Data Visualization - 8. Polishing and Presenting Plots

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Code Horizons

October 2, 2024

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
```

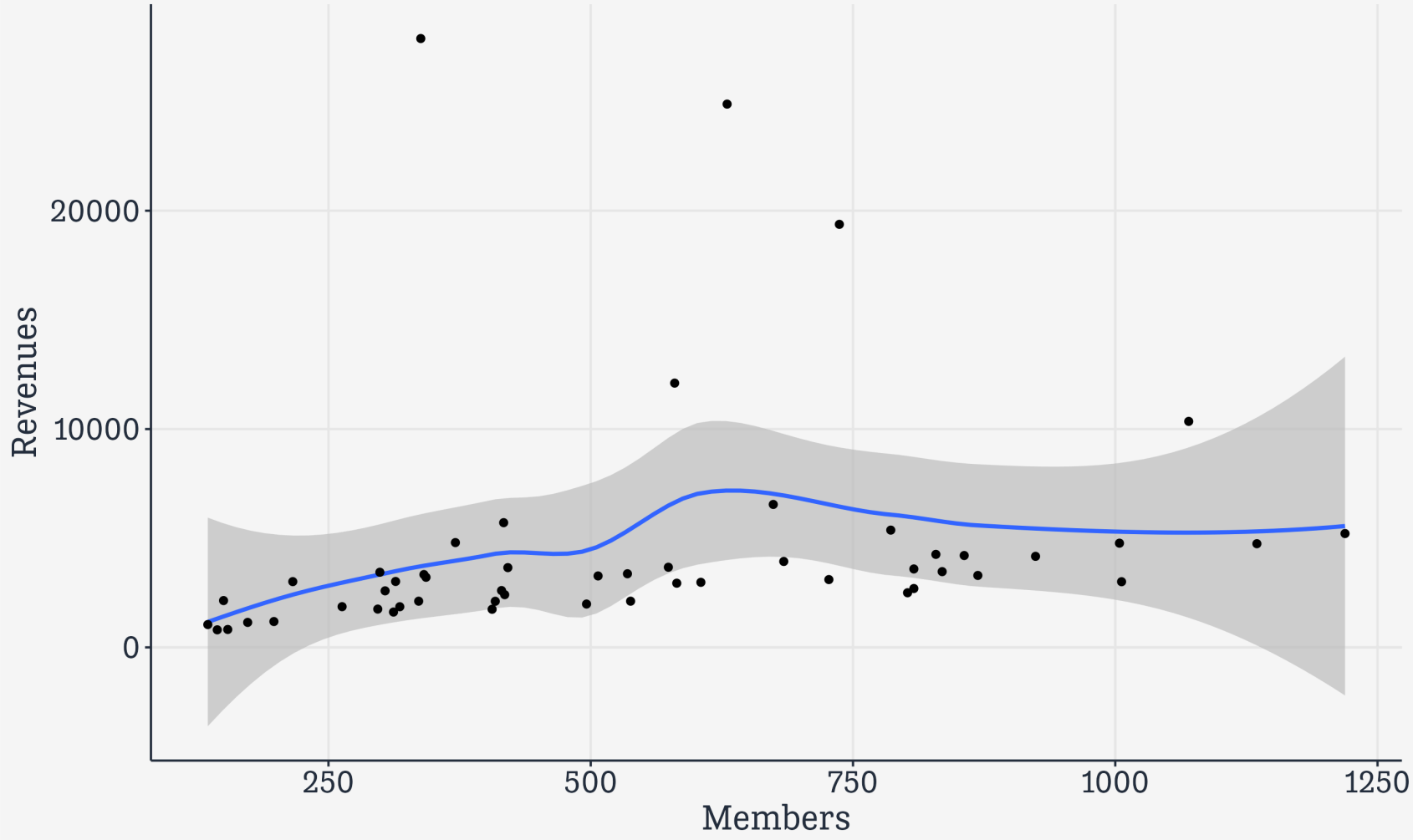
Piece by piece,
Layer by layer

Build your plots a piece at a time

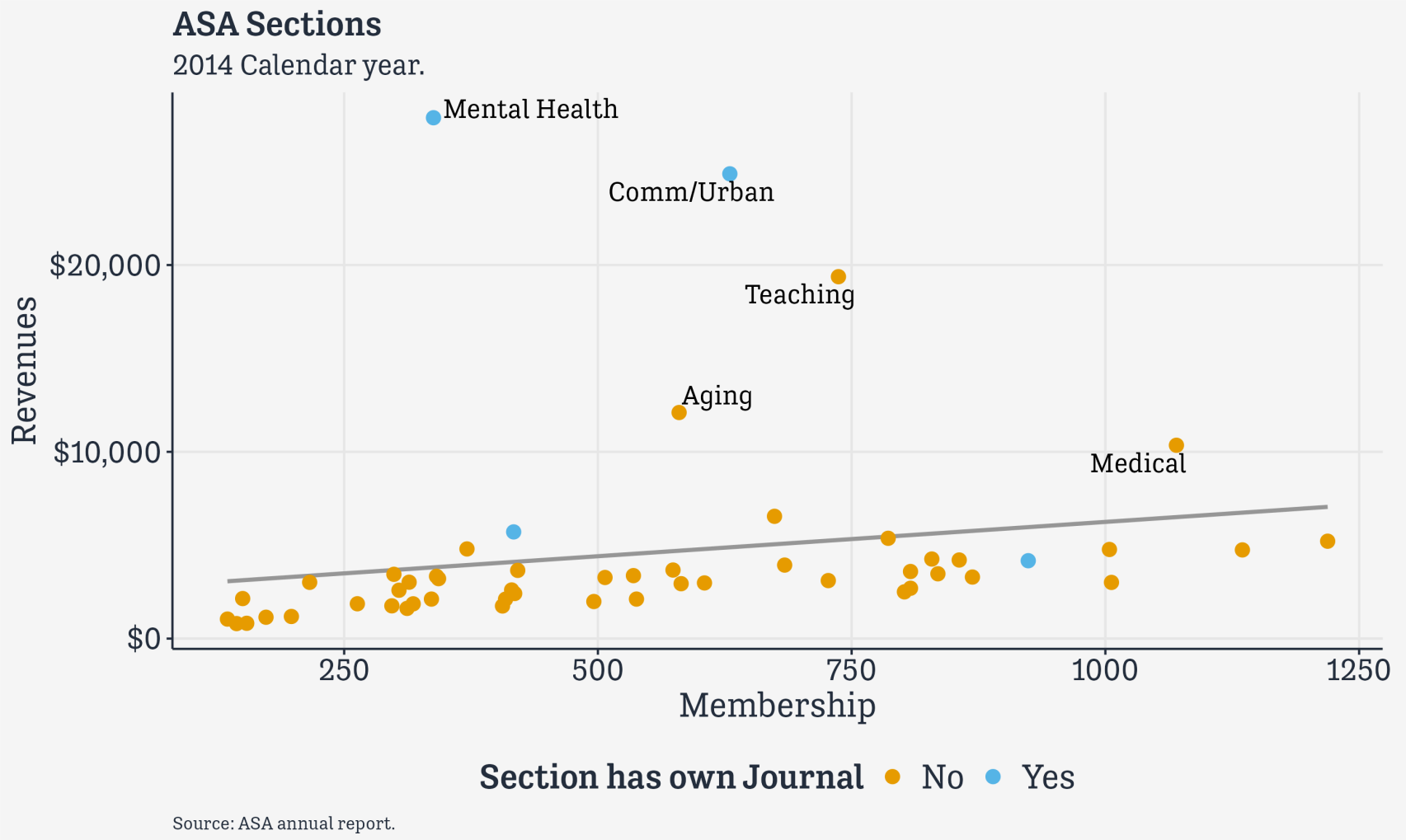
```
asasec ← as_tibble(asasec)
asasec
```

```
# 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



Build your plots a piece at a time

```
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

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

```
# A tibble: 52 × 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
# ℹ 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.")
```

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>   <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

```
organandata ▷
  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"
```

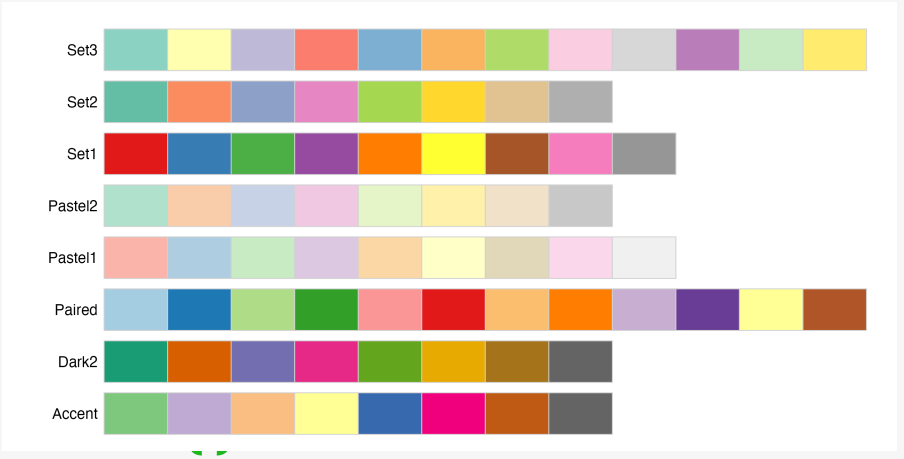
Use balanced palettes

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.brewe`

Qualitative palettes



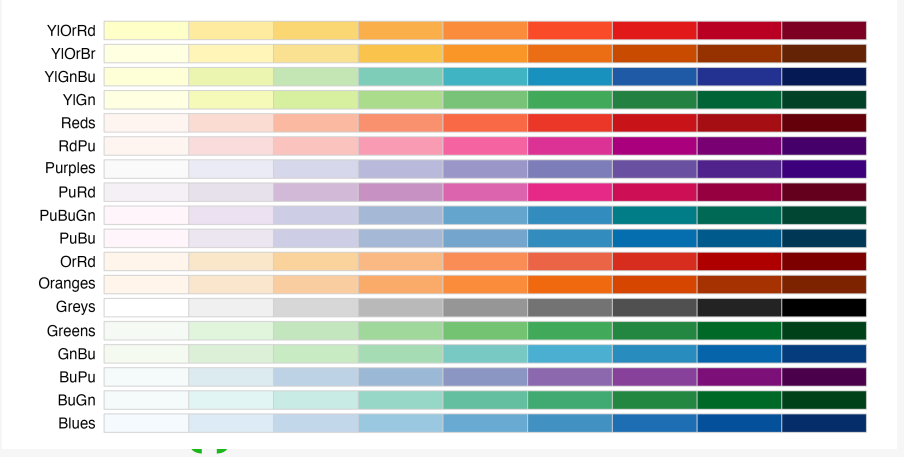
Use balanced palettes

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.brewe`

Sequential palettes



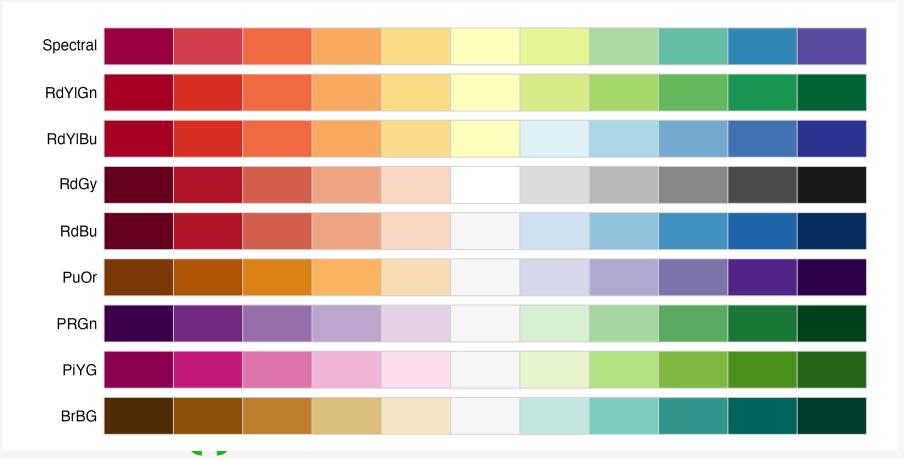
Use balanced palettes

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.brewe`

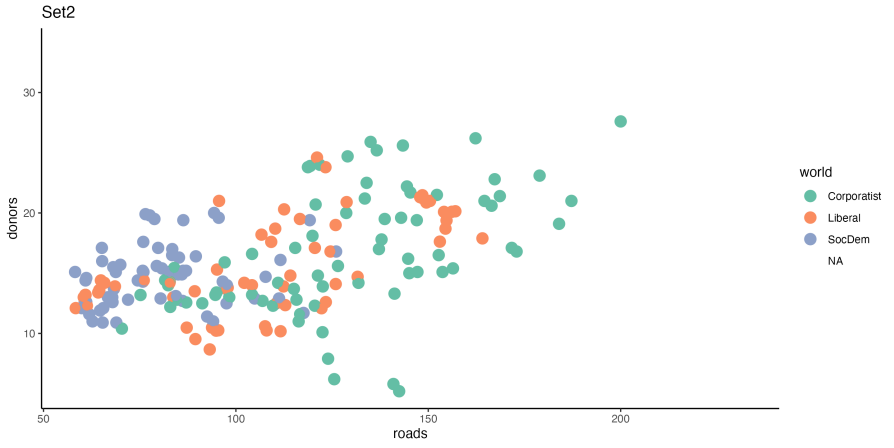
Diverging palettes

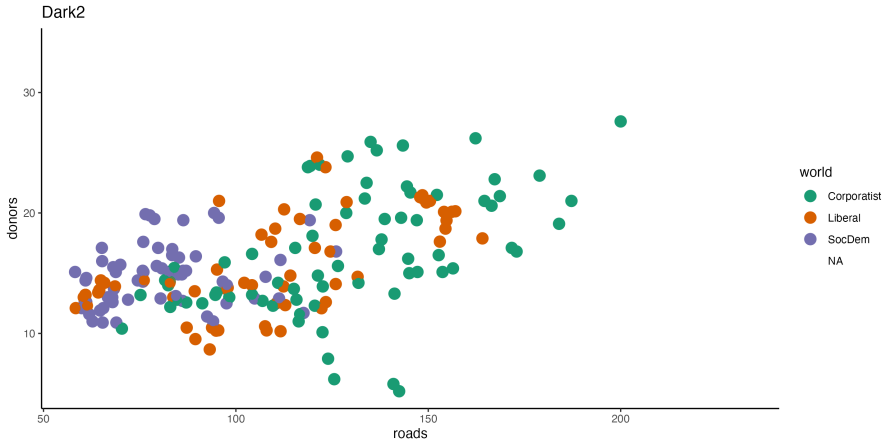


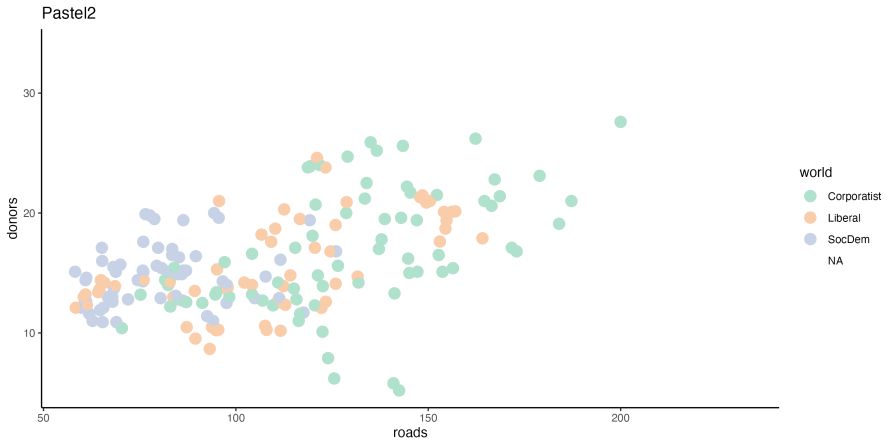
Qualitative Brewer Palettes

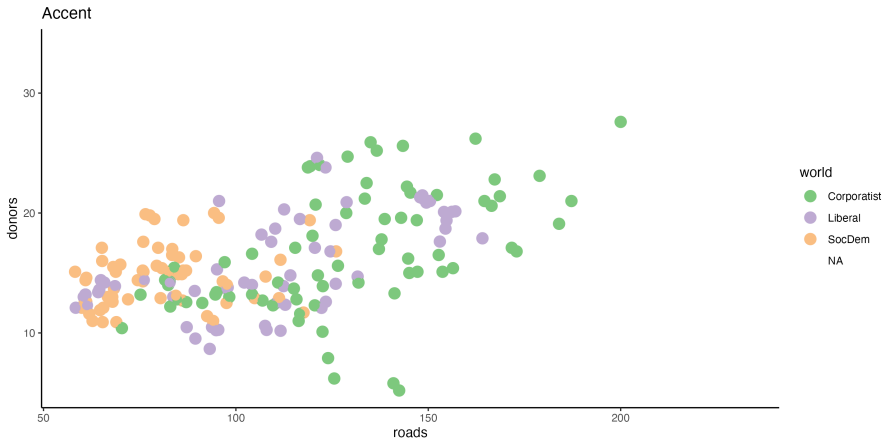
```
p + geom_point(size = 2) +
  scale_color_brewer(palette = "Set2") +
  labs(title = "Set2")

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







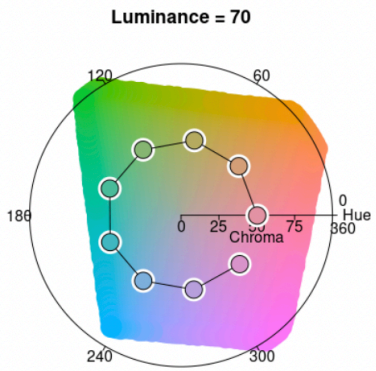


The colorspace package has more

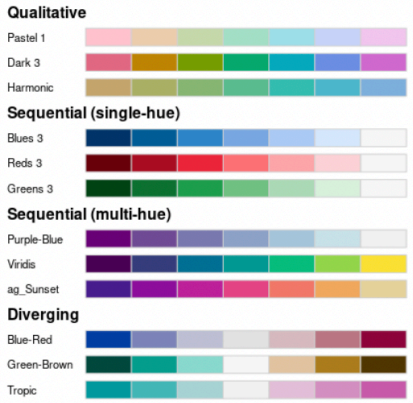
colorspace 2.0-4 Get started Articles Reference Changelog Contact

A Toolbox for Manipulating and Assessing Colors and Palettes

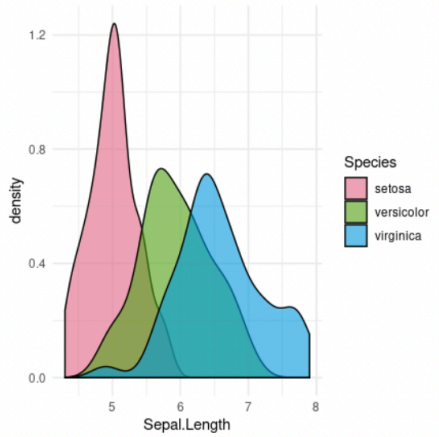
Color spaces



HCL-based palettes



ggplot2 scales



Links

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

Report a bug at 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

Many palettes

So many colors

The `colorspace` function convention

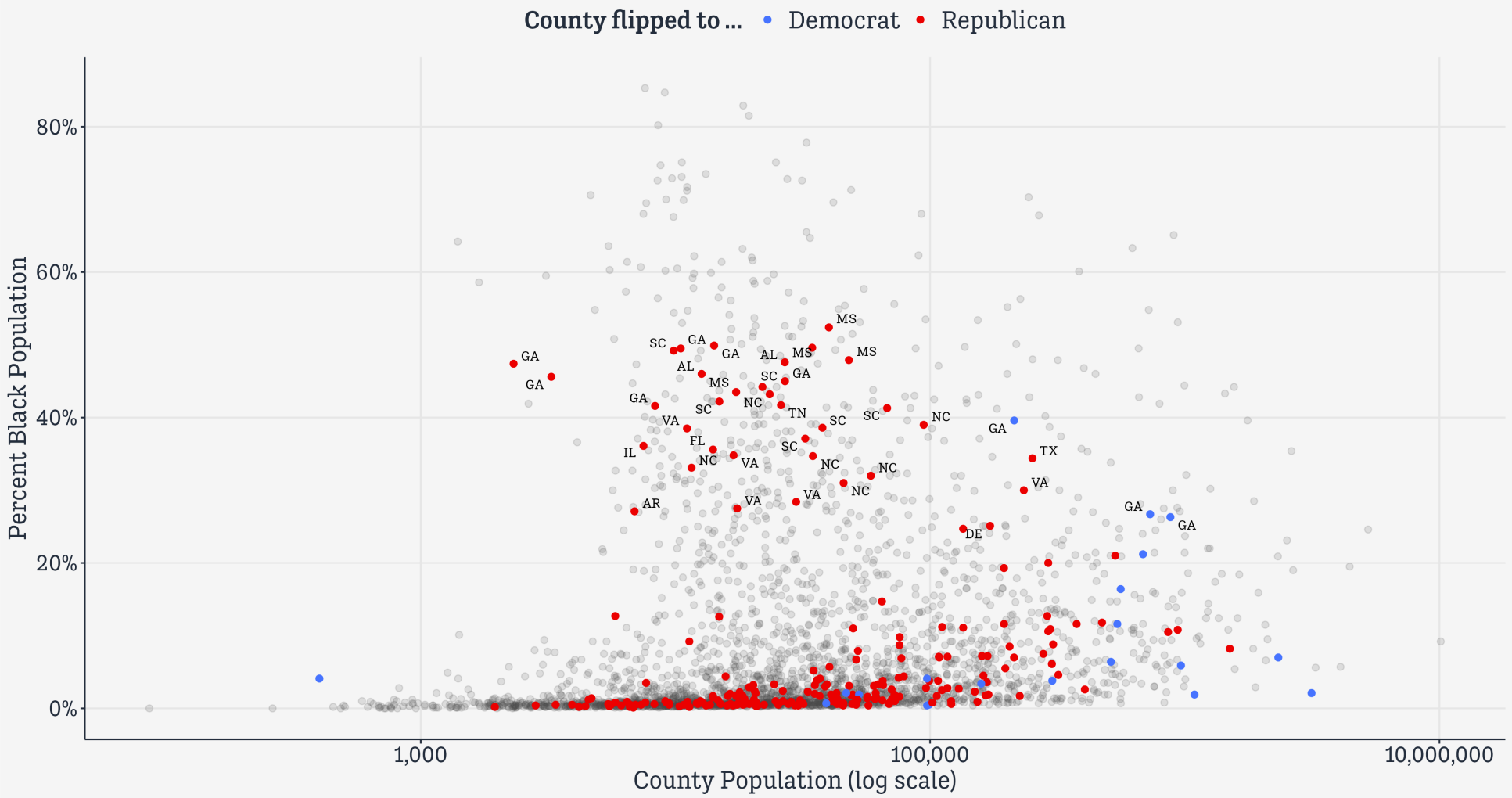
scale_<MAPPING>_<KIND><COLORSCALE>()

```
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



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())
```

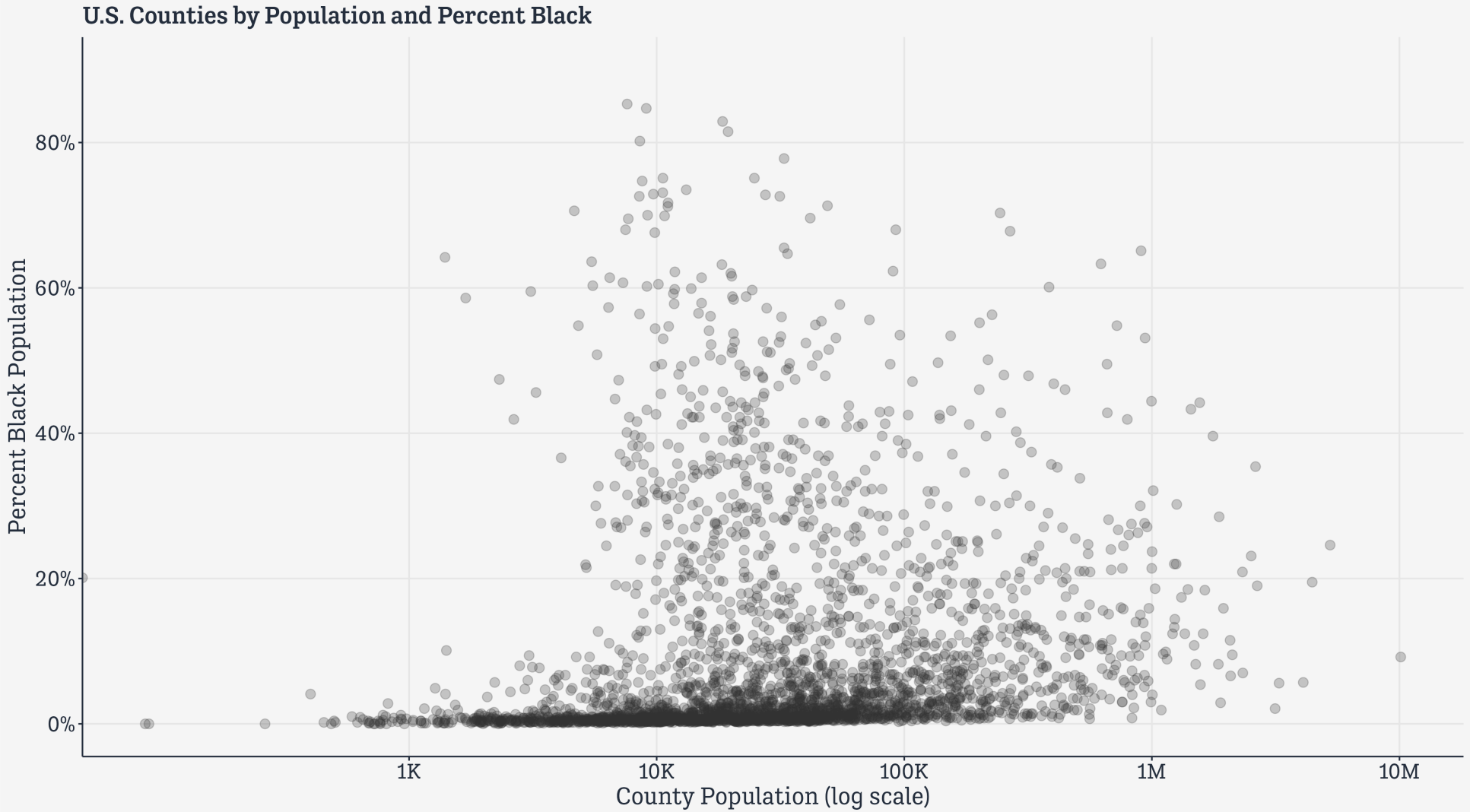
We know how to build this

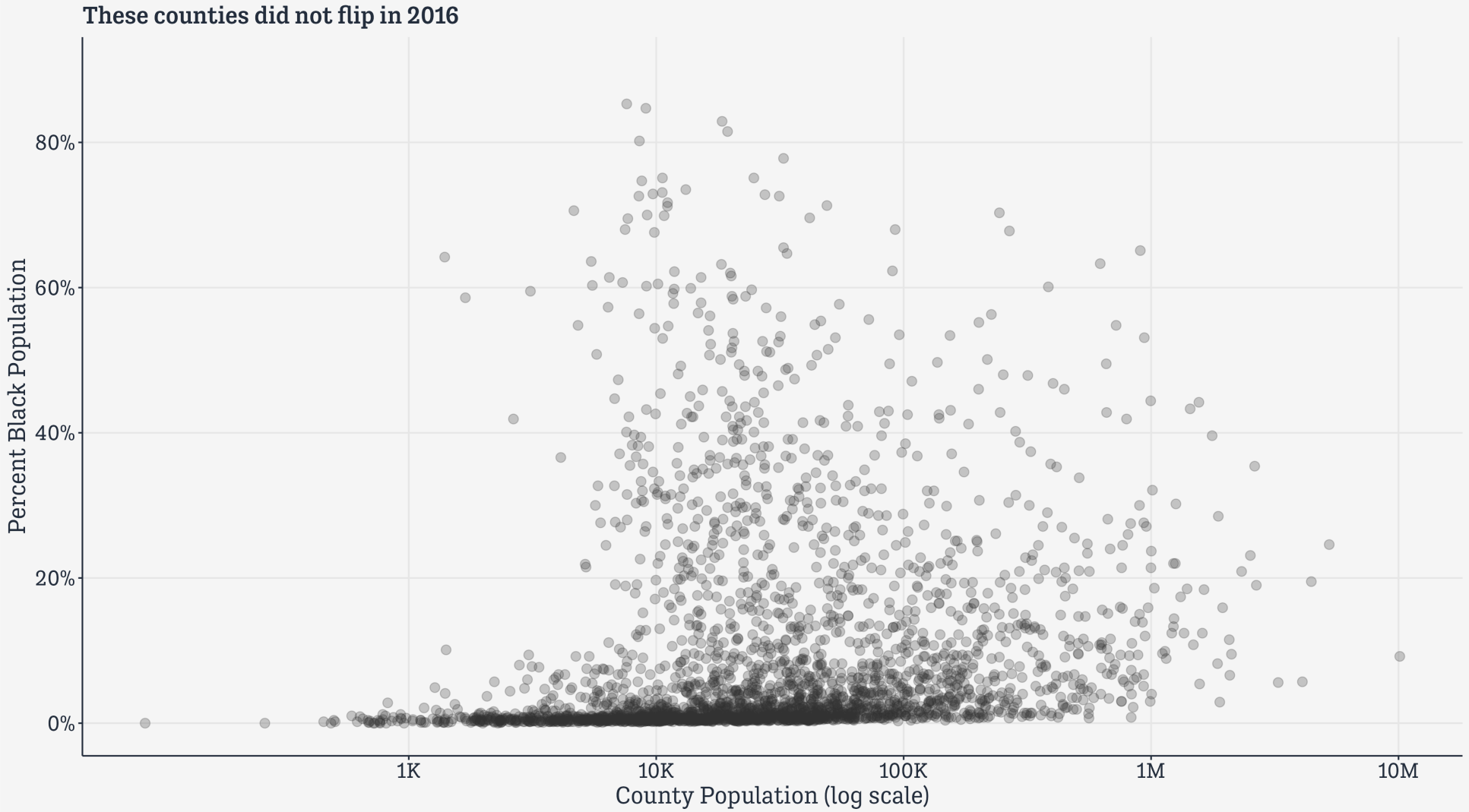
```
## Brighter Blue and Red
party_colors ← c("royalblue1", "red2")

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 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.")
```

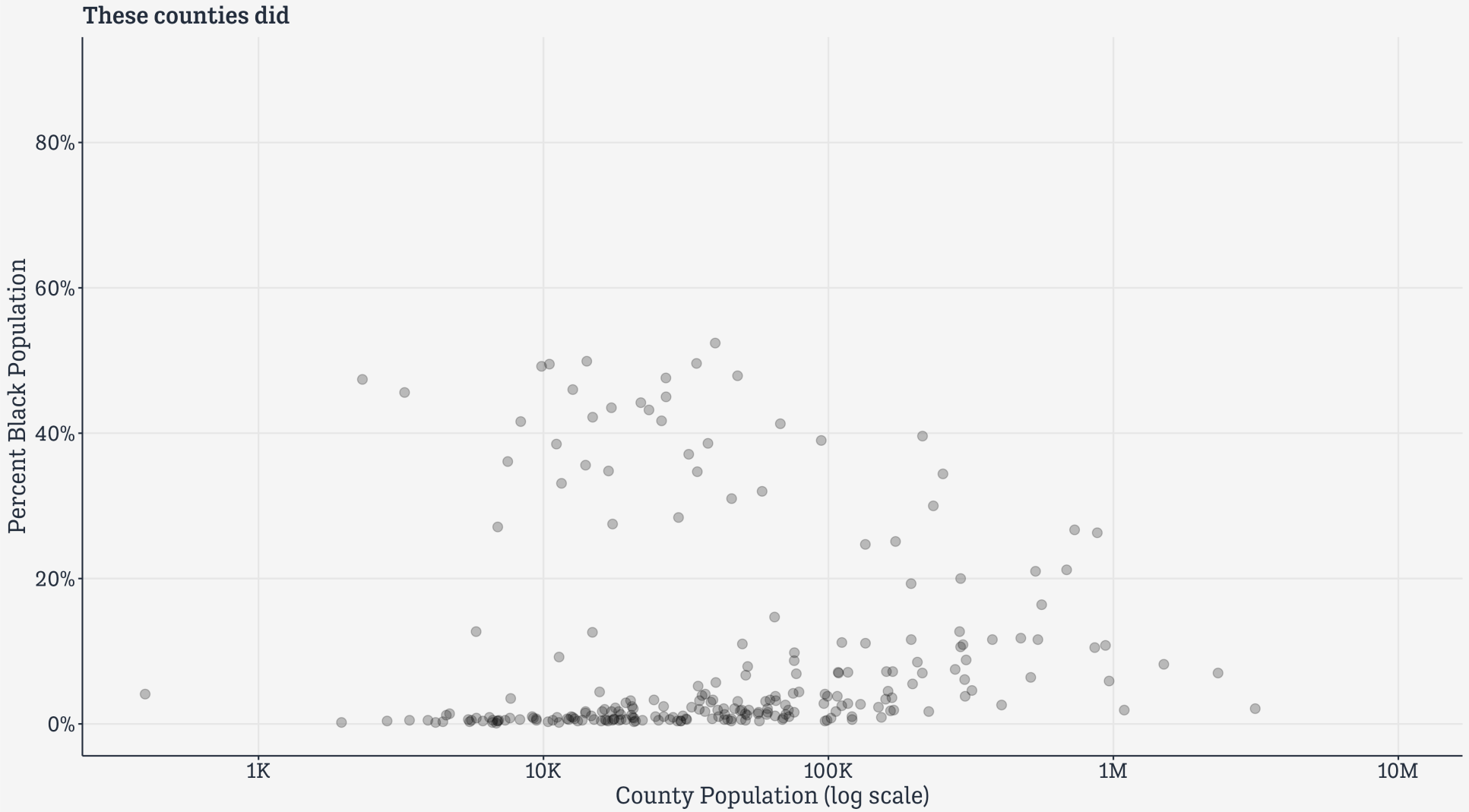
We know how to build this

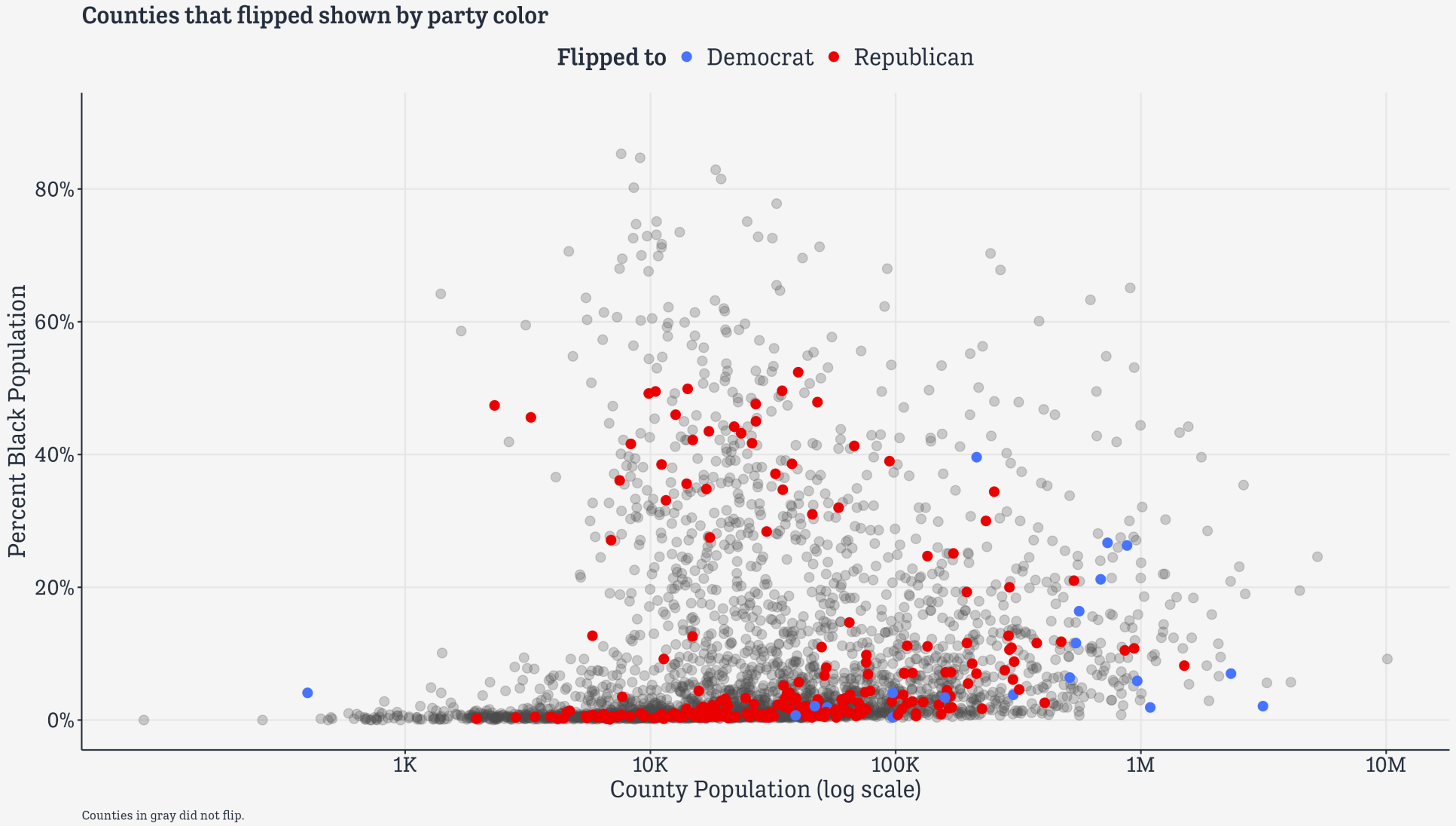
```
## Brighter Blue and Red
party_colors ← c("royalblue1", "red2")

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.")
```

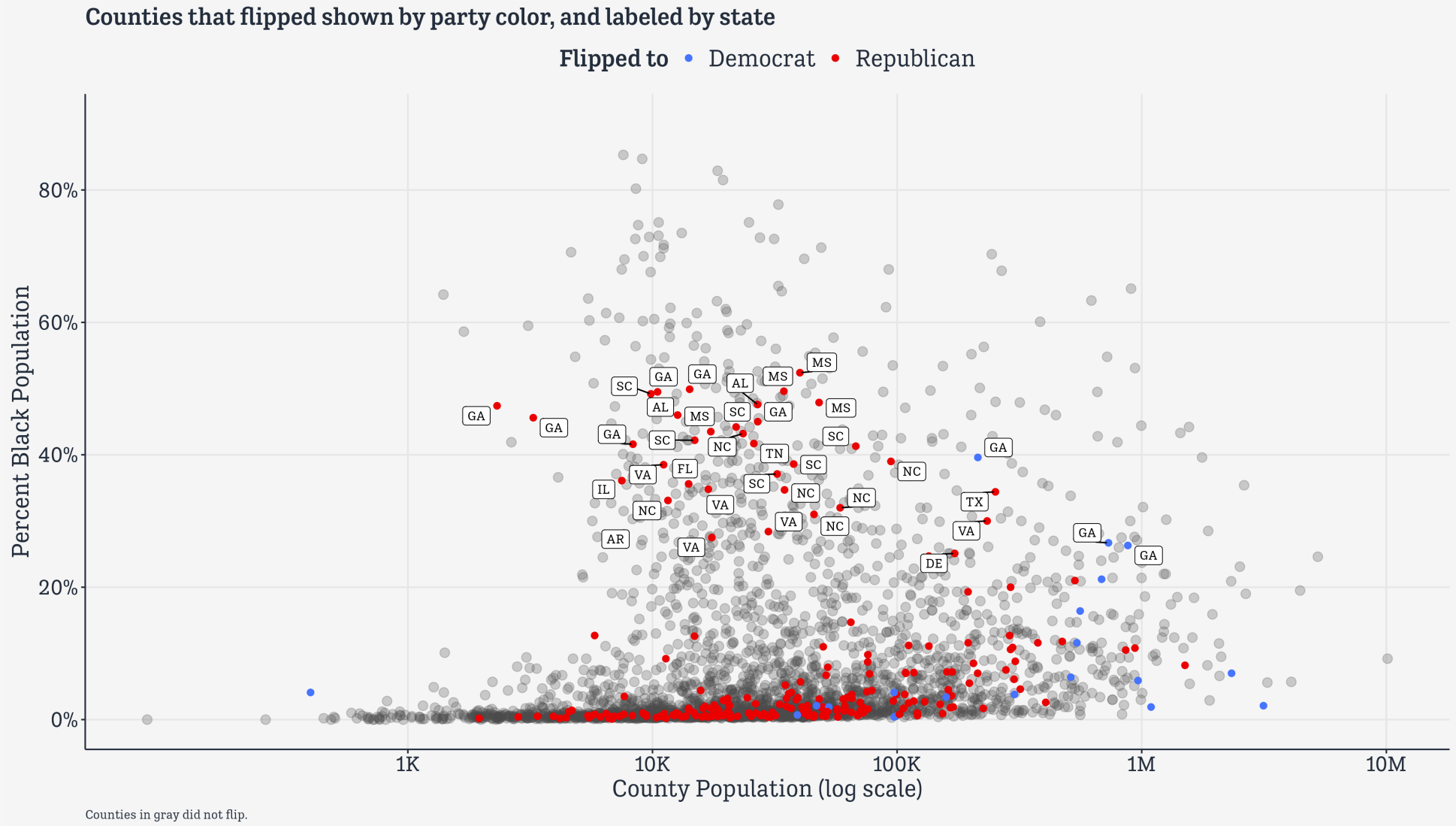
Leverage ggplot's layered approach

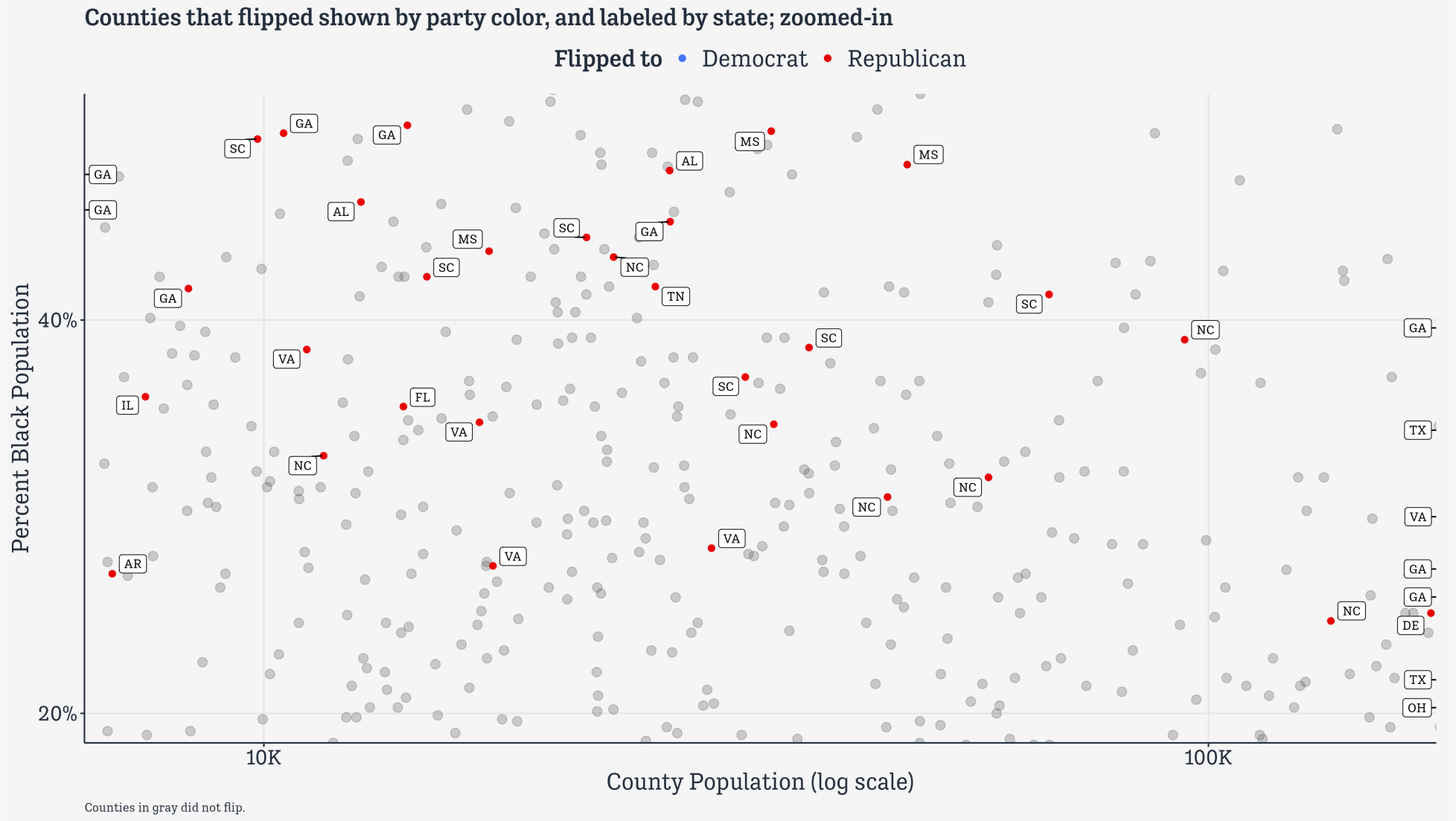

U.S. Counties by Population and Percent Black
Percent Black Population
80%
60%
40%
20%
0%
1K
10K
100K
1M
10M
County Population (log scale)


These counties did not flip in 2016
Percent Black Population
80%
60%
40%
20%
0%
1K
10K
100K
1M
10M
County Population (log scale)

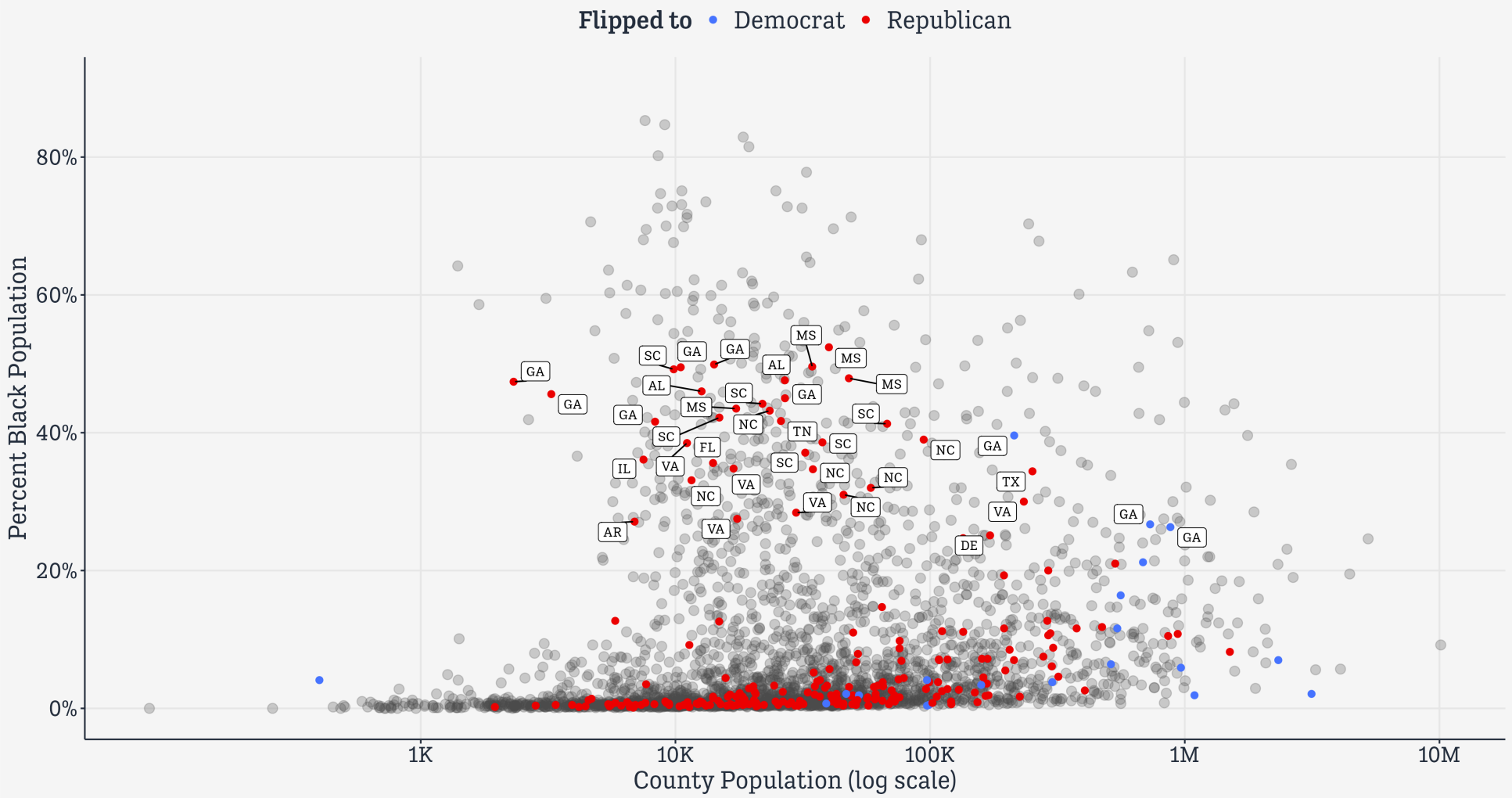

These counties did
80%
60%
40%
20%
0%
Percent Black Population
1K
10K
100K
1M
10M
County Population (log scale)


Counties that flipped shown by party color
Flipped to
Democrat
Republican
80%
60%
40%
20%
0%
Percent Black Population
1K
10K
100K
1M
10M
County Population (log scale)
Counties in gray did not flip.


Counties that flipped shown by party color, and labeled by state
Flipped to
Democrat
Republican
80%
60%
40%
20%
0%
Percent Black Population
1K
10K
100K
1M
10M
County Population (log scale)
GA
SC
AL
MS
NC
VA
TN
FL
IL
AR
DE
TX
Counties in gray did not flip.


Counties that flipped shown by party color, and labeled by state; zoomed-in
Flipped to Democrat Republican
Percent Black Population
40%
20%
10K
100K
County Population (log scale)
GA
SC
AL
MS
NC
TN
VA
FL
IL
AR
TX
DE
OH
Counties in gray did not flip.

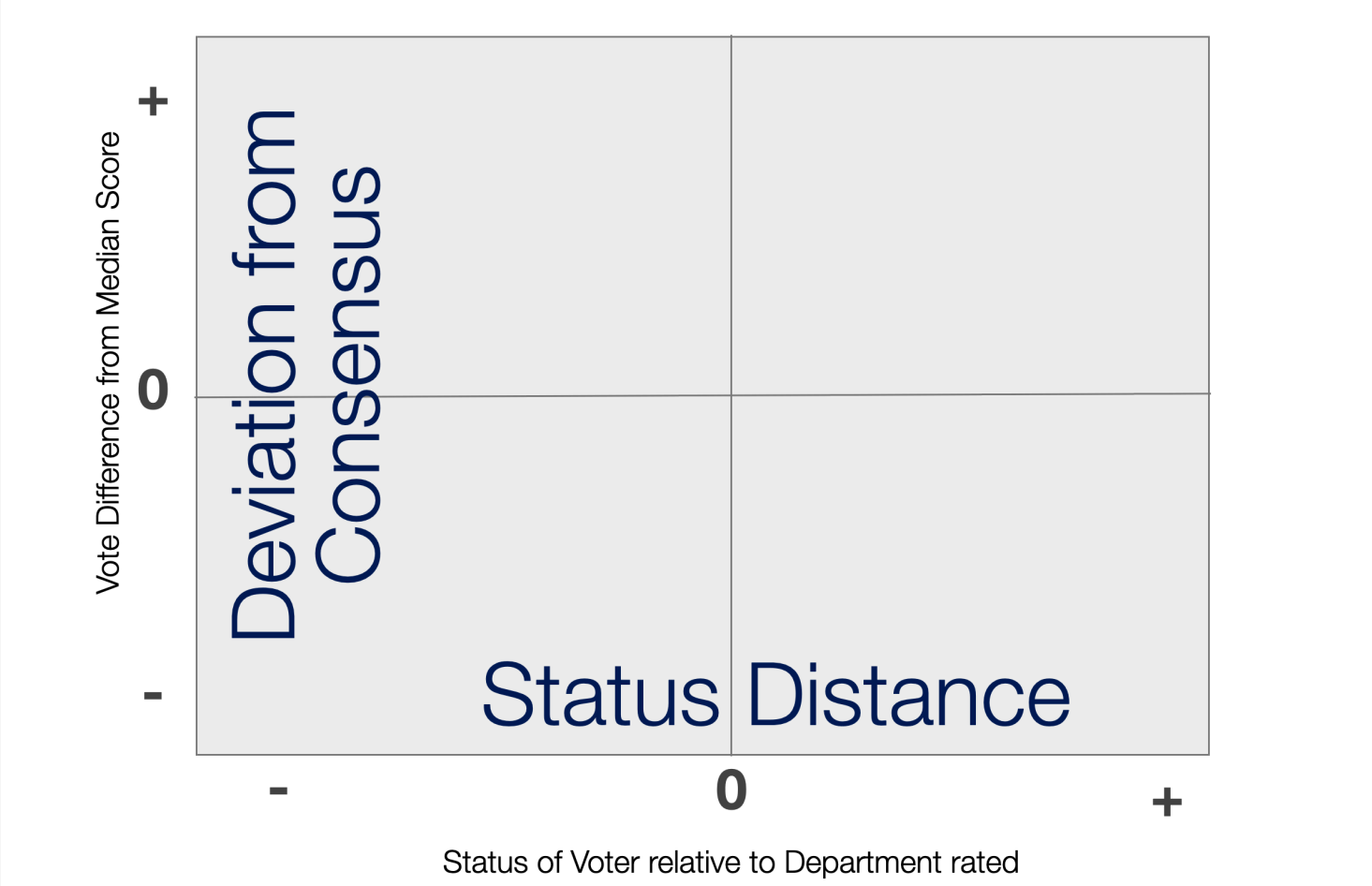
Counties that flipped shown by party color, and labeled by state



Counties in gray did not flip.

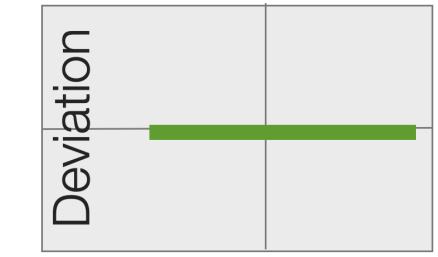
Layer,
Highlight,
Repeat

Build from ideas to data

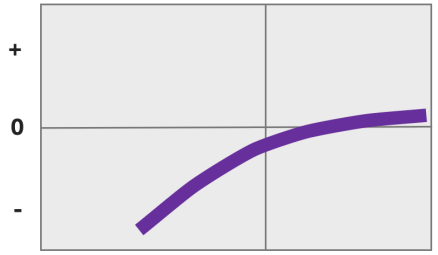


The relationship of interest

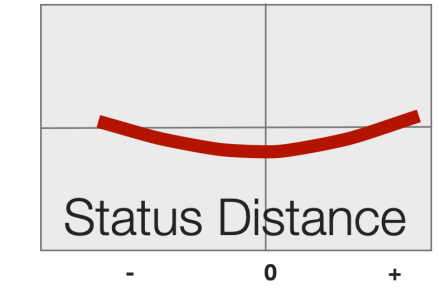
Build from ideas to data



1. Pure Objectivity



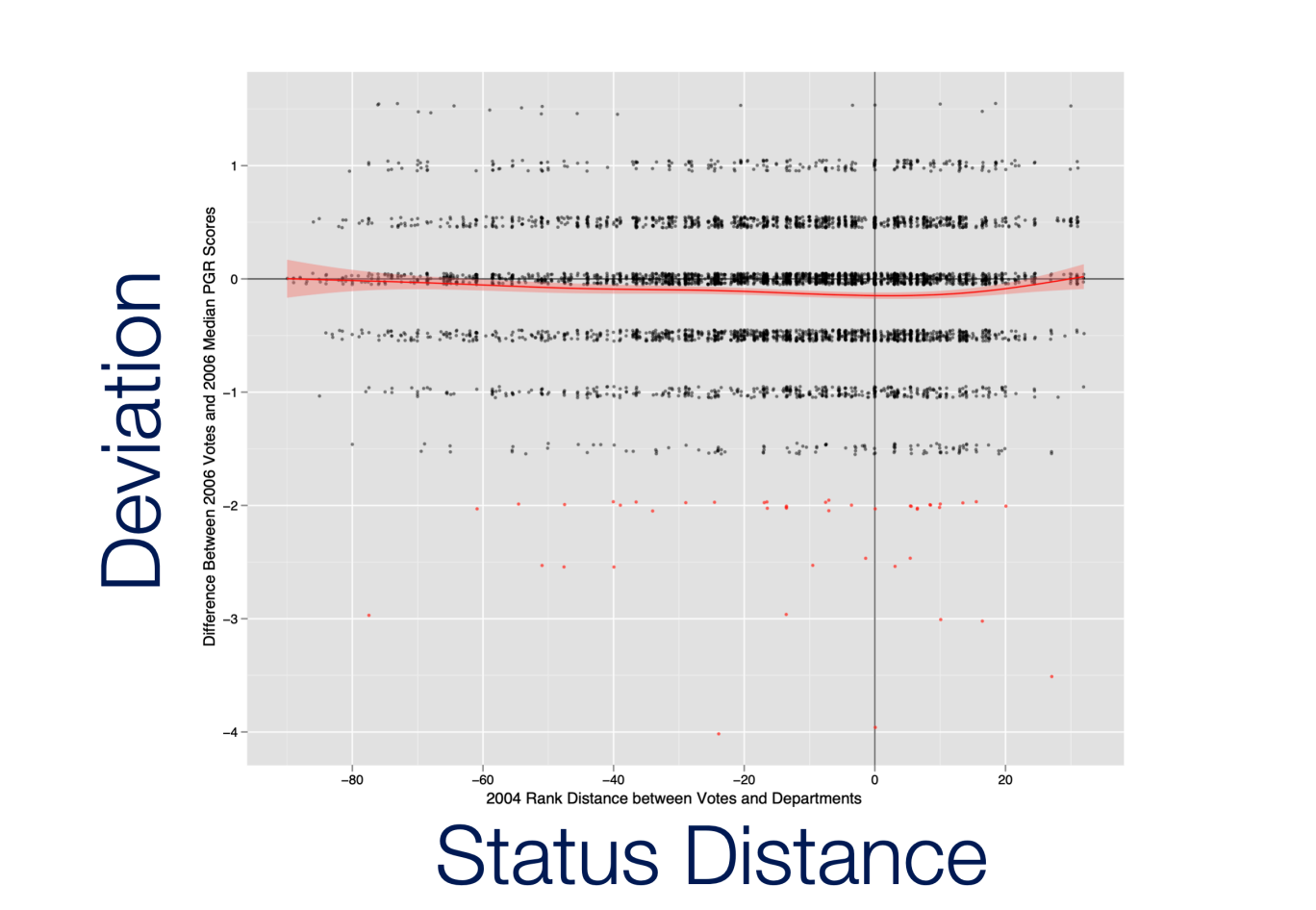
2. Distant Envy



3. Local Competition

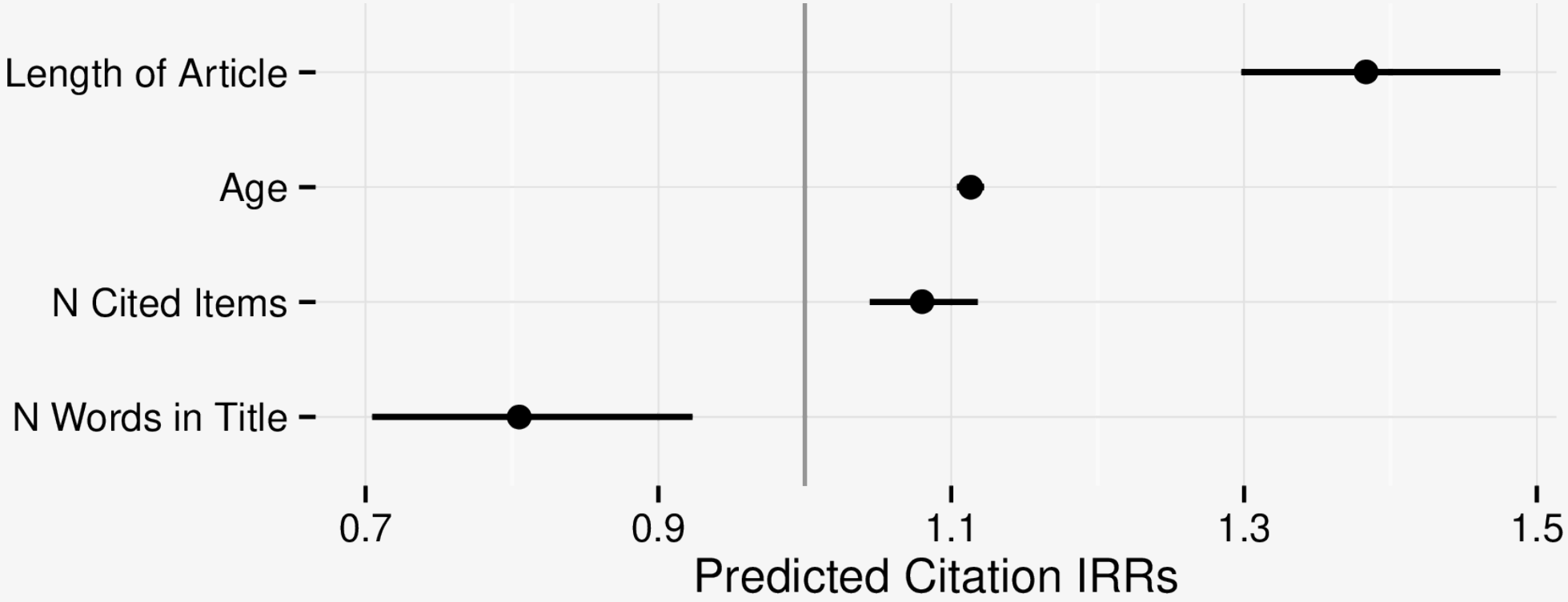
Theory says …

Build from ideas to data



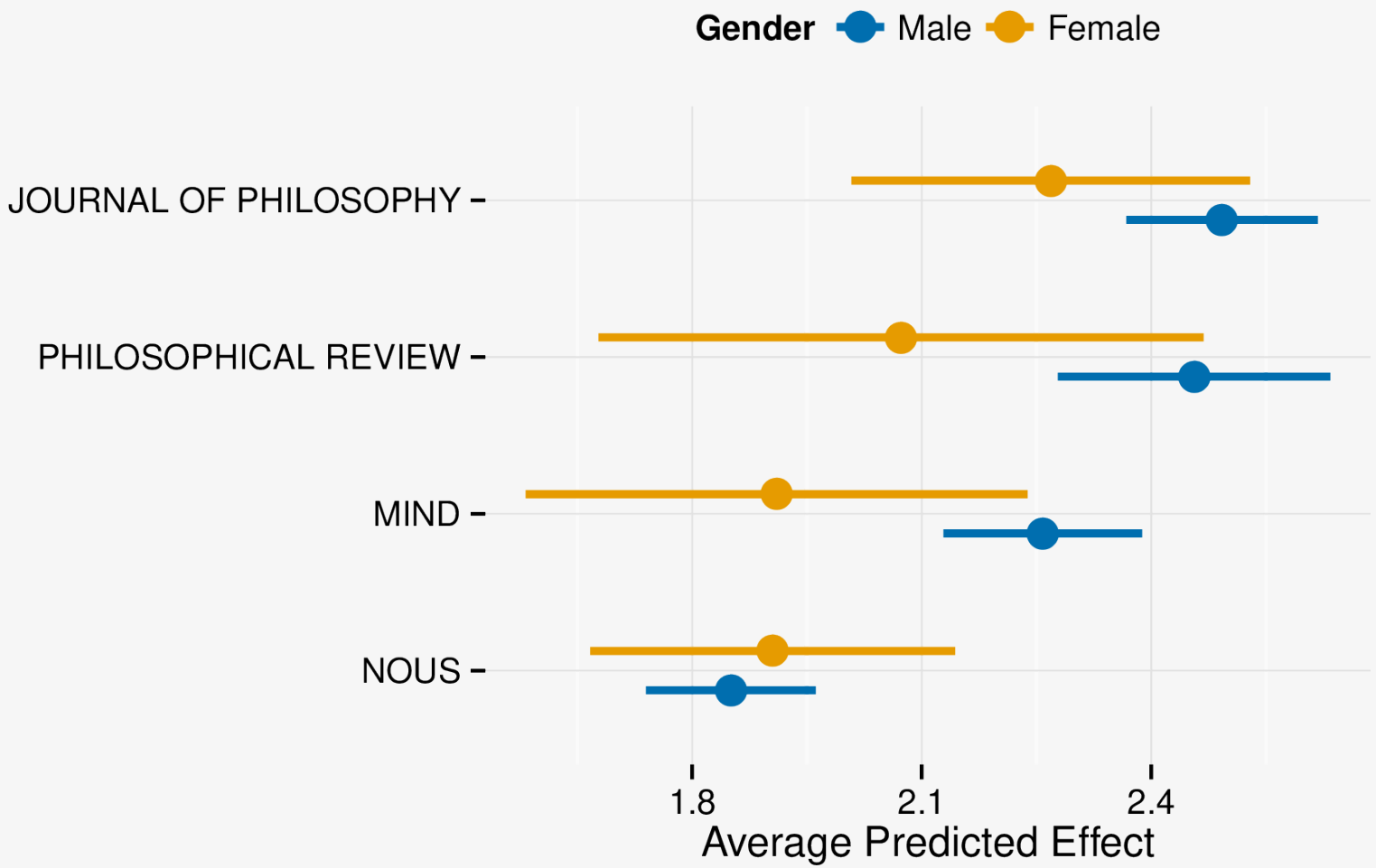
Data suggests ...

Repeat to differentiate



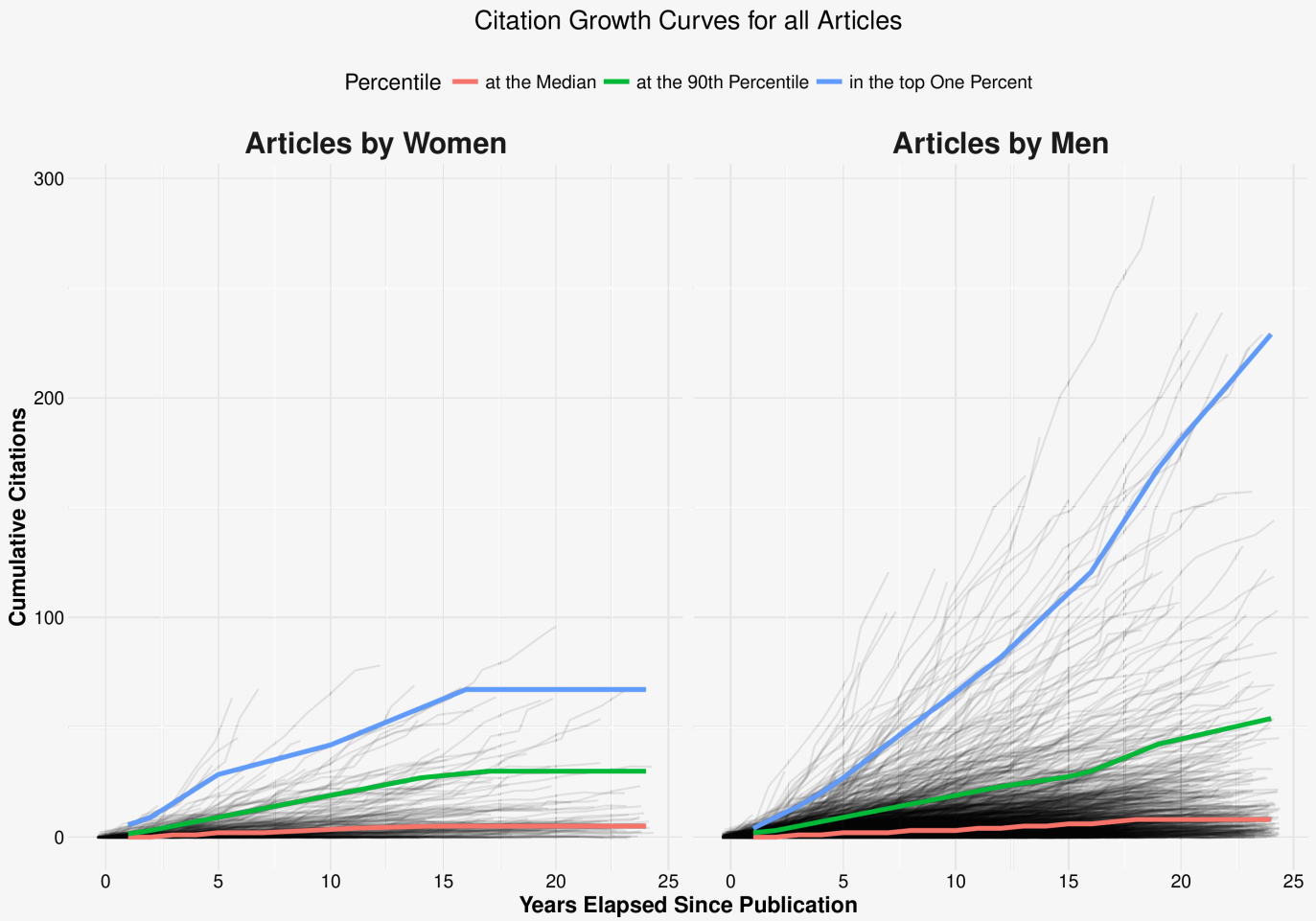
Pointrange

Repeat to differentiate



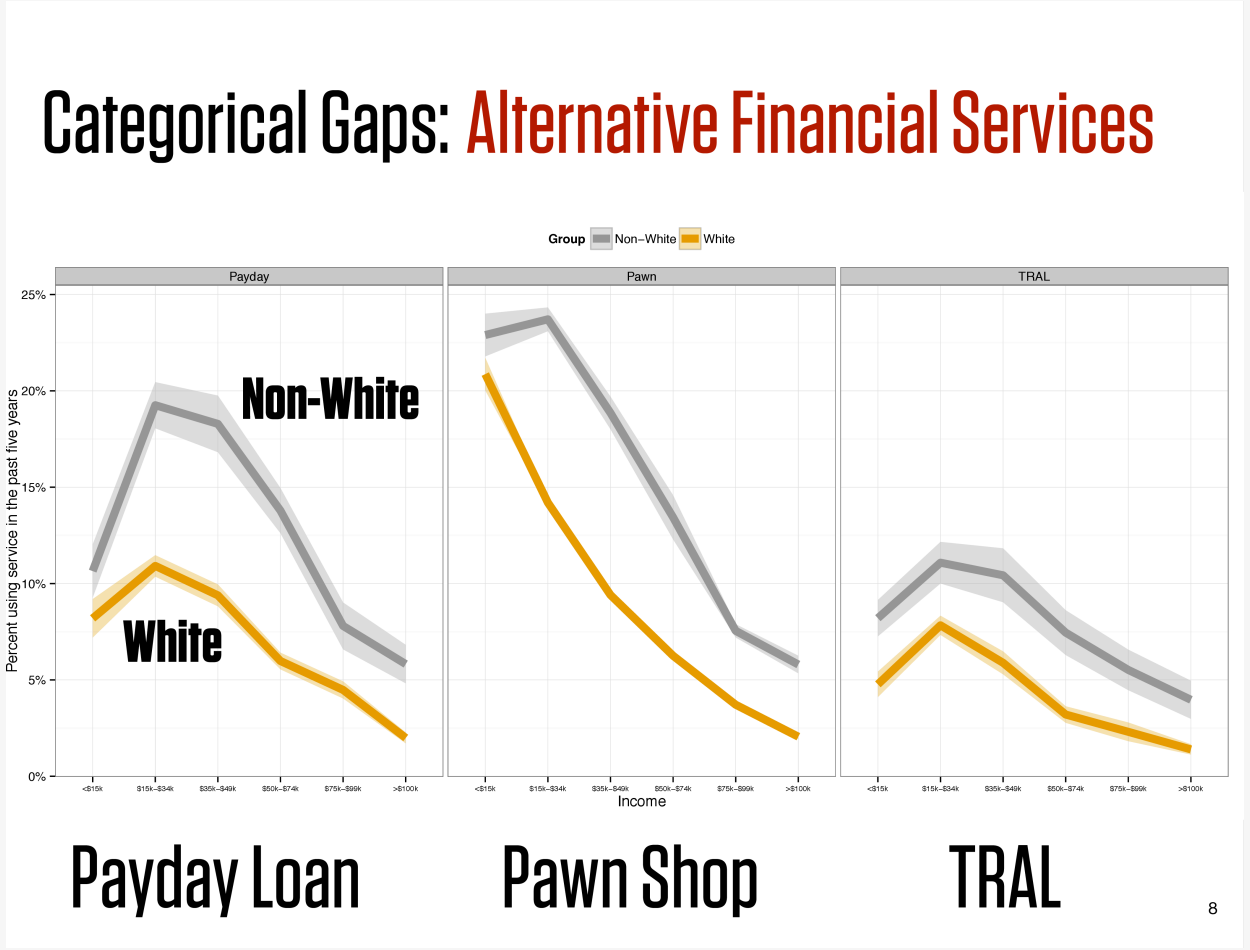
Add a comparison group

Layer and repeat with facets



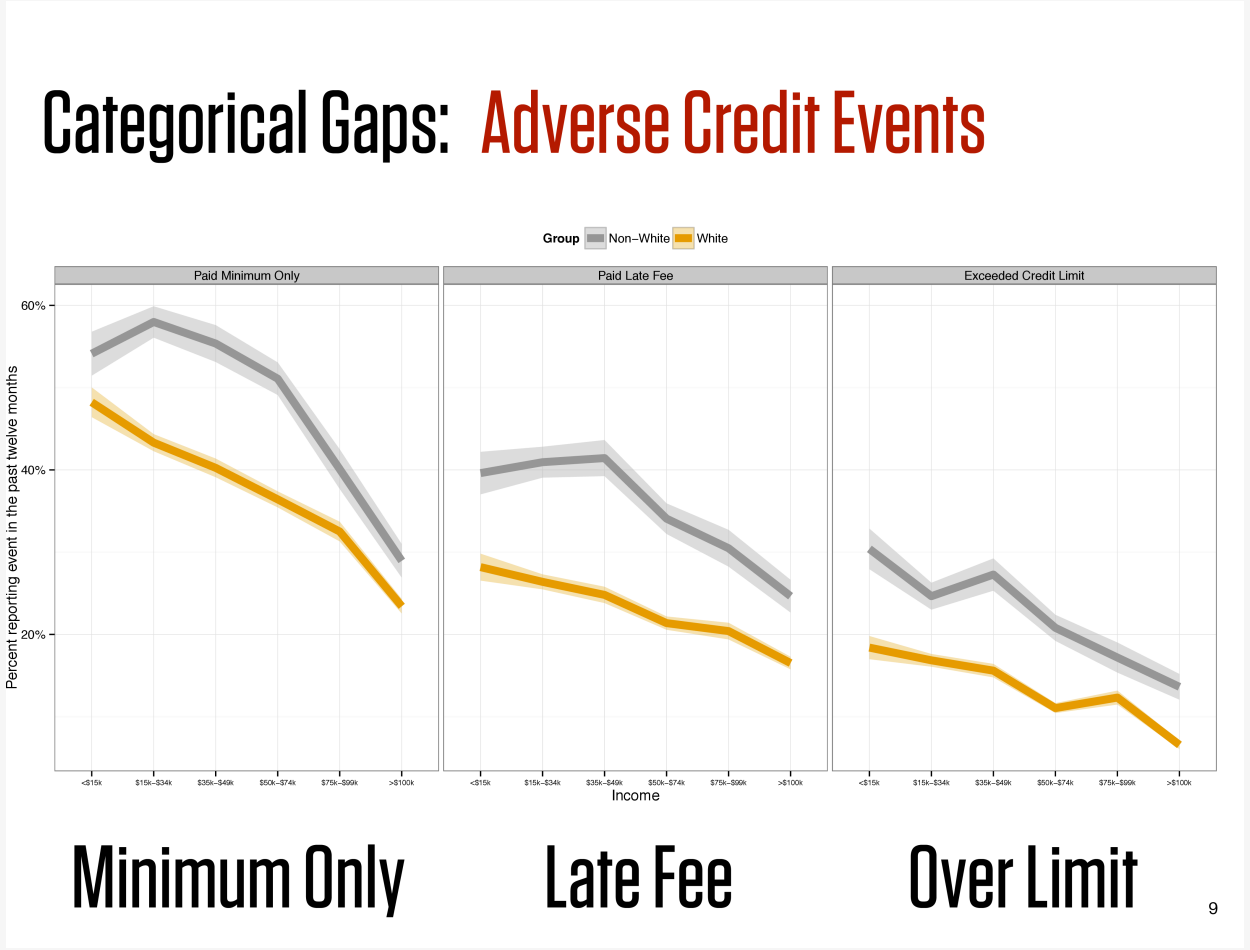
Compare across facets

Layer and repeat across facets



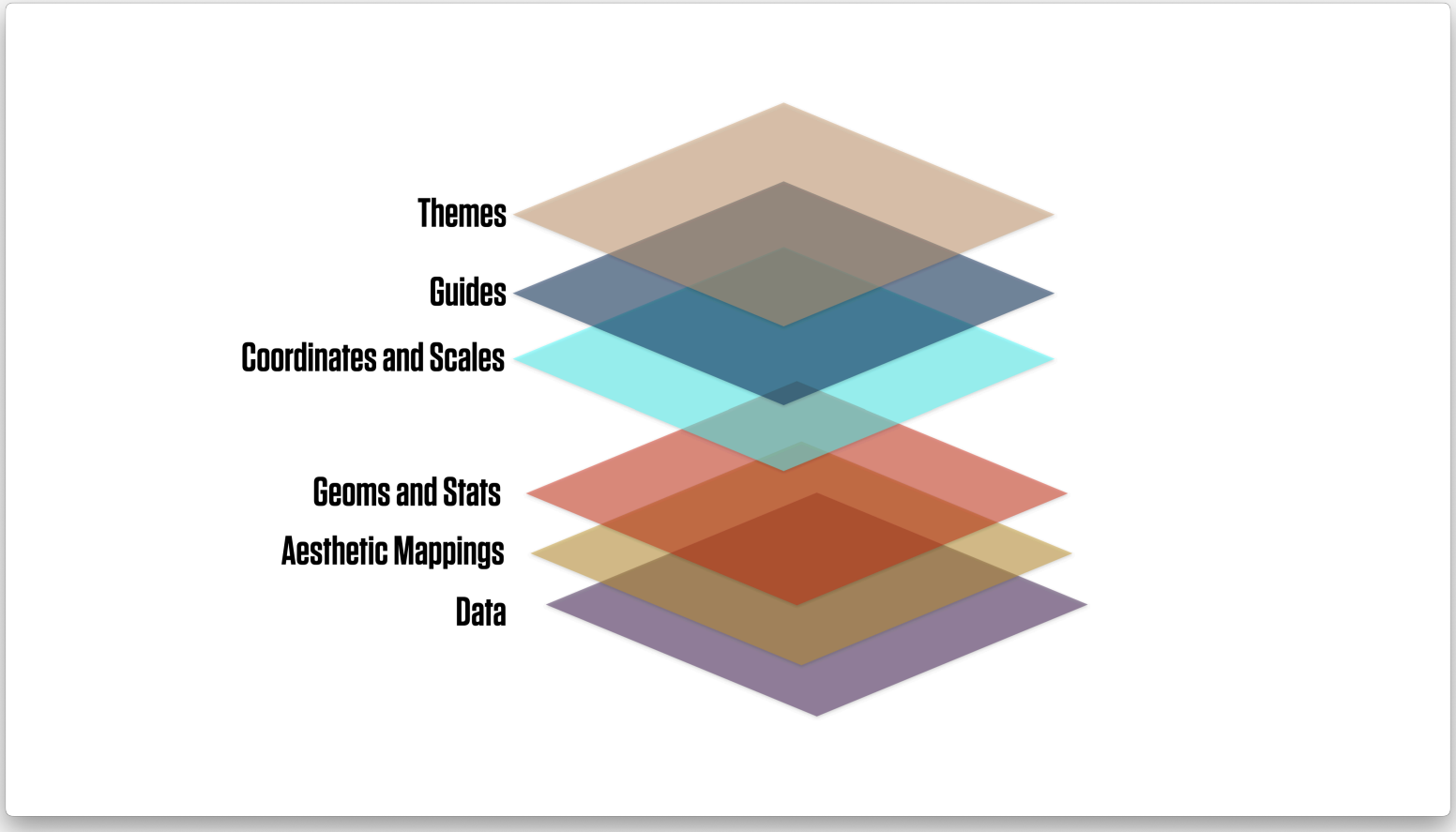
Layer to compare

Layer and repeat across facets



Layer to copmare

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*

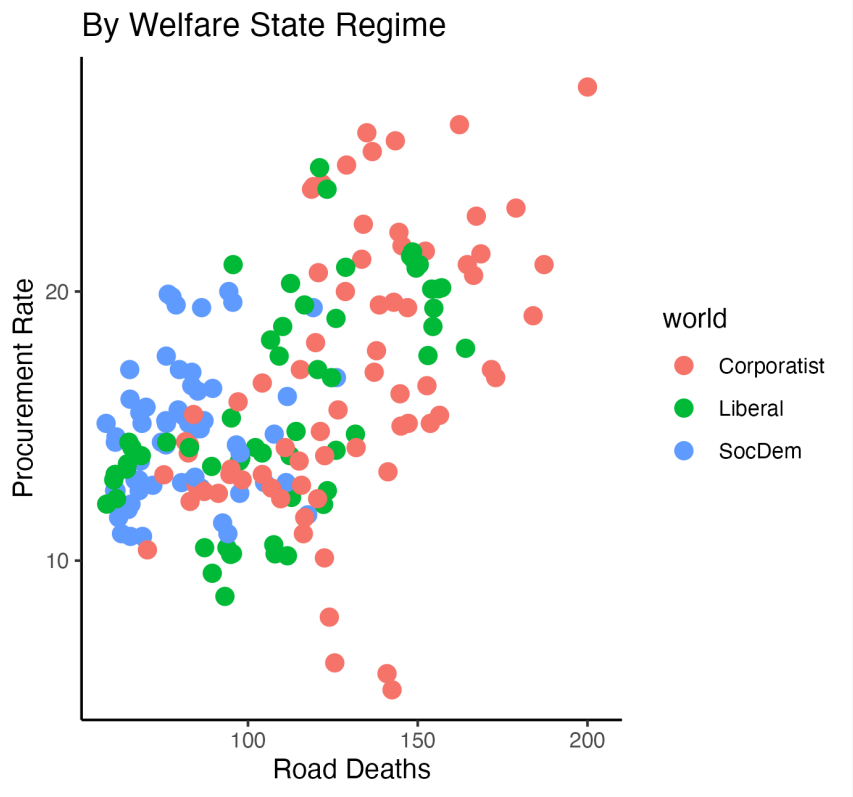
and most importantly ...

Thematic elements do not represent data directly

Make a plot

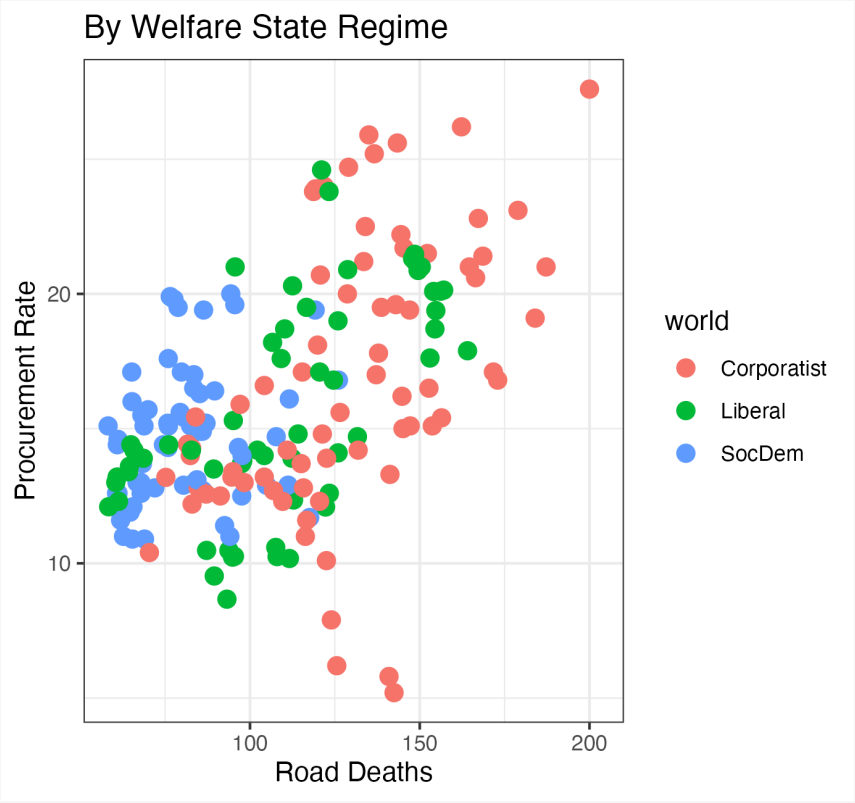
```
kjh_set_classic_theme(3)
```

```
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
```



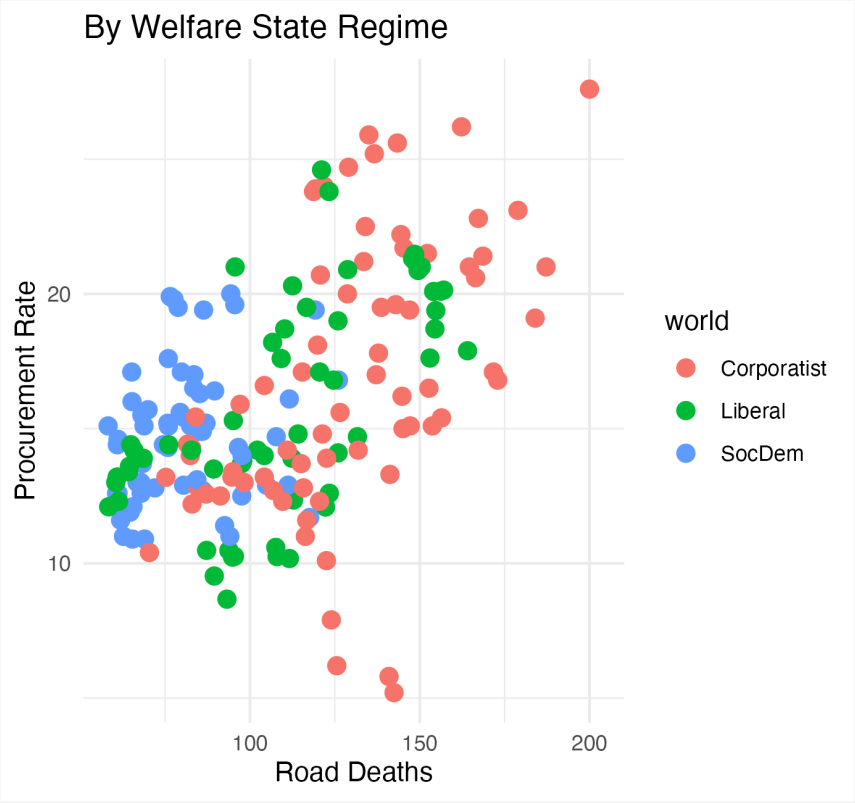
Add a theme ... theme_bw()

```
p + theme_bw()
```



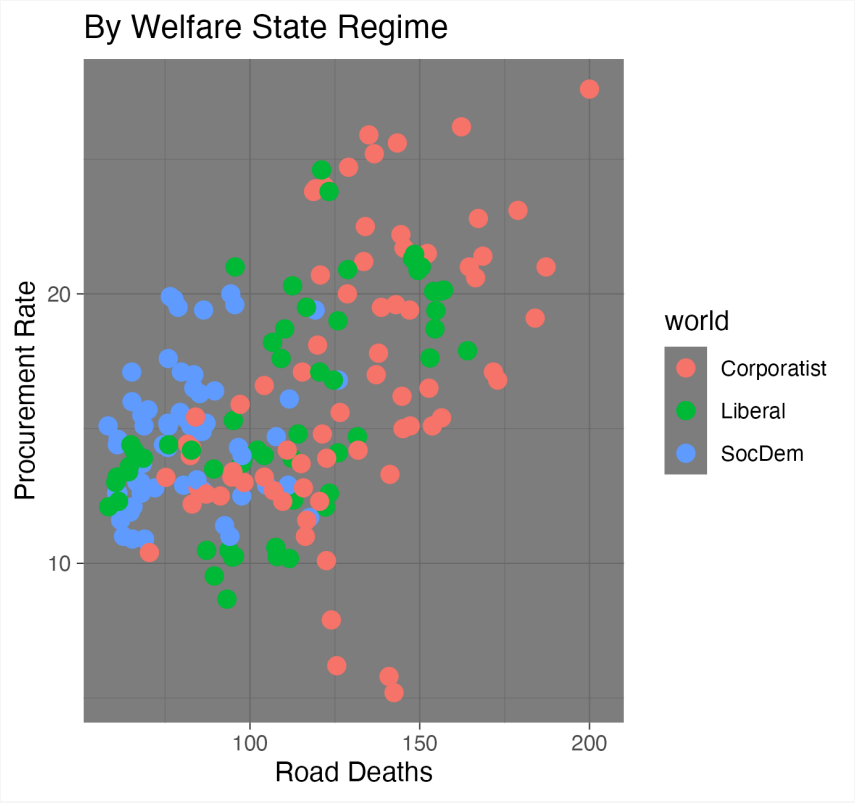
Add a theme ... theme_minimal()

```
p + theme_minimal()
```



Add a theme ... theme_dark()

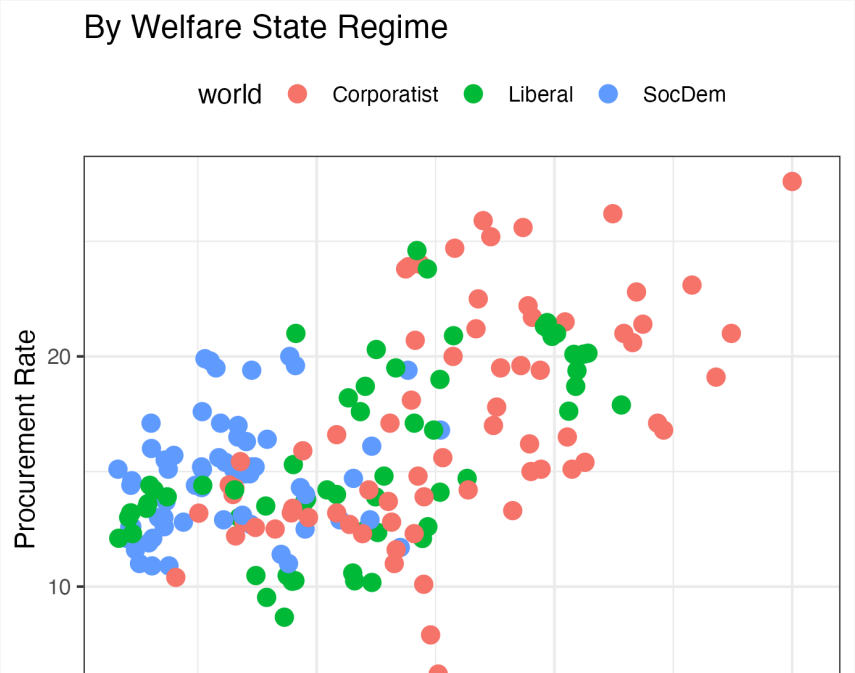
```
p + theme_dark()
```



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.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

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.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**

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...

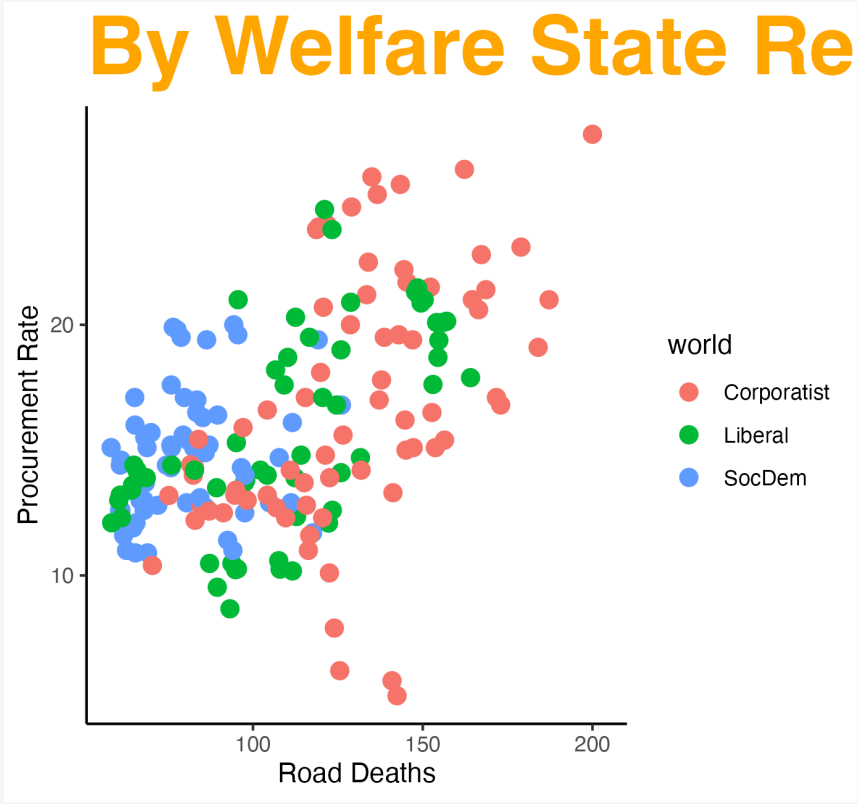
If adjusting a thematic element, ask...

For example ...

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

For example ...

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

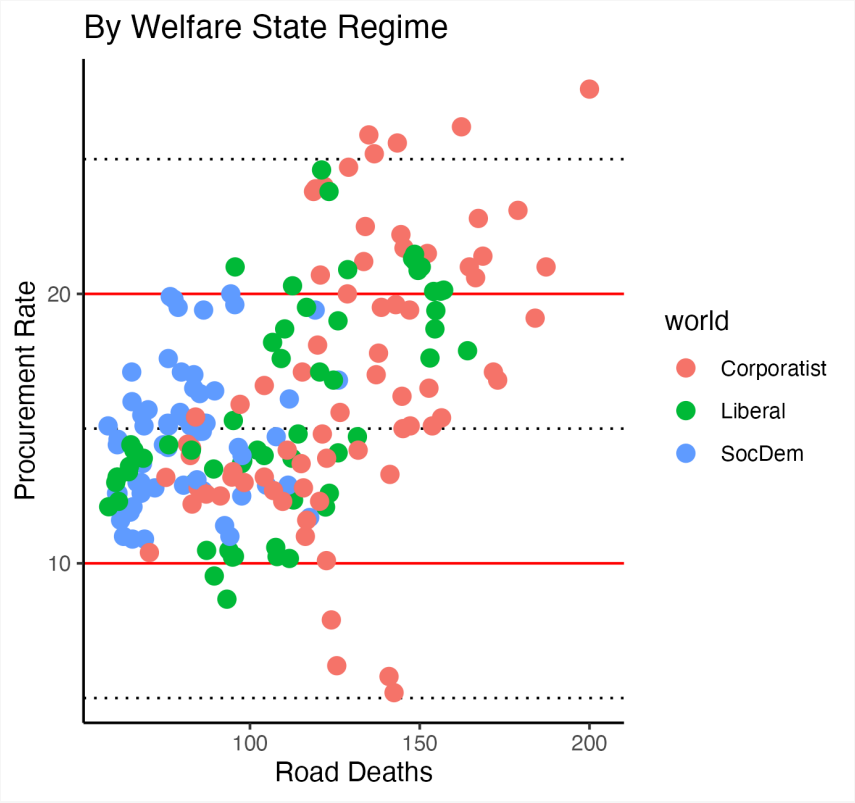


For example ...

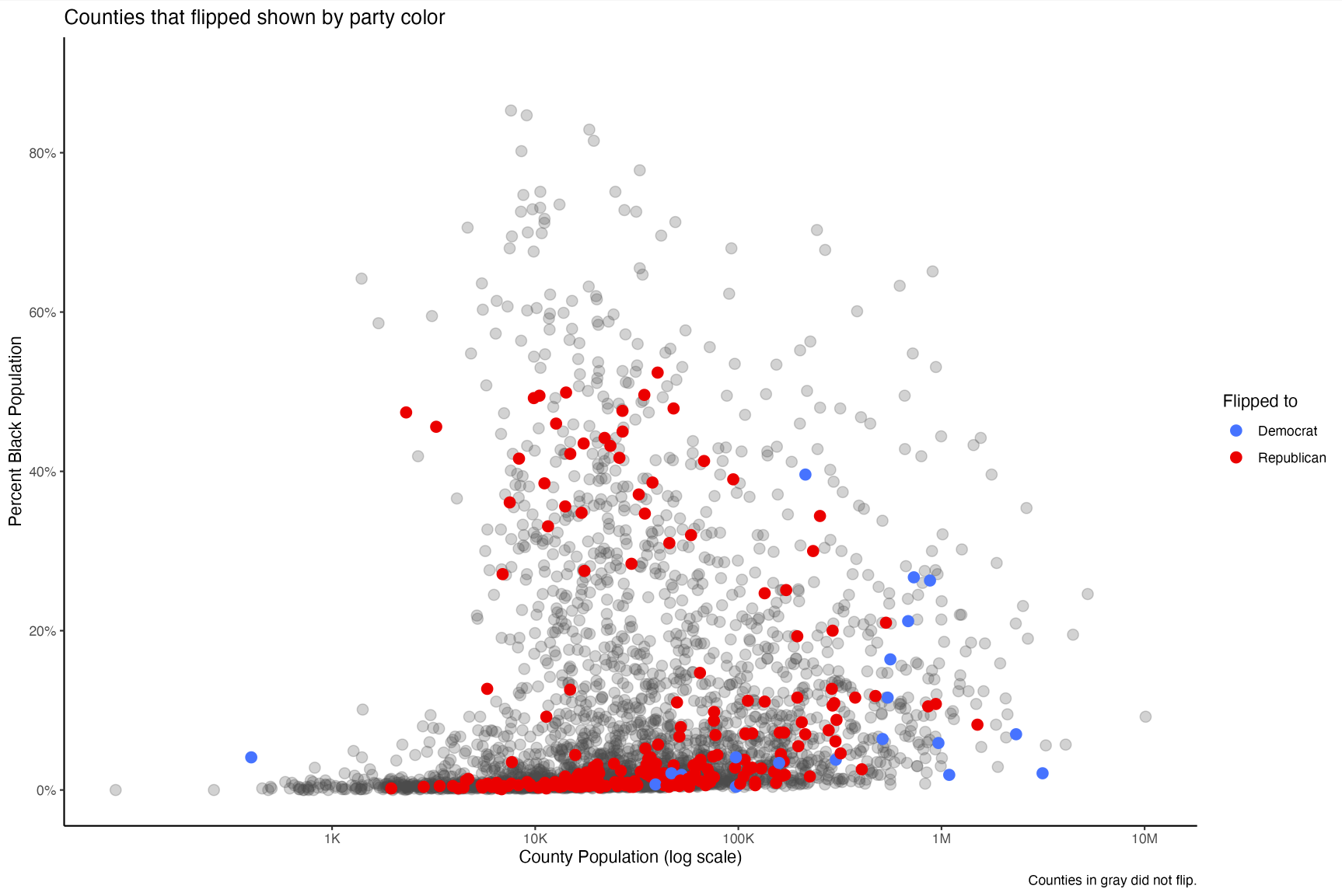
“I want to adjust y axis grid lines on the plot”

For example ...

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



The ggthemes package

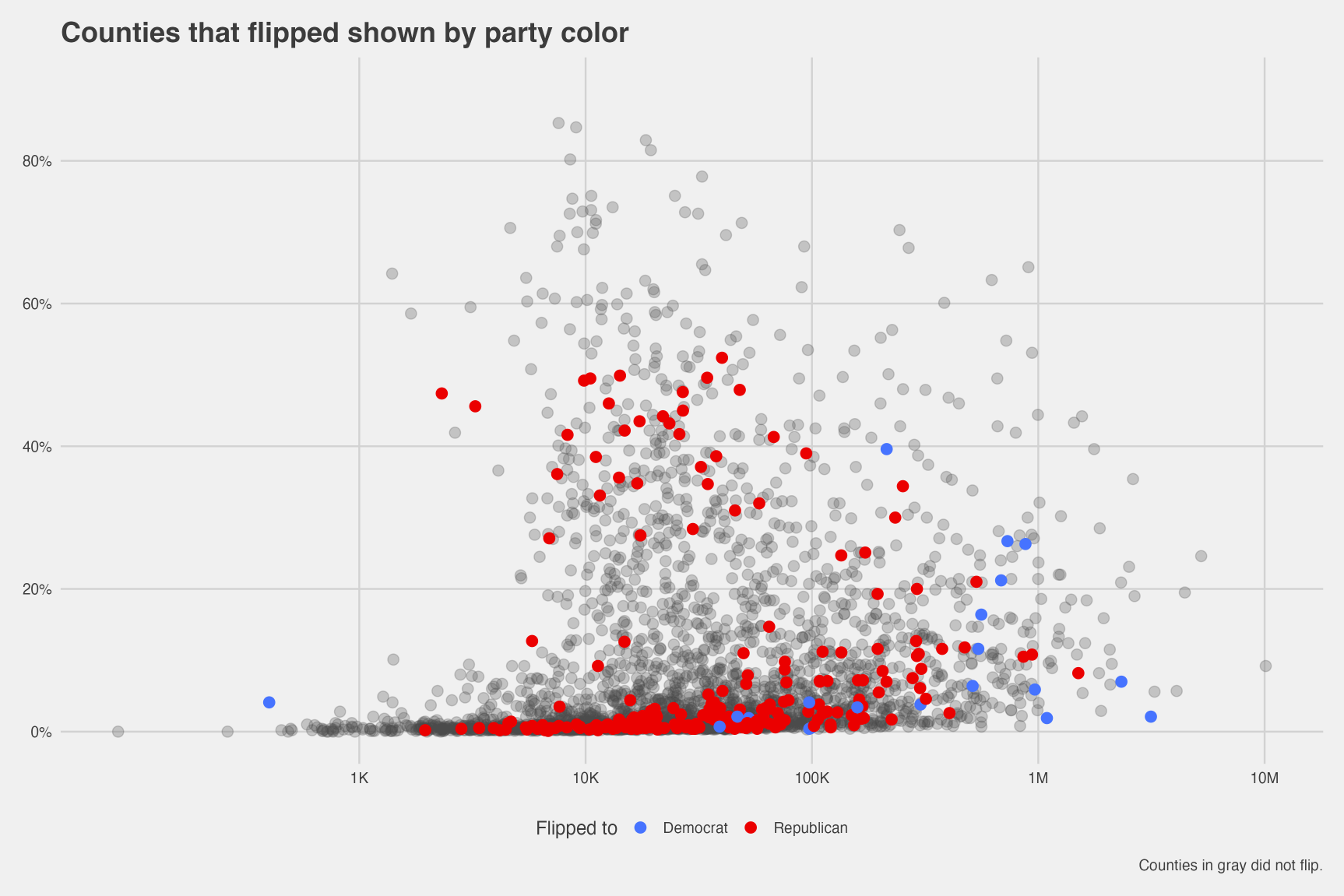


We made this earlier. Here it is in a default theme.

Theming a plot

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

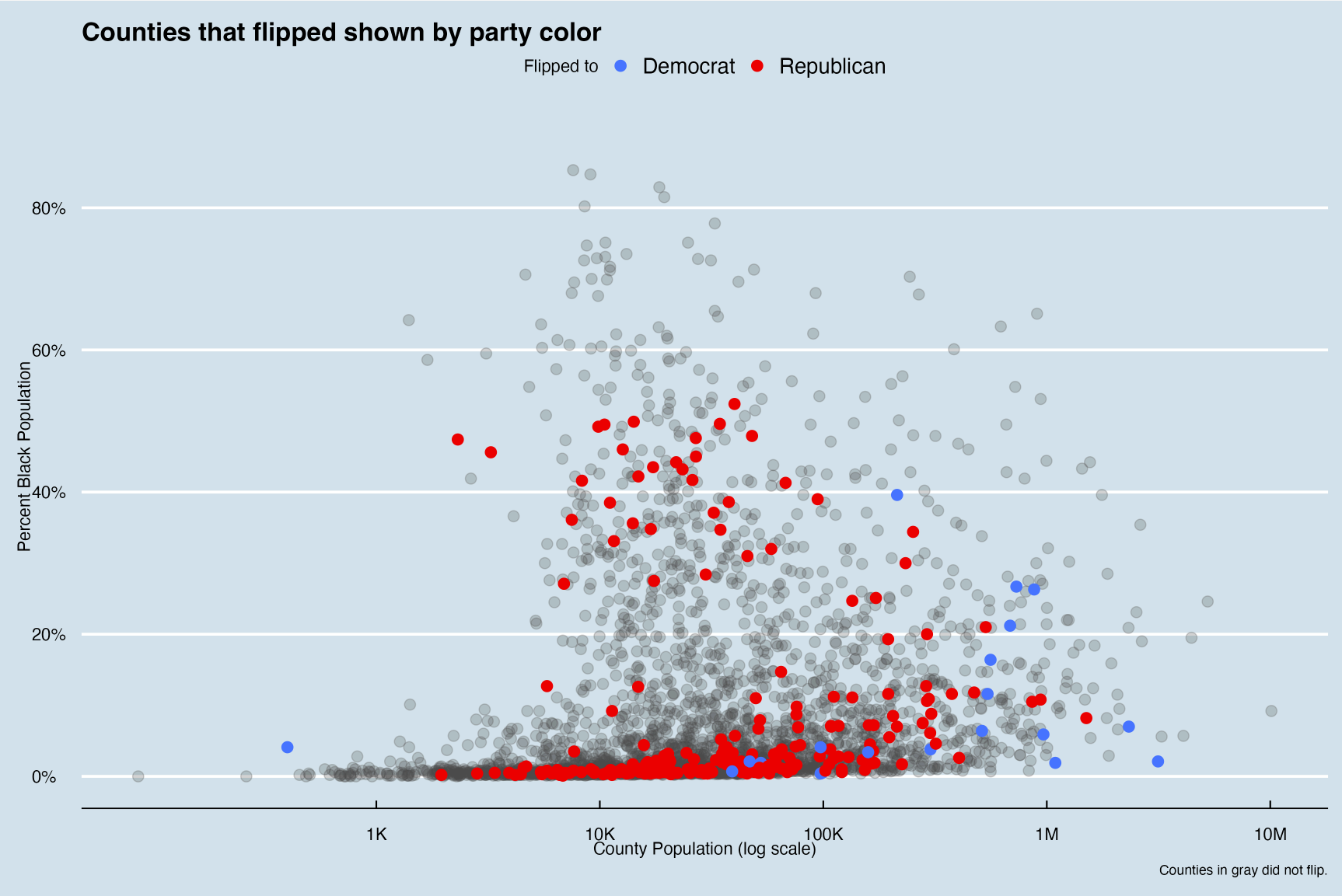
See how the full function call goes inside `theme_set()`, including the parentheses, because we are actually running that function to set all the elements.



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

Theming a plot

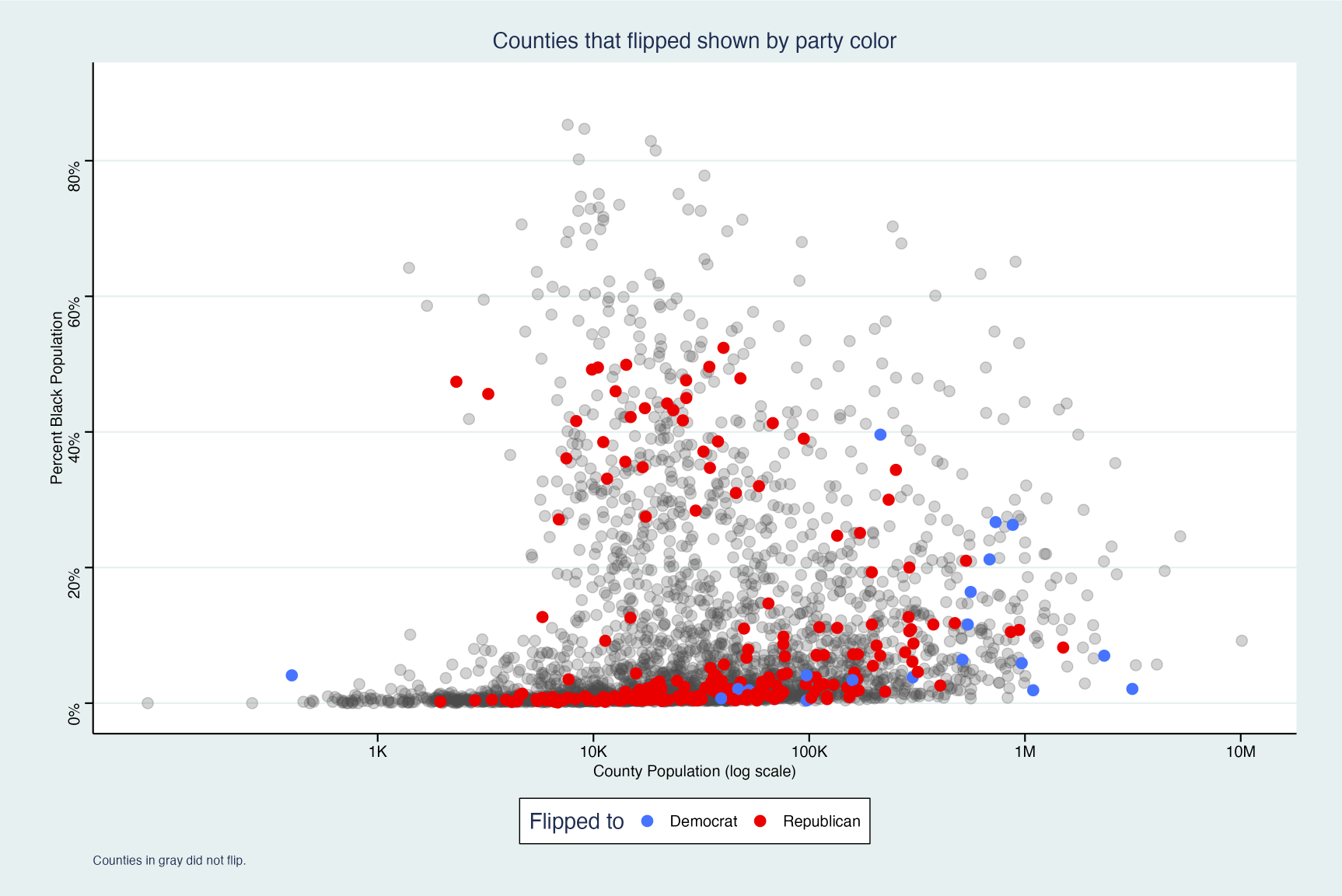
```
theme_set(theme_economist())
```



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

This seems morally wrong

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



Why would you do this to yourself?

Pick a theme
and stick with it