETTE
See your colours in action

By: Elijah Meeks & Susie Lu

Use Chroma.js

Use Colorgorical

Use ColorBrewer

Add

Replace

EDIT

7 Colors

Add

#hex rgb

1 #ffd700
2 #ffb14e
3 #fa8775
4 #ea5f94
5 #cd34b5
6 #9d02d7

Background color: #ffffff

Font color: #000000

COLORS IN ACTION

Charts made with Semiotic

Color Population:

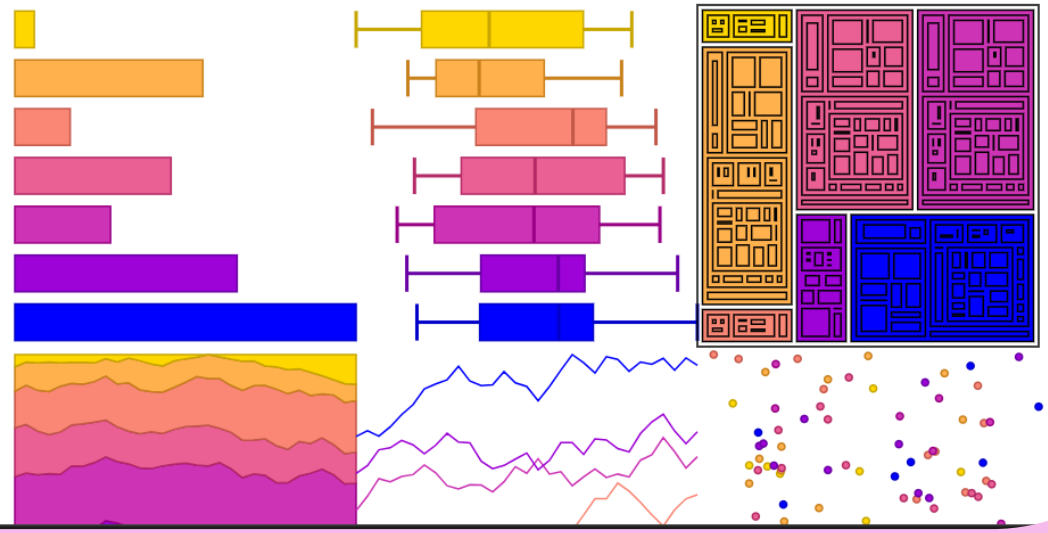
No Color Deficiency - 96% | Deuteranomaly - 2.7% | Protanomaly - 0.66%

Protanopia - 0.59% | Deuteranopia - 0.56% | Greyscale

Sample font

Randomize Data

Stroke: Dark None



WebAIM COLOUR CONTRAST CHECKER

Contrast Checker

Home > Resources > Contrast Checker

Foreground

Hex Value

F5BBEB

Color Picker

Alpha

1

Lightness

Background

Hex Value

1313BE

Color Picker

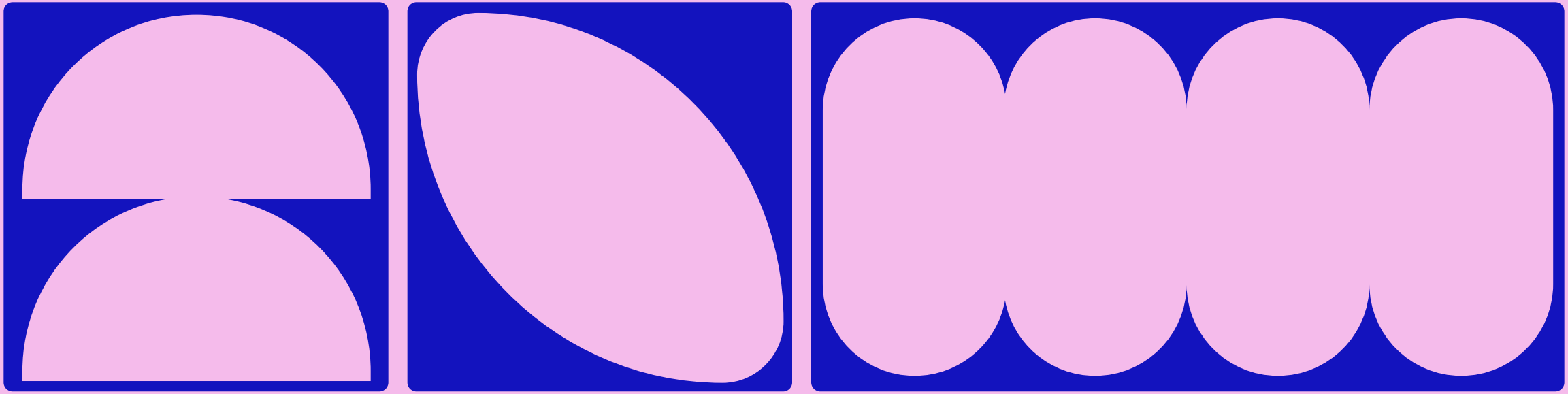
Lightness

Contrast Ratio

7.07:1

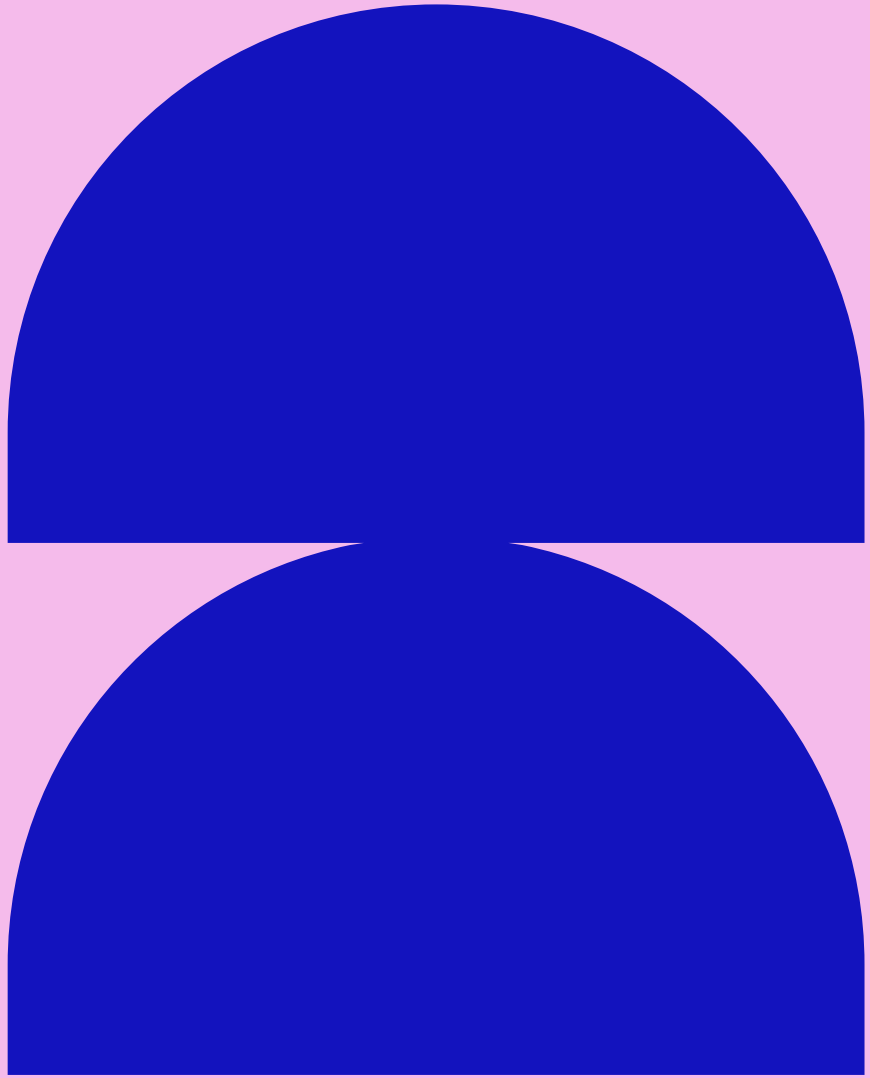
permalink

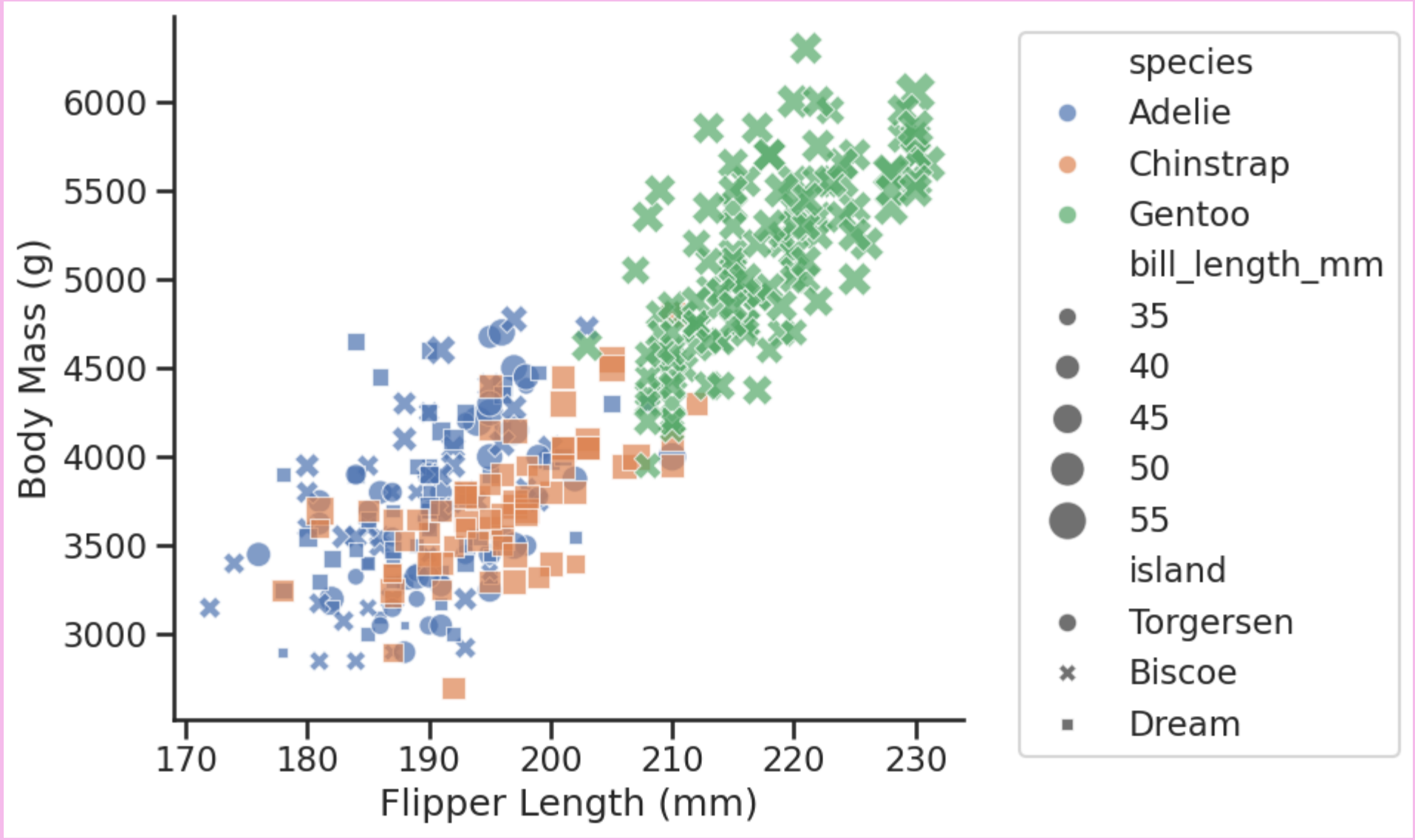
8. MINIMISE COGNITIVE LOAD

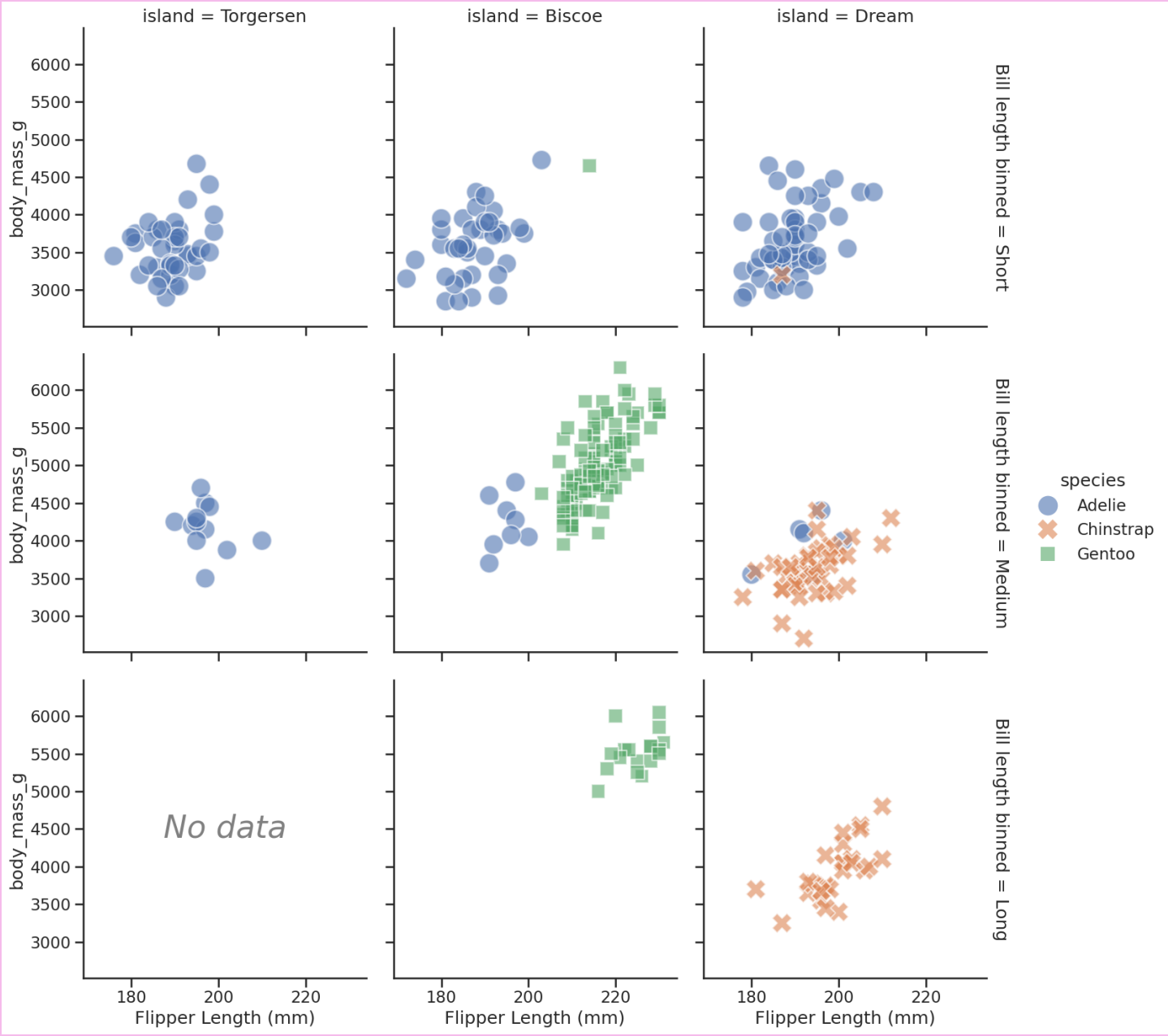


MINIMISE COGNITIVE LOAD FOR YOUR AUDIENCE

- Check the complexity of your plots
  - How much information will someone gather at a glance?
  - How long will they need to study it to “get the gist”?
  - How many different encodings have you going on at the same time?
    - Try using multiple panels or multiple plots instead!
- Walk away from your plot for a while
  - Sometimes it’s easier to recognise confusion-causing complexity when you’ve been working on something different for a while

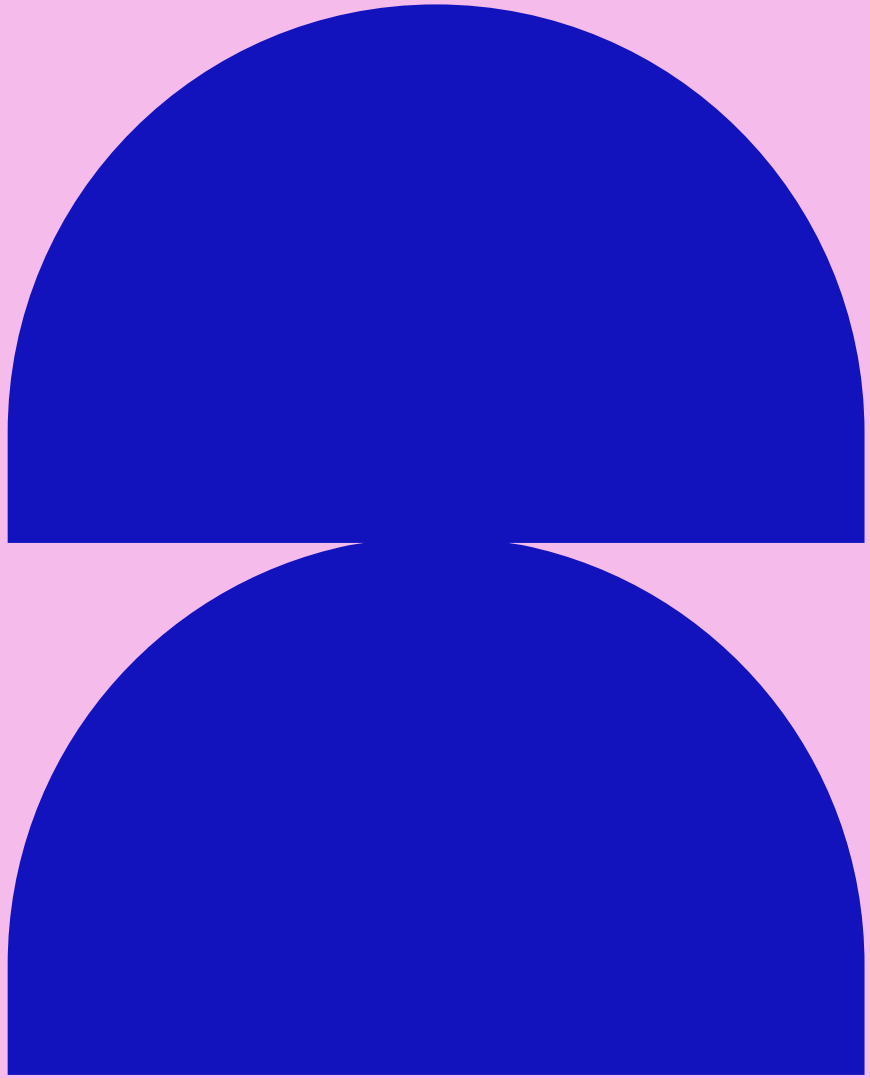


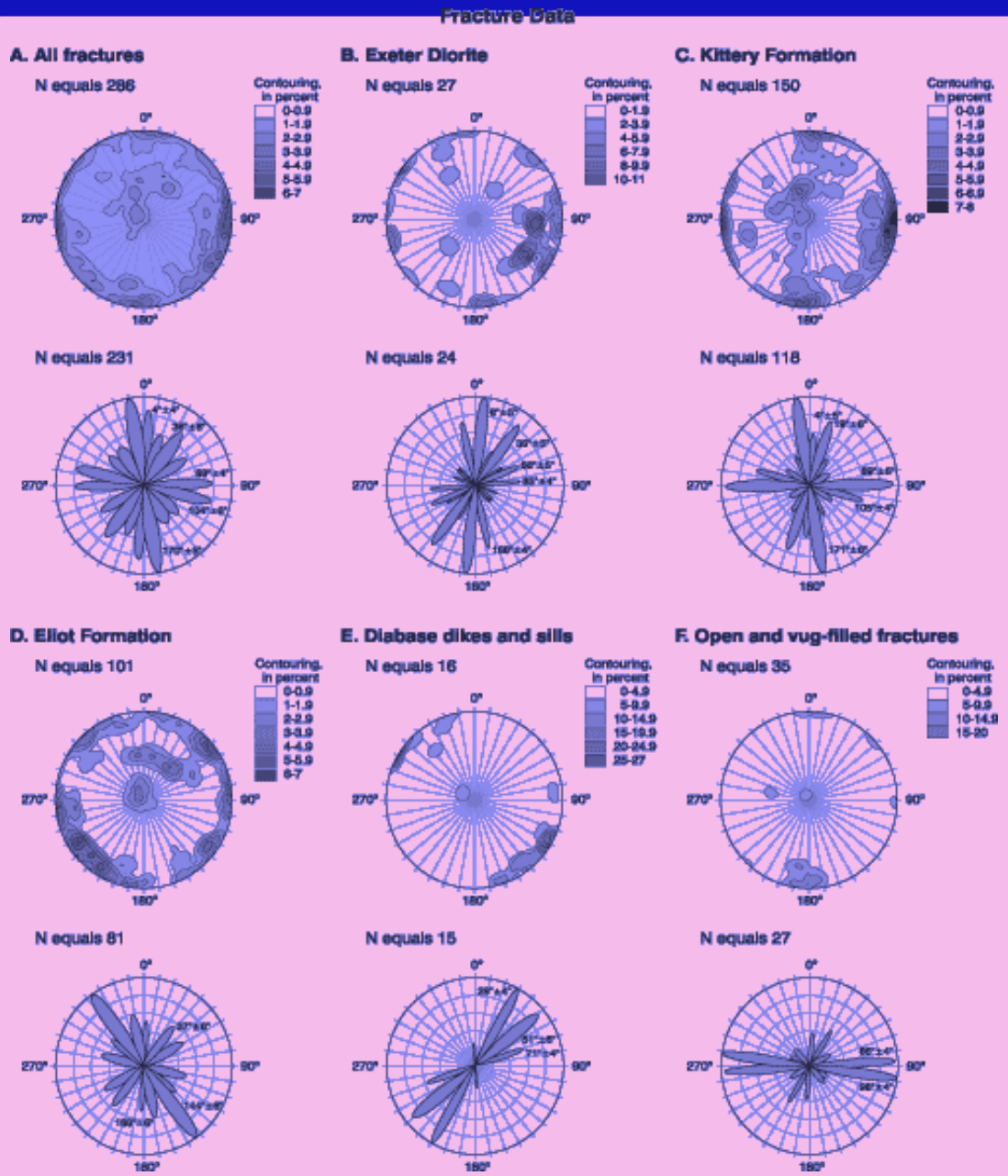

Body Mass (g)
6000
5500
5000
4500
4000
3500
3000
170
180
190
200
210
220
230
Flipper Length (mm)
species
Adelie
Chinstrap
Gentoo
bill_length_mm
35
40
45
50
55
island
Torgersen
Biscoe
Dream


island = Torgersen
island = Biscoe
island = Dream
Bill length binned = Short
Bill length binned = Medium
Bill length binned = Long
body_mass_g
6000
5500
5000
4500
4000
3500
3000
No data
180
200
220
Flipper Length (mm)
species
Adelie
Chinstrap
Gentoo

RELY ON YOUR AUDIENCE'S FAMILIARITY

- If you are presenting to experts in a field:
  - Lean on pre-existing standards/conventions unless you have a good reason not to!
  - This reduces cognitive load, even if the plot is very complex: familiarity outweighs "busyness"
- Reuse the same type of plot for different datasets:
  - If you introduce a specialist plot (e.g. violin plot), use this same plot for all similar datasets, instead of introducing another plot type that carries out a similar role (e.g. box plot or strip plot)

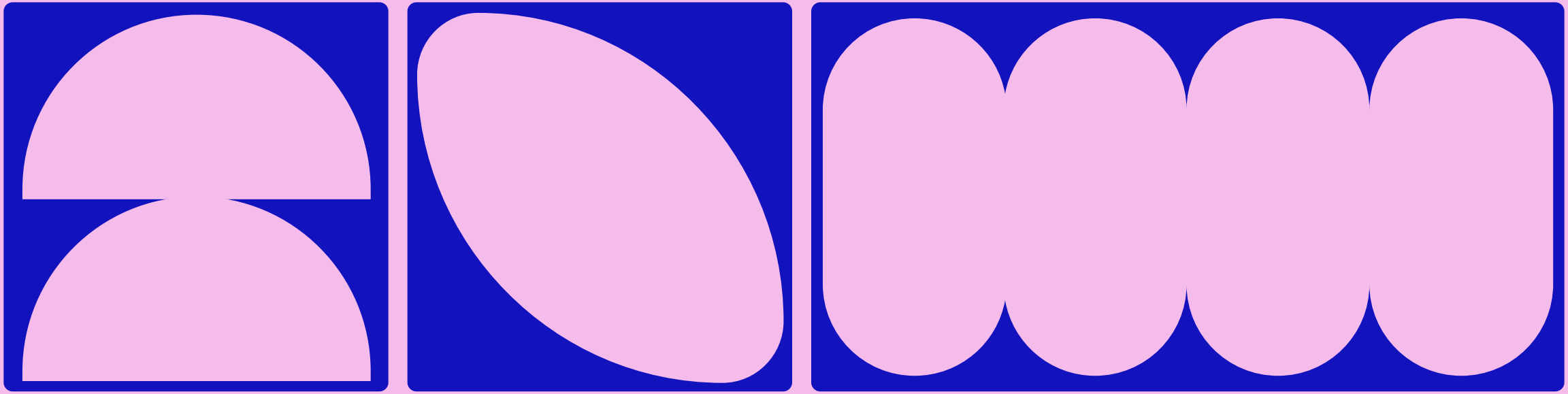




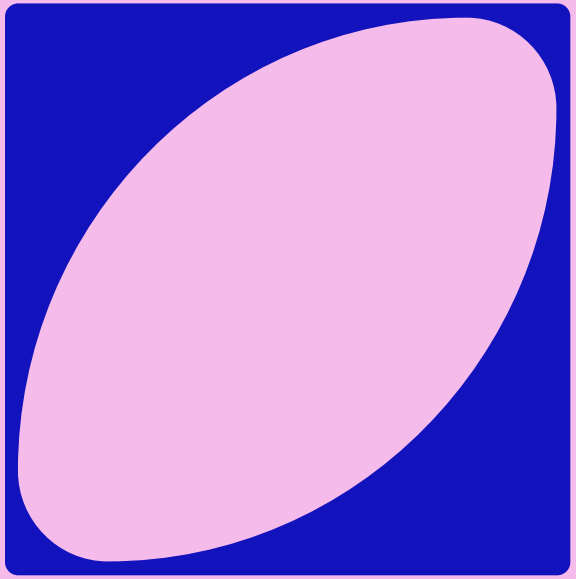
From USGS bedrock analysis

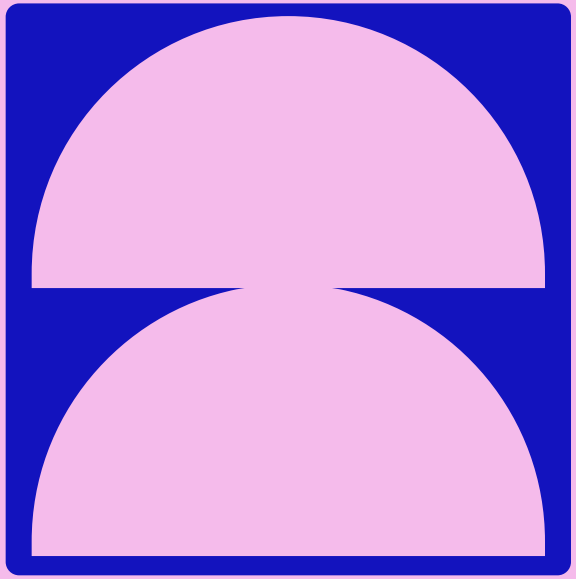
- Sometimes a plot which looks totally overwhelming and incomprehensible to some may be totally normal in a specific field!
  - Think back to “know your audience”

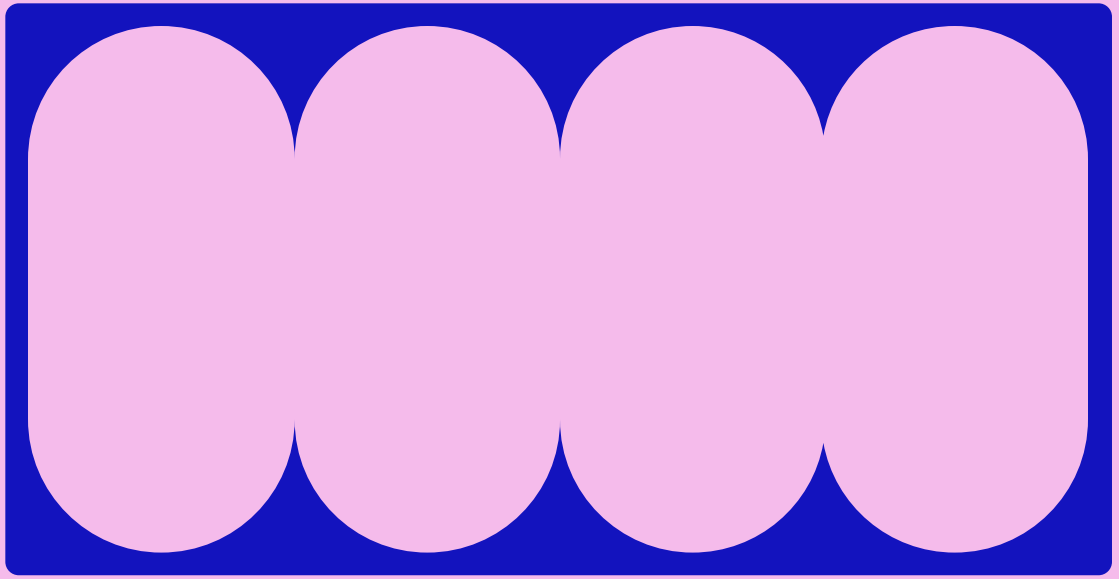
9. GET OPINIONS AND TEST

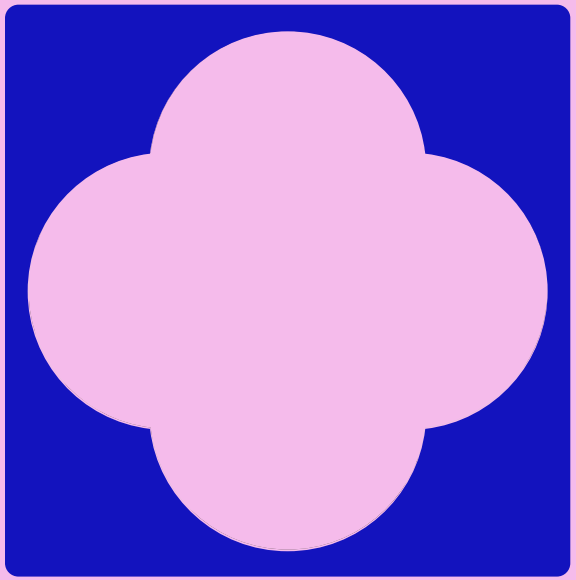


SHOW OTHER PEOPLE YOUR DATA VIS









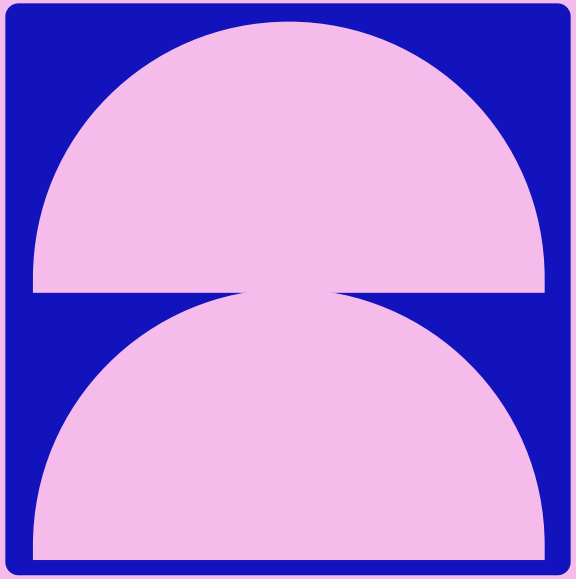
Don’t provide them with anything other than your draft visualisation, the caption, and a sentence on the setting:

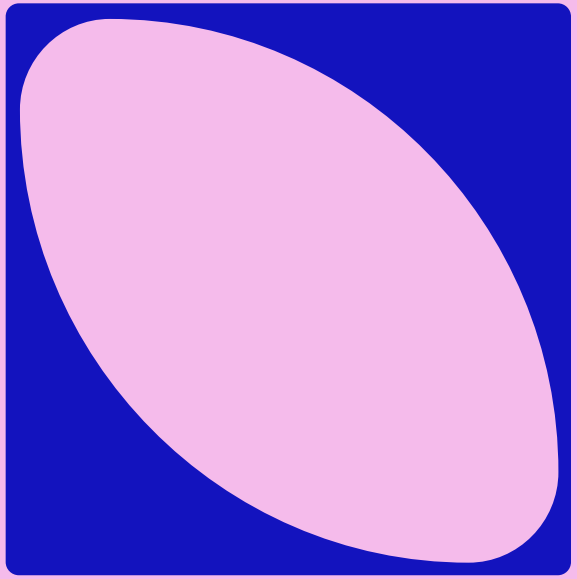
For a conference talk on xyz with an audience of specialists

ITERATE

You don't have to implement *all* feedback!

OBJECT ORIENTED PROGRAMMING



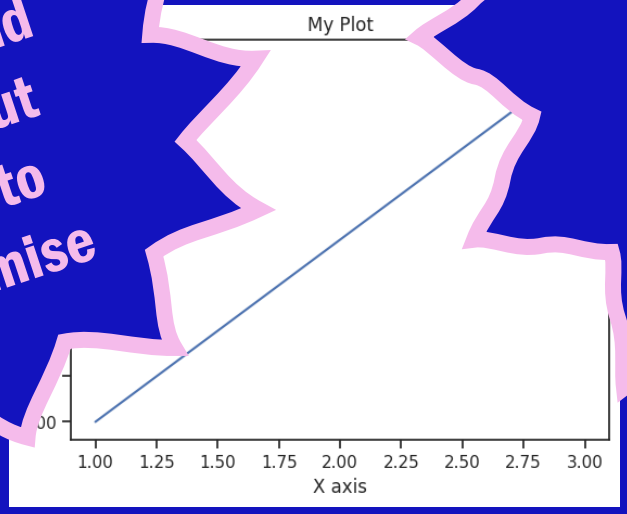


YOU MAY HAVE SEEN SNIPPETS OF MATPLOTLIB CODE BEFORE...

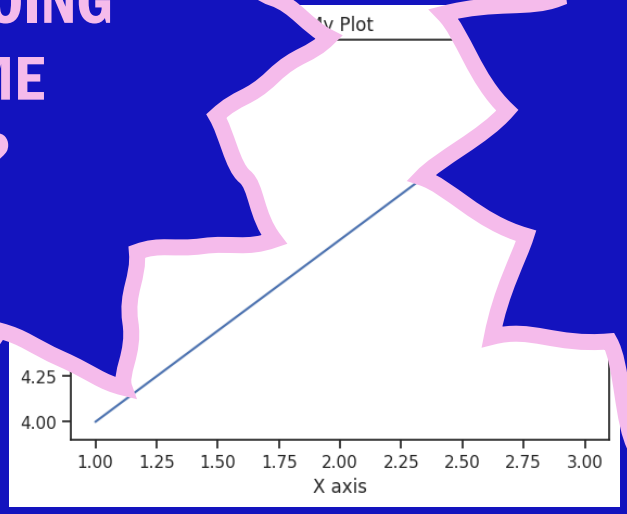
PYPLOT STYLE	OBJECT ORIENTED STYLE

`plt.plot([1, 2, 3], [4, 5, 6])`
`plt.xlabel('X axis')`
`plt.title('My Plot')`
`plt.show()`
	`fig, ax = plt.subplots()`
	`ax.plot([1, 2, 3], [4, 5, 6])`
	`ax.set_xlabel('X axis')`
	`ax.set_title('My Plot')`

"Quick and easy" but tricky to customise



WHY HAVE TWO WAYS OF DOING THE SAME THING?

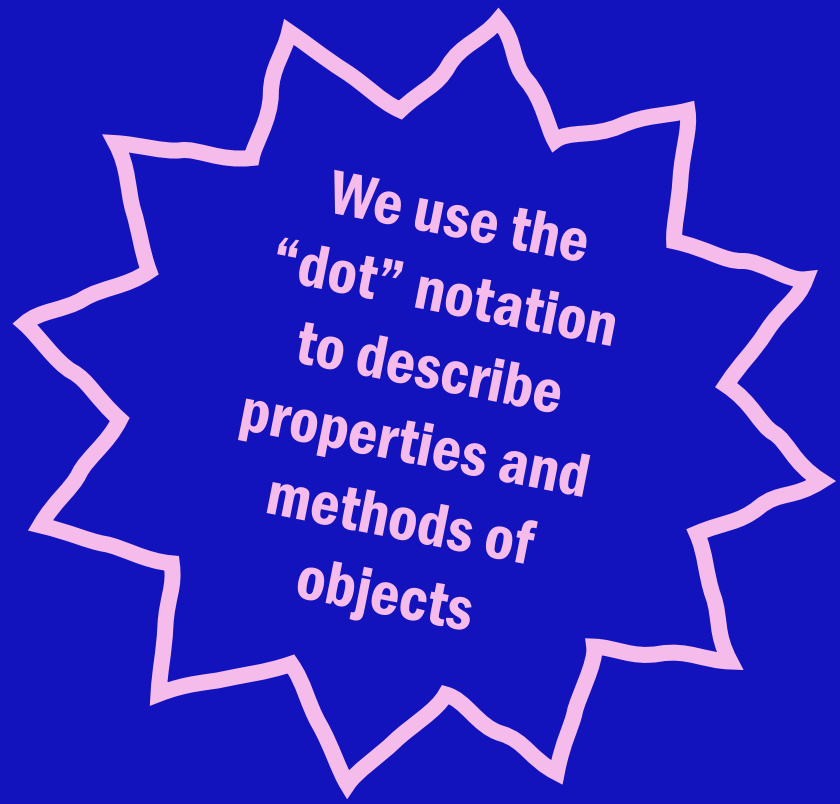


A little "longwinded" but very flexible

WHAT IS AN OBJECT?

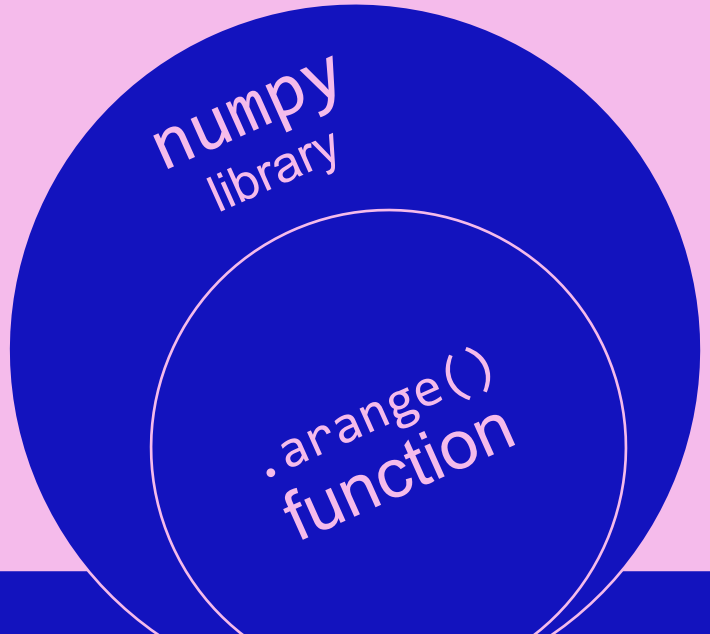
- Think of an object like a real-world thing that has:
  - Properties (what it is) - like a car's colour or speed
  - Methods (what it can do) - like a car can .accelerate() or .brake()

- In Python/Matplotlib:
  - A Figure object is like a blank canvas
  - An Axes object is like a drawing area on that canvas
  - These objects have methods like .plot(), .set_xlabel(), etc.



OBJECT.FEATURE()

```
import numpy
numpy.arange()
```



We use the "dot" notation to describe properties and methods of objects

OBJECTS IN MATPLOTLIB

Matplotlib uses a hierarchy (objects inside objects):
The figure -> the axes -> plot elements (lines, points)

- Figure = Picture frame
- Axes = The actual artwork inside
- Plot elements = Brushstrokes on the artwork

OBJECT ORIENTED STYLE

```
fig, ax = plt.subplots()
ax.plot([1, 2, 3], [4, 5, 6])
ax.set_xlabel('X axis')
ax.set_title('My Plot')
plt.show()
```

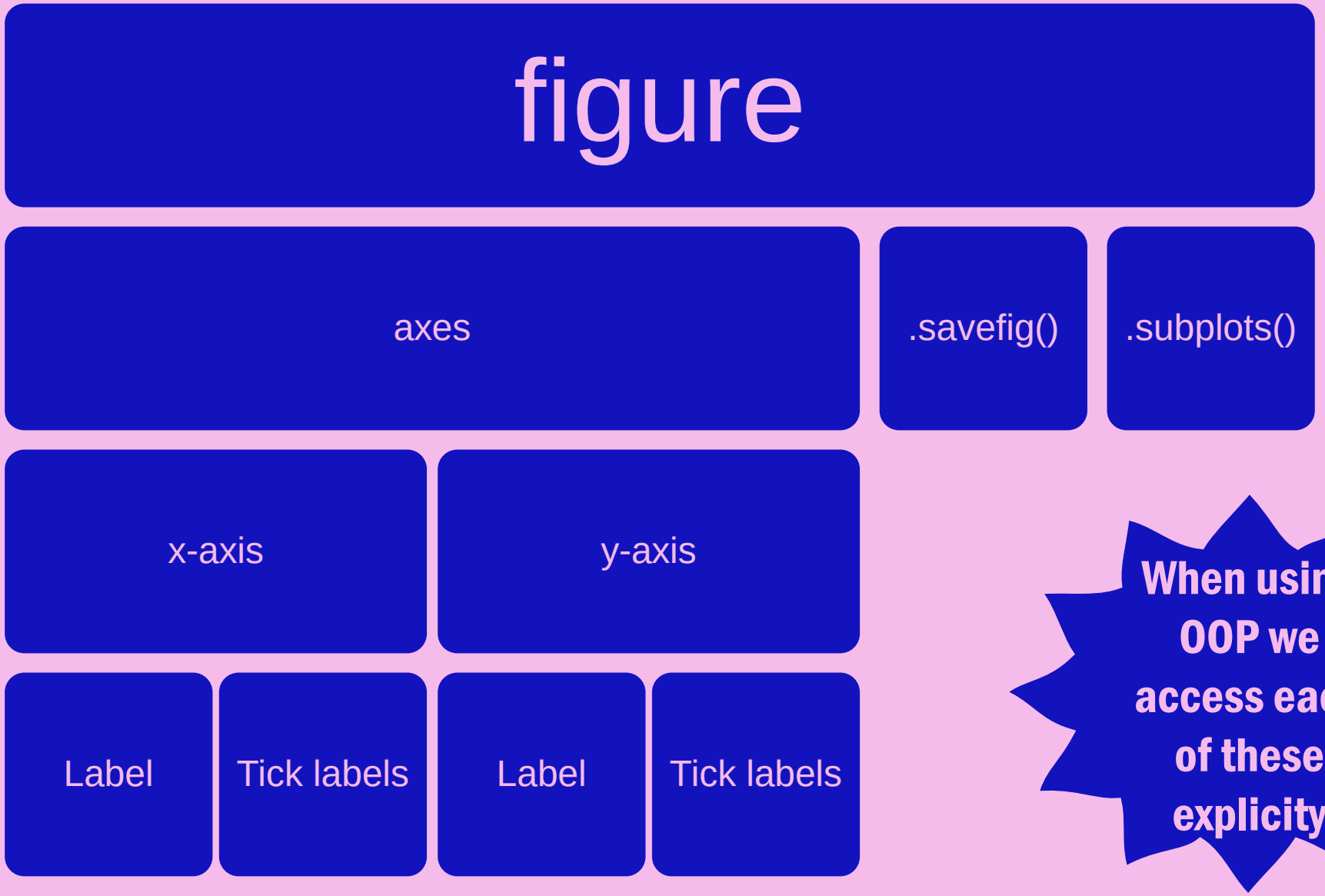


figure
axes
.savefig()
.subplots()
x-axis
y-axis
Label
Tick labels
Label
Tick labels
When using OOP we access each of these explicity

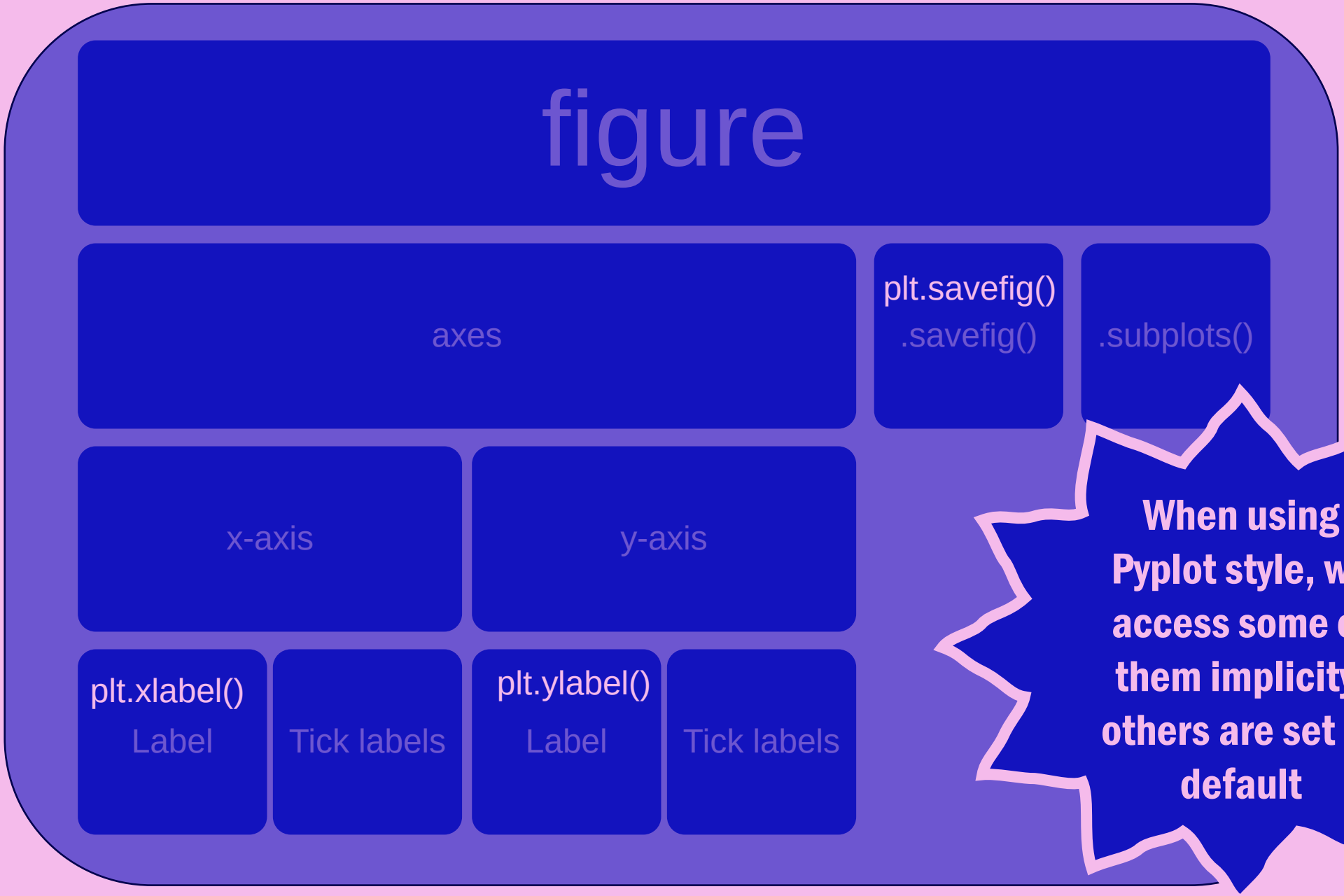
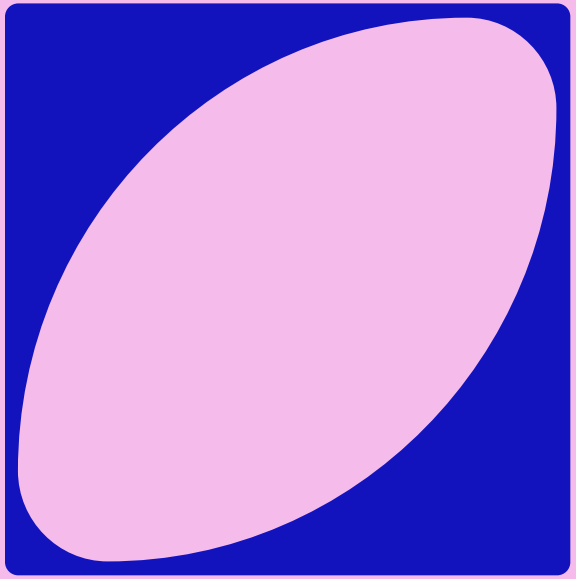
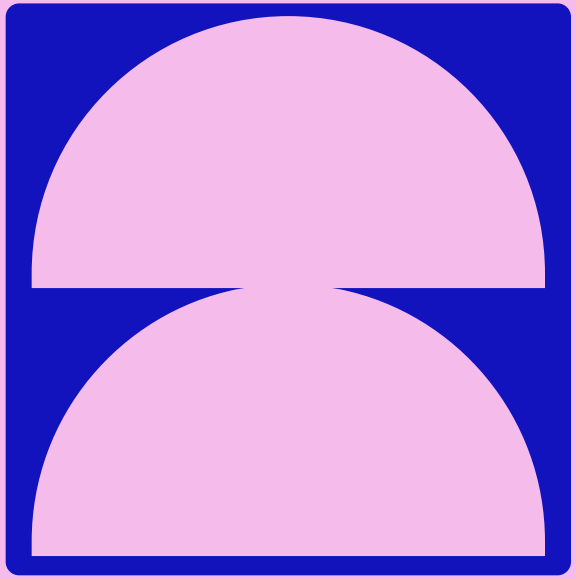
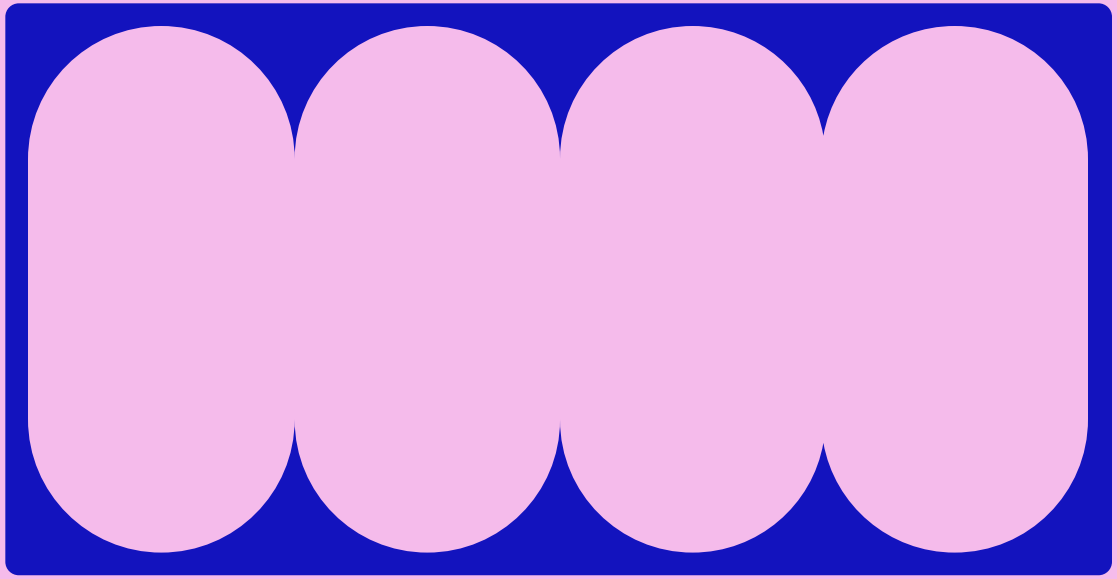


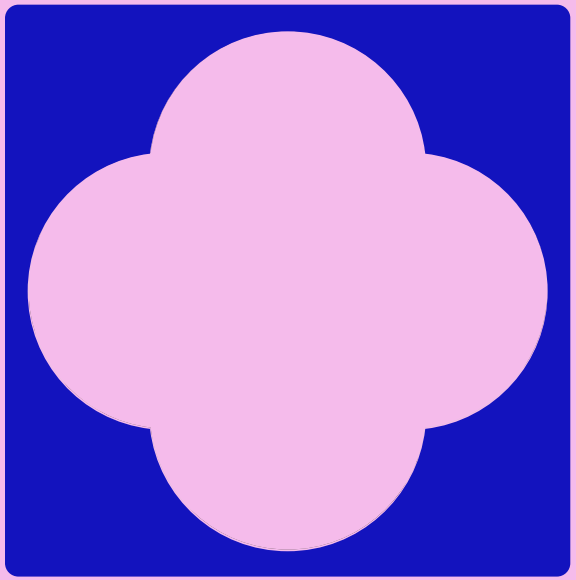
figure
axes
plt.savefig()
.savefig()
.subplots()
x-axis
y-axis
plt.xlabel()
Label
Tick labels
plt.ylabel()
Label
Tick labels
When using Pyplot style, we access some of them implicity; others are set by default

THAT'S ENOUGH THEORY









Let's actually give it a go on Google Colab

WHAT KIND OF PLOTS WOULD YOU LIKE TO COVER TOMORROW?

WHAT KIND OF PLOTS WOULD YOU LIKE TO COVER TOMORROW?

RESULTS SLIDE