

Polishing your plots and Presenting them

Data Visualization: Session 8

Kieran Healy
Code Horizons, April 2022

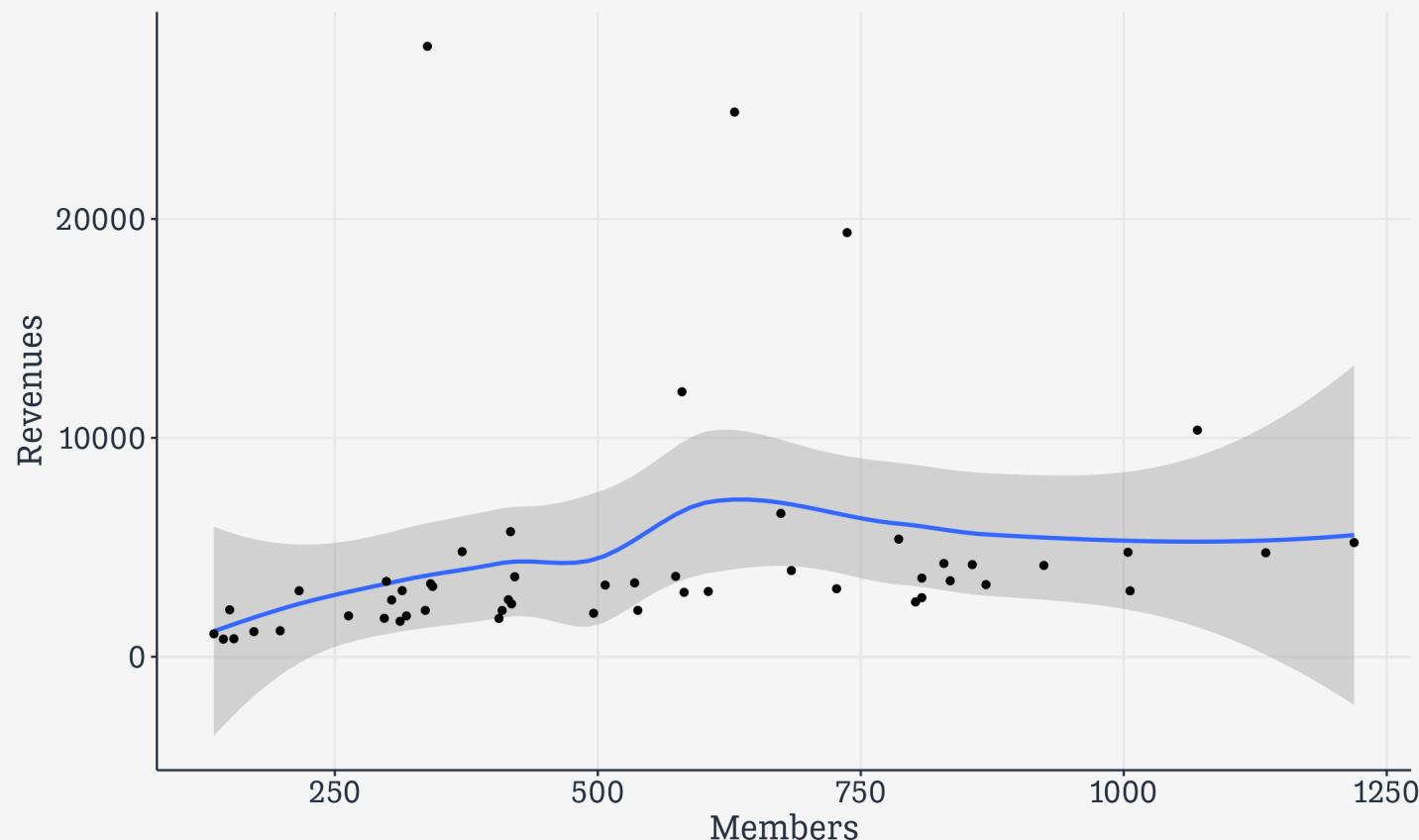
**Piece by piece,
Layer by layer**

Build your plots a piece at a time

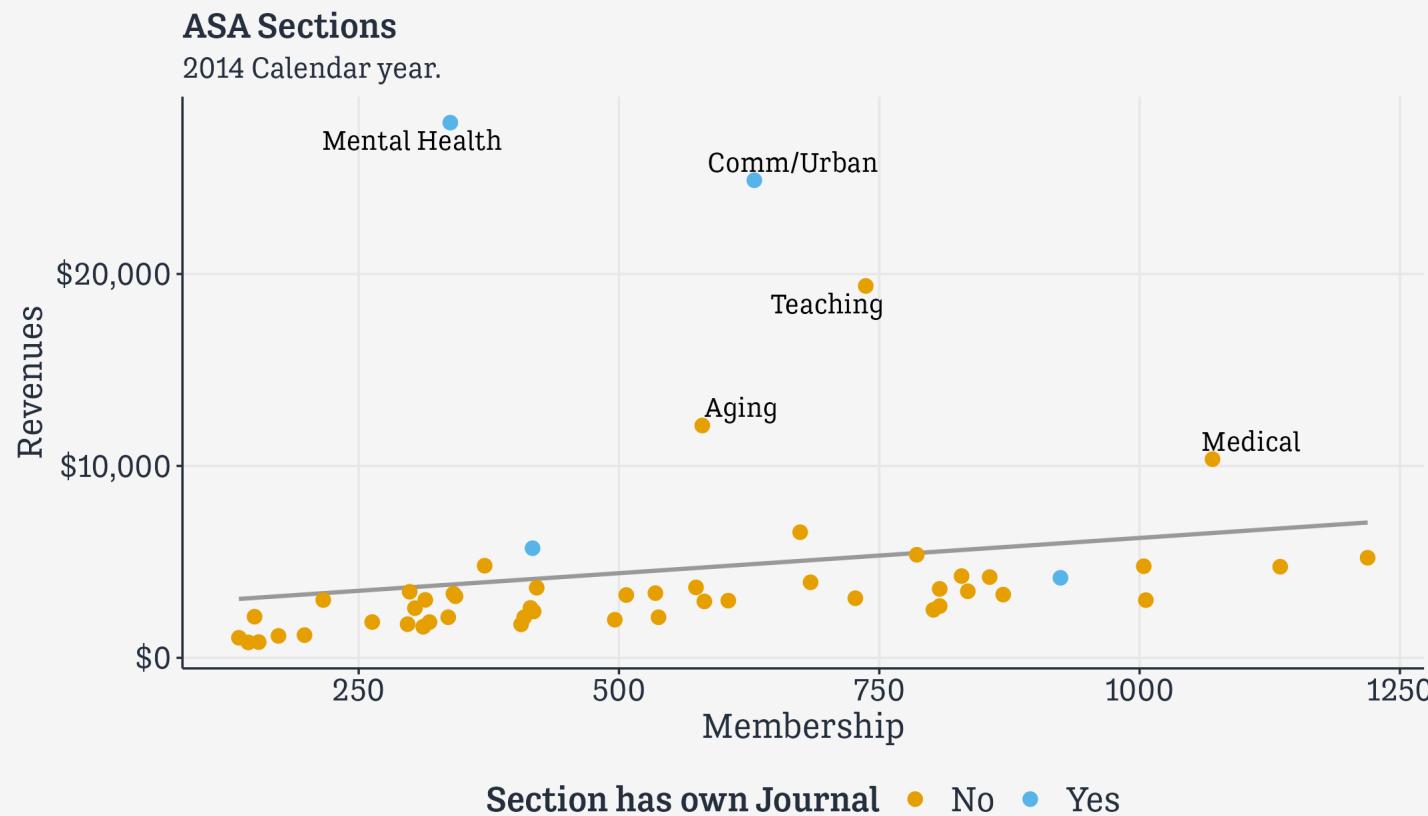
```
asasec <- as_tibble(asasec)
asasec

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

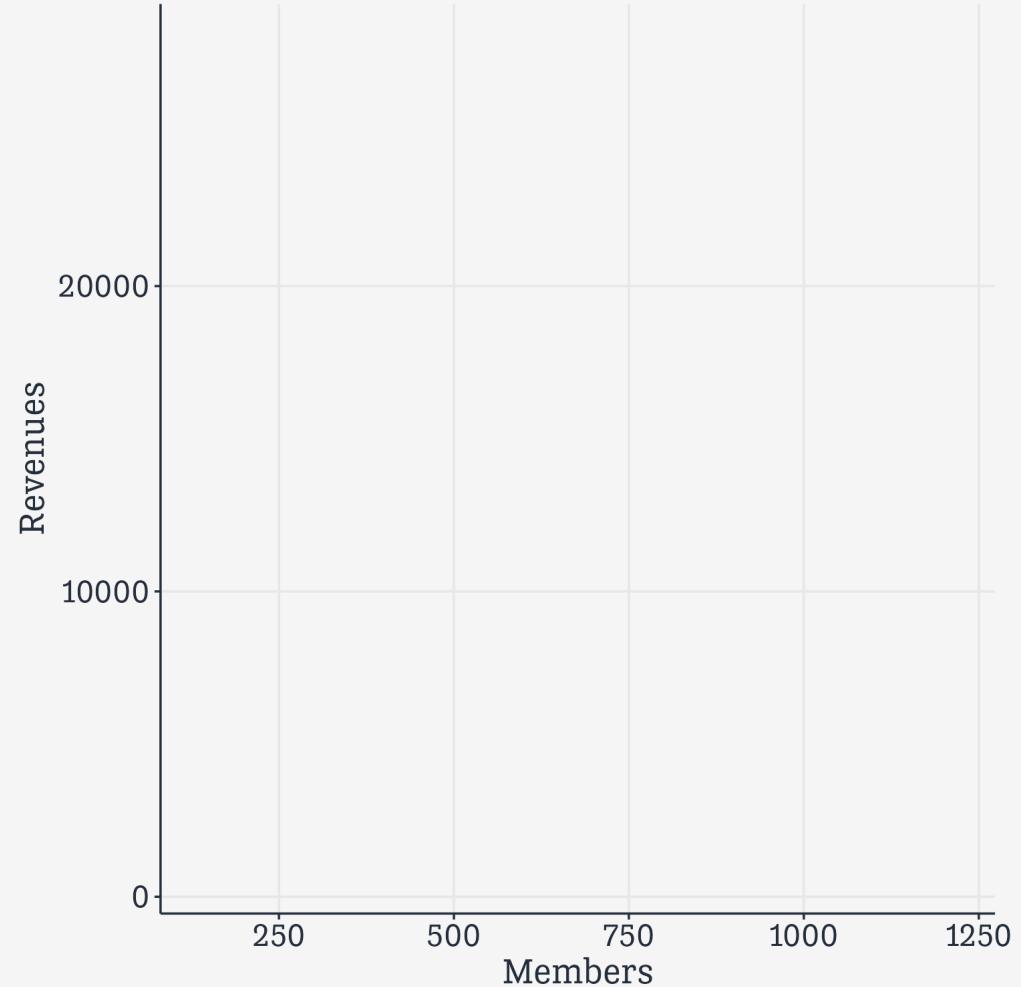
Build your plots a piece at a time

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

	## # A tibble: 52 × 9	## Section	Sname	Beginning	Revenues	Expenses	Ending	Journal	Year	Mem
		## <fct>	<fct>	<int>	<int>	<int>	<int>	<fct>	<int>	<int>
## 1	## Aging and the...	Aging	12752	12104	12007	12849	No	2014		
## 2	## Alcohol, Drug...	Alco...	11933	1144	400	12677	No	2014		
## 3	## Altruism and ...	Altr...	1139	1862	1875	1126	No	2014		
## 4	## Animals and S...	Anim...	473	820	1116	177	No	2014		
## 5	## Asia/Asian Am...	Asia	9056	2116	1710	9462	No	2014		
## 6	## Body and Embo...	Body	3408	1618	1920	3106	No	2014		
## 7	## Children and ...	Chil...	3692	3653	3713	3632	No	2014		
## 8	## Coll Behavior...	CBSM	8127	3470	2704	8893	No	2014		
## 9	## Communication...	CITA...	17093	4800	4804	17089	No	2014		
## 10	## Community and...	Comm...	26598	24883	23379	28102	Yes	2014		
## # ... with 42 more rows										

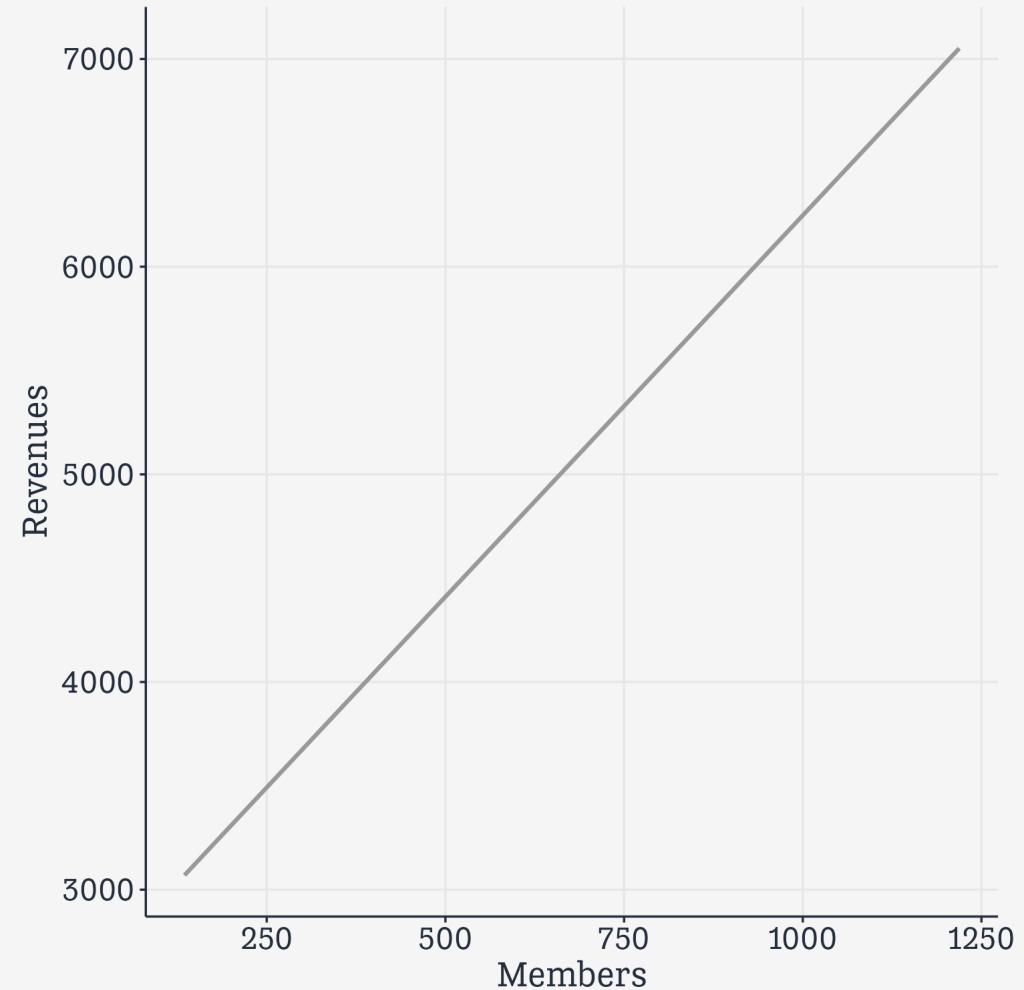
Build your plots a piece at a time

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



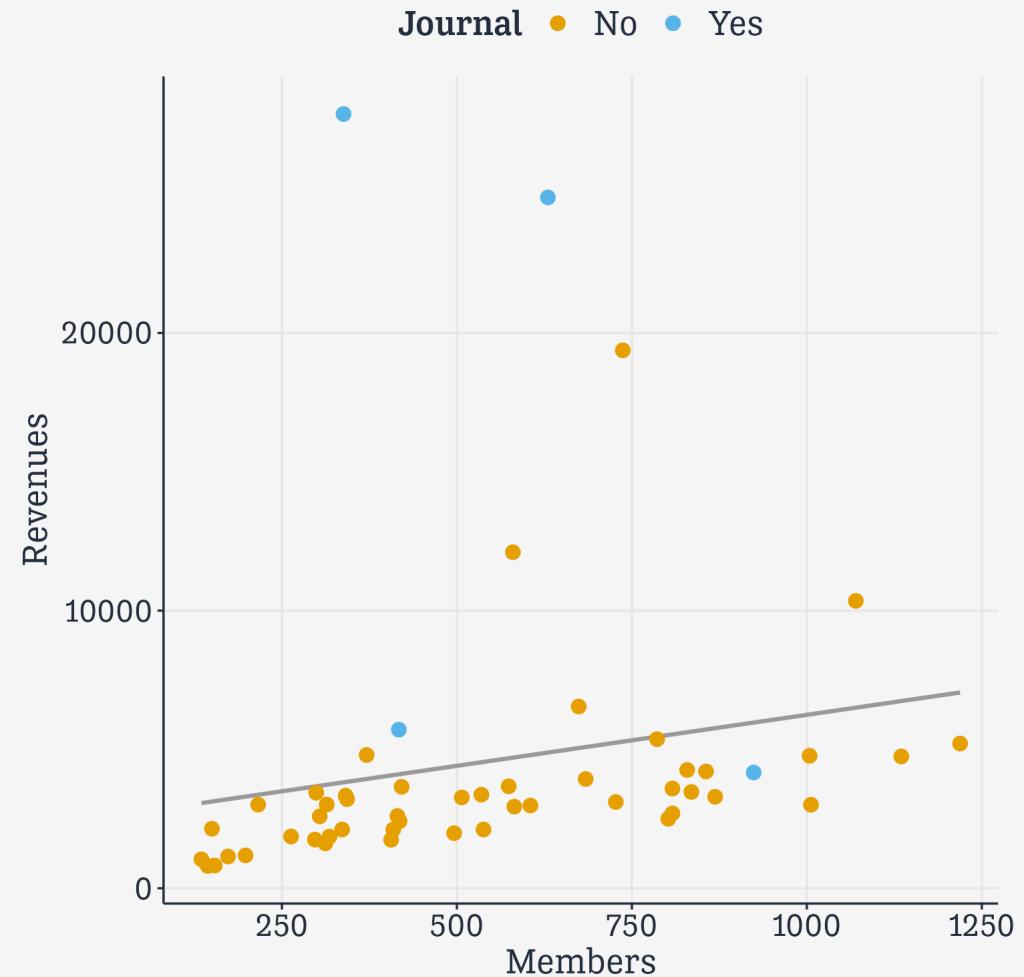
Build your plots a piece at a time

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



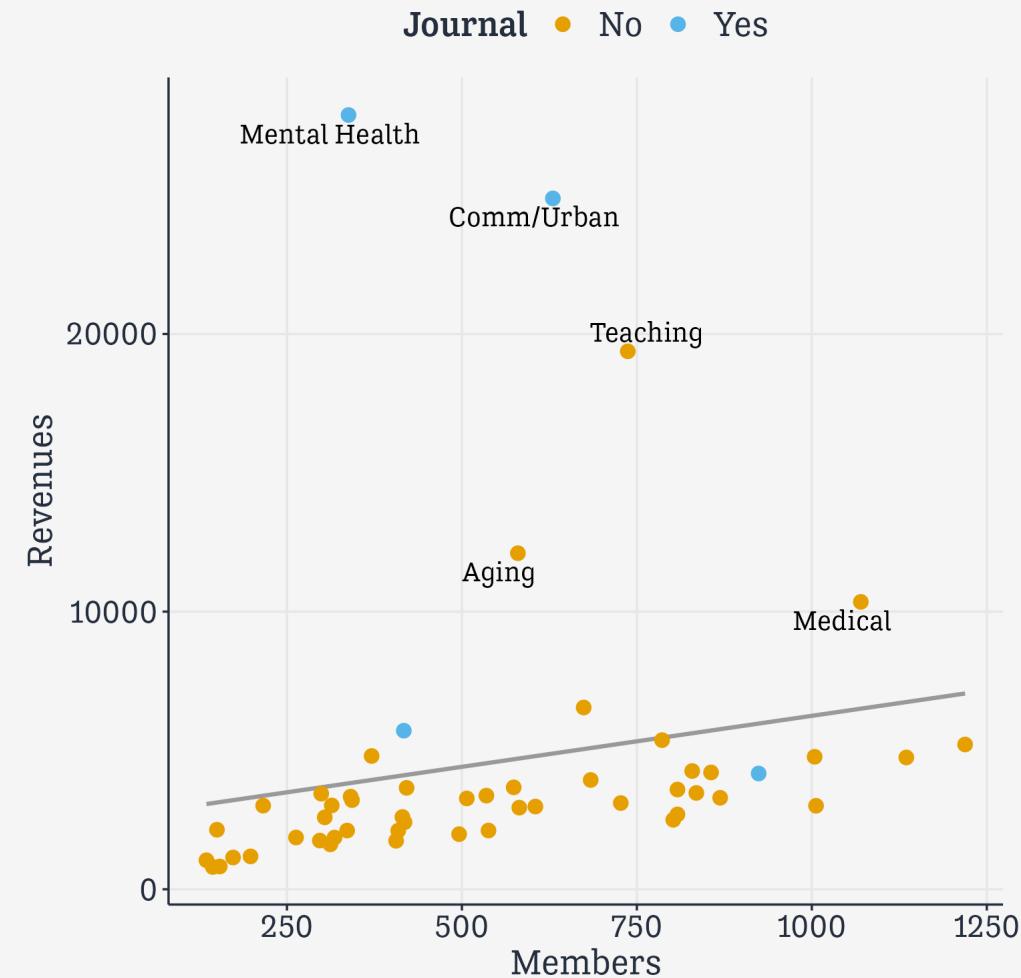
Build your plots a piece at a time

```
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))
```



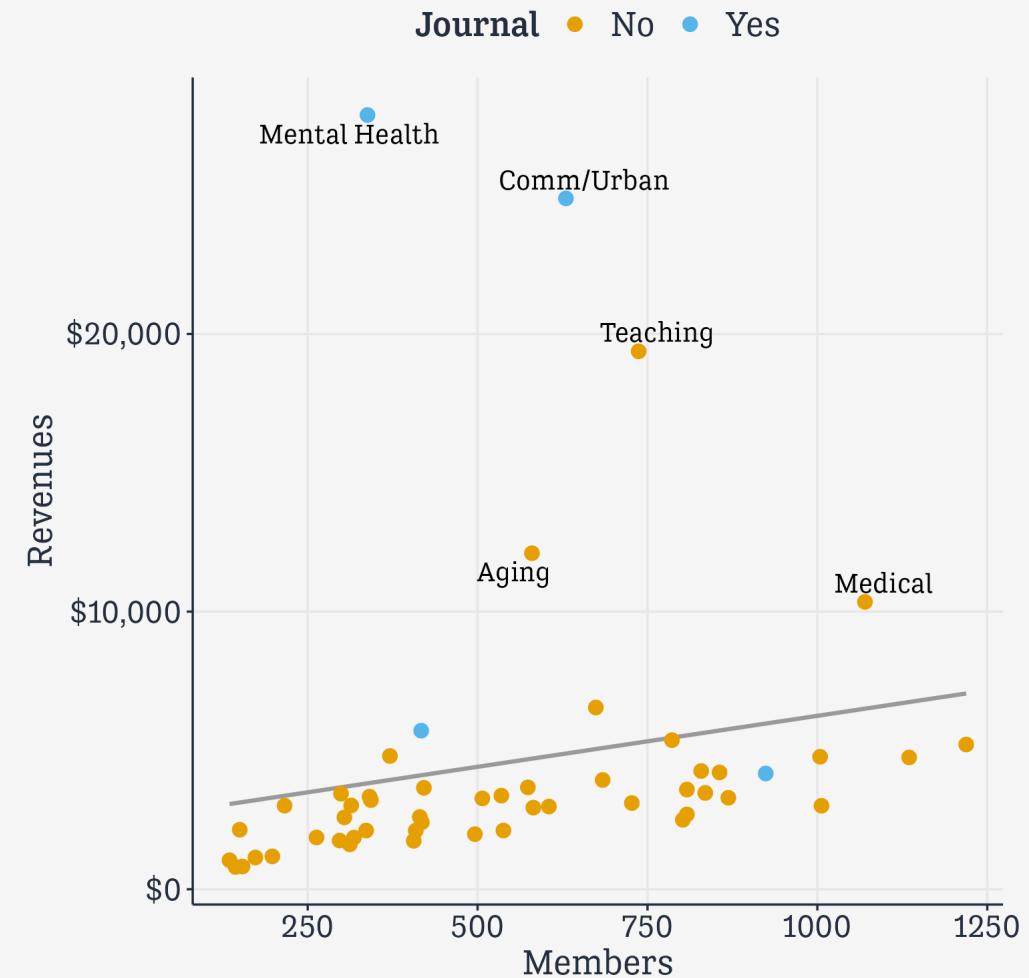
Build your plots a piece at a time

```
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())
```



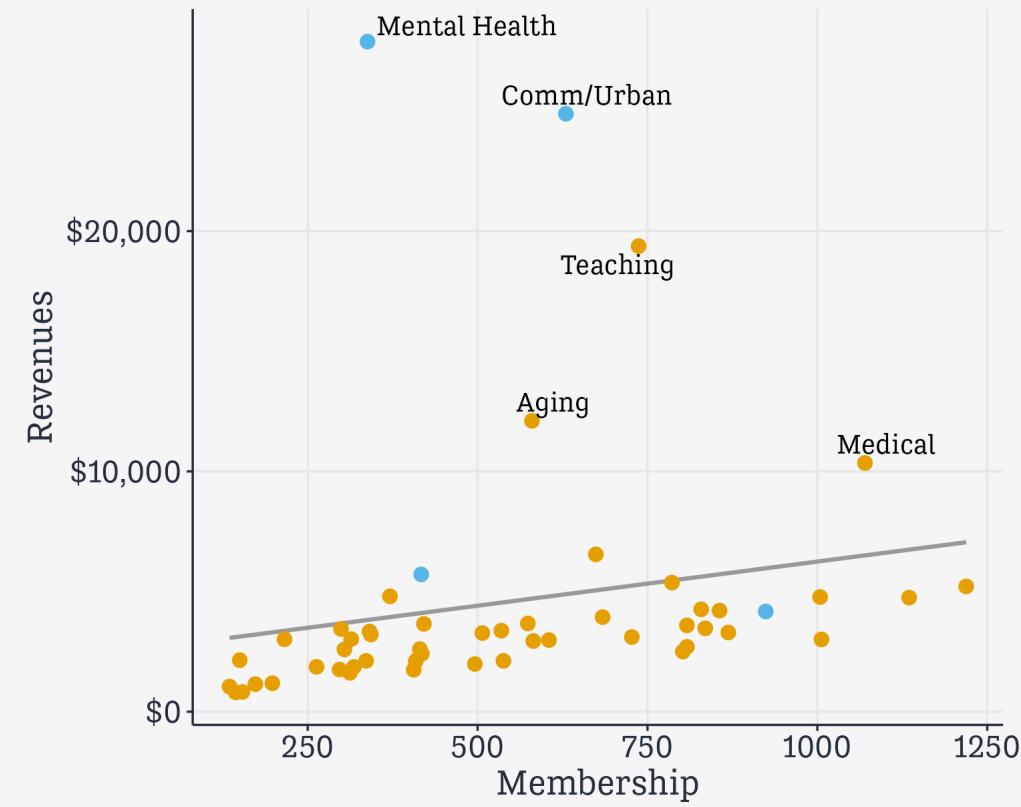
Build your plots a piece at a time

```
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.")
```

ASA Sections

2014 Calendar year.

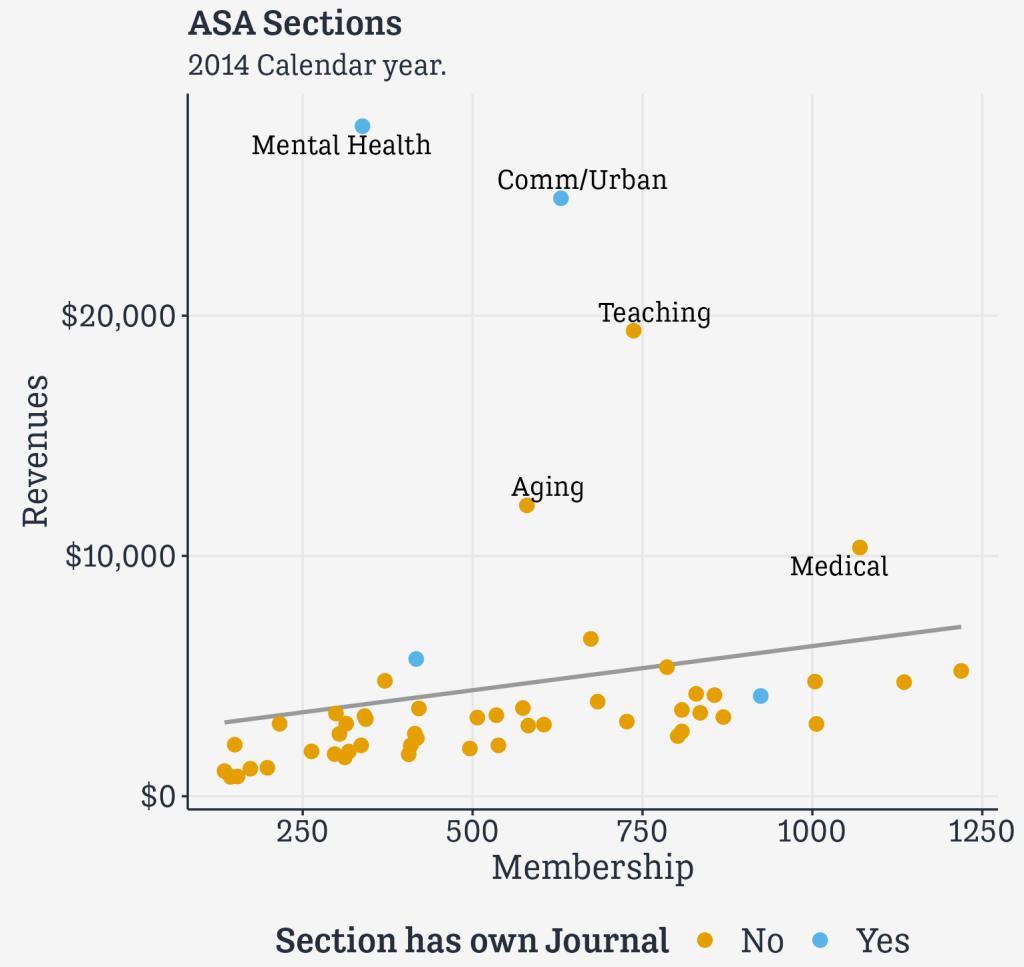
Section has own Journal • No • Yes



Source: ASA annual report.

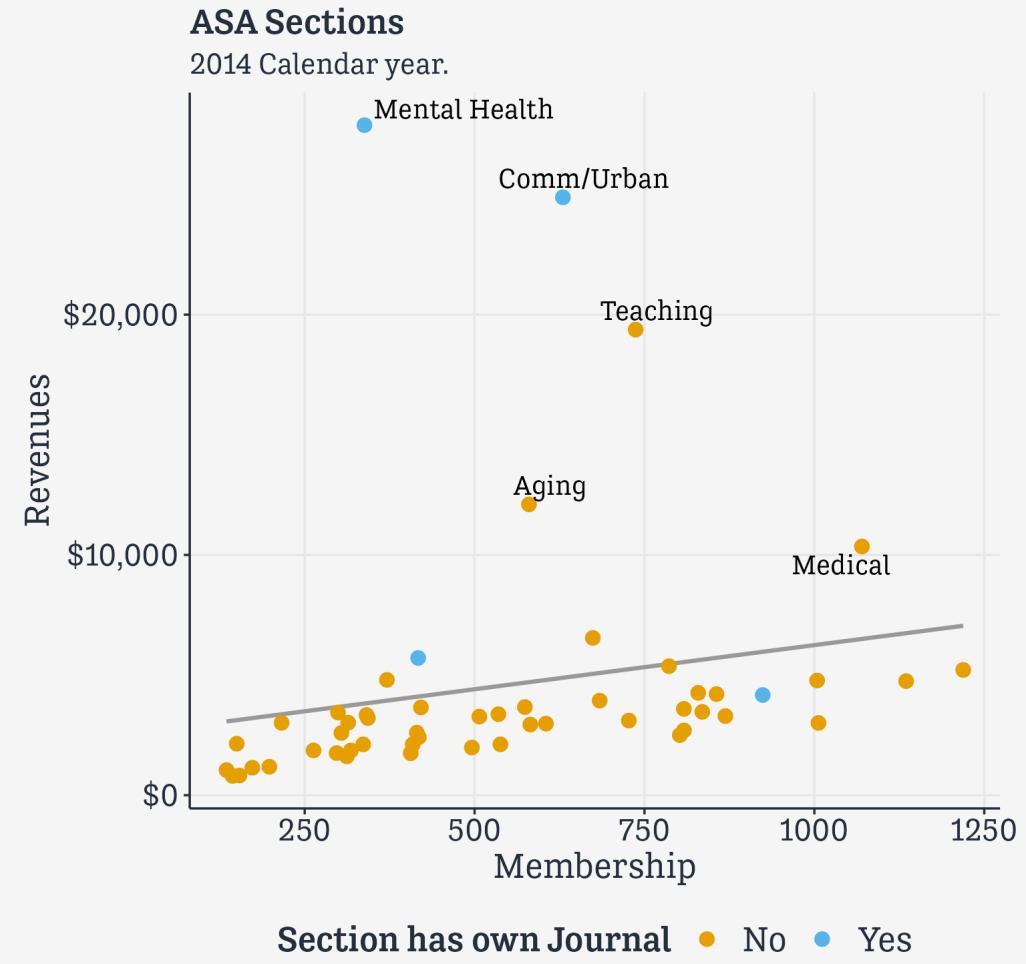
Build your plots a piece at a time

```
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 always specify scales manually

```
p <- ggplot(data = organdata,  
             mapping = aes(x = roads,  
                            y = donors,  
                            color = world))
```

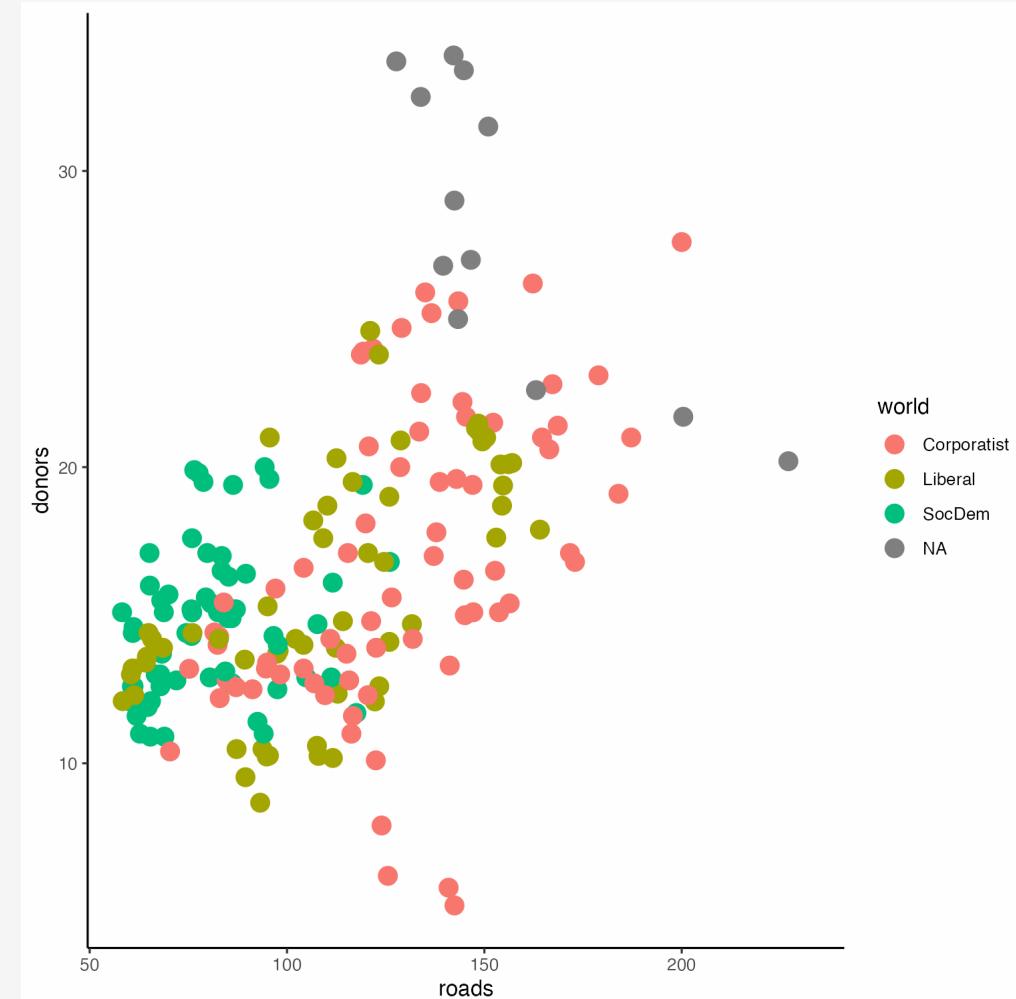
You can always specify scales manually

```
p <- ggplot(data = organdata,  
             mapping = aes(x = roads,  
                            y = donors,  
                            color = world)) +  
  geom_point(size = 4)
```

You can always specify scales manually

```
p <- ggplot(data = organdata,
             mapping = aes(x = roads,
                           y = donors,
                           color = world)) +
  geom_point(size = 4)

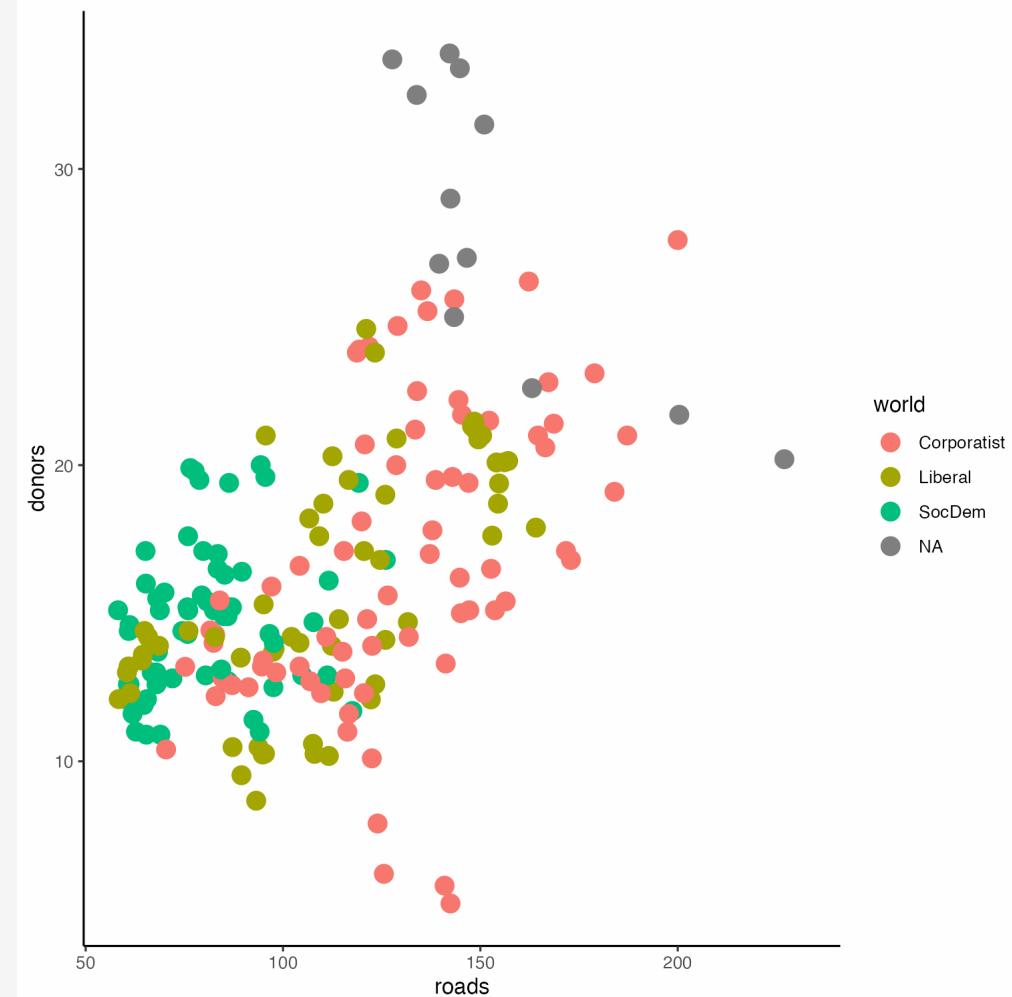
p
```



You can always specify scales manually

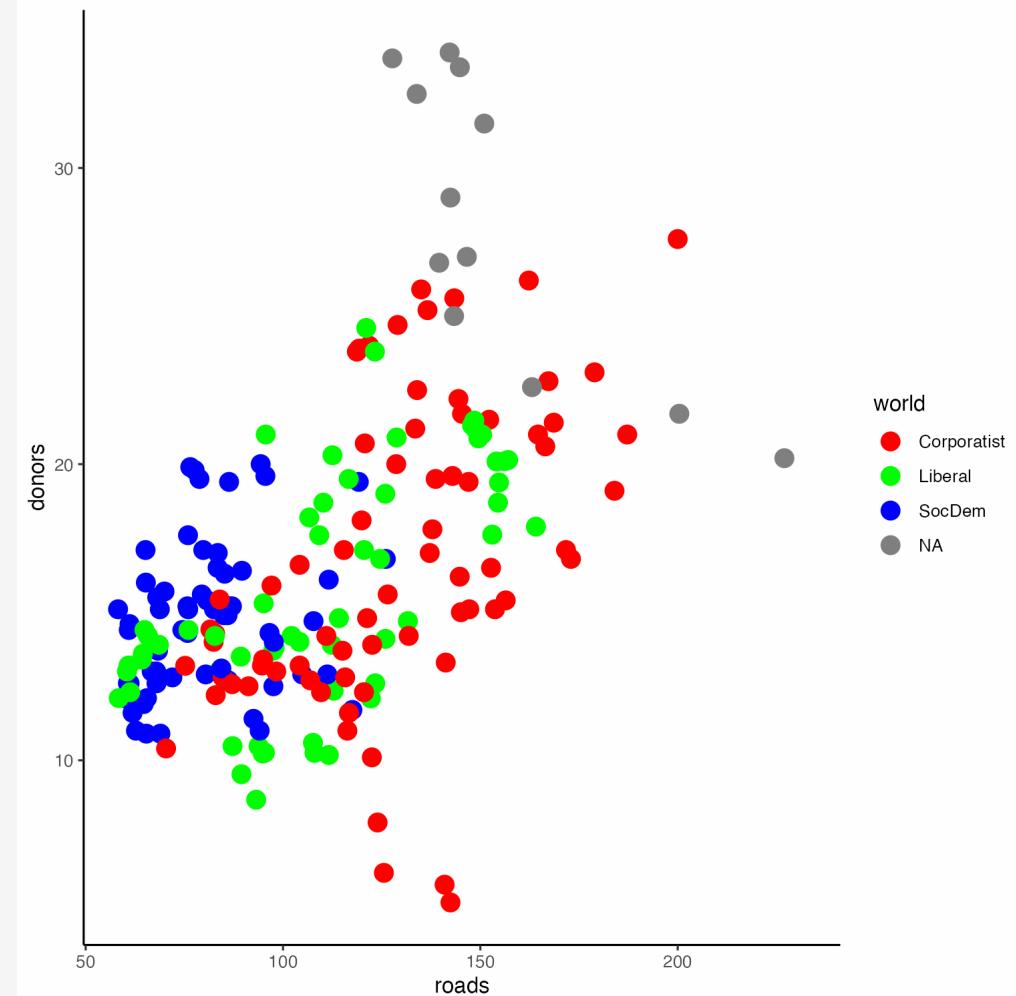
```
p <- ggplot(data = organdata,
             mapping = aes(x = roads,
                           y = donors,
                           color = world)) +
  geom_point(size = 4)

p
```



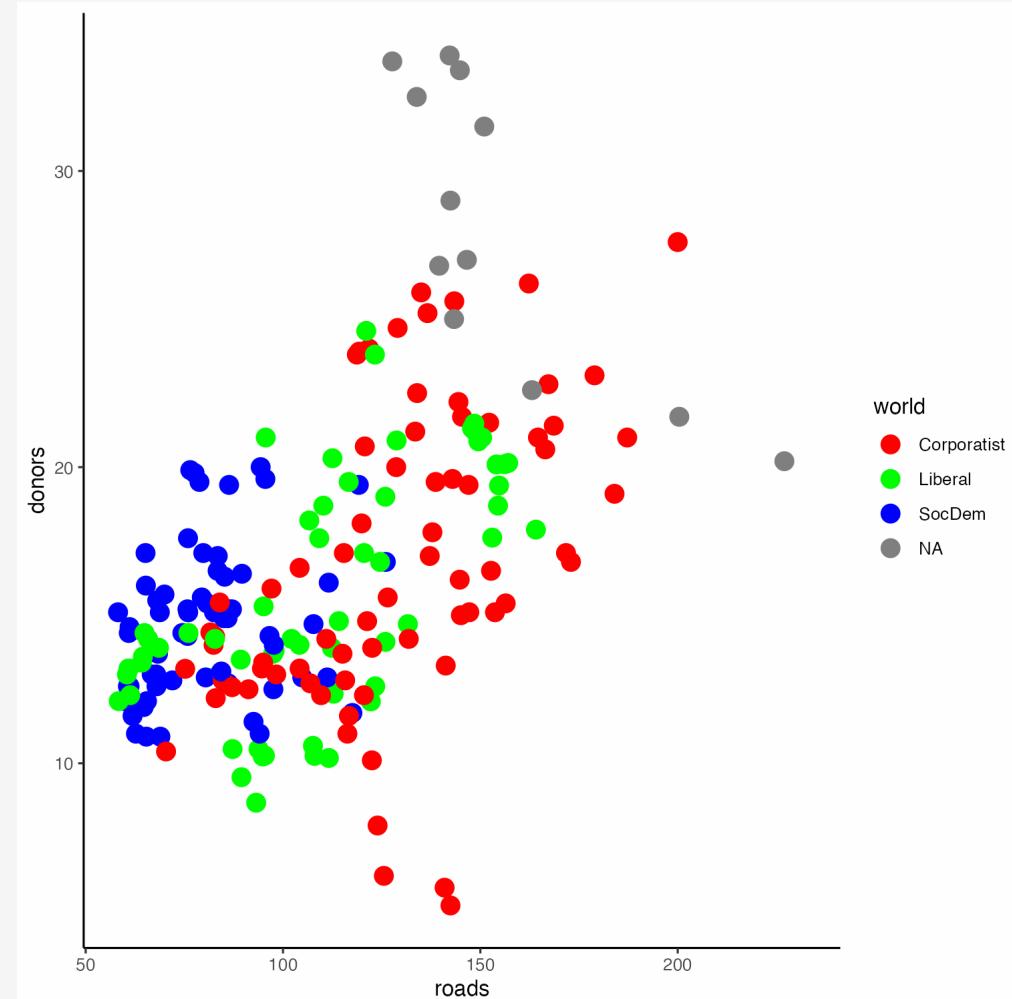
You can always specify scales manually

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



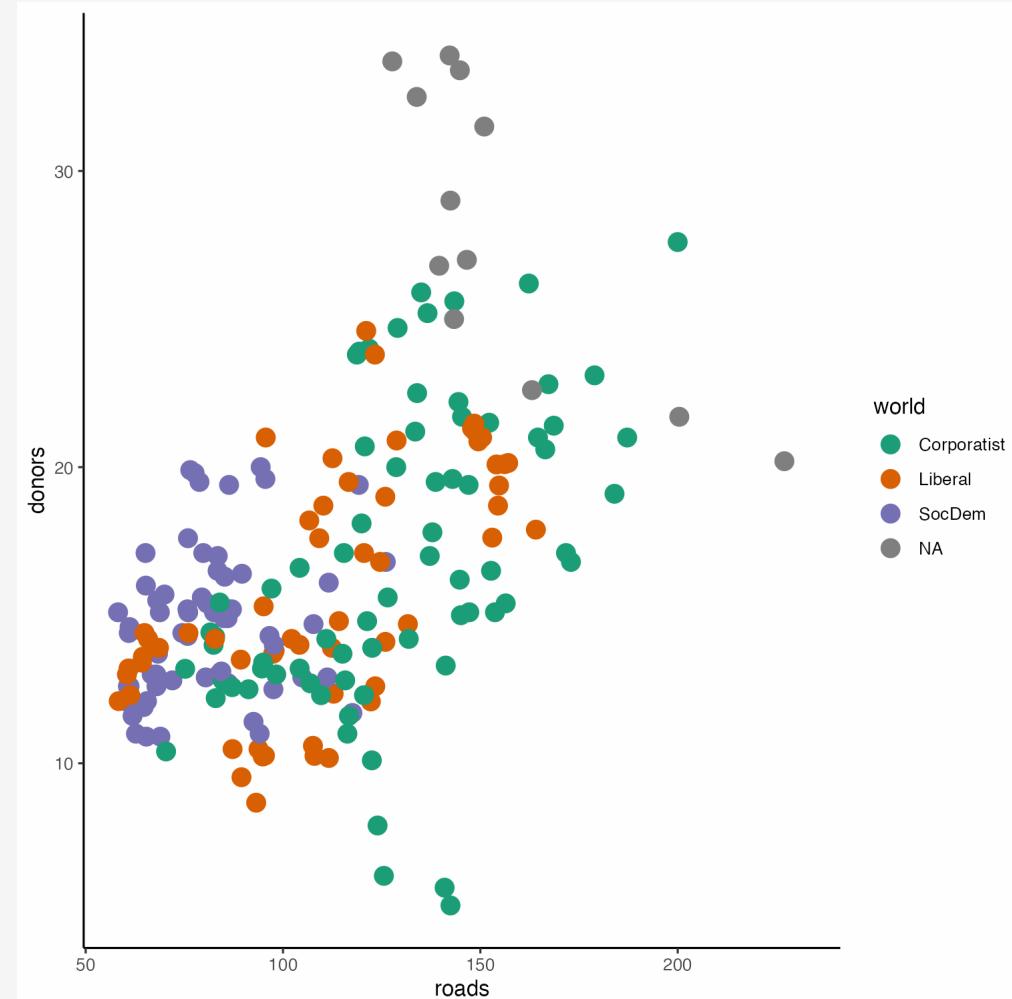
You can always specify scales manually

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



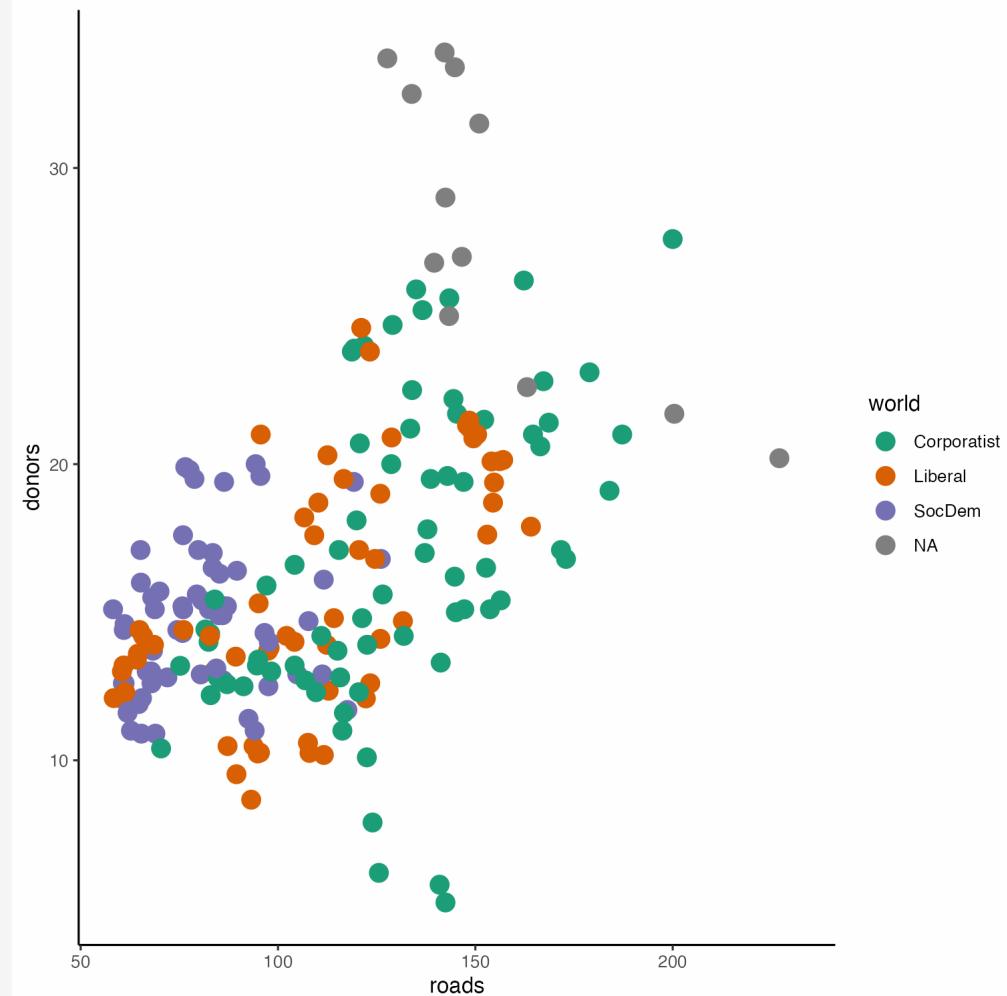
You can always specify scales manually

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



You can always specify scales manually

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



You can always specify scales manually

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

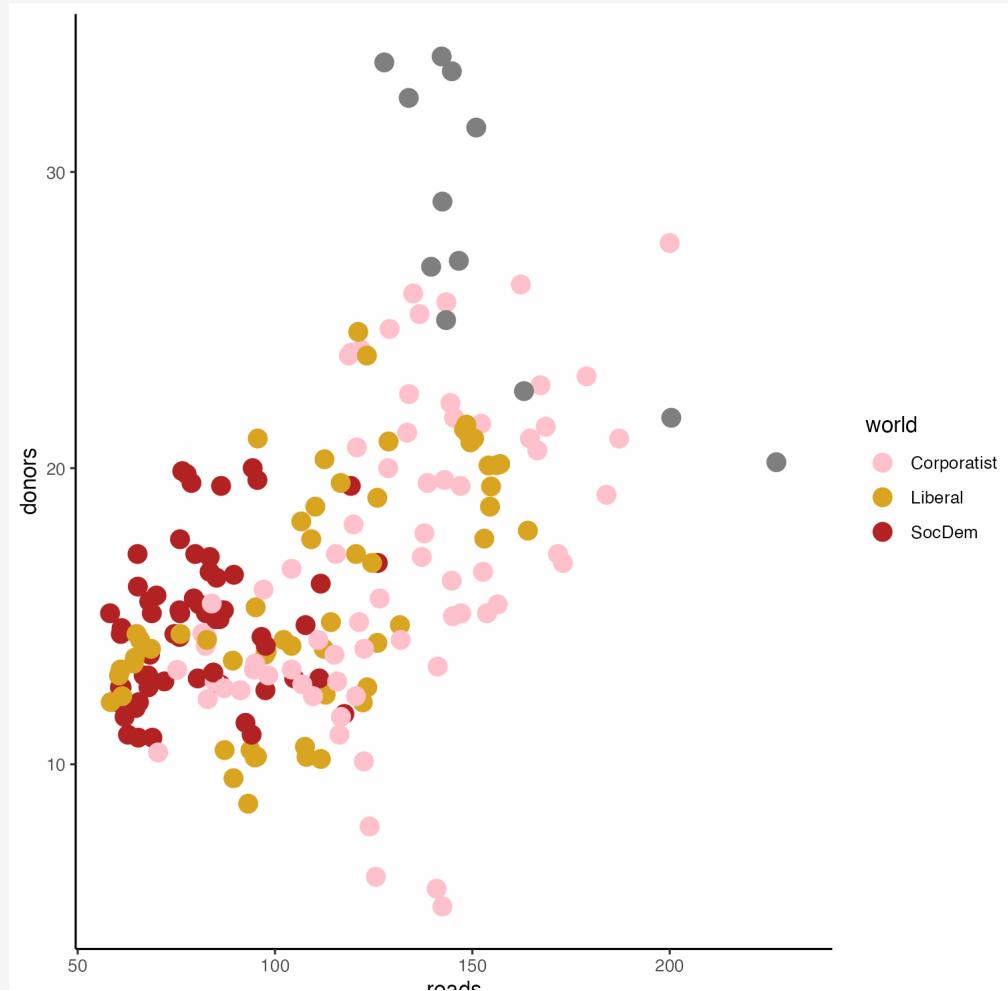
You can always specify scales manually

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

You can always specify scales manually

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

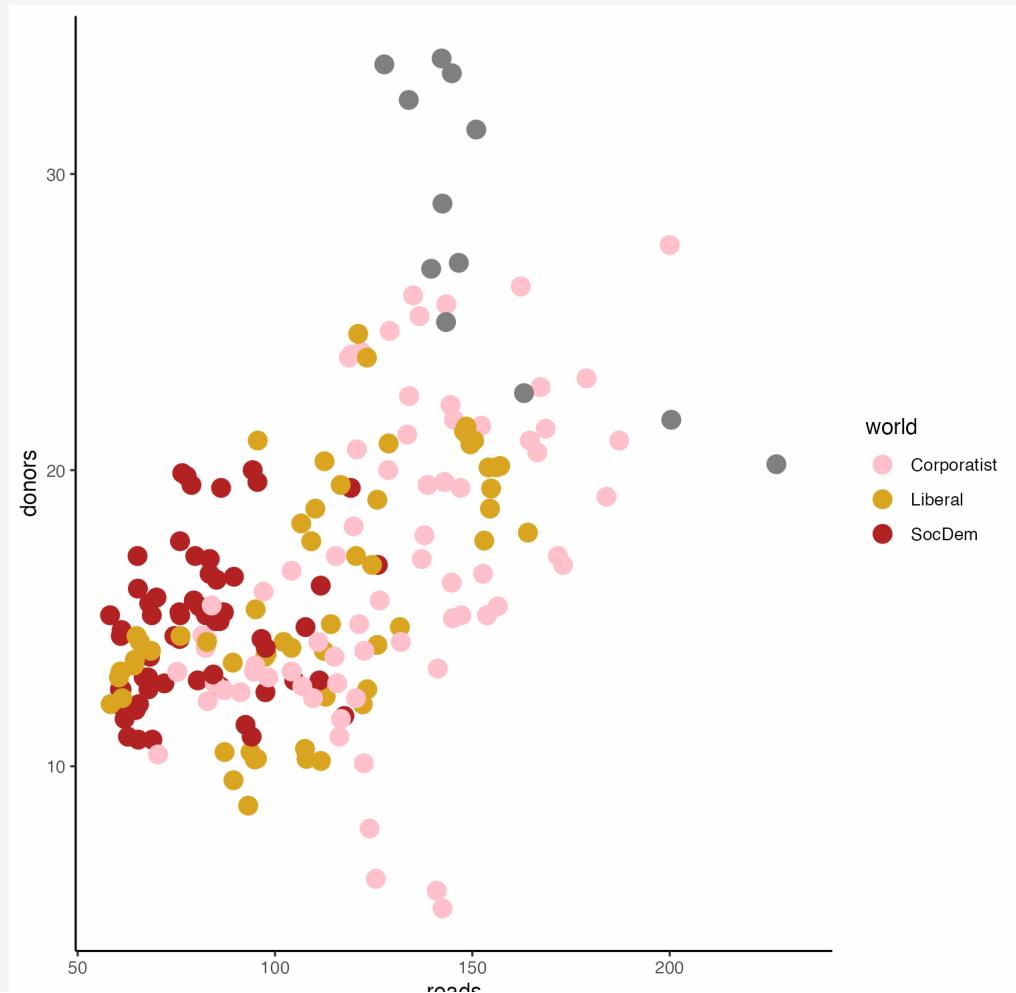
```
## Corporatist      Liberal      SocDem
##          "pink" "goldenrod" "firebrick"
```



You can always specify scales manually

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

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



But many balanced palettes are available

E.g., the RColorBrewer Palettes

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

See the palettes with
`RColorBrewer::display.brewer.all()`

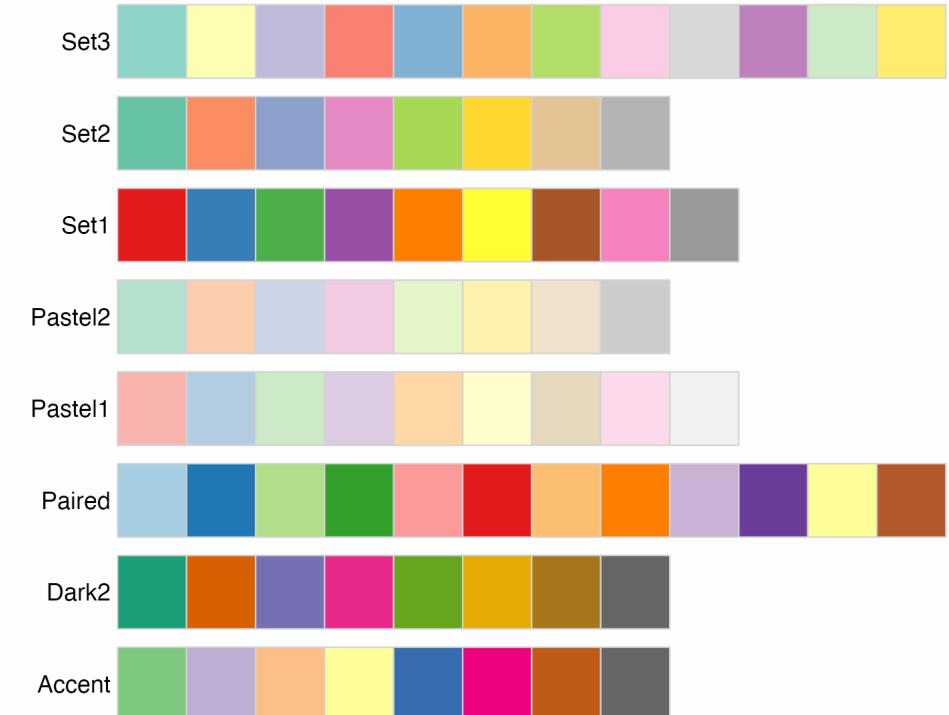
But many balanced palettes are available

E.g., the RColorBrewer Palettes

Qualitative palettes

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

See the palettes with
`RColorBrewer::display.brewer.all()`



But many balanced palettes are available

E.g., the RColorBrewer Palettes

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

See the palettes with
`RColorBrewer::display.brewer.all()`

But many balanced palettes are available

E.g., the RColorBrewer Palettes

Sequential palettes

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

See the palettes with
`RColorBrewer::display.brewer.all()`



But many balanced palettes are available

E.g., the RColorBrewer Palettes

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

See the palettes with
`RColorBrewer::display.brewer.all()`

But many balanced palettes are available

E.g., the RColorBrewer Palettes

Diverging palettes

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

See the palettes with
`RColorBrewer::display.brewer.all()`



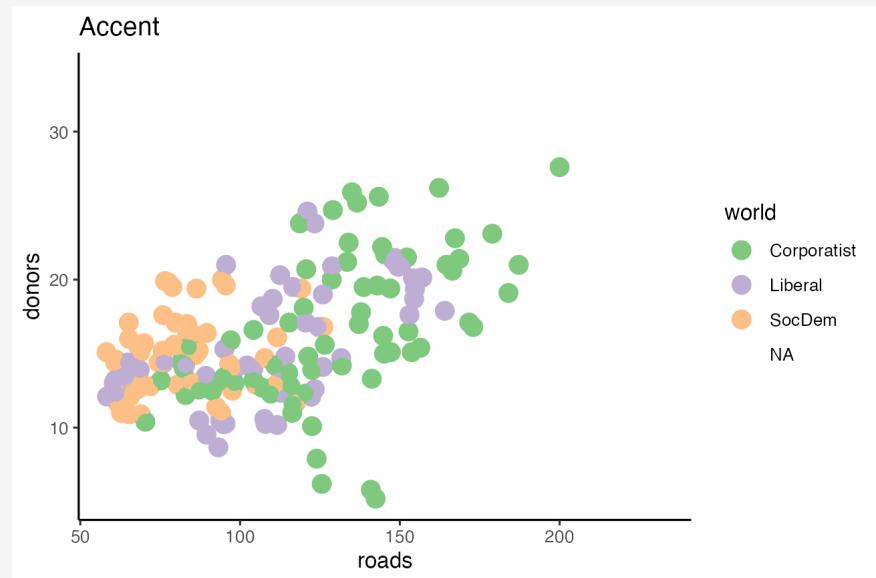
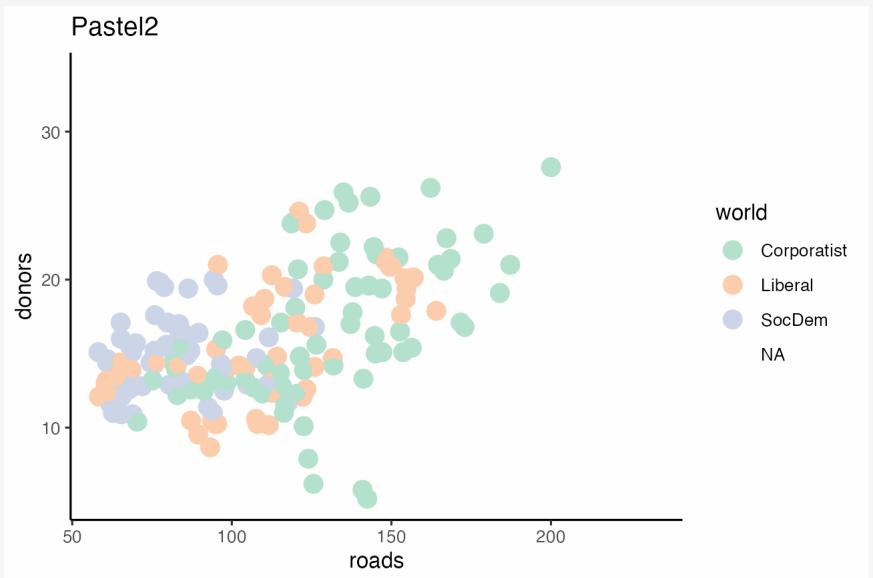
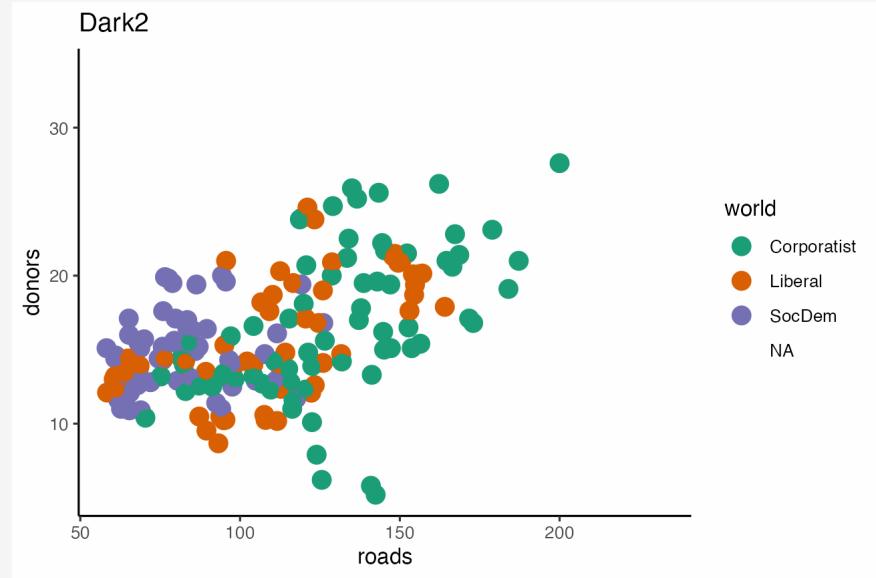
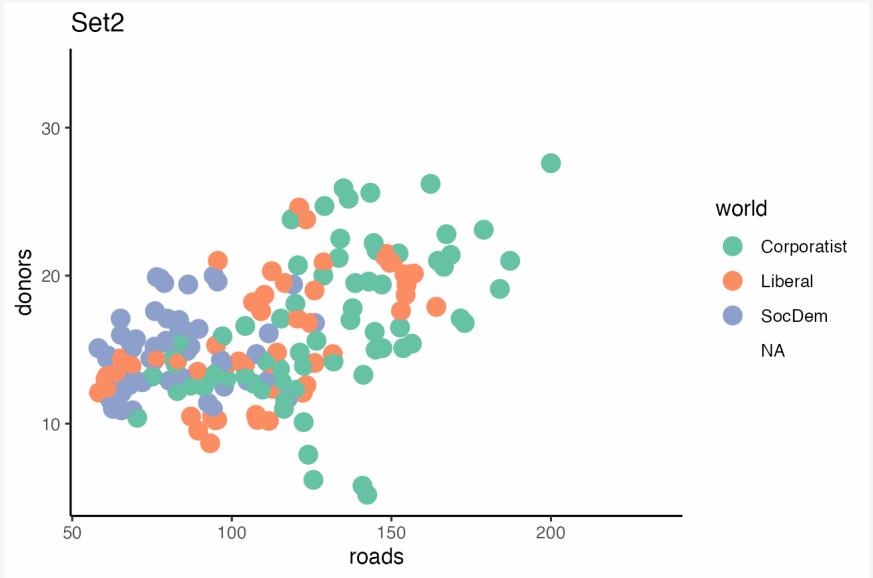
Qualitative Brewer Palettes

```
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")
```



The colorspace package has even more

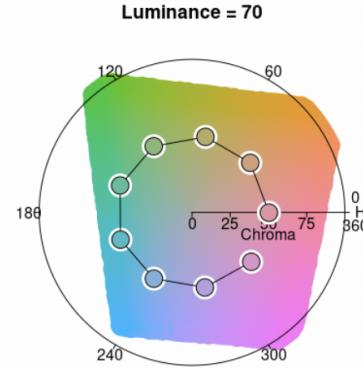
colorspace 2.0-4

Get started Articles ▾ Reference Changelog Contact

A Toolbox for Manipulating and Assessing Colors and Palettes

Color spaces

Luminance = 70



HCL-based palettes

Qualitative

- Pastel 1
- Dark 3
- Harmonic

Sequential (single-hue)

- Blues 3
- Reds 3
- Greens 3

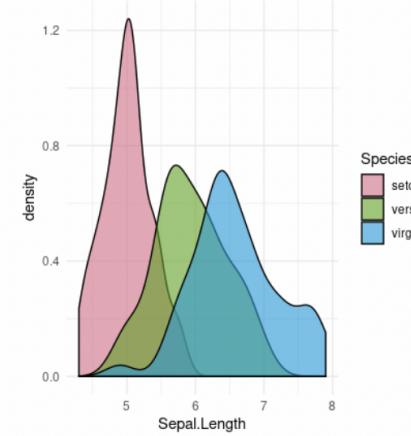
Sequential (multi-hue)

- Purple-Blue
- Viridis
- ag_Sunset

Diverging

- Blue-Red
- Green-Brown
- Tropic

ggplot2 scales



Species

- setosa
- versicolor
- virginica

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

Qualitative		Reds 2		Terrain 2		BurgYI		RdPu		Blue-Red 3	
Pastel 1		Reds 3		Viridis		RedOr		PuRd		Red-Green	
Dark 2		Greens 2		Plasma		OrYel		Purples		Purple-Green	
Dark 3		Greens 3		Inferno		Purp		PuBuGn		Purple-Brown	
Set 2		Oslo		Rocket		PurpOr		PuBu		Green-Brown	
Set 3		Sequential (multi-hue)		Mako		Sunset		Greens		Blue-Yellow	
Warm		Purple-Blue		Dark Mint		Magenta		BuGn		Blue-Yellow	
Cold		Red-Purple		Mint		SunsetDark		GnBu		Green-Orange	
Harmonic		Red-Blue		BluGrn		ag_Sunset		BuPu		Cyan-Mage	
Dynamic		Purple-Oran		Teal		BrwnYI		Blues		Tropic	
Sequential (single-hue)		Purple-Yell		TealGrn		YIOrRd		Lajolla		Broc	
Grays		Blue-Yellow		Emrld		YIOrBr		Turku		Cork	
Light Grays		Green-Yello		BluYI		OrRd		Hawaii		Vik	
Blues 2		Red-Yellow		ag_GrnYI		Oranges		Batlow		Berlin	
Blues 3		Heat		Peach		YIGn				Lisbon	
Purples 2		Heat 2		PinkYI		YIGnBu		Blue-Red		Tofino	
Purples 3		Terrain		Burg		Reds		Blue-Red 2			
Diverging											

So many colors

The colorspace function convention

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

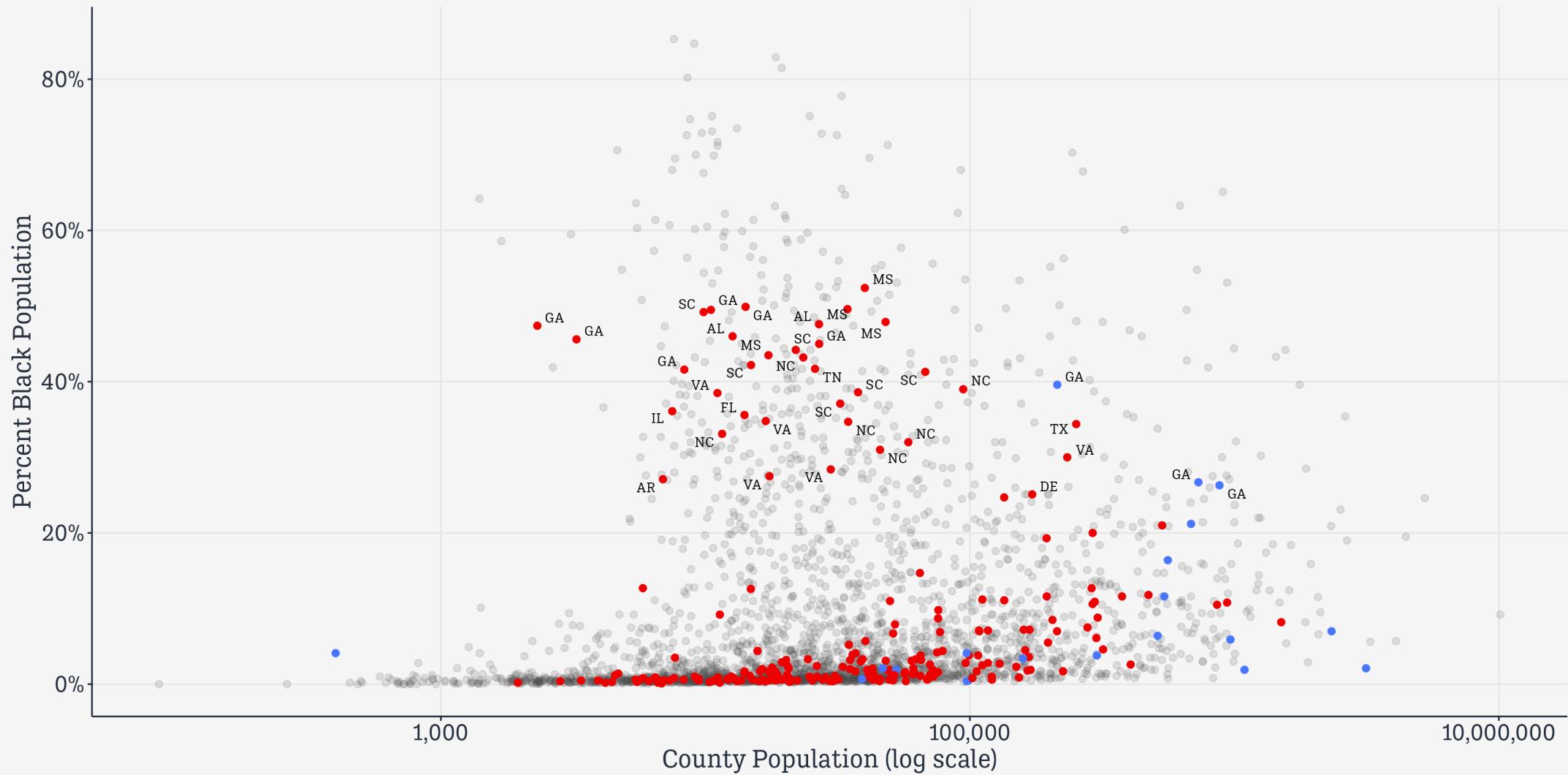
`scale_color_binned_diverging()`
`scale_color_binned_qualitative()`
`scale_color_binned_sequential()`
`scale_color_continuous_diverging()`
`scale_color_continuous_qualitative()`
`scale_color_continuous_sequential()`
`scale_color_discrete_diverging()`
`scale_color_discrete_qualitative()`
`scale_color_discrete_sequential()`

`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

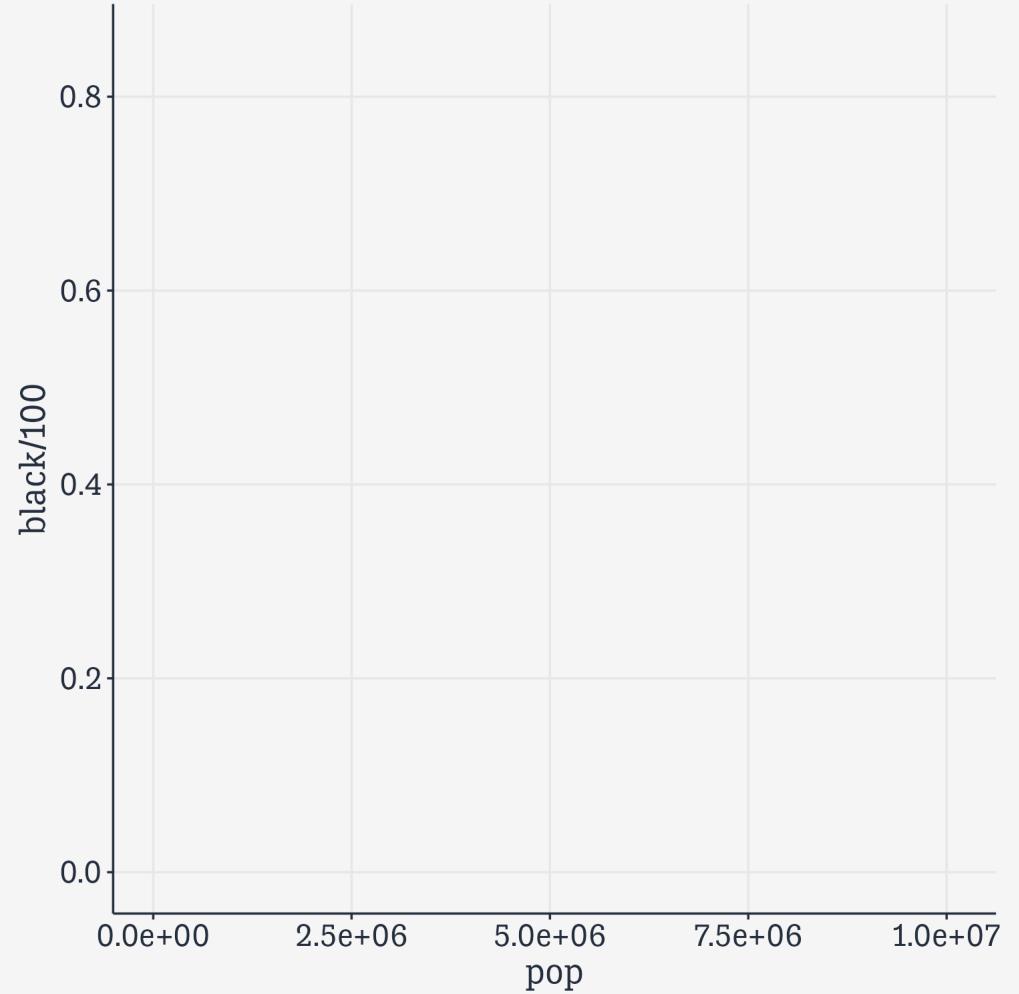


We know how to build this

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

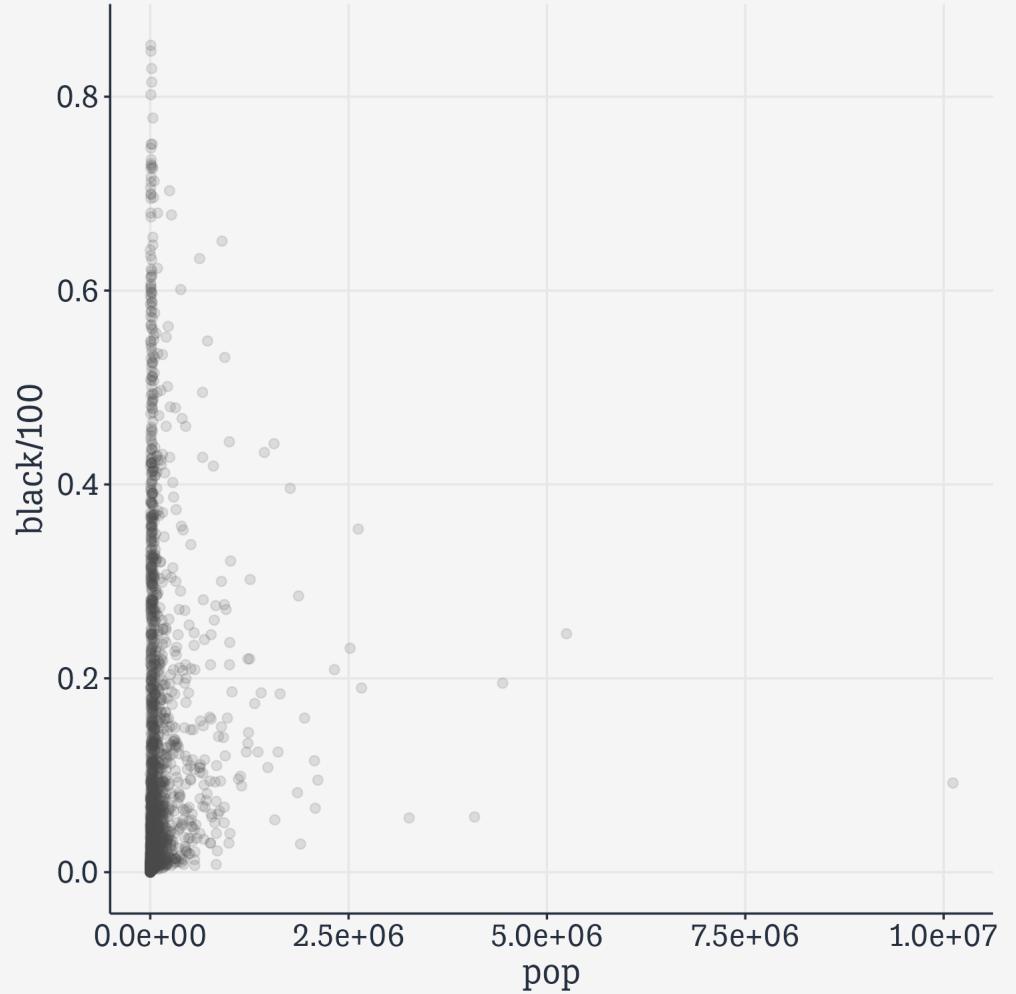
We know how to build this

```
# Brighter Blue and Red  
party_colors <- c("royalblue1", "red2")  
  
ggplot(data = subset(county_data,  
                     flipped == "No"),  
        mapping = aes(x = pop,  
                      y = black/100))
```



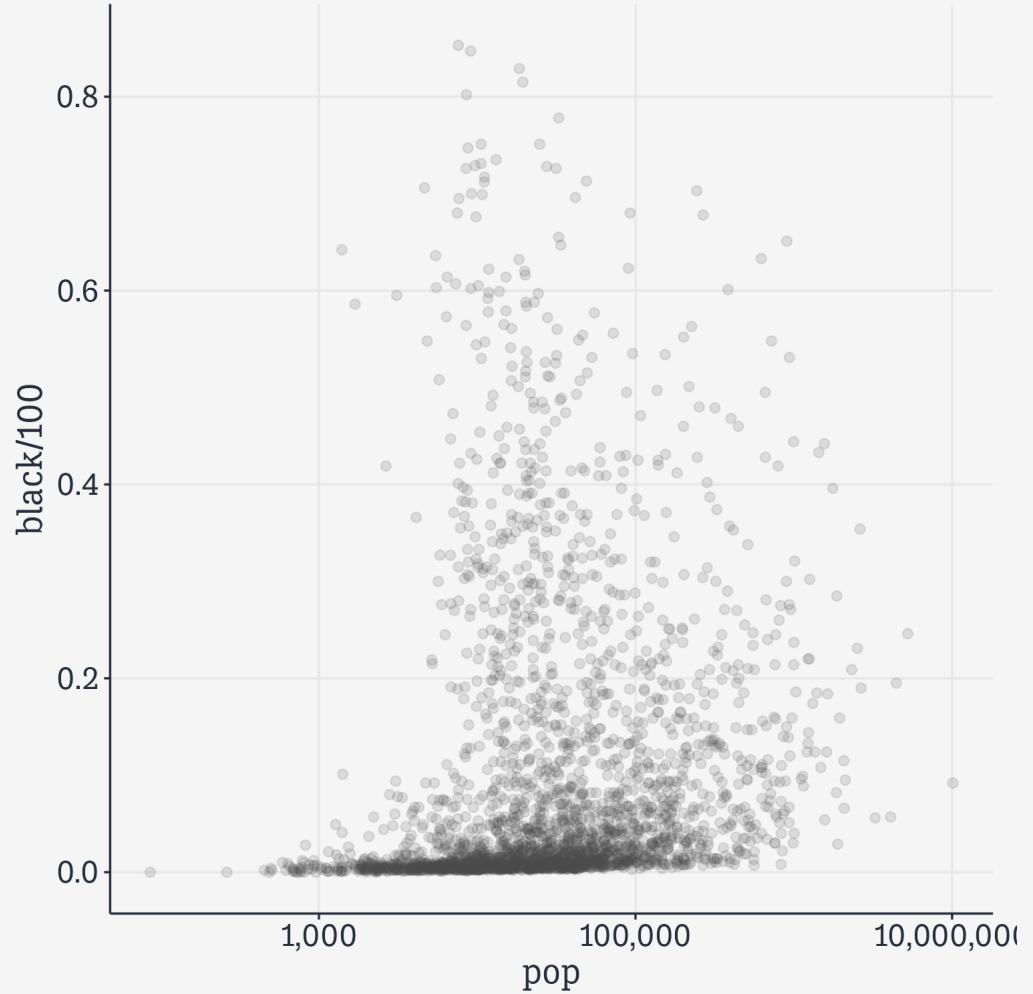
We know how to build this

```
# 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))
```



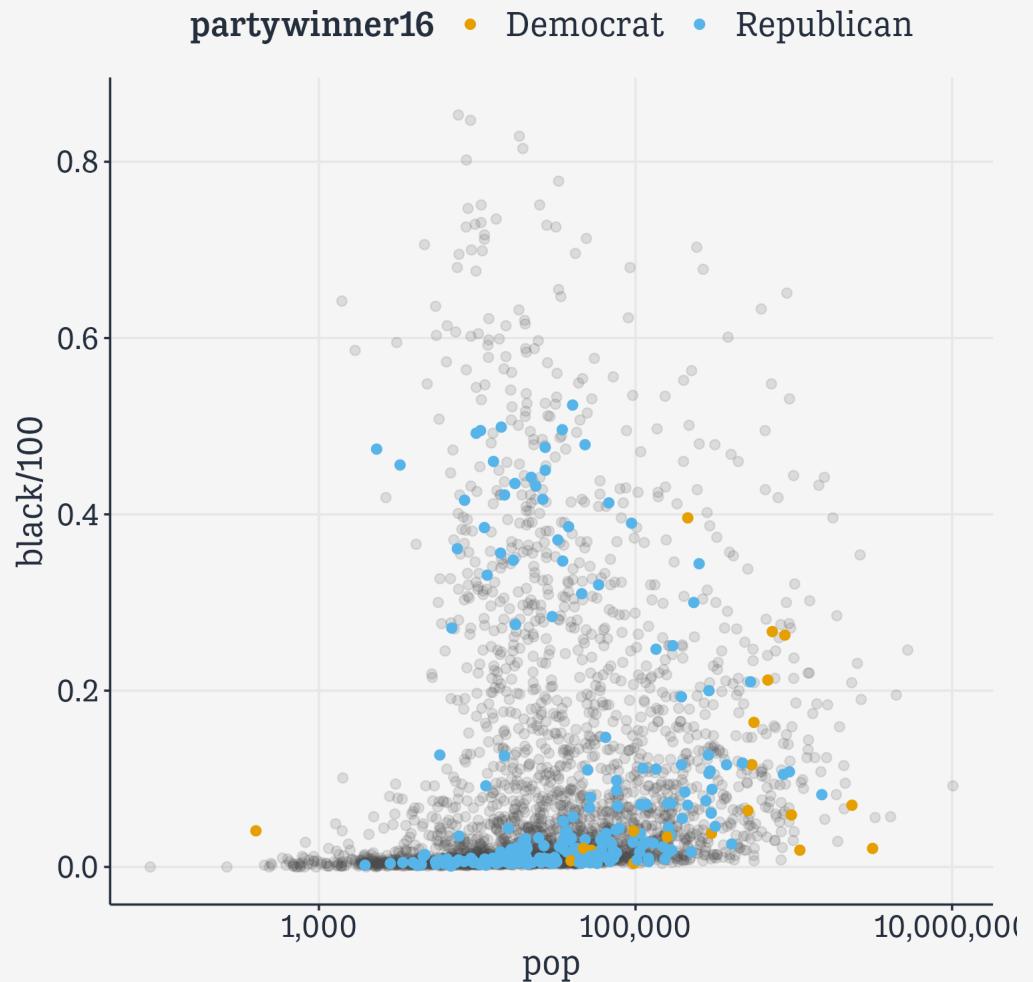
We know how to build this

```
# 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

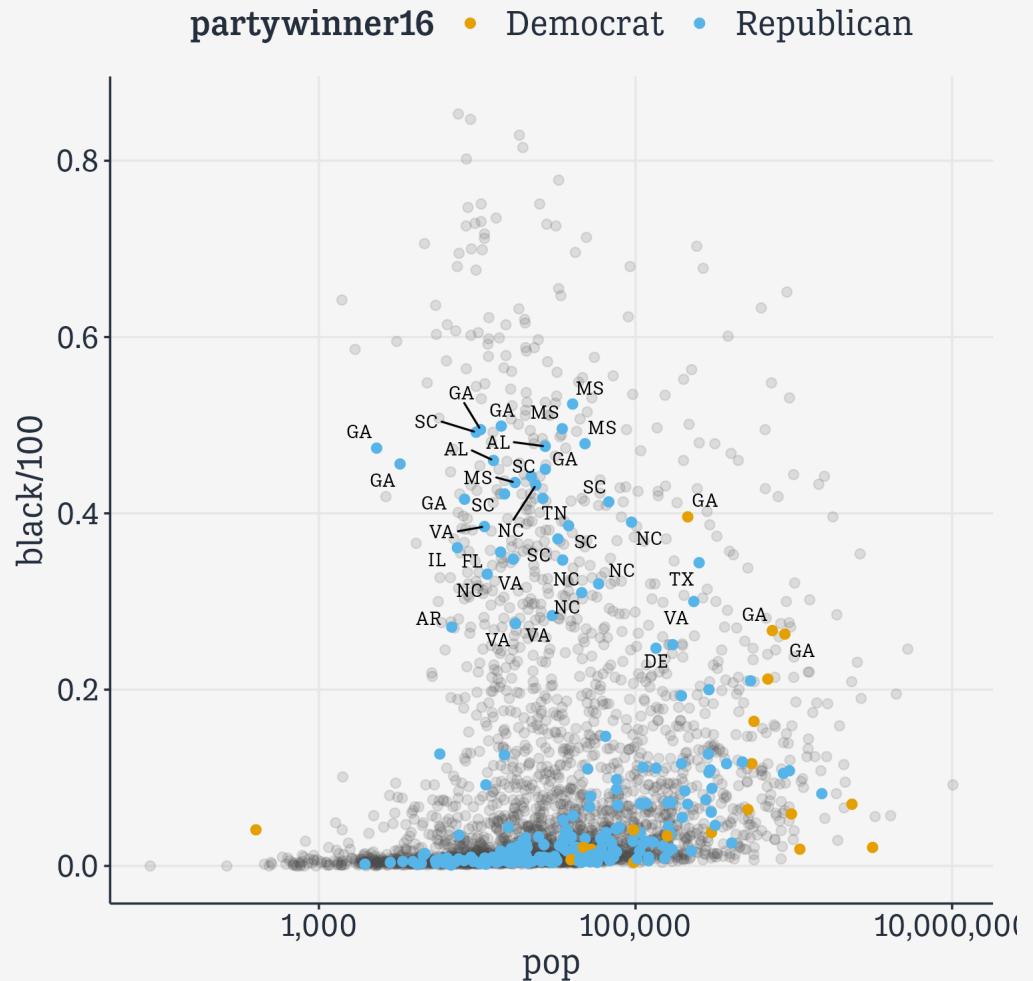
```
# Brighter Blue and Red  
party_colors <- c("royalblue1", "red2")  
  
ggplot(data = subset(county_data,  
                     flipped == "No"),  
        mapping = aes(x = pop,  
                      y = black/100)) +  
  geom_point(alpha = 0.15, color = "gray30",  
             size = rel(2)) +  
  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

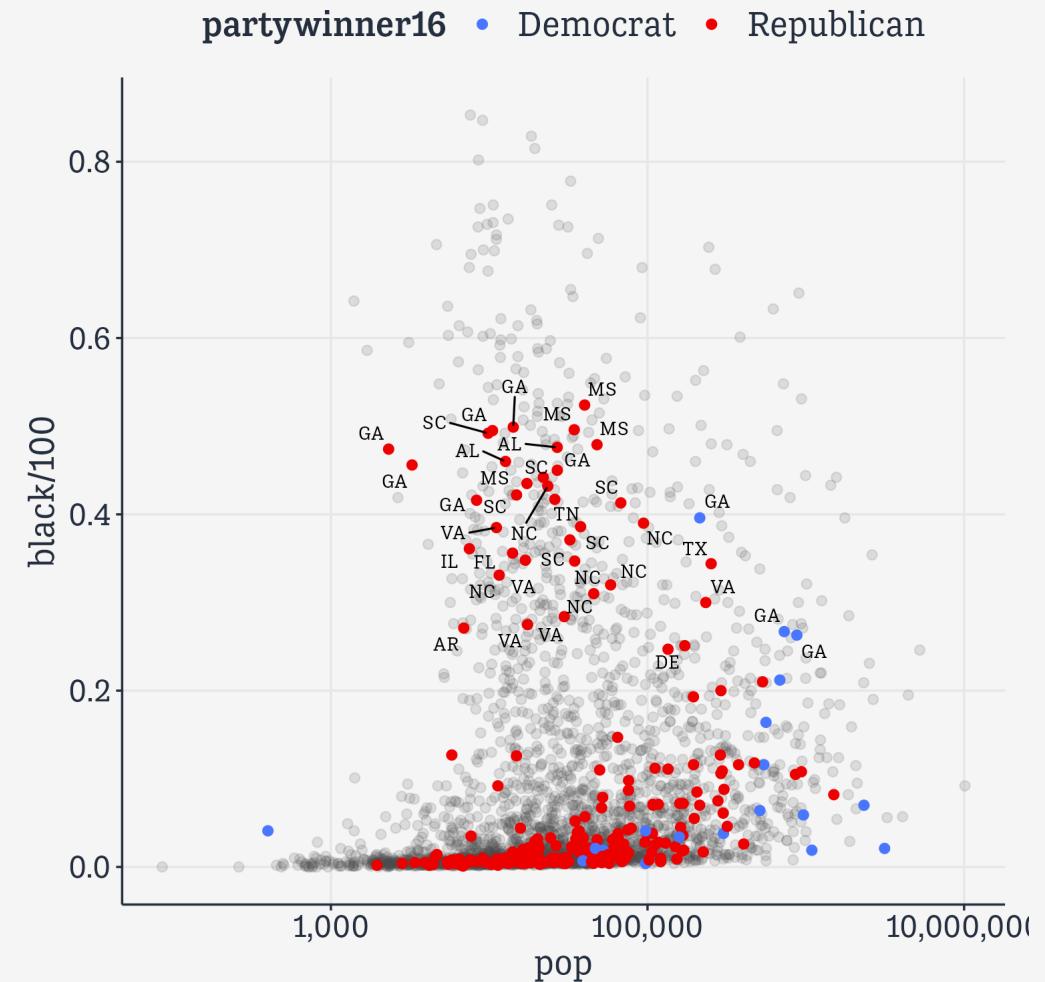
```
# Brighter Blue and Red
party_colors <- c("royalblue1", "red2")

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

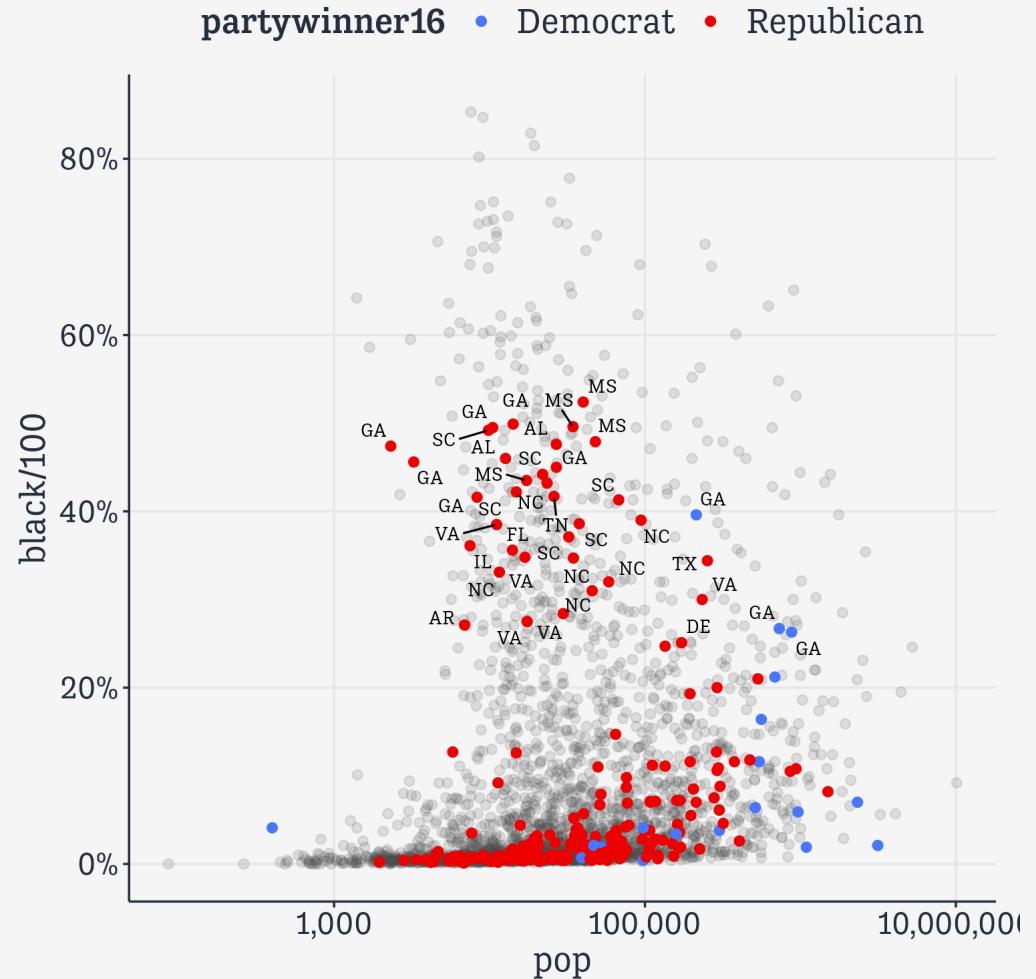
```
# Brighter Blue and Red  
party_colors <- c("royalblue1", "red2")  
  
ggplot(data = subset(county_data,  
                     flipped == "No"),  
        mapping = aes(x = pop,  
                      y = black/100)) +  
  geom_point(alpha = 0.15, color = "gray30",  
             size = rel(2)) +  
  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")

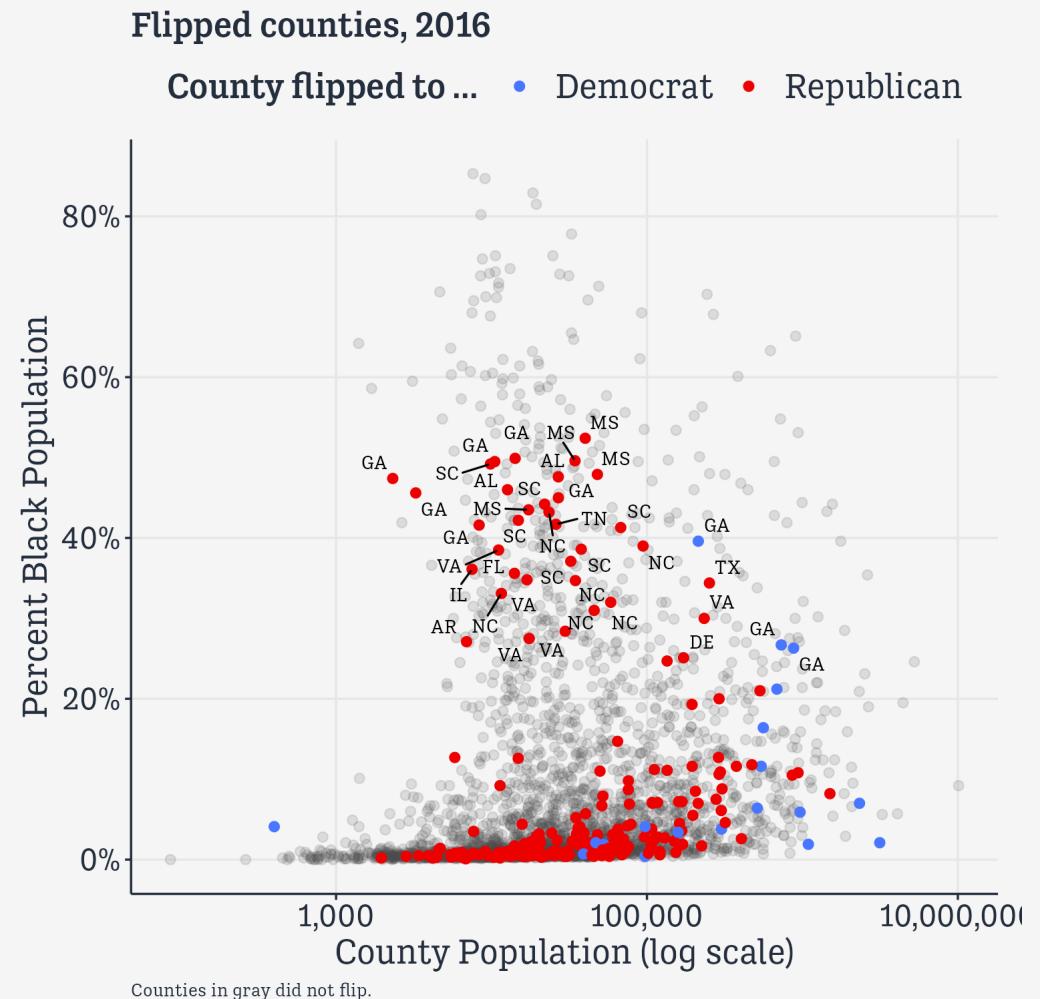
ggplot(data = subset(county_data,
                     flipped == "No"),
       mapping = aes(x = pop,
                     y = black/100)) +
  geom_point(alpha = 0.15, color = "gray30",
             size = rel(2)) +
  scale_x_log10(labels = label_comma()) +
  geom_point(data = subset(county_data,
 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

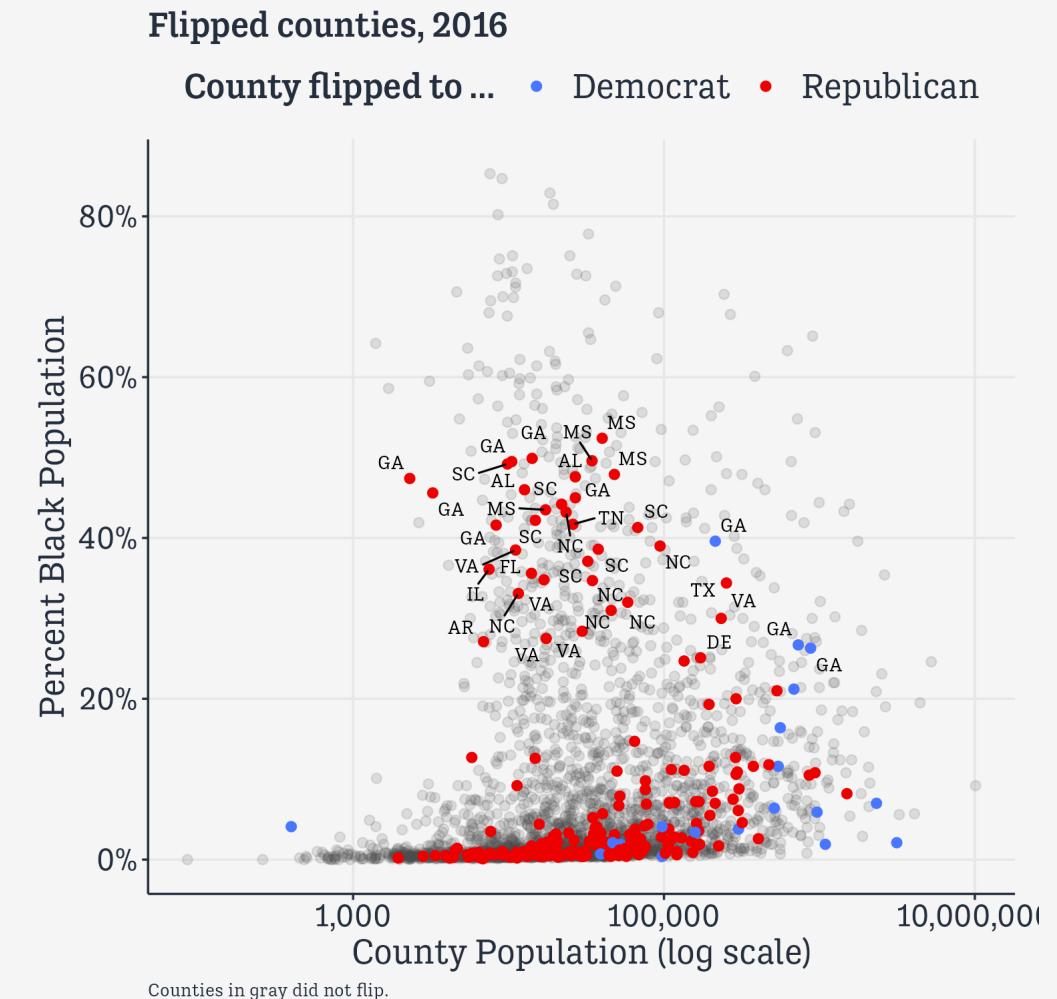
ggplot(data = subset(county_data,
                     flipped == "No"),
       mapping = aes(x = pop,
                     y = black/100)) +
  geom_point(alpha = 0.15, color = "gray30",
             size = rel(2)) +
  scale_x_log10(labels = label_comma()) +
  geom_point(data = subset(county_data,
 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

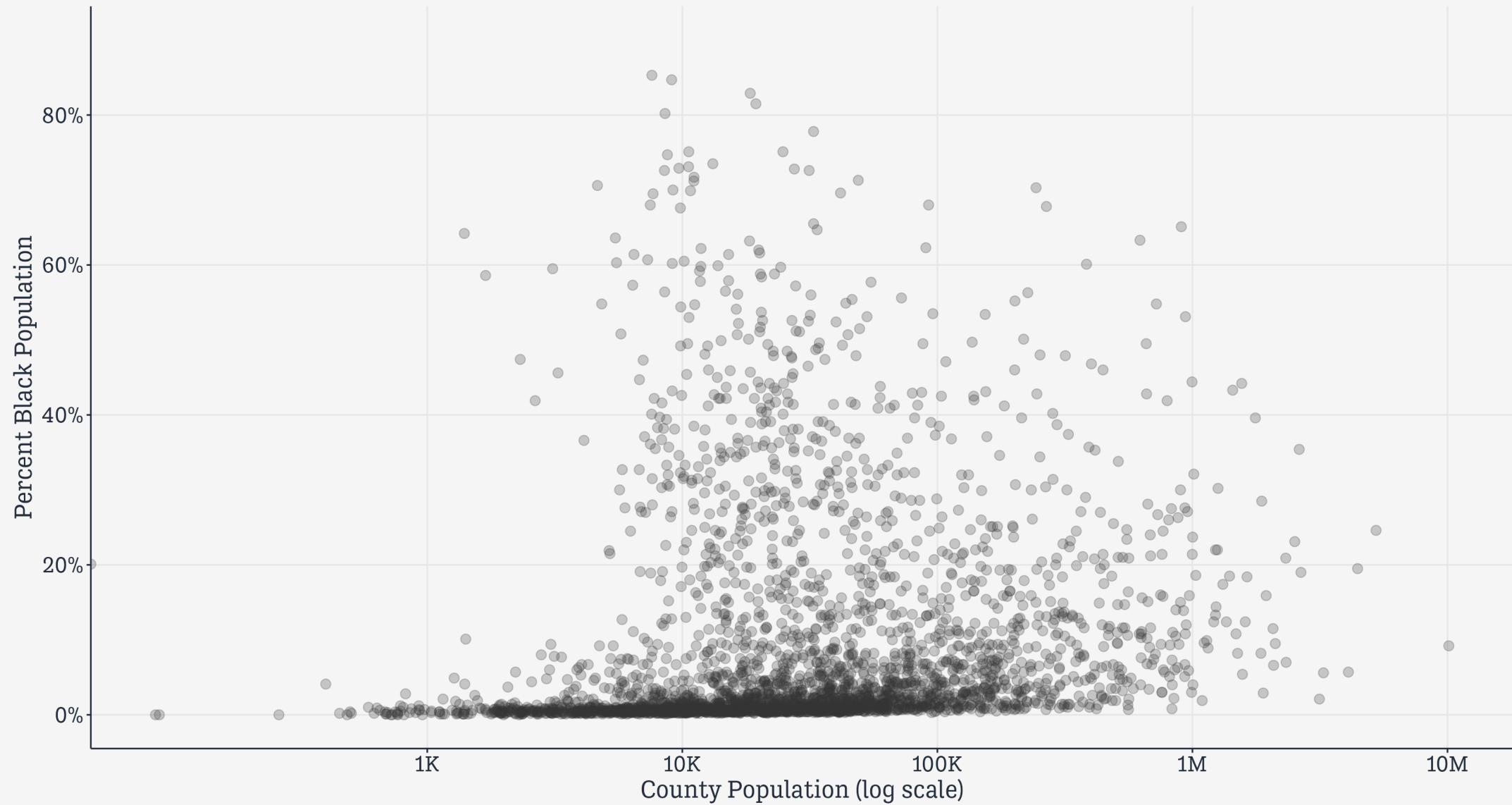
```
# Brighter Blue and Red
party_colors <- c("royalblue1", "red2")

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 Slide",
                                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.")
```

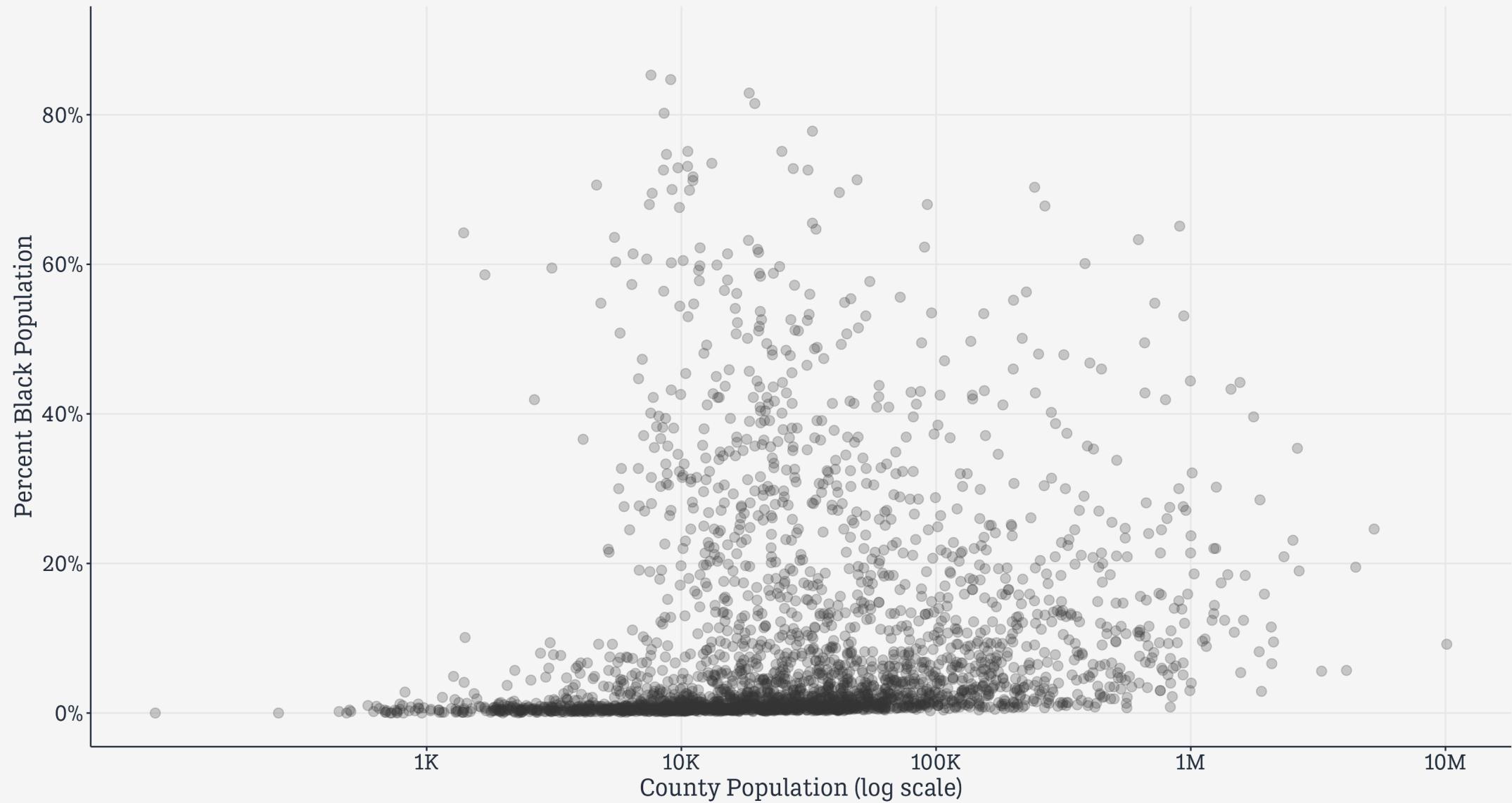


**Leverage ggplot's
layered approach**

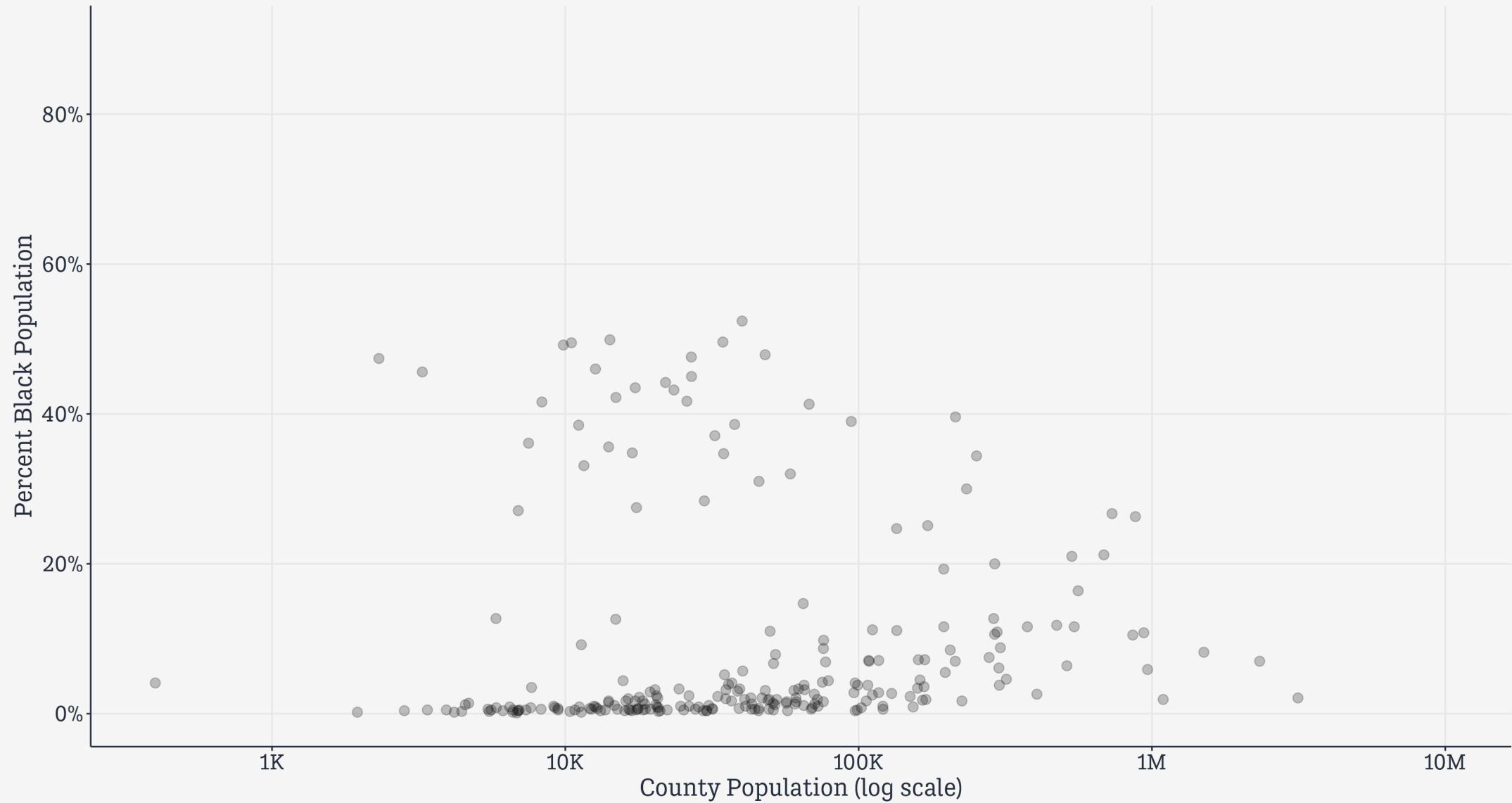
U.S. Counties by Population and Percent Black



These counties did not flip in 2016

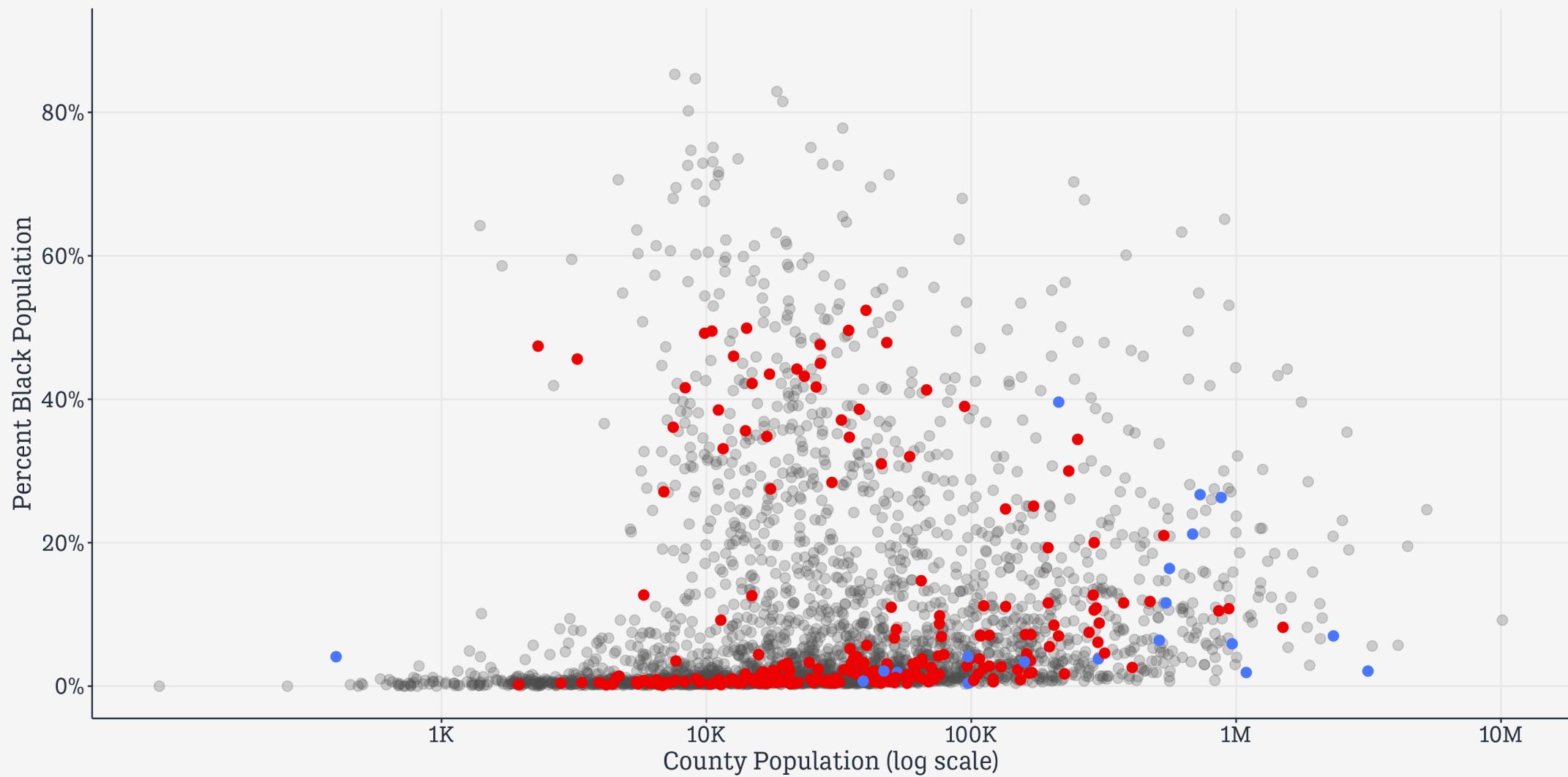


These counties did



Counties that flipped shown by party color

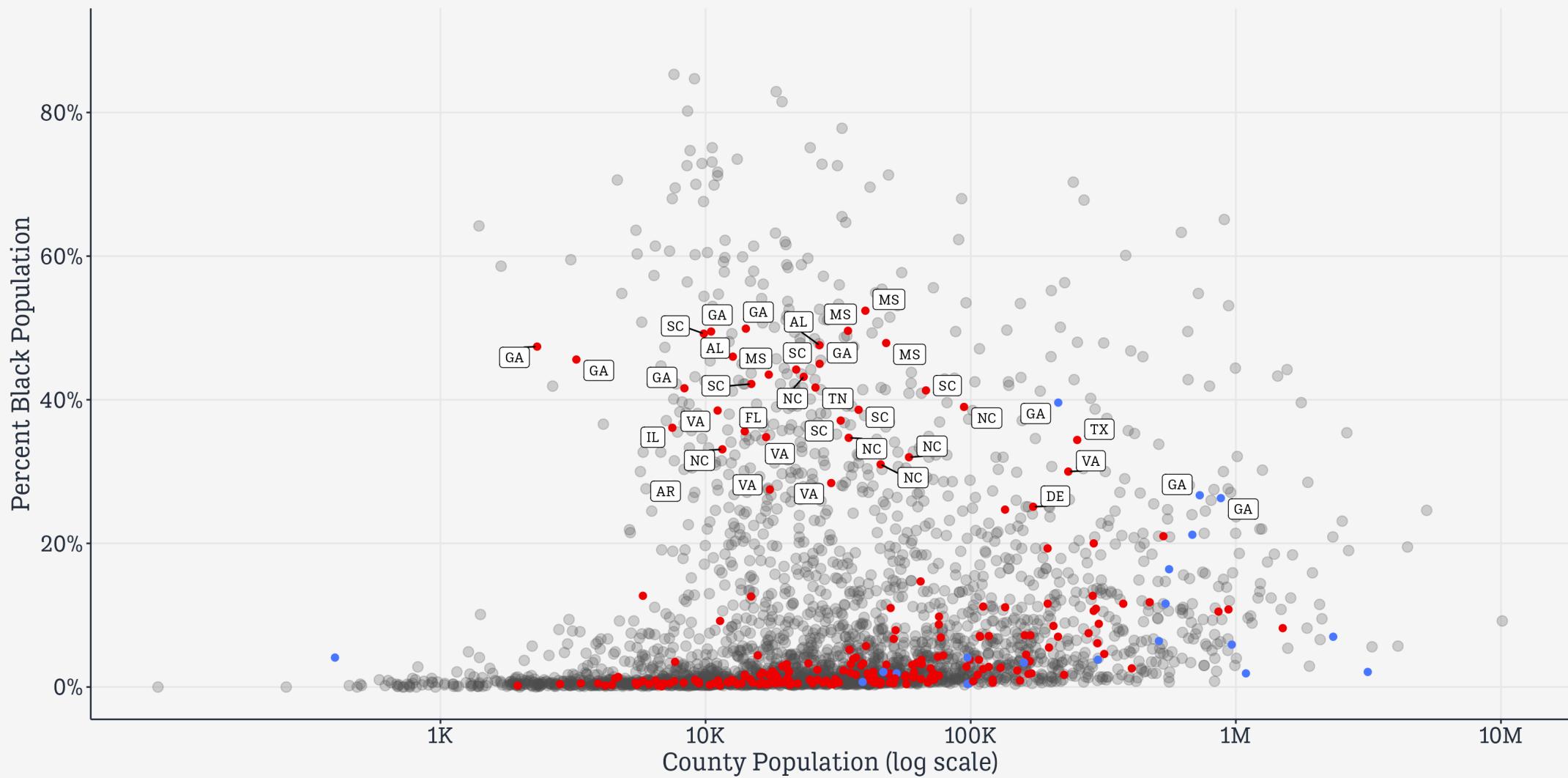
Flipped to • Democrat • Republican



Counties in gray did not flip.

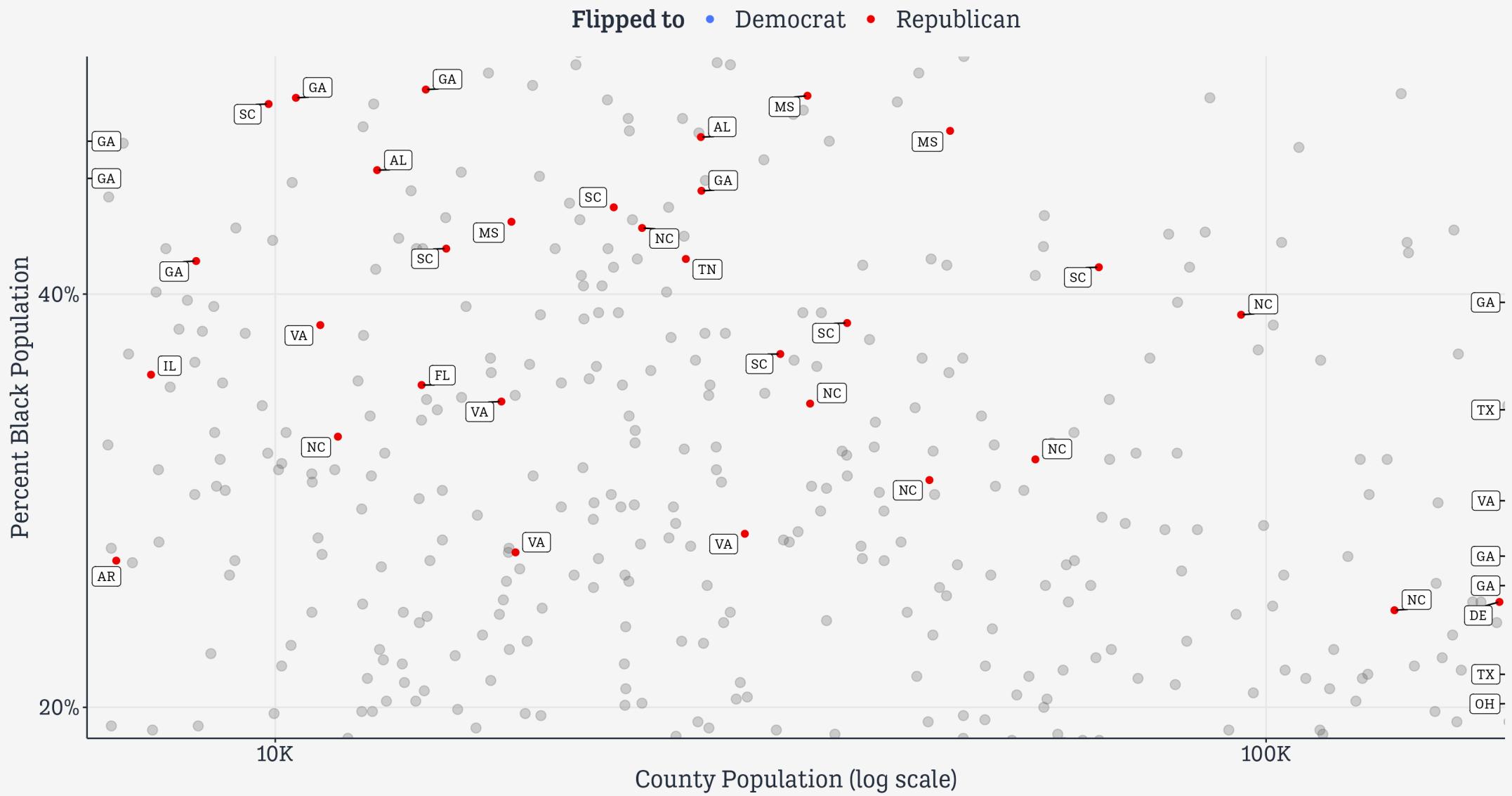
Counties that flipped shown by party color, and labeled by state

Flipped to • Democrat • Republican



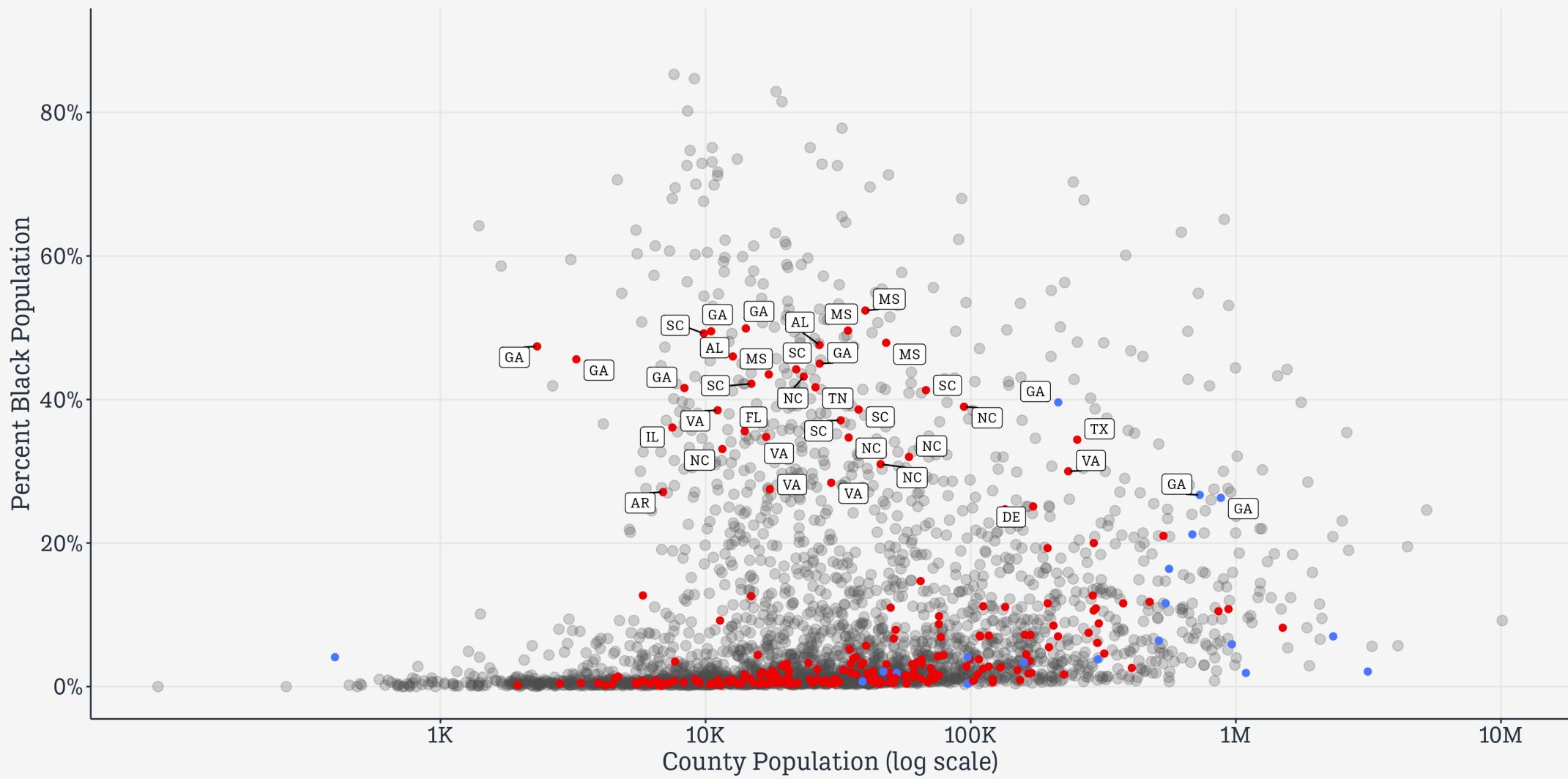
Counties in gray did not flip.

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



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

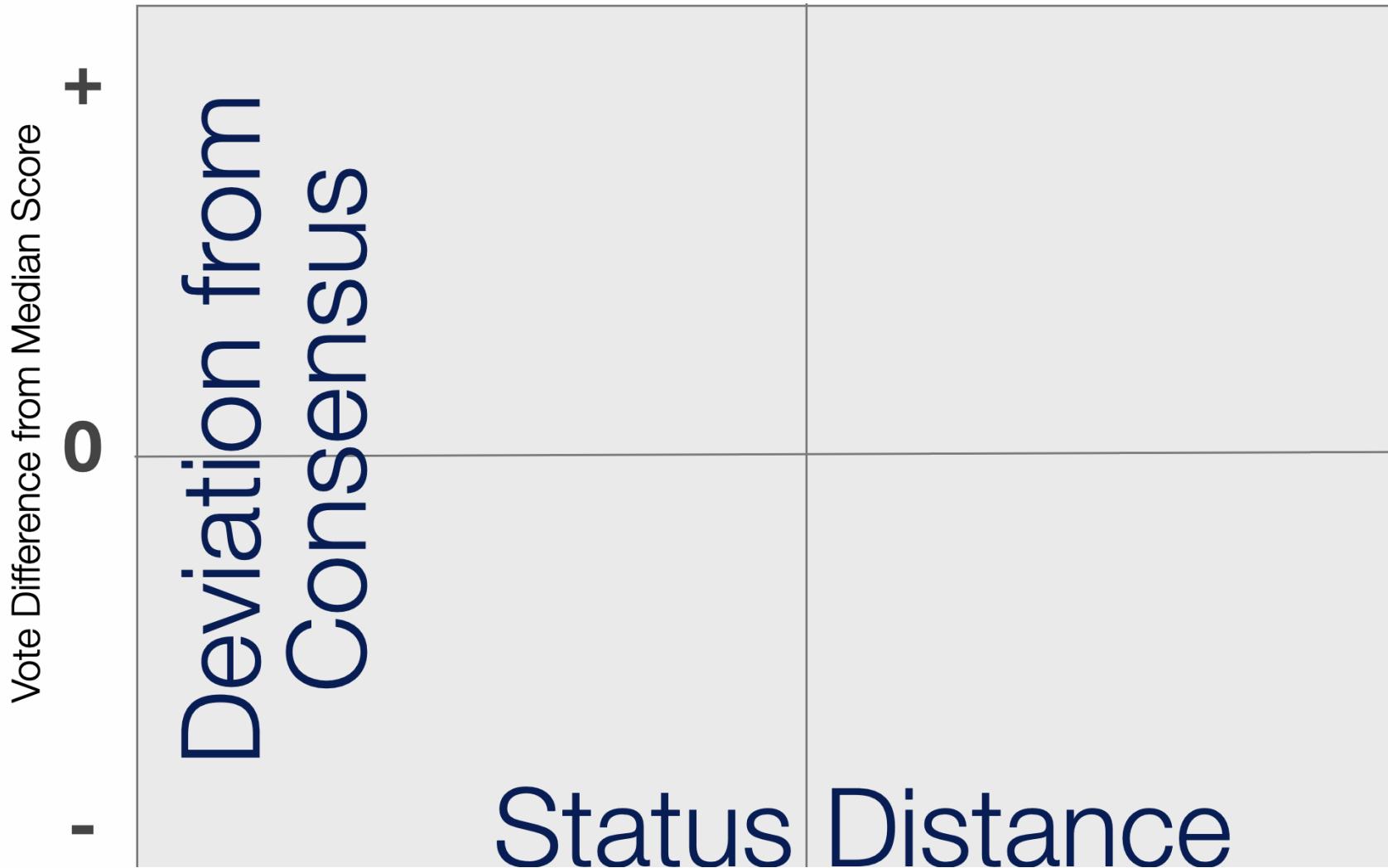
Flipped to • Democrat • Republican



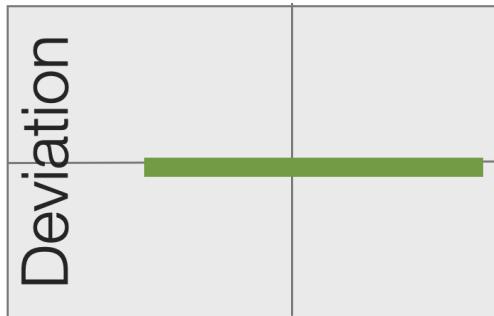
Counties in gray did not flip.

**Layer,
Highlight,
Repeat**

Build from ideas to data



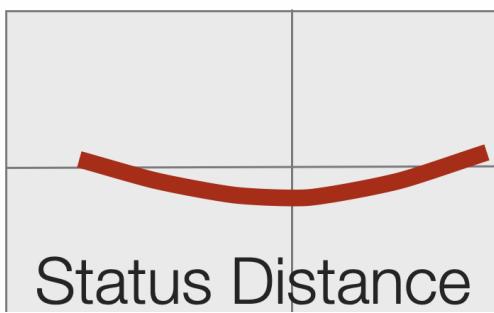
Build from ideas to data



1. Pure Objectivity



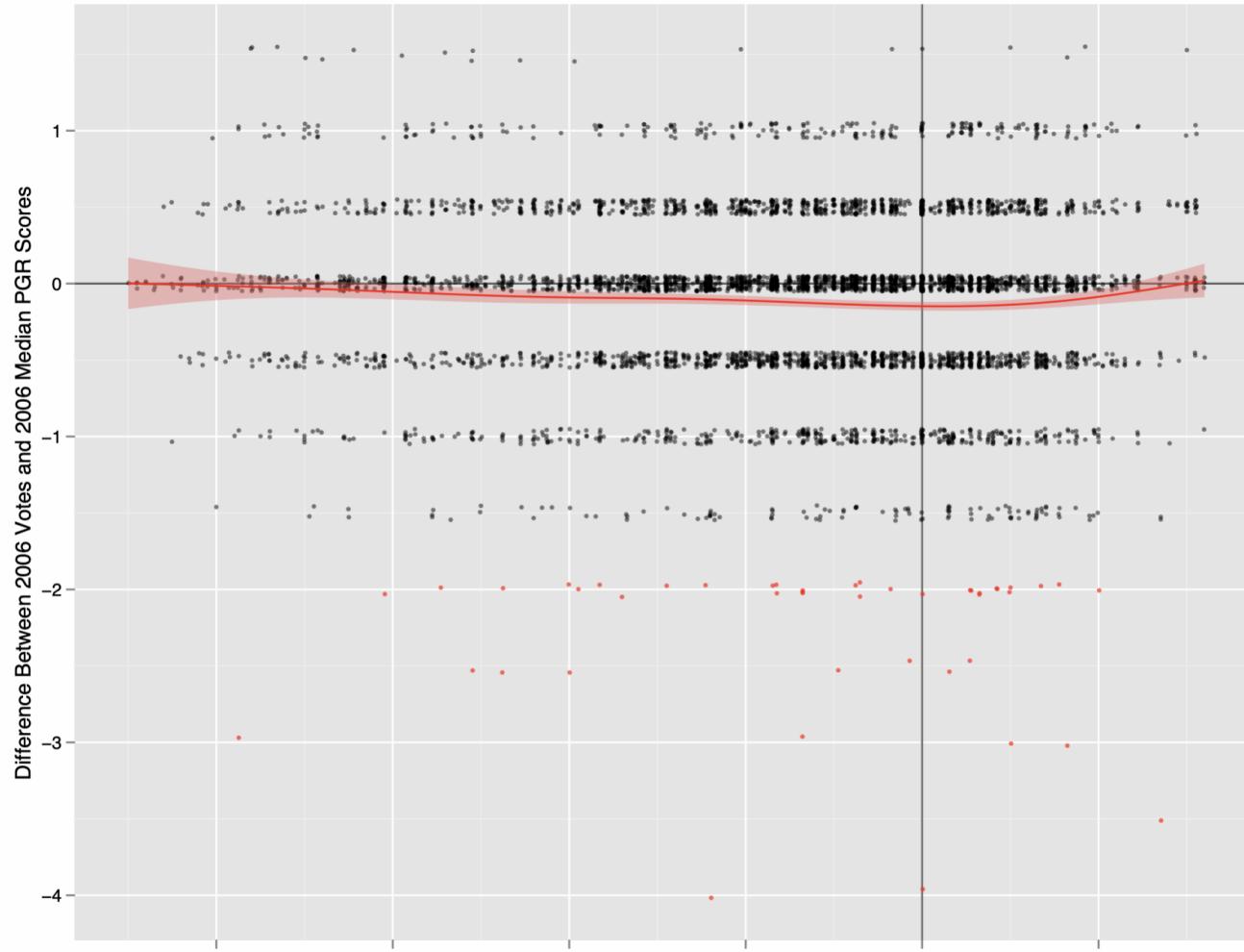
2. Distant Envy



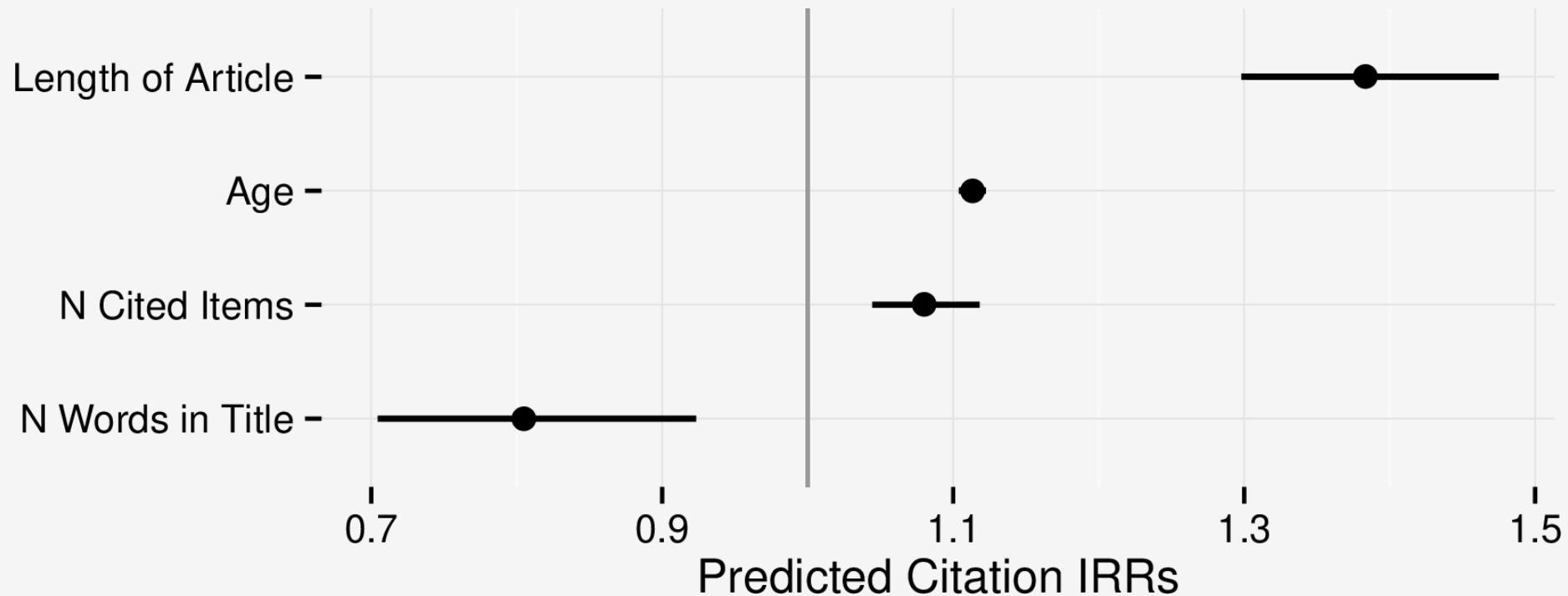
3. Local Competition

Build from ideas to data

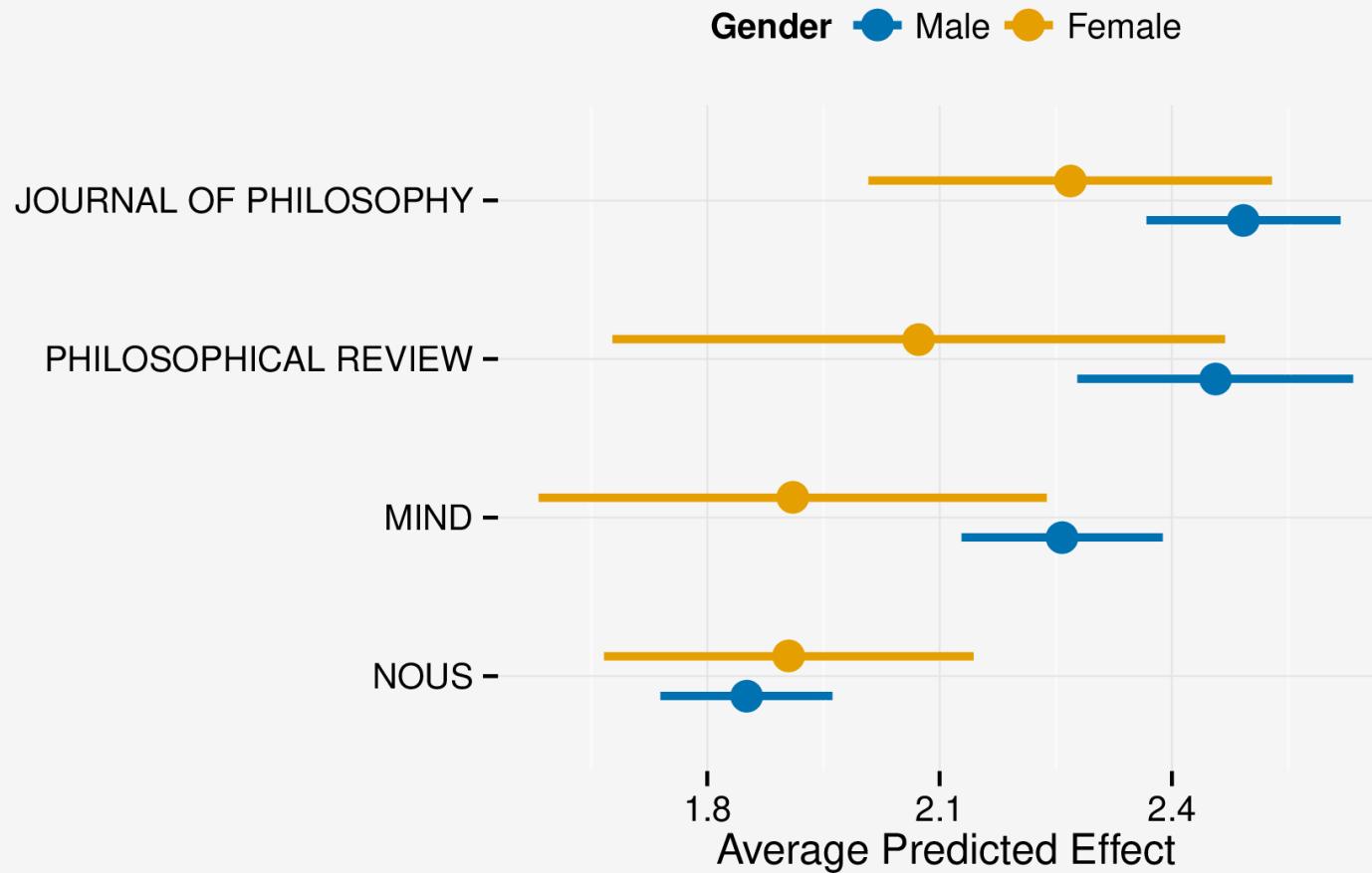
Deviation



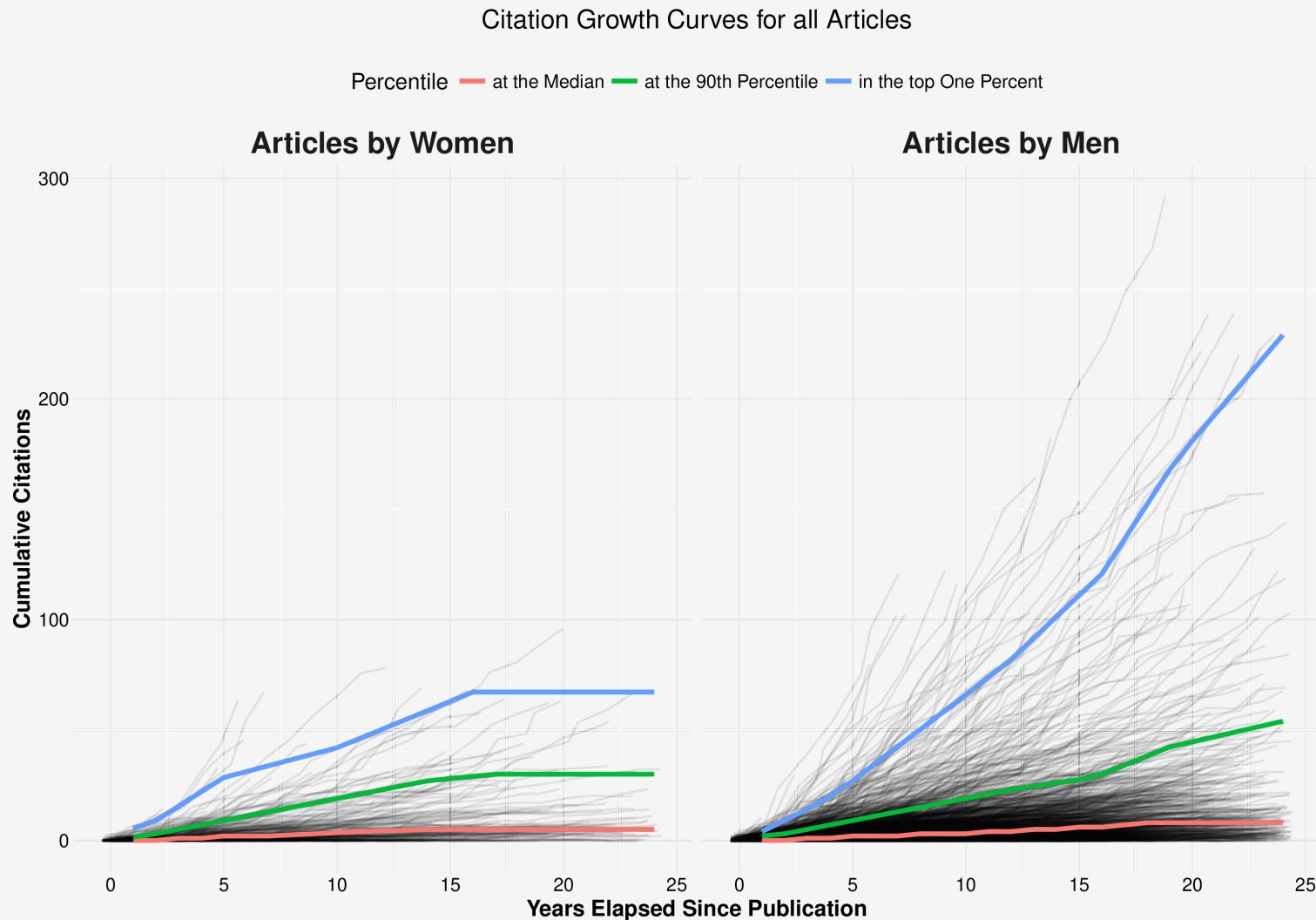
Repeat to differentiate



Repeat to differentiate

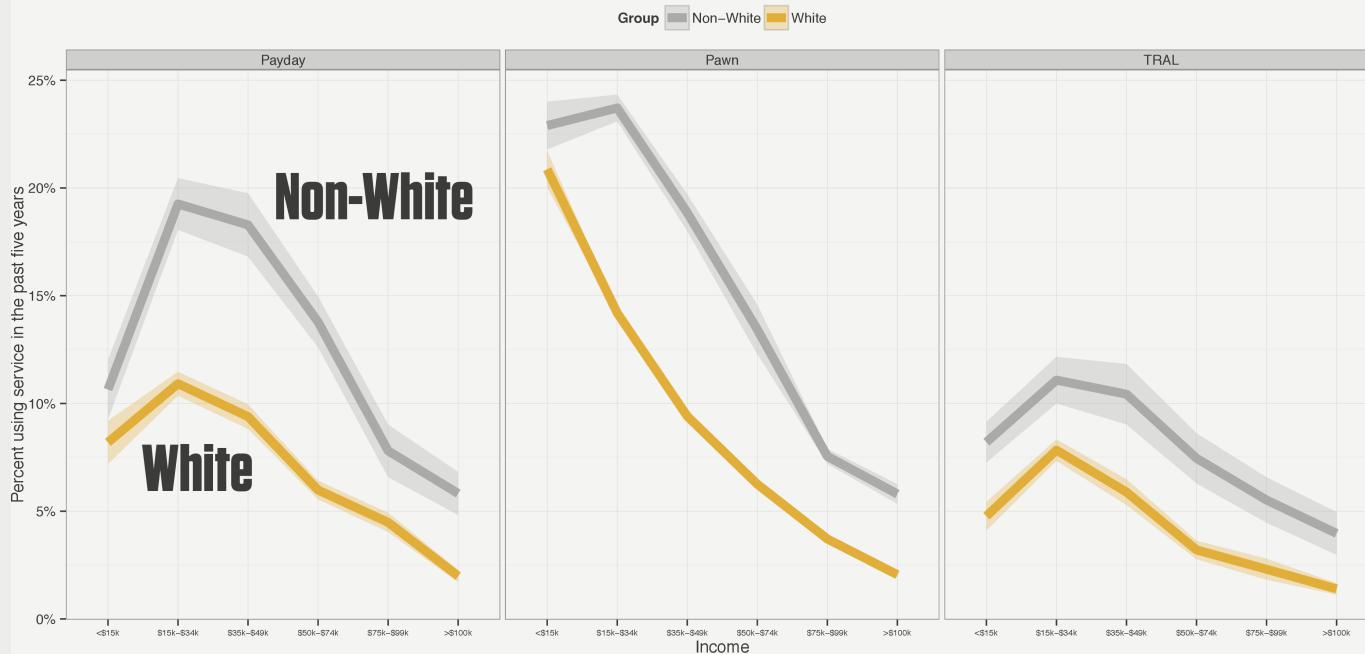


Layer and repeat with facets



Layer and repeat across facets

Categorical Gaps: Alternative Financial Services



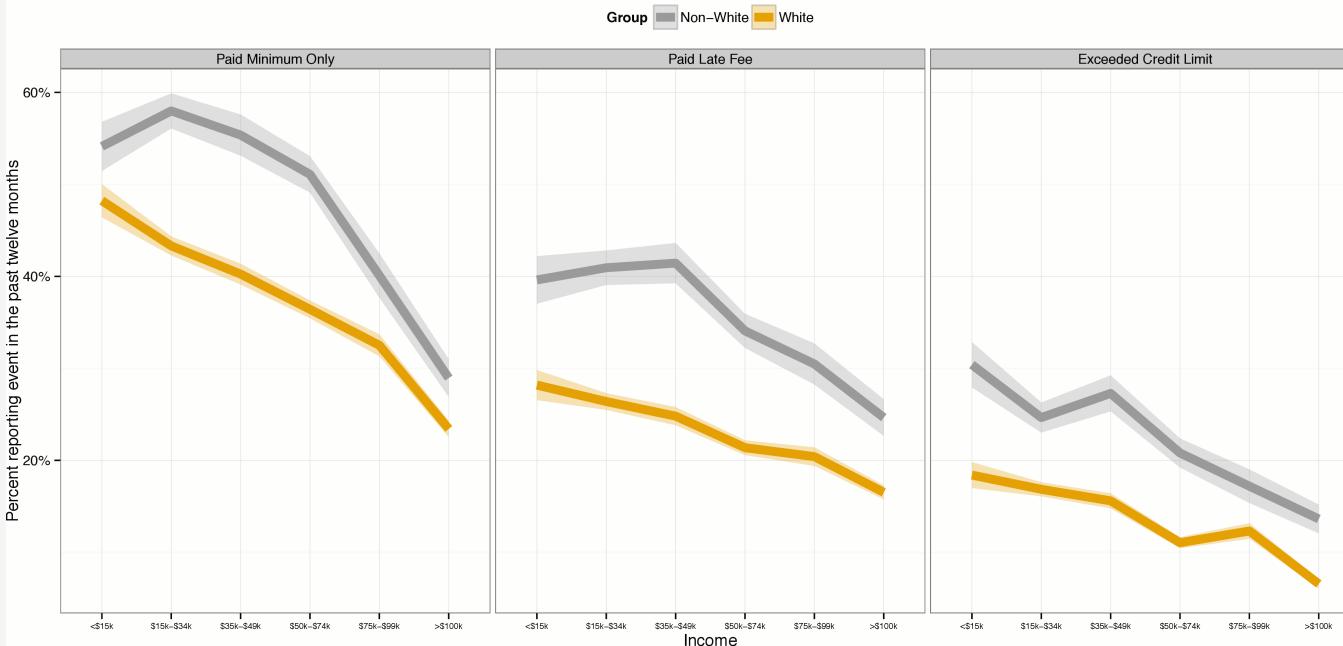
Payday Loan

Pawn Shop

TRAL

Layer and repeat across facets

Categorical Gaps: Adverse Credit Events

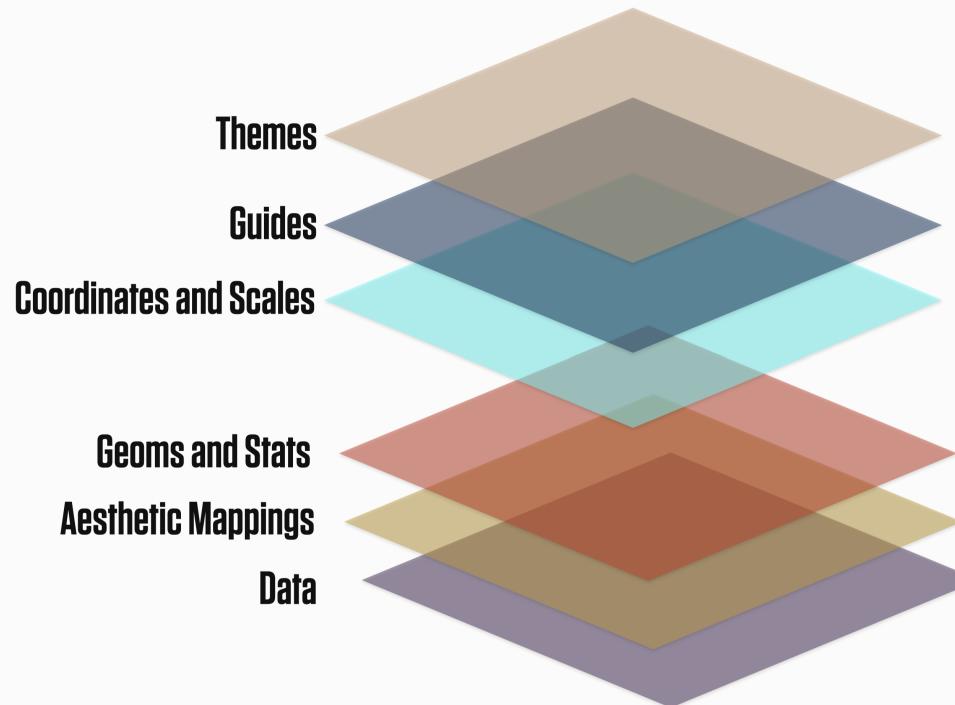


Minimum Only

Late Fee

Over Limit

X-Ray Vision



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")
```

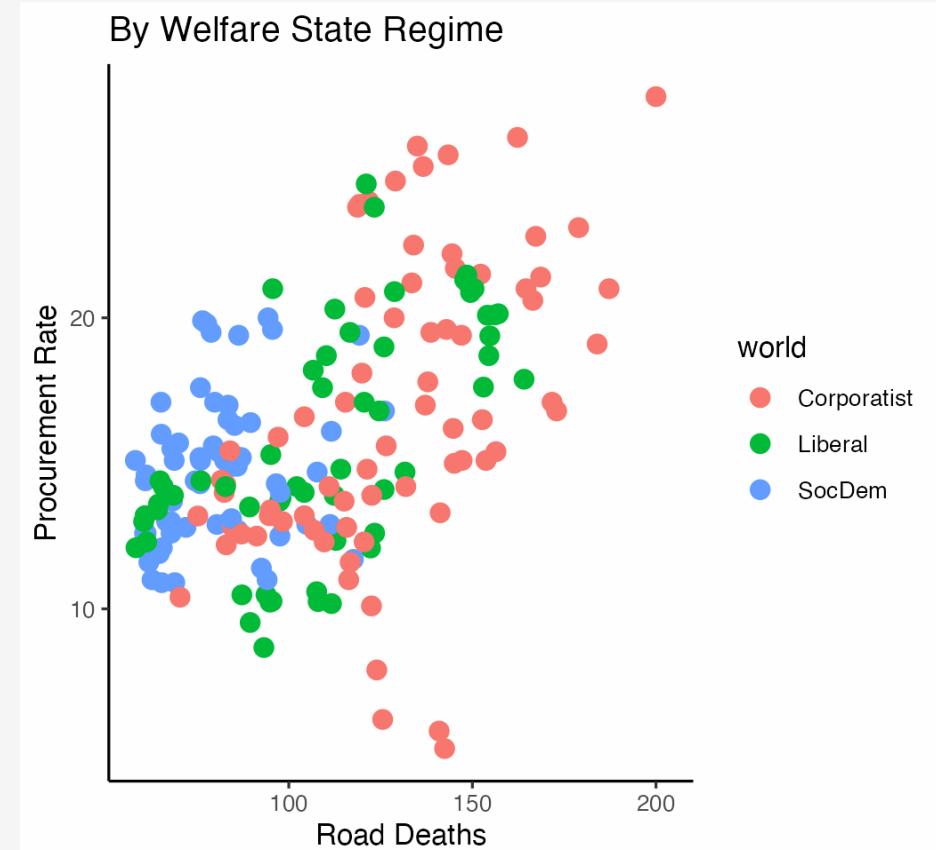
```
p
```

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
```



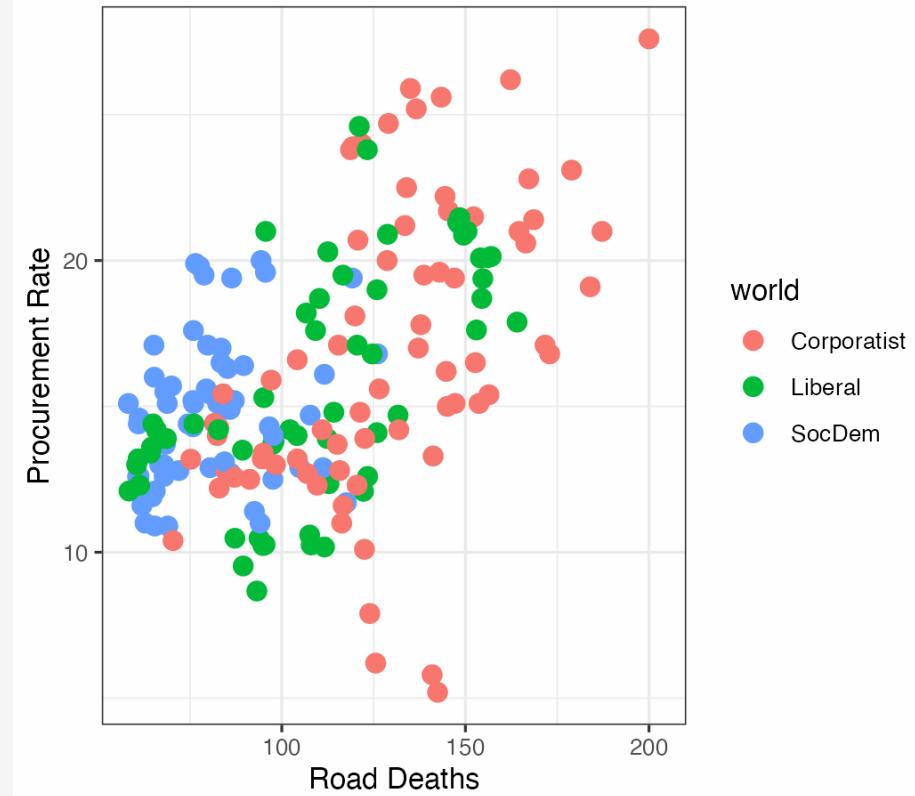
Add a theme ... theme_bw()

```
p + theme_bw()
```

Add a theme ... `theme_bw()`

```
p + theme_bw()
```

By Welfare State Regime



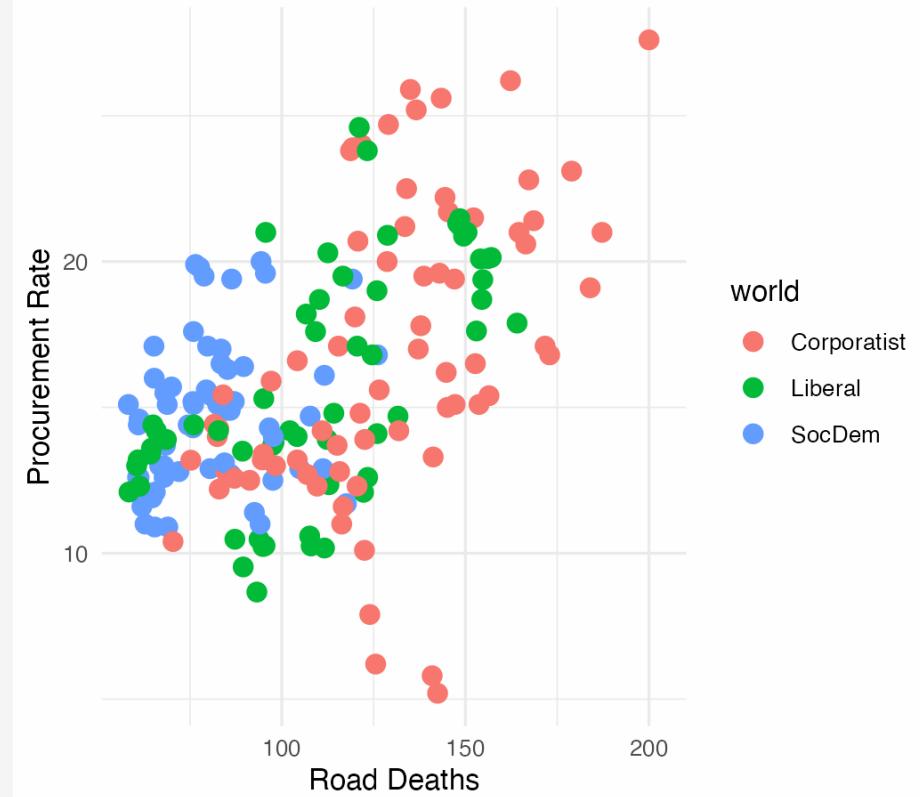
Add a theme ... `theme_minimal()`

```
p + theme_minimal()
```

Add a theme ... `theme_minimal()`

```
p + theme_minimal()
```

By Welfare State Regime

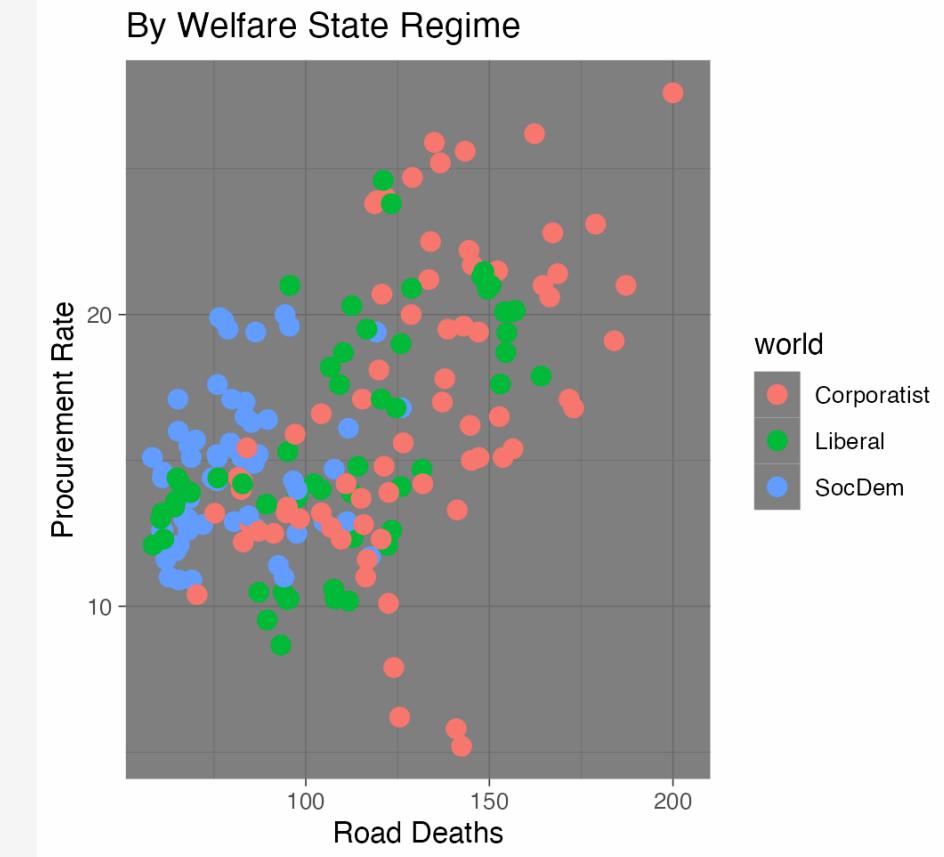


Add a theme ... theme_dark()

```
p + theme_dark()
```

Add a theme ... `theme_dark()`

```
p + theme_dark()
```



Adjustments with the `theme()` function

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

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.

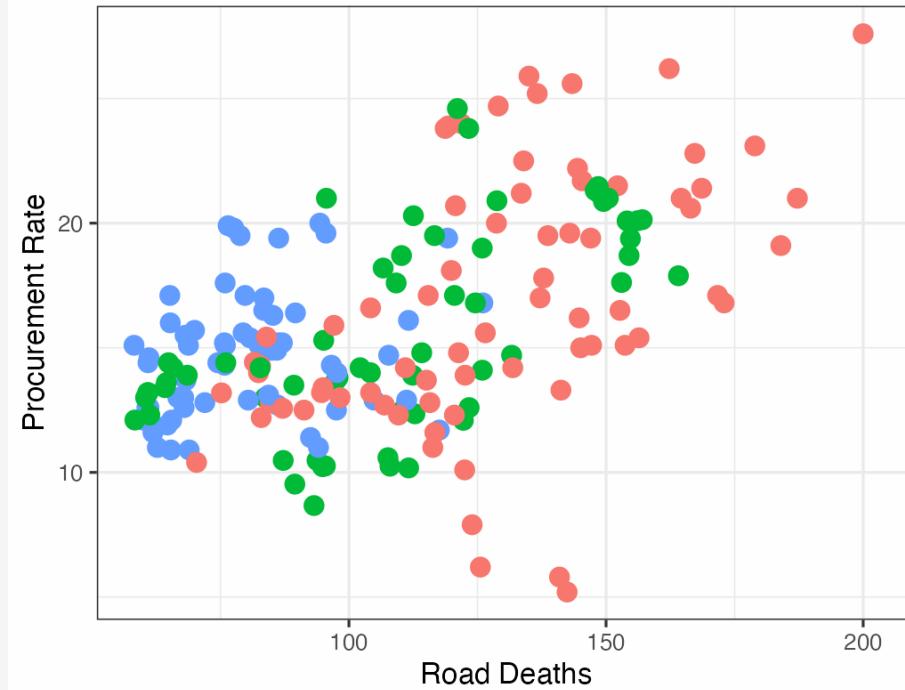
Adjustments with the `theme()` function

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By Welfare State Regime

world ● Corporatist ● Liberal ● SocDem



There are *many* adjustable 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.ontop  
  
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.y  
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").

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, first 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, first 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`

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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, then ask ...

What *kind* of element is it?

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

If adjusting a thematic element, then 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.

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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, then 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, then 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, then 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`.

For example ...

"I want to adjust the styling of the plot title"

The relevant element is `plot.title`.

It's *text*.

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()`.

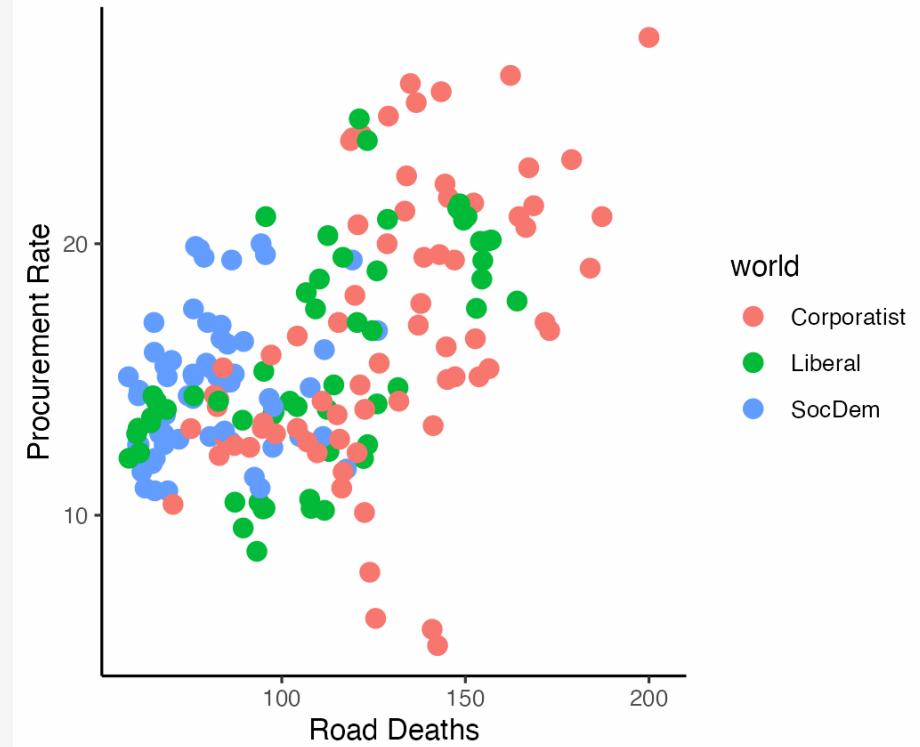
For example ...

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

For example ...

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

By Welfare State Re



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`.

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*.

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*.

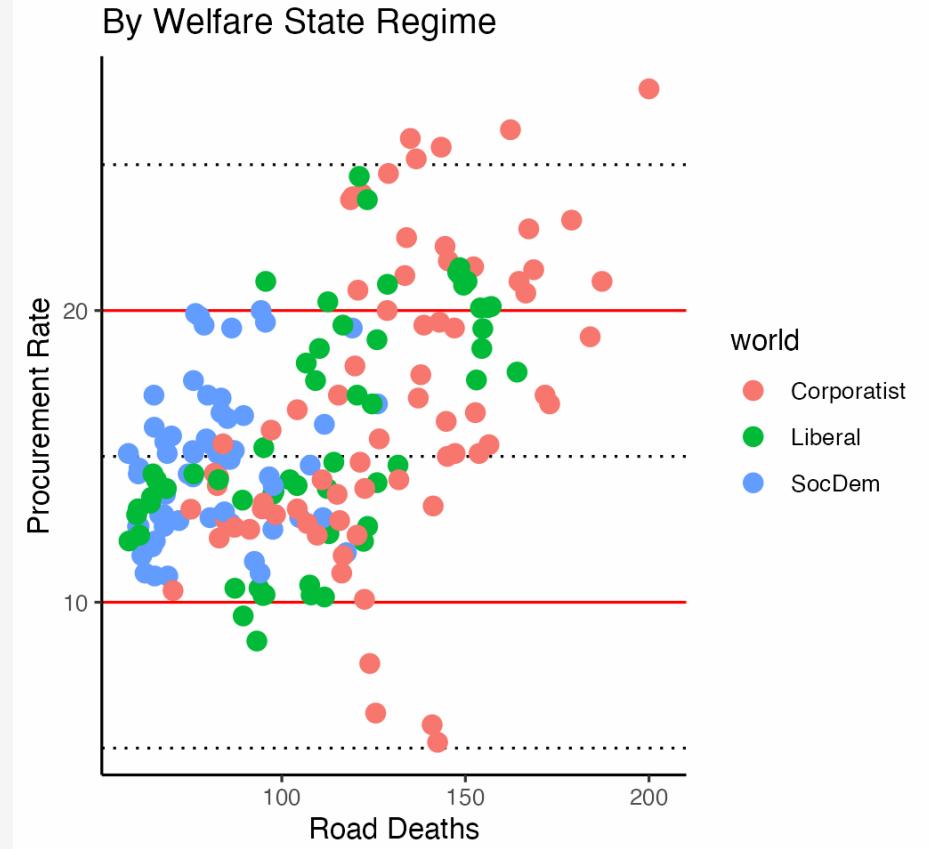
Inside the theme function, adjust it with `element_line()`.

For example ...

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

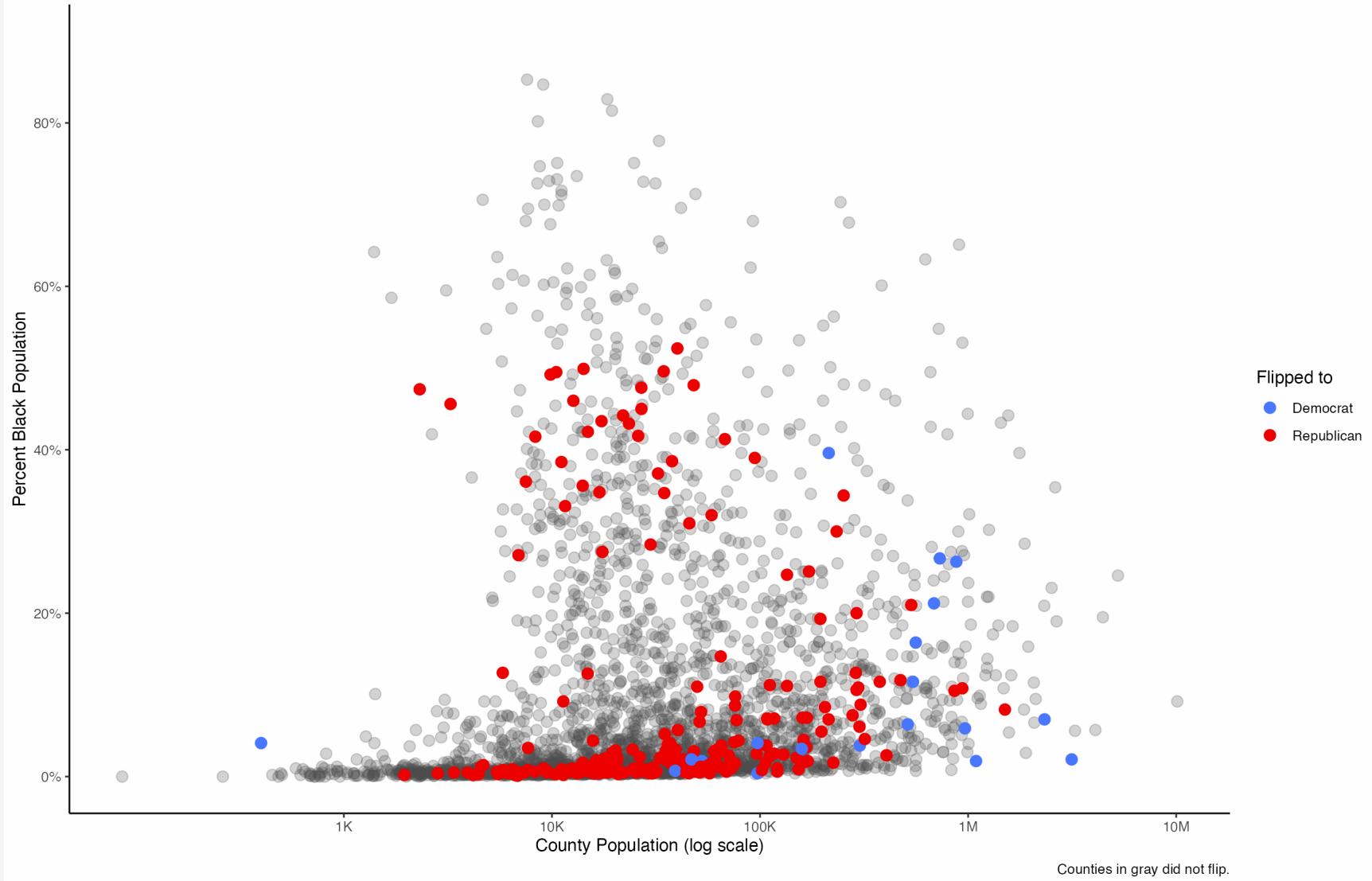
For example ...

```
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



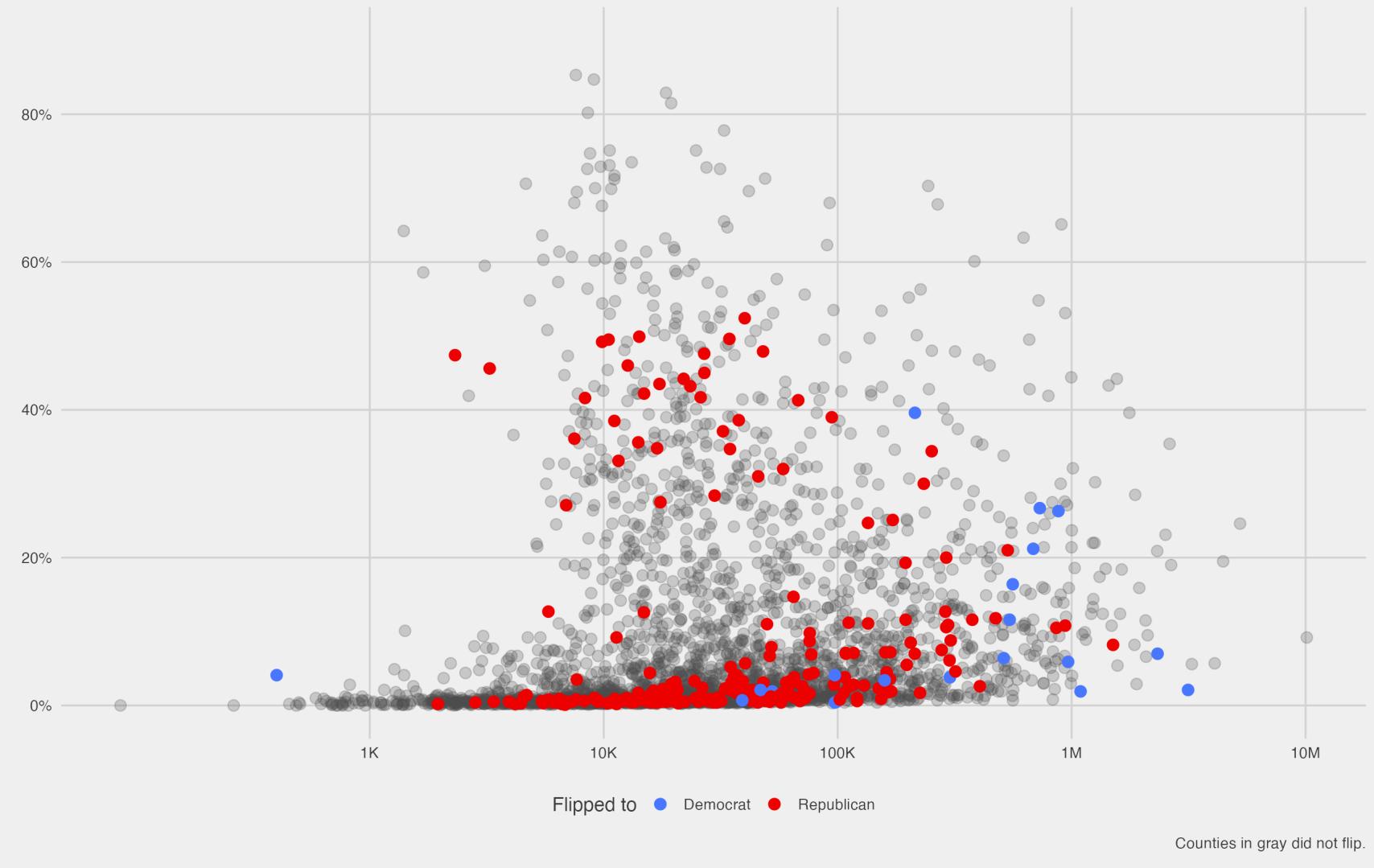
We made this earlier. Here it is in a default theme.

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



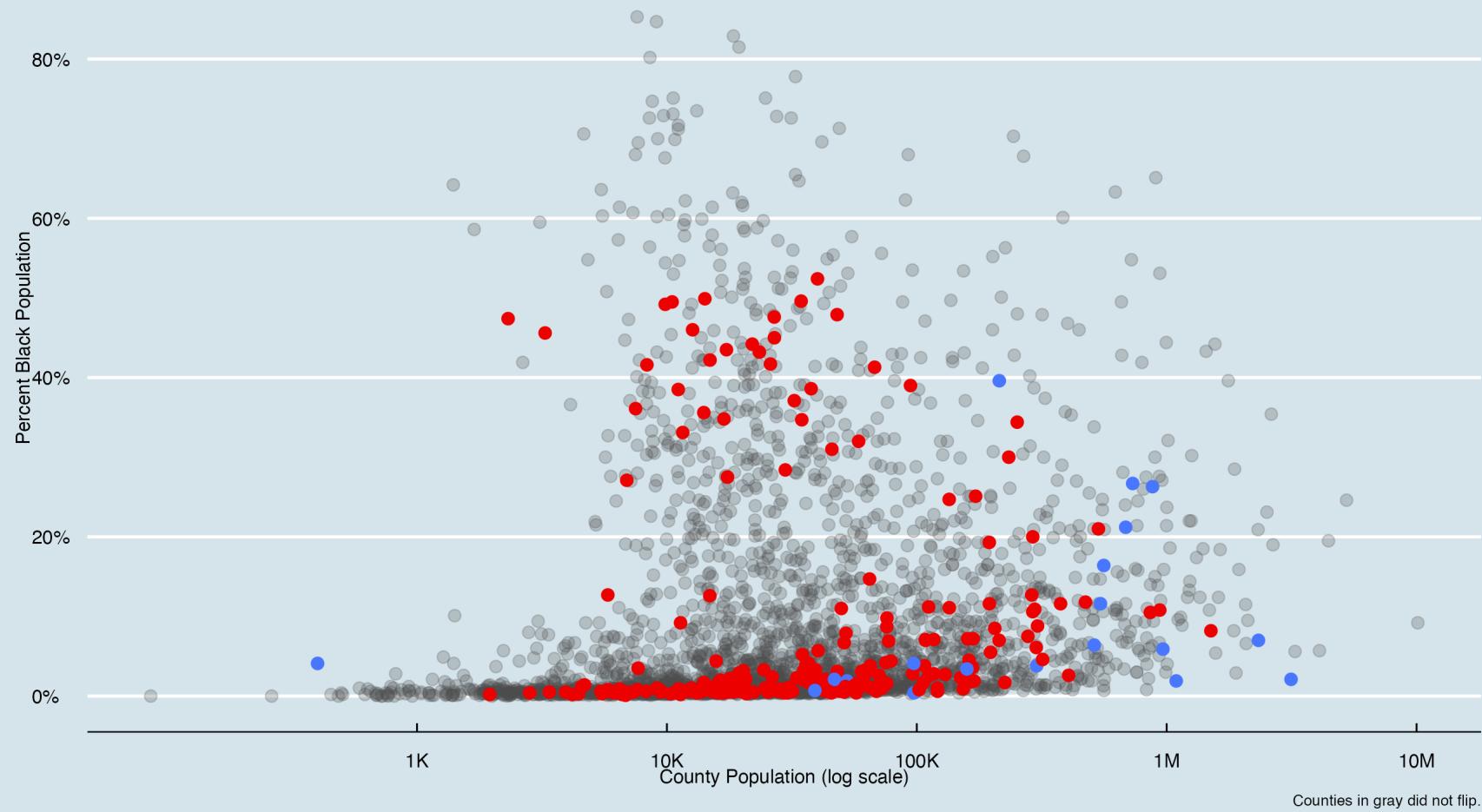
Calling the object now draws the plot with the thematic elements added.

Theming a plot

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

Counties that flipped shown by party color

Flipped to ● Democrat ● Republican

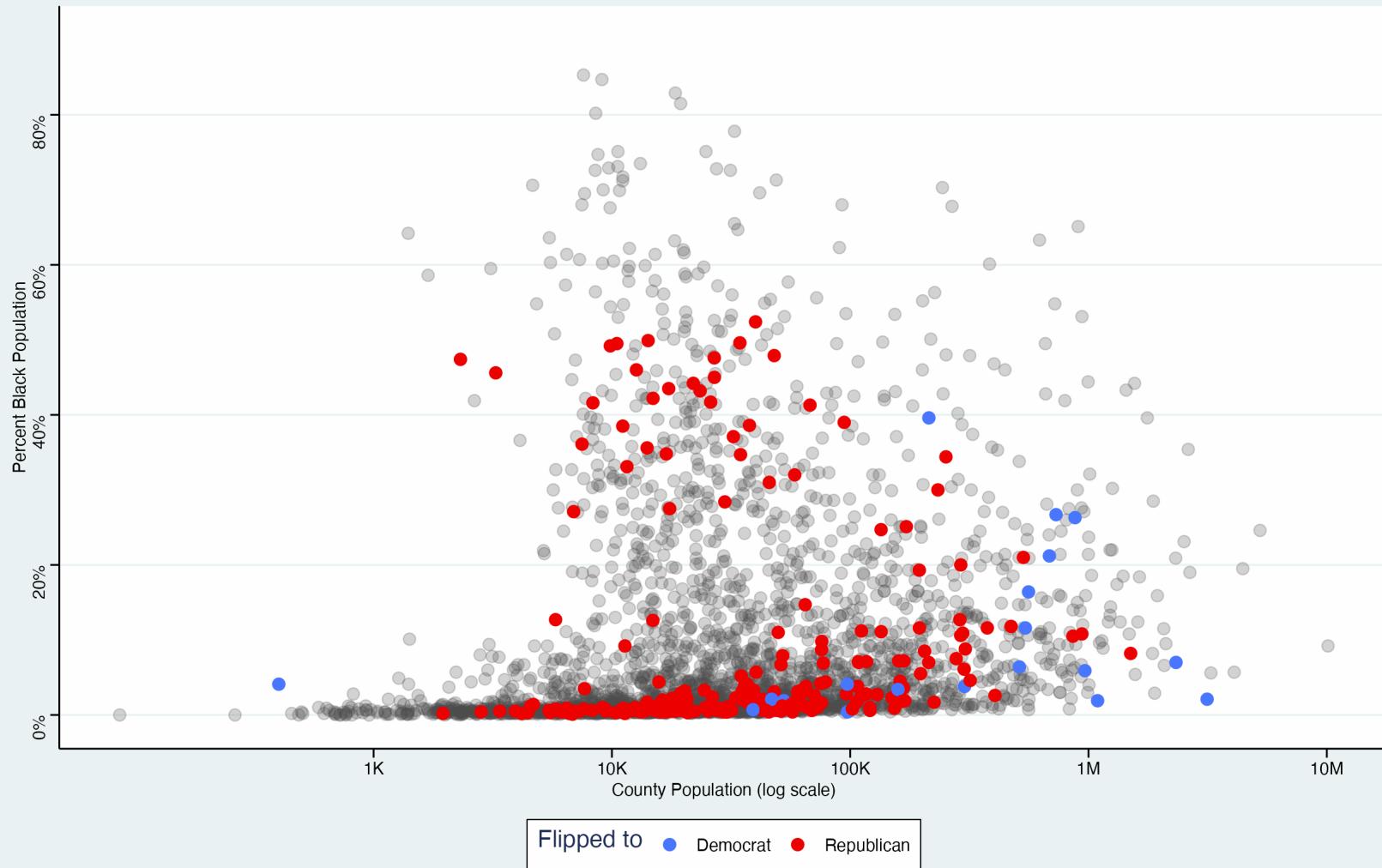


Calling the object now draws the plot with the thematic elements added.

This seems morally wrong

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

Counties that flipped shown by party color



Counties in gray did not flip.

Why would you do this to yourself?

**Pick a theme
and stick with it**