```
library(dplyr)

rladies_global %>%
  filter(city == 'Austin')
```


# R FOR DATA SCIENCE: R Markdown and graphics for communication (ggplot2)

# Hello!

## Welcome to R-Ladies

# Thanks to our sponsors!

R Studio | Web.com

# 1. Introduction

R language, RStudio,
R4DS Workshop series

# Three things
## you'll need to install

1. **Install R** -- this is the open-source programming language we'll use (download via CRAN -- Comprehensive R Archive Network)
2. **Install RStudio** -- this is the most popular IDE for R and will make your life a lot easier (download from rstudio.com/download)
3. **Install the tidyverse** -- this is the group of packages we'll use within R to work with data. Install with one line of code in R:
   `install.packages("tidyverse")`

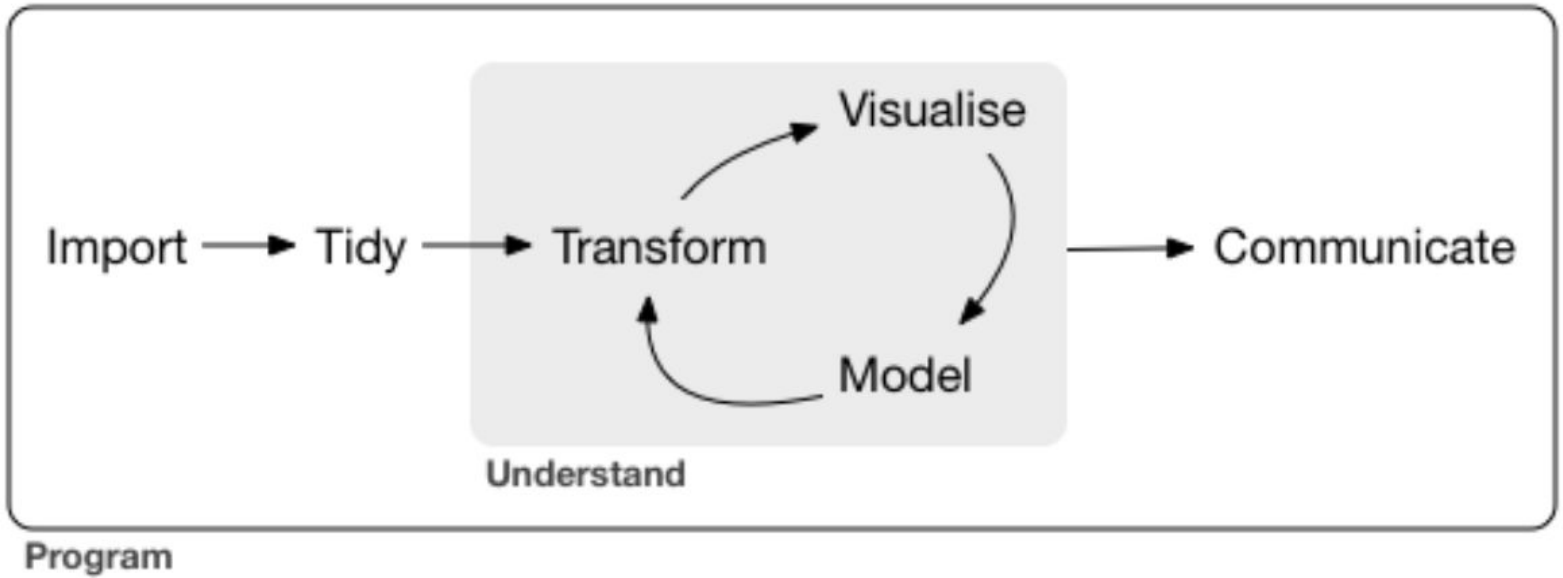
# 1b. Introduction

R for Data Science Workshop Series

# R4DS
# Workshop Series

- **Exploring Data with ggplot2 + dplyr** [DONE]
- **Exploratory Data Analysis and Workflow** [DONE]
- **Data Wrangling in the Tidyverse** [November 28]
- **Programming -- Functions, Vectors, and Iteration** [December 13]
- **Modeling with modelr, purrr, and broom** [January 24]
- **Communicating Results with rmarkdown and ggplot2** [February 21]

# The data science process (tidied)



# What is
# the tidyverse?

- Collection of R packages based on tidy data principles
- Designed to work together
- An easier way to code!
- AKA “Hadleyverse” (most packages written by Hadley Wickham)

# What is
# the tidyverse?

# What is
# tidy data?

- Each variable is a column
- Each observation is a row
- Each type of observational unit is a table

| id | artist | track | time |
|---|---|---|---|
| 1 | 2 Pac | Baby Don't Cry | 4:22 |
| 2 | 2Ge+her | The Hardest Part Of ... | 3:15 |
| 3 | 3 Doors Down | Kryptonite | 3:53 |
| 4 | 3 Doors Down | Loser | 4:24 |
| 5 | 504 Boyz | Wobble Wobble | 3:35 |
| 6 | 98^0 | Give Me Just One Nig... | 3:24 |
| 7 | A*Teens | Dancing Queen | 3:44 |
| 8 | Aaliyah | I Don't Wanna | 4:15 |
| 9 | Aaliyah | Try Again | 4:03 |
| 10 | Adams, Yolanda | Open My Heart | 5:30 |
| 11 | Adkins, Trace | More | 3:05 |
| 12 | Aguilera, Christina | Come On Over Baby | 3:38 |
| 13 | Aguilera, Christina | I Turn To You | 4:00 |
| 14 | Aguilera, Christina | What A Girl Wants | 3:18 |
| 15 | Alice Deejay | Better Off Alone | 6:50 |

# 2.
# R Markdown
# + formats
# + workflow

# What is
# R Markdown?

A tool for integrating prose, code, and results in a fully reproducible way.

Designed to be used 3 ways:

+ Communicating with decision makers who want to focus on conclusions (rather than the code behind analysis)
+ Collaborating with other data scientists (like future you!) who are interested in conclusions and code
+ As an environment to *do* analysis, like a modern lab notebook

# R Markdown
## File Basics

A plain-text file with a .Rmd extension

Contains three types of content:

1. An optional YAL header surrounded by ---s
2. Chunks of R code surrounded by ```
3. Text mixed with simple formatting like # heading and _italics_

# Using
# R Markdown

| | |
|---|---|
| Create a .Rmd file: | File -> New File -> R Markdown |
| Add a code chunk: | click insert or Cmd/Ctrl-Alt-I |
| Run each code chunk: | click run or Cmd/Ctrl-Shift-Enter |
| Produce full report: | click ‘Knit’ or Cmd/Ctrl-Shift-K |

# R Markdown
## and knitr

When you knit a document,

- knitr executes all code chunks
- knitr creates a new Markdown (.md) document
  - includes both code and output
- Markdown file is processed by pandoc

# Text Formatting
# With Markdown

## syntax

```
Plain text
End a line with two spaces to start a new paragraph.
*italics* and _italics_
**bold** and __bold__
superscript^2^
~~strikethrough~~
[link](www.rstudio.com)

# Header 1

## Header 2

### Header 3

#### Header 4

##### Header 5

###### Header 6
```

## becomes

Plain text
End a line with two spaces to start a new paragraph.
*italics* and *italics*
**bold** and **bold**
superscript$^2$
~~strikethrough~~
link

# Header 1

## Header 2

### Header 3

#### Header 4

##### Header 5

###### Header 6

# Text Formatting
## With Markdown (Cont.)

```
image: ![](path/to/smallorb.png)

horizontal rule (or slide break):

***

> block quote

* unordered list
* item 2
    + sub-item 1
    + sub-item 2

1. ordered list
2. item 2
    + sub-item 1
    + sub-item 2

Table Header   | Second Header
-------------- | -------------
Table Cell     | Cell 2
Cell 3         | Cell 4
```

image: 

horizontal rule (or slide break):

> block quote

- unordered list
- item 2
  - sub-item 1
  - sub-item 2

1. ordered list
2. item 2
   - sub-item 1
   - sub-item 2

| Table Header | Second Header |
|---|---|
| Table Cell | Cell 2 |
| Cell 3 | Cell 4 |

# R Markdown

## Creating Code Chunks

Three ways to insert a code chunk:

1. The insert button icon in RStudio editor toolbar
2. Keyboard shortcut: Cmd/Ctrl-Alt-I
3. Manually typing delimiters ```` ```{r} ```` and ```` ``` ````

# R Markdown

## Naming Code Chunks

Chunks can be given an optional name: ```{ r name_here}

Three advantages:

1. You can easily navigate to specific chunks using the drop-down code navigator in bottom-left of script editor
2. Makes it easier to access graphics produced by named chunks
3. You can cache “networks” of chunks to avoid re-performing expensive operations on each code run

Note: chunk named ‘setup’ will be run automatically before any others

# R Markdown

## Chunk Options

| option | default | effect |
|---|---|---|
| eval | TRUE | Whether to evaluate the code and include its results |
| echo | TRUE | Whether to display code along with its results |
| warning | TRUE | Whether to display warnings |
| error | FALSE | Whether to display errors |
| message | TRUE | Whether to display messages |
| tidy | FALSE | Whether to reformat code in a tidy way when displaying it |
| results | "markup" | "markup", "asis", "hold", or "hide" |
| cache | FALSE | Whether to cache results for future renders |
| comment | "##" | Comment character to preface results with |
| fig.width | 7 | Width in inches for plots created in chunk |
| fig.height | 7 | Height in inches for plots created in chunk |

For more details visit yihui.name/knitr/

# R Markdown
## Inline Code

Inline code lets you quickly combine text with generated code outputs:

> We have data about `` `r nrow(diamonds)` `` diamonds. Only `` `r nrow(diamonds) - nrow(smaller)` `` are larger than 2.5 carats. The distribution of the remainder is shown below:

> We have data about 53940 diamonds. Only 126 are larger than 2.5 carats. The distribution of the remainder is shown below:

Tip: Use `format()` to control number of digits and `big.mark` for readability

# R Markdown
## Troubleshooting

1. Restart R, then “Run all chunks”
2. Checking the working directory of interactive environment vs. R Markdown environment (`getwd()`)
3. Look for other differences between interactive environment and R Markdown environment

# R Markdown
## Formats

+ HTML Document (this is default)
+ Other Documents (PDF, Word, RTF, Github, etc.)
+ Notebooks (like HTML docs but contain full source code)
+ Presentations (ioslides, slidy, beamer)
+ Dashboards (flexdashboard)
+ Bookdown
+ Blogdown

HTML formats can be interactive!

+ htmlwidgets
+ shiny

# R Markdown
## Workflow

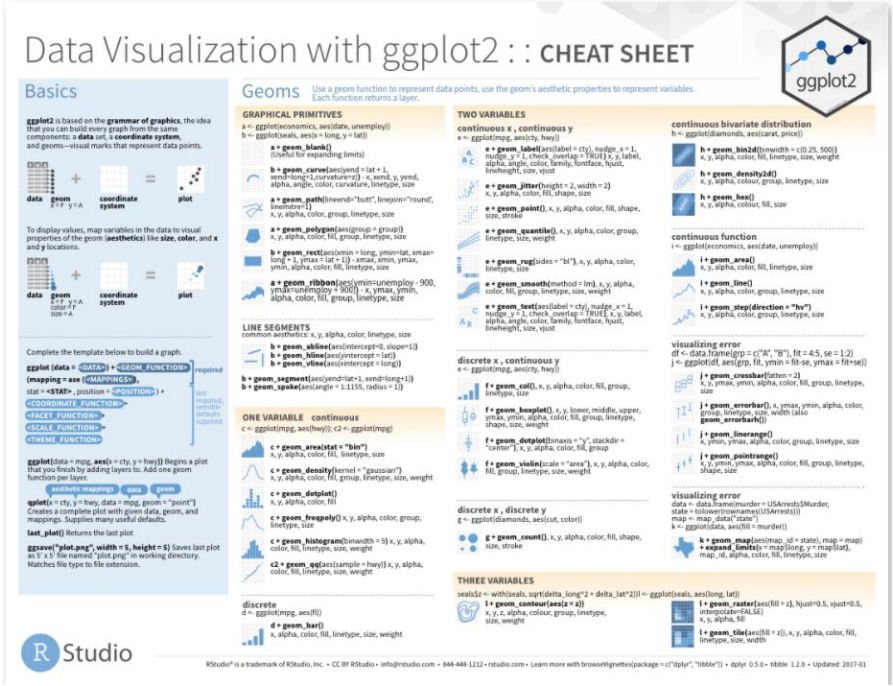
R Markdown blurs the lines between interactive exploration and more long-term code capture.

Think of it as an analysis notebook:

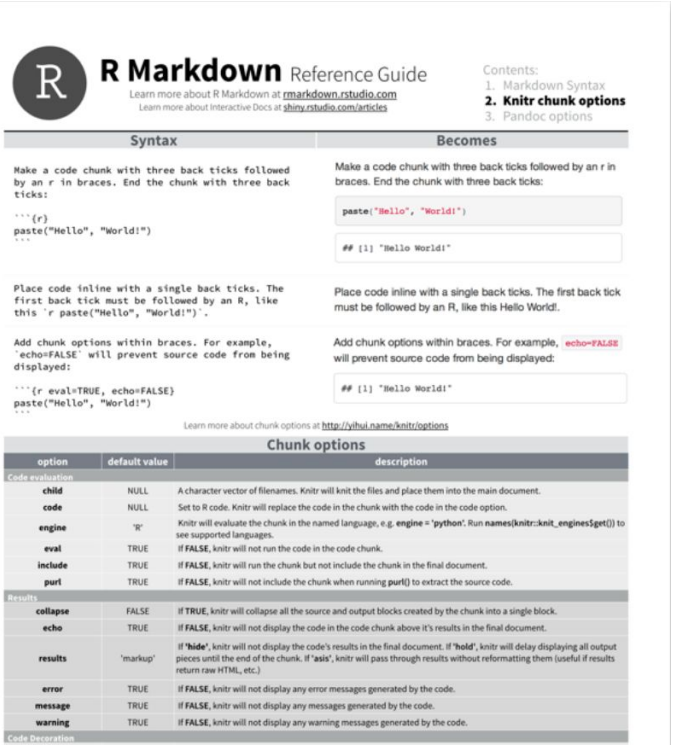
+ Records what you did and why
+ Supports rigorous thinking
+ Speeds up time it takes to write up analysis
+ Helps others understand your work
+ Supports good reproducibility habits

# More resources: rstudio.com/cheatsheets

Cheat Sheet



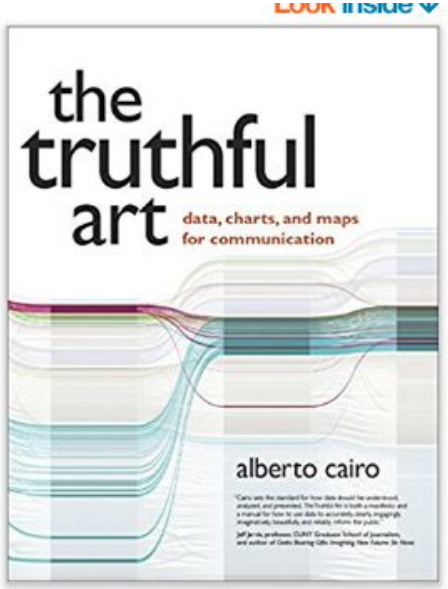

Reference Guide

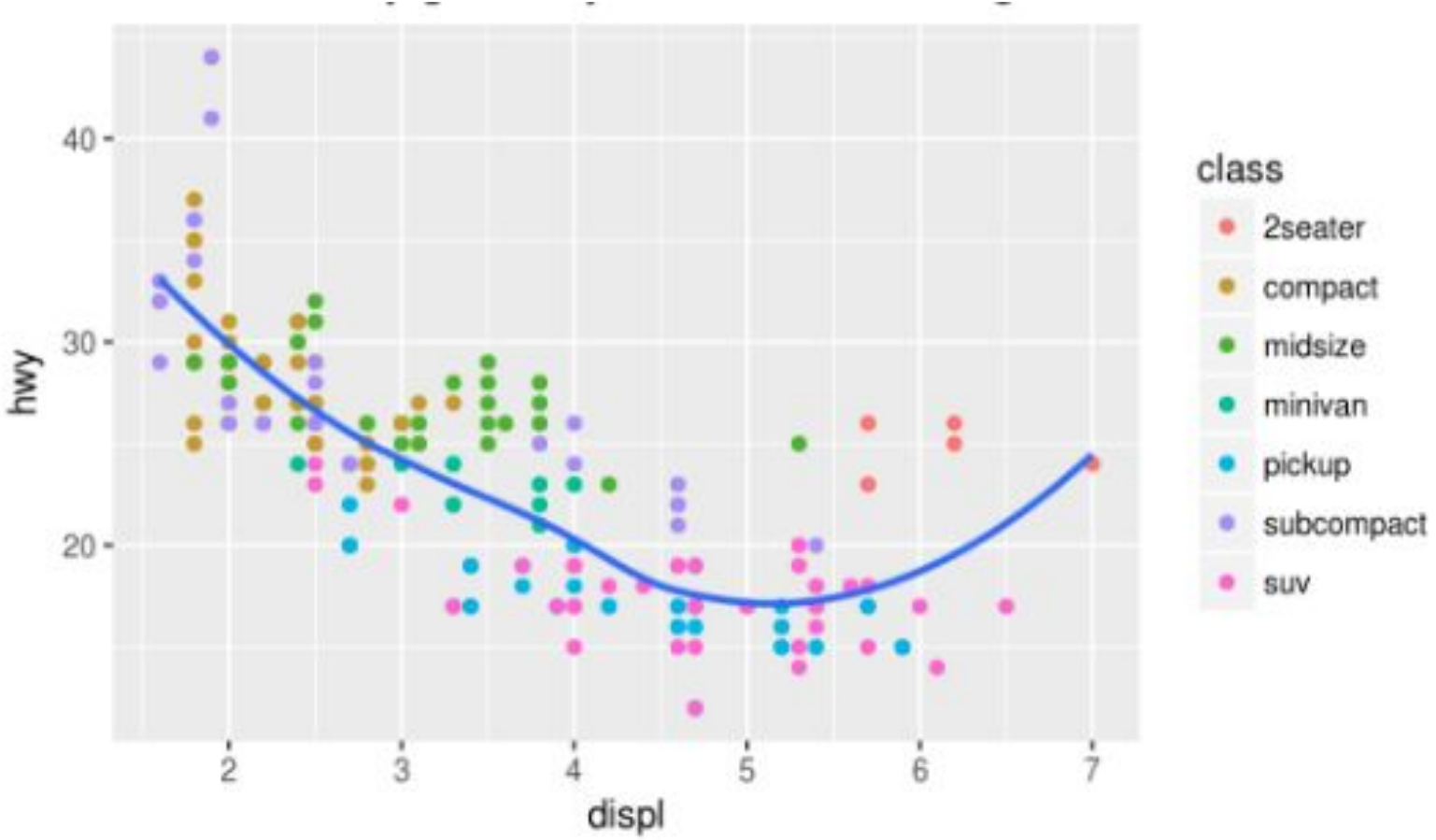


# 3.
# Graphics for communication with ggplot2

# ggplot2 is back!

- Communicate your results
- You know your data, but others likely don't
- GOAL:
  - Make your plots as self explanatory as possible!




hwy
40
30
20
2
3
4
5
6
7
displ
class
2seater
compact
midsize
minivan
pickup
subcompact
suv

# label

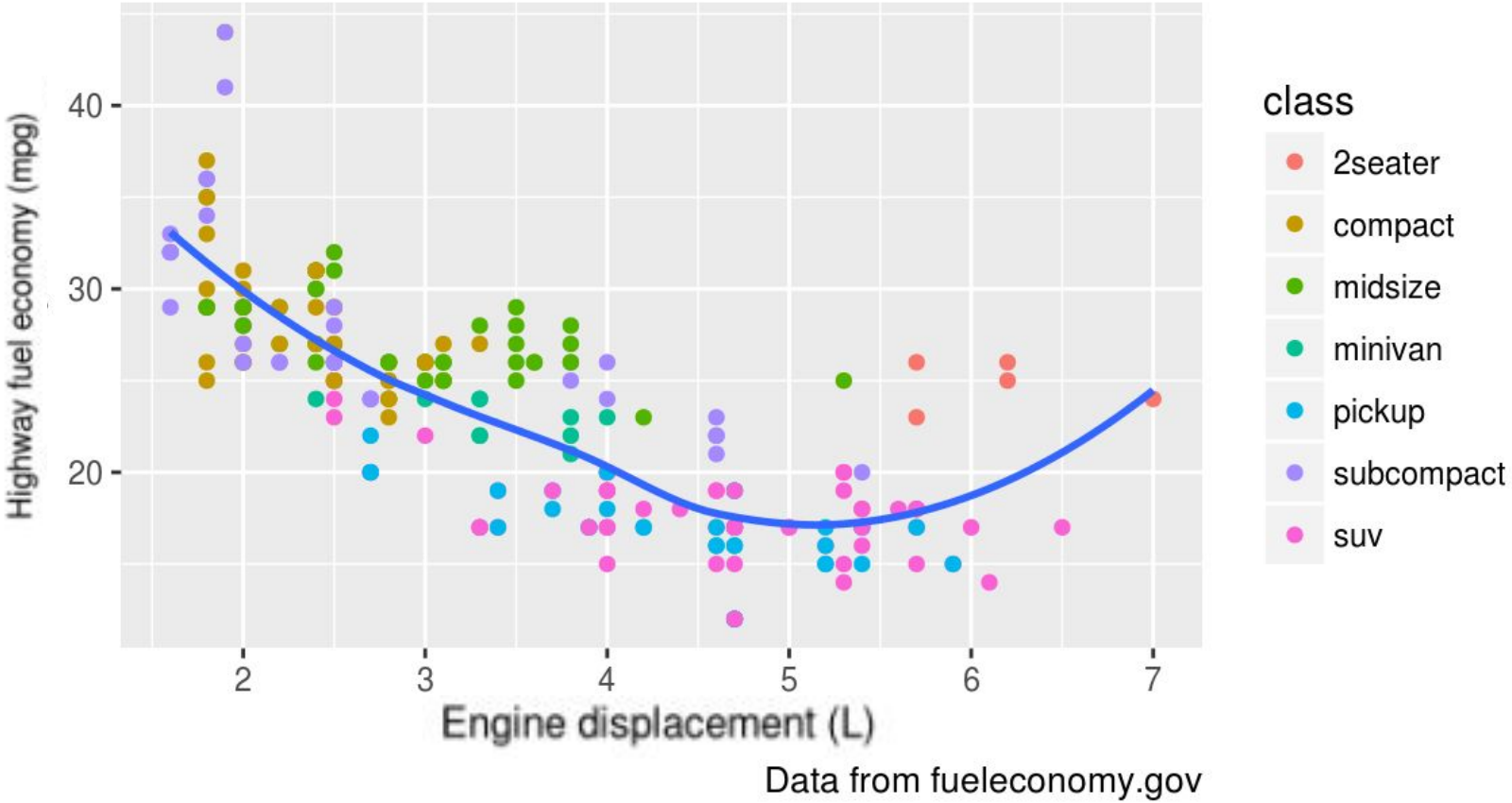
```
ggplot(mpg, aes(displ, hwy)) +
  geom_point(aes(color = class)) +
  geom_smooth(se = FALSE) +
  labs(
    title = "Fuel efficiency generally decreases with engine size",
    subtitle = "Two seaters (sports cars) are an exception because
of their light weight",
    caption = "Data from fueleconomy.gov",

    x = "Engine displacement (L)",
    y = "Highway fuel economy (mpg)"
  )
```

+ Can add mathematical equations as labels--see book for examples

# Fuel efficiency generally decreases with engine size

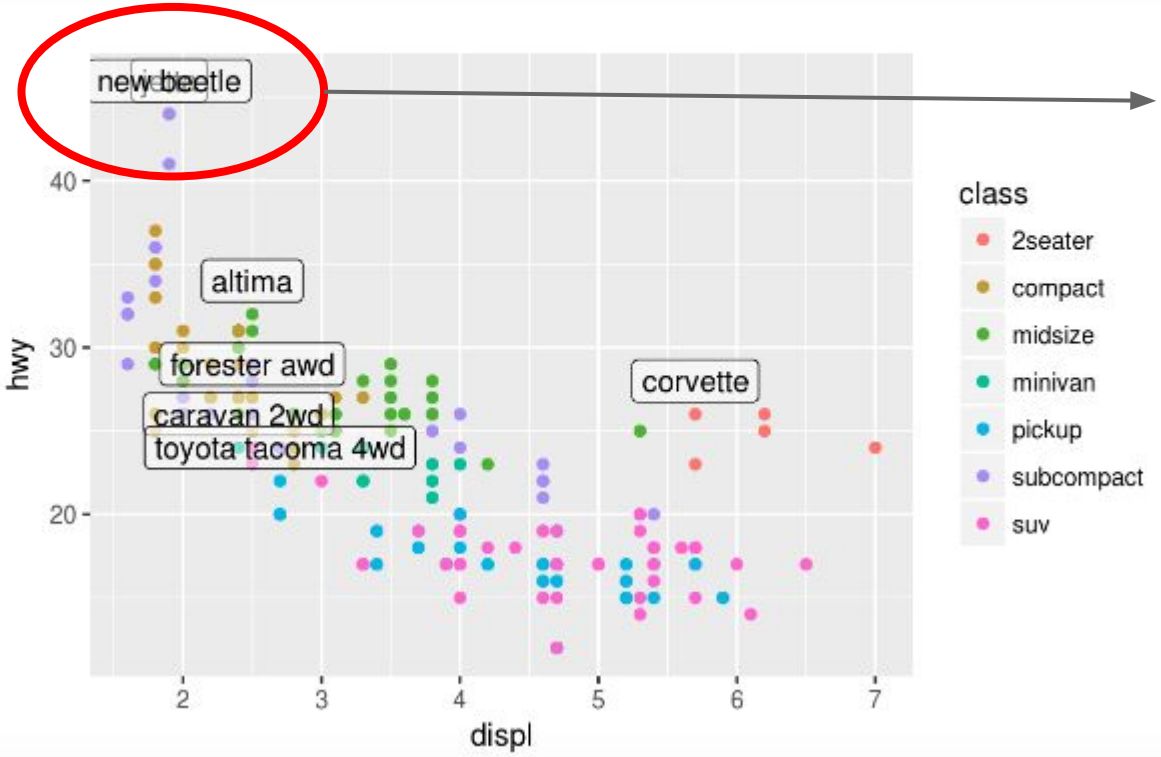
Two seaters (sports cars) are an exception because of their light weight



# annotations

- Annotations vs. labels
  - Annotations add information to the data points
  - But annotation uses geom_label…
  - In general, good to have a tibble with your labels in it
- `geom_text()`
  - `Has label argument`
  - `Can bring in other datasets with labels`
  - `Labels with text only`
- `geom_label()`
  - `Has label and data args too`
  - `Labels with a box around the label`

```
ggplot(mpg, aes(displ, hwy)) +
  geom_point(aes(colour = class)) +
  geom_label(aes(label = model), data = best_in_class, nudge_y = 2, alpha = 0.5)
```

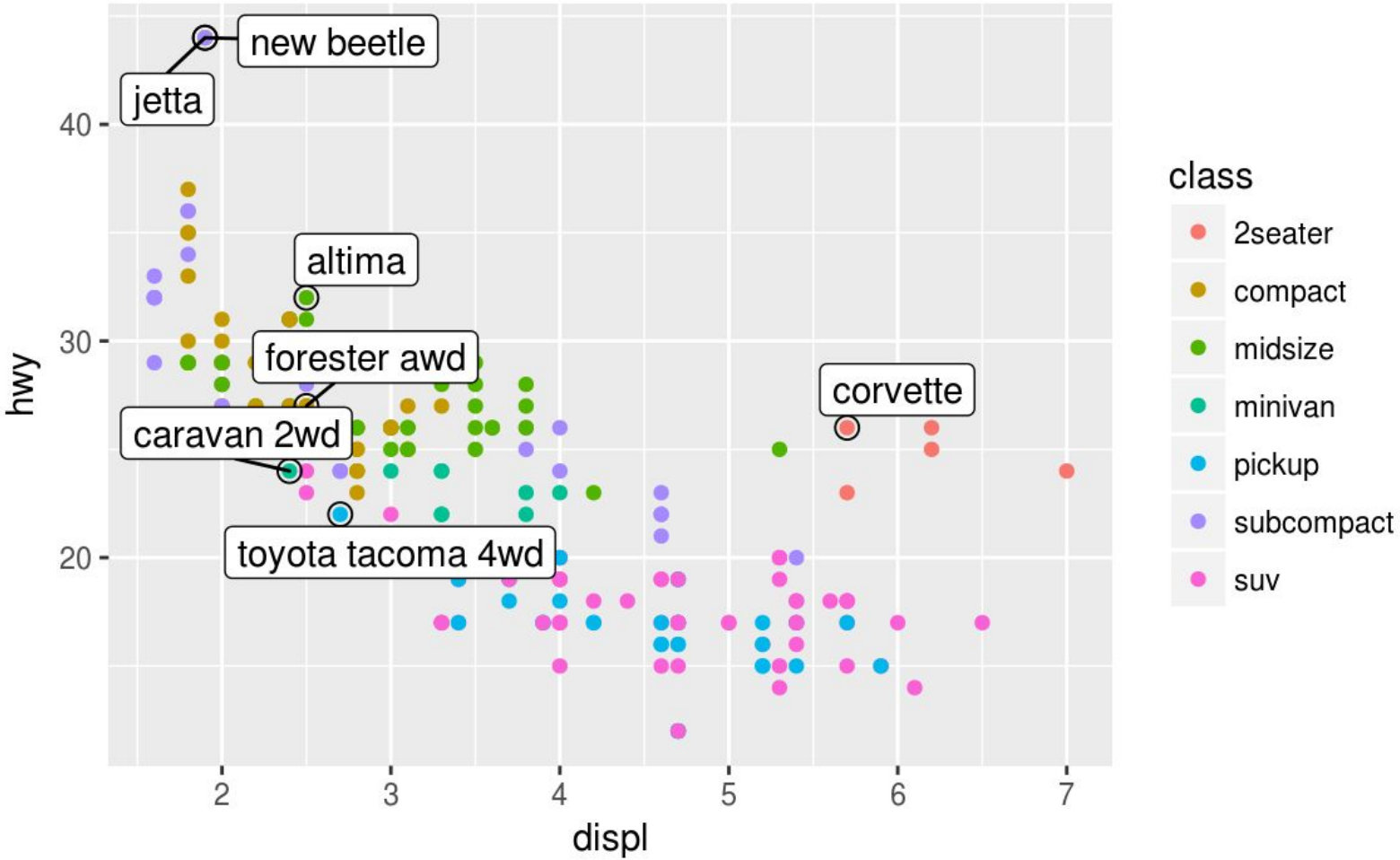



Overlapping labels--how to solve?

# overlapping labels

- Nudge--moves all labels the same way
- ggrepel package!!
  - Moves so you can see them!

```
ggrepel::geom_label_repel(aes(label =
model), data = best_in_class)
```


new beetle
jetta
altima
forester awd
caravan 2wd
toyota tacoma 4wd
corvette
hwy
40
30
20
displ
2
3
4
5
6
7
class
2seater
compact
midsize
minivan
pickup
subcompact
suv

# Other annotations

- Use `geom_hline()` and `geom_vline()` to add reference lines. I often make them thick (`size = 2`) and white (`colour = white`), and draw them underneath the primary data layer. That makes them easy to see, without drawing attention away from the data.
- Use `geom_rect()` to draw a rectangle around points of interest. The boundaries of the rectangle are defined by aesthetics `xmin`, `xmax`, `ymin`, `ymax`.
- Use `geom_segment()` with the `arrow` argument to draw attention to a point with an arrow. Use aesthetics `x` and `y` to define the starting location, and `xend` and `yend` to define the end location.

# scales

- Default scales are part of each ggplot
- Sometimes you want to change this
  - `Breaks`
    - `Control tick marks`
  - `Labels`
    - `Control what labels appear on the axes`
    - `Use NULL to remove entirely`
  - `Scale_x_date--a bit different`

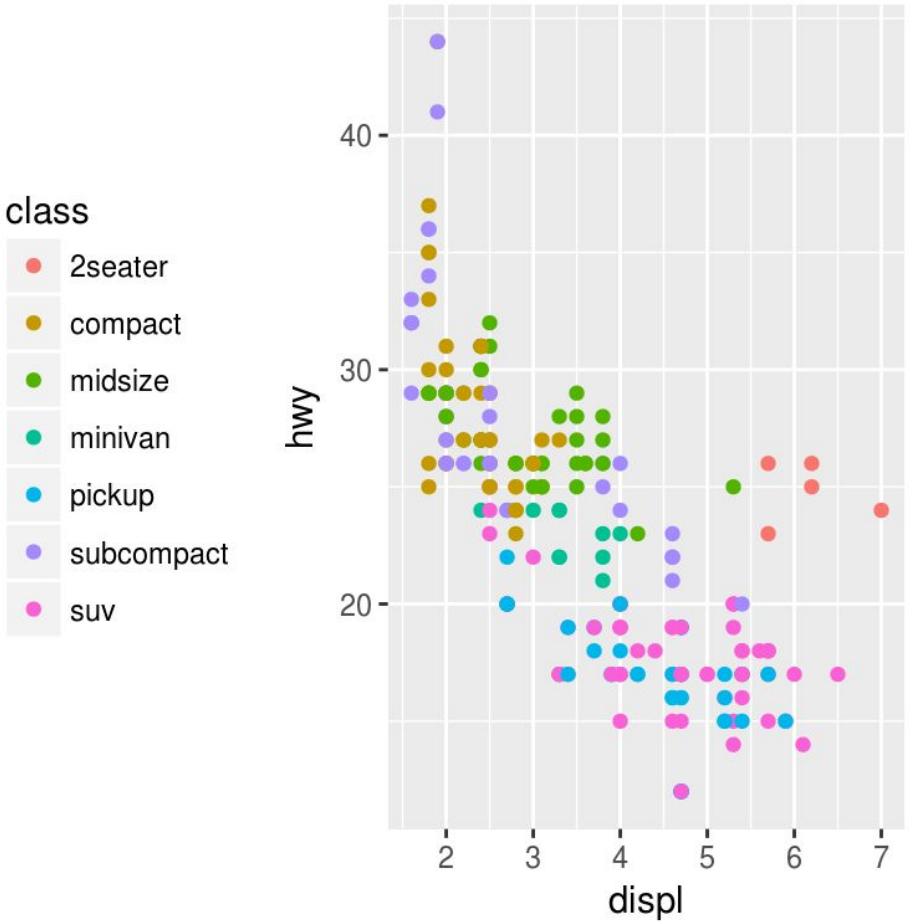
# Pic of scales

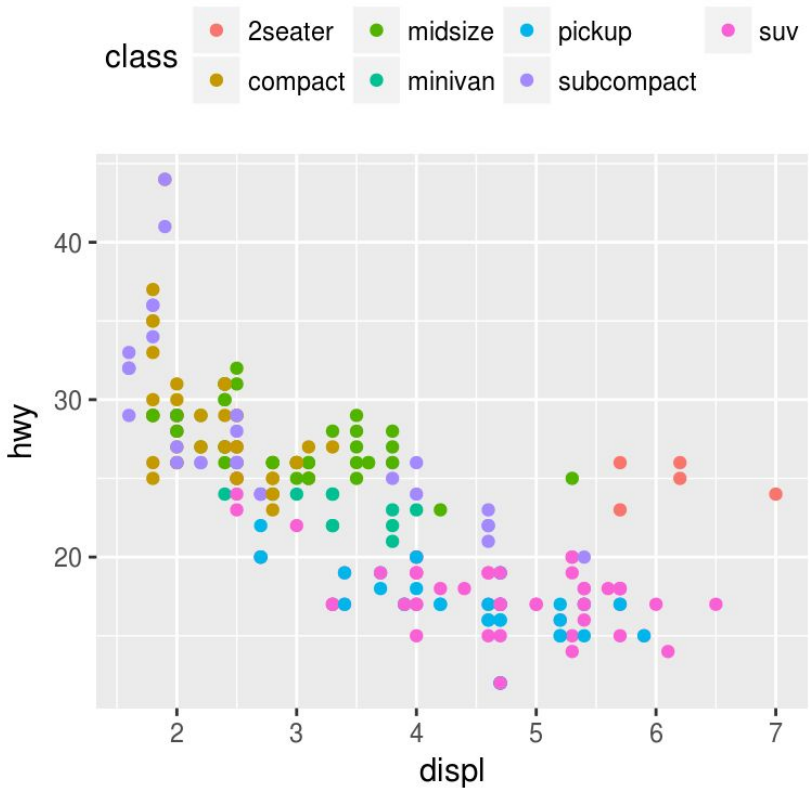
Try in R!

```
ggplot(mpg, aes(displ, hwy)) +
  geom_point() +
  scale_y_continuous(breaks = seq(15, 40, by = 5))
```

# Working with legends

- Change the position or layout of a legend
  - ```
    base <- ggplot(mpg, aes(displ, hwy)) +
      geom_point(aes(colour = class))
    base + theme(legend.position =
    "left/right/top/bottom")
    ```
- Remove a legend
  - `legend.position = "none"`
- Change the aesthetics of the legend
  - ```
    guides(colour = guide_legend(nrow = 1,
    override.aes = list(size = 4)))
    ```


class
2seater
compact
midsize
minivan
pickup
subcompact
suv
hwy
40
30
20
2
3
4
5
6
7
displ

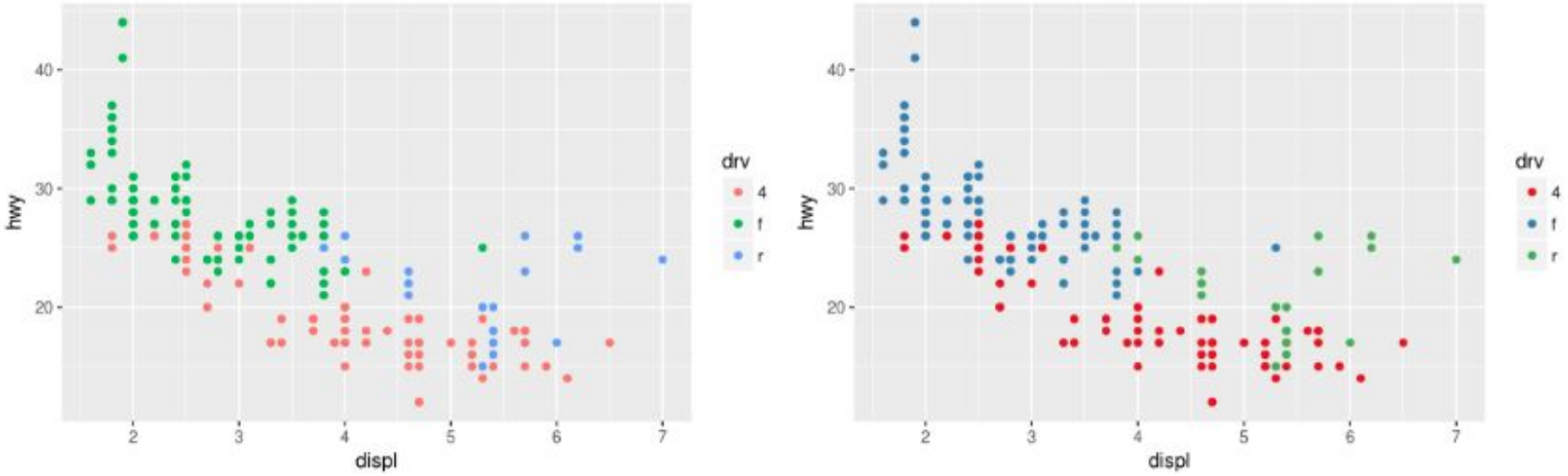

class
2seater
midsize
pickup
suv
compact
minivan
subcompact
hwy
40
30
20
2
3
4
5
6
7
displ

# Changing scales

- Transformed data vs untransformed scales
  - E.g. plot log data, but scale in original form for easier interpretation
- Changing colors!
  - R Color Brewer!
    - http://colorbrewer2.org
      http://www.cookbook-r.com/Graphs/Colors_(ggplot2)/
    - `scale_fill_brewer()`
    - `scale_colour_brewer()`
  - `Scale_fill_manual()`
    - Select exact colors you want

```r
ggplot(mpg, aes(displ, hwy)) +
  geom_point(aes(color = drv))

ggplot(mpg, aes(displ, hwy)) +
  geom_point(aes(color = drv)) +
  scale_colour_brewer(palette = "Set1")
```



# zooming

There are three ways to control the plot limits:

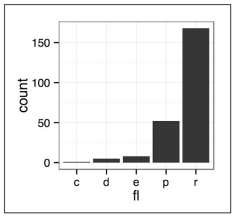
1. Adjusting what data are plotted
2. Setting the limits in each scale
3. Setting `xlim` and `ylim` in `coord_cartesian()`

# themes

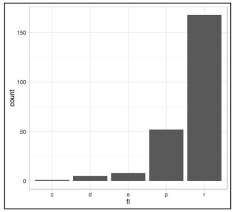
```
ggplot(mpg, aes(displ, hwy)) +
  geom_point(aes(color = class)) +
  geom_smooth(se = FALSE) +
  theme_bw()
```

## Themes

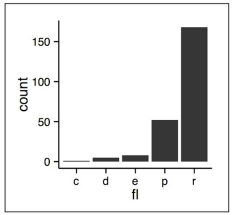
Theme functions change the appearance of your plot.



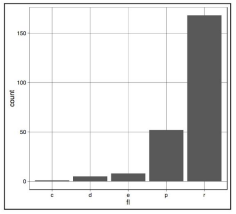

**theme_bw()**
White background with grid lines



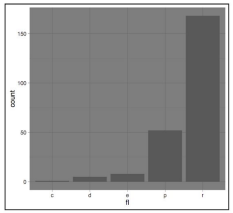
**theme_light()**
Light axes and grid lines



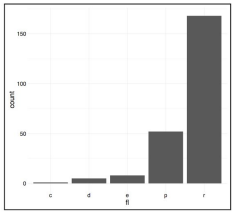

**theme_classic()**
Classic theme, axes but no grid lines



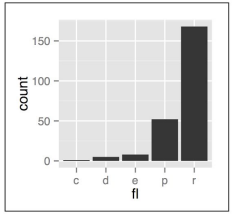
**theme_linedraw()**
Only black lines



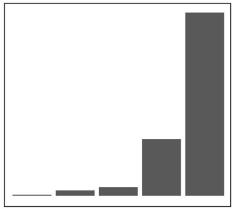
**theme_dark()**
Dark background for contrast



**theme_minimal()**
Minimal theme, no background




**theme_gray()**
Grey background (default theme)



**theme_void()**
Empty theme, only geoms are visible

# saving & learning more

Go to R--other options:

R markdown

- `fig.width`, `fig.height`, `fig.asp`, `out.width` and `out.height`

`ggsave()`

# R-Ladies Austin
## Upcoming Events

**ALL the Ladies in Tech HH** [March 7]

**From Zero to Web App with Shiny!** [March 28]

*Lightning talks?*

*Another book for book club?*