

# Effective Data Visualization

*INFO 290 - Public Policy Data Lab*  
*April 10, 2025*

Berkeley SCHOOL OF INFORMATION

# Data viz experience

**BOSTON POLICE DEPARTMENT COURT OVERTIME**  
 A report by the ACLU of Massachusetts, Progressive Massachusetts Council, Ricardo Arroyo, and the RJ Sparkle Lab  
 Submitted or facilitated to the Boston City Council Committee on Wayward Justice during our Dockets  
 #0529 & #0629 - December 16, 2025

**SUMMARY**

We present findings resulting from data analysis of Boston police court overtime records from 2014 to 2018. These data support five observations about the nature of court overtime practices at the Boston Police Department:

1. The four-hour minimum court appearance policy is wasteful.
2. Officers are increasingly exploiting court overtime.
3. Reserve overtime operates as an incentive.
4. Not all court appearances are treated equal.
5. BPD accountability requires greater transparency.

While we share these highlights here, the entire portfolio of interactive visualizations is publicly available [here](#).

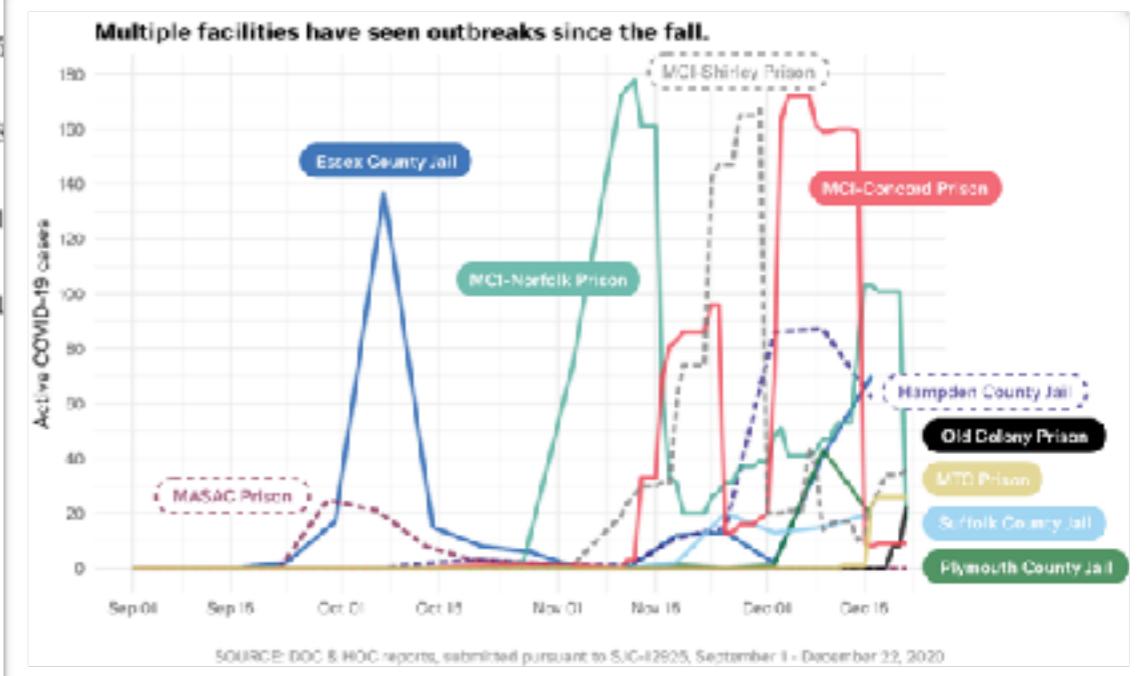
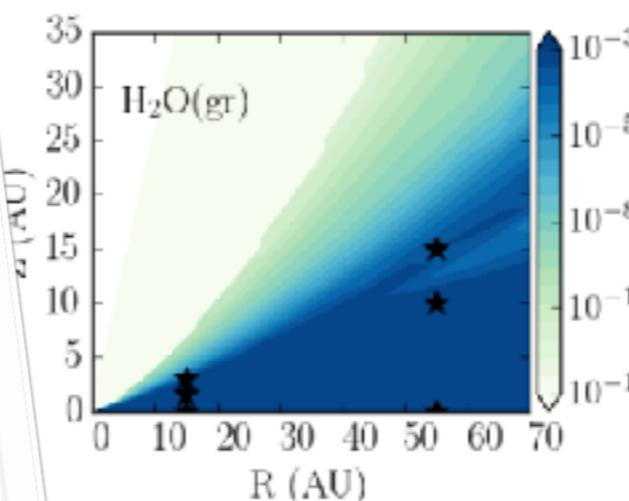
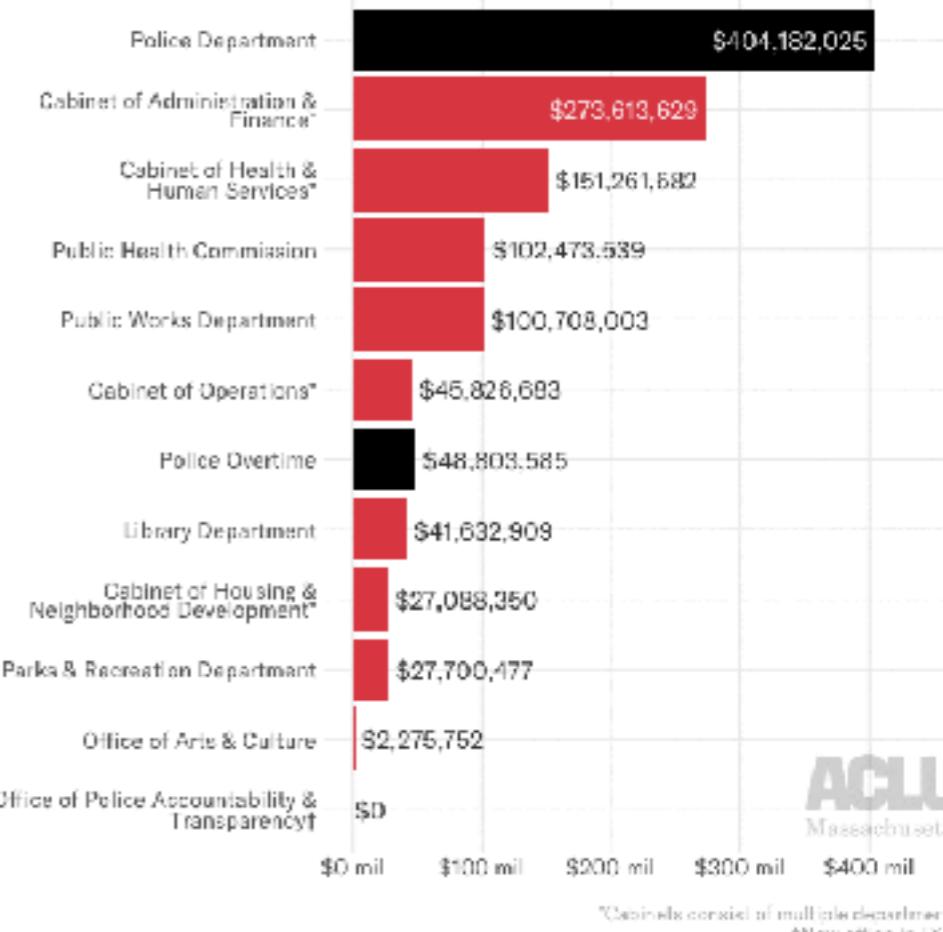
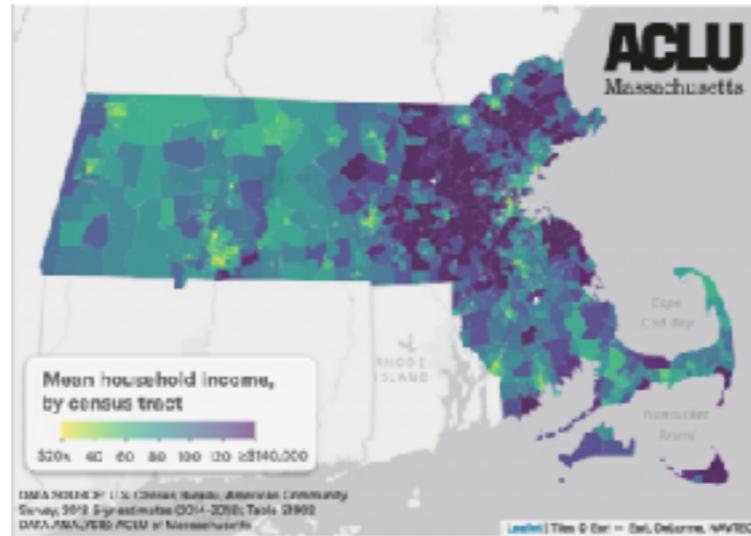
**1. THE 4-HR MINIMUM COURT APPEARANCE POLICY IS WASTEFUL.**

A major aspect of Boston police overtime policy that has come under scrutiny in recent months is the practice of paying officers four hours of overtime pay for any court appearance lasting four hours or less. This practice is defined in Article V, Section 1 of the City's Collective Bargaining Agreement with the Boston Police Patrolmen's Association: a Boston Police Department employee who stands over as a witness or under subpoena to class summmons "shall be entitled to overtime compensation for every hour or fraction thereof during which he was in cash attendance on appearance, but in no event less than 4 hours and pay on an overtime basis".

In practice, this policy means that officers are entitled to a few minutes for a task as simple as dropping off discovery documents, and yet still be paid for four hours of overtime at time and a half. Unsurprisingly, this policy takes up quickly and costs the City immensely. As shown in Figure 1, a large proportion of overtime pay to Boston police is for hours not worked.

Please note that the RJ Sparkle Lab participates in this project as a technical partner, providing data processing and visualization only, and that neither the lab nor the individual researchers are responsible for the political analysis and conclusions expressed by Progressive Mass and ACLU-MA.

Year	OT Hours Worked	OT Hours Paid
2014	~1000	~100
2015	~1000	~100
2016	~1000	~100
2017	~1000	~100
2018	~1000	~100



# Today we will explore...

- ▶ why data visualization is important
- ▶ how to identify the different components and types of data visualizations
- ▶ how to interpret visualizations critically
- ▶ how to intentionally tell a story by visualizing data

To learn more,  
consider taking  
**INFO 247:**  
**Information**  
**Visualization &**  
**Presentation**

***All resources shared  
today are available at:***  
  
*[https://github.com/  
laurenmarietta/  
effective-data-viz-2025](https://github.com/laurenmarietta/effective-data-viz-2025)*

This presentation is  
adapted from a  
workshop designed  
by Kira Tebbe in  
February 2020



# Workshop outline

- ▶ What is data visualization 💬
- ▶ Anatomy of a data visualization
- ▶ Types of data visualization
- ▶ Roast! This! Viz! 💬
- ▶ ✨ 10 Best Practices ✨
- ▶ Improve! This! Viz!
- ▶ Exercises 💬
- ▶ Interactivity, inspiration, and learning more

*What does the term  
“data visualization”  
mean to you? Why is it  
important?*

*Why is data  
visualization  
important?*

**data = information**

**data visualization = communication**

**good data visualization = effective communication**

**bad data visualization = miscommunication**

# What do mediocre visualizations lead to?

- ▶ confusion and frustration
- ▶ loss of attention
- ▶ poor impression of work quality
- ▶ misinterpretation of findings

## What do Tory voters think?

**Q** Given the choice, would you prefer that Boris Johnson was still Prime Minister in a year's time, or would you prefer someone else?

**Johnson to remain Prime Minister**



25%

**I would prefer someone else to be PM**



60%

**Don't know**



15%

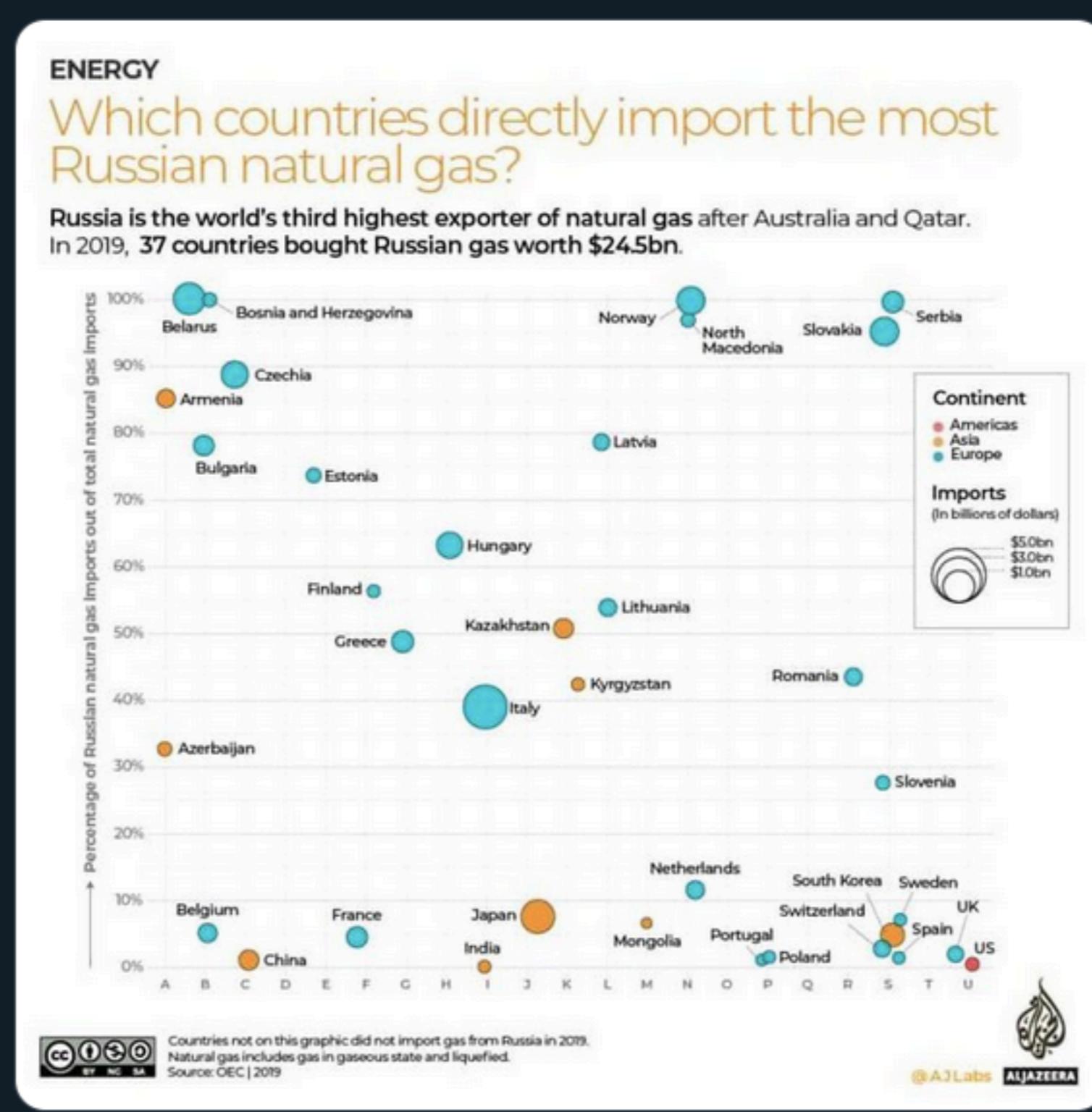
Source: YouGov, June 22-23.  
1,671 adults. Results show  
those who voted  
Conservative in 2019.

Source: Will Bailey-Watson on [Twitter](#)

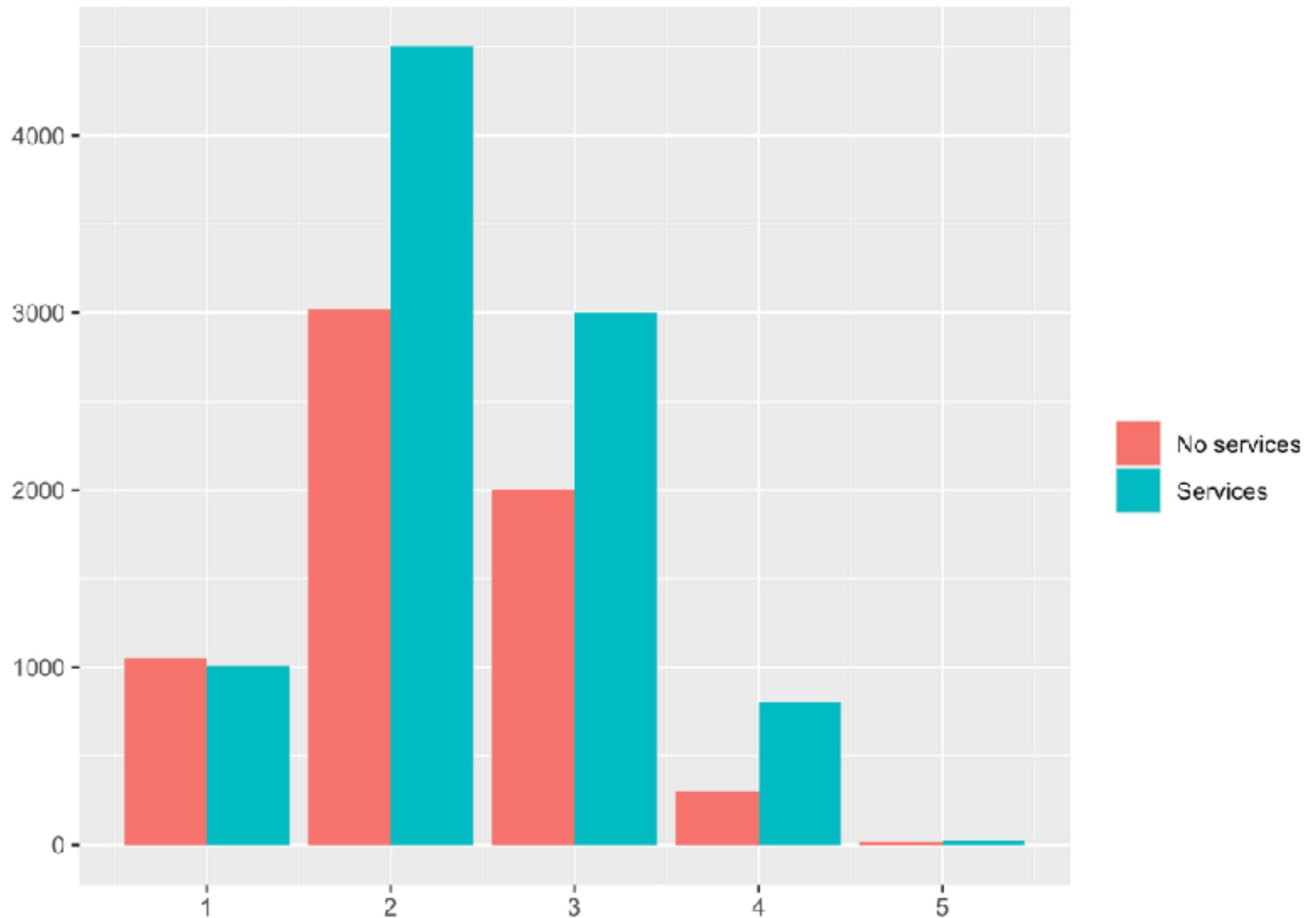
Ben Stanley  
@BDStanley

...

Incredible x-axis here.

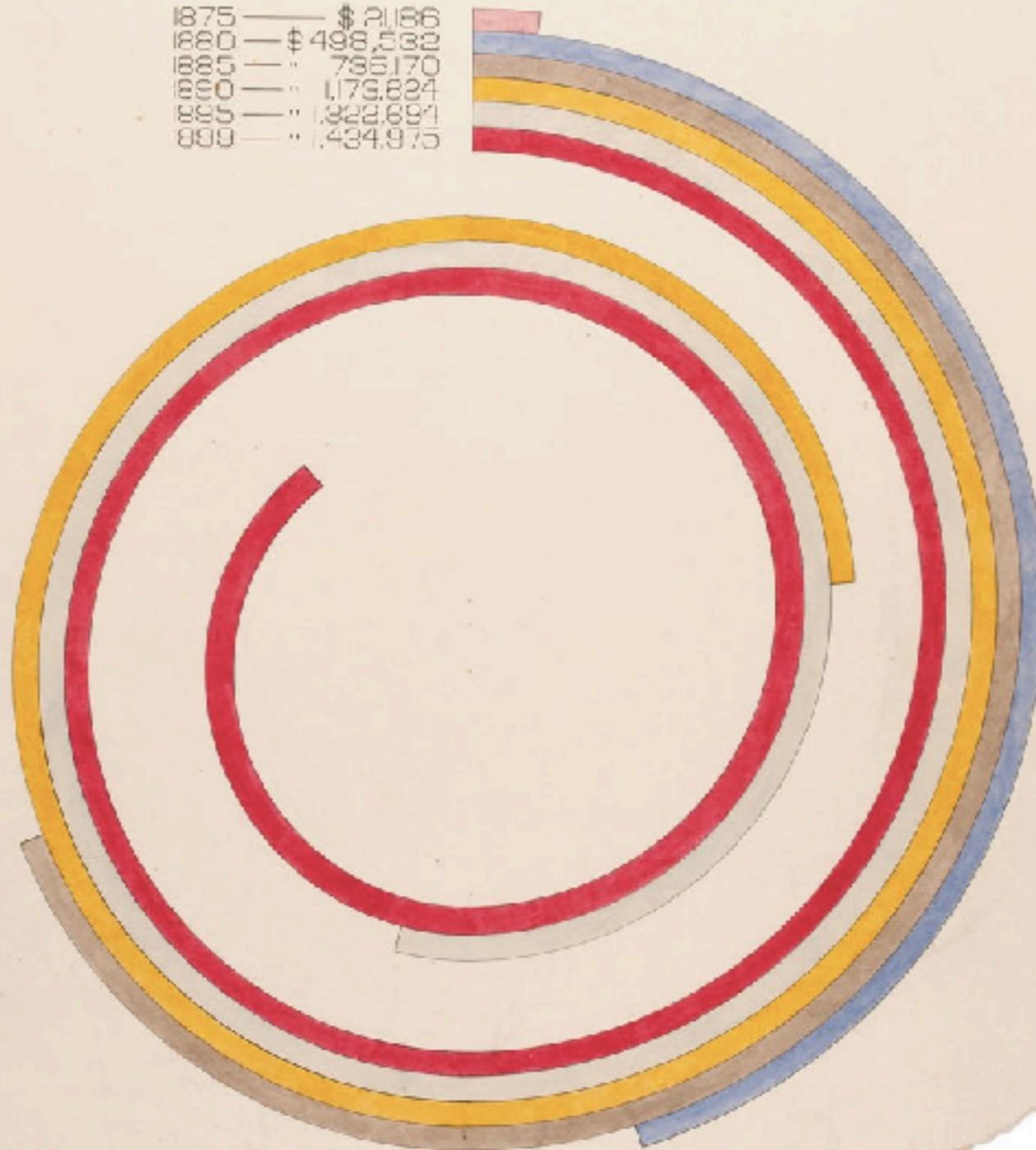


Source: Ben Stanley on [Twitter](#)



## ASSESSED VALUE OF HOUSEHOLD AND KITCHEN FURNITURE OWNED BY GEORGIA NEGROES.

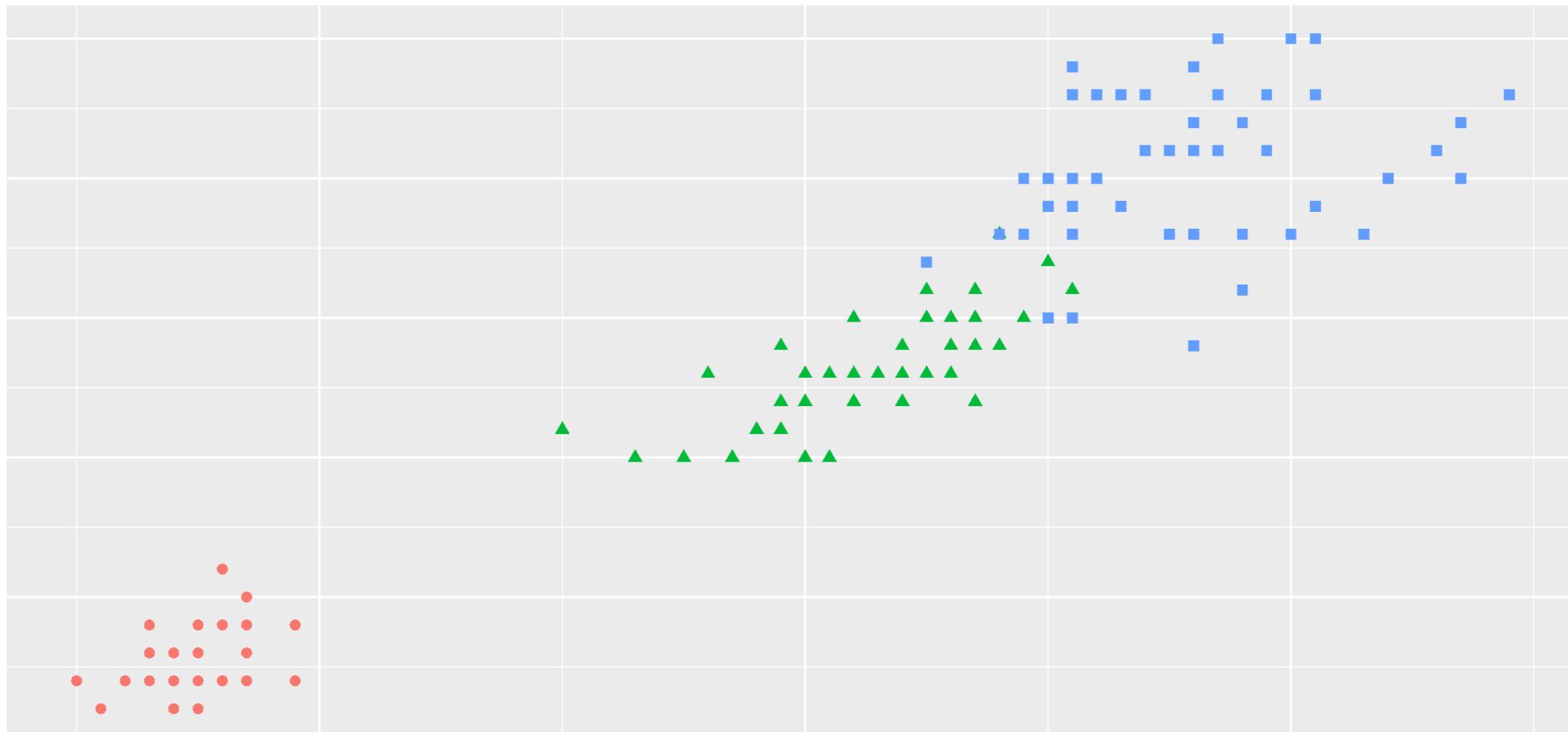
1875 — \$ 2186  
1880 — \$ 498,532  
1885 — " 786,170  
1890 — " 1,798,824  
1895 — " 1,822,694  
1900 — " 1,434,975



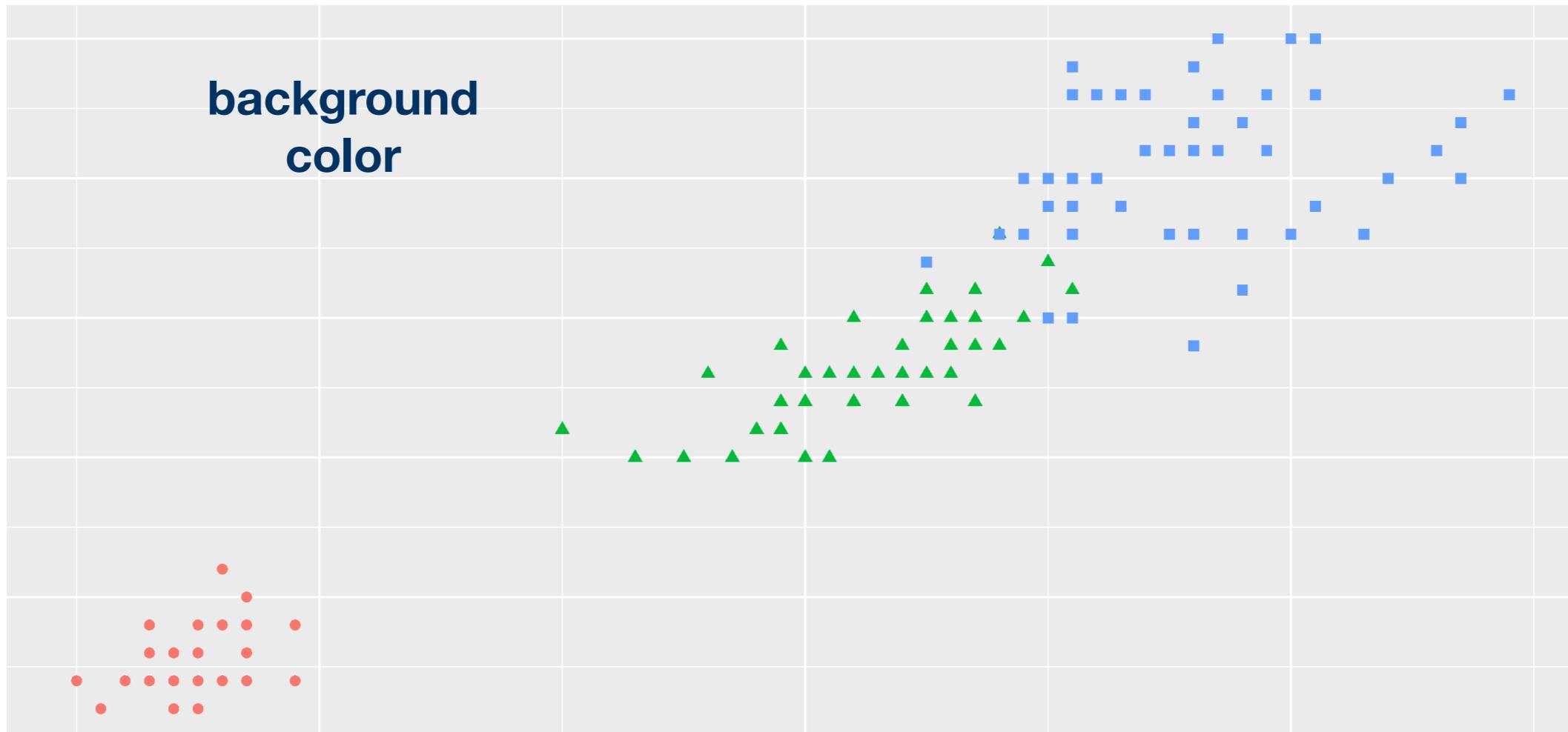
Source: W.E.B. Du Bois, ca. 1900

# *Anatomy of a data visualization*

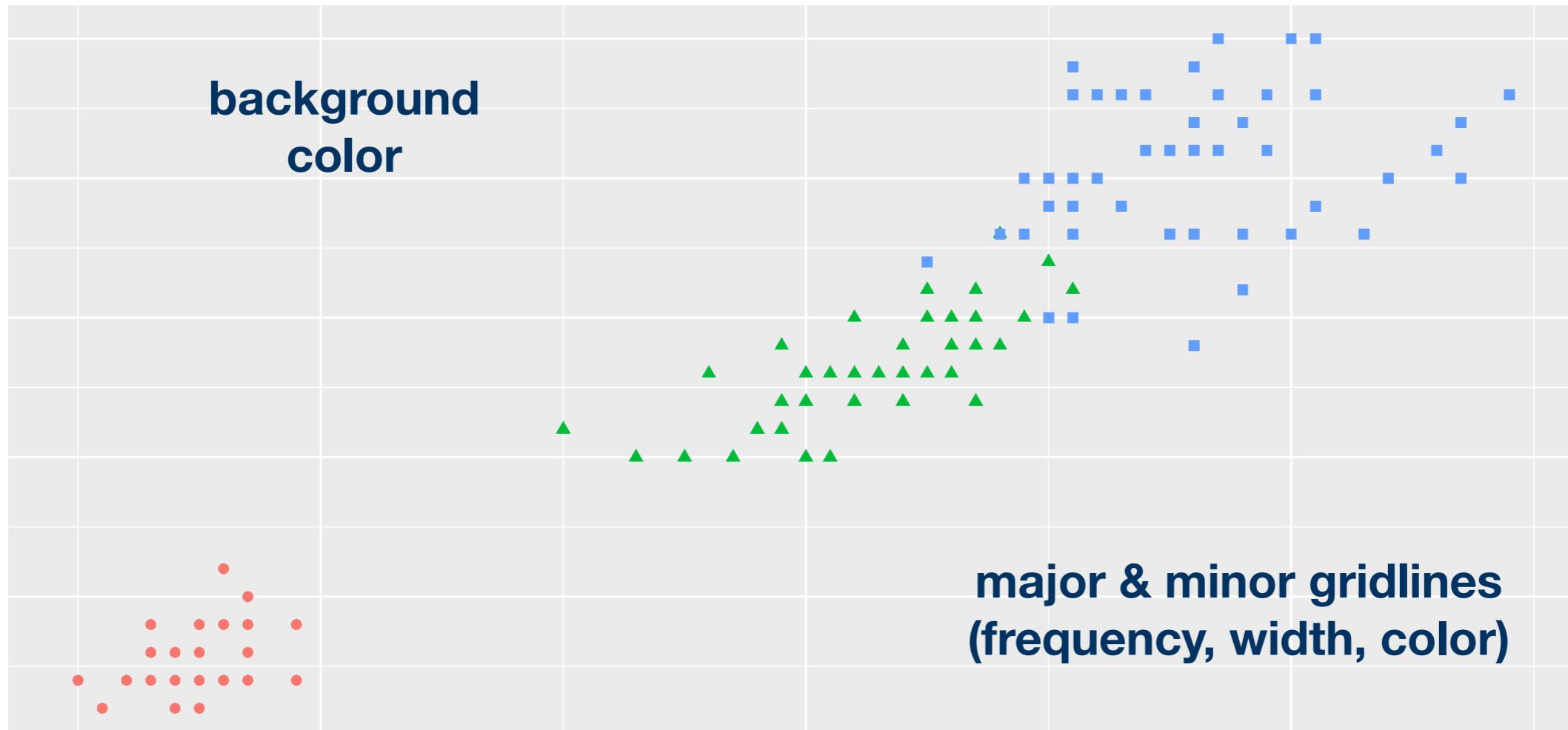
## plot type & aesthetics (colors, sizes, shapes, opacity)



## plot type & aesthetics (colors, sizes, shapes, opacity)



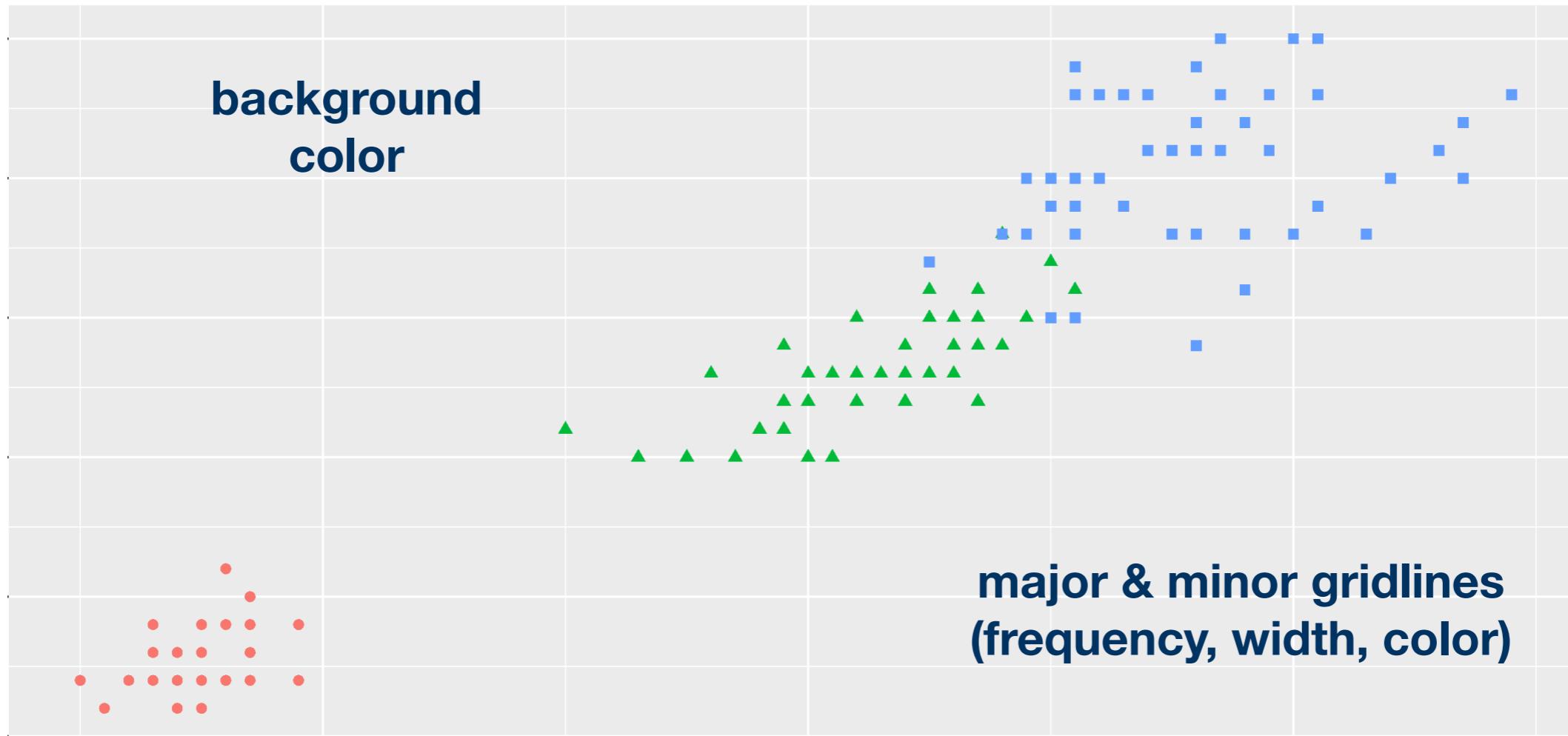
## plot type & aesthetics (colors, sizes, shapes, opacity)



## **title & subtitle (size, font, color, location)**

## **plot type & aesthetics (colors, sizes, shapes, opacity)**

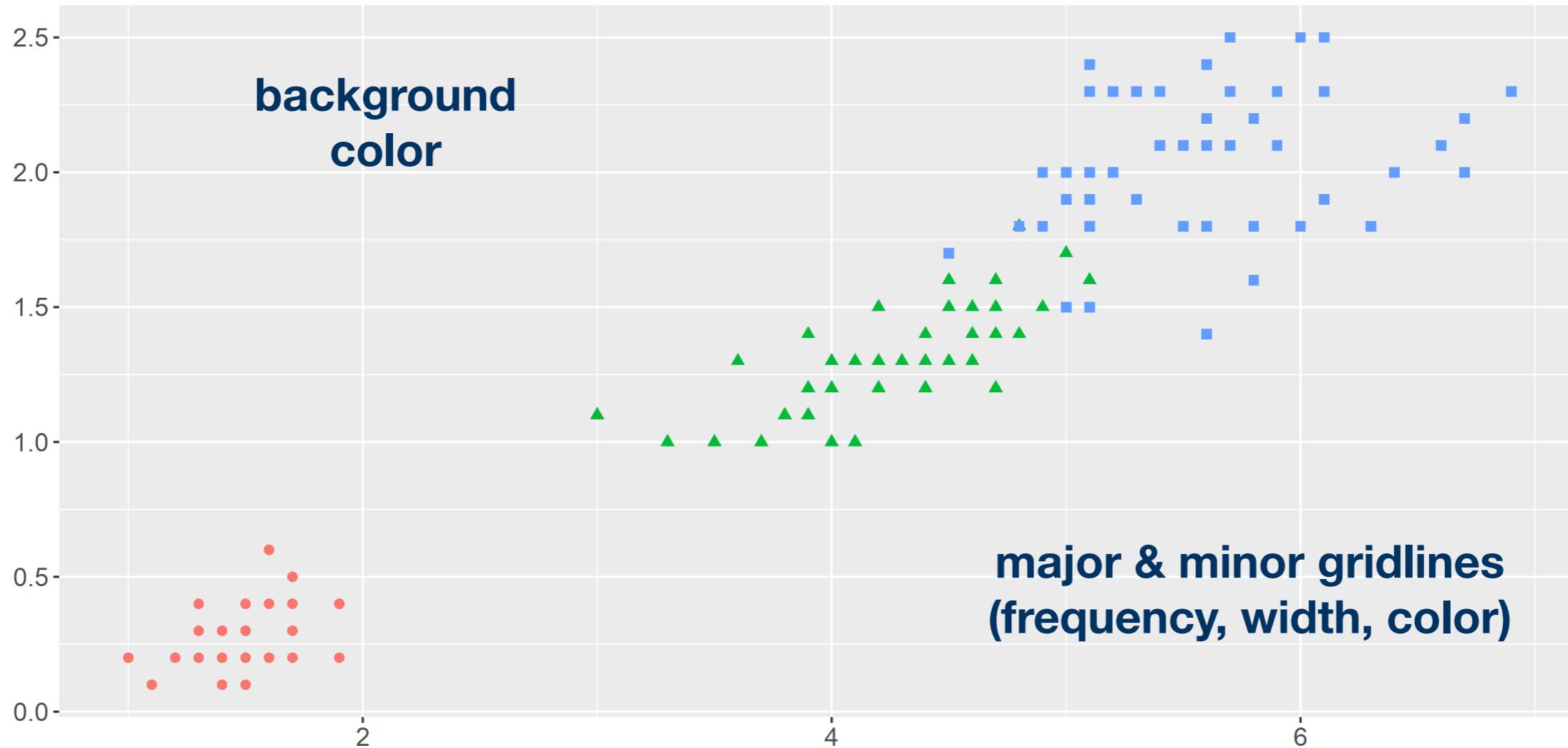
Plant petal sizes are grouped by species  
And Virginica are the biggest!



## **title & subtitle (size, font, color, location)**

## **plot type & aesthetics (colors, sizes, shapes, opacity)**

Plant petal sizes are grouped by species  
And Virginica are the biggest!

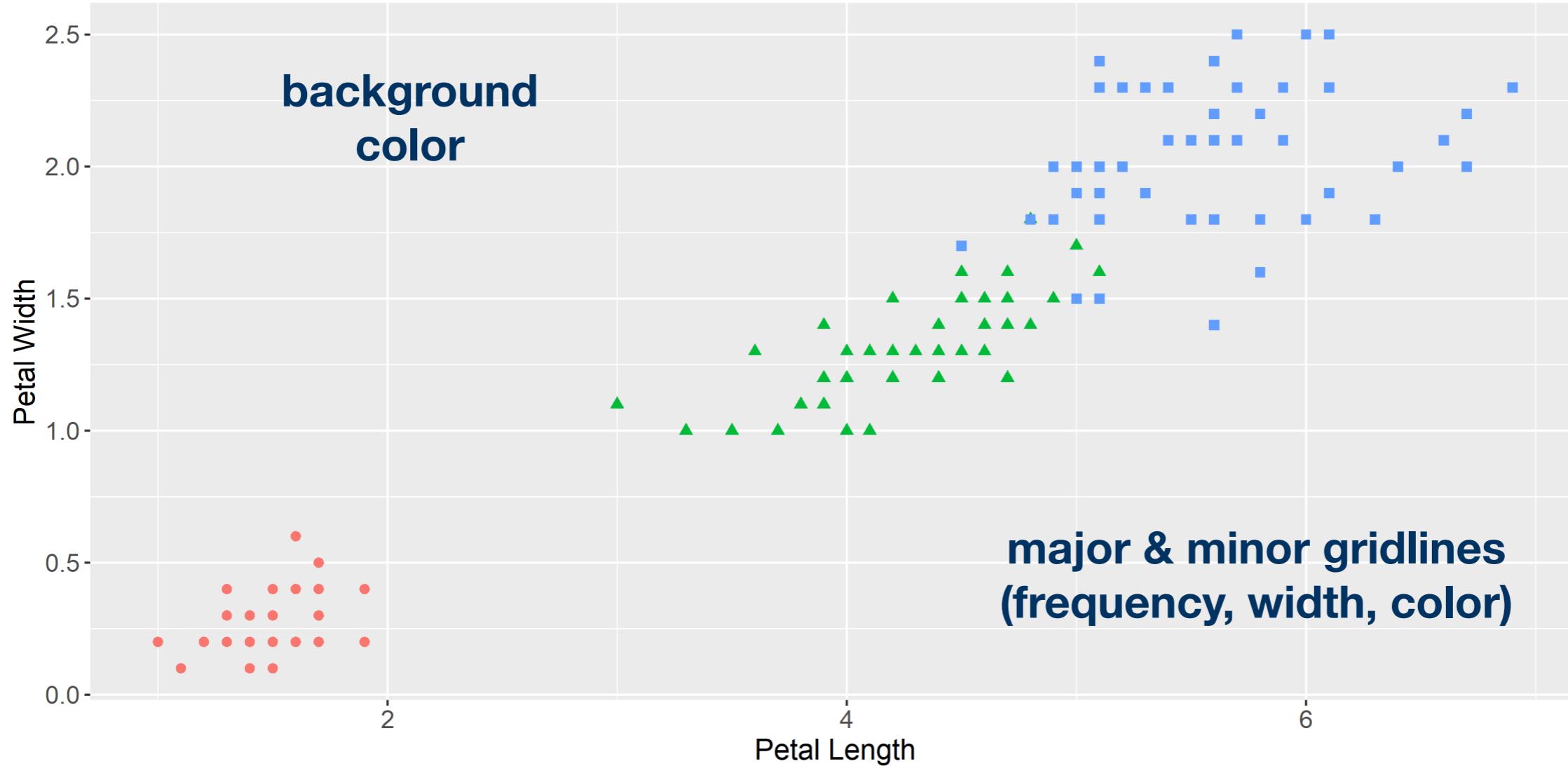


## **X & Y tick marks (frequency, size, font, color, angle)**

## **title & subtitle (size, font, color, location)**

## **plot type & aesthetics (colors, sizes, shapes, opacity)**

Plant petal sizes are grouped by species  
And Virginica are the biggest!



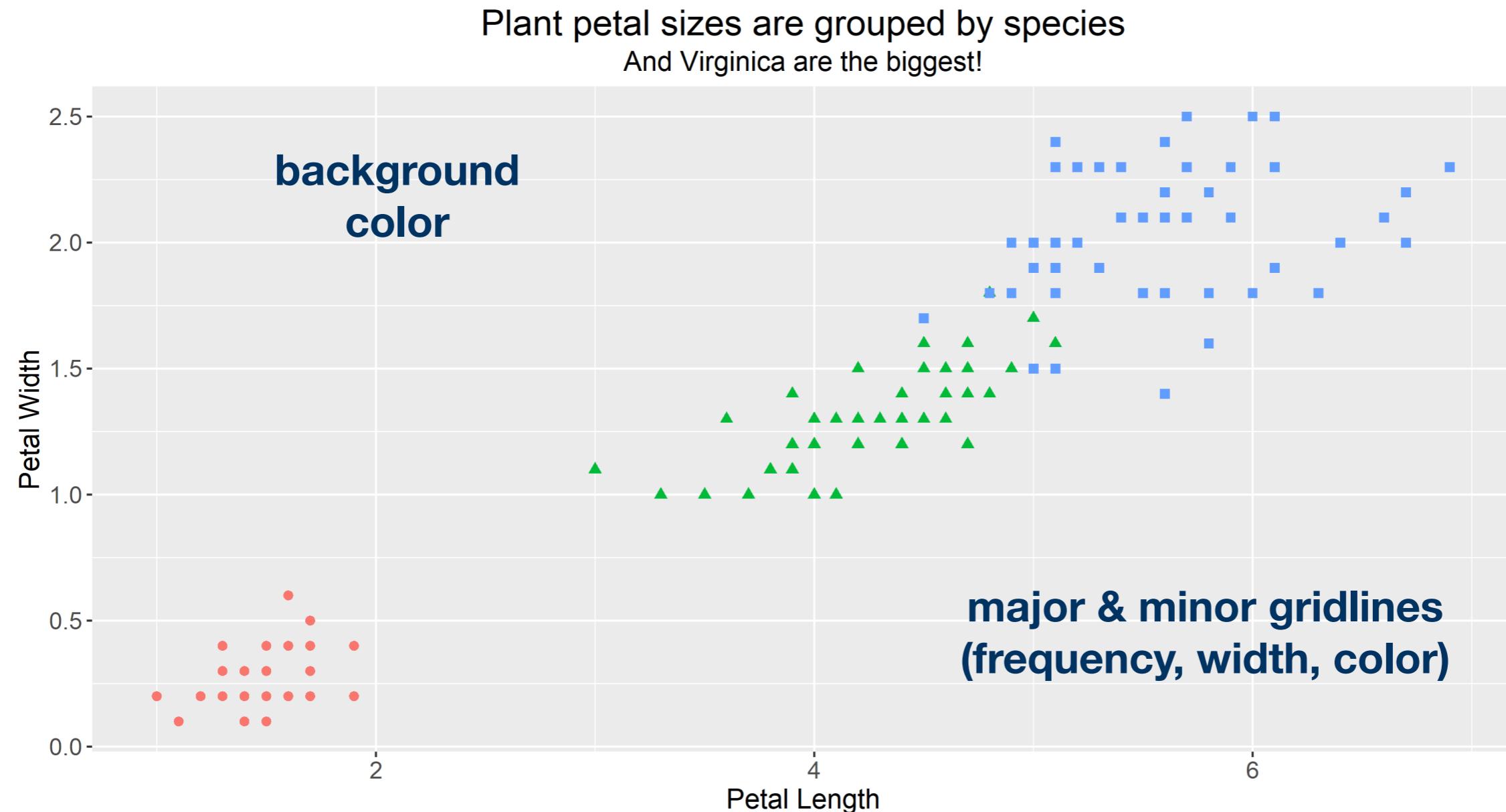
## **X & Y axis labels (size, font, color, angle)**

## **X & Y tick marks (frequency, size, font, color, angle)**

## title & subtitle

(size, font, color, location)

plot type & aesthetics  
(colors, sizes, shapes, opacity)



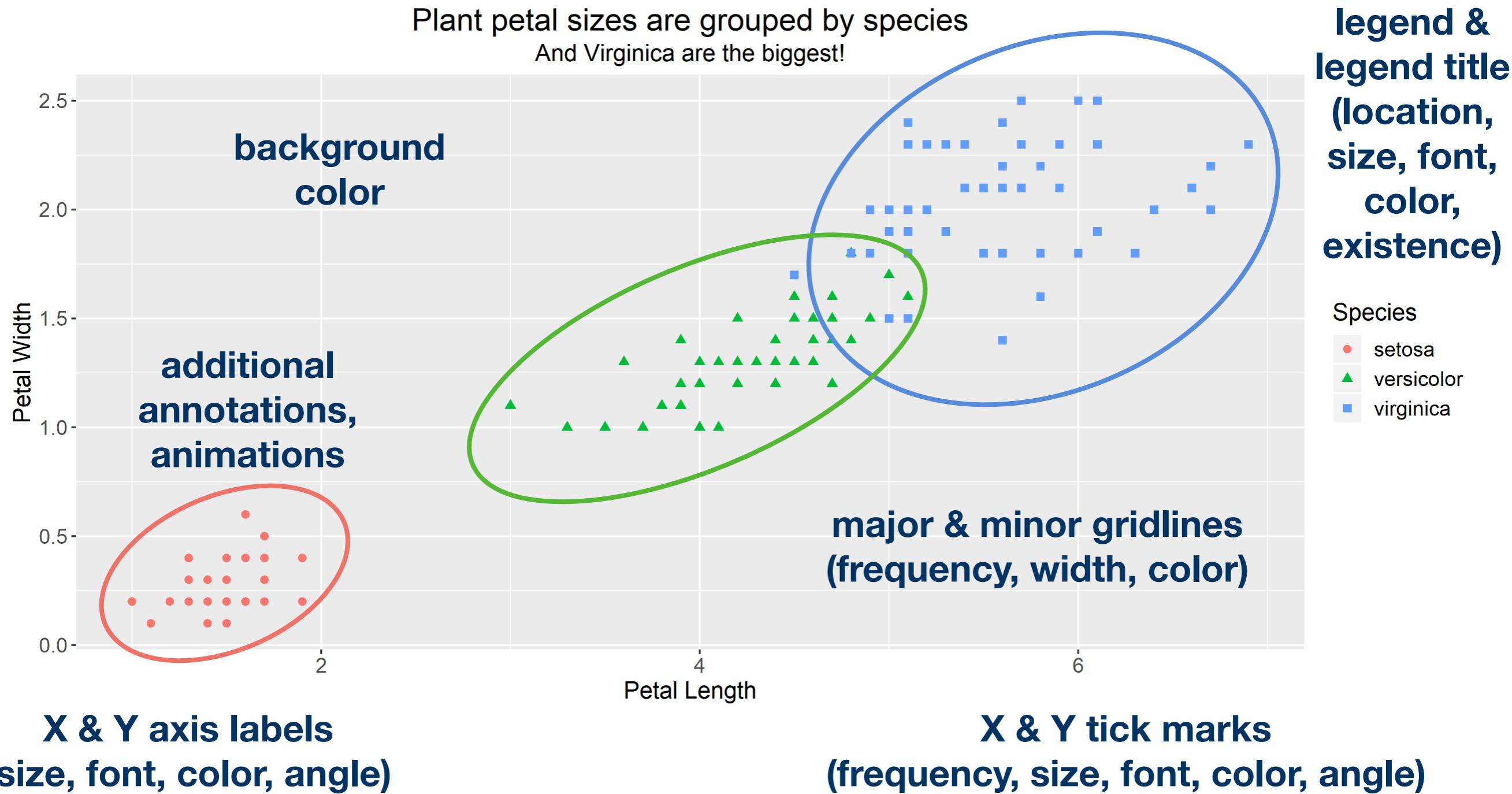
X & Y axis labels  
(size, font, color, angle)

X & Y tick marks  
(frequency, size, font, color, angle)

# title & subtitle

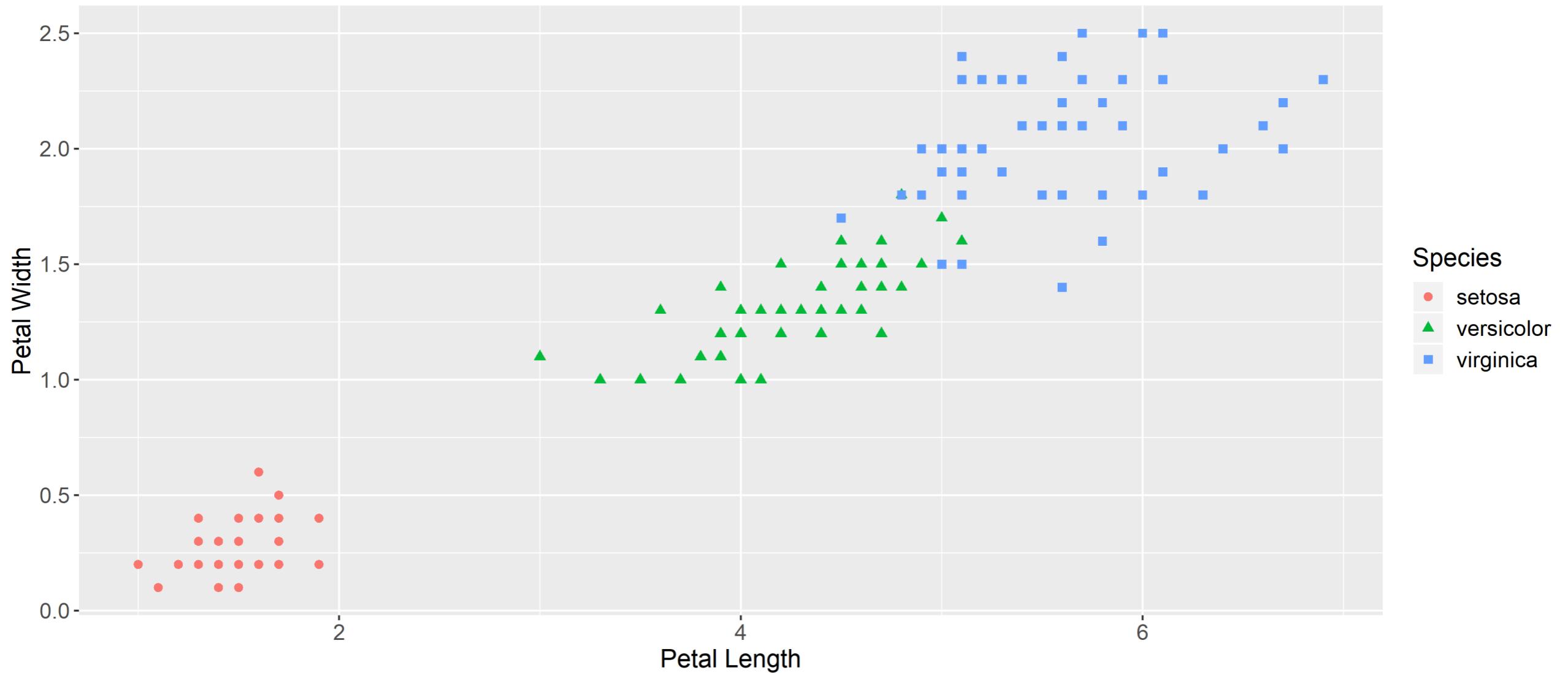
**(size, font, color, location)**

## plot type & aesthetics (colors, sizes, shapes, opacity)



*Adapted from  
Kira Tebbe*

Plant petal sizes are grouped by species  
And Virginica are the biggest!



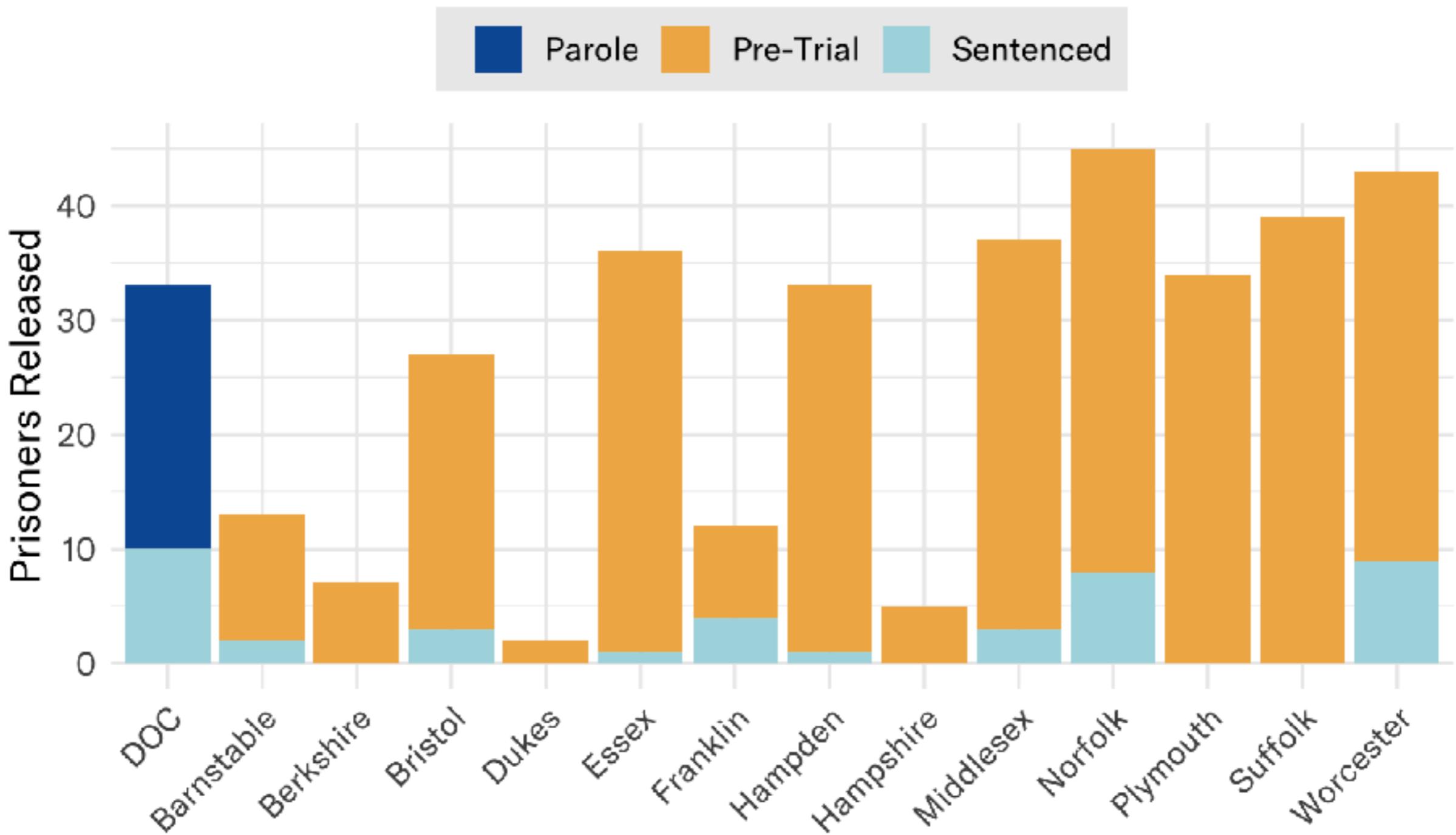
# *Types of data visualization*

# Tables

Rank	Boston Police Officer	FY20 Earnings	Change From FY19	
			Rank	Earnings
1	Smith, Sean P.	\$365,001	↑ +3	+\$22,378
2	Lee, Waiman	\$360,143	↑ +3	+\$20,628
3	Brown, John M.	\$345,758	↑ +12	+\$28,388
4	Danilecki, John H.	\$339,928	↓ -2	-\$8,127
5	Barrett, Thomas E.	\$339,353	↑ +2	+\$7,275
6	McCormick, Kelley J.	\$336,898	↑ +5	+\$15,922
7	Connolly, Timothy	\$334,077	↑ +18	+\$31,109
8	Sweeney, Steve	\$332,908	↑ +1	+\$3,932
9	Cullity, Patrick J.	\$329,101	↑ +3	+\$9,032
10	Hughes, John C.	\$322,637	↑ +31	+\$31,203
11	Thomas, Terry J.	\$319,001	↑ +9	+\$11,134
12	Pusey, Daniel C.	\$318,886	↑ +24	+\$23,156
13	Webb, Keith A.	\$318,141	↑ +1	-\$200
14	Facey, Leighton B.	\$317,506	↑ +29	+\$28,844
15	Kervin, Timothy M.	\$314,690	↓ -14	-\$40,849
16	Harrington, Mark William	\$314,443	↑ +29	+\$27,098
17	Ciccolo, Robert W.	\$314,026	↑ +9	+\$12,894
18	Kozmiski, Therese M.	\$313,656	↑ +53	+\$35,552
19	Sullivan, Marc	\$313,437	↓ -2	+\$2,515
20	Gero, Jarrod A.	\$311,210	↑ +19	+\$17,573

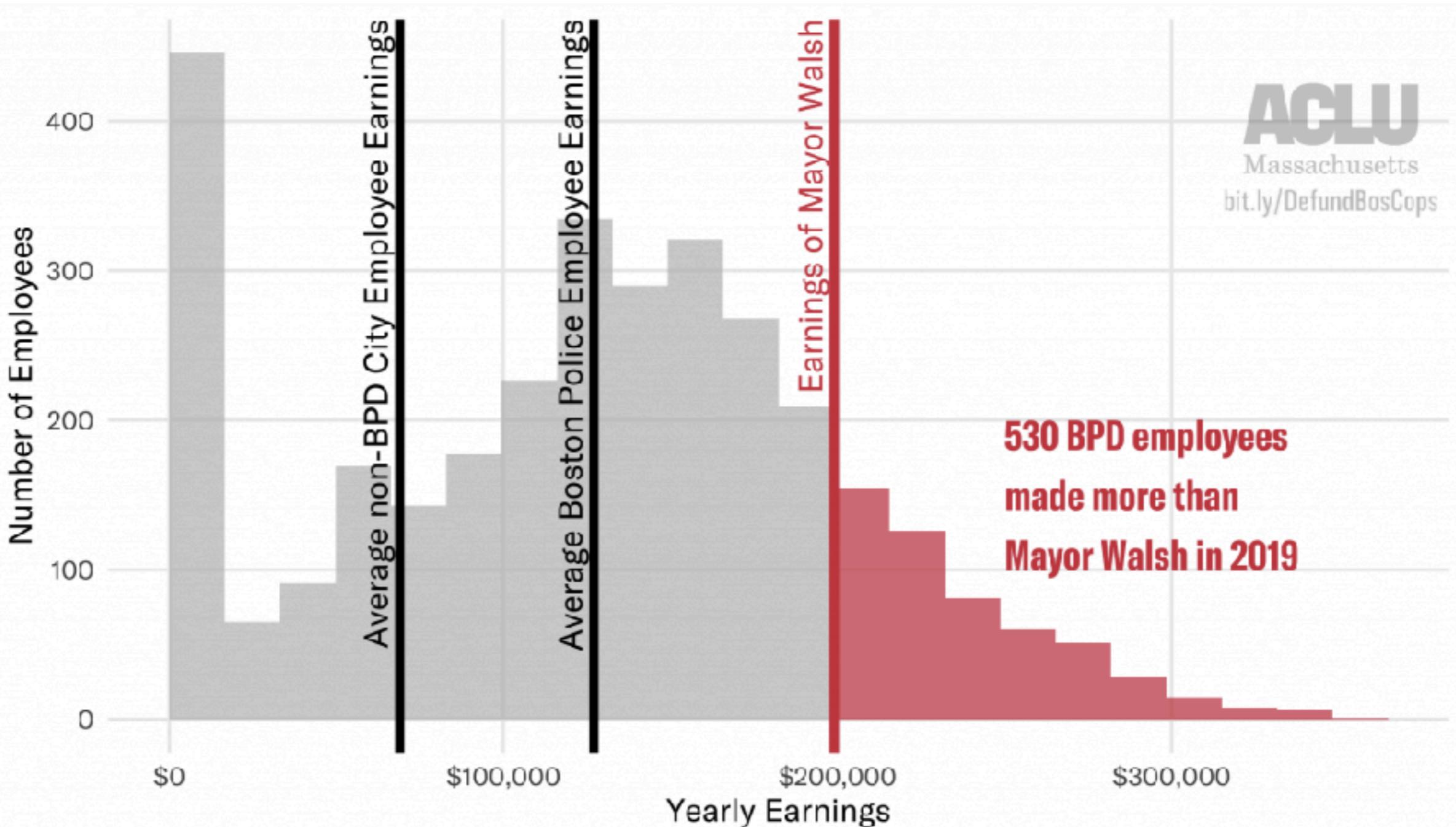
Source: "More of the Same: Unpacking the 2022 Boston Police Budget,"  
ACLU of Massachusetts Data for Justice Project

# Bar charts



Source: "Incarcerated and In Danger: COVID-19 in Massachusetts Prisons and Jails," ACLU of Massachusetts Data for Justice Project

# Histogram



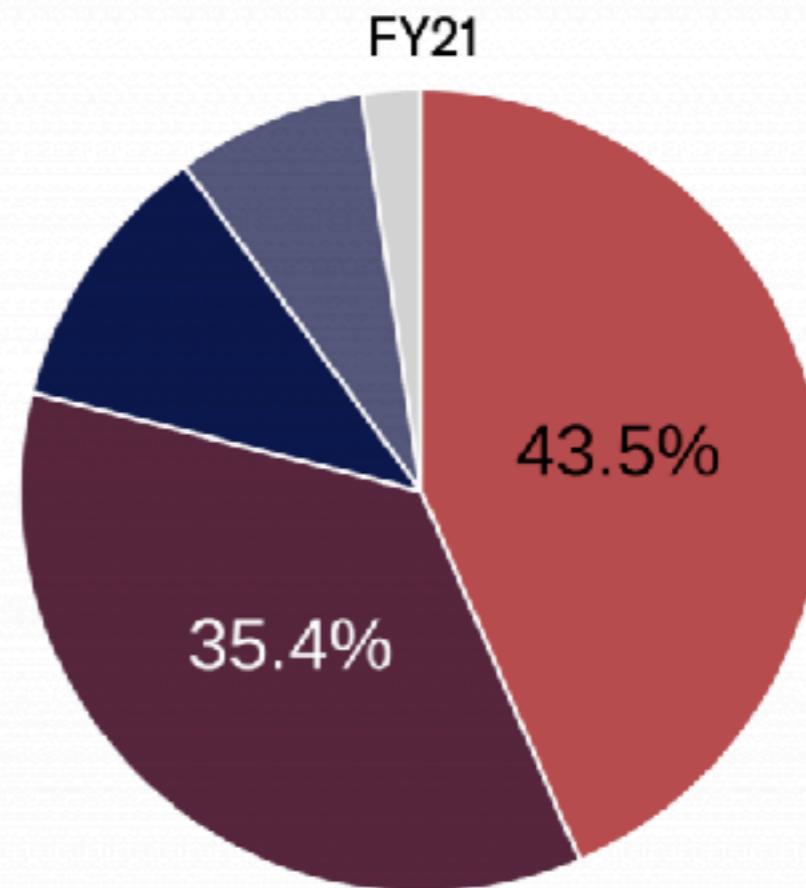
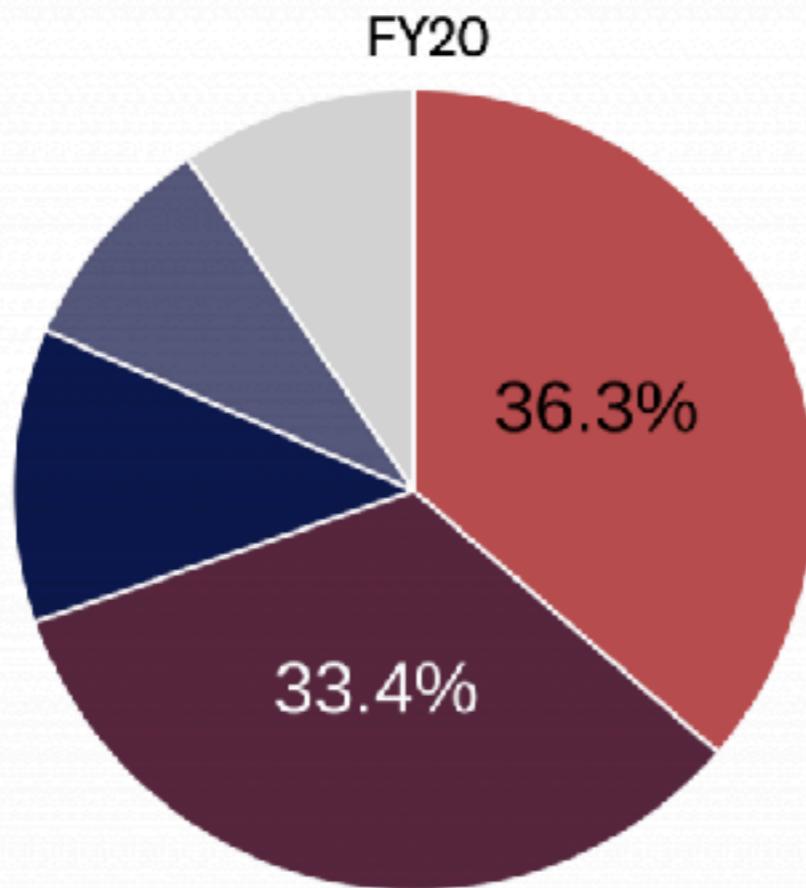
Source: "Unpacking the Boston Police Budget,"  
ACLU of Massachusetts Data for Justice Project

**ACLU**  
Massachusetts  
[bit.ly/DefundBosCops](http://bit.ly/DefundBosCops)

# Pie charts

**Overtime dominated by replacement personnel, extended tours**

July 1 - February 19



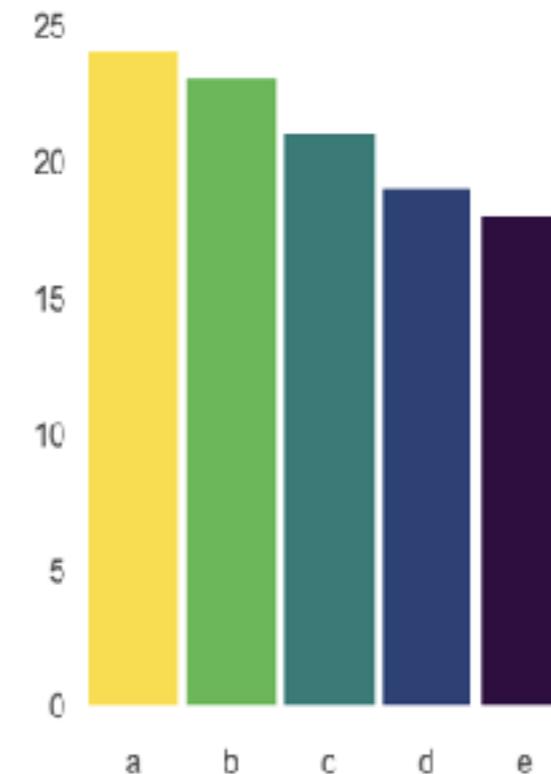
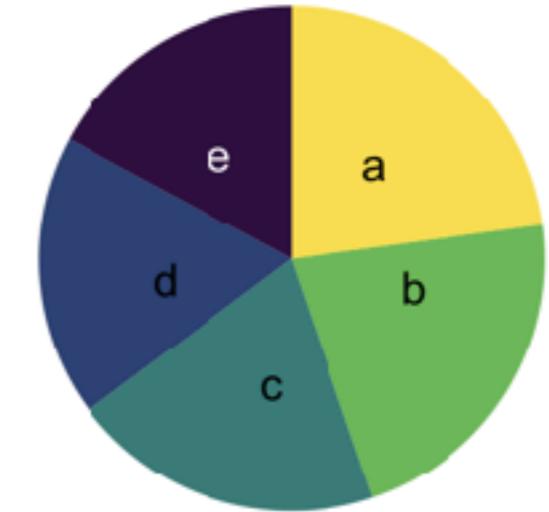
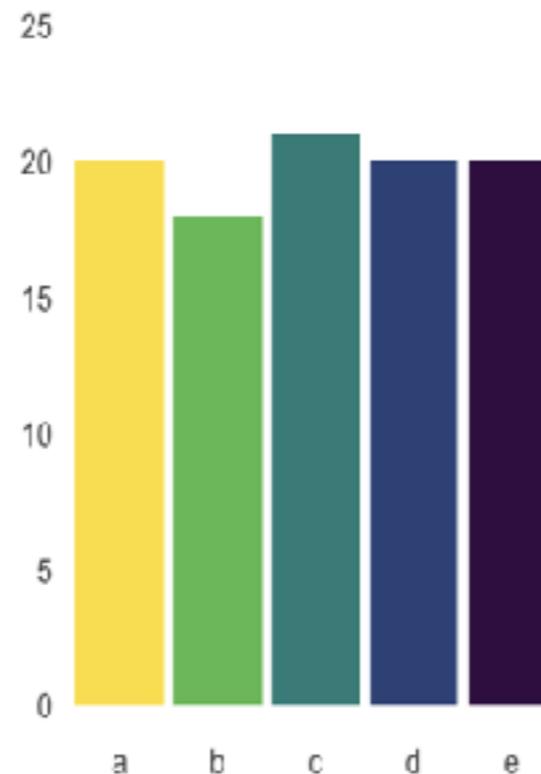
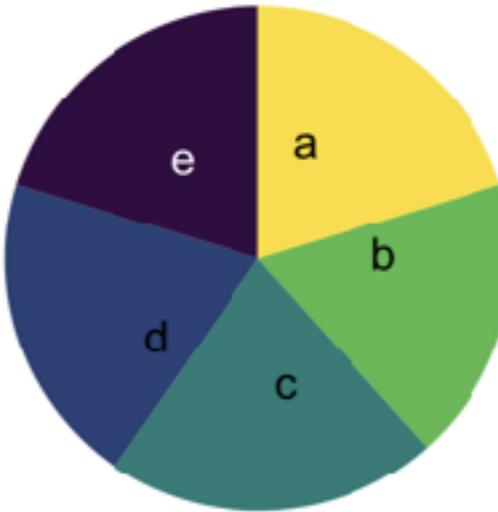
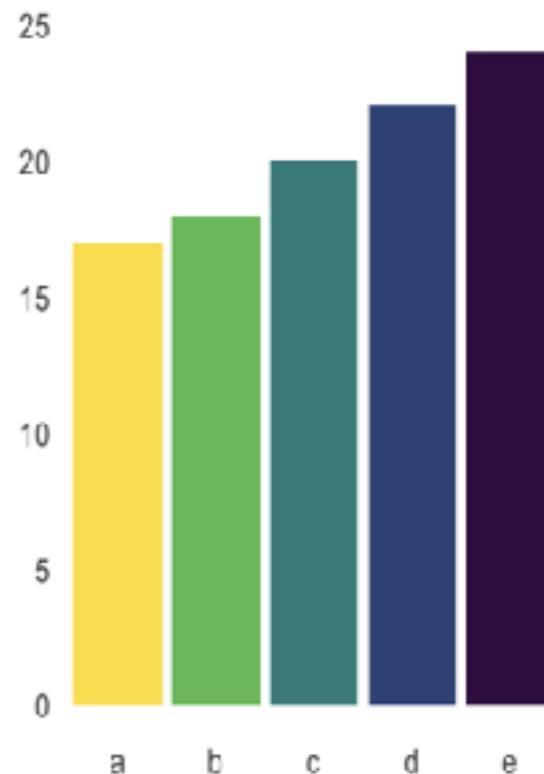
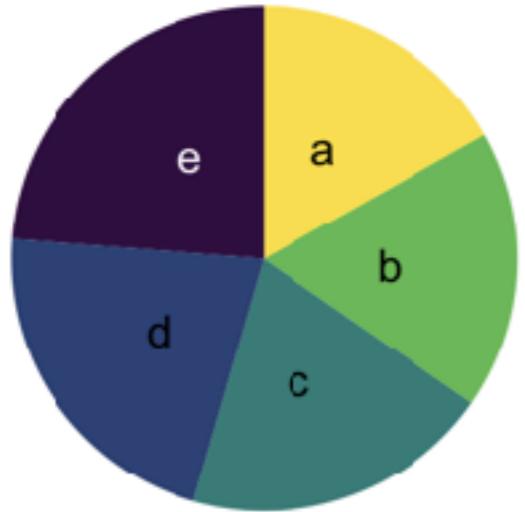
Type of Overtime

- |   |                          |  |                       |
|---|--------------------------|--|-----------------------|
| <span style="color: darkblue;">█</span>   | Additional Tour/Call Out | <span style="color: darkred;">█</span> | Extended Tours        |
| <span style="color: mediumblue;">█</span> | Special Events           | <span style="color: red;">█</span>     | Replacement Personnel |
| <span style="color: lightgray;">█</span>  | Court                    |  |                       |



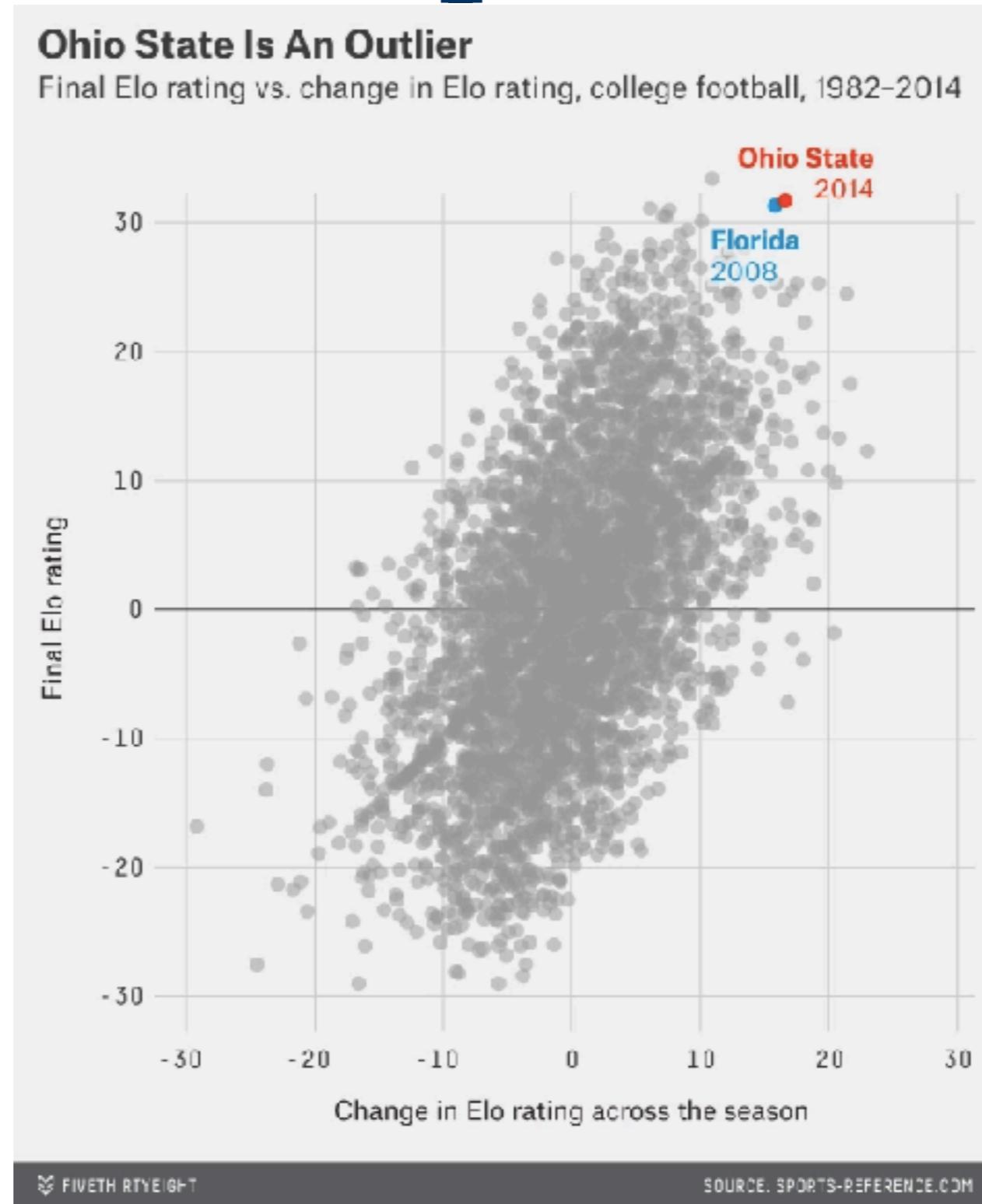
Source: "A Mayor's Roadmap to Curb Boston Police Overtime,"  
ACLU of Massachusetts Data for Justice Project

# Pie charts

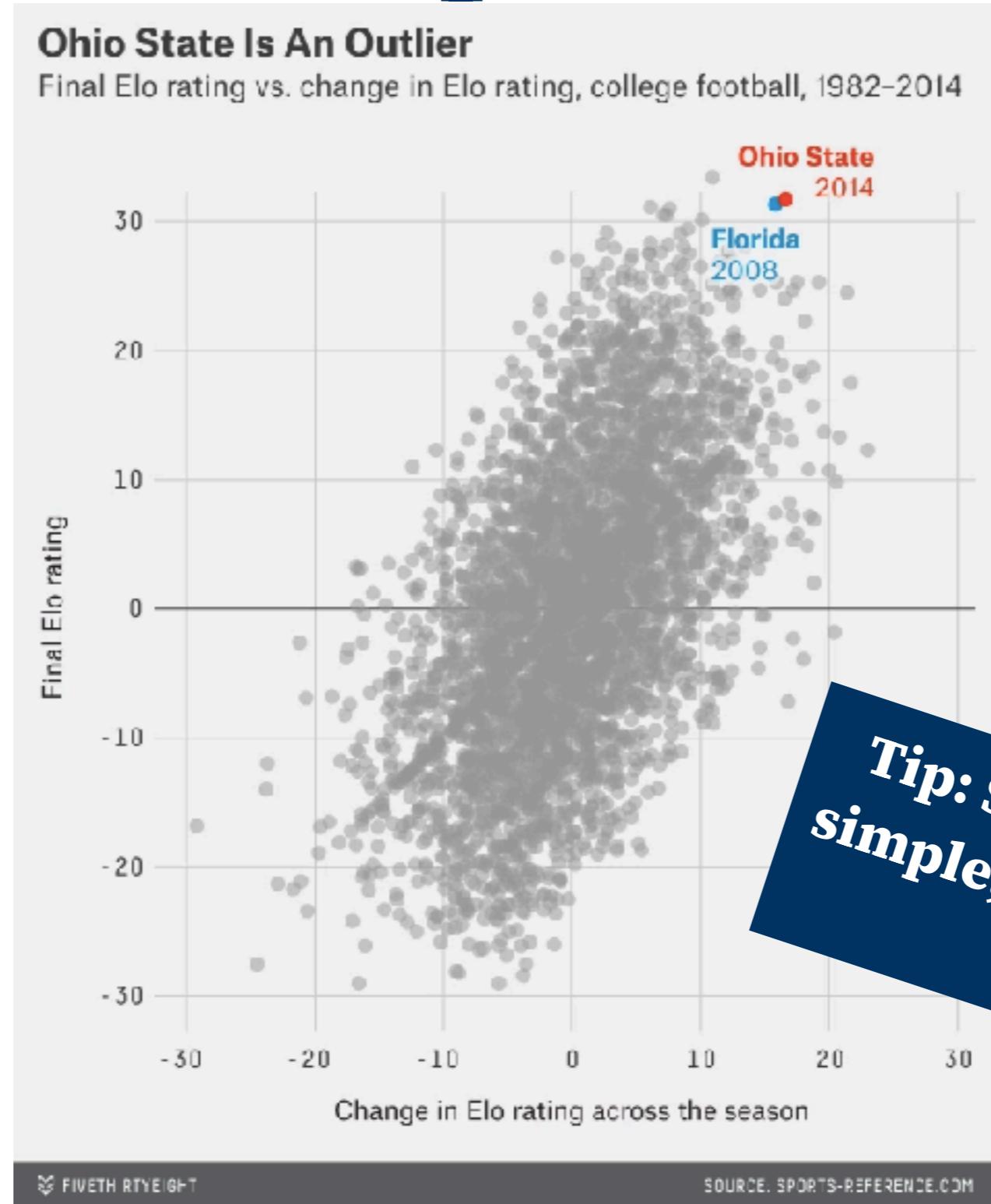


Source: "The Issue with Pie Chart,"  
Data to Viz

# Scatter/circle plots



# Scatter/circle plots

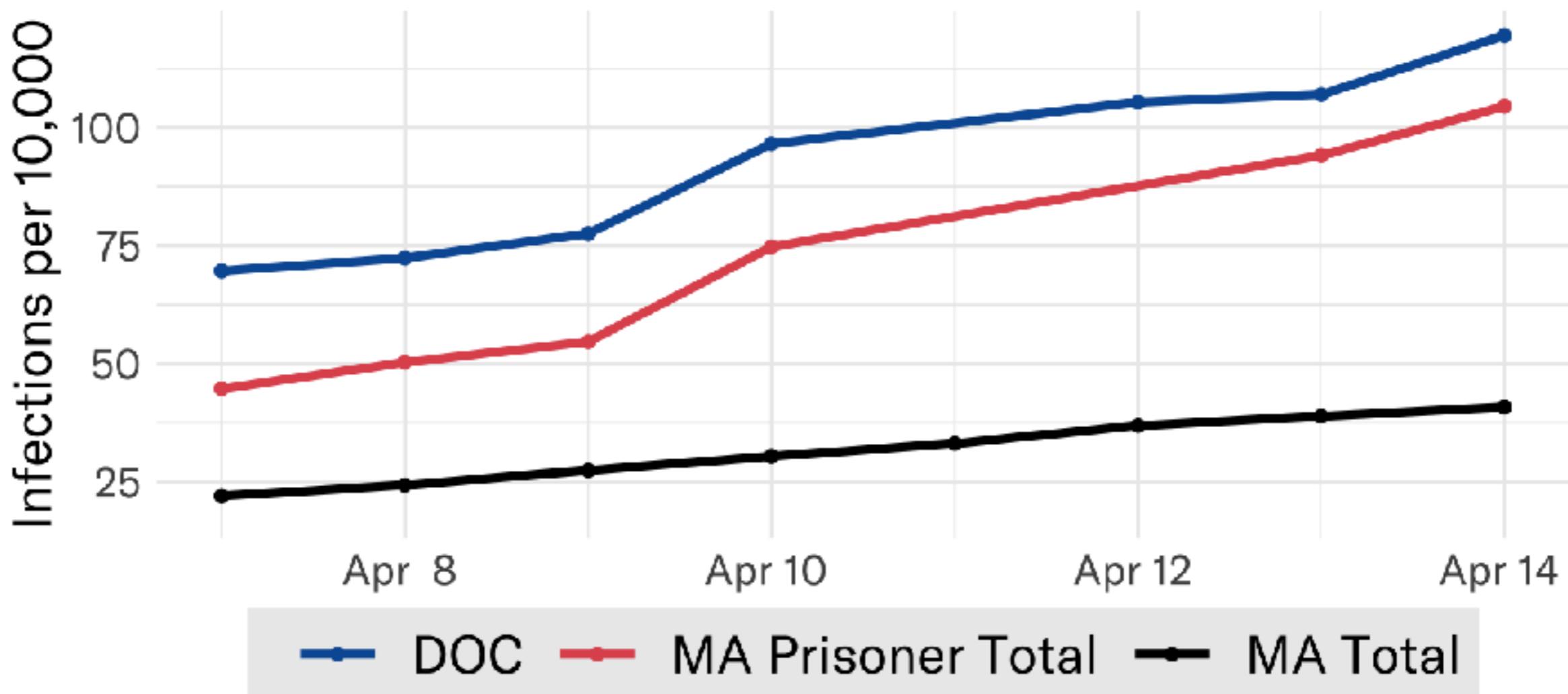


*Tip: Scatter plots seem simple, but require extra attention*

# Line plots

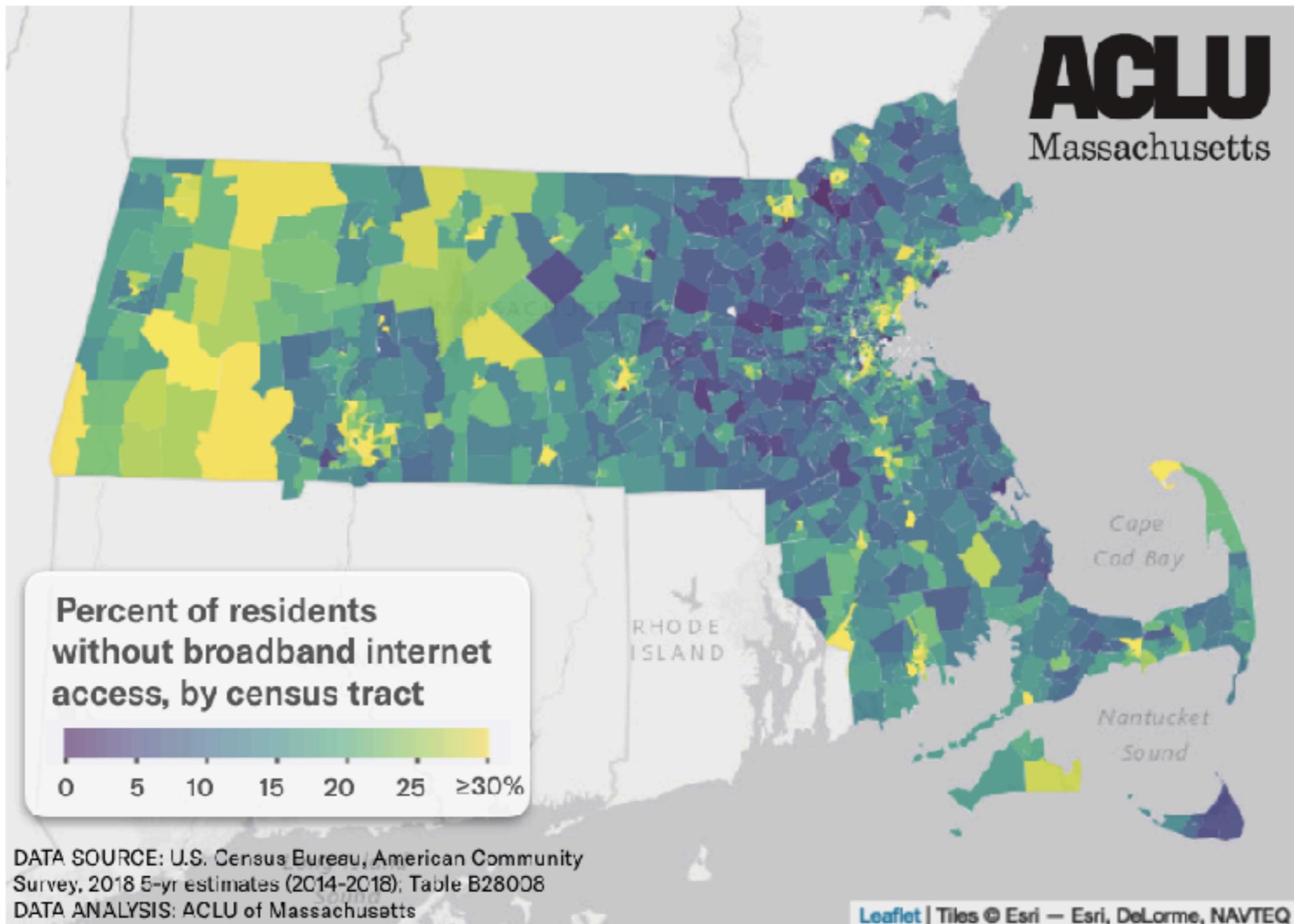
## COVID-19 Incidence Rate Over Time

Positive Cases per 10,000 Prisoners



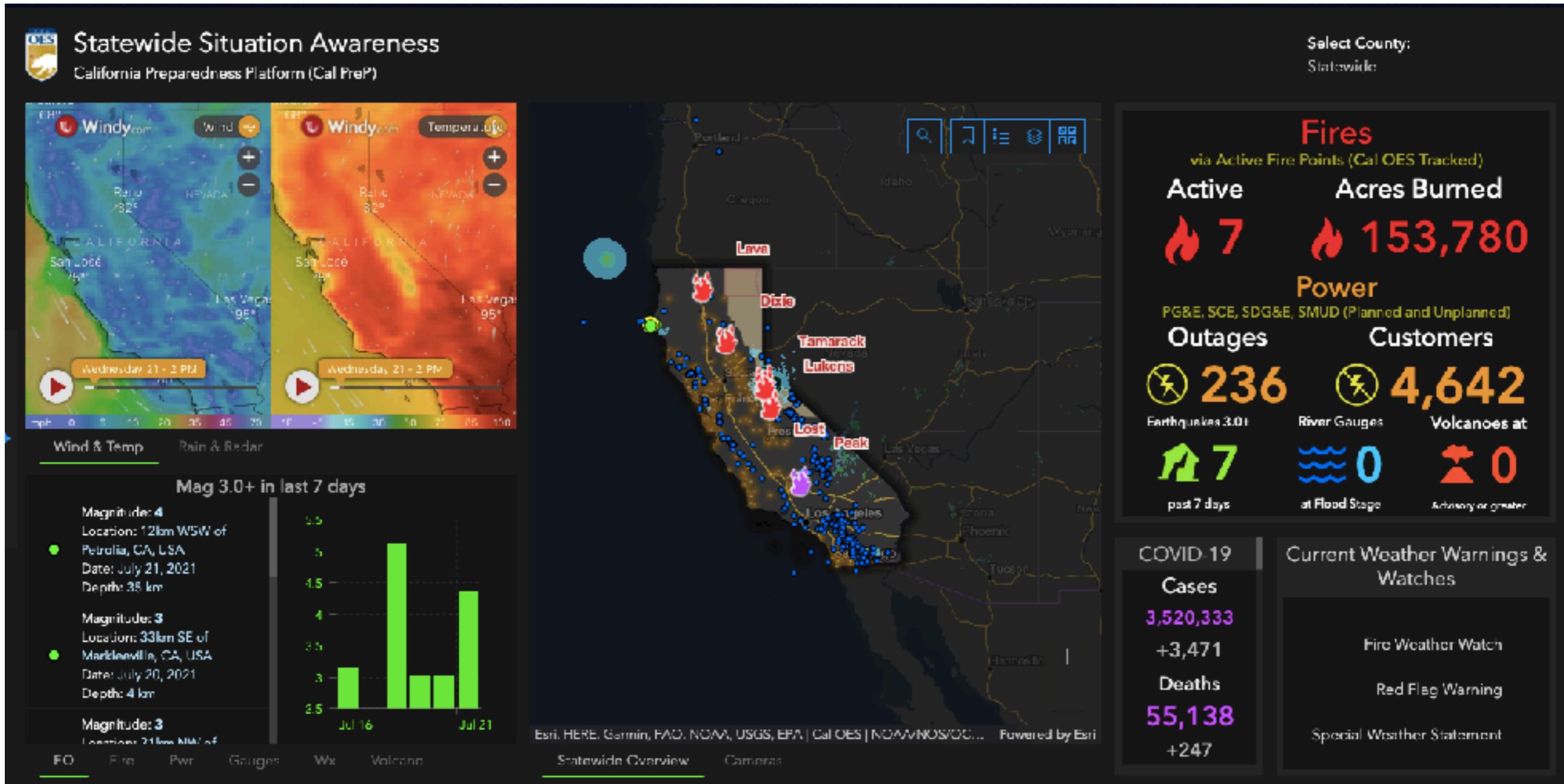
Source: "Incarcerated and In Danger: COVID-19 in Massachusetts Prisons and Jails," ACLU of Massachusetts Data for Justice Project

# Maps



Source: "Internet Deserts Prevent Remote Learning in COVID-19,"  
ACLU of Massachusetts Data for Justice Project

# Dashboards

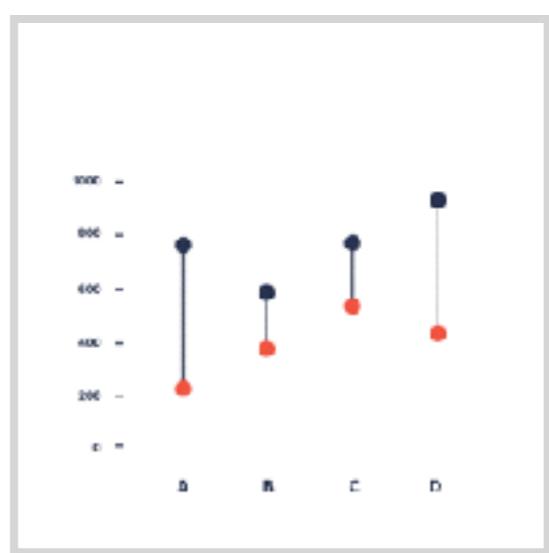
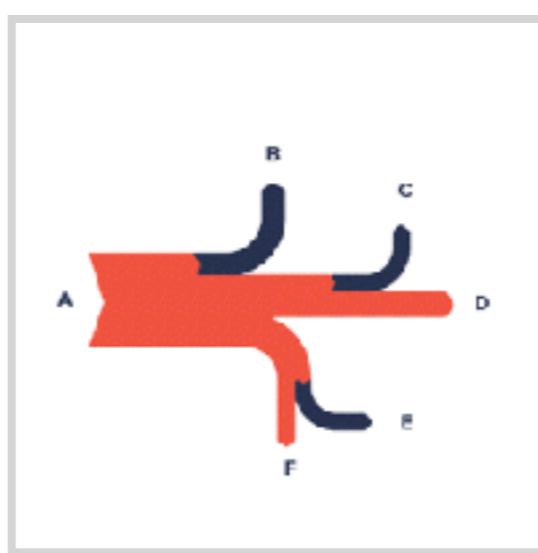
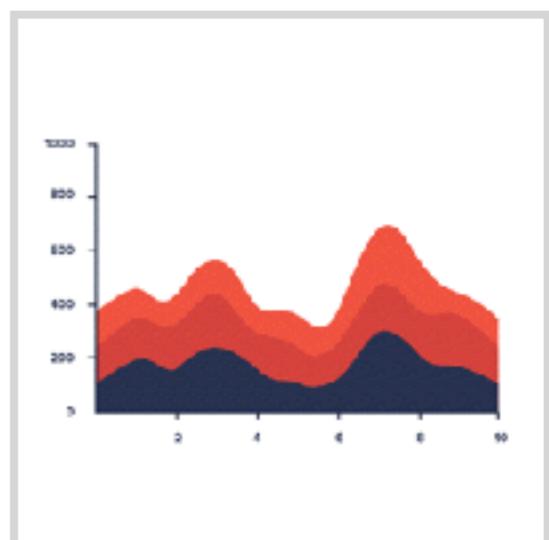
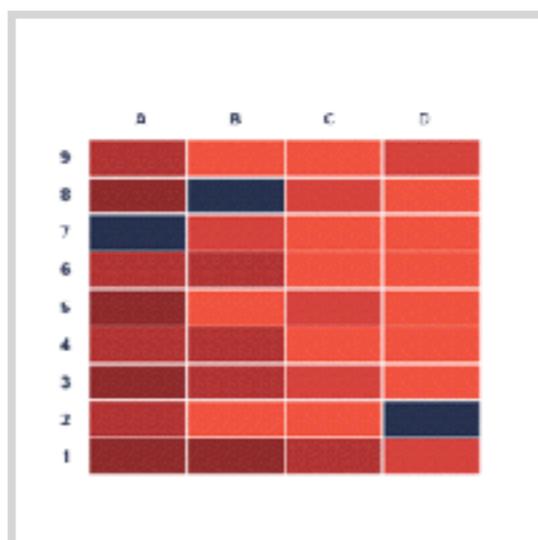
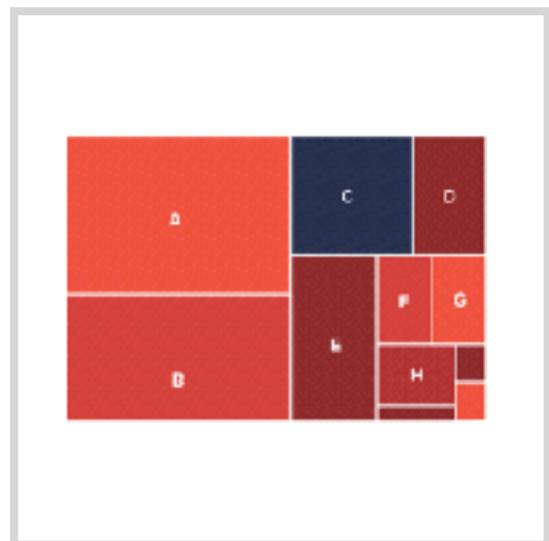


Source: California Governor's Office of Emergency Services Preparedness Platform

# And more!

- ▶ Pictorial charts
- ▶ Treemaps
- ▶ 2-D histogram / heat map
- ▶ Area chart
- ▶ Alluvial/Sankey diagram
- ▶ Dumbbell plot

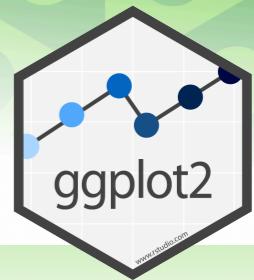
For more, see: [datavizproject.com](http://datavizproject.com)



Source: Data Viz Project



# Data Visualization with ggplot2 :: CHEAT SHEET



## Basics

**ggplot2** is based on the **grammar of graphics**, the idea that you can build every graph from the same components: a **data** set, a **coordinate system**, and geoms—visual marks that represent data points.



To display values, map variables in the data to visual properties of the geom (**aesthetics**) like **size**, **color**, and **x** and **y** locations.



Complete the template below to build a graph.

```
ggplot(data = <DATA>) +
  <GEOM_FUNCTION>(mapping = aes(<MAPPINGS>),
  stat = <STAT>, position = <POSITION>) +
  <COORDINATE_FUNCTION> +
  <FACET_FUNCTION> +
  <SCALE_FUNCTION> +
  <THEME_FUNCTION>
```

[ required ]

[ Not required, sensible defaults supplied ]

**ggplot(data = mpg, aes(x = cty, y = hwy))** Begins a plot that you finish by adding layers to. Add one geom function per layer.

**aesthetic mappings**   **data**   **geom**  
**qplot(x = cty, y = hwy, data = mpg, geom = "point")**  
Creates a complete plot with given data, geom, and mappings. Supplies many useful defaults.

**last\_plot()** Returns the last plot

**ggsave("plot.png", width = 5, height = 5)** Saves last plot as 5'x5' file named "plot.png" in working directory. Matches file type to file extension.

R Studio

## Geoms

Use a geom function to represent data points, use the geom's aesthetic properties to represent variables.  
Each function returns a layer.

### GRAPHICAL PRIMITIVES

```
a <- ggplot(economics, aes(date, unemploy))
b <- ggplot(seals, aes(x = long, y = lat))
```

**a + geom\_blank()**  
(Useful for expanding limits)

**b + geom\_curve(aes(yend = lat + 1,**  
**xend = long + 1), curvature = 1) - x, xend, y, yend,**  
**alpha, angle, color, curvature, linetype, size**

**a + geom\_path(lineend = "butt", linejoin = "round",**  
**linemitre = 1)**  
**x, y, alpha, color, group, linetype, size**

**a + geom\_polygon(aes(group = group))**  
**x, y, alpha, color, fill, group, linetype, size**

**b + geom\_rect(aes(xmin = long, ymin = lat, xmax =**  
**long + 1, ymax = lat + 1)) - xmax, xmin, ymax,**  
**ymin, alpha, color, fill, linetype, size**

**a + geom\_ribbon(aes(ymin = unemploy - 900,**  
**ymax = unemploy + 900)) - x, ymax, ymin,**  
**alpha, color, fill, group, linetype, size**

### LINE SEGMENTS

common aesthetics: x, y, alpha, color, linetype, size

**b + geom\_abline(aes(intercept = 0, slope = 1))**  
**b + geom\_hline(aes(yintercept = lat))**  
**b + geom\_vline(aes(xintercept = long))**

**b + geom\_segment(aes(yend = lat + 1, xend = long + 1))**  
**b + geom\_spoke(aes(angle = 1:1155, radius = 1))**

### ONE VARIABLE continuous

```
c <- ggplot(mpg, aes(hwy)); c2 <- ggplot(mpg)
```

**c + geom\_area(stat = "bin")**  
**x, y, alpha, color, fill, linetype, size**

**c + geom\_density(kernel = "gaussian")**  
**x, y, alpha, color, fill, group, linetype, size, weight**

**c + geom\_dotplot()**  
**x, y, alpha, color, fill**

**c + geom\_freqpoly()**  
**x, y, alpha, color, group, linetype, size**

**c + geom\_histogram(binwidth = 5)**  
**x, y, alpha, color, fill, linetype, size, weight**

**c2 + geom\_qq(aes(sample = hwy))**  
**x, y, alpha, color, fill, linetype, size, weight**

### discrete

```
d <- ggplot(mpg, aes(fl))
```

**d + geom\_bar()**  
**x, alpha, color, fill, linetype, size, weight**

### TWO VARIABLES

#### continuous x , continuous y

```
e <- ggplot(mpg, aes(cty, hwy))
```

**e + geom\_label(aes(label = cty), nudge\_x = 1,**  
**nudge\_y = 1, check\_overlap = TRUE)**  
**x, y, label, alpha, angle, color, family, fontface, hjust,**  
**lineheight, size, vjust**

**e + geom\_jitter(height = 2, width = 2)**  
**x, y, alpha, color, fill, shape, size**

**e + geom\_point()**, x, y, alpha, color, fill, shape,  
size, stroke

**e + geom\_quantile()**, x, y, alpha, color, group,  
linetype, size, weight

**e + geom\_rug(sides = "bl")**, x, y, alpha, color,  
linetype, size

**e + geom\_smooth(method = lm)**, x, y, alpha,  
color, fill, group, linetype, size, weight

**e + geom\_text(aes(label = cty), nudge\_x = 1,**  
**nudge\_y = 1, check\_overlap = TRUE)**, x, y, label,  
**alpha, angle, color, family, fontface, hjust,**  
**lineheight, size, vjust**

#### discrete x , continuous y

```
f <- ggplot(mpg, aes(class, hwy))
```

**f + geom\_col()**, x, y, alpha, color, fill, group,  
linetype, size

**f + geom\_boxplot()**, x, y, lower, middle, upper,  
ymax, ymin, alpha, color, fill, group, linetype,  
shape, size, weight

**f + geom\_dotplot(binaxis = "y", stackdir =**  
**"center")**, x, y, alpha, color, fill, group

**f + geom\_violin(scale = "area")**, x, y, alpha, color,  
fill, group, linetype, size, weight

#### discrete x , discrete y

```
g <- ggplot(diamonds, aes(cut, color))
```

**g + geom\_count()**, x, y, alpha, color, fill, shape,  
size, stroke

### THREE VARIABLES

```
seals$z <- with(seals, sqrt(delta_long^2 + delta_lat^2)); l <- ggplot(seals, aes(long, lat))
```

**l + geom\_contour(aes(z = z))**  
**x, y, z, alpha, colour, group, linetype,**  
**size, weight**

#### continuous bivariate distribution

```
h <- ggplot(diamonds, aes(carat, price))
```

**h + geom\_bin2d(binwidth = c(0.25, 500))**  
**x, y, alpha, color, fill, linetype, size, weight**

**h + geom\_density2d()**  
**x, y, alpha, colour, group, linetype, size**

**h + geom\_hex()**  
**x, y, alpha, colour, fill, size**

#### continuous function

```
i <- ggplot(economics, aes(date, unemploy))
```

**i + geom\_area()**  
**x, y, alpha, color, fill, linetype, size**

**i + geom\_line()**  
**x, y, alpha, color, group, linetype, size**

**i + geom\_step(direction = "hv")**  
**x, y, alpha, color, group, linetype, size**

#### visualizing error

```
df <- data.frame(grp = c("A", "B"), fit = 4:5, se = 1:2)
```

```
j <- ggplot(df, aes(grp, fit, ymin = fit - se, ymax = fit + se))
```

**j + geom\_crossbar(fatten = 2)**  
**x, y, ymax, ymin, alpha, color, fill, group, linetype,**  
**size**

**j + geom\_errorbar()**, x, y, max, min, alpha, color,  
group, linetype, size, width (also  
**geom\_errorbarh()**)

**j + geom\_linerange()**  
**x, ymin, ymax, alpha, color, group, linetype, size**

**j + geom\_pointrange()**  
**x, y, ymin, ymax, alpha, color, fill, group, linetype,**  
**shape, size**

#### maps

```
data <- data.frame(murder = USAreests$Murder,
```

```
state = tolower(rownames(USAreests)))
```

```
map <- map_data("state")
```

```
k <- ggplot(data, aes(fill = murder))
```

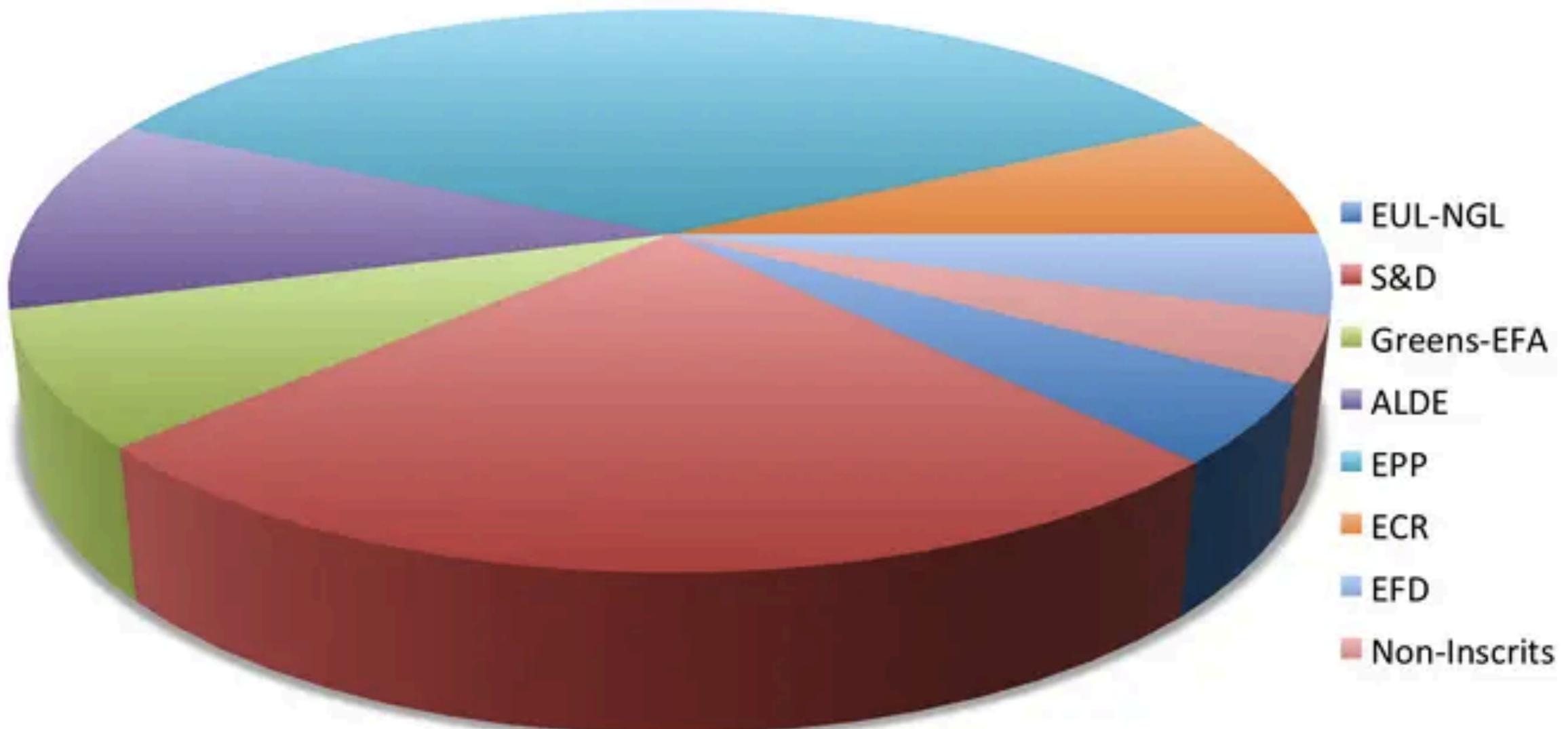
**k + geom\_map(aes(map\_id = state), map = map)**  
**+ expand\_limits(x = map\$long, y = map\$lat),**  
**map\_id, alpha, color, fill, linetype, size**

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*Roast! This! Viz!*

# What could be improved?

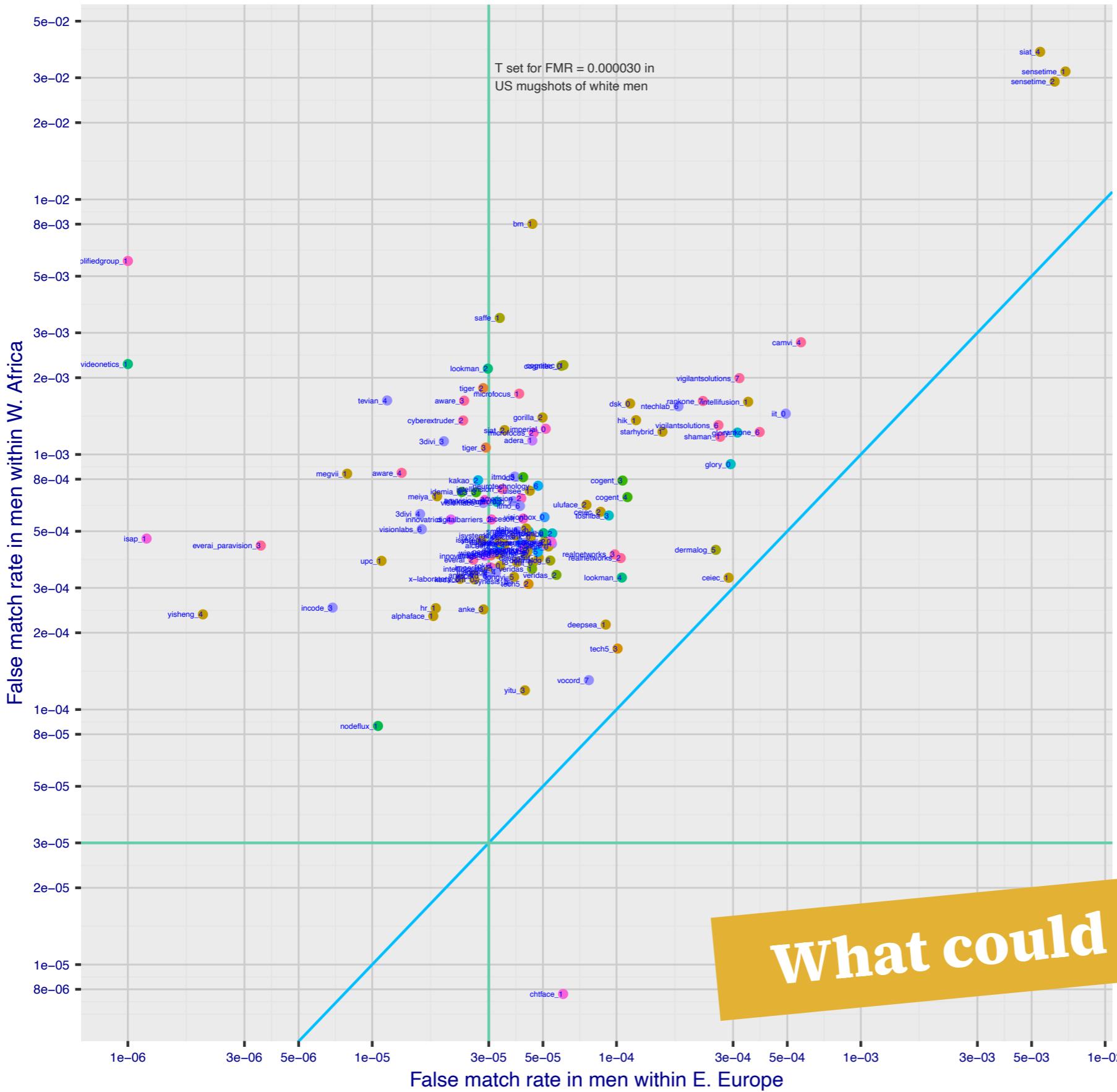
## European Parliament Party Breakdown



Source: Walter Hickey, Business Insider

*What could  
be improved?*





# What could be improved?

*Source: NIST.IR.8280*

*Adapted from  
Kira Tebbe*

# *10 Best Practices for Effective Data Visualization*

## **1. Know your audience!**

- For public vizzes, this usually requires bar, line, and scatter plots.
- Basically never use undefined acronyms or symbols.

## **2. Question the defaults.** This means fonts, colors, sizes, shapes, and more.

## **3. Use descriptive titles:** *tell* your viewer what they should see, and don't be redundant.

## **4. Be selective in data and design.** Consider your data-to-ink ratio and remove distractions.

## **5. Use color sparingly, intentionally, and consistently.**

- Keep branding in mind
- Remember colorblindness

## **6. Use reasonable axis tick formats and frequencies, not just the default.**

## **7. Consider creative alternatives to legends.**

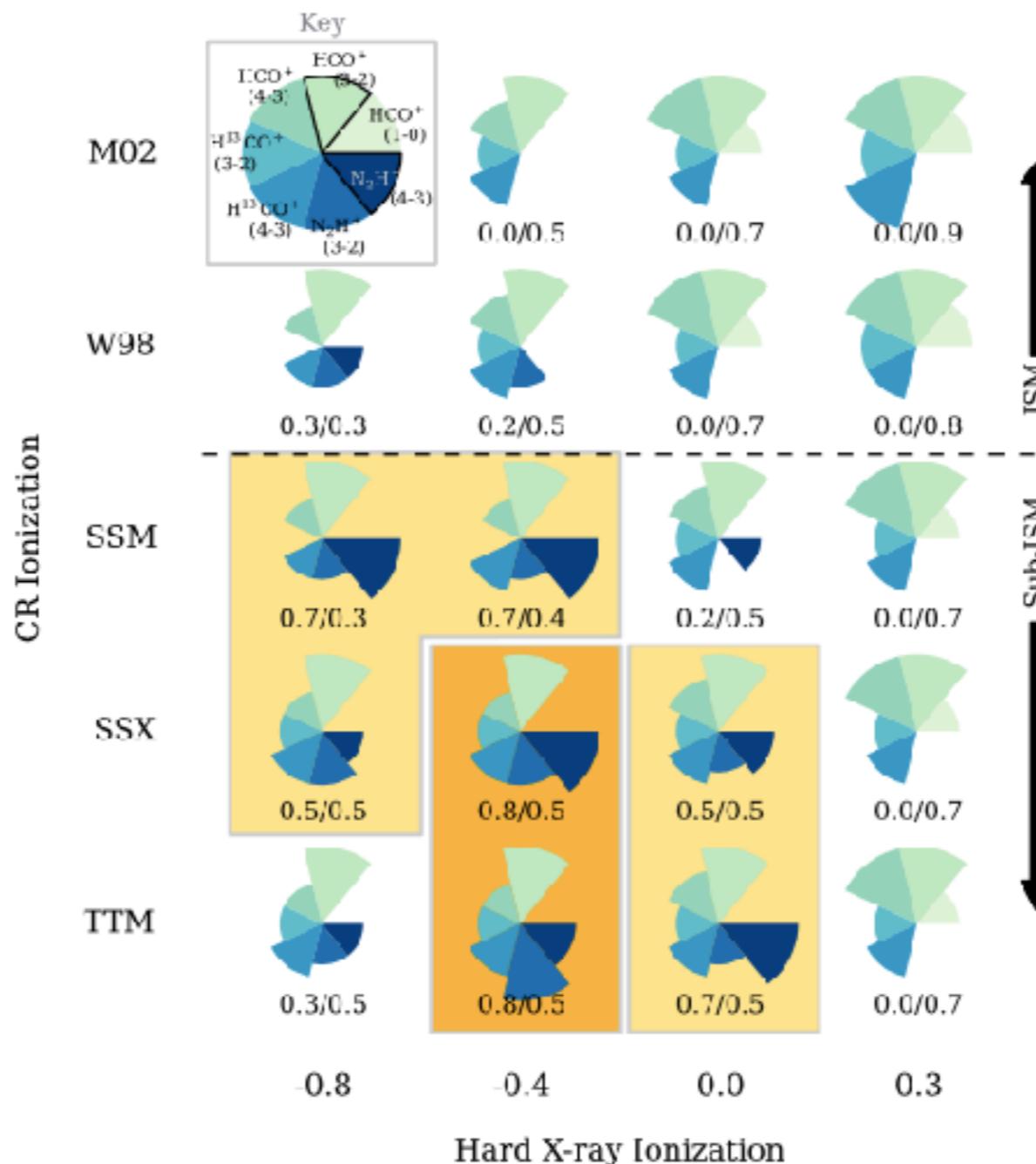
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## **10. Use the blink test.**

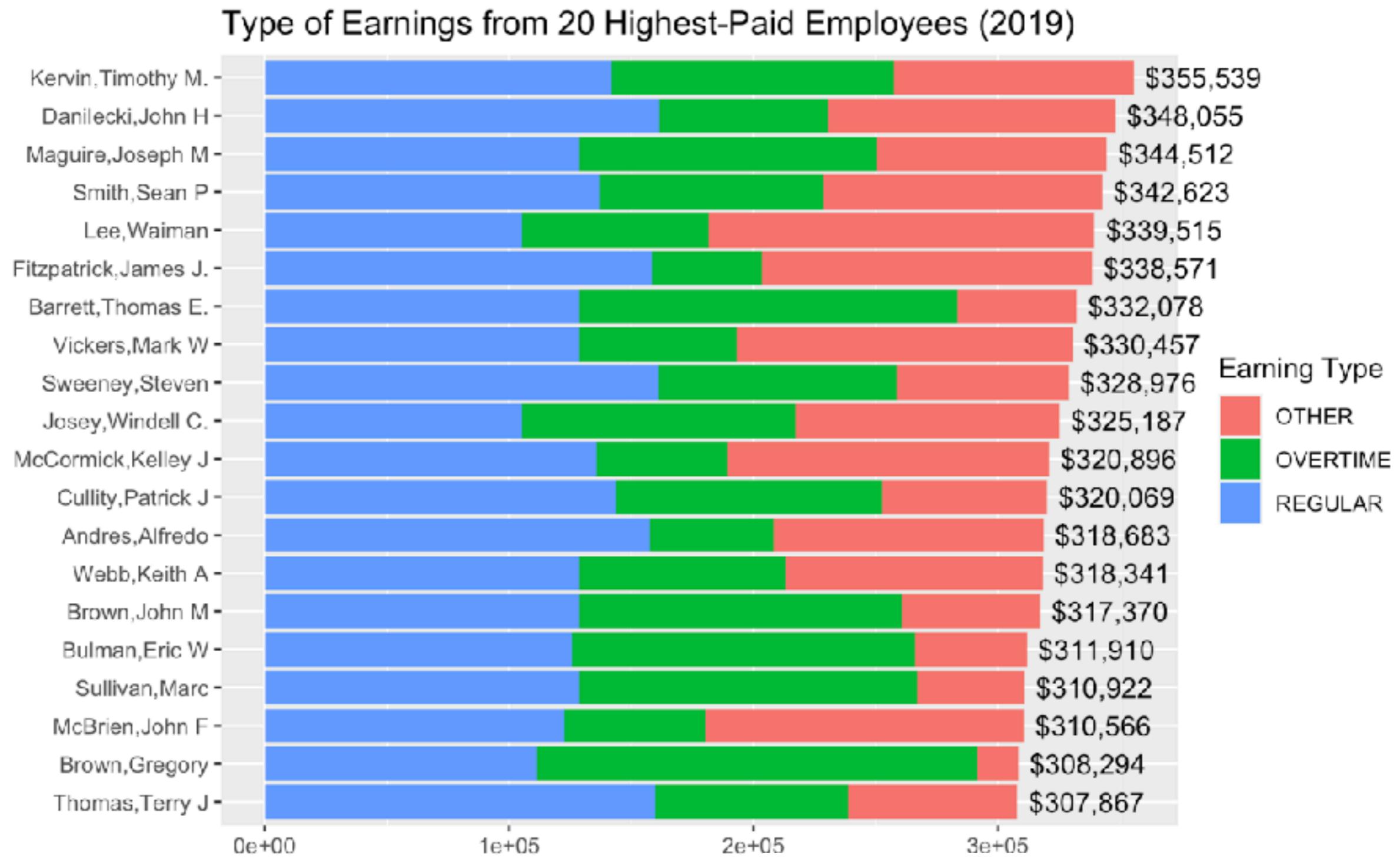
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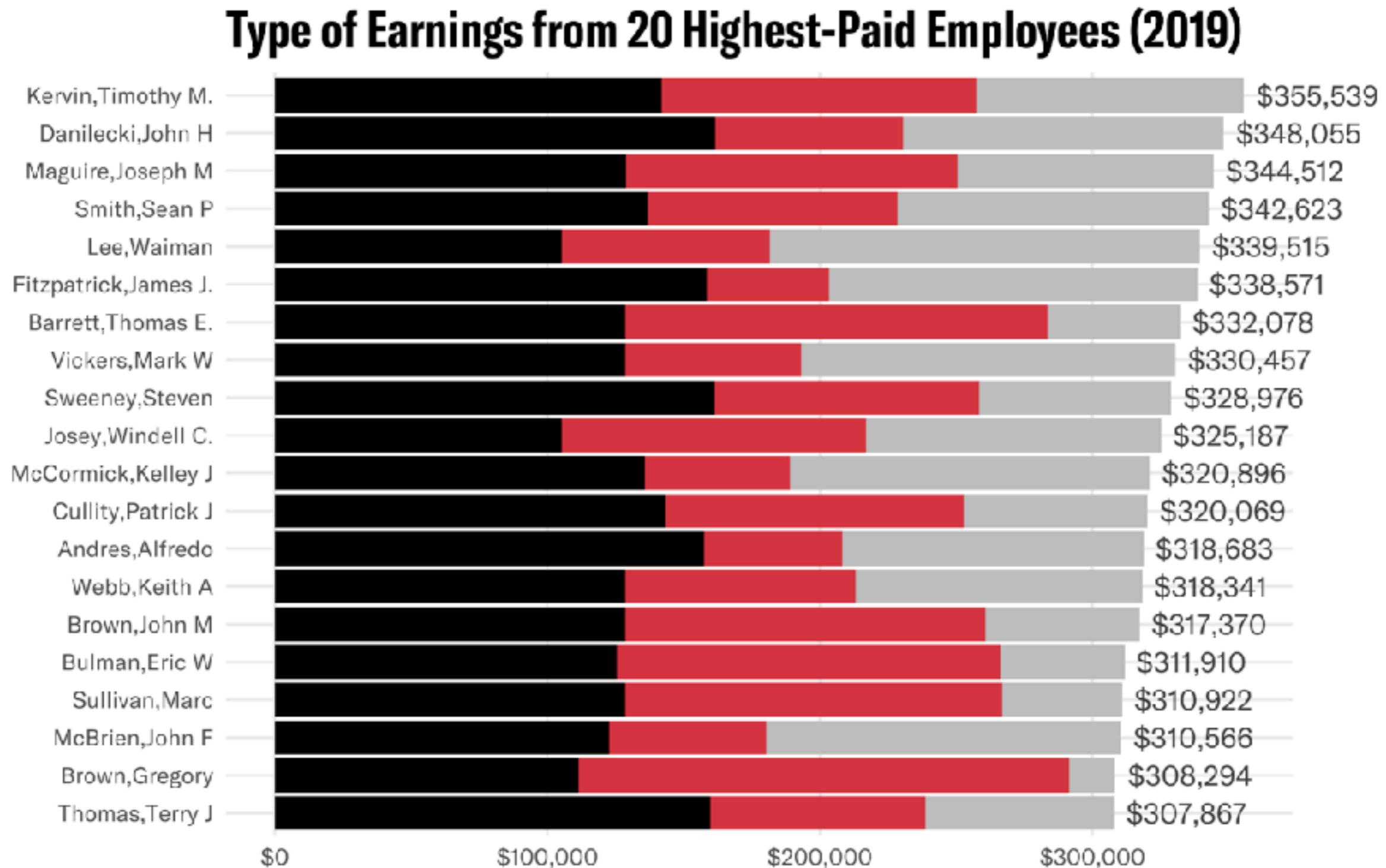


Source: "Constraining the X-ray and Cosmic Ray Ionization Chemistry of the TW Hya Protoplanetary Disk: Evidence for a Sub-interstellar Cosmic Ray Rate," Cleeves et al., 2015

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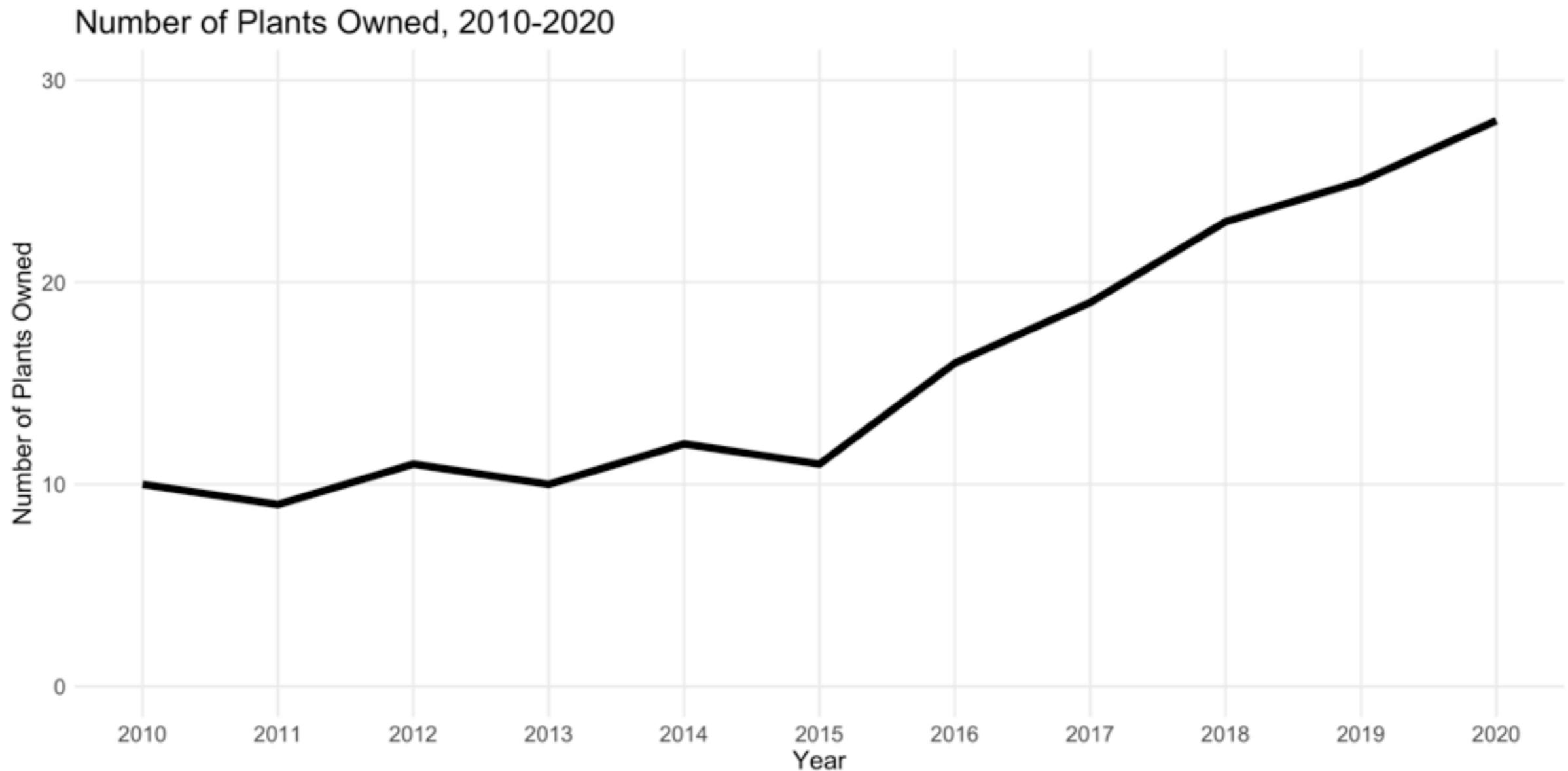


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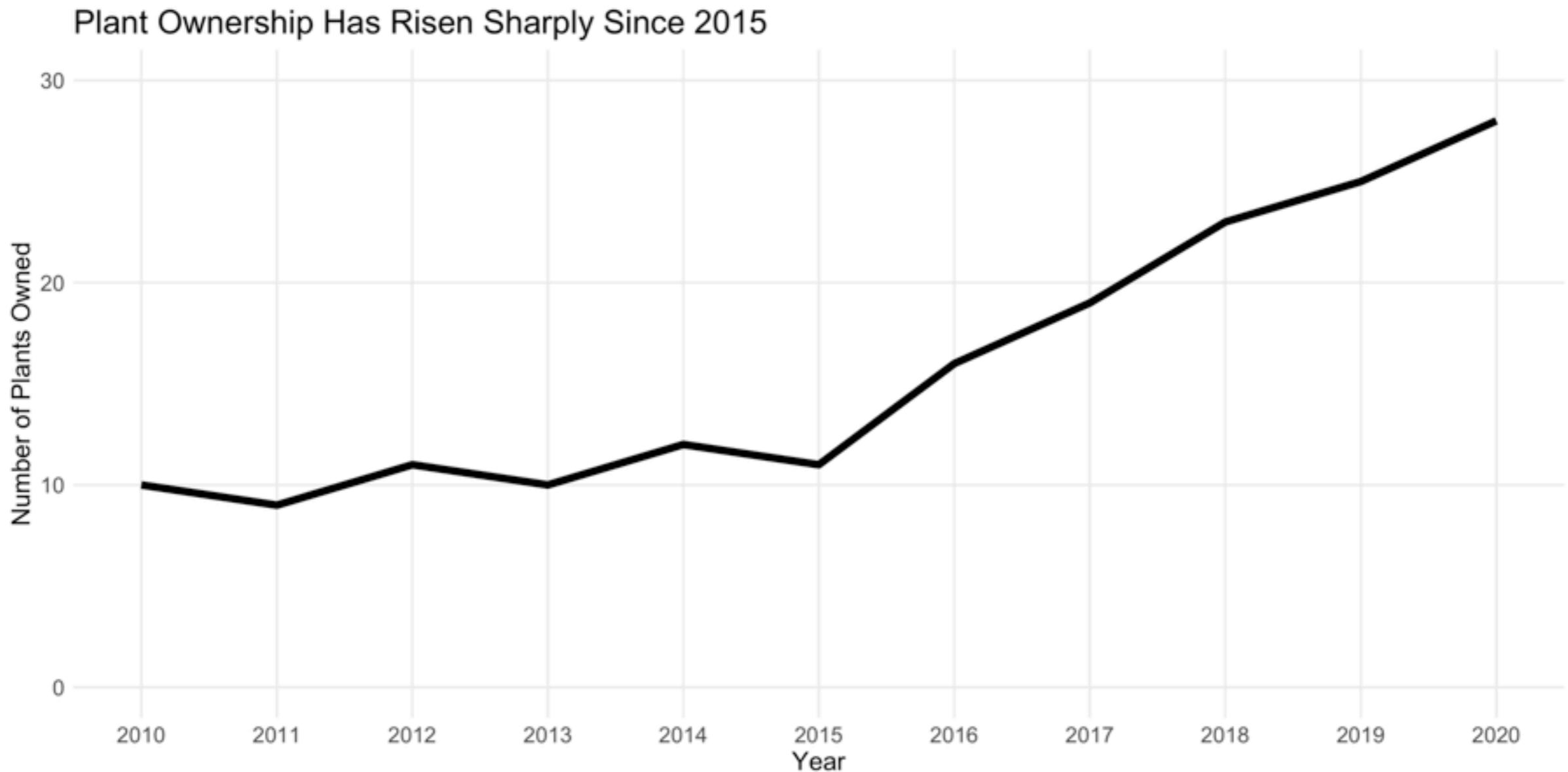


Source: "Unpacking the Boston Police Budget,"  
ACLU of Massachusetts Data for Justice Project

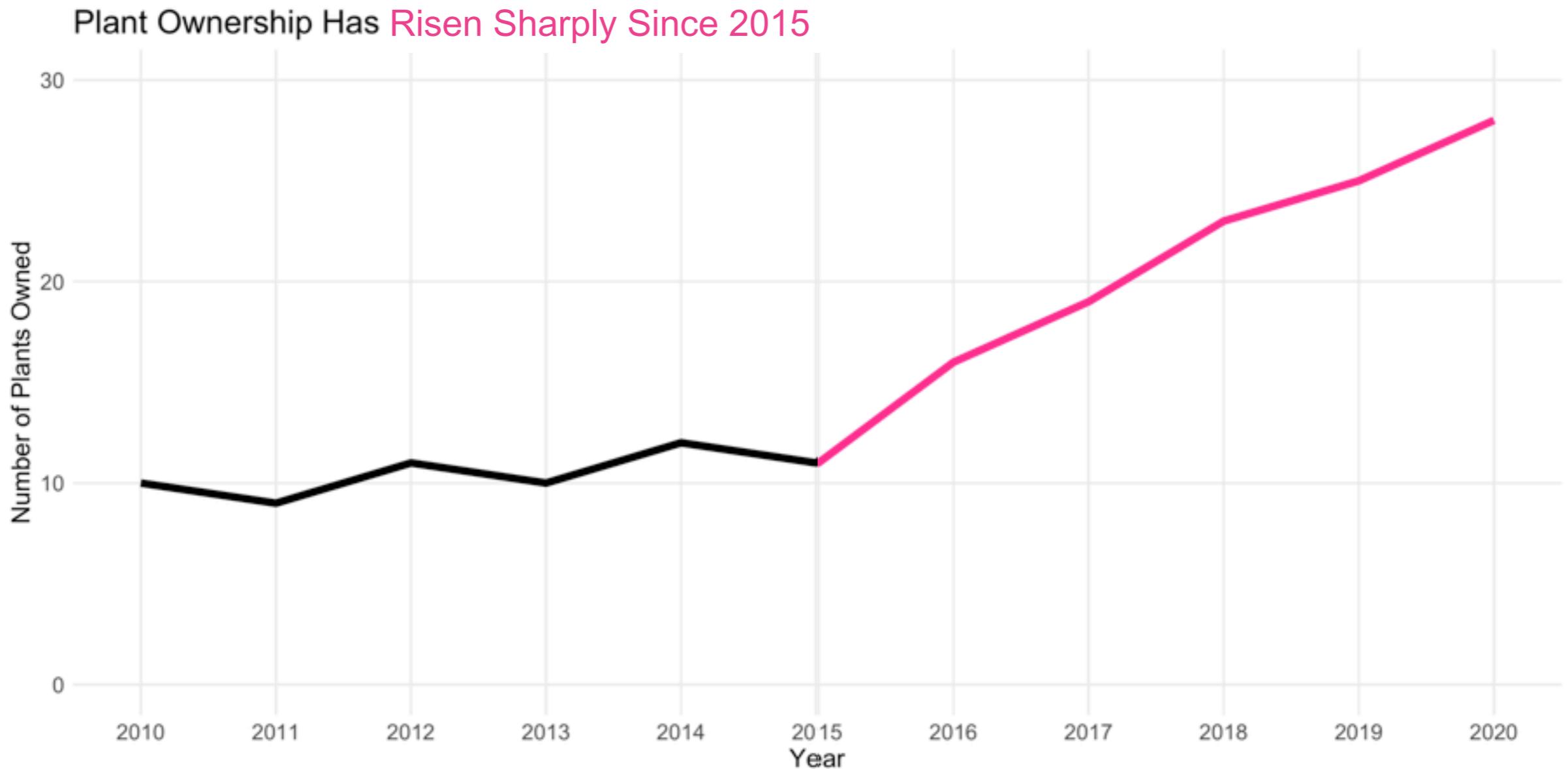
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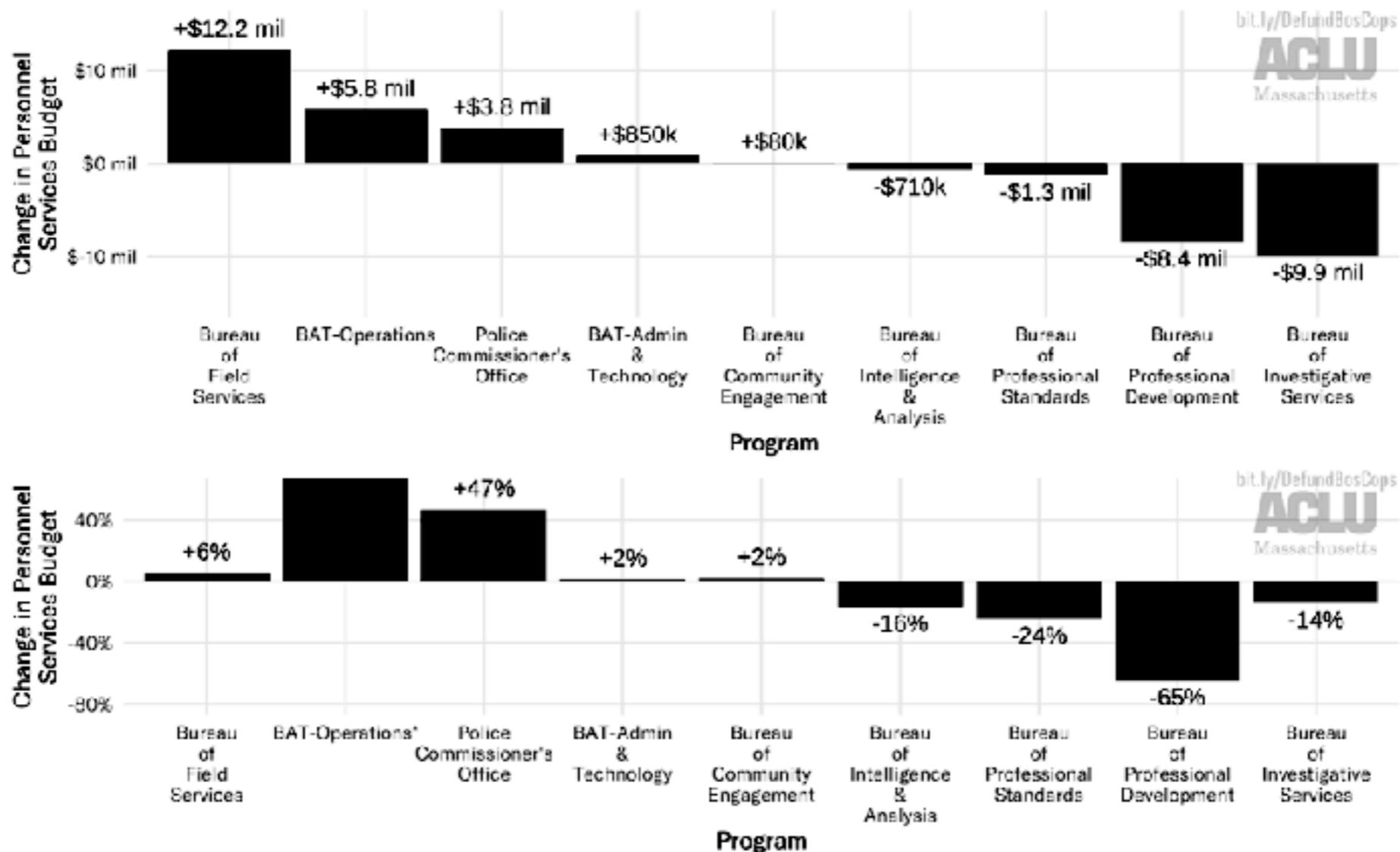


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Category	Department	FY 19		FY 20		FY 21		FY 22	
		Expenditure	Appropriation	Expenditure	Appropriation	Expenditure	Appropriation	Expenditure	Appropriation
Administration	Mayor's Office	4,118,112	4,359,117	5,338,114	5,439,036	5,193,315	5,439,036	5,193,315	5,439,036
	Cemetery Department	3,995,673	3,226,689	5,551,595	5,261,333	-162,095	-162,095	-162,095	-162,095
	Community Relations	11,974,320	12,917,112	13,950,001	13,719,587	13,719,587	13,719,587	13,719,587	13,719,587
	Human Rights Commission	6,501,54	6,179,422	1,371,006	8,333,078	186,345	8,333,078	186,345	8,333,078
	Law Dept. Legal	2,42,903	237,298	346,318	463,037	89,629	463,037	89,629	463,037
	Police Commission	2,42,903	237,298	346,318	463,037	89,629	463,037	89,629	463,037
	Total	16,621,548	16,389,995	21,819,073	21,669,386	307,399	21,669,386	307,399	21,669,386
Operations	Property Management Department	11,927,380	8,800,207	8,183,900	11,380,379	-1,200,730	11,380,379	-1,200,730	11,380,379
	Public Facilities Department	5,445,714	6,554,871	7,165,685	7,246,944	76,325	7,246,944	76,325	7,246,944
	Intergovernmental Services Department	16,565,925	19,530,455	18,349,255	20,590,329	2,050,044	20,590,329	2,050,044	20,590,329
	Total	41,941,449	45,549,591	41,695,744	45,825,638	359,399	45,825,638	359,399	45,825,638
Civic Engagement	Neighborhood Services	3,641,683	3,447,745	3,781,208	3,697,529	108,221	3,697,529	108,221	3,697,529
	Total	3,641,683	3,447,745	3,781,208	3,697,529	108,221	3,697,529	108,221	3,697,529
Arts & Culture	Office of Arts & Culture	1,347,305	1,007,575	2,093,666	2,275,752	224,986	2,275,752	224,986	2,275,752
	Library Department	30,758,400	30,663,059	-6,324,902	-6,625,039	-395,037	-6,625,039	-395,037	-6,625,039
	Total	32,105,705	30,663,059	21,381,748	43,894,683	1,822,983	43,894,683	1,822,983	43,894,683
Economic Development	Office of Economic Development	2,335,200	3,535,309	3,846,210	3,493,509	-42,610	3,493,509	-42,610	3,493,509
	Consumer Affairs & Licensing	110,765	1,322,348	1,362,023	1,367,936	103,982	1,367,936	103,982	1,367,936
	Office of Tourism	1,014,559	1,333,880	1,318,803	1,619,678	304,820	1,619,678	304,820	1,619,678
	Total	4,425,518	6,067,267	6,315,244	6,371,727	395,785	6,371,727	395,785	6,371,727
Environment	Boston Parks Services	1,691,760,530	1,784,974,078	1,779,564,375	1,758,631,065	10,843,360	1,758,631,065	10,843,360	1,758,631,065
	Total	1,691,760,530	1,784,974,078	1,779,564,375	1,758,631,065	10,843,360	1,758,631,065	10,843,360	1,758,631,065
Environment, Energy & Open Space	Environment Department	7,458,777	4,774,367	3,897,338	5,383,379	109,981	5,383,379	109,981	5,383,379
	Parks & Recreation Department	19,122,847	25,980,610	29,846,871	21,201,417	-1,021,330	21,201,417	-1,021,330	21,201,417
	Total	19,122,847	25,980,610	29,846,871	21,201,417	-1,021,330	21,201,417	-1,021,330	21,201,417
Administrative > Finance	Administration & Finance	1,781,938	79,731	2,121,751	2,046,773	-144,983	2,046,773	-144,983	2,046,773
	Planning Department	1,781,938	1,781,938	1,781,938	1,781,938	0	1,781,938	0	1,781,938
	Building Department	2,690,020	2,725,280	2,741,200	2,544,256	-2,096	2,544,256	-2,096	2,544,256
	Human Resources	2,848,653	2,762,639	3,347,743	5,615,337	87,461	5,615,337	87,461	5,615,337
	Transportation	19,353,269	19,233,999	3,000,000	3,049,206	0	3,049,206	0	3,049,206
	Health Insurance	20,360,339	21,029,339	22,341,219	20,593,323	-134,776	20,593,323	-134,776	20,593,323
	Facilities	1,258,300	4,654,546	5,880,713	5,916,308	32,603	5,916,308	32,603	5,916,308
	Procurement	9,353,432	10,473,257	12,000,000	12,649,309	0	12,649,309	0	12,649,309
	Regulatory Division	1,074,661	1,296,215	1,688,611	1,688,559	921	1,688,559	921	1,688,559
	Finance Department	9,780,938	10,901,845	11,108,361	11,730,976	-14,398,331	11,730,976	-14,398,331	11,730,976
	Unemployment Compensation	0	0	2,354,031	1,688,300	0	1,688,300	0	1,688,300
	Workers' Compensation (WRC)	1,280,068	1,885,546	2,000,000	2,080,309	0	2,080,309	0	2,080,309
	Total	21,581,642	20,653,023	23,440,629	24,394,306	-14,398,331	24,394,306	-14,398,331	24,394,306
Health & Human Services	Office of Health & Human Services	0	0	0	1,639,795	1,639,795	1,639,795	1,639,795	1,639,795
	Sealock Center for Youth & Families	29,128,168	27,404,086	28,469,798	28,469,979	-96,481	28,469,979	-96,481	28,469,979
	Disability Services W/ Disabilities	82,239	400,491	481,540	50,616	23,376	50,616	23,376	50,616
	Aids Program	3,546,500	3,522,652	3,765,665	4,159,059	216,612	4,159,059	216,612	4,159,059
	Housing & Equity	1,769,644	2,019,734	3,616,546	31,914	31,914	31,914	31,914	31,914
	Office of Management & Advancement	1,134,449	13,584	621,767	873,589	247,792	873,589	247,792	873,589
	Public Health Commission	76,582,139	87,662,432	83,446,238	82,735,529	948,301	82,735,529	948,301	82,735,529
	Healthcare Commission	3,271,407	2,917,675	4,795,679	4,422,875	-87,536	4,422,875	-87,536	4,422,875
	Healthcare Sector	6,236,200	6,081,034	6,590,580	7,110,021	927,418	7,110,021	927,418	7,110,021
	Health Engagement & Employment	0	0	1,264,181	1,264,181	0	1,264,181	0	1,264,181
	Total	87,244,750	93,736,610	93,334,314	102,160,987	1,814,246	102,160,987	1,814,246	102,160,987
Belonging & Neighborhood Development	Neighborhood Services	13,495,648	14,203,732	29,571,514	27,064,316	-6,526,754	27,064,316	-6,526,754	27,064,316
	Total	13,495,648	14,203,732	29,571,514	27,064,316	-6,526,754	27,064,316	-6,526,754	27,064,316
Information & Technology	Department of Information & Technology	39,806,508	39,059,080	54,346,347	35,351,549	901,342	35,351,549	901,342	35,351,549
	Total	39,806,508	39,059,080	54,346,347	35,351,549	901,342	35,351,549	901,342	35,351,549
Public Safety	Emergency Management	558,751	498,252	815,453	985,446	935,227	985,446	935,227	985,446
	Fire Department	270,020,428	270,020,428	277,020,081	277,020,081	0	277,020,081	0	277,020,081
	Nature Department	209,912,408	419,397,538	211,398,728	214,397,376	-174,400	214,397,376	-174,400	214,397,376
	Total	323,374,237	617,254,966	535,398,756	503,223,958	-1,043,380	503,223,958	-1,043,380	503,223,958
Health	Central Health Management	2,370,344	2,918,112	4,114,494	3,841,716	-64,369	3,841,716	-64,369	3,841,716
	Office of Justice	1,796,367	1,783,409	2,217,307	3,122,928	-94,235	3,122,928	-94,235	3,122,928
	Police, Fire & Emergency	82,963,183	88,343,039	96,027,303	130,793,338	44,730	130,793,338	44,730	130,793,338
	Health Record	29,148,750	22,762,634	28,798,344	25,647,530	279,460	25,647,530	279,460	25,647,530
	Transportation Department	35,520,540	28,806,728	38,276,358	39,029,768	423,366	39,029,768	423,366	39,029,768
	Total	103,860,213	101,268,285	98,428,486	127,645,489	941,346	127,645,489	941,346	127,645,489
State-National Departments	City Clerk	1							

## 5. Use color sparingly, intentionally, and consistently.

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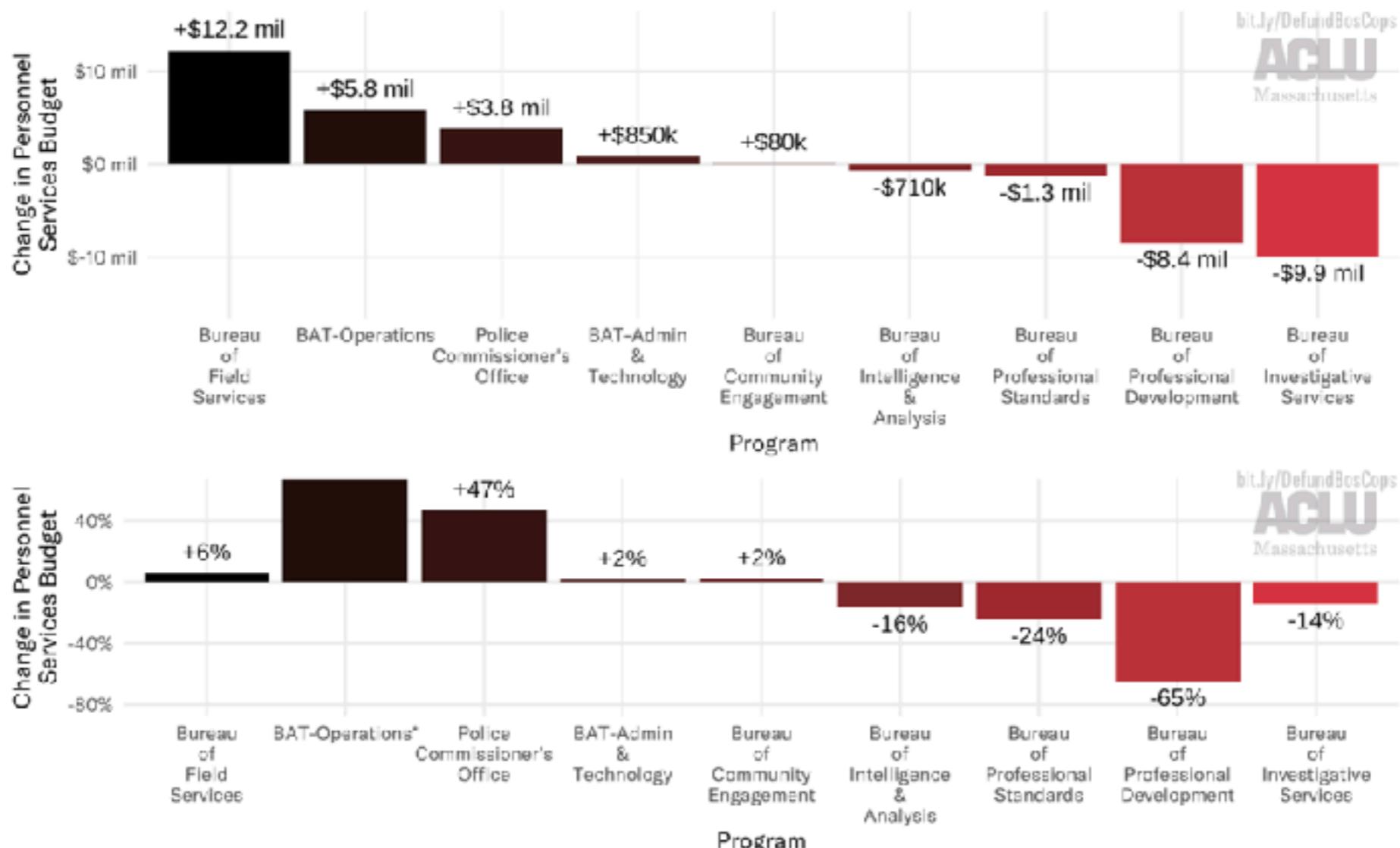


\*The disproportionate % increase in the BAT-Operations budget seems to be due to a lapse in funding in FY20 and subsequent reinstatement in FY21.

Source: "Unpacking the Boston Police Budget,"  
ACLU of Massachusetts Data for Justice Project

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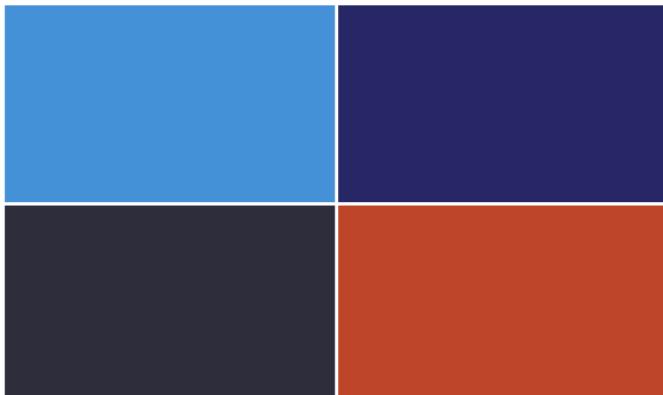
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SCIENCE INSTITUTE

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Overpass



**ACLU**  
Massachusetts

**GT America**  
Century Schoolbook

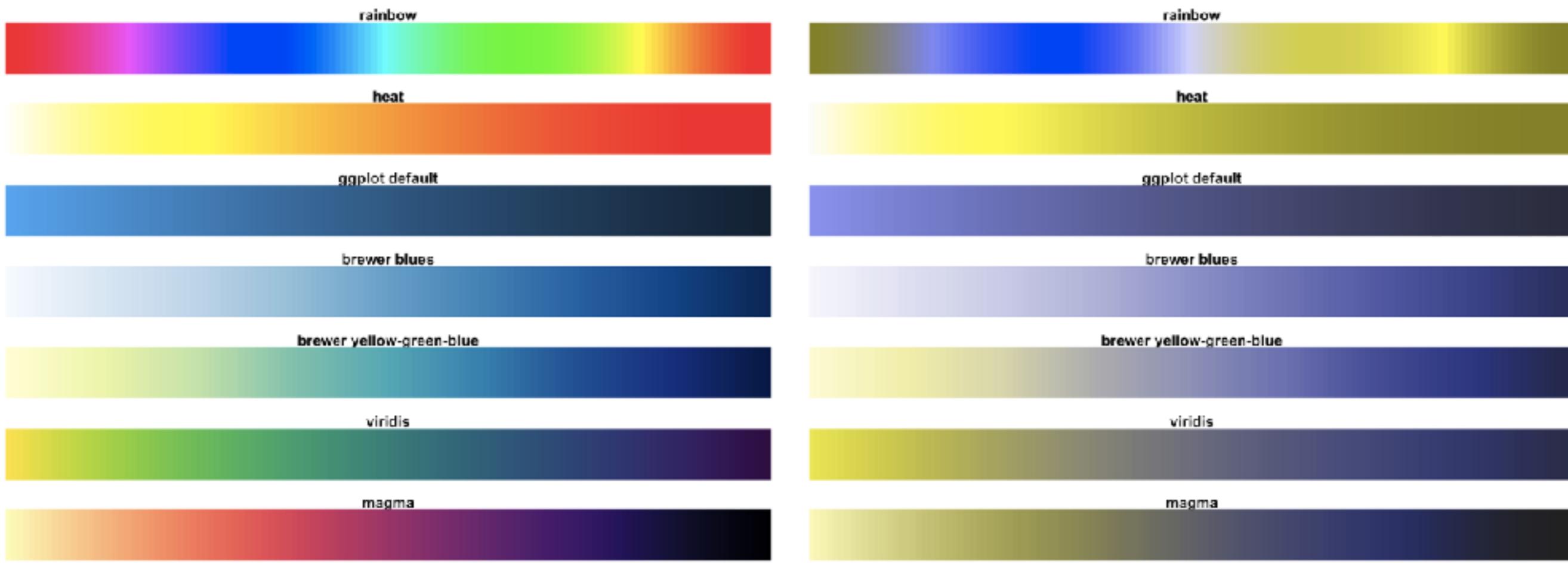


**Source Serif**  
Inter



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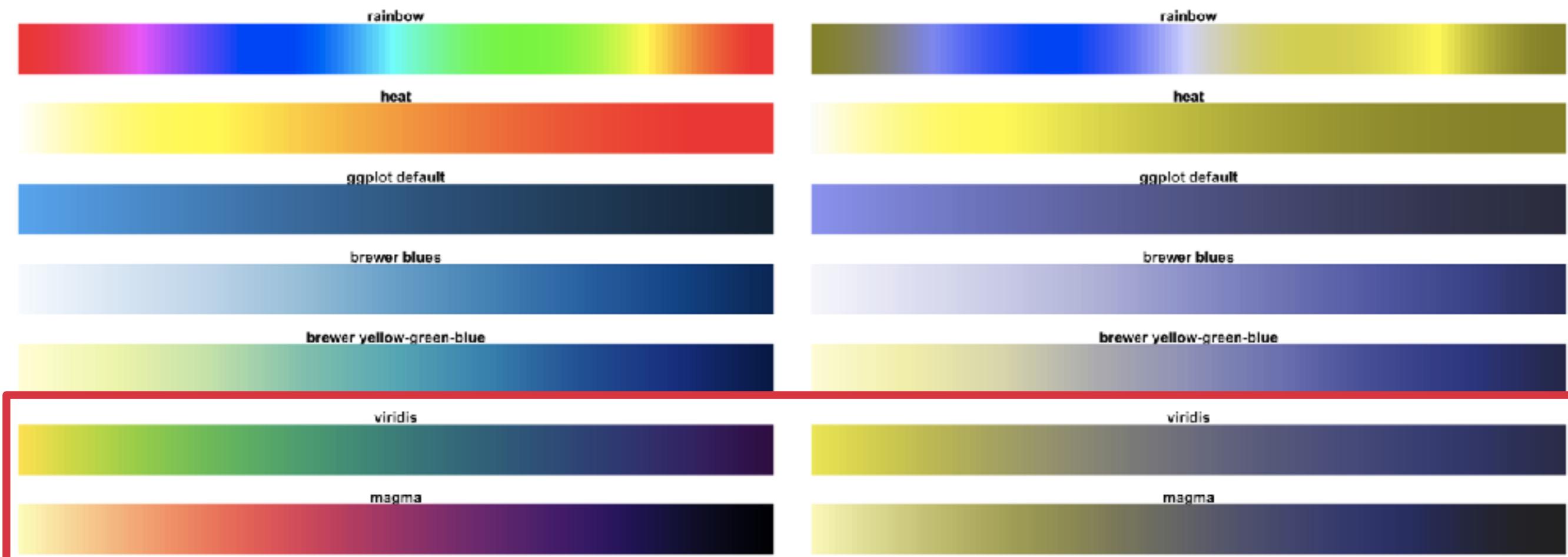


*Deuteranopia*

Source: "Introduction to the viridis color maps," Bob Rudis, Noam Ross and Simon Garnier, CRAN

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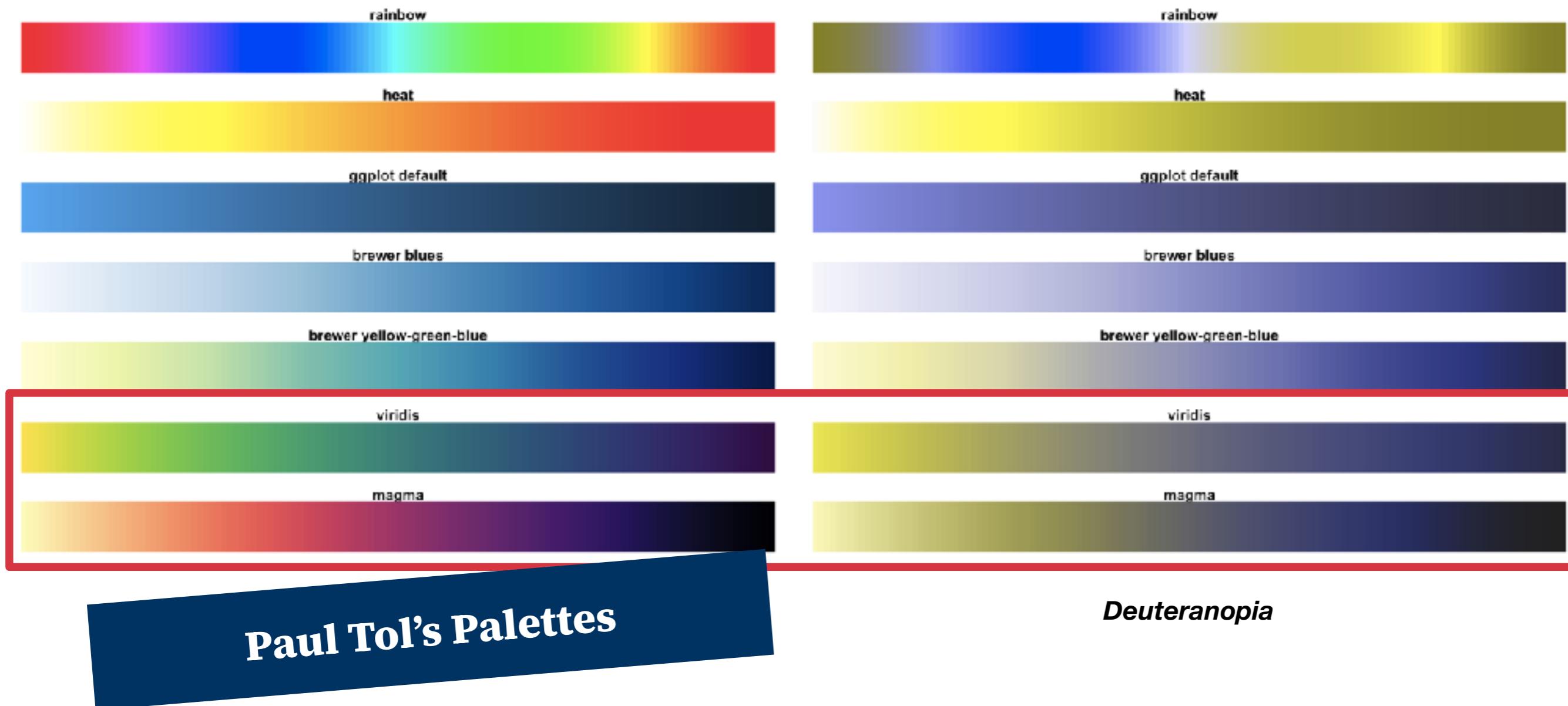
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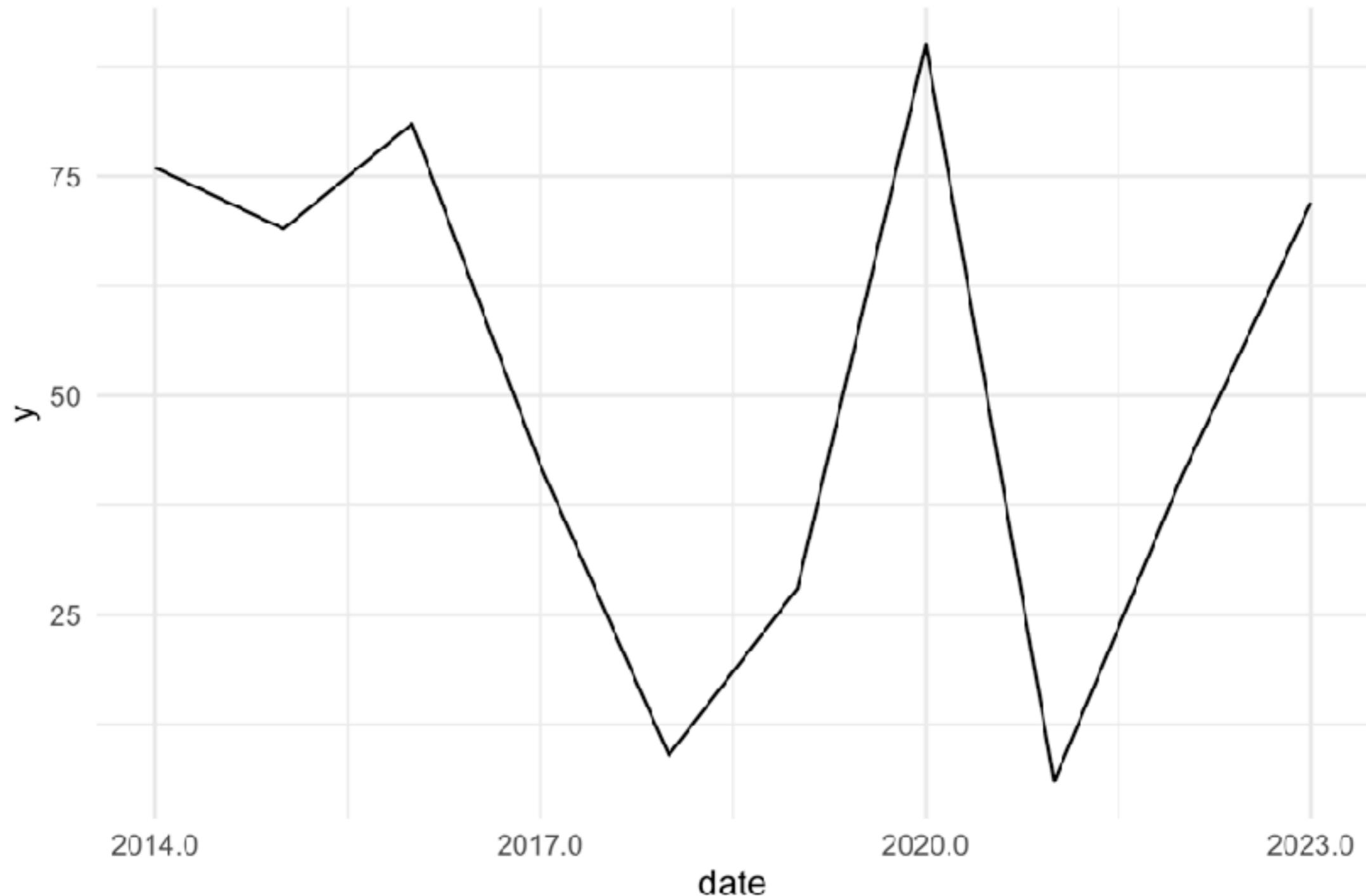
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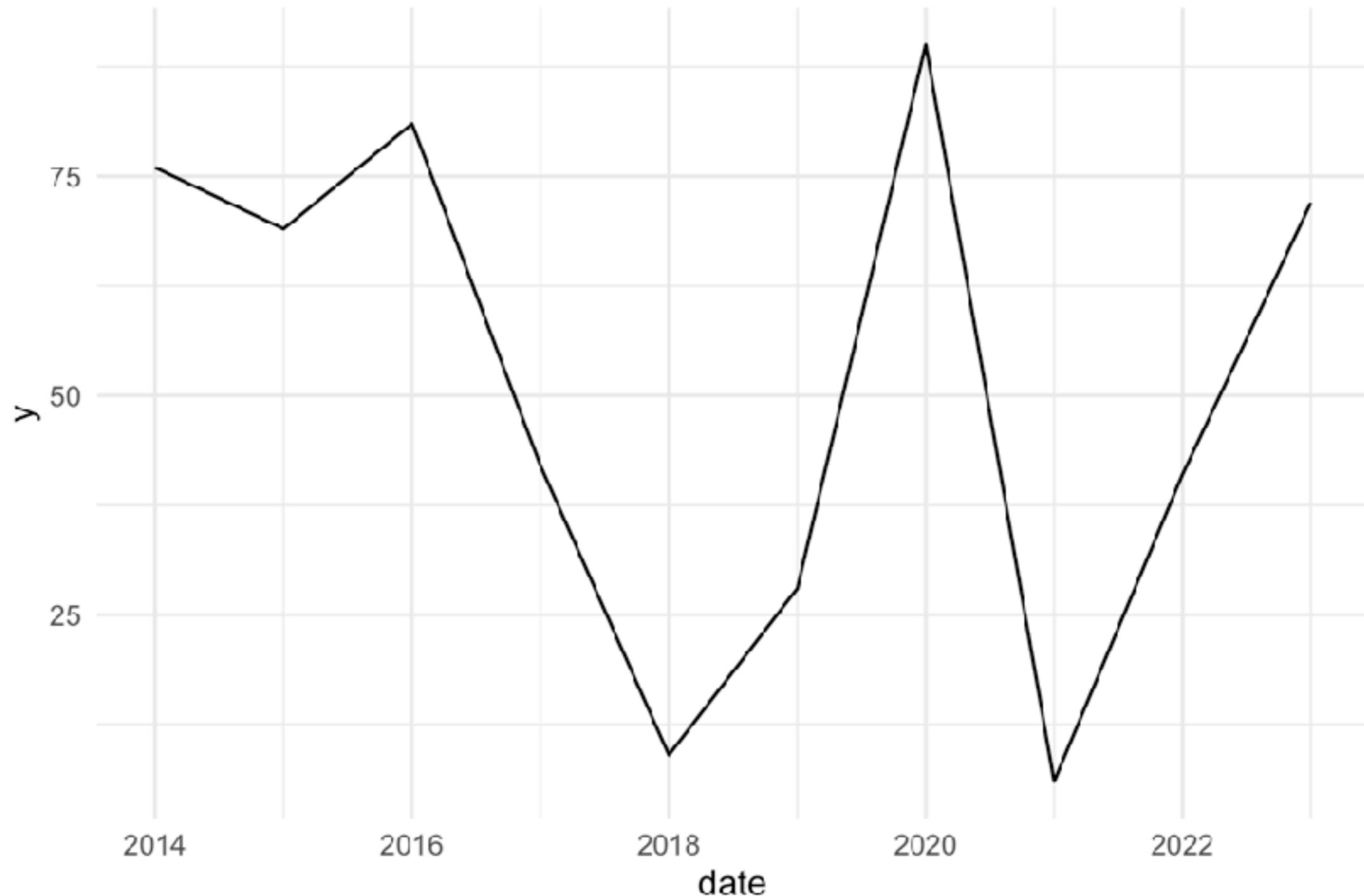


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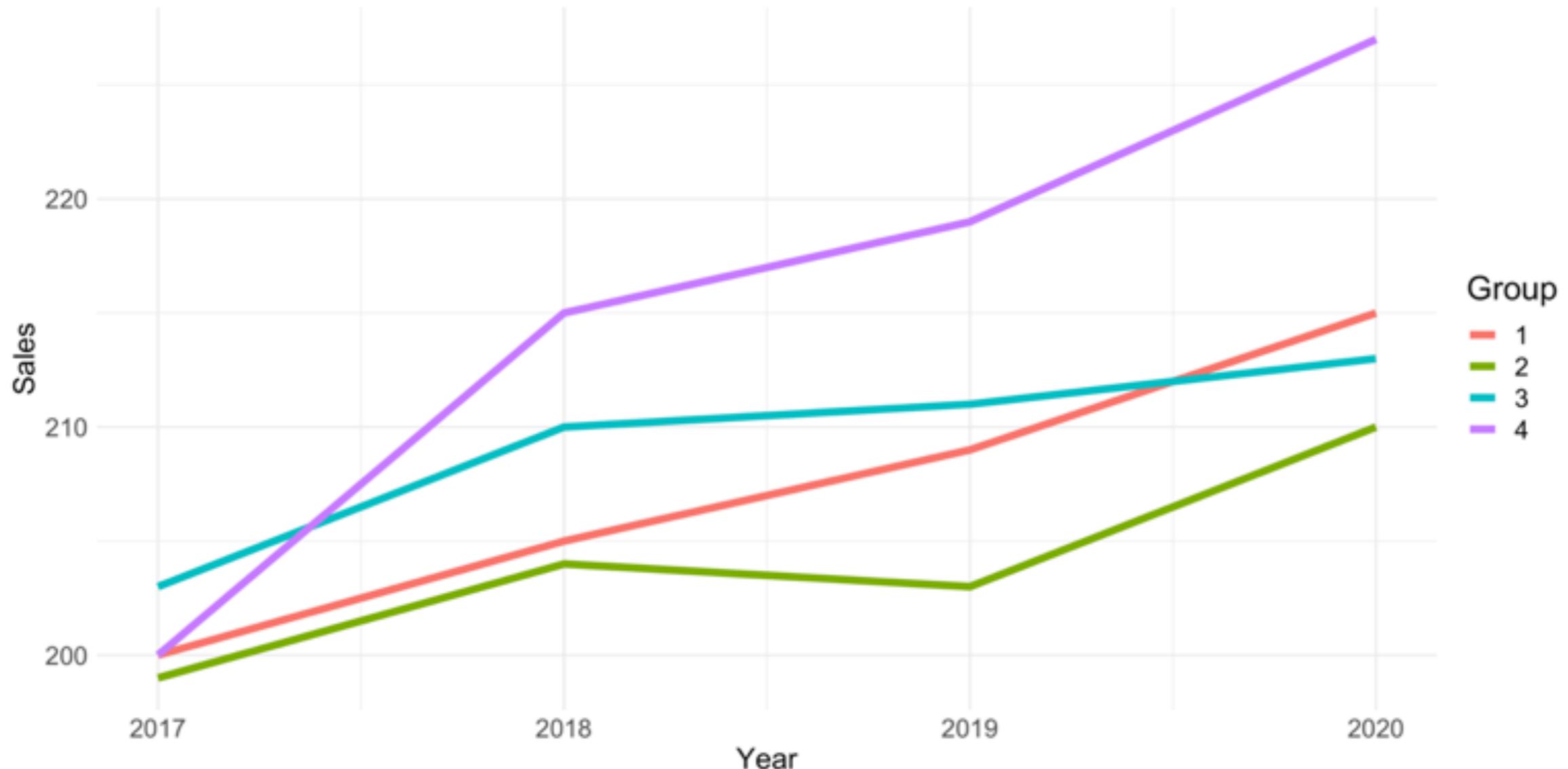
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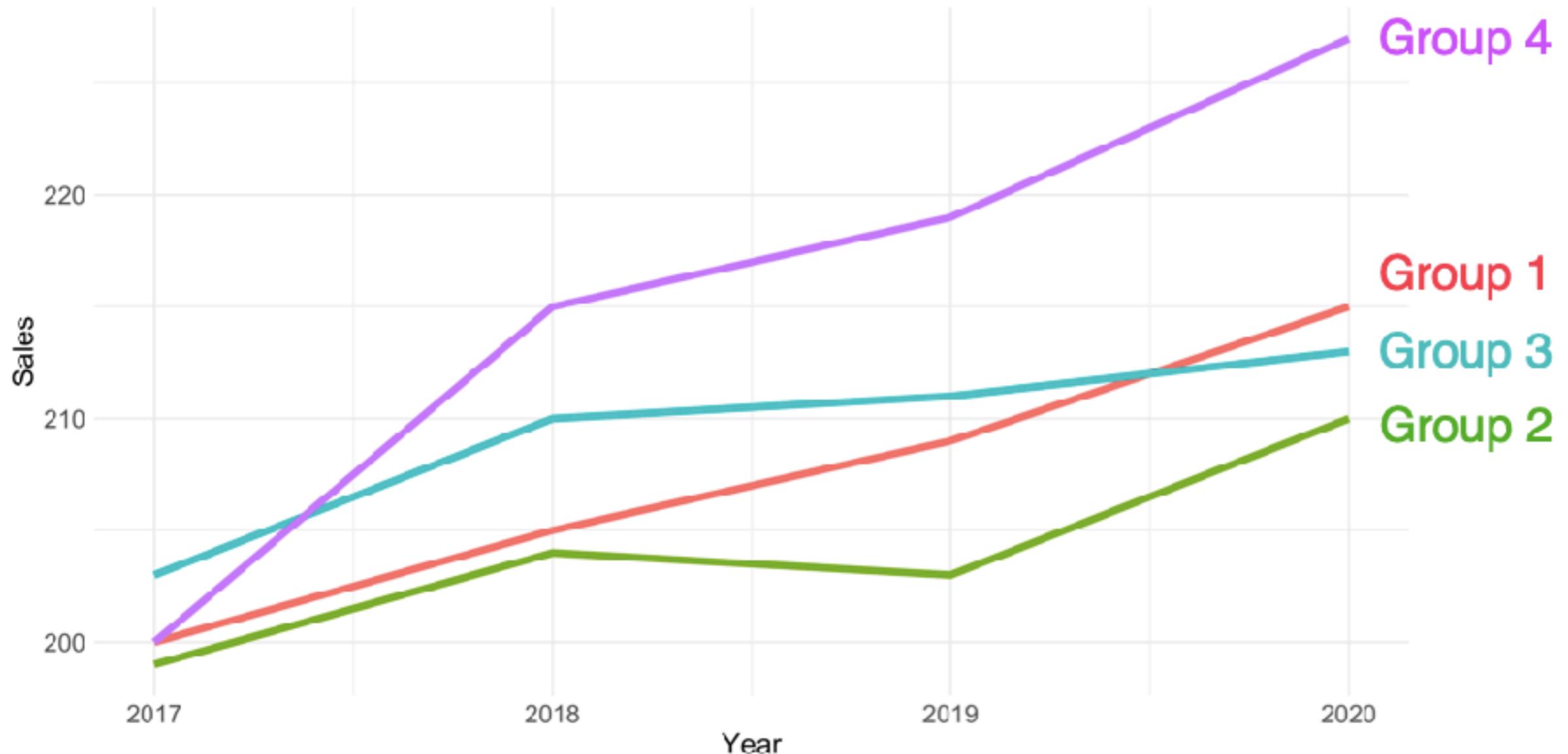
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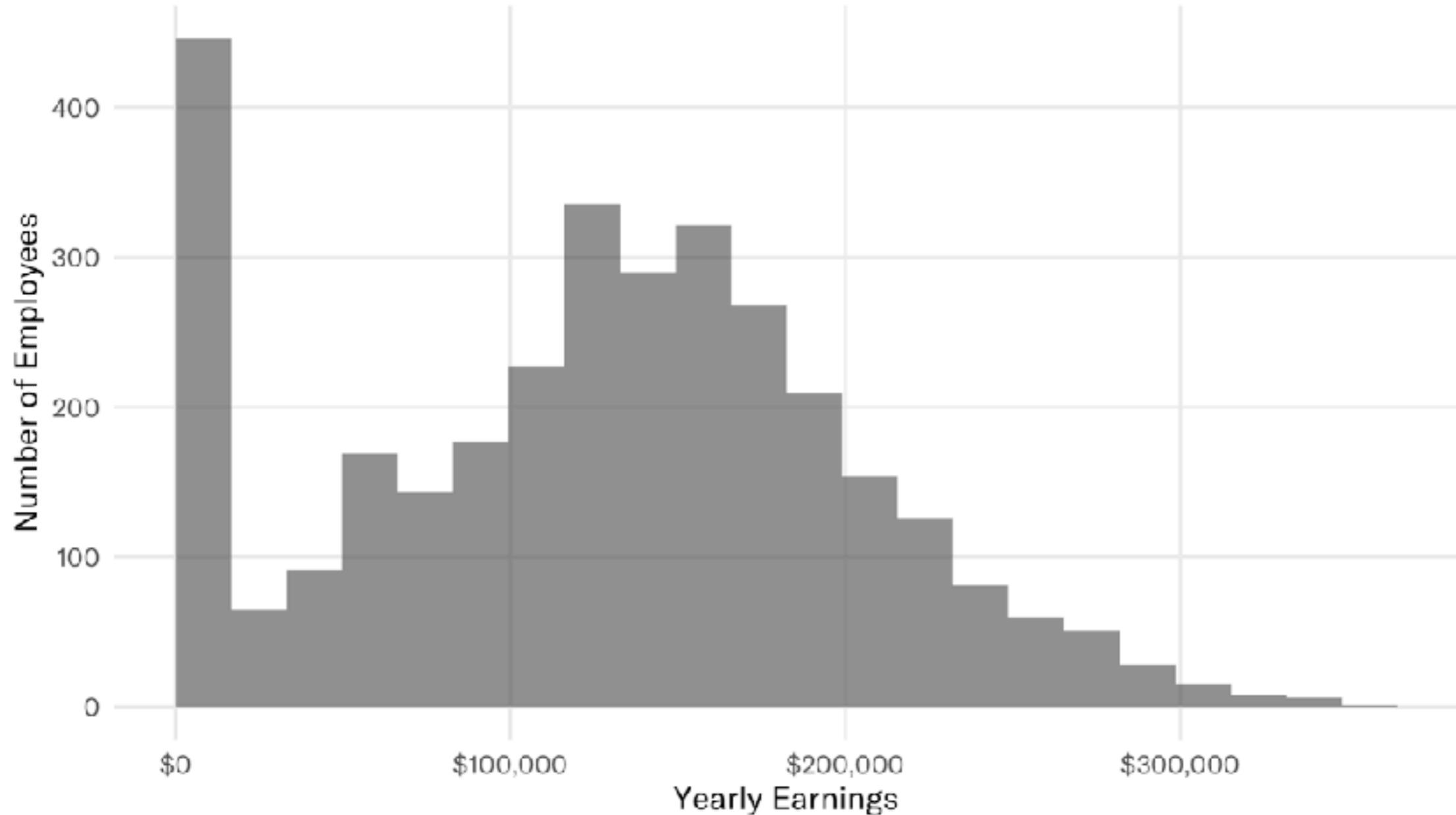
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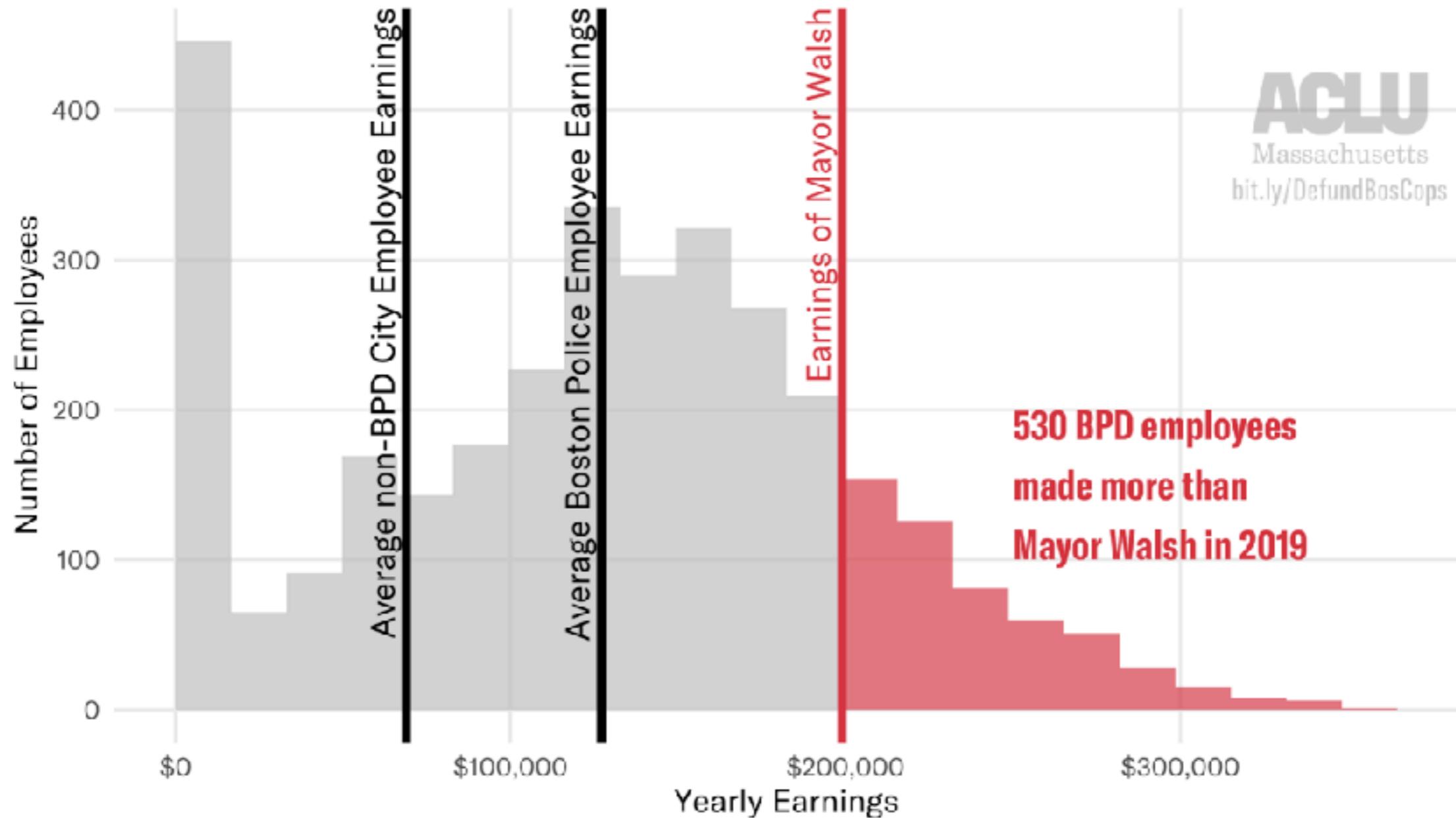


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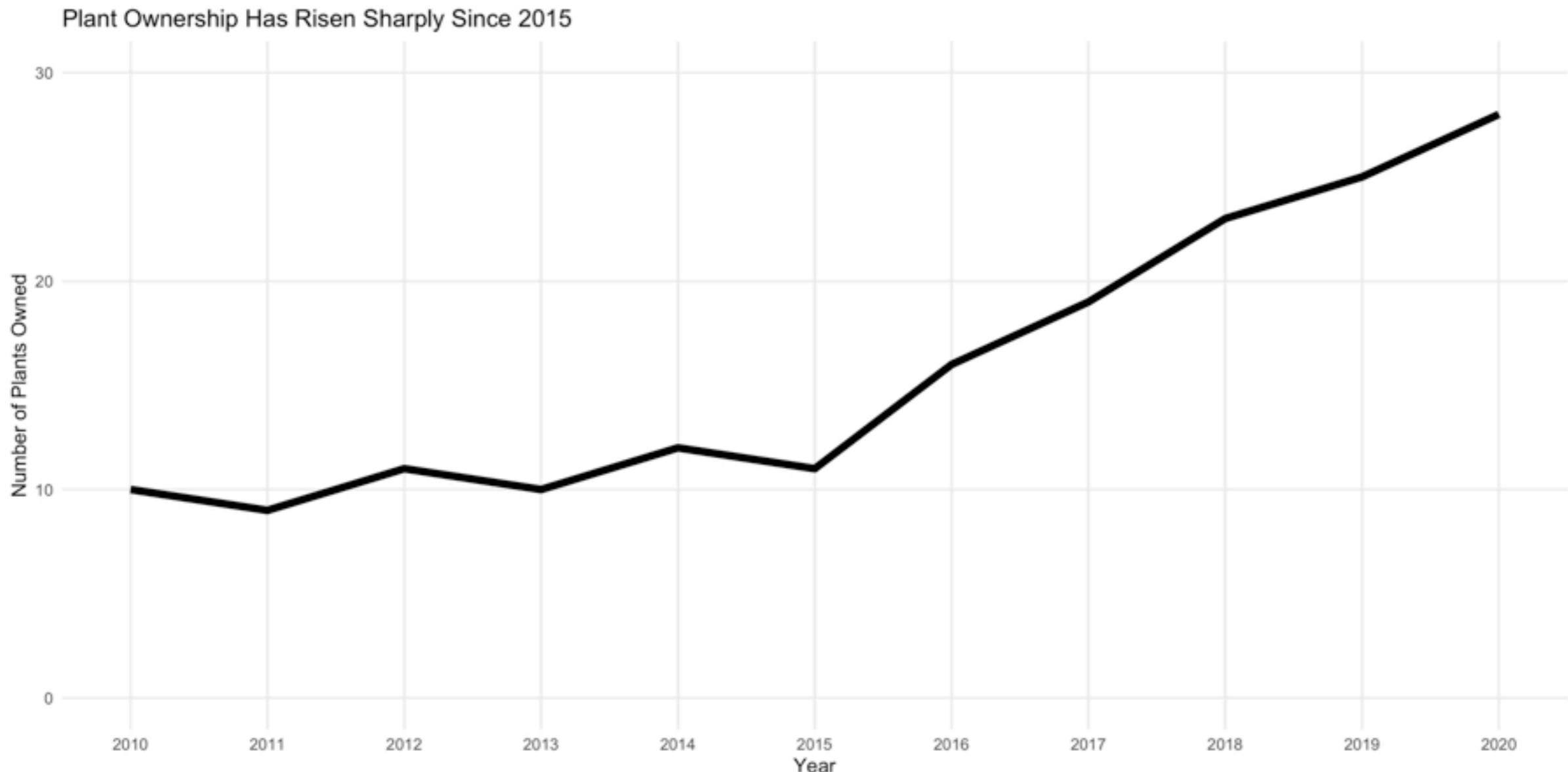
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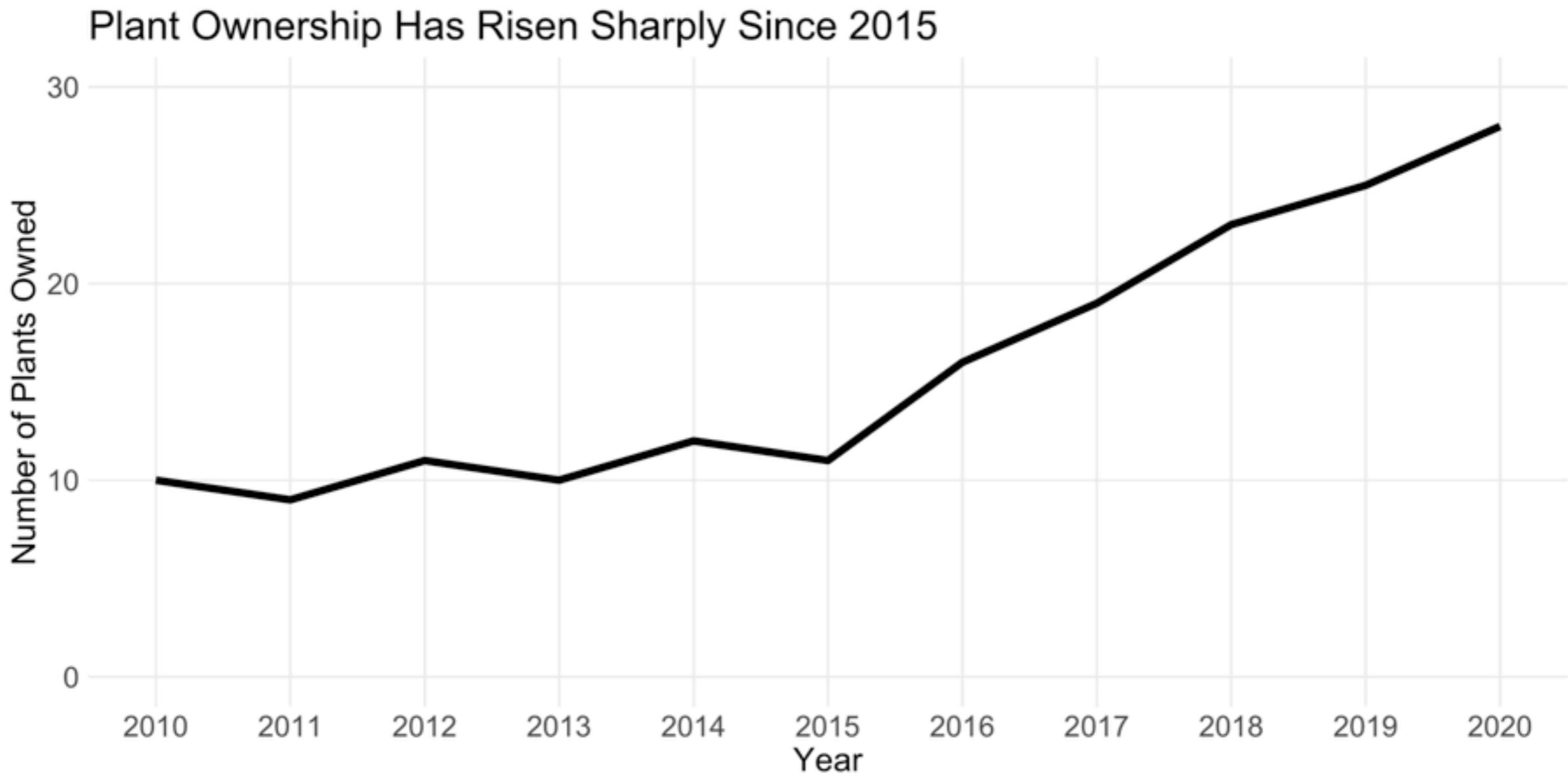


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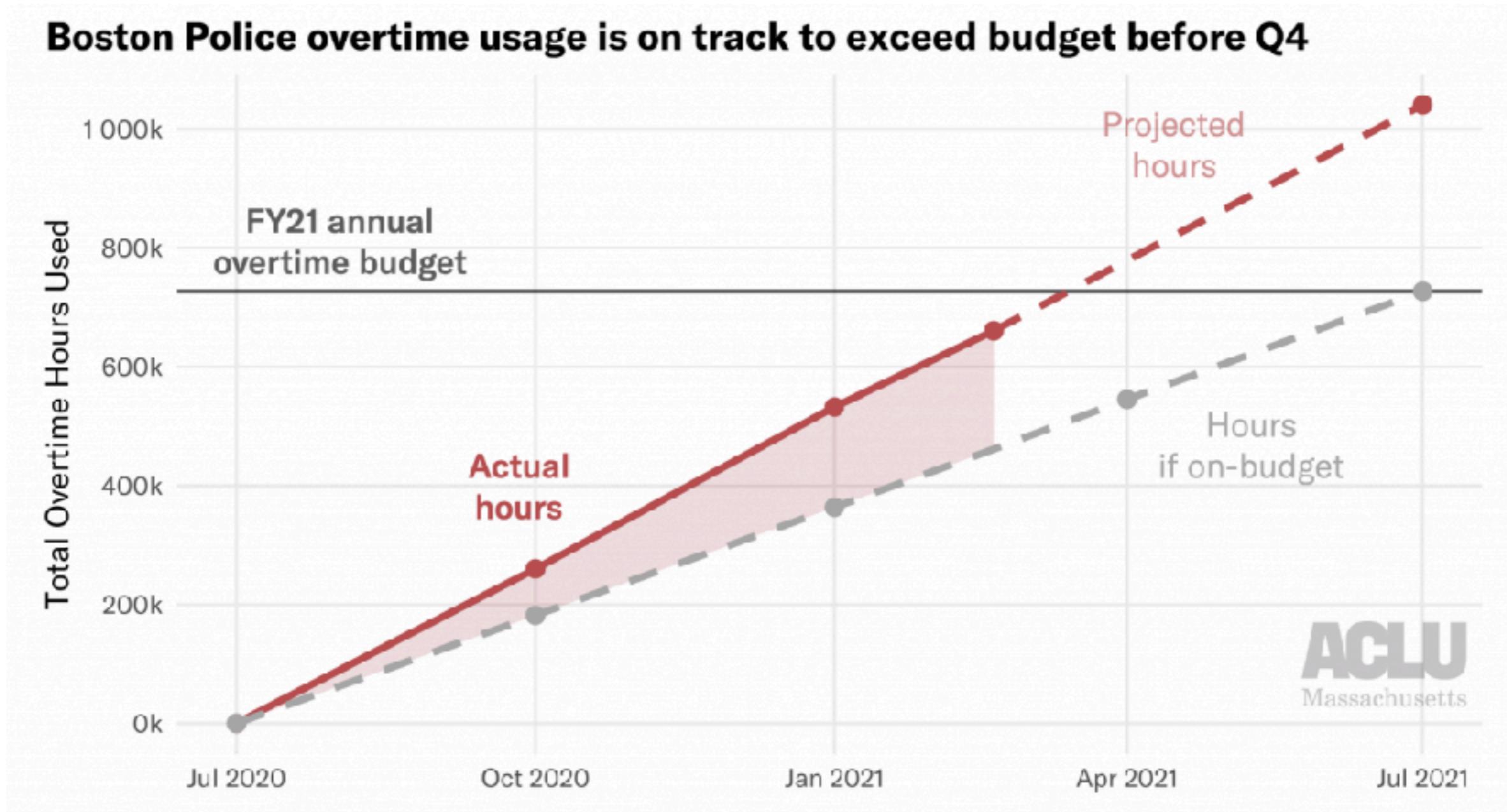
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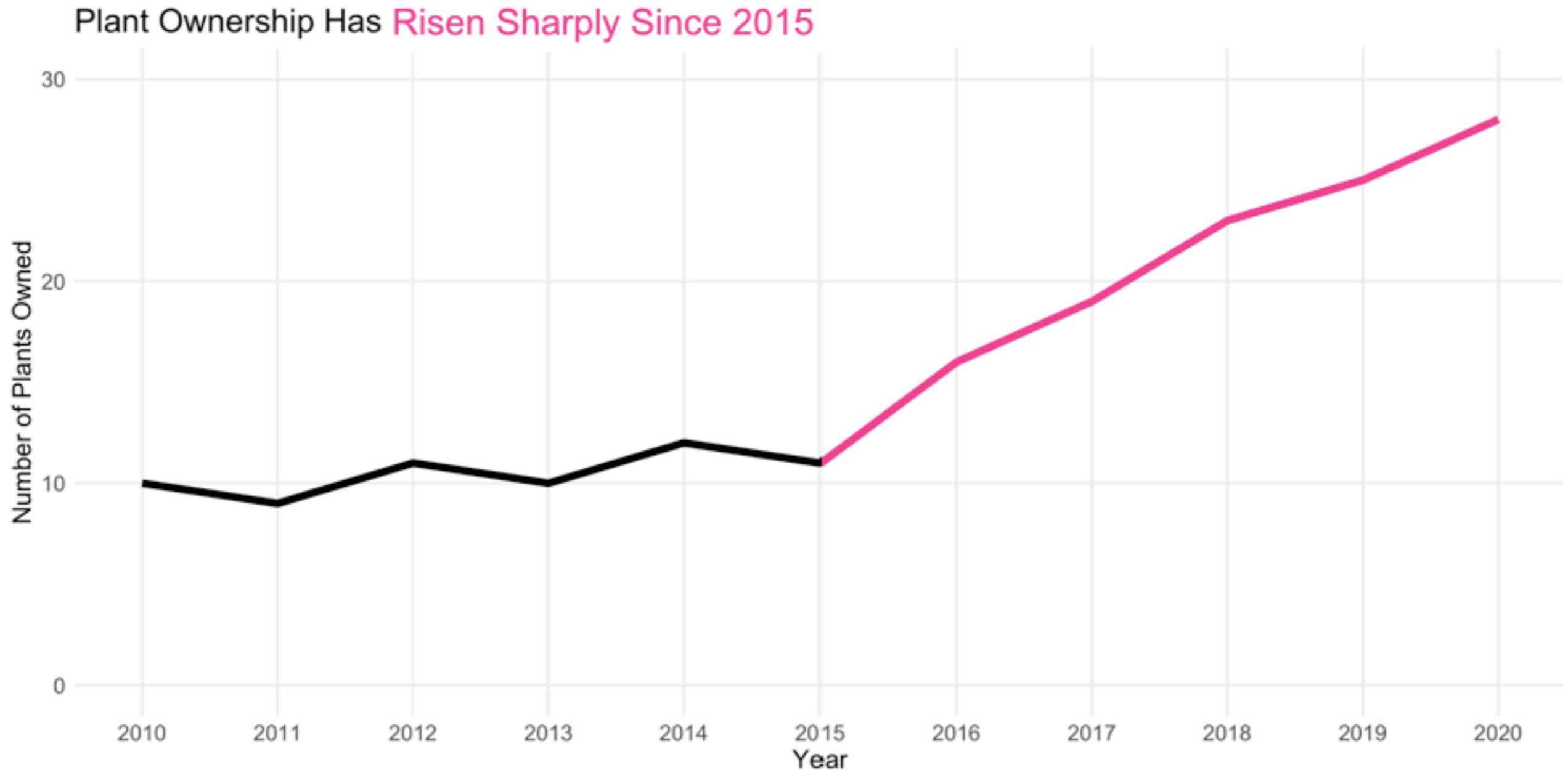


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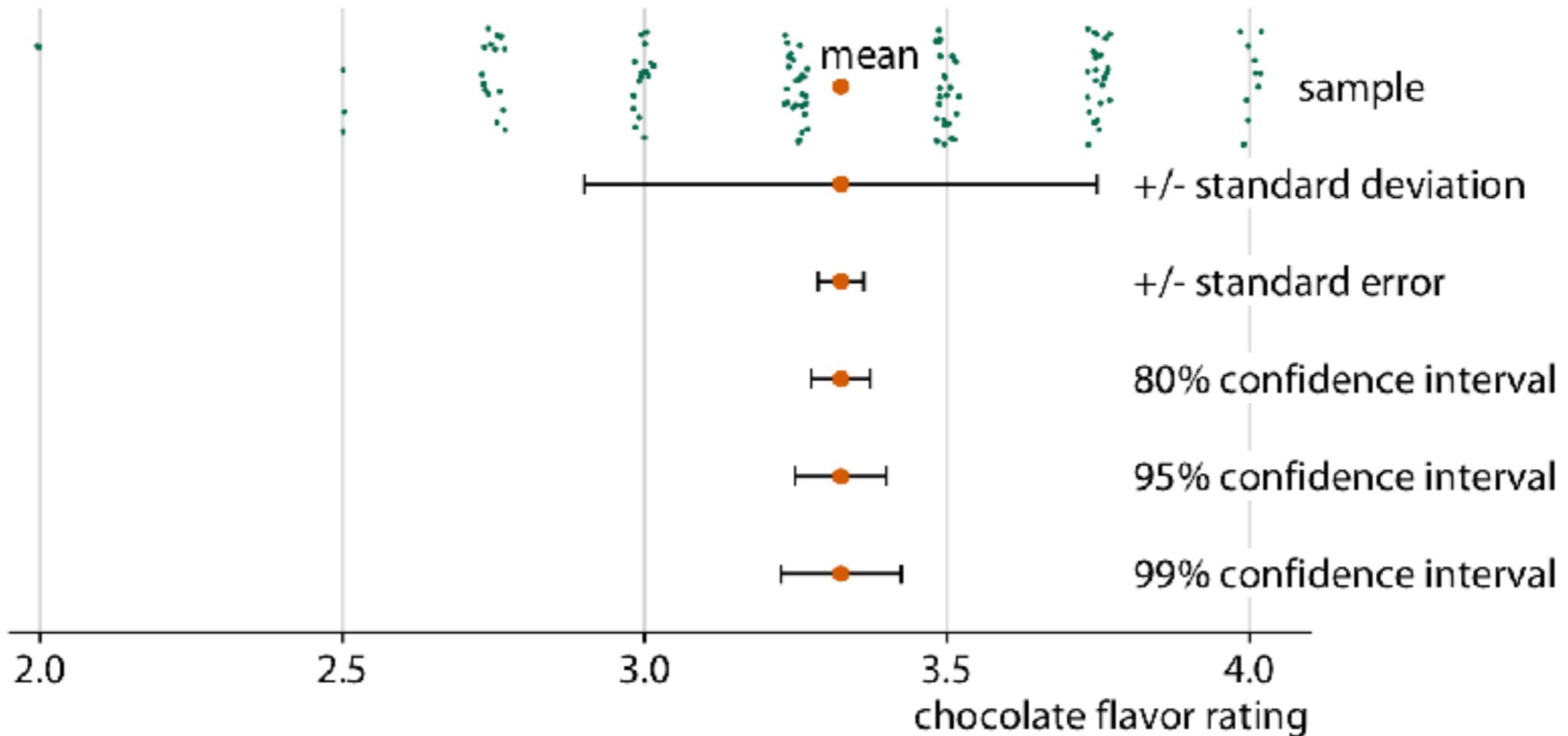
Source: "A Mayor's Roadmap to Curb Boston Police Overtime,"  
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## 10. Use the blink test.



# Bonus: Visualizing error

- ▶ Understand the difference between standard deviation, standard error, and confidence intervals. Use the appropriate error! (And know when there is no need to visualize error.)



Source: "Visualizing Uncertainty," Claus Wilde

# Bonus: Visualizing error

- ▶ Understand the difference between standard deviation, standard error, and confidence intervals. Use the appropriate error! (And know when there is no need to visualize error.)
- ▶ There are more ways of representing error than just bars. Consider alternative ways of visualizing error like violin plots, box plots, confidence bands...
- ▶ Make sure error bars / bands are clearly visible (color, line width, line pattern, caps)
- ▶ Always make the meaning of an error bar/band (1 SD, 95% CI, ....) explicit in a caption or annotation
- ▶ For more, check out Claus Wilke's guide:  
<https://clauswilke.com/dataviz/visualizing-uncertainty>

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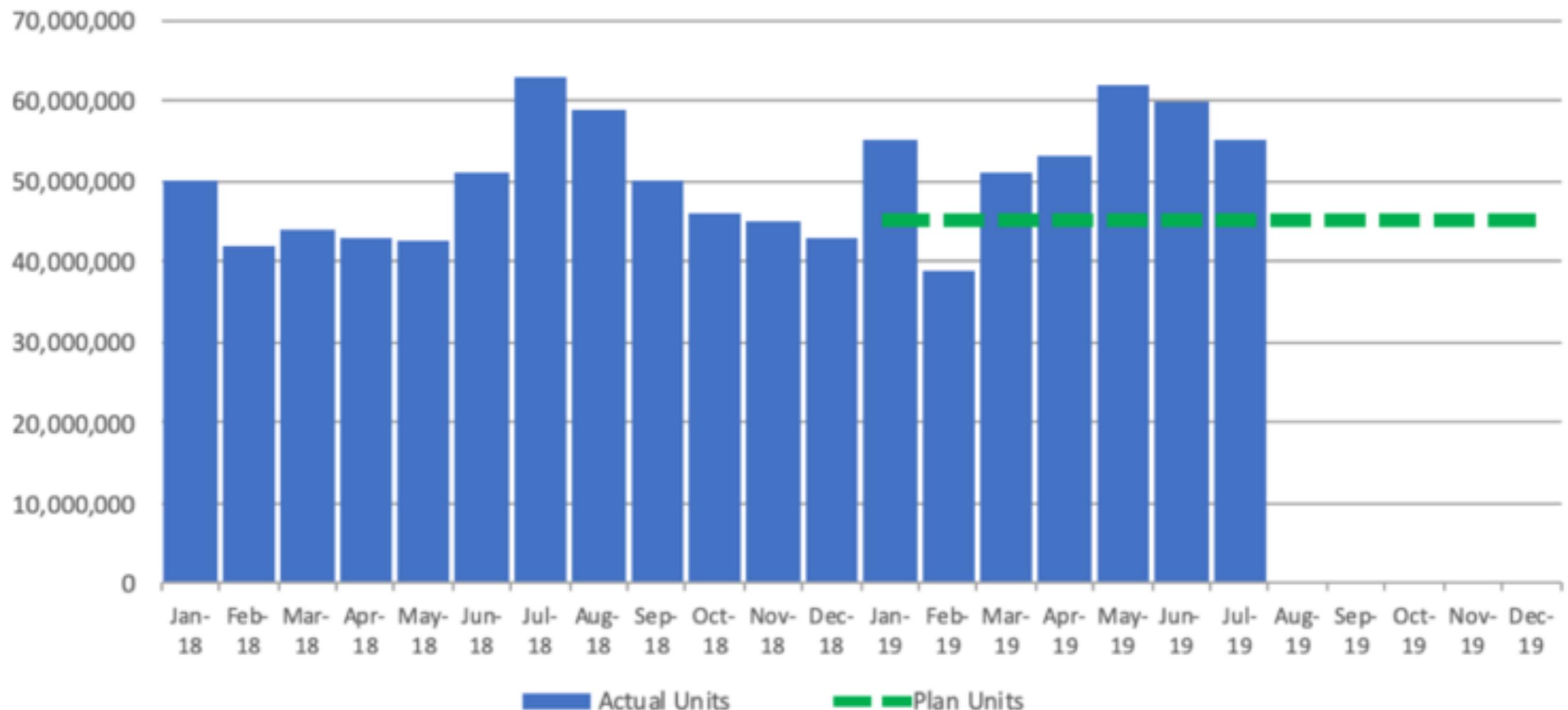
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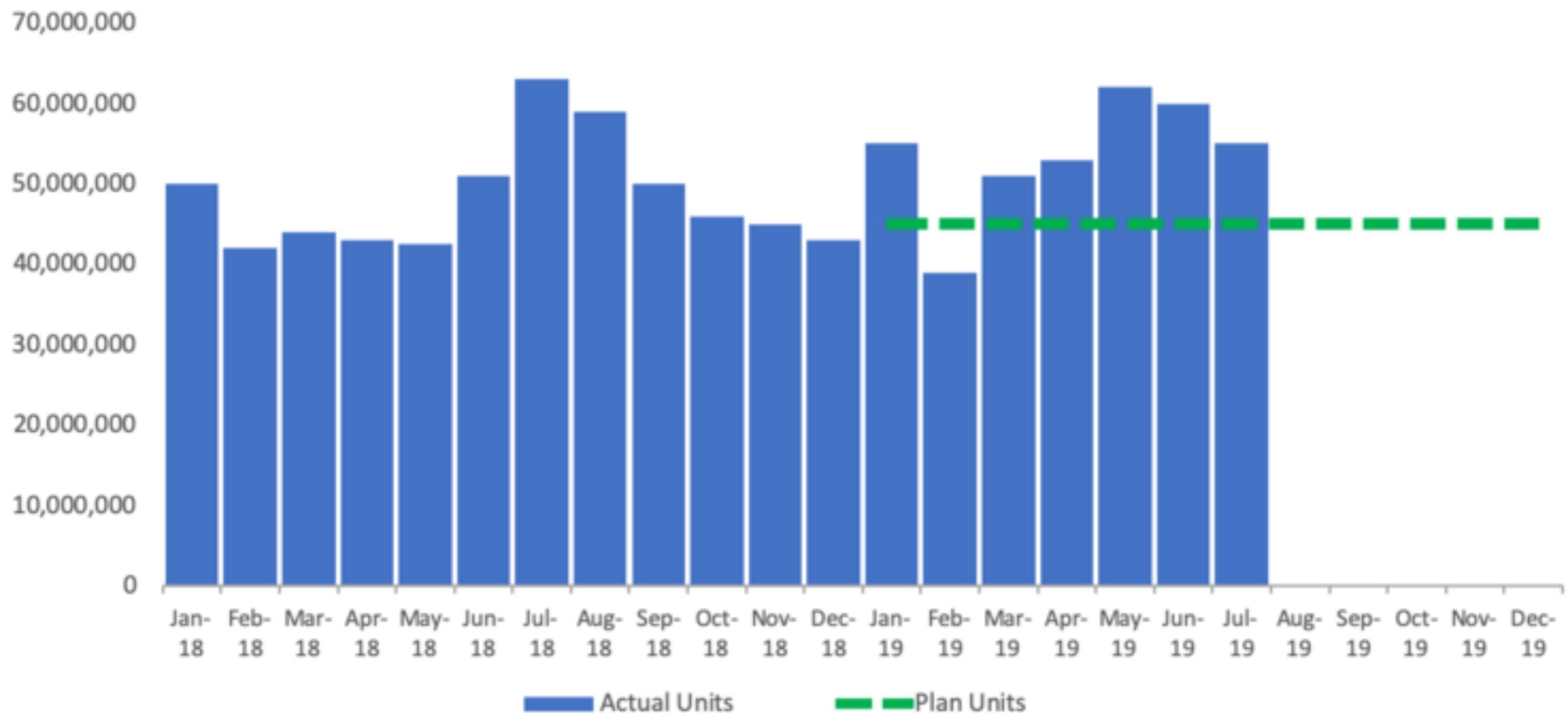
## **10. Use the blink test.**

*Improve! This! Viz!*

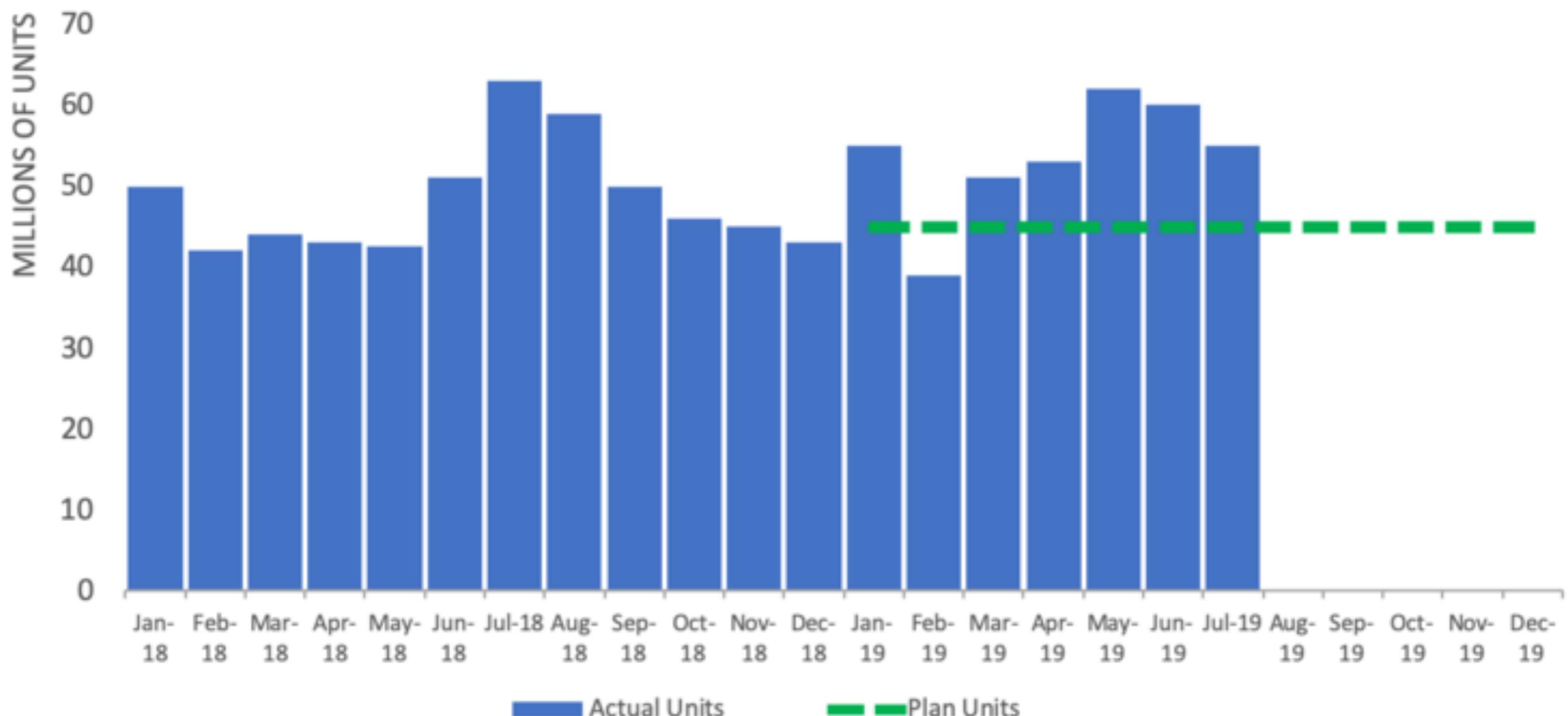
## PRIMARY PRODUCT Units



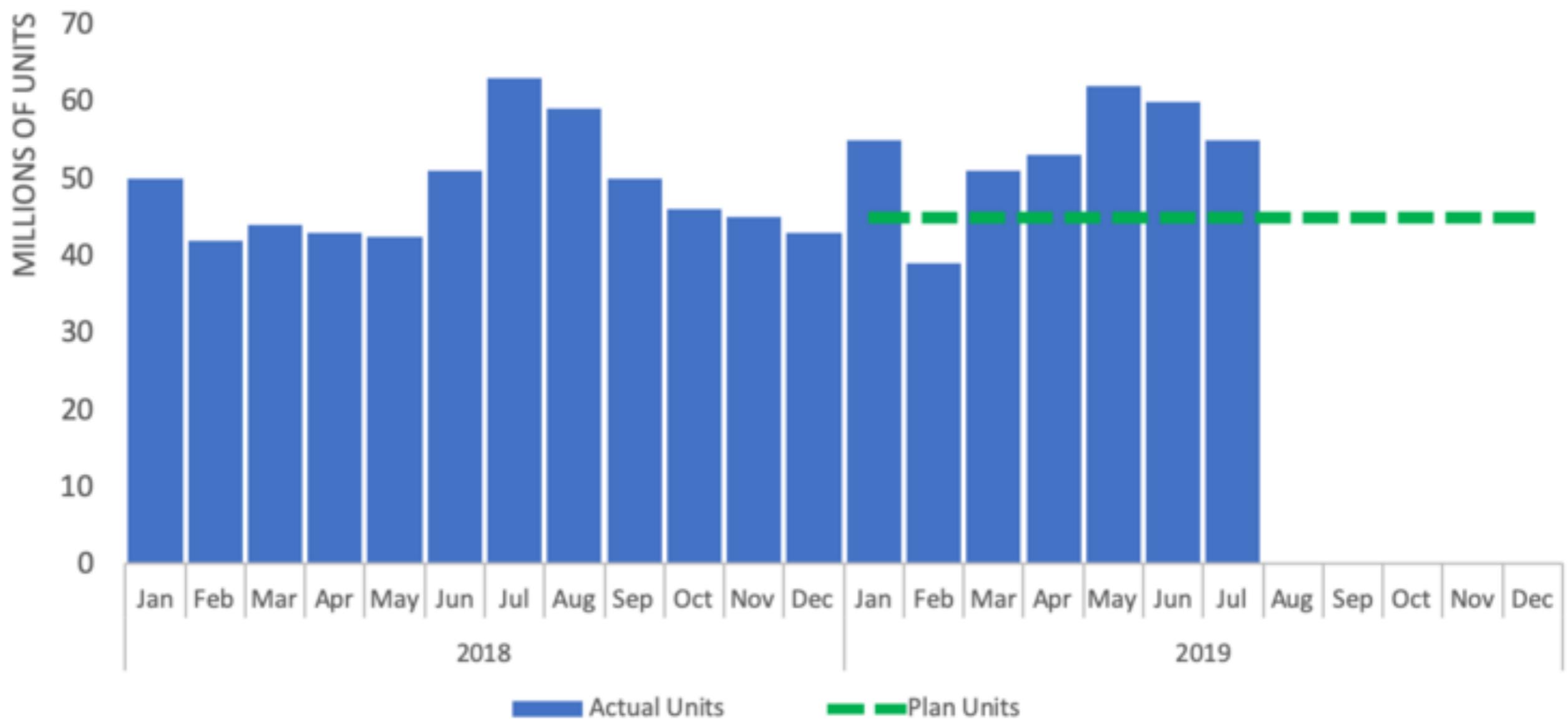
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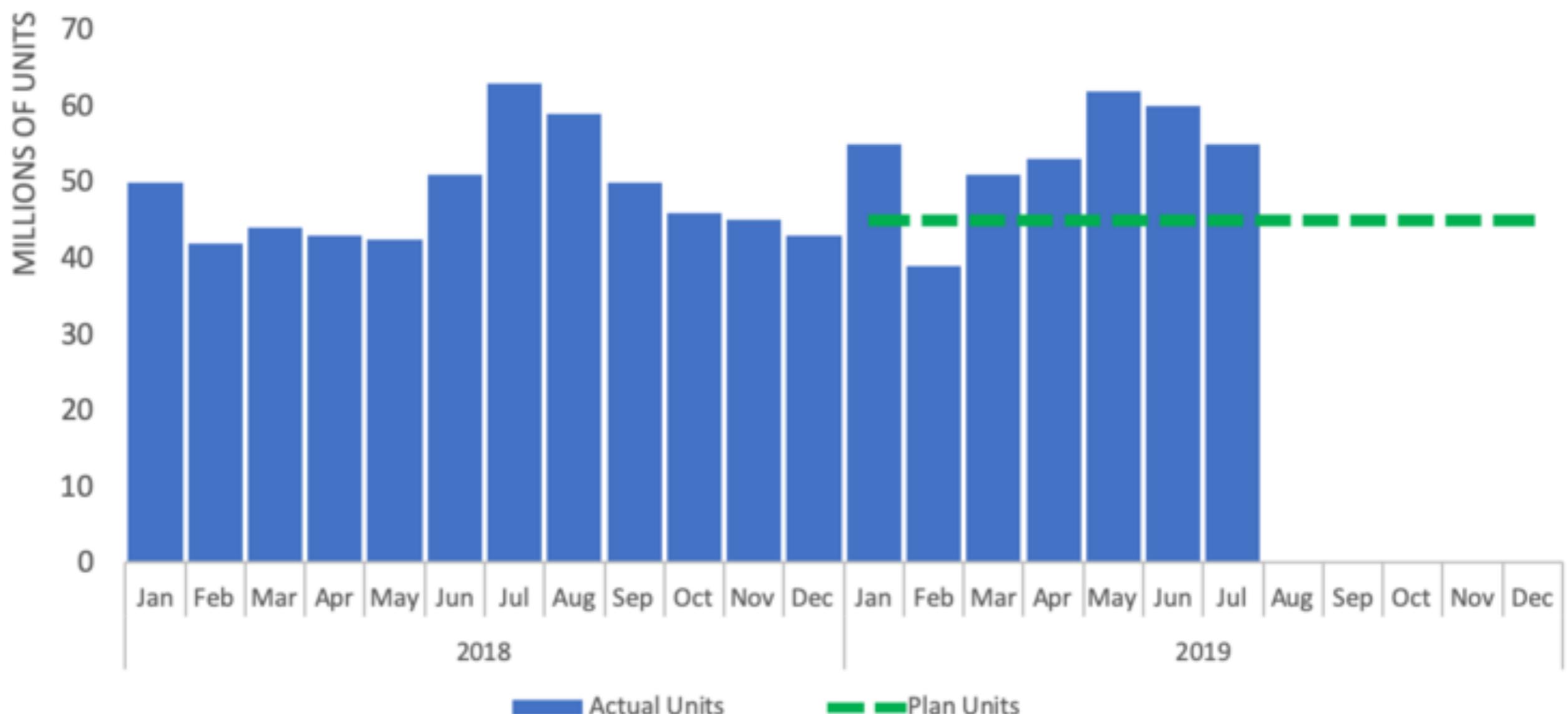
## PRIMARY PRODUCT Units



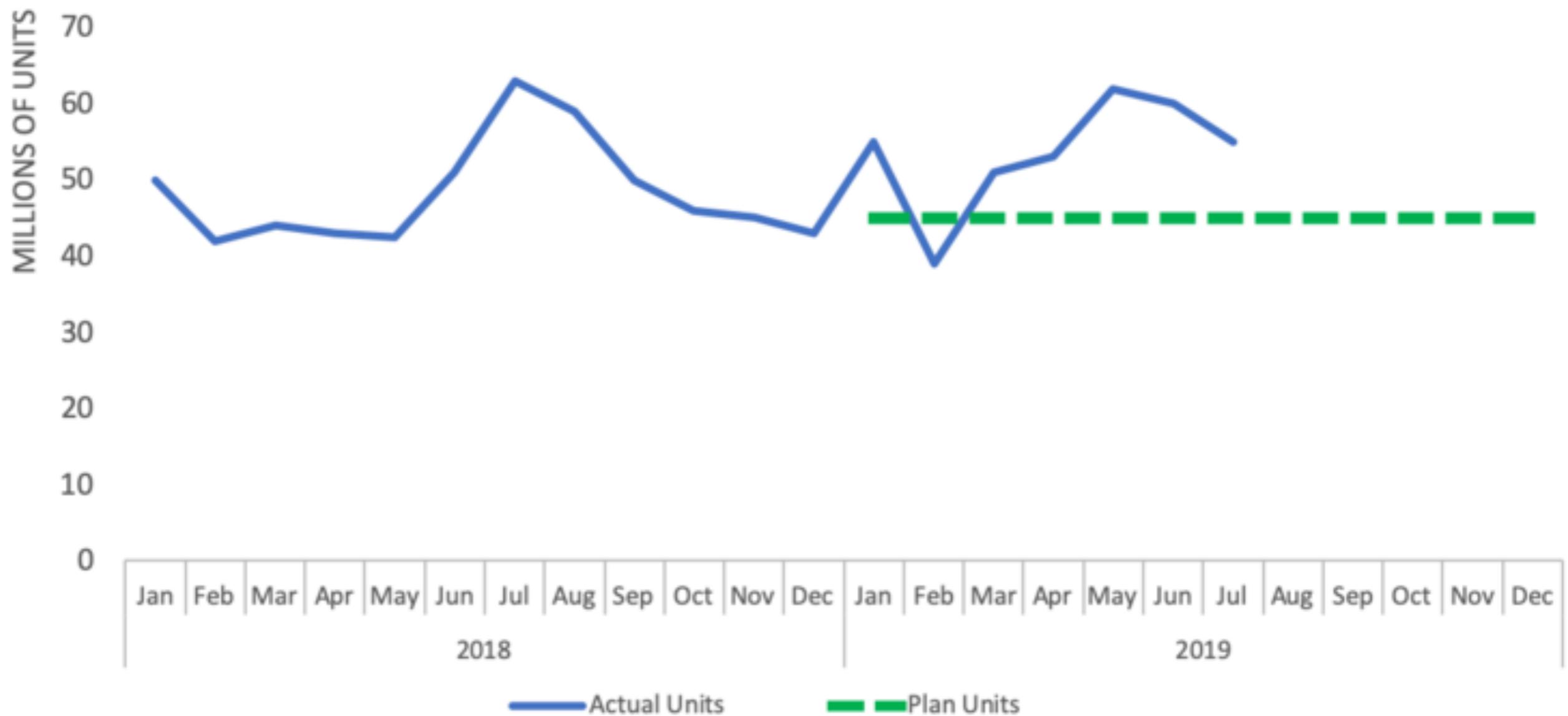
## PRIMARY PRODUCT Units



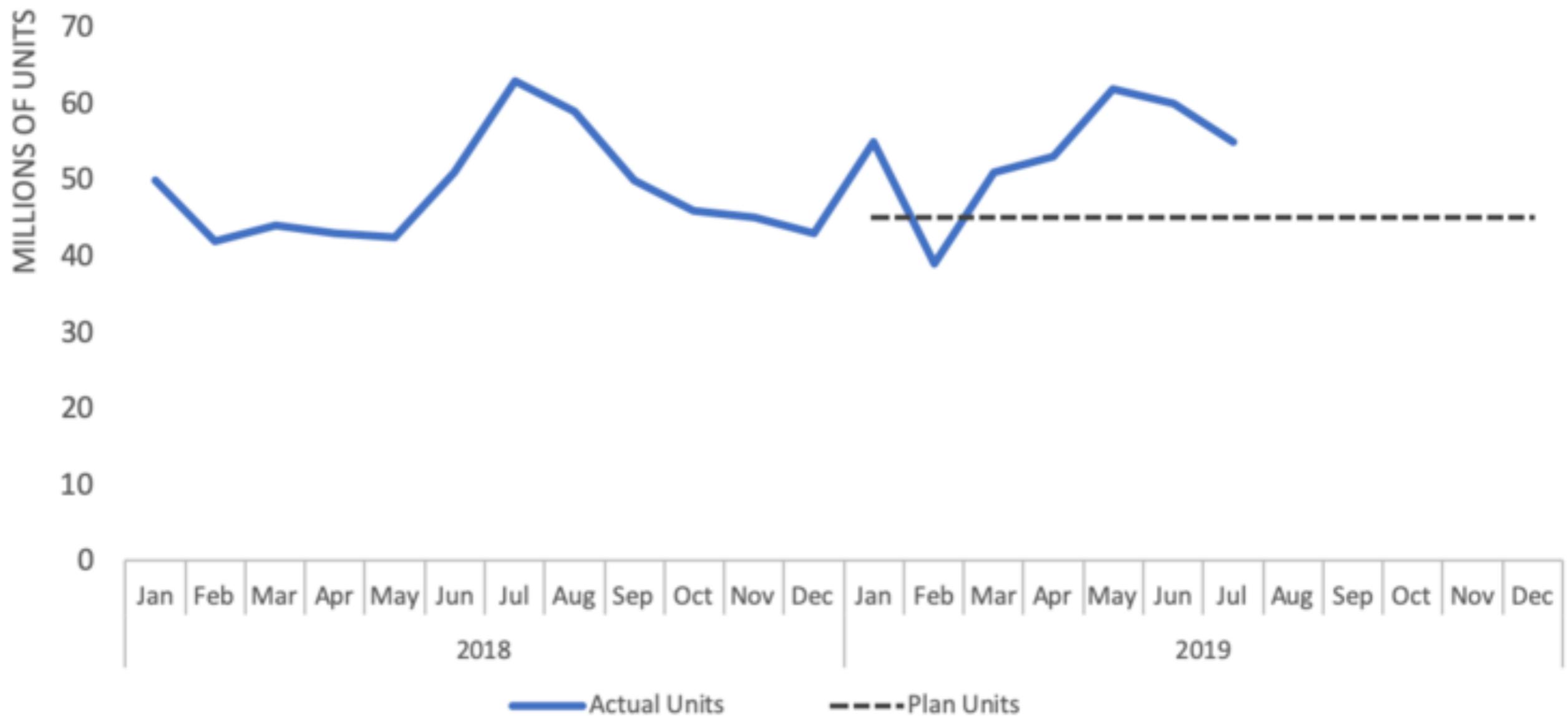
## PRIMARY PRODUCT: unit sales



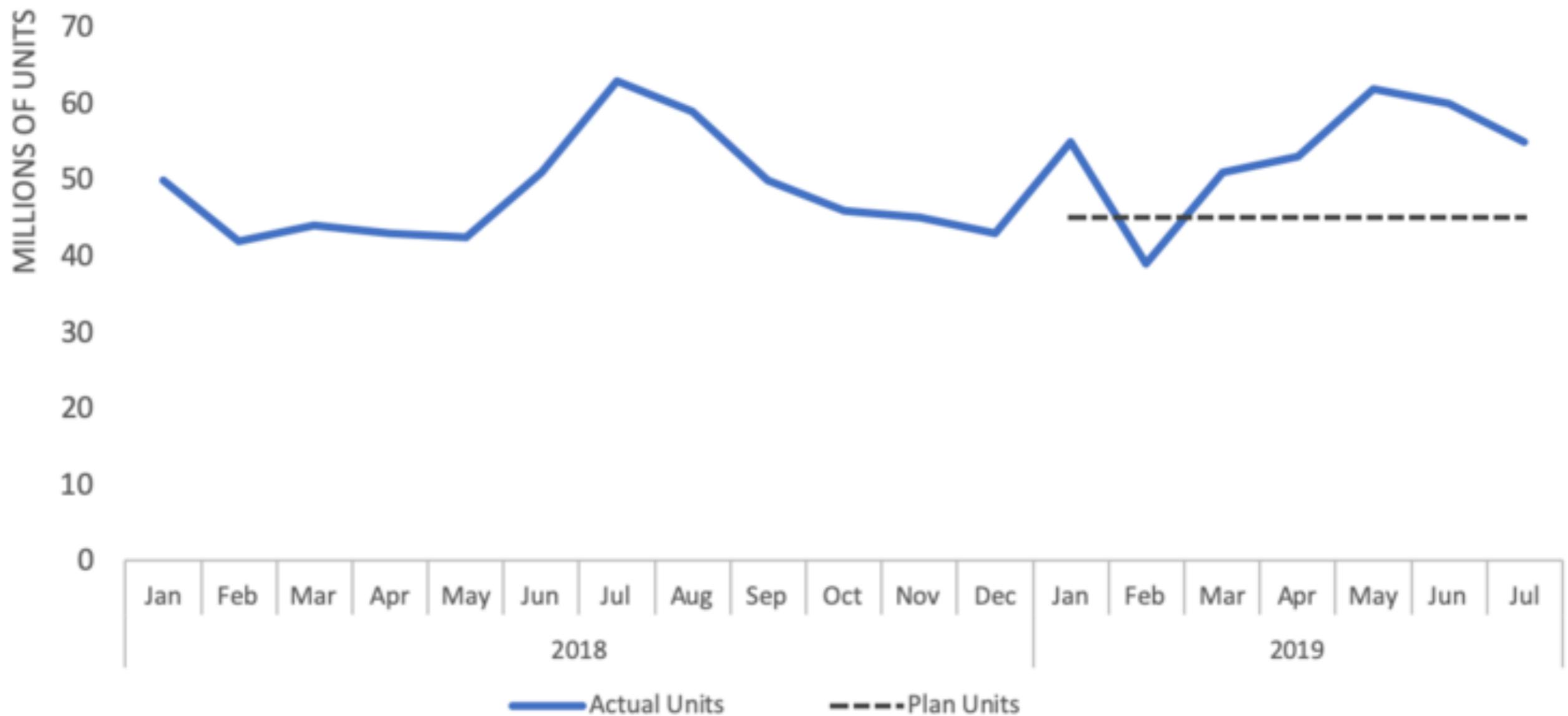
## PRIMARY PRODUCT: unit sales



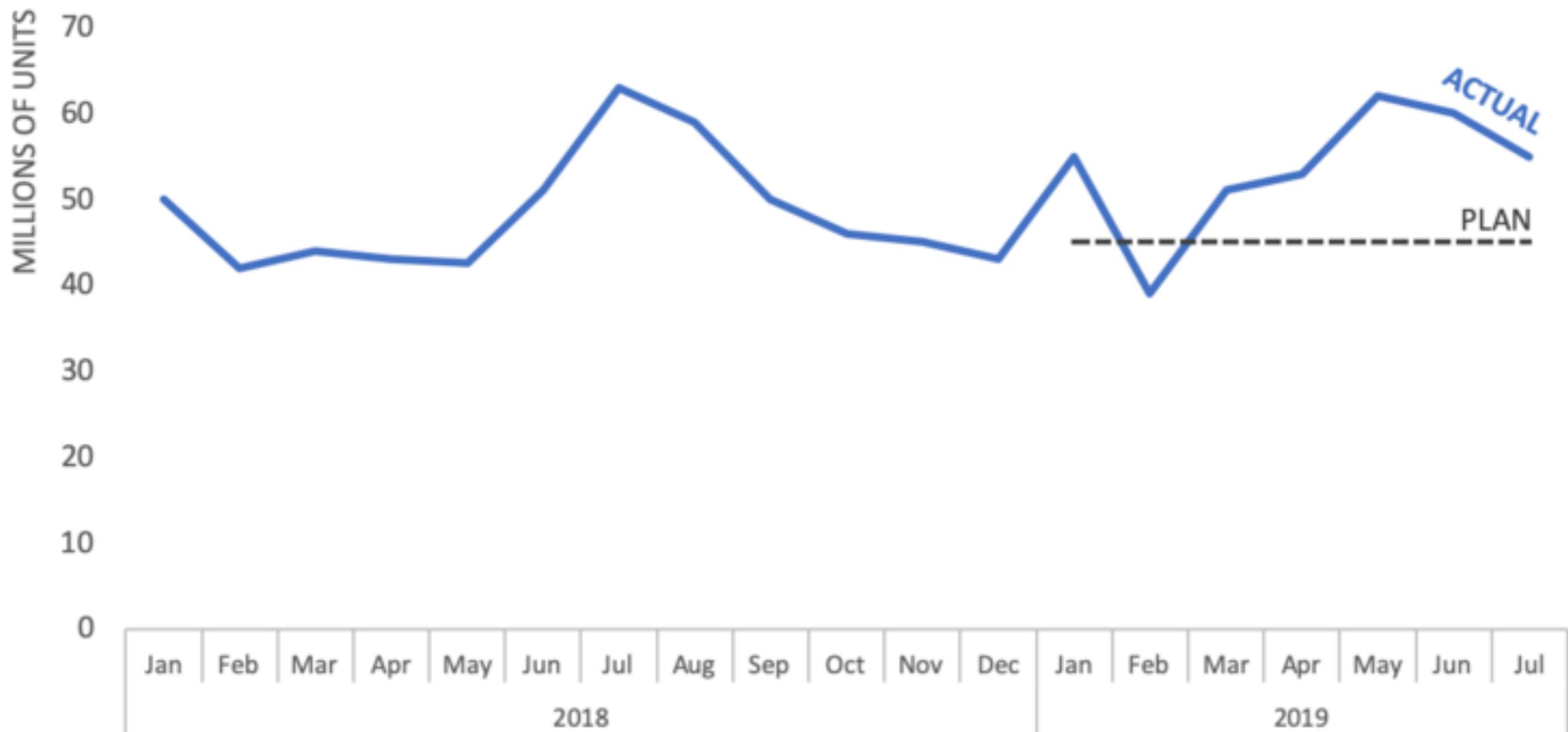
## PRIMARY PRODUCT: unit sales



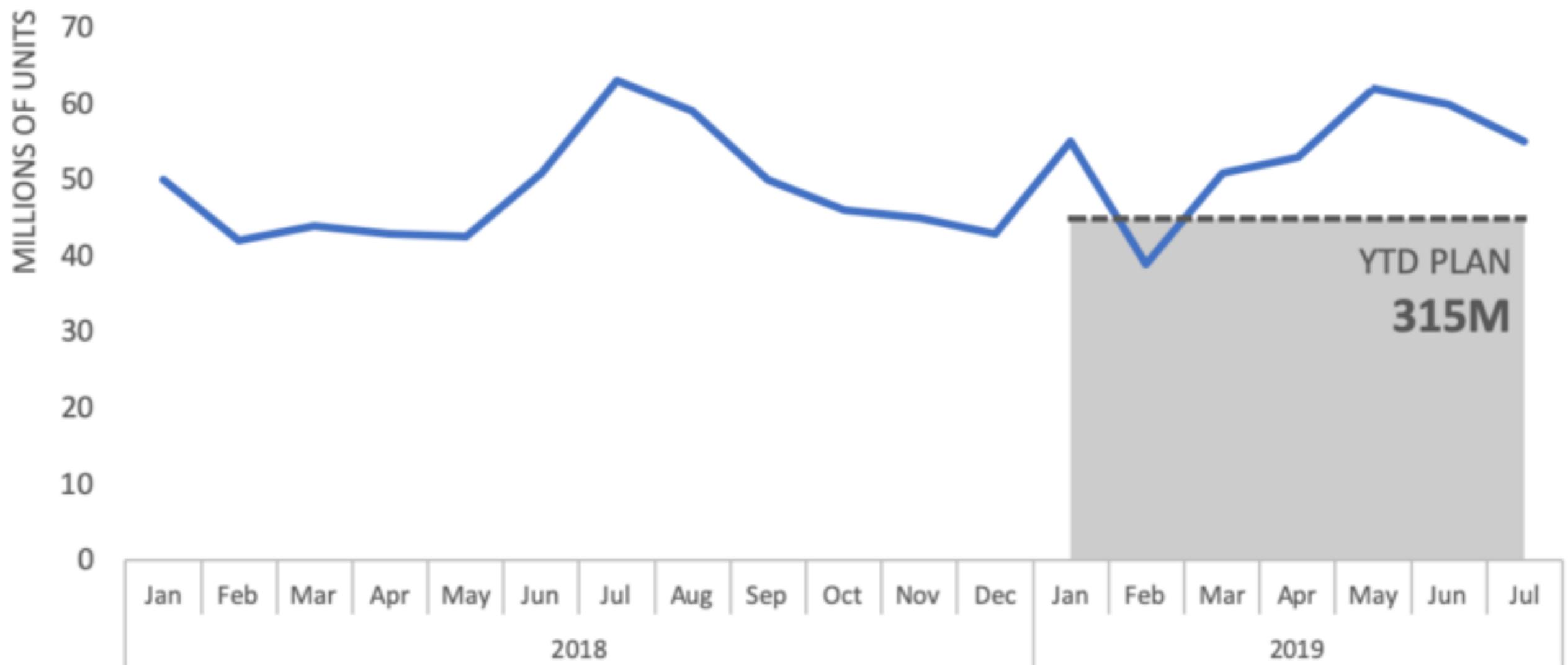
## PRIMARY PRODUCT: unit sales



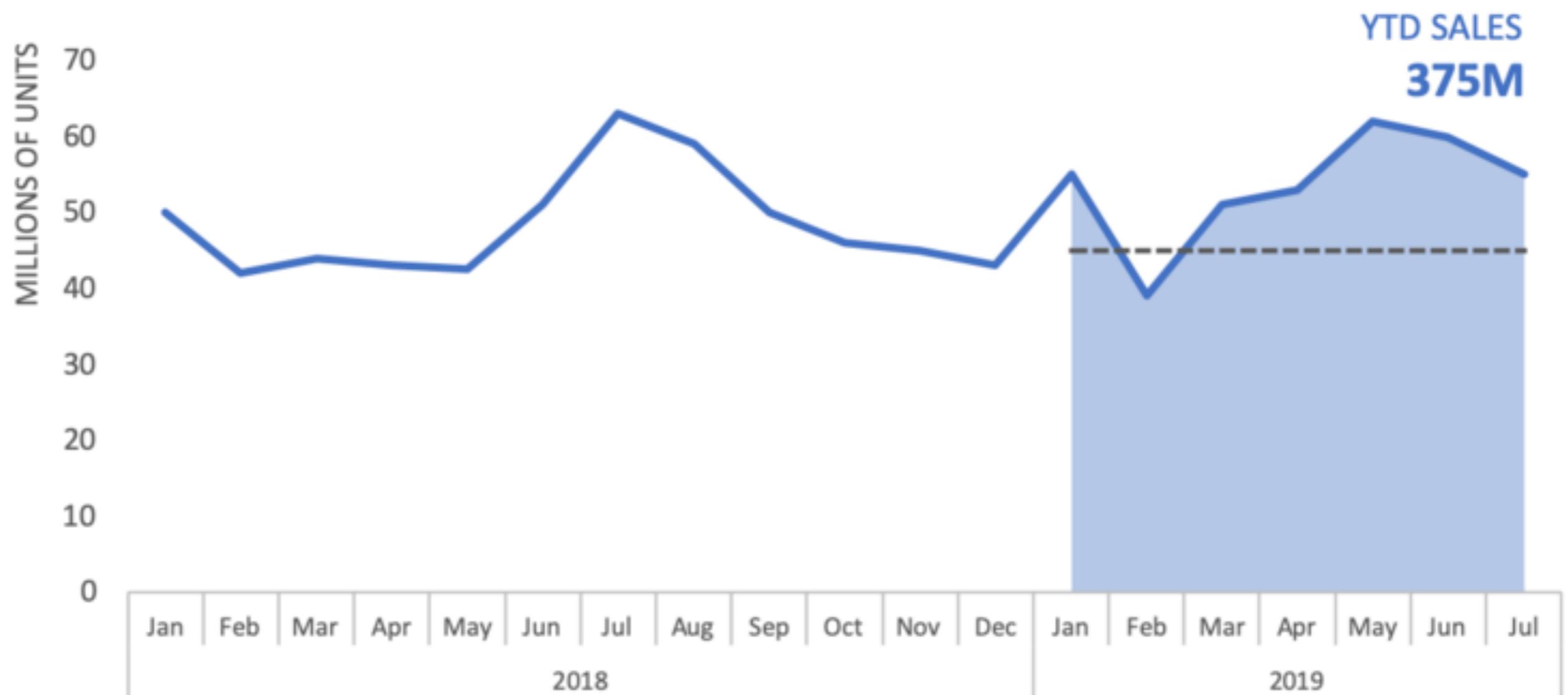
## PRIMARY PRODUCT: unit sales



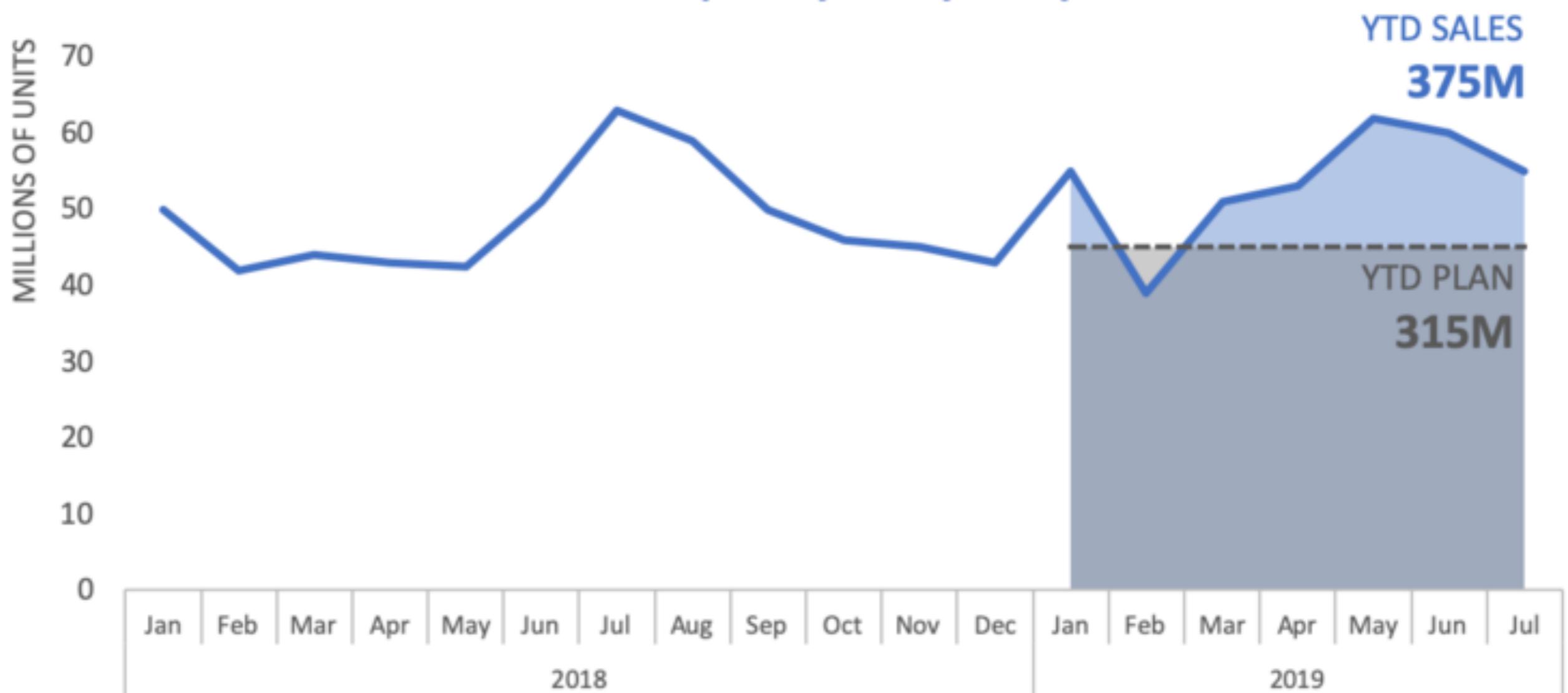
## PRIMARY PRODUCT: unit sales



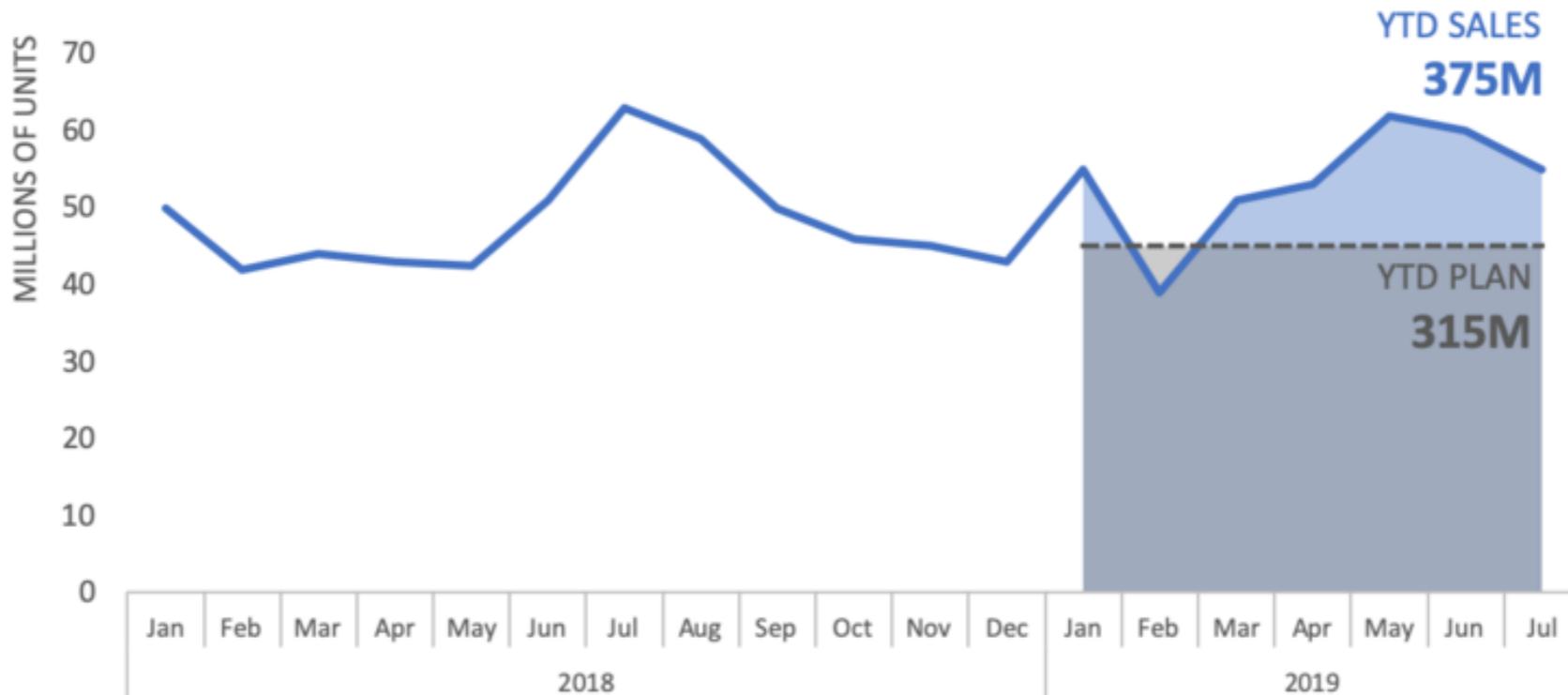
## PRIMARY PRODUCT: unit sales



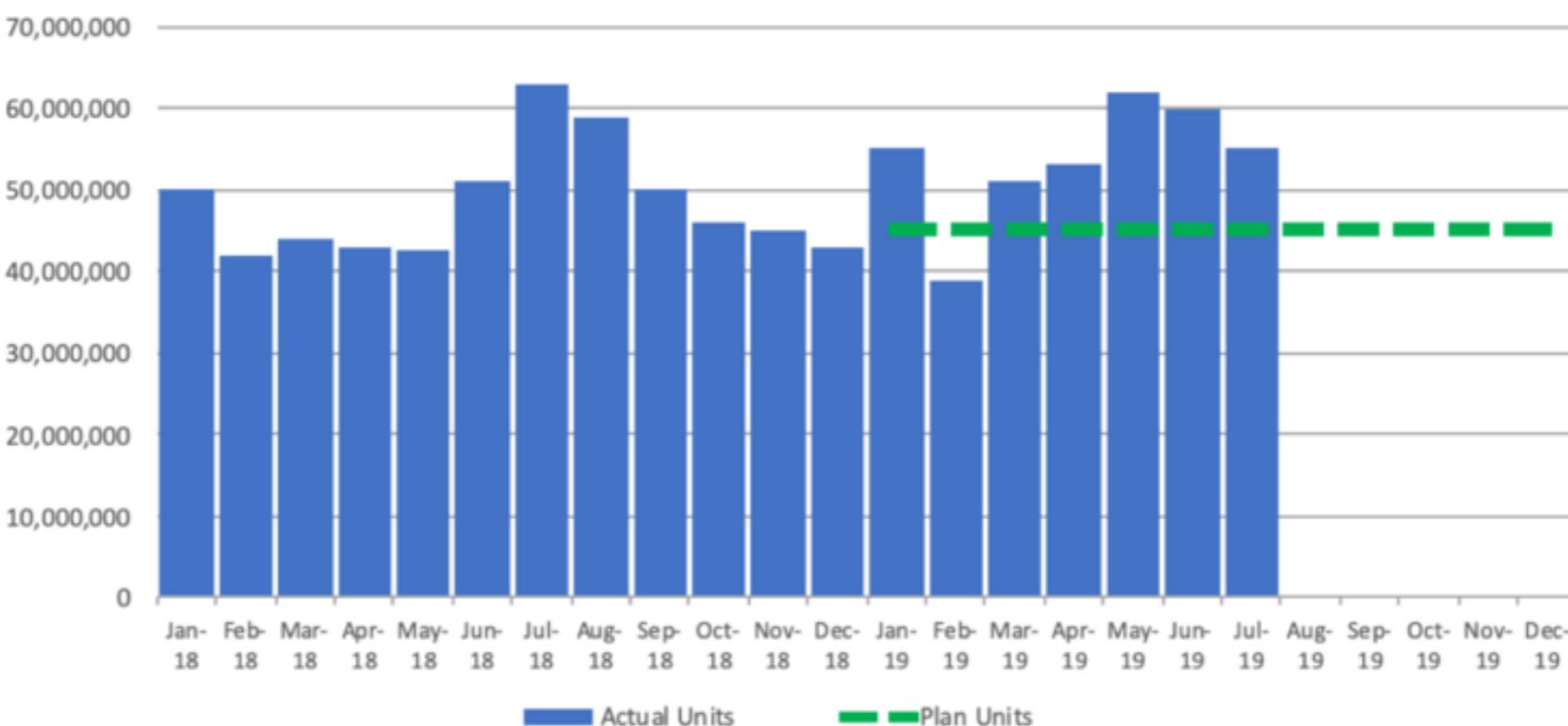
PRIMARY PRODUCT: **unit sales exceed plan by nearly 20% year to date**



**PRIMARY PRODUCT: unit sales exceed plan by nearly 20% year to date**



**PRIMARY PRODUCT Units**



## ***Group Exercise:***

*Write the headline*

[http://tiny.cc/  
INFO290\\_headlines](http://tiny.cc/ INFO290_headlines)

## ***Individual Exercise:***

*Visualizing  
tabular data by  
hand*

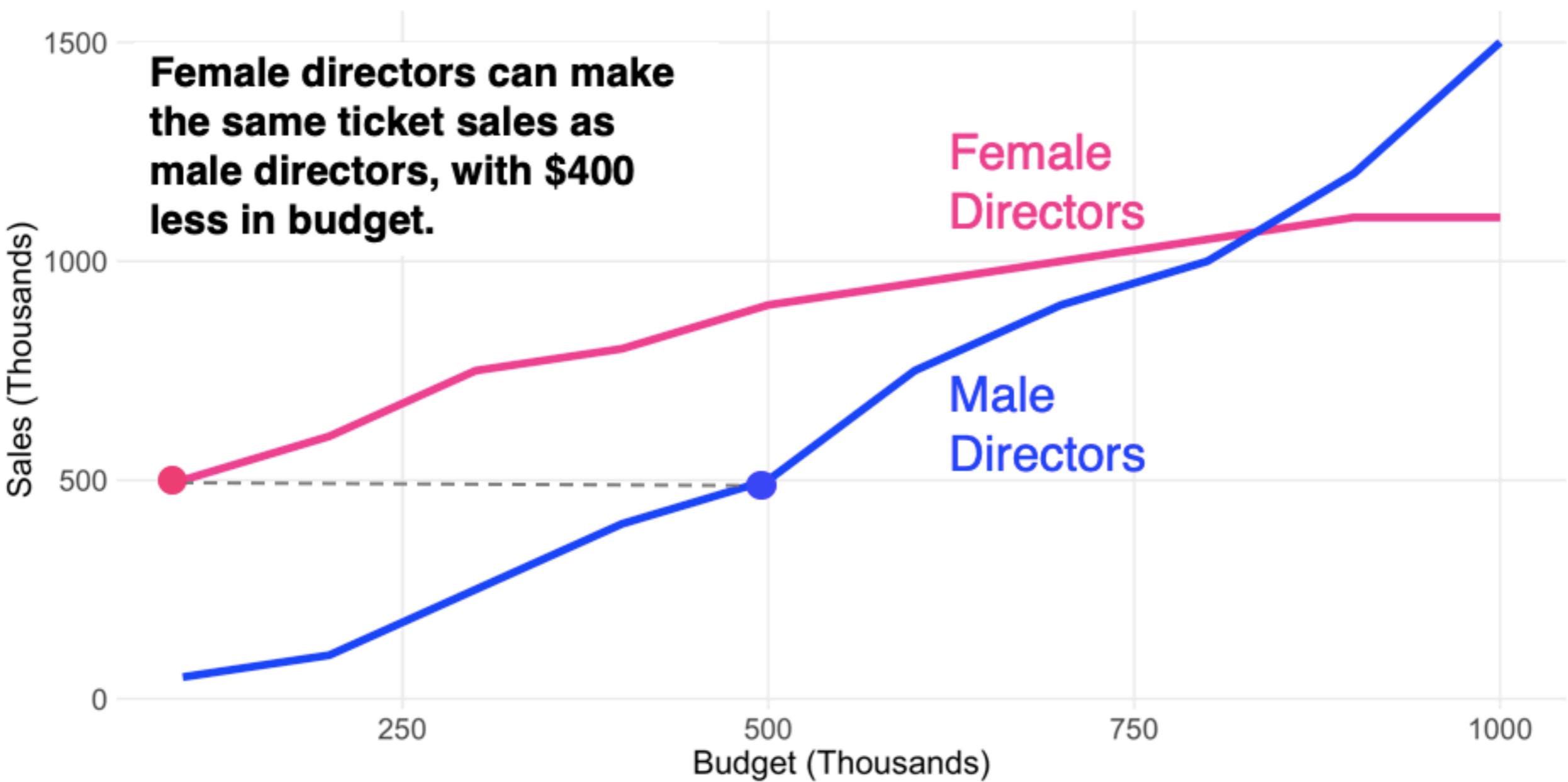
# *Individual Exercise:*

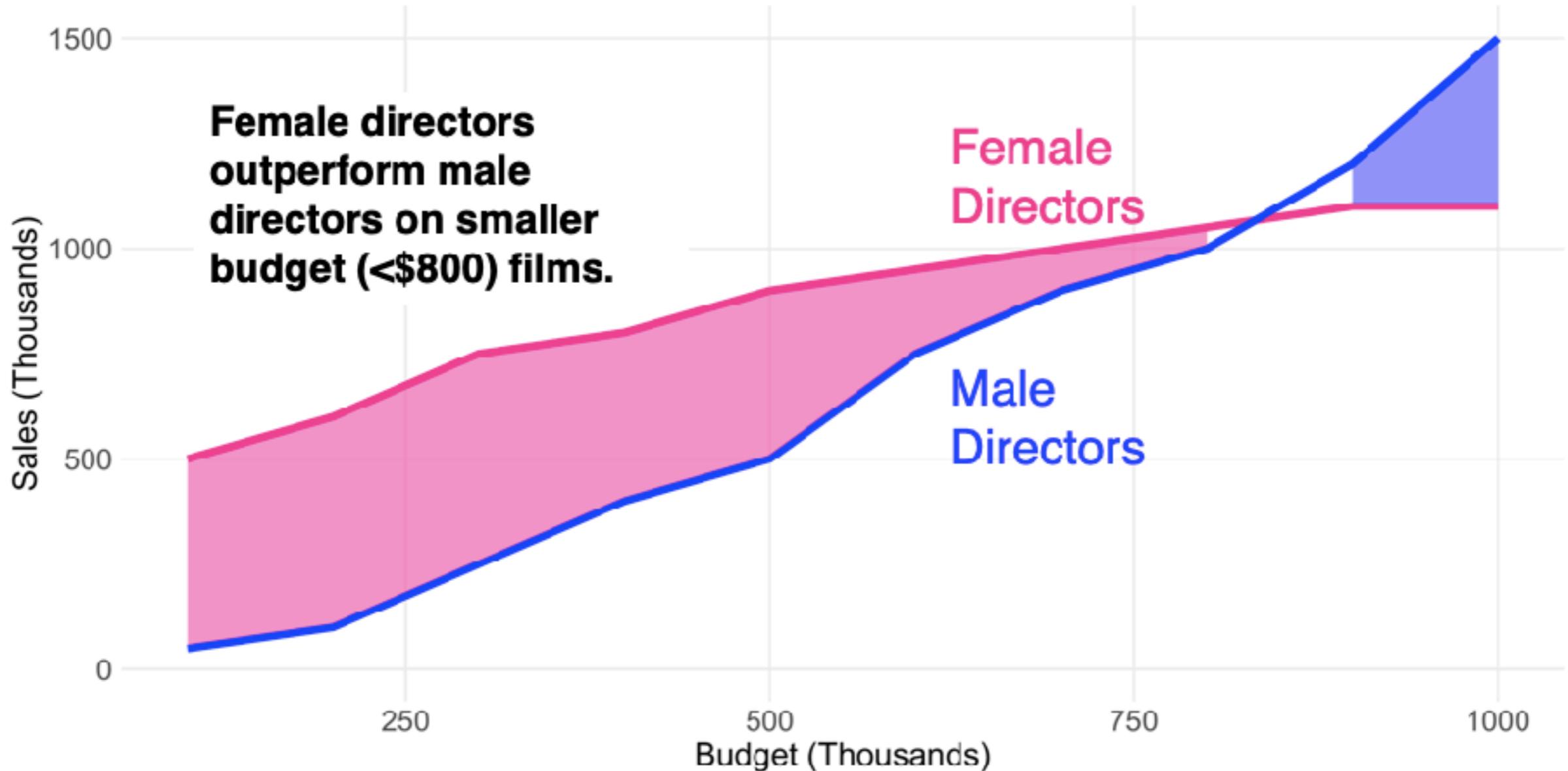
## *Visualizing tabular data by hand*

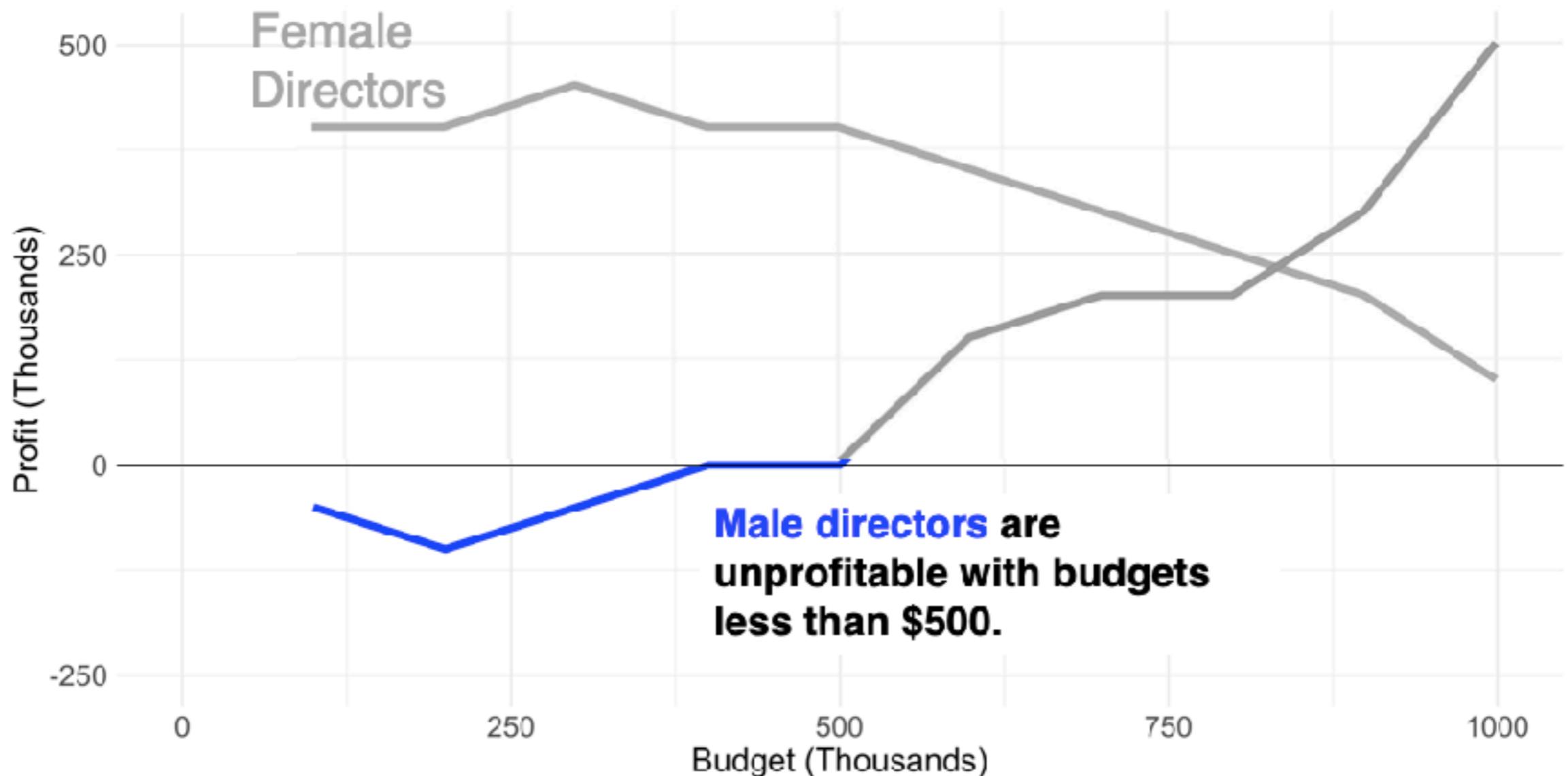
***Take 7 minutes to draw, by hand, a visualization of the below data:***

Budget (thousands)	Director Gender	Ticket Sales (thousands)
100	Female	500
200	Female	600
300	Female	750
400	Female	800
500	Female	900
600	Female	950
700	Female	1,000
800	Female	1,050
900	Female	1,100
1,000	Female	1,100

Budget (thousands)	Director Gender	Ticket Sales (thousands)
100	Male	50
200	Male	100
300	Male	250
400	Male	400
500	Male	500
600	Male	750
700	Male	900
800	Male	1,000
900	Male	1,200
1,000	Male	1,500







*Going interactive  
and beyond*

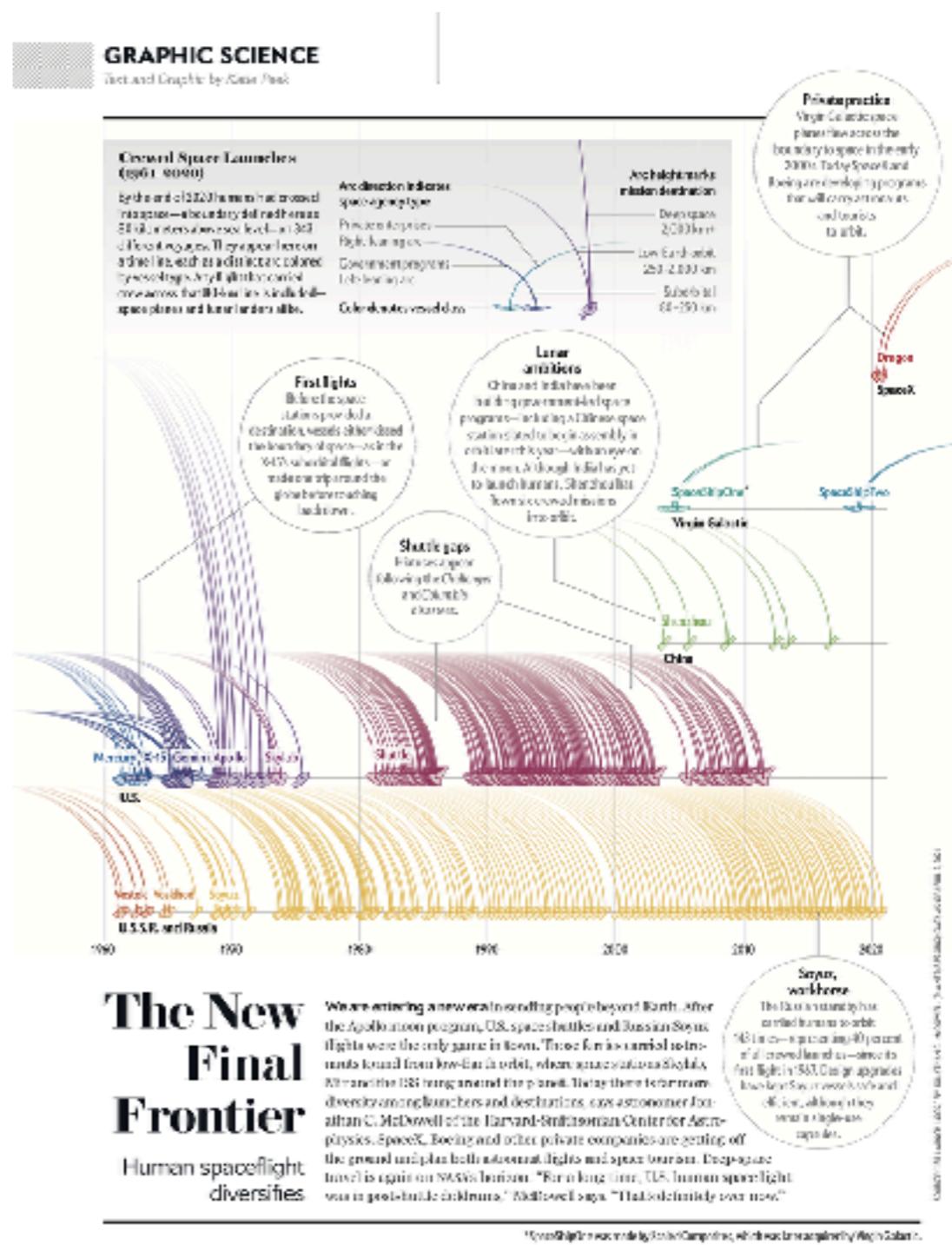


# Examples

- ▶ Tableau: [Massachusetts Trial Court](#)
- ▶ Leaflet: [Police Violence Happens Here](#)
- ▶ Plotly: [Tracking COVID-19 in MA Prisons](#)
- ▶ Bokeh: [COVID-19 in Portugal](#)
- ▶ D3: [NASA Spacecraft](#)

# Where to find viz inspiration

- ▶ NYT's *The Upshot*
- ▶ *The Pudding*
- ▶ Tableau's public gallery
- ▶ Graphic science in *Scientific American*



# Helpful resources

- ▶ Paul Tol's [colorblind-friendly categorical color palettes](#)
- ▶ [Data Viz Project](#): catalog of different viz types
- ▶ Gina Reynolds' [ggplot flipbook](#)
- ▶ Kira Tebbe's [Effective Data Visualization workshop](#)
- ▶ Free online book: [Fundamentals of Data Visualization](#)
- ▶ *Storytelling with Data* [books](#)

*Find these resources:*

[https://github.com/laurenmarietta/  
effective-data-viz-2025](https://github.com/laurenmarietta/effective-data-viz-2025)

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