Week 10: *Polishing Charts*

EMSE 4572 / 6572: Exploratory Data Analysis

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October 30, 2024

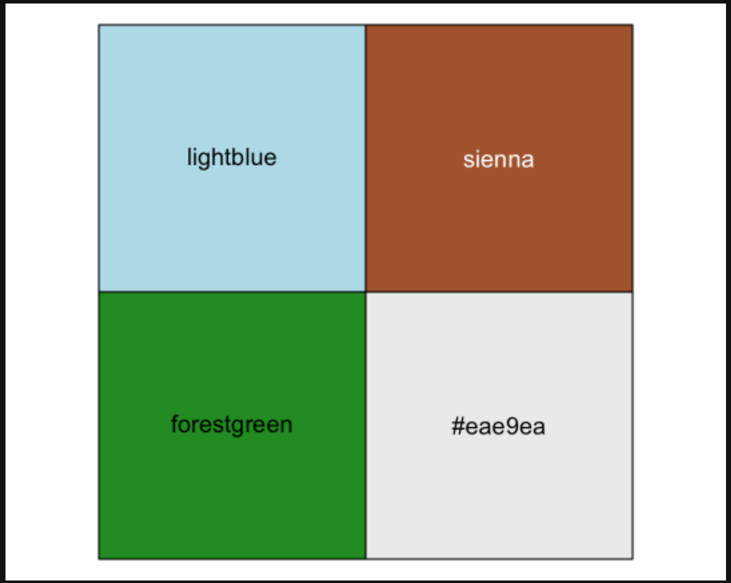
Tip of the week

Ever wondered what colors look like *before* you plot them?

Use `scales::show_col()` to preview them

Example:

```
colors <- c('lightblue', 'sienna', 'forestgreen', '#eae9ea')
scales::show_col(colors)
```



Today's data

```r
wildlife_impacts <- read_csv(here::here('data', 'wildlife_impacts.csv'))
federal_spending <- read_csv(here::here('data', 'federal_spending_long.csv'))
milk_production  <- read_csv(here::here('data', 'milk_production.csv'))
lotr_words       <- read_csv(here::here('data', 'lotr_words.csv'))
msleep           <- read_csv(here::here('data', 'msleep.csv'))
```

New (?) package:

```r
install.packages('hrbrthemes')
```

Week 10: *Polishing Charts*

1. Scales

2. Annotations

BREAK

3. Colors

4. Fonts

5. qmd tricks

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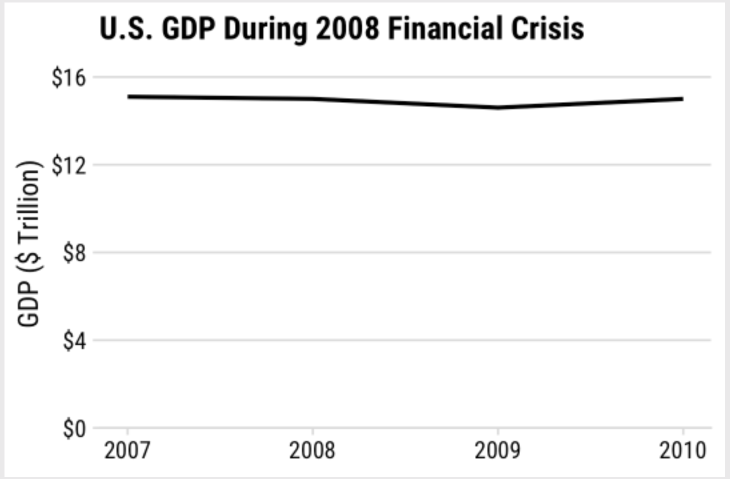
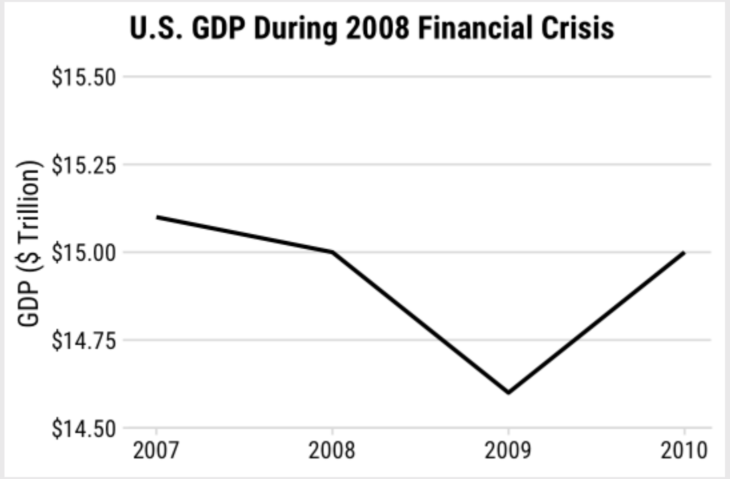
When is it okay to to truncate an axis?

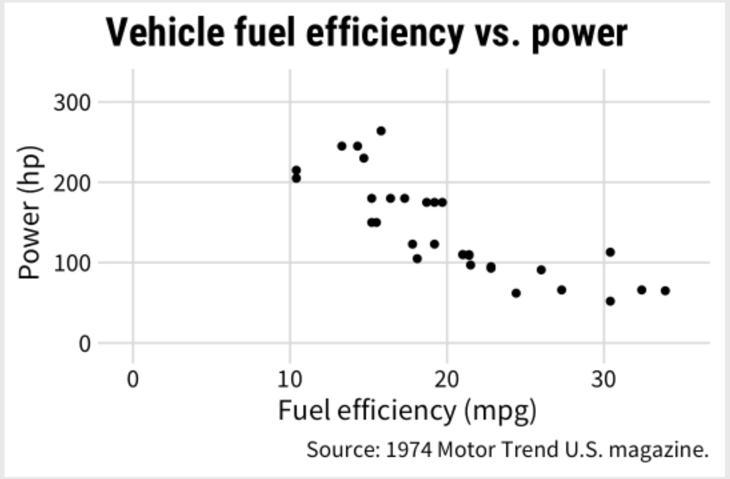
- **When small movements matter**

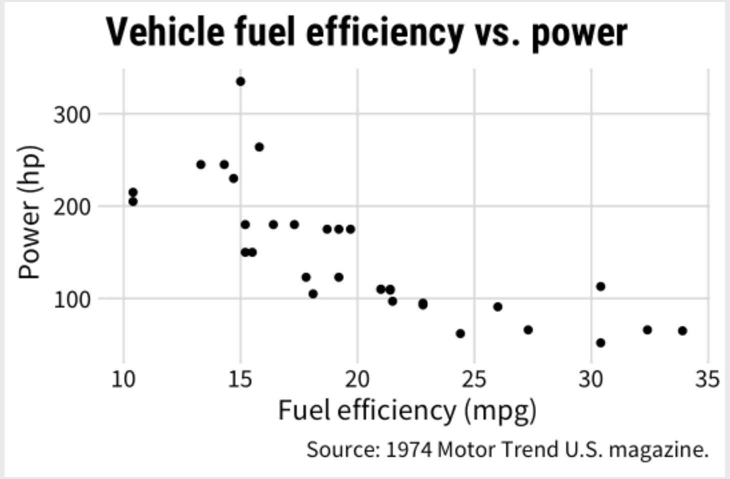




When is it okay to to truncate an axis?

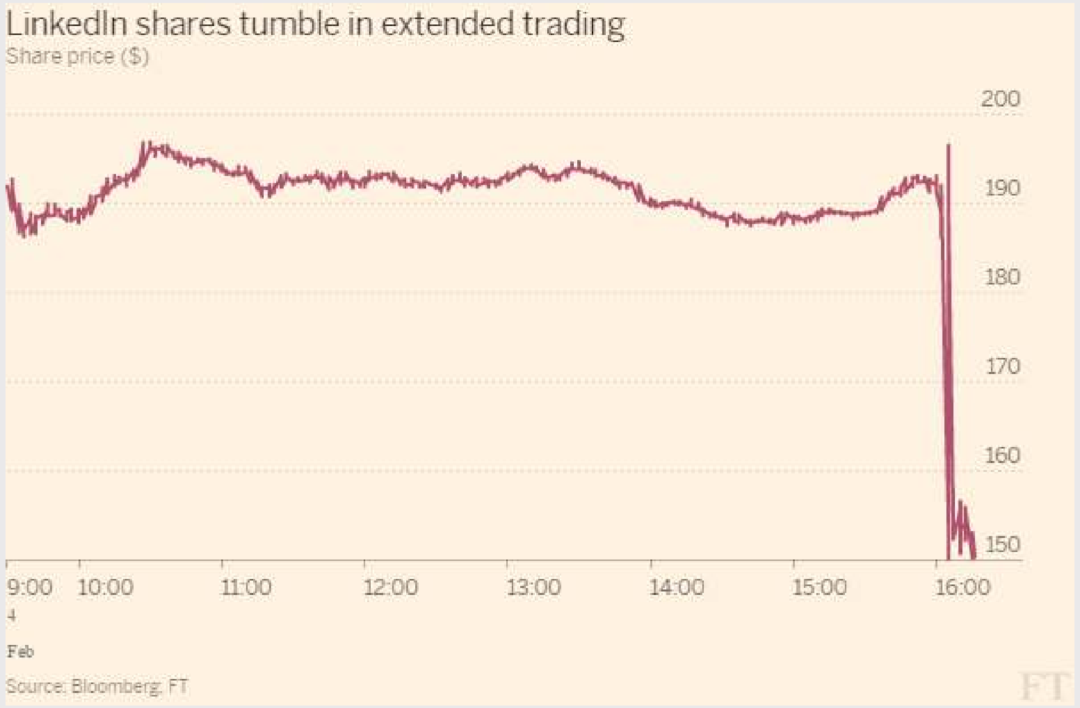
- When small movements matter
- **When zero values are impossible**





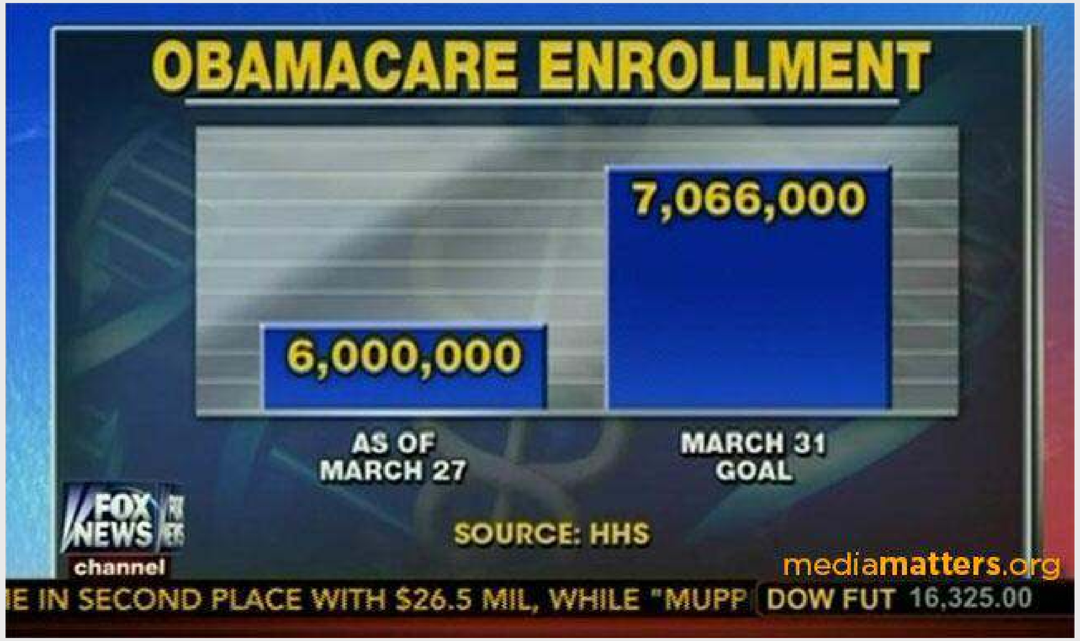
When is it okay to to truncate an axis?

- When small movements matter
- When zero values are impossible
- **When it's normal / a convention**



When is it okay to to truncate an axis?

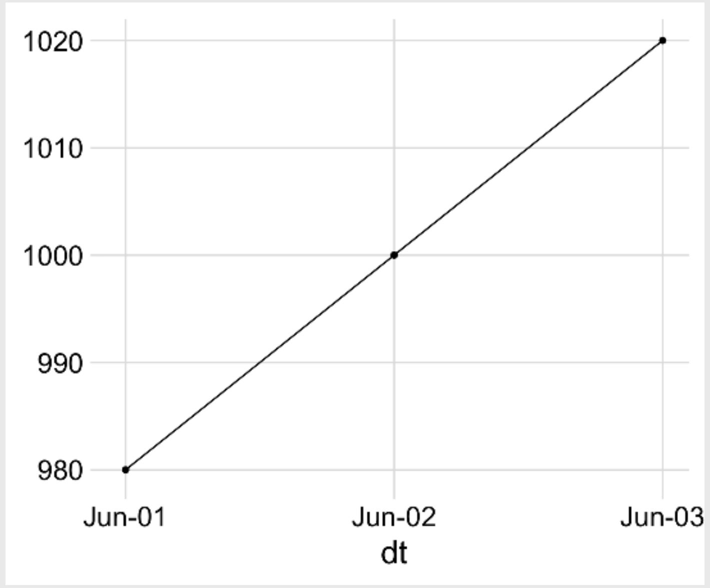
- When small movements matter
- When zero values are impossible
- When it's normal / a convention
- **Never on a bar chart**



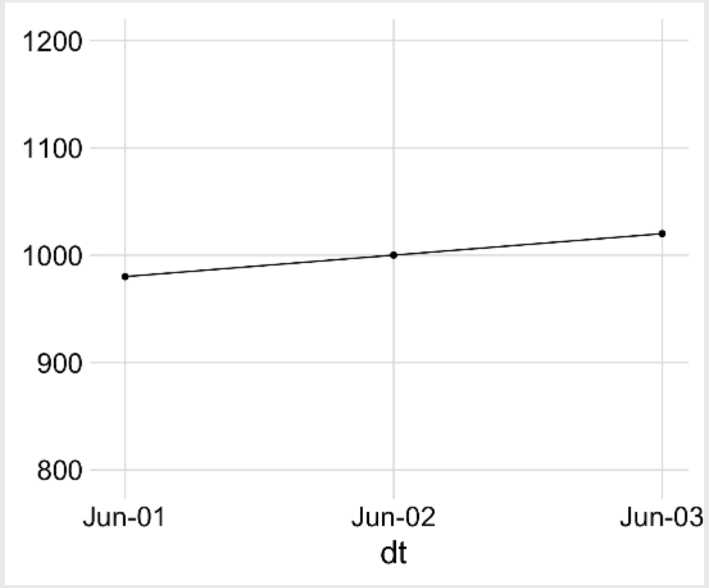
You are most sensitive to changes in angles close to 45 degrees

You are most sensitive to changes in angles close to 45 degrees

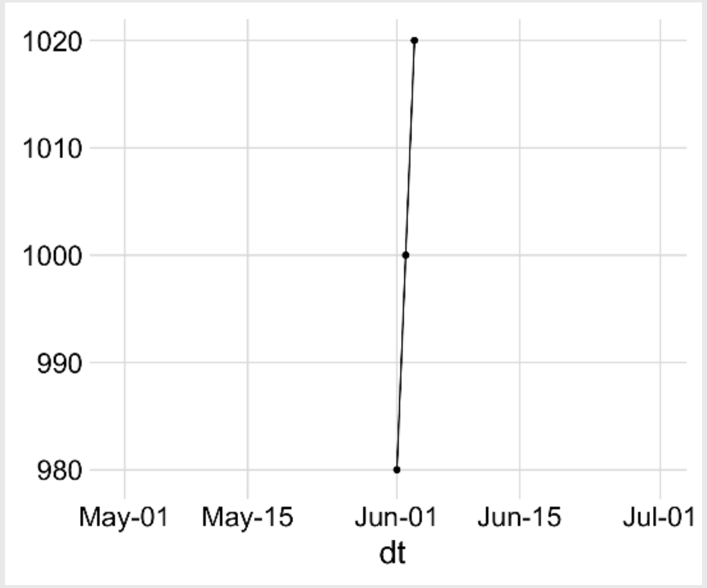
Good scaling



Y scale too large

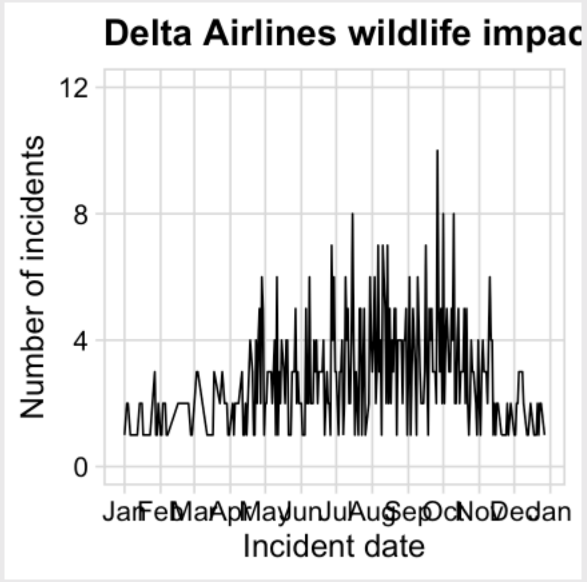


X scale too large

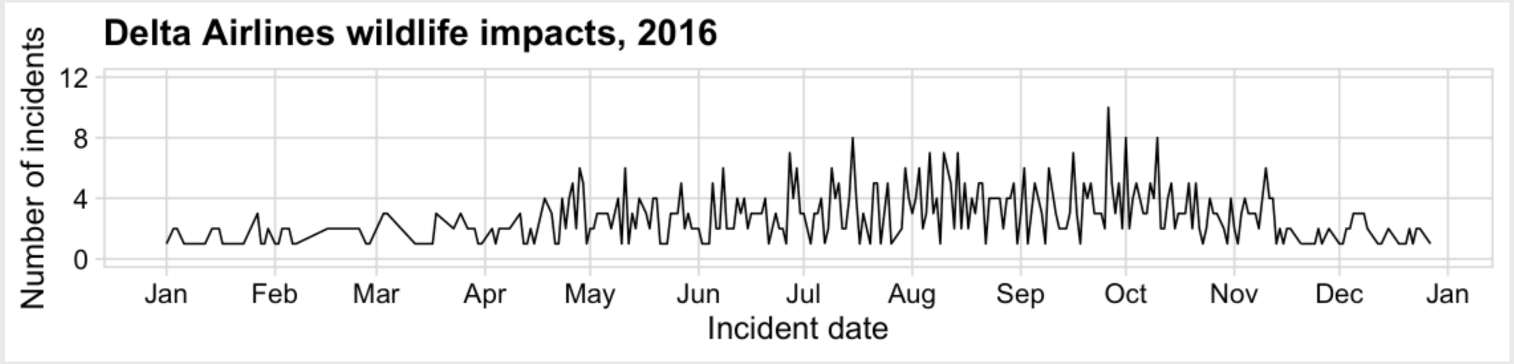


You are most sensitive to changes in angles close to 45 degrees

Bad



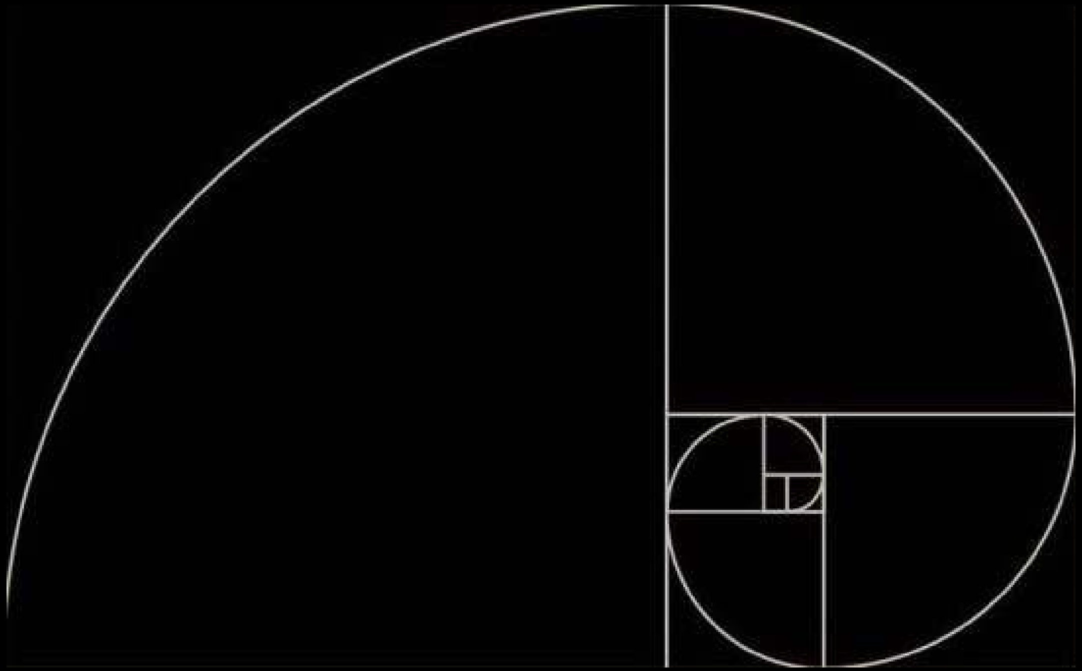
Better



Set image dimensions in R chunk header:

~~~
```{r}
#| fig.width: 5
#| fig.height: 3.1

plot
~~~

Consider setting dimensions to "Golden Ratio" (1 : 1.618)



Approx. to golden ratio:

width	height
5	3.1 or 3
6	3.7 or 4
7	4.3

[Also check out Donald Duck in Mathemagic Land]

Adjust axes with `scale_*` functions

Continous variables

```
scale_x_continuous()
scale_y_continuous()
```

Discrete variables

```
scale_x_discrete()
scale_y_discrete()
```

Others

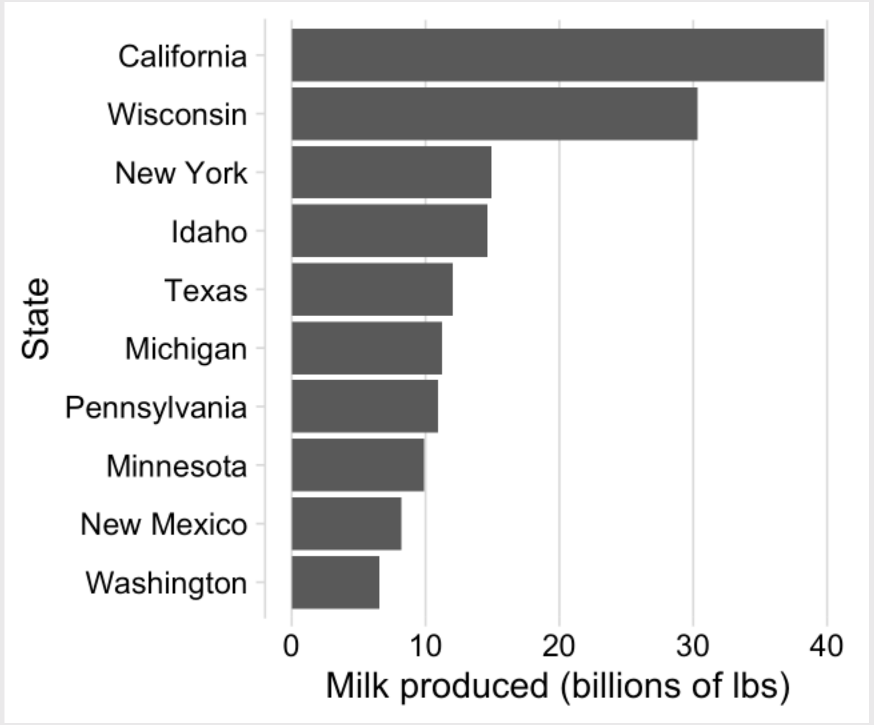
```
scale_x_log10()
scale_y_log10()
scale_x_date()
```

Common arguments for **continuous** variables

```
scale_y_continuous(
  # Set the lower & upper boundaries
  limits = c(lower, upper),

  # Explicitly set the break points
  breaks = c(break1, break2, etc.)

  # Adjust the axis so bars start at 0
  expand = expand_scale(mult = c(0, 0.05))
)
```

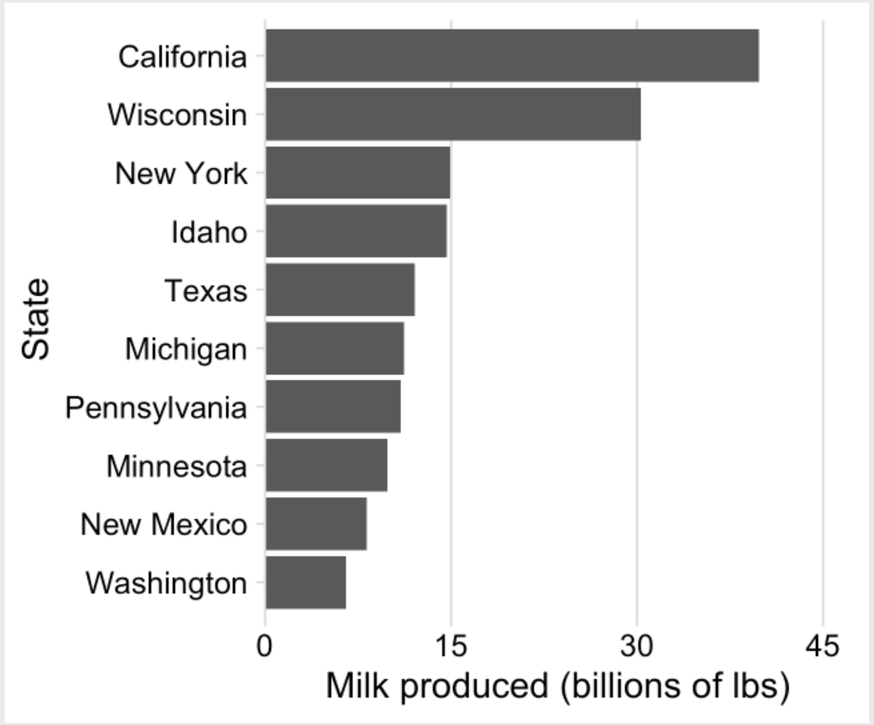
Adjusting **continuous** scales

```
milk_bars <- milk_production %>%
  filter(year == 2017) %>%
  arrange(desc(milk_produced)) %>%
  slice(1:10) %>%
  mutate(
      milk_produced = milk_produced / 10^9,
      state = fct_reorder(state, milk_produced)) %>
  ggplot() +
  geom_col(aes(x = milk_produced, y = state)) +
  theme_minimal_vgrid(font_size = 18) +
  labs(x = 'Milk produced (billions of lbs)',
       y = 'State')

milk_bars
```



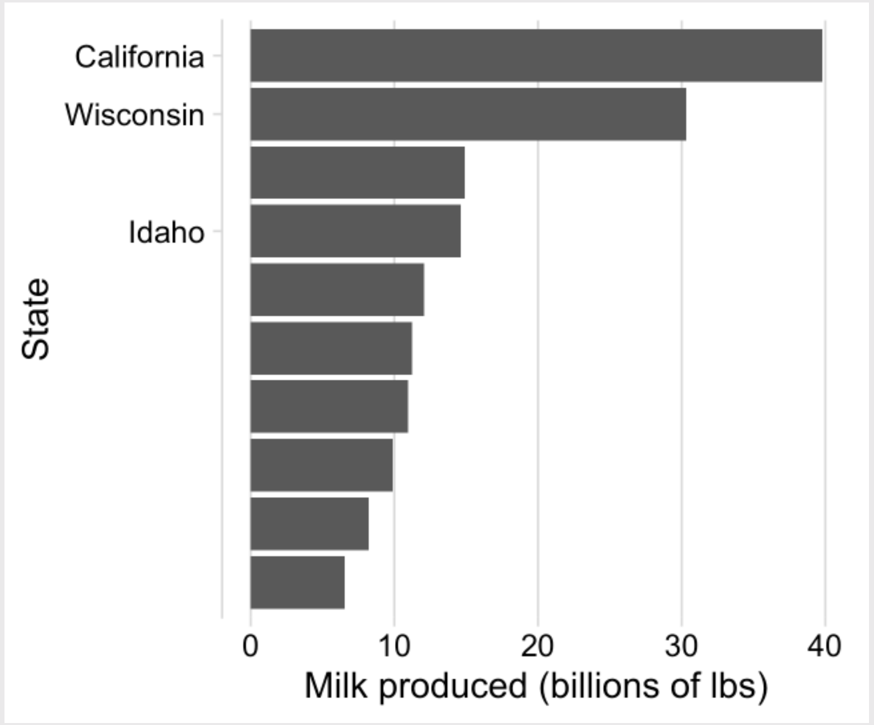
Adjusting **continuous** scales

```
milk_bars +
  scale_x_continuous(
    breaks = c(0, 15, 30, 45),
    limits = c(0 , 45),
    expand = expand_scale(mult = c(0, 0.05)))
```



Adjusting **discrete** scales

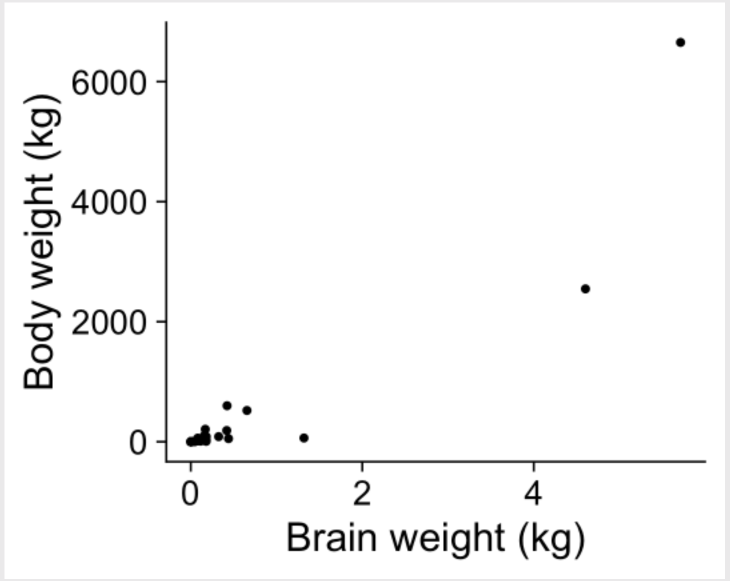
```r
milk_bars +
  scale_y_discrete(
    breaks = c('California', 'Wisconsin', 'Idaho'))
```



Adjusting **log** scales

Regular scaling

```
plot <- ggplot(msleep) +
  geom_point(aes(x = brainwt, y = bodywt)) +
  theme_half_open(font_size = 20) +
  labs(x = 'Brain weight (kg)',
       y = 'Body weight (kg)')

plot
```



Adjusting **log** scales

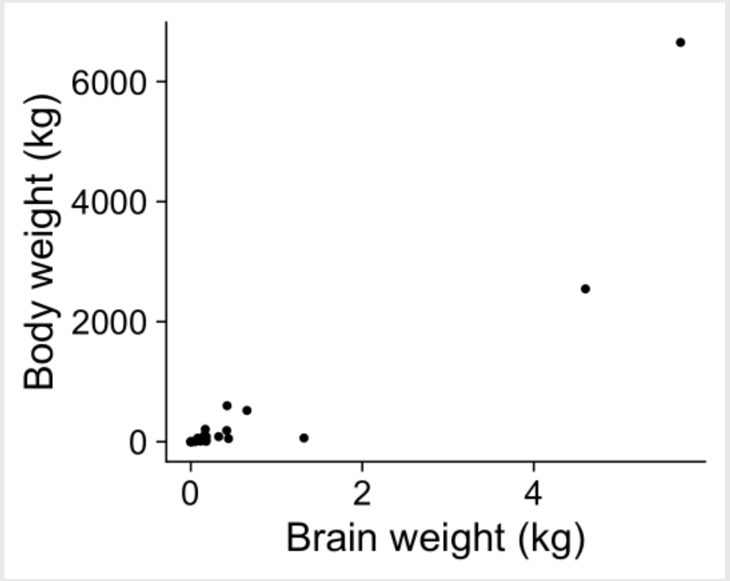
Log scaling

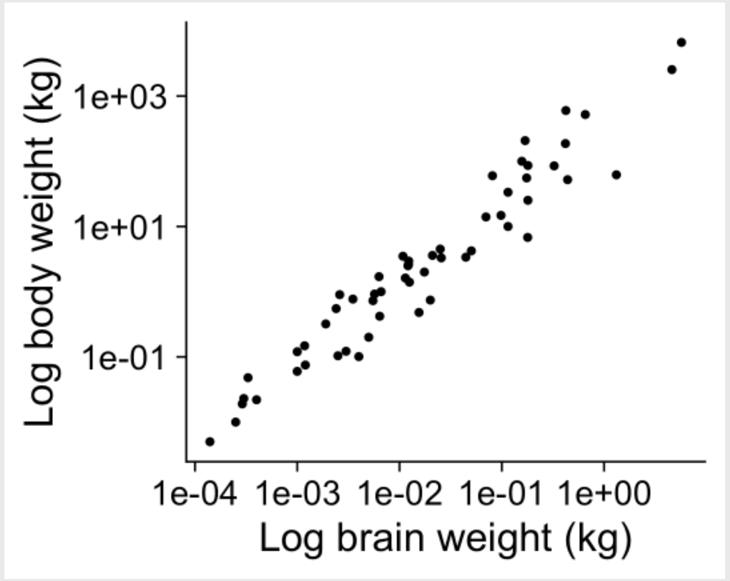
```
plot +
  scale_x_log10() +
  scale_y_log10() +
  labs(x = 'Log brain weight (kg)',
       y = 'Log body weight (kg)')
```

Log-log relationship:

$$y = x^n$$

$$\log(y) = n\log(x)$$

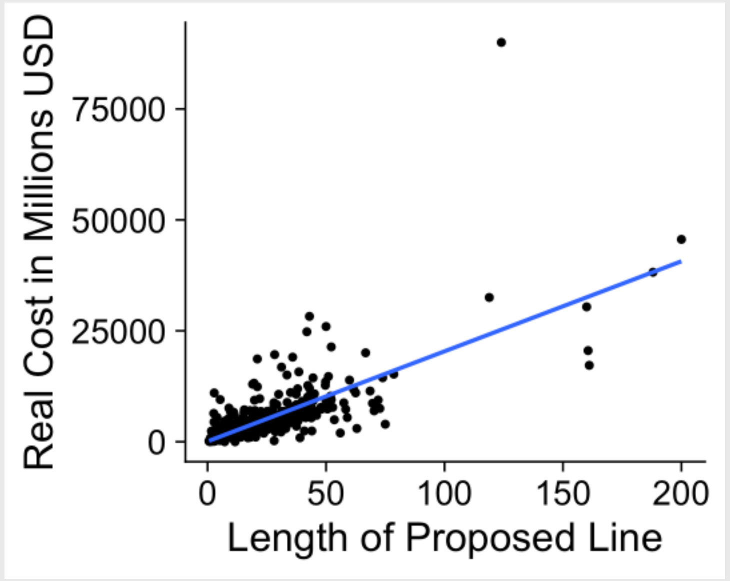




Example from Mini Project 2

Regular scaling

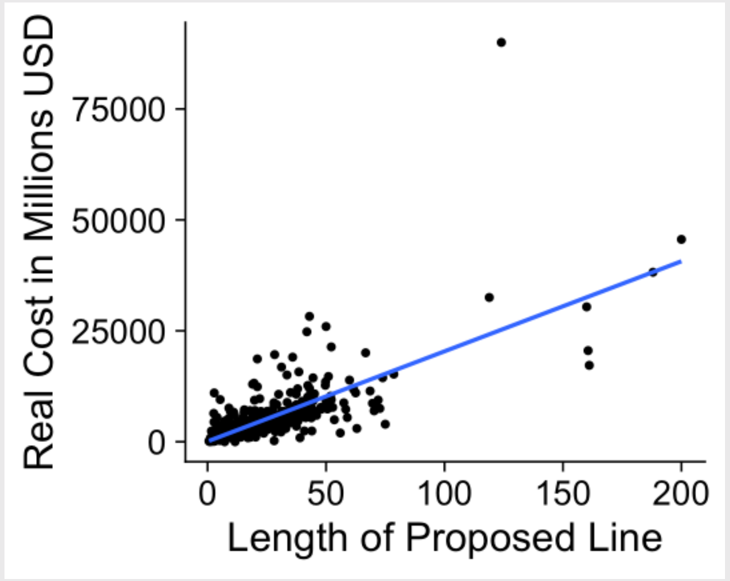
```r
plot <- transit_cost %>%
  filter(!is.na(length)) %>%
  filter(length < 2500) %>%
  mutate(cost = as.numeric(real_cost)) %>%
  ggplot(aes(x = length, y = cost)) +
  geom_point() +
  geom_smooth(method = 'lm', se = FALSE) +
  theme_half_open(font_size = 20) +
  labs(x = "Length of Proposed Line",
       y = "Real Cost in Millions USD")

plot
```



Example from Mini Project 2

Log scaling

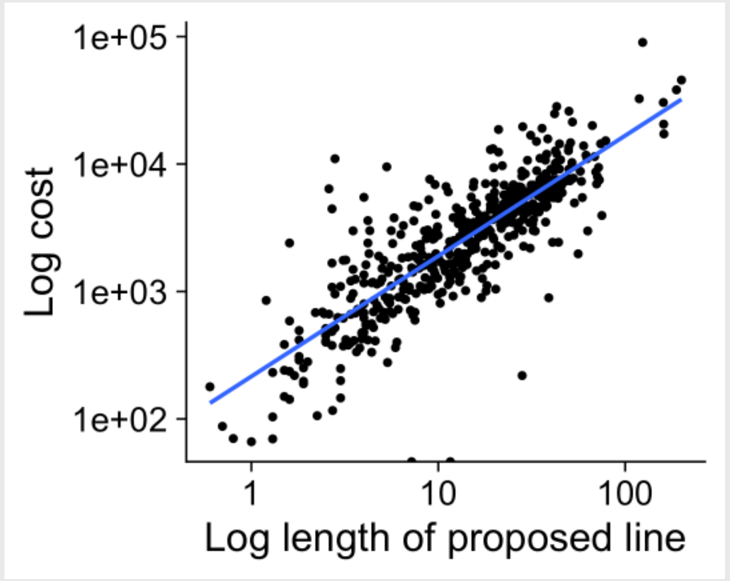
```
plot +
  scale_x_log10() +
  scale_y_log10() +
  labs(x = 'Log length of proposed line',
       y = 'Log cost')
```



Log-log relationship:

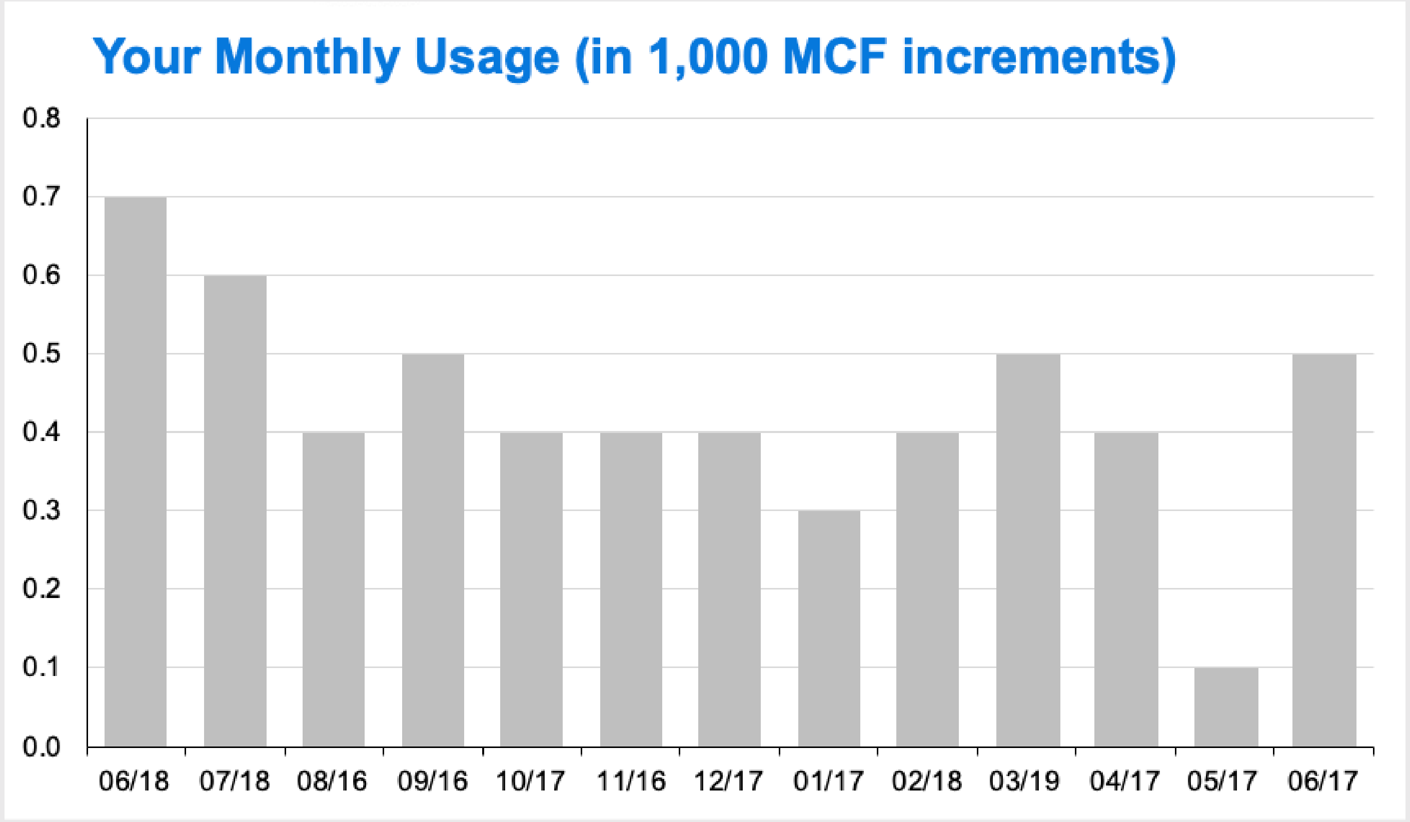
$$y = x^n$$

$$\log(y) = n\log(x)$$



Date scales can be confusing

What's wrong with this chart?



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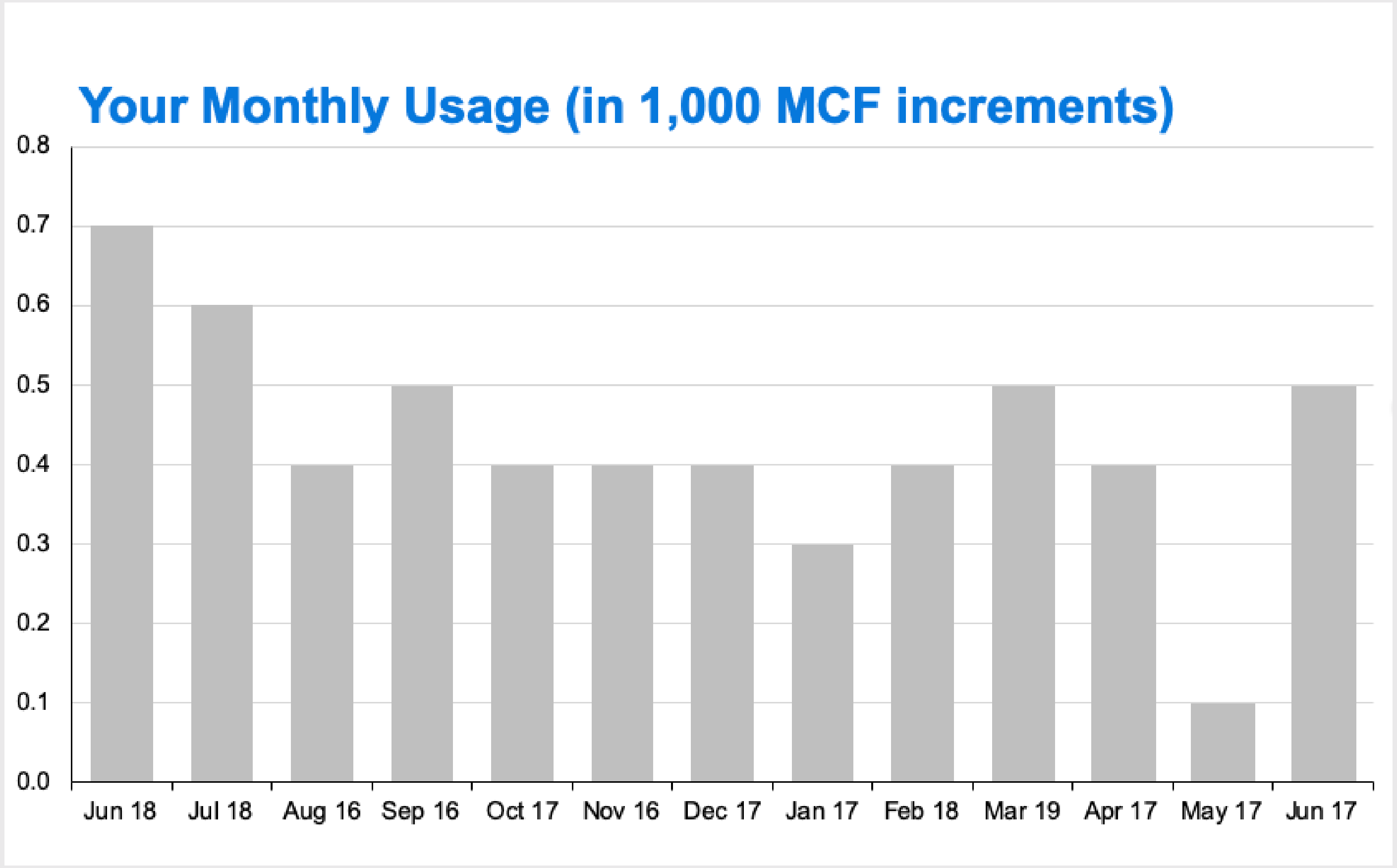

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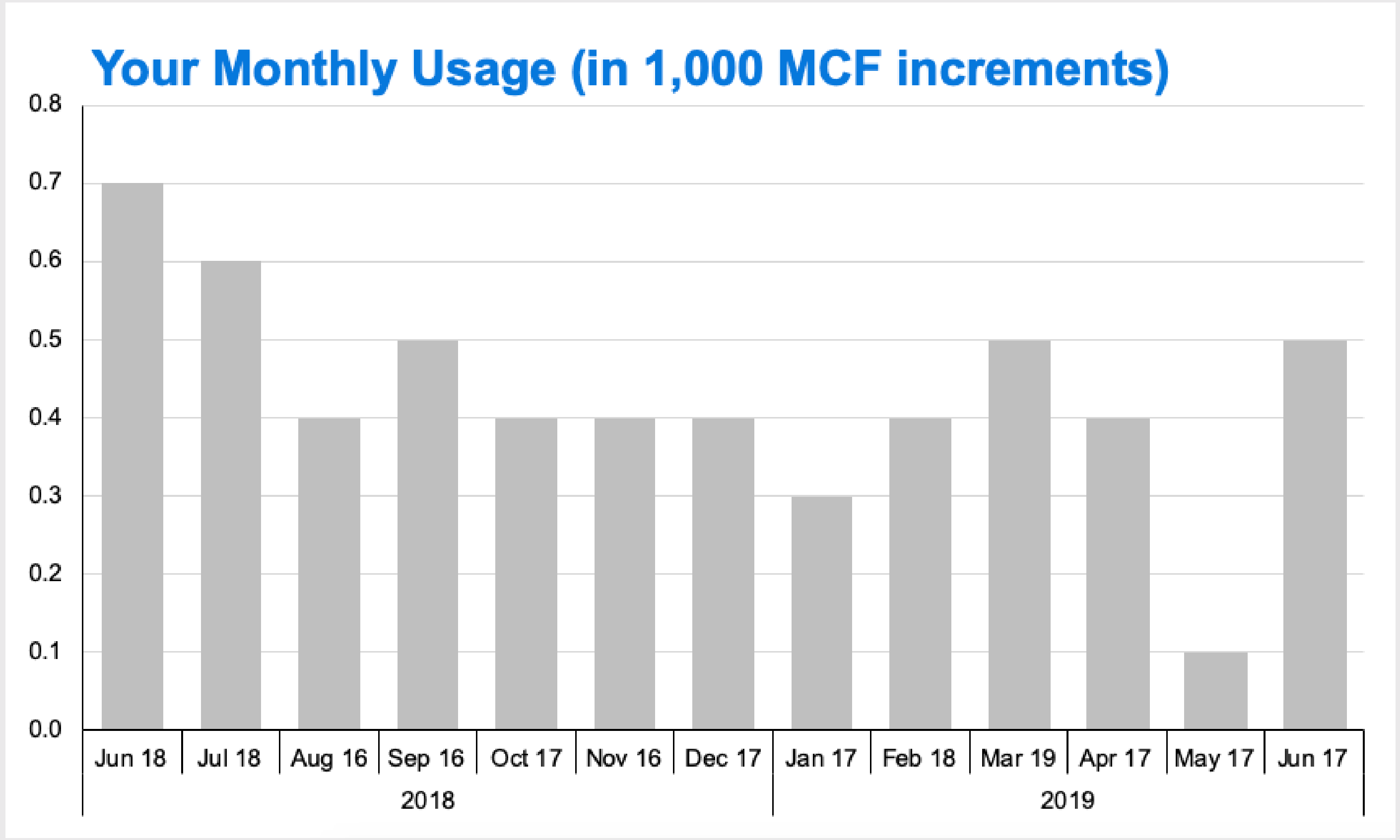

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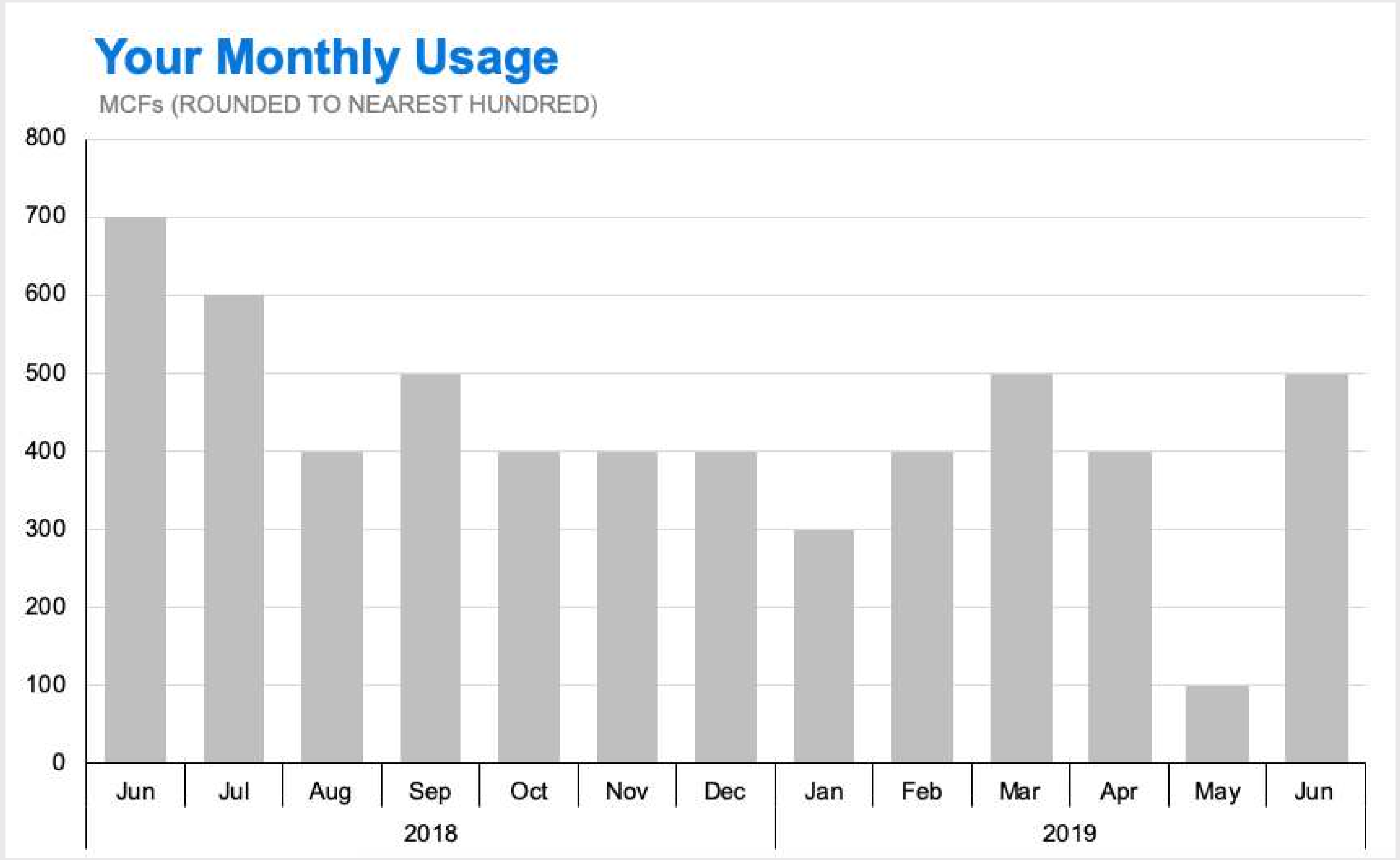
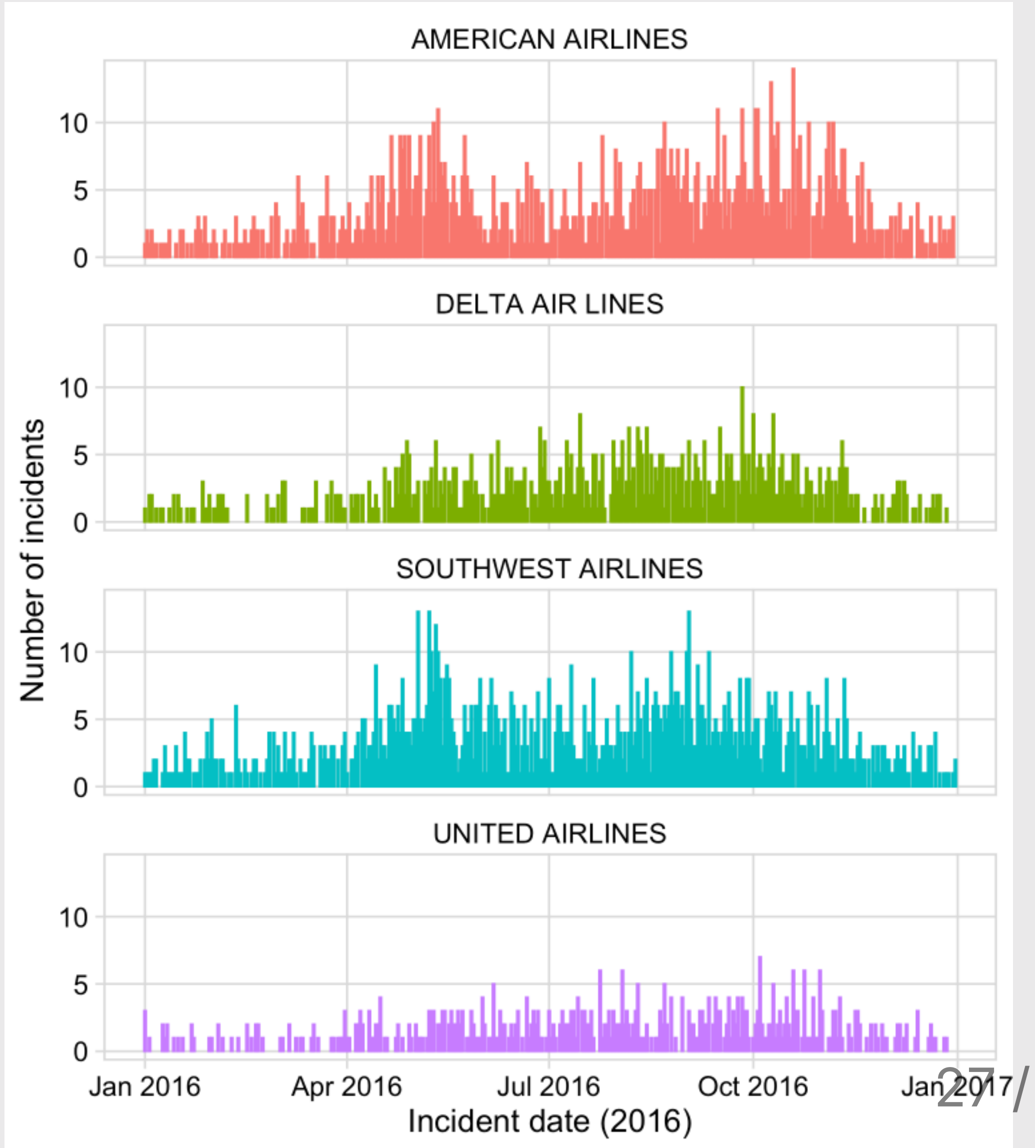


Adjusting **date** scales

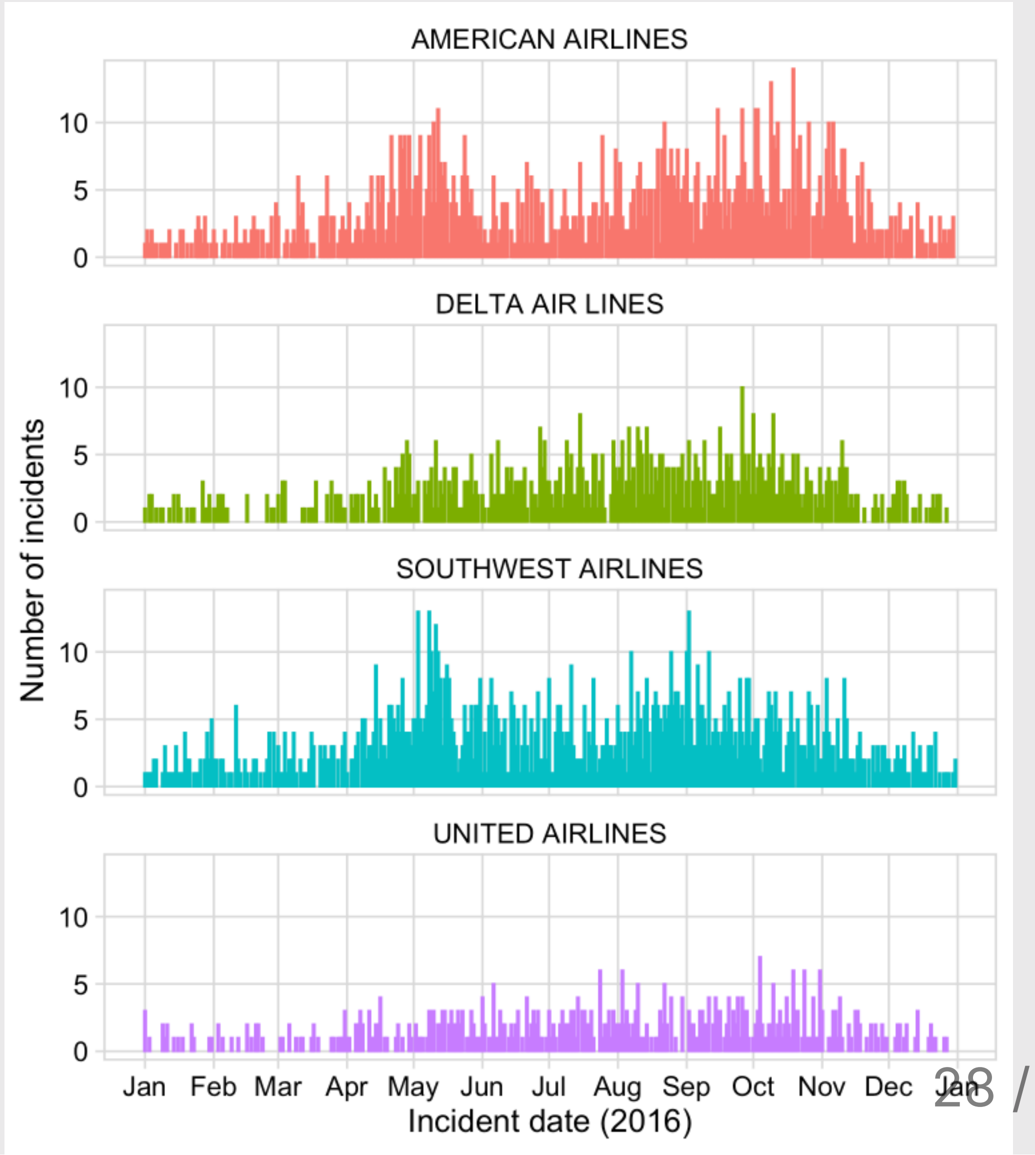
Summarise the data

```r
library(lubridate)

plot <- wildlife_impacts %>%
  filter(incident_year == 2016) %>%
  count(operator, incident_date) %>%
  mutate(incident_date = ymd(incident_date)) %>
  ggplot() +
  geom_col(
    aes(x = incident_date, y = n,
        color = operator)) +
  facet_wrap(~operator, ncol = 1) +
  theme_minimal_grid(font_size = 16) +
  panel_border() +
  theme(legend.position = 'none') +
  labs(x = 'Incident date (2016)',
       y = 'Number of incidents')

plot
```



Adjusting **date** scales

```
plot +
  scale_x_date(
    date_breaks = '1 month',
    date_labels = '%b')
```



Adjusting **date** scales

```
scale_x_date(
  date_breaks = '1 month',
  date_labels = '%b')
```

```
date_breaks = '1 month'
```

- '1 day'
- '10 days'
- '1 month'
- '3 months'
- '1 year'
- '3 years'

```
date_labels = '%b'
```

Example date: March 04, 2020

- %Y = 2020
- %y = 20
- %B = March
- %b = Mar
- %D = 03/04/2020
- %d = 03

Use **scales** library to modify scale **text**

`scales` converts numbers to formatted characters

```r
scales::comma(200000)
```

```
#> [1] "200,000"
```

```r
scales::dollar(200000)
```

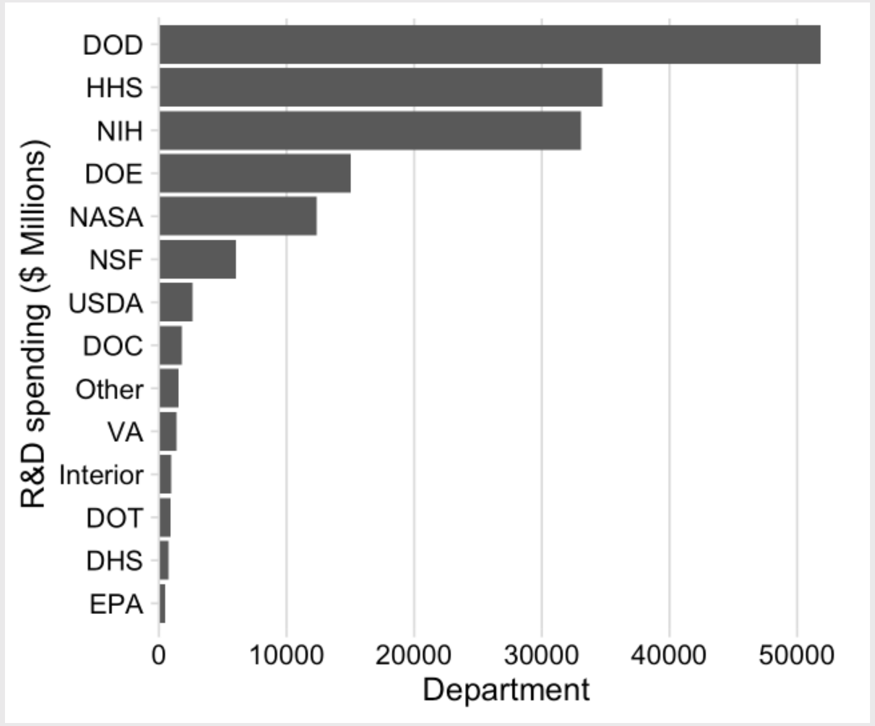
```
#> [1] "$200,000"
```

```r
scales::percent(0.5)
```

```
#> [1] "50%"
```

Use **scales** library to modify scale text

```
federal_spending %>%
  filter(year == 2017) %>%
  mutate(
    department = fct_reorder(
      department, rd_budget)) %>%
  ggplot() +
  geom_col(aes(x = rd_budget, y = department))
  scale_x_continuous(
    expand = expand_scale(mult = c(0, 0.05))) +
  theme_minimal_vgrid(font_size = 16) +
  labs(x = 'Department',
       y = 'R&D spending ($ Millions)')
```



Use **scales** library to modify scale text

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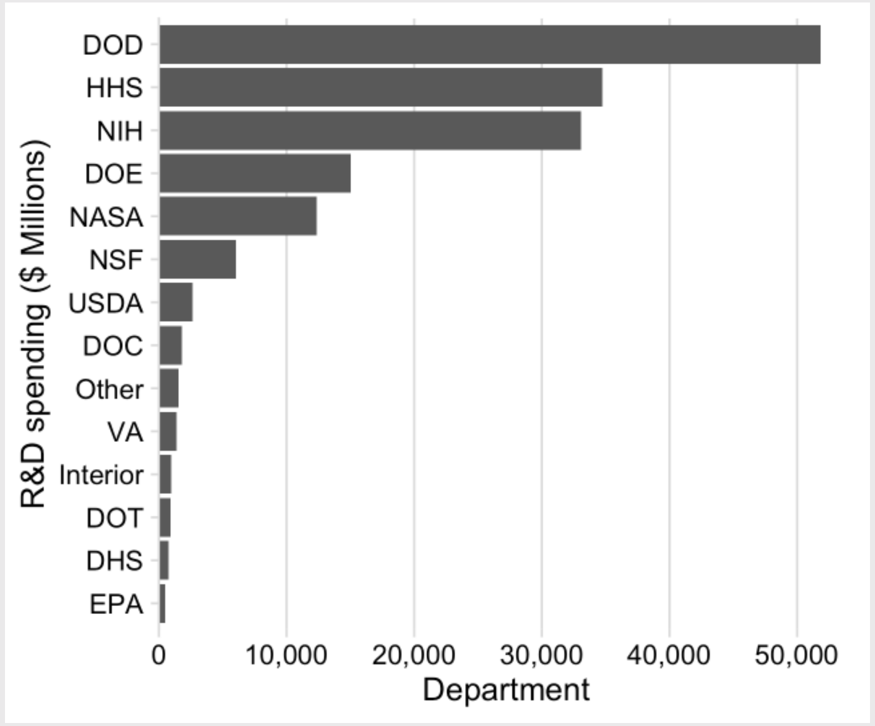
  filter(year == 2017) %>%
  mutate(
    department = fct_reorder(
      department, rd_budget)) %>%
  ggplot() +
  geom_col(aes(x = rd_budget, y = department))
  scale_x_continuous(
    labels = scales::comma,
    expand = expand_scale(mult = c(0, 0.05))) +
  theme_minimal_vgrid(font_size = 16) +
  labs(x = 'Department',
       y = 'R&D spending ($ Millions)')
```



Use **scales** library to modify scale text

```r
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  filter(year == 2017) %>%
  mutate(
    department = fct_reorder(
      department, rd_budget)) %>%
  ggplot() +
  geom_col(aes(x = rd_budget, y = department))
  scale_x_continuous(
    labels = scales::dollar,
    expand = expand_scale(mult = c(0, 0.05))) +
  theme_minimal_vgrid(font_size = 16) +
  labs(x = 'Department',
       y = 'R&D spending ($ Millions)')
```
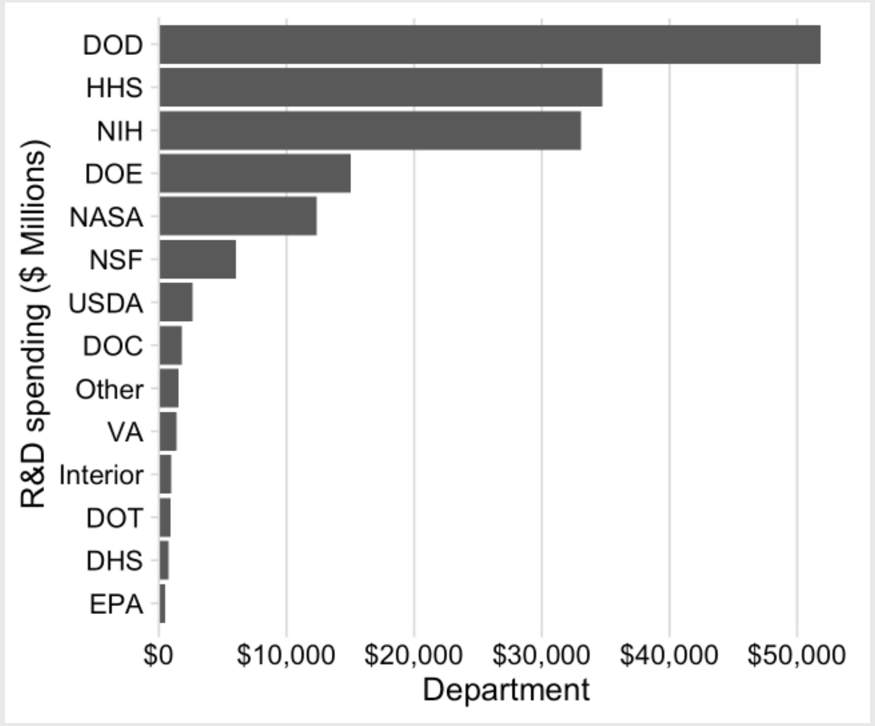
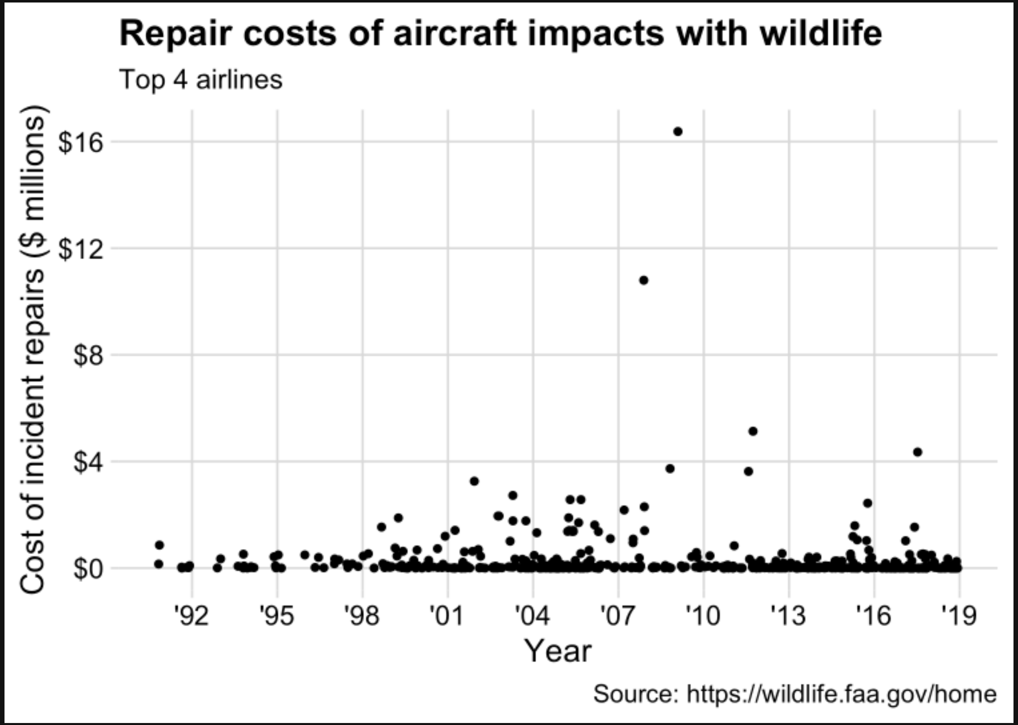



Check out this guide to scales:
https://ggplot2tor.com/scales

Your turn

15:00

Adjust the scales in the code chunk provided to match the chart on the slides.



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1. Scales
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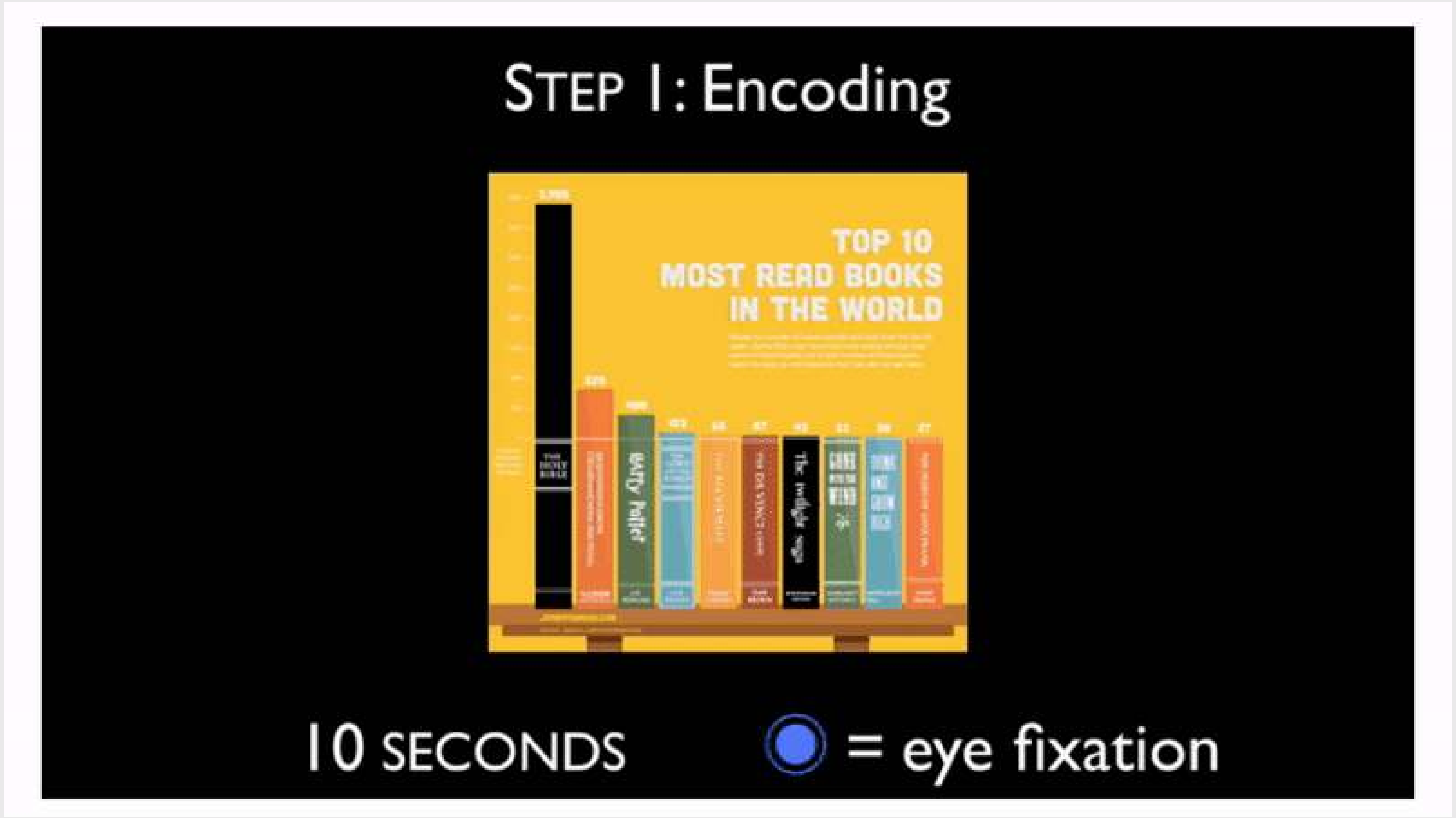
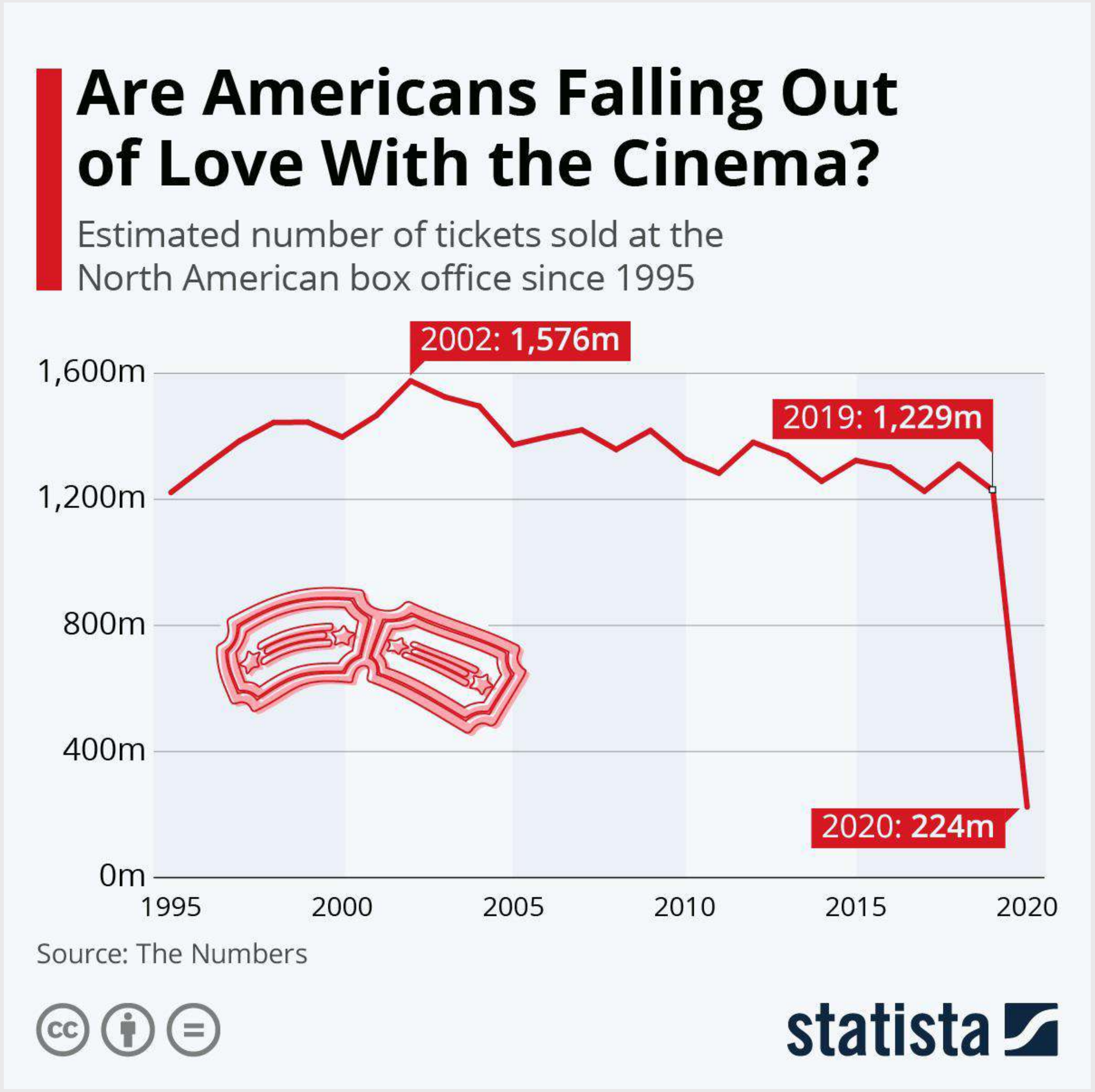
BREAK

3. Colors
4. Fonts
5. qmd tricks

Text is usually the single most important component on your chart



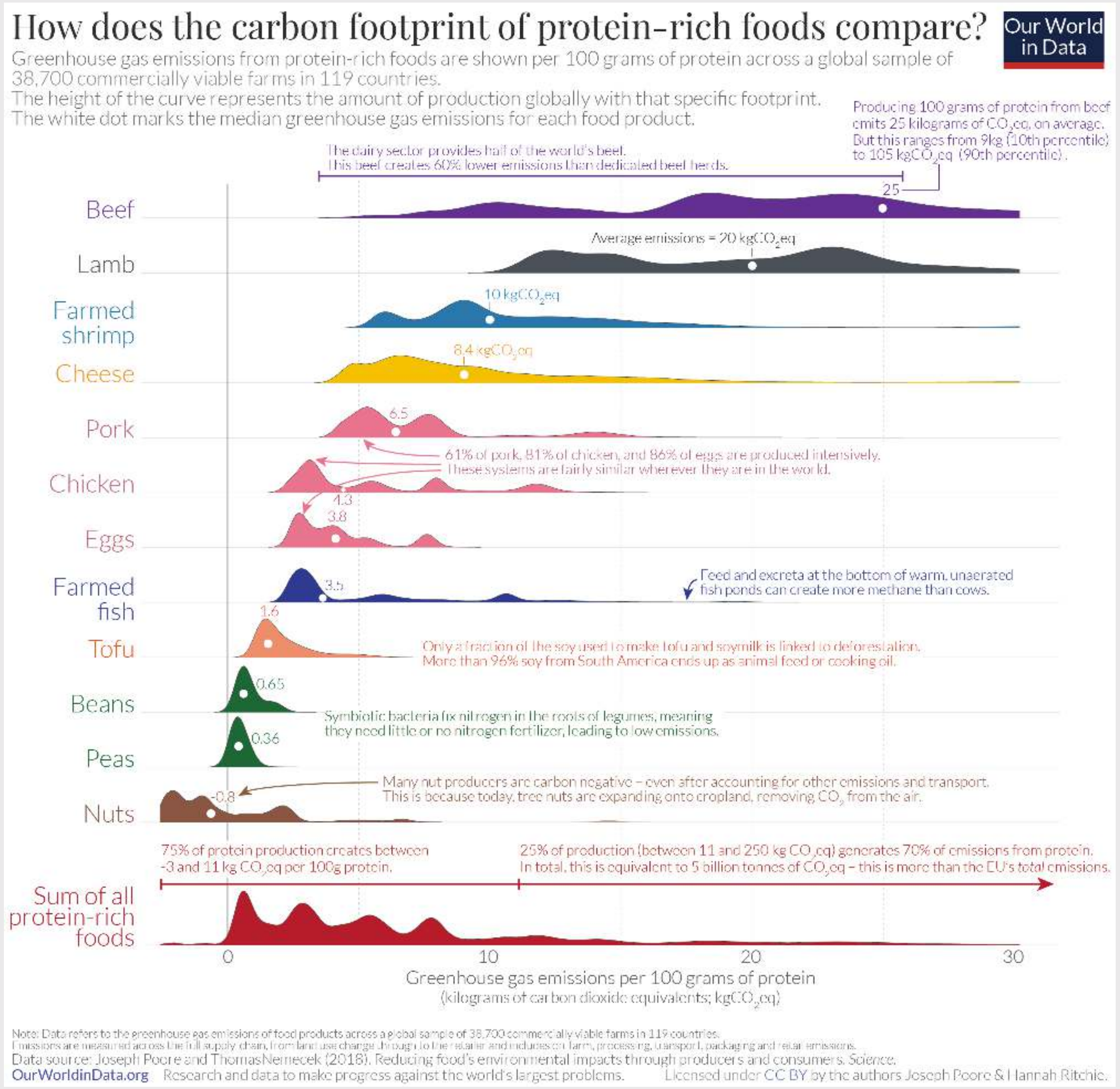
Michelle Borkin, et al. (2015) Beyond Memorability: Visualization Recognition and Recall



Titles matter

Source:
https://www.reddit.com/r/dataisugly/co

Good annotations should tell a story



How does the carbon footprint of protein-rich foods compare?

Greenhouse gas emissions from protein-rich foods are shown per 100 grams of protein across a global sample of 38,700 commercially viable farms in 119 countries.
The height of the curve represents the amount of production globally with that specific footprint.
The white dot marks the median greenhouse gas emissions for each food product.

Producing 100 grams of protein from beef emits 25 kilograms of CO_2eq, on average. But this ranges from 9kg (10th percentile) to 105 $kgCO_2eq$ (90th percentile).

The dairy sector provides half of the world's beef.
This beef creates 60% lower emissions than dedicated beef herds.

Average emissions = 20 $kgCO_2eq$

61% of pork, 81% of chicken, and 86% of eggs are produced intensively.
These systems are fairly similar wherever they are in the world.

Feed and excreta at the bottom of warm, unaerated fish ponds can create more methane than cows.

Only a fraction of the soy used to make tofu and soymilk is linked to deforestation.
More than 96% soy from South America ends up as animal feed or cooking oil.

Symbiotic bacteria fix nitrogen in the roots of legumes, meaning they need little or no nitrogen fertilizer, leading to low emissions.

Many nut producers are carbon negative – even after accounting for other emissions and transport.
This is because today, tree nuts are expanding onto cropland, removing CO_2 from the air.

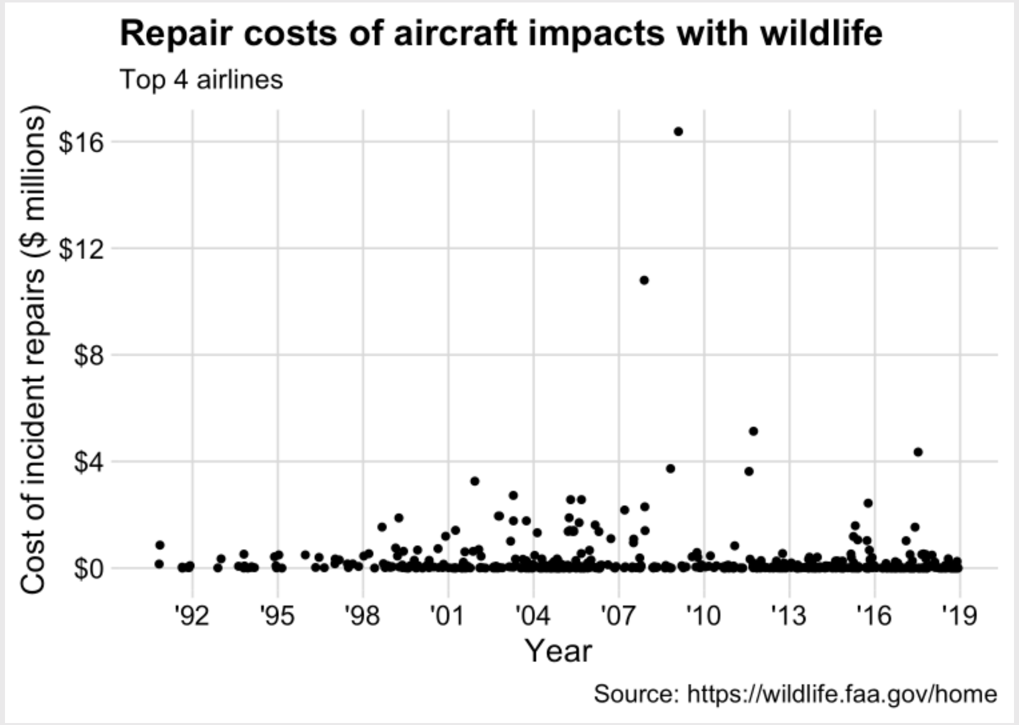
75% of protein production creates between -3 and 11 kg CO_2eq per 100g protein.

25% of production (between 11 and 250 kg CO_2eq) generates 70% of emissions from protein.
In total, this is equivalent to 5 billion tonnes of CO_2eq – this is more than the EU's *total* emissions.

Note: Data refers to the greenhouse gas emissions of food products across a global sample of 38,700 commercially viable farms in 119 countries.
Emissions are measured across the full supply chain, from land use change through to the retailer and includes on farm, processing, transport, packaging and retail emissions.
Data source: Joseph Poore and Thomas Nemecek (2018). Reducing food's environmental impacts through producers and consumers. Science.
OurWorldinData.org Research and data to make progress against the world's largest problems. Licensed under CC BY by the authors Joseph Poore & Hannah Ritchie.

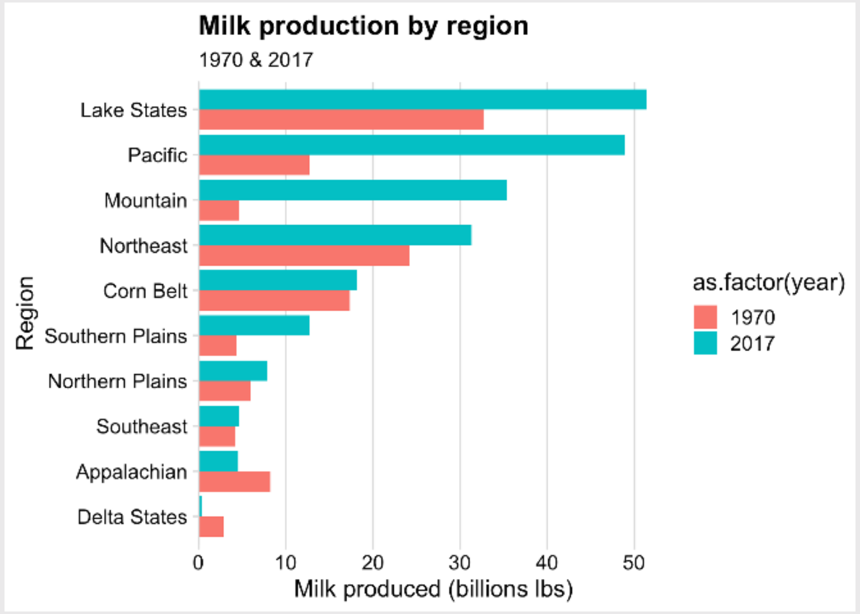
Source: https://ourworldindata.org/less-meat-or-sustainable-meat

```
labs(
  x = 'Year',
  y = 'Cost of incident repairs ($ millions)',
  title = 'Repair costs of aircraft impacts with wildlife',
  subtitle = 'Top 4 airlines',
  caption = 'Source: https://wildlife.faa.gov/home')
```



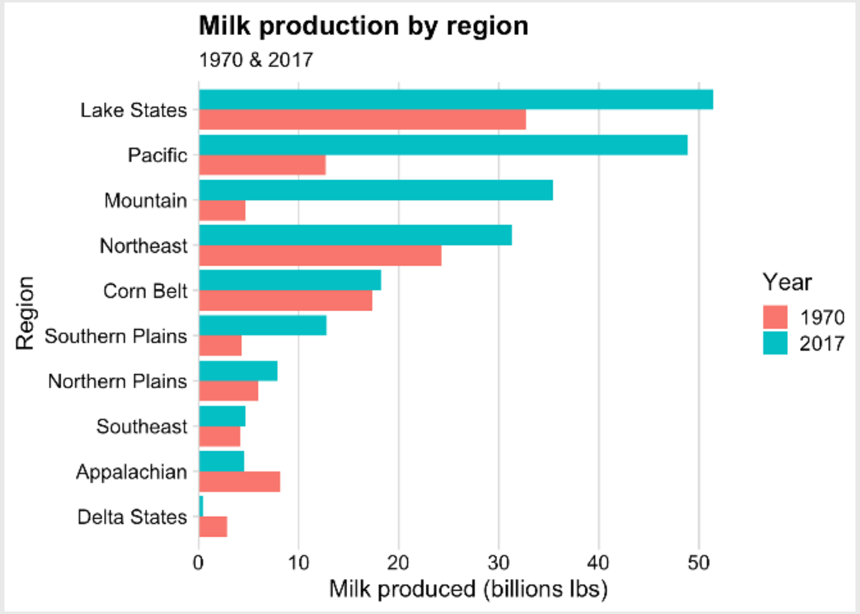
Use mapped variables in `aes()` in `labs()`

```
milk_production %>%
  filter(year %in% c(1970, 2017)) %>%
  group_by(year, region) %>%
  summarise(milk_produced = sum(milk_produced) / 10^9) %>
  ungroup() %>%
  mutate(
    region = fct_reorder2(region, year, desc(milk_produce
  ggplot() +
  geom_col(
    aes(x = milk_produced,
        y = region,
        fill = as.factor(year)),
    position = "dodge") +
  scale_x_continuous(expand = expansion(mult = c(0, 0.05
  theme_minimal_vgrid() +
  labs(
    x = 'Milk produced (billions lbs)',
    y = 'Region',
    title = 'Milk production by region',
    subtitle = '1970 & 2017')
```



Use mapped variables in aes() in labs()

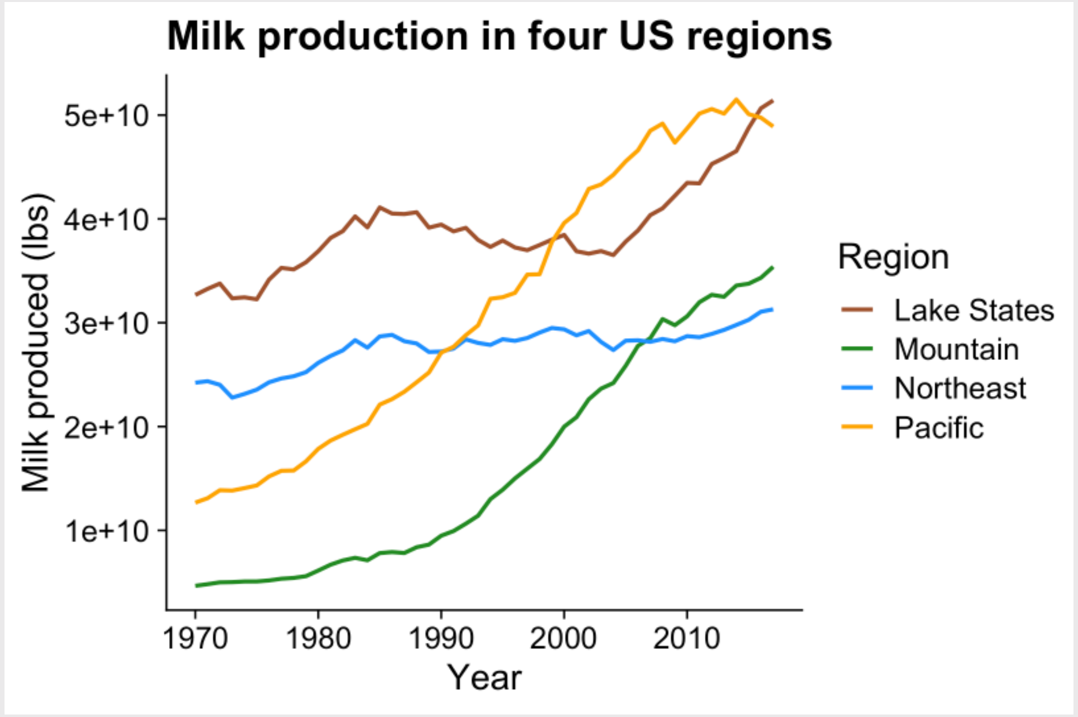
```
milk_production %>%
  filter(year %in% c(1970, 2017)) %>%
  group_by(year, region) %>%
  summarise(milk_produced = sum(milk_produced) / 10^9) %
  ungroup() %>%
  mutate(
    region = fct_reorder2(region, year, desc(milk_produce
  ggplot() +
  geom_col(
    aes(x = milk_produced,
        y = region,
        fill = as.factor(year)),
    position = "dodge") +
  scale_x_continuous(expand = expansion(mult = c(0, 0.05
  theme_minimal_vgrid() +
  labs(
    x = 'Milk produced (billions lbs)',
    y = 'Region',
    title = 'Milk production by region',
    subtitle = '1970 & 2017',
    fill = "Year")
```



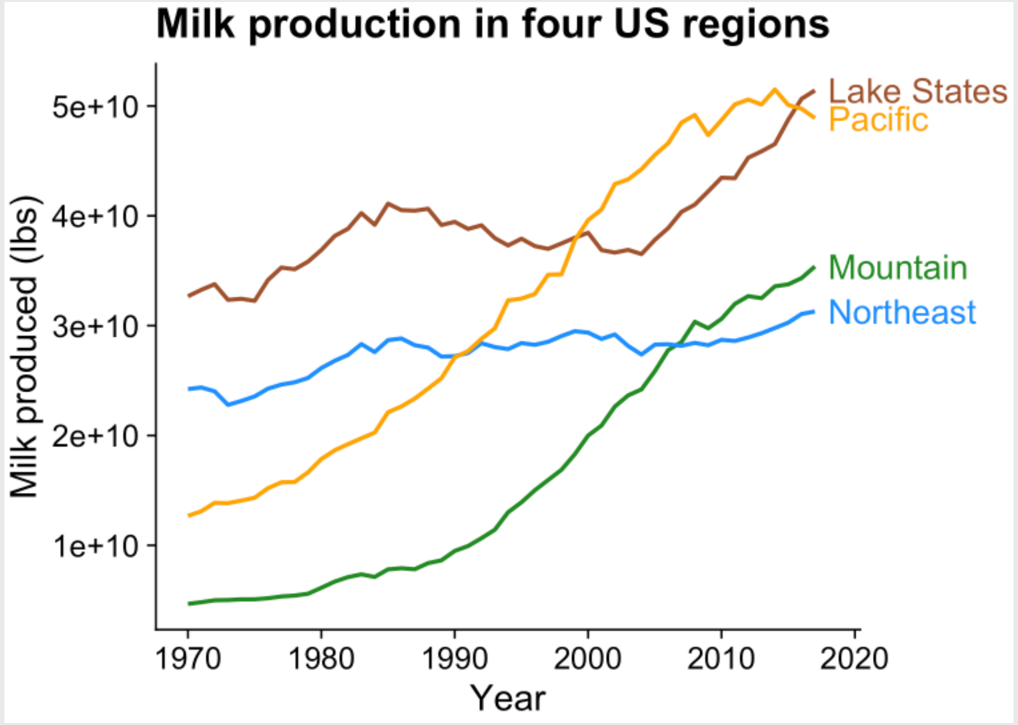
Legends suck

Legends suck

Legends require look-up task

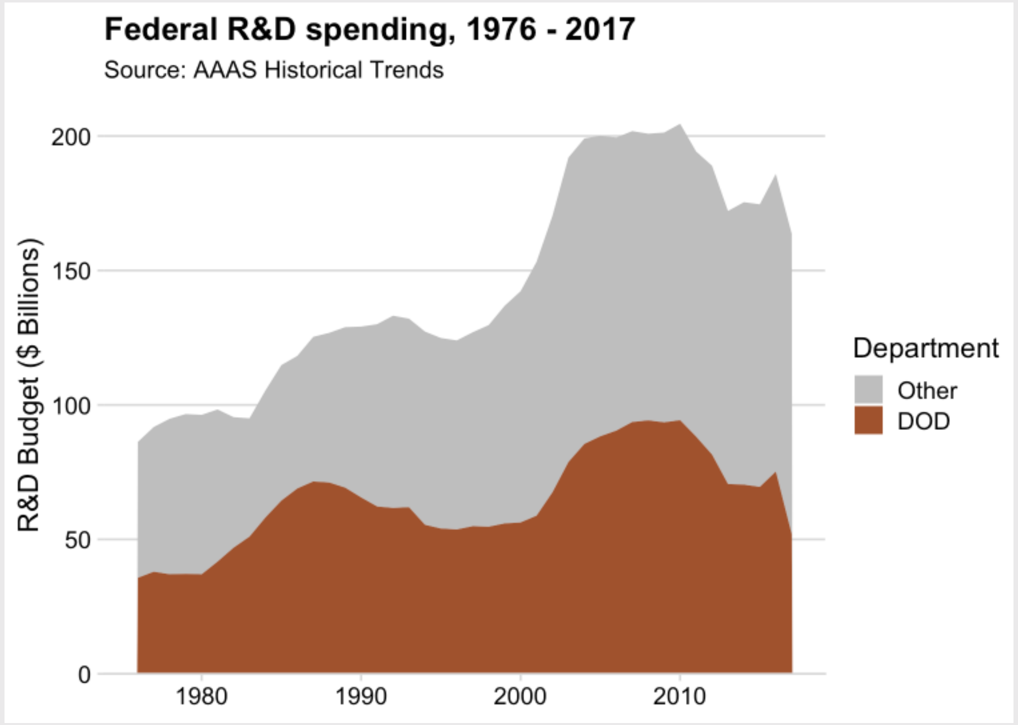


Direct labeling is much better

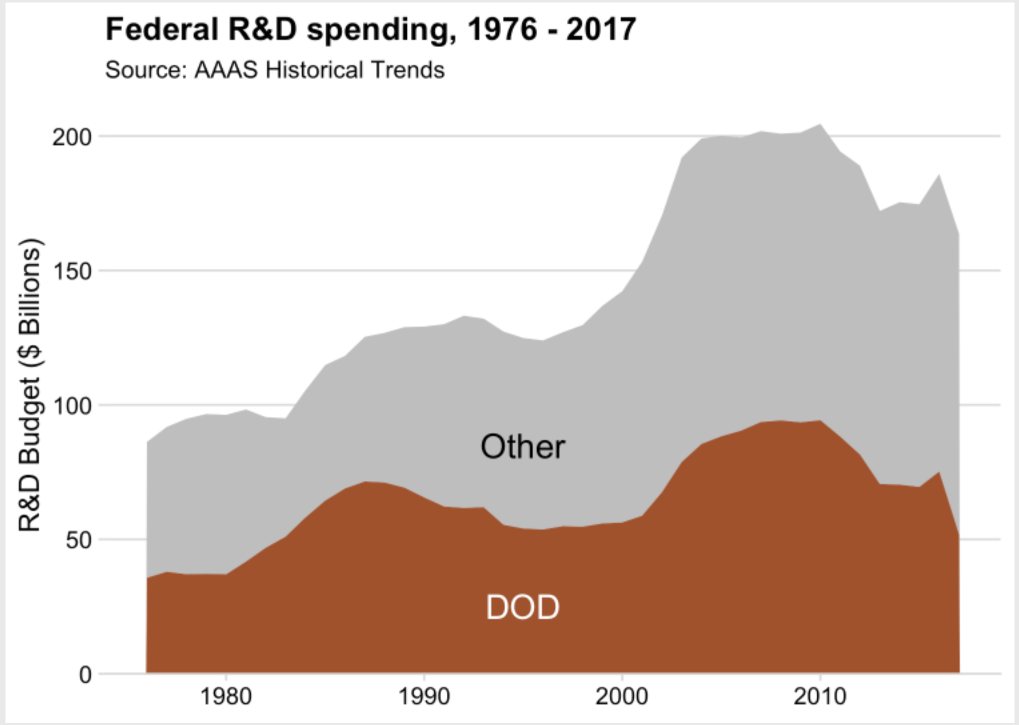


Legends suck

Legends require look-up task

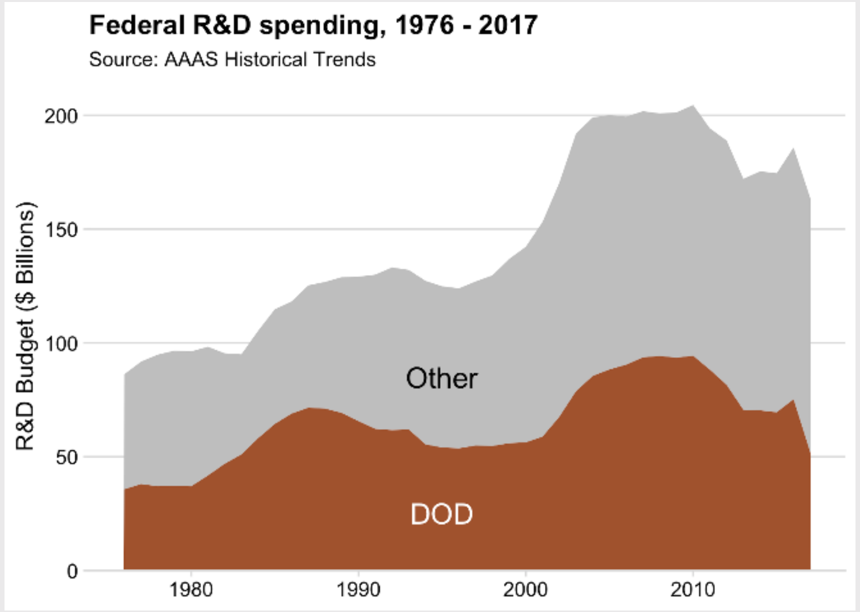


Direct labeling is much better



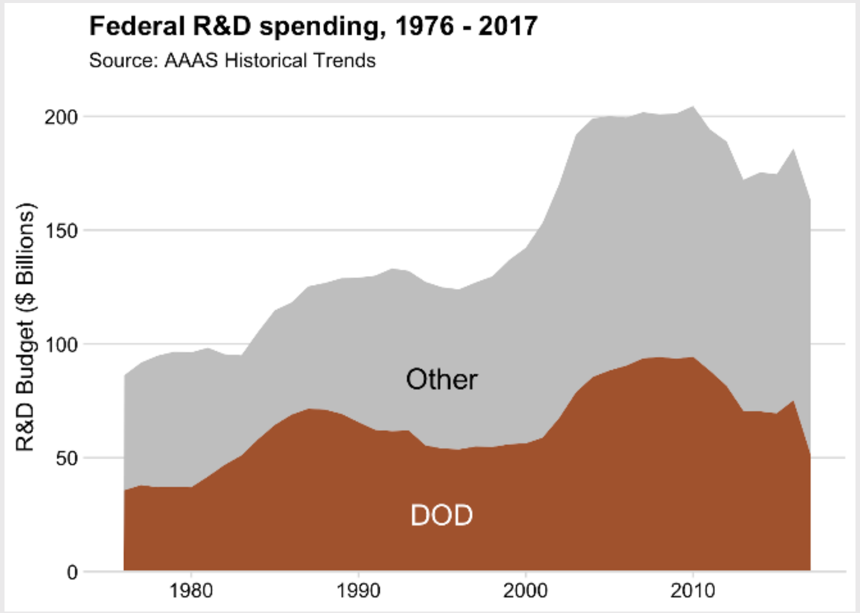
Use annotate() to add text to chart

```r
dod_spending <- ggplot(federal_spending_summary) +
    geom_area(aes(x = year, y = rd_budget,
                  fill = department)) +
    annotate(geom = 'text', x = 1995, y = 85,
             label = 'Other', size = 6, color = 'black')
    annotate(geom = 'text', x = 1995, y = 25,
             label = 'DOD', size = 6, color = 'white') +
    scale_y_continuous(
        expand = expand_scale(mult = c(0, 0.05))) +
    scale_fill_manual(values = c('grey', 'sienna')) +
    theme_minimal_hgrid() +
    theme(legend.position = 'none') +
    labs(x = NULL,
         y = 'R&D Budget ($ Billions)',
         title = 'Federal R&D spending, 1976 - 2017',
         subtitle = 'Source: AAAS Historical Trends')

dod_spending
```



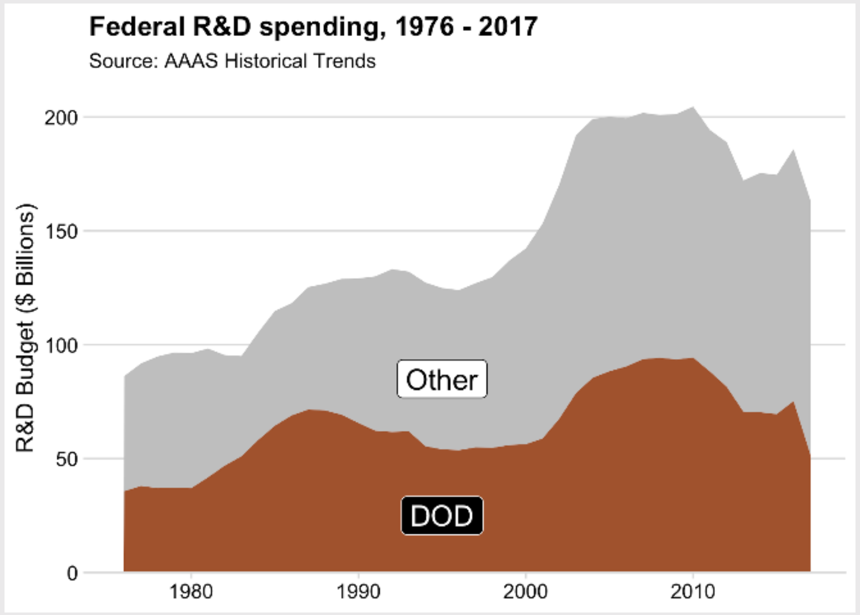
Use `geom_text()` to add text to chart

```r
dod_spending <- ggplot(federal_spending_summary) +
    geom_area(aes(x = year, y = rd_budget,
                  fill = department)) +
    geom_text(
      data = data.frame(x = 1995, y = 85, label = 'Other
      aes(x = x, y = y, label = label),
      size = 6, color = 'black') +
    geom_text(
      data = data.frame(x = 1995, y = 25, label = 'DOD')
      aes(x = x, y = y, label = label),
      size = 6, color = 'white') +
    scale_y_continuous(
        expand = expand_scale(mult = c(0, 0.05))) +
    scale_fill_manual(values = c('grey', 'sienna')) +
    theme_minimal_hgrid() +
    theme(legend.position = 'none') +
    labs(x = NULL,
         y = 'R&D Budget ($ Billions)',
         title = 'Federal R&D spending, 1976 - 2017',
         subtitle = 'Source: AAAS Historical Trends')

dod_spending
```



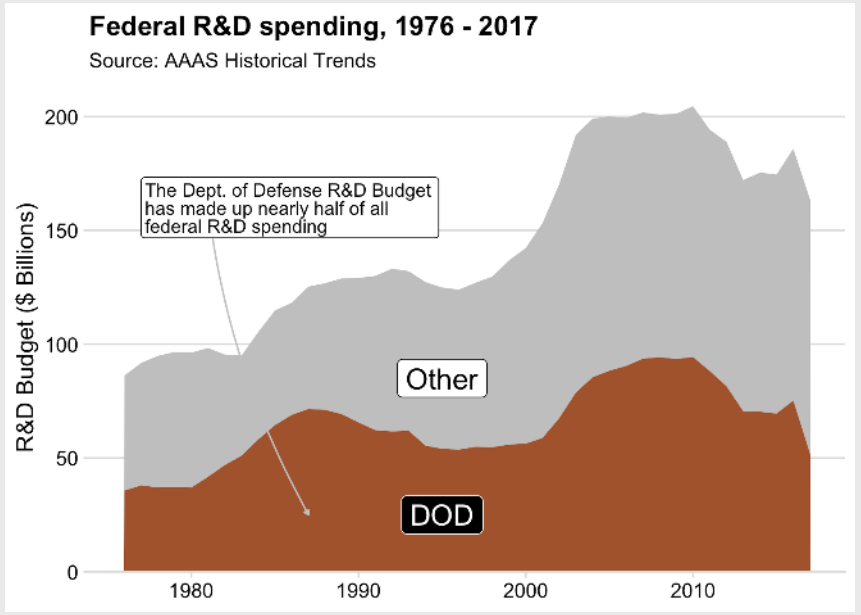
Use `geom_label()` to add text to chart **with a background**

```r
dod_spending <- ggplot(federal_spending_summary) +
    geom_area(aes(x = year, y = rd_budget,
                  fill = department)) +
    geom_label(
      data = data.frame(x = 1995, y = 85, label = 'Other
      aes(x = x, y = y, label = label),
      size = 6) +
    geom_label(
      data = data.frame(x = 1995, y = 25, label = 'DOD')
      aes(x = x, y = y, label = label),
      size = 6, fill = "black", color = "white") +
    scale_y_continuous(
      expand = expand_scale(mult = c(0, 0.05))) +
    scale_fill_manual(values = c('grey', 'sienna')) +
    theme_minimal_hgrid() +
    theme(legend.position = 'none') +
    labs(x = NULL,
         y = 'R&D Budget ($ Billions)',
         title = 'Federal R&D spending, 1976 - 2017',
         subtitle = 'Source: AAAS Historical Trends')

dod_spending
```



Use geom_curve() + geom_label() to direct attention

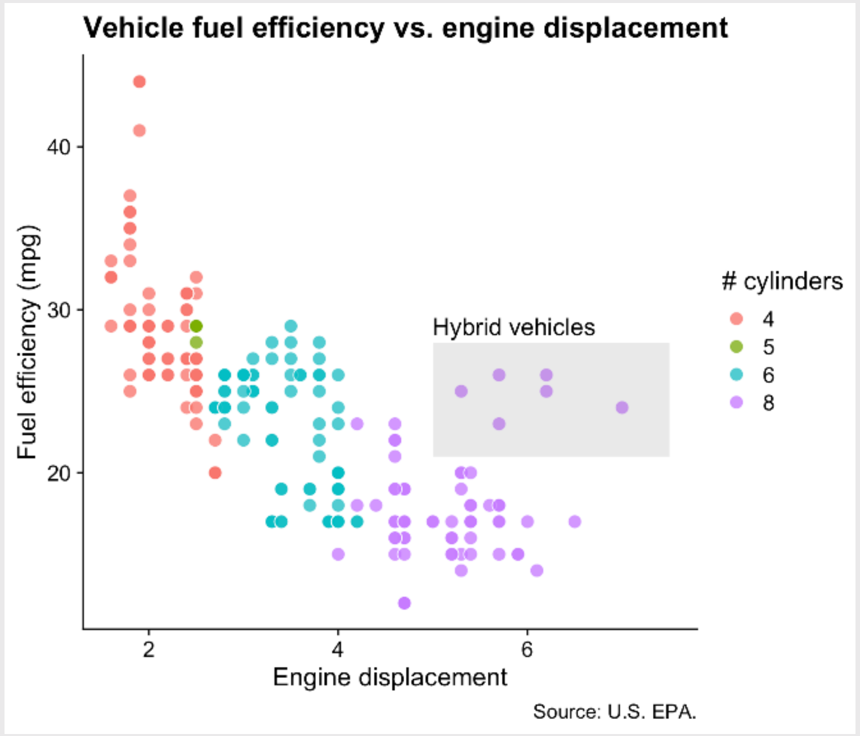
```
label <- "The Dept. of Defense R&D Budget
has made up nearly half of all
federal R&D spending"

dod_spending +
  geom_curve(
    data = data.frame(
      x = 1981, xend = 1987, y = 160, yend = 25),
    mapping = aes(x = x, xend = xend, y = y, yend = yend
    color = 'grey75', size = 0.5, curvature = 0.1,
    arrow = arrow(length = unit(0.01, "npc"),
                  type = "closed")) +
  geom_label(
    data = data.frame(x = 1977, y = 160, label = label),
    mapping = aes(x = x, y = y, label = label),
    hjust = 0, lineheight = 0.8)
```



Use annotate() to direct attention

Use `geom = "rect"` for box, `geom = "text"` for label

```
ggplot(mpg, aes(x = displ, y = hwy)) +
  geom_point(
    aes(fill = as.factor(cyl)),
    color = 'white', alpha = 0.8,
    size = 3.5, shape = 21) +
  annotate(geom = "rect",
    xmin = 5, xmax = 7.5,
    ymin = 21, ymax = 28,
    fill = "grey55", alpha = 0.2) +
  annotate(geom = "text",
    x = 5, y = 29, label = "Hybrid vehicles",
    hjust = 0, size = 5) +
  theme_half_open(font_size = 15) +
  labs(x = "Engine displacement",
       y = "Fuel efficiency (mpg)",
       fill = '# cylinders',
       title = "Vehicle fuel efficiency vs. engine displa
       caption = "Source: U.S. EPA.")
```



Find where to put annotations with `ggannotate`

Install:

```
remotes::install_github("mattcowgill/ggannotate")
```

Use:

```
library(ggannotate)

plot <- ggplot(mpg) +
  geom_point(aes(x = displ, y = hwy, color = as.factor(cy
  theme_half_open()

ggannotate(plot)
```

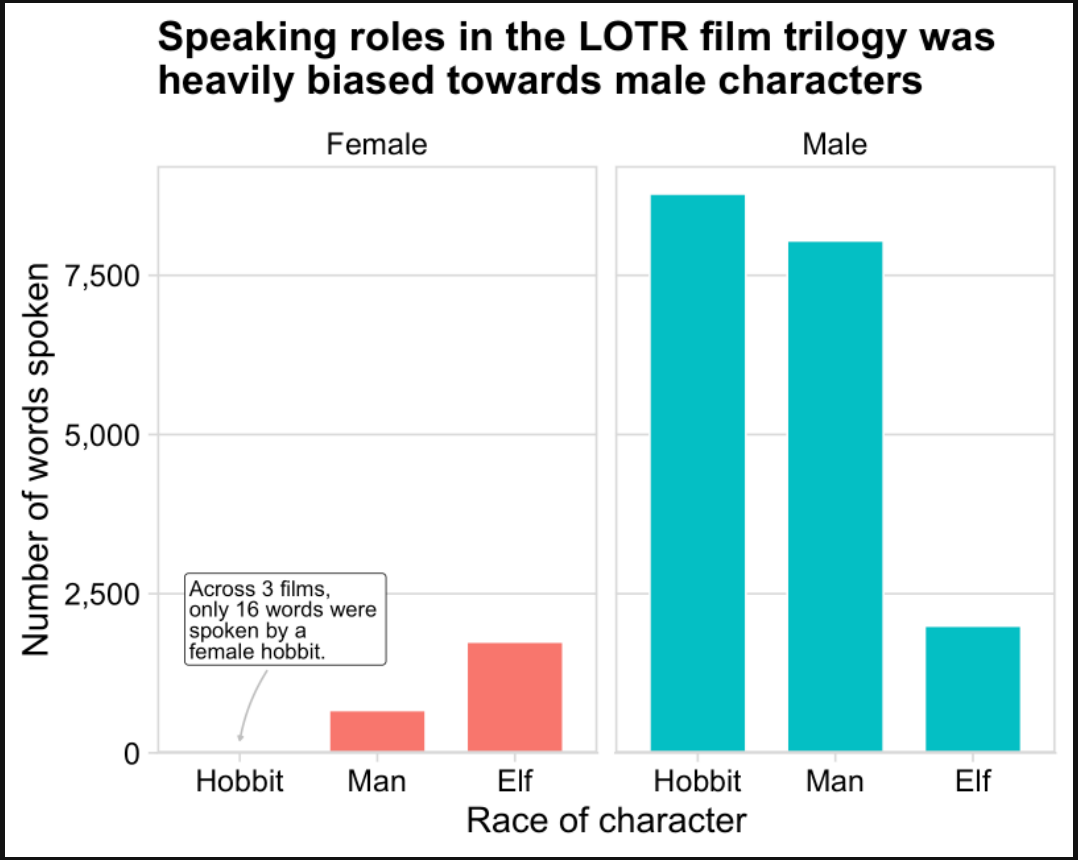
Your turn

20:00

Use the `lotr_summary` data frame to create the following chart.

Hints:

- For the `geom_label()`, use these points:
  - `x = 0.6`
  - `y = 2100`
- For the `geom_curve()`, use these points:
  - `x = 1.2`
  - `xend = 1`
  - `y = 1300`
  - `yend = 200`



Intermission

05:00

Week 10: *Polishing Charts*

1. Scales

2. Annotations

BREAK

3. Colors

4. Fonts

5. qmd tricks

Color is hard

How do I know what colors look good together?

Use the color wheel

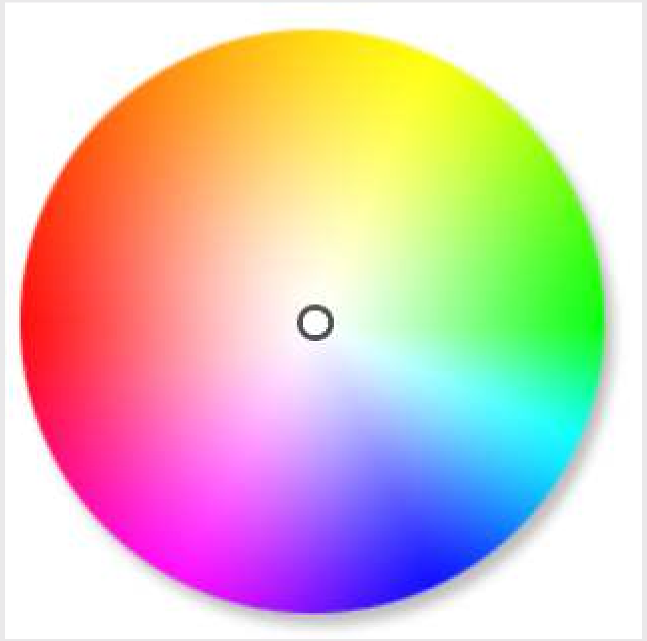


Image from this color wheel tool

How do I know what colors look good together?

Use the color wheel

1. **Complementary**: High contrast

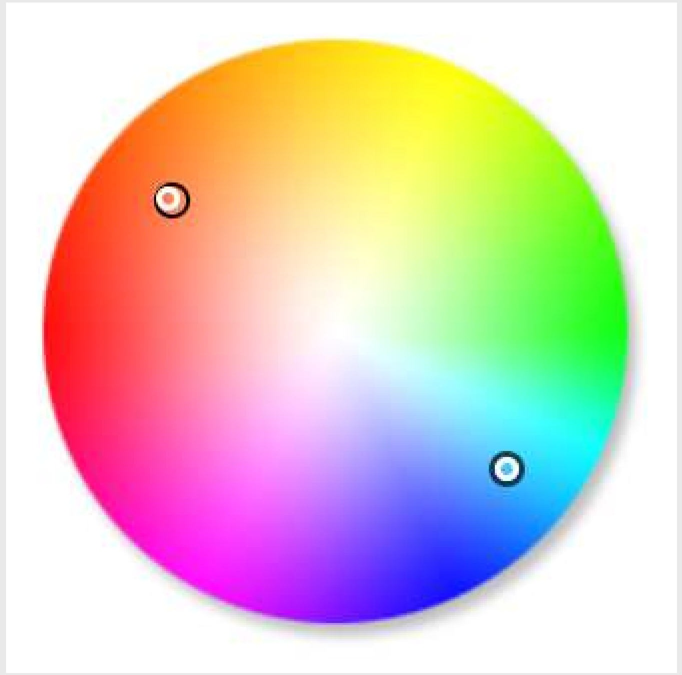


Image from this color wheel tool

How do I know what colors look good together?

Use the color wheel

1. Complementary: High contrast
2. **Analogous**: Calm, harmonious

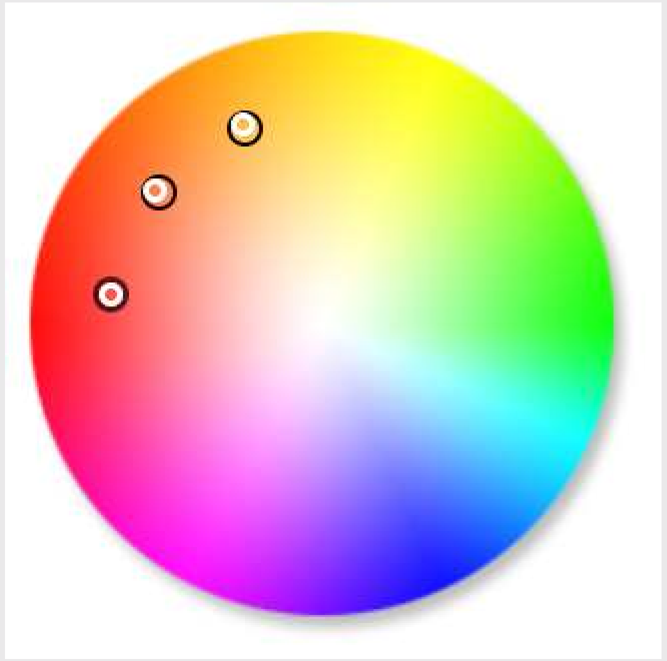


Image from this color wheel tool

How do I know what colors look good together?

Use the color wheel

1. Complementary: High contrast
2. Analogous: Calm, harmonious
3. **Triadic**: Vibrant, contrast

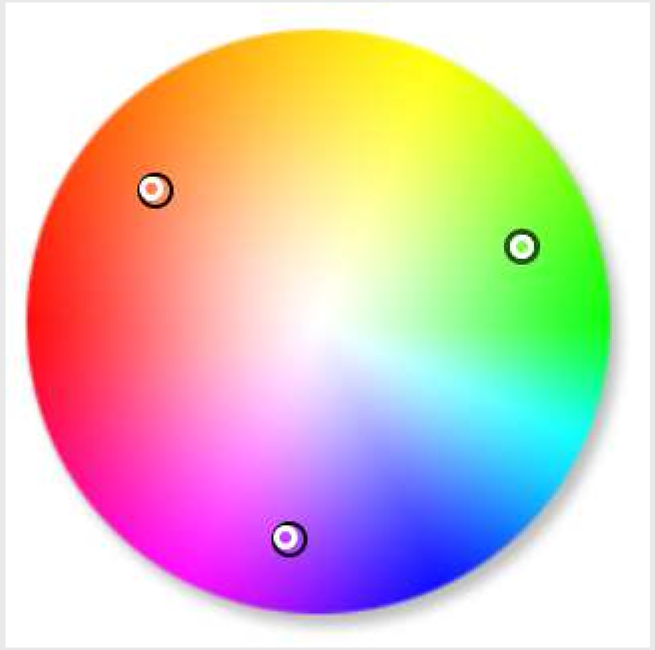


Image from this color wheel tool

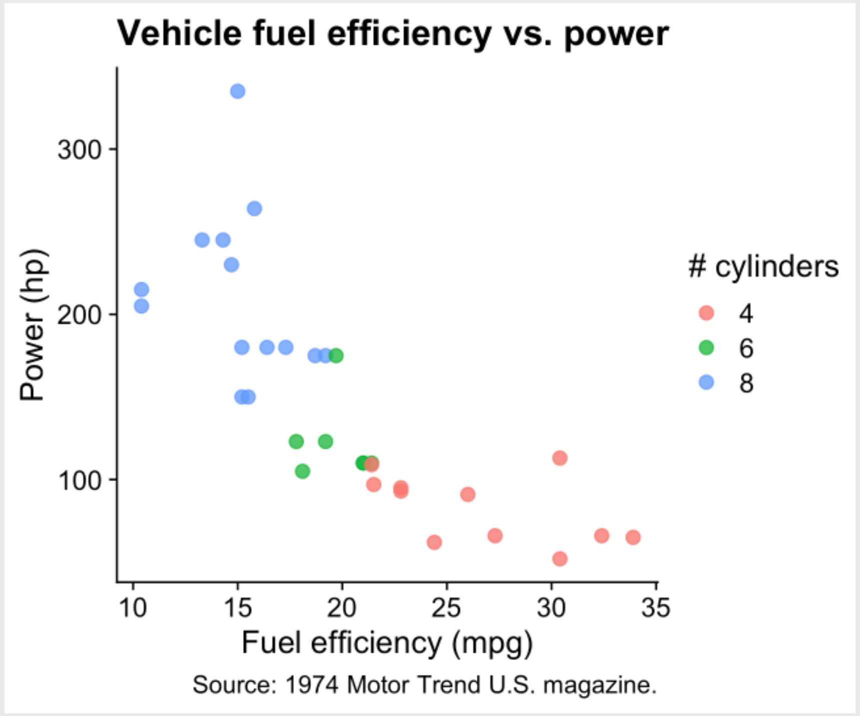
Artists use color theory too!

Steal colors with the eye dropper tool

Using your own colors

Map color to variable

```
mpg_plot <- ggplot(mtcars, aes(x = mpg, y = hp)) +
  geom_point(
    aes(color = as.factor(cyl)),
    alpha = 0.8, size = 3) +
  theme_half_open(font_size = 16) +
  labs(x = "Fuel efficiency (mpg)",
       y = "Power (hp)",
       color = '# cylinders',
       title = "Vehicle fuel efficiency vs. power",
       caption = "Source: 1974 Motor Trend U.S. magazine
```



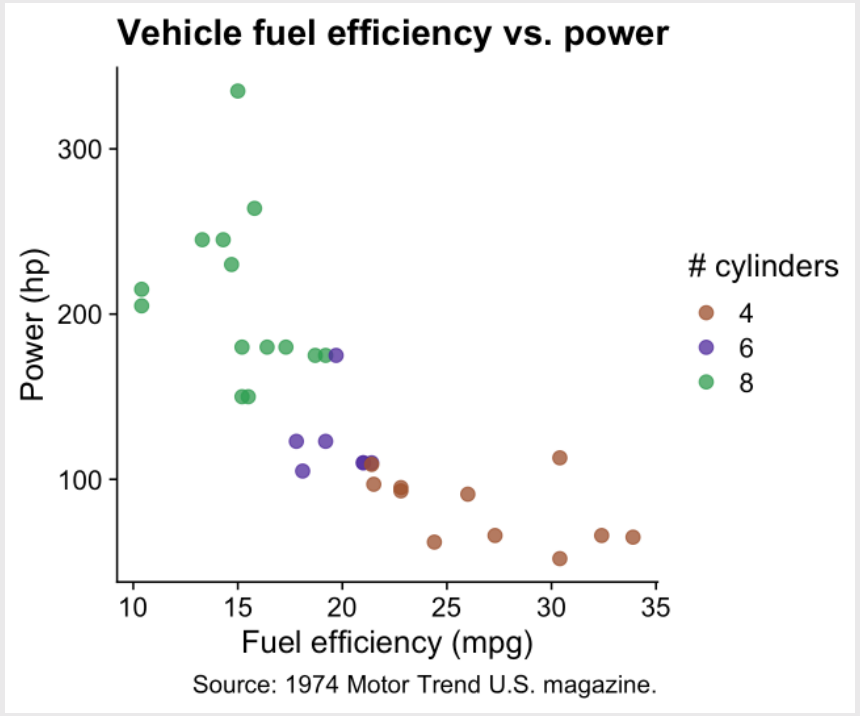
Using your own colors

Map color to variable

```r
mpg_plot <- ggplot(mtcars, aes(x = mpg, y = hp)) +
  geom_point(
    aes(color = as.factor(cyl)),
    alpha = 0.8, size = 3) +
  theme_half_open(font_size = 16) +
  labs(x = "Fuel efficiency (mpg)",
       y = "Power (hp)",
       color = '# cylinders',
       title = "Vehicle fuel efficiency vs. power",
       caption = "Source: 1974 Motor Trend U.S. magazine
```

Manually change colors

```r
mpg_plot +
    scale_color_manual(values = c(
        '#a0522d', '#522da0', '#2da052'))
```



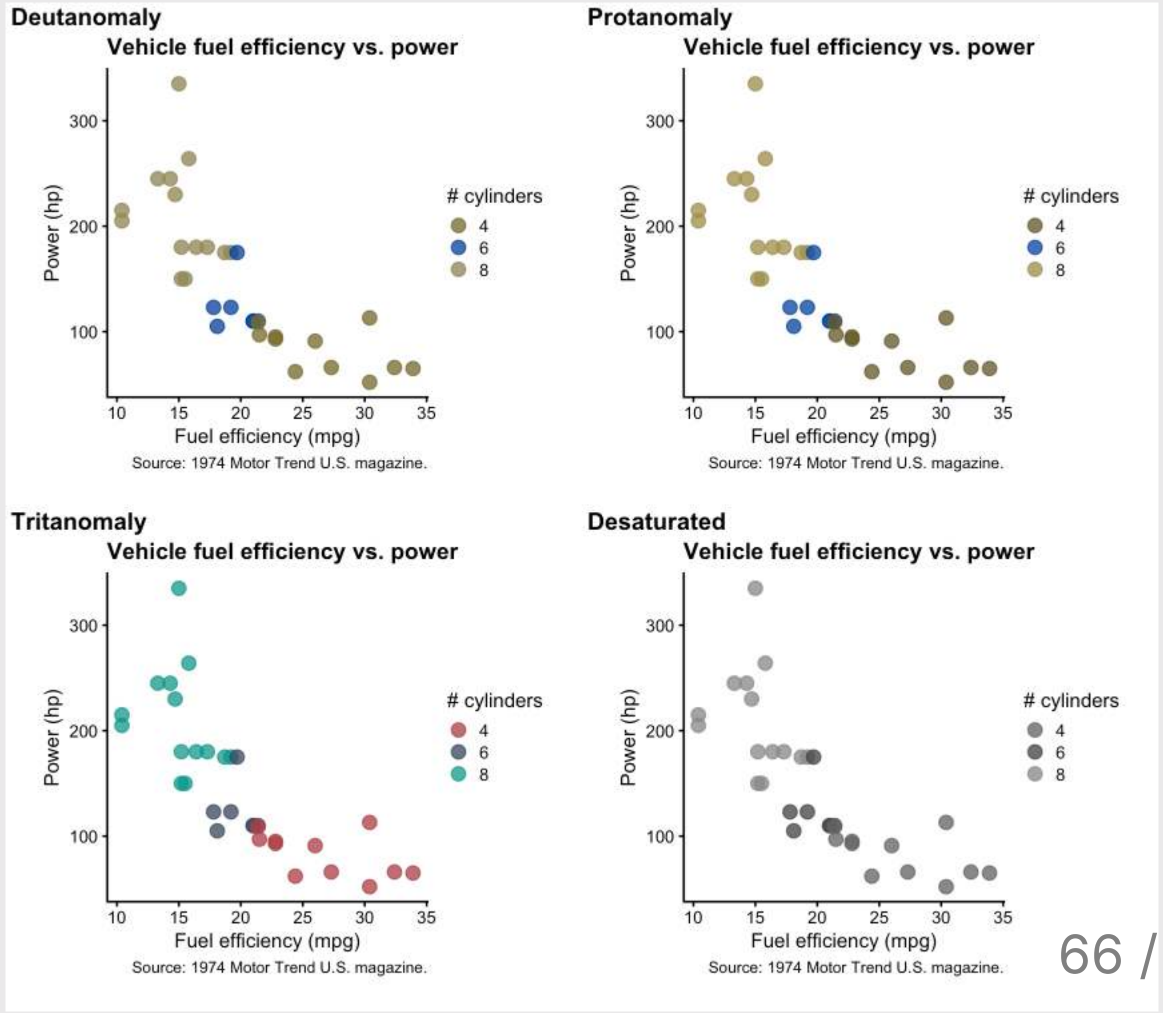
Consider color blind friendly colors

Manually change colors

```
mpg_plot_mycolors <- mpg_plot +
    theme_half_open(font_size = 10) +
    scale_color_manual(values = c(
        '#a0522d', '#522da0', '#2da052'))
```

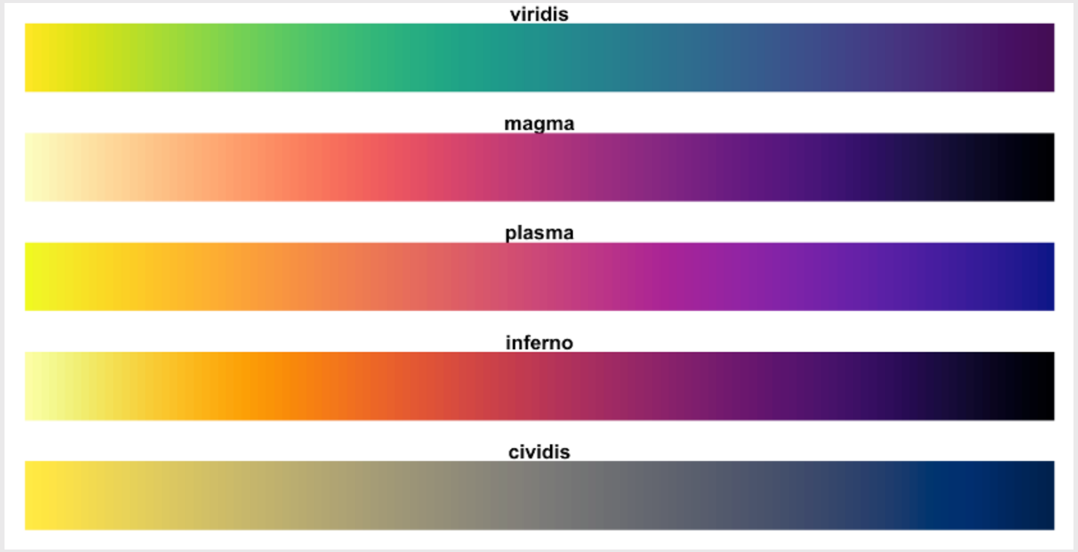
Simulate color blindness with colorblindr

```
# remotes::install_github("clauswilke/colo
library(colorblindr)

cvd_grid(mpg_plot_mycolors)
```

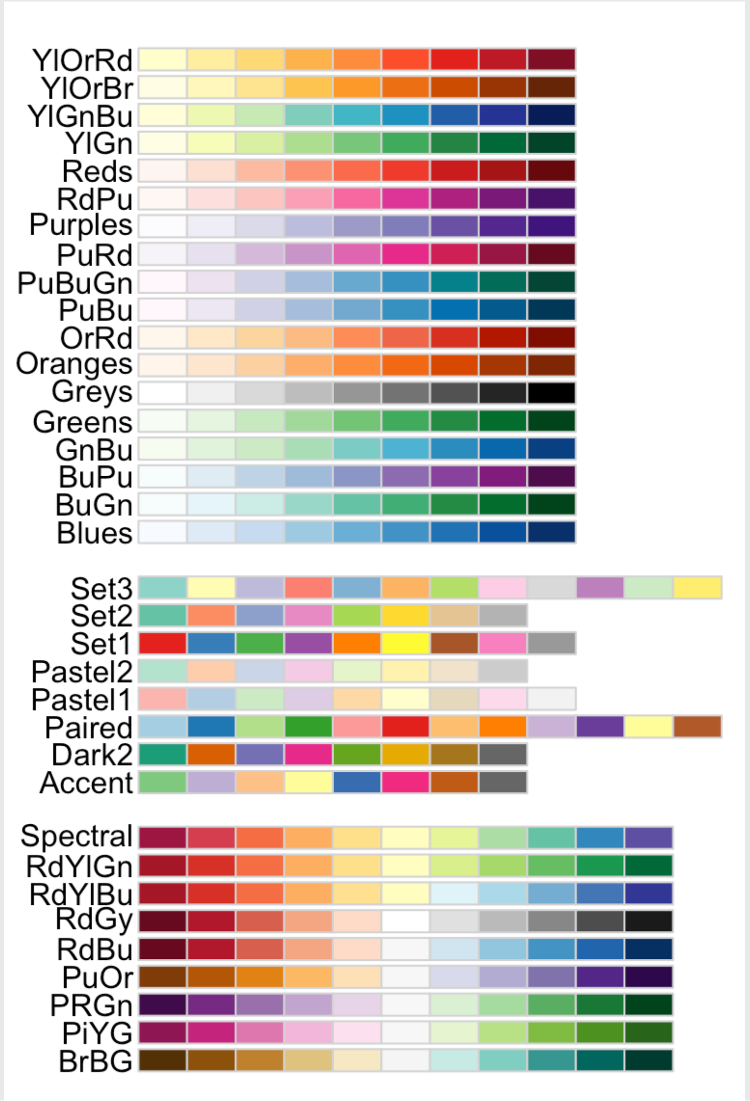


Use palettes

Viridis



ColorBrewer



3 types of palettes

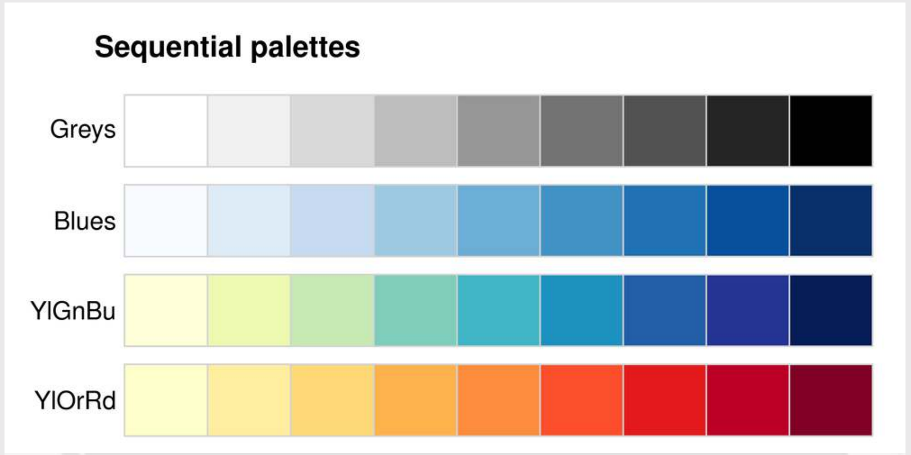
1. Sequential

2. Diverging

3. Categorical

3 types of palettes

1. **Sequential**
2. Diverging
3. Categorical



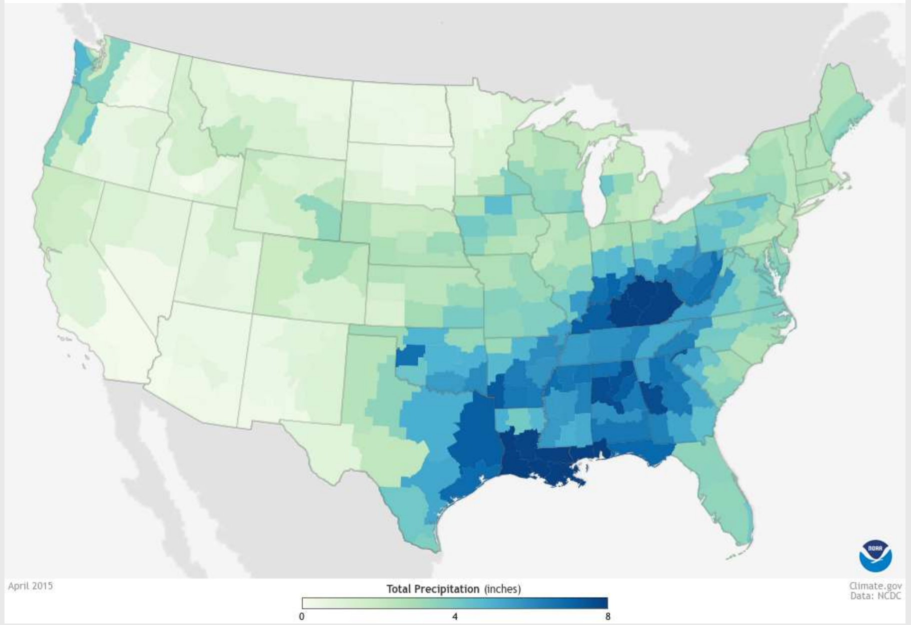


Image from betterfigures.org

3 types of palettes

1. Sequential
2. **Diverging**
3. Categorical

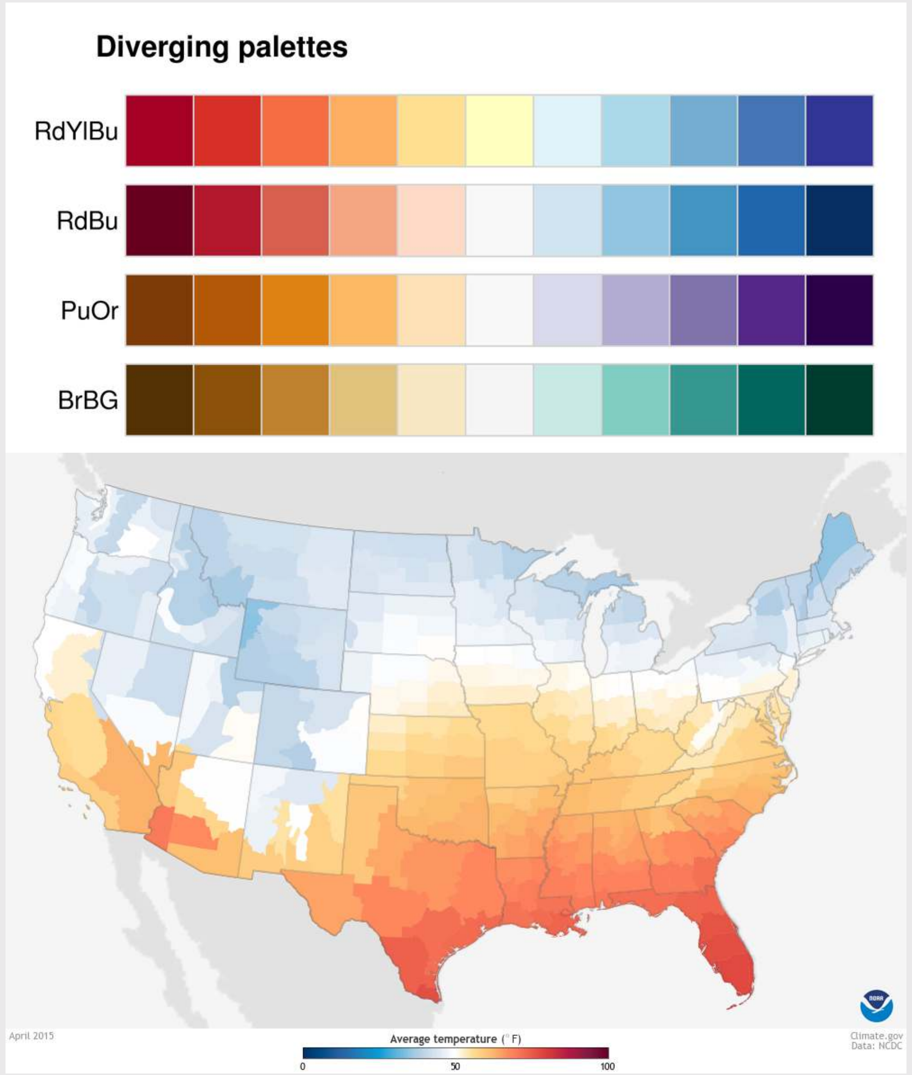
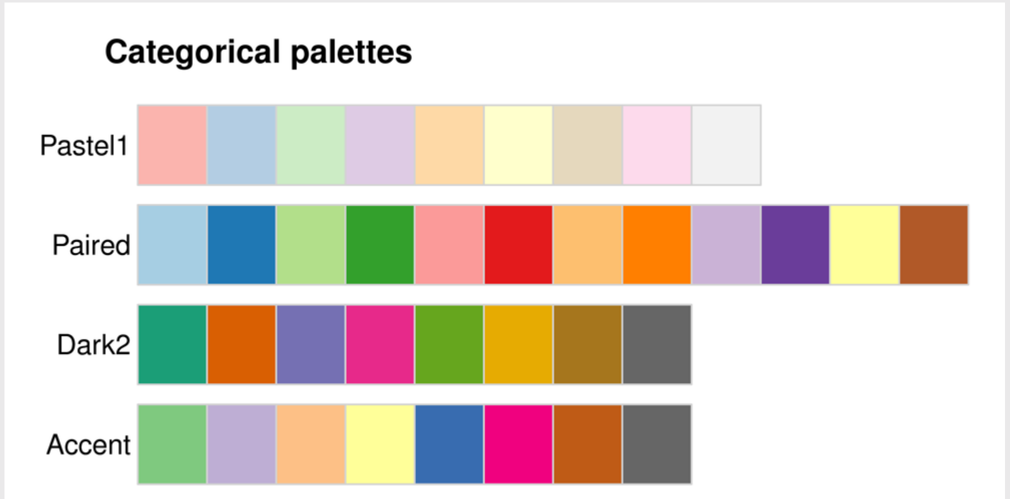
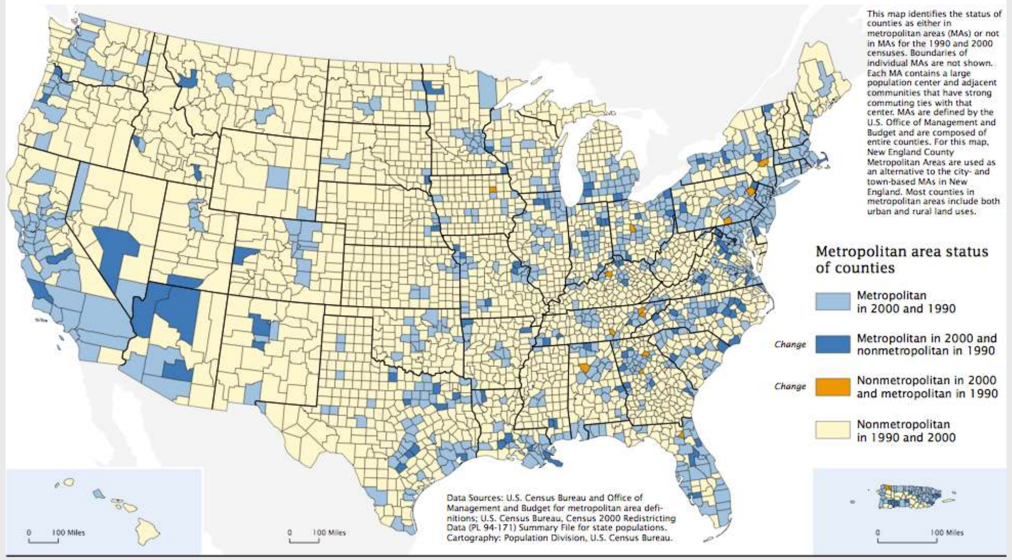


Image from betterfigures.org

3 types of palettes

1. Sequential
2. Diverging
3. **Categorical**




Metropolitan area status of counties
Metropolitan in 2000 and 1990
Change
Metropolitan in 2000 and nonmetropolitan in 1990
Change
Nonmetropolitan in 2000 and metropolitan in 1990
Nonmetropolitan in 1990 and 2000
0 100 Miles
0 100 Miles
0 100 Miles

This map identifies the status of counties as either in metropolitan areas (MAs) or not in MAs for the 1990 and 2000 censuses. Boundaries of individual MAs are not shown. Each MA contains a large population center and adjacent communities that have strong commuting ties with that center. MAs are defined by the U.S. Office of Management and Budget and are composed of entire counties. For this map, New England County Metropolitan Areas are used as an alternative to the city- and town-based MAs in New England. Most counties in metropolitan areas include both urban and rural land uses.

Data Sources: U.S. Census Bureau and Office of Management and Budget for metropolitan area definitions; U.S. Census Bureau, Census 2000 Redistricting Data (PL 94-171) Summary File for state populations. Cartography: Population Division, U.S. Census Bureau.

Image from betterfigures.org

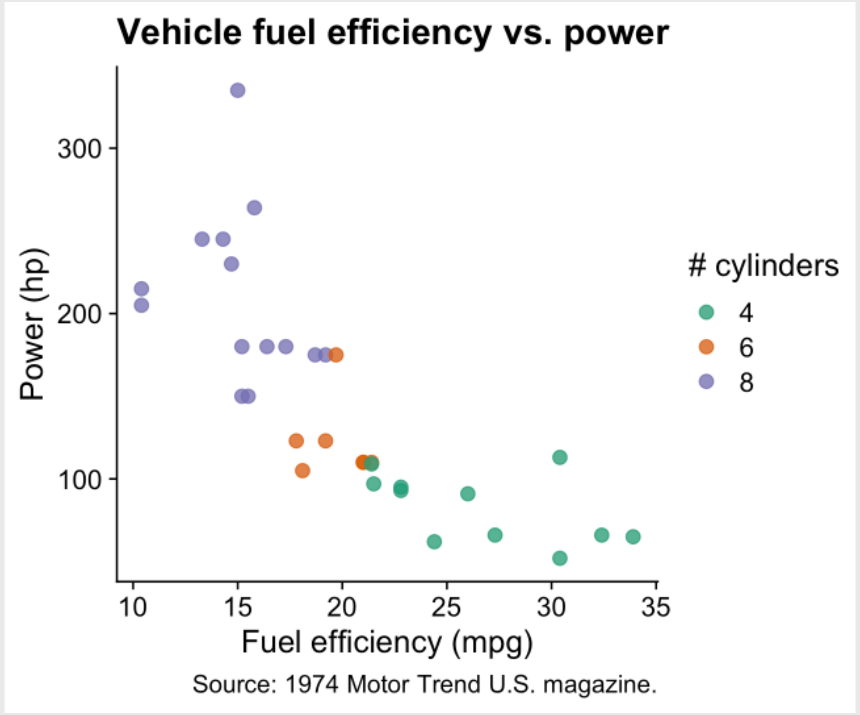
ColorBrewer palettes

Map color to variable

```
mpg_plot <- ggplot(mtcars, aes(x = mpg, y = hp)) +
    geom_point(aes(color = as.factor(cyl)),
               alpha = 0.8, size = 3) +
    theme_half_open(font_size = 16) +
    labs(x = "Fuel efficiency (mpg)",
         y = "Power (hp)",
         color = '# cylinders',
         title = "Vehicle fuel efficiency vs. power",
         caption = "Source: 1974 Motor Trend U.S. magazi
```

Use "Dark2" palette

```
mpg_plot +
    scale_color_brewer(palette = 'Dark2')
```

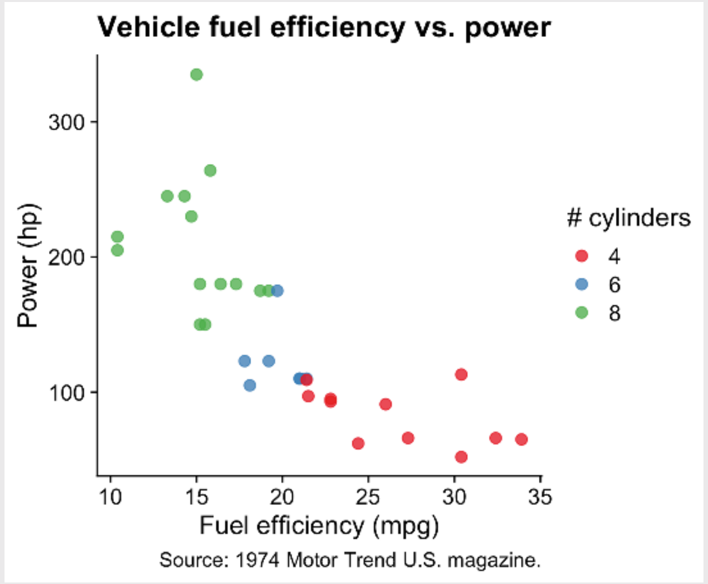


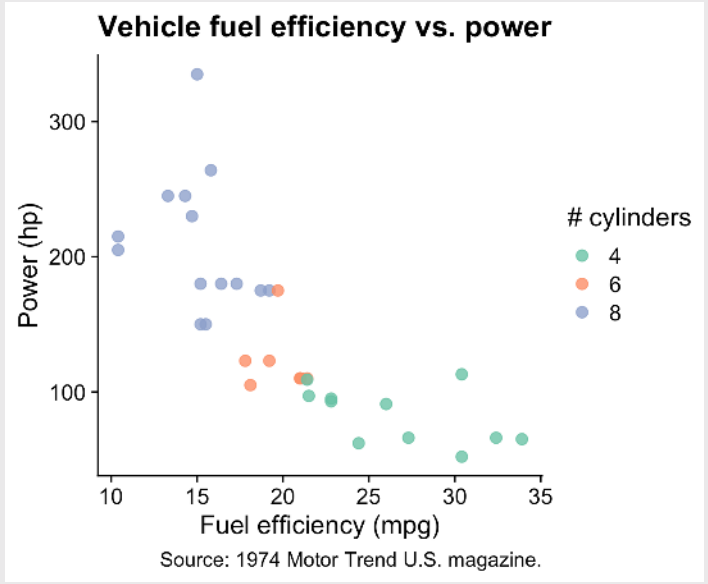
ColorBrewer palettes

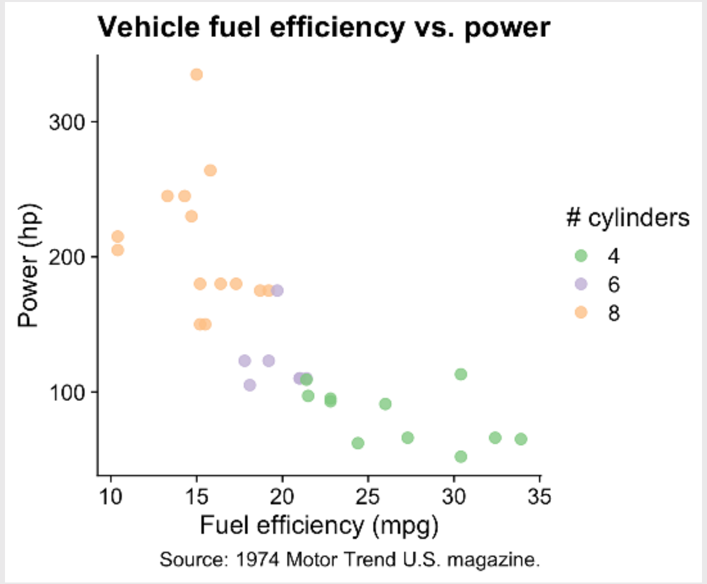
```
mpg_plot +
    scale_color_brewer(
        palette = 'Set1')
```

```
mpg_plot +
    scale_color_brewer(
        palette = 'Set2')
```

```
mpg_plot +
    scale_color_brewer(
        palette = 'Accent')
```







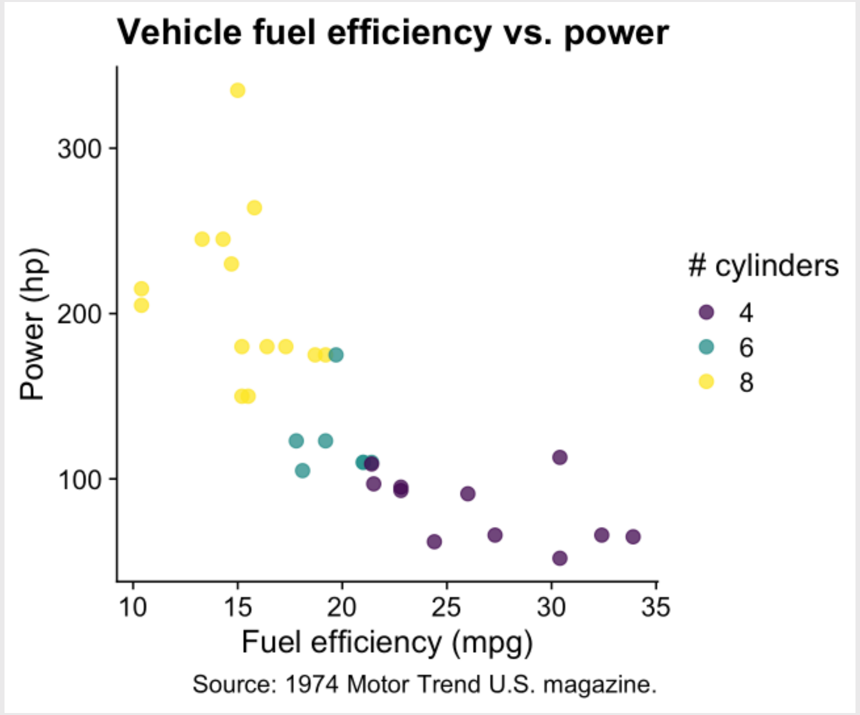
viridis palettes

Map color to variable

```r
mpg_plot <- ggplot(mtcars, aes(x = mpg, y = hp)) +
    geom_point(aes(color = as.factor(cyl)),
               alpha = 0.8, size = 3) +
    theme_half_open(font_size = 16) +
    labs(x = "Fuel efficiency (mpg)",
         y = "Power (hp)",
         color = '# cylinders',
         title = "Vehicle fuel efficiency vs. power",
         caption = "Source: 1974 Motor Trend U.S. magazi
```

Use viridis colors

```r
mpg_plot +
    scale_color_viridis(discrete = TRUE)
```

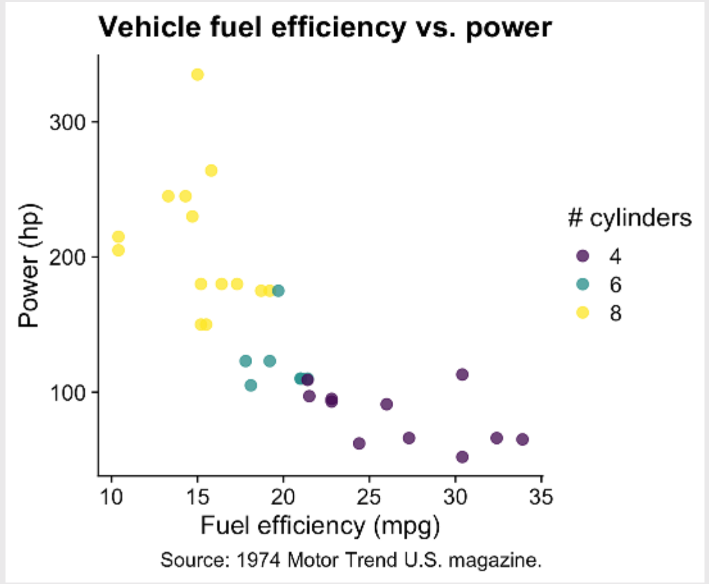


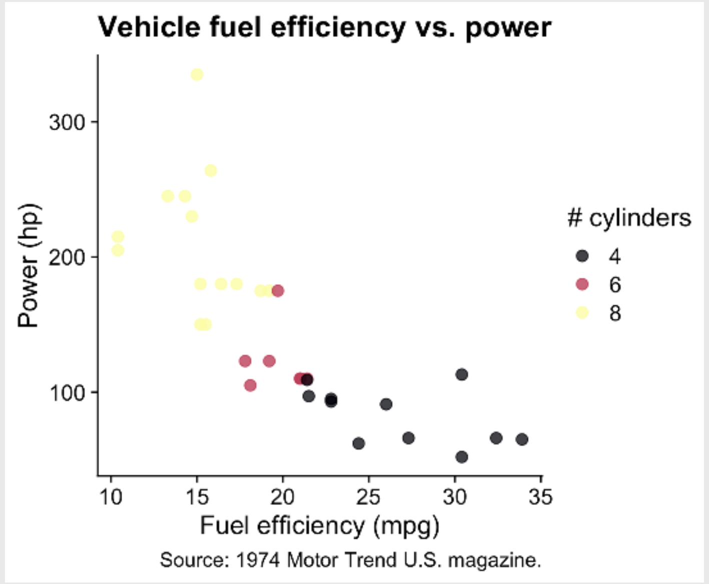
viridis palettes

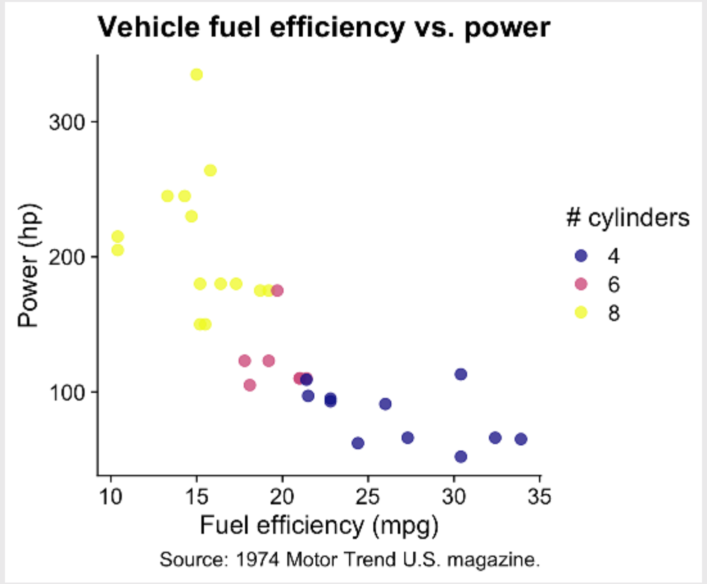
```
mpg_plot +
    scale_color_viridis(
        discrete = TRUE,
        option = 'viridis')
```

```
mpg_plot +
    scale_color_viridis(
        discrete = TRUE,
        option = 'inferno')
```

```
mpg_plot +
    scale_color_viridis(
        discrete = TRUE,
        option = 'plasma')
```

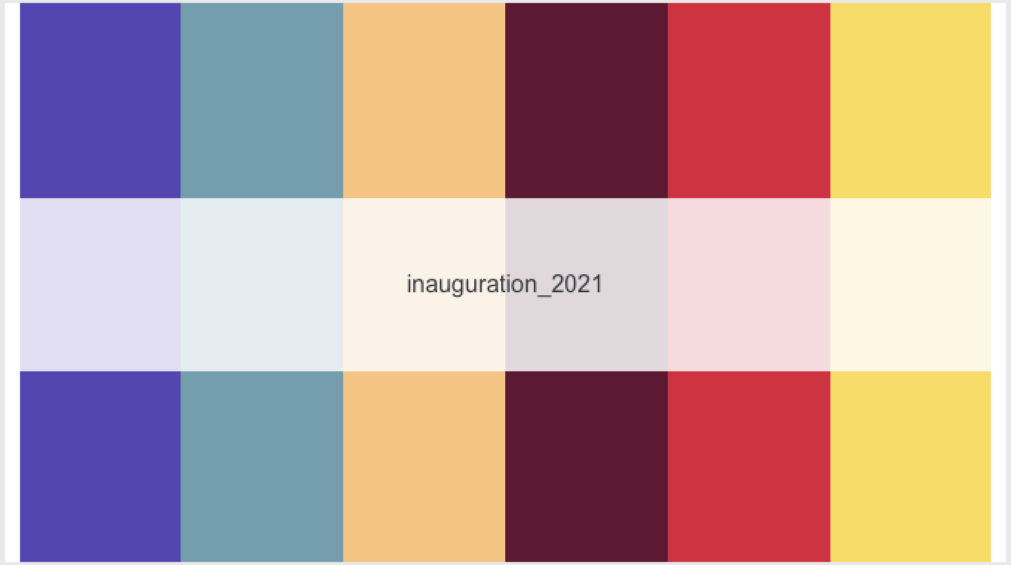




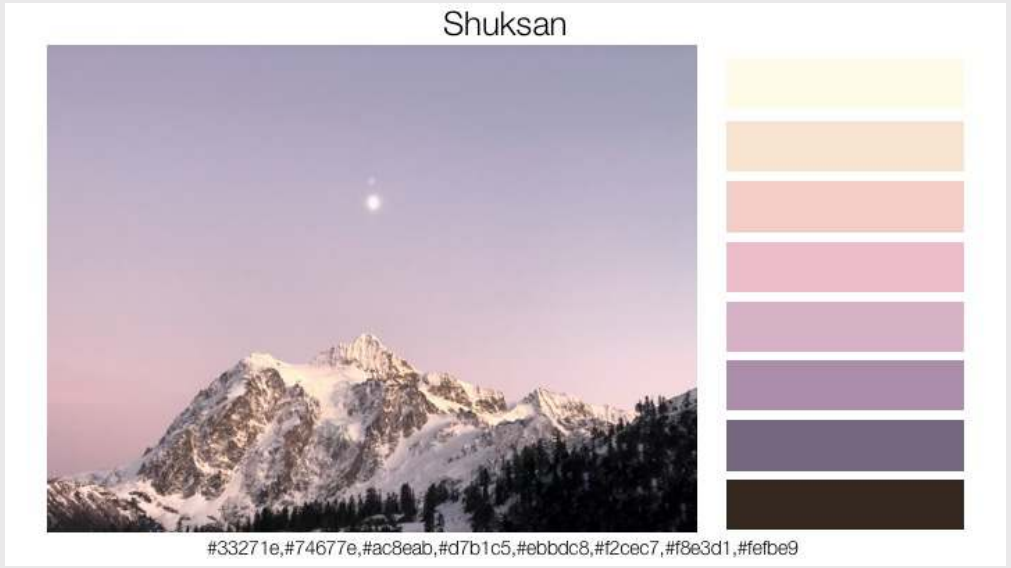


Fun custom palettes

Inauguration palette

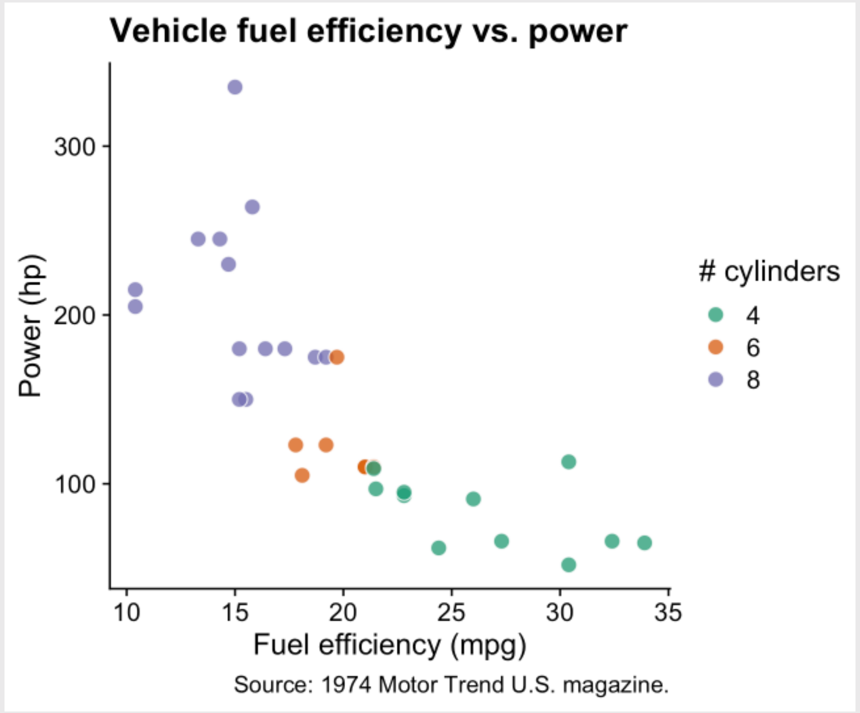


PNWColors



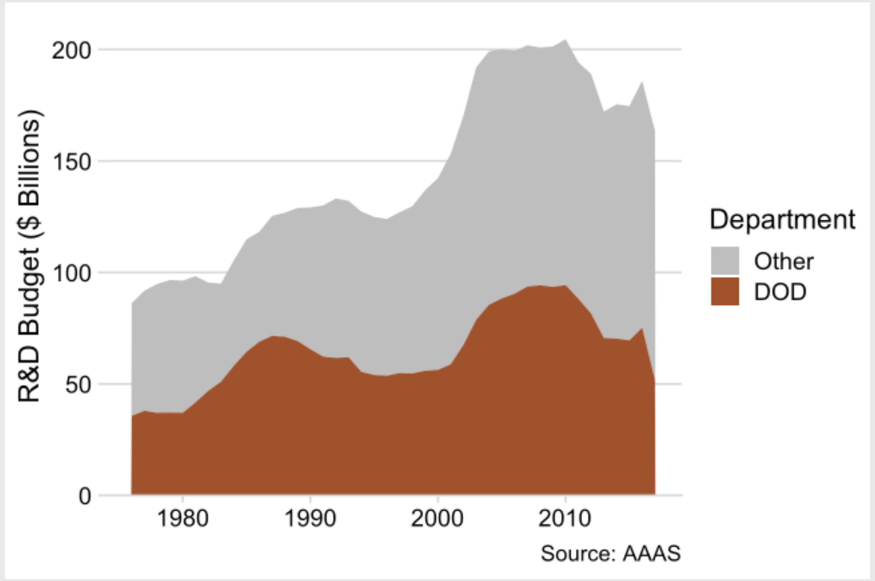
Consider using `color` + `fill` for points

```r
ggplot(mtcars, aes(x = mpg, y = hp)) +
  geom_point(
    aes(fill = as.factor(cyl)),
    color = 'white', shape = 21,
    size = 3.5, alpha = 0.8) +
  scale_fill_brewer(palette = 'Dark2') +
  theme_half_open(font_size = 15) +
  labs(
    x = "Fuel efficiency (mpg)",
    y = "Power (hp)",
    fill = '# cylinders',
    title = "Vehicle fuel efficiency vs. power",
    caption = "Source: 1974 Motor Trend U.S. magazine.")
```



grey = "Other"

```r
dod_spending_plot <- federal_spending %>%
  mutate(department = fct_other(
    department, keep = 'DOD')) %>%
  group_by(department, year) %>%
  summarise(rd_budget = sum(rd_budget) / 10^3)
  ungroup() %>%
  mutate(department = fct_relevel(
  department, c('Other', 'DOD'))) %>%
  ggplot() +
  geom_area(aes(x = year, y = rd_budget,
                fill = department)) +
  scale_y_continuous(
      expand = expand_scale(mult = c(0, 0.05)))
  scale_fill_manual(
    values = c('grey', 'sienna')) +
  theme_minimal_hgrid() +
  labs(x = NULL,
       y = 'R&D Budget ($ Billions)',
       fill = 'Department',
       caption = 'Source: AAAS')

dod_spending_plot
```

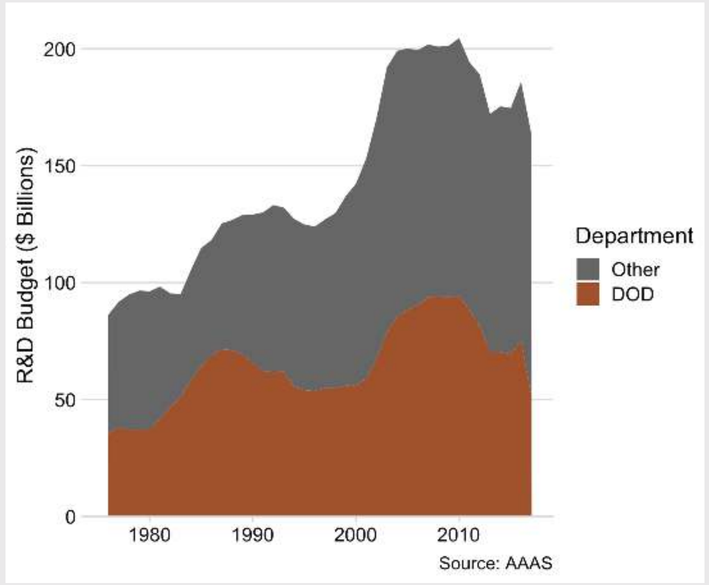


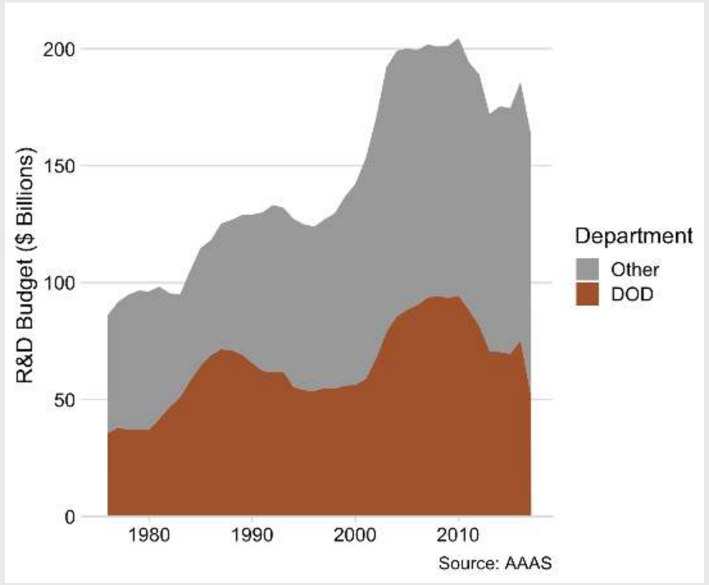
grey = "Other"

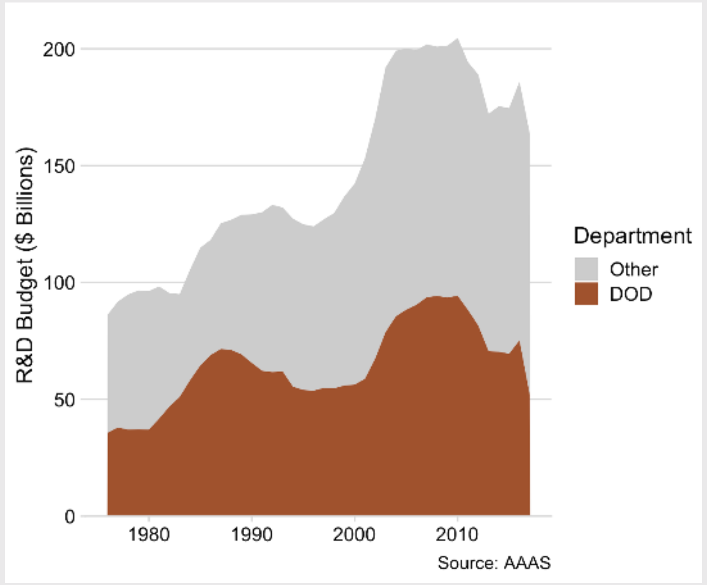
```
dod_spending_plot +
    scale_fill_manual(
        values = c('grey40', 'sienn
```

```
dod_spending_plot +
    scale_fill_manual(
        values = c('grey60', 'sienna
```

```
dod_spending_plot +
    scale_fill_manual(
        values = c('grey80', 'sienn
```







Your turn

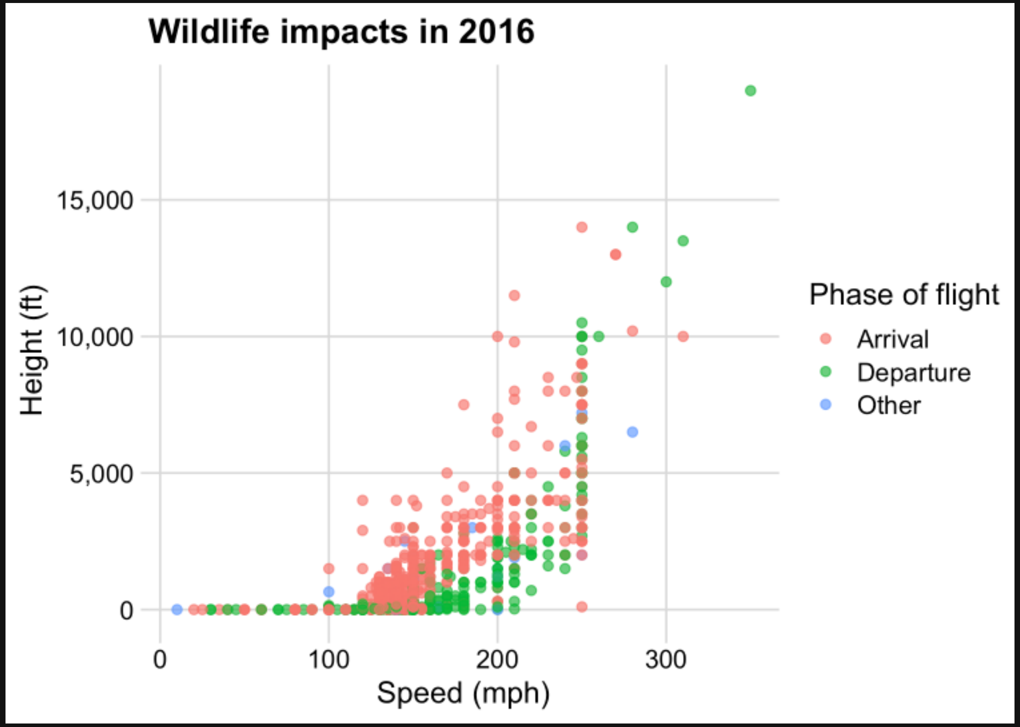
20:00

Make 3 different versions of this chart:

1. Change the colors to the `"RdYlBu"` ColorBrewer palette.
2. Change the colors to the `"inferno"` palette from the **viridis** library.

3. Change the colors to your custom triadic palette:

   - Use the ["eye dropper"]() tool in Google Chrome to select a color from a website, then
   - Use your color and the [color wheel tool]() to find a triadic color palette.



Week 10: *Polishing Charts*

1. Scales

2. Annotations

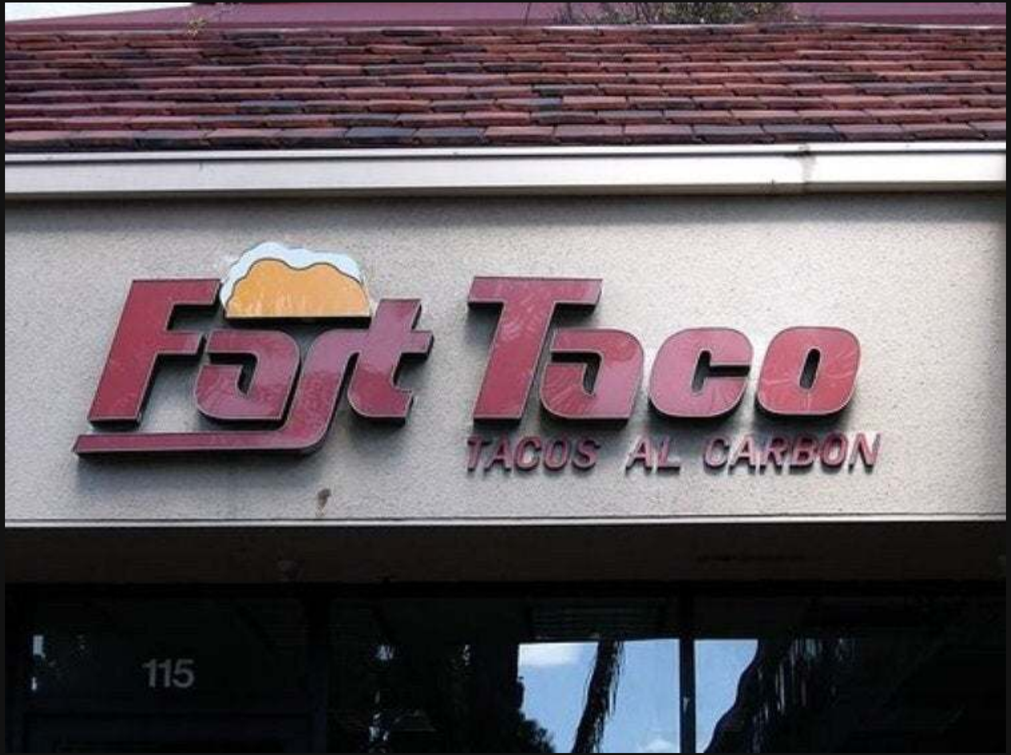
BREAK

3. Colors

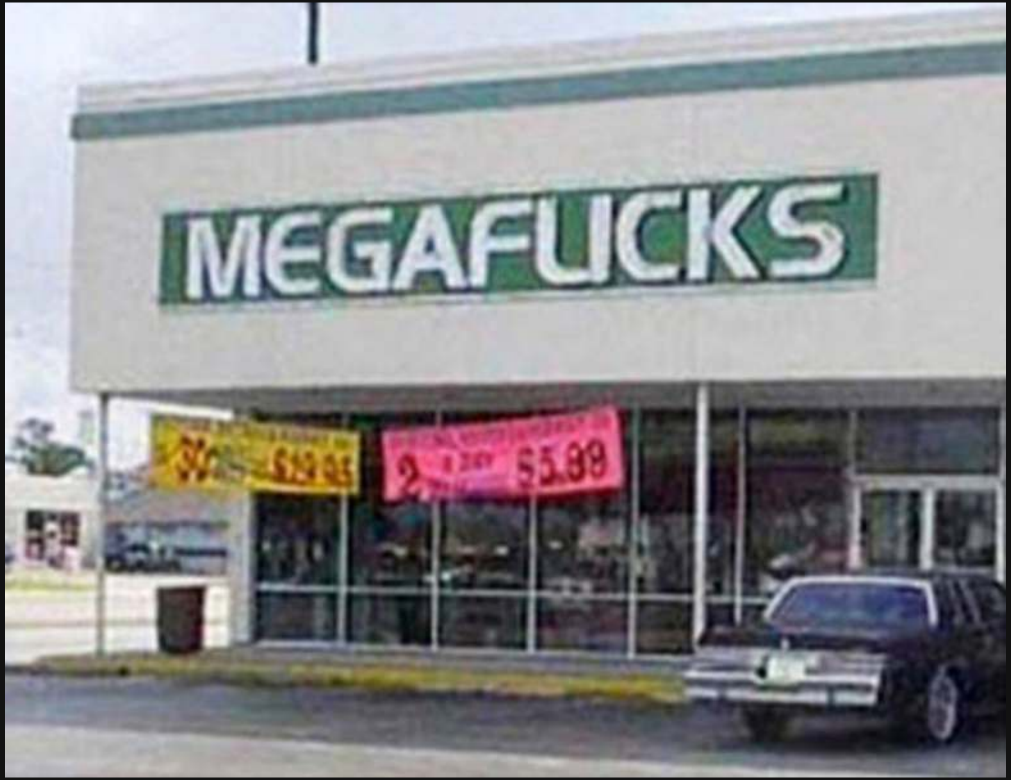
4. Fonts

5. qmd tricks

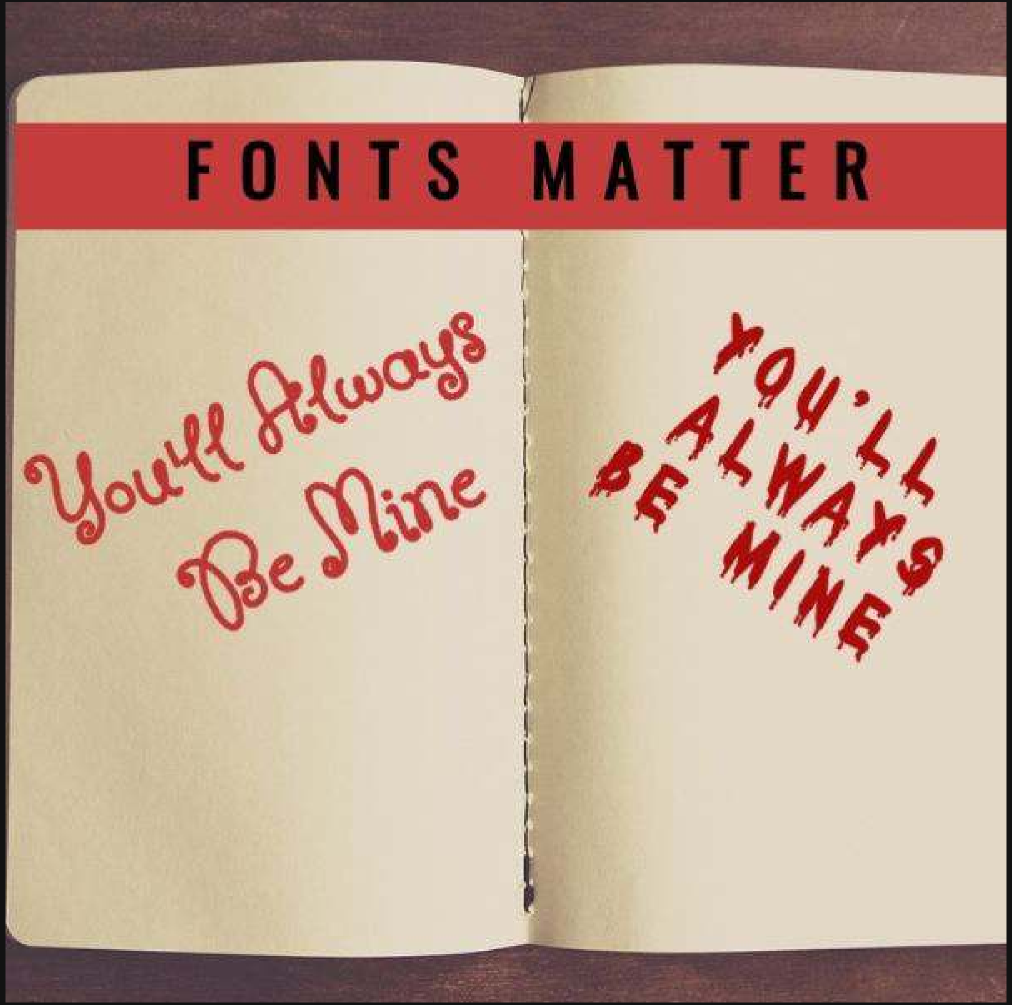
Fonts matter



"Fast Taco"



"Mega Flicks"


FONTS MATTER
You'll Always Be Mine
YOU'LL ALWAYS BE MINE

Best resource on fonts:

practicaltypography.com

Font families you should consider using

Roboto

Source

Fira

Alegreya

Lato

Download:

- Individually from https://fonts.google.com/
- All of these with this zip file

Use fonts to create **hierarchy**

```
# Hierarchy

## Hierarchy

### Hierarchy

#### Hierarchy
```

Hierarchy

Hierarchy

Hierarchy

Hierarchy

Title

This is some text that goes into detail and explains a lot more about the topic described in the title. Here's some random Latin words: Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua.

Size

This is some text that goes into detail and explains a lot more about the topic described in the title. Here's some random Latin words: Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua.

Weight

This is some text that goes into detail and explains a lot more about the topic described in the title. Here's some random Latin words: Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua.

Color

This is some text that goes into detail and explains a lot more about the topic described in the title. Here's some random Latin words: Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua.

Spacing

This is some text that goes into detail and explains a lot more about the topic described in the title. Here's some random Latin words: Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua.

Typeface

This is some text that goes into detail and explains a lot more about the topic described in the title. Here's some random Latin words: Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua.

Title

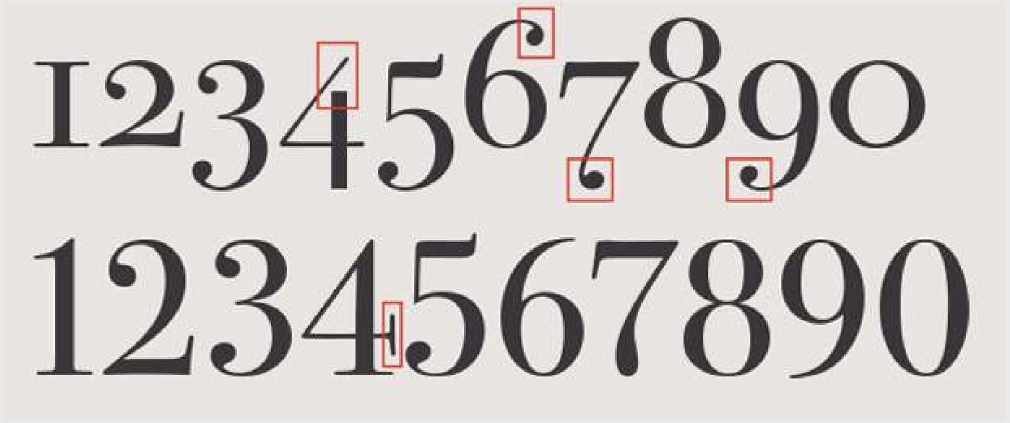
Subtitle

This is some text that goes into detail and explains a lot more about the topic described in the title. Here's some random Latin words: Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua.

Use fonts with **same-height** numbers

"Oldstyle" (bad)

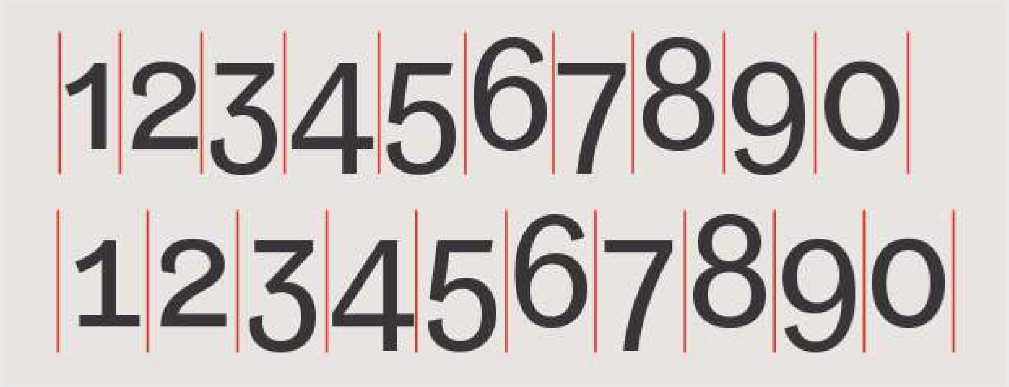
Lining (good)



Use fonts with **same-width** numbers

"Proportional" (bad)

"Tabular" (good)



How to customize fonts in **ggplot**

1. Change the whole theme

For "Base R" themes, use `base_family`:

```
theme_minimal(base_family = "Roboto Condensed")
```

```
theme_bw(base_family = "Roboto Condensed")
```

For "cowplot" themes, use `font_family`:

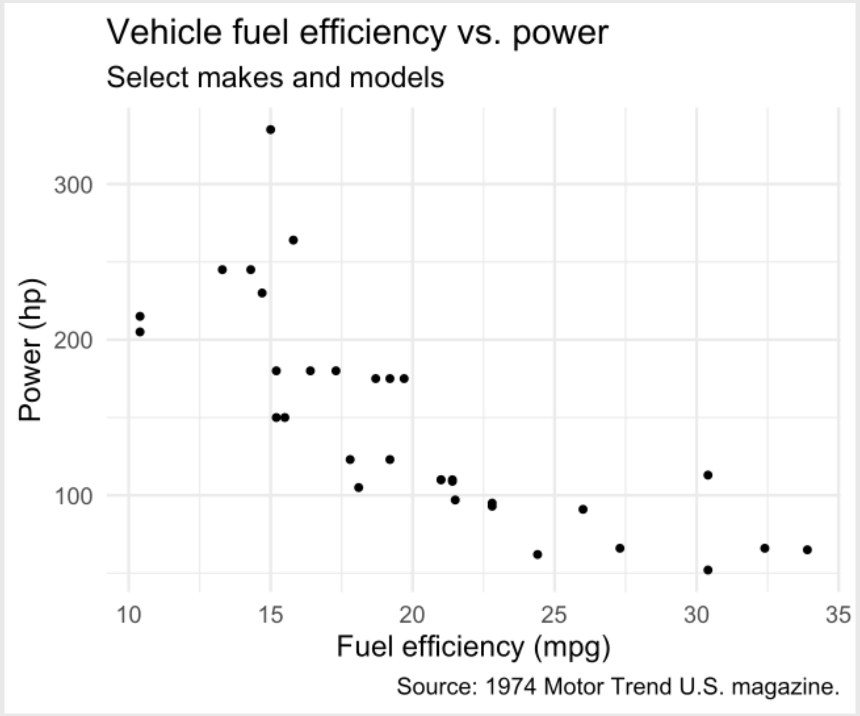
```
theme_half_open(font_family = "Roboto Condensed")
```

```
theme_minimal_grid(font_family = "Roboto Condensed")
```

1. Change the whole theme font

Make the base plot

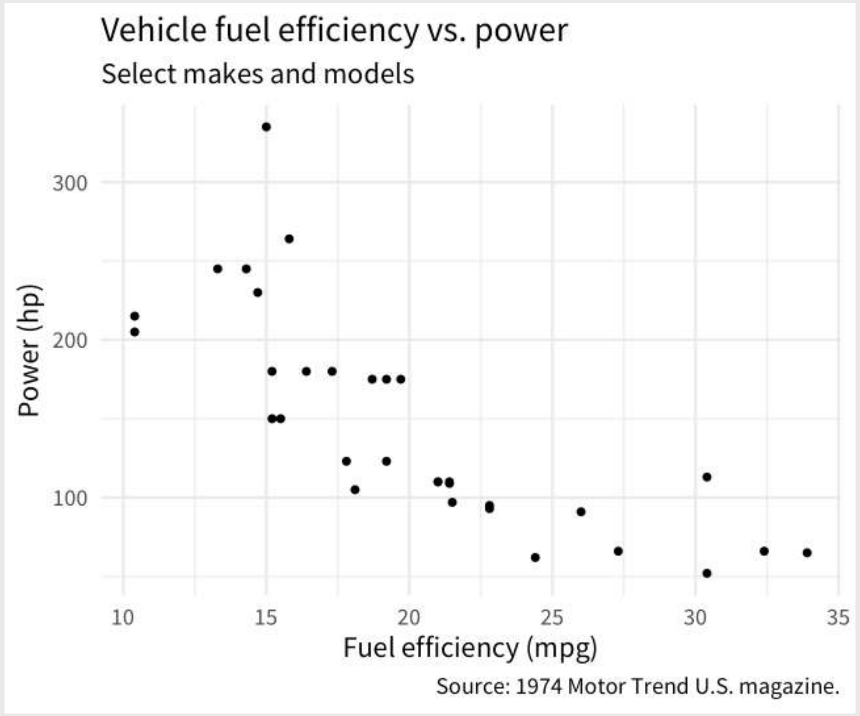
```
mpg_plot <- ggplot(mtcars) +
  geom_point(aes(x = mpg, y = hp)) +
  theme_minimal(base_size = 15) +
  labs(
    x = "Fuel efficiency (mpg)",
    y = "Power (hp)",
    title = "Vehicle fuel efficiency vs. power",
    subtitle = "Select makes and models",
    caption = "Source: 1974 Motor Trend U.S. magazine.")
```



1. Change the whole theme font

Use `base_family` with base themes

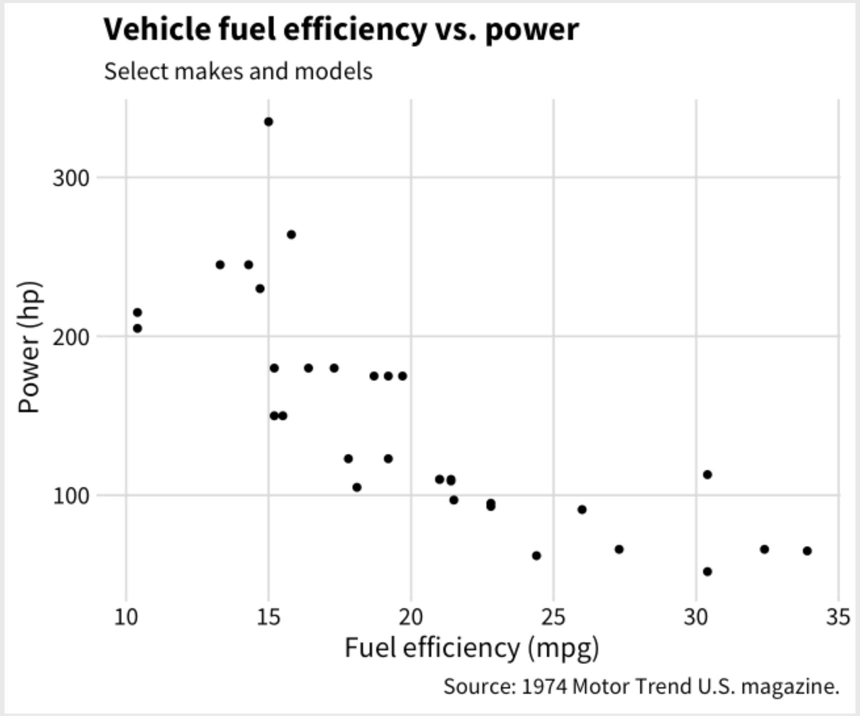
```
mpg_plot <- ggplot(mtcars) +
  geom_point(aes(x = mpg, y = hp)) +
  theme_minimal(
    base_family = 'Source Sans Pro',
    base_size = 15) +
  labs(
    x = "Fuel efficiency (mpg)",
    y = "Power (hp)",
    title = "Vehicle fuel efficiency vs. power",
    subtitle = "Select makes and models",
    caption = "Source: 1974 Motor Trend U.S. magazine.")
```



1. Change the whole theme font

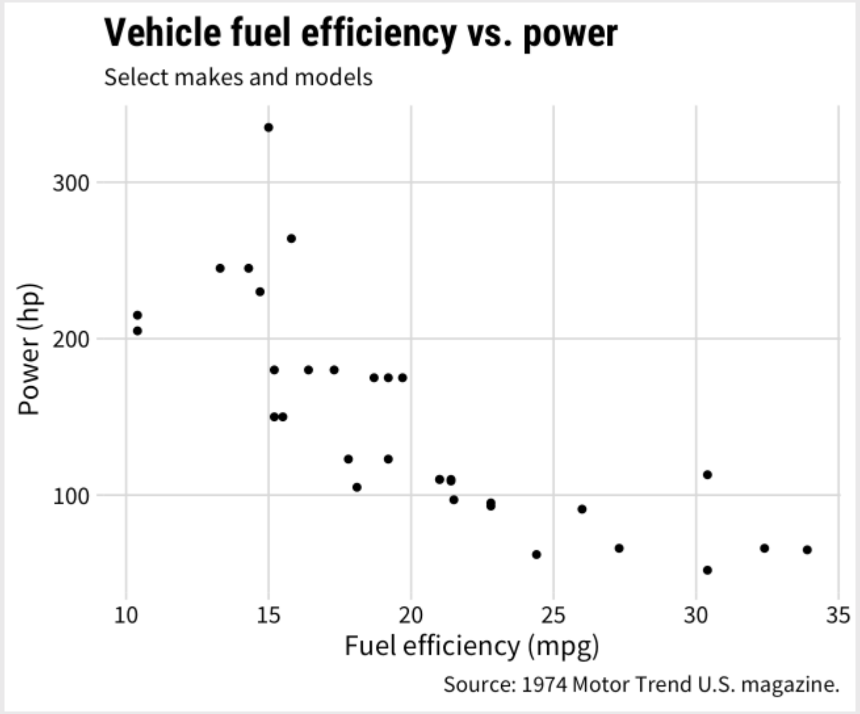
Use `font_family` with cowplot themes

```r
mpg_plot <- ggplot(mtcars) +
  geom_point(aes(x = mpg, y = hp)) +
  theme_minimal_grid(
    font_family = 'Source Sans Pro',
    font_size = 15) +
  labs(
    x = "Fuel efficiency (mpg)",
    y = "Power (hp)",
    title = "Vehicle fuel efficiency vs. power",
    subtitle = "Select makes and models",
    caption = "Source: 1974 Motor Trend U.S. magazine.")
```



2. Adjust theme elements with `element_text()`

```r
mpg_plot <- ggplot(mtcars) +
  geom_point(aes(x = mpg, y = hp)) +
  theme_minimal_grid(
    font_family = 'Source Sans Pro',
    font_size = 15) +
  theme(
    plot.title = element_text(
      family = "Roboto Condensed",
      size = 20)) +
  labs(
    x = "Fuel efficiency (mpg)",
    y = "Power (hp)",
    title = "Vehicle fuel efficiency vs. power",
    subtitle = "Select makes and models",
    caption = "Source: 1974 Motor Trend U.S. magazine.")
```

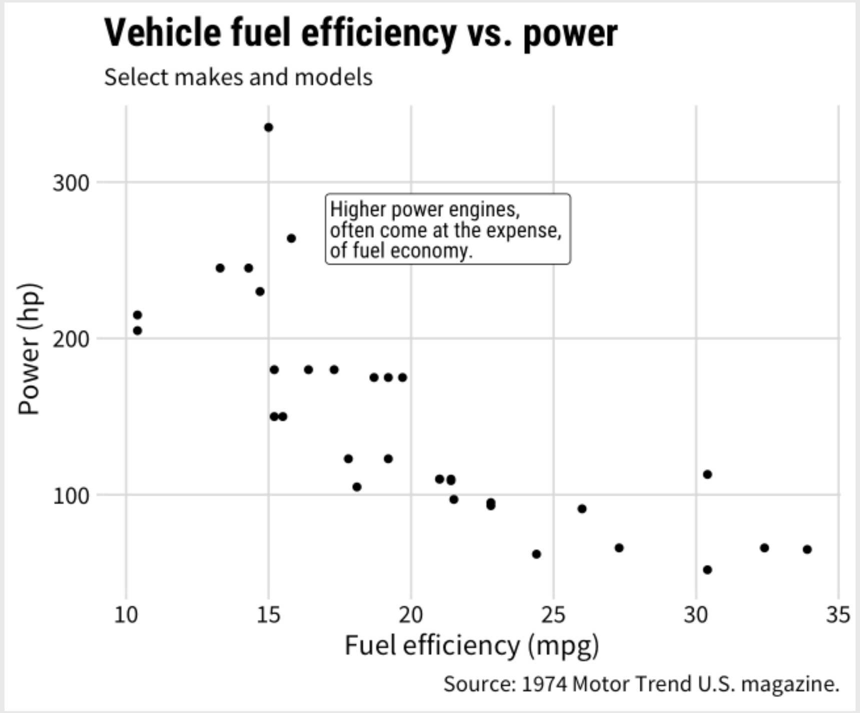


See theme components here

3. Adjust annotations:

`geom_text()`, `geom_label()`, and `annotate()`

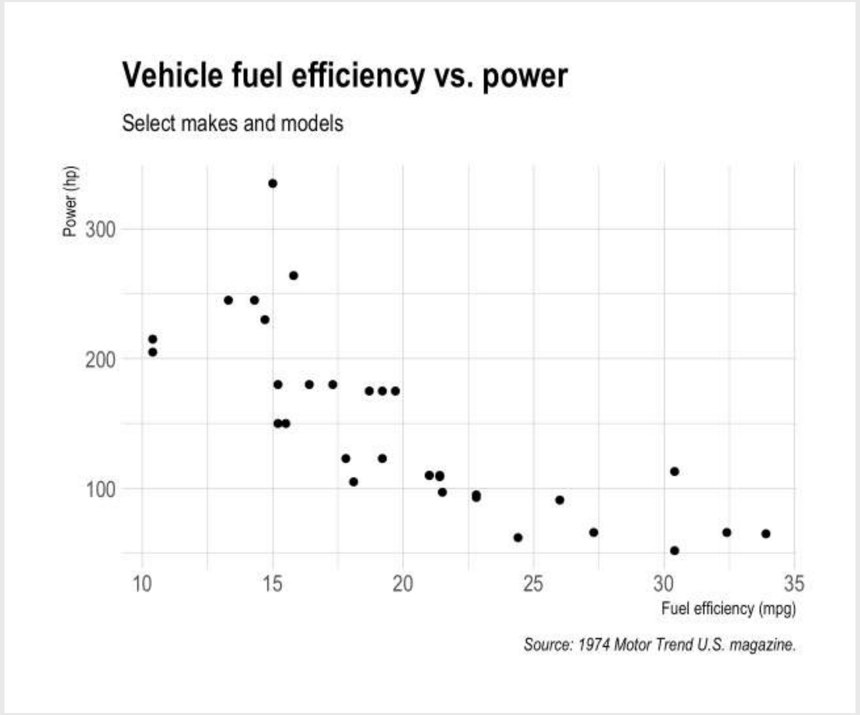
```r
label <- "Higher power engines,
often come at the expense,
of fuel economy."

mpg_plot +
    geom_label(
      data = data.frame(
        x = 17, y = 270, label = label),
      aes(x = x, y = y, label = label),
      lineheight = .8, hjust = 0,
      family = 'Roboto Condensed')
```



The hrbrthemes package:

Great themes + great fonts

```r
library(hrbrthemes)

mpg_plot <- ggplot(mtcars) +
  geom_point(aes(x = mpg, y = hp)) +
  labs(
    x = "Fuel efficiency (mpg)",
    y = "Power (hp)",
    title = "Vehicle fuel efficiency vs. power",
    subtitle = "Select makes and models",
    caption = "Source: 1974 Motor Trend U.S. magazine

mpg_plot +
  theme_ipsum()
```



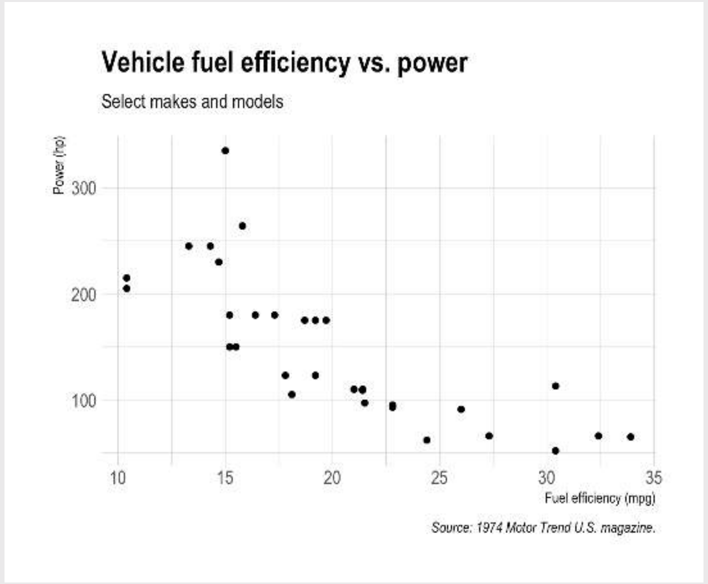
The hrbrthemes package:

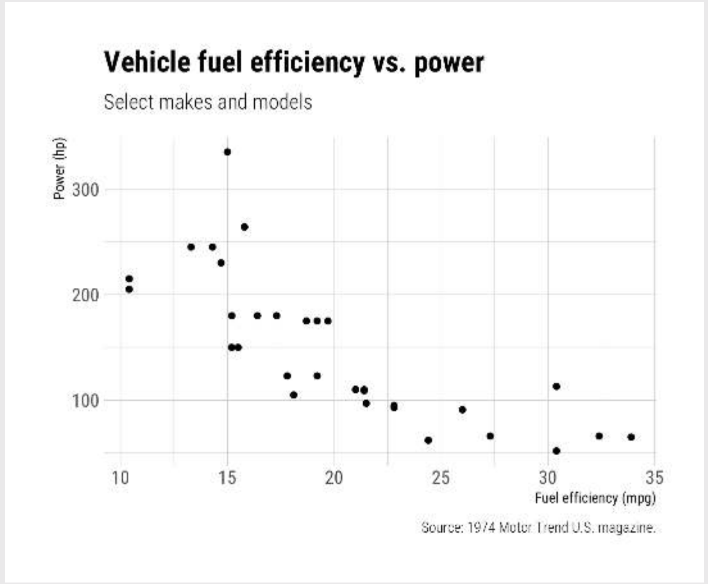
Great themes + great fonts

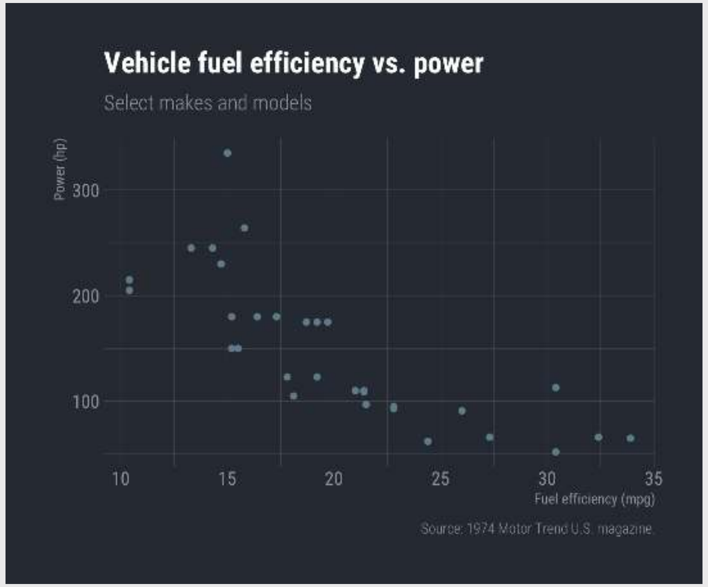
```
mpg_plot +
  theme_ipsum()
```

```
mpg_plot +
  theme_ipsum_rc()
```

```
mpg_plot +
  theme_ft_rc()
```







Your turn

15:00

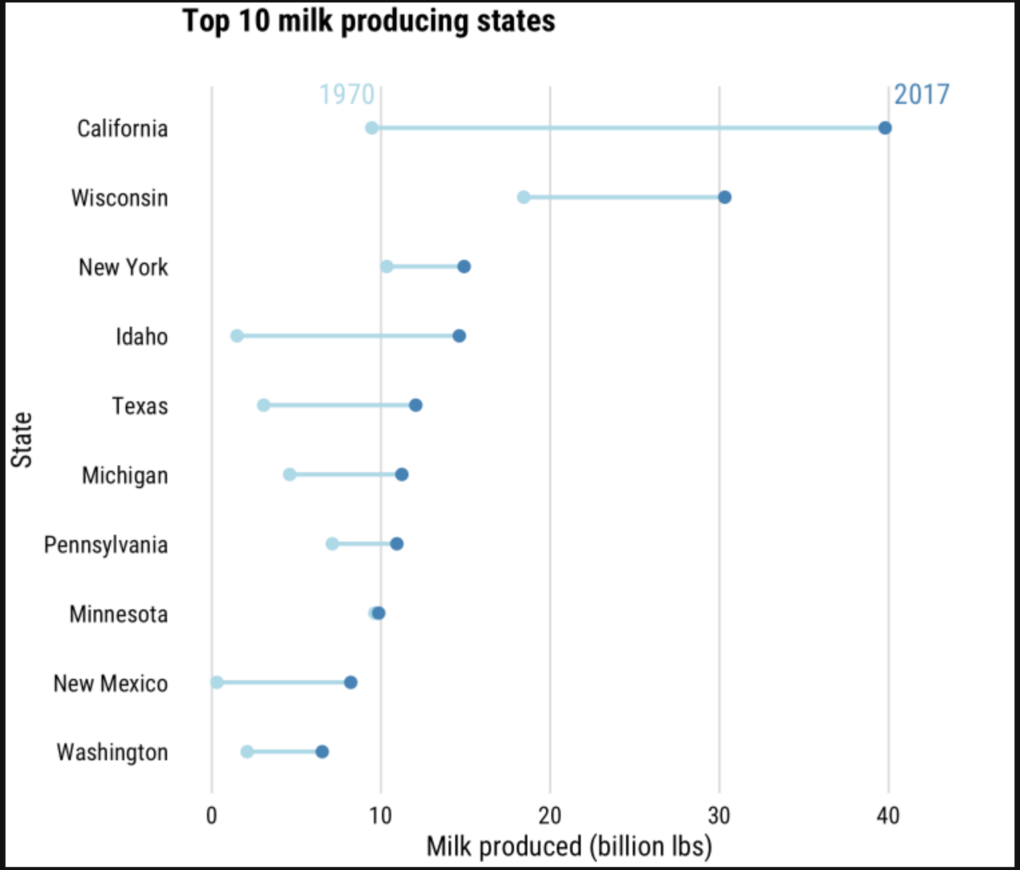
Modify the fonts and annotations in the dumbbell chart to match the chart shown here. The main font is `'Roboto Condensed'`.

Once you've recreated the plot, try other fonts and themes, such as:

- The `'Source Sans Pro'` font.
- The `'Lato'` font.
- The `theme_ipsum()` theme from the `hrbrthemes` library.

Hint: Use `annotate()` to insert the year labels at the top:

- 1970: `x = 9`, `y = 10.5`
- 2017: `x = 40`, `y = 10.5`



Week 10: *Polishing Charts*

1. Scales

2. Annotations

BREAK

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5. qmd tricks

Use themes to change global look

Change theme in YAML header

```
---
title: Your title
author: Author name
toc: true
format:
  html:
    theme: united
---
```

List of themes

https://quarto.org/docs/output-formats/html-themes.html

Use Quarto extensions

https://quarto.org/docs/extensions/

Some personal favoriates:

- lightbox
- elevator
- webR

Set a global chart theme

```
theme_set(theme_minimal_grid())
```

Check out these Quarto tricks, by Yan Holtz