STAT115: Introduction to Biostatistics

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Lecture 3: Statistical Software

- How do we interact with data?
- In the past: pen and paper
- Today we use computers
- This lecture will introduce software for data and statistics

Statistical software

- There are many statistical software packages
  - R
  - SAS
  - Stata
  - SPSS
  - ...
- Other software packages are also used
  - Excel
  - Python
  - Julia
  - ...

R (and Excel)

- We are going to focus on one of these: R
  - R has a learning curve
    - Provide support in lectures, tutorials and assignments
- We will also see Excel
  - Excel is used by many researchers to record data
  - It is also used by many researchers to analyze data
  - Excel has many weaknesses for data handling and statistics
    - Data handling: easy to (unintentionally) change/corrupt data
    - Statistical modelling: has basic functionality
  - Learn how to import data into R

R: NZ on the world stage

- R was developed at the University of Auckland in the early 90s
  - Ross Ihaka (Ngati Kahungunu, Rangitane)
  - Robert Gentleman
- It is used around the world
- Advantages:
  - Freely available
  - External packages that extend base functionality [a]
    - Contributed by researchers around the world
    - New methodology often readily implemented in R

[a] We may see how to install and use packages later

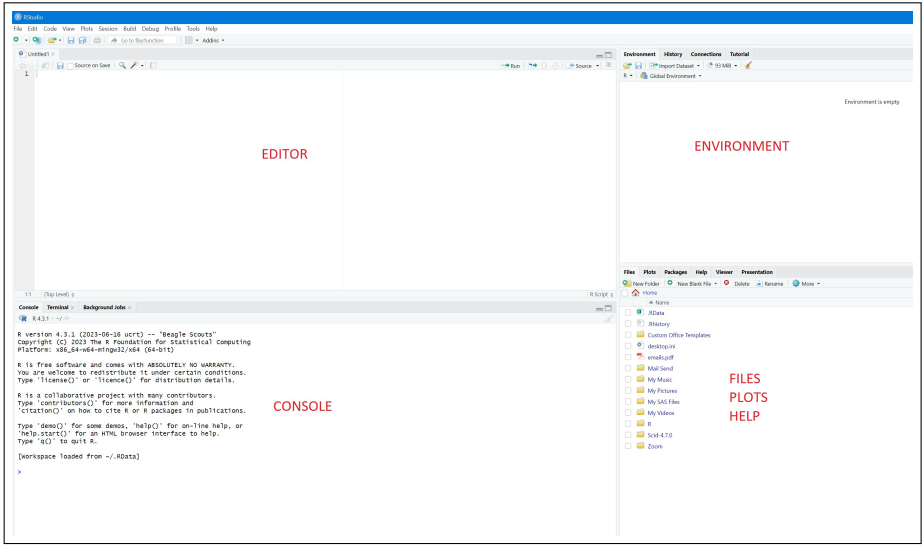
Getting R and RStudio Up and Running

- We will be using RStudio
  - R is the language (command line)
  - Rstudio is an IDE (integrated development environment) for R
    - Provides a more user-friendly experience
- *Option 1 (recommended)*: Download and install R and RStudio on own device
  - See video on Blackboard information for installation instructions
  - Difficult/impossible on Chromebook or tablet
- *Option 2*: Run RStudio using *Apps at Otago*
  - See `https://ask.otago.ac.nz/knowledgebase/article/KA-10005663`
- **Important: get R and RStudio working for you as soon as possible**

A First Session with R

- Move into Rstudio
- Look at some data
- We will mostly see data in csv (*comma separated values*) files
  - Comma separated file
  - Tabular (or rectangular) data
  - Opened by spreadsheet (like Excel), but is plain text
  - See video on blackboard for how to obtain a csv from Excel
  - It is possible to import data directly from Excel
    - It requires installing and loading an additional package
    - Not considered further in this course
  - Some csv datasets can be imported directly from the URL

RStudio: Getting Started



RStudio: Getting Started

Commentary

- Four panes
  1. LL: Console pane (where R code is run)
     - Start with this today: get things working initially
  2. UL: Editor pane (where we work)
     - Circle back around to how to use editor
     - This is our primary 'work environment'
  3. UR: Environment (etc.) pane (what have we done)
  4. LR: Files (etc.) pane (help, plots, packages)

RStudio: Importing Data

General Process

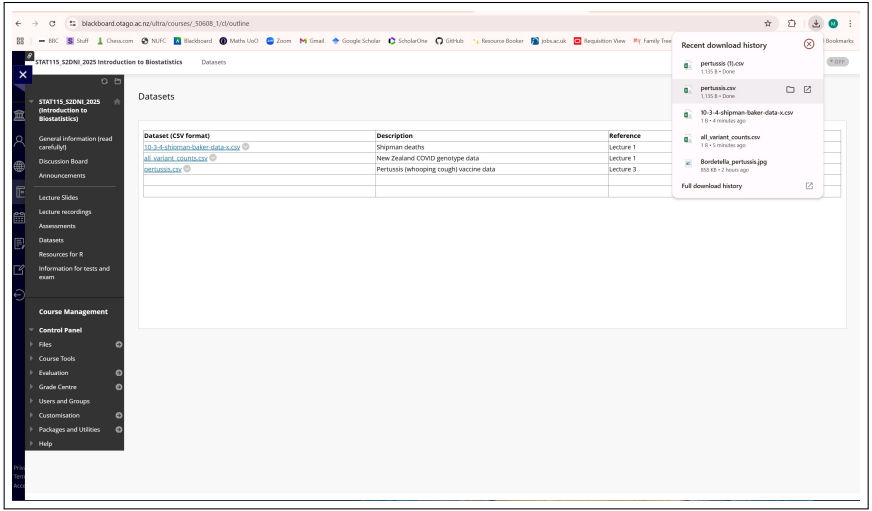
- Download data
  - By default, this will likely be in the computer's `Downloads` folder
- Convert to CSV format (if required)
  - Maybe use Excel to do this
- Import into R studio
  - Can be done in various ways
  - `File` > `Import Dataset` > `From text (base)`
- View data
  - Can look in 'Environment' tab (reopen if necessary)

Example: Pertussis Vaccine Response Data

- Medical researchers constantly searching for better vaccines.
- This example is concerned with vaccine for pertussis (whooping cough)
- Compares antibody response for three different vaccines:
  - WCV: whole cell pertussis vaccine
  - APV: pertussis acellular vaccine
  - DAPV: double dose APV
- $n = 91$ infants age 17–19 months randomly assigned one of the vaccines
- Response, in $\log(\text{IU/ml})$, measured one month after immunization

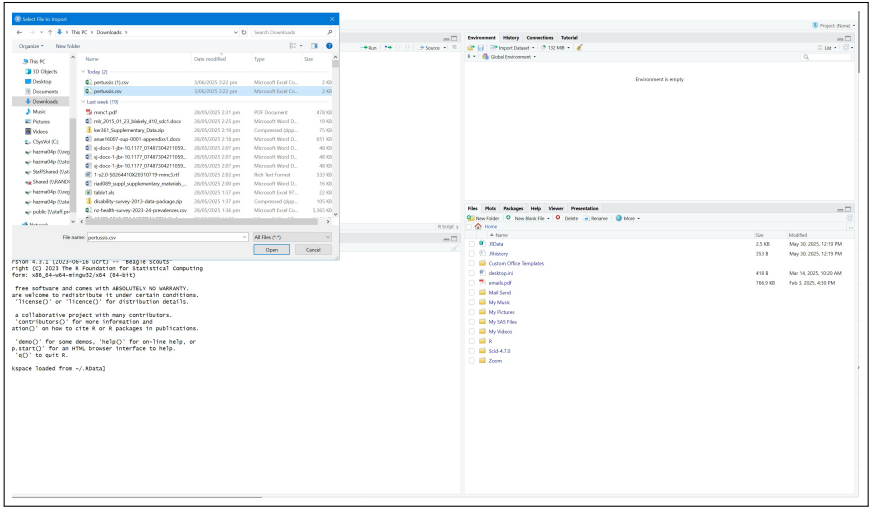
Example: Pertussis Vaccine Response Data

Data download



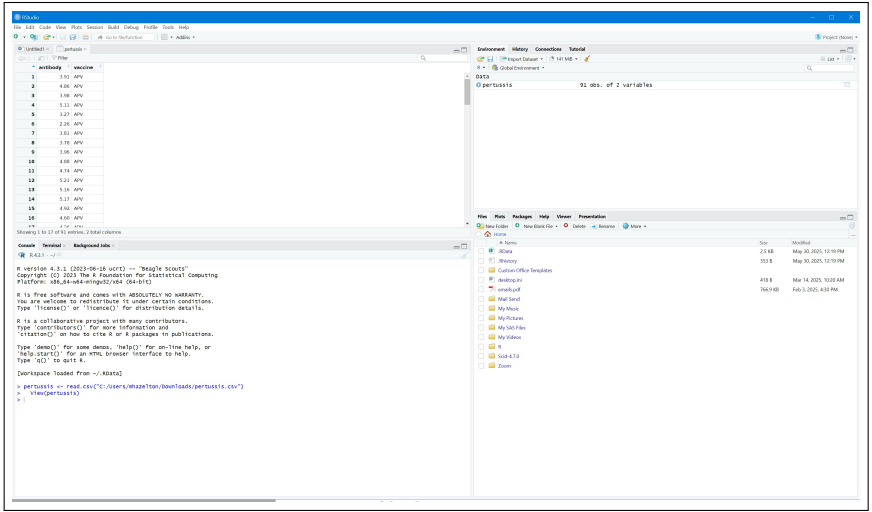
Example: Pertussis Vaccine Response Data

Data import



Example: Pertussis Vaccine Response Data

Data view



RStudio: Next Steps

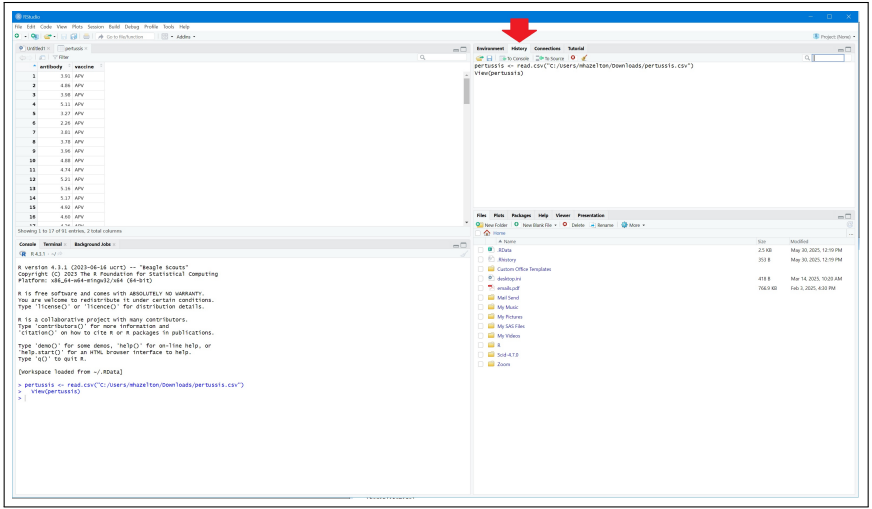
- So far we can look at data in a 'spreadsheet'
- To do anything more we have to engage with editor
  - Command line
  - Typing commands to R

RStudio: Workflow

- If we exit out of Rstudio
  - Lose most of what we have done
  - Start again
  - Frustrating: assignments and bigger projects
- Solution is to work in the editor
  - It can be intimidating at first
  - Rstudio itself helps out
    - 'History'

RStudio: Workflow

History



Rstudio: Getting Started with Editor

- Instructions for importing data onto editor (alternative method)
  - 'History' tab shows the R commands for what we have done
    - Put this in the editor window (for when we come back next time)
  - Care is needed with file structures
    - I suggest creating a STAT115 folder
    - Use this as a 'working directory'

Rstudio: Getting Started with Editor

- The working directory is the folder (on your computer) that R uses
- Change the working directory:
  - `Session` > Set `Working Directory` > `Choose Directory`
  - Equivalent command line expression
- Many of the mistakes we see with 100-level students
  - Asking R to find a file, but you're in the wrong folder
- First ensure in the correct folder
  - Then import the data

Example: Pertussis Vaccine Response Data

Initial exploration

- The data has information about two variables
  - Antibody response
  - Vaccine type
- What if we want to select one of these?
  - Use `$` : allows us to access specific variables by name
  - Use `[,1]` : allows us to access columns of the data frame by number

```
pertussis$antibody
```

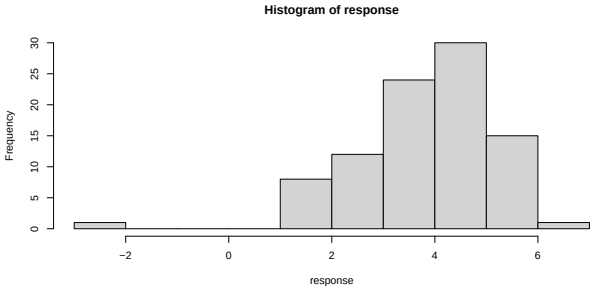
- Assign the new variable to `response`
  - Use = or <-
  - Use these values later (next slide!)

```
response = pertussis$antibody
```

Example: Some Summaries of Pertussis Vaccine Data

- We can now look at numeric summaries of antibody response, e.g.
  - mean: `mean(response)`
  - median: `median(response)`
  - standard deviation: `sd(response)`
- We can also look at graphical summaries of antibody responose, e.g. histogram

```
hist(response)
```



RStudio: Help!

- How would we know that in R?
  - `mean`: calculate the mean
  - `hist`: plot a histogram
- There is internal help: probably not the first place to look
- For you in STAT115:
  - Lecture slides
  - Assignments
  - Tutorials
  - Google: e.g. 'Finding an average in R'
  - AI (e.g. chatgpt)[1]

[1] A word of caution: AI tools are excellent for helping you get started with R. AI tools are not a replacement for thinking, but can be helpful tools for learning.

R Code

- R code will be displayed on lecture slides as follows:

```
mean(response)

## [1] 3.818
```

- These commands can be copied and pasted
  - Focus on understanding what the R code is doing
  - Support for RStudio in tutorials

Summary

- We will be using R/Rstudio in STAT115
- Free, powerful, and widely used
- We saw how:
  - Change our working directory
  - Import data
  - Subset one variable (antibody response)
  - Summarize that variable
    - Numerically
    - Graphically