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HDS Tutorial 1

Week 2

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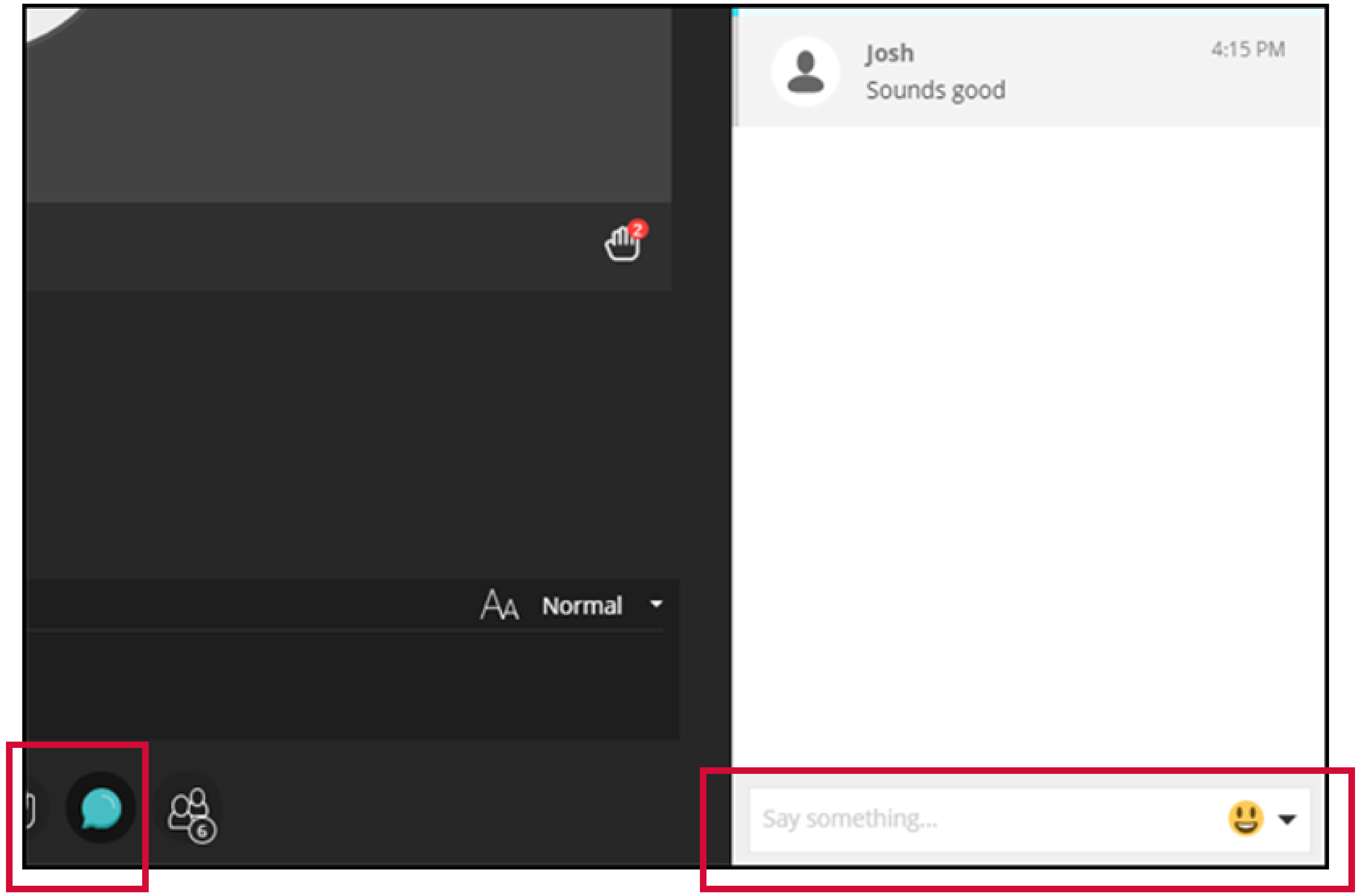
Josh 4:15 PM
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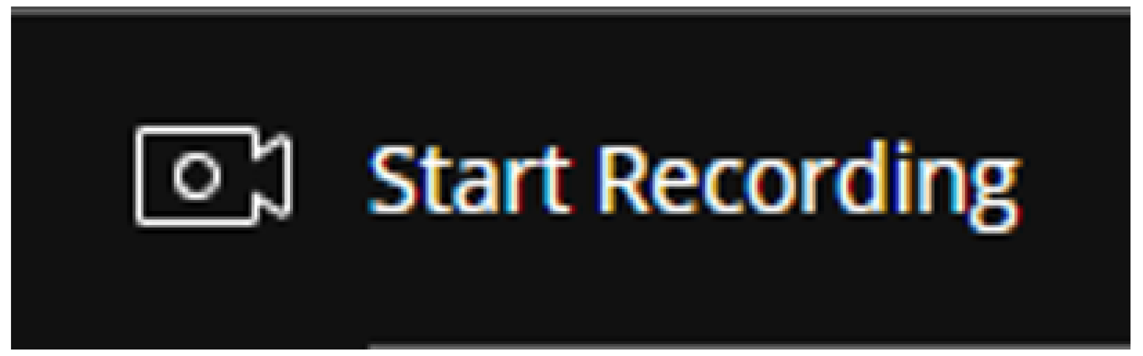

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HDS Tutorial 1

Week 2

Agenda

- What is R
- Why use R
- Example data flow presentation using health data
- Tips for starting out with R
- How to search for help online
- Q&A

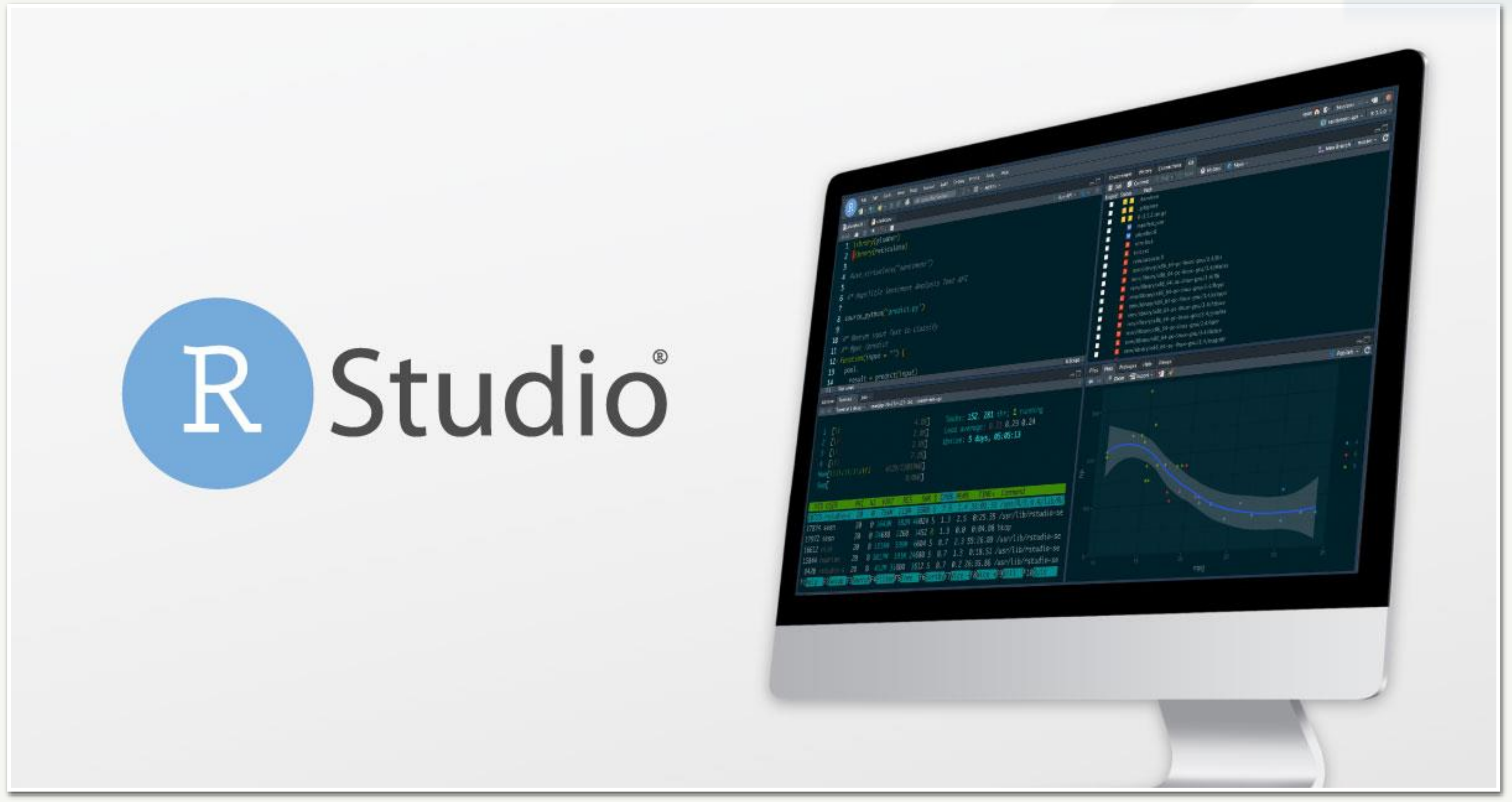
Has everyone downloaded R/R Studio?

Or are you using Noteable?

Organisations behind R

- The R Project
- Comprehensive R Archive Network (CRAN)
- R Studio

The Comprehensive R Archive Network



What are some of the reasons you want to learn R?
What benefits have you heard over other programming languages?

Advantages

- **“Open source” software**
  - Free (!!)
- **New methods implemented faster**
- **More flexible/customizable**
- **Anyone can contribute**
  - Do not have to work at R to contribute to R

Disadvantages

- **No centralized support**
- **Many find it harder to learn -** but that is why we are here!
- **Less consistency across procedures**
  - other software you rely on the programmers
- **…anyone can contribute (some packages are far better than others)**

Further Reasons for Why R…

- **High quality and robust data visualization**
  - e.g., ggplot2 — covered in depth in Week 4
- **Go-to language for statistics and data science; used in almost every industry**
- **Vast R community support**
  - Stack Overflow !
  - Twitter Rstats
  - etc.

- **The most comprehensive statistical analysis package new technology & ideas often appear first in R**
- **tidyverse**
- **RMarkdown (covered in Week 6)**
- **you can do so many things beyond data analysis/processing… maps, calendars, etc.!**
- **It can be very satisfying and fun once you get the hang of it!**

Formalized set of packages and tools that have a consistently structured programming interface

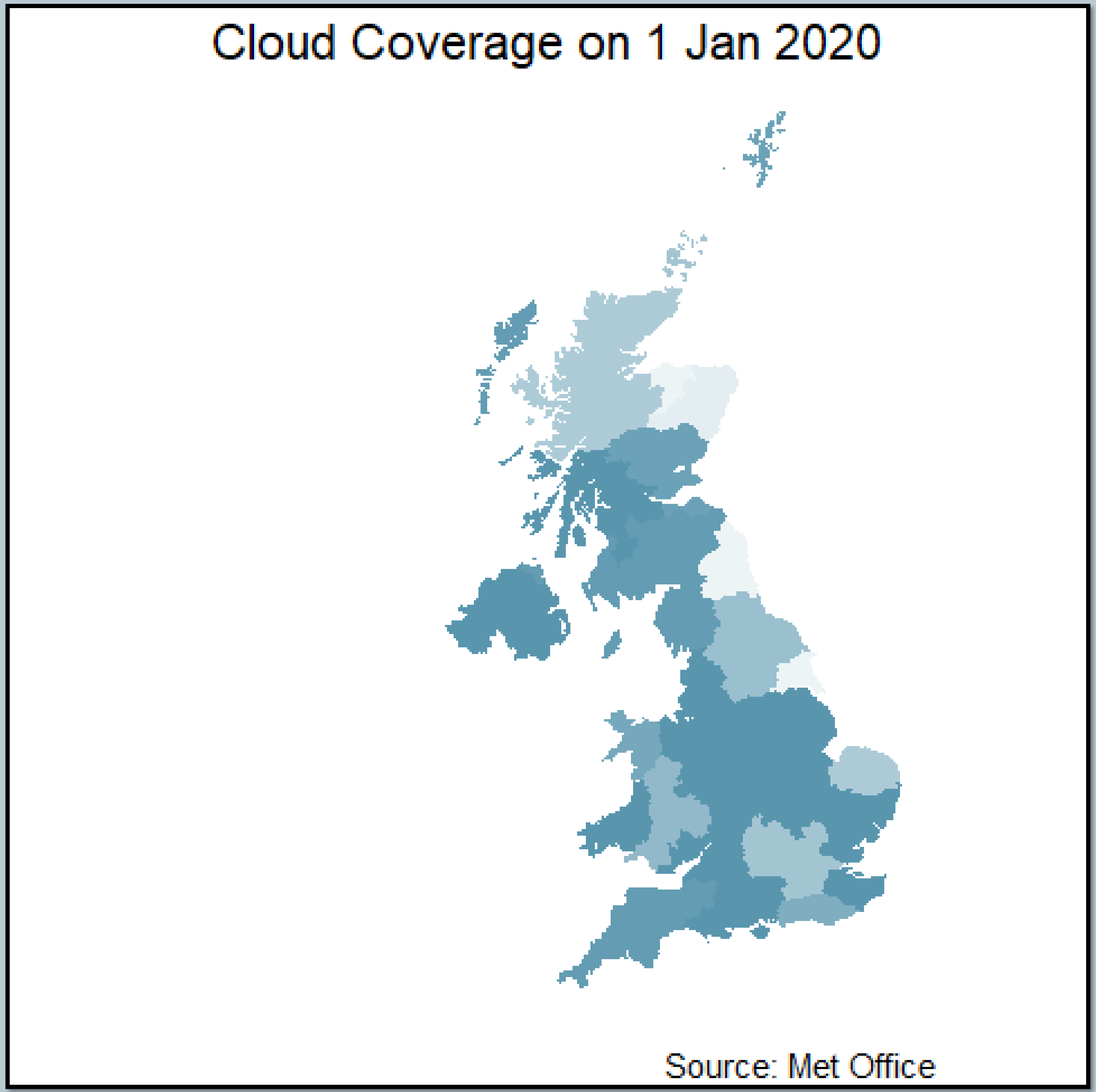
- as opposed to base R, which is more complex/varied and less user friendly

`library(tidyverse)` loads the core tidyverse packages

`ggplot2`	Make amazing graphs
`tibble`	Nice data frames
`tidyr`	Tidy your data
`readr`	Get data into R
`purrr`	Cool functional programming stuff
`dplyr`	Action verbs for manipulating data
`stringr`	Regular Expression tools for strings
`forcats`	Deal with factors

Into the Tidyverse!

streamlined data wrangling & visualization



An animation made by Kevin!

An example of:

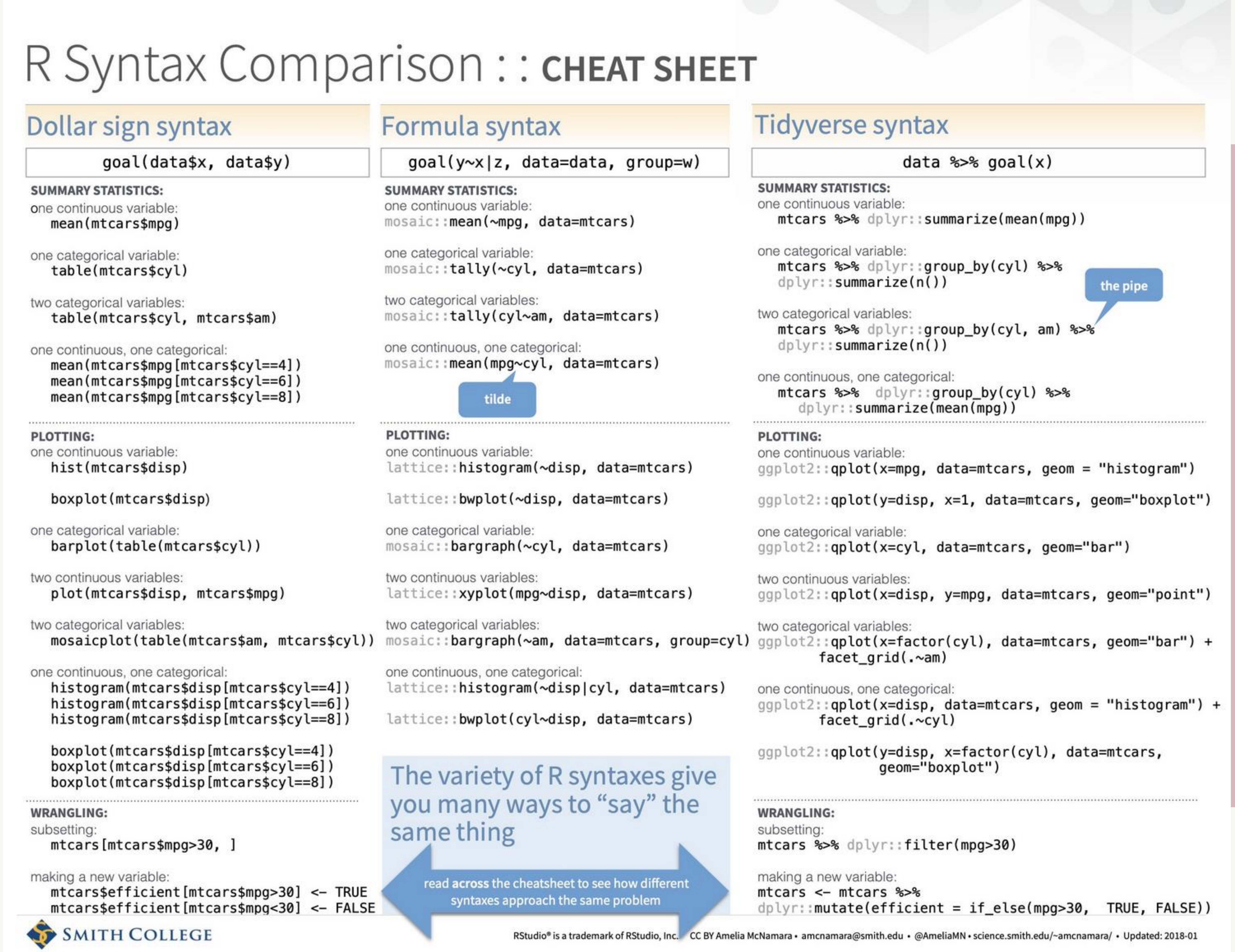
- the power of data visualization in R
- what HDS is building you towards

Animation (gganimate package) with maps (sf package) and Met Office data

R Syntax

There are 3 main different types of syntax you might come across:

1. **base R (**$**)**
2. **tidy verse (**%>%**)**
3. **formula (**~**)**



R Syntax Comparison : : CHEAT SHEET

Dollar sign syntax

```
goal(data$x, data$y)
```

SUMMARY STATISTICS:

one continuous variable:
```
mean(mtcars$mpg)
```
one categorical variable:
```
table(mtcars$cyl)
```
two categorical variables:
```
table(mtcars$cyl, mtcars$am)
```
one continuous, one categorical:
```
mean(mtcars$mpg[mtcars$cyl==4])
mean(mtcars$mpg[mtcars$cyl==6])
mean(mtcars$mpg[mtcars$cyl==8])
```

PLOTTING:

one continuous variable:
```
hist(mtcars$disp)

boxplot(mtcars$disp)
```
one categorical variable:
```
barplot(table(mtcars$cyl))
```
two continuous variables:
```
plot(mtcars$disp, mtcars$mpg)
```
two categorical variables:
```
mosaicplot(table(mtcars$am, mtcars$cyl))
```
one continuous, one categorical:
```
histogram(mtcars$disp[mtcars$cyl==4])
histogram(mtcars$disp[mtcars$cyl==6])
histogram(mtcars$disp[mtcars$cyl==8])

boxplot(mtcars$disp[mtcars$cyl==4])
boxplot(mtcars$disp[mtcars$cyl==6])
boxplot(mtcars$disp[mtcars$cyl==8])
```

WRANGLING:

subsetting:
```
mtcars[mtcars$mpg>30, ]
```
making a new variable:
```
mtcars$efficient[mtcars$mpg>30] <- TRUE
mtcars$efficient[mtcars$mpg<30] <- FALSE
```

Formula syntax

```
goal(y~x|z, data=data, group=w)
```

SUMMARY STATISTICS:

one continuous variable:
```
mosaic::mean(~mpg, data=mtcars)
```
one categorical variable:
```
mosaic::tally(~cyl, data=mtcars)
```
two categorical variables:
```
mosaic::tally(cyl~am, data=mtcars)
```
one continuous, one categorical:
```
mosaic::mean(mpg~cyl, data=mtcars)
```

PLOTTING:

one continuous variable:
```
lattice::histogram(~disp, data=mtcars)

lattice::bwplot(~disp, data=mtcars)
```
one categorical variable:
```
mosaic::bargraph(~cyl, data=mtcars)
```
two continuous variables:
```
lattice::xyplot(mpg~disp, data=mtcars)
```
two categorical variables:
```
mosaic::bargraph(~am, data=mtcars, group=cyl)
```
one continuous, one categorical:
```
lattice::histogram(~disp|cyl, data=mtcars)

lattice::bwplot(cyl~disp, data=mtcars)
```

The variety of R syntaxes give you many ways to "say" the same thing

read **across** the cheatsheet to see how different syntaxes approach the same problem

Tidyverse syntax

```
data %>% goal(x)
```

SUMMARY STATISTICS:

one continuous variable:
```
mtcars %>% dplyr::summarize(mean(mpg))
```
one categorical variable:
```
mtcars %>% dplyr::group_by(cyl) %>%
dplyr::summarize(n())
```

two categorical variables:
```
mtcars %>% dplyr::group_by(cyl, am) %>%
dplyr::summarize(n())
```
one continuous, one categorical:
```
mtcars %>%  dplyr::group_by(cyl) %>%
  dplyr::summarize(mean(mpg))
```

PLOTTING:

one continuous variable:
```
ggplot2::qplot(x=mpg, data=mtcars, geom = "histogram")

ggplot2::qplot(y=disp, x=1, data=mtcars, geom="boxplot")
```
one categorical variable:
```
ggplot2::qplot(x=cyl, data=mtcars, geom="bar")
```
two continuous variables:
```
ggplot2::qplot(x=disp, y=mpg, data=mtcars, geom="point")
```
two categorical variables:
```
ggplot2::qplot(x=factor(cyl), data=mtcars, geom="bar") +
        facet_grid(.~am)
```
one continuous, one categorical:
```
ggplot2::qplot(x=disp, data=mtcars, geom = "histogram") +
        facet_grid(.~cyl)

ggplot2::qplot(y=disp, x=factor(cyl), data=mtcars,
               geom="boxplot")
```

WRANGLING:

subsetting:
```
mtcars %>% dplyr::filter(mpg>30)
```
making a new variable:
```
mtcars <- mtcars %>%
dplyr::mutate(efficient = if_else(mpg>30,  TRUE, FALSE))
```

SMITH COLLEGE

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- last updated 2018, needs some updating
- credit to Amelia McNamara
- Full cheat sheet here

Bar chart demonstration in R using heath care data

Tips to start out with R

- **Add comments to your code if using script**
  - Use a # at the beginning of the line or at the end of the line
- **You can also add sections to your script code**
  - At the end of a section add 4 dashes - or 4 hashes #
- **Avoid dots and spaces in variable names**
  - instead used capital letters or underscore
- **Check Cheatsheets, especially when using a new package**
  - Top menu *Help > Cheatsheets* or https://rstudio.com/resources/cheatsheets/
- **If you are unsure of what something does, type into the console a question mark followed by the function or package**
  - >?function
  - for common functions, check the introverse package documentation
- **General introduction to R as a programming language: A Succinct Intro to R**
- **Always load packages at the start of a script**
- **Make sure everything is spelled correctly! and capitalization is consistent when loading in data**
- **Practice makes perfect. Build familiarity with the system and don't be afraid to make mistakes**
- **When in doubt, Google it!!**

Have you looked for R help online?
If so, was it effective?
What did you type in?

How to effectively search for help online:

- when in doubt, copy and paste an error into google
- include the package name or “in R” in your search
- built-in R help function >?function
- StackOverflow
- RStudio Community
- Be willing and ready to adapt code to your context
- Holly has a lovely document with more details

Questions?

Some helpful definitions…

Working Directory

- After installing R & RStudio, you need to set the working directory
  - This is the location on your computer where any data files to imported can be found, and where any R scripts (the files that save your code) will be saved
- In R studio, you can set the working directory with the menus (*Session >> Set Working Directory >> Choose Directory*) or with a line of code that gives the path of the folder on your computer:
  - >setwd("Drive:/Folder1/Folder2")
- If you have made a new R Project from an existing Directory as shown in the live demo, working directory will be set this way
- can always check working directory with the function:
  - >getwd()

Some vocabulary

- **Function =** how you get stuff done in R (chapters in metaphor)
- **Argument =** specifications of functions (specific pages in metaphor)
- **Packages =** are a collection of R functions, complied code and sample data. By default a set of packages are installed during installation. They are stored under a directory called "library" in the R environment (books in metaphor)
- **Documentation =** the explanations of functions and arguments for different packages written by the authors (glossary in metaphor)
- **"run" or "running code" =** enter command into the R console to make it happen
- **Script** = a text file containing (almost) the same commands that you would enter on the command line of R
- **Data frame** = a *special type of list* where every element of the list has same length (i.e. data frame is a "rectangular" list); *de facto* data structure for most tabular data and what we use for statistics.
  - **Tibble** = tidyverse style dataframe
- **Indexing** = selecting a subset of the elements in order to use them in further analysis or possibly change them. Style depends on syntax (see slide 13 + cheat sheets)

Variable Types in R

- **character**: `"a"`, `“swc"`
- **numeric**: `2`, `15.5`
  - “continuous” variable in other software
  - **integer** is similar, use numeric in practice (less limitations)
  - **double** is similar, but is a numeric value with decimal places
- **logical**: `TRUE`, `FALSE`
- **complex:** `1+4i` (complex numbers with real and imaginary parts)
- **factor**: used to describe items that can have a finite number of values (gender, social class, etc.).
  - A factor has a `levels` attribute and class `"factor"`
  - Optionally, it may also contain a `contrasts` attribute which controls the parametrization used when the factor is used in a modeling functions.
  - “categorical” variable in other software. Tell R that a variable is **nominal** by making it a factor. An ordered factor is used to represent an **ordinal variable**.

Data Structures in R

- **Vectors** = most common and basic structure in R; a collection of elements that are most commonly of mode `character`, `logical`, `integer` or `numeric`.
  - **Atomic vector** = vector where elements much be the same data type; default vector type
  - **List =** a special type of vector. Each element can be a different type.
- **Matrix =** an extension of the numeric or character vectors. They are not a separate type of object but simply an atomic vector with dimensions; the number of rows and columns. As with atomic vectors, the elements of a matrix must be of the same data type.
- **Array** = similar to matrices but can have more than two dimensions
- **Data frame =** a *special type of list* where every element of the list has same length (i.e. data frame is a "rectangular" list); *de facto* data structure for most tabular data and what we use for statistics