

Class 7: Data visualization III

February 13, 2018



Announcements

- No reading for Thursday's class
- Come talk to me ASAP if...
 - ...you are still experiencing issues with using Github to submit assignments
 - ...your RStudio installation continues to give you unknown errors
- **Website** will be updated soon with prior lecture's slides and homework 1

Data visualization with `ggplot2`

Structure of R commands

Functions in R are often verbs, and then in parantheses are the arguments for those functions.

```
verb(what-you-want-to-apply-verb-to, other-arguments)
```

For example:

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For example:

```
glimpse(mpg)           # Glimpse into the mpg dataset
```

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```

For example:

```
glimpse(mpg)           # Glimpse into the mpg dataset
```

```
ggplot(mpg) +           # Create plot window; plot
                        #   variables found in mpg
                        #   dataset
  geom_point(aes(x = displ, y = hwy)) # Create scatterplot with displ
                                     #   variable on x-axis, hwy
                                     #   variable on y-axis
```

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To use ggplot2 functions, load `tidyverse`:

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  other options
```

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  other options
```

Geoms, short for geometric objects, describe the type of plot you will produce.

About ggplot2

- ggplot2 is the name of the package
- The `gg` in "ggplot2" stands for Grammar of Graphics
- Inspired by the book **Grammar of Graphics** by Lee Wilkinson
- `ggplot()` is the main function in ggplot2

Visualizing Star Wars

Star Wars data

Loading `tidyverse` also loads a dataset called `starwars` into your RStudio environment:

```
library(tidyverse)
starwars
```

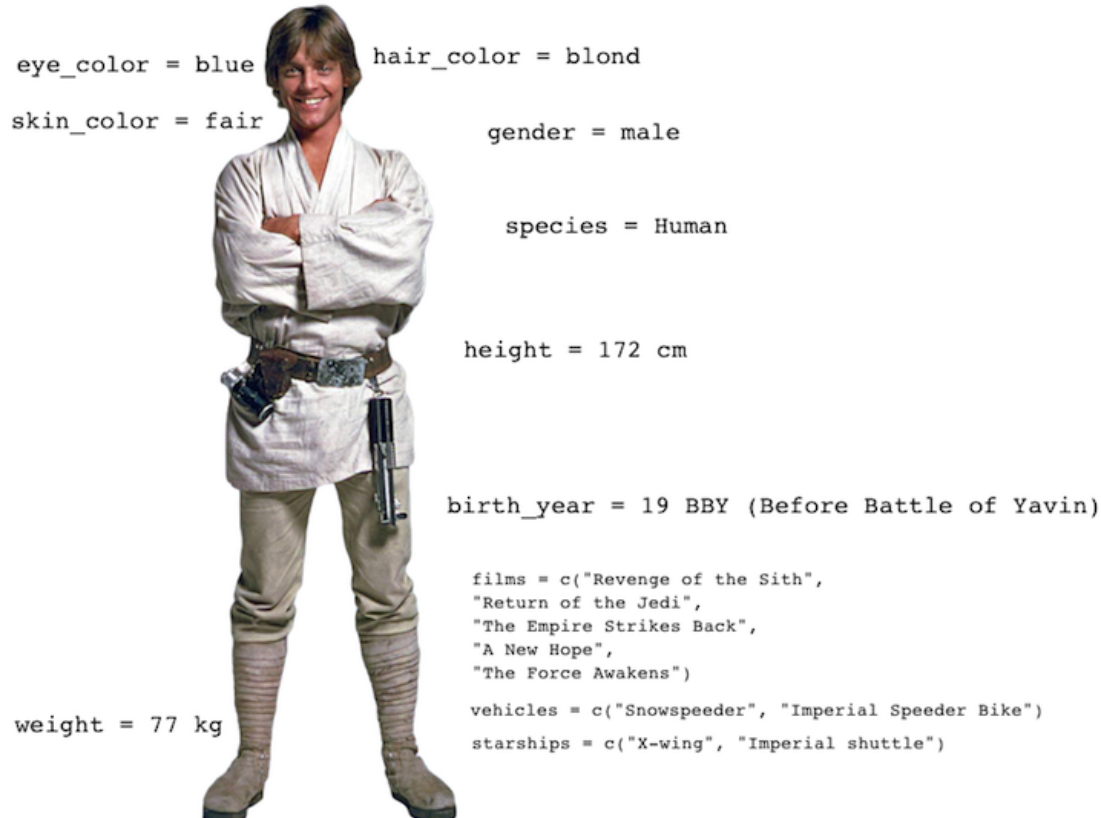
```
## # A tibble: 87 x 13
##       name height  mass hair_color skin_color eye_color
##       <chr>  <int> <dbl>   <chr>    <chr>    <chr>
## 1 Luke Skywalker    172    77    blond    fair     blue
## 2 C-3PO             167    75    <NA>     gold     yellow
## 3 R2-D2              96    32    <NA>     white, blue red
## 4 Darth Vader       202   136    none     white     yellow
## 5 Leia Organa       150    49    brown    light     brown
## 6 Owen Lars         178   120    brown, grey light     blue
## 7 Beru Whitesun lars 165    75    brown    light     blue
## 8 R5-D4              97    32    <NA>     white, red red
## 9 Biggs Darklighter 183    84    black    light     brown
## 10 Obi-Wan Kenobi    182    77    auburn, white fair blue-gray
## # ... with 77 more rows, and 7 more variables: birth_year <dbl>,
## #   gender <chr>, homeworld <chr>, species <chr>, films <list>,
## #   vehicles <list>, starships <list>
```

Dataset terminology

What does each row represent? What does each column represent?

```
## # A tibble: 87 x 13
##           name height  mass  hair_color skin_color eye_color
##           <chr>  <int> <dbl>    <chr>      <chr>    <chr>
## 1   Luke Skywalker   172    77    blond      fair     blue
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## #   vehicles <list>, starships <list>
```

Luke Skywalker



What's in the Star Wars data?

Take a `glimpse` at the data:

```
glimpse(starwars)
```

```
## Observations: 87
## Variables: 13
## $ name      <chr> "Luke Skywalker", "C-3PO", "R2-D2", "Darth Vader",
## $ height    <int> 172, 167, 96, 202, 150, 178, 165, 97, 183, 182, 188
## $ mass      <dbl> 77.0, 75.0, 32.0, 136.0, 49.0, 120.0, 75.0, 32.0, 8
## $ hair_color <chr> "blond", NA, NA, "none", "brown", "brown, grey", "b
## $ skin_color <chr> "fair", "gold", "white, blue", "white", "light", "l
## $ eye_color  <chr> "blue", "yellow", "red", "yellow", "brown", "blue",
## $ birth_year <dbl> 19.0, 112.0, 33.0, 41.9, 19.0, 52.0, 47.0, NA, 24.0
## $ gender     <chr> "male", NA, NA, "male", "female", "male", "female",
## $ homeworld  <chr> "Tatooine", "Tatooine", "Naboo", "Tatooine", "Alder
## $ species    <chr> "Human", "Droid", "Droid", "Human", "Human", "Human
## $ films      <list> [<"Revenge of the Sith", "Return of the Jedi", "Th
## $ vehicles   <list> [<"Snowspeeder", "Imperial Speeder Bike">, <>, <>,
## $ starships  <list> [<"X-wing", "Imperial shuttle">, <>, <>, "TIE Adva
```

What's in the Star Wars data?

Run the following **in the Console** to view the help

```
?starwars
```

starwars (dplyr)

R Documentation

Starwars characters

Description

This data comes from SWAPI, the Star Wars API, <http://swapi.co/>

Usage

```
starwars
```

Format

A tibble with 87 rows and 13 variables:

name

Name of the character

height

Height (cm)

mass

Weight (kg)

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Usage

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Format

A tibble with 87 rows and 13 variables:

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Name of the character

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Height (cm)

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Weight (kg)

How many rows and columns does this dataset have?

What does each row represent? What does each column represent?

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starwars (dplyr) R Documentation

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Description

This data comes from SWAPI, the Star Wars API, <http://swapi.co/>

Usage

```
starwars
```

Format

A tibble with 87 rows and 13 variables:

name	Name of the character
height	Height (cm)
mass	Weight (kg)

How many rows and columns does this dataset have?

What does each row represent? What does each column represent?

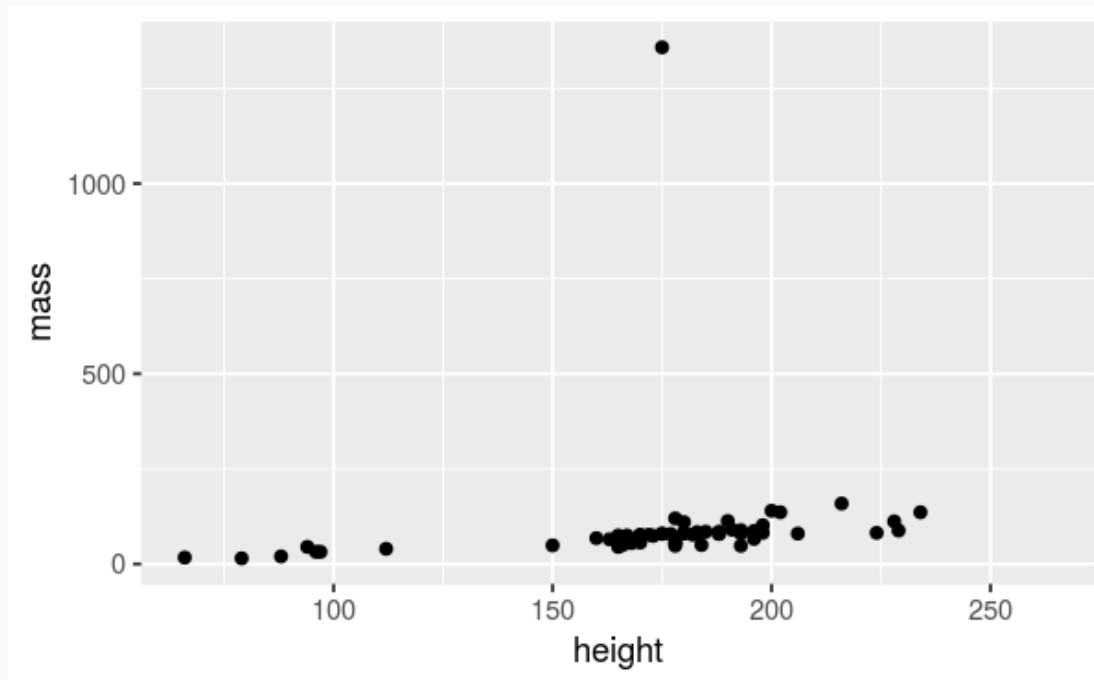
Make a prediction: What relationship do you expect to see between height and mass?

Scatterplots

Mass vs. height (`geom_point()`)

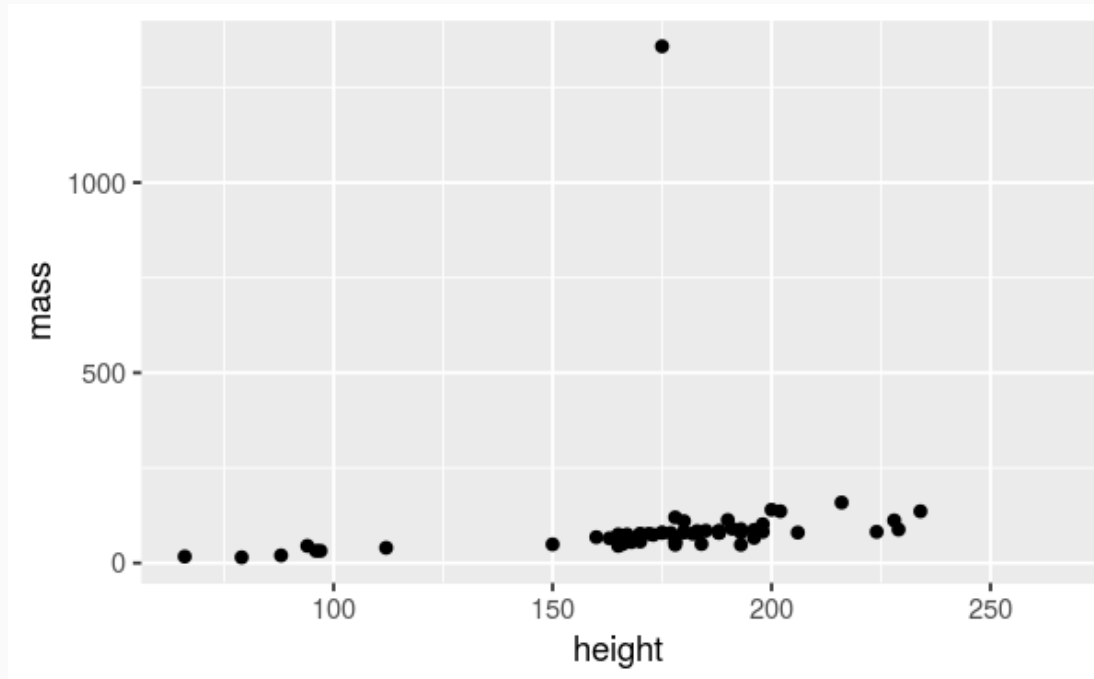
Not all characters have height and mass information (hence 28 of them not plotted)

```
ggplot(data = starwars) +  
  geom_point(mapping = aes(x = height, y = mass))
```



Mass vs. height

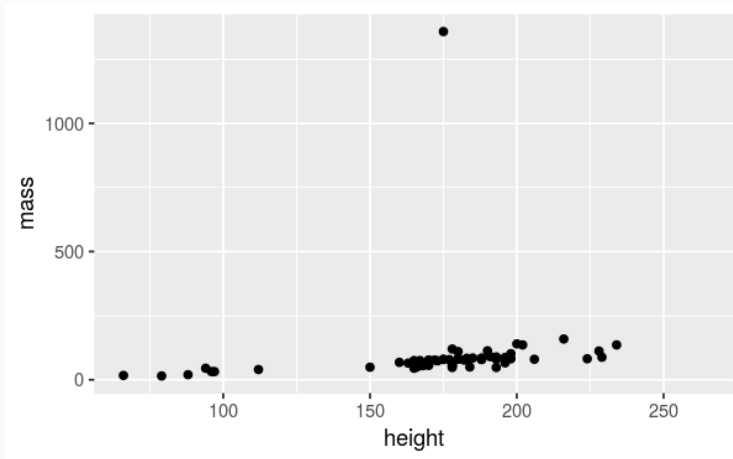
How would you describe this relationship? What other variables would help us understand data points that don't follow the overall trend?



Mass vs. height

Who is the not so tall but really massive character?

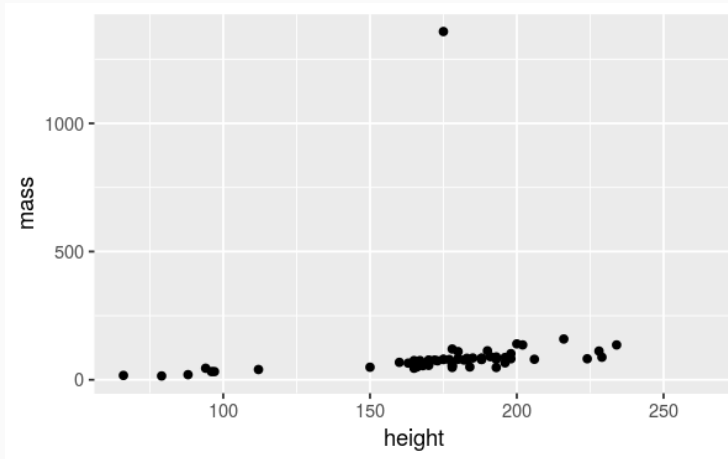
```
ggplot(data = starwars) +  
  geom_point(mapping = aes(x = height, y = mass))
```



Mass vs. height

Who is the not so tall but really massive character?

```
ggplot(data = starwars) +  
  geom_point(mapping = aes(x = height, y = mass))
```



Additional variables

Can display additional variables with

- aesthetics (like shape, colour, size), or
- faceting (small multiples displaying different subsets)

Aesthetics

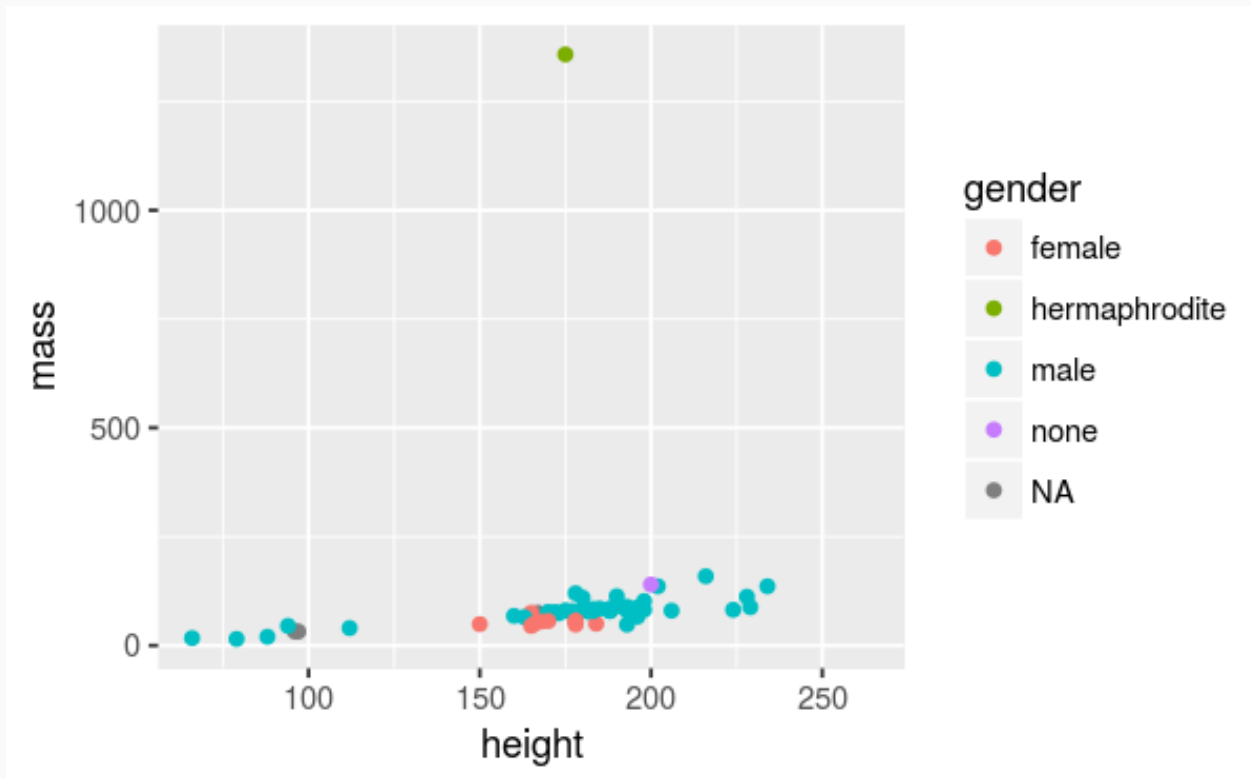
Aesthetics options

Visual characteristics of plotting characters that can be **mapped to data** are

- `color`
- `size`
- `shape`
- `alpha` (transparency)

Mass vs. height + gender

```
ggplot(data = starwars) +  
  geom_point(mapping = aes(x = height, y = mass, color = gender))
```



Aesthetics summary

- Continuous variable are measured on a continuous scale
- Discrete variables are measured (or often counted) on a discrete scale

aesthetics	discrete	continuous
color	rainbow of colors	gradient
size	discrete steps	linear mapping between radius and value
shape	different shape for each	shouldn't (and doesn't) work

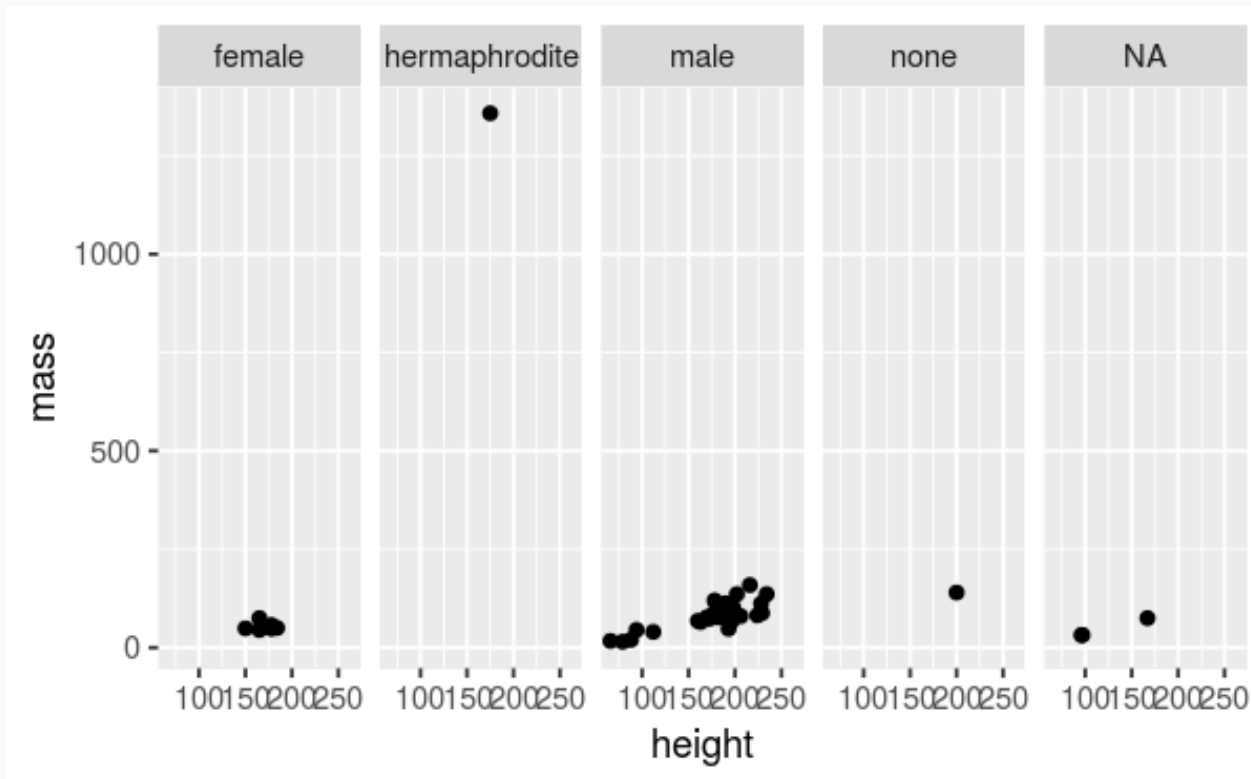
Faceting

Faceting options

- Smaller plots that display different subsets of the data
- Useful for exploring conditional relationships and large data

Mass vs. height by gender

```
ggplot(data = starwars) +  
  geom_point(mapping = aes(x = height, y = mass)) +  
  facet_grid(. ~ gender)
```

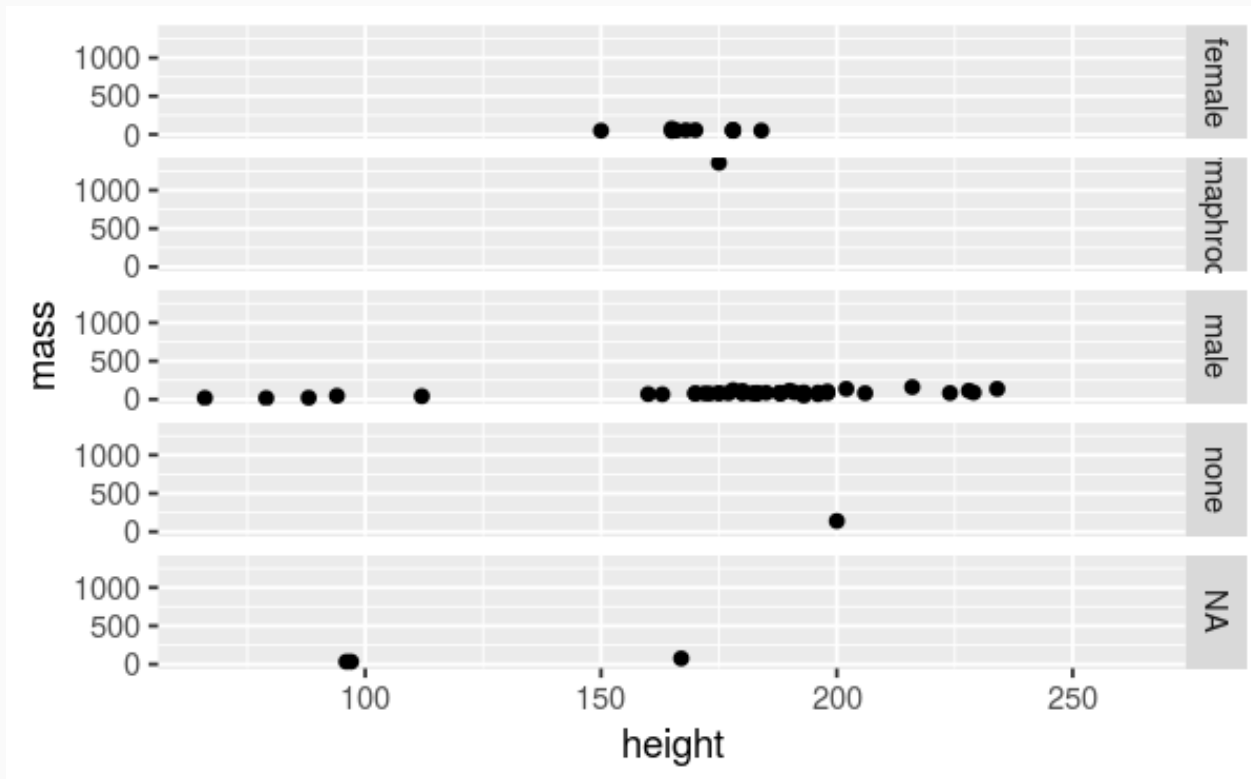


Many ways to facet

In the next few examples, think about what each plot displays. Think about how the code relates to the output.

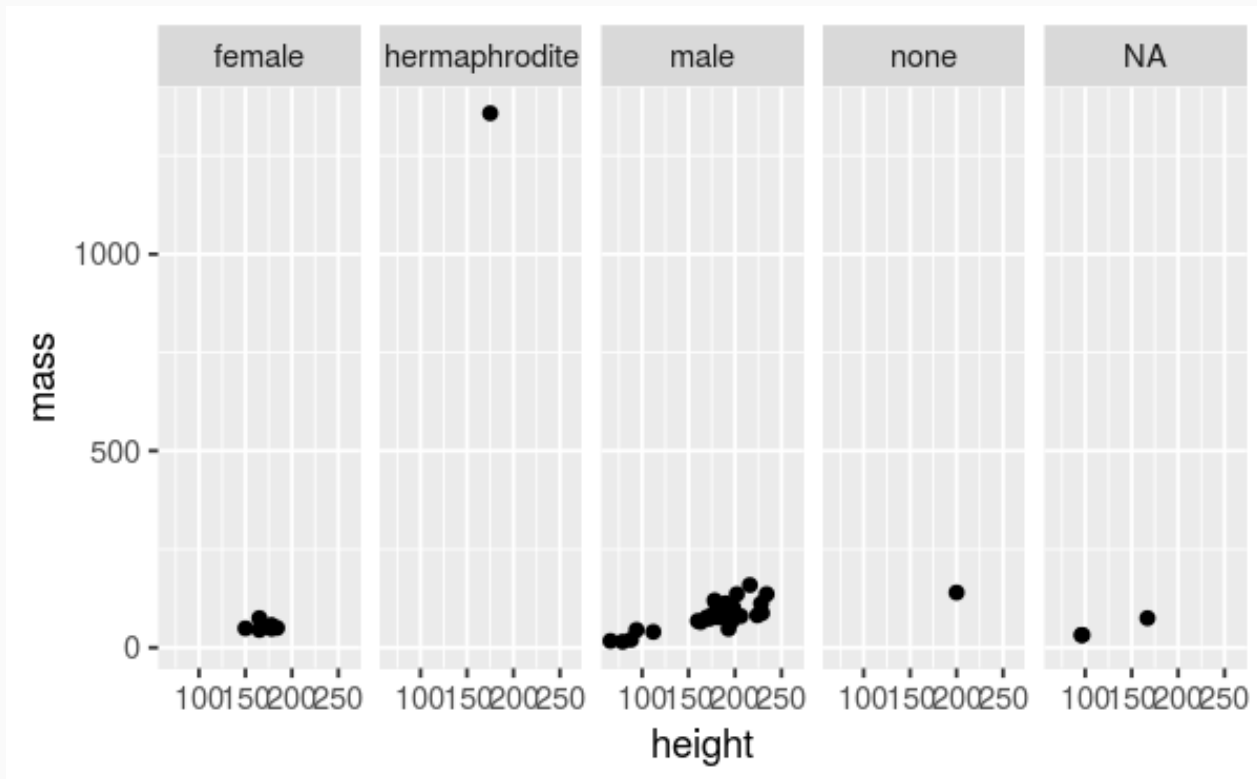
Many ways to facet

```
ggplot(data = starwars) +  
  geom_point(mapping = aes(x = height, y = mass)) +  
  facet_grid(gender ~ .)
```



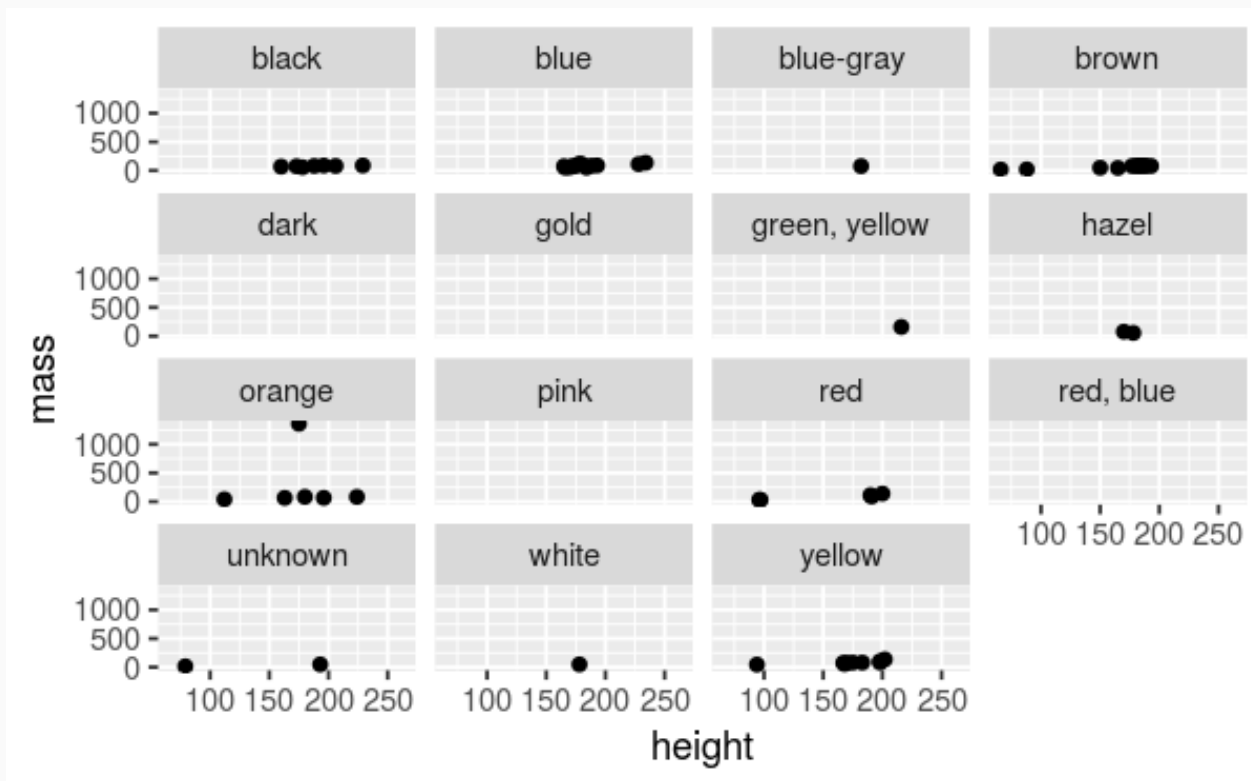
Many ways to facet

```
ggplot(data = starwars) +  
  geom_point(mapping = aes(x = height, y = mass)) +  
  facet_grid(. ~ gender)
```



Many ways to facet

```
ggplot(data = starwars) +  
  geom_point(mapping = aes(x = height, y = mass)) +  
  facet_wrap(~ eye_color)
```



Facet summary

- `facet_grid()`: 2d grid, rows ~ cols, . for no split
- `facet_wrap()`: 1d ribbon wrapped into 2d

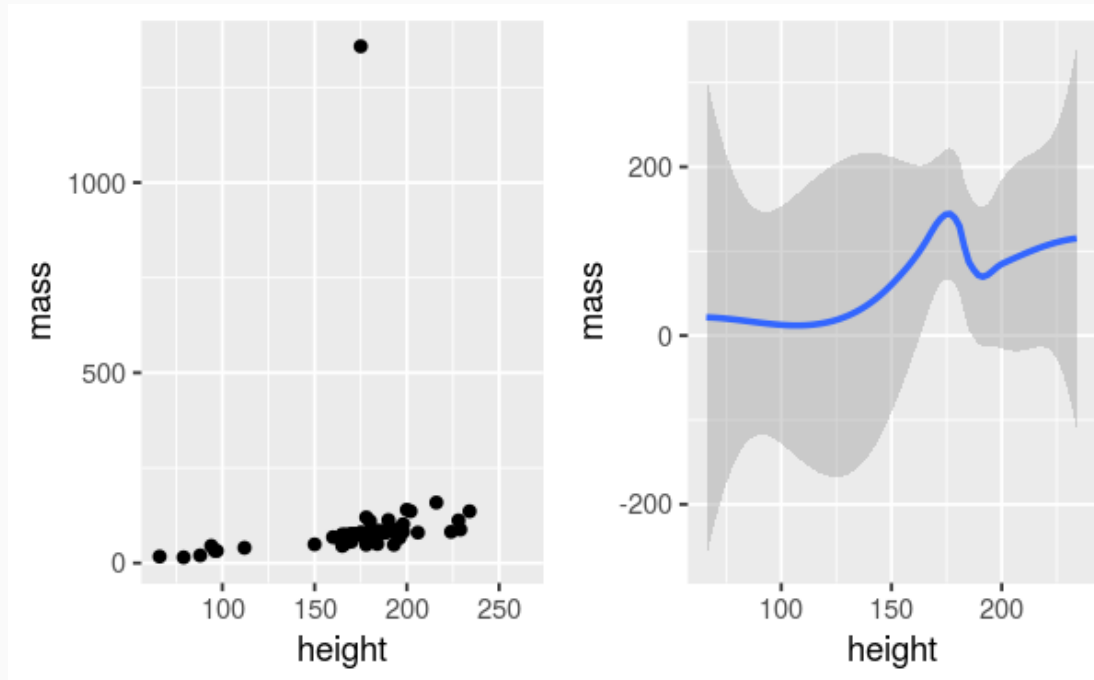
Other geoms

Height vs. mass, take 2

How are these plots similar? How are they different?

Height vs. mass, take 2

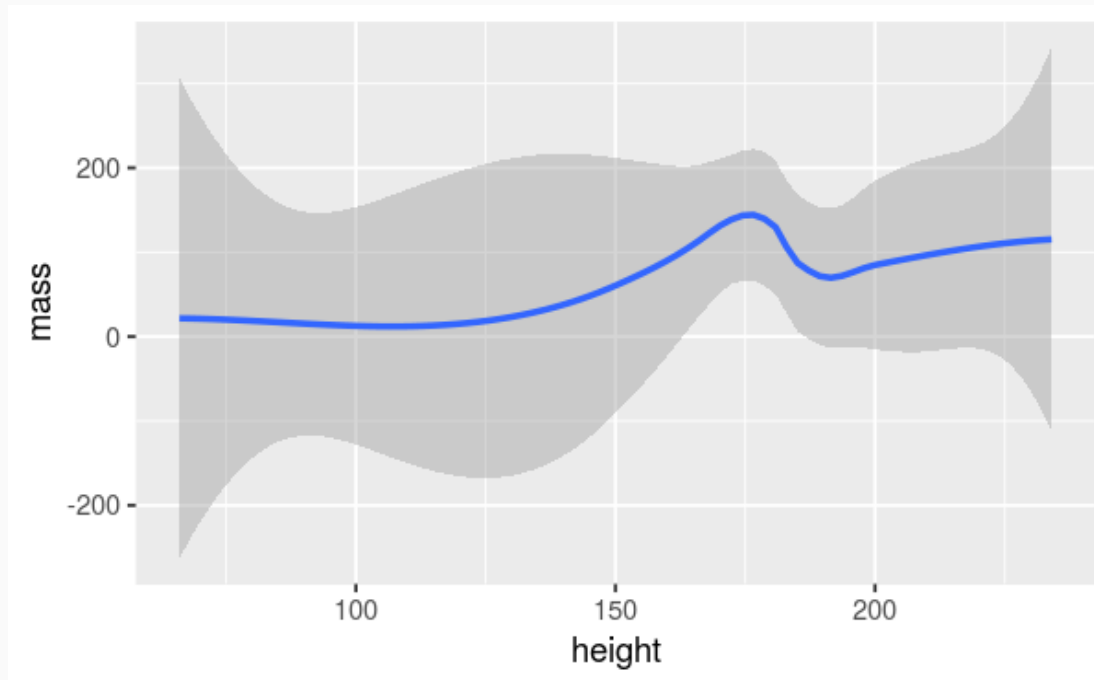
How are these plots similar? How are they different?



geom_smooth

To plot a smooth curve, use `geom_smooth()`

```
ggplot(data = starwars) +  
  geom_smooth(mapping = aes(x = height, y = mass))
```



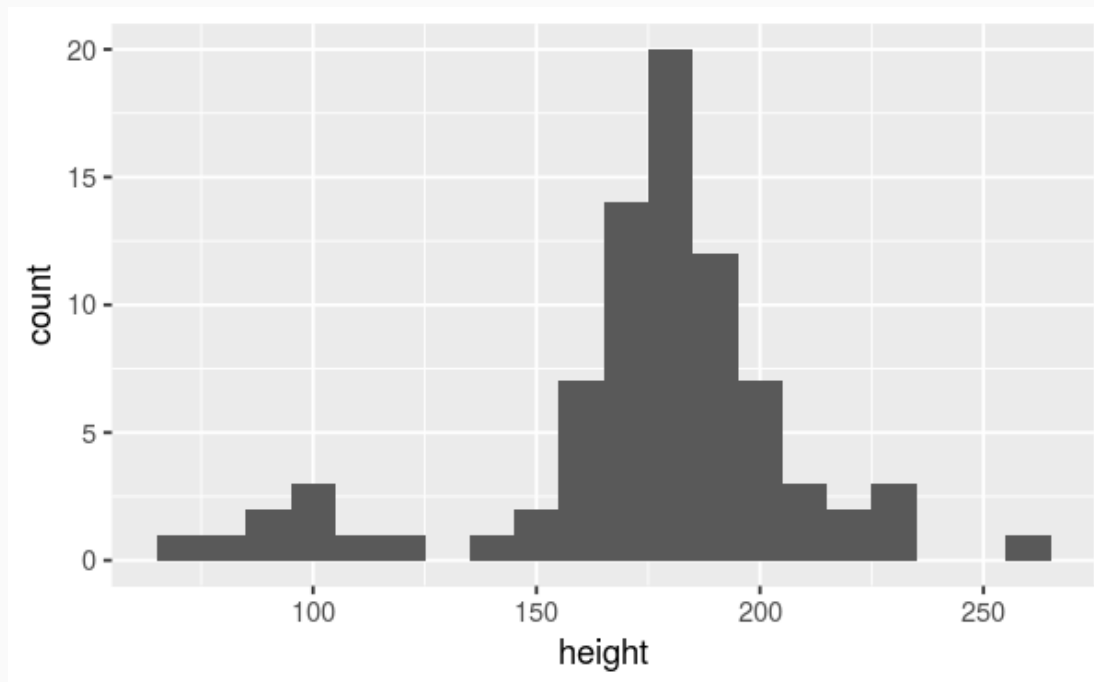
Describing shapes of numerical

- shape:
 - skewness: right-skewed, left-skewed, symmetric (skew is to the side of the longer tail)
 - modality: unimodal, bimodal, multimodal, uniform
- center: mean (mean), median (median), mode (not always useful)
- spread: range (range), standard deviation (sd), inter-quartile range (IQR)
- unusual observations

Histograms

For numerical variables

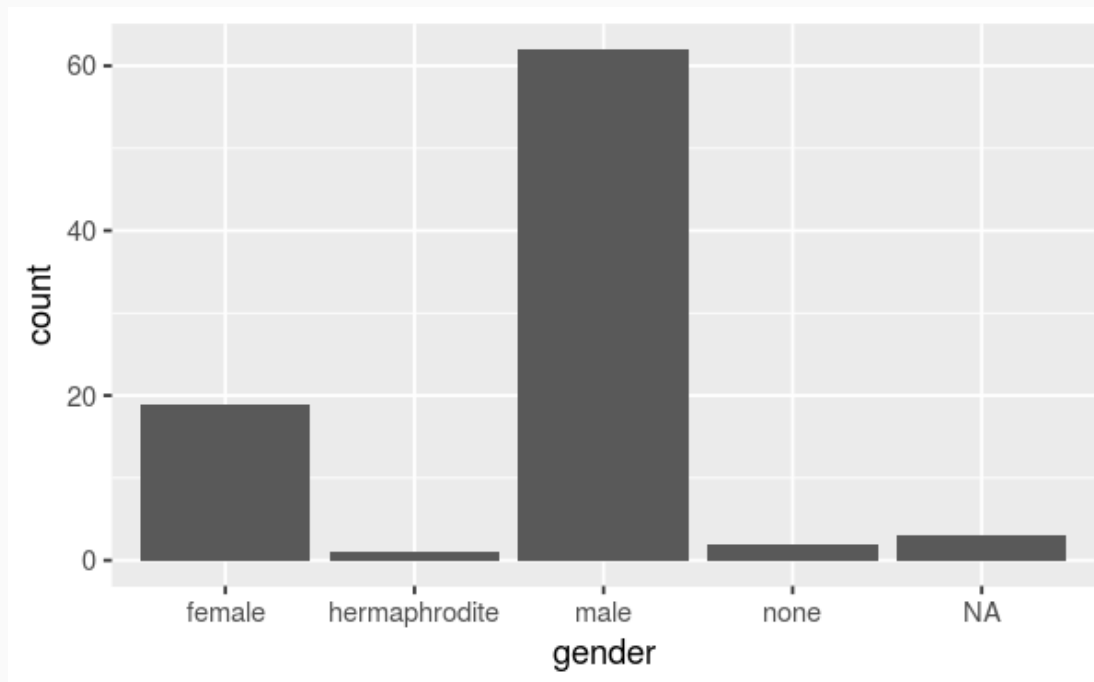
```
ggplot(starwars) +  
  geom_histogram(mapping = aes(x = height), binwidth = 10)
```



Bar plots

For categorical variables

```
ggplot(starwars) +  
  geom_bar(mapping = aes(x = gender))
```



Group Exercises

Form groups with the neighboring students and complete as many of the following exercises in *R for Data Science* as you can before the class period ends:

- Chapter 3.2.4: exercises 4, 5
- Chapter 3.3.1: exercise 3
- Chapter 3.5.1: exercises 1, 2, 6
- Chapter 3.6.1: exercise 5
- Chapter 3.7.1: exercises 2, 5

At the end of the class period, send me the group `.Rmd` file using [Slack](#).

Credits

- Examples and descriptions were adapted from the [Fundamentals of data & data visualization](#) slides developed by Mine Çetinkaya-Rundel and made available under the [CC BY license](#).