AD

TESTPILOT

Data visualization

ggplot2

We'll be primarily using ggplot2 in this workshop.

- Makes pretty good formatting choices out of the box
- Works like pipes!!
- Is declarative (tell it what you want) without getting caught up in minutae
- Strongly leverages data frames (good practice)
- Fast enough
- There are good templates if you want to change the look

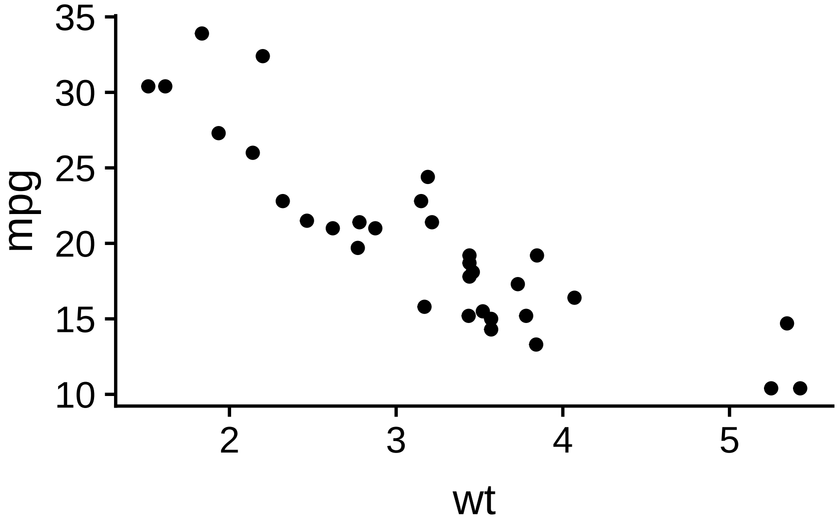
The `ggplot2` package is a very flexible and (to me) intuitive way of visualizing data. It is based on the concept of layering elements on a canvas.

> This idea of layering graphics on a canvas is, to me, a nice way of building graphs

- A `data.frame` object
- *Aesthetic mappings* (aes) to say what data is used for what purpose in the viz
  - x- and y-direction
  - shapes, colors, lines
- A *geometry object* (geom) to say what to draw
  - You can "layer" geoms on each other to build plots

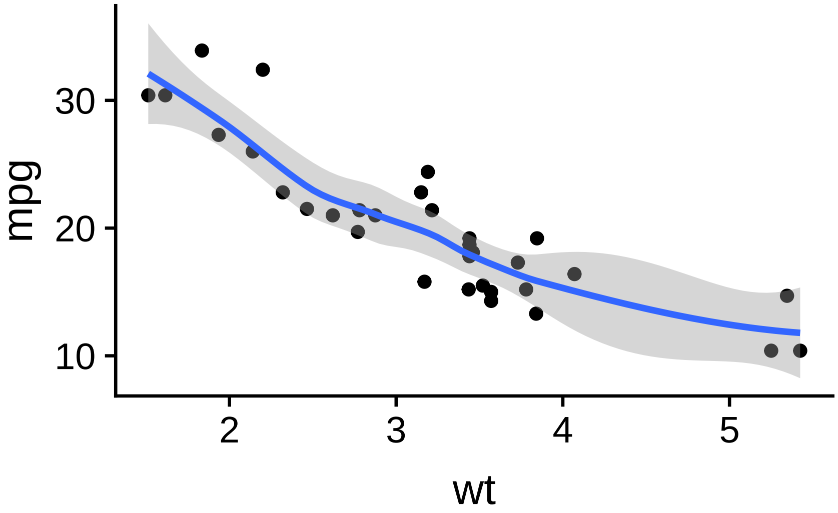
> `ggplot` used pipes before pipes were a thing.
>
> However, it uses the + symbol for piping rather than the `%>%` operator, since it pre-dates the `tidyverse`

```r
library(ggplot2)
ggplot(mtcars, aes(x = wt, y = mpg)) + geom_point()
```



- A `data.frame` object: mtcars
- Aesthetic mapping:
  - x-axis: wt
  - y-axis: mpg
- Geometry:
  - geom_point: draw points

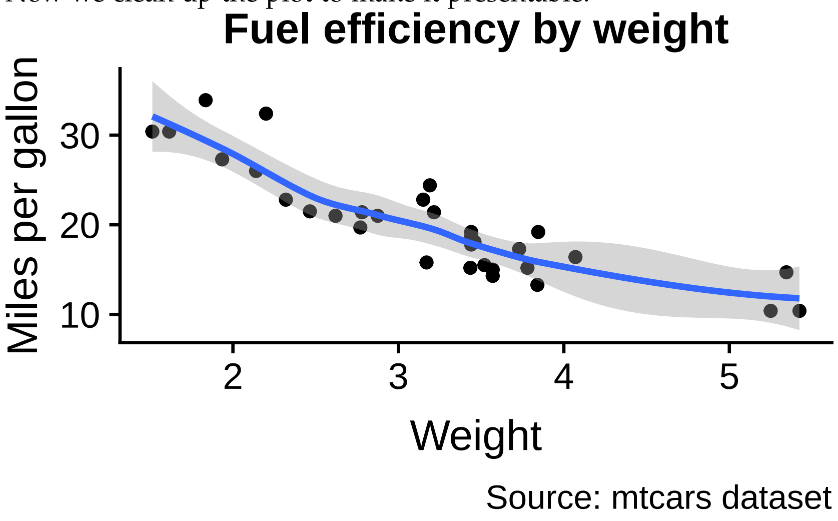
```
ggplot(mtcars, aes(x = wt, y = mpg)) + geom_point() +
    geom_smooth()
```



- A `data.frame` object: mtcars
- Aesthetic mapping:
  - x-axis: wt
  - y-axis: mpg

- Geometry:
  - geom_point: draw points
  - geom_smooth: Add a layer which draws a best-fitting line

Now we clean up the plot to make it presentable.



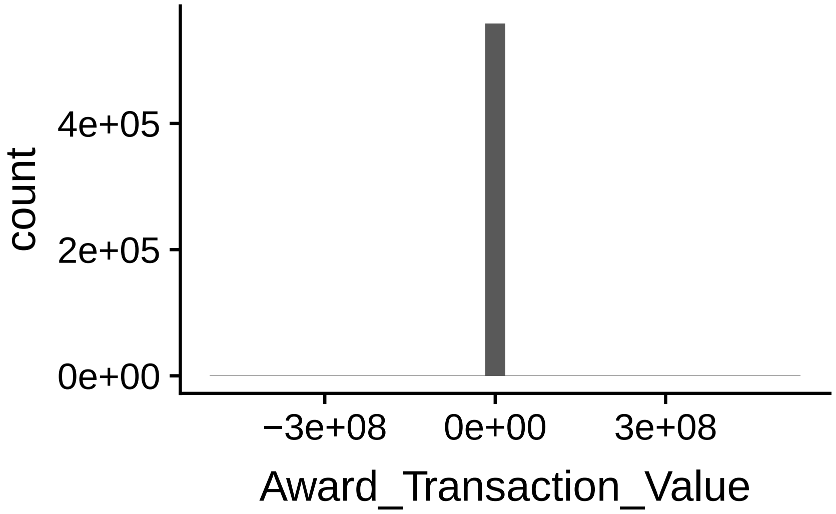
Fuel efficiency by weight

Source: mtcars dataset

Single continuous variable

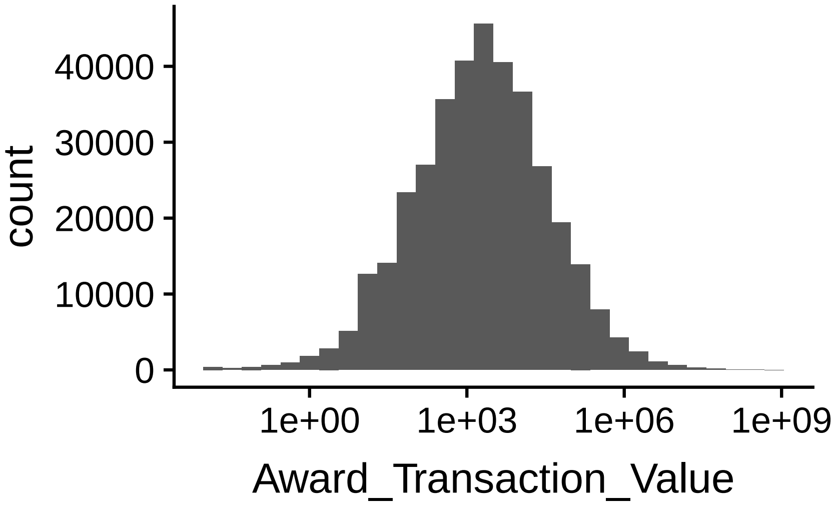
Histogram

```
dos <- import("data/Department of State.csv")
dos %>% ggplot(aes(x = Award_Transaction_Value)) +
    geom_histogram()
```



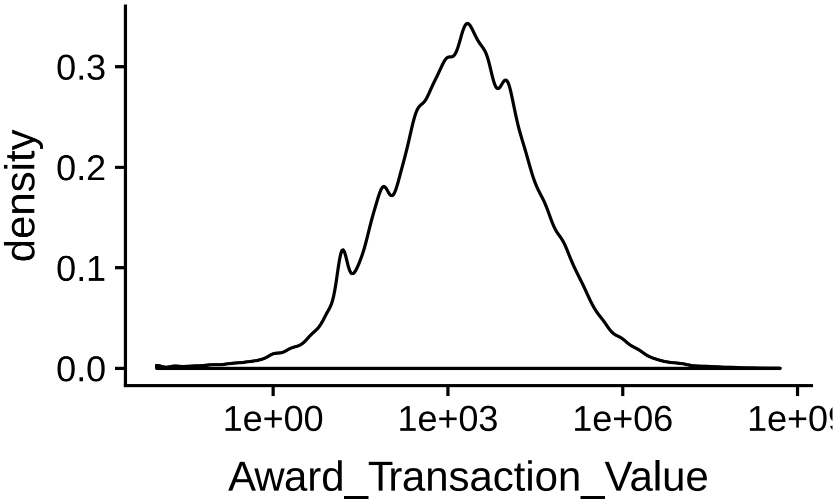
Change the axis to the log scale for better visual

```
dos %>% ggplot(aes(x = Award_Transaction_Value)) +
    geom_histogram() + scale_x_log10()  # x-axis on log scale
```



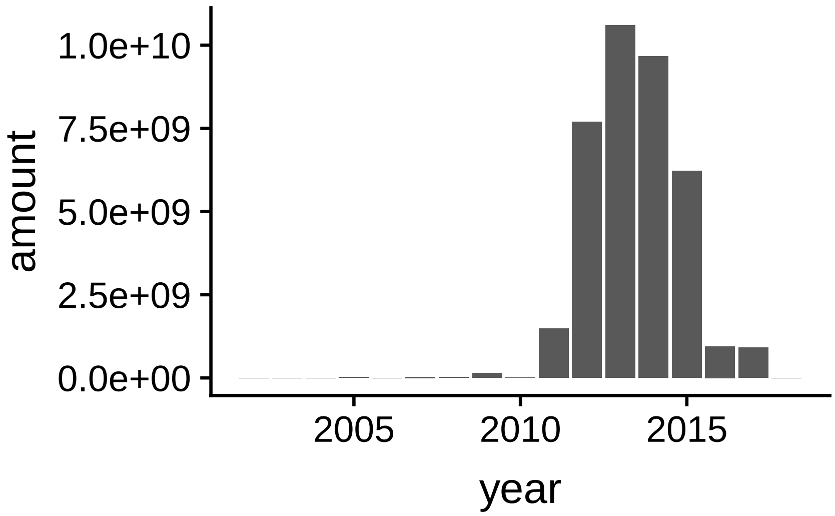
Density plot

```
dos %>% ggplot(aes(x = Award_Transaction_Value)) +
    geom_density() + scale_x_log10()
```



Bar plots

```
library(lubridate)
dos %>%
  group_by(year = year(as_date(Award_Start_Date))) %>%
  summarize(amount = sum(Award_Transaction_Value)) %>%
  ggplot(aes(x = year, y = amount)) + # Note change in pipe operator
    geom_bar(stat='identity')
```

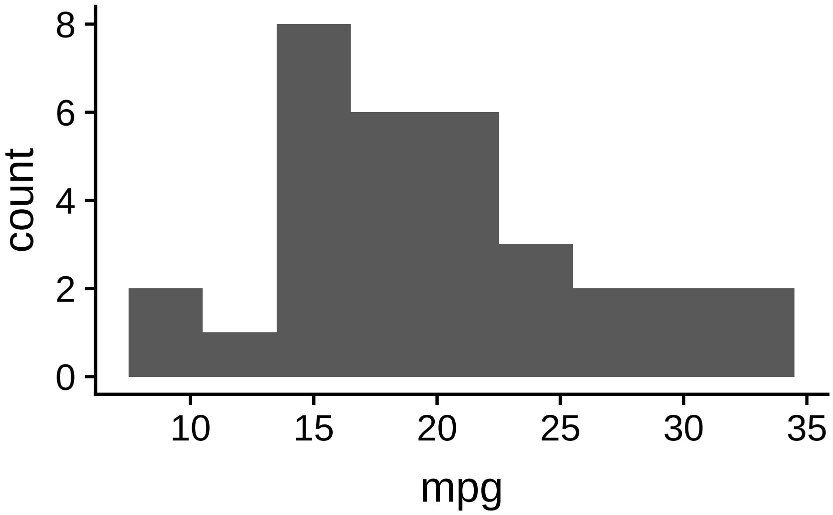


Exercise

Using the `mtcars` dataset in R, create:

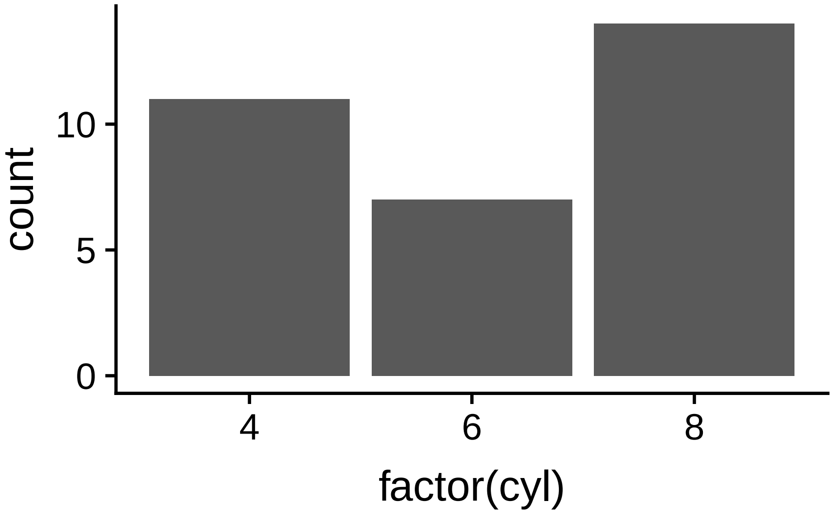
1. A histogram of the fuel efficiences (`mpg`) in the data set
2. A bar plot of frequencies of number of cylinders (`cyl`) in the car

```
ggplot(mtcars, aes(x = mpg)) + geom_histogram(binwidth = 3)
```



```r
# ggplot(mtcars) + geom_histogram(aes(x =
# mpg), binwidth = 3)
```

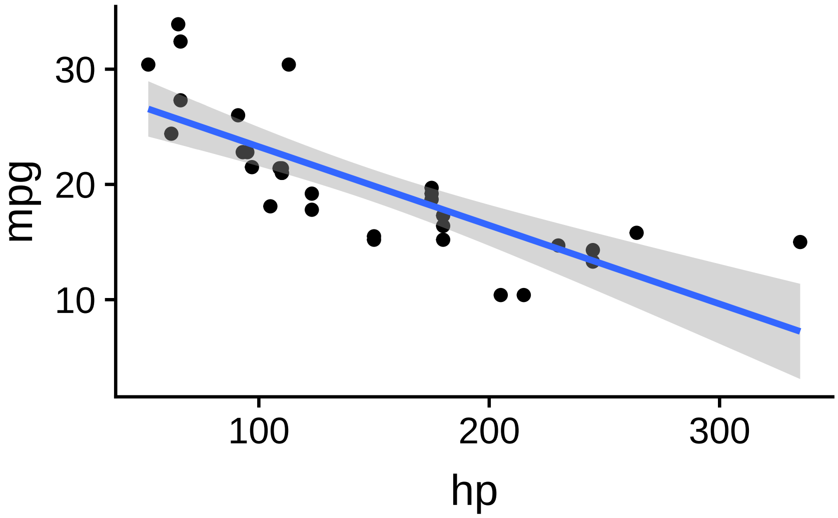
```r
ggplot(mtcars, aes(x = factor(cyl))) + geom_bar()
```



Two continuous variables

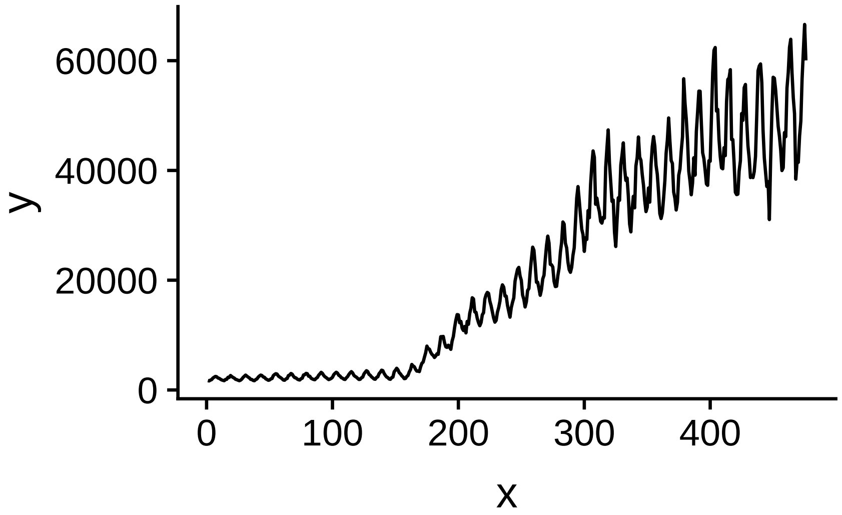
Adding a best fitting straight line

```r
ggplot(mtcars, aes(x = hp, y = mpg)) + geom_point() +
    geom_smooth(method = "lm")
```


30
20
10
mpg
100
200
300
hp

Time series

```r
library(forecast)
d <- data.frame(x = 1:length(gas), y = gas)  # Australian monthly gas production
ggplot(d, aes(x, y)) + geom_line()
```



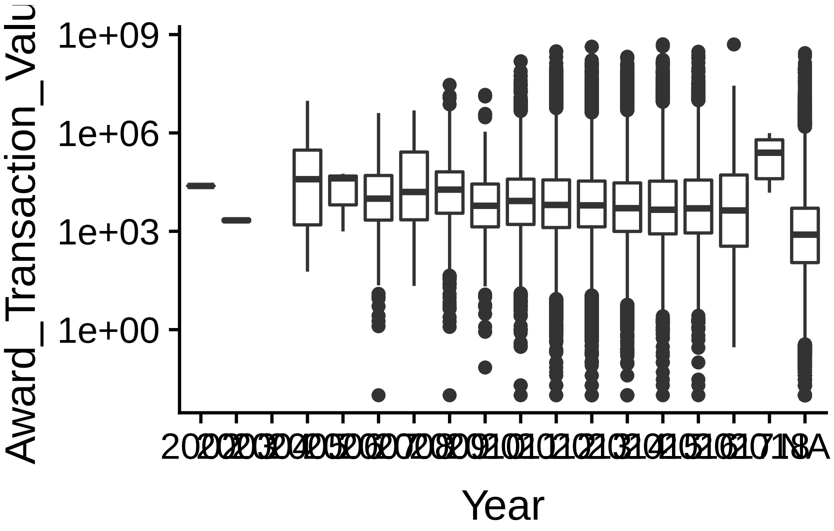
Exercise

1. Create a scatter plot of sepal length and sepal width from the `iris` dataset, and add a smooth line through it

Continuous variable iwth discrete variable

Boxplot

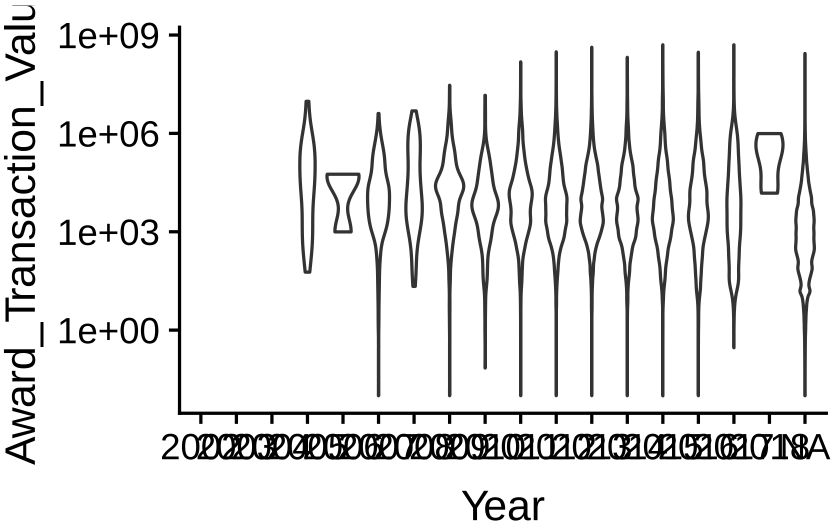
```r
dos %>% ggplot(aes(x = factor(year(as_date(Award_Start_Date))),
    y = Award_Transaction_Value)) + geom_boxplot() +
    scale_y_log10() + labs(x = "Year")
```



Violin plot

This is essetially a reflected density plot and gives a better sense of the data distribution

```
dos %>% ggplot(aes(x = factor(year(as_date(Award_Start_Date))),
    y = Award_Transaction_Value)) + geom_violin() +
    scale_y_log10() + labs(x = "Year")
```



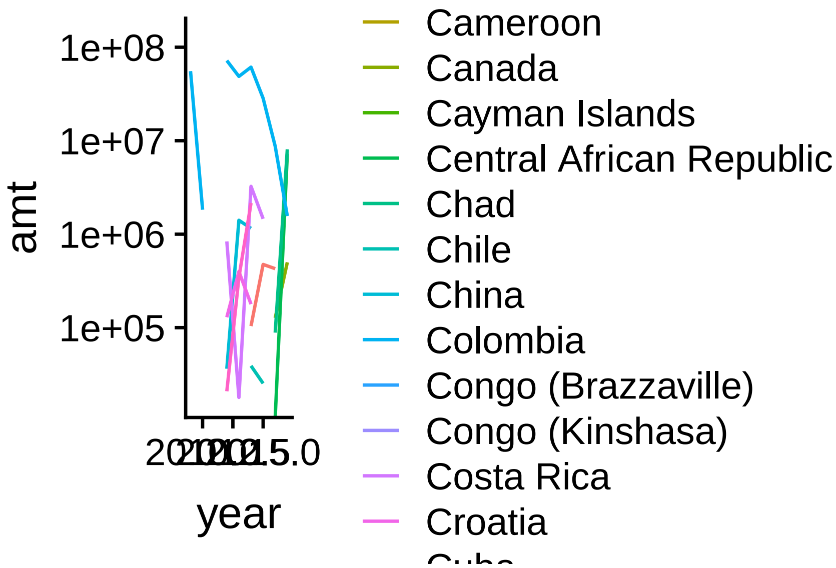
Exercise

1. Plot a boxplot of petal length by species using the `iris` dataset

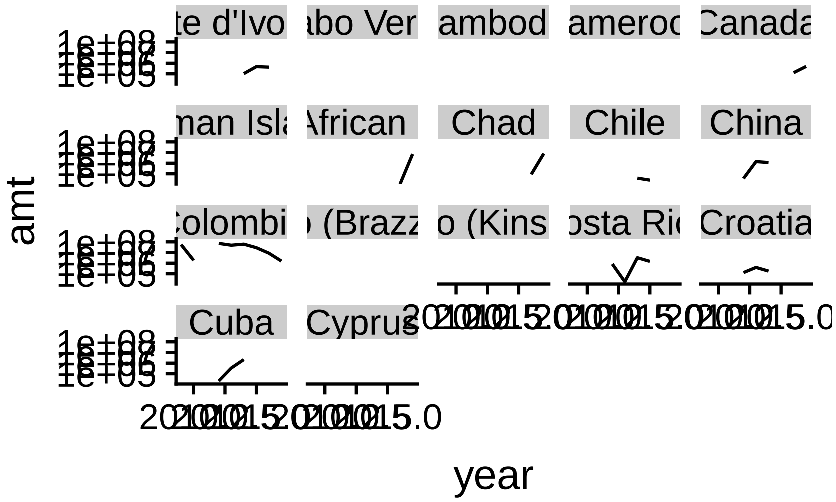
Grouped visualizations

We're going to plot the change in aid provided to each country over time. To do this we need summaries by time and location

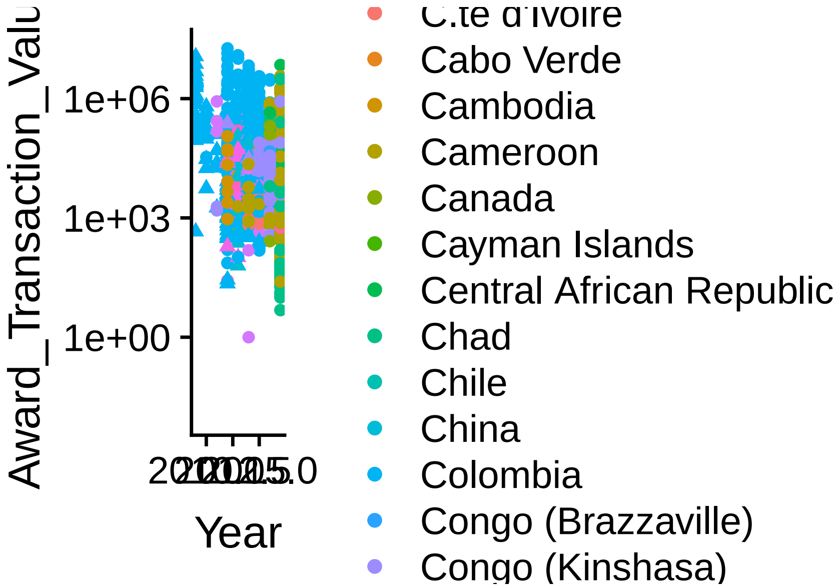
```
grp_data <- dos %>% group_by(Recipient_Location,
    year = year(as_date(Award_Start_Date))) %>%
    summarize(amt = sum(Award_Transaction_Value)) %>%
    filter(str_detect(Recipient_Location, "^C"))
ggplot(grp_data, aes(x = year, y = amt, color = Recipient_Location)) +
    geom_line() + scale_y_log10()
```



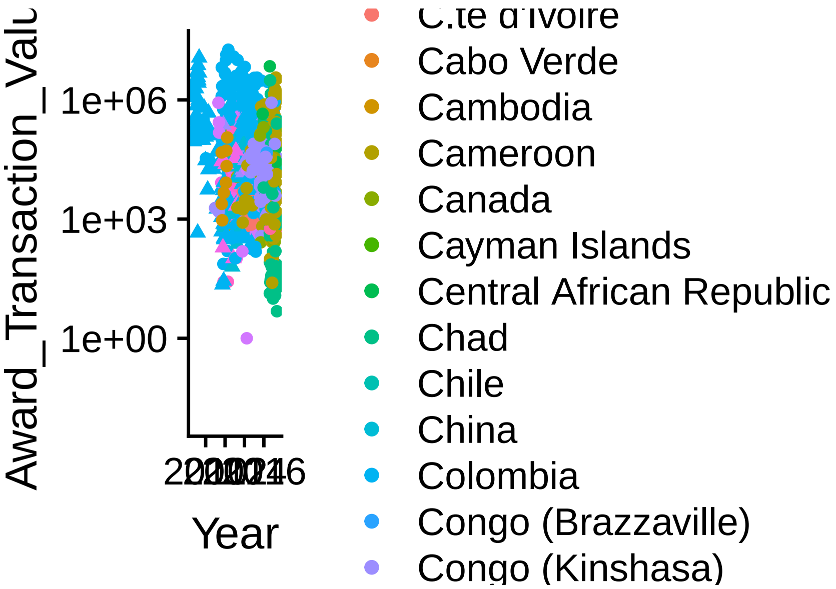
```
ggplot(grp_data, aes(x = year, y = amt)) + geom_line() +
    scale_y_log10() + facet_wrap(~Recipient_Location)
```



```
## dos %>%
## filter(str_detect(Recipient_Location, '^C'))
## %>% ggplot(aes(x =
## year(as_date(Award_Start_Date)), y =
## Award_Transaction_Value, color =
## Recipient_Location, shape =
## Award_Transaction_Type))+ geom_point()+
## labs(x = 'Year', color='Location')+
## scale_y_log10()
```

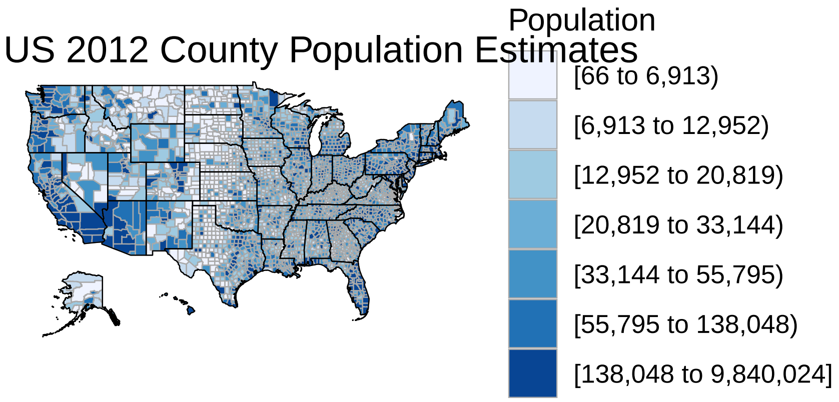


```
## dos %>%
## filter(str_detect(Recipient_Location, '^C'))
## %>% ggplot(aes(x =
## year(as_date(Award_Start_Date)), y =
## Award_Transaction_Value, color =
## Recipient_Location, shape =
## Award_Transaction_Type))+ geom_jitter()+
## labs(x = 'Year', color='Location')+
## scale_y_log10()
```



```r
schools <- rio::import("data/schools.rds")
schools %>% filter(tophead == "Elementary schools",
    head2 == "Average hours in school day") %>%
    filter(!is.na(State), State != "United States") %>%
    ggplot(aes(x = State, y = stats, ymin = stats -
        2 * se, ymax = stats + 2 * se)) + geom_pointrange() +
    labs(y = "Avg hours in school day") + theme_bw() +
    theme(axis.text.x = element_text(angle = 45,
        hjust = 1))
```

Maps



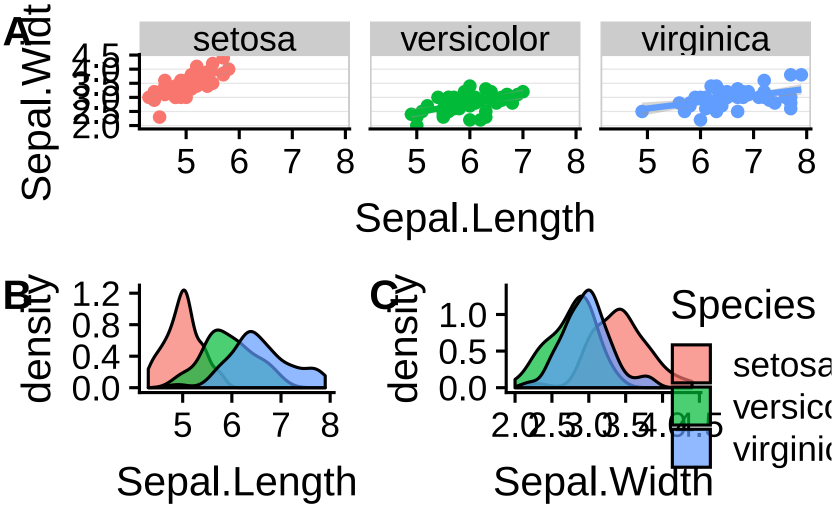
We can also ingest SHP files to draw maps. We don't show the final version since it took too long to render.

```
library(sf)
hrr_info <- st_read("~/Downloads/hrr_bdry-1/HRR_Bdry.SHP")
head(hrr_info)
ggplot(hrr_info) + geom_sf()
ggsave("map.png")
```

Stitching maps together.

```
# install.packages('cowplot')
library(cowplot)
p1 <- ggplot(iris, aes(Sepal.Length, Sepal.Width,
    color = Species)) + geom_point() + facet_grid(. ~
    Species) + stat_smooth(method = "lm") + background_grid(major = "y",
    minor = "none") + panel_border() + theme(legend.position = "none")

# plot B
p2 <- ggplot(iris, aes(Sepal.Length, fill = Species)) +
    geom_density(alpha = 0.7) + theme(legend.justification = "top")
p2a <- p2 + theme(legend.position = "none")
```

```
# plot C
p3 <- ggplot(iris, aes(Sepal.Width, fill = Species)) +
    geom_density(alpha = 0.7) + theme(legend.position = "none")

# legend
legend <- get_legend(p2)

# align all plots vertically
plots <- align_plots(p1, p2a, p3, align = "v",
    axis = "l")

# put together bottom row and then everything
bottom_row <- plot_grid(plots[[2]], plots[[3]],
    legend, labels = c("B", "C"), rel_widths = c(1,
        1, 0.3), nrow = 1)
plot_grid(plots[[1]], bottom_row, labels = c("A"),
    ncol = 1)
```



```
## library(ggplot2) library(plotly)
## p=ggplot(iris, aes(x=Sepal.Length,
## y=Sepal.Width, color=Species,
## shape=Species)) + geom_point(size=6,
## alpha=0.6) mytext=paste('Sepal Length = ',
## iris$Sepal.Length, '\n' , 'Sepal Width = ',
## iris$Sepal.Width, '\n', 'Row Number:
## ',rownames(iris), sep='')
## pp=plotly::plotly_build(p) style( pp,
## text=mytext, hoverinfo = 'text', traces =
## c(1, 2, 3) )
```

Interactive graphics

We won't put these in the notes, since they don't work well in printed form