Problem Set #1

INSERT YOUR NAME HERE

Invalid Date

Table of contents

```r
library(tidyverse)
```

```
-- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
v dplyr     1.1.4     v readr     2.1.5
v forcats   1.0.0     v stringr   1.5.1
v ggplot2   3.5.0     v tibble    3.2.1
v lubridate 1.9.3     v tidyr     1.3.1
v purrr     1.0.2
-- Conflicts ------------------------------------------ tidyverse_conflicts() --
x dplyr::filter() masks stats::filter()
x dplyr::lag()    masks stats::lag()
i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to becom
```

Overview:

In this problem set, you will be using the **ggpot2** package (part of tidyverse) to practice the basics of plotting. Unlike later homeworks, this is just a basic set of exercises, so you will not be asked use your own data (although you're welcome to if you'd really like to).

For demonstration, we'll use the `starwars` dataset from the `dplyr` package, which you will have access to after loading the `tidyverse` package.

```
data(starwars)
head(starwars)
```

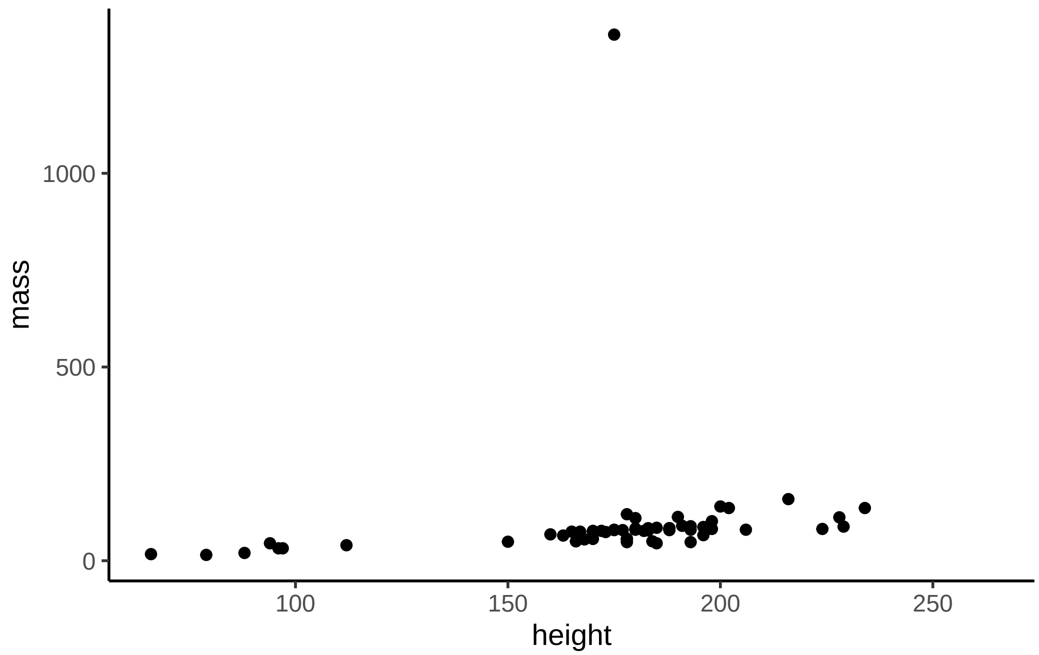
```
# A tibble: 6 x 14
  name      height  mass hair_color skin_color eye_color birth_year sex   gender
  <chr>      <int> <dbl> <chr>      <chr>      <chr>          <dbl> <chr> <chr>
1 Luke Sky~    172    77 blond      fair       blue            19   male  mascu~
2 C-3PO        167    75 <NA>       gold       yellow         112   none  mascu~
3 R2-D2         96    32 <NA>       white, bl~ red             33   none  mascu~
4 Darth Va~    202   136 none       white      yellow          41.9 male  mascu~
5 Leia Org~    150    49 brown      light      brown           19   fema~ femin~
6 Owen Lars    178   120 brown, gr~ light      blue            52   male  mascu~
# i 5 more variables: homeworld <chr>, species <chr>, films <list>,
#   vehicles <list>, starships <list>
```

Question 1: `geom_point()`

1. Plot the relationship between mass and height using `geom_point()`.

```
starwars %>%
  ggplot(aes(x = height, y = mass)) +
  geom_point() +
  theme_classic()
```

```
Warning: Removed 28 rows containing missing values or values outside the scale range
(`geom_point()`).
```



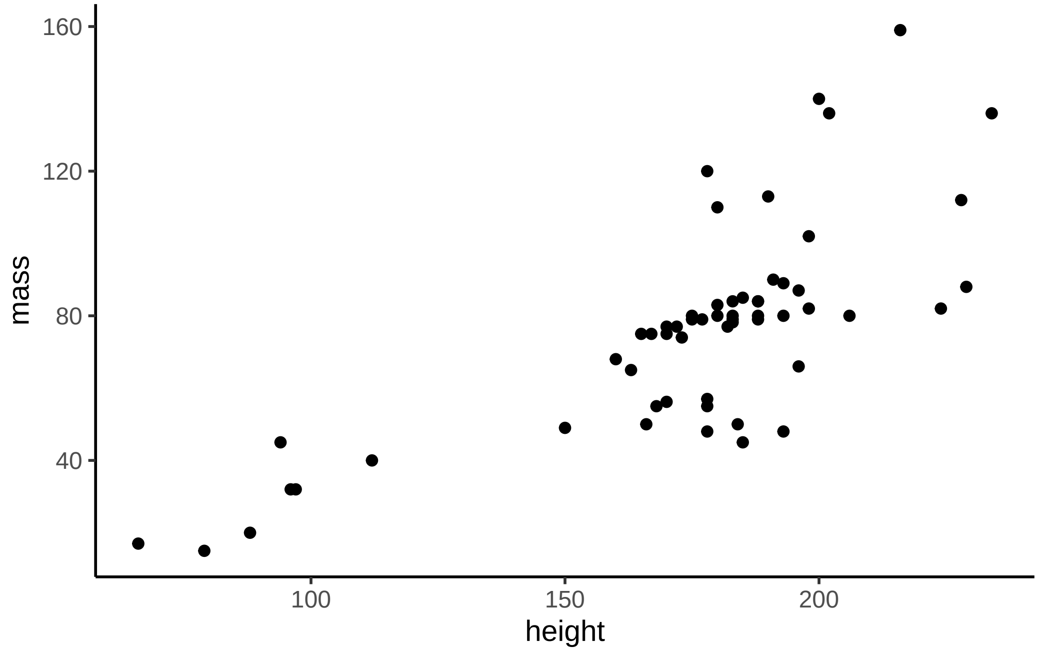
2. What an outlier! Let's

```
starwars %>%
  filter(mass > 200)
```

```
# A tibble: 1 x 14
  name      height  mass hair_color skin_color eye_color birth_year sex   gender
  <chr>      <int> <dbl> <chr>      <chr>      <chr>          <dbl> <chr> <chr>
1 Jabba De~    175  1358 <NA>       green-tan~ orange           600 herm~ mascu~
# i 5 more variables: homeworld <chr>, species <chr>, films <list>,
#   vehicles <list>, starships <list>
```

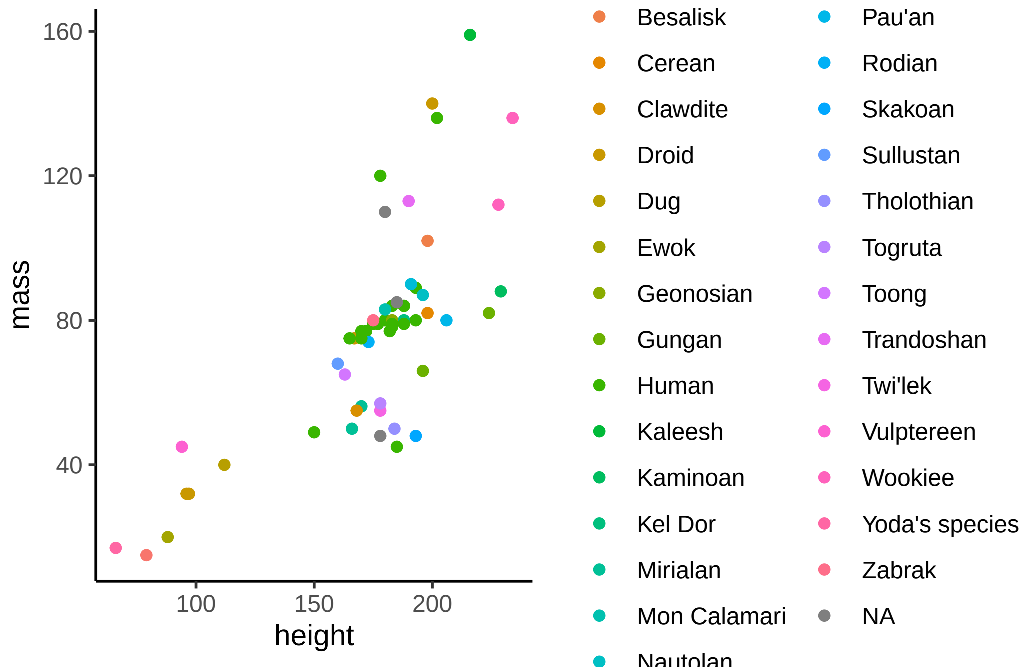
3. Now, plot the relationship between mass and height again, removing that outlier.

```
starwars %>%
  filter(mass < 200) %>%
  ggplot(aes(x = height, y = mass)) +
  geom_point() +
  theme_classic()
```



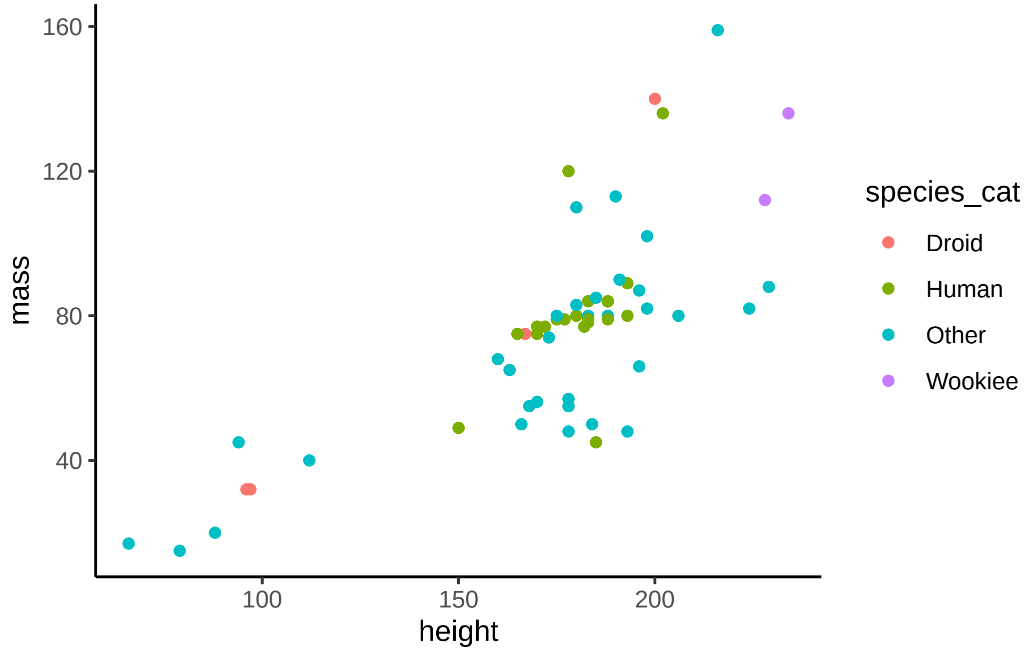
4. It's possible that different species in the starwars universe have different weight-height patterns. Let's test that by setting `color = species`.:

```
starwars %>%
  filter(mass < 200) %>%
  ggplot(aes(x = height, y = mass, color = species)) +
  geom_point() +
  theme_classic()
```



5. Oops – that's a lot of species, let's reduce that to humans, Droids, and Wookiees and collapse the others to "Other" (hint create a new variable with mutate). Then replot. Once you're done, assign that plot to object `p1`. Remember that `ggplot` is a layered grammar of graphics, so assigning this plot to an object will let us layer additional things on top of this base plot.

```
p1 <- starwars %>%
  mutate(species_cat = ifelse(species %in% c("Human", "Droid", "Wookiee"), species, "Other
  filter(mass < 200) %>%
  ggplot(aes(x = height, y = mass, color = species_cat)) +
  geom_point() +
  theme_classic()
p1
```



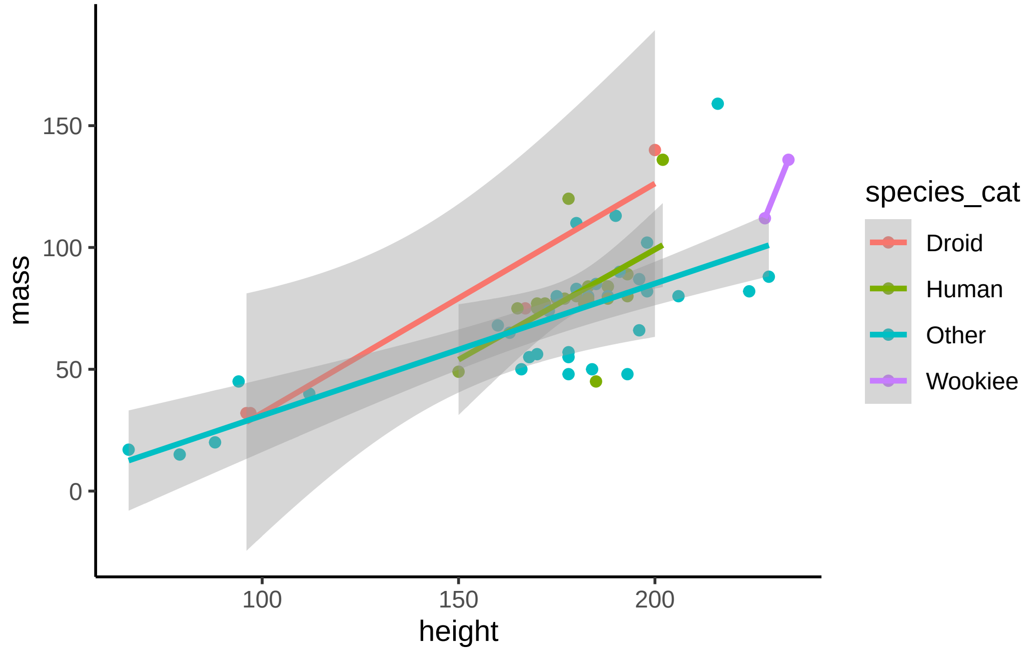
Question 2: `geom_smooth()`

Now that we've got our scatterplot, let's layer a line of best fit on top. We're going to test out different fits here. You can get a since of this by typing `?geom_smooth` in your console.

1. First, let's test a linear fit between height and weight using `geom_smooth()`. To do this, you'll set `method = "lm"`:

```
p2 <- p1 +
  geom_smooth(
    method = "lm"
  )
p2
```

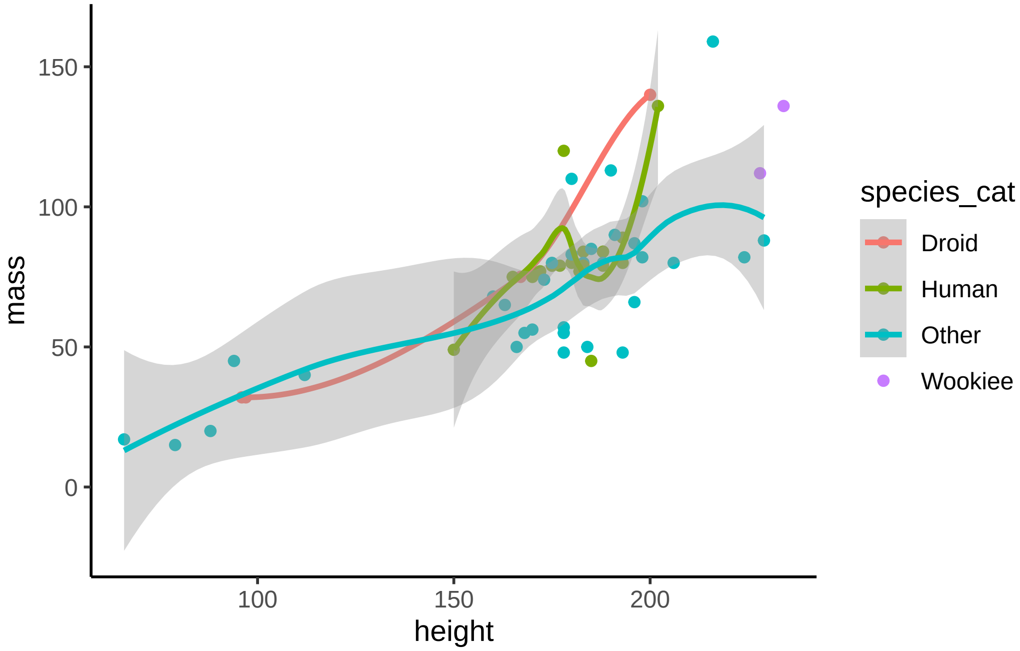
```
`geom_smooth()` using formula = 'y ~ x'
```



2. Hmmm, that maybe isn't super linear. Let's test out a non-linear fit. To get a better sense of the general pattern, let's start with a loess line (hint: set `method = "loess"`):

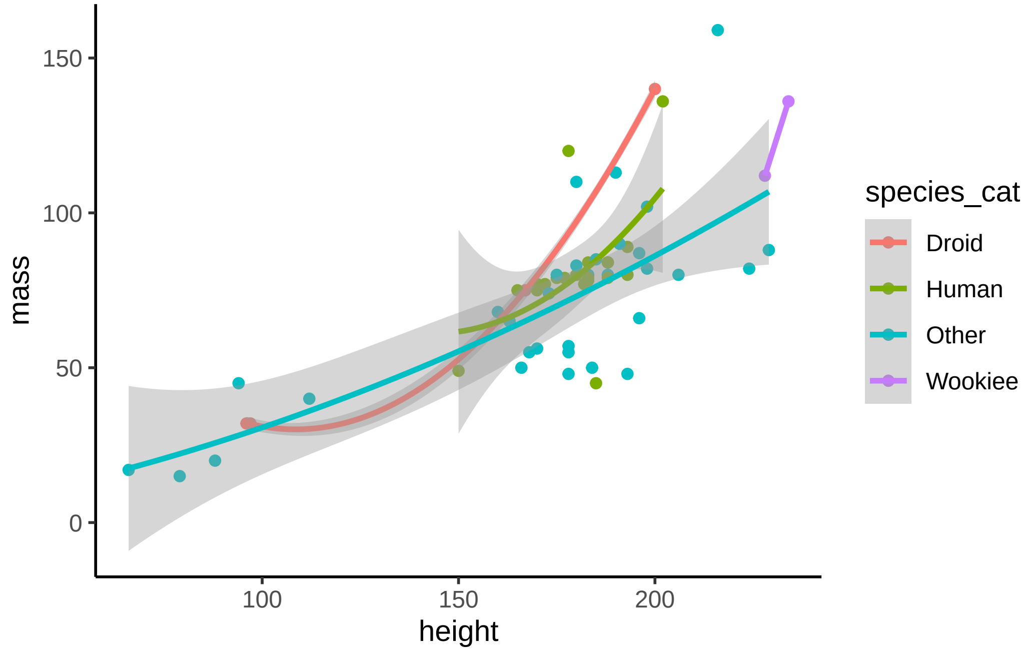
```
p1 +
  geom_smooth(
    method = "loess"
  )
```

```
`geom_smooth()` using formula = 'y ~ x'
```



3. That's not totally clear – what about quadratic? We can change the formula that links x and y via the formula argument (`formula = y ~ x + I(x^2)`)

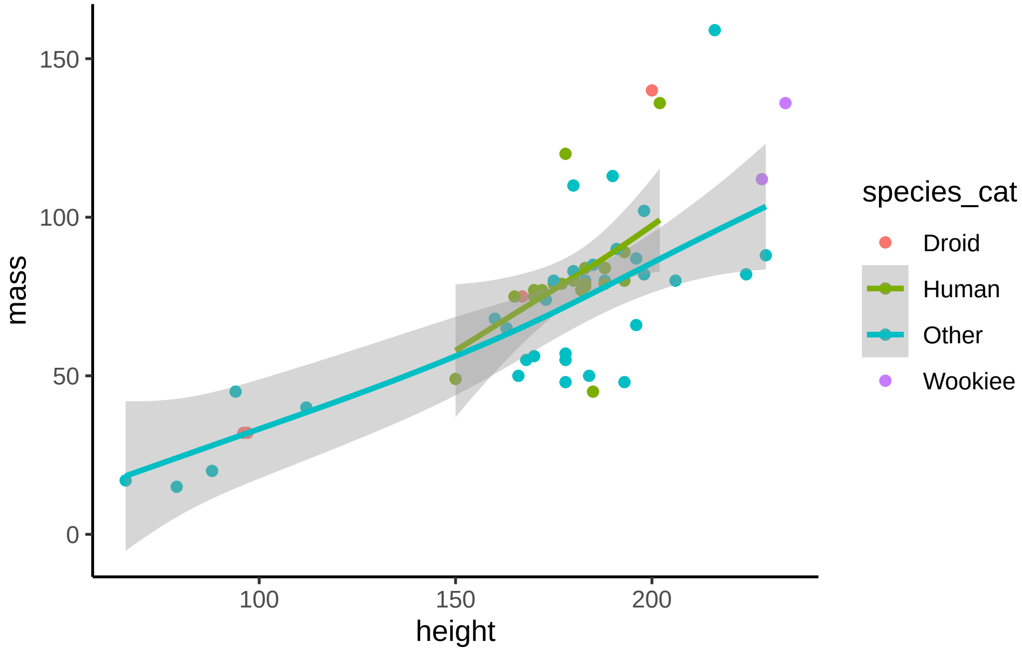
```
p1 +
  geom_smooth(
    method = "lm"
    , formula = y ~ x + I(x^2)
  )
```



4. Let's try one more. Set the method to "gam":

```
p1 +
  geom_smooth(
    method = "gam"
    )
```

```
`geom_smooth()` using formula = 'y ~ s(x, bs = "cs")'
```



5. Choose one of these and save it as object `p2`.

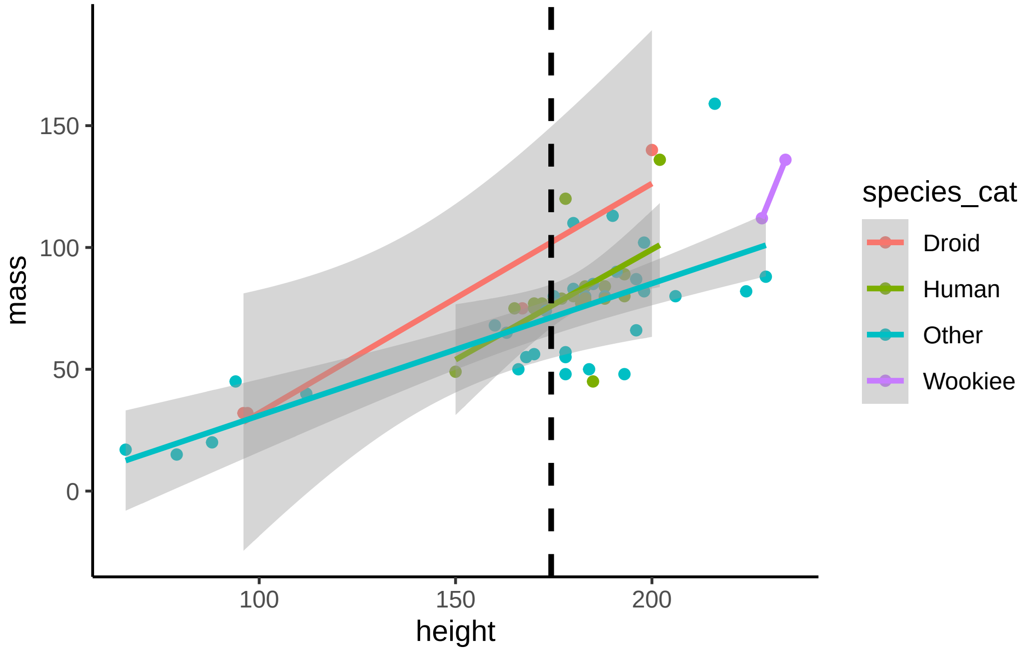
Question 3: `geom_vline()` and `geom_hline()`:

Now, let's practice adding vertical and horizontal lines. Let's add a line at the mean of both height (vertical) and weight (horizontal) using `geom_vline()` and `geom_hline()`, respectively.

1. Add a vertical line at the mean of height. Make it dashed and increase the thickness. Assign this to p3.

```
p3 <- p2 +
  geom_vline(
    aes(xintercept = mean(height))
    , linetype = "dashed"
    , size = 1
    )
p3
```

```
`geom_smooth()` using formula = 'y ~ x'
```



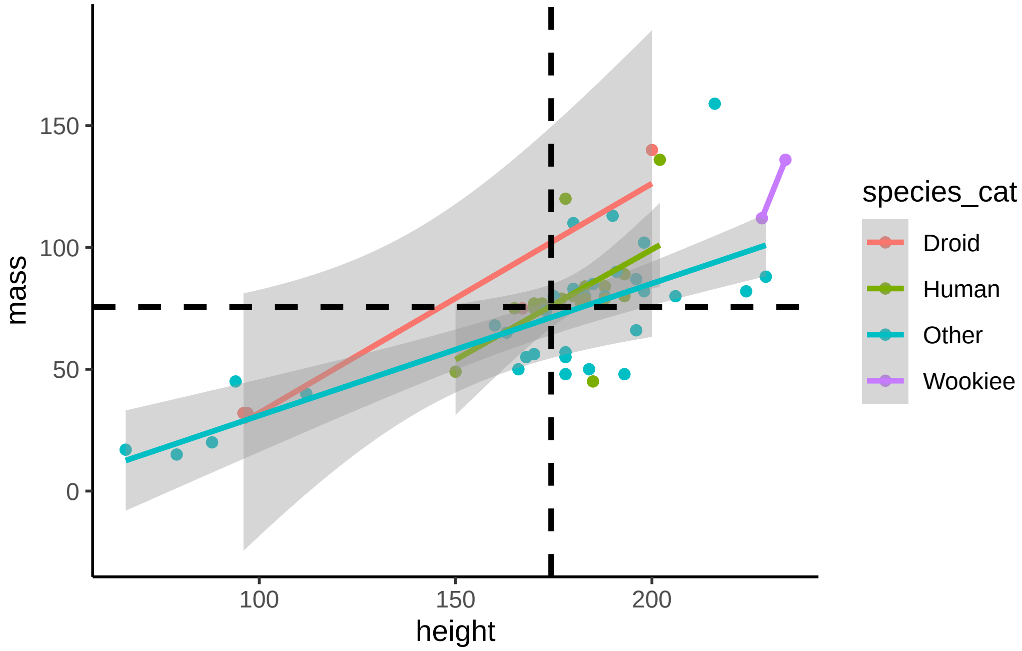
2. Add a horizontal line at the mean of weight Make it dashed and increase the thickness. Assign this to p4.

```r
p4 <- p3 +
  geom_hline(
    aes(yintercept = mean(mass))
    , linetype = "dashed"
    , size = 1
    )
p4
```

```
`geom_smooth()` using formula = 'y ~ x'

Warning in qt((1 - level)/2, df): NaNs produced

Warning in max(ids, na.rm = TRUE): no non-missing arguments to max; returning
-Inf
```



Question 4: `geom_bar()`

But maybe we do actually just care about the means, so let's plot the mean and SDs of height and weight across species. Here's code to get the descriptives to help you get started:

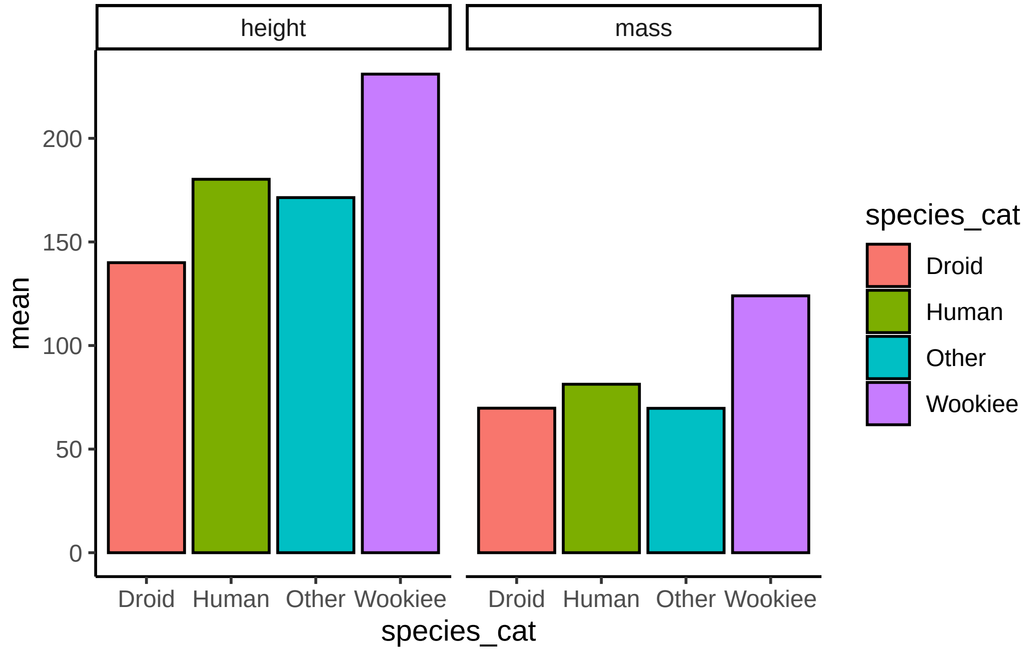
```
starwars2 <- starwars %>%
  mutate(species_cat = ifelse(species %in% c("Human", "Droid", "Wookiee"), species, "Other
  filter(mass < 200) %>%
  select(name, height, mass, species_cat) %>%
  pivot_longer(
    cols = c(height, mass)
    , names_to = "measure"
    , values_to = "value"
  )

starwars_desc <- starwars2 %>%
  group_by(species_cat, measure) %>%
  summarize_at(vars(value), lst(mean, sd), na.rm = T) %>%
  ungroup()
starwars_desc
```

```
# A tibble: 8 x 4
  species_cat measure  mean    sd
  <chr>       <chr>   <dbl> <dbl>
1 Droid       height  140   52.0
2 Droid       mass     69.8 51.0
3 Human       height  180.  11.5
4 Human       mass     81.3 19.3
5 Other       height  171.  40.4
6 Other       mass     69.7 29.5
7 Wookiee     height  231    4.24
8 Wookiee     mass    124   17.0
```

1. Plot the mean of both height and mass using `geom_col()` or `geom_bar()`, splitting the two measures (height & weight using `facet_grid()`), filling by species and setting `color = "black"` to add an outline:

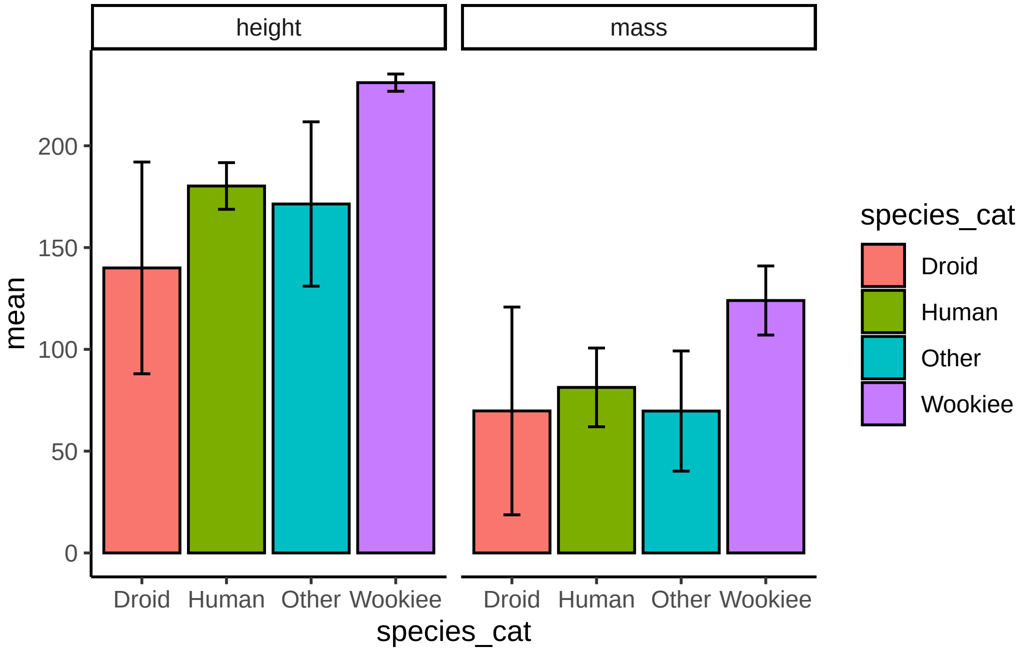
```
starwars_desc %>%
  ggplot(aes(x = species_cat)) +
  geom_col(aes(y = mean, fill = species_cat), color = "black") +
  facet_grid(~measure) +
  theme_classic()
```



2. Now add the SD using `geom_errorbar()`. Your key new arguments are `ymin = mean`

`- sd` and `ymax = mean + sd` (hint: set the width to a smaller value to improve the aesthetic):

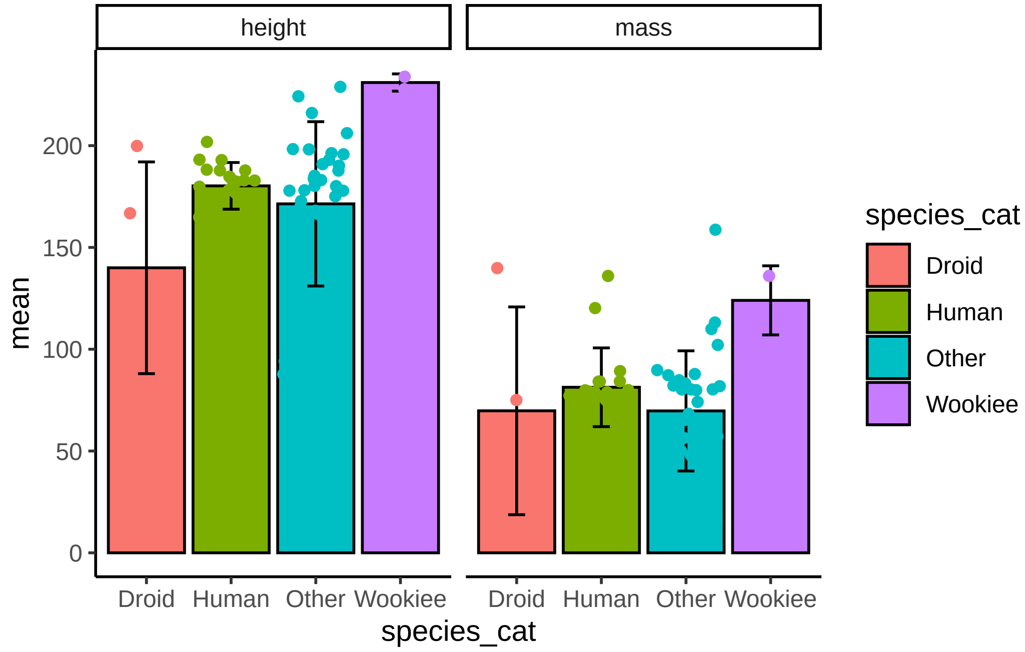
```
starwars_desc %>%
  ggplot(aes(x = species_cat)) +
  geom_col(
    aes(y = mean, fill = species_cat)
    , color = "black"
    ) +
  geom_errorbar(
    aes(ymin = mean - sd, ymax = mean + sd)
    , width = .2
    ) +
  facet_grid(~measure) +
  theme_classic()
```



3. Now let's re-add the raw data back in using geom_jitter() (jittering in the x direction only). Note the following hints:

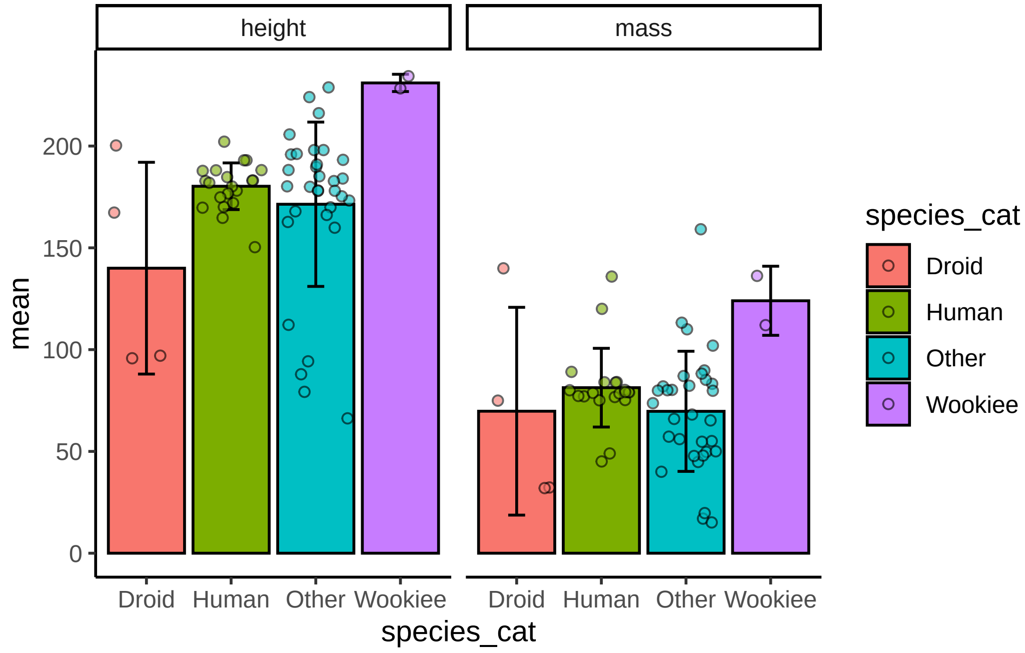
- You will need to use a different data set. You can do this by using the `data` argument within `geom_jitter()` (`data = starwars2`)
- You want to jitter the x direction, not y, which you can do by setting `height = 0`
- Don't forget to change the color by setting `color = species_cat`

```
starwars_desc %>%
  ggplot(aes(x = species_cat)) +
  geom_col(
    aes(y = mean, fill = species_cat)
    , color = "black"
    ) +
  geom_errorbar(
    aes(ymin = mean - sd, ymax = mean + sd)
    , width = .2
    ) +
  geom_jitter(
    data = starwars2
    , aes(y = value, color = species_cat)
  ) +
  facet_grid(~measure) +
  theme_classic()
```



4. Hmm, we can't really see the points. We'll do three things here. We'll change the `shape`, change fill for color, set `color = "black"`, and adjust the alpha (transparency):

```
starwars_desc %>%
  ggplot(aes(x = species_cat)) +
  geom_col(
    aes(y = mean, fill = species_cat)
    , color = "black"
    ) +
  geom_errorbar(
    aes(ymin = mean - sd, ymax = mean + sd)
    , width = .2
    ) +
  geom_jitter(
    data = starwars2
    , shape = 21
    , color = "black"
    , aes(y = value, fill = species_cat)
    , alpha = .6
  ) +
  facet_grid(~measure) +
  theme_classic()
```



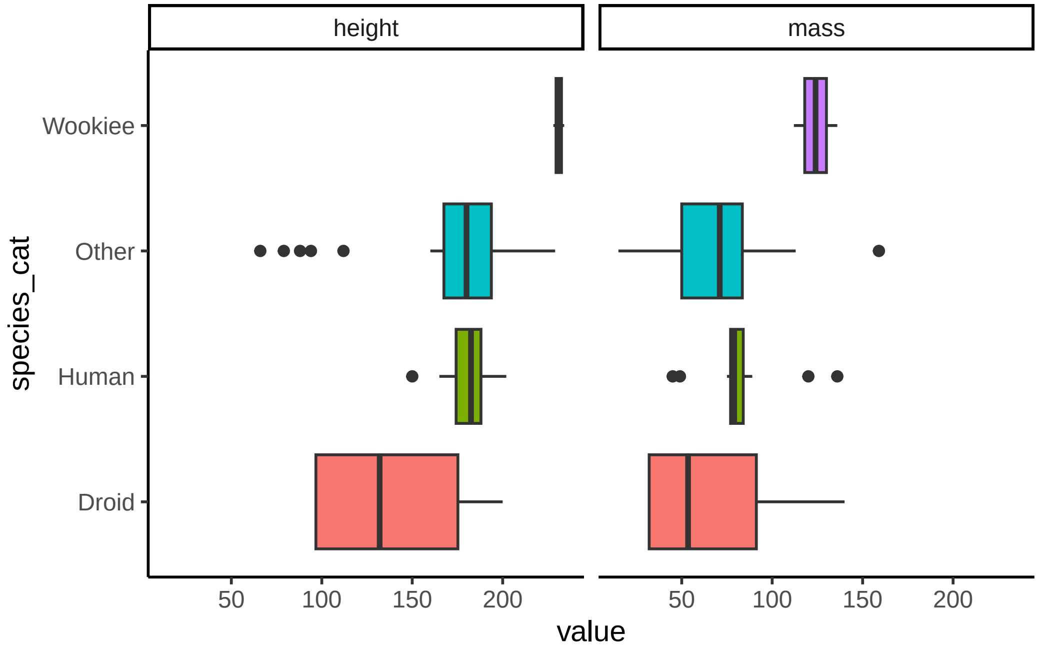
Question 5: `geom_boxplot()` and `geom_density()`

Lastly, let's do some quick practice with distributions of data using `geom_density()` and `geom_boxplot()`.

1. Make a boxplot of mass and height using `geom_boxplot()` and the `starwars2` dataset

- hint:`y = species_cat` and `x = value`
- Don't forget to use facet_grid again!
- set `fill = species_cat`
- remove the unnecessary legend using `theme(legend.position = "none")`

```
starwars2 %>%
  ggplot(aes(x = value, y = species_cat)) +
  geom_boxplot(aes(fill = species_cat)) +
  facet_grid(~measure) +
  theme_classic() +
  theme(legend.position = "none")
```



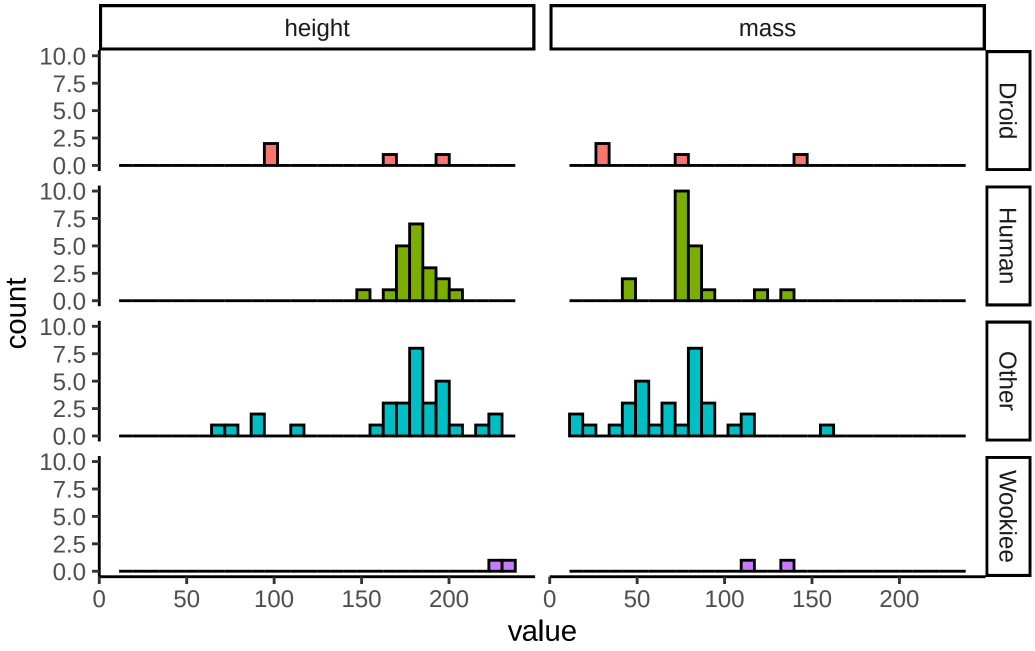
1. Make a histogram of mass and height using `geom_histogram()` and the `starwars2` dataset

- hint: `x = value`

- Don't forget to use facet_grid again; this time, you also need to add species_cat to it!
- set `fill = species_cat`
- set `color = "black"`
- remove the unnecessary legend using `theme(legend.position = "none")`

```
starwars2 %>%
  ggplot(aes(x = value)) +
  geom_histogram(
    aes(fill = species_cat)
    , color = "black"
    ) +
  facet_grid(species_cat~measure) +
  theme_classic() +
  theme(legend.position = "none")
```

```
`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

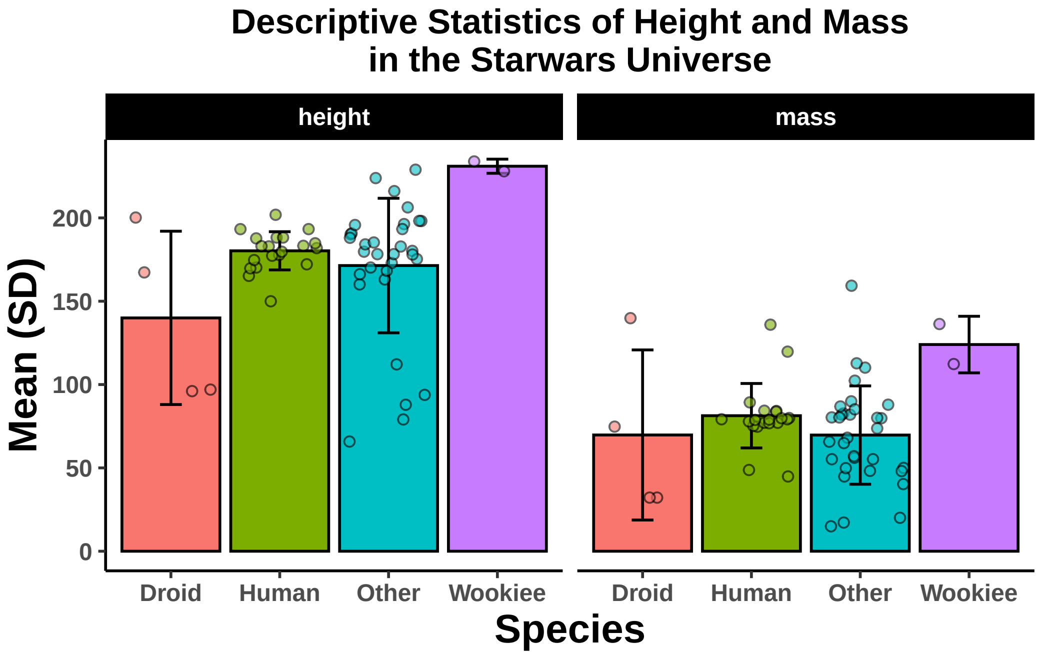


Question 6: Aesthetics

Choose any plot above that has some sort of color or fill mapping to improve it's aesthetic appearance.

1. **Axis labels**:
   - Adjust the x and y labels using the `labs()` function.
   - Modify their appearance using `theme(axis.text = element_text(face = "bold"), axis.title = element_text(face = "bold", size = rel(1.4))`
2. **Plot title**:
   - Add a plot title using the `labs()` function.
   - Change the appearance of the title using `theme(plot.title = element_text())`
3. **Legend**:
   - Redundant legend? Remove it
   - Side legend? Move it to the bottom
   - Weird title for the legend? Adjust it by updating the title for the relevant aesthetic in `labs()`
4. Facets:
   - Weird facet range for one panel? Play around with setting the argument `scale` to `"free"`, `"free_x"`, and `"free_y"`.
   - Change their appearance using theme. Try `theme(strip.background = element_rect(fill = "black"))` to set the background color. Then change the font color and appearance using `strip.text = element_text(color = "white", face = "bold")`

```r
starwars_desc %>%
  ggplot(aes(x = species_cat)) +
  geom_col(
    aes(y = mean, fill = species_cat)
    , color = "black"
    ) +
  geom_errorbar(
    aes(ymin = mean - sd, ymax = mean + sd)
    , width = .2
    ) +
  geom_jitter(
    data = starwars2
    , shape = 21
    , color = "black"
    , aes(y = value, fill = species_cat)
    , alpha = .6
  ) +
  labs(
    x = "Species"
    , y = "Mean (SD)"
    , title = "Descriptive Statistics of Height and Mass\nin the Starwars Universe") +
  facet_grid(~measure) +
  theme_classic() +
  theme(
    legend.position = "none"
    , plot.title = element_text(face = "bold", hjust = .5)
    , strip.background = element_rect(fill = "black")
    , strip.text = element_text(color = "white", face = "bold")
    , axis.text = element_text(face = "bold")
    , axis.title = element_text(face = "bold", size = rel(1.4))
    )
```



Render to html and submit problem set

Render to html by clicking the “Render” button near the top of your RStudio window (icon with blue arrow)

- Go to the Canvas –> Assignments –> Problem Set 1
- Submit both .qmd and .html files

- Use this naming convention "lastname_firstname_ps#" for your .qmd and html files (e.g. beck_emorie_ps1.qmd & beck_emorie_ps1.html)