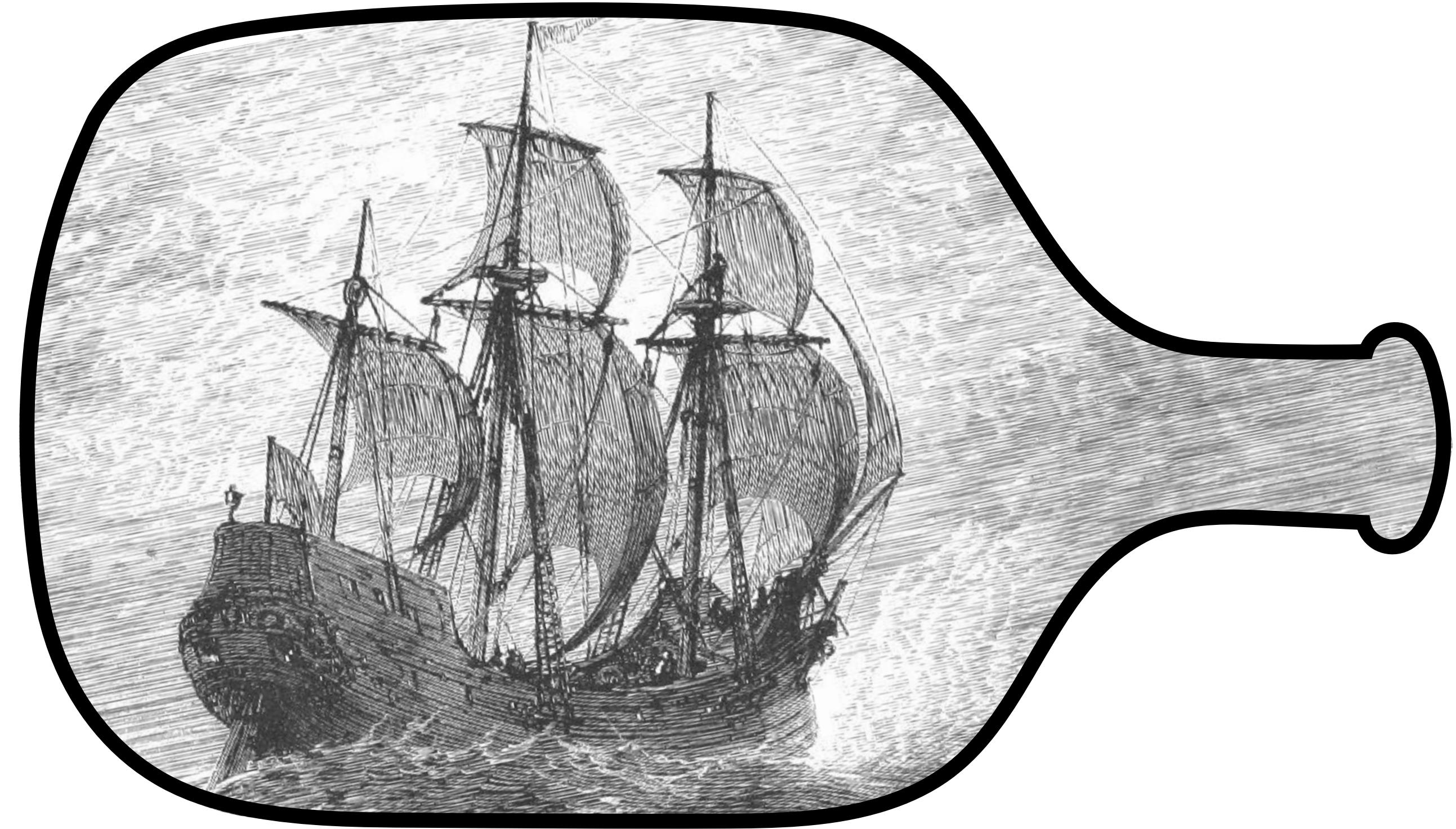


The Cognitive Craft



Master The Tidyverse

1. How do you make a **graph**?
2. What does **dplyr** do?
3. How and why should you **tidy** untidy **data**?
4. What is the process for **importing data**?
5. What are the most useful things to know about **data types** in R?
6. How do you **iterate over a list** with map()?
7. What is a **statistical model**?
How do you fit one with R?
8. How can you use **list columns** to store an entire analysis in a table?

Your Turn

05 : 00

Divide these topics between your group members.
(one per group member, some unassigned)

1. How do you make a graph?
2. What does **dplyr** do?
3. How and why should you **tidy** untidy **data**?
4. What is the process for **importing data**?
5. What are the most useful things to know about **data types** in R?
6. How do you **iterate over a list** with `map()`?
7. What is a **statistical model**? How do you fit one with R?
8. How can you use **list columns** to store an entire analysis in a table?

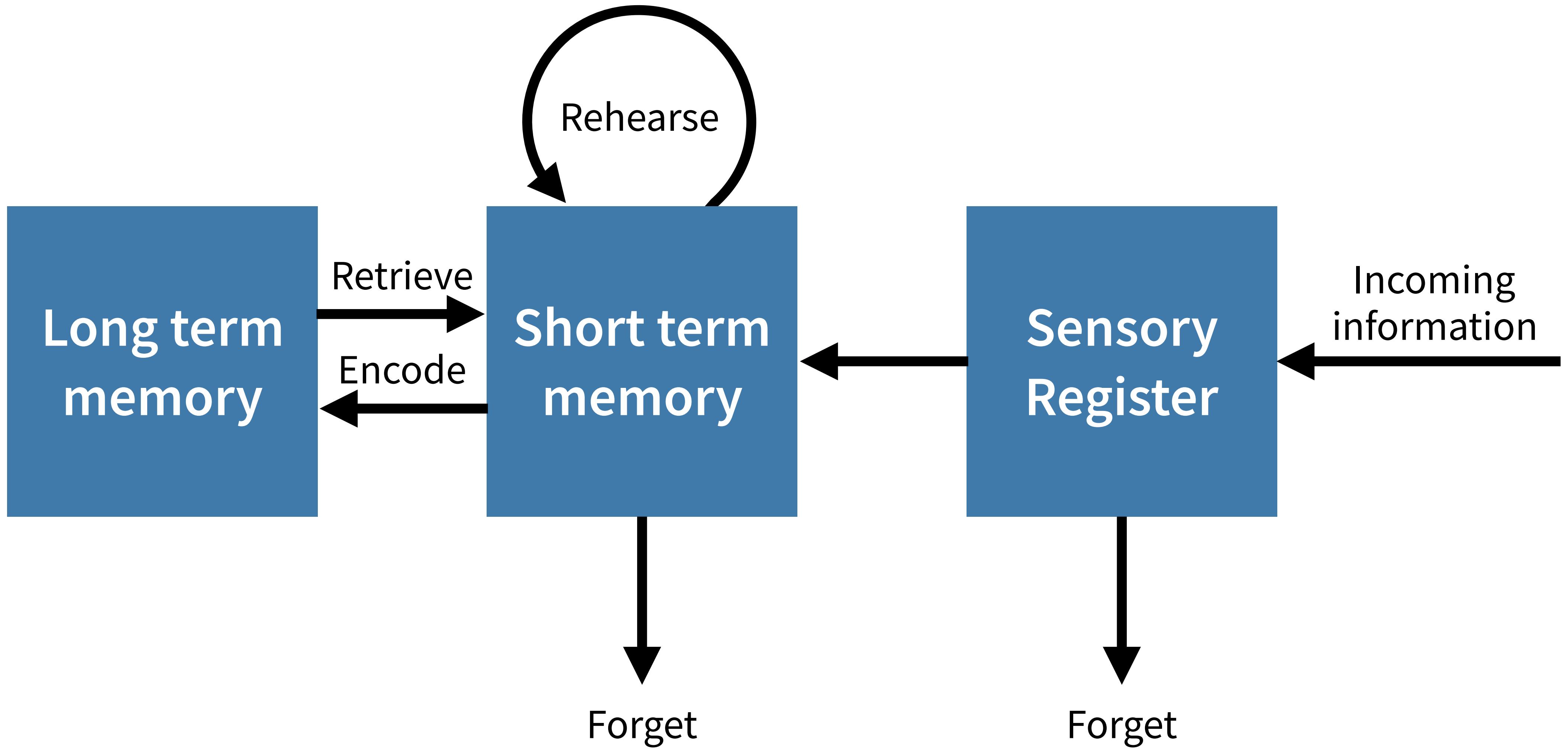
Your Turn

10 : 00

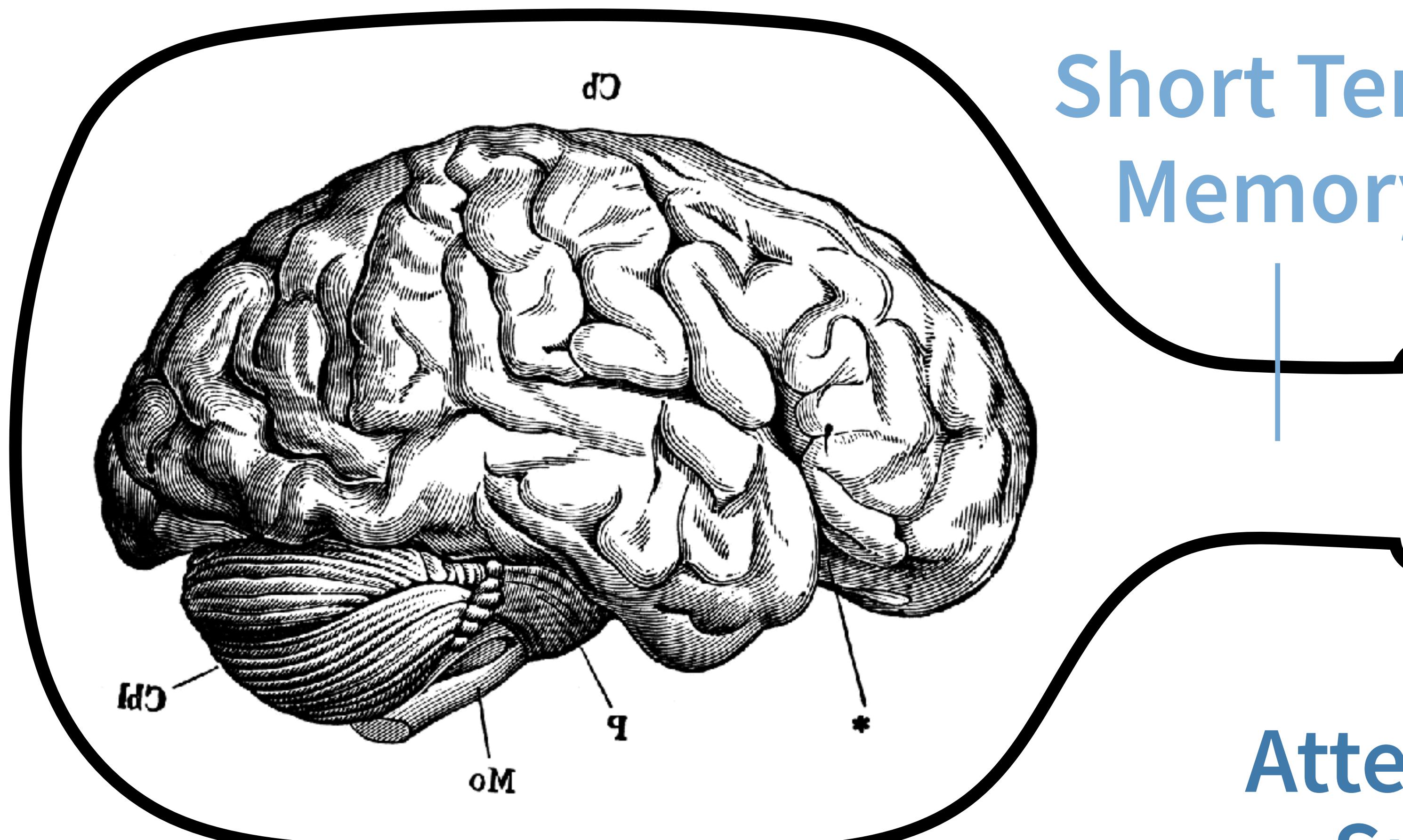
Create a detailed concept map for your topic.

1. How do you make a graph?
2. What does **dplyr** do?
3. How and why should you **tidy** untidy **data**?
4. What is the process for **importing data**?
5. What are the most useful things to know about **data types** in R?
6. How do you **iterate over a list** with `map()`?
7. What is a **statistical model**? How do you fit one with R?
8. How can you use **list columns** to store an entire analysis in a table?

The cognitive bottleneck

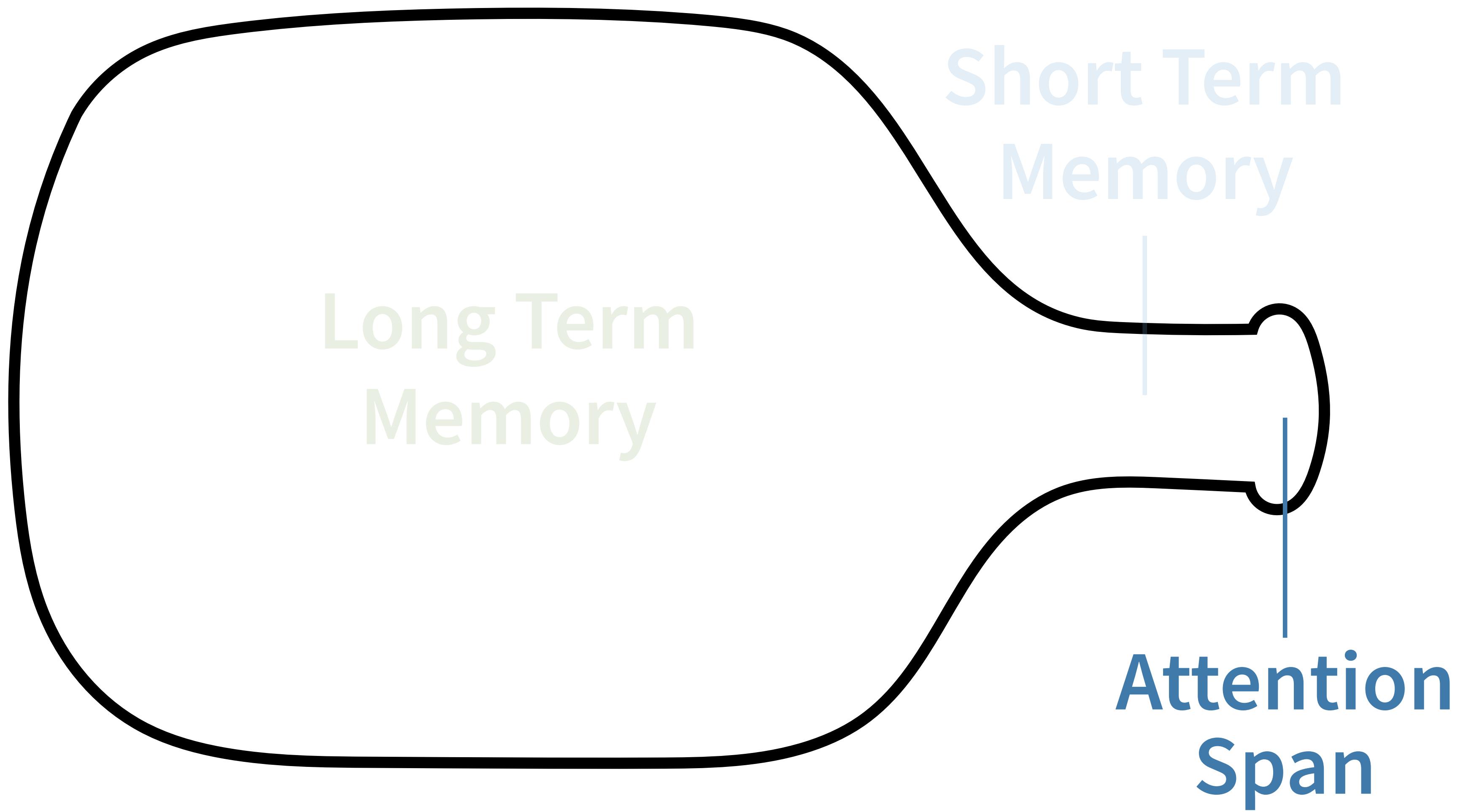


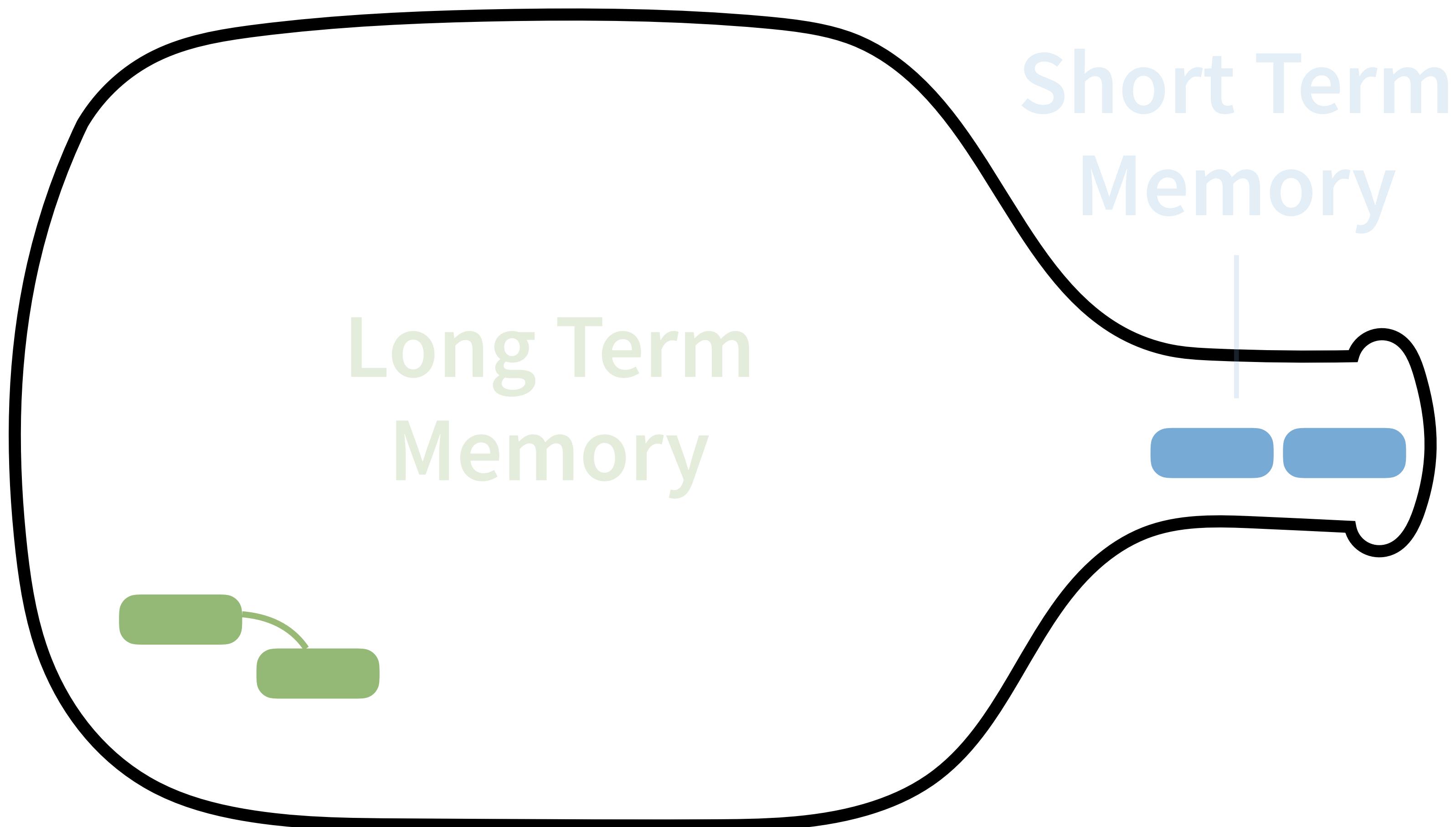
- [Adapted from Atkinson, R. C., & Shiffrin, R. M. \(1968\). Human memory: A proposed system and its control processes. Psychology of learning and motivation, 2, 89-195. Chicago](#)

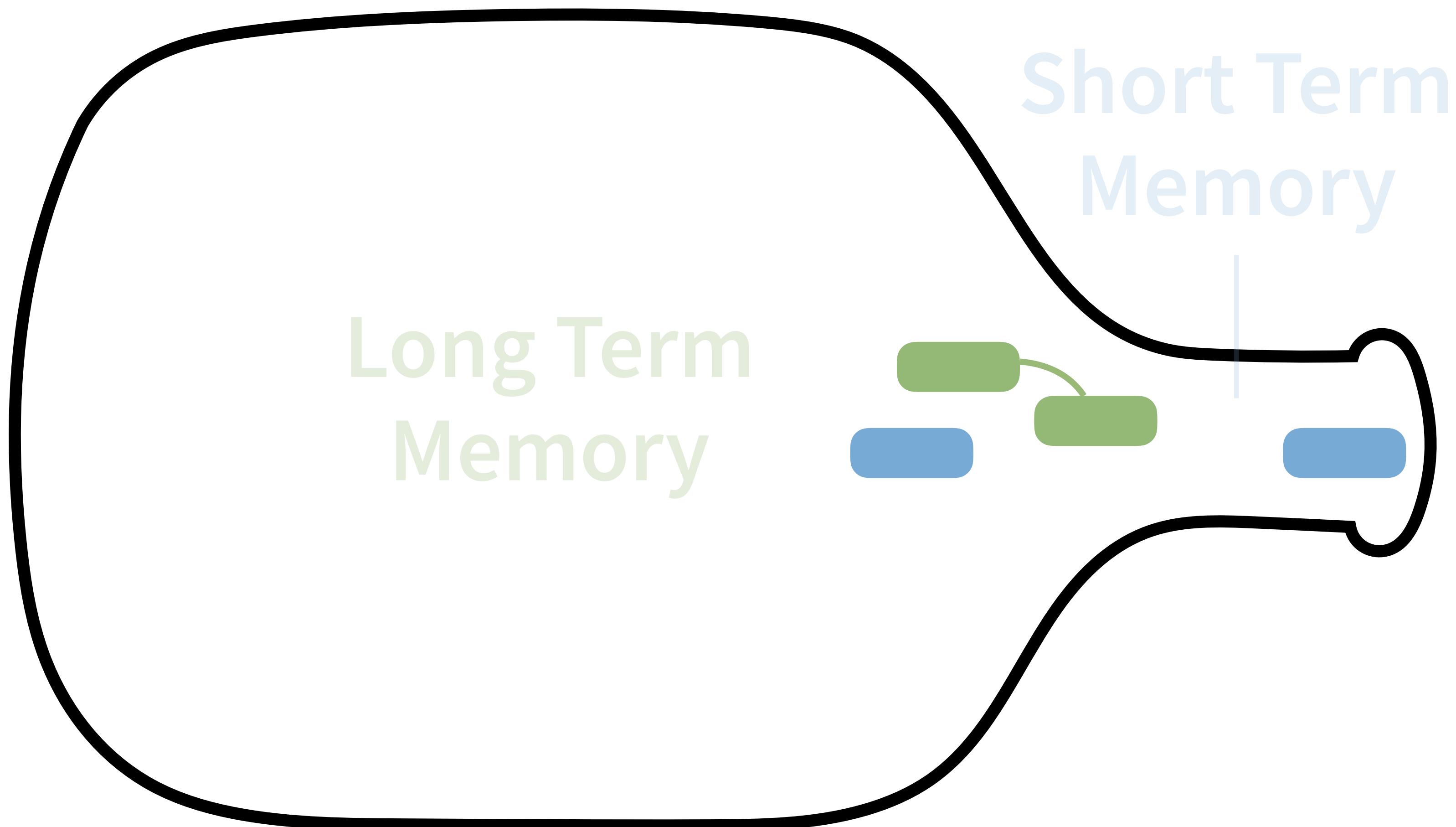


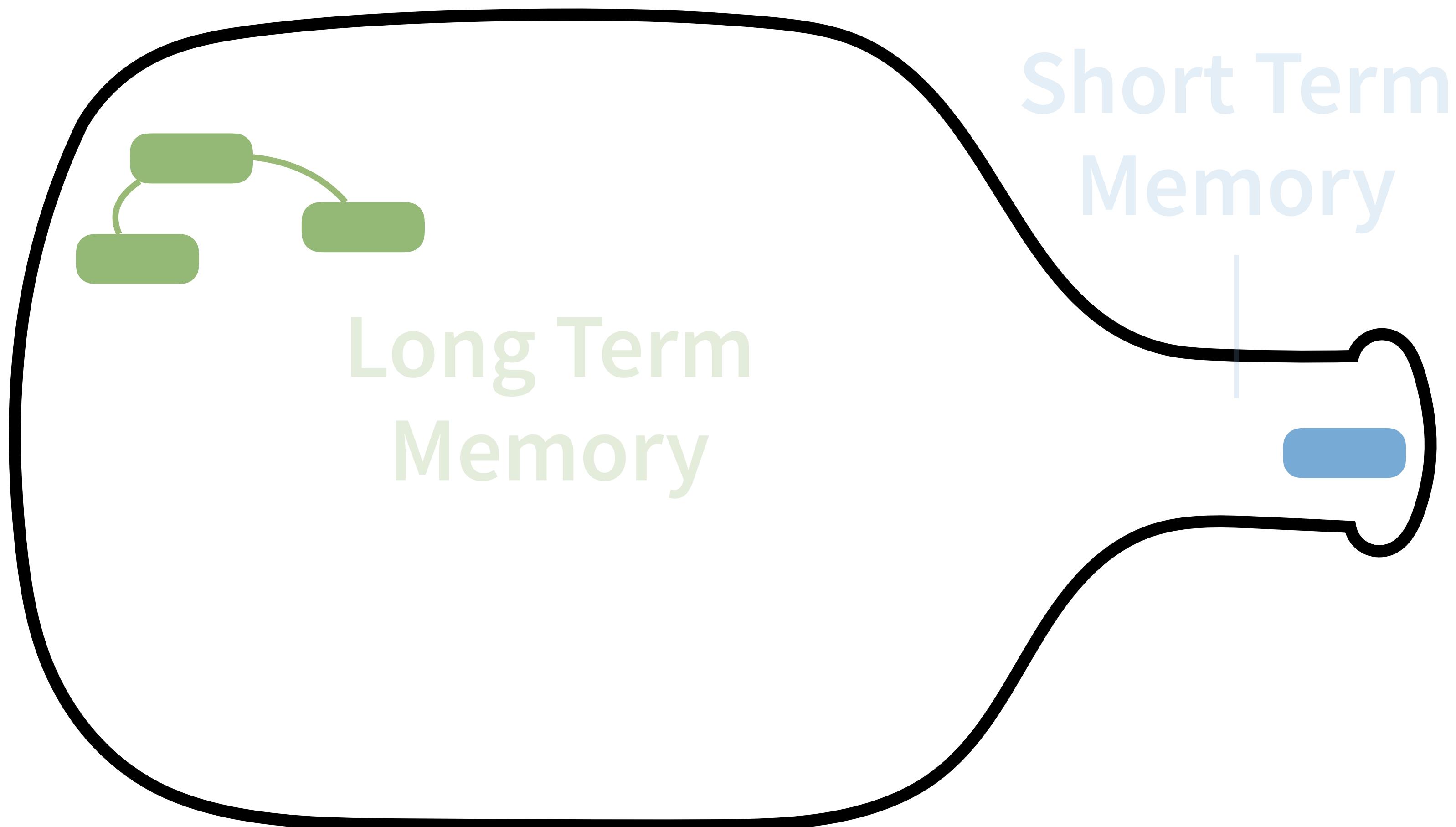
Short Term
Memory

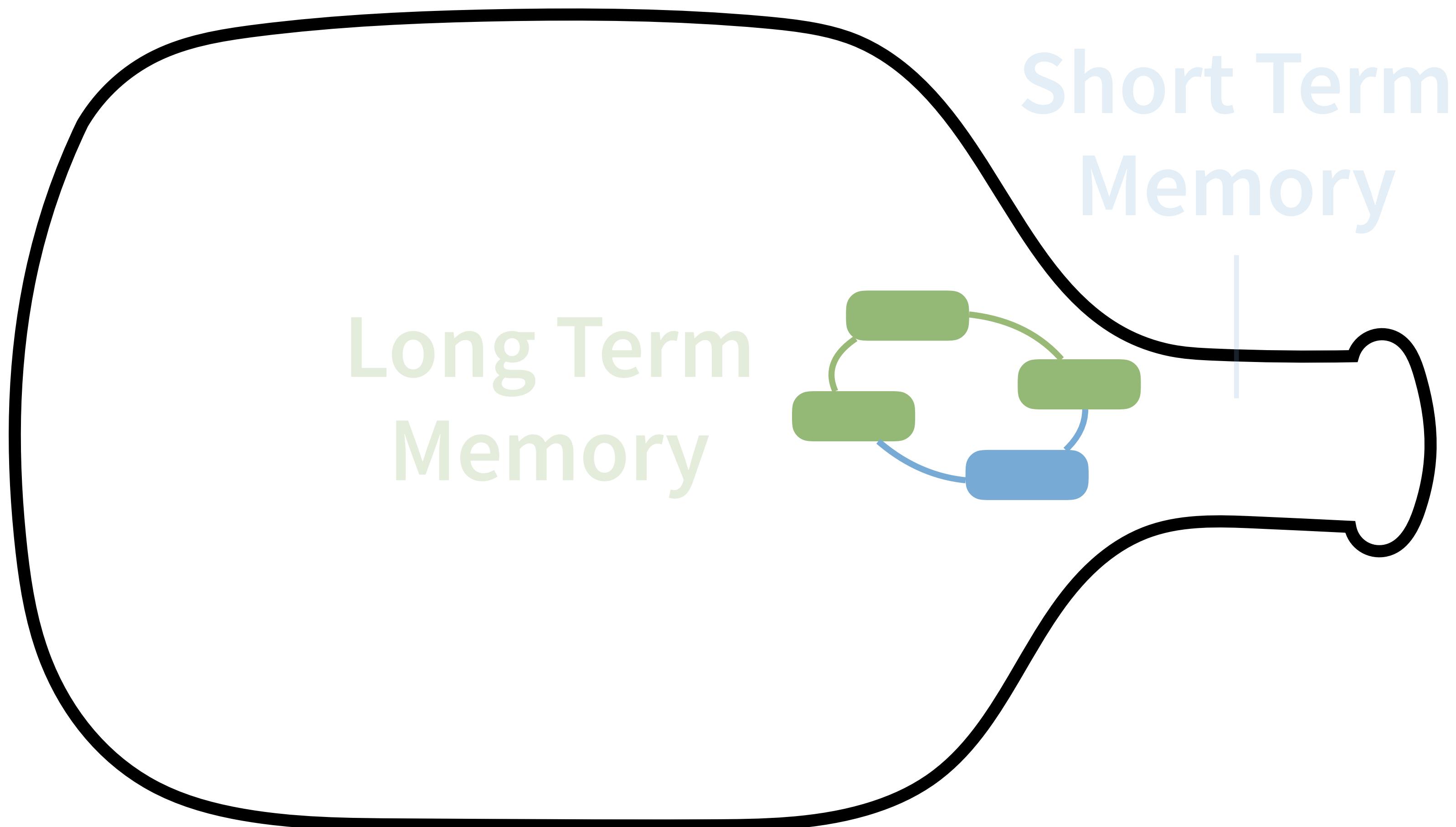
Attention
Span

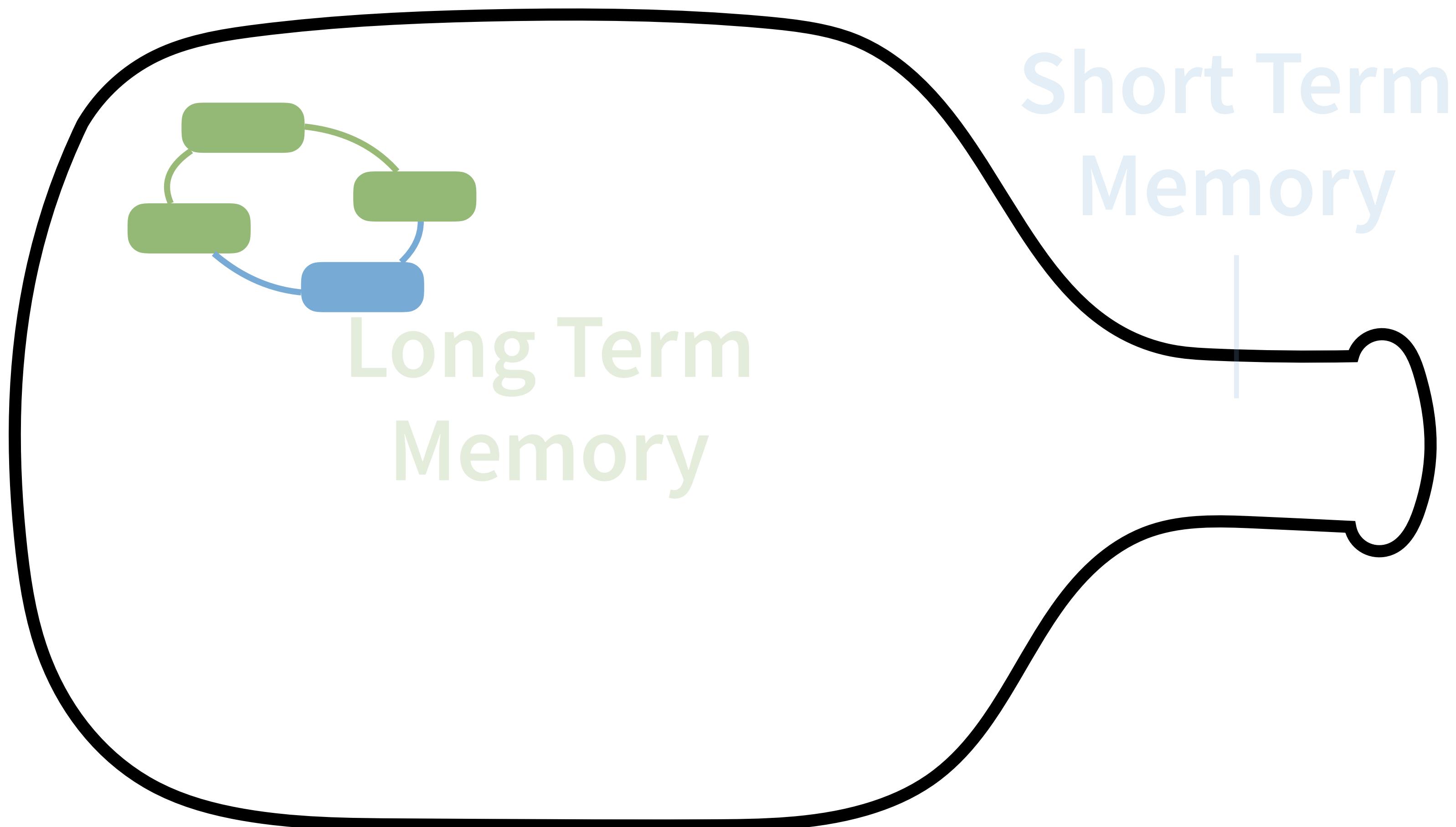






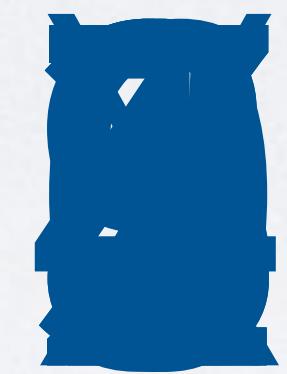






Your Turn

Remember the numbers in order



8 7 1 2 4 8 2 5 9 6 2 5 7 1 0



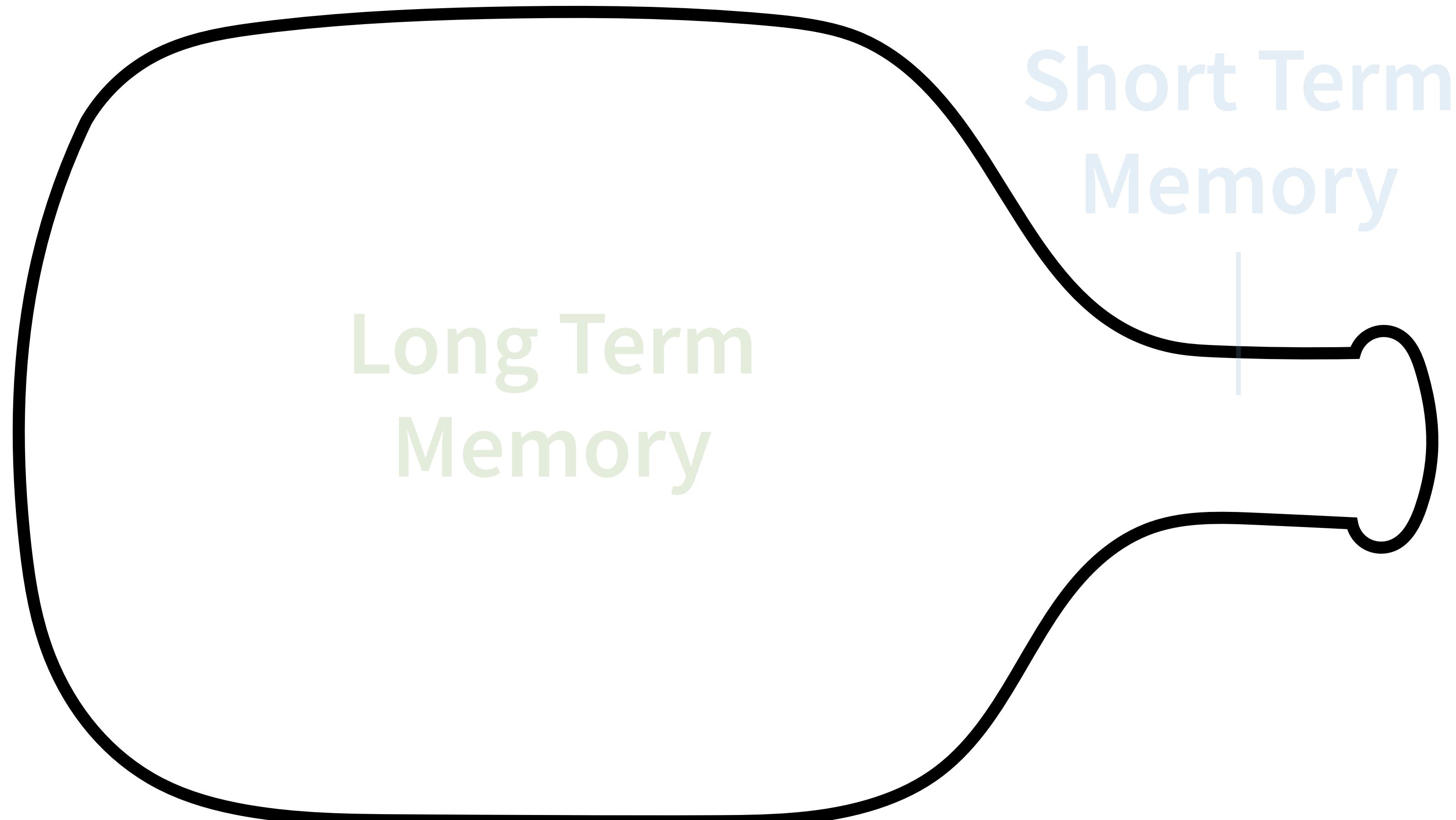
- [Miller, G. A. \(1956\). The magical number seven, plus or minus two: some limits on our capacity for processing information. Psychological review, 63\(2\), 81.](#)
- [Cowan, N. \(2001\). The magical number 4 in short-term memory: A reconsideration of mental storage capacity. Behavioral and brain sciences, 24\(1\), 154-176.](#)

How many in order did
you remember?

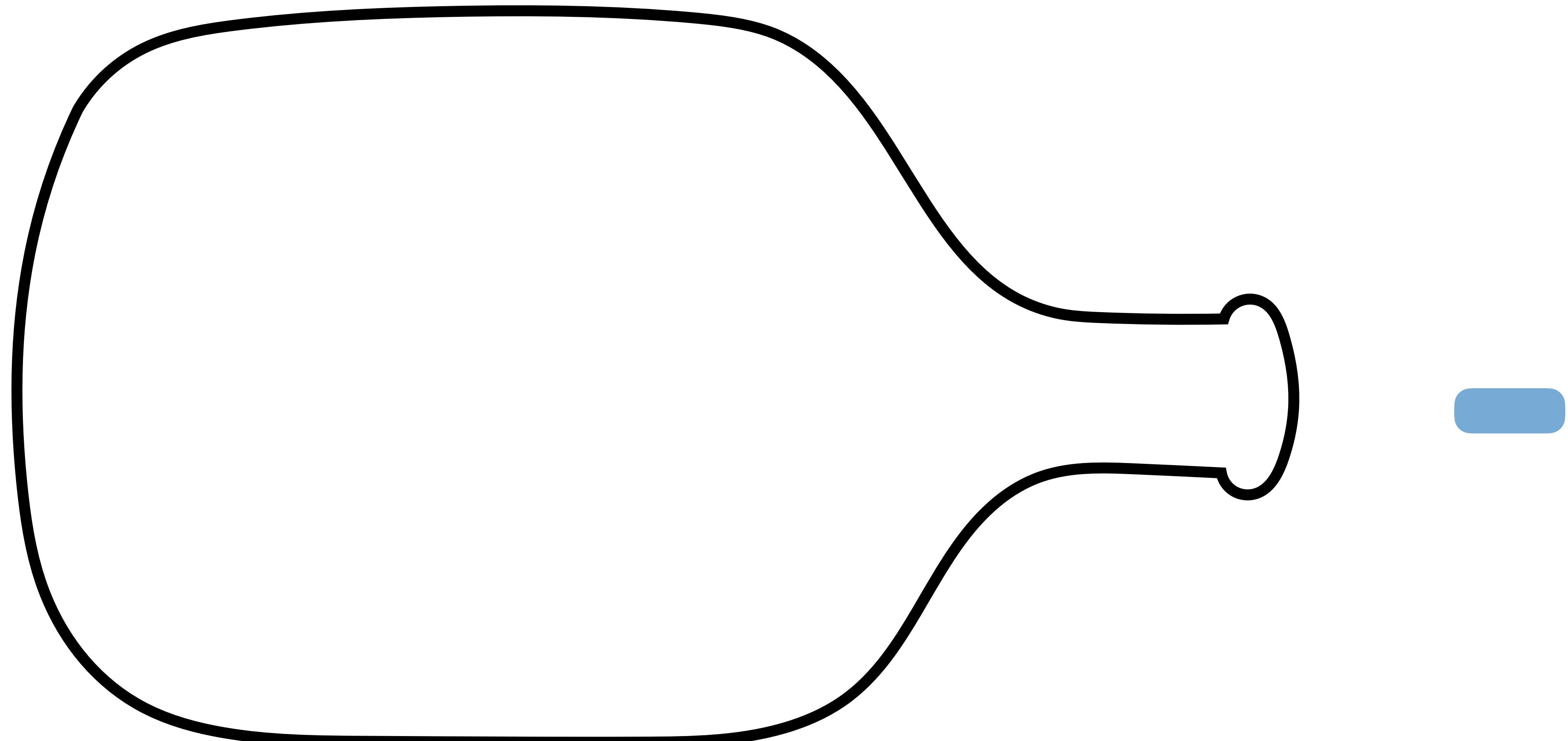
Cognitive Load Theory



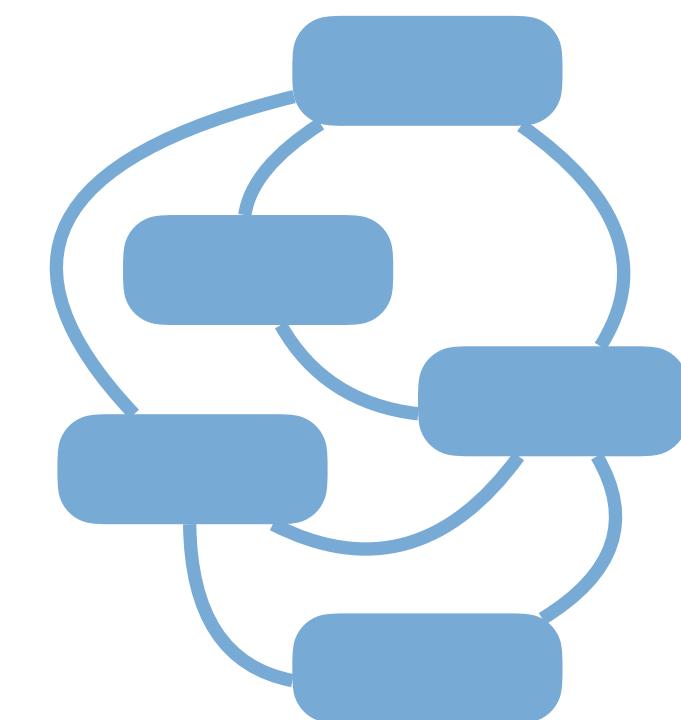
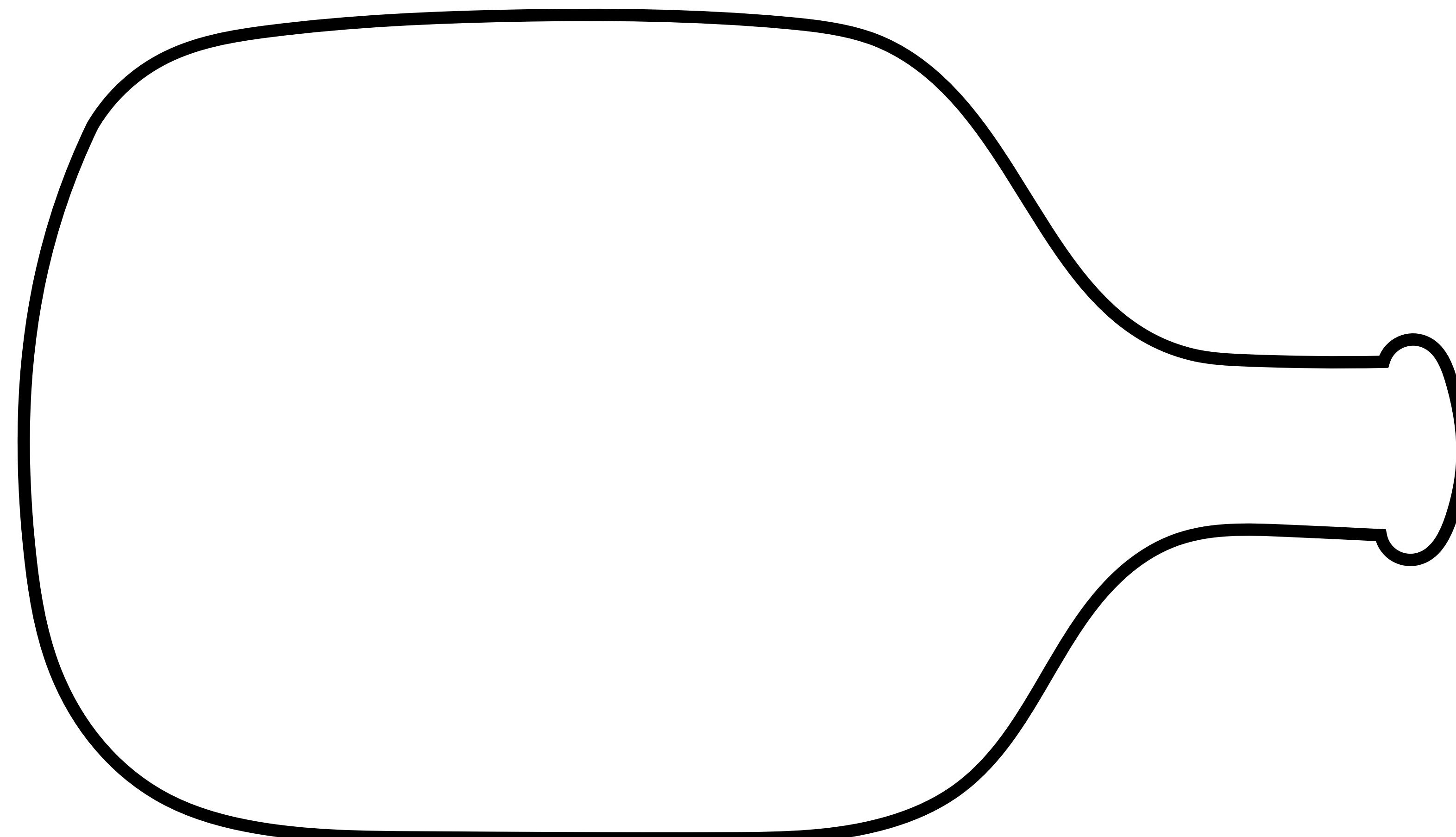
1. Your short term memory has a limited amount of **cognitive load** to spend on processing information.



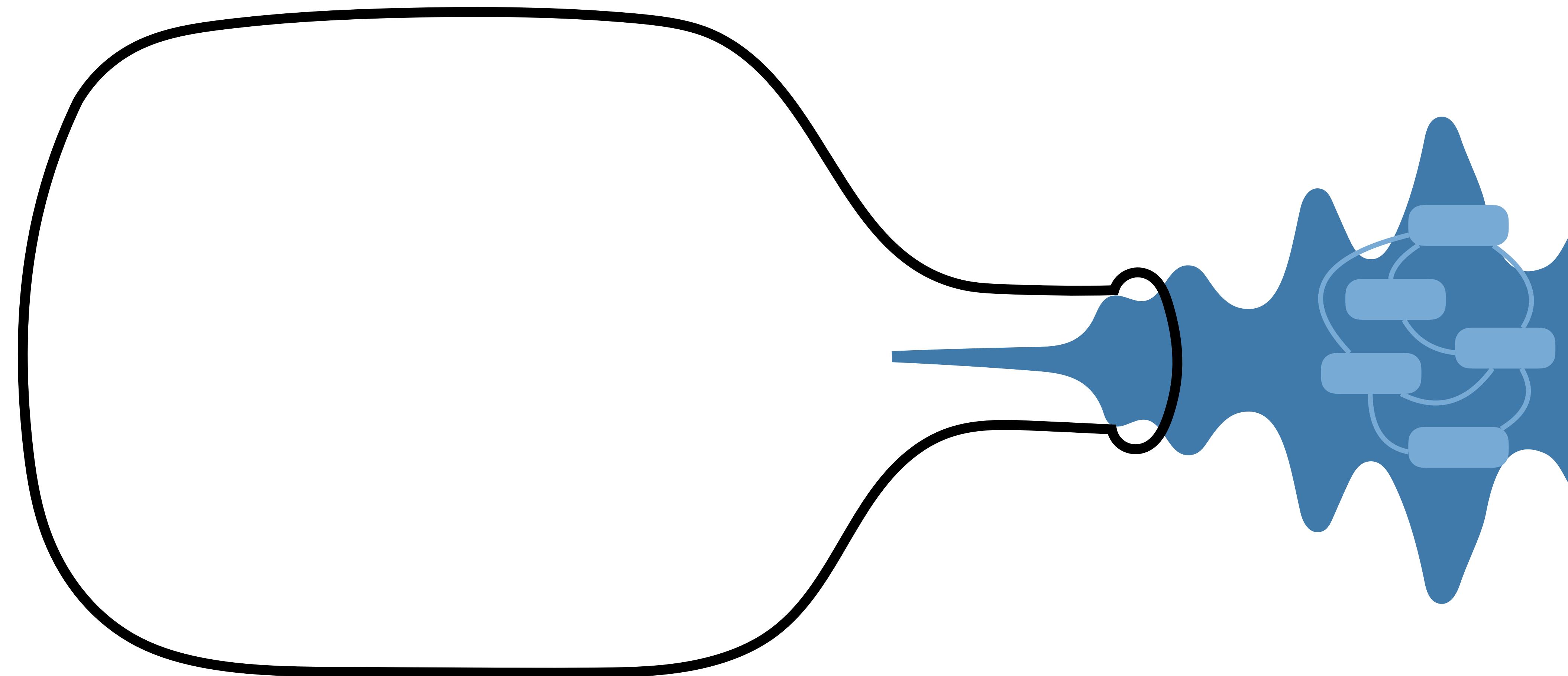
2. If the **load required by a learning task** exceeds the available load, learning does not occur.



2. If the **load required by a learning task** exceeds the available load, learning does not occur.



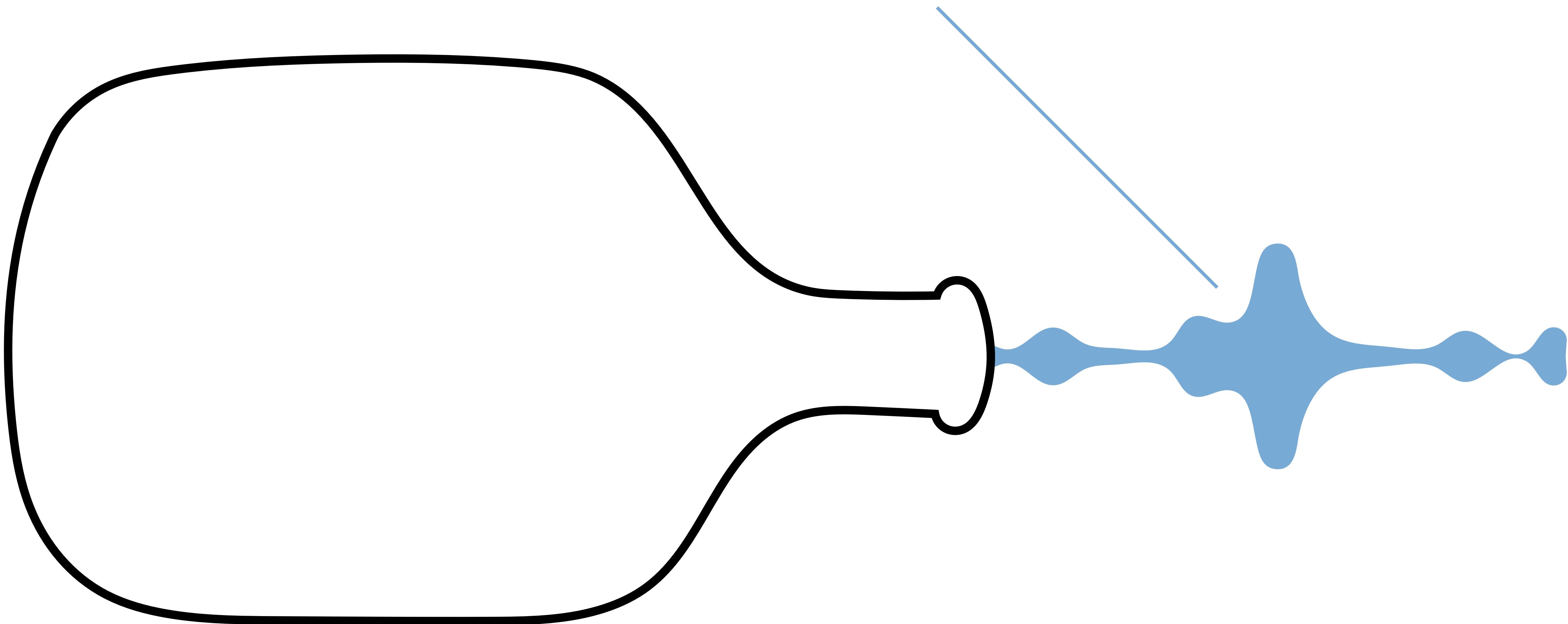
2. If the **load required by a learning task** exceeds the available load, learning does not occur.





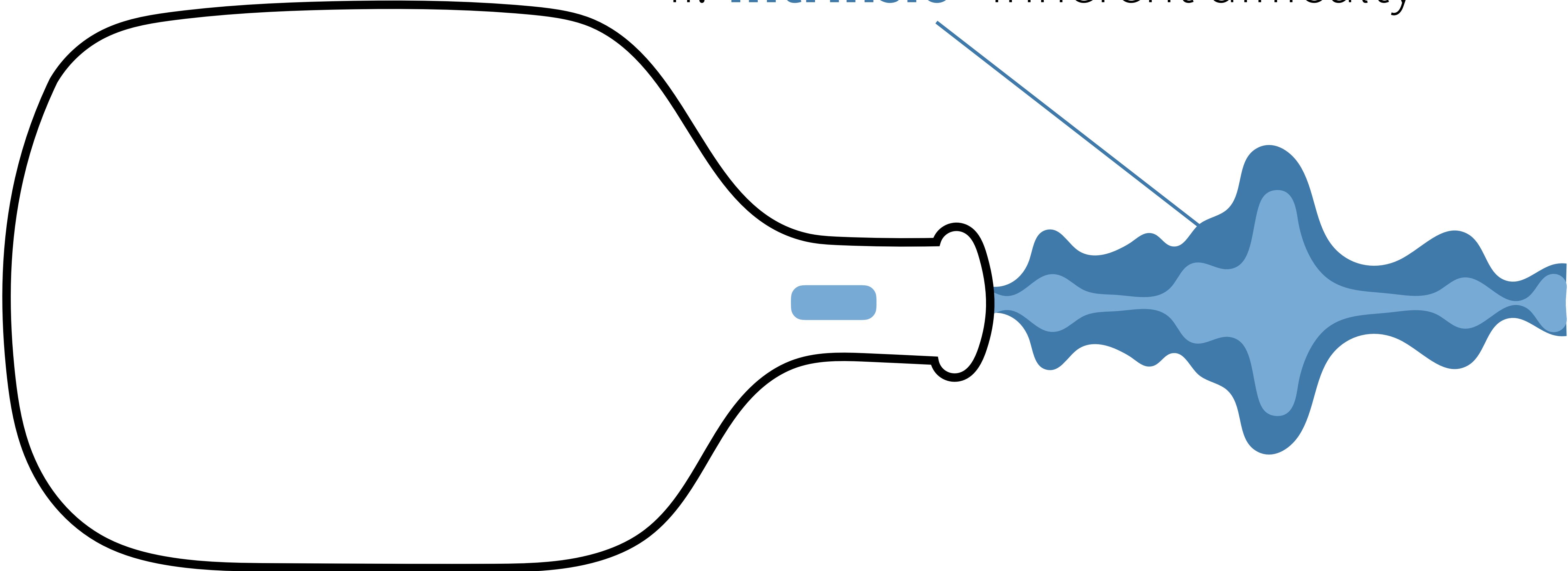
3. Learning tasks involve **three types of load**

i. **Extraneous** - lost to distractions



3. Learning tasks involve **three types of load**

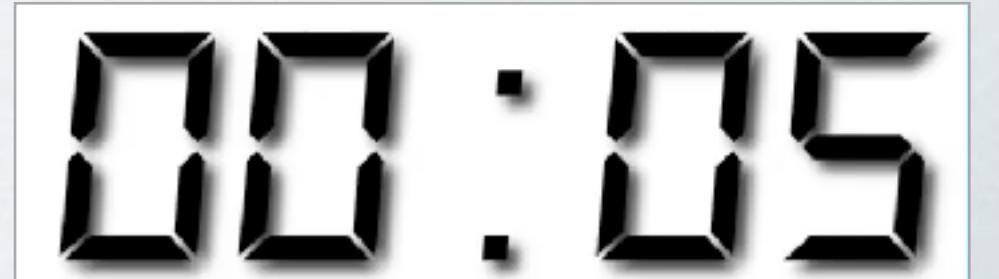
- i. **Extraneous** - lost to distractions
- ii. **Intrinsic** - inherent difficulty



Your Turn

Memorize these letters:

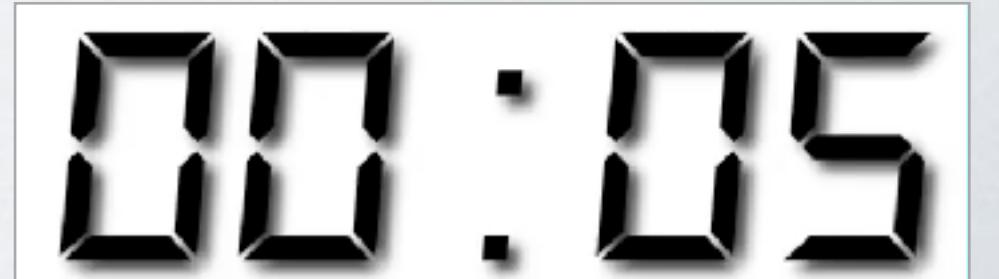
rlxtteraeoxstftsretrlttsr
eryseyhaeesoteseseiehfi



Your Turn

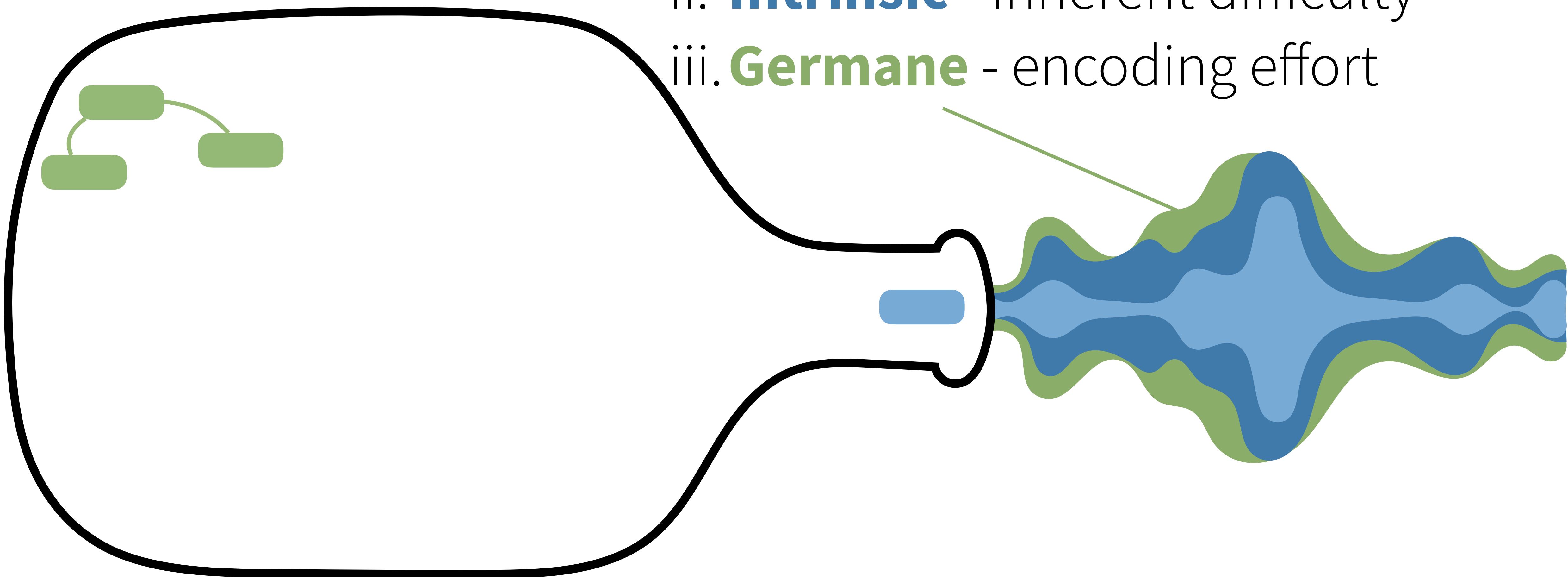
Memorize these letters:

These are forty six letters.
These are forty six letters.



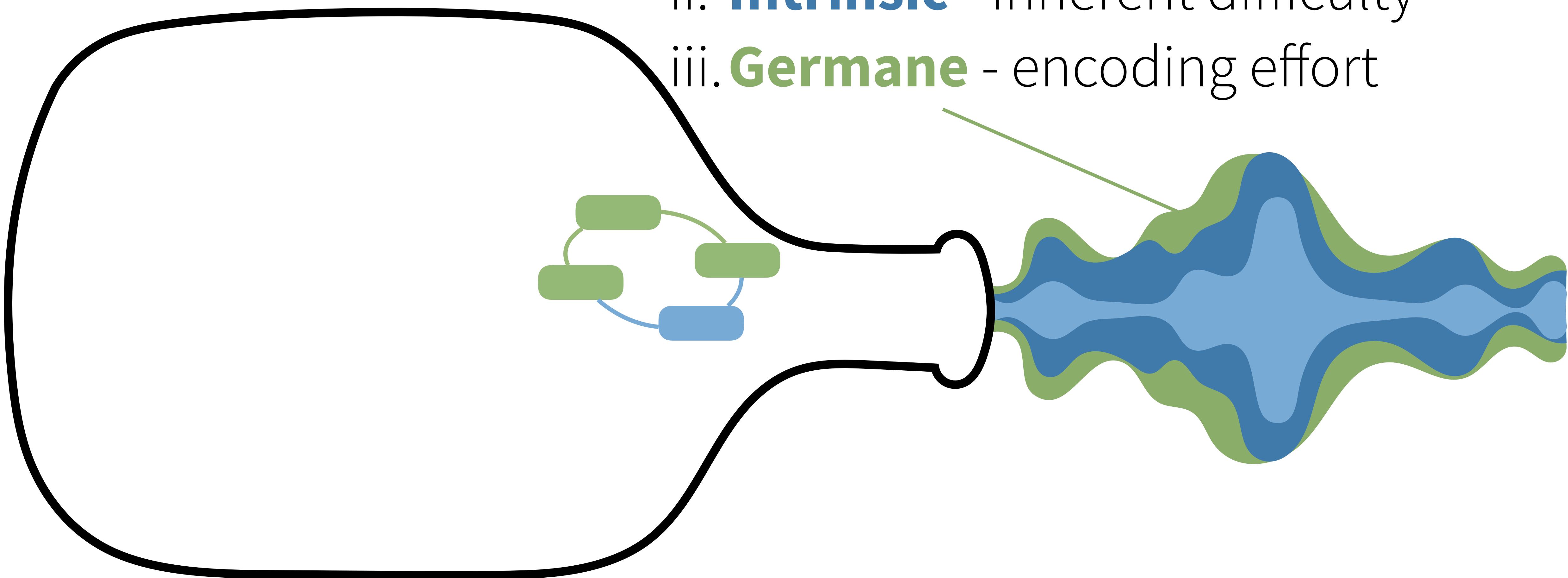
3. Learning tasks involve **three types of load**

- i. **Extraneous** - lost to distractions
- ii. **Intrinsic** - inherent difficulty
- iii. **Germane** - encoding effort



3. Learning tasks involve **three types of load**

- i. **Extraneous** - lost to distractions
- ii. **Intrinsic** - inherent difficulty
- iii. **Germane** - encoding effort



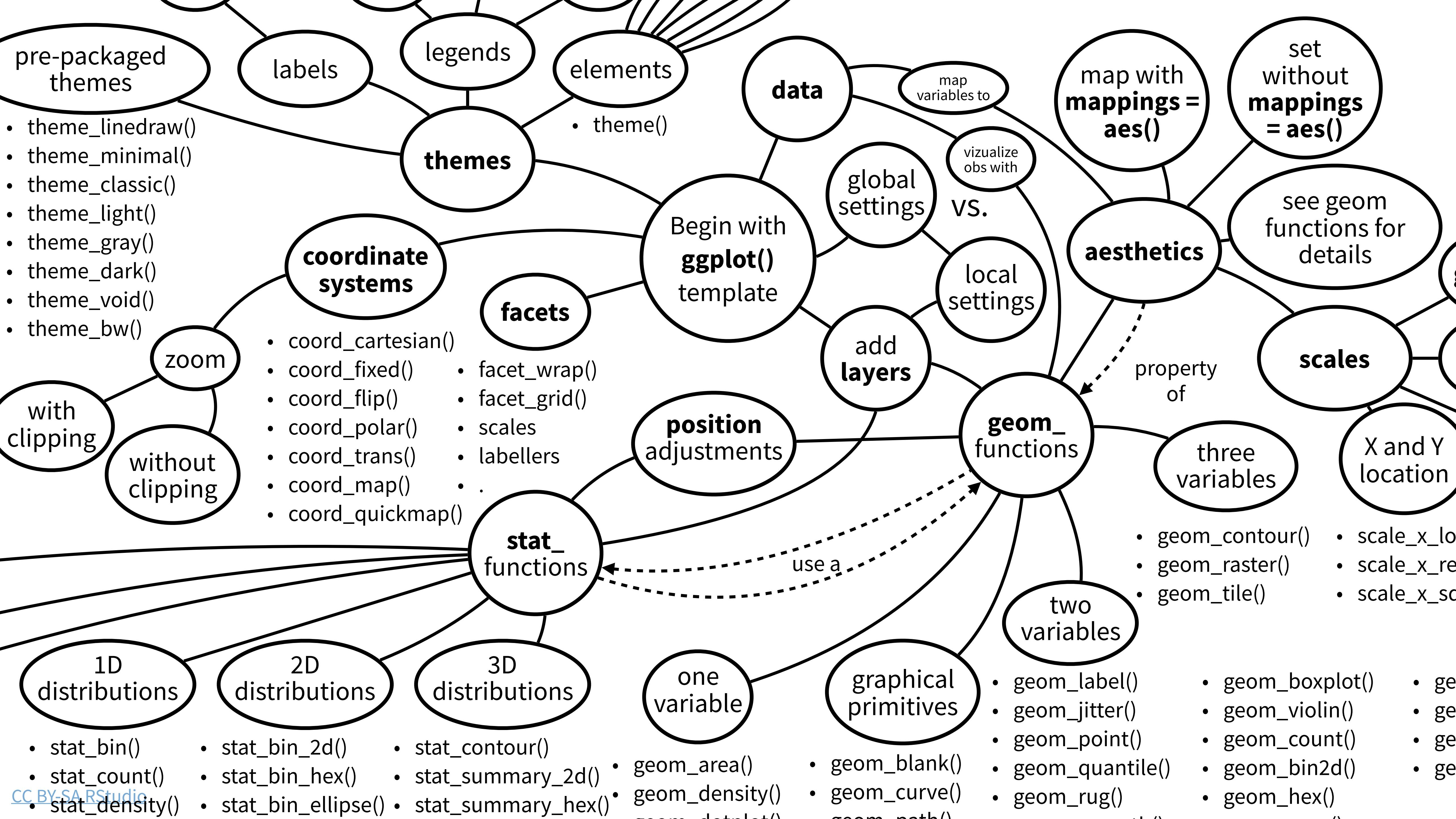
Cognitive Load Theory

1. Your short term memory has a limited amount of **cognitive load** to spend on processing information.
2. If the **load required by a learning task** exceeds the available load, learning does not occur.
3. Learning tasks involve **three types of load**
 - [Sweller, J., Ayres, P., & Kalyuga, S. \(2011\). Cognitive load theory \(Vol. 1\). Springer Science & Business Media. Chicago](#)

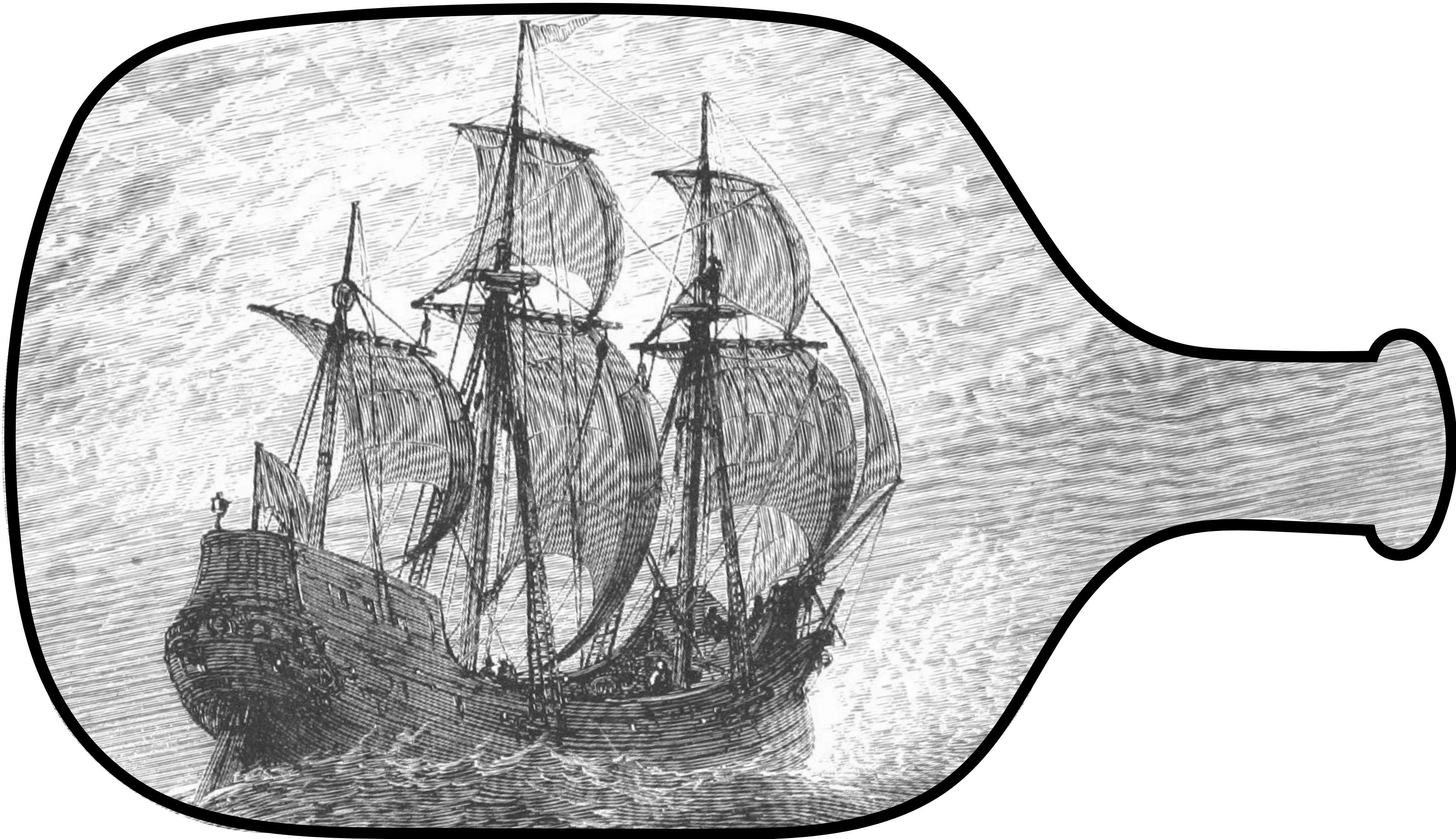
Your Turn

Complete your handout and then compare answers with your group mates.





How to Explain Anything Effectively

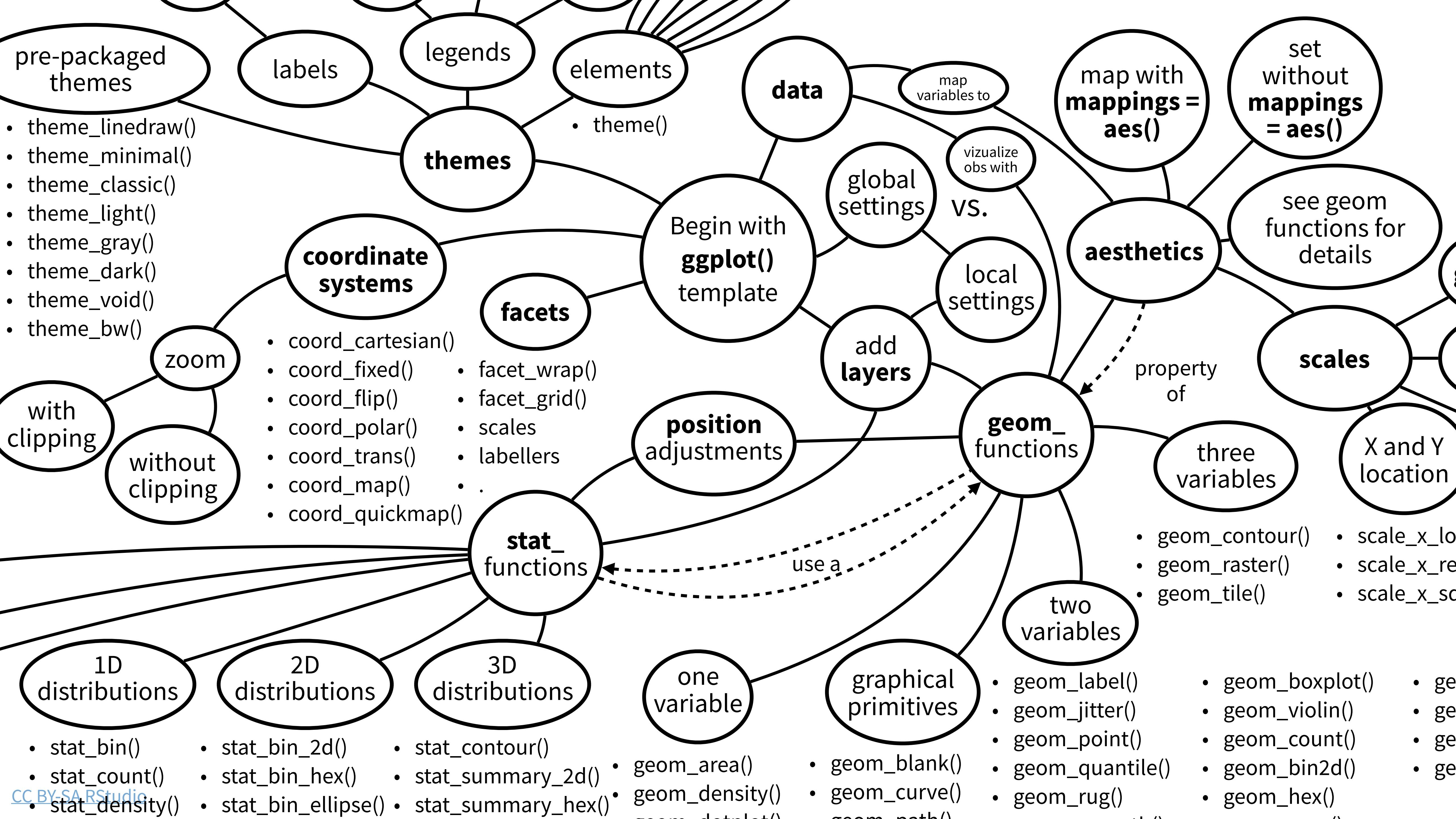


- 1. Lay the keel**
- 2. Build topics in order**
- 3. Connect to familiar things**

Lay the keel

A large, semi-transparent graphic consisting of two overlapping circles. The left circle contains the letter 'R' and the right circle contains the letter 'L', both in a bold, light green font.

R
L



What is the keel of your mental model?

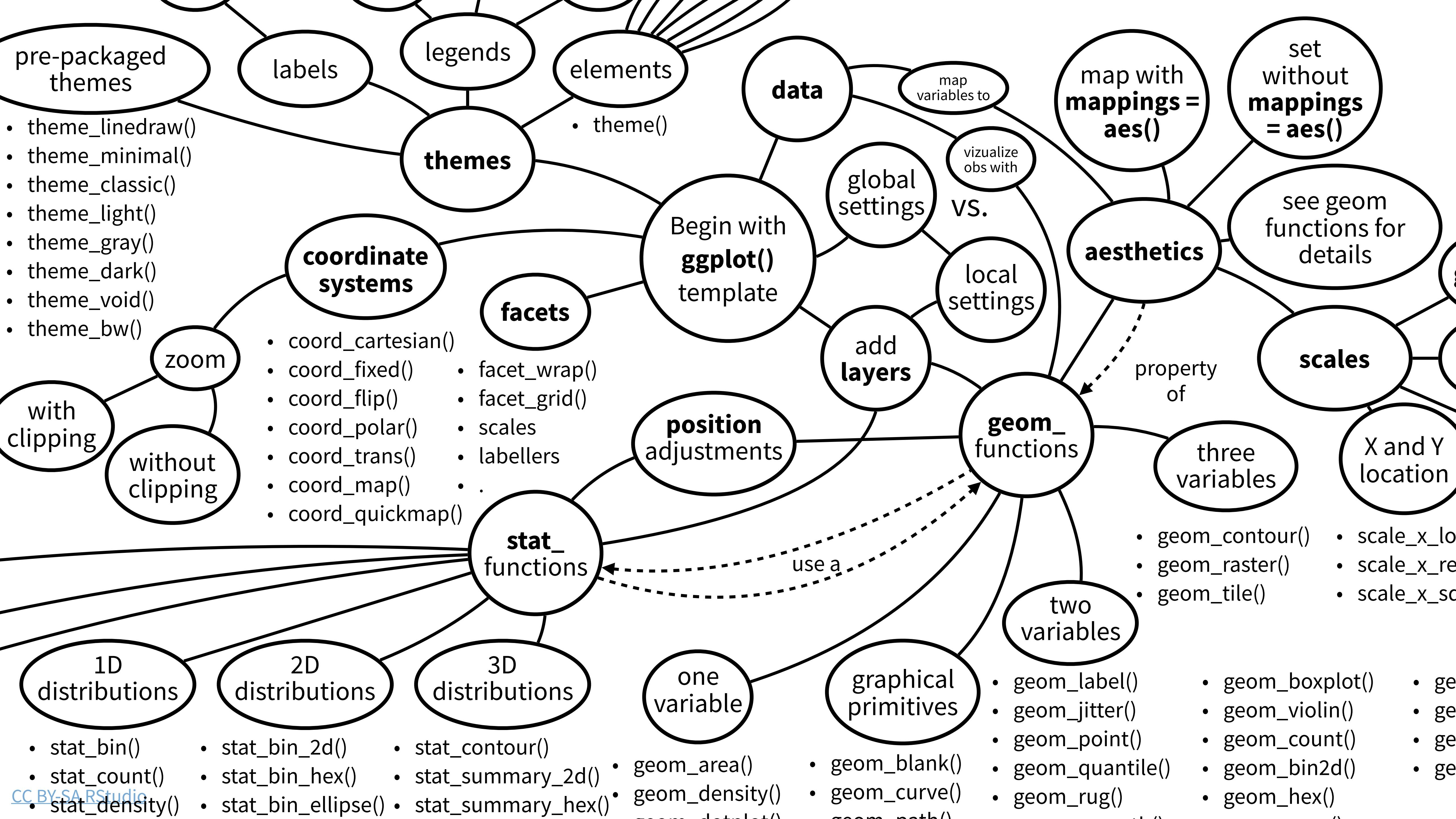
i.e., the core that everything else can hang on?



Your Turn

Examine the slides in 01-Data-Visualization. Spot the "initial" mental model of the section.



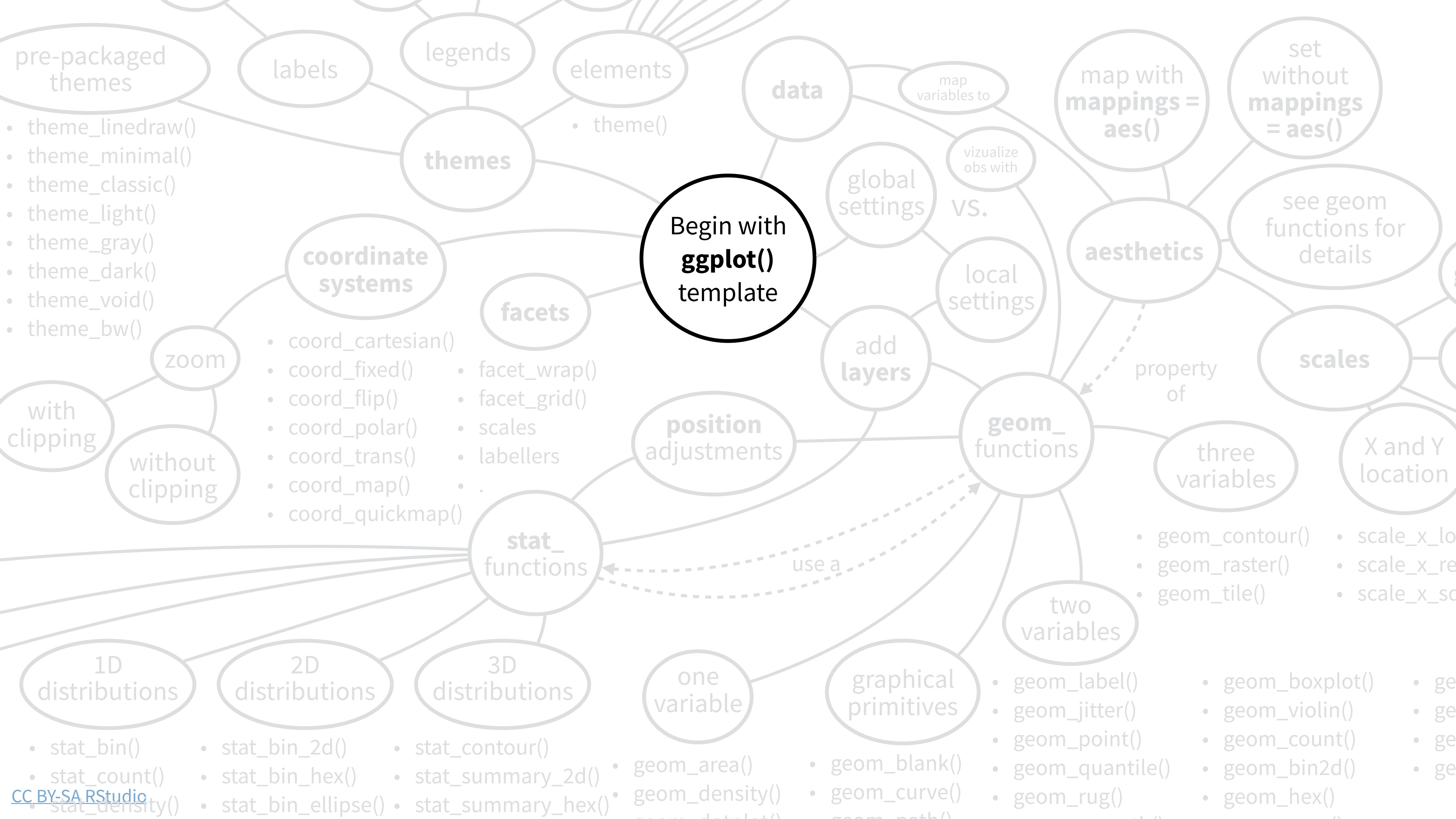


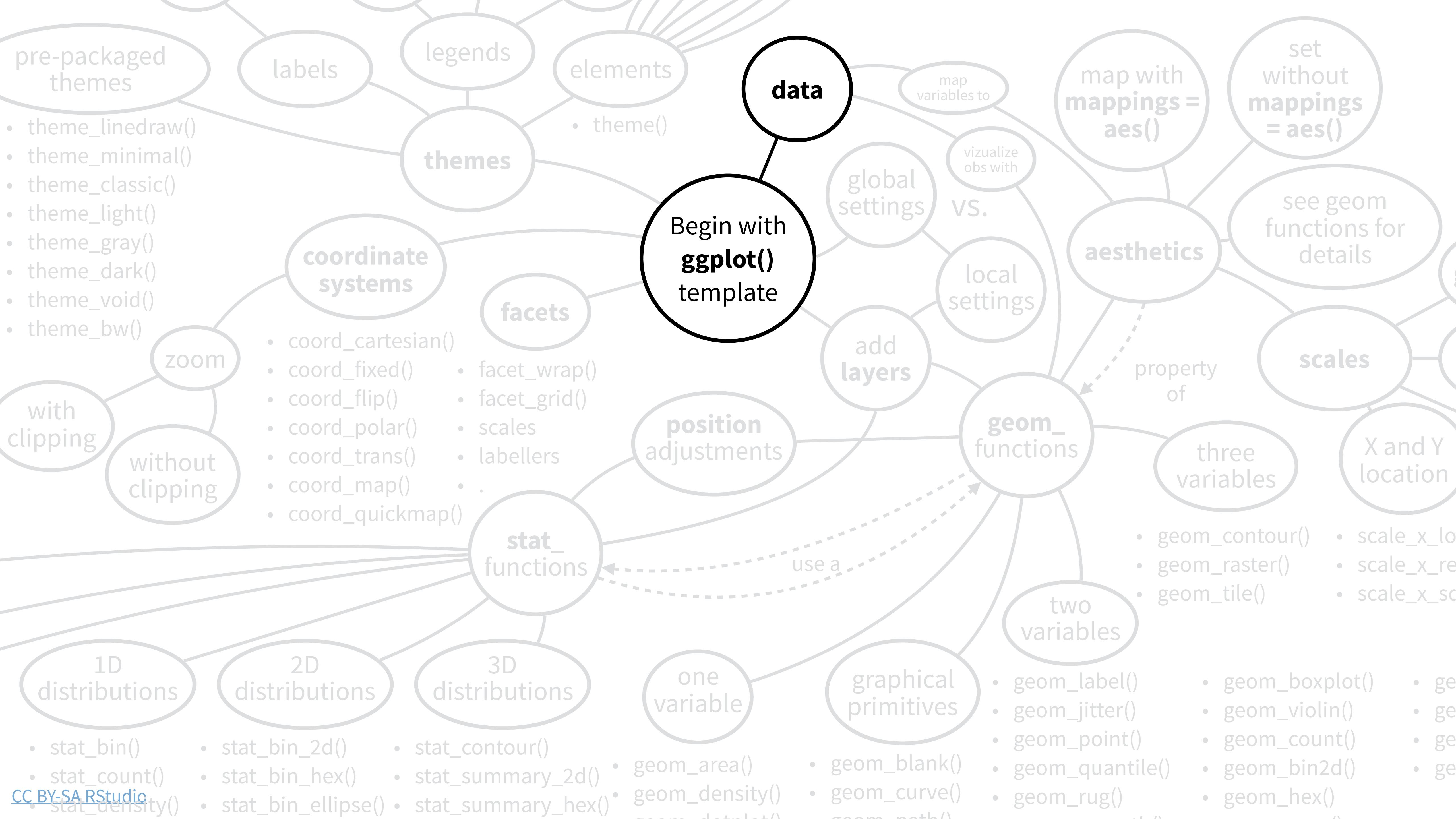
A template

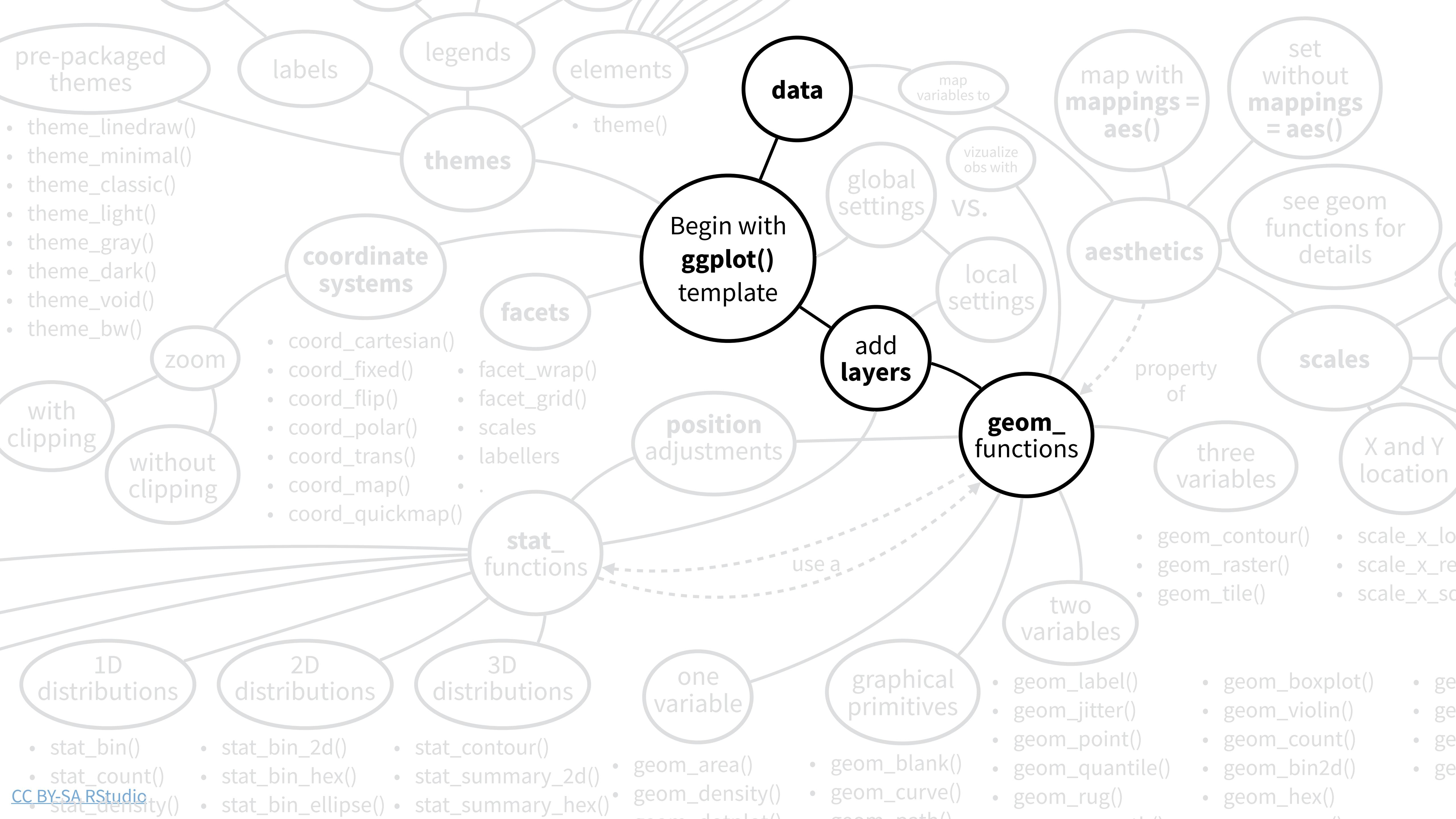
```
ggplot(data = <DATA>) +  
<GEOM_FUNCTION>(mapping = aes(<MAPPINGS>))
```

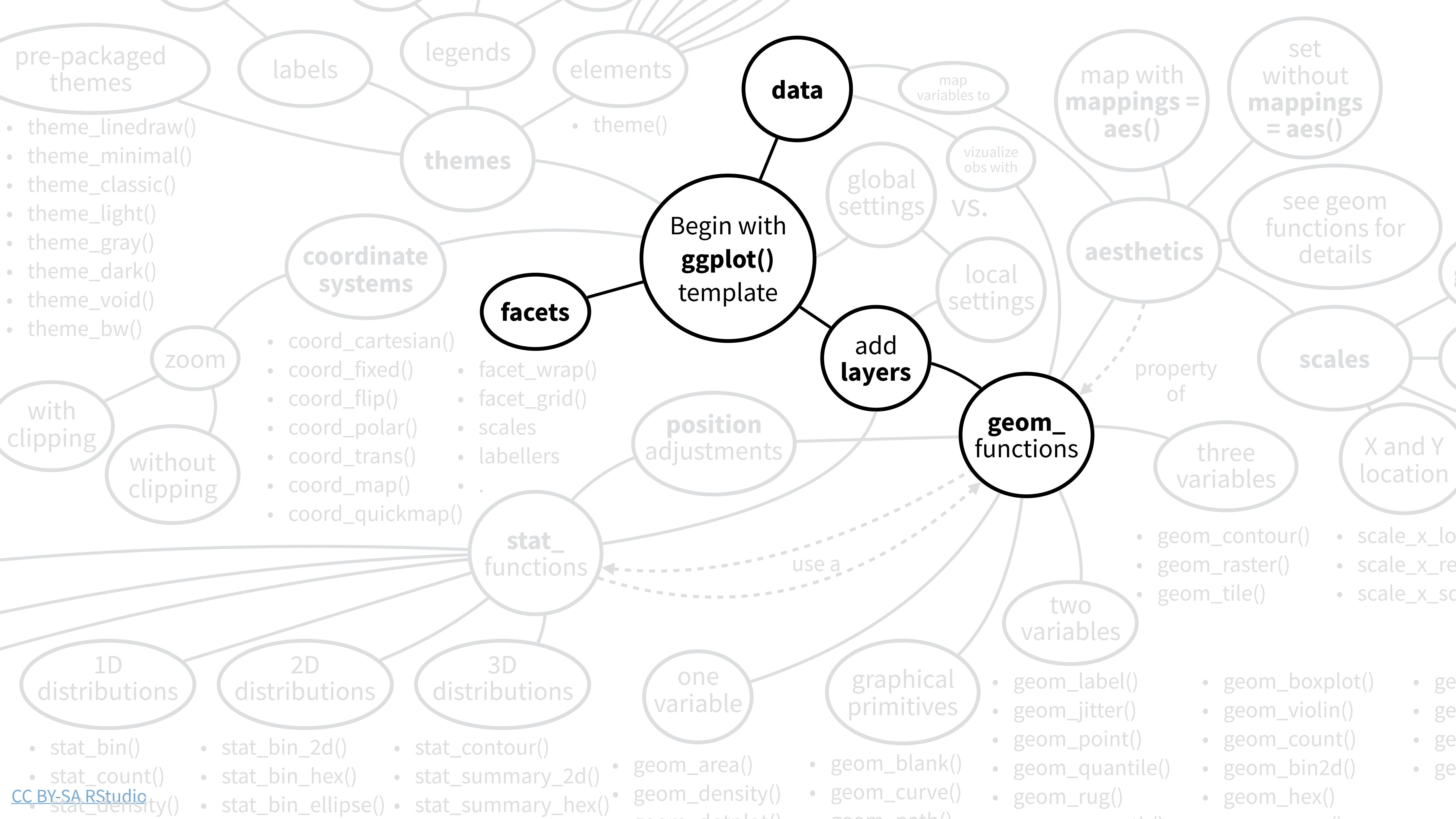


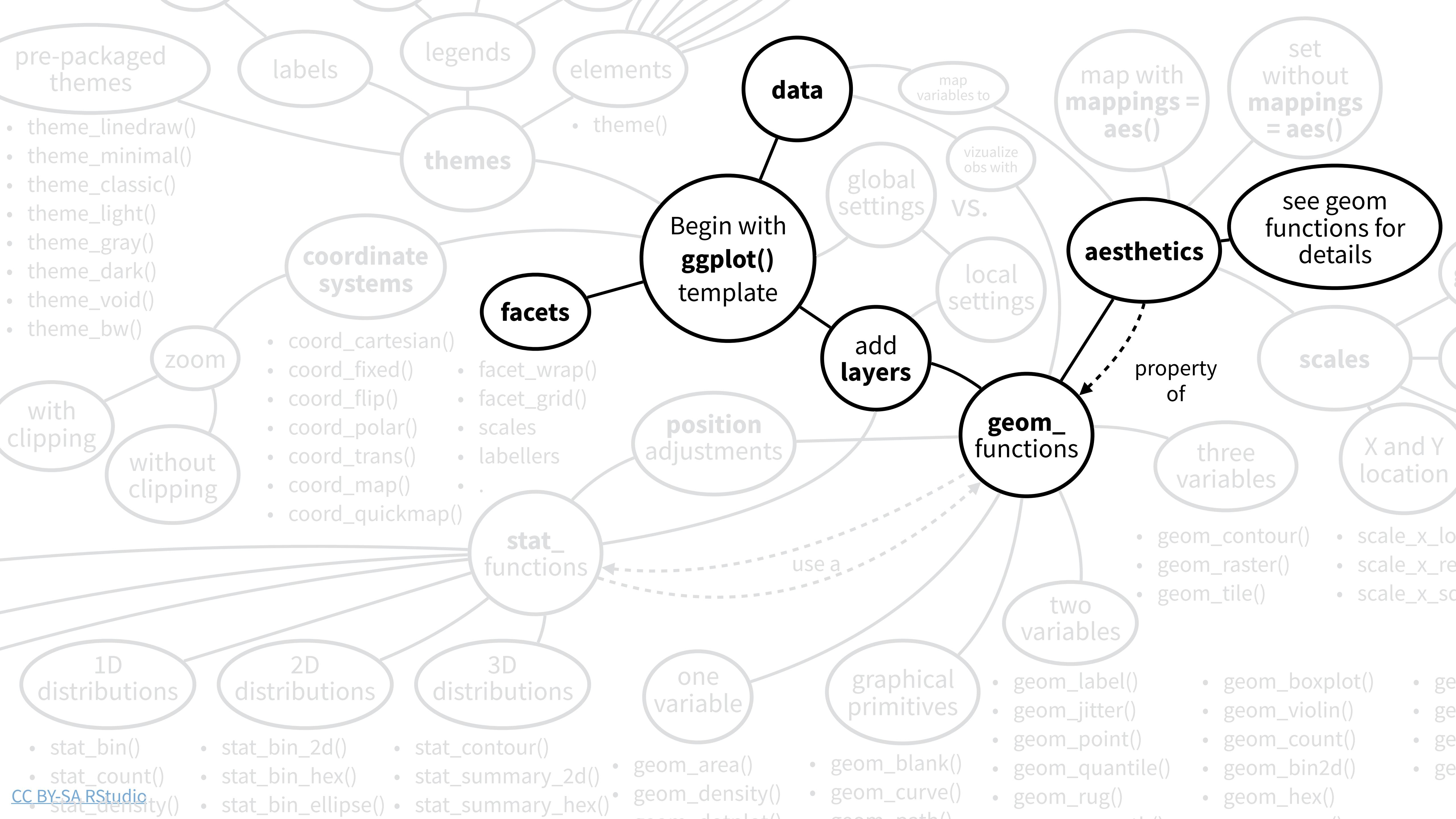
Begin with **ggplot()** template



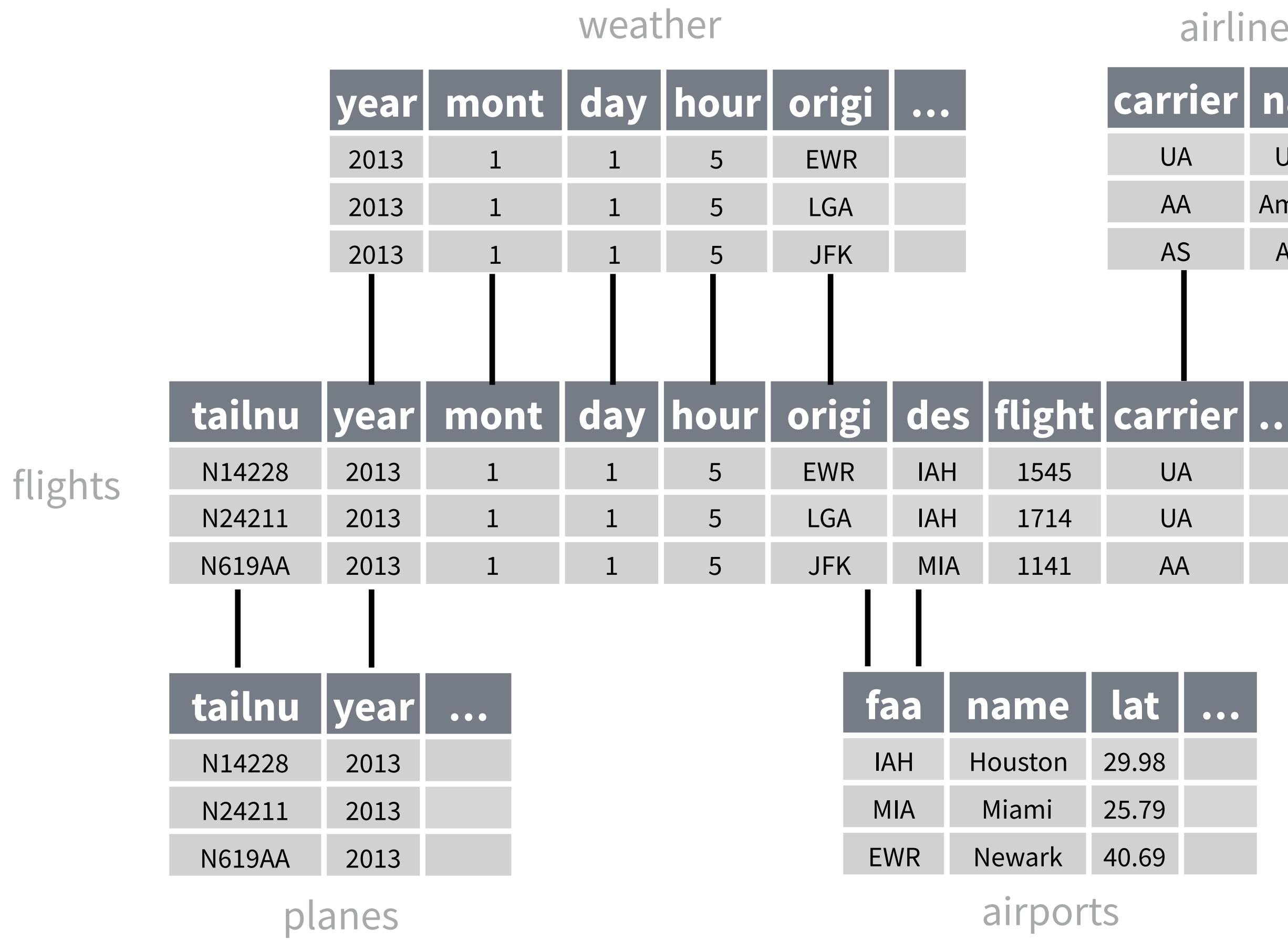




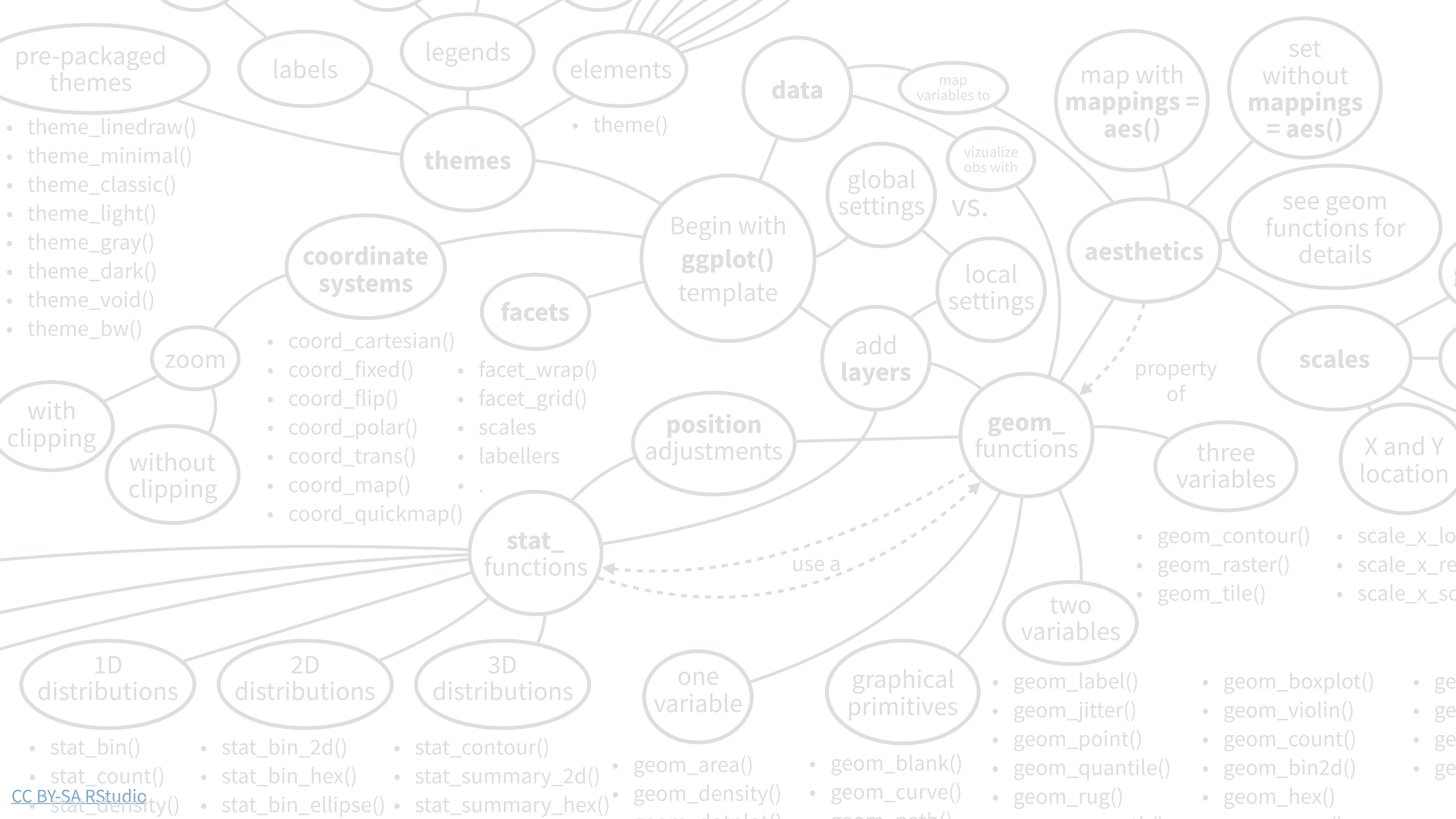


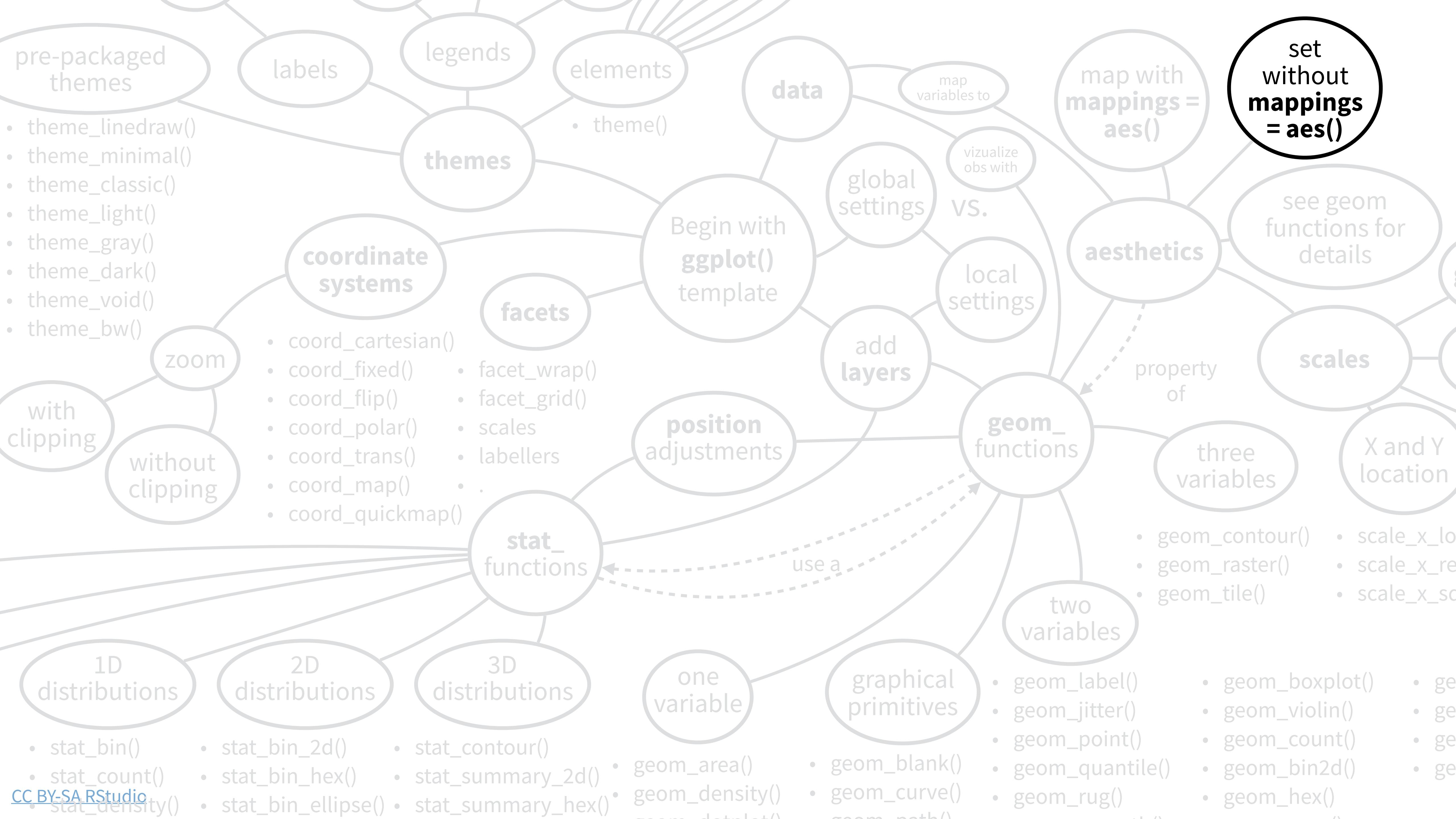


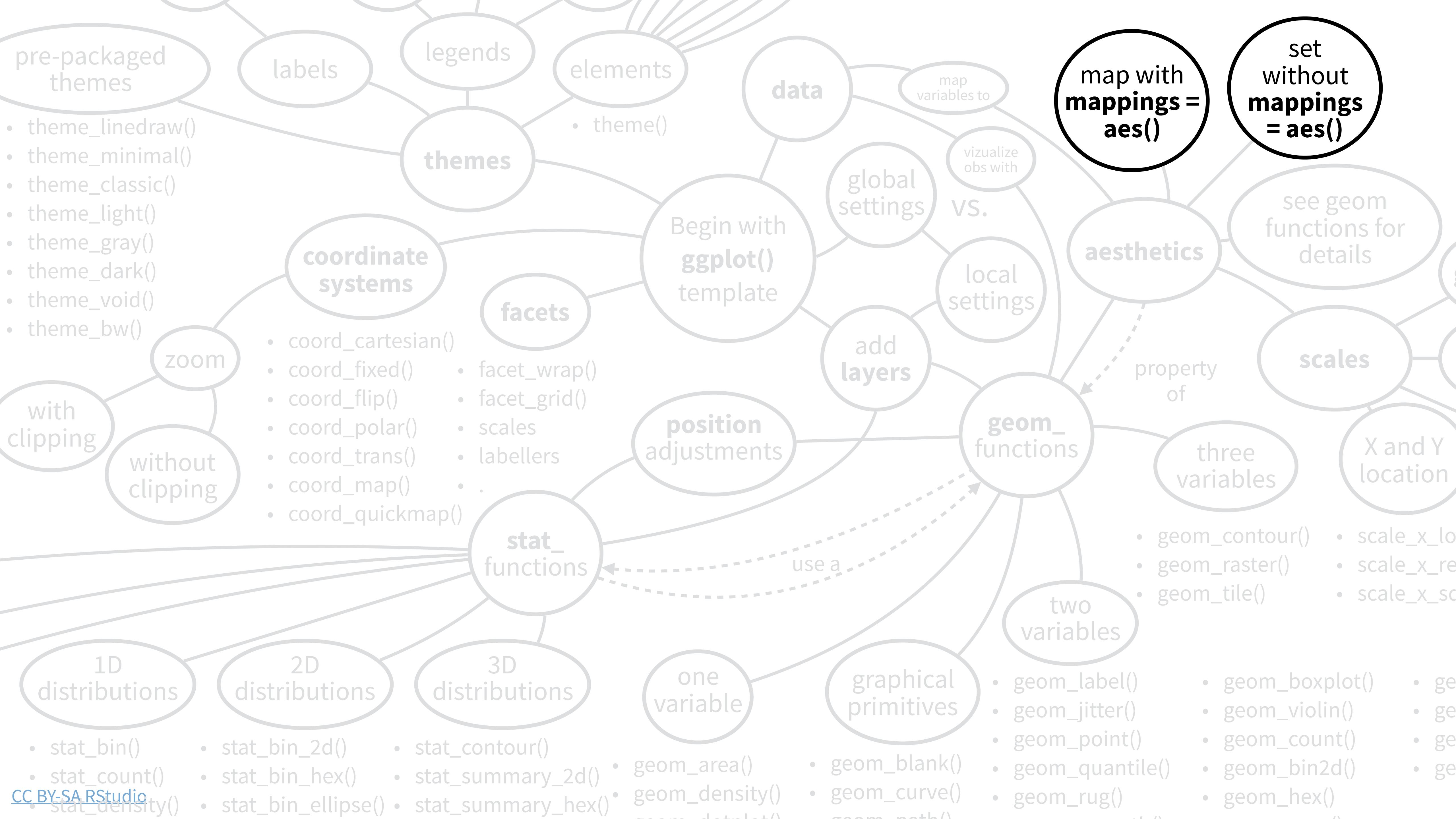
Competent Practitioner

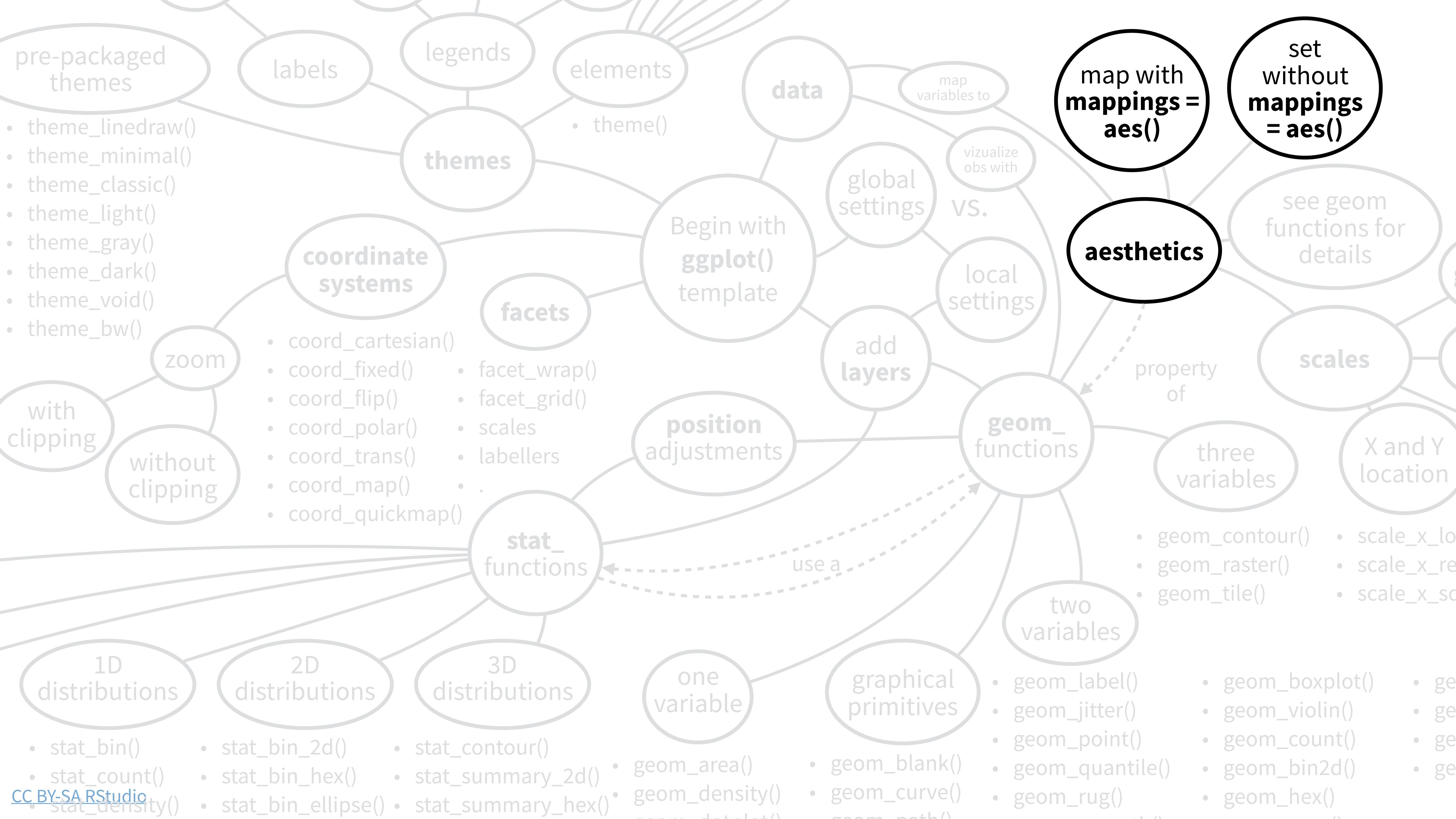


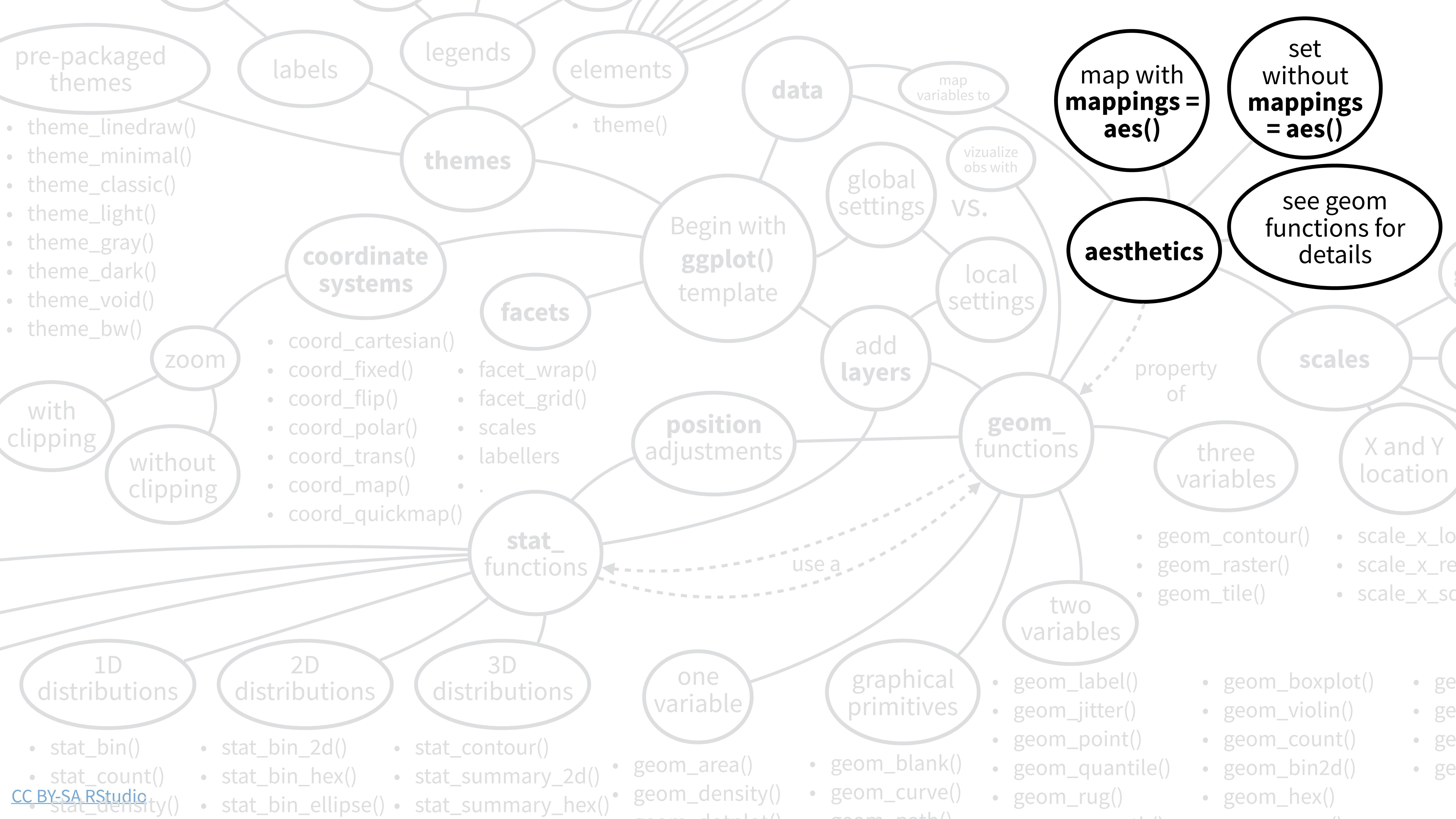
Useful
mental model

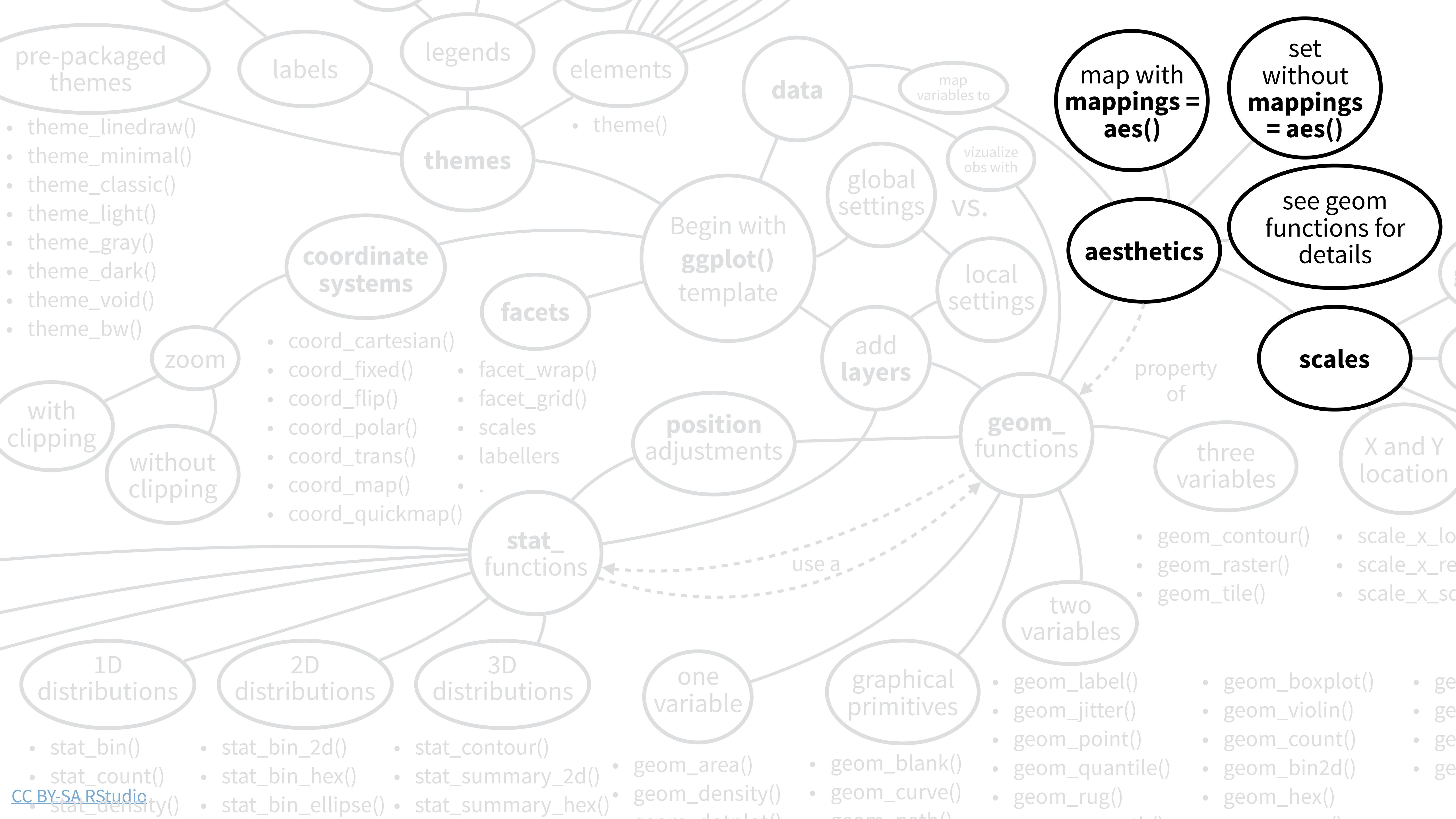


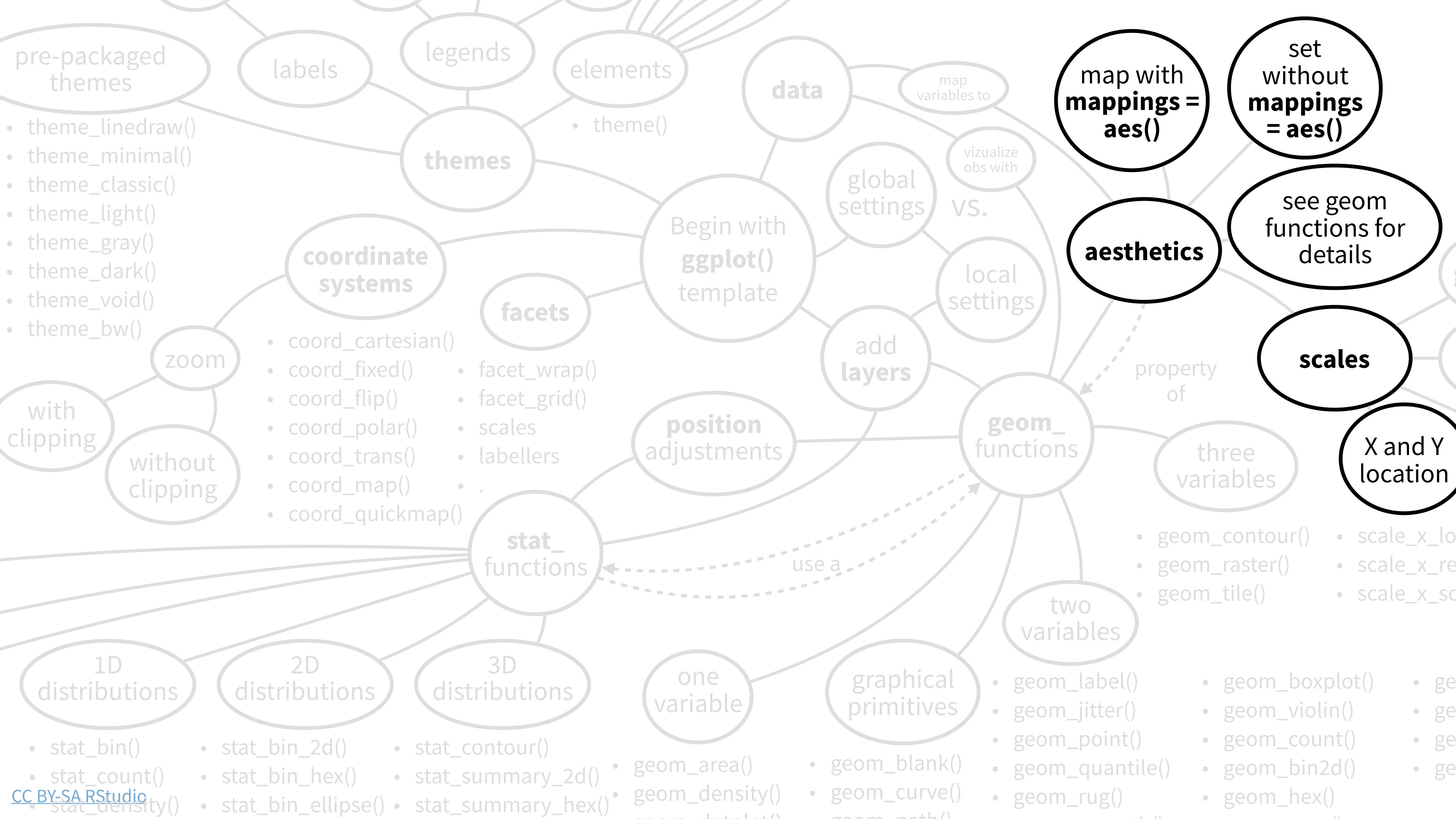


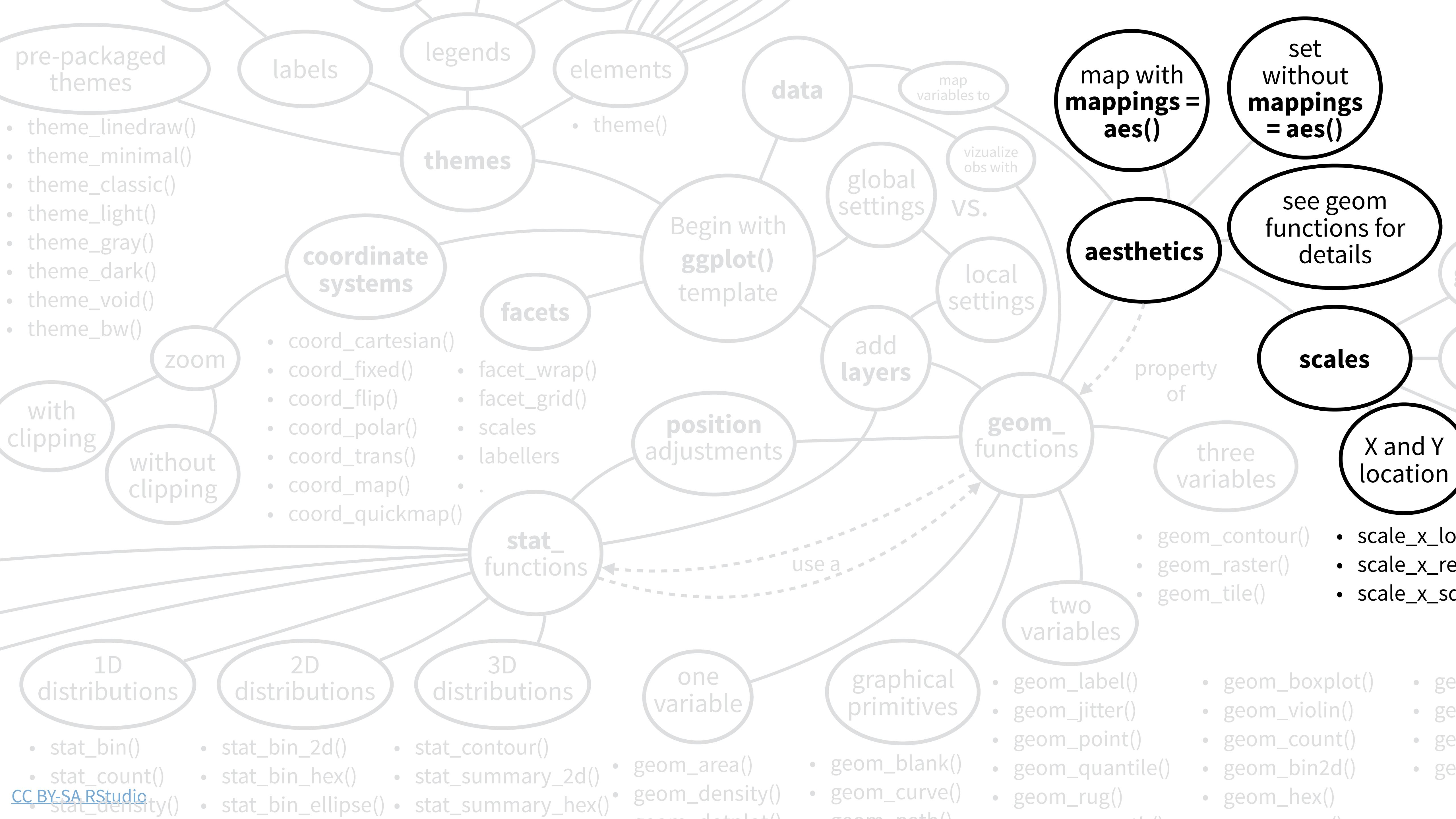




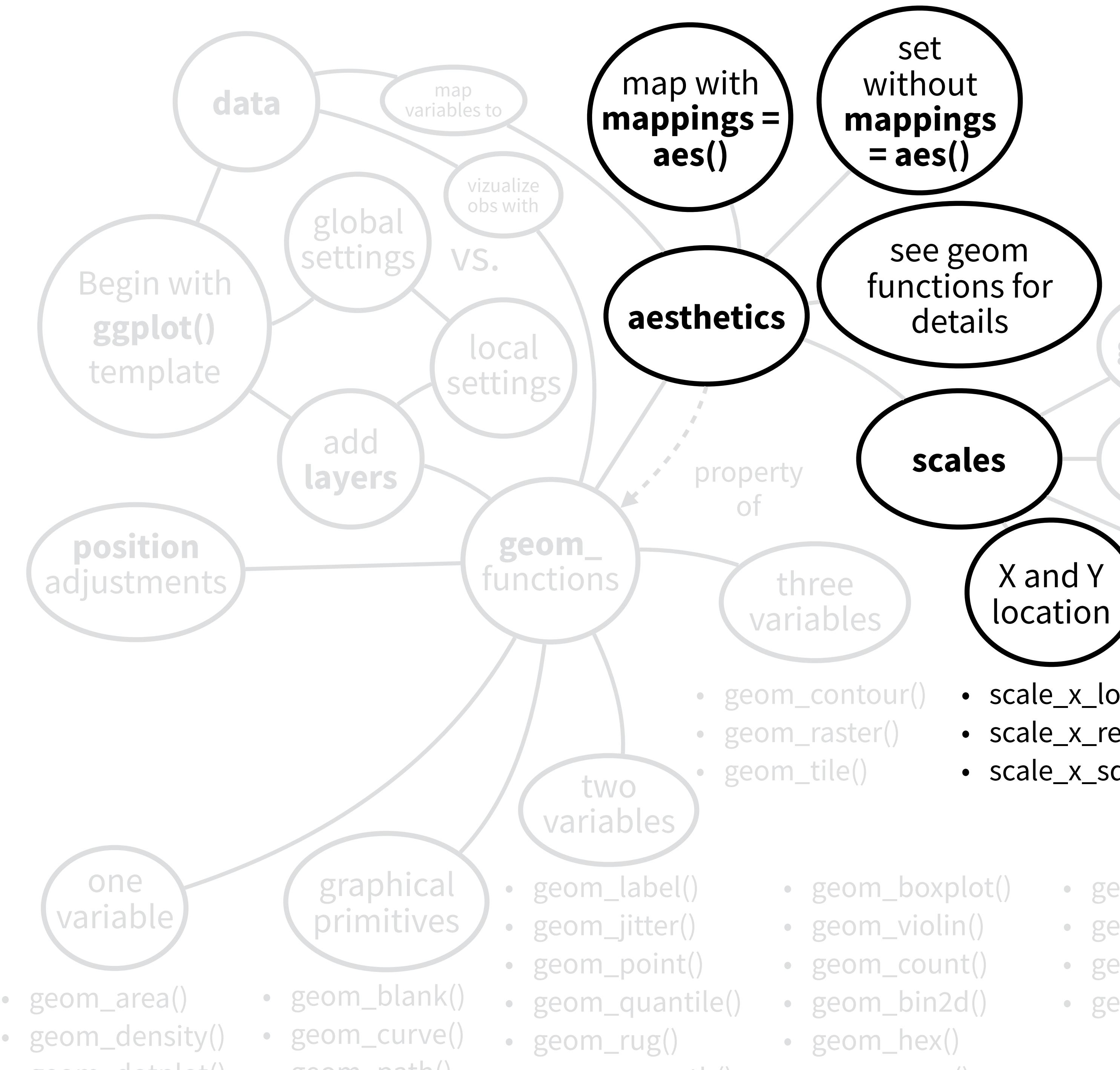








- set without **mappings** = `aes()`
- map with **mappings** = `aes()`
- **aesthetics**
- see geom functions for details
- **scales**
- X and Y location
- `scale_x_log10()`
- `scale_x_reverse()`
- `scale_x_sqrt()`



Beginner



No
mental model

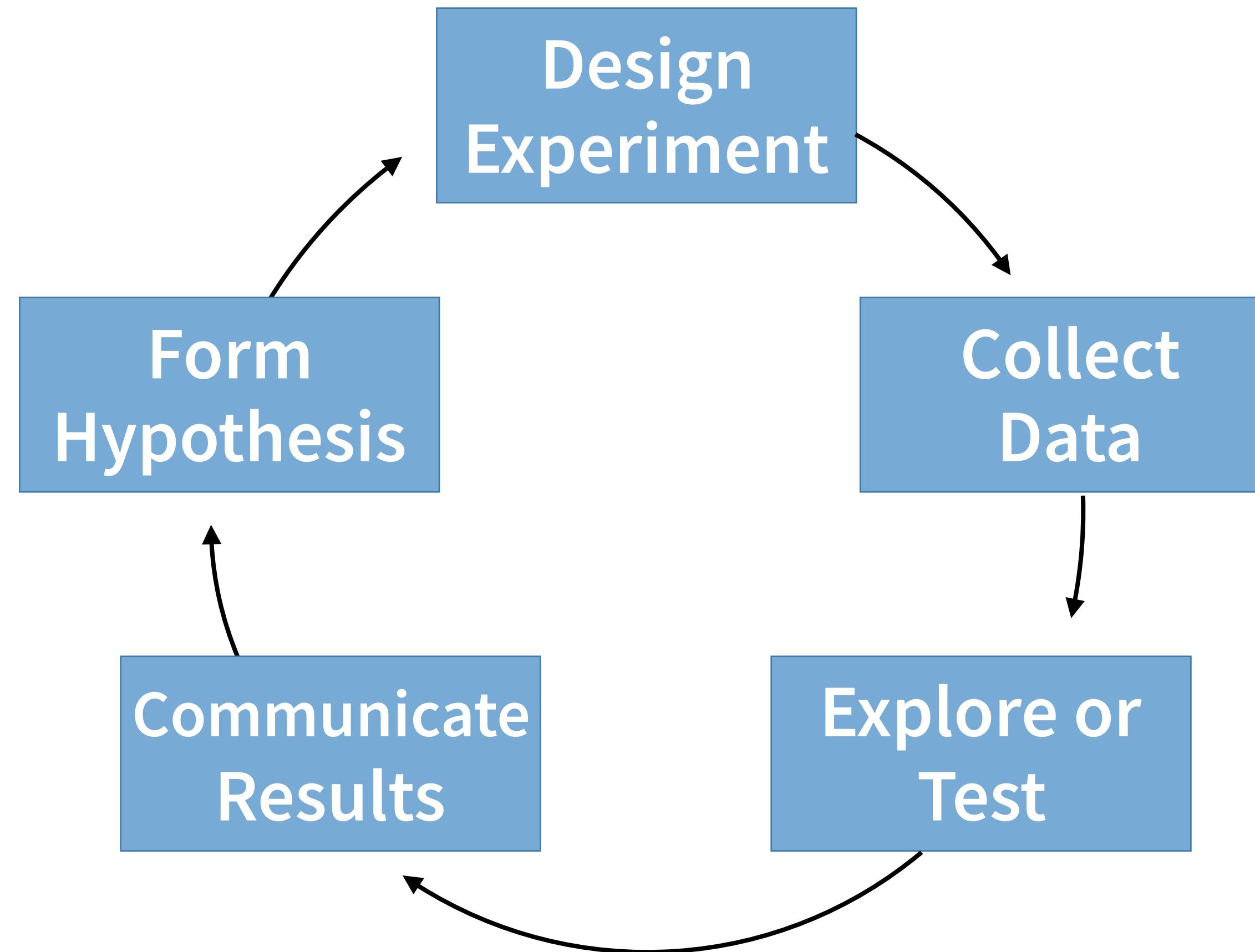
- LGA is LaGuardia Airport
- It rained at JFK on 1/3/2013
- UA is United
- N619AA is a Cessna Plane
- Flight 1532 was delayed on 12/31/13
- Flight 1714 flew from LGA to IAH
- Houston airport is at 29.98 latitude
- Miami is MIA

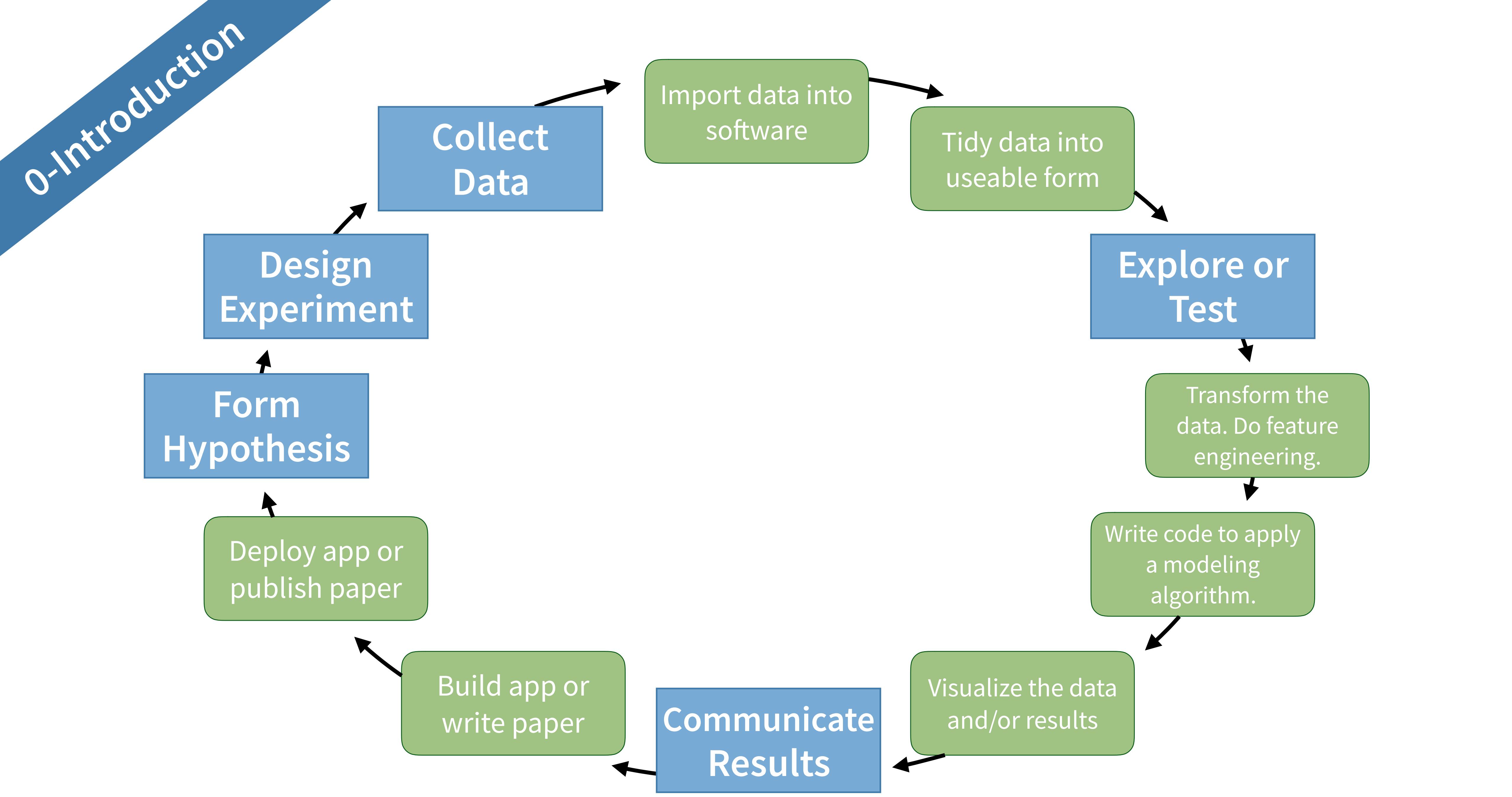
A template

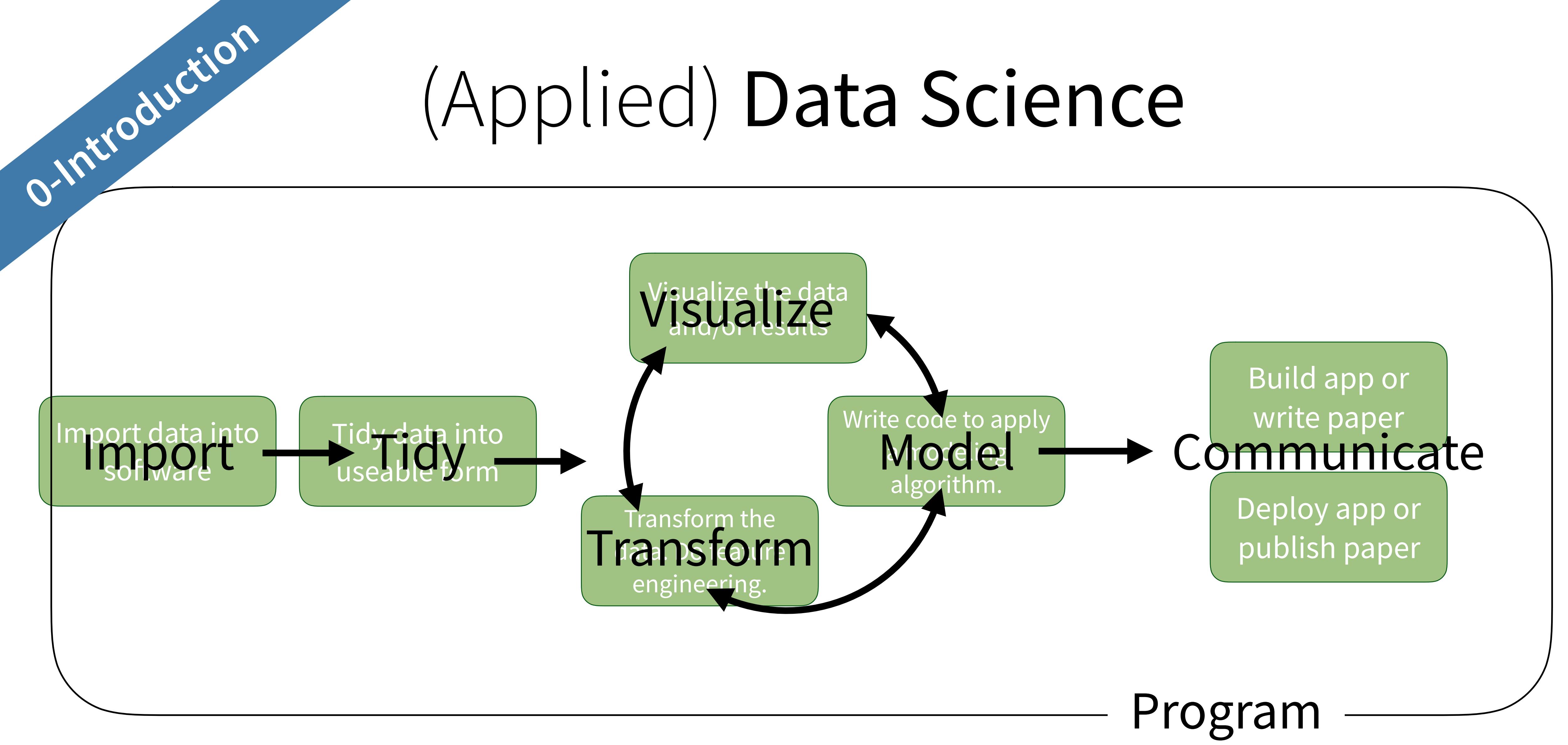
```
ggplot(data = <DATA>) +  
<GEOM_FUNCTION>(mapping = aes(<MAPPINGS>))
```



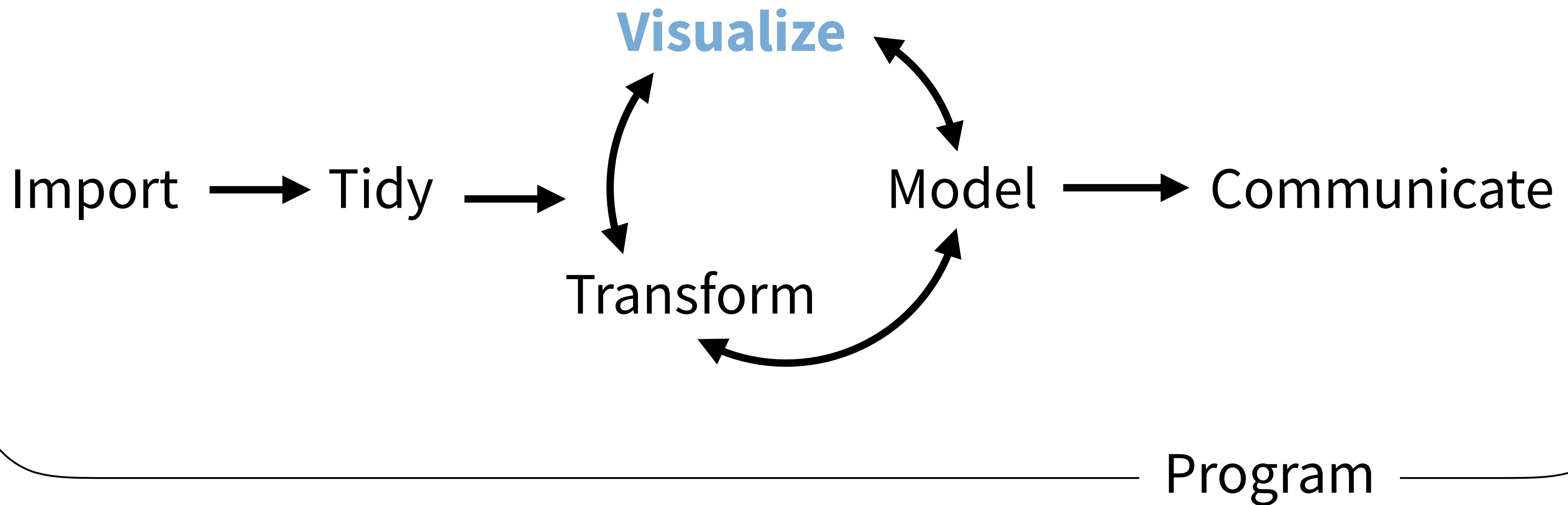
"Data Science"







(Applied) Data Science



Your Turn

Use your concept map to spot an initial mental model for your topic.



Your Turn

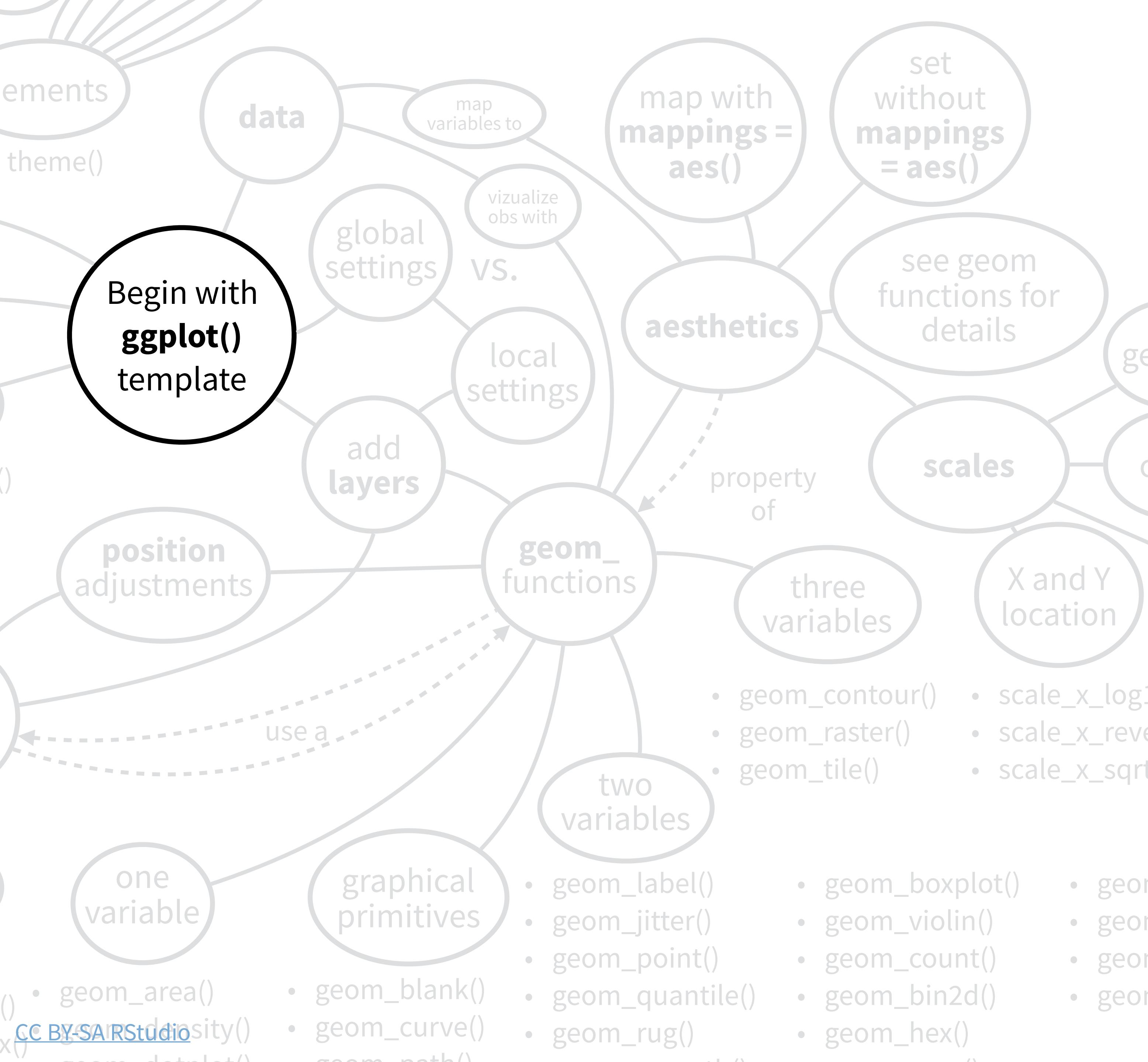
Explain your initial mental model to your group members and then share feedback.

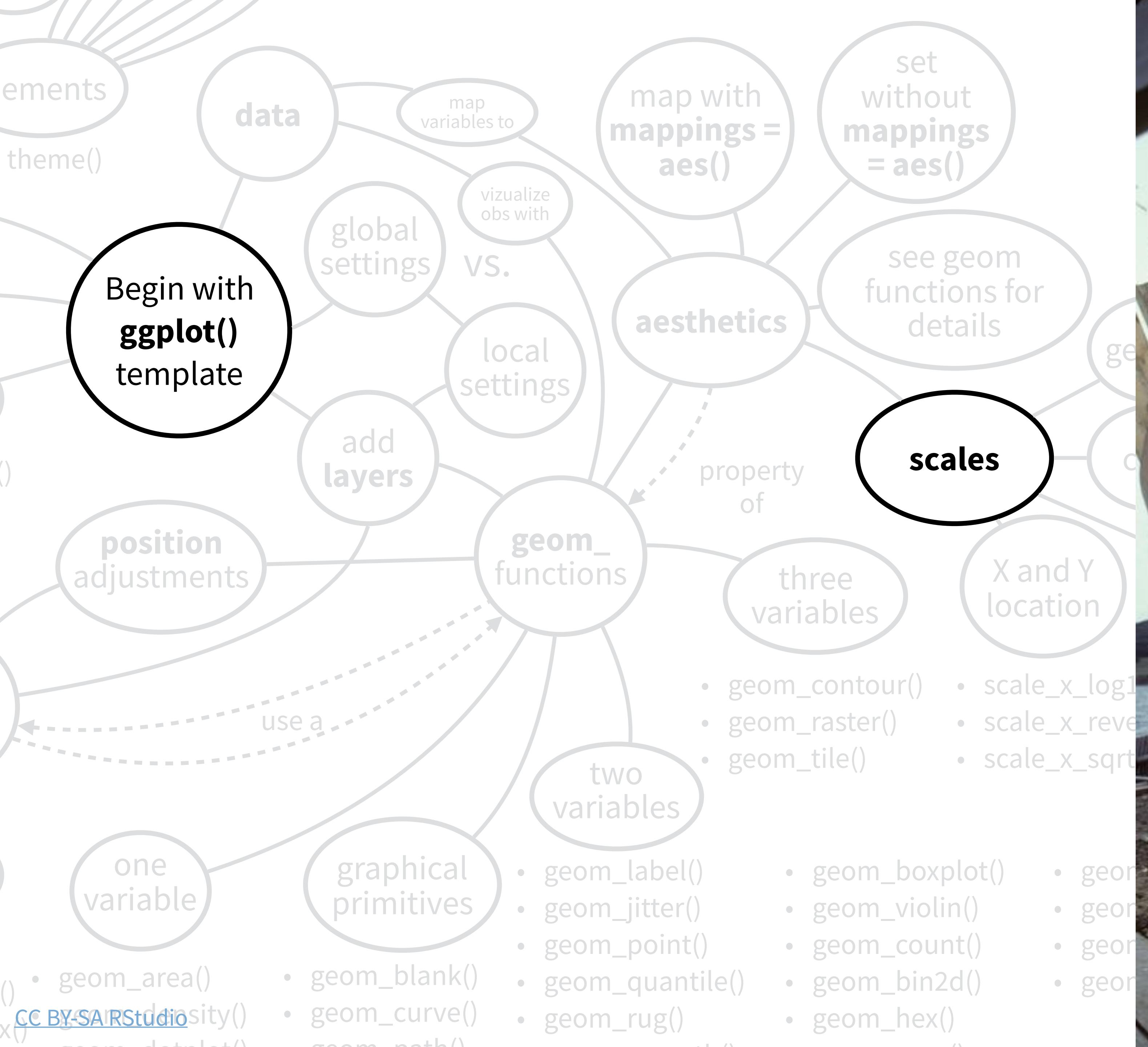


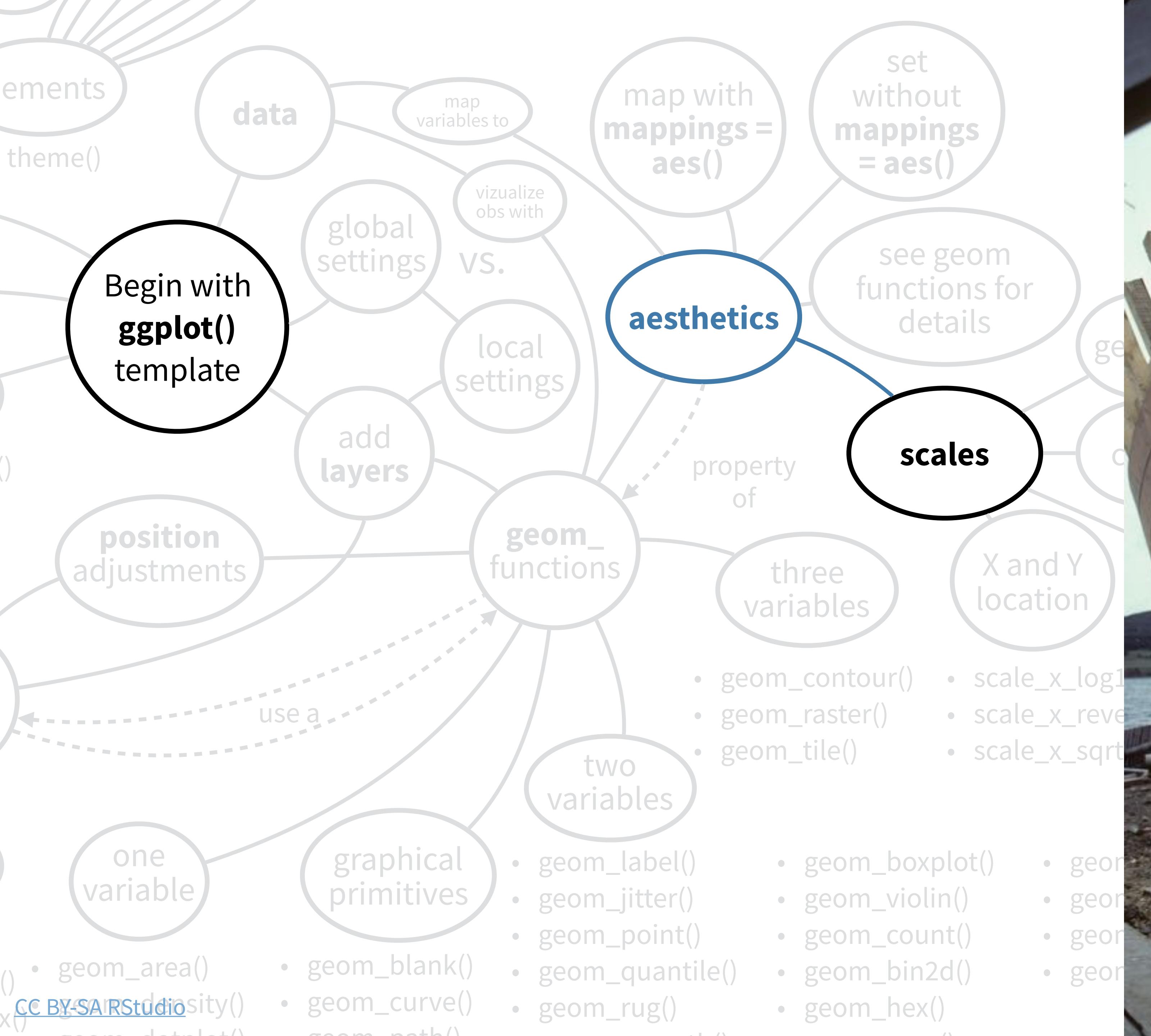
- 1. Lay the keel**
- 2. Build topics in order**

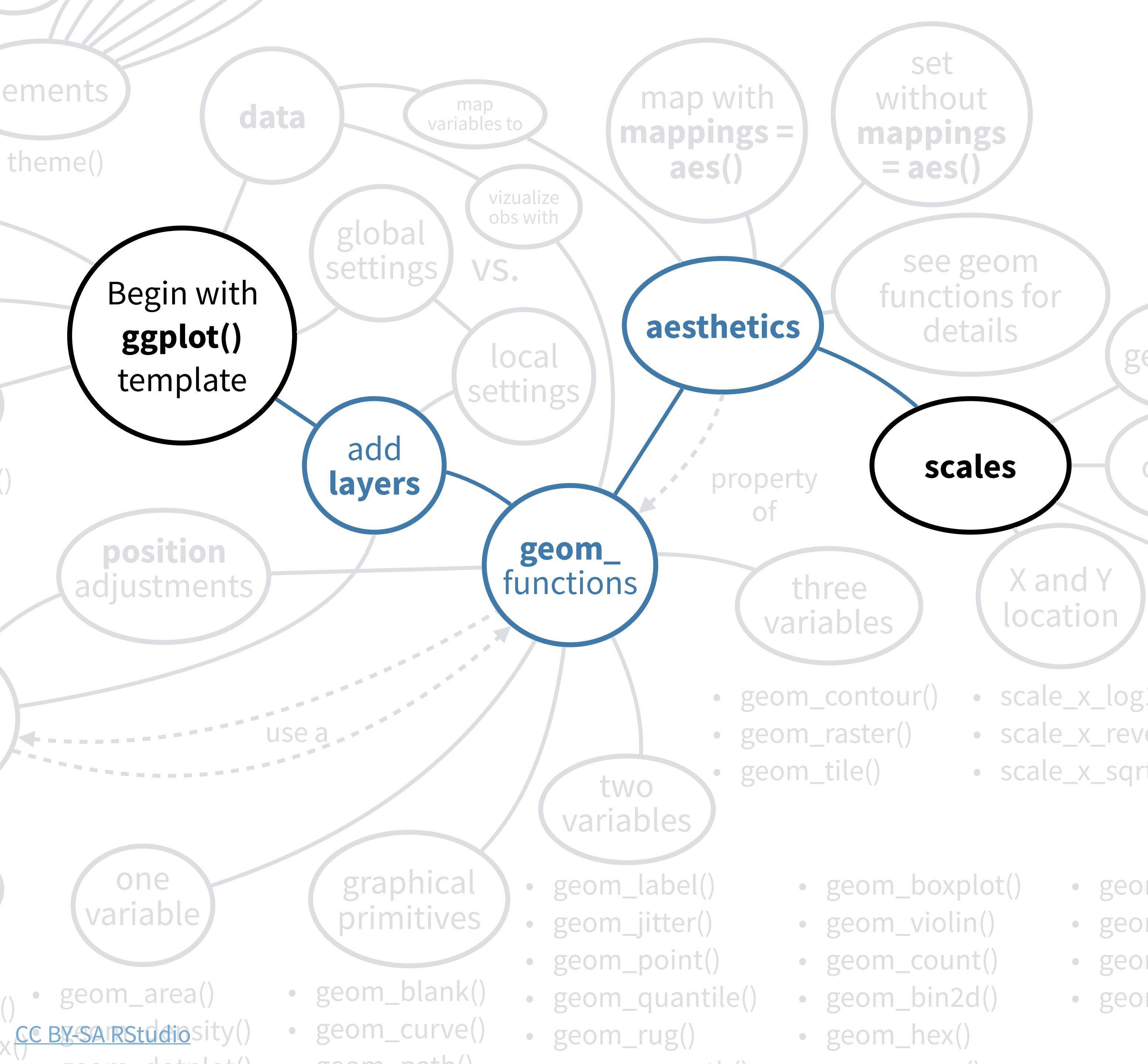
Build topics
in order

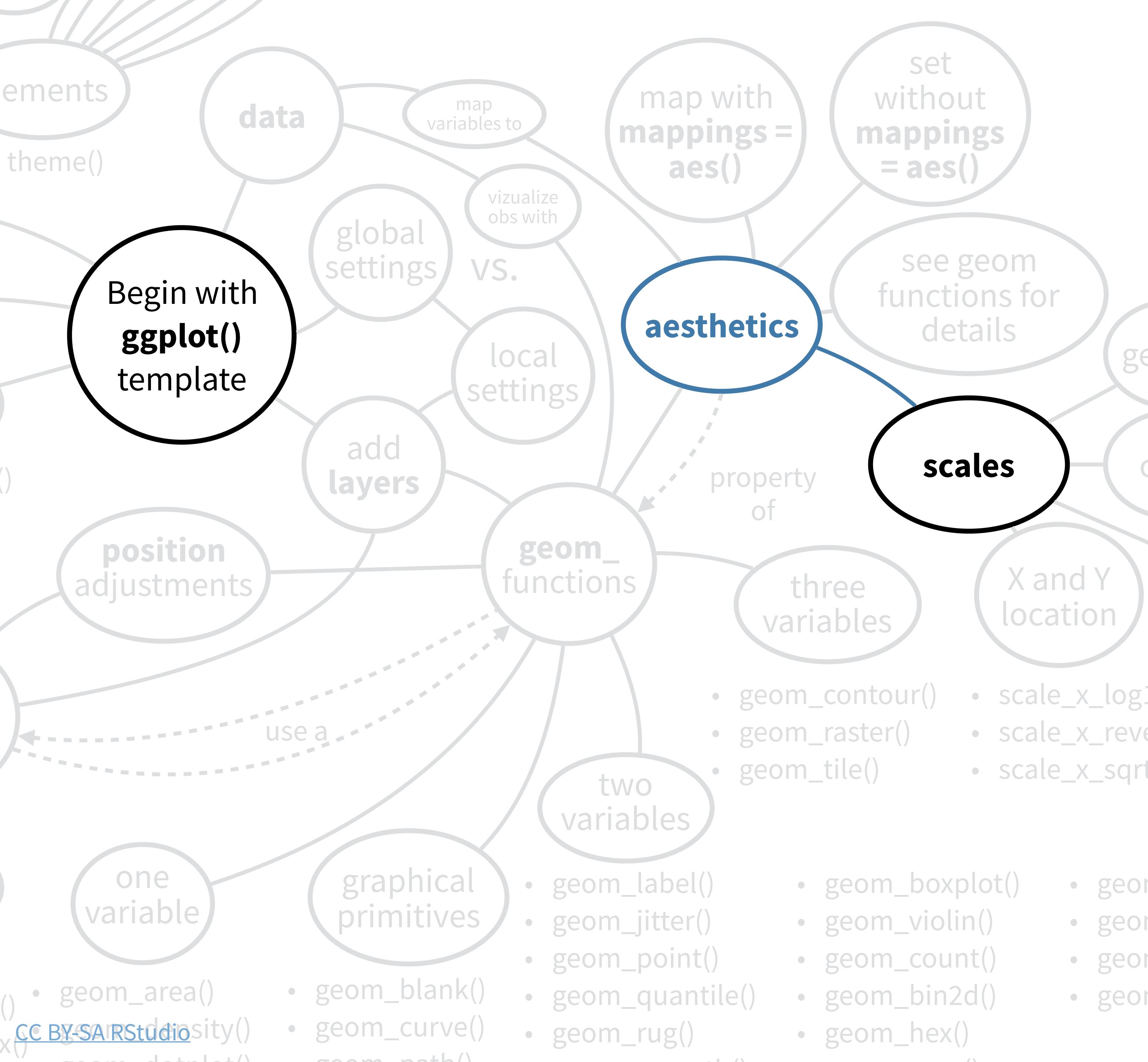
R

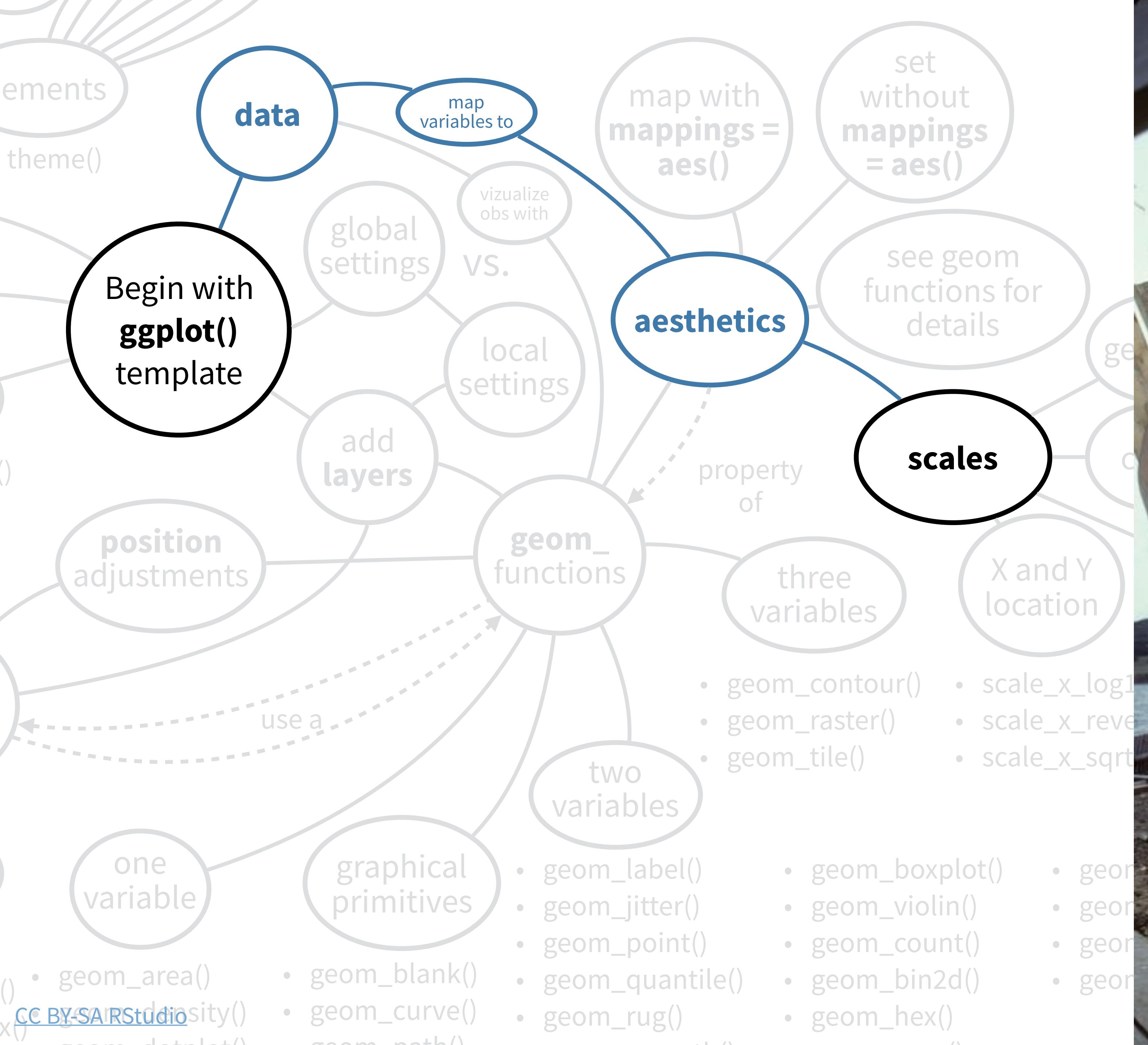


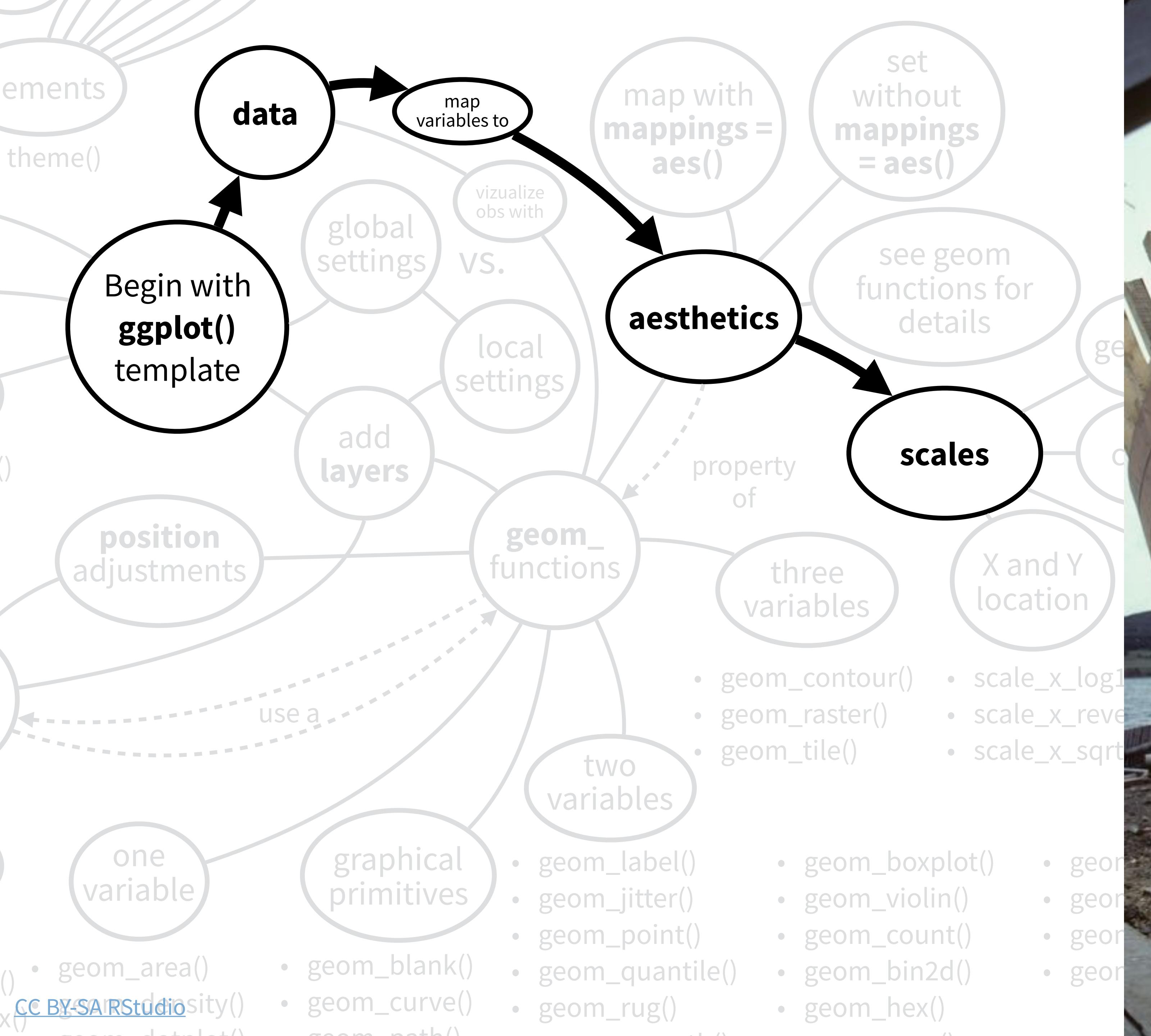












- 1. Lay the keel**
- 2. Build topics in order**
- 3. Connect to familiar things**

Connect to
familiar things



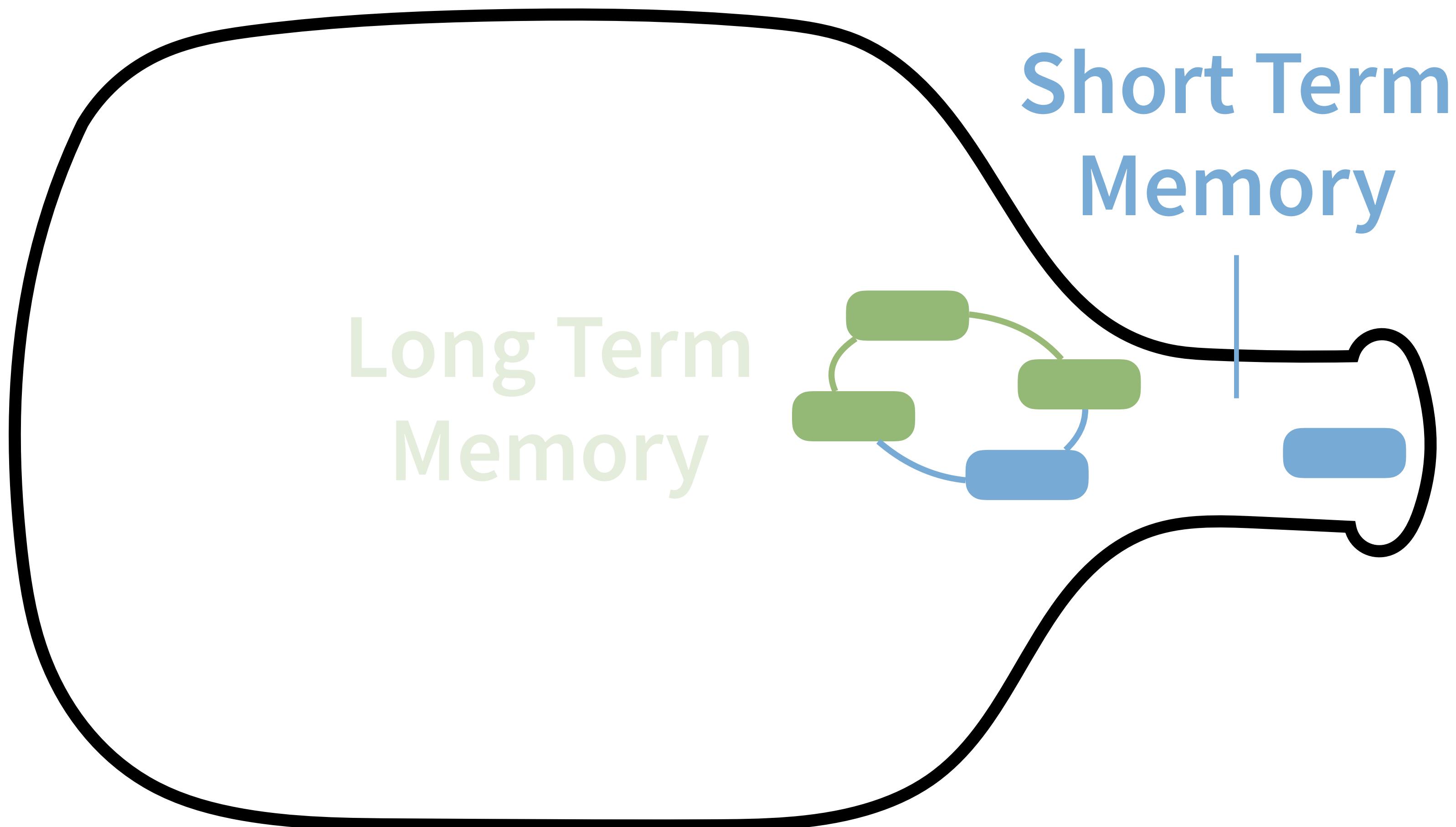
Your Turn

Imagine that you will explain the **map()** function to three different students:

1. One who uses the **lapply()** family of functions
2. One who uses **for()** loops
3. One who has never written a **for()** loop

In your group, determine what different questions each will ask.





Grammar of Graphics

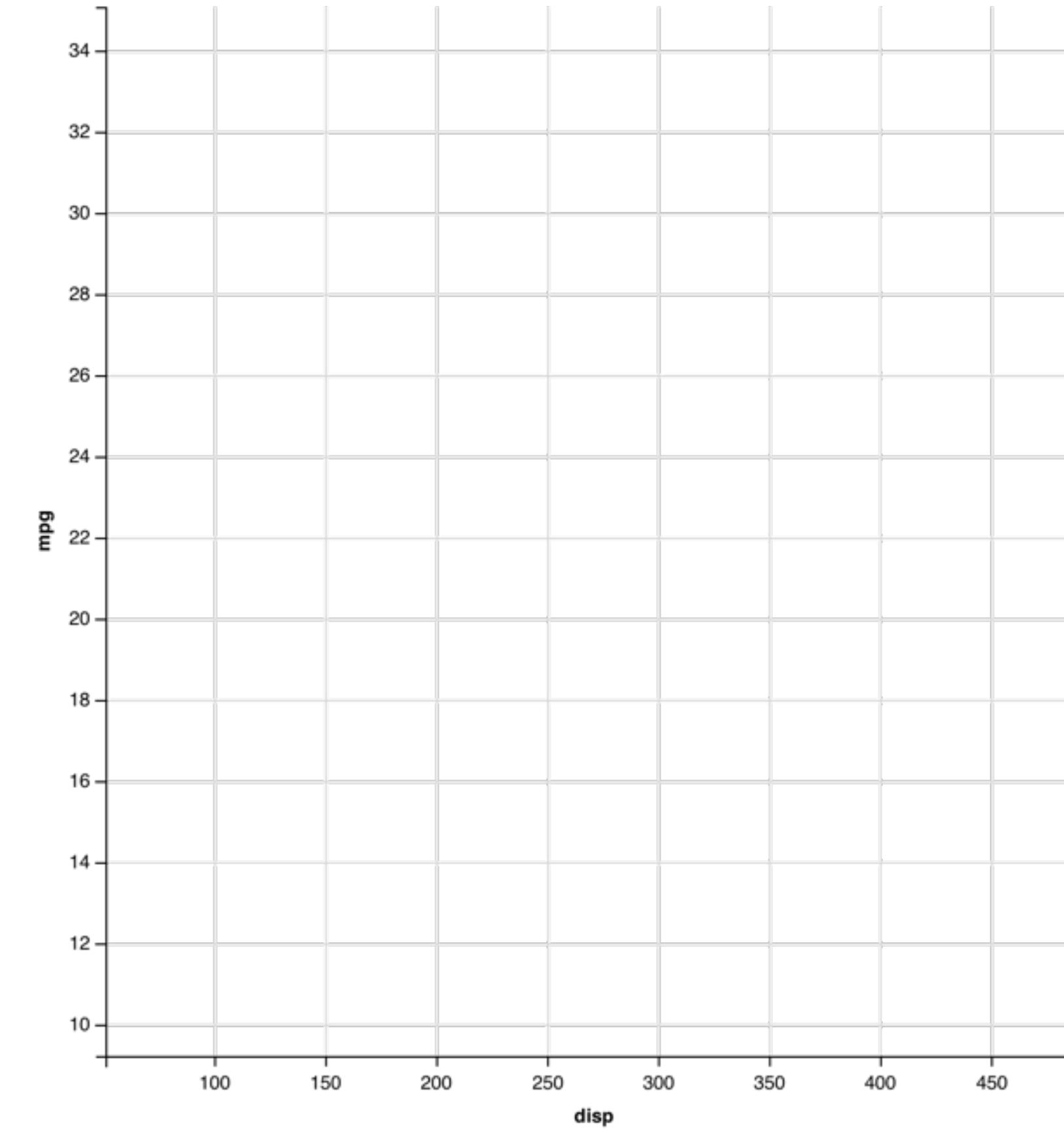


1-Visualize-Data

mpg	cyl	disp	hp	
21.0	6	160.0	2	●
21.0	6	160.0	2	●
22.8	4	108.0	1	●
21.4	6	258.0	2	●
18.7	8	360.0	3	●
18.1	6	225.0	2	●
14.3	8	360.0	5	●
24.4	4	146.7	1	●
22.8	4	140.8	1	●
19.2	6	167.6	2	●
17.8	6	167.6	2	●
16.4	8	275.8	3	●
17.3	8	275.8	3	●
15.2	8	275.8	3	●
10.4	8	472.0	4	●
10.4	8	460.0	4	●
14.7	8	440.0	4	●
32.4	4	78.7	1	●
30.4	4	75.7	1	●
33.9	4	71.1	1	●

data

geom



1-Visualize-Data

mappings

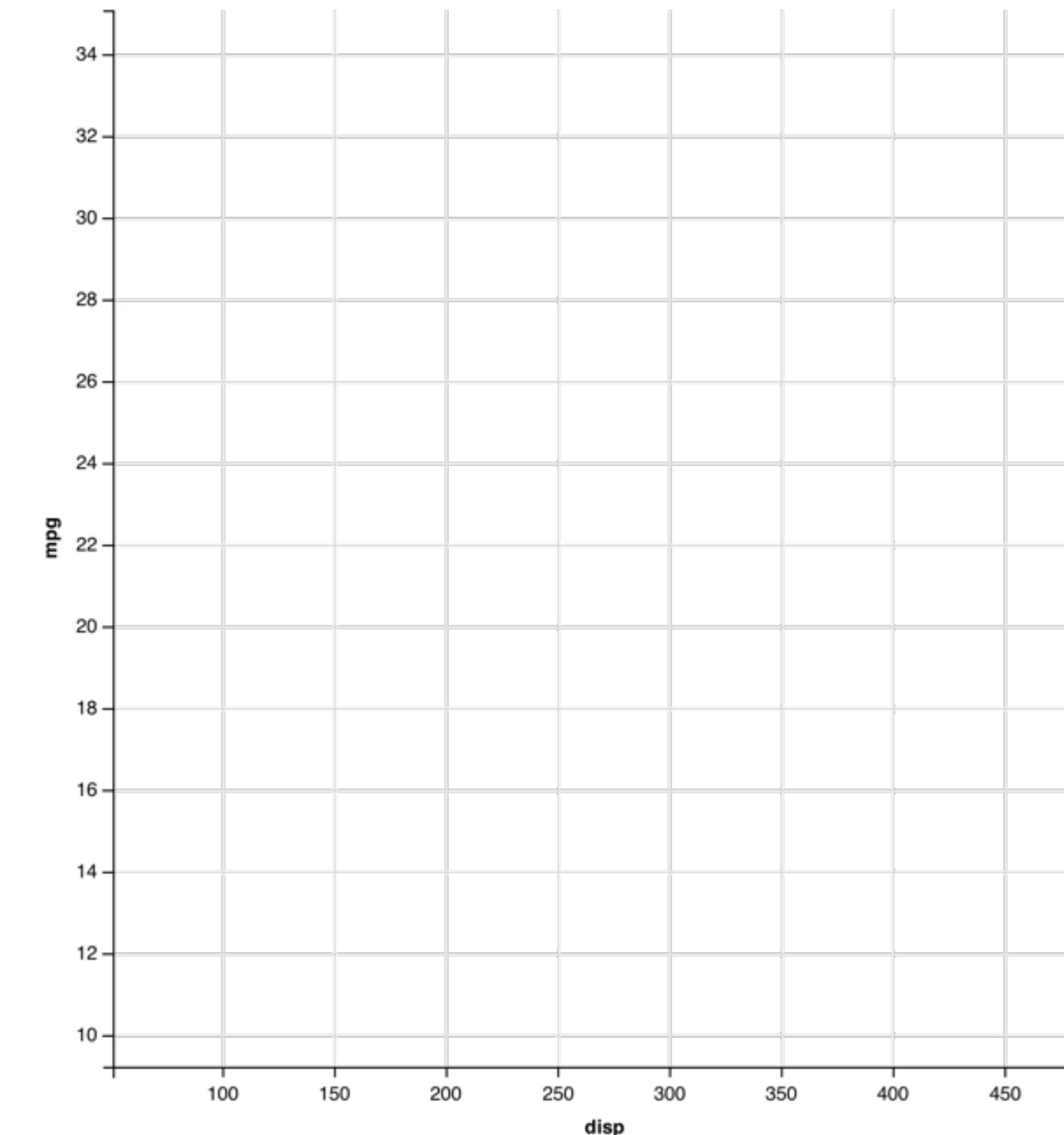
mpg	cyl	disp	hp
21.0	6	160.0	2
21.0	6	160.0	2
22.8	4	108.0	1
21.4	6	258.0	2
18.7	8	360.0	3
18.1	6	225.0	2
14.3	8	360.0	5
24.4	4	146.7	1
22.8	4	140.8	1
19.2	6	167.6	2
17.8	6	167.6	2
16.4	8	275.8	3
17.3	8	275.8	3
15.2	8	275.8	3
10.4	8	472.0	4
10.4	8	460.0	4
14.7	8	440.0	4
32.4	4	78.7	1
30.4	4	75.7	1
33.9	4	71.1	1

fill



data

geom



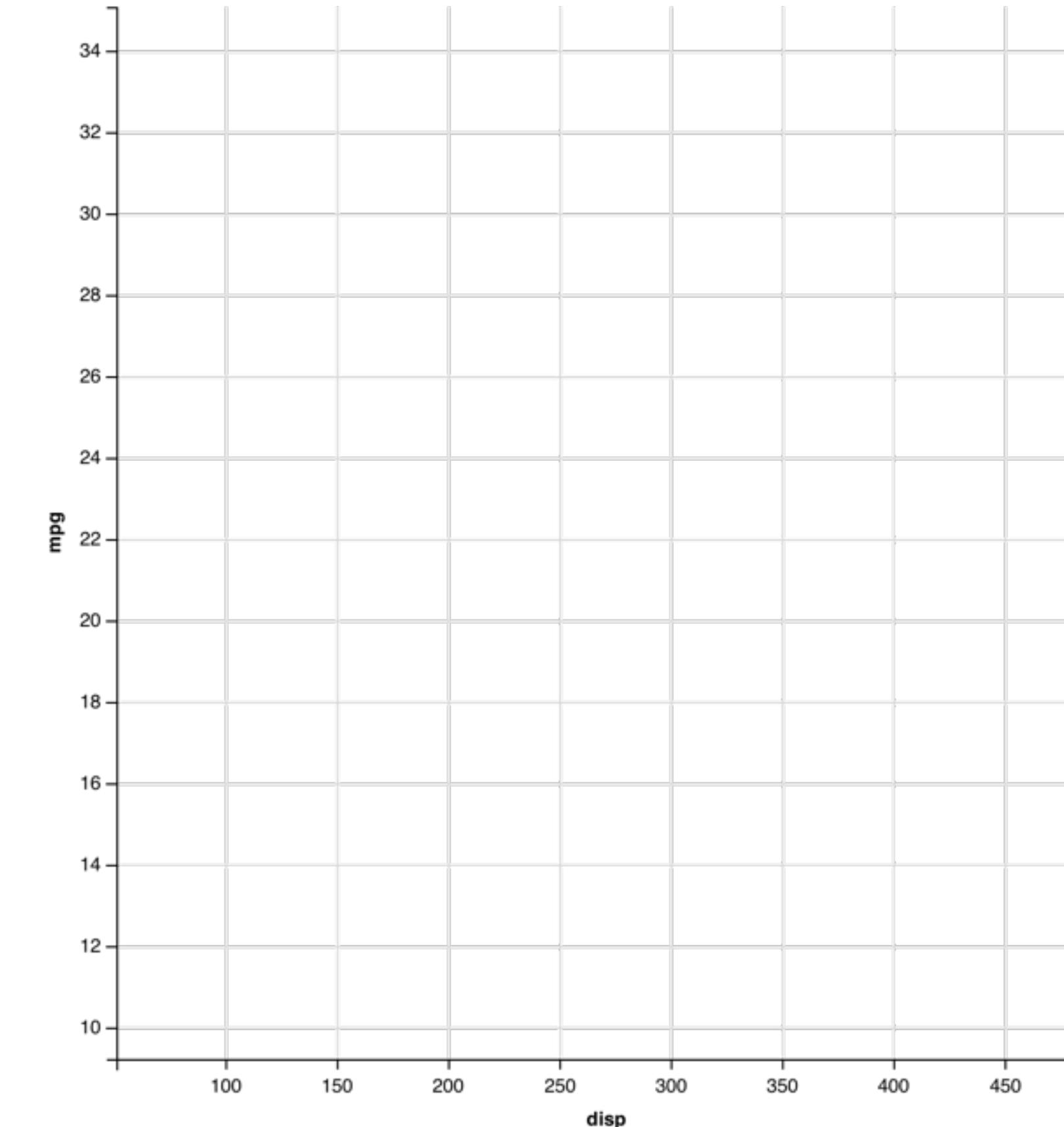
1-Visualize-Data

mappings

	shape		fill
mpg	cyl	disp	hp
21.0	6 +	160.0	2
21.0	6 +	160.0	2
22.8	4 ●	108.0	1
21.4	6 +	258.0	2
18.7	8 ♦	360.0	3
18.1	6 +	225.0	2
14.3	8 ♦	360.0	5
24.4	4 ●	146.7	1
22.8	4 ●	140.8	1
19.2	6 +	167.6	2
17.8	6 +	167.6	2
16.4	8 ♦	275.8	3
17.3	8 ♦	275.8	3
15.2	8 ♦	275.8	3
10.4	8 ♦	472.0	4
10.4	8 ♦	460.0	4
14.7	8 ♦	440.0	4
32.4	4 ●	78.7	1
30.4	4 ●	75.7	1
33.9	4 ●	71.1	1

data

geom



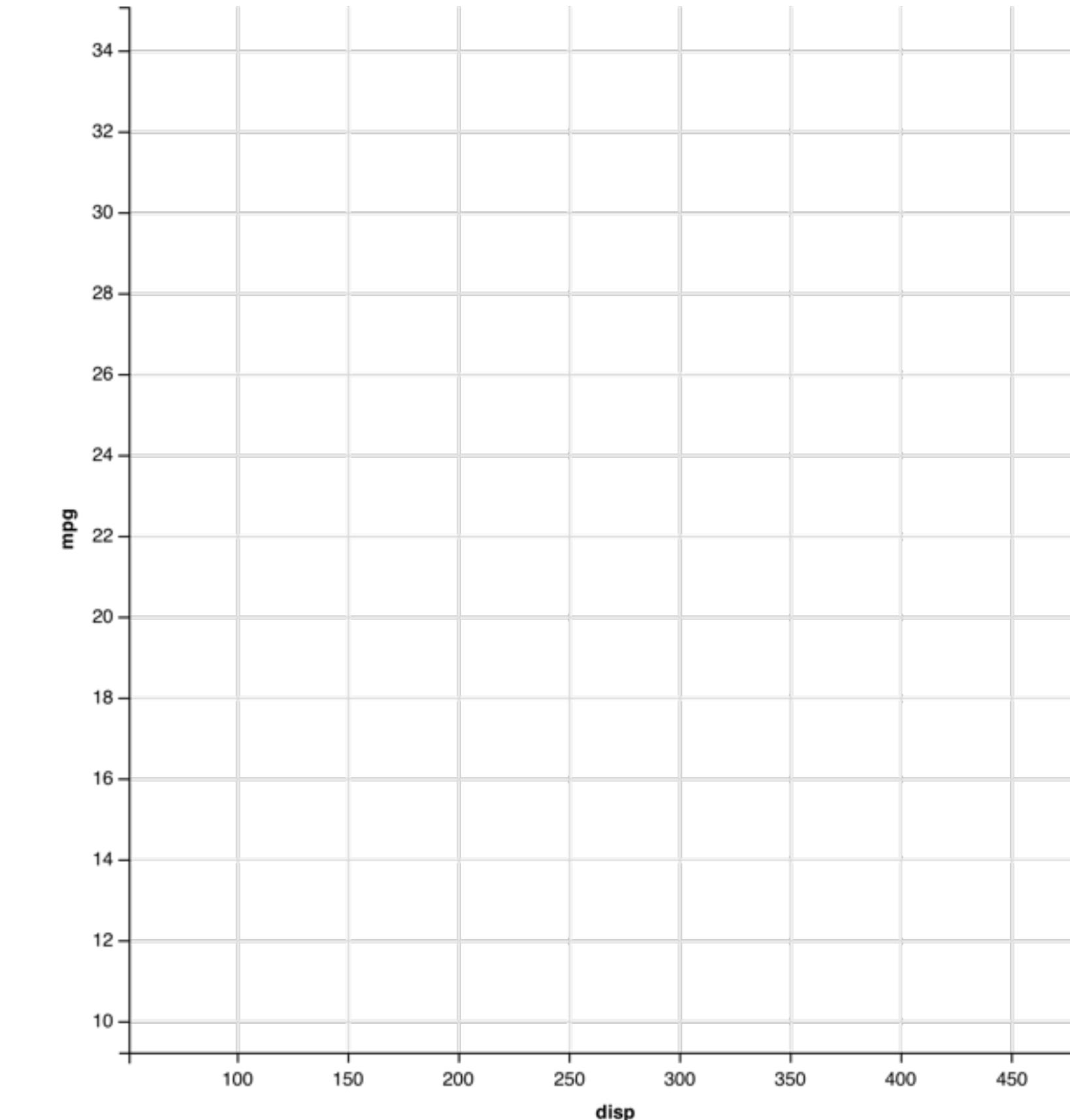
1-Visualize-Data

mappings

	shape	x	fill
mpg	cyl	disp	hp
21.0	6	160.0	2
21.0	6	160.0	2
22.8	4	108.0	1
21.4	6	258.0	2
18.7	8	360.0	3
18.1	6	225.0	2
14.3	8	360.0	5
24.4	4	146.7	1
22.8	4	140.8	1
19.2	6	167.6	2
17.8	6	167.6	2
16.4	8	275.8	3
17.3	8	275.8	3
15.2	8	275.8	3
10.4	8	472.0	4
10.4	8	460.0	4
14.7	8	440.0	4
32.4	4	78.7	1
30.4	4	75.7	1
33.9	4	71.1	1

data

geom



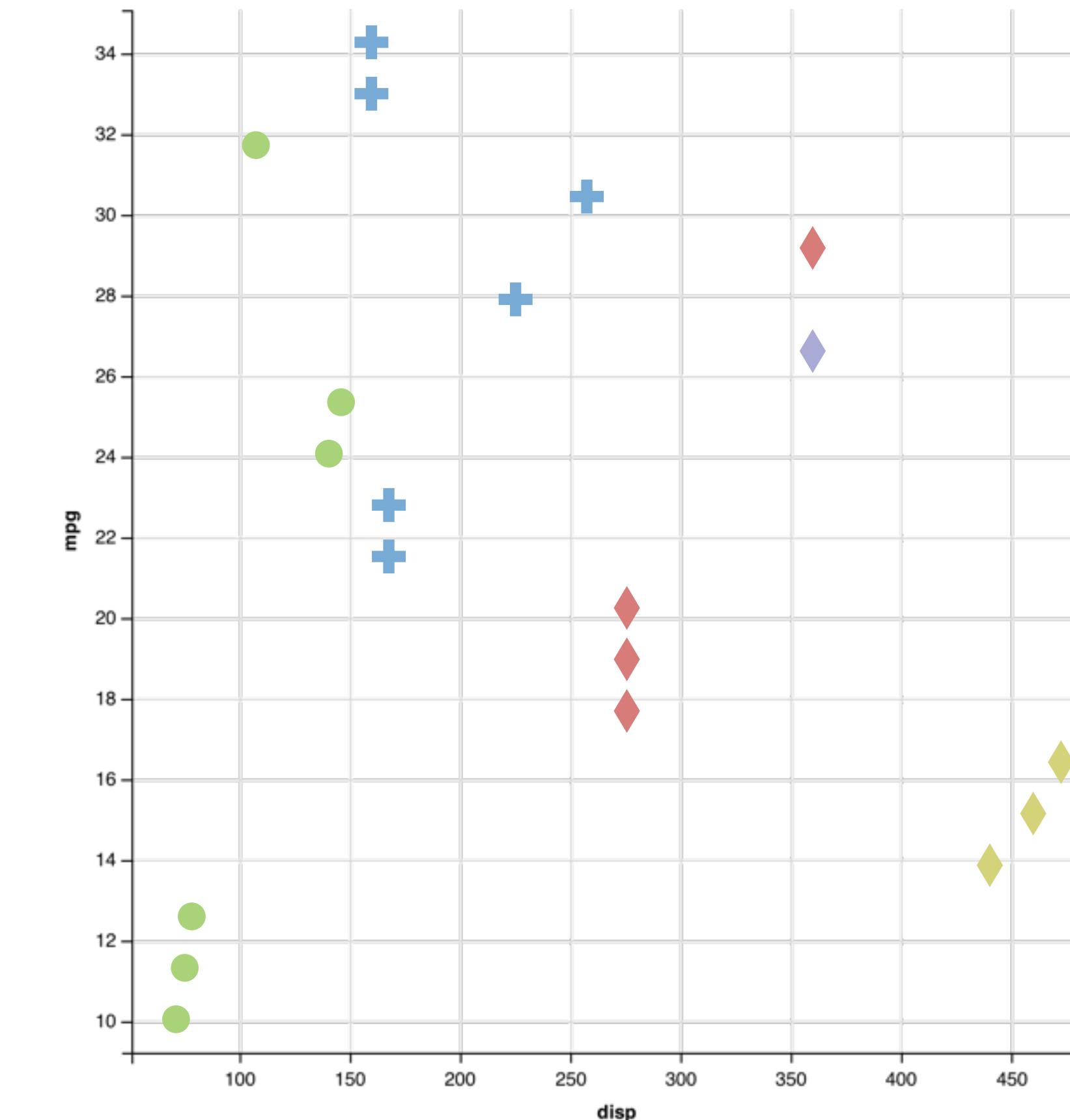
1-Visualize-Data

mappings

	y	shape	x	fill
	mpg	cyl	disp	hp
21.0	6	160.0	2	
21.0	6	160.0	2	
22.8	4	108.0	1	
21.4	6	258.0	2	
18.7	8	360.0	3	
18.1	6	225.0	2	
14.3	8	360.0	5	
24.4	4	146.7	1	
22.8	4	140.8	1	
19.2	6	167.6	2	
17.8	6	167.6	2	
16.4	8	275.8	3	
17.3	8	275.8	3	
15.2	8	275.8	3	
10.4	8	472.0	4	
10.4	8	460.0	4	
14.7	8	440.0	4	
32.4	4	78.7	1	
30.4	4	75.7	1	
33.9	4	71.1	1	

data

geom



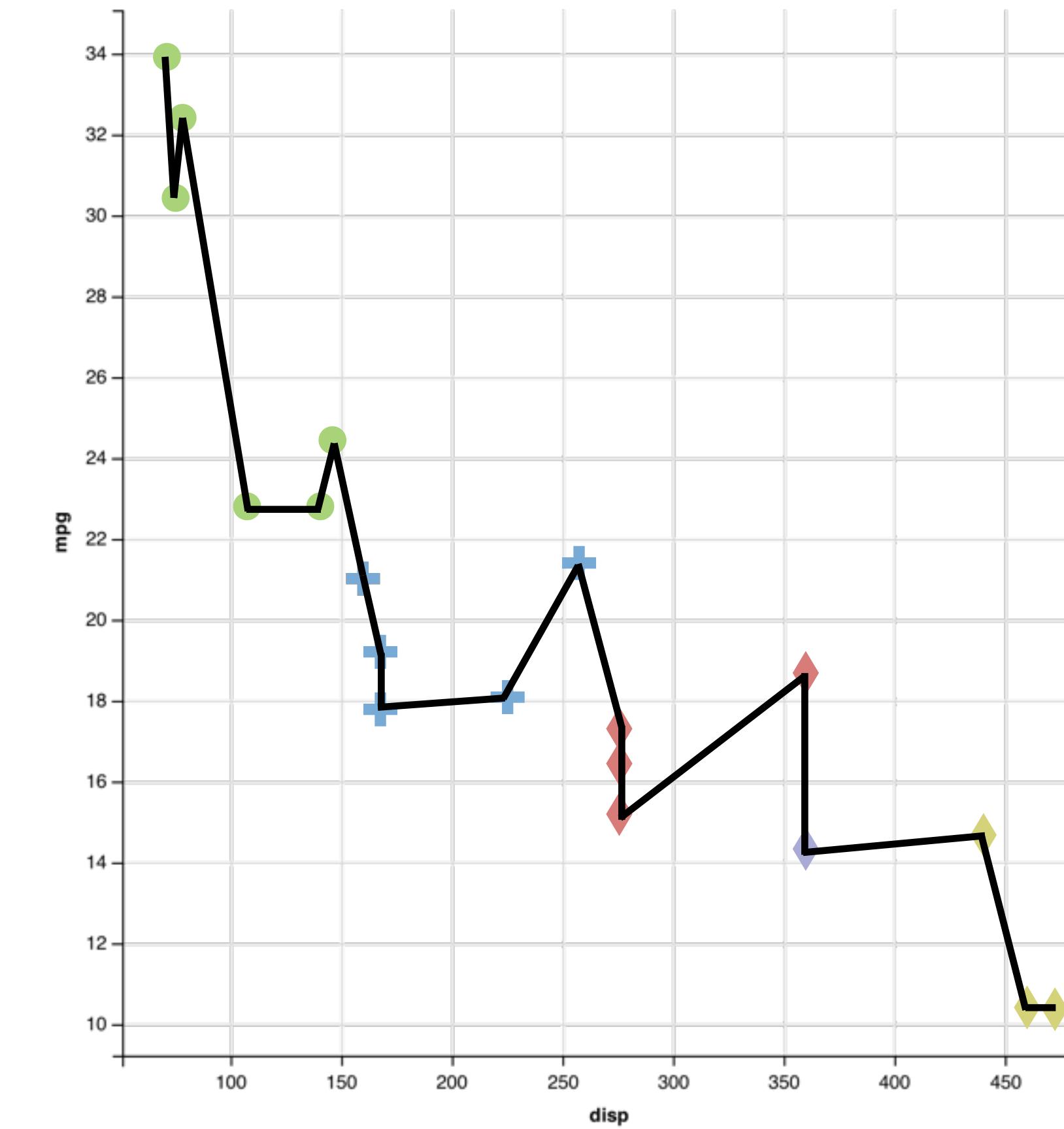
1-Visualize-Data

mappings

	y	shape	x	fill
	mpg	cyl	disp	hp
21.0	6	160.0	2	
21.0	6	160.0	2	
22.8	4	108.0	1	
21.4	6	258.0	2	
18.7	8	360.0	3	
18.1	6	225.0	2	
14.3	8	360.0	5	
24.4	4	146.7	1	
22.8	4	140.8	1	
19.2	6	167.6	2	
17.8	6	167.6	2	
16.4	8	275.8	3	
17.3	8	275.8	3	
15.2	8	275.8	3	
10.4	8	472.0	4	
10.4	8	460.0	4	
14.7	8	440.0	4	
32.4	4	78.7	1	
30.4	4	75.7	1	
33.9	4	71.1	1	

data

geom
points
lines



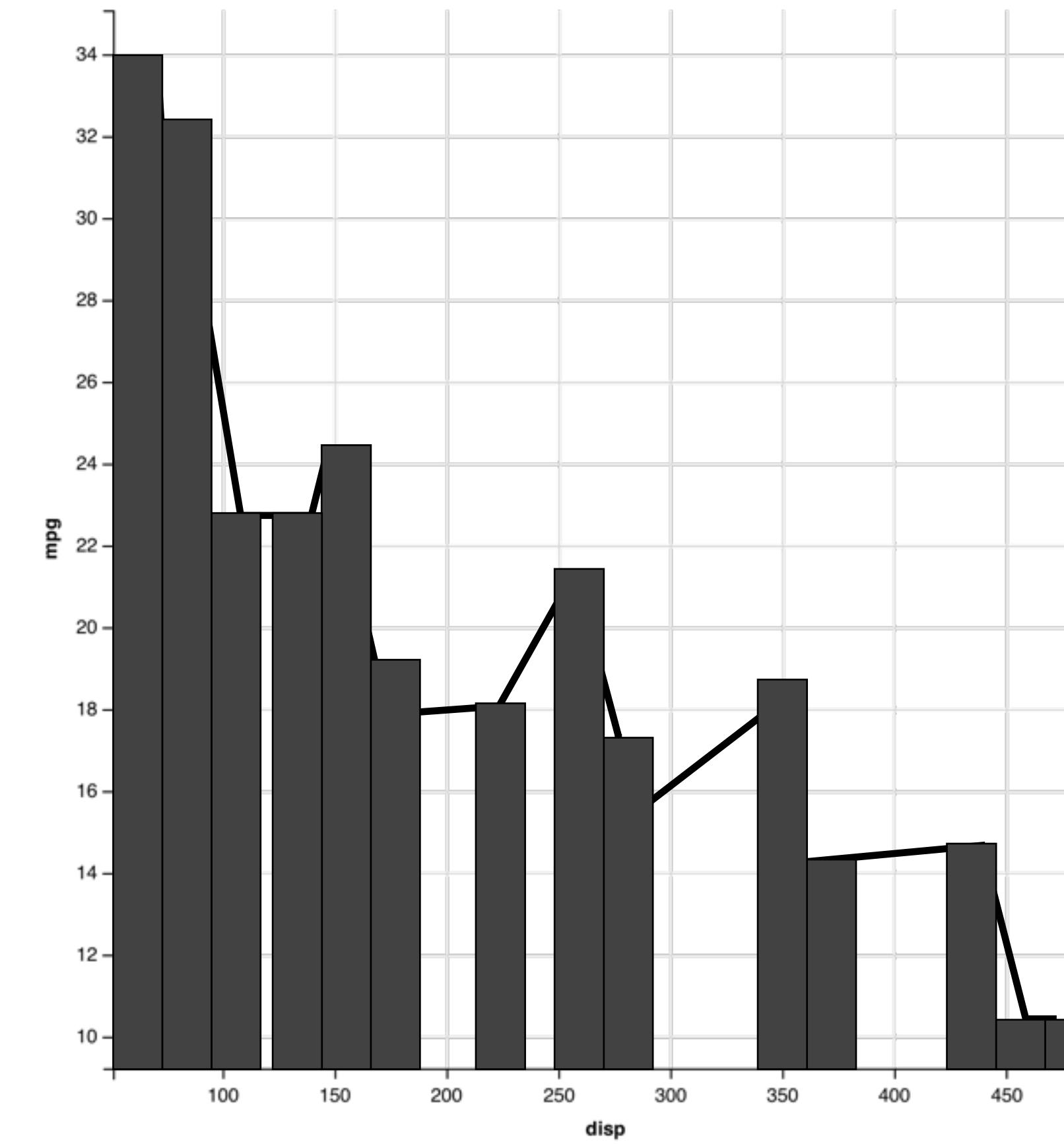
1-Visualize-Data

mappings

	y	x	
mpg	↓	↑	
cyl	↑	↓	
21.0	6	160.0	2
21.0	6	160.0	2
22.8	4	108.0	1
21.4	6	258.0	2
18.7	8	360.0	3
18.1	6	225.0	2
14.3	8	360.0	5
24.4	4	146.7	1
22.8	4	140.8	1
19.2	6	167.6	2
17.8	6	167.6	2
16.4	8	275.8	3
17.3	8	275.8	3
15.2	8	275.8	3
10.4	8	472.0	4
10.4	8	460.0	4
14.7	8	440.0	4
32.4	4	78.7	1
30.4	4	75.7	1
33.9	4	71.1	1

data

geom
points
lines
bars

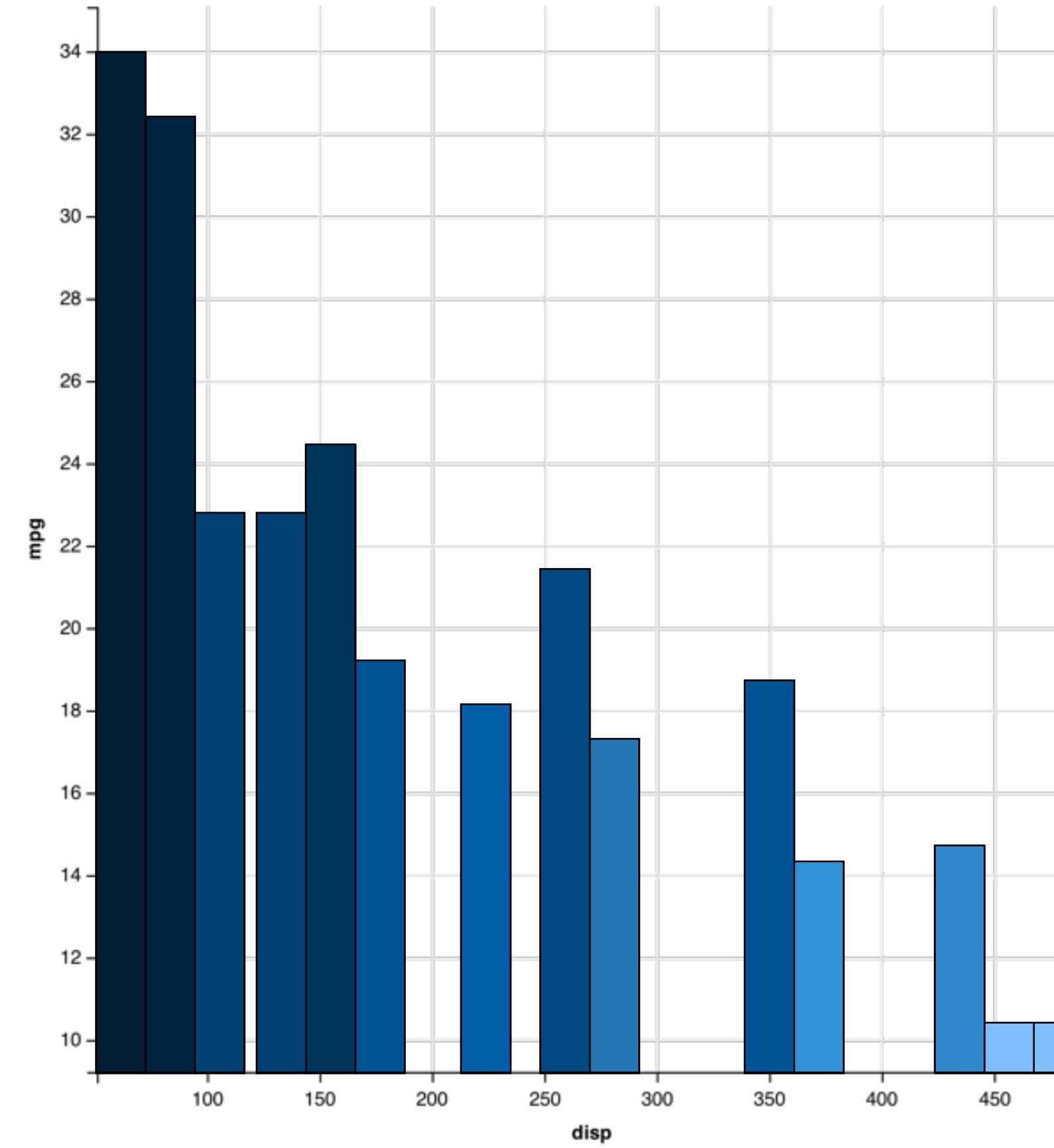


1-Visualize-Data

mappings

mpg	cyl	disp	hp
21.0	6	160.0	2
21.0	6	160.0	2
22.8	4	108.0	1
21.4	6	258.0	2
18.7	8	360.0	3
18.1	6	225.0	2
14.3	8	360.0	5
24.4	4	146.7	1
22.8	4	140.8	1
19.2	6	167.6	2
17.8	6	167.6	2
16.4	8	275.8	3
17.3	8	275.8	3
15.2	8	275.8	3
10.4	8	472.0	4
10.4	8	460.0	4
14.7	8	440.0	4
32.4	4	78.7	1
30.4	4	75.7	1
33.9	4	71.1	1

data
geom
points
lines
bars



To make a graph

[template]

```
ggplot(data = <DATA>) +  
<GEOM_FUNCTION>(mapping = aes(<MAPPINGS>))
```



To make a graph

mpg	cyl	disp	hp
21.0	6	160.0	2
21.0	6	160.0	2
22.8	4	108.0	1
21.4	6	258.0	2
18.7	8	360.0	3
18.1	6	225.0	2
14.3	8	360.0	5
24.4	4	146.7	1
22.8	4	140.8	1
19.2	6	167.6	2
17.8	6	167.6	2
16.4	8	275.8	3
17.3	8	275.8	3
15.2	8	275.8	3
10.4	8	472.0	4
10.4	8	460.0	4
14.7	8	440.0	4
32.4	4	78.7	1
30.4	4	75.7	1
33.9	4	71.1	1

data

1. Pick a **data** set

```
ggplot(data = <DATA>) +  
<GEOM_FUNCTION>(mapping = aes(<MAPPINGS>))
```



To make a graph

mpg	cyl	disp	hp	
21.0	6	160.0	2	●
21.0	6	160.0	2	●
22.8	4	108.0	1	●
21.4	6	258.0	2	●
18.7	8	360.0	3	●
18.1	6	225.0	2	●
14.3	8	360.0	5	●
24.4	4	146.7	1	●
22.8	4	140.8	1	●
19.2	6	167.6	2	●
17.8	6	167.6	2	●
16.4	8	275.8	3	●
17.3	8	275.8	3	●
15.2	8	275.8	3	●
10.4	8	472.0	4	●
10.4	8	460.0	4	●
14.7	8	440.0	4	●
32.4	4	78.7	1	●
30.4	4	75.7	1	●
33.9	4	71.1	1	●

data

geom

1. Pick a **data** set

```
ggplot(data = <DATA>) +  
<GEOM_FUNCTION>(mapping = aes(<MAPPINGS>))
```

2. Choose a **geom**
to display cases



mappings

mpg	cyl	disp	hp
21.0	6	160.0	2
21.0	6	160.0	2
22.8	4	108.0	1
21.4	6	258.0	2
18.7	8	360.0	3
18.1	6	225.0	2
14.3	8	360.0	5
24.4	4	146.7	1
22.8	4	140.8	1
19.2	6	167.6	2
17.8	6	167.6	2
16.4	8	275.8	3
17.3	8	275.8	3
15.2	8	275.8	3
10.4	8	472.0	4
10.4	8	460.0	4
14.7	8	440.0	4
32.4	4	78.7	1
30.4	4	75.7	1
33.9	4	71.1	1

data

geom

fill
↑↑

To make a graph

1. Pick a **data** set

```
ggplot(data = <DATA>) +  
<GEOM_FUNCTION>(mapping = aes(<MAPPINGS>))
```

2. Choose a **geom**
to display cases3. **Map** aesthetic
properties to
variables

Your Turn

Find the people with your topic.

Say hello and then work together to add to your maps:

1. An order to present your topic
2. Prior knowledge to connect to

When you are finished, turn your concept map into a linear outline.



The Cognitive Challenge

