Layers on Layers on Layers

Last Time

Multipanel Plots

- Faceting
- Combining separate plots into 1 cohesive figure

Adding Stuff

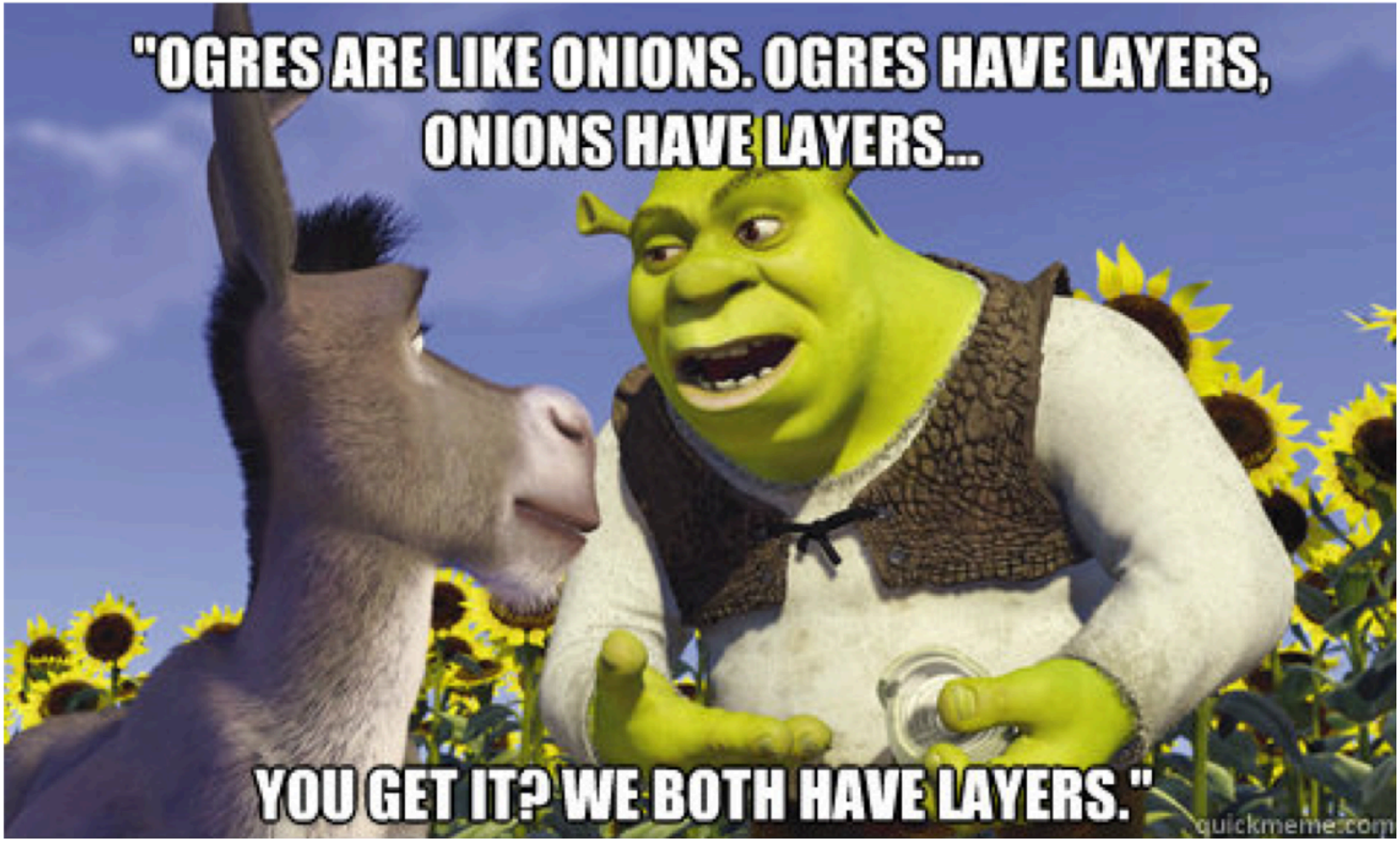
- Lines
- Text

This time

Miscellaneous & Remaining Details

- Bar plots & Error bars
- Jittering
- Adding layers
- Misc.

Layers on layers on layers



Bar Plots & Error Bars

- Usually bar plots reflect the *mean* of a group (or at least some summary statistic)
- Just like vertical/horizontal lines, we'll need to transform our raw data into summary statistics

- If you decide to work with summary stats, you have a few options:
    - You can calculate the summaries within the `ggplot` code
    - Calculate the summaries as their own data.frame, then call it from inside the `ggplot` function
    - I personally suggest the latter

Bar Plots & Error Bars

- When it comes to error bars, you need to decide what your bars will reflect and calculate the appropriate statistic!
    - 1 standard deviation
    - 95% confidence intervals
    - 1 standard error of the mean
- For now, we'll stick to +/- 1 standard deviation

Bar Plots & Error Bars

Step 1: Summarize your data

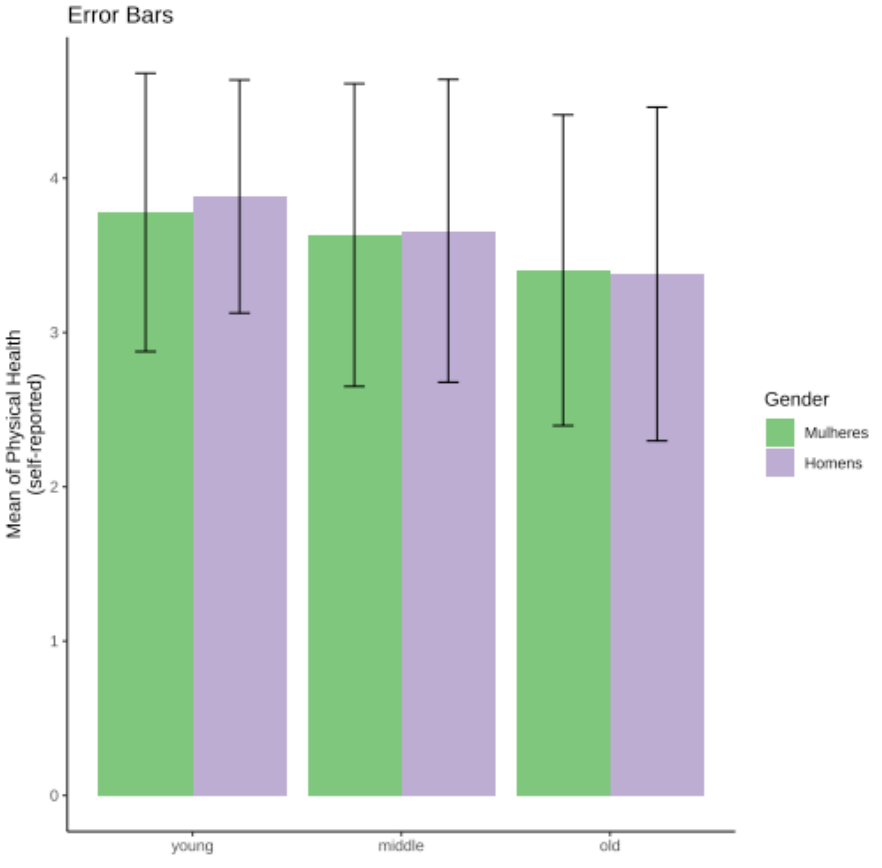
```
summaryStats <- midus %>%
  group_by(age_category, sex) %>%
  summarize(means = mean(physical_health_self),
            sds = sd(physical_health_self)) %>%
  mutate(sdLower = means - sds) %>%
  mutate(sdUpper = means + sds)

summaryStats
```

```
## # A tibble: 6 x 6
## # Groups:   age_category [3]
##   age_category sex    means   sds sdLower sdUpper
##   <fct>        <fct>  <dbl> <dbl>   <dbl>   <dbl>
## 1 young        Female  3.78 0.902    2.88    4.68
## 2 young        Male    3.88 0.755    3.13    4.64
## 3 middle       Female  3.63 0.981    2.65    4.61
## 4 middle       Male    3.66 0.981    2.68    4.64
## 5 old          Female  3.40 1.01     2.40    4.41
## 6 old          Male    3.38 1.08     2.30    4.46
```

Bar Plots & Error Bars

Now we can plot

```
ggplot(data = summaryStats,
       aes(x = age_category,
           y = means,
           fill = sex)) +
  geom_col(position = position_dodge(width=
  geom_errorbar(aes(ymin = sdLower,
                    ymax = sdUpper),
                position = position_dodge(w
                width = .2) +
  theme_classic() +
  scale_fill_brewer(palette = "Accent",
                    labels = c("Mulheres",
                               "Homens")) +
  labs(title = "Error Bars",
       x = "",
       y = "Mean of Physical Health\n(self-
       fill = "Gender")
```

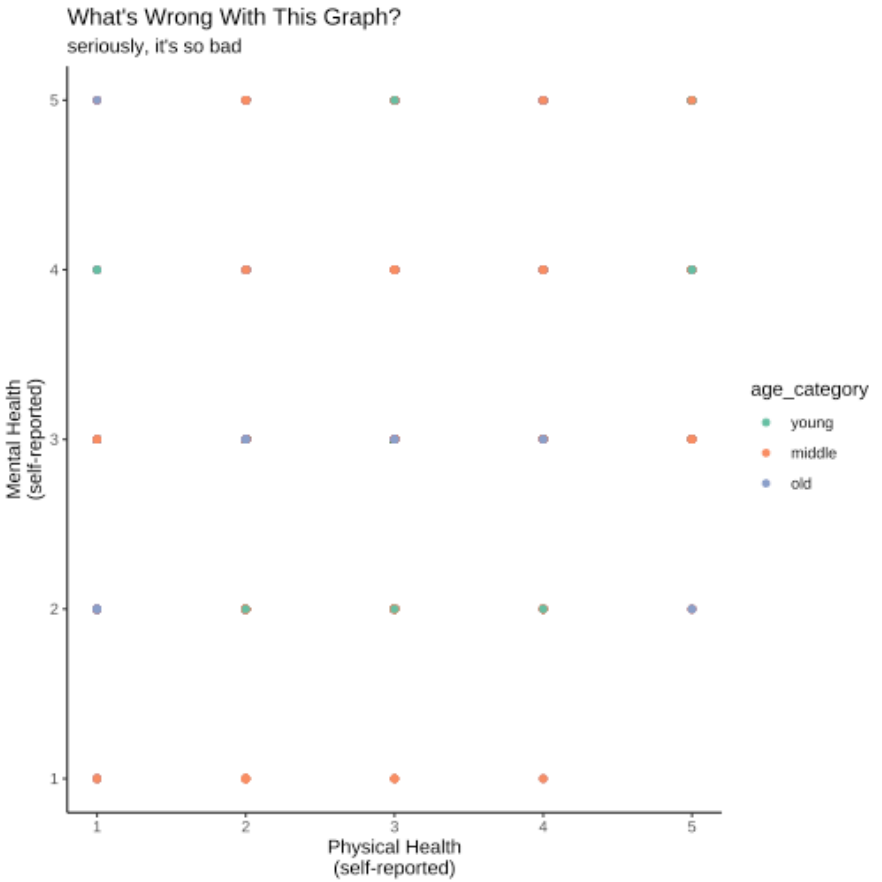


Jittering

Why does this plot look so weird?

- (Hint, how many observations do we have in the `midus` data set?)

```
ggplot(data = midus,
       aes(x = physical_health_self,
           y = mental_health_self)) +
  geom_point(aes(color = age_category)) +
  theme_classic() +
  scale_color_brewer(palette = "Set2") +
  labs(x = "Physical Health\n(self-reported)
       y = "Mental Health\n(self-reported)"
       title = "What's Wrong With This Graph
       subtitle = "seriously, it's so bad")
```



Jittering

The way we can get around this is with **jittering**

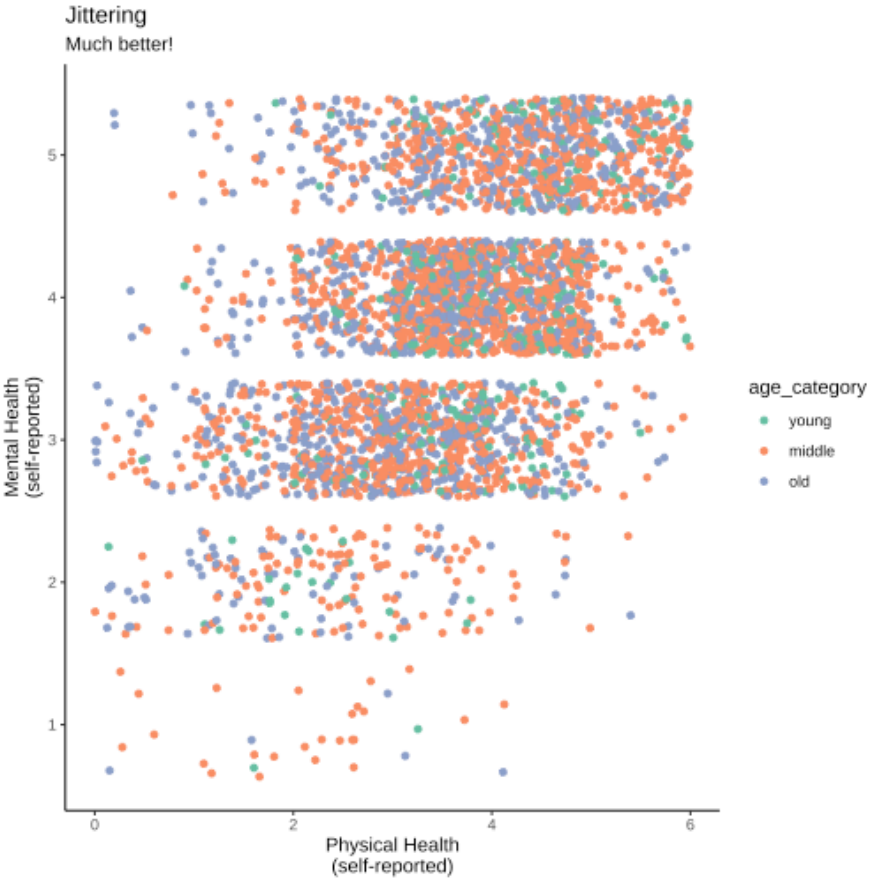
- A **jitter** is a slight irregular movement, variance, or unsteadiness
- Someone is jittery means someone is *shaky*, usually with nervousness

We can **jitter** the points on the x-axis to randomly shift them. This let's us see *all* of the points.

- We are adding in some random variance to make things more visible.

Jittering

```
ggplot(data = midus,
       aes(x = physical_health_self,
           y = mental_health_self)) +
  geom_jitter(aes(color = age_category),
              width = 1) +
  theme_classic() +
  scale_color_brewer(palette = "Set2") +
  labs(x = "Physical Health\n(self-reported
       y = "Mental Health\n(self-reported)"
       title = "Jittering",
       subtitle = "Much better!")
```

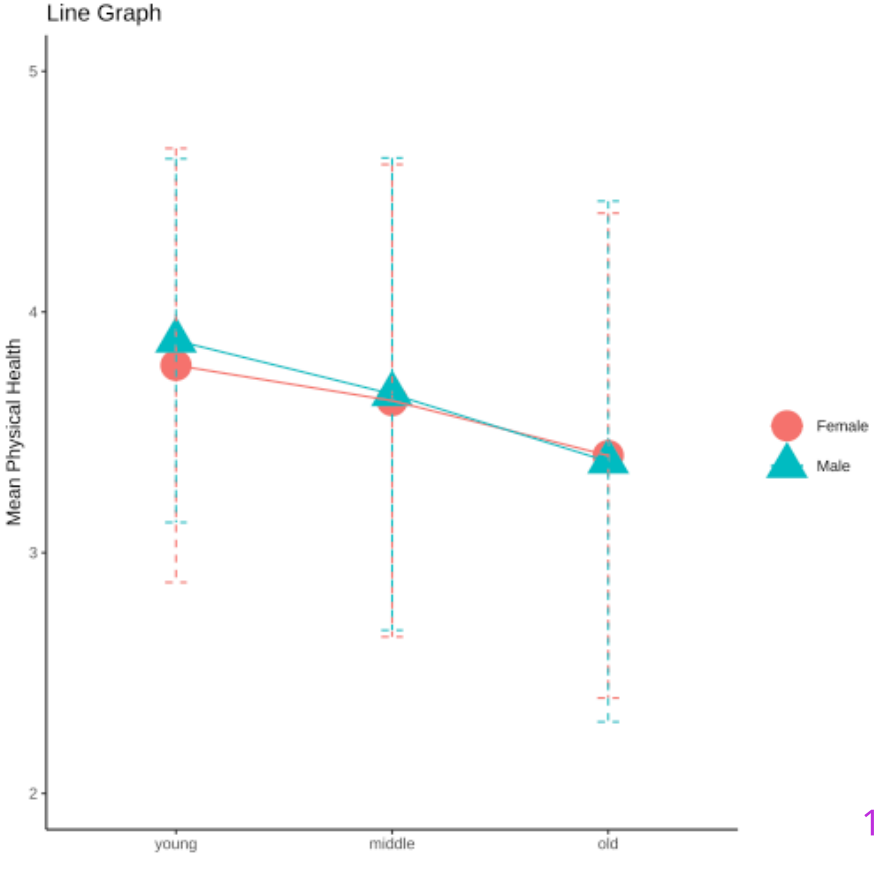


Layers on Layers on Layers

- By now you've hopefully realized that you can add as many layers as you'd like to your `ggplot`
- This means you can use multiple shapes or `geom_`s from the same data on the same plot
- Be careful!
  - You are layering `geom`s *on top* of each other
  - Order matters depending on what you're doing!

Layers on Layers: Line Graph Example

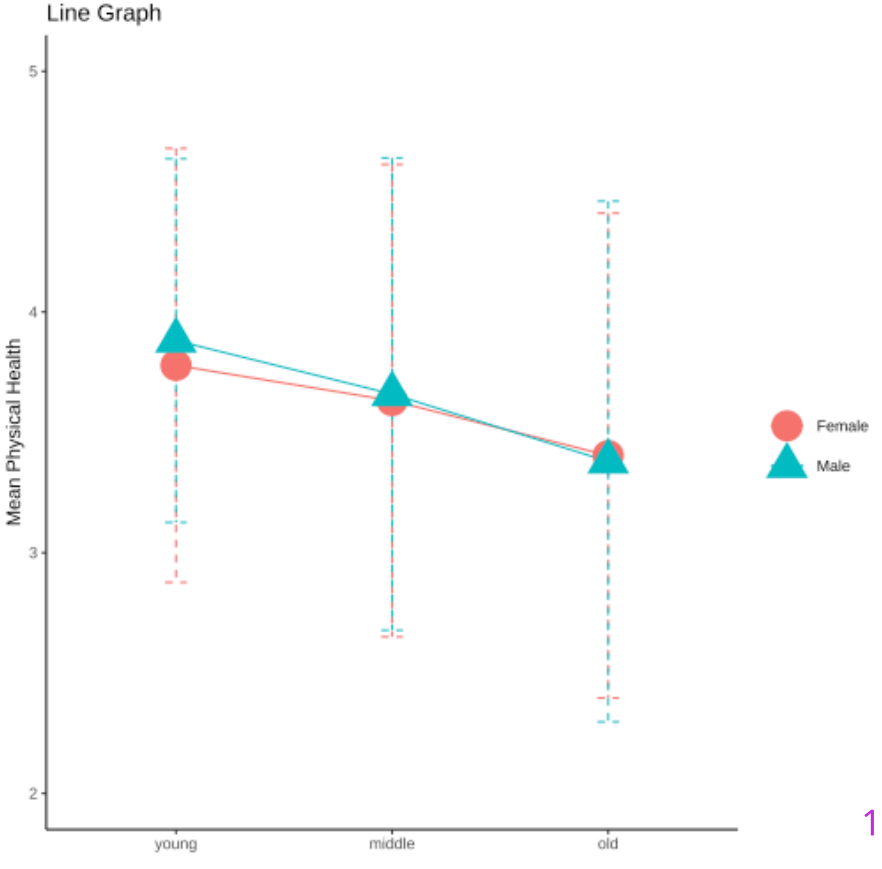
```
ggplot(data = summaryStats,
       aes(x = age_category,
           y = means,
           group = sex)) +
  geom_point(aes(color = sex,
                 shape = sex),
             size = 8) +
  geom_errorbar(aes(ymin = sdLower,
                    ymax = sdUpper,
                    color = sex),
                width = .1,
                linetype = "dashed") +
  ylim(c(2,5)) +
  geom_line(aes(color = sex)) +
  theme_classic() +
  labs(y = "Mean Physical Health",
       x = "",
       color = "",
       shape = "",
       title = "Line Graph")
```



Layers on Layers: Line Graph Example

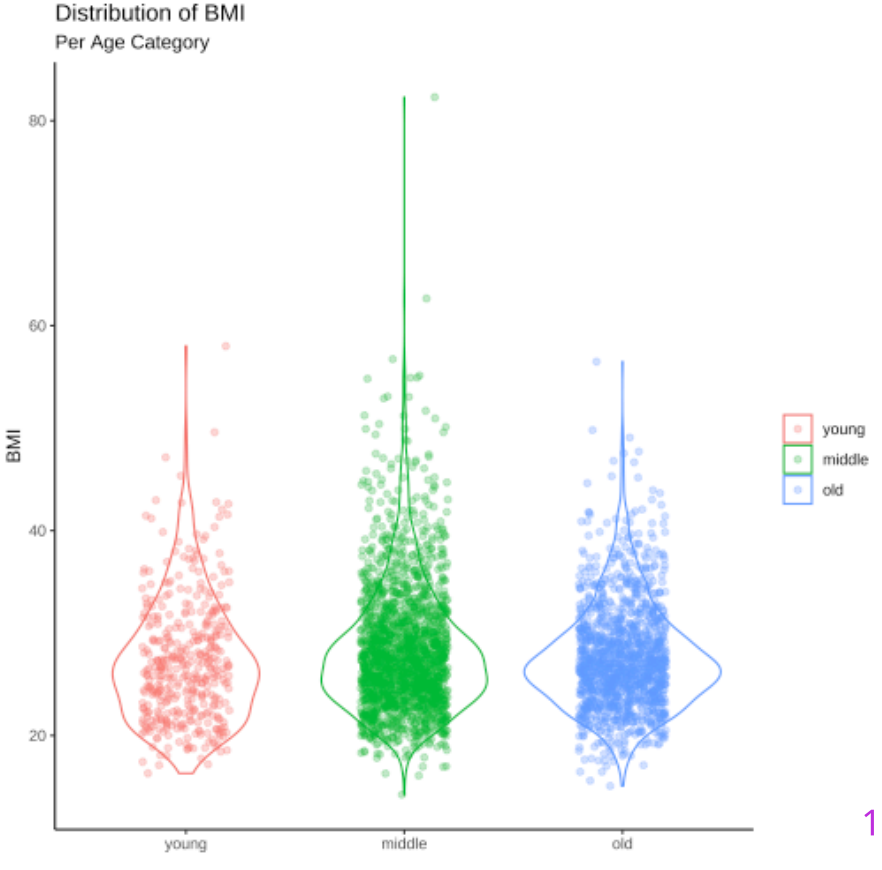
Order switch

```
ggplot(data = summaryStats,
       aes(x = age_category,
           y = means,
           group = sex)) +
  geom_errorbar(aes(ymin = sdLower,
                    ymax = sdUpper,
                    color = sex),
                width = .1,
                linetype = "dashed") +
  ylim(c(2,5)) +
  geom_line(aes(color = sex)) +
  geom_point(aes(color = sex,
                 shape = sex),
             size = 8) +
  theme_classic() +
  labs(y = "Mean Physical Health",
       x = "",
       color = "",
       shape = "",
       title = "Line Graph")
```



Layers on Layers: Distributions Example

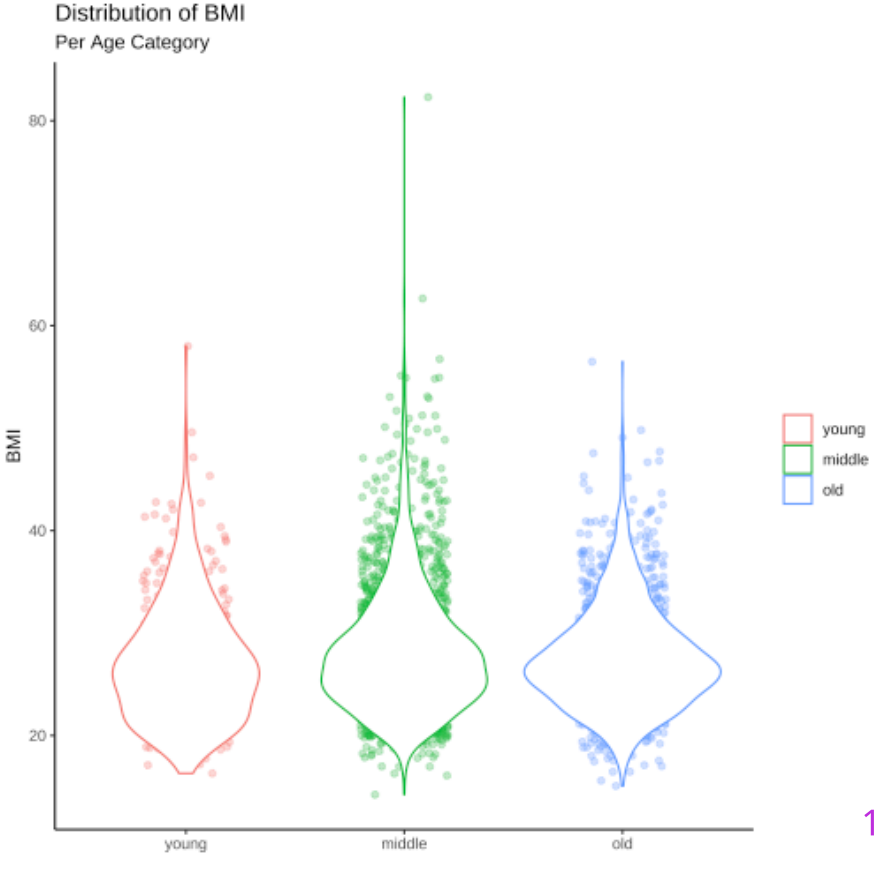
```
ggplot(data = midus,
       aes(x = age_category,
           y = BMI)) +
  geom_violin(aes(color = age_category),
              fill = "white") +
  geom_jitter(aes(color = age_category),
              width = .2,
              alpha = .3) +
  theme_classic() +
  labs(title = "Distribution of BMI",
       subtitle = "Per Age Category",
       x = "",
       color = "")
```



Layers on Layers: Distributions Example

- When combining mutliple `geom`s, the order matters!
- Look what happens when you switch `geom_violin` and `geom_point`:

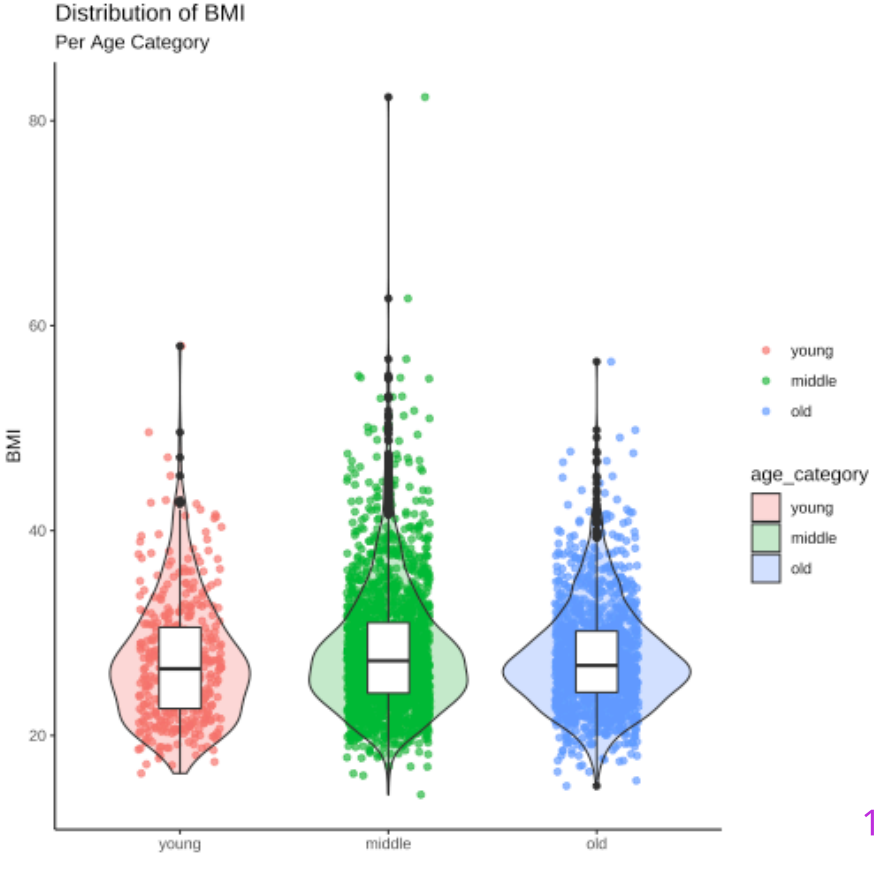
```
ggplot(data = midus,
   aes(x = age_category,
       y = BMI)) +
geom_jitter(aes(color = age_category)
          width = .2,
          alpha = .3) +
geom_violin(aes(color = age_category)
           fill = "white") +
theme_classic() +
labs(title = "Distribution of BMI",
   subtitle = "Per Age Category",
   x = "",
   color = "")
```



Layers on Layers: Distributions Example

- Adding a 3rd `geom`
- Not quite right...
- *This is a great example of jittering!*

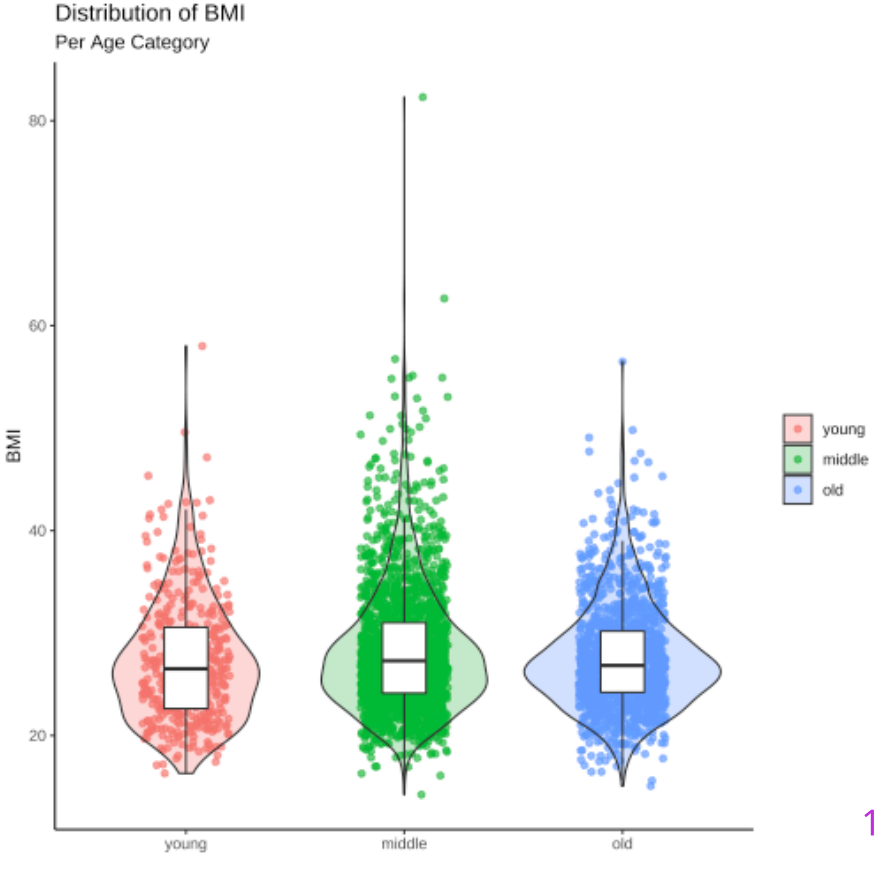
```
ggplot(data = midus,
   aes(x = age_category,
       y = BMI)) +
geom_jitter(aes(color = age_category)
         width = .2,
         alpha = .7) +
geom_violin(aes(fill = age_category),
          alpha = .3) +
geom_boxplot(fill = "white",
           width = .2) +
theme_classic() +
labs(title = "Distribution of BMI",
   subtitle = "Per Age Category",
   x = "",
   color = "")
```



Layers on Layers: Distributions Example

- Where should I look to figure out *how* to fix this?

```
ggplot(data = midus,
   aes(x = age_category,
       y = BMI)) +
geom_jitter(aes(color = age_category)
         width = .2,
         alpha = .7) +
geom_violin(aes(fill = age_category),
          alpha = .3) +
geom_boxplot(fill = "white",
           width = .2,
           outlier.shape = NA) +
theme_classic() +
labs(title = "Distribution of BMI",
   subtitle = "Per Age Category",
   x = "",
   color = "",
   fill = "")
```



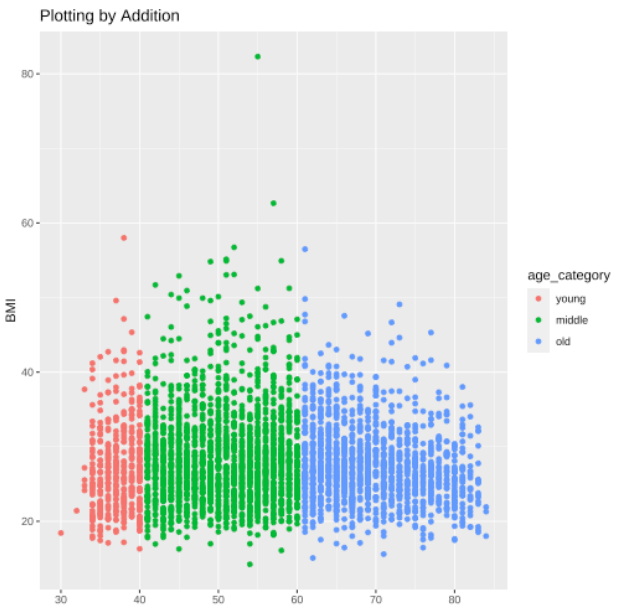
Last Remaining Thoughts

- Idea of "addition" & "piping"
- Exporting plots
- Debugging
- Fun!

Idea of "addition"

- When you use the + at the end of a line, you are literally telling R that you want to *add* something -- you're saying *"add another layer to the plot"*
- As a result, you will see a lot of code, especially in the help documentation, that looks like this:

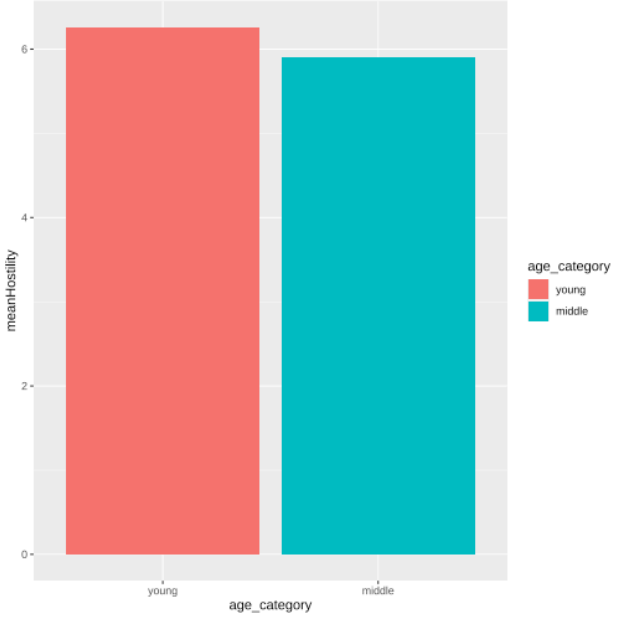
```
p <- ggplot(data = midus)
p <- p + geom_point(aes(x = age, y = BMI, color = age_category))
p <- p + labs(title = "Plotting by Addition")
p
```



Idea of "piping"

- You can also "pipe" `ggplot2` code into `tidyverse` code
- Notice that the pipe `%>%` changes into a `+` when you entire `ggplot2` code!

```
midus %>%
  filter(age_category != "old") %>%
  group_by(age_category) %>%
  summarize(meanHostility = mean(hostility)) %>%
  ggplot(aes(x = age_category, y = meanHostility)) +
  geom_col(aes(fill = age_category))
```



Exporting

- So you've made a plot. Yay! Now you need to get it out of R and into a file format you can upload (.png, .tiff, .jpf, .pdf etc.)
- Method 1: `ggsave()` function
    - It should work most of the time
    - Simplier, easier
    - Not as much control
- Method 2: Turn on/off the graphic device
    - Better if you need something specific
    - Specific resolution, compression etc.
    - Slightly more annoying, but not by much

IMPORTANT: You must consider your working directory! Your plot will save to your working directory

Exporting

```
# Method 1: `ggsave()`
ggsave(filename = "plotSaveTest.png",
       width = 7,
       height = 7,
       units = "in")

# Note: this uses the last plot you generated
```

```
# Method 2: graphic device
# First, you call the device
# Then you plot,
# Then you turn the device off

tiff(filename = "plotSave2.tiff",
     width = 7,
     height = 7,
     units = "in",
     res = 300,
     compression = "lzw")

ggplot(data = data,
       aes(x = x, y = y)) +
  geom_point()

dev.off() # Leave parentheses empty.
```

If you get a pop-up that's like "quartz_off_screen" or something, that's OK.

Debugging

If your code isn't working, and you really think that it should, you might be using a function that comes from a different package.

- Ex: `alpha` exists in both the `ggplot2` and `psych` packages
- If it gives you trouble, just specify the package like this `ggplot2::alpha`

If you still want to cry 😢 because your plot still isn't giving you what you want, try:

- Store the plot as an object
- Then look at its inner workings using `ggplot_build(plotObject)` where `plotObject` is the name of your plot

Finally, when looking around the internet for help, make sure that the version number is kind of close to the one you're working with (usually doesn't need to be exact). The `tidyverse` including `ggplot2` has been around for some time now, and they have gone through many iterations over the years.

Fun!

Want to look at pictures of cute puppies in RStudio?

- pupR package!

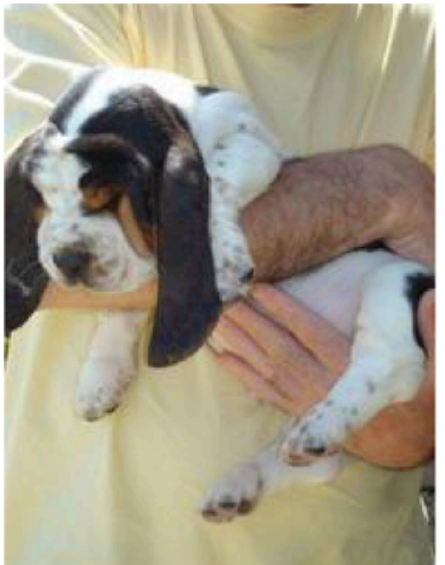
```
# use this line of code to install the package
# devtools::install_github("melissanjohnson/pupR")

library(pupR)
pupR()
```

Fun!

Want to look at pictures of cute puppies in RStudio?

- pupR package!

```
# use this line of code to install the package
# devtools::install_github("melissanjohnson/pupR")

library(pupR)
pupR(dog_type = "basset")
```



Fun!

For those of you who get bored and like to procrastinate with remarkably dumb things, you can make your own XKCD plot in R!

- Use the `xkcd` package and the `extrafont` packages

```
library(xkcd)
library(extrafont)
```

Fun!

```
set.seed(1234) #this makes sure the random numbers generated will be the

df <- data.frame(vacc = rnorm(50, sd = .75), #make fake data
                 autism = rnorm(50, sd = .55))


xrange <- c(-2,2) # specific for xkcd
yrange <- c(-2,2) # specific for xkcd

ratioxy <- diff(xrange) / diff(yrange) # specific for xkcd

mapping <- aes(x,  y,    # specific for xkcd
               scale,
               ratioxy,
               angleofspine ,
               anglerighthumerus,
               anglelefthumerus,
               anglerightradius,
               angleleftradius,
               anglerightleg,
               angleleftleg,
               angleofneck)
```

Fun!

This code makes the little stick figure dude. You choose the angles of each line. You can use π charts!

```
dataman <- data.frame(x= 1.75, y=-.4,   # specific for xkcd
                      scale = .5,
                      ratioxy = 1,
                      angleofspine =  -pi/2  ,
                      anglerighthumerus = c((7*pi)/4),
                      angleleftthumerus = c((5*pi)/4), # use the charts!
                      anglerightradius = c(pi/6),
                      angleleftradius = c((5*pi)/6),
                      angleleftleg = 3*pi/2  + pi / 12 ,
                      anglerightleg = 3*pi/2  - pi / 12,
                      angleofneck = runif(1, 3*pi/2-pi/10, 3*pi/2+pi/10)
```

Fun!

Finally, something you know -- ggplot!

```
ggplot(df, aes(x = vacc, y = autism, group = 1)) +
  geom_point() +
  geom_smooth(color = "red", method = "lm", se = FALSE) +
  xkcdaxis(xrange, yrange) +
  xkcdman(mapping, dataman) +
  annotate("text", x=0, y = -1.75,
           label = "The relationship between vaccines
           and autism is as flat as the earth",
           family="Humor Sans", size = 3) +
  labs(y = "Autism",
       x = "Vaccines",
       title = "Which conspiracy theory\nshould you believe??") +
  theme_xkcd() +
  theme(text = element_text(family = "Humor Sans", size = 11))
```

Fun!

And here's the actual plot