

Data Visualization - 8.

Polishing and

Presenting Plots

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Code Horizons

December 11, 2023

Polishing your plots
and Presenting them

Load our packages

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

Piece by piece,
Layer by layer

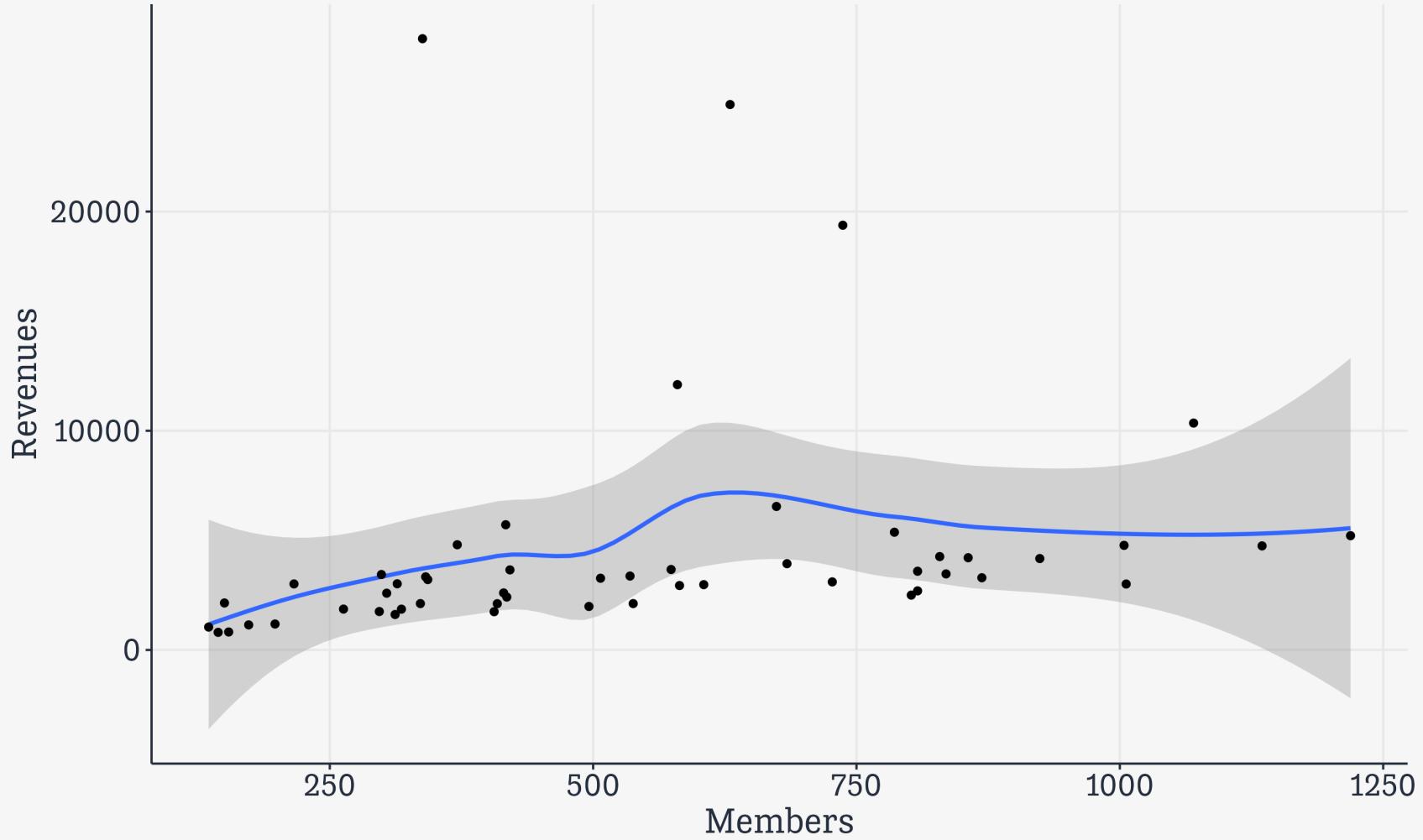
Build your plots a piece at a time

```
asasec ← as_tibble(asasec)
```

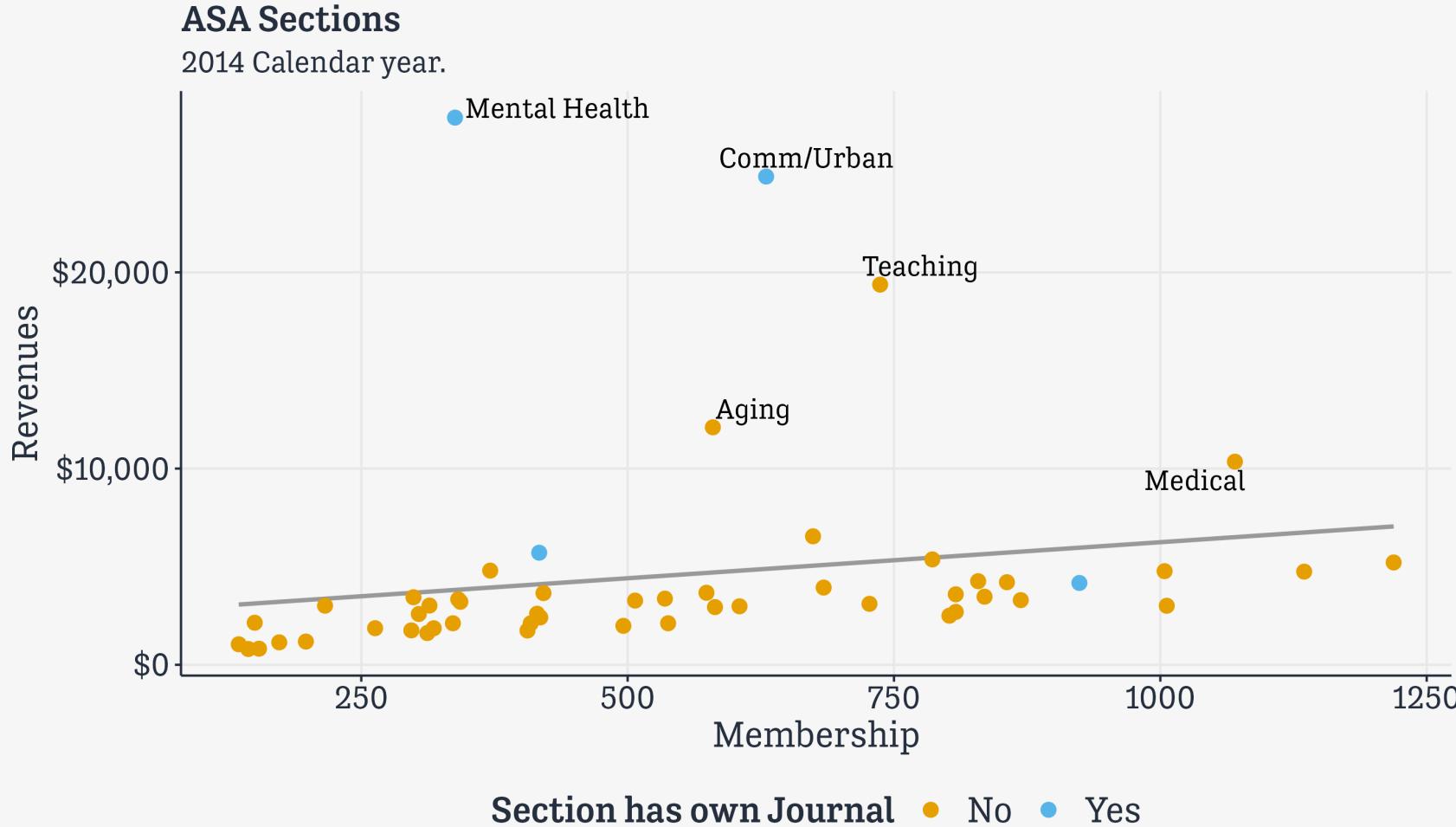
```
asasec
```

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

Build your plots a piece at a time



Build your plots a piece at a time



Source: ASA annual report.

Build your plots a piece at a time

1 asasec

Build your plots a piece at a time

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

Build your plots a piece at a time

```
1 asasec ▷  
2   filter(Year = 2014) ▷  
3   ggplot(mapping = aes(x = Members,  
4                         y = Revenues,  
5                         label = Sname))
```



Build your plots a piece at a time

```
1 asasec >
2   filter(Year = 2014) >
3     ggplot(mapping = aes(x = Members,
4                           y = Revenues,
5                           label = Sname)) +
6     geom_smooth(method = "lm",
7                  se = FALSE,
8                  color = "gray60")
```



Build your plots a piece at a time

```
1 asasec >
2   filter(Year == 2014) >
3     ggplot(mapping = aes(x = Members,
4                           y = Revenues,
5                           label = Sname)) +
6     geom_smooth(method = "lm",
7                  se = FALSE,
8                  color = "gray60") +
9     geom_point(mapping = aes(color = Journal),
10                size = rel(3))
```



Build your plots a piece at a time

```
1 asasec >
2   filter(Year == 2014) >
3     ggplot(mapping = aes(x = Members,
4                           y = Revenues,
5                           label = Sname)) +
6     geom_smooth(method = "lm",
7                  se = FALSE,
8                  color = "gray60") +
9     geom_point(mapping = aes(color = Journal),
10                size = rel(3)) +
11     geom_text_repel(data=subset(asasec,
12                           Year == 2014 &
13                           Revenues > 7000),
14                           size = rel(5),
15                           mapping =
16                           aes(family = "Tenso Slide"))
```



Build your plots a piece at a time

```
1 asasec >
2   filter(Year == 2014) >
3     ggplot(mapping = aes(x = Members,
4                           y = Revenues,
5                           label = Sname)) +
6     geom_smooth(method = "lm",
7                  se = FALSE,
8                  color = "gray60") +
9     geom_point(mapping = aes(color = Journal),
10                size = rel(3)) +
11     geom_text_repel(data=subset(asasec,
12                           Year == 2014 &
13                           Revenues > 7000),
14                           size = rel(5),
15                           mapping =
16                           aes(family = "Tenso Slide"))
17     scale_y_continuous(labels =
18                           scales::label_dollar())
```



Build your plots a piece at a time

```
1 asasec >
2   filter(Year == 2014) >
3     ggplot(mapping = aes(x = Members,
4                           y = Revenues,
5                           label = Sname)) +
6     geom_smooth(method = "lm",
7                  se = FALSE,
8                  color = "gray60") +
9     geom_point(mapping = aes(color = Journal),
10                size = rel(3)) +
11     geom_text_repel(data=subset(asasec,
12                           Year == 2014 &
13                           Revenues > 7000),
14                           size = rel(5),
15                           mapping =
16                           aes(family = "Tenso Slide"))
17     scale_y_continuous(labels =
18                           scales::label_dollar()) +
19     labs(x="Membership", y="Revenues",
20           color = "Section has own Journal",
21           title = "ASA Sections",
22           subtitle = "2014 Calendar year.",
23           caption = "Source: ASA annual report.")
```



Build your plots a piece at a time

```
1 asasec >
2   filter(Year == 2014) >
3     ggplot(mapping = aes(x = Members,
4                           y = Revenues,
5                           label = Sname)) +
6     geom_smooth(method = "lm",
7                  se = FALSE,
8                  color = "gray60") +
9     geom_point(mapping = aes(color = Journal),
10                size = rel(3)) +
11     geom_text_repel(data=subset(asasec,
12                           Year == 2014 &
13                           Revenues > 7000),
14                           size = rel(5),
15                           mapping =
16                           aes(family = "Tenso Slide"))
17     scale_y_continuous(labels =
18                           scales::label_dollar()) +
19     labs(x="Membership", y="Revenues",
20           color = "Section has own Journal",
21           title = "ASA Sections",
22           subtitle = "2014 Calendar year.",
23           caption = "Source: ASA annual report.") +
24     theme(legend.position = "bottom")
```



Build your plots a piece at a time

```
1 asasec >
2   filter(Year == 2014) >
3     ggplot(mapping = aes(x = Members,
4                           y = Revenues,
5                           label = Sname)) +
6     geom_smooth(method = "lm",
7                  se = FALSE,
8                  color = "gray60") +
9     geom_point(mapping = aes(color = Journal),
10                size = rel(3)) +
11     geom_text_repel(data=subset(asasec,
12                           Year == 2014 &
13                           Revenues > 7000),
14                           size = rel(5),
15                           mapping =
16                           aes(family = "Tenso Slide"))
17     scale_y_continuous(labels =
18                           scales::label_dollar()) +
19     labs(x="Membership", y="Revenues",
20           color = "Section has own Journal",
21           title = "ASA Sections",
22           subtitle = "2014 Calendar year.",
23           caption = "Source: ASA annual report.") +
24     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.

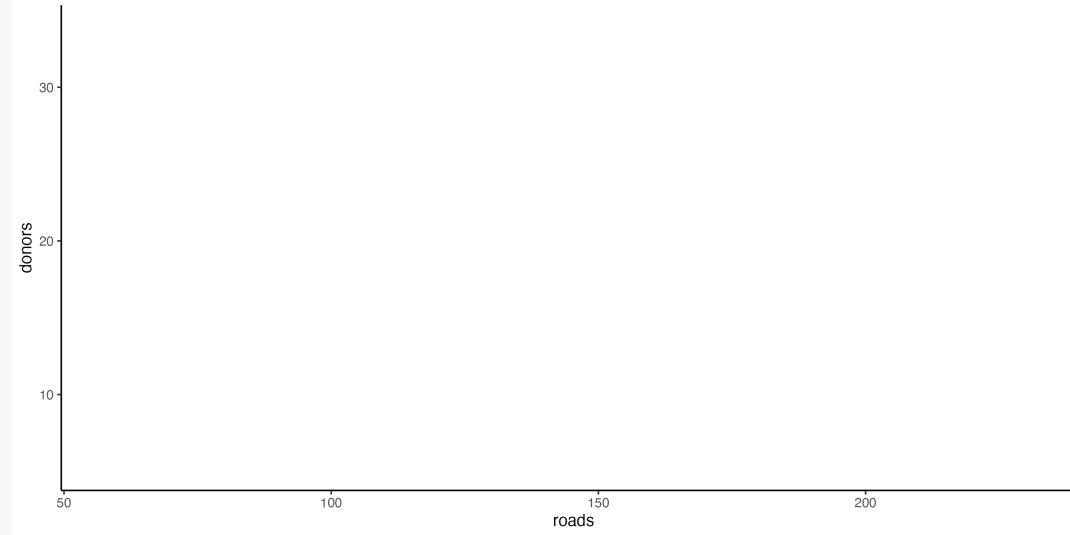
You can specify scales manually

```
1 organdata
```

```
# A tibble: 238 × 21
  country     year    donors   pop  pop_dens    gdp gdp_lag health health_lag
  <chr>      <date>   <dbl> <int>    <dbl> <int>  <dbl> <dbl>    <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>
```

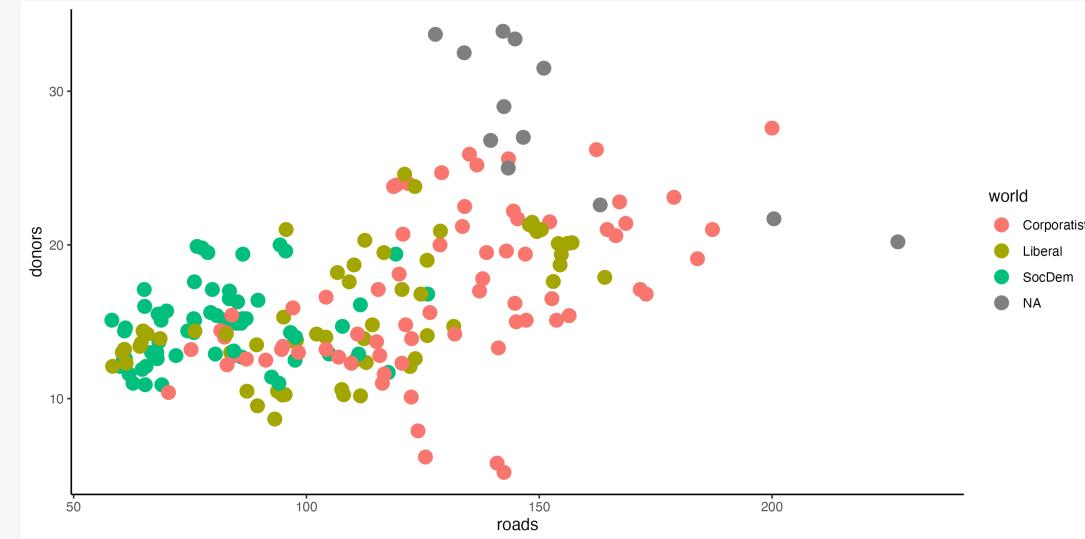
You can specify scales manually

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



You can specify scales manually

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



You can specify scales manually

```
1 organdata %>
2   ggplot(mapping = aes(x = roads,
3                         y = donors,
4                         color = world)) +
5   geom_point(size = 4) ->
6   p
```

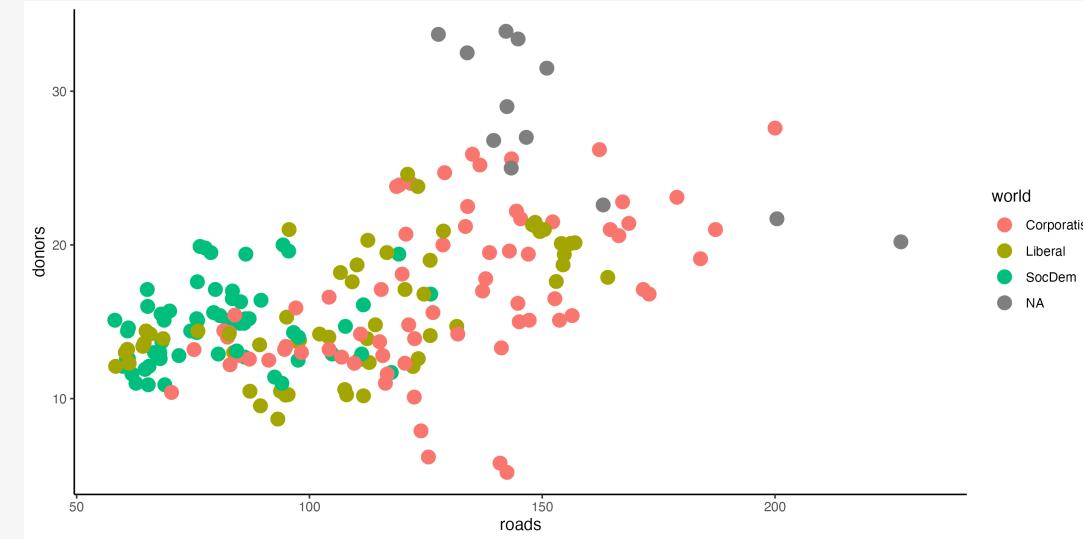
You can specify scales manually

```
1 organdata >
2   ggplot(mapping = aes(x = roads,
3                         y = donors,
4                         color = world)) +
5   geom_point(size = 4) ->
6   p
```

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

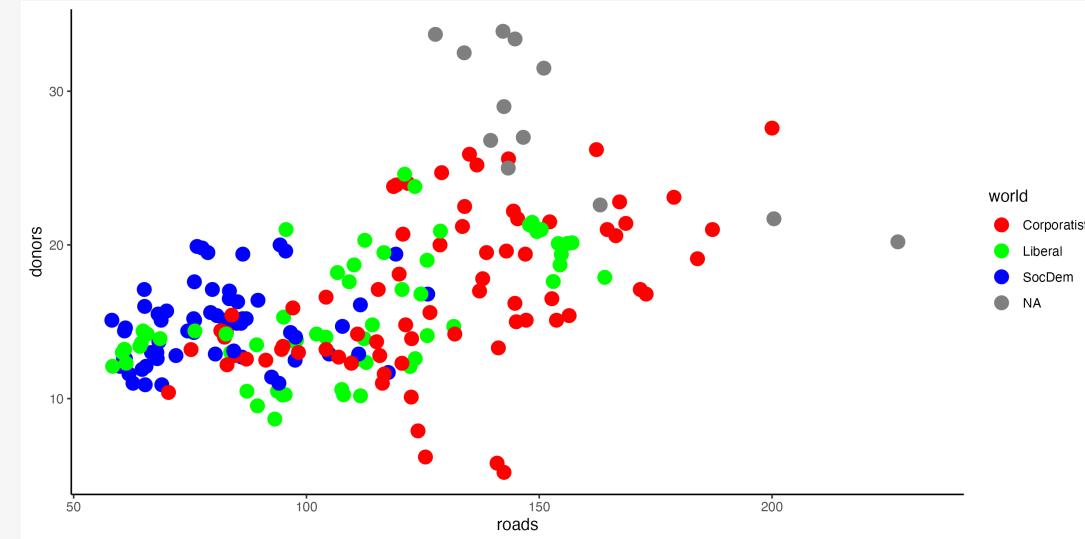
You can specify scales manually

1 p



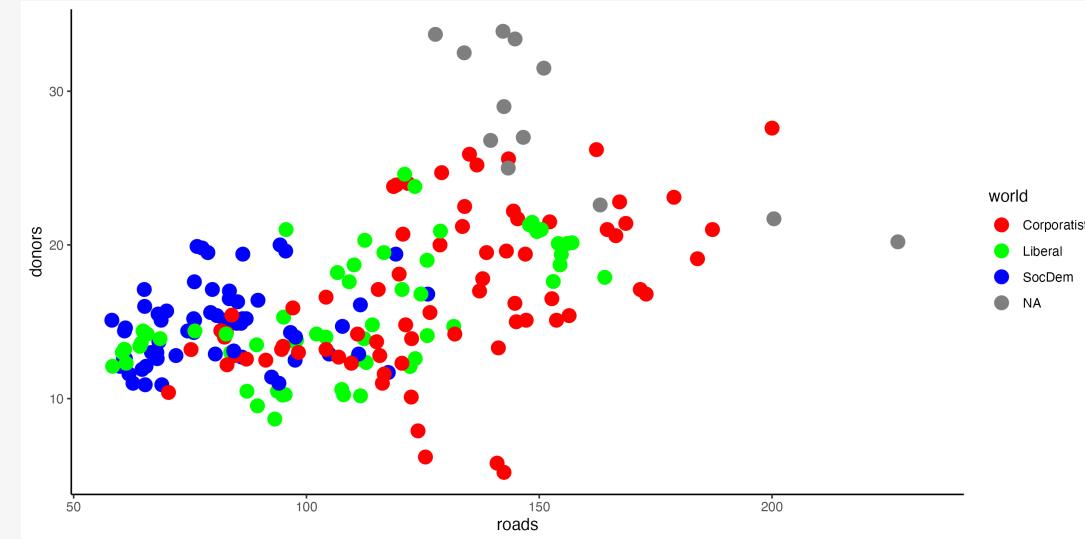
You can specify scales manually

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



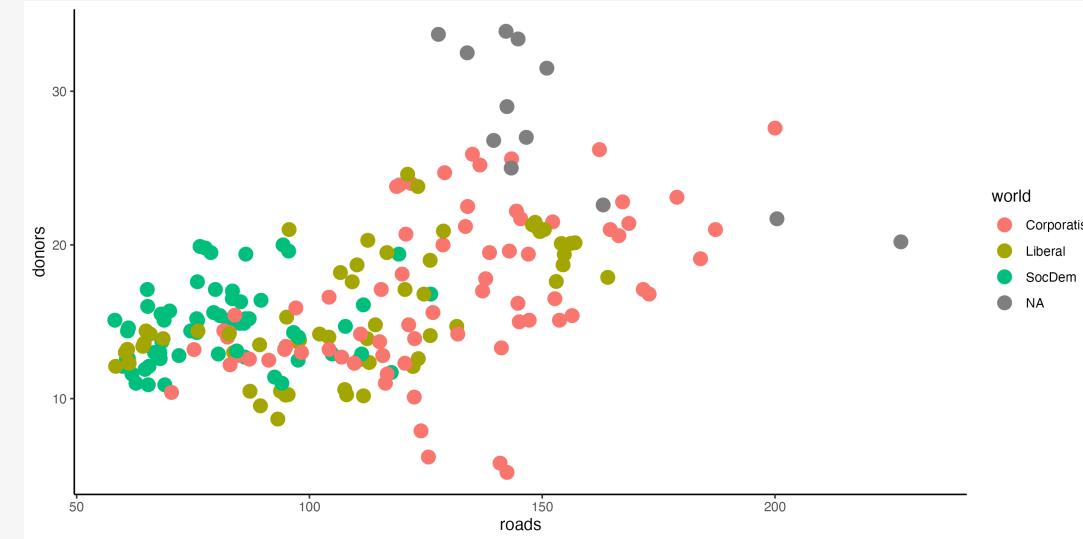
You can specify scales manually

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



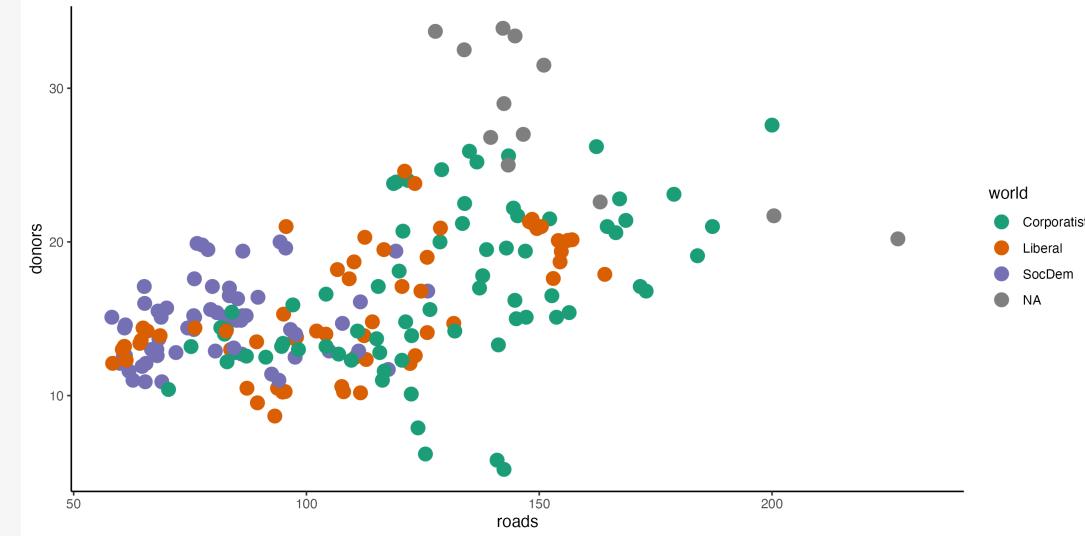
You can specify scales manually

1 p



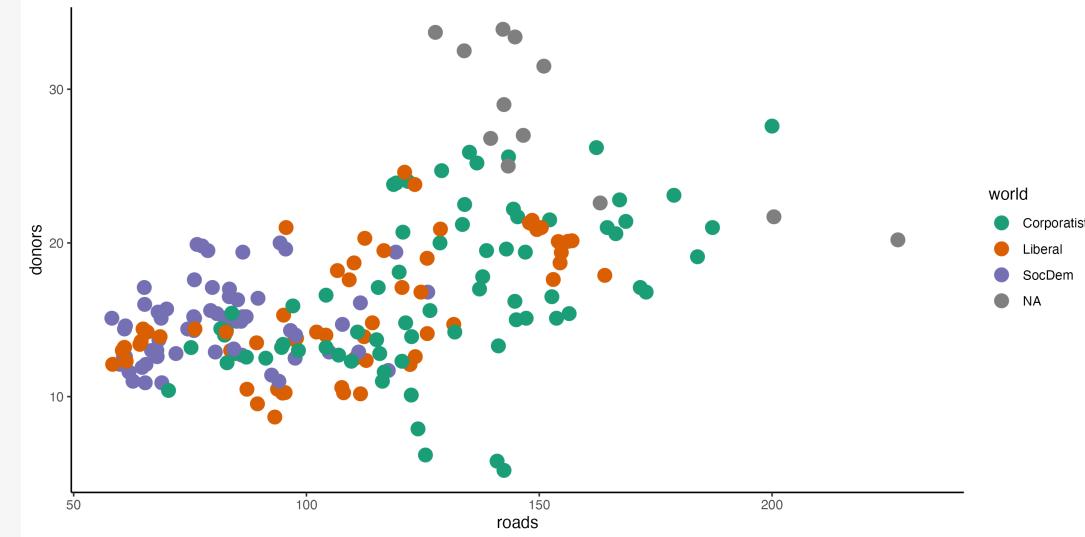
You can specify scales manually

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



You can specify scales manually

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



You can specify scales manually

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

You can specify scales manually

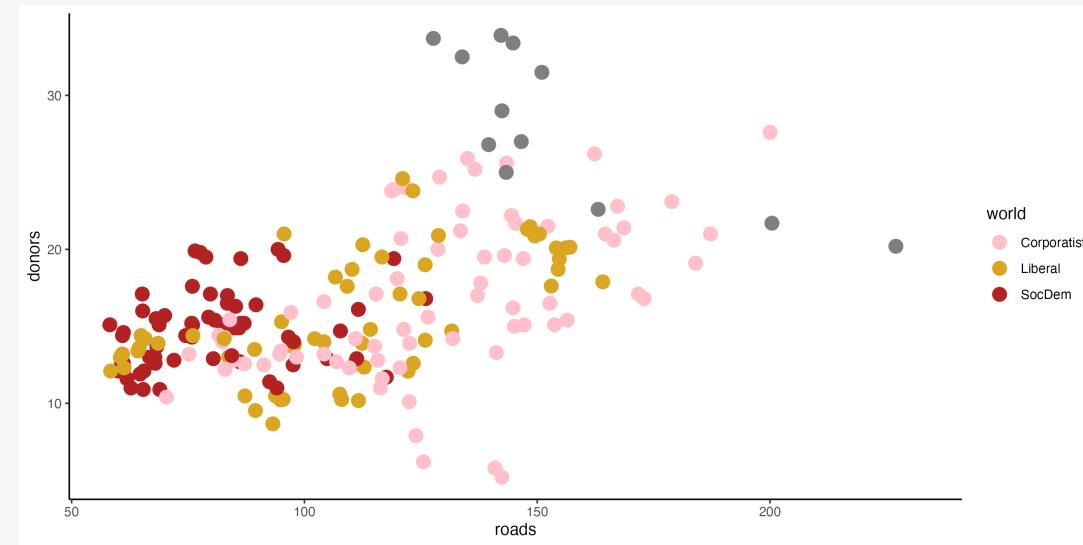
```
1 colkey ← c("Corporatist" = "pink",
2           "Liberal" = "goldenrod",
3           "SocDem" = "firebrick")
4 colkey
```

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

You can specify scales manually

```
1 colkey <- c("Corporatist" = "pink",
2           "Liberal" = "goldenrod",
3           "SocDem" = "firebrick")
4 colkey
5
6 p + scale_color_manual(
7   values = colkey)
```

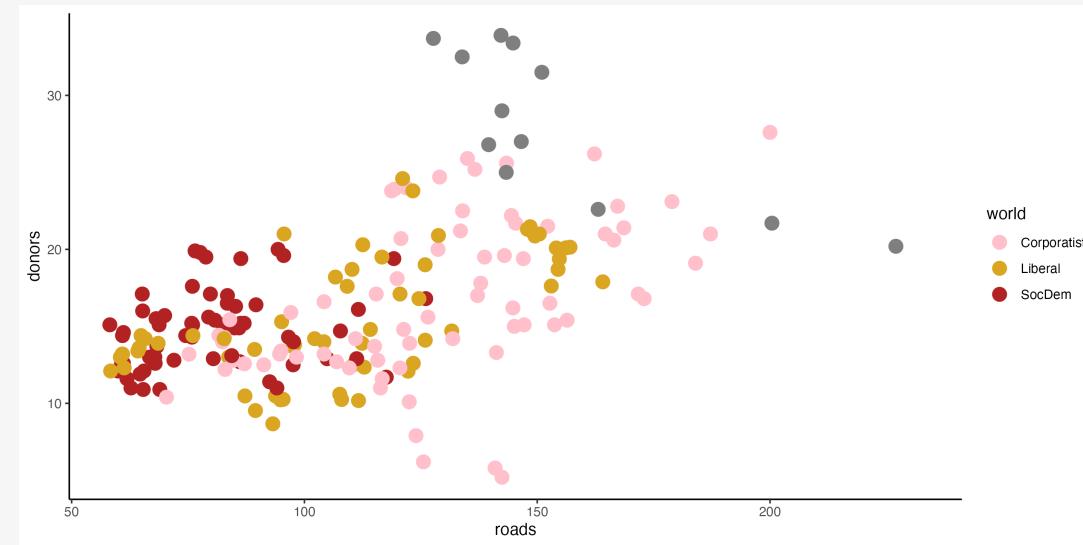
```
Corporatist      Liberal      SocDem
"pink" "goldenrod" "firebrick"
```



You can specify scales manually

```
1 colkey <- c("Corporatist" = "pink",
2           "Liberal" = "goldenrod",
3           "SocDem" = "firebrick")
4 colkey
5
6 p + scale_color_manual(
7   values = colkey)
```

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



Use balanced palettes

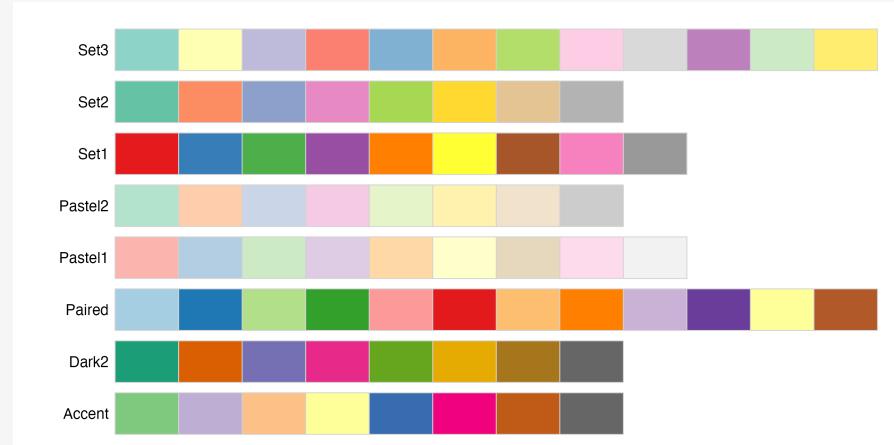
E.g., the `RColorBrewer` Palettes

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

See the palettes with

```
RColorBrewer :: display.brewer.all()
```

Qualitative palettes



Use balanced palettes

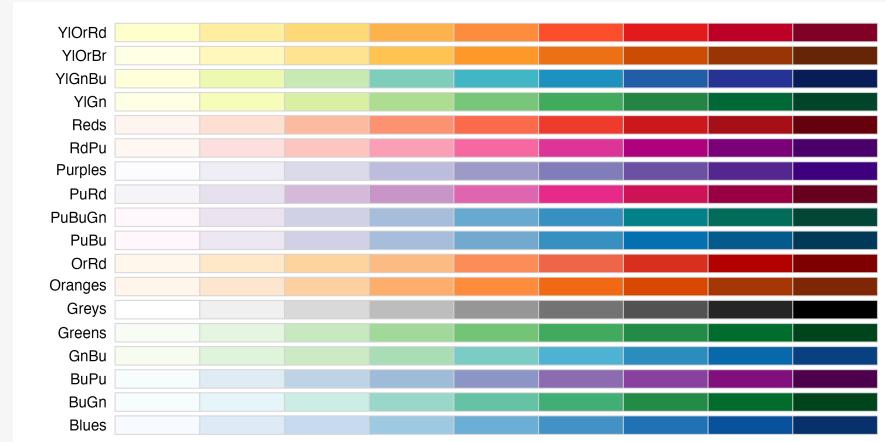
E.g., the RColorBrewer Palettes

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()
```

Sequential palettes



Use balanced palettes

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()
```

Diverging palettes



Qualitative Brewer Palettes

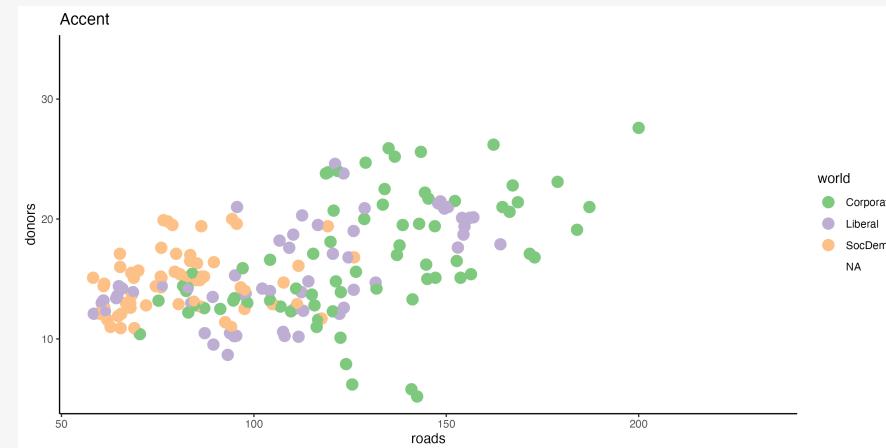
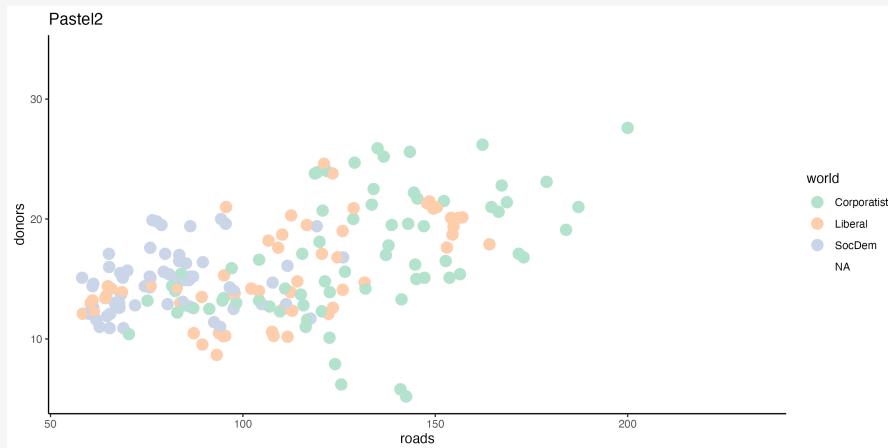
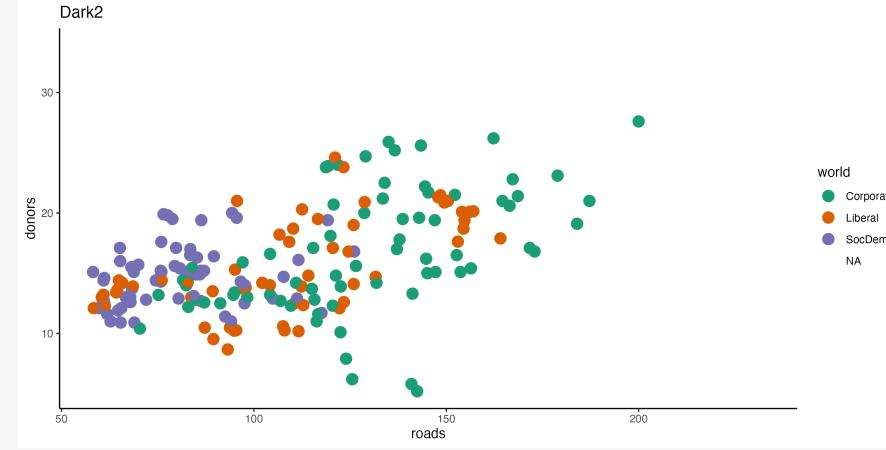
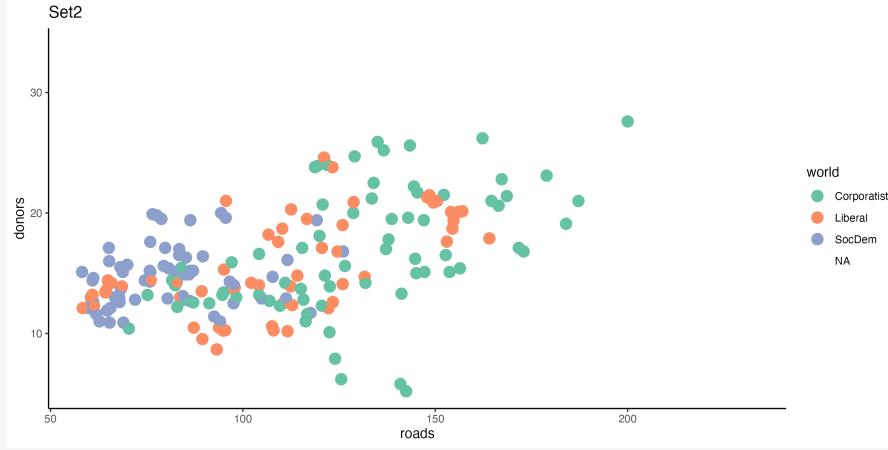
```
p + geom_point(size = 2) +
  scale_color_brewer(palette = "Set2") +
  labs(title = "Set2")

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

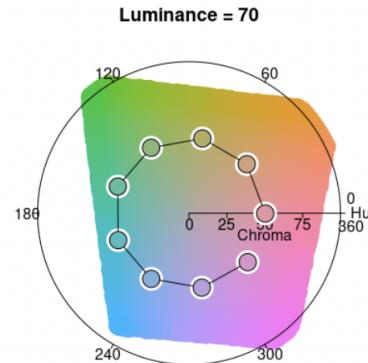


2.0-4

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A Toolbox for Manipulating and Assessing Colors and Palettes

Color spaces



HCL-based palettes

Qualitative

Pastel 1
Dark 3
Harmonic

Sequential (single-hue)

Blues 3
Reds 3
Greens 3

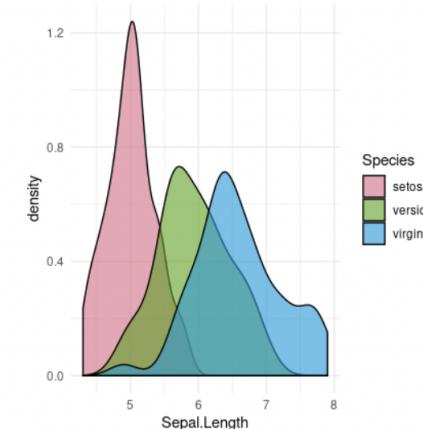
Sequential (multi-hue)

Purple-Blue
Viridis
ag_Sunset

Diverging

Blue-Red
Green-Brown
Tropic

ggplot2 scales



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

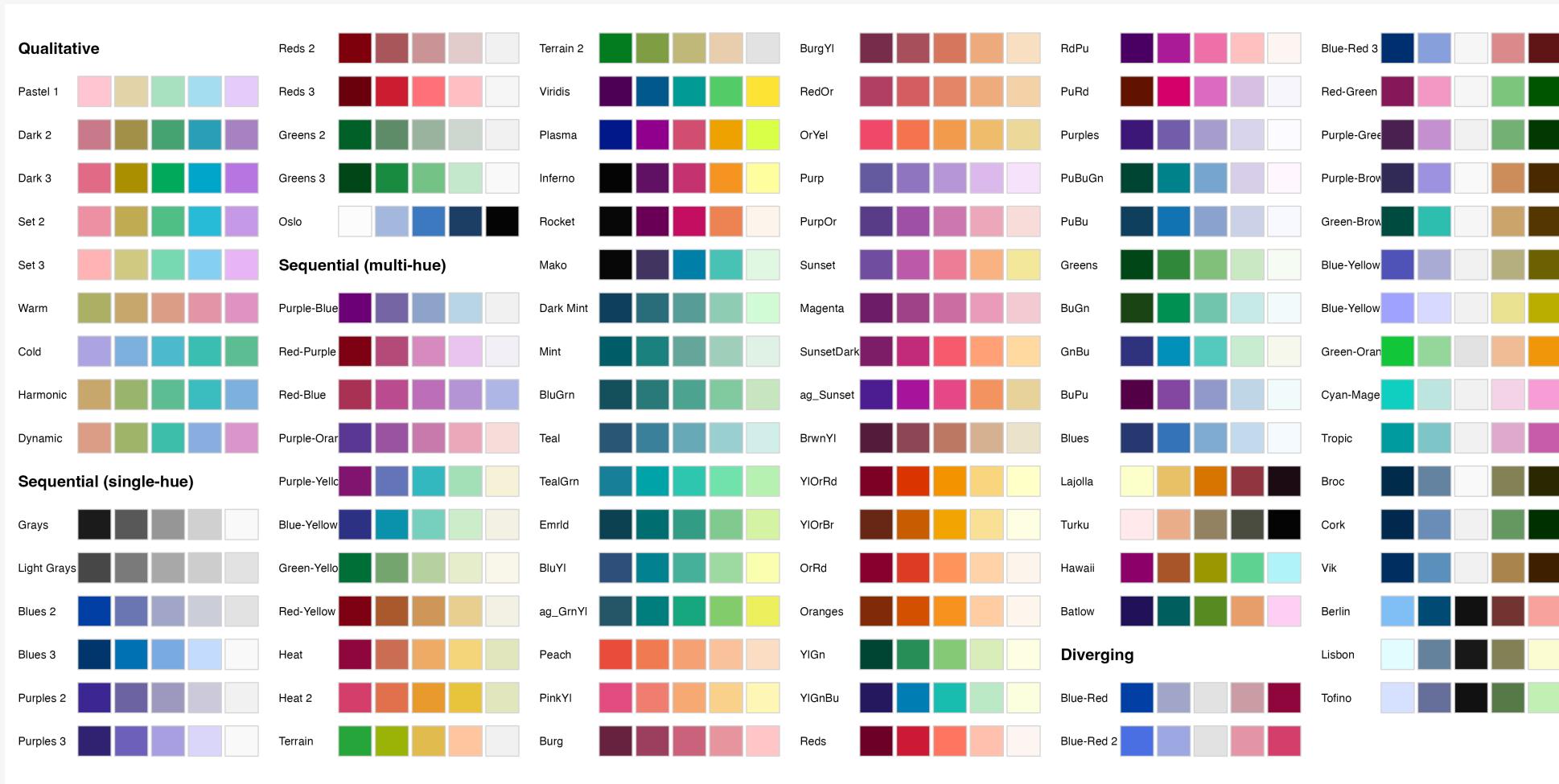
Citation

[Citing colorspace](#)

Developers

Ross Ihaka
Author

Many palettes



So many colors

The `colorspace` function convention

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

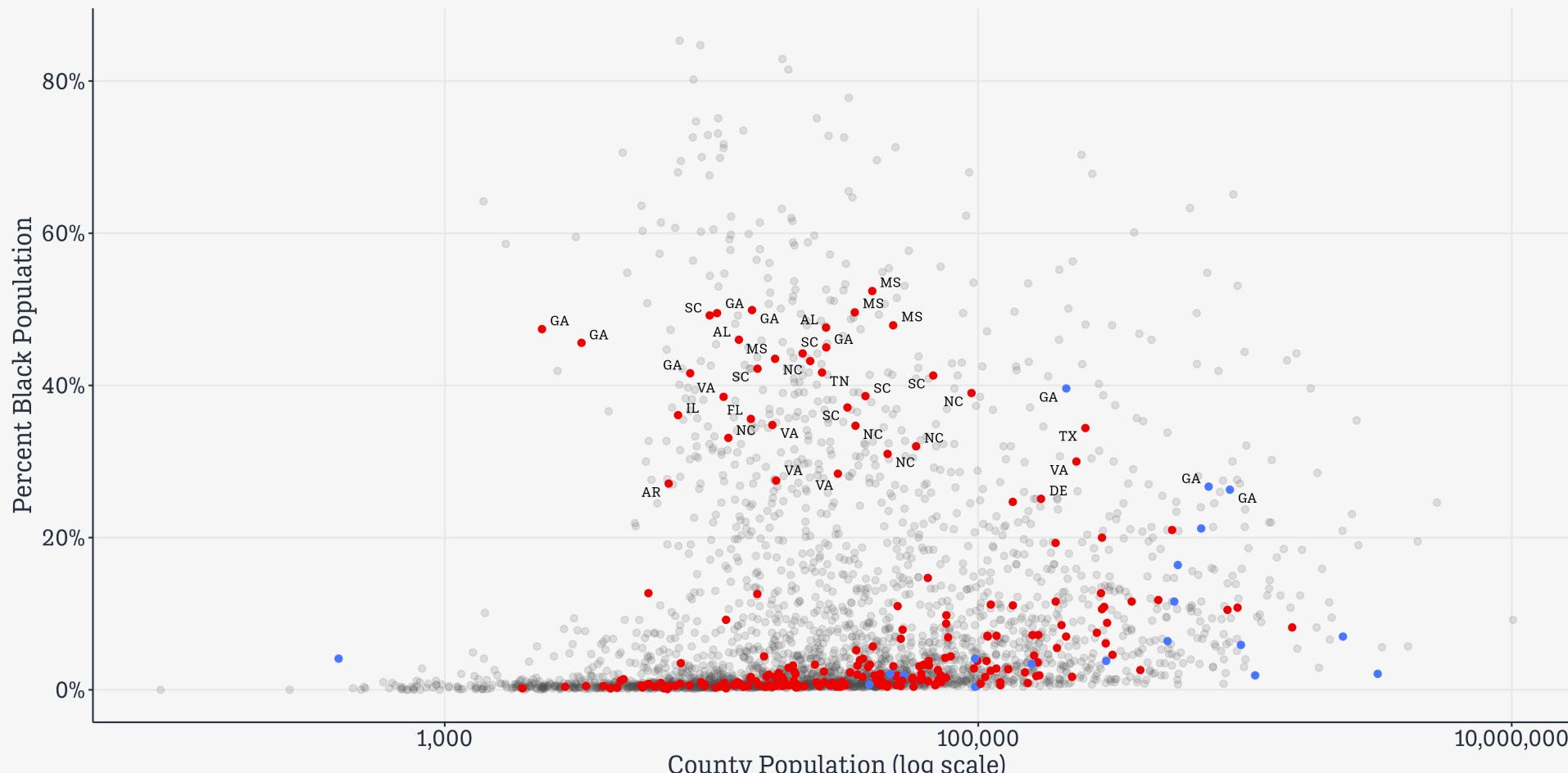
`scale_color_binned_diverging()`
`scale_color_binned_qualitative()`
`scale_color_binned_sequential()`
`scale_color_continuous_diverging()`
`scale_color_continuous_qualitative()`
`scale_color_continuous_sequential()`
`scale_color_discrete_diverging()`
`scale_color_discrete_qualitative()`
`scale_color_discrete_sequential()`

`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

County flipped to ... • Democrat • Republican



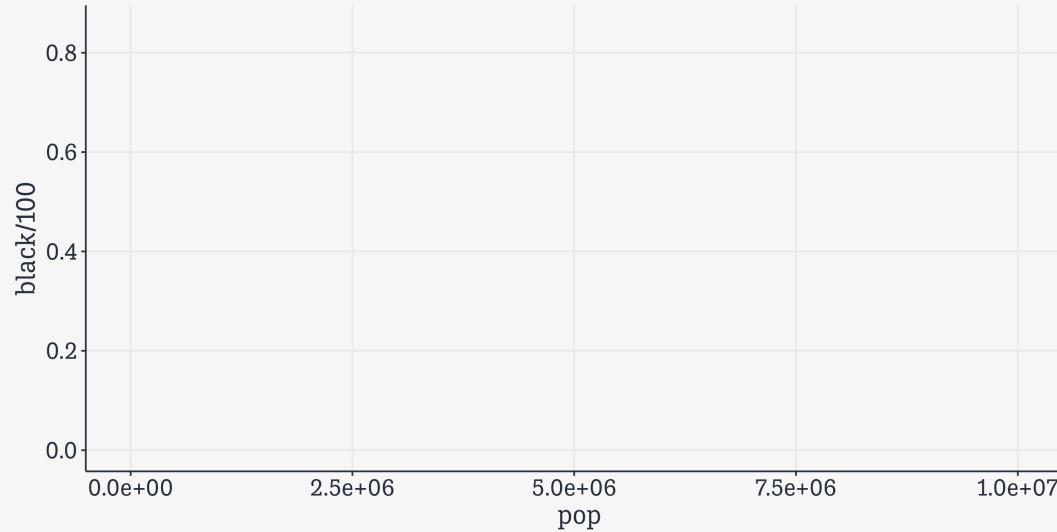
Counties in gray did not flip.

We know how to build this

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

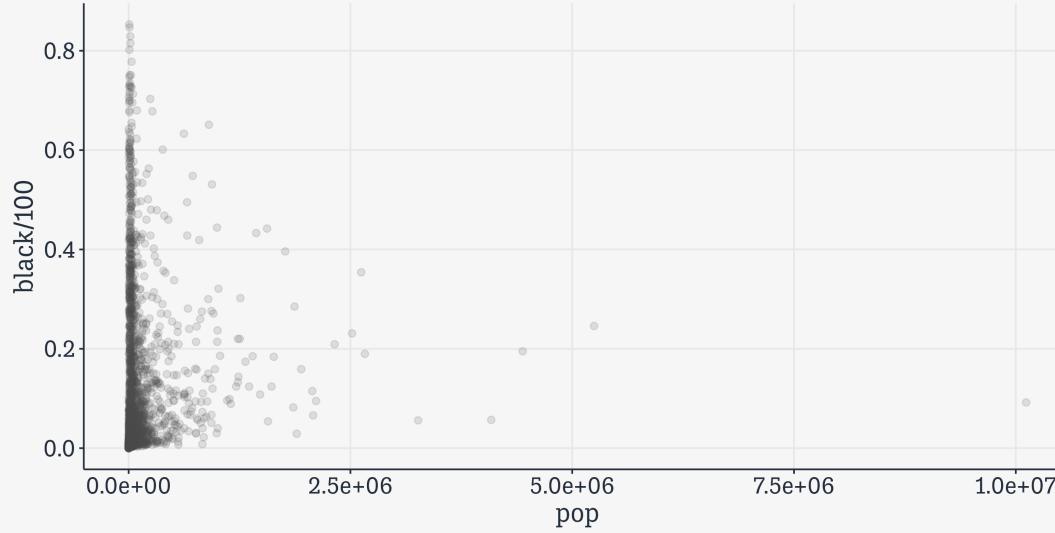
We know how to build this

```
1 # Brighter Blue and Red
2 party_colors ← c("royalblue1", "red2")
3
4 ggplot(data = subset(county_data,
5                     flipped = "No"),
6         mapping = aes(x = pop,
7                     y = black/100))
```



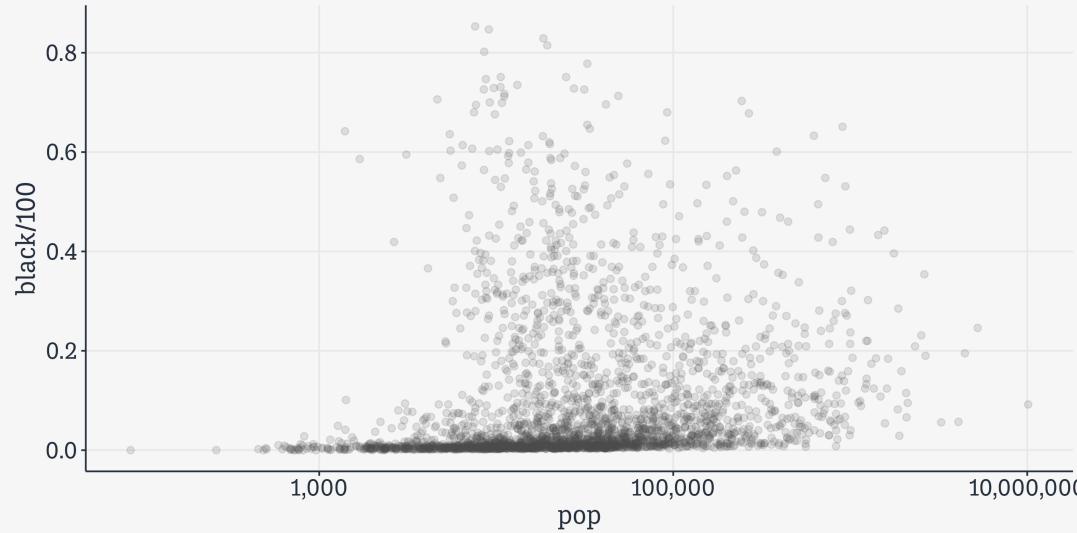
We know how to build this

```
1 # Brighter Blue and Red
2 party_colors ← c("royalblue1", "red2")
3
4 ggplot(data = subset(county_data,
5                   flipped = "No"),
6         mapping = aes(x = pop,
7                         y = black/100)) +
8         geom_point(alpha = 0.15, color = "gray30",
9                     size = rel(2))
```



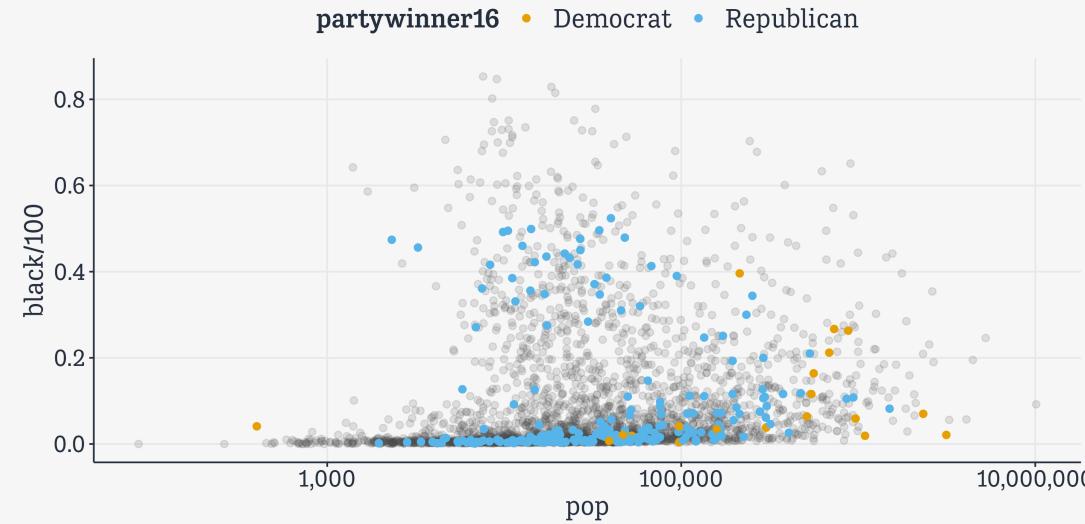
We know how to build this

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1 # Brighter Blue and Red
2 party_colors ← c("royalblue1", "red2")
3
4 ggplot(data = subset(county_data,
5                   flipped = "No"),
6         mapping = aes(x = pop,
7                         y = black/100)) +
8         geom_point(alpha = 0.15, color = "gray30",
9                     size = rel(2)) +
10        scale_x_log10(labels = label_comma())
```



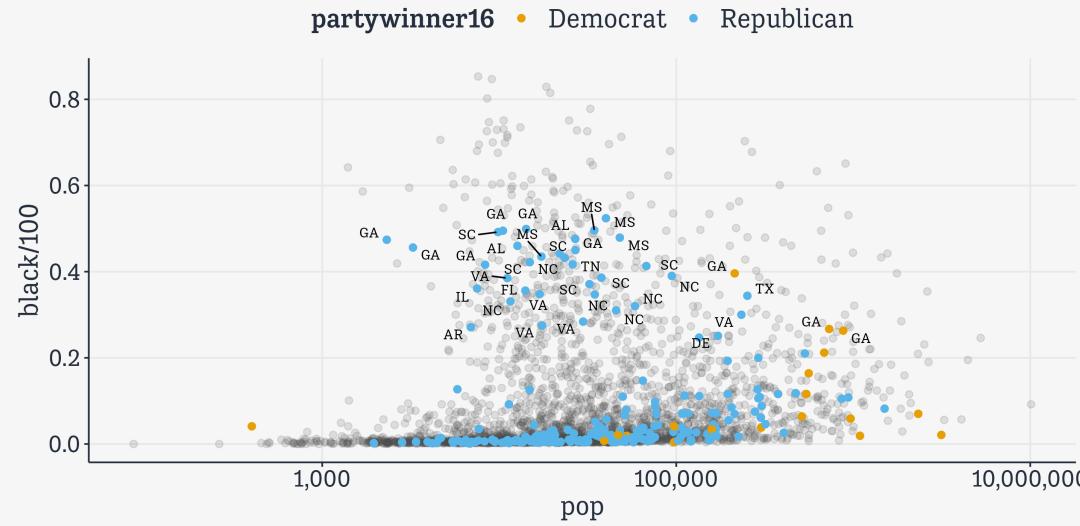
We know how to build this

```
1 # Brighter Blue and Red
2 party_colors ← c("royalblue1", "red2")
3
4 ggplot(data = subset(county_data,
5                   flipped = "No"),
6         mapping = aes(x = pop,
7                        y = black/100)) +
8   geom_point(alpha = 0.15, color = "gray30",
9              size = rel(2)) +
10  scale_x_log10(labels = label_comma()) +
11  geom_point(data = subset(county_data,
12                  flipped = "Yes"),
13             mapping = aes(x = pop, y = black/10
14                           color = partywinner16
15             size = rel(2))
```



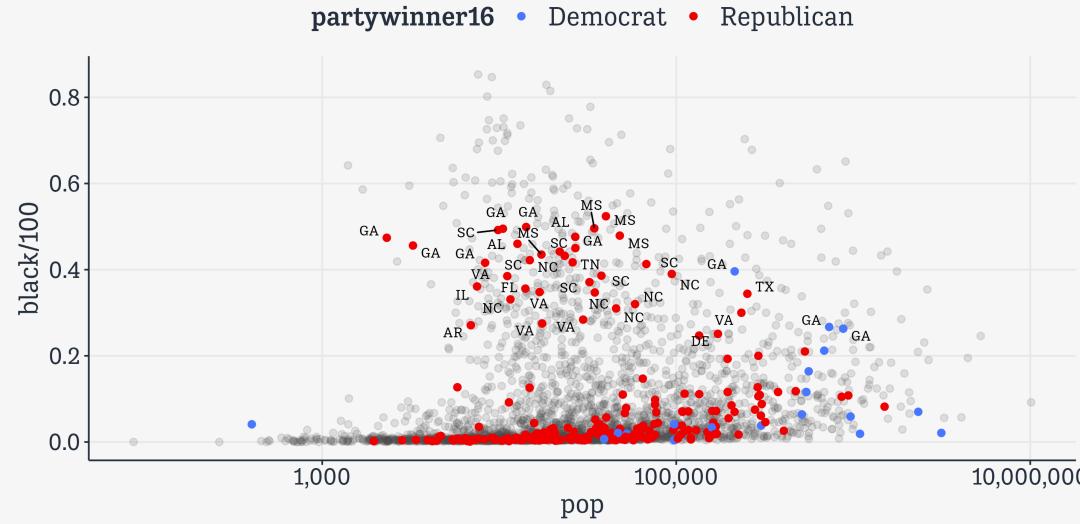
We know how to build this

```
1 # Brighter Blue and Red
2 party_colors ← c("royalblue1", "red2")
3
4 ggplot(data = subset(county_data,
5     flipped = "No"),
6     mapping = aes(x = pop,
7         y = black/100)) +
8     geom_point(alpha = 0.15, color = "gray30",
9         size = rel(2)) +
10    scale_x_log10(labels = label_comma()) +
11    geom_point(data = subset(county_data,
12        flipped = "Yes"),
13        mapping = aes(x = pop, y = black/10
14            color = partywinner16
15            size = rel(2)) +
16    geom_text_repel(data = subset(county_data,
17        flipped = "Yes" & black > 25),
18        mapping = aes(x = pop,
19            y = black/100, label = state
20            family = "Tenso Slides",
21            face = "bold"), size = rel(3
```



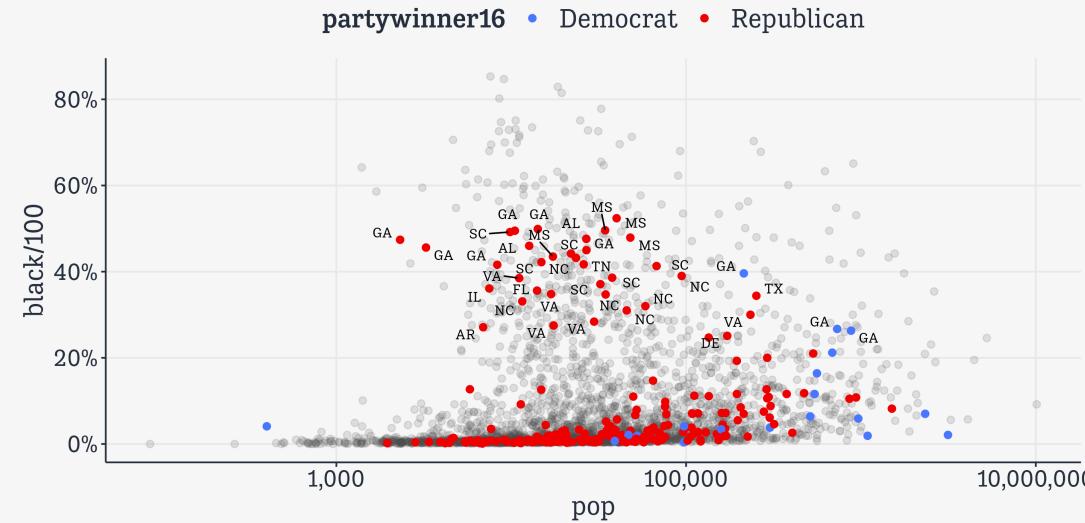
We know how to build this

```
1 # Brighter Blue and Red
2 party_colors ← c("royalblue1", "red2")
3
4 ggplot(data = subset(county_data,
5     flipped = "No"),
6     mapping = aes(x = pop,
7         y = black/100)) +
8     geom_point(alpha = 0.15, color = "gray30",
9         size = rel(2)) +
10    scale_x_log10(labels = label_comma()) +
11    geom_point(data = subset(county_data,
12        flipped = "Yes"),
13        mapping = aes(x = pop, y = black/10
14            color = partywinner16
15            size = rel(2)) +
16    geom_text_repel(data = subset(county_data,
17        flipped = "Yes" & black > 25),
18        mapping = aes(x = pop,
19            y = black/100, label = state
20            family = "Tenso Slide",
21            face = "bold"), size = rel(3
22    scale_color_manual(values = party_colors)
```



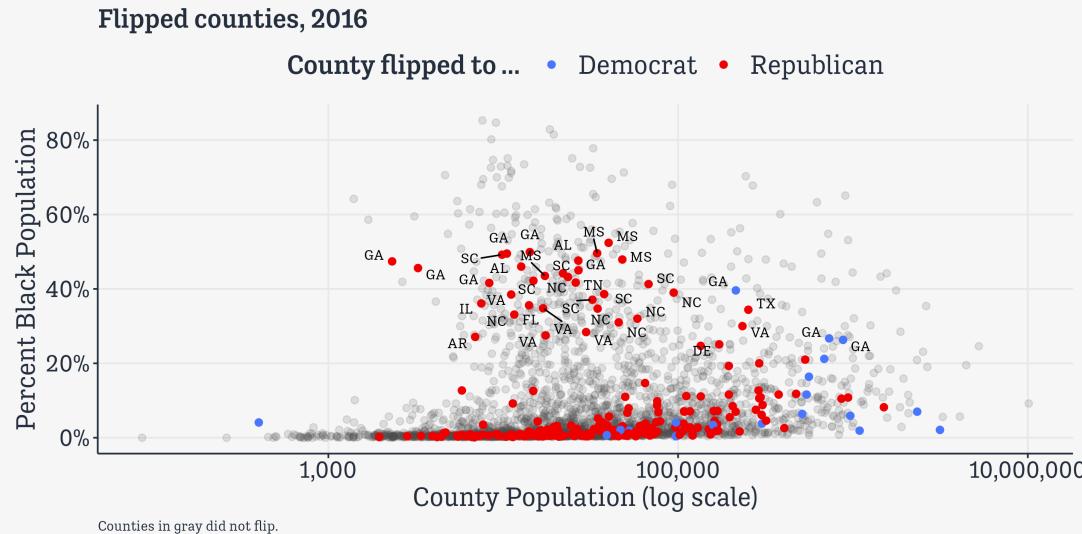
We know how to build this

```
1 # Brighter Blue and Red
2 party_colors ← c("royalblue1", "red2")
3
4 ggplot(data = subset(county_data,
5     flipped = "No"),
6     mapping = aes(x = pop,
7         y = black/100)) +
8     geom_point(alpha = 0.15, color = "gray30",
9         size = rel(2)) +
10    scale_x_log10(labels = label_comma()) +
11    geom_point(data = subset(county_data,
12        flipped = "Yes"),
13        mapping = aes(x = pop, y = black/10
14            color = partywinner16
15            size = rel(2)) +
16    geom_text_repel(data = subset(county_data,
17        flipped = "Yes" & black > 25,
18        mapping = aes(x = pop,
19            y = black/100, label = state
20            family = "Tenso Slide",
21            face = "bold"), size = rel(3
22    scale_color_manual(values = party_colors) +
23    scale_y_continuous(labels = label_percent())
```



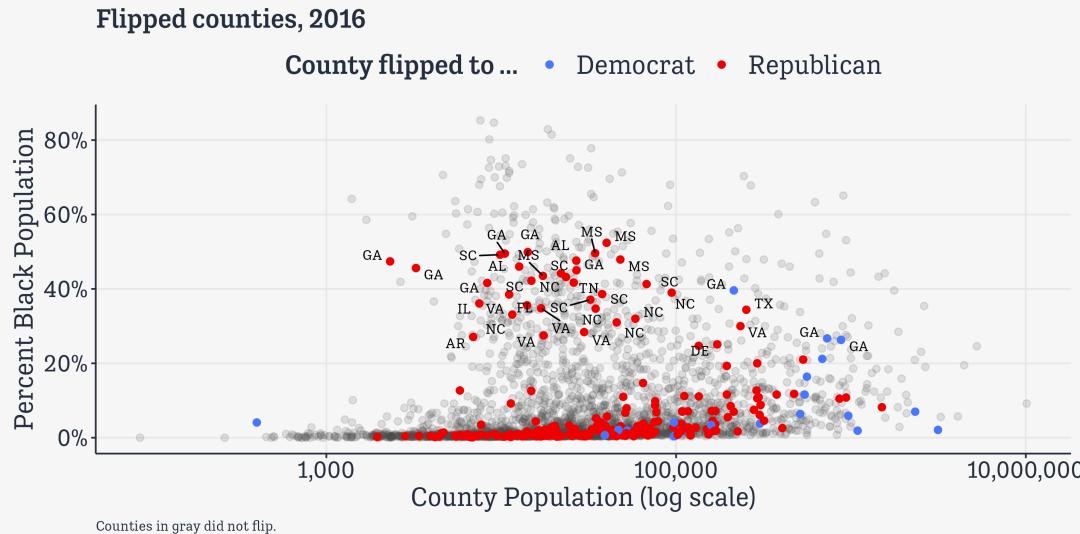
We know how to build this

```
1 # Brighter Blue and Red
2 party_colors <- c("royalblue1", "red2")
3
4 ggplot(data = subset(county_data,
5     flipped = "No"),
6     mapping = aes(x = pop,
7         y = black/100)) +
8     geom_point(alpha = 0.15, color = "gray30",
9         size = rel(2)) +
10    scale_x_log10(labels = label_comma()) +
11    geom_point(data = subset(county_data,
12        flipped = "Yes"),
13        mapping = aes(x = pop, y = black/10
14            color = partywinner16
15            size = rel(2)) +
16    geom_text_repel(data = subset(county_data,
17        flipped = "Yes" & black > 25),
18        mapping = aes(x = pop,
19            y = black/100, label = state
20            family = "Tenso Slide",
21            face = "bold"), size = rel(3
22    scale_color_manual(values = party_colors) +
23    scale_y_continuous(labels = label_percent()) +
24    labs(color = "County flipped to ... ",
25        x = "County Population (log scale)",
26        y = "Percent Black Population",
27        title = "Flipped counties, 2016",
28        caption = "Counties in gray did not flip.
```



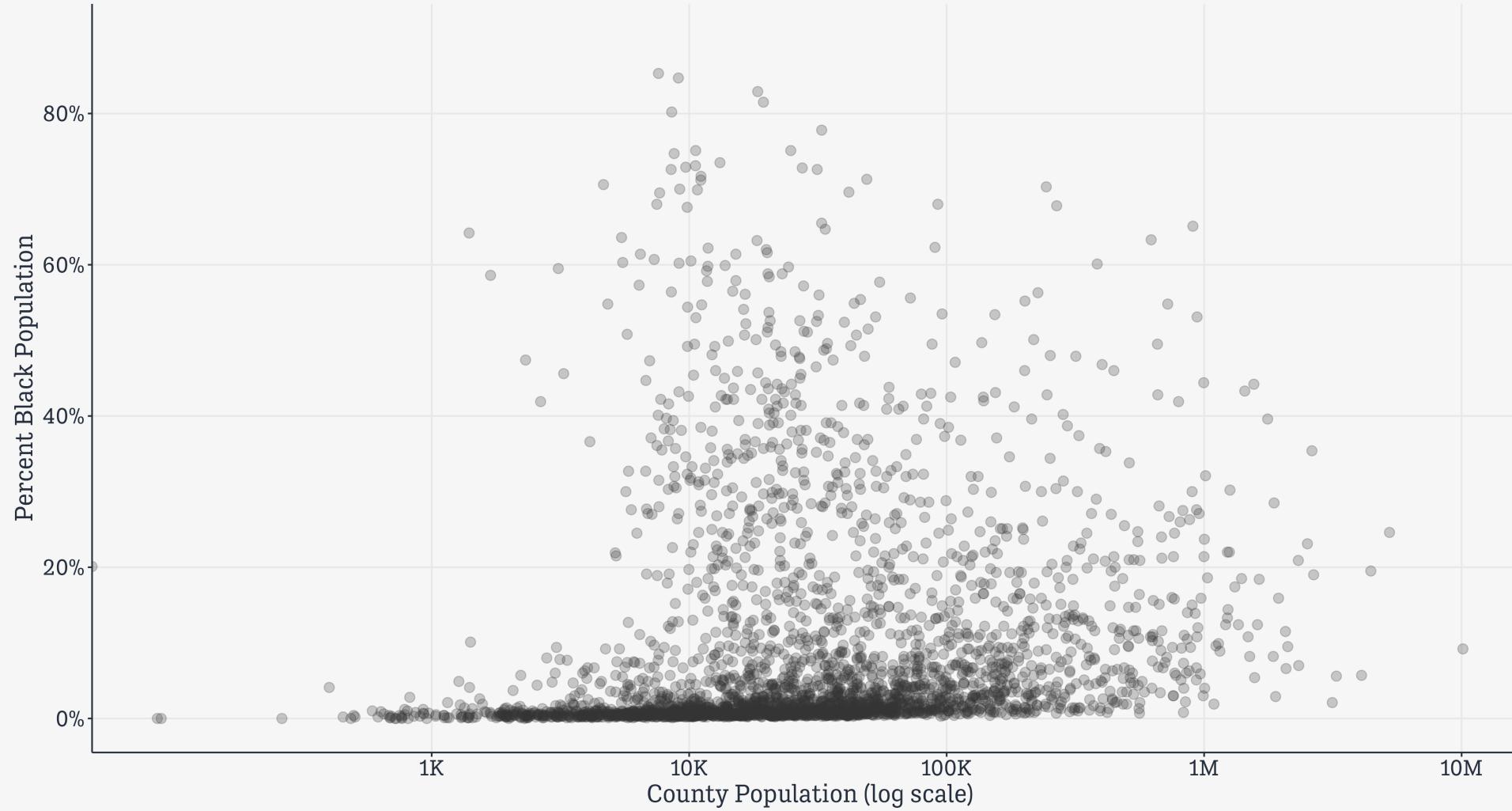
We know how to build this

```
1 # Brighter Blue and Red
2 party_colors <- c("royalblue1", "red2")
3
4 ggplot(data = subset(county_data,
5     flipped = "No"),
6     mapping = aes(x = pop,
7         y = black/100)) +
8     geom_point(alpha = 0.15, color = "gray30",
9         size = rel(2)) +
10    scale_x_log10(labels = label_comma()) +
11    geom_point(data = subset(county_data,
12        flipped = "Yes"),
13        mapping = aes(x = pop, y = black/10
14            color = partywinner16
15            size = rel(2)) +
16    geom_text_repel(data = subset(county_data,
17        flipped = "Yes" & black > 25),
18        mapping = aes(x = pop,
19            y = black/100, label = state
20            family = "Tenso Slide",
21            face = "bold"), size = rel(3
22    scale_color_manual(values = party_colors) +
23    scale_y_continuous(labels = label_percent()) +
24    labs(color = "County flipped to ... ",
25        x = "County Population (log scale)",
26        y = "Percent Black Population",
27        title = "Flipped counties, 2016",
28        caption = "Counties in gray did not flip.
```

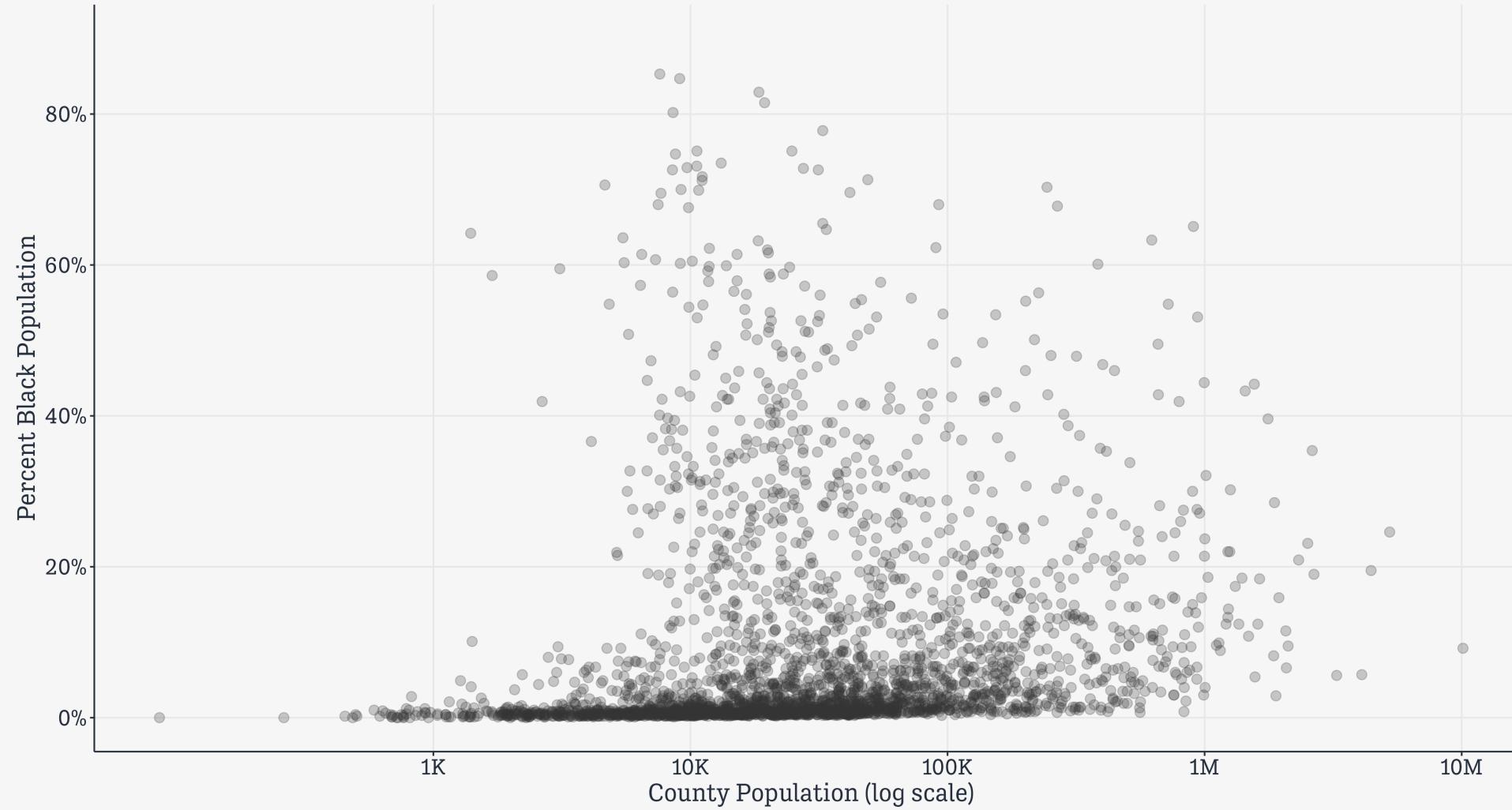


Leverage ggplot's
layered approach

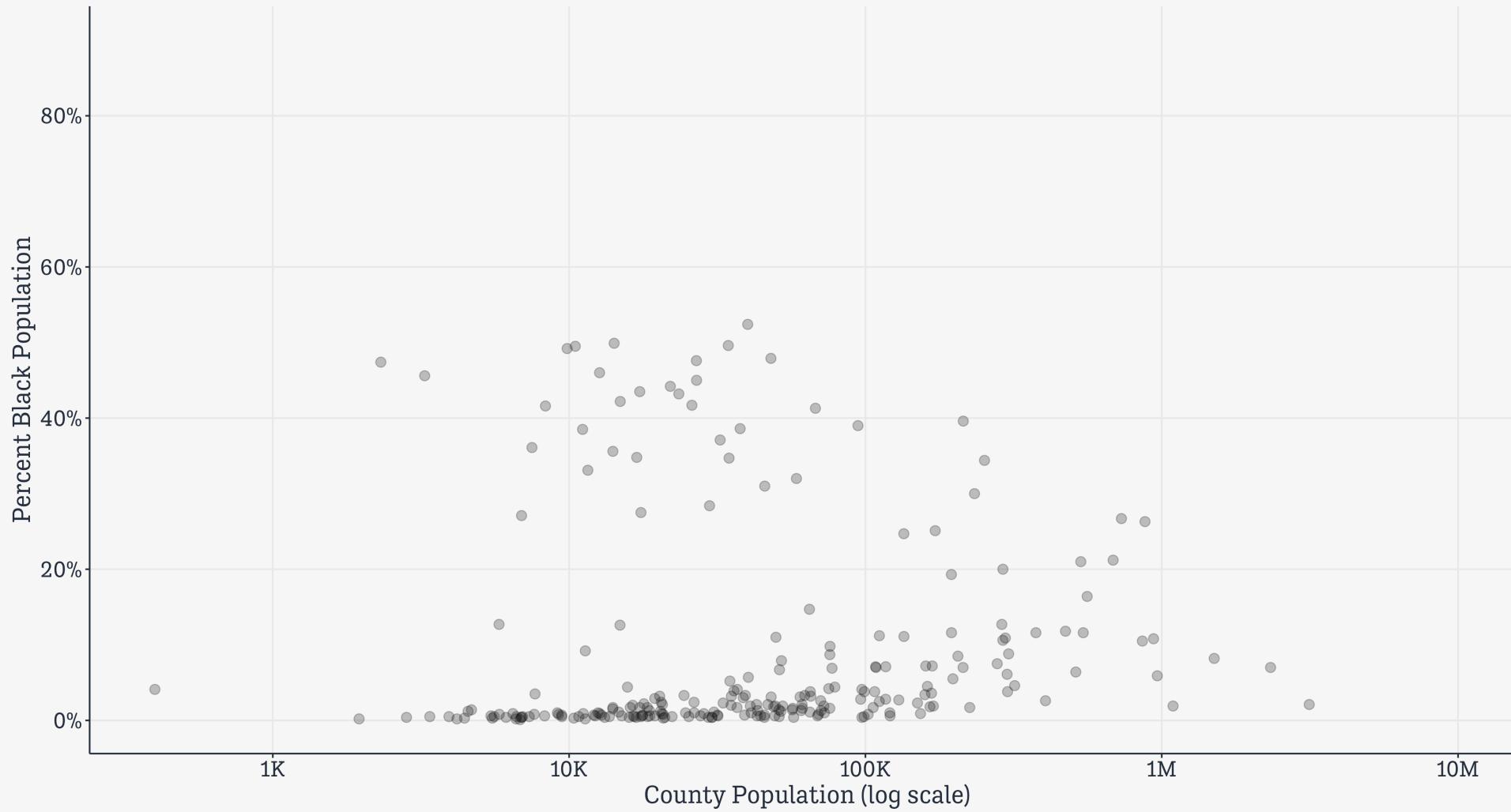
U.S. Counties by Population and Percent Black



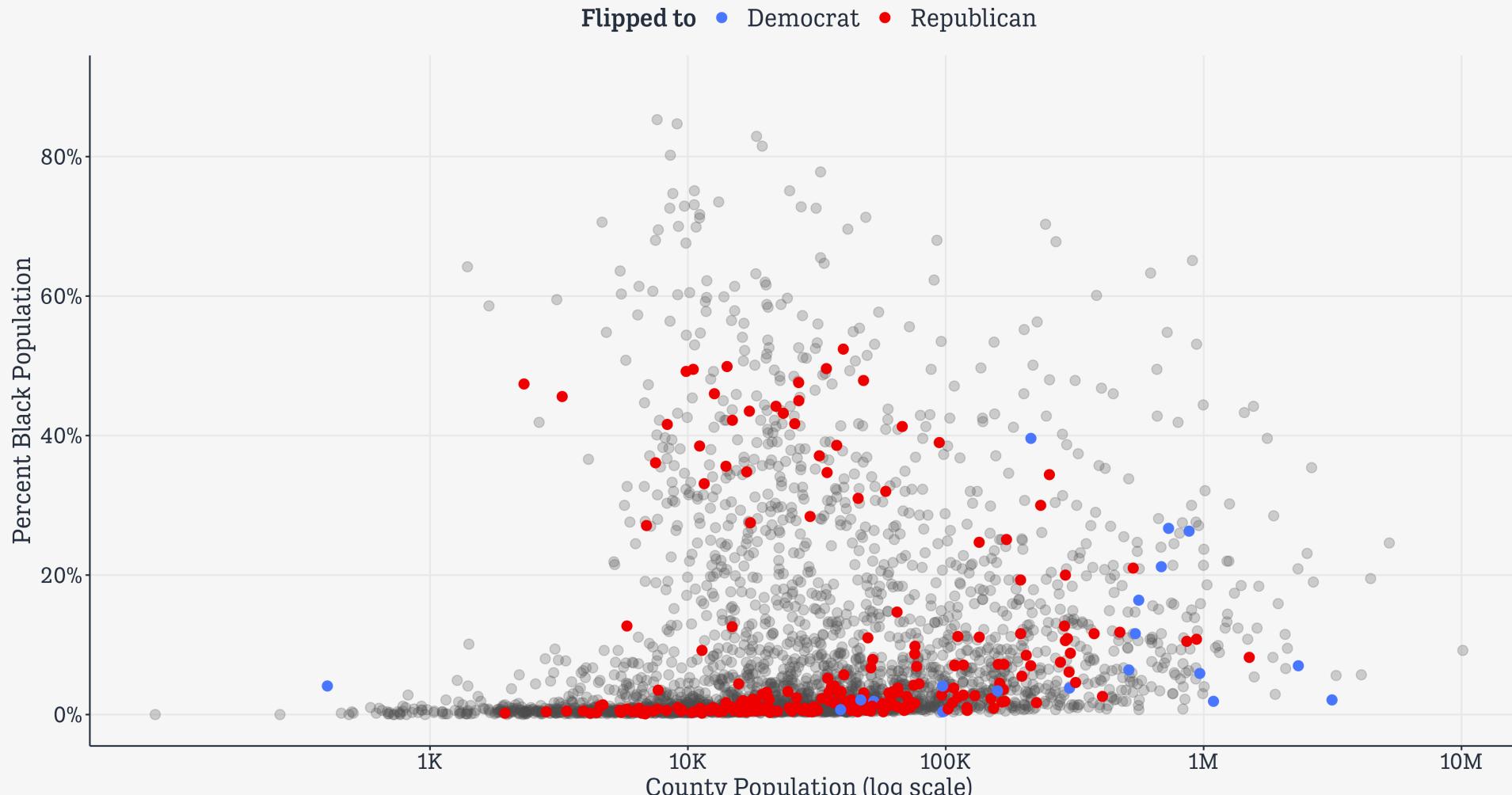
These counties did not flip in 2016



These counties did



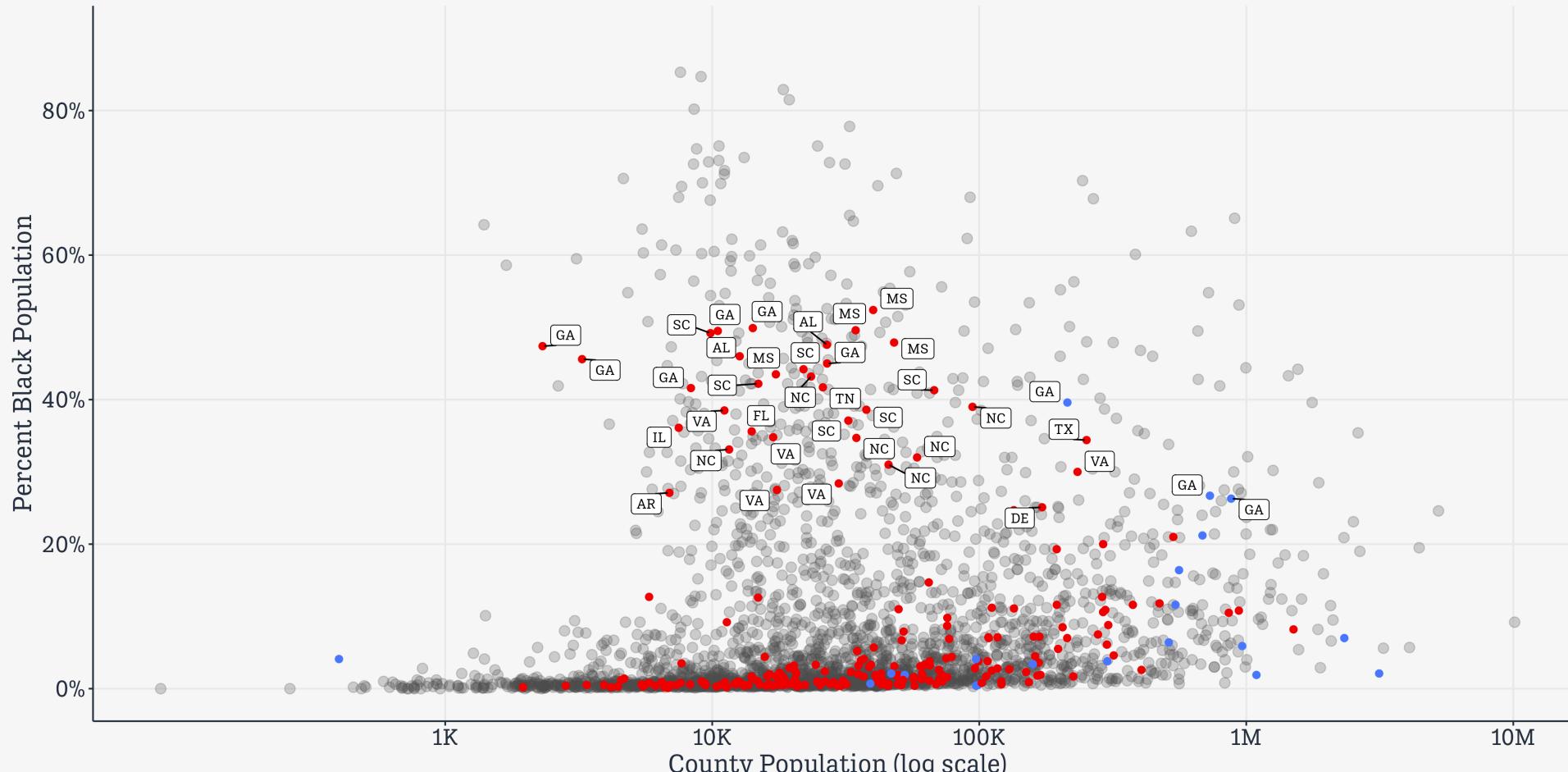
Counties that flipped shown by party color



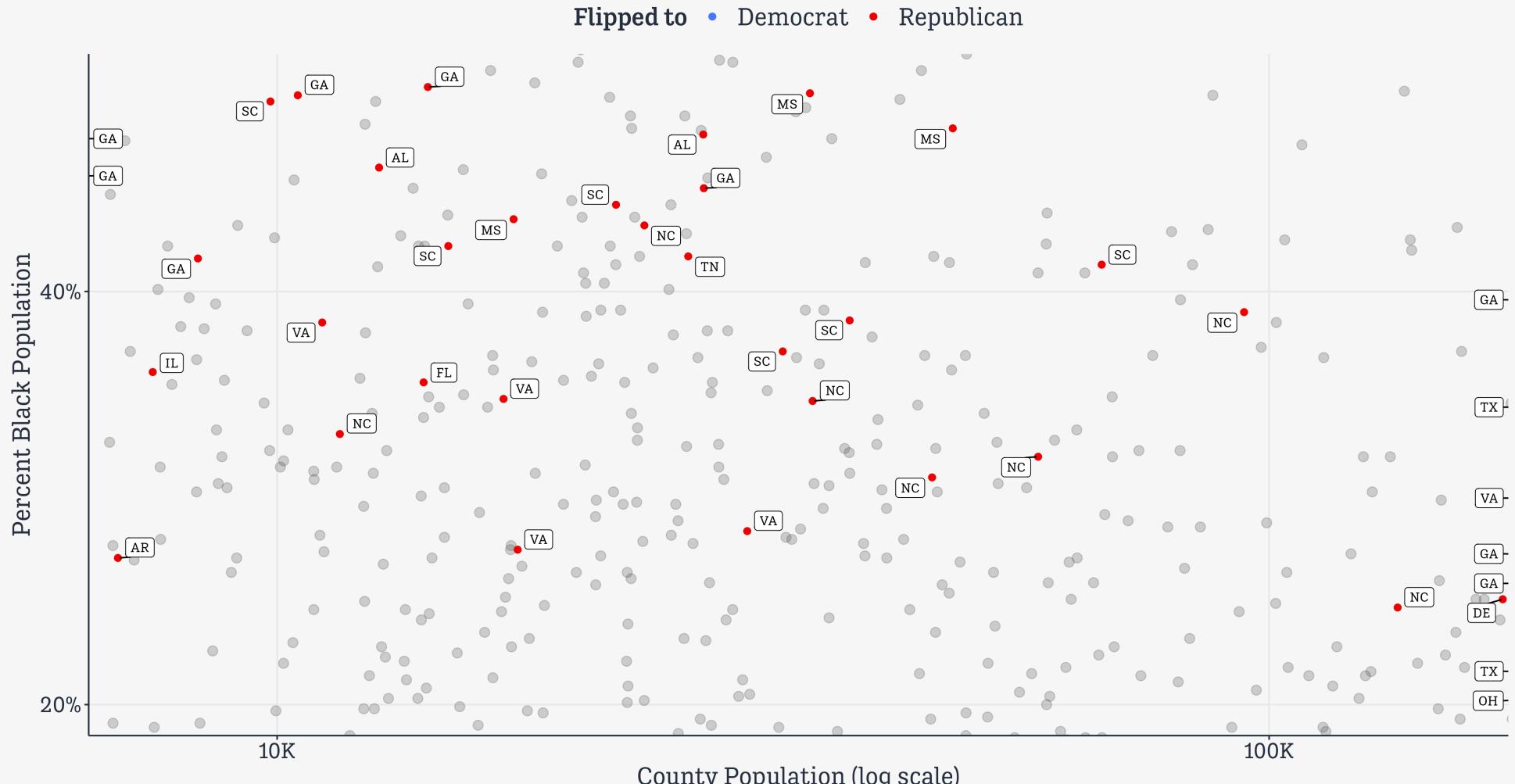
Counties in gray did not flip.

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

Flipped to • Democrat • Republican



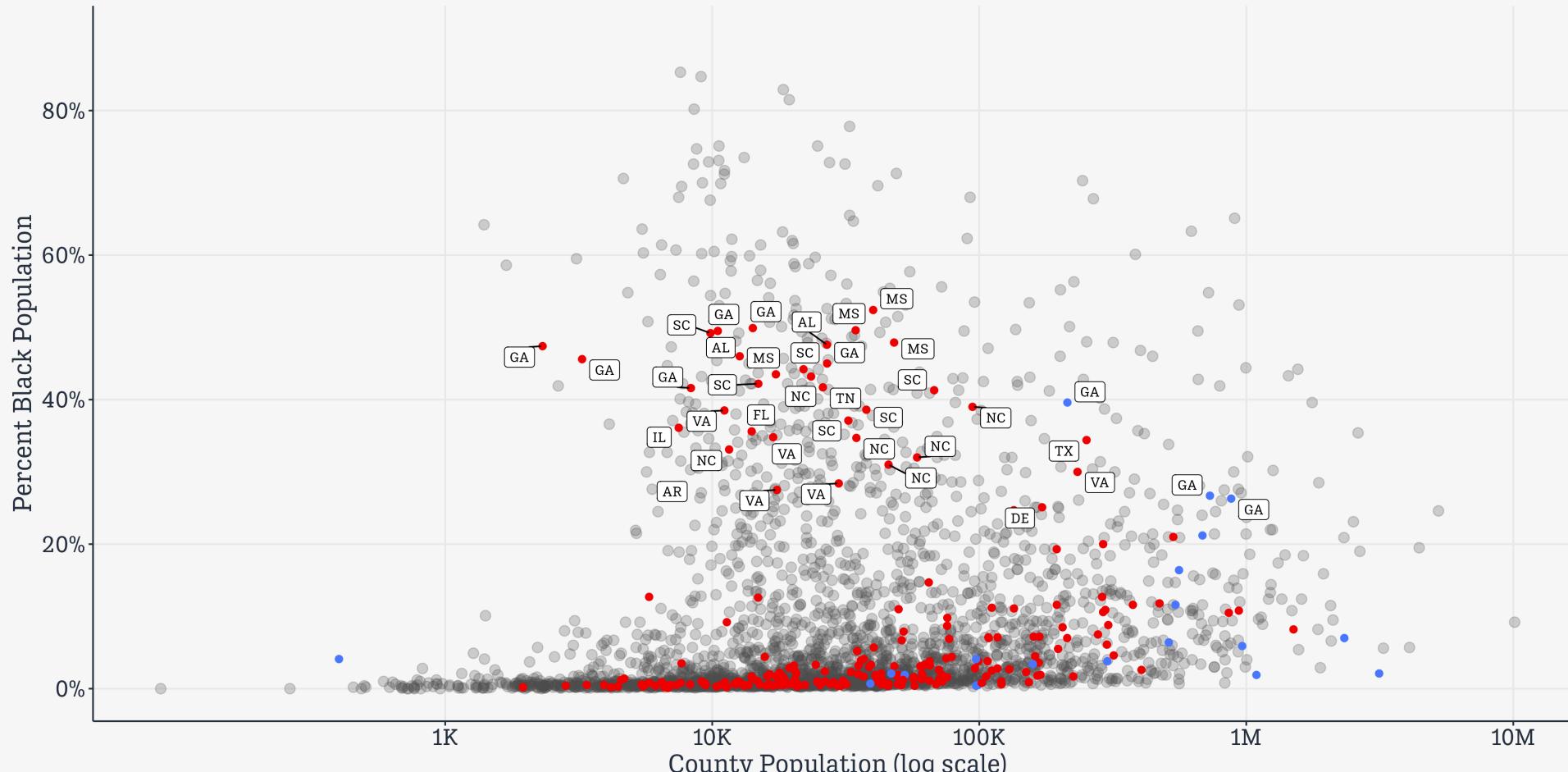
Counties that flipped shown by party color, and labeled by state; zoomed-in



Counties in gray did not flip.

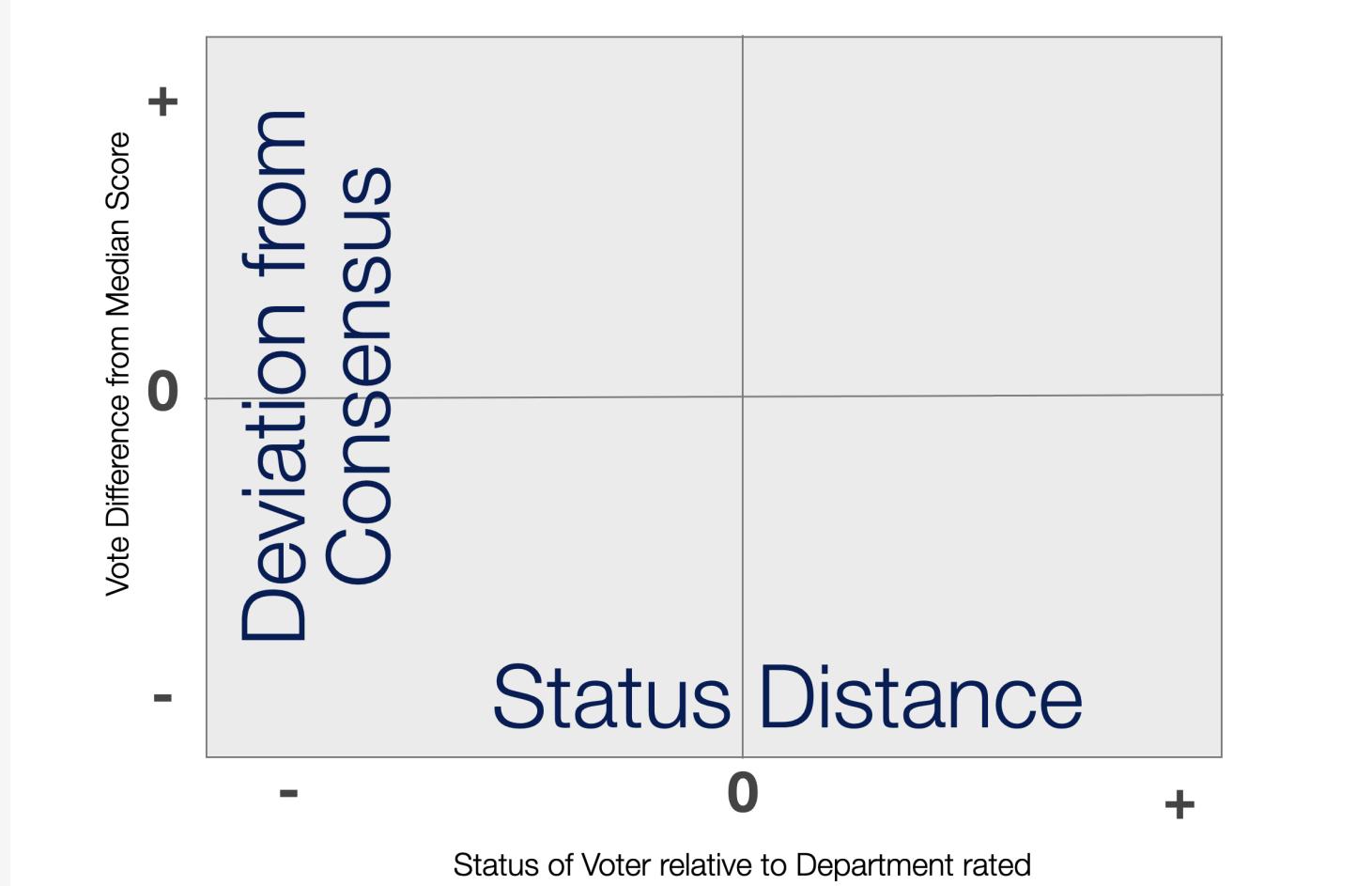
Counties that flipped shown by party color, and labeled by state

Flipped to • Democrat • Republican



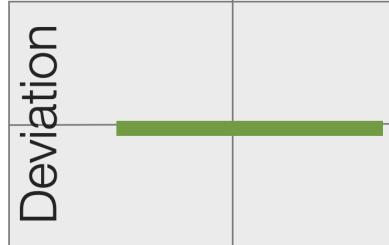
Layer,
Highlight,
Repeat

Build from ideas to data

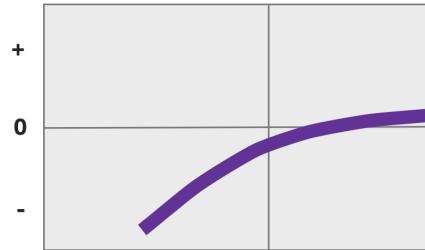


The relationship of interest

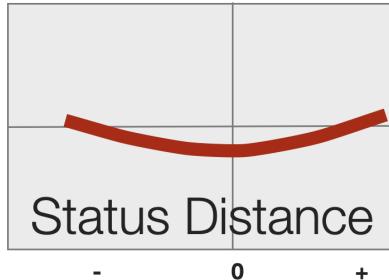
Build from ideas to data



1. Pure Objectivity



2. Distant Envy

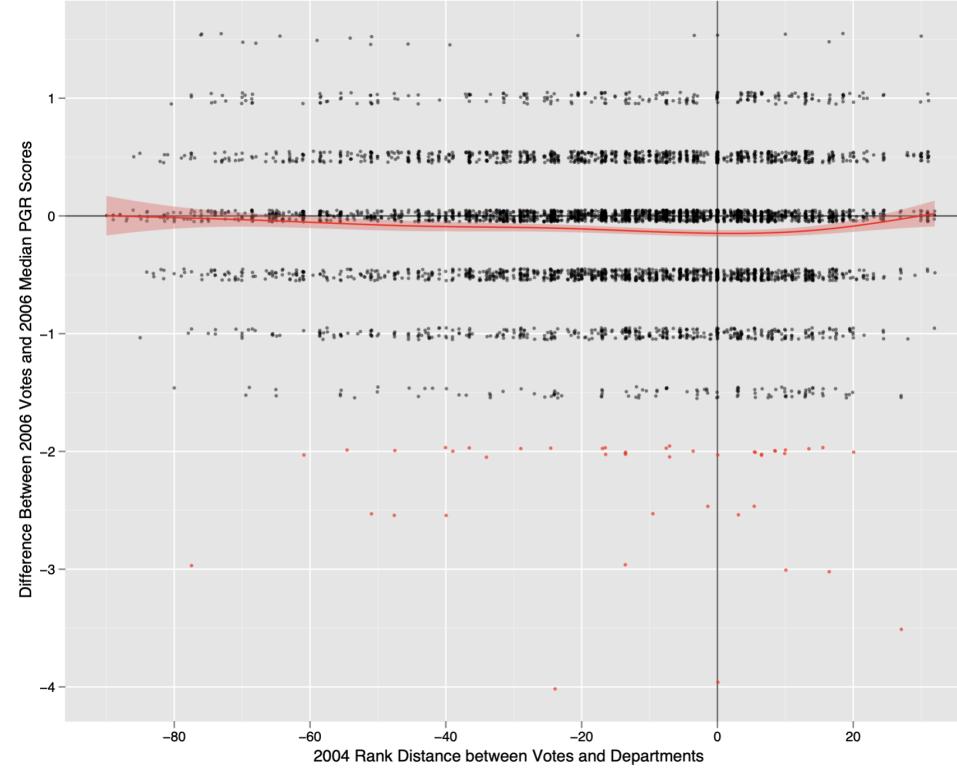


3. Local Competition

Theory says ...

Build from ideas to data

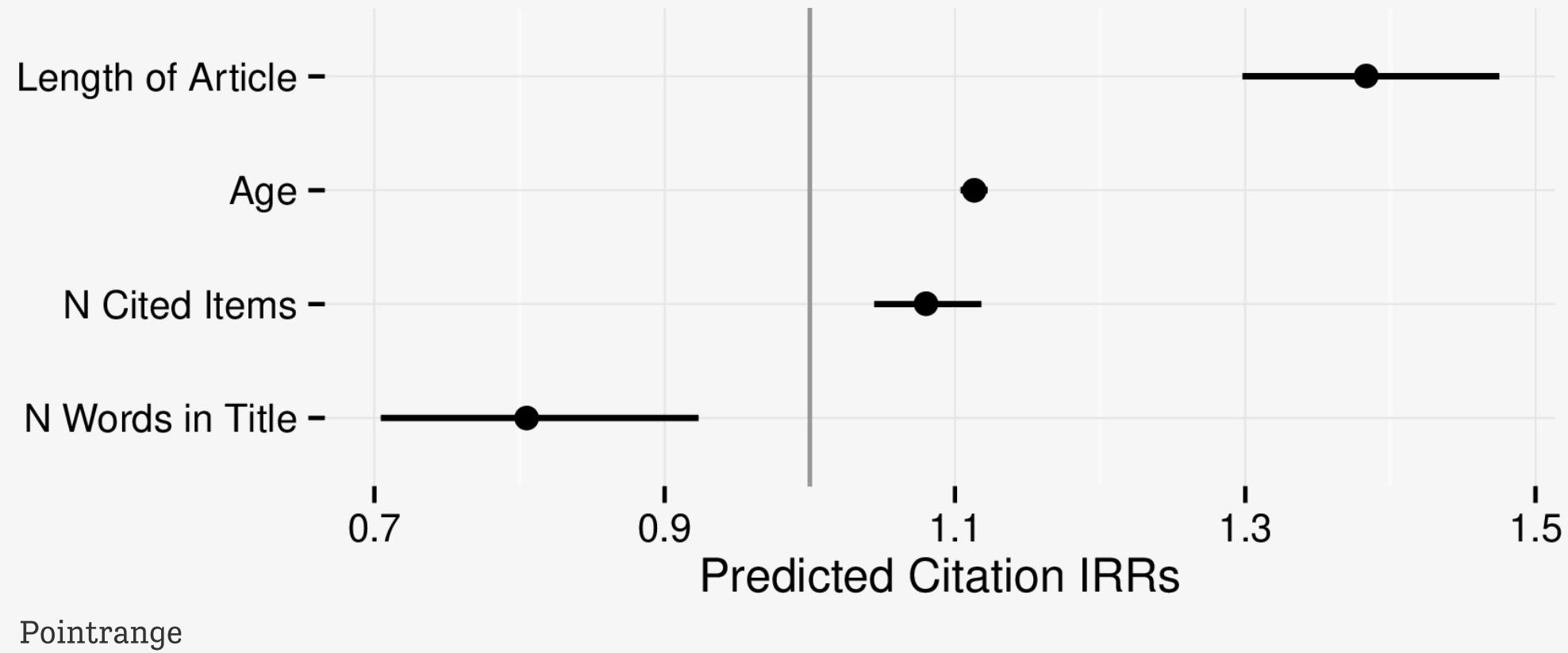
Deviation



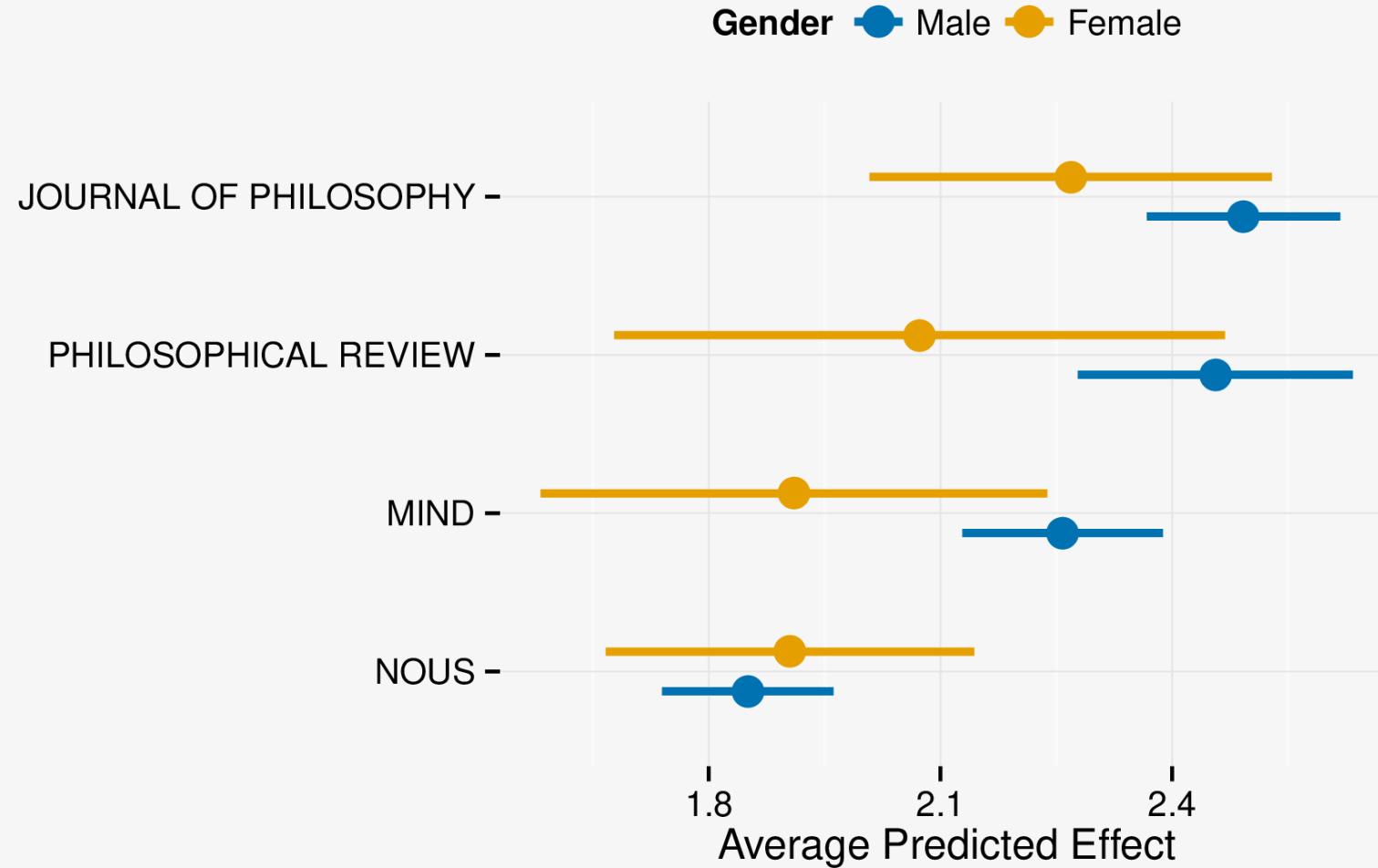
Status Distance

Data suggests ...

Repeat to differentiate

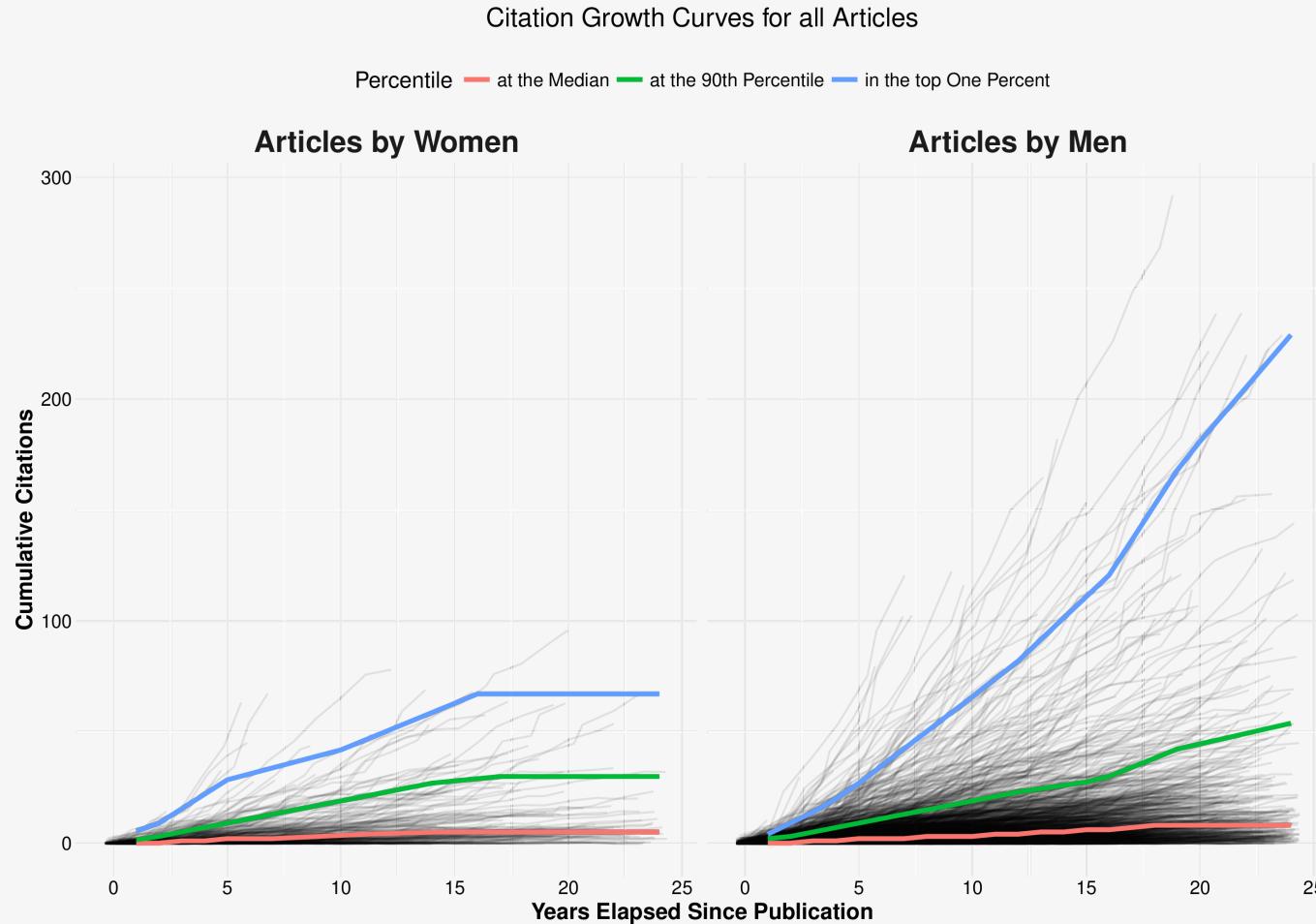


Repeat to differentiate



Add a comparison group

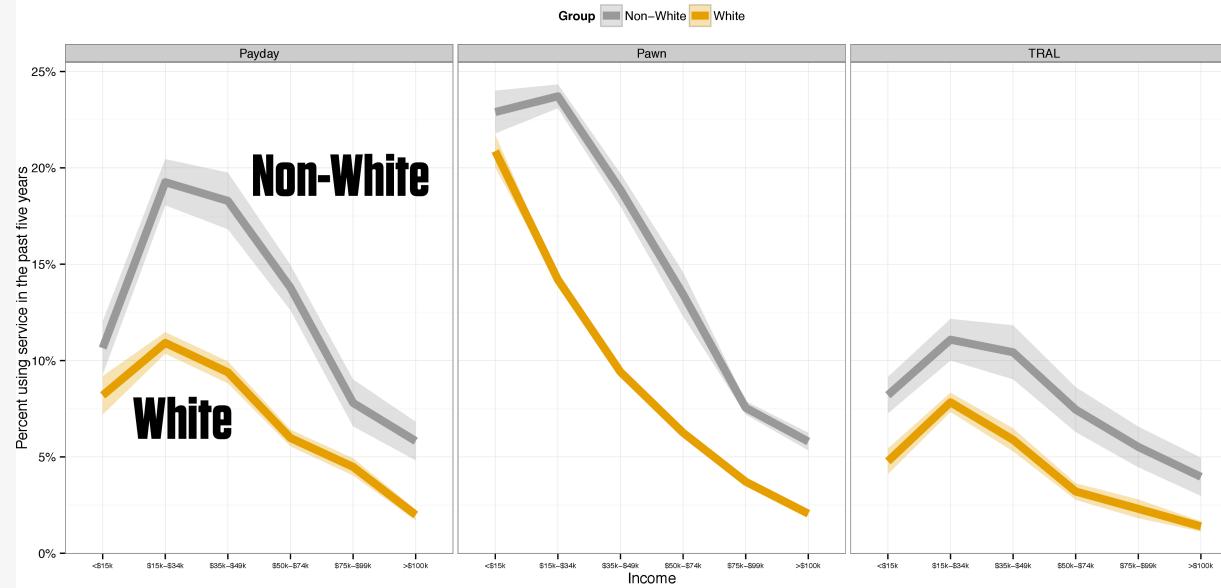
Layer and repeat with facets



Compare across facets

Layer and repeat across facets

Categorical Gaps: Alternative Financial Services



Payday Loan

Pawn Shop

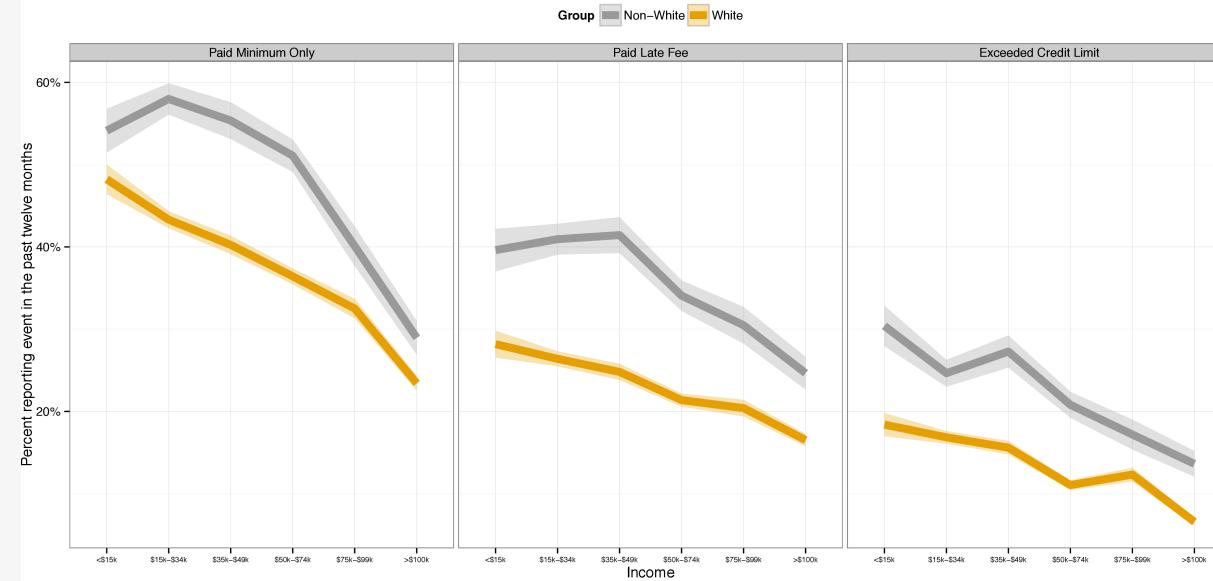
TRAL

8

Layer to compare

Layer and repeat across facets

Categorical Gaps: Adverse Credit Events



Minimum Only

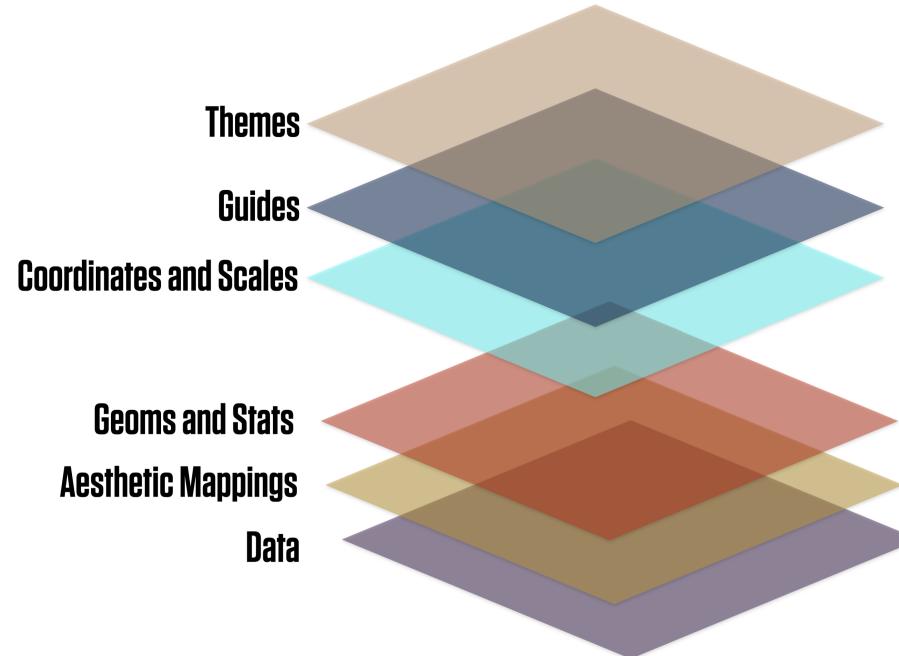
Late Fee

Over Limit

9

Layer to compare

X-Ray Vision



Seeing through it

Themes

Themes ...

are controlled by the `theme()` function

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

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

make changes that are applied *additively*

and most importantly ...

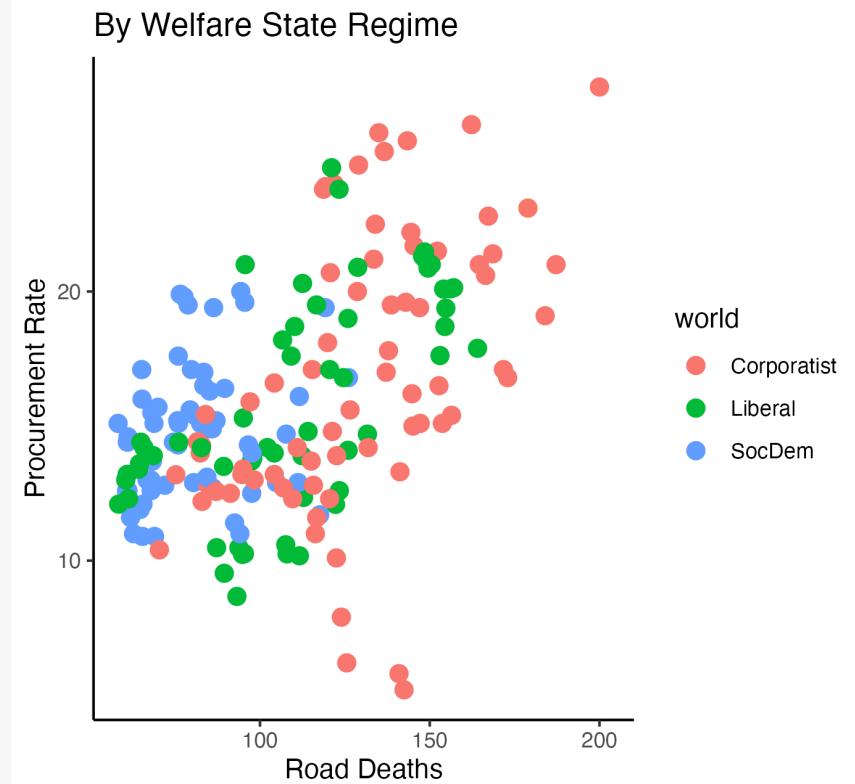
Thematic
elements do not
represent data
directly

Make a plot

```
kjh_set_classic_theme(3)
```

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

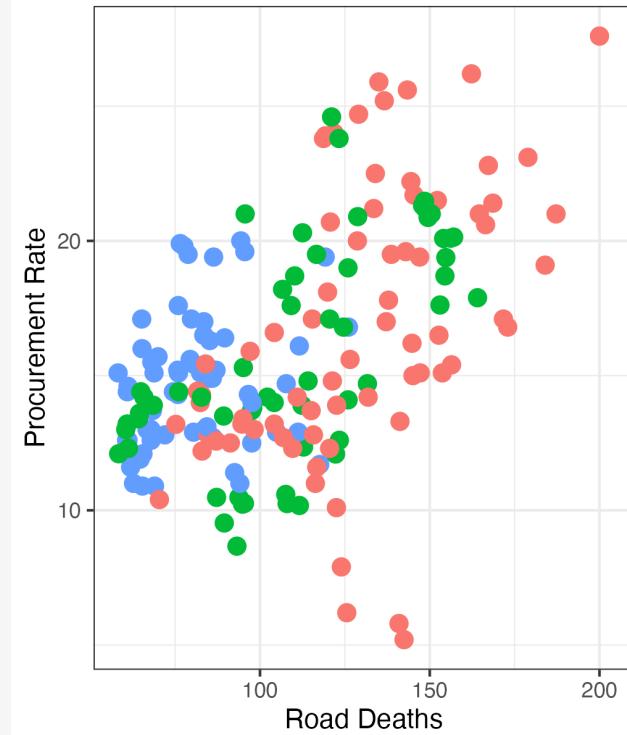
```
p
```



Add a theme ... `theme_bw()`

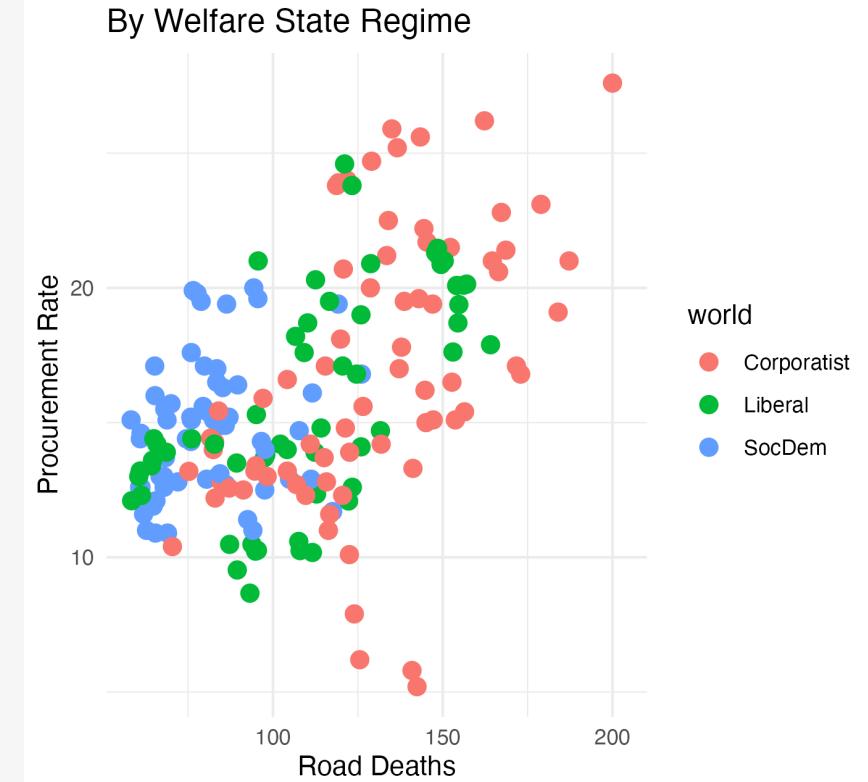
```
p + theme_bw()
```

By Welfare State Regime



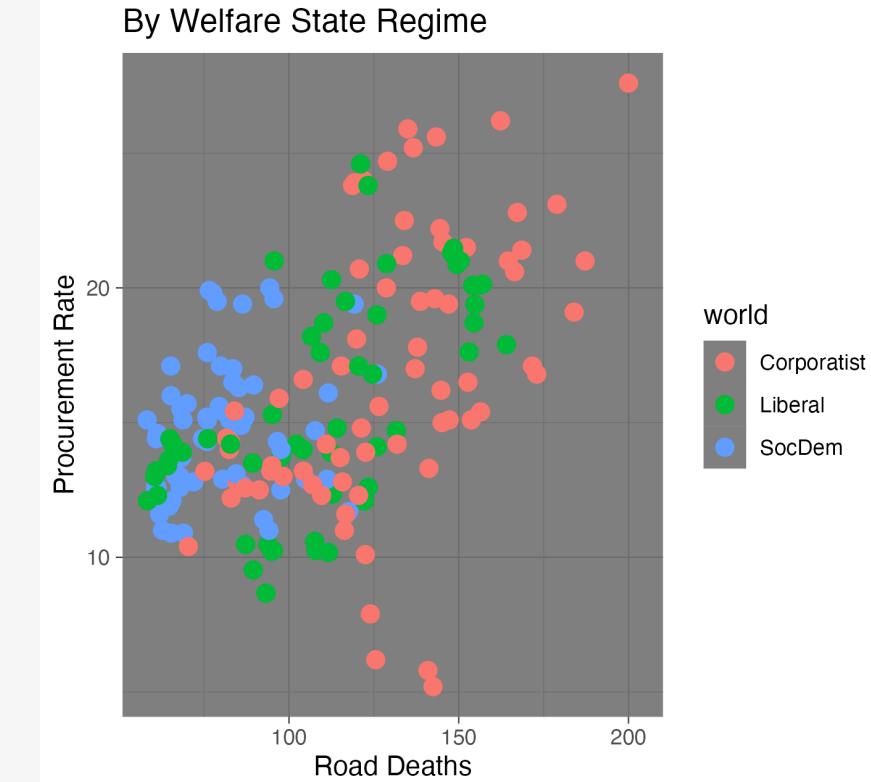
Add a theme ... `theme_minimal()`

```
p + theme_minimal()
```



Add a theme ... `theme_dark()`

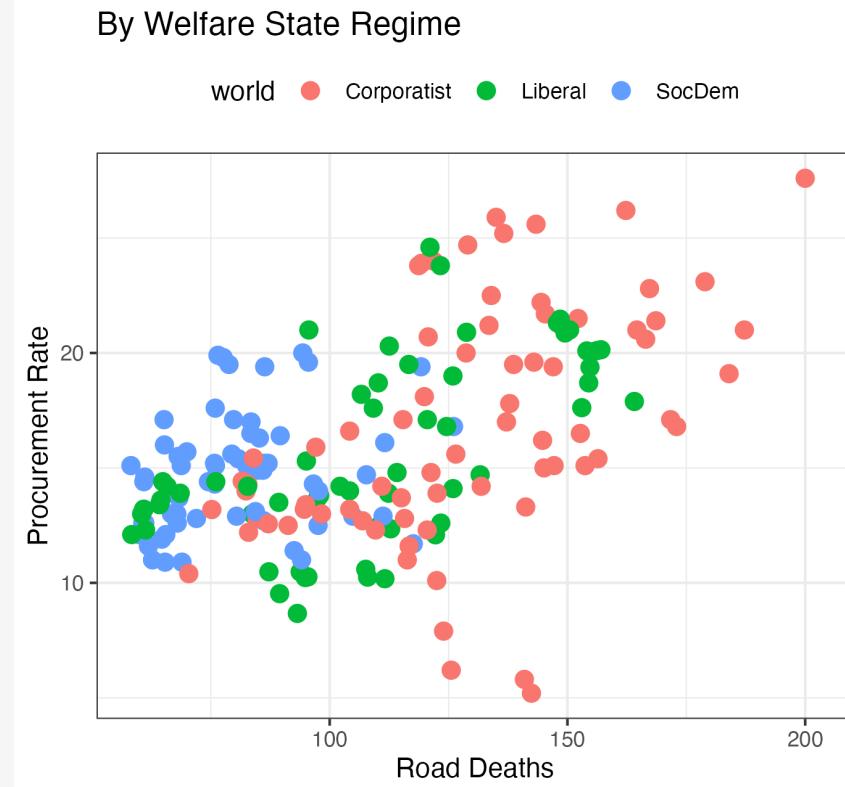
```
p + theme_dark()
```



Adjust with the `theme()` function

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

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



There are *many* theme elements

line rect text title aspect.ratio

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

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

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

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

But they are structured

```
line rect text title aspect.ratio  
  
axis.title axis.title.x axis.title.x.top axis.title.x.bottom  
axis.title.y axis.title.y.left axis.title.y.right axis.text  
axis.text.x axis.text.x.top axis.text.x.bottom axis.text.y  
axis.text.y.left axis.text.y.right axis.ticks axis.ticks.x  
axis.ticks.x.top axis.ticks.x.bottom axis.ticks.y  
axis.ticks.y.left axis.ticks.y.right axis.ticks.length  
axis.ticks.length.x axis.ticks.length.x.top  
axis.ticks.length.x.bottom axis.ticks.length.y  
axis.ticks.length.y.left axis.ticks.length.y.right axis.line  
axis.line.x axis.line.x.top axis.line.x.bottom axis.line.y  
axis.line.y.left axis.line.y.right  
  
legend.background legend.margin legend.spacing  
    legend.spacing.x legend.spacing.y legend.key  
legend.key.size legend.key.height legend.key.width  
    legend.text legend.text.align legend.title  
legend.title.align legend.position legend.direction  
    legend.justification legend.box legend.box.just  
    legend.box.margin legend.box.background  
        legend.box.spacing  
  
panel.background panel.border panel.spacing  
    panel.spacing.x panel.spacing.y panel.grid  
panel.grid.major panel.grid.minor panel.grid.major.x  
    panel.grid.major.y panel.grid.minor.x  
        panel.grid.minor.y panel.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.on top

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

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

Two kinds of adjustment

It's a single setting.

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

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

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

If the latter ...

If adjusting a thematic element ask...

Where on the plot is it?

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

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

You want `axis.ticks.x`

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

You want `panel.grid.major.y`

If adjusting a thematic element, ask...

What *kind* of element is it?

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”

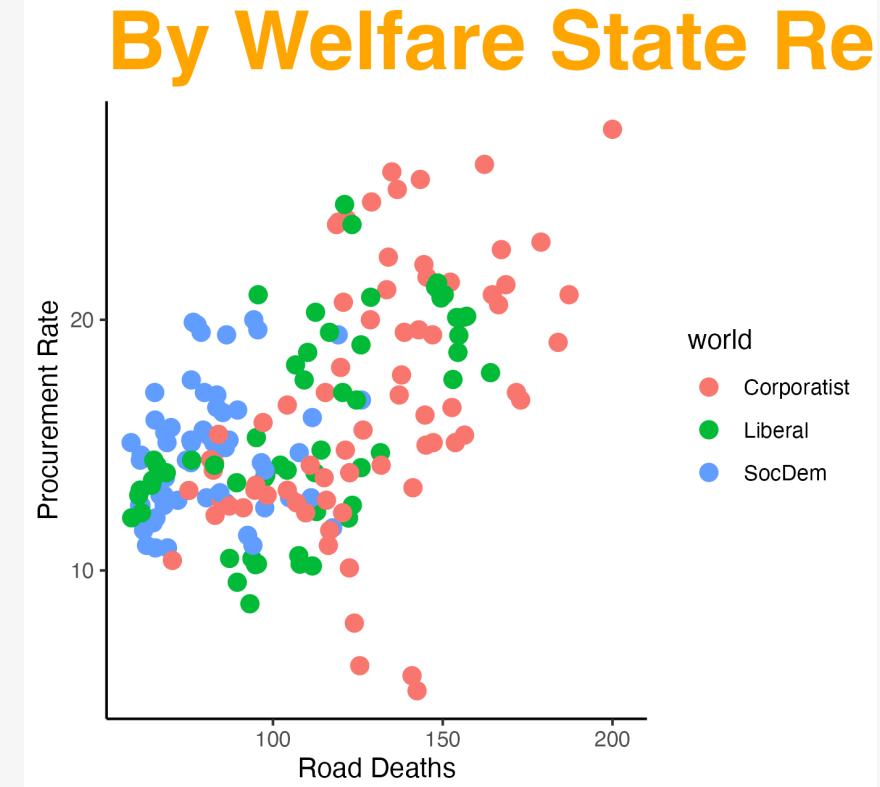
The relevant element is `plot.title`.

It's *text*.

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

For example ...

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



For example ...

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

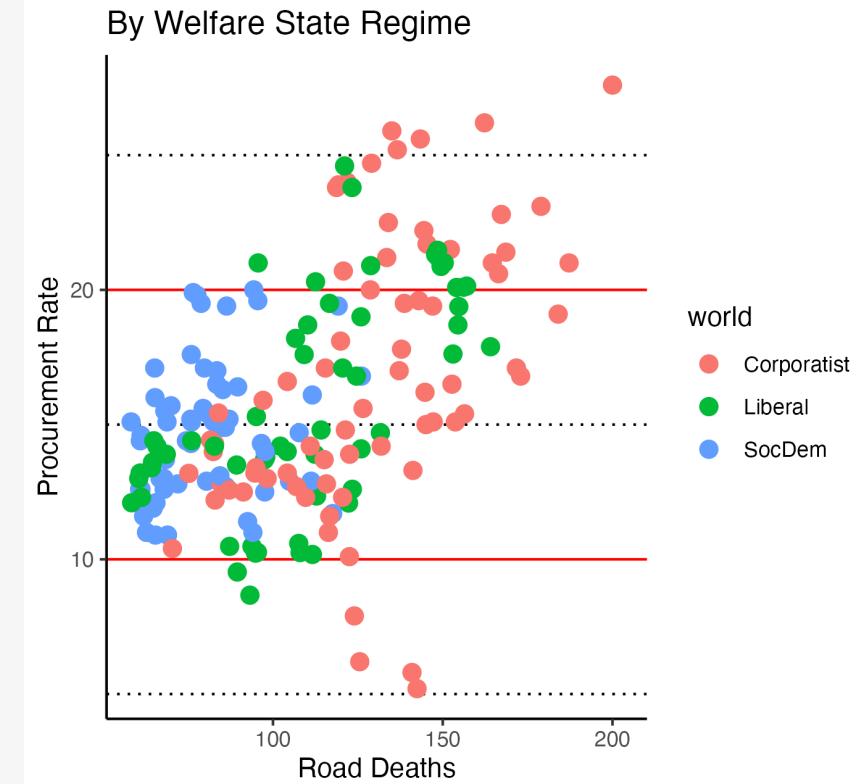
The relevant elements are `panel.grid.major.y` and `panel.grid.minor.y`.

These are *lines*.

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

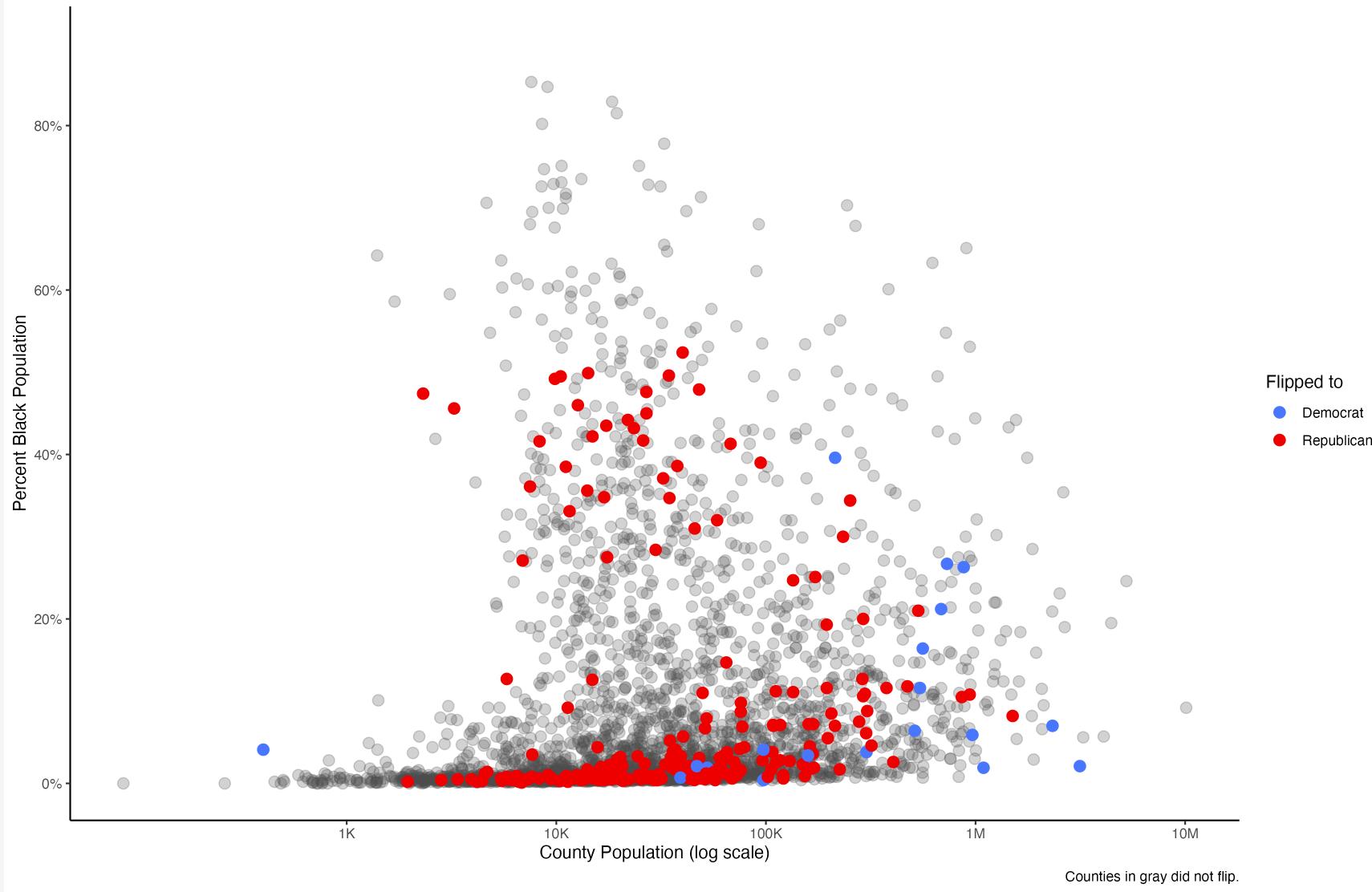
For example ...

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



The ggthemes package

Counties that flipped shown by party color



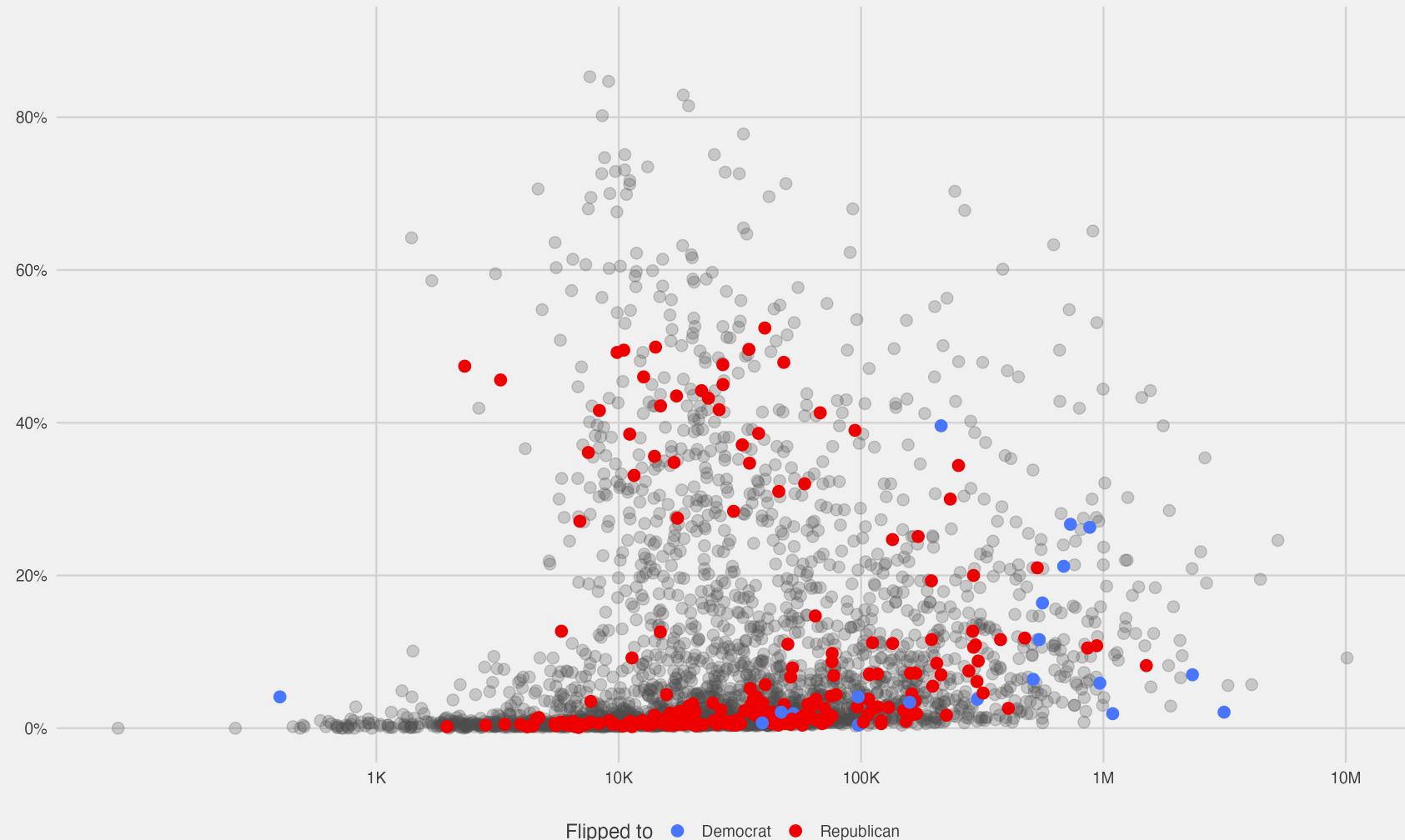
We made this earlier. Here it is in a default theme.

Theming a plot

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

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

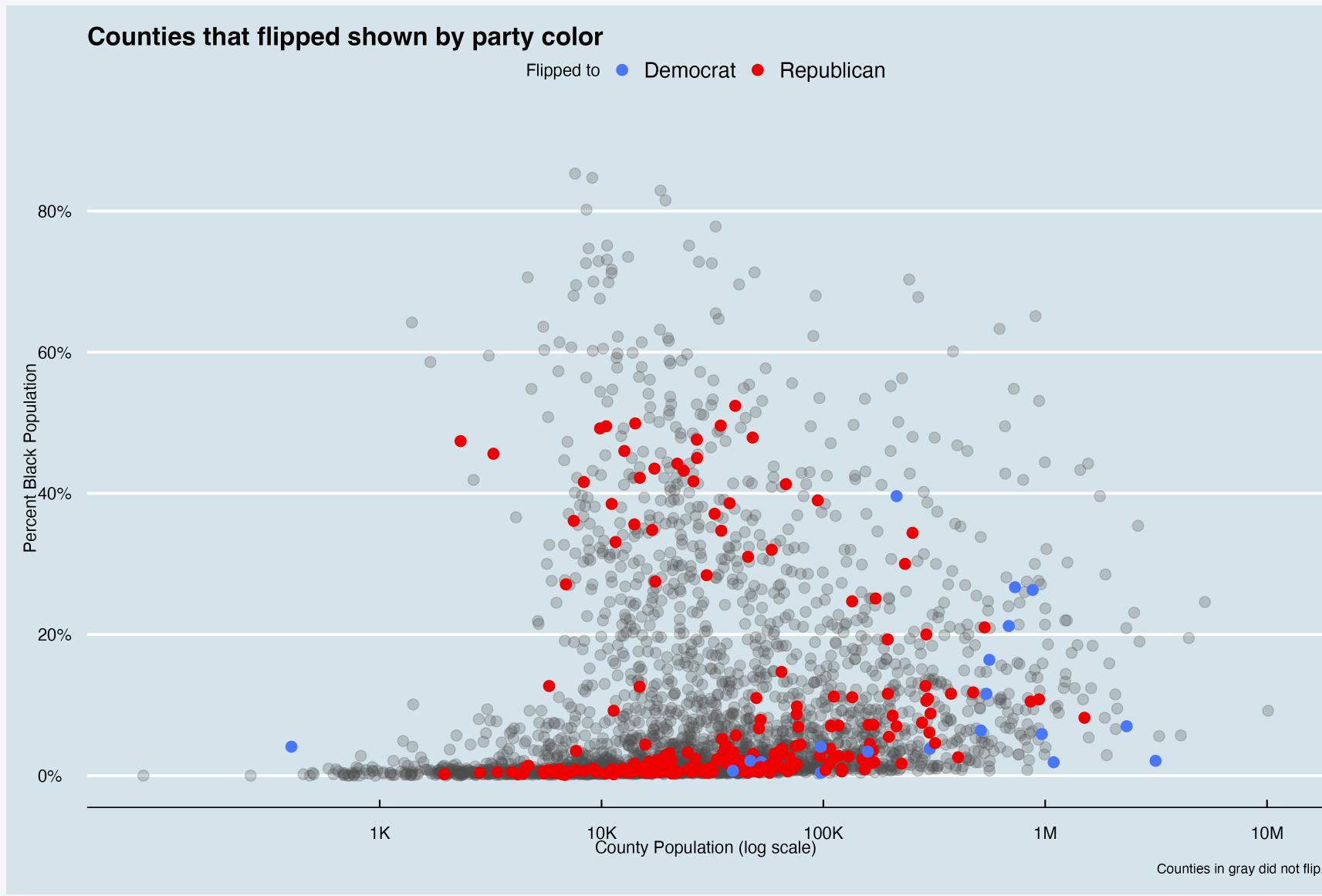
Counties that flipped shown by party color



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

Theming a plot

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

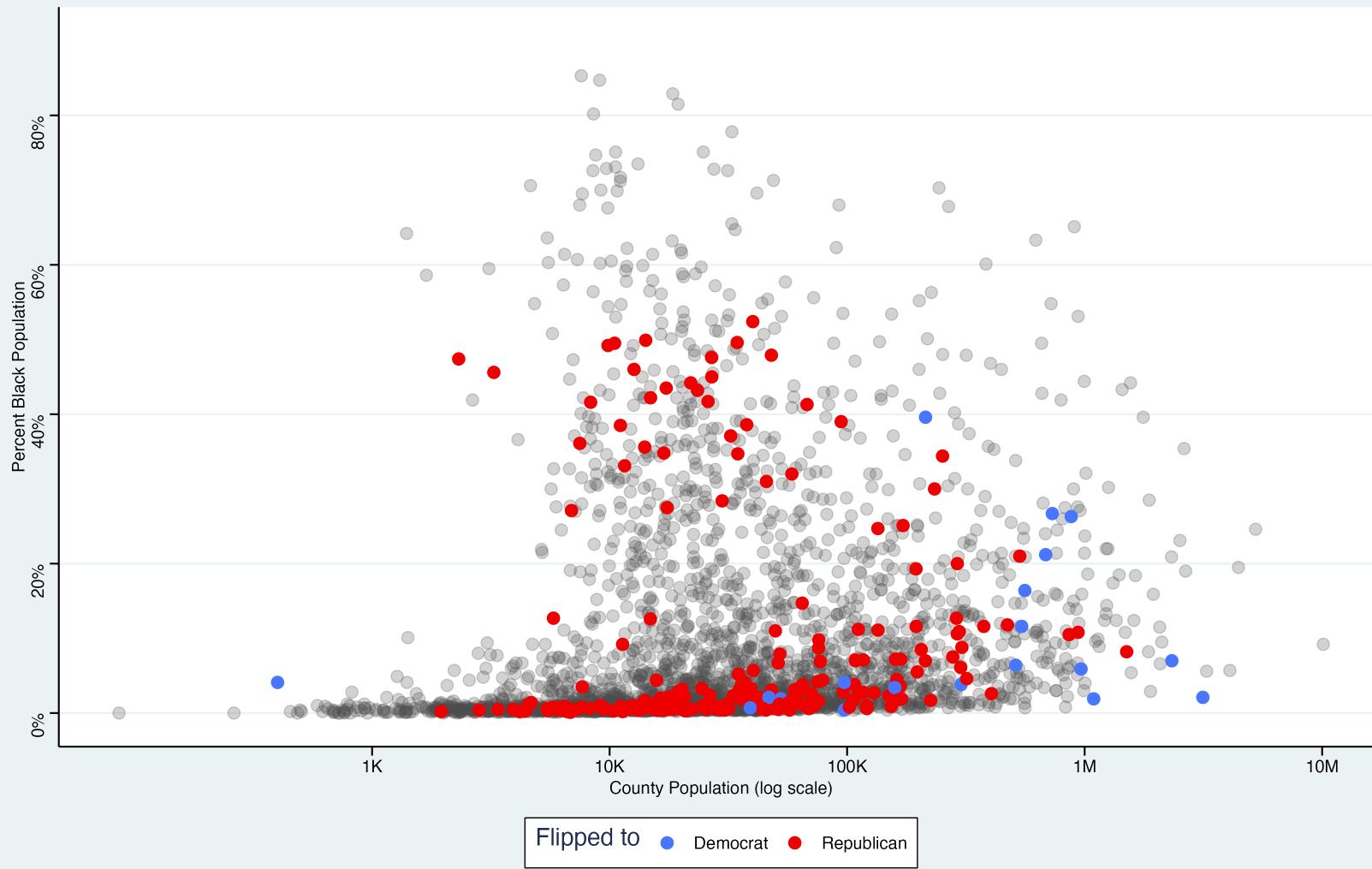


Calling the object now draws the plot with the thematic elements added.

This seems morally wrong

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

Counties that flipped shown by party color



Why would you do this to yourself?

Pick a theme
and stick with it