

Data Visualization - 8.

Polishing and

Presenting Plots

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Code Horizons

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Polishing your plots and Presenting them

Load our packages

```
library(here)      # manage file paths
library(tidyverse) # your friend and mine
library(socviz)    # data and some useful functions
library(ggrepel)   # Text and labels
library(colorspace) # luminance-balanced palettes
library(scales)     # scale adjustments and enhancements
library(ggforce)   # useful enhancements to ggplot
```

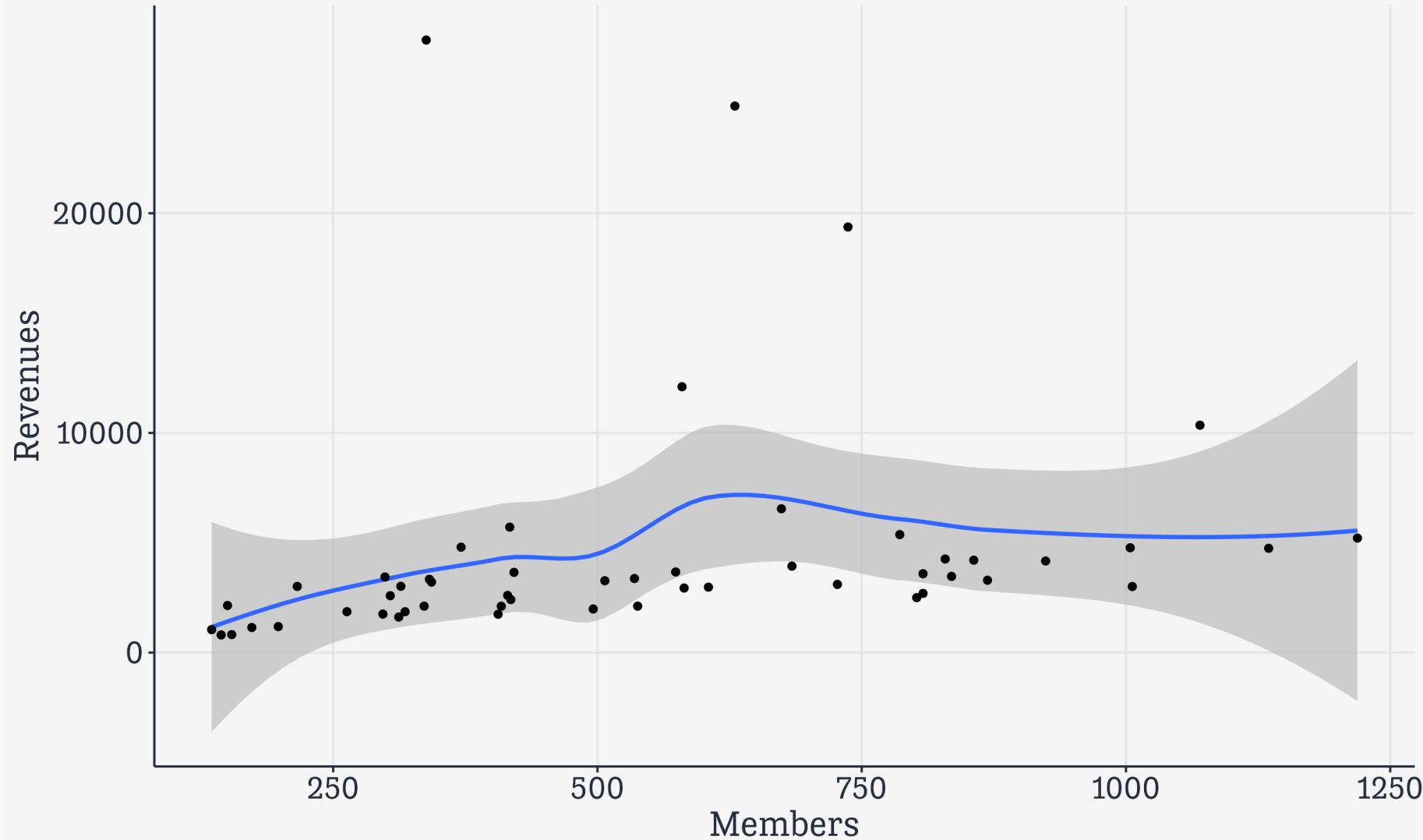
Piece by piece,
Layer by layer

Build your plots a piece at a time

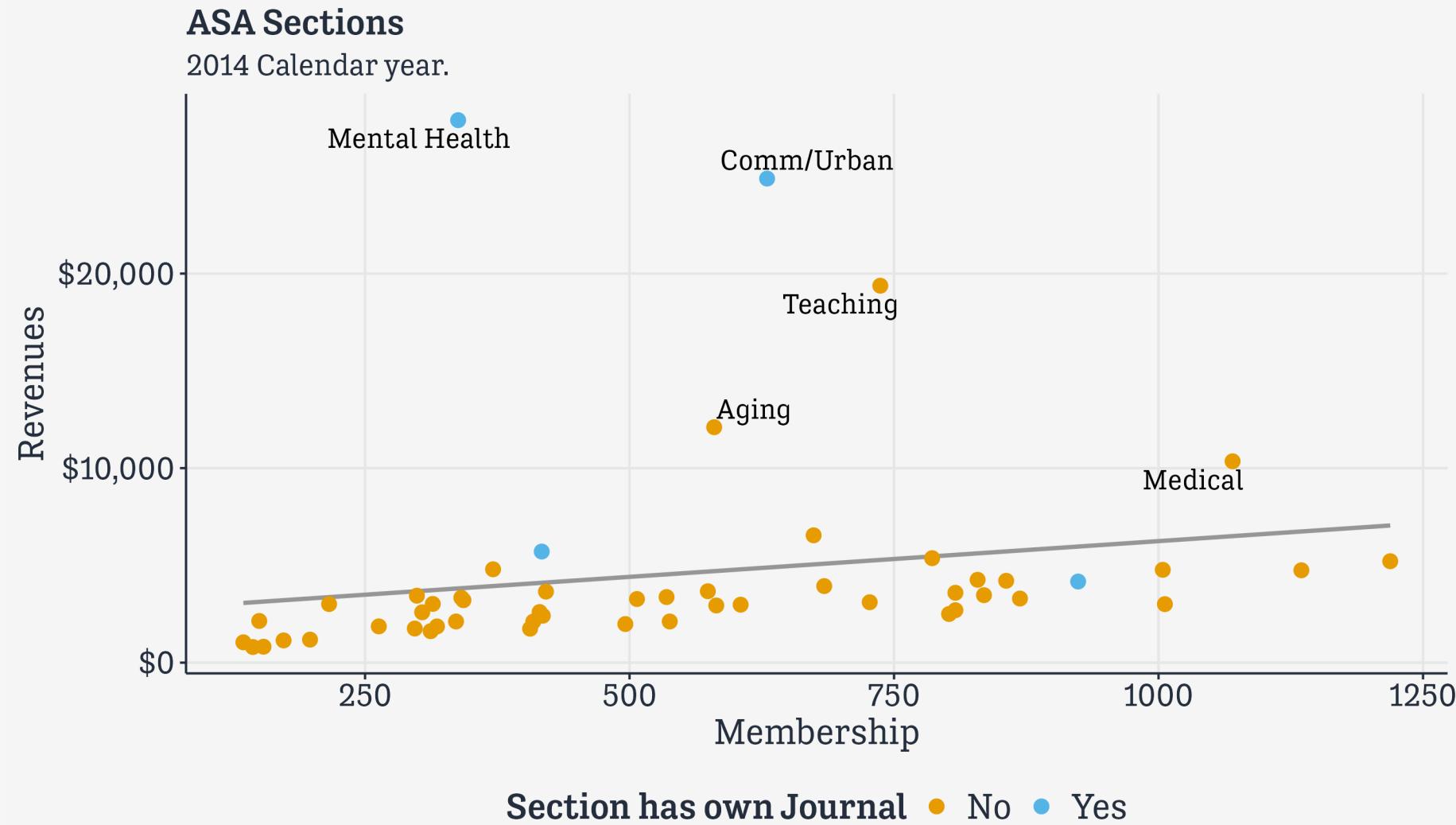
```
asasec ← as_tibble(asasec)
asasec
```

```
# A tibble: 572 × 9
  Section      Sname Beginning Revenues Expenses Ending Journal Year Members
  <fct>       <fct>    <int>     <int>   <int>   <int> <fct>  <int>   <int>
1 Aging and the... Aging     12752    12104    12007   12849 No     2005     598
2 Alcohol, Drug... Alco...    11933     1144      400    12677 No     2005     301
3 Altruism and ... Altr...    1139      1862     1875    1126 No     2005     NA
4 Animals and S... Anim...     473       820     1116     177 No     2005     209
5 Asia/Asian Am... Asia     9056      2116     1710    9462 No     2005     365
6 Body and Embo... Body     3408      1618     1920    3106 No     2005     NA
7 Children and ... Chil...    3692      3653     3713    3632 No     2005     418
8 Coll Behavior... CBSM     8127      3470     2704    8893 No     2005     708
9 Communication... CITA...   17093     4800     4804   17089 No     2005     301
10 Community and... Comm...   26598    24883    23379   28102 Yes    2005     721
# i 562 more rows
```

Build your plots a piece at a time



Build your plots a piece at a time



Source: ASA annual report.

Build your plots a piece at a time

asasec

Build your plots a piece at a time

```
asasec >  
  filter(Year == 2014)
```

#	A tibble: 52 x 9								
	Section	Sname	Beginning	Revenues	Expenses	Ending	Journal	Year	Members
	<fct>	<fct>	<int>	<int>	<int>	<int>	<fct>	<int>	<int>
1	Aging and the...	Aging	12752	12104	12007	12849	No	2014	580
2	Alcohol, Drug...	Alco...	11933	1144	400	12677	No	2014	173
3	Altruism and ...	Altr...	1139	1862	1875	1126	No	2014	318
4	Animals and S...	Anim...	473	820	1116	177	No	2014	154
5	Asia/Asian Am...	Asia	9056	2116	1710	9462	No	2014	336
6	Body and Embo...	Body	3408	1618	1920	3106	No	2014	312
7	Children and ...	Chil...	3692	3653	3713	3632	No	2014	421
8	Coll Behavior...	CBSM	8127	3470	2704	8893	No	2014	835
9	Communication...	CITA...	17093	4800	4804	17089	No	2014	371
10	Community and...	Comm...	26598	24883	23379	28102	Yes	2014	630

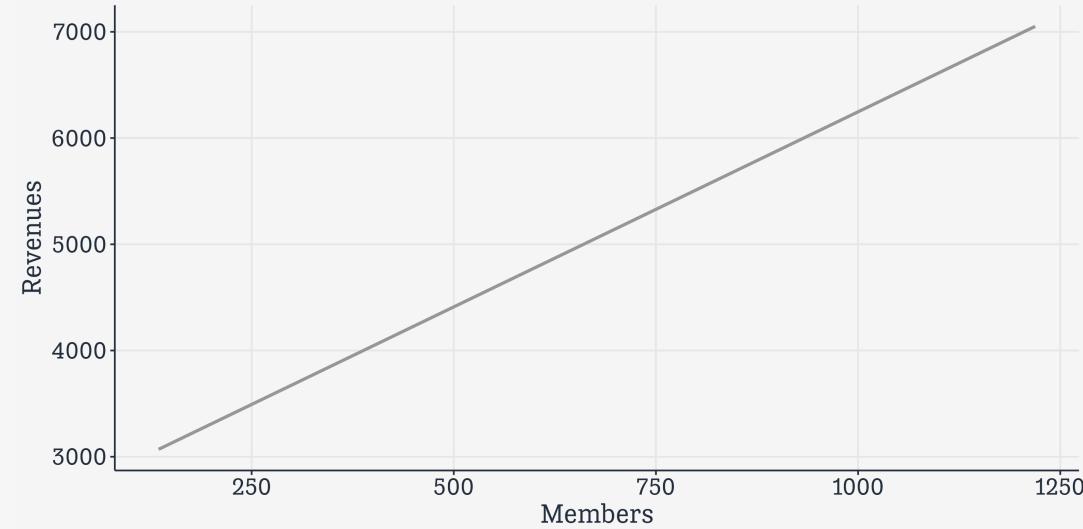
Build your plots a piece at a time

```
asasec %>  
  filter(Year == 2014) %>  
  ggplot(mapping = aes(x = Members,  
                      y = Revenues,  
                      label = Sname))
```



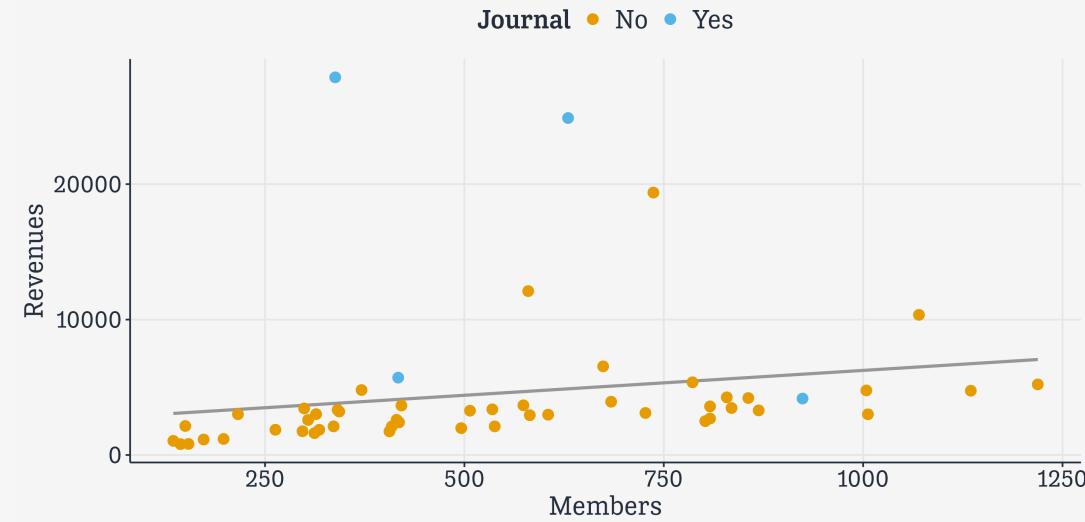
Build your plots a piece at a time

```
asasec >  
  filter(Year == 2014) >  
  ggplot(mapping = aes(x = Members,  
                        y = Revenues,  
                        label = Sname)) +  
  geom_smooth(method = "lm",  
              se = FALSE,  
              color = "gray60")
```



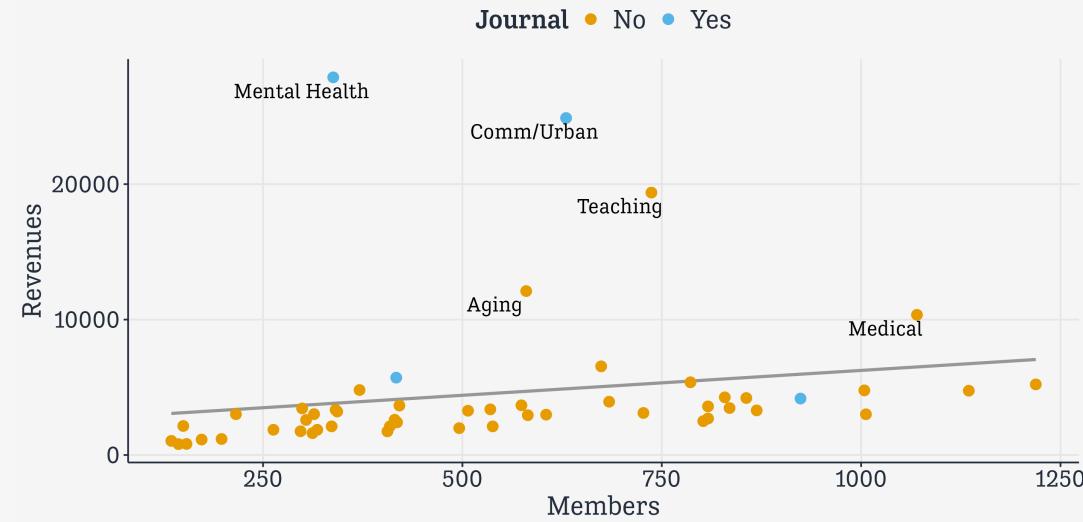
Build your plots a piece at a time

```
asasec >  
  filter(Year = 2014) >  
  ggplot(mapping = aes(x = Members,  
                        y = Revenues,  
                        label = Sname)) +  
  geom_smooth(method = "lm",  
              se = FALSE,  
              color = "gray60") +  
  geom_point(mapping = aes(color = Journal),  
             size = rel(3))
```



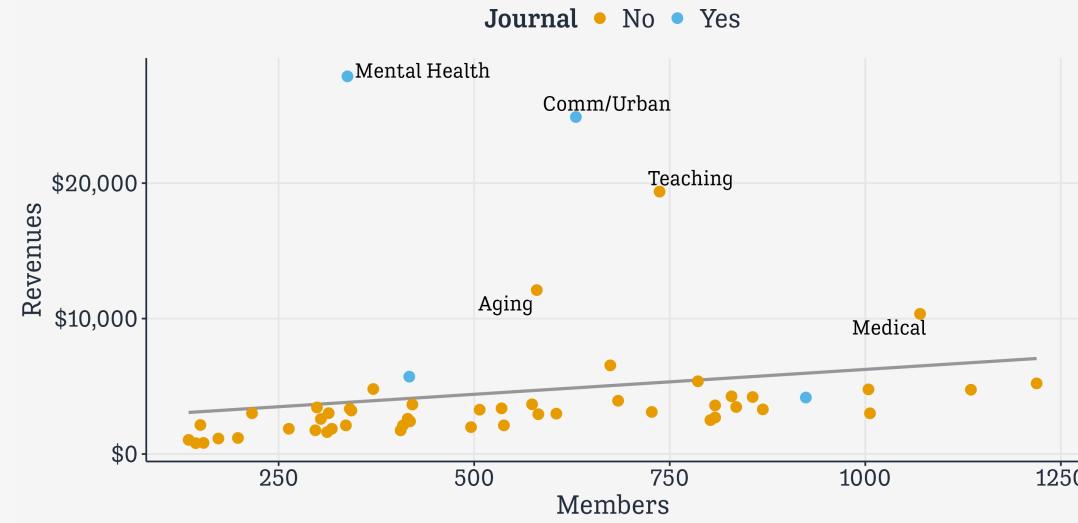
Build your plots a piece at a time

```
asasec %>  
  filter(Year == 2014) %>  
  ggplot(mapping = aes(x = Members,  
                        y = Revenues,  
                        label = Sname)) +  
  geom_smooth(method = "lm",  
              se = FALSE,  
              color = "gray60") +  
  geom_point(mapping = aes(color = Journal),  
             size = rel(3)) +  
  geom_text_repel(data=subset(asasec,  
                             Year == 2014 &  
                             Revenues > 7000),  
                 size = rel(5),  
                 mapping =  
                 aes(family = "Tenso Slide"))
```



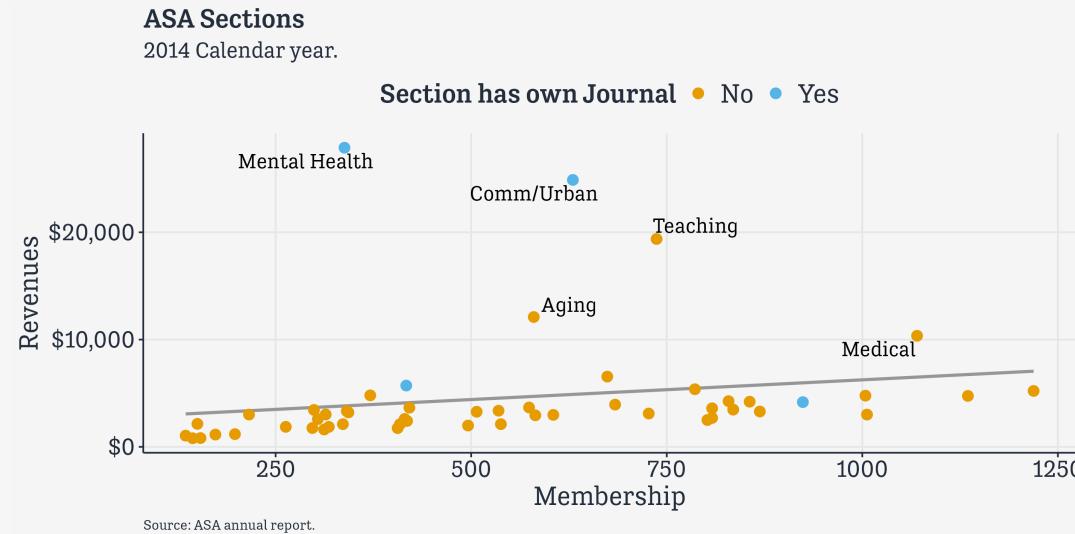
Build your plots a piece at a time

```
asasec >
  filter(Year == 2014) >
  ggplot(mapping = aes(x = Members,
                        y = Revenues,
                        label = Sname)) +
  geom_smooth(method = "lm",
              se = FALSE,
              color = "gray60") +
  geom_point(mapping = aes(color = Journal),
             size = rel(3)) +
  geom_text_repel(data=subset(asasec,
                             Year == 2014 &
                               Revenues > 7000),
                 size = rel(5),
                 mapping =
                   aes(family = "Tenso Slide")) +
  scale_y_continuous(labels =
    scales::label_dollar())
```



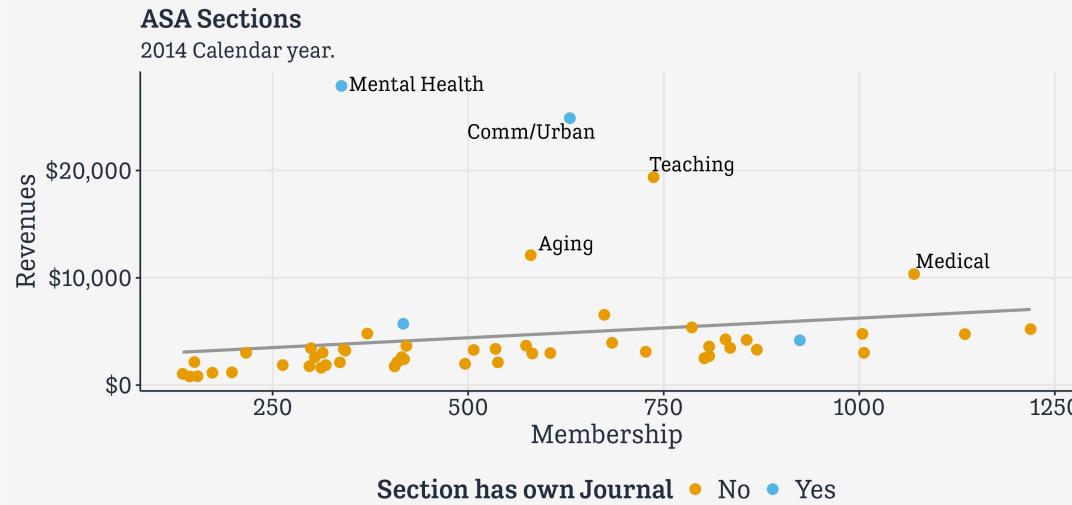
Build your plots a piece at a time

```
asasec %>
  filter(Year == 2014) %>
  ggplot(mapping = aes(x = Members,
                        y = Revenues,
                        label = Sname)) +
  geom_smooth(method = "lm",
              se = FALSE,
              color = "gray60") +
  geom_point(mapping = aes(color = Journal),
             size = rel(3)) +
  geom_text_repel(data=subset(asasec,
                             Year == 2014 &
                               Revenues > 7000),
                 size = rel(5),
                 mapping =
                   aes(family = "Tenso Slide")) +
  scale_y_continuous(labels =
    scales::label_dollar()) +
  labs(x="Membership", y="Revenues",
       color = "Section has own Journal",
       title = "ASA Sections",
       subtitle = "2014 Calendar year.",
       caption = "Source: ASA annual report.")
```



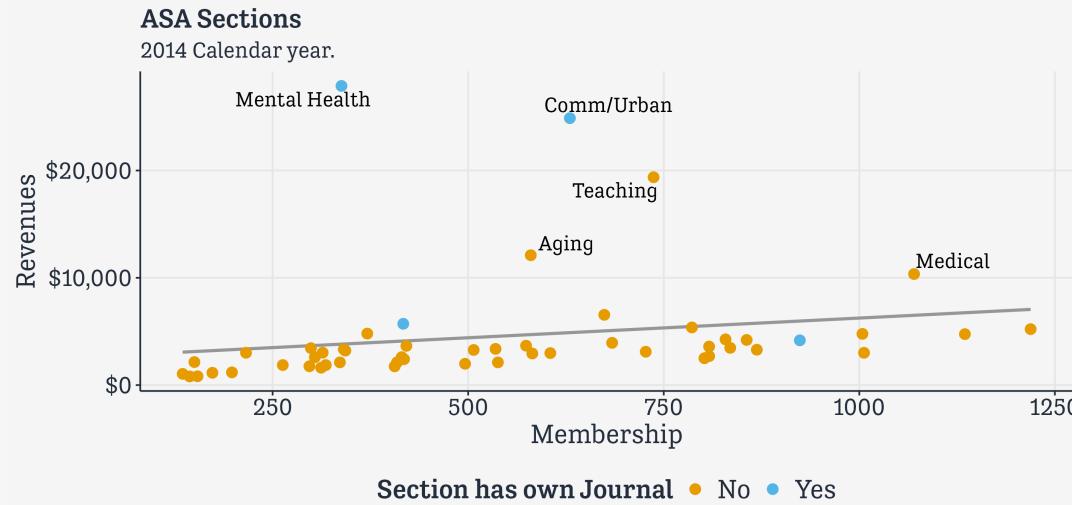
Build your plots a piece at a time

```
asasec %>
  filter(Year == 2014) %>
  ggplot(mapping = aes(x = Members,
                        y = Revenues,
                        label = Sname)) +
  geom_smooth(method = "lm",
              se = FALSE,
              color = "gray60") +
  geom_point(mapping = aes(color = Journal),
             size = rel(3)) +
  geom_text_repel(data=subset(asasec,
                             Year == 2014 &
                               Revenues > 7000),
                 size = rel(5),
                 mapping =
                   aes(family = "Tenso Slide")) +
  scale_y_continuous(labels =
    scales::label_dollar()) +
  labs(x="Membership", y="Revenues",
       color = "Section has own Journal",
       title = "ASA Sections",
       subtitle = "2014 Calendar year.",
       caption = "Source: ASA annual report.") +
  theme(legend.position = "bottom")
```



Build your plots a piece at a time

```
asasec %>
  filter(Year == 2014) %>
  ggplot(mapping = aes(x = Members,
                        y = Revenues,
                        label = Sname)) +
  geom_smooth(method = "lm",
              se = FALSE,
              color = "gray60") +
  geom_point(mapping = aes(color = Journal),
             size = rel(3)) +
  geom_text_repel(data=subset(asasec,
                             Year == 2014 &
                               Revenues > 7000),
                 size = rel(5),
                 mapping =
                   aes(family = "Tenso Slide")) +
  scale_y_continuous(labels =
    scales::label_dollar()) +
  labs(x="Membership", y="Revenues",
       color = "Section has own Journal",
       title = "ASA Sections",
       subtitle = "2014 Calendar year.",
       caption = "Source: ASA annual report.") +
  theme(legend.position = "bottom")
```



More about Scales

Working with `color` and `fill` scales

`scale_<MAPPING>_<KIND>()`

Scale functions control the display of the variables they map. So to change the colors for `color` or `fill` mappings, you adjust the corresponding `scale_` function, not the `theme()` function.

`ggplot` has several color palettes built in. A variety of packages provide others.

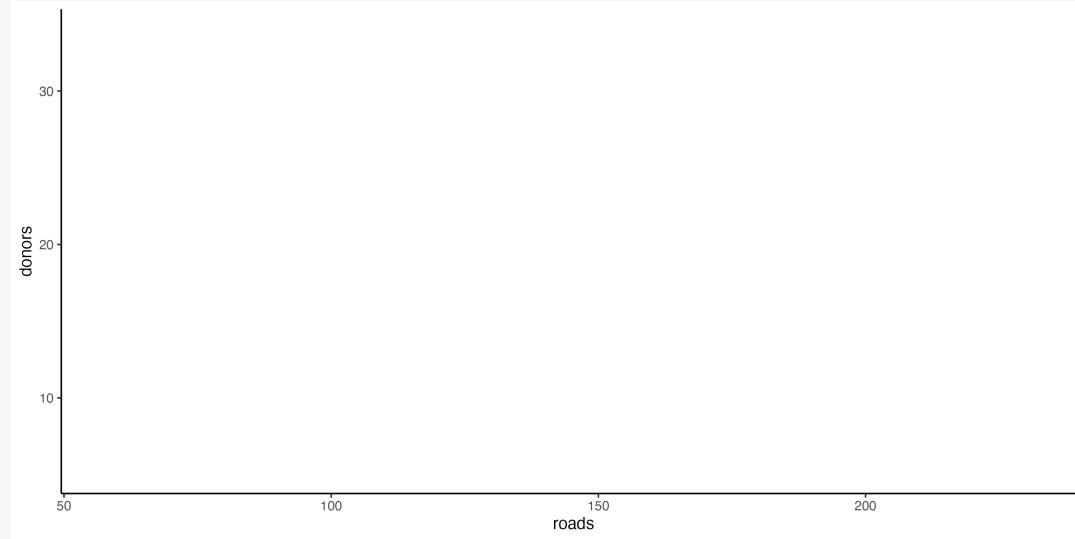
You can specify scales manually

organdata

```
# A tibble: 238 × 21
  country     year    donors    pop  pop_dens    gdp  gdp_lag health health_lag
  <chr>     <date>   <dbl>   <int>    <dbl>   <int>   <dbl>    <dbl>
1 Australia NA        NA  17065    0.220  16774  16591  1300    1224
2 Australia 1991-01-01 12.1 17284    0.223  17171  16774  1379    1300
3 Australia 1992-01-01 12.4 17495    0.226  17914  17171  1455    1379
4 Australia 1993-01-01 12.5 17667    0.228  18883  17914  1540    1455
5 Australia 1994-01-01 10.2 17855    0.231  19849  18883  1626    1540
6 Australia 1995-01-01 10.2 18072    0.233  21079  19849  1737    1626
7 Australia 1996-01-01 10.6 18311    0.237  21923  21079  1846    1737
8 Australia 1997-01-01 10.3 18518    0.239  22961  21923  1948    1846
9 Australia 1998-01-01 10.5 18711    0.242  24148  22961  2077    1948
10 Australia 1999-01-01 8.67 18926    0.244  25445  24148  2231   2077
# i 228 more rows
# i 12 more variables: pubhealth <dbl>, roads <dbl>, cerebvas <int>,
# assault <int>, external <int>, txp_pop <dbl>, world <chr>, opt <chr>,
# consent_law <chr>, consent_practice <chr>, consistent <chr>, ccode <chr>
```

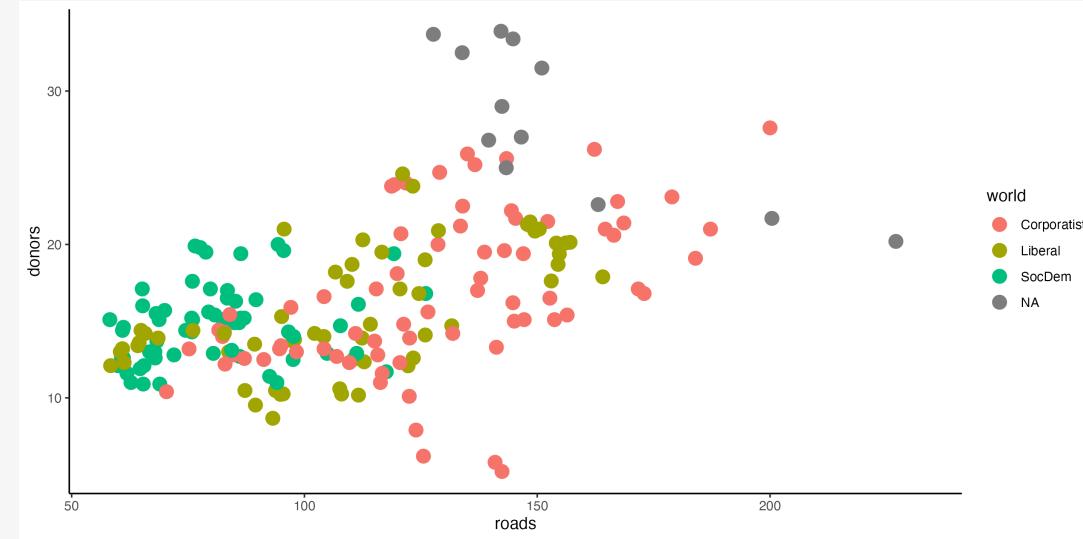
You can specify scales manually

```
organdata %>%  
  ggplot(mapping = aes(x = roads,  
                        y = donors,  
                        color = world))
```



You can specify scales manually

```
organdata %>  
  ggplot(mapping = aes(x = roads,  
                        y = donors,  
                        color = world)) +  
  geom_point(size = 4)
```



You can specify scales manually

```
organdata %>  
  ggplot(mapping = aes(x = roads,  
                        y = donors,  
                        color = world)) +  
  geom_point(size = 4) →  
  p
```

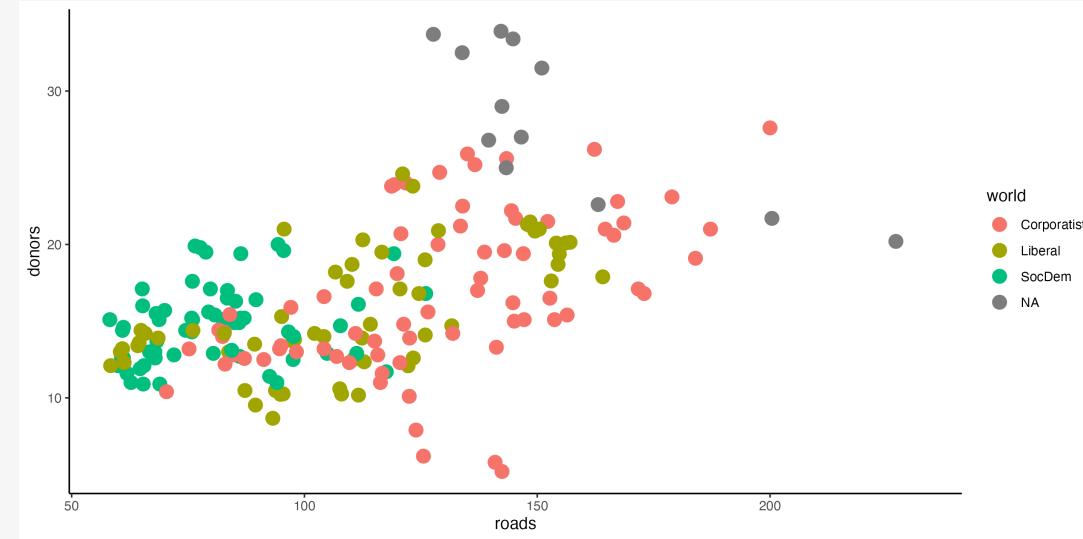
You can specify scales manually

```
organdata %>  
  ggplot(mapping = aes(x = roads,  
                        y = donors,  
                        color = world)) +  
  geom_point(size = 4) →  
p
```

```
p ← organdata %>  
  ggplot(mapping = aes(x = roads,  
                        y = donors,  
                        color = world)) +  
  geom_point(size = 4)
```

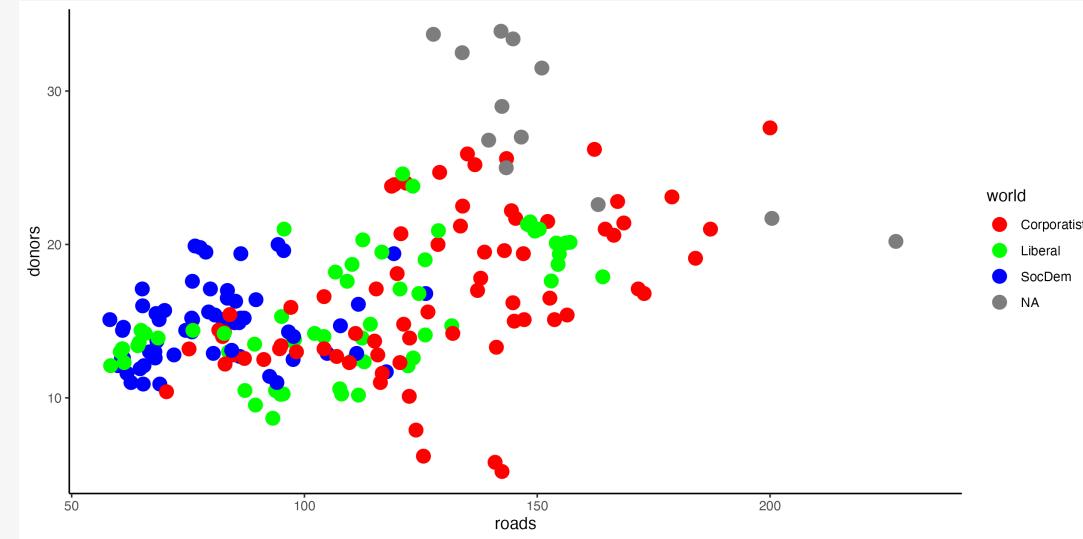
You can specify scales manually

p



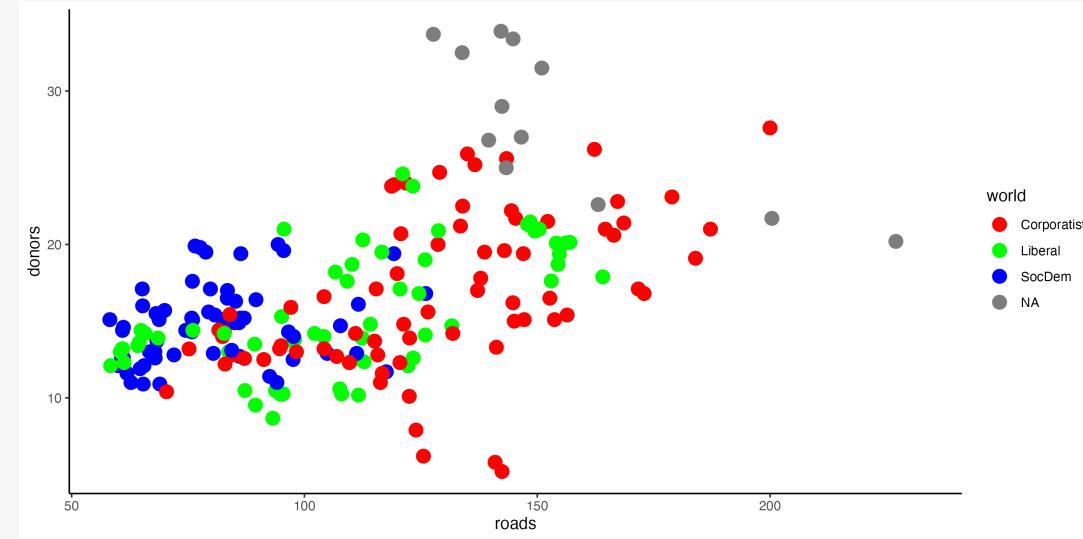
You can specify scales manually

```
p +  
  scale_color_manual(  
    values = c("red", "green", "blue"))
```



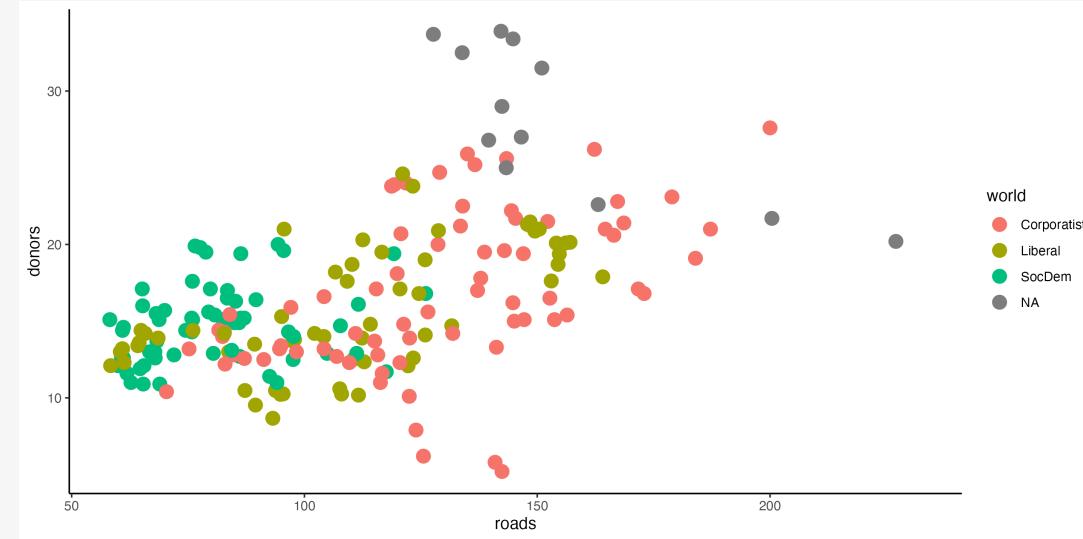
You can specify scales manually

```
p +  
  scale_color_manual(  
    values = c("red", "green", "blue"))
```



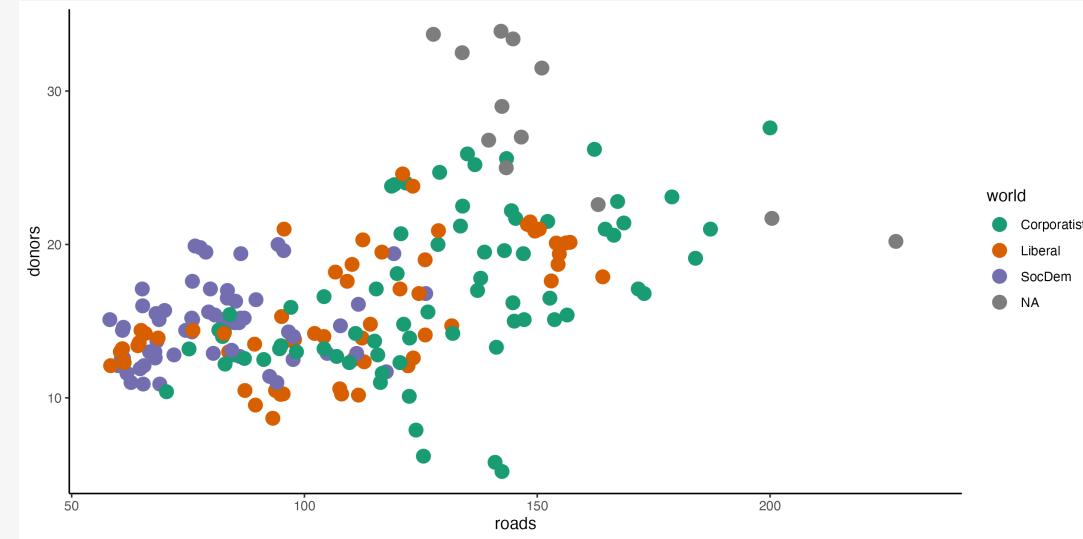
You can specify scales manually

p



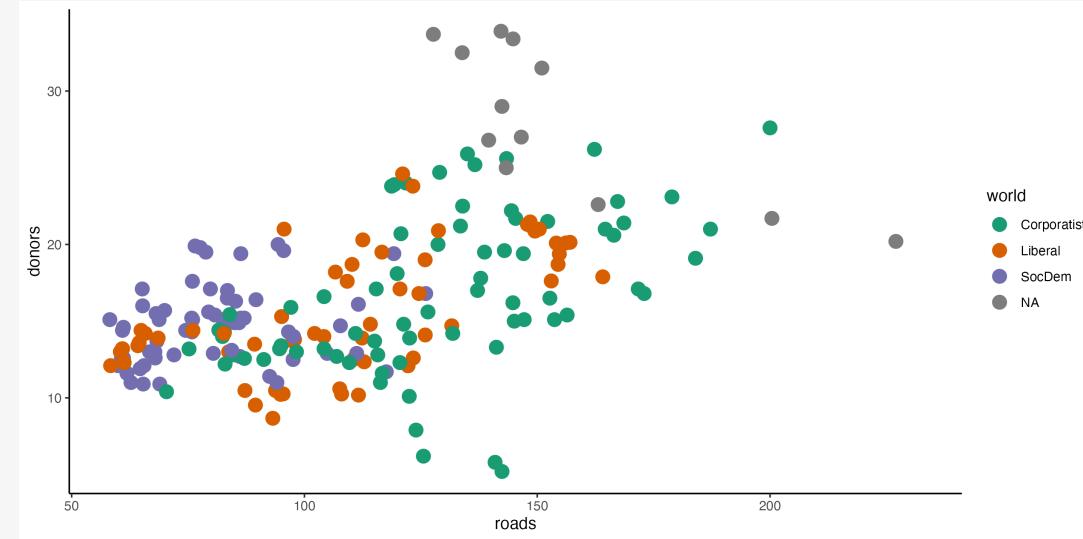
You can specify scales manually

```
p +  
  scale_color_manual(  
    values = c("#1B9E77", "#D95F02", "#7570B3"))
```



You can specify scales manually

```
p +  
  scale_color_manual(  
    values = c("#1B9E77", "#D95F02", "#7570B3"))
```



You can specify scales manually

```
colkey ← c("Corporatist" = "pink",
          "Liberal" = "goldenrod",
          "SocDem" = "firebrick")
```

You can specify scales manually

```
colkey ← c("Corporatist" = "pink",
          "Liberal" = "goldenrod",
          "SocDem" = "firebrick")
colkey
```

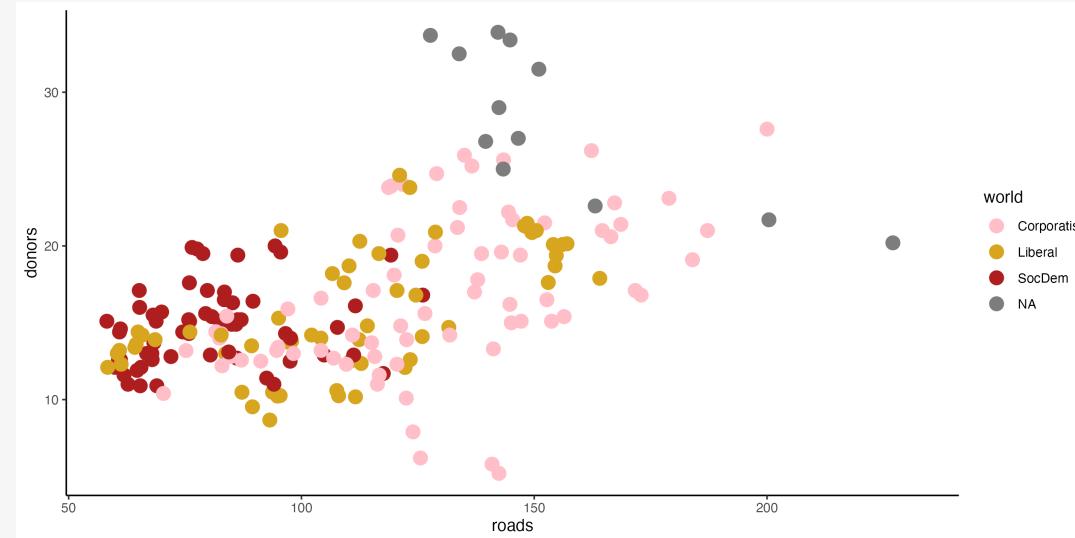
```
Corporatist      Liberal      SocDem
"pink" "goldenrod" "firebrick"
```

You can specify scales manually

```
colkey <- c("Corporatist" = "pink",
          "Liberal" = "goldenrod",
          "SocDem" = "firebrick")
colkey

p + scale_color_manual(
  values = colkey)
```

```
Corporatist      Liberal      SocDem
"pink" "goldenrod" "firebrick"
```

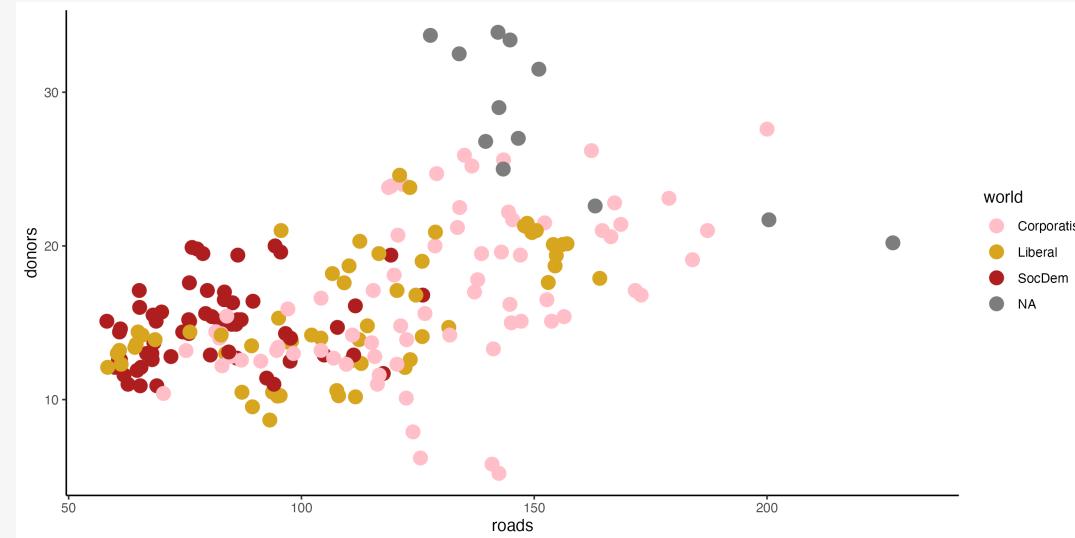


You can specify scales manually

```
colkey <- c("Corporatist" = "pink",
          "Liberal" = "goldenrod",
          "SocDem" = "firebrick")
colkey

p + scale_color_manual(
  values = colkey)
```

```
Corporatist      Liberal      SocDem
"pink" "goldenrod" "firebrick"
```



Use balanced palettes

E.g., the `RColorBrewer` Palettes

These are available through the `scale_color-brewer()` and `scale_fill_brewer()` functions, as independently.

See the palettes with
`RColorBrewer :: display.brewer`

Qualitative palettes



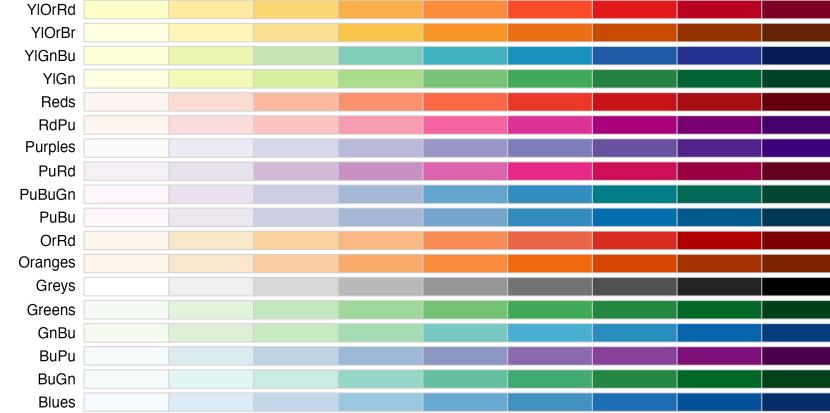
Use balanced palettes

E.g., the `RColorBrewer` Palettes

These are available through the `scale_color-brewer()` and `scale_fill_brewer()` functions, as independently.

See the palettes with
`RColorBrewer :: display.brewer`

Sequential palettes



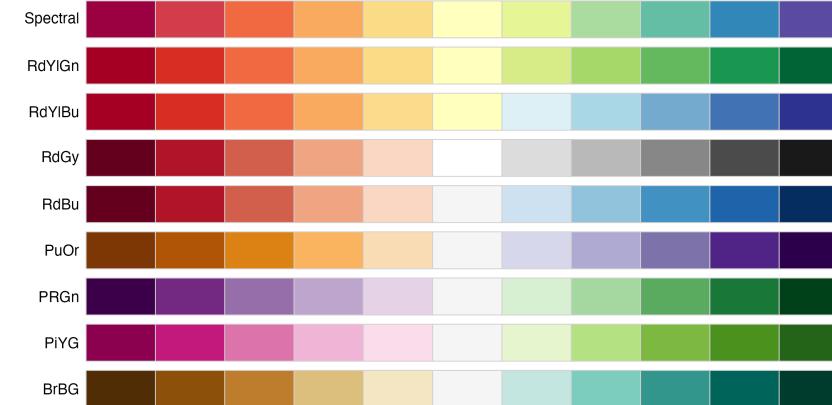
Use balanced palettes

E.g., the `RColorBrewer` Palettes

These are available through the `scale_color-brewer()` and `scale_fill_brewer()` functions, as independently.

See the palettes with
`RColorBrewer :: display.brewer`

Diverging palettes



Qualitative Brewer Palettes

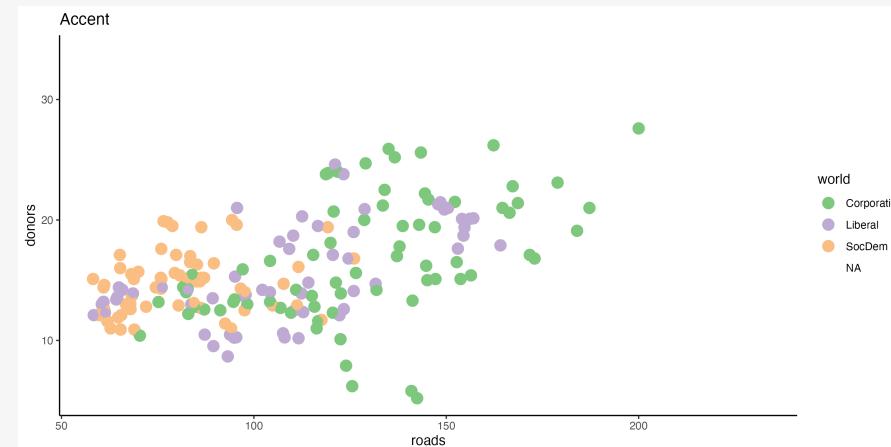
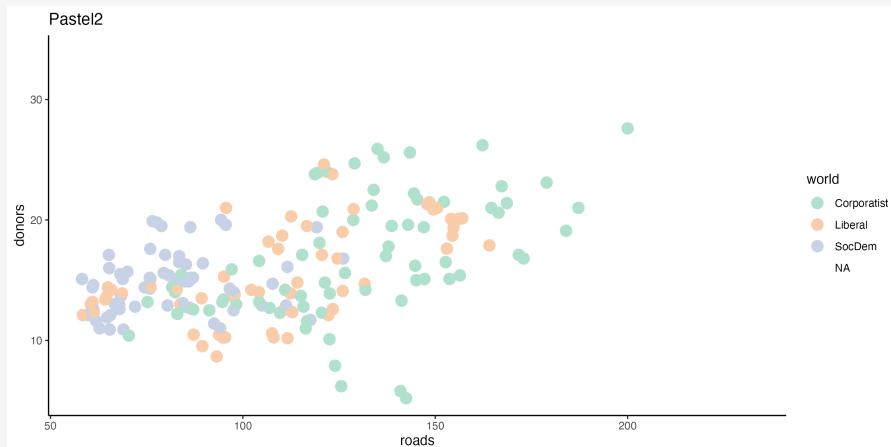
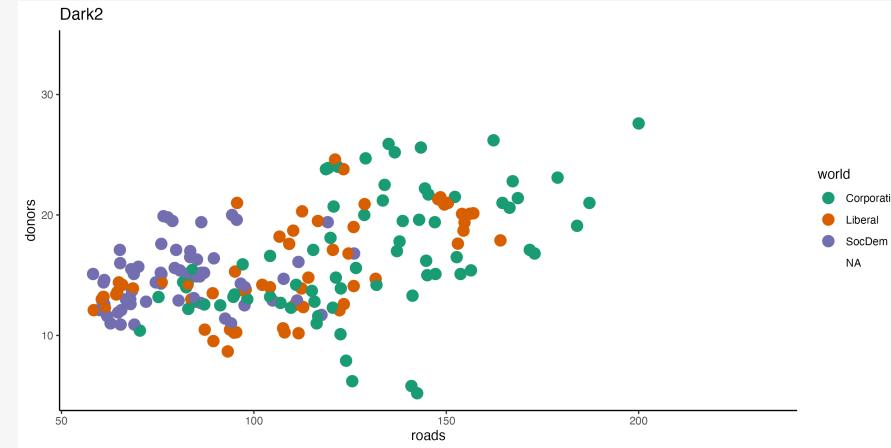
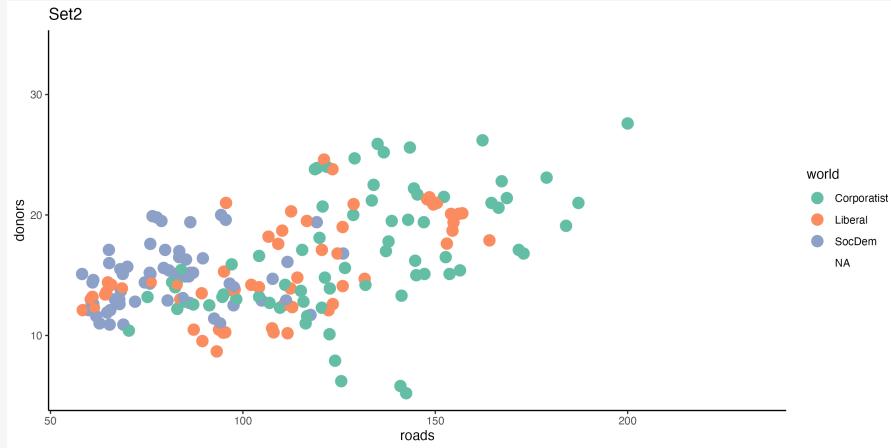
```
p + geom_point(size = 2) +
  scale_color_brewer(palette = "Set2") +
  labs(title = "Set2")

p + geom_point(size = 2) +
  scale_color_brewer(palette = "Pastel2") +
  labs(title = "Pastel2")

p + geom_point(size = 2) +
  scale_color_brewer(palette = "Dark2") +
  labs(title = "Dark2")

p + geom_point(size = 2) +
  scale_color_brewer(palette = "Accent") +
  labs(title = "Accent")
```

Some color palettes

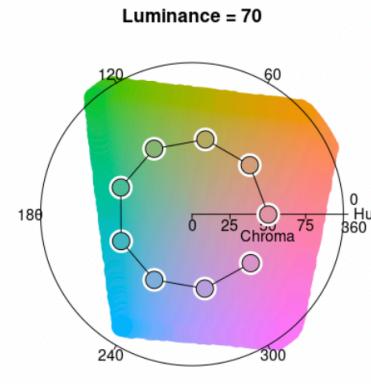


The `colorspace` package has more

[Get started](#)[Articles ▾](#)[Reference](#)[Changelog](#)[Contact](#)

A Toolbox for Manipulating and Assessing Colors and Palettes

Color spaces



HCL-based palettes

Qualitative

Pastel 1	pink	orange	green	blue	purple	yellow
Dark 3	dark pink	dark orange	dark green	dark blue	dark purple	dark yellow
Harmonic	light pink	light orange	light green	light blue	light purple	light yellow

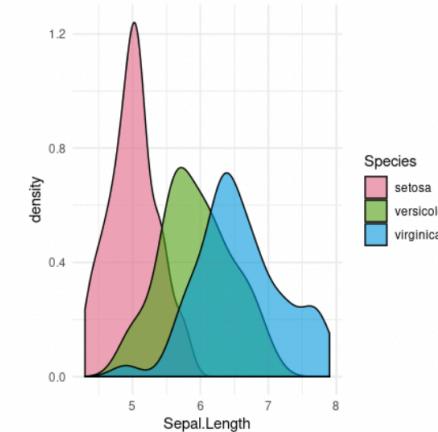
Sequential (single-hue)

Blues 3	dark blue	medium blue	light blue
Reds 3	dark red	medium red	light red
Greens 3	dark green	medium green	light green

Sequential (multi-hue)

Purple-Blue	purple	dark blue	medium blue	light blue
Viridis	dark purple	dark teal	medium teal	light yellow
ag_Sunset	dark purple	dark orange	medium orange	light yellow
Diverging	dark blue	medium blue	white	dark red
Blue-Red	dark blue	medium blue	white	medium red
Green-Brown	dark green	medium green	white	medium brown
Tropic	dark teal	medium teal	white	dark magenta

ggplot2 scales



Many palettes

Links

Download from CRAN at
[https://cloud.r-project.org/
package=colorspace](https://cloud.r-project.org/package=colorspace)

Report a bug at
[https://colorspace.R-Forge.R-project.org/
contact.html](https://colorspace.R-Forge.R-project.org/contact.html)

Online color apps at
<https://hclwizard.org/>

License

[BSD_3_clause](#) + file LICENSE

Citation

[Citing colorspace](#)

Developers

Ross Ihaka
Author



So many colors

The `colorspace` function convention

`scale_<MAPPING>_<KIND><COLORSCALE>()`

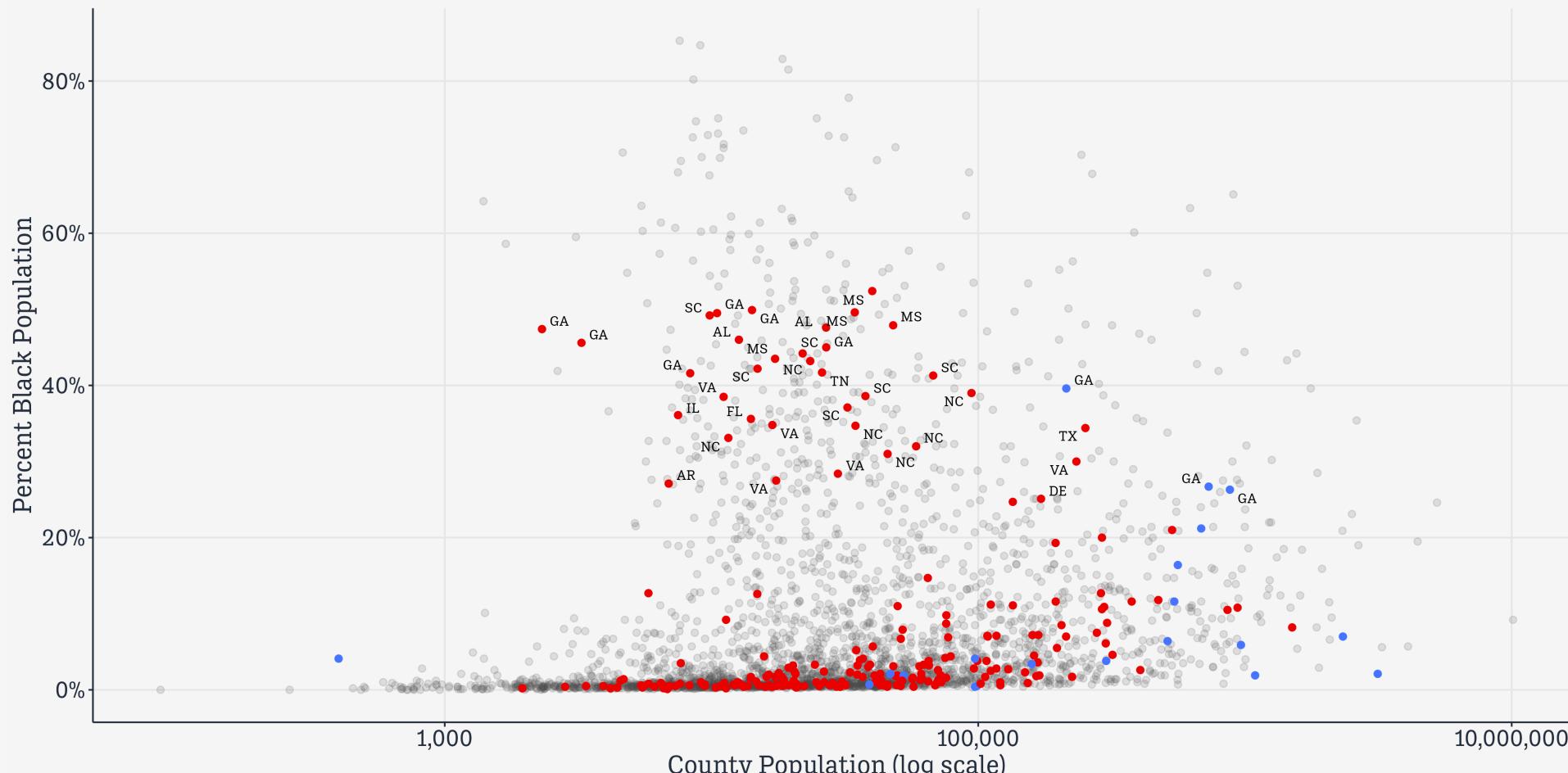
`scale_color_binned_diverging()`
`scale_color_binned_qualitative()`
`scale_color_binned_sequential()`
`scale_color_continuous_diverging()`
`scale_color_continuous_qualitative()`
`scale_color_continuous_sequential()`
`scale_color_discrete_diverging()`
`scale_color_discrete_qualitative()`
`scale_color_discrete_sequential()`

`scale_fill_binned_diverging()`
`scale_fill_binned_divergingx()`
`scale_fill_binned_qualitative()`
`scale_fill_binned_sequential()`
`scale_fill_continuous_diverging()`
`scale_fill_continuous_qualitative()`
`scale_fill_continuous_sequential()`
`scale_fill_discrete_diverging()`
`scale_fill_discrete_qualitative()`
`scale_fill_discrete_sequential()`

**Layer color and text
to your advantage**

Flipped counties, 2016

County flipped to ... • Democrat • Republican



Counties in gray did not flip.

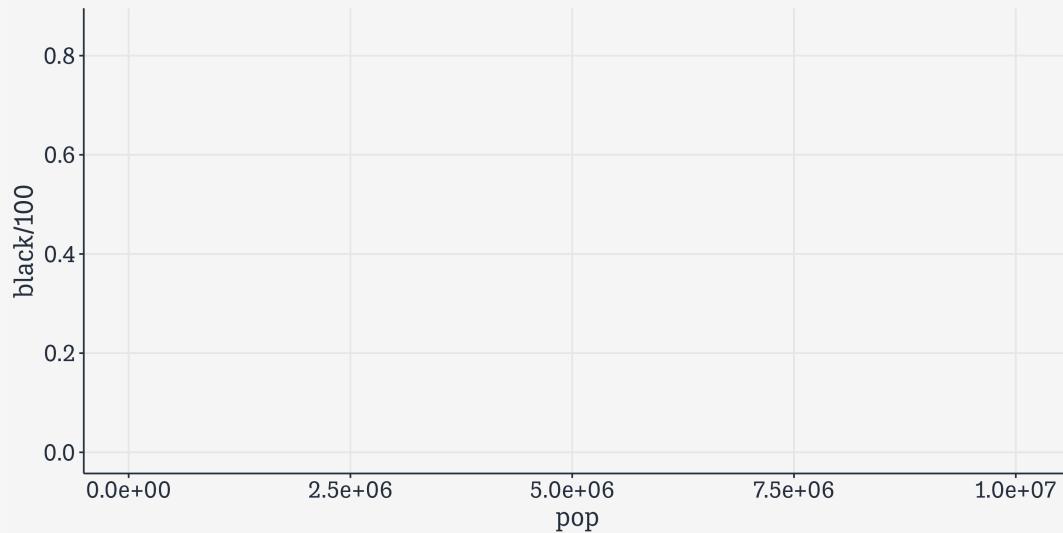
We know how to build this

```
## Brighter Blue and Red  
party_colors ← c("royalblue1", "red2")
```

We know how to build this

```
## Brighter Blue and Red
party_colors ← c("royalblue1", "red2")

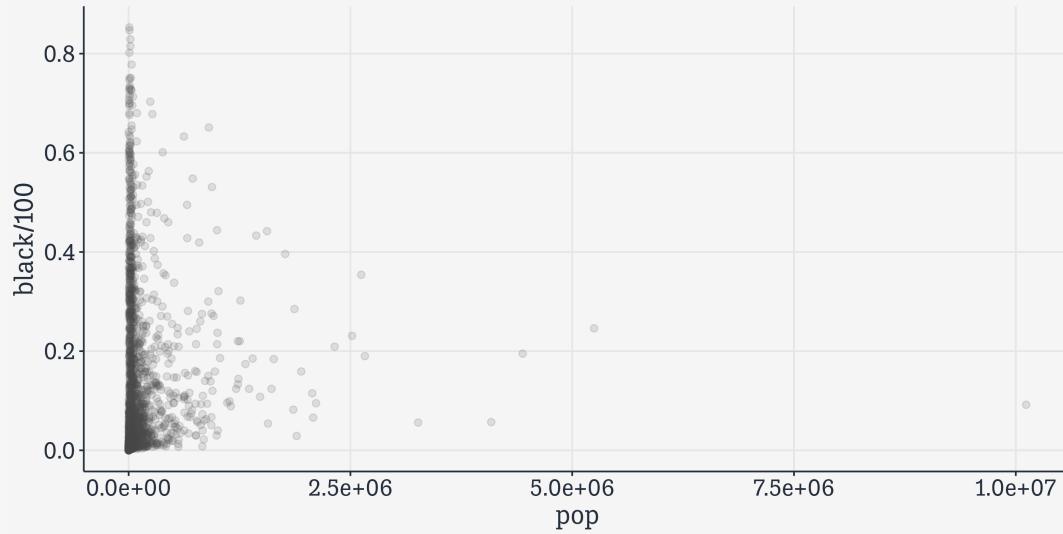
ggplot(data = subset(county_data,
                     flipped = "No"),
       mapping = aes(x = pop,
                     y = black/100))
```



We know how to build this

```
## Brighter Blue and Red
party_colors <- c("royalblue1", "red2")

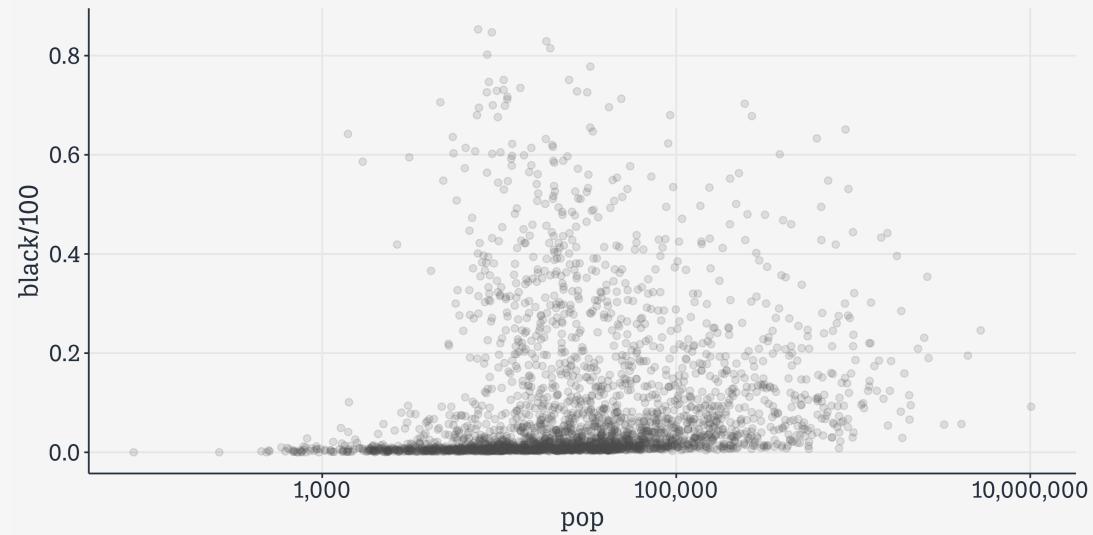
ggplot(data = subset(county_data,
                     flipped = "No"),
       mapping = aes(x = pop,
                     y = black/100)) +
  geom_point(alpha = 0.15, color = "gray30",
             size = rel(2))
```



We know how to build this

```
## Brighter Blue and Red
party_colors <- c("royalblue1", "red2")

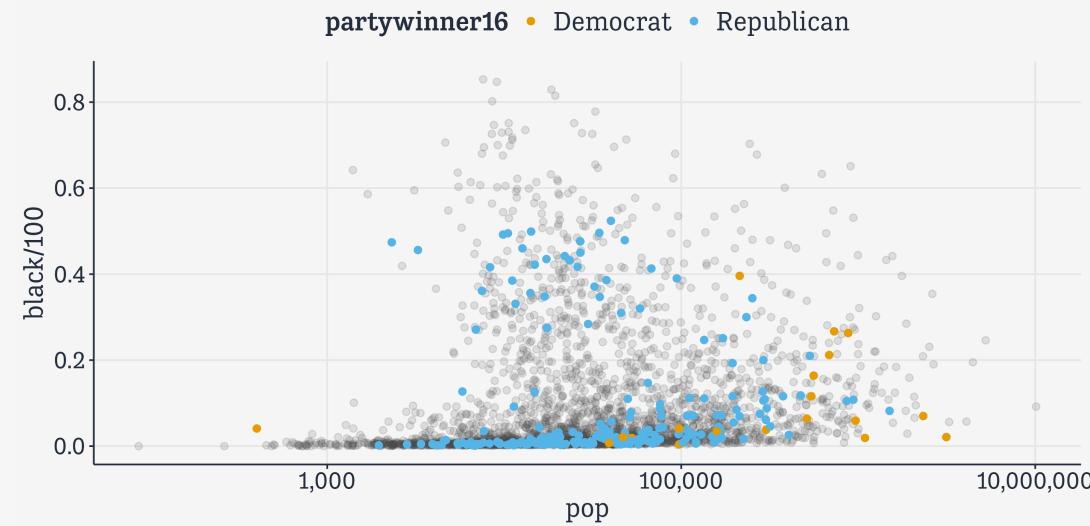
ggplot(data = subset(county_data,
                     flipped = "No"),
       mapping = aes(x = pop,
                     y = black/100)) +
  geom_point(alpha = 0.15, color = "gray30",
             size = rel(2)) +
  scale_x_log10(labels = label_comma())
```



We know how to build this

```
## Brighter Blue and Red
party_colors <- c("royalblue1", "red2")

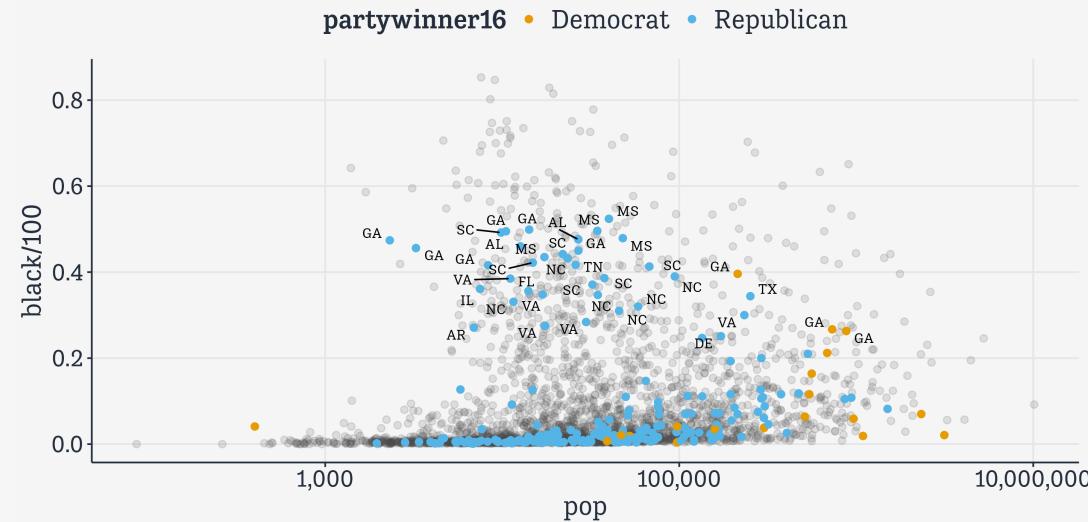
ggplot(data = subset(county_data,
                     flipped = "No"),
       mapping = aes(x = pop,
                     y = black/100)) +
  geom_point(alpha = 0.15, color = "gray30",
             size = rel(2)) +
  scale_x_log10(labels = label_comma()) +
  geom_point(data = subset(county_data,
                           flipped = "Yes"),
             mapping = aes(x = pop, y = black/100,
                           color = partywinner16),
             size = rel(2))
```



We know how to build this

```
## Brighter Blue and Red
party_colors <- c("royalblue1", "red2")

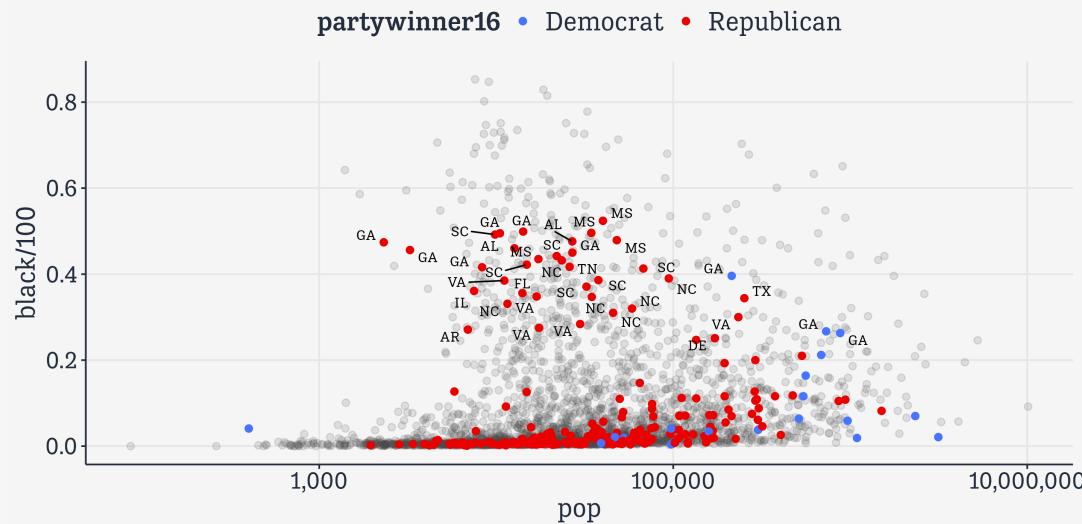
ggplot(data = subset(county_data,
                     flipped = "No"),
       mapping = aes(x = pop,
                      y = black/100)) +
  geom_point(alpha = 0.15, color = "gray30",
             size = rel(2)) +
  scale_x_log10(labels = label_comma()) +
  geom_point(data = subset(county_data,
                           flipped = "Yes"),
             mapping = aes(x = pop, y = black/100,
                            color = partywinner16),
             size = rel(2)) +
  geom_text_repel(data = subset(county_data,
                               flipped = "Yes" & black > 25),
                  mapping = aes(x = pop,
                                 y = black/100, label = state,
                                 family = "Tenso Slide",
                                 face = "bold"), size = rel(3.5))
```



We know how to build this

```
## Brighter Blue and Red
party_colors <- c("royalblue1", "red2")

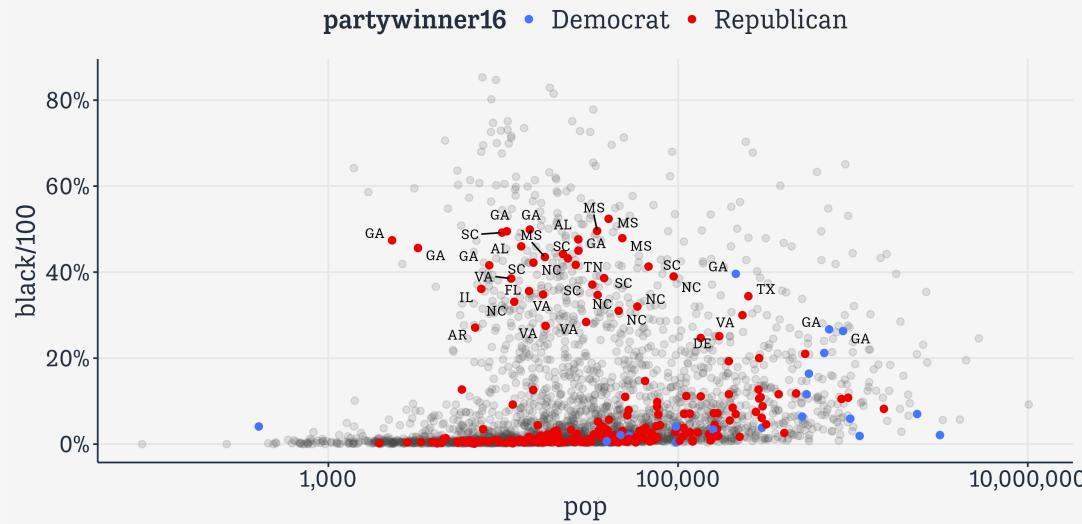
ggplot(data = subset(county_data,
                     flipped = "No"),
       mapping = aes(x = pop,
                     y = black/100)) +
  geom_point(alpha = 0.15, color = "gray30",
             size = rel(2)) +
  scale_x_log10(labels = label_comma()) +
  geom_point(data = subset(county_data,
                           flipped = "Yes"),
             mapping = aes(x = pop, y = black/100,
                           color = partywinner16),
             size = rel(2)) +
  geom_text_repel(data = subset(county_data,
                               flipped = "Yes" & black > 25),
                  mapping = aes(x = pop,
                                y = black/100, label = state,
                                family = "Tenso Slide",
                                face = "bold"), size = rel(3.5))
  scale_color_manual(values = party_colors)
```



We know how to build this

```
## Brighter Blue and Red
party_colors <- c("royalblue1", "red2")

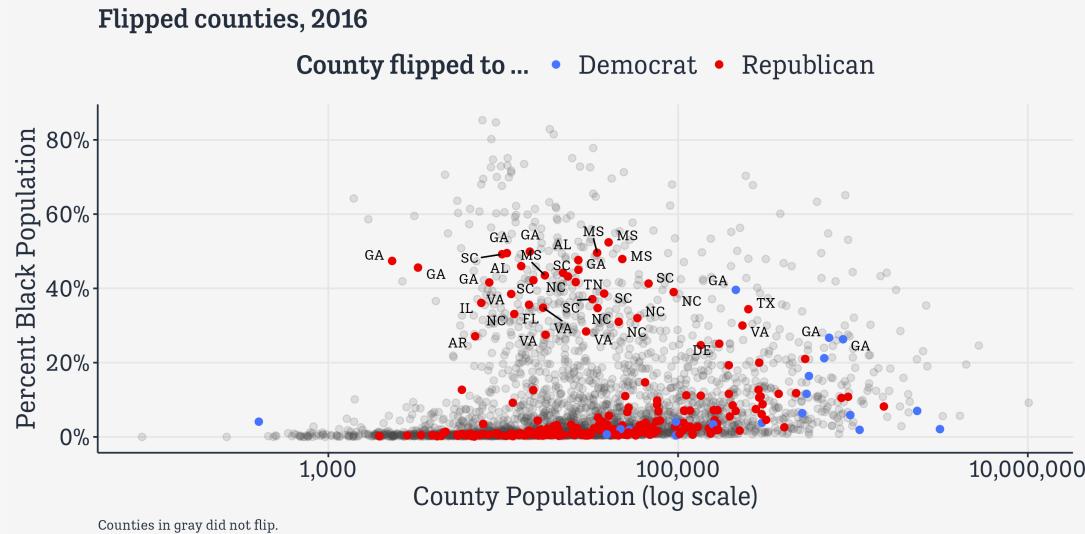
ggplot(data = subset(county_data,
                     flipped = "No"),
       mapping = aes(x = pop,
                      y = black/100)) +
  geom_point(alpha = 0.15, color = "gray30",
             size = rel(2)) +
  scale_x_log10(labels = label_comma()) +
  geom_point(data = subset(county_data,
                           flipped = "Yes"),
             mapping = aes(x = pop, y = black/100,
                            color = partywinner16),
             size = rel(2)) +
  geom_text_repel(data = subset(county_data,
                               flipped = "Yes" & black > 25),
                  mapping = aes(x = pop,
                                 y = black/100, label = state,
                                 family = "Tenso Slide",
                                 face = "bold"), size = rel(3.5))
  scale_color_manual(values = party_colors) +
  scale_y_continuous(labels = label_percent())
```



We know how to build this

```
## Brighter Blue and Red
party_colors <- c("royalblue1", "red2")

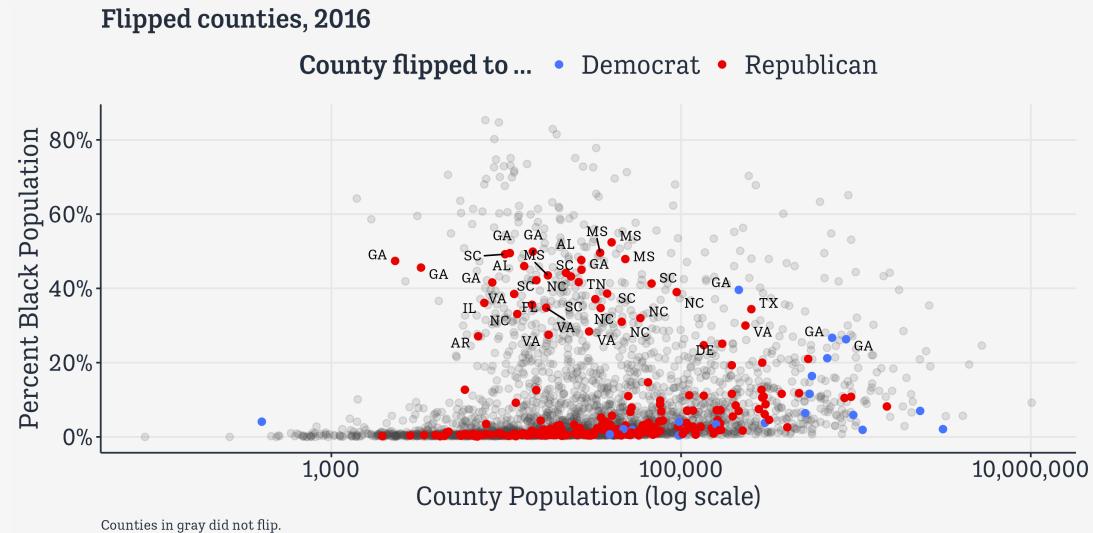
ggplot(data = subset(county_data,
                     flipped = "No"),
       mapping = aes(x = pop,
                     y = black/100)) +
  geom_point(alpha = 0.15, color = "gray30",
             size = rel(2)) +
  scale_x_log10(labels = label_comma()) +
  geom_point(data = subset(county_data,
                           flipped = "Yes"),
             mapping = aes(x = pop, y = black/100,
                           color = partywinner16),
             size = rel(2)) +
  geom_text_repel(data = subset(county_data,
                               flipped = "Yes" & black > 25),
                  mapping = aes(x = pop,
                                y = black/100, label = state,
                                family = "Tenso Slab",
                                face = "bold"), size = rel(3.5))
  scale_color_manual(values = party_colors) +
  scale_y_continuous(labels = label_percent()) +
  labs(color = "County flipped to ...",
       x = "County Population (log scale)",
       y = "Percent Black Population",
       title = "Flipped counties, 2016",
       caption = "Counties in gray did not flip.")
```



We know how to build this

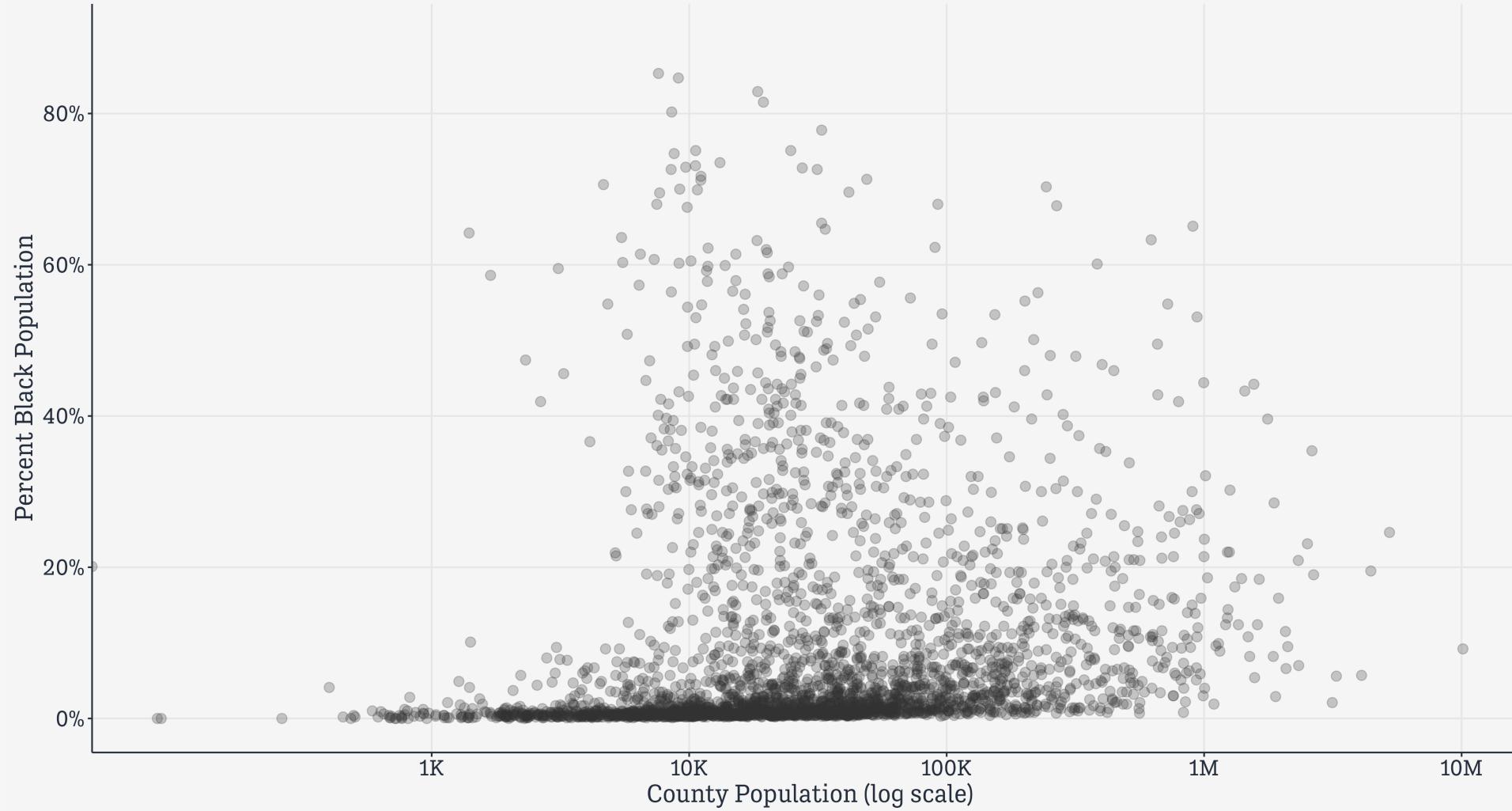
```
## Brighter Blue and Red
party_colors <- c("royalblue1", "red2")

ggplot(data = subset(county_data,
                     flipped = "No"),
       mapping = aes(x = pop,
                     y = black/100)) +
  geom_point(alpha = 0.15, color = "gray30",
             size = rel(2)) +
  scale_x_log10(labels = label_comma()) +
  geom_point(data = subset(county_data,
                           flipped = "Yes"),
             mapping = aes(x = pop, y = black/100,
                           color = partywinner16),
             size = rel(2)) +
  geom_text_repel(data = subset(county_data,
                               flipped = "Yes" & black > 25),
                  mapping = aes(x = pop,
                                y = black/100, label = state,
                                family = "Tenso Slab",
                                face = "bold"), size = rel(3.5))
  scale_color_manual(values = party_colors) +
  scale_y_continuous(labels = label_percent()) +
  labs(color = "County flipped to ...",
       x = "County Population (log scale)",
       y = "Percent Black Population",
       title = "Flipped counties, 2016",
       caption = "Counties in gray did not flip.")
```

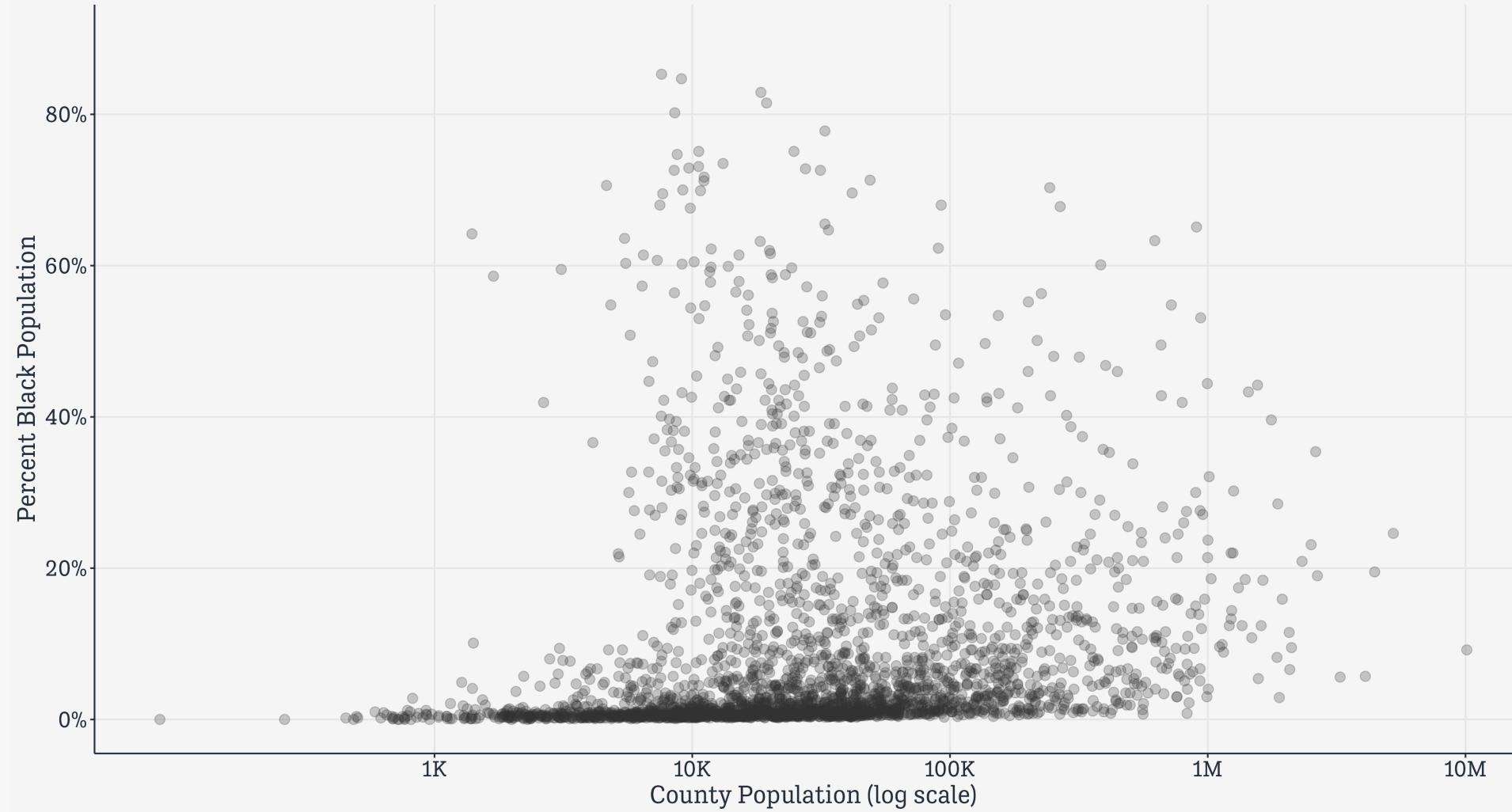


Leverage ggplot's
layered approach

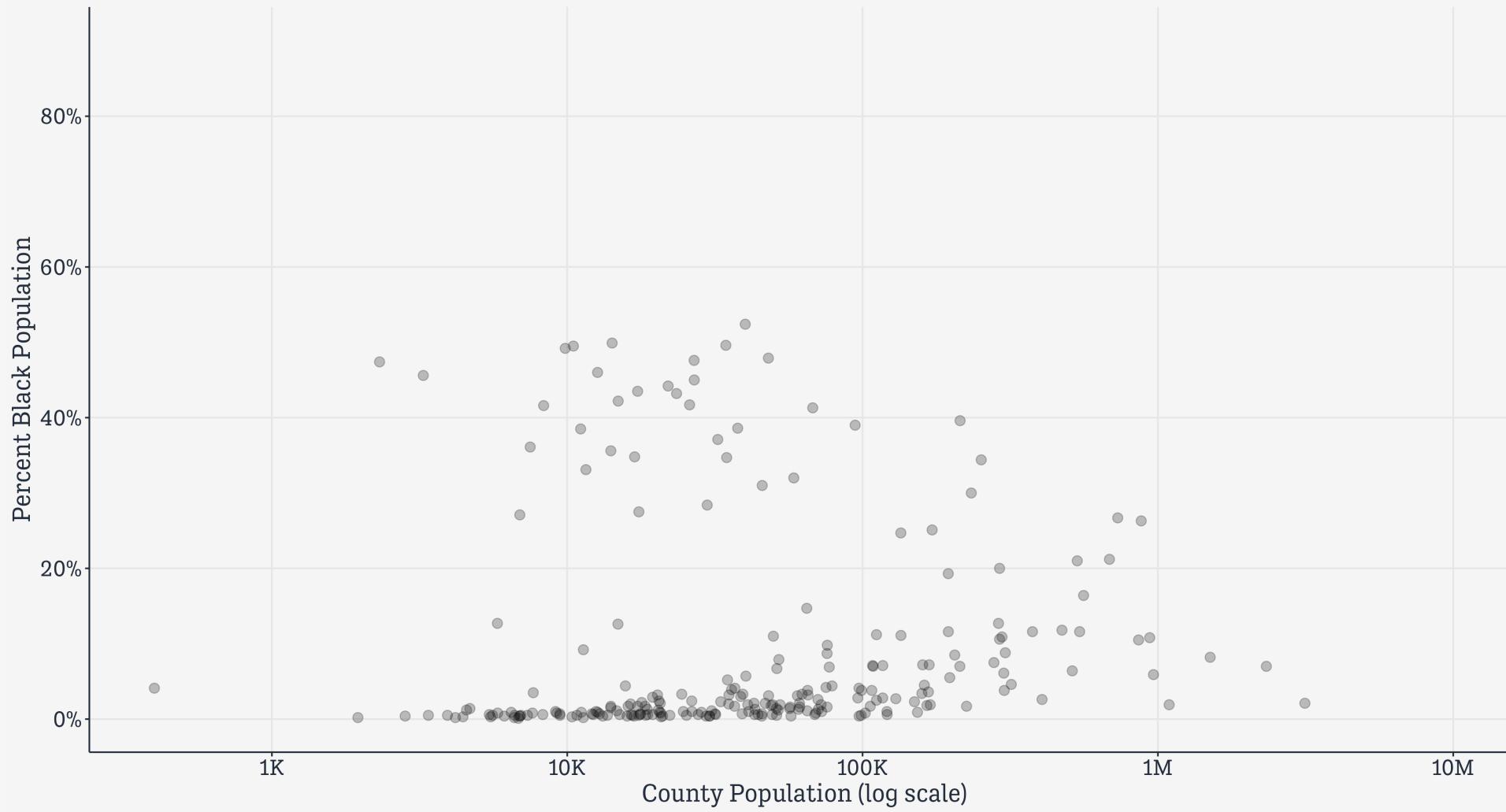
U.S. Counties by Population and Percent Black



These counties did not flip in 2016

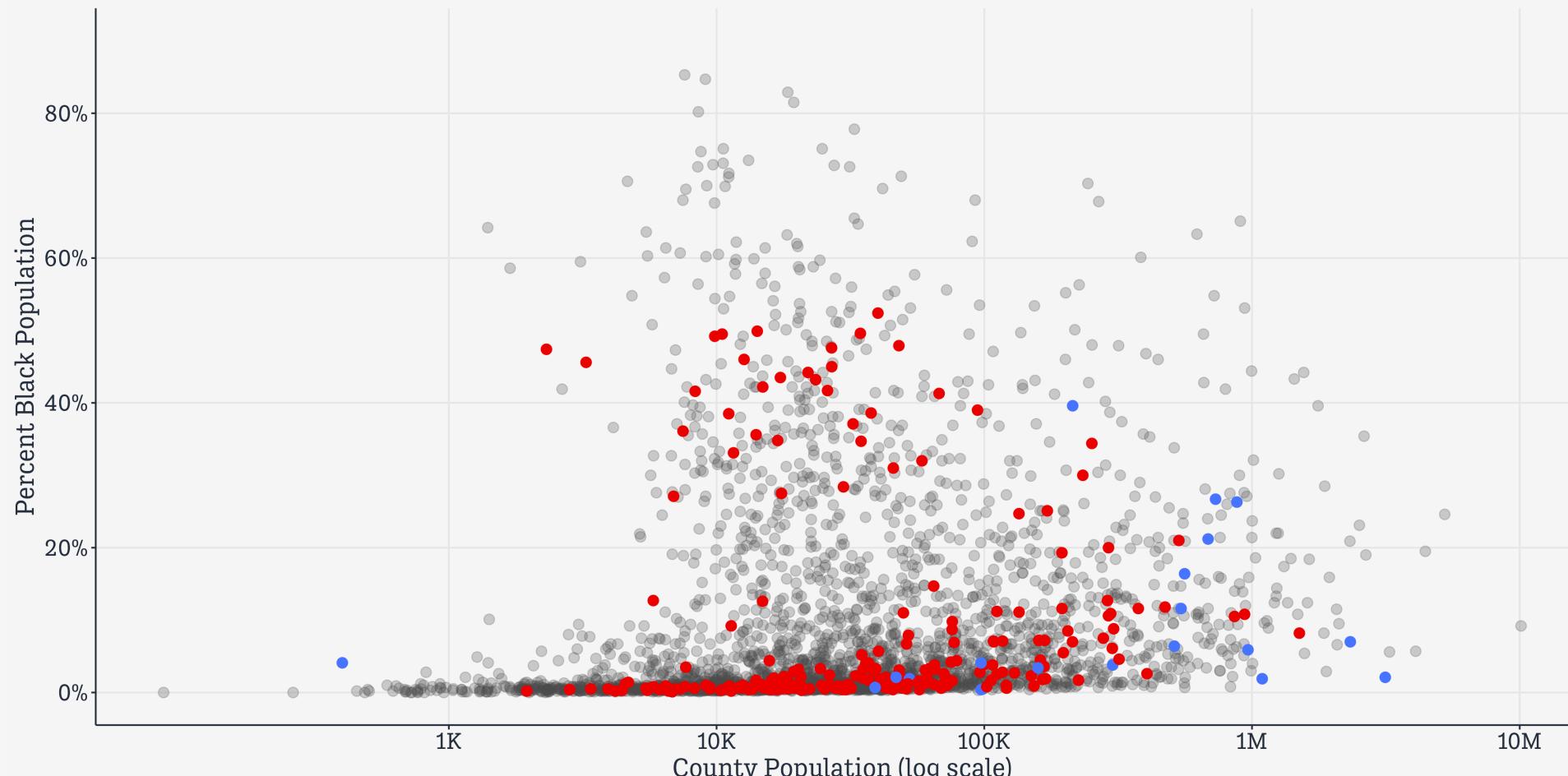


These counties did



Counties that flipped shown by party color

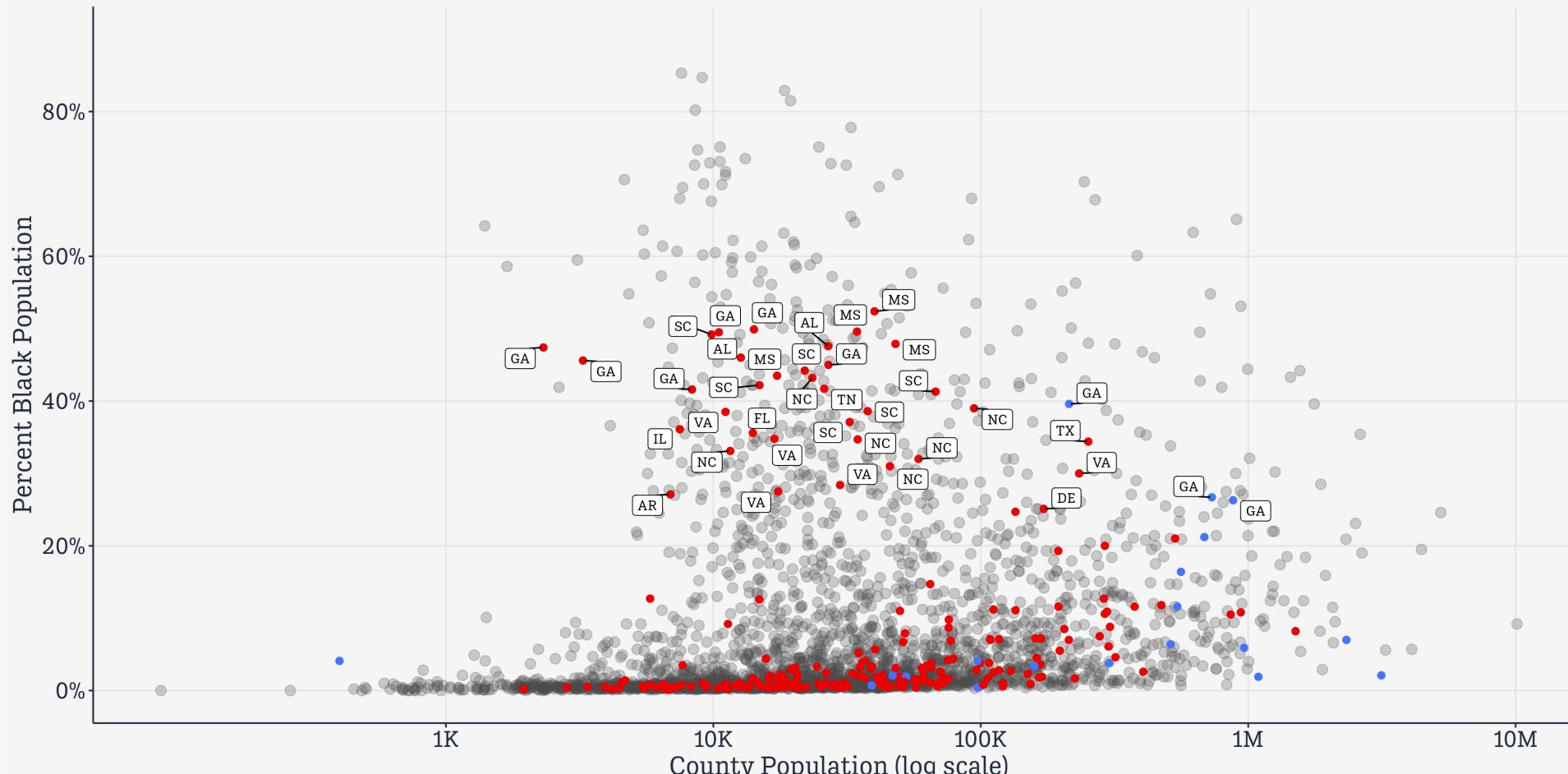
Flipped to • Democrat • Republican



Counties in gray did not flip.

Counties that flipped shown by party color, and labeled by state

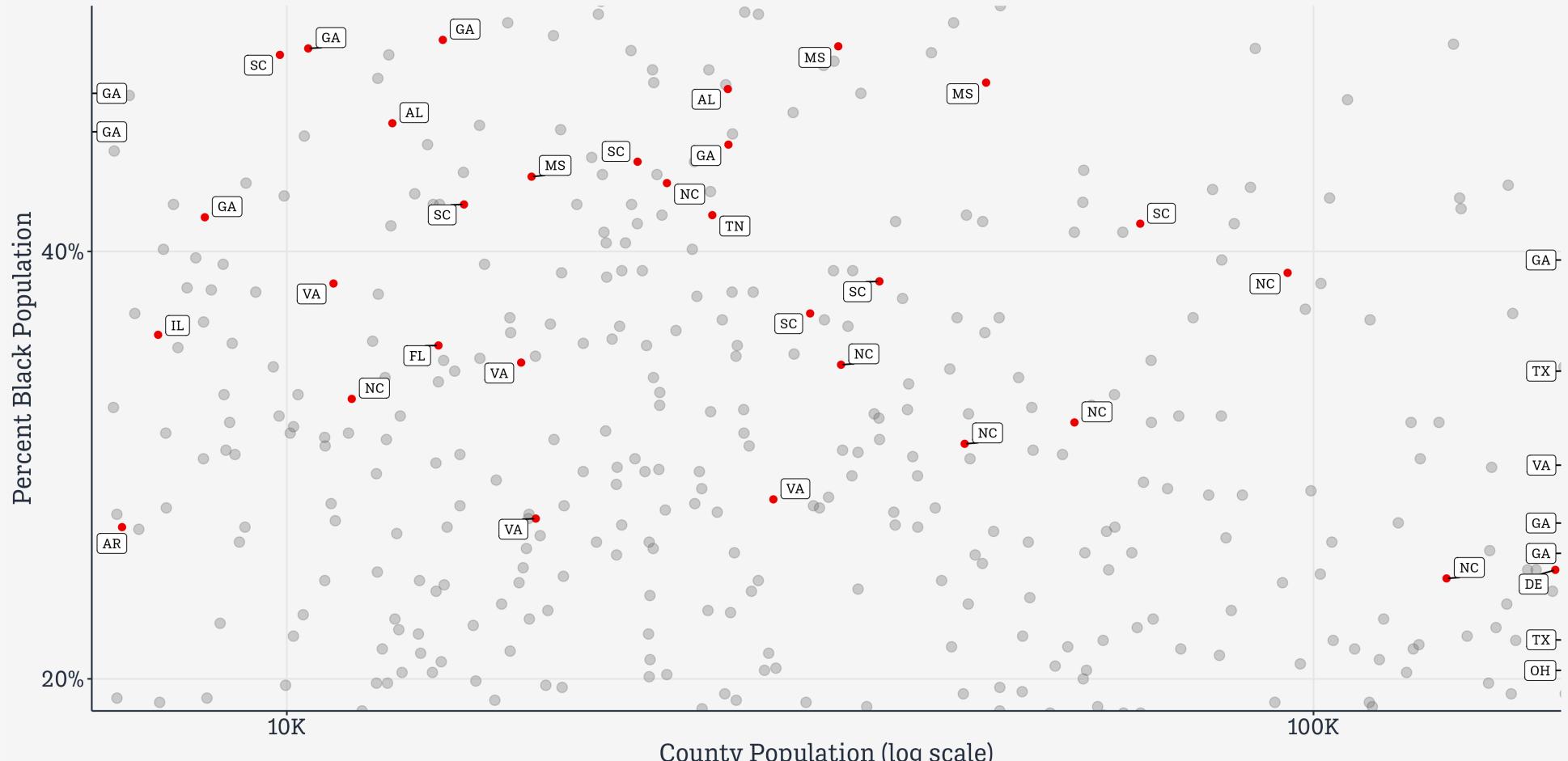
Flipped to • Democrat • Republican



Counties in gray did not flip.

Counties that flipped shown by party color, and labeled by state; zoomed-in

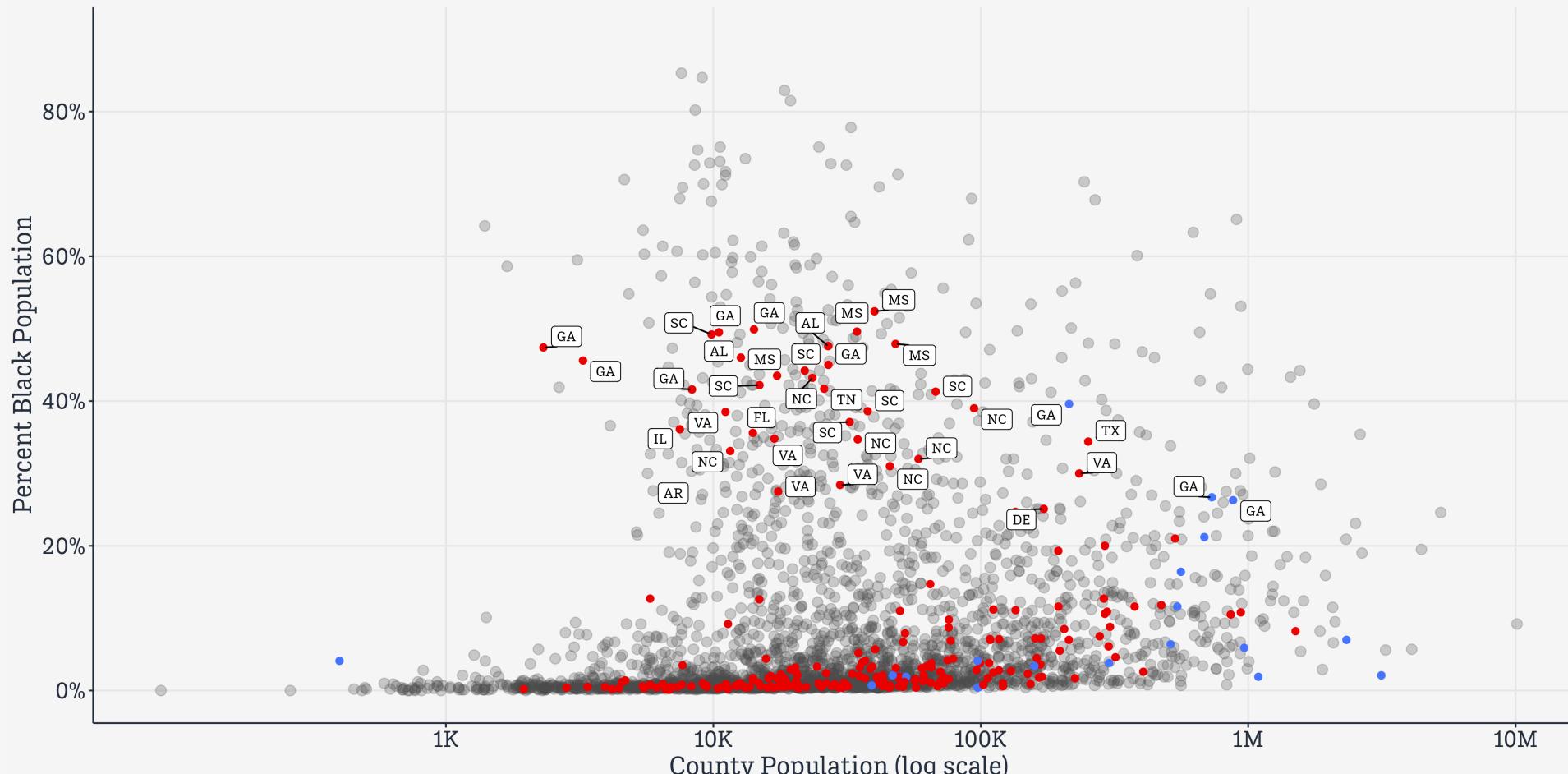
Flipped to • Democrat • Republican



Counties in gray did not flip.

Counties that flipped shown by party color, and labeled by state

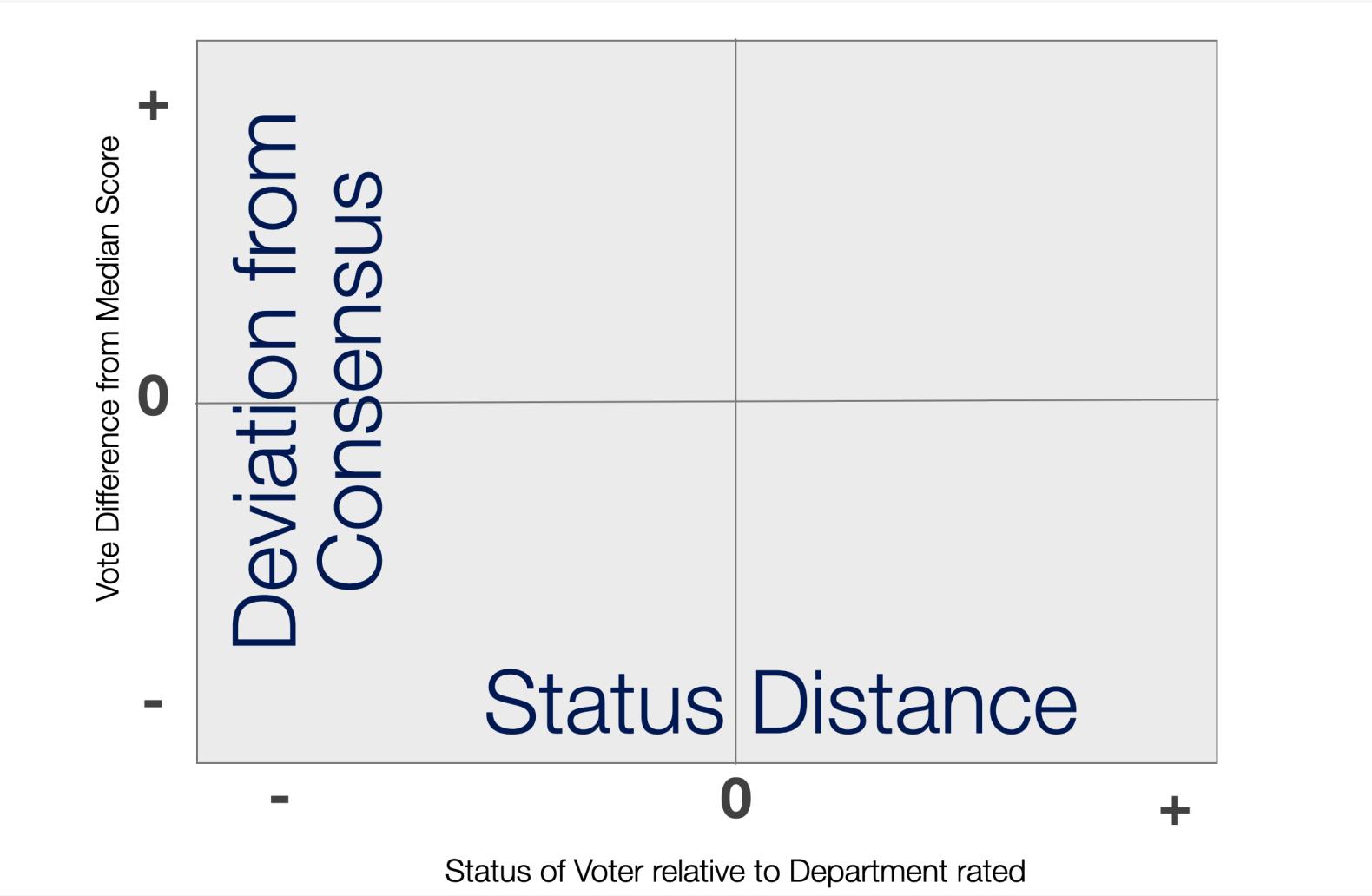
Flipped to • Democrat • Republican



Counties in gray did not flip.

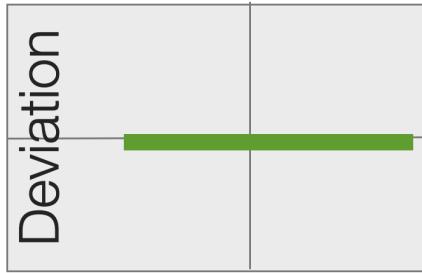
Layer,
Highlight,
Repeat

Build from ideas to data

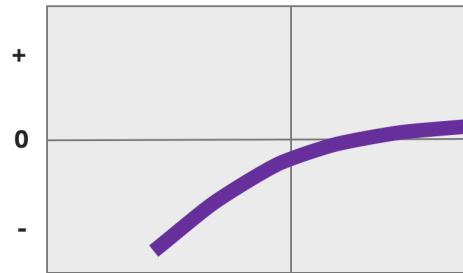


The relationship of interest

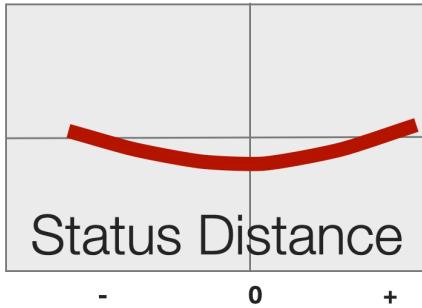
Build from ideas to data



1. Pure Objectivity



2. Distant Envy

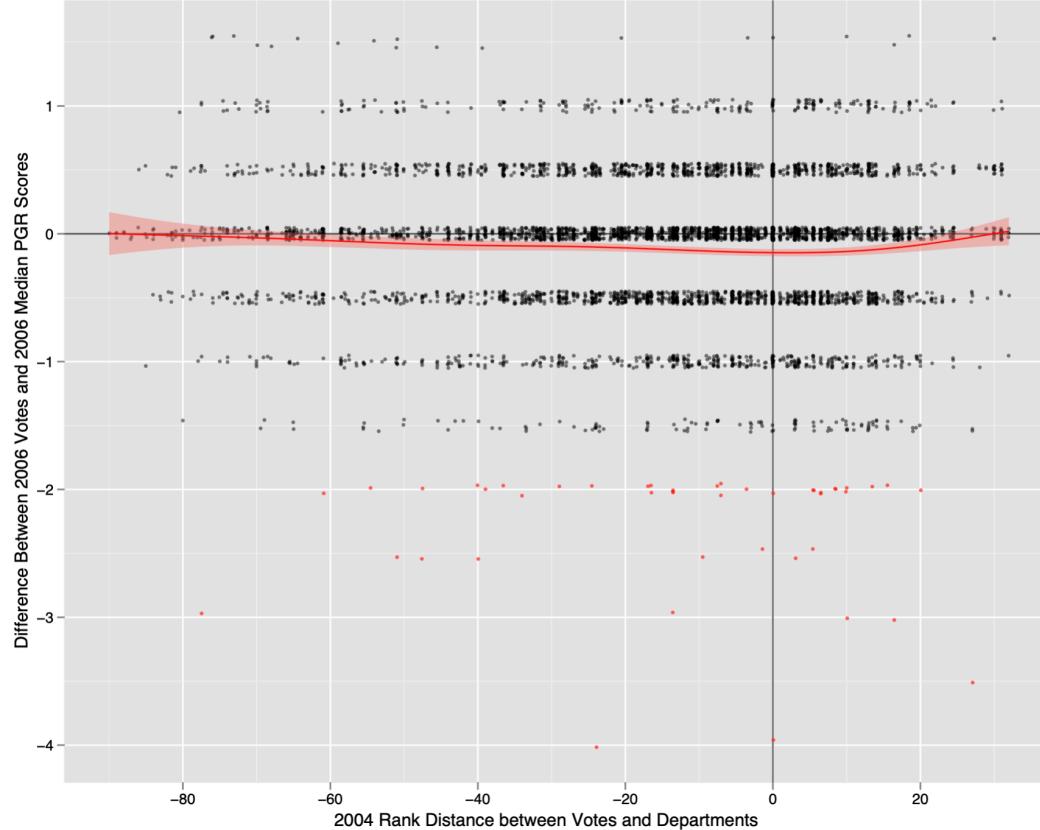


3. Local Competition

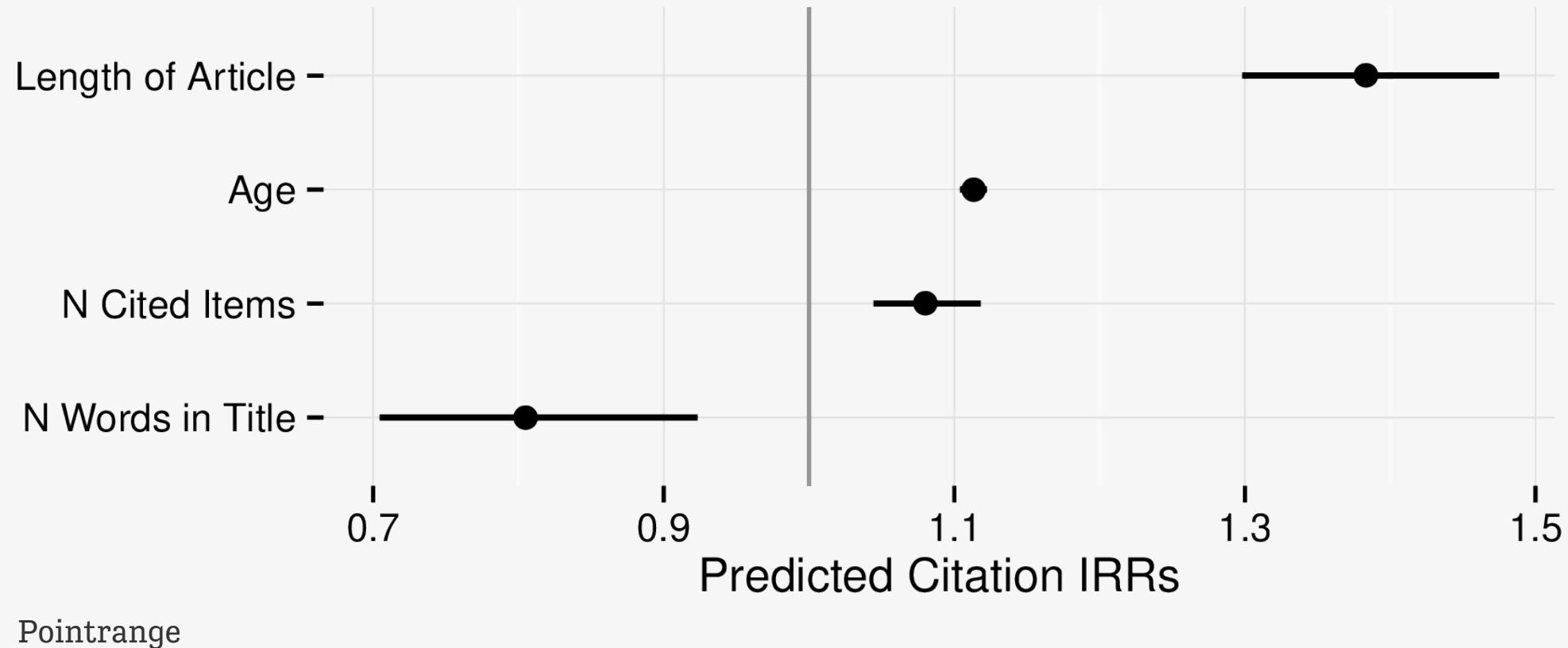
Theory says ...

Build from ideas to data

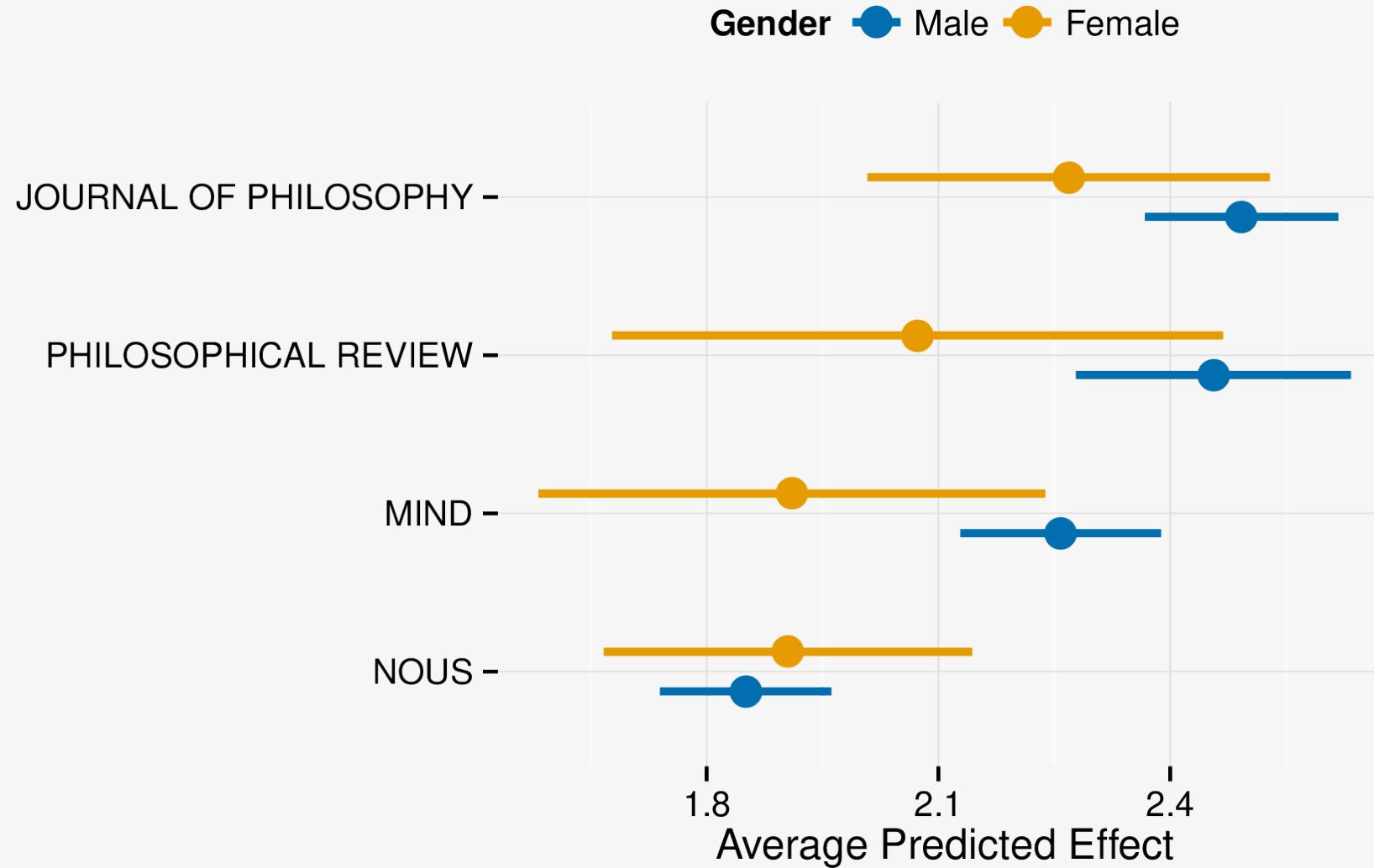
Deviation



Repeat to differentiate



Repeat to differentiate

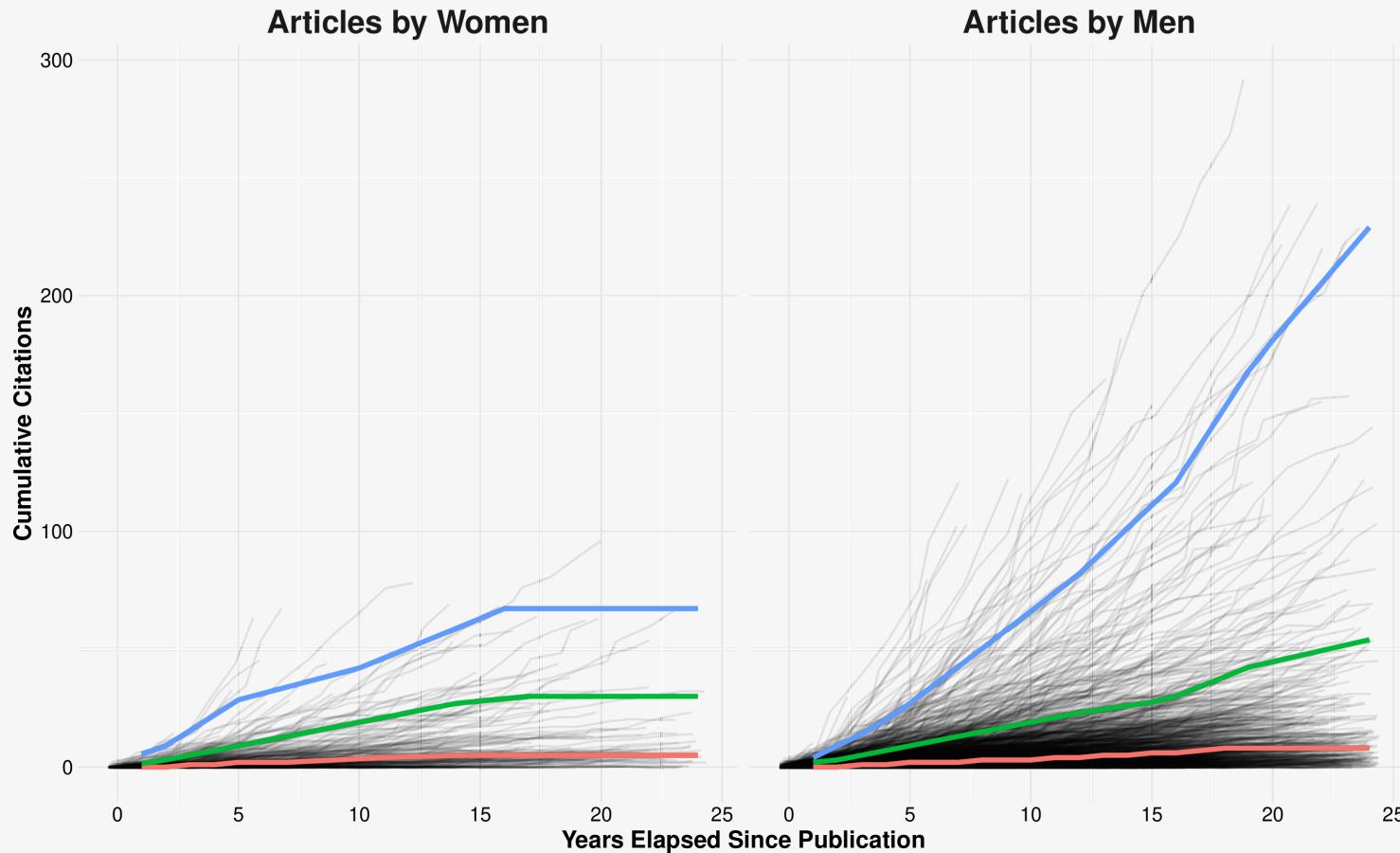


Add a comparison group

Layer and repeat with facets

Citation Growth Curves for all Articles

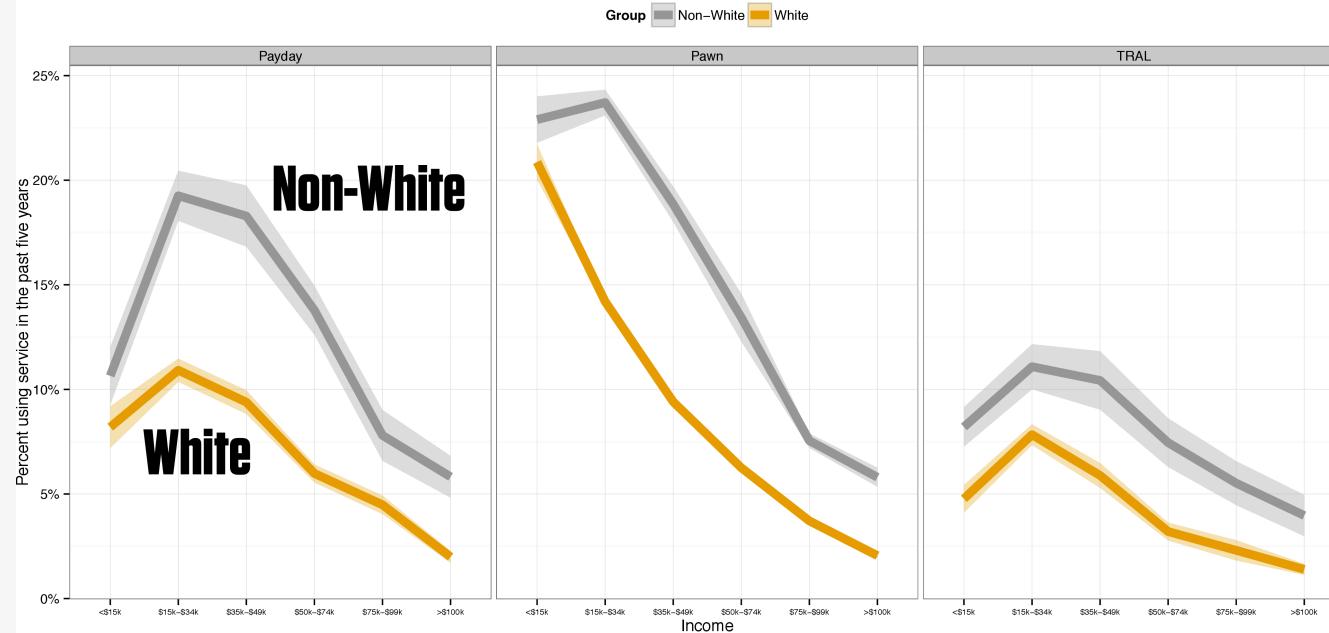
Percentile — at the Median — at the 90th Percentile — in the top One Percent



Compare across facets

Layer and repeat across facets

Categorical Gaps: Alternative Financial Services



Payday Loan

Pawn Shop

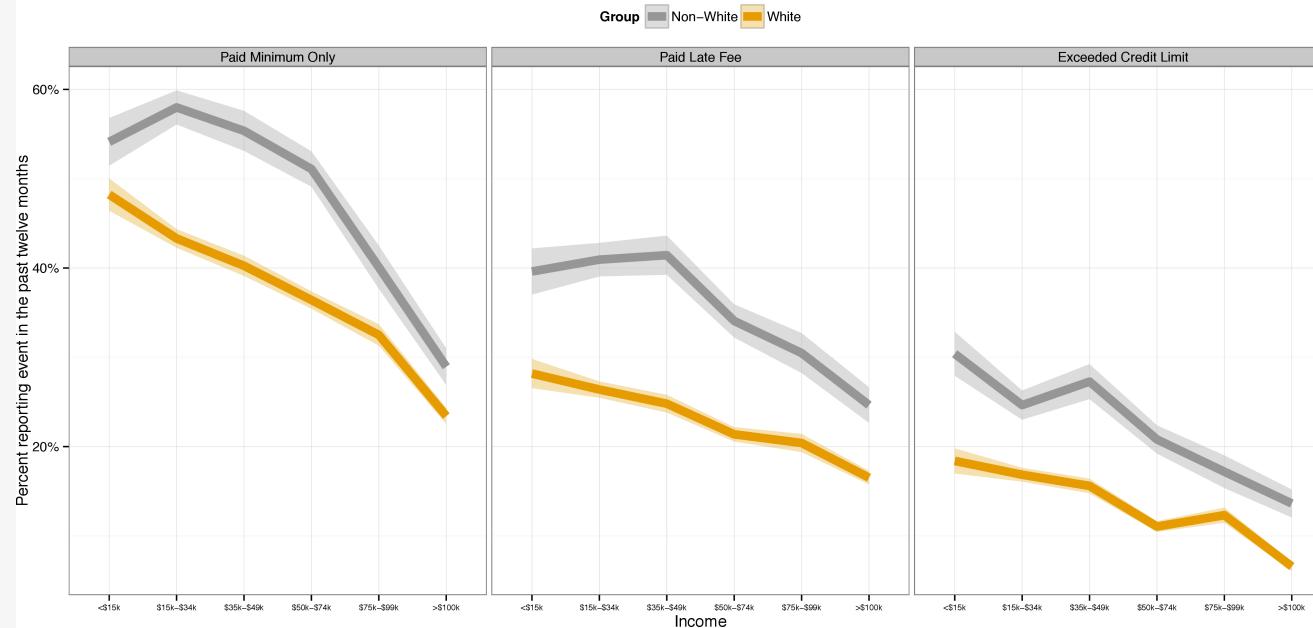
TRAL

8

Layer to compare

Layer and repeat across facets

Categorical Gaps: Adverse Credit Events



Minimum Only

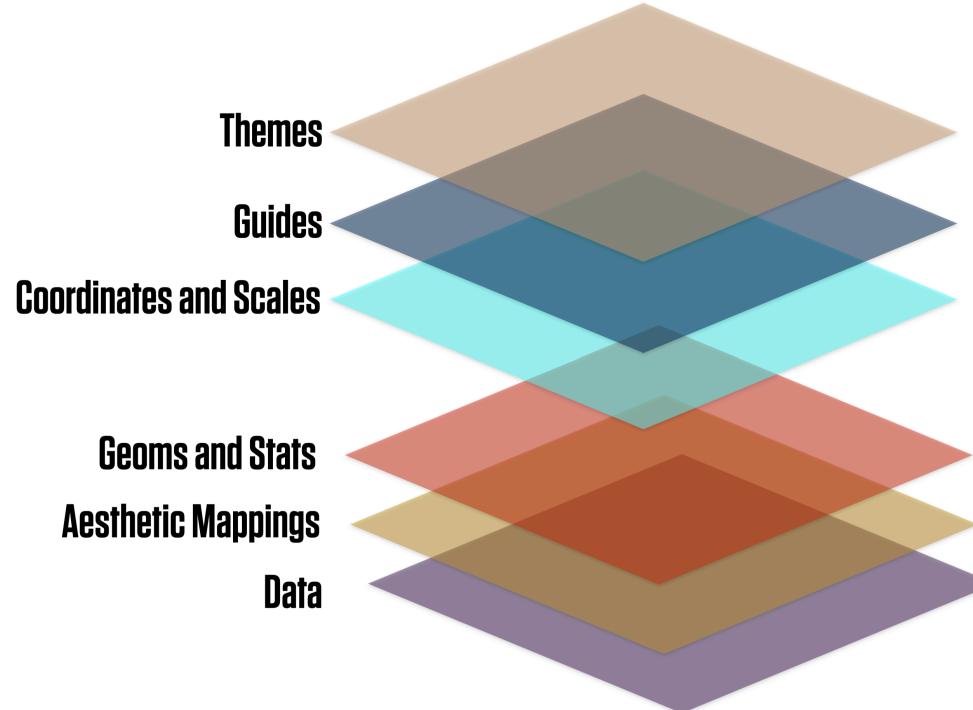
Late Fee

Over Limit

9

Layer to compare

X-Ray Vision



Seeing through it

Themes

Themes ...

are controlled by the `theme()` function

can be bundled into functions of their own, like `theme_bw()` or
`theme_minimal()`

can be set for the duration of a file or project with `theme_set()`

make changes that are applied *additively*

and most importantly ...

Thematic
elements do not
represent data
directly

Make a plot

```
kjh_set_classic_theme(3)
```

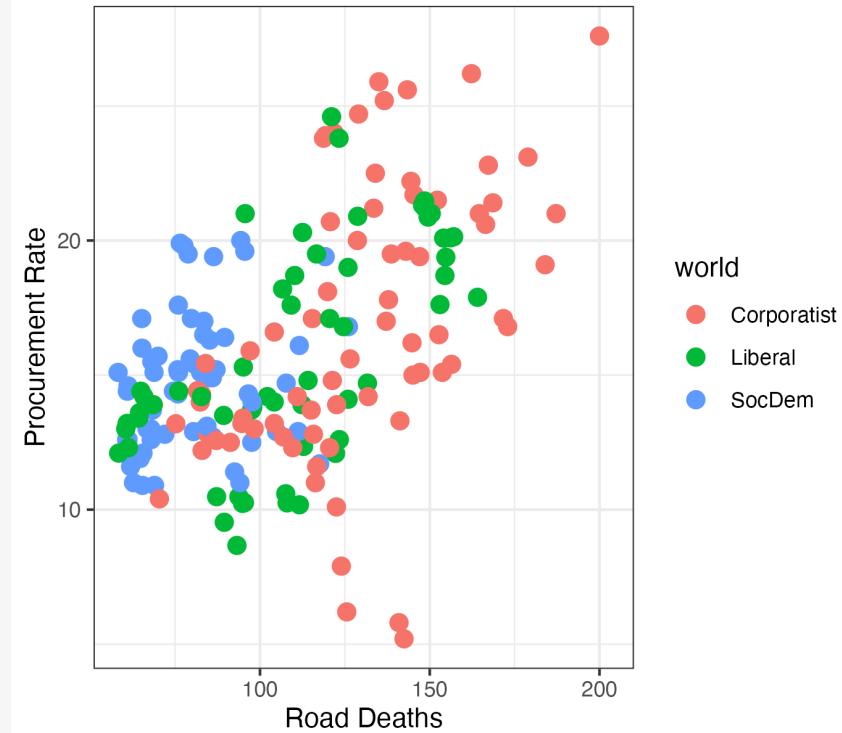
```
p ← organdata %>%  
  drop_na(world) %>%  
  ggplot(mapping = aes(x = roads, y = donors,  
                        color = world)) +  
  geom_point(size = 3) +  
  labs(x = "Road Deaths",  
       y = "Procurement Rate",  
       title = "By Welfare State Regime")  
  
p
```



Add a theme ... `theme_bw()`

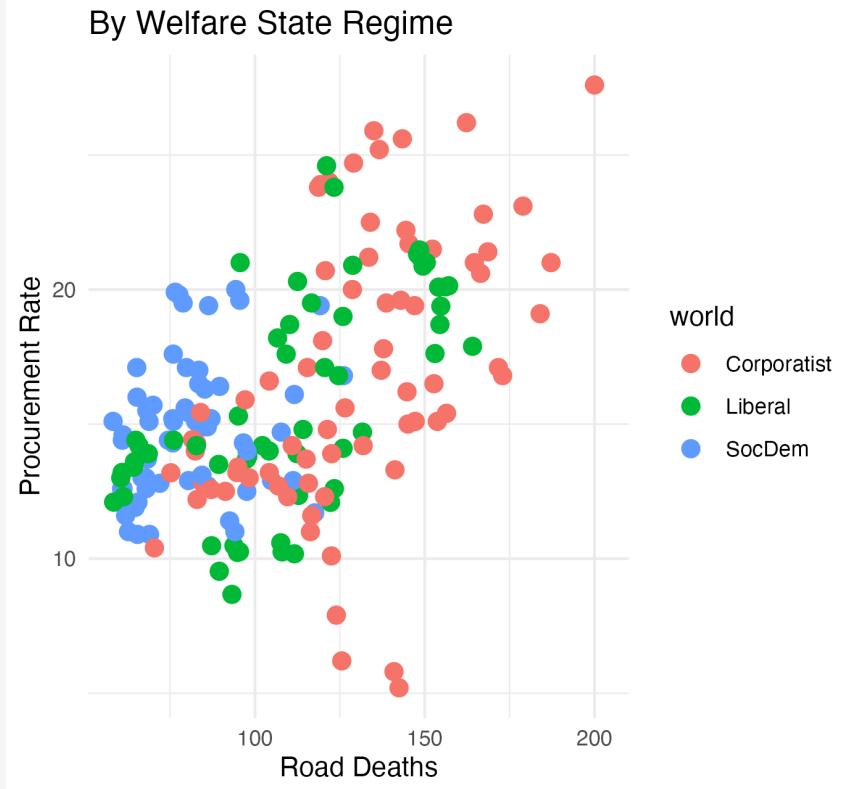
```
p + theme_bw()
```

By Welfare State Regime



Add a theme ... `theme_minimal()`

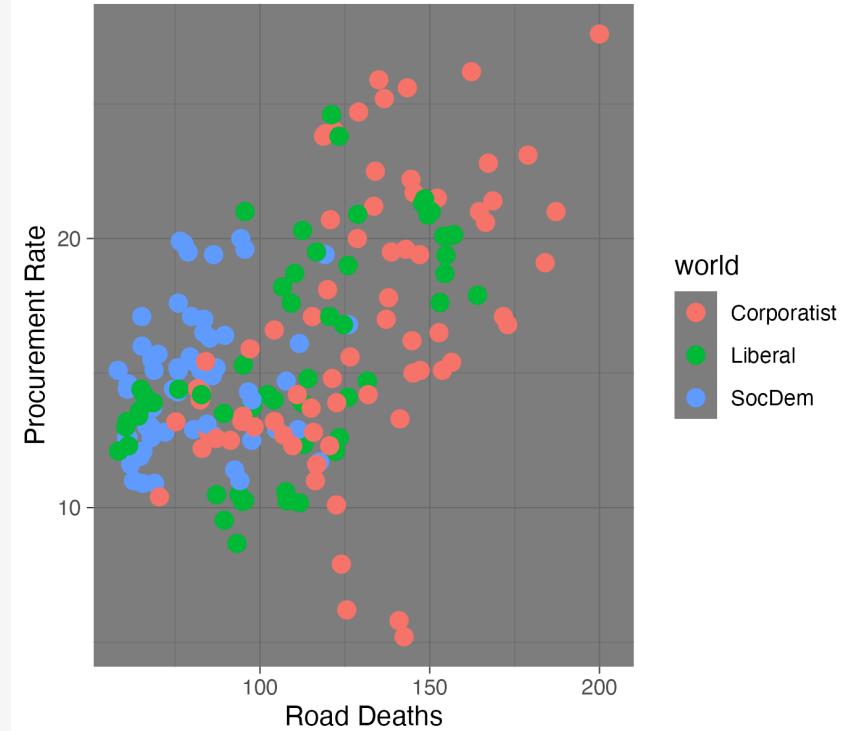
```
p + theme_minimal()
```



Add a theme ... `theme_dark()`

```
p + theme_dark()
```

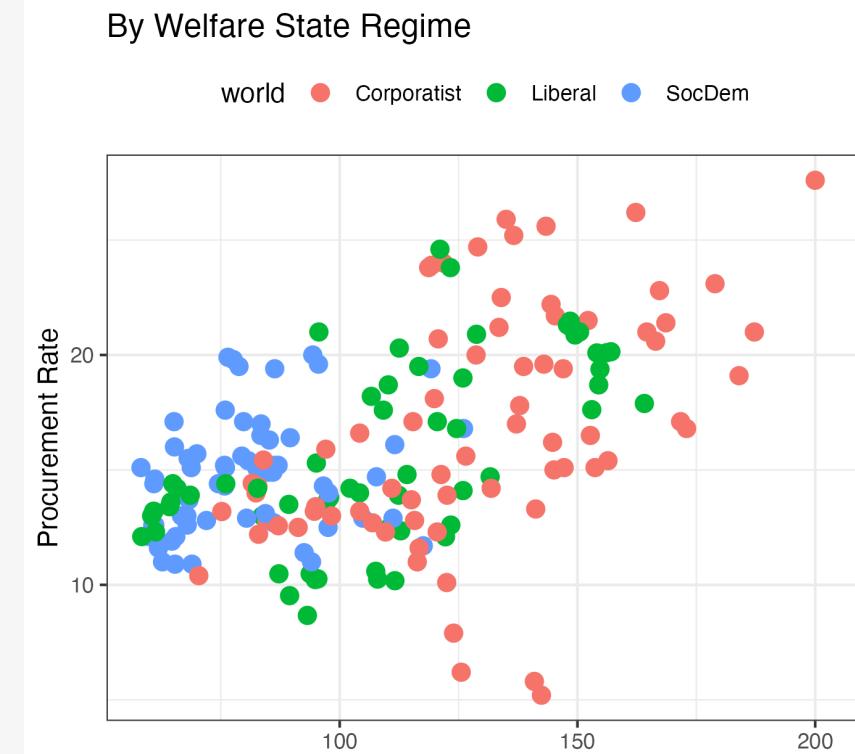
By Welfare State Regime



Adjust with the `theme()` function

None of this directly touches the parts of the plot that are representing your data—i.e. the visual parts that are mapped to a variable, and thus have a scale. Adjusting those is the job of the `scale_` and `guide()` functions.

```
p + theme_bw() +  
  theme(legend.position = "top")
```



There are *many* theme elements

line rect text title aspect.ratio

axis.title axis.title.x axis.title.x.top axis.title.x.bottom
axis.title.y axis.title.y.left axis.title.y.right axis.text
axis.text.x axis.text.x.top axis.text.x.bottom axis.text.y
axis.text.y.left axis.text.y.right axis.ticks axis.ticks.x
axis.ticks.x.top axis.ticks.x.bottom axis.ticks.y
axis.ticks.y.left axis.ticks.y.right axis.ticks.length
axis.ticks.length.x axis.ticks.length.x.top
axis.ticks.length.x.bottom axis.ticks.length.y
axis.ticks.length.y.left axis.ticks.length.y.right axis.line
axis.line.x axis.line.x.top axis.line.x.bottom axis.line.y
axis.line.y.left axis.line.y.right

legend.background legend.margin legend.spacing
legend.spacing.x legend.spacing.y legend.key
legend.key.size legend.key.height legend.key.width
legend.text legend.text.align legend.title
legend.title.align legend.position legend.direction
legend.justification legend.box legend.box.just
legend.box.margin legend.box.background
legend.box.spacing

panel.background panel.border panel.spacing
panel.spacing.x panel.spacing.y panel.grid
panel.grid.major panel.grid.minor panel.grid.major.x
panel.grid.major.y panel.grid.minor.x
panel.grid.minor.y panel.on top plot.background
plot.title plot.title.position plot.subtitle plot.caption
plot.caption.position plot.tag plot.tag.position
plot.margin

strip.background strip.background.x
strip.background.y strip.placement strip.text
strip.text.x strip.text.y strip.switch.pad.grid
strip.switch.pad.wrap

But they are structured

line rect text title aspect.ratio

axis.title axis.title.x axis.title.x.top axis.title.x.bottom
axis.title.y axis.title.y.left axis.title.y.right axis.text
axis.text.x axis.text.x.top axis.text.x.bottom axis.text.y
axis.text.y.left axis.text.y.right axis.ticks axis.ticks.x
axis.ticks.x.top axis.ticks.x.bottom axis.ticks.y
axis.ticks.y.left axis.ticks.y.right axis.ticks.length
axis.ticks.length.x axis.ticks.length.x.top
axis.ticks.length.x.bottom axis.ticks.length.y
axis.ticks.length.y.left axis.ticks.length.y.right axis.line
axis.line.x axis.line.x.top axis.line.x.bottom axis.line.y
axis.line.y.left axis.line.y.right

legend.background legend.margin legend.spacing
legend.spacing.x legend.spacing.y legend.key
legend.key.size legend.key.height legend.key.width
legend.text legend.text.align legend.title
legend.title.align legend.position legend.direction
legend.justification legend.box legend.box.just
legend.box.margin legend.box.background
legend.box.spacing

panel.background panel.border panel.spacing
panel.spacing.x panel.spacing.y panel.grid
panel.grid.major panel.grid.minor panel.grid.major.x
panel.grid.major.y panel.grid.minor.x
panel.grid.minor.y panel.on top

plot.background plot.title plot.title.position
plot.subtitle plot.caption plot.caption.position plot.tag
plot.tag.position plot.margin

strip.background strip.background.x
strip.background.y strip.placement strip.text
strip.text.x strip.text.y strip.switch.pad.grid
strip.switch.pad.wrap

And *inherit*

line rect text title aspect.ratio

axis.title axis.title.x axis.title.x.top axis.title.x.bottom
axis.title.y axis.title.y.left axis.title.y.right **axis.text**
axis.text.x axis.text.x.top axis.text.x.bottom axis.text.y
axis.text.y.left axis.text.y.right **axis.ticks** axis.ticks.x
axis.ticks.x.top axis.ticks.x.bottom axis.ticks.y
axis.ticks.y.left axis.ticks.y.right axis.ticks.length
axis.ticks.length.x axis.ticks.length.x.top
axis.ticks.length.x.bottom axis.ticks.length.y
axis.ticks.length.y.left axis.ticks.length.y.right **axis.line**
axis.line.x axis.line.x.top axis.line.x.bottom axis.line.y
axis.line.y.left axis.line.y.right

legend.background legend.margin legend.spacing

legend.spacing.x legend.spacing.y legend.key
legend.key.size legend.key.height legend.key.width
legend.text legend.text.align legend.title
legend.title.align legend.position legend.direction
legend.justification legend.box legend.box.just
legend.box.margin legend.box.background
legend.box.spacing

panel.background panel.border panel.spacing

panel.spacing.x panel.spacing.y panel.grid
panel.grid.major panel.grid.minor panel.grid.major.x
panel.grid.major.y panel.grid.minor.x panel.grid.minor.y
panel.on top

plot.background plot.title plot.title.position
plot.subtitle plot.caption plot.caption.position plot.tag
plot.tag.position plot.margin

strip.background strip.background.x
strip.background.y strip.placement strip.text
strip.text.x strip.text.y strip.switch.pad.grid
strip.switch.pad.wrap

Two kinds of adjustment

It's a single setting.

E.g., `legend.position` can be "none", "left", "right", "bottom", or "top"

Hence, e.g., `theme(legend.position = "top")`, which we have seen several times. Similarly for e.g. `legend.direction` (can be "horizontal" or "vertical").

It's a component of the plot that might be styled in several ways. E.g., The text on the axes, or the lines in the plot panel.

If the latter ...

If adjusting a thematic element ask...

Where on the plot is it?

If adjusting a thematic element ask...

Where on the plot is it?

Is it part of an *axis*, part of the *panel*, the *strip* (facet title) box, or the *legend*? This will help you find the name of the thing you want to adjust.

If adjusting a thematic element ask...

Where on the plot is it?

Is it part of an *axis*, part of the *panel*, the *strip* (facet title) box, or the *legend*? This will help you find the name of the thing you want to adjust.

E.g. “I want to adjust the text for the markings on the x-axis”

You want `axis.ticks.x`

E.g. “I want to adjust the styling of the main y-axis grid lines inside the plot”

You want `panel.grid.major.y`

If adjusting a thematic element, ask...

What *kind* of element is it?

If adjusting a thematic element, ask...

What *kind* of element is it?

Is it *text*, or a *line*, or a *rectangle*?

This will tell you what function to use to make the adjustment to the named element.

If adjusting a thematic element, ask...

What *kind* of element is it?

Is it *text*, or a *line*, or a *rectangle*?

This will tell you what function to use to make the adjustment to the named element.

If it's text, adjust the element with `element_text()`

If adjusting a thematic element, ask...

What *kind* of element is it?

Is it *text*, or a *line*, or a *rectangle*?

This will tell you what function to use to make the adjustment to the named element.

If it's text, adjust the element with `element_text()`

If it's a line, adjust it with `element_line()`

If adjusting a thematic element, ask...

What *kind* of element is it?

Is it *text*, or a *line*, or a *rectangle*?

This will tell you what function to use to make the adjustment to the named element.

If it's text, adjust the element with `element_text()`

If it's a line, adjust it with `element_line()`

If it's a rectangle, with `element_rect()`

If adjusting a thematic element, ask...

What *kind* of element is it?

Is it *text*, or a *line*, or a *rectangle*?

This will tell you what function to use to make the adjustment to the named element.

If it's text, adjust the element with `element_text()`

If it's a line, adjust it with `element_line()`

If it's a rectangle, with `element_rect()`

If you want to *fully turn off* an element, use `element_blank()`

For example ...

“I want to adjust the styling of the plot title”

For example ...

“I want to adjust the styling of the plot title”

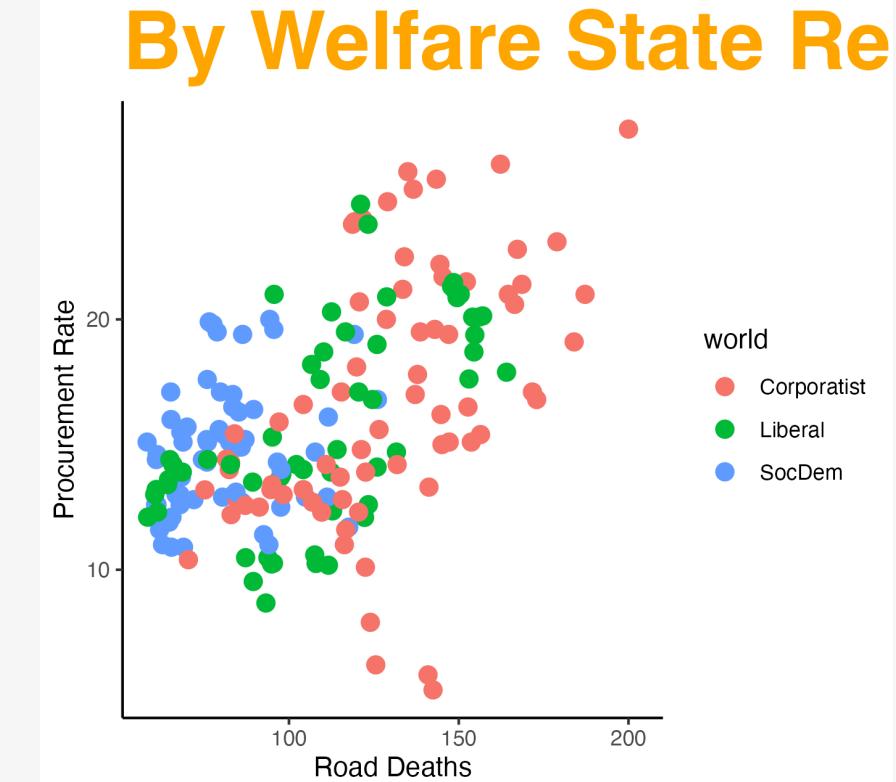
The relevant element is `plot.title`.

It's *text*.

Inside the theme function, adjust it with `element_text()`.

For example ...

```
p + theme(plot.title =  
          element_text(size = rel(3),  
                      face = "bold",  
                      color = "orange"))
```



For example ...

“I want to adjust y axis grid lines on the plot”

For example ...

“I want to adjust y axis grid lines on the plot”

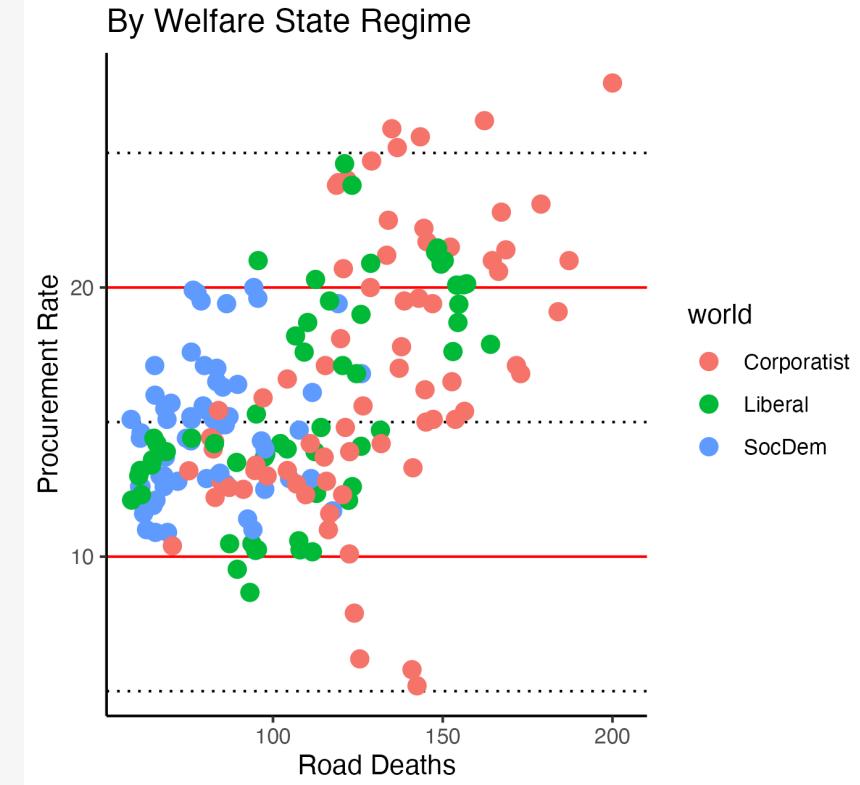
The relevant elements are `panel.grid.major.y` and
`panel.grid.minor.y`.

These are *lines*.

Inside the theme function, adjust it with `element_line()`.

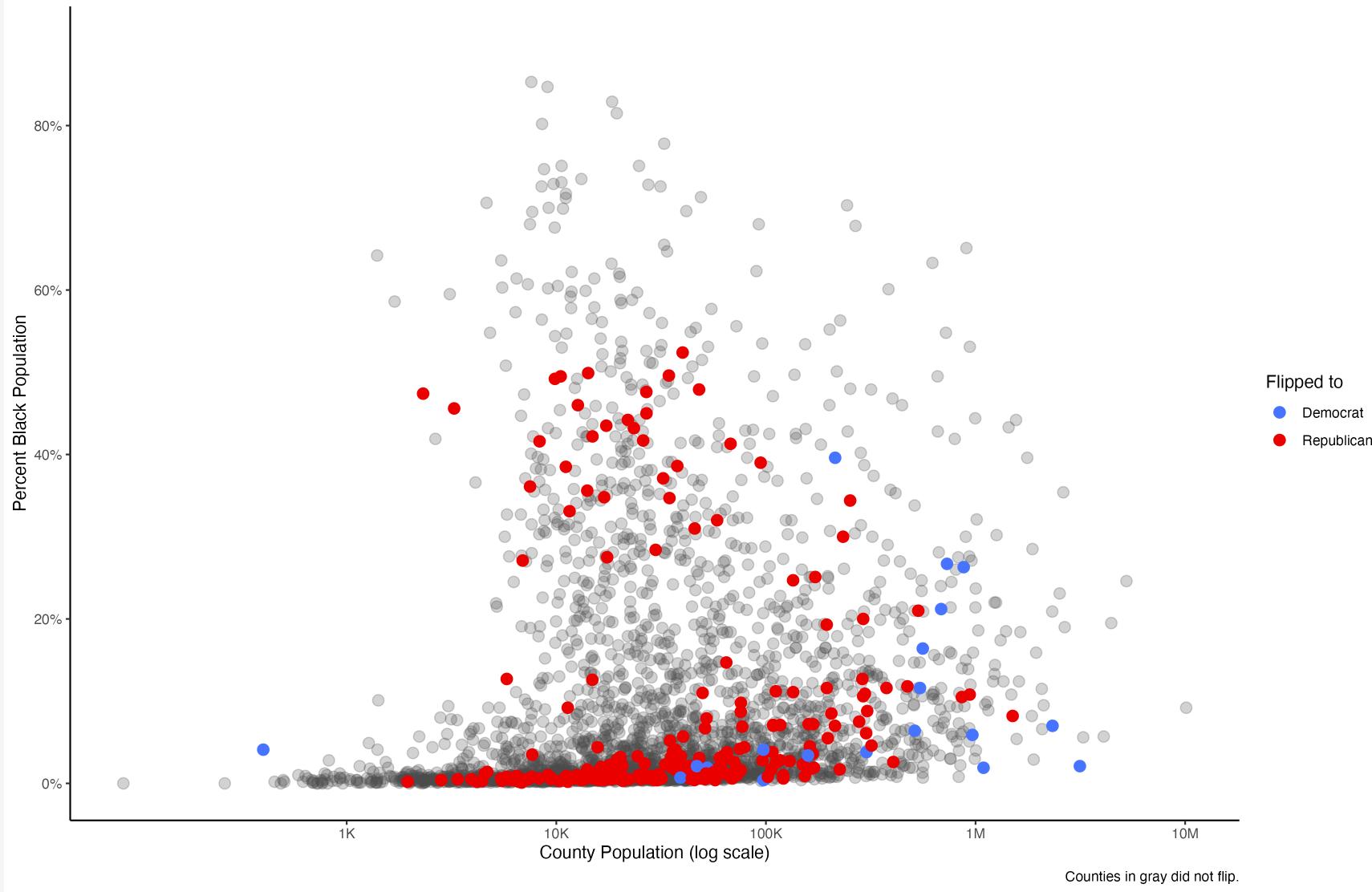
For example ...

```
p + theme(panel.grid.major.y =  
          element_line(color = "red"),  
          panel.grid.minor.y =  
          element_line(color = "black",  
                       linetype = "dotted"))
```



The ggthemes package

Counties that flipped shown by party color



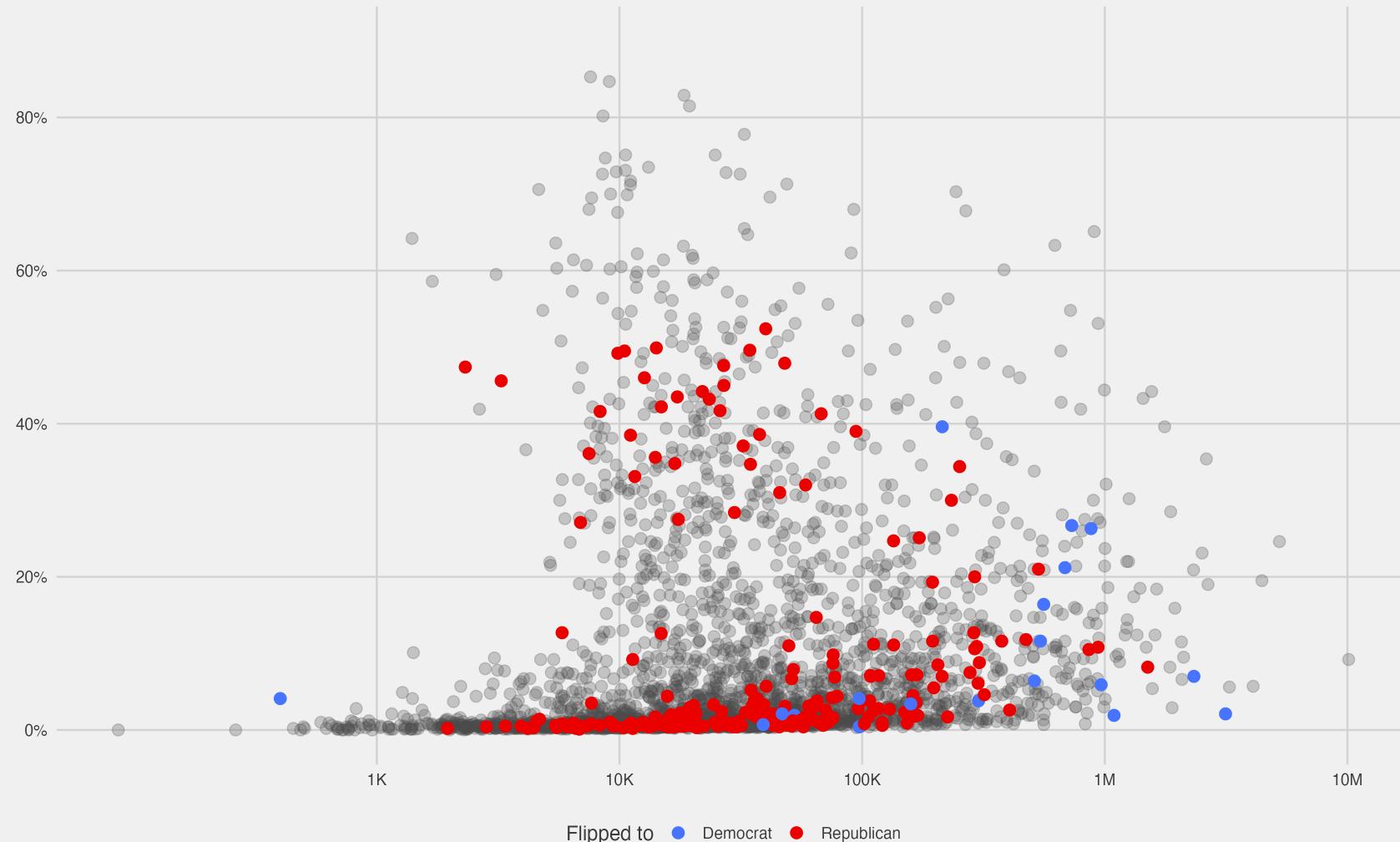
We made this earlier. Here it is in a default theme.

Theming a plot

```
library(ggthemes)
theme_set(theme_fivethirtyeight())
```

See how the full function call goes inside `theme_set()`, including the parentheses, because we are actually running that function to set all the elements.

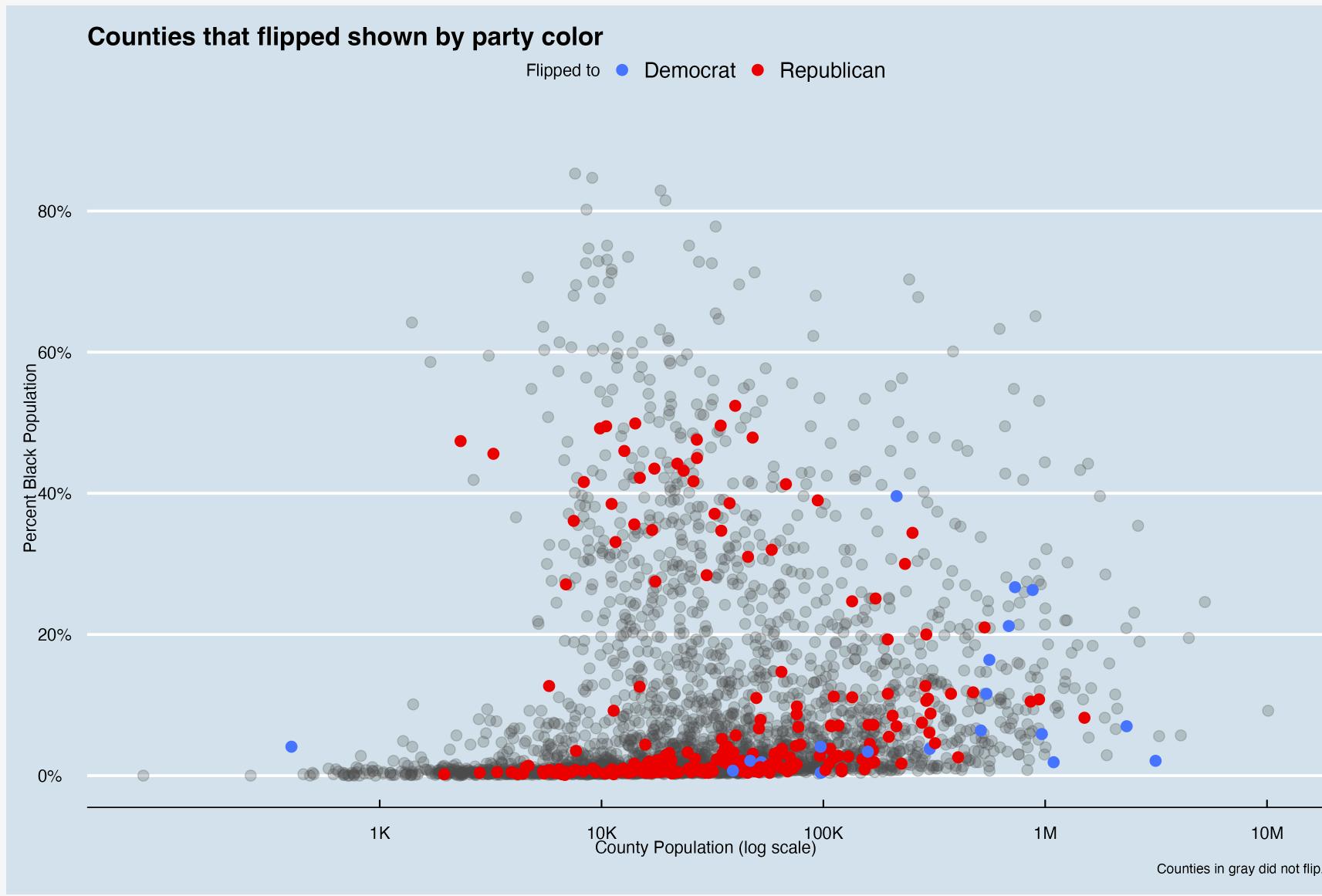
Counties that flipped shown by party color



Calling the object now draws the plot with the thematic elements added.

Theming a plot

```
theme_set(theme_economist())
```



Calling the object now draws the plot with the thematic elements added.

This seems morally wrong

```
theme_set(theme_stata())
```

Counties that flipped shown by party color



Why would you do this to yourself?

Pick a theme
and stick with it