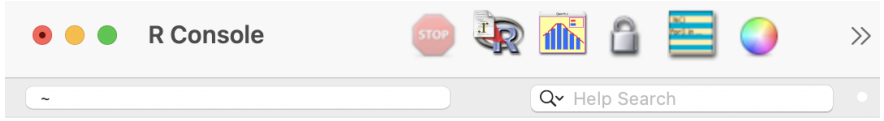
Day 1, PM Session

R Basics

Richard Flamio Jr., Ph.D.
Madison Zimmerman
Kristina M. Ramstad, Ph.D.
University of South Carolina Aiken

R and RStudio

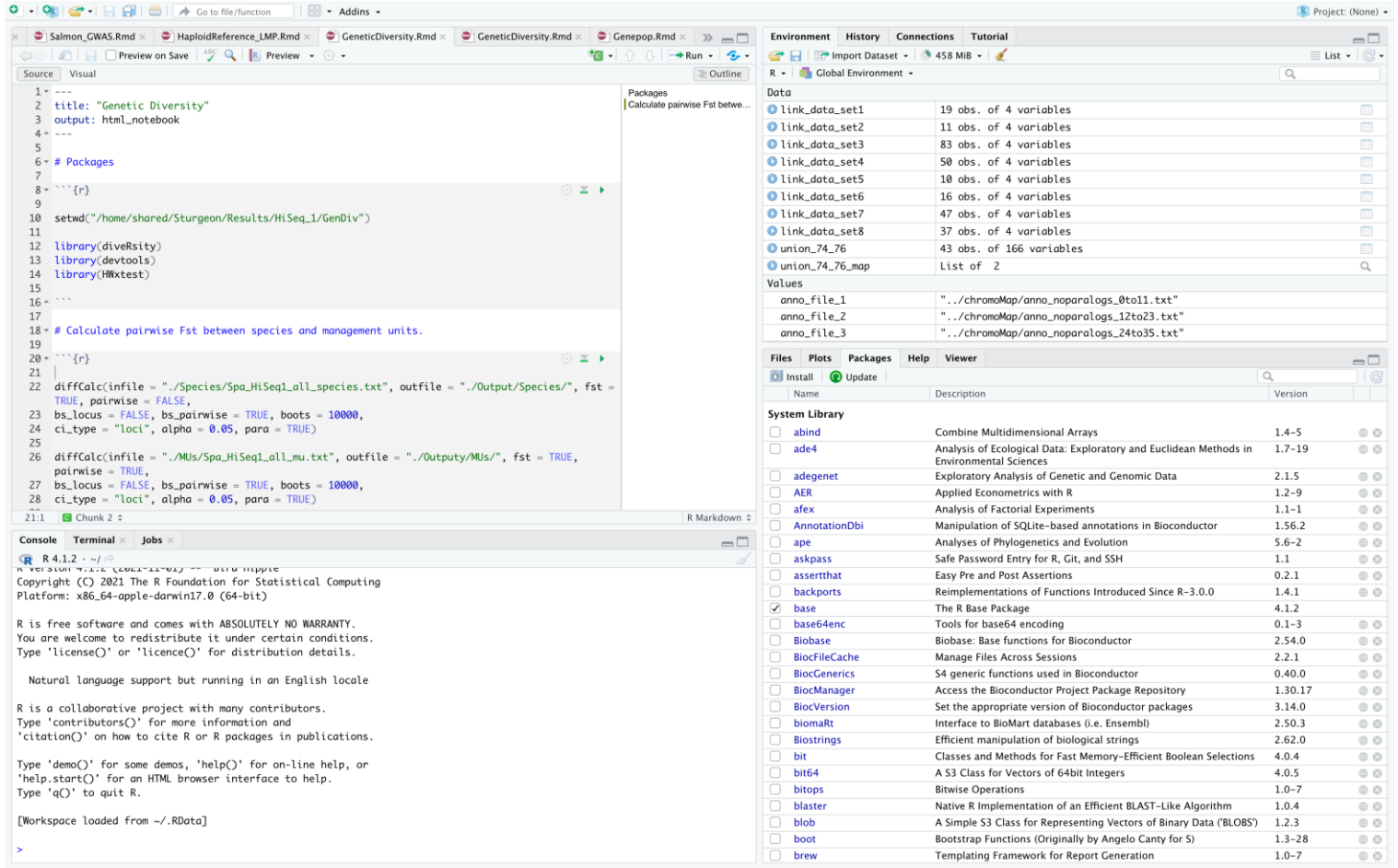
R = statistical programming




```
R version 4.1.2 (2021-11-01) -- "Bird Hippie"
Copyright (C) 2021 The R Foundation for Statistical Computing
Platform: x86_64-apple-darwin17.0 (64-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

  Natural language support but running in an English locale

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

[R.app GUI 1.77 (8007) x86_64-apple-darwin17.0]

[Workspace restored from /Users/rick/.RData]
[History restored from /Users/rick/.Rapp.history]

>
```

You must download base R before you can download and use RStudio.

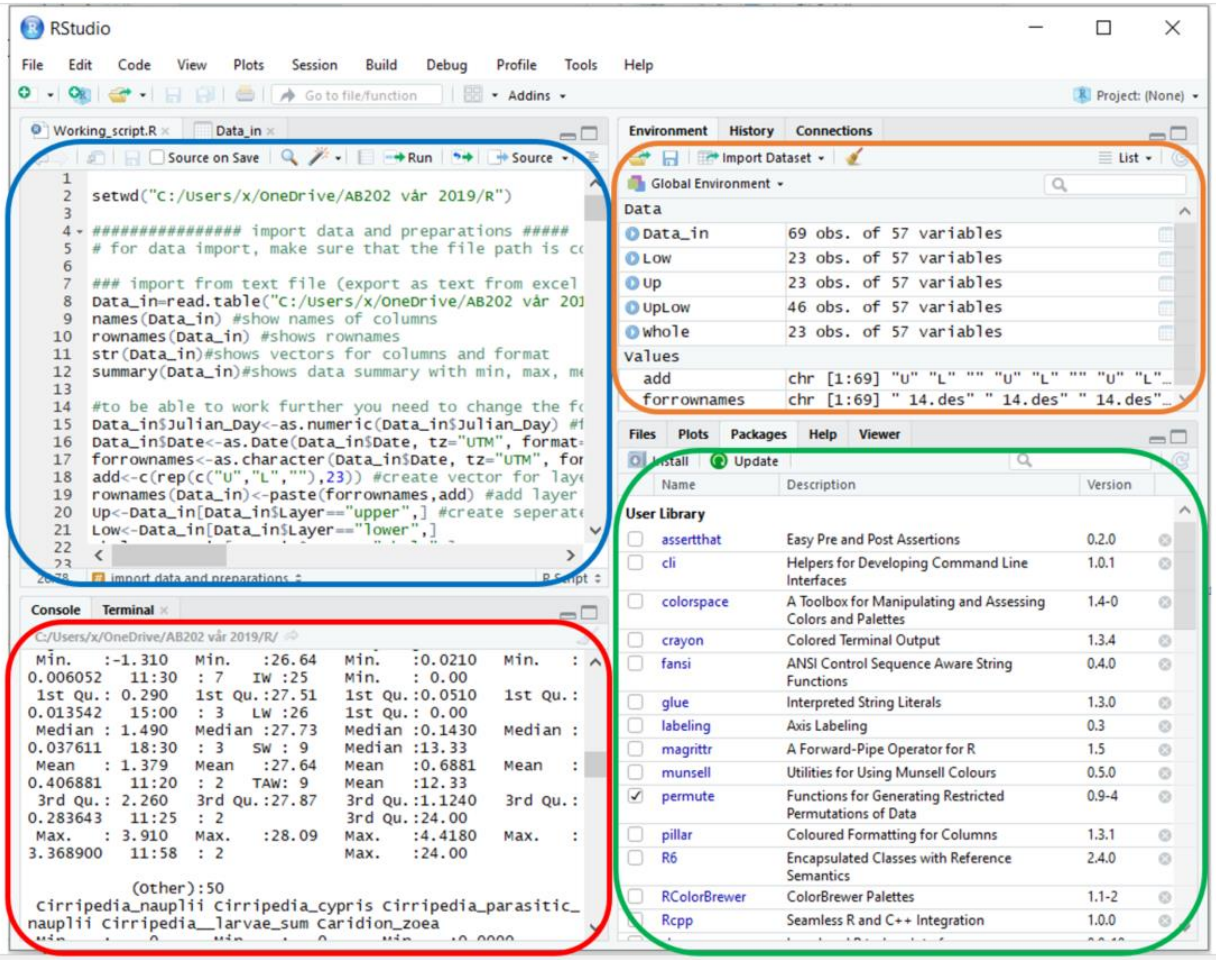
RStudio = interface for R with extra tools



Parts of RStudio

Editor: write, edit, annotate and save your script

Consol: execute commands interactively and see output



Environment: Data you have loaded into R; inspect through click

Overview over packages installed in R; you can install more and activate/deactivate them with a click

Console

- Input, calculations, and output display
- The console is present in RStudio and base R

Exercise

1. Type 3+4 in console, followed by Enter
2. Type 3 + 4 in console, followed by Enter
3. Type 3+4;2+3, followed by Enter

Console continued

- Notice how spaces do not matter in R
- Each command must be on a different line or separated by a semicolon (;)

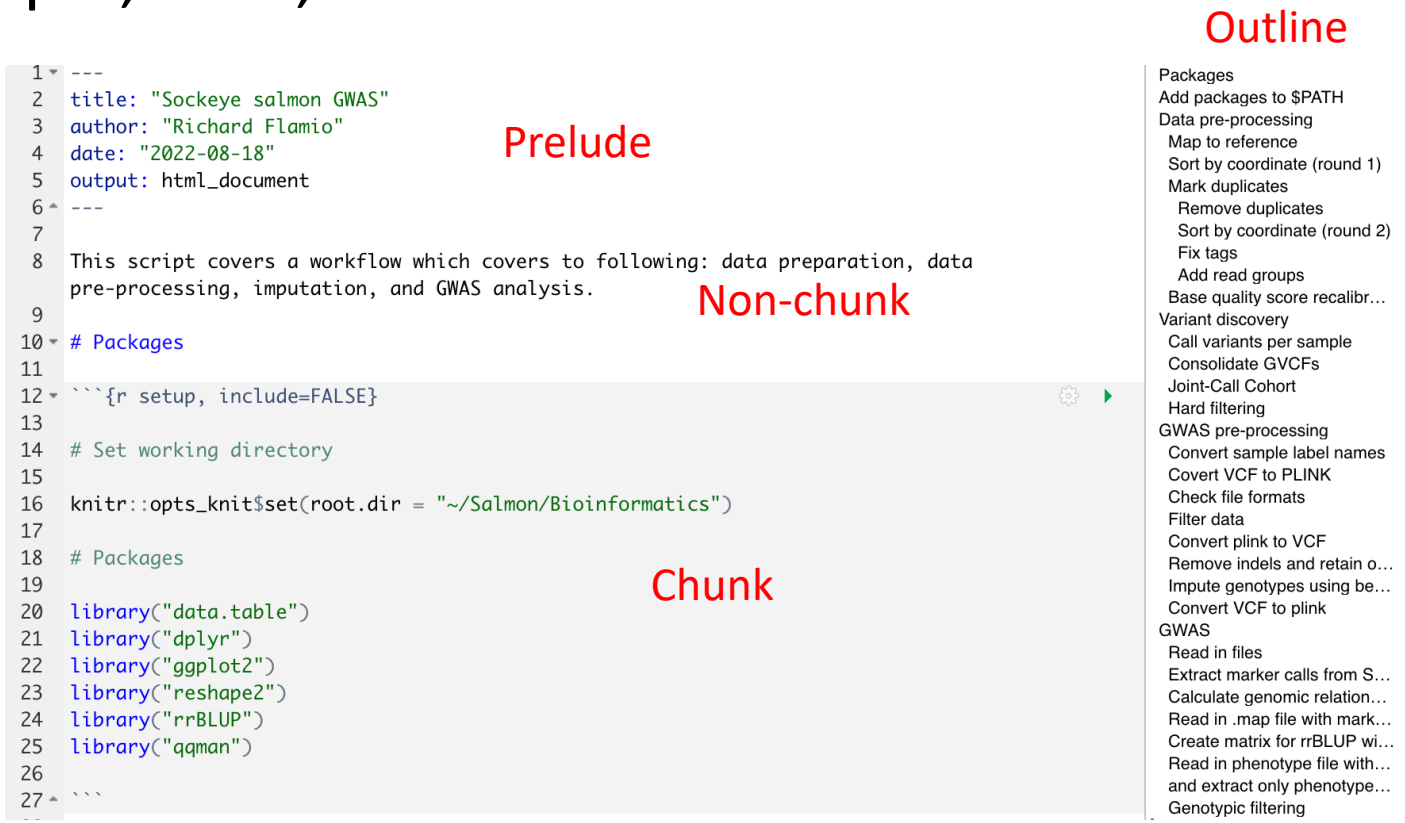
```
> 3+3
[1] 6
> 3+4
[1] 7
> 3 + 4
[1] 7
>
> 3+4;2+3
[1] 7
[1] 5
```

Editor

- Unique to RStudio
- Allows you to run commands, saved in a text file, at the same time
- File > New File > R Script
- Scripts are saved as .R files
- Each line is a separate command
- Run some lines by highlighting lines of interest and clicking Run on top of the Editor
- Run whole script by CTRL+A and selecting Run

R Markdown

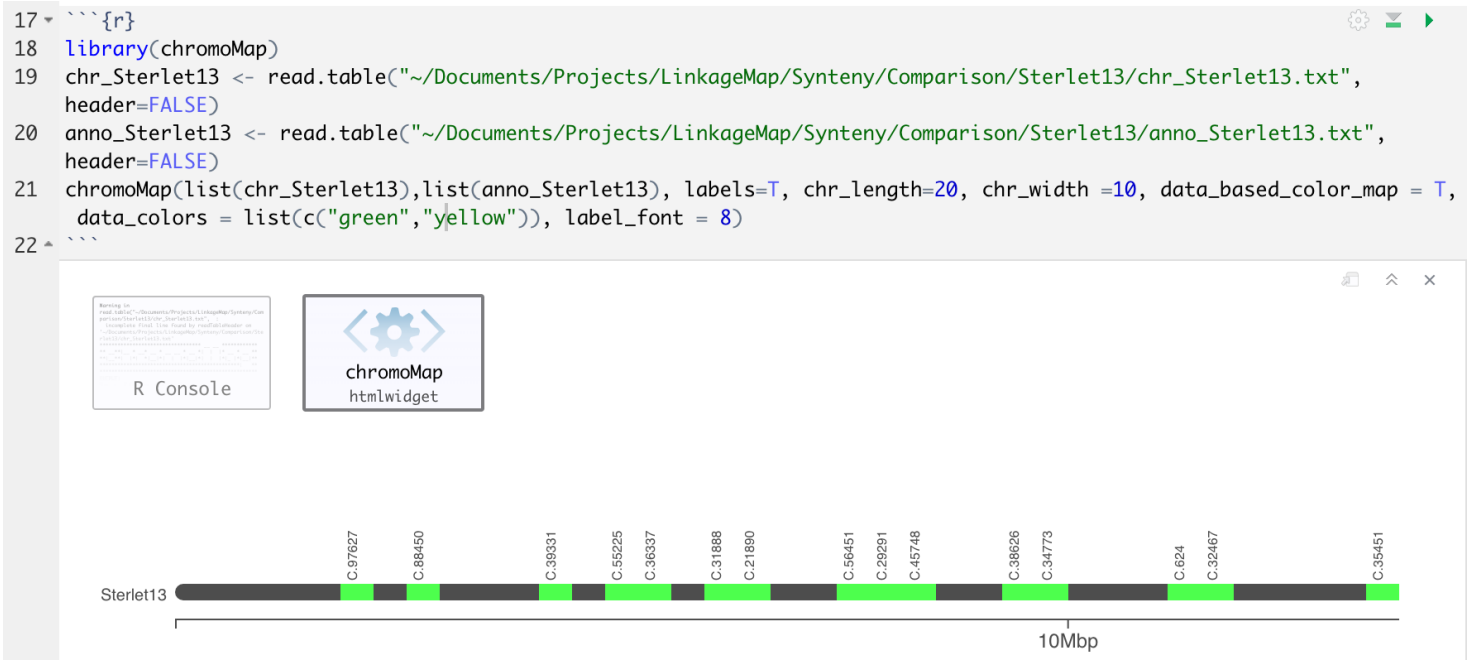
- Save scripts in a format for reproducible reports
- Can save in pdf, html, etc. file extensions



Outline

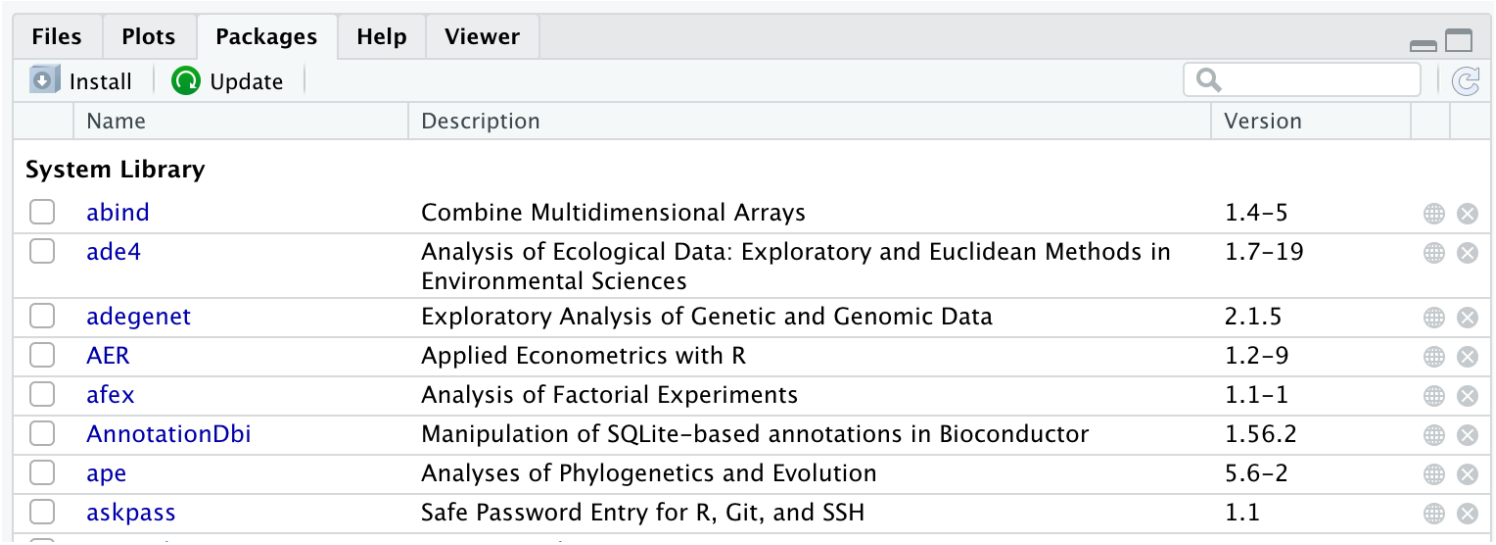
R Markdown continued

- Run a chunk by clicking the green triangle.
- To run all chunks above this chunk, press the gray triangle.
- When you run a chunk, the code will be printed beneath it.



Lower right-hand window

- Files = open files, but usually easier to open files using script
- Plots = displays plots
- Packages = install, load, and view packages
  - Add-ons for R that extend its capabilities
  - Install package using Install → turn on package by clicking on package in list or typing library("*package*") in the console
  - Packages come with manuals that describe functions (look up online or just click the blue hyperlink in the package list to direct you to the tab Help)
- Help = documentation for packages



File Directories

Want to load an external file? Use the working directory

Command	Description
get.wd()	Print working directory path
set.wd()	Set new working directory

Functions

- Mathematical operators
  - + (addition)
  - - (subtraction)
  - / (division)
  - * (multiplication)
- Most functions have form: function(x,y,z,etc.)
  - x,y,z are options called arguments
  - when arguments are not specified, default arguments are used

Environment

- What is saved in your R sessions including….

Objects

Objects

- Most things (except graphs) in R are objects
  - E.g., datasets, functions, results, etc.
- Save output (e.g., external file) in your R session temporarily as an R object
  - name <- function(x,y,z)
  - Example: data <- read.csv(“turtles.csv”)
- View() to view R object

Objects

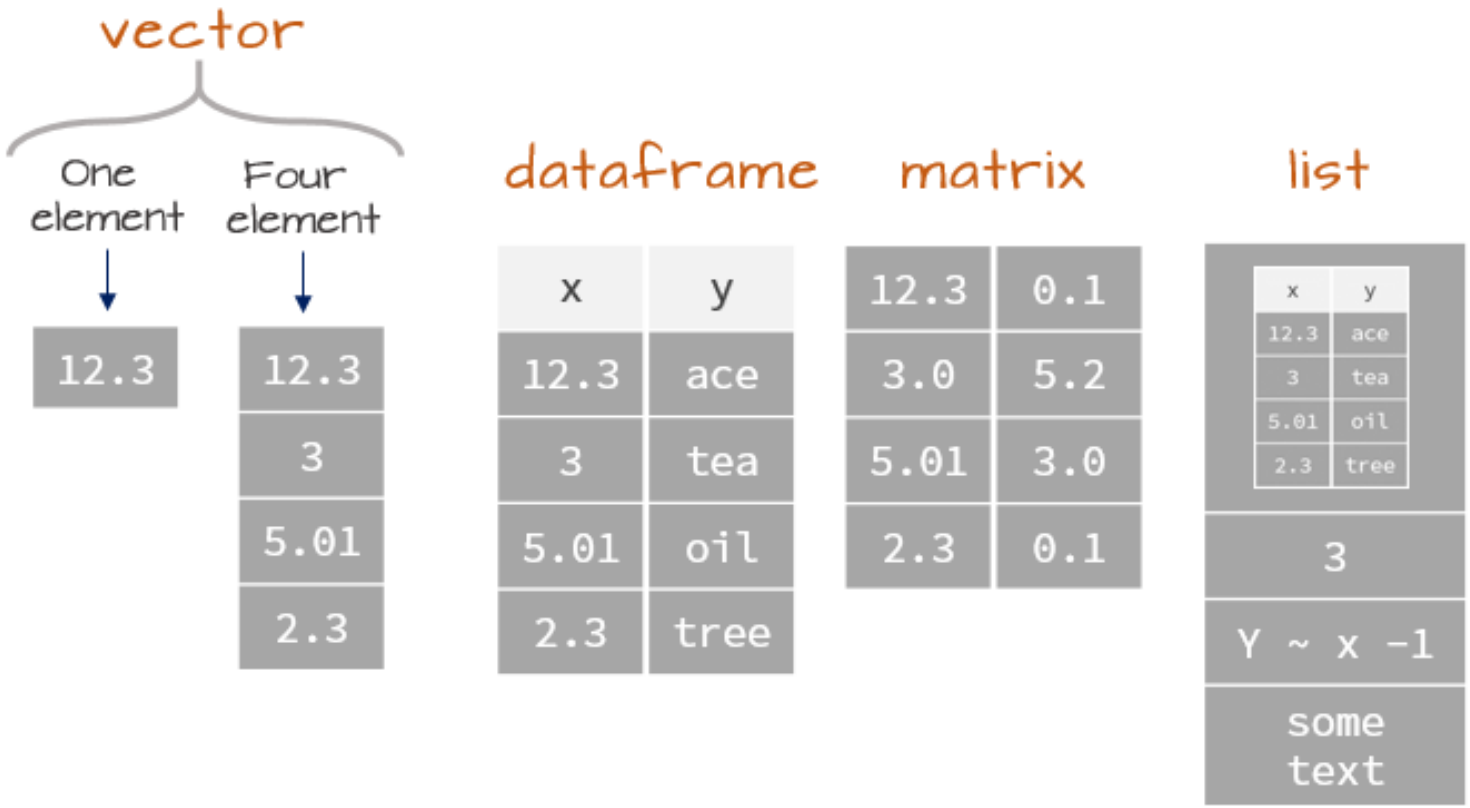
- Each R object has a mode (type) and a class
  - Type = how objects are stored, description of contents
    - Numeric, character, factor, logical
  - Class = general structure
    - Vector, matrix, list, data frame, array

Command	Description
typeof(*object*)	Determine type of object
class(*object*)	Determine class of object

Object Types

- Numeric = values interpreted as numbers
  - 1, 1.1, 2, etc.
- Character = values interpreted as strings (combinations of letters, words, symbols, etc.) and are surrounded by quotation marks
  - “dog”, “cat”
- Factor = values interpreted as group level
  - 0, 1, 2, etc.
- Logical = values interpreted as TRUE/T or FALSE/F

Object Classes



https://vectorpediaonline.blogspot.com/2020/08/list-to-vector-r.html

Vectors

- Single dimension of values
- All values must have same type (e.g., numeric, character)

Exercise: Create two vectors and determine their lengths

```
num_vec <- c(0,1,2,3)
char_vec <- c(“Yes”, “No”, “Maybe”)
length(num_vec)
```

Lists

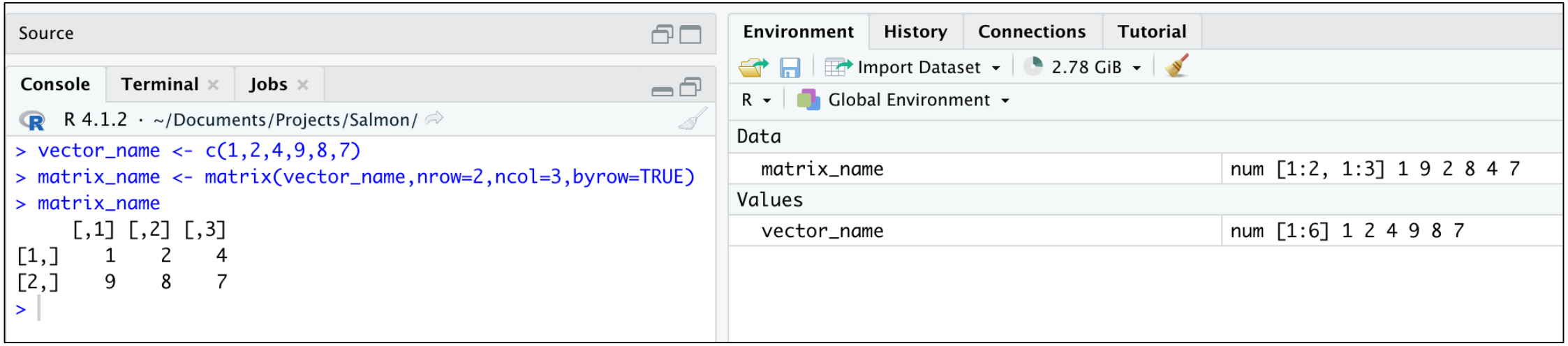
- Collection of objects of different types

Exercise: Combine previous two vectors into one object

list1 <- list(num_vec, char_vec)

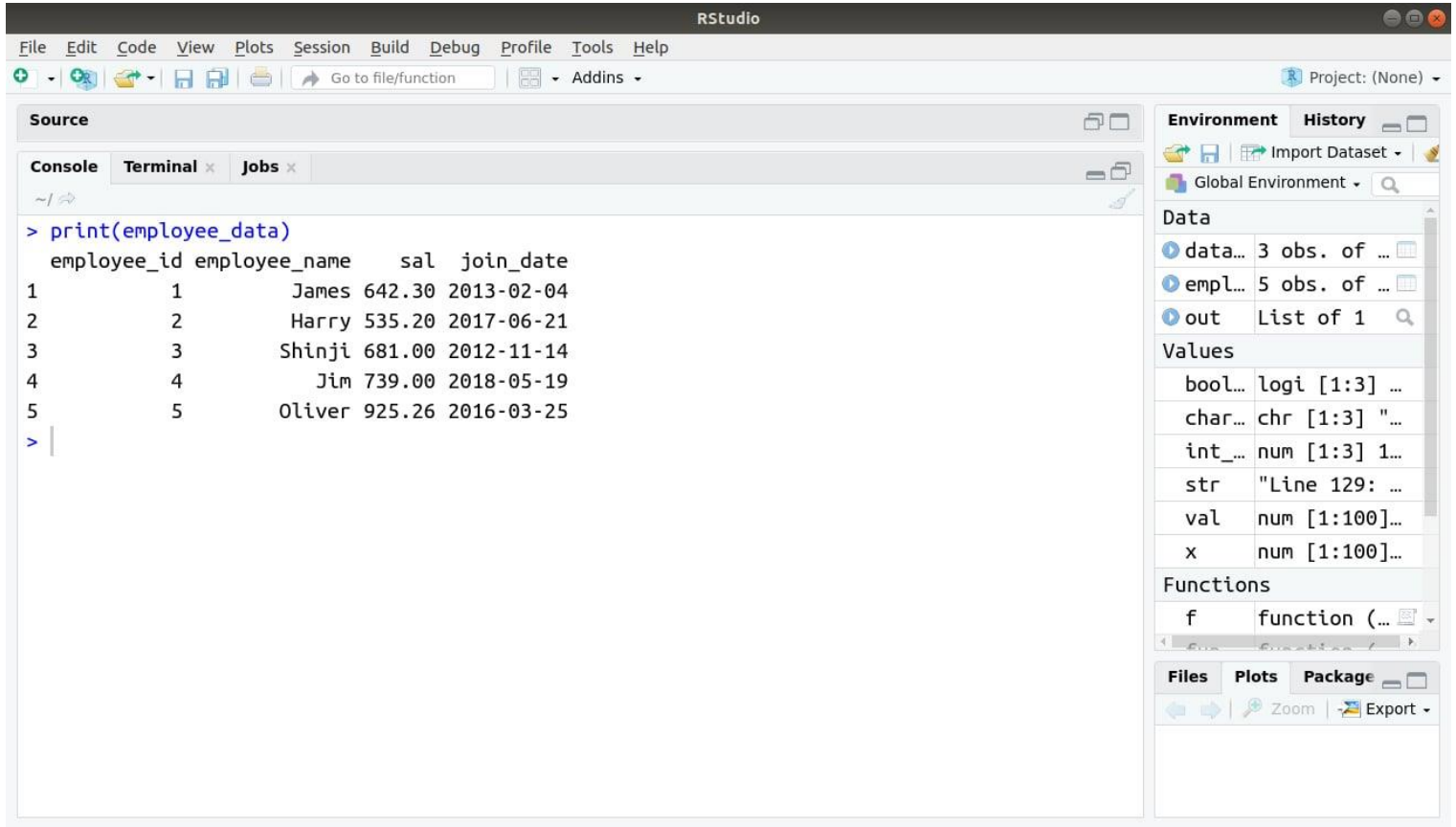
Matrix (plural matrices)

- Object with two dimensions
- Must be same type



Data Frames

object with multiple lists, best viewed using the View() function



Object Types

For vectors and matrices (but not lists or data frames), the type can be found using: typeof(*name*)

- double = numeric
- character

```
> typeof(vector_name)
[1] "double"
```

Exercise: Try to find the type of the number *2* and the word *dog* on your own.

Object Types Exercise Answer

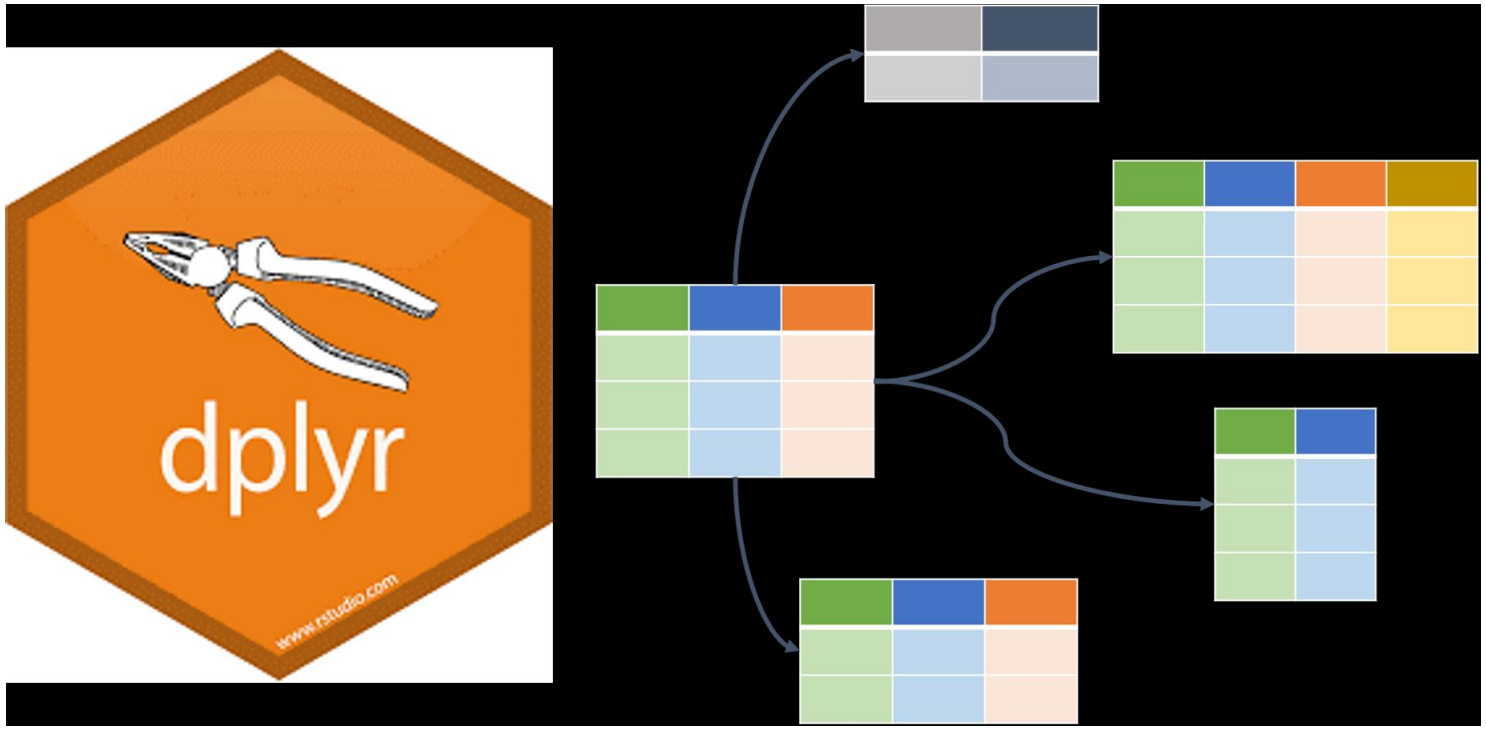
```
> typeof(2)
[1] "double"
> typeof("dog")
[1] "character"
```

Why do you think lists or dataframes cannot be used with typeof()?

10 minute break

Data Manipulation

- Choosing subset of the values/observations, filtering, creating new variables, etc.
- Use the dplyr package

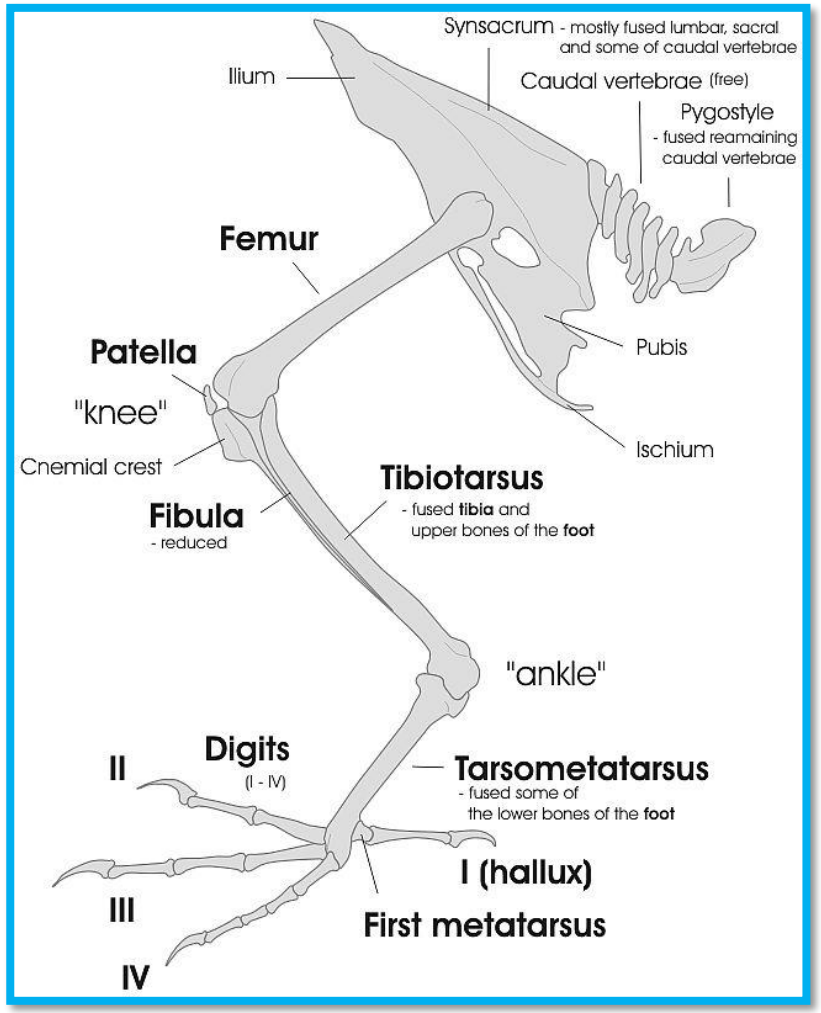


Let us manipulate a data frame

Exercise

- First, set the working directory.
  - Either through Session > Set Working Directory or the command line
- Read in the .csv file and save as R object called *test*
- View the object
- Install and load the dplyr package

Bird Leg



https://www.pinterest.com.au/pin/httpsuploadwikimediaorgwikipediacommonsffabird_leg_and_pelvic_girdle_skeleton_engif--235453886746677962/

Answer

setwd(“C:/Users/richard.Flamio/Documents/Software/Workshop”)

test <- read.csv(“R_dataset.csv”)

View(test) Also, notice the output if you just write *test* in the console.

install.packages(“dplyr”)

library(dplyr)

Select

- Include or exclude certain variables/columns and reorder the columns
- select(dataset, variable1, variable2)
- Variable order matters!
- Removal of a column requires “-” in the beginning of the name

Exercise:

Produce an R object called *test_s* that has only information from the 1st and 3rd column of the data frame

Produce an R object called *test_s2* that has only information from the 1st and 3rd column, but the data frame is now in the order Column 3, Column 1

Answer

```
test_s <- select(test,Sample,Age)
test_s2 <- select(test,Age,Sample)
```

Filter

- Reduce dataset based on criteria
- filter(dataset, criteria1, criteria2)

- Requires conditional operators

Operator	Description
==	equal to
!=	not equal to
>	greater than
>=	greater than or equal to
<	less than
<=	less than or equal to

- criterion takes form of column name, conditional operator, value
- For example, Sex==“F” is all females.

Filter

Exercise:

Produce a dataset “filter1” that does not include female observations.

Produce a dataset “filter2” that only includes observations with femur length equal to or greater than 8.

Produce a dataset “filter3” that only includes observations of males with tibiotarsus lengths above 8.

Reminder: character type needs to be in parentheses, numeric type does not

Answer

```
filter1 <- filter(test, Sex!=“F”)
filter2 <- filter(test,Femur>=8)
filter3 <- filter(test,Sex==“M”&Tibiotarsus>8)
```

Mutate

- Create new variable to the dataset from other variables

Exercise: Produce a column called *Leg* to the data table where you are determining the leg length (femur + tibiotarsus). Call the object *mutate1*.

Answer

```
mutate1 <- mutate(test, Leg=Femur+Tibiotarsus)
```

Rename

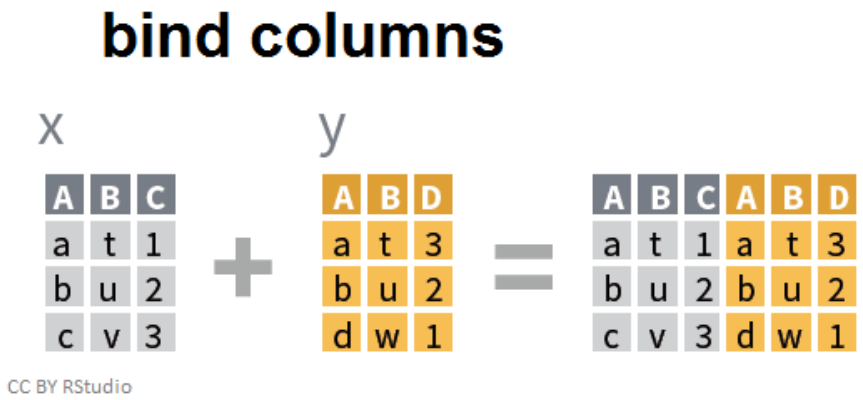
- rename(data, variable1_newname=variable1_oldname)
- Notice the new name goes first

Exercise: Change the name of Sample to ID using an R object *rename1*

Answer

```
rename1 <- rename(test, ID=Sample)
```

Combining Datasets



- Combines tables
- Notice this function is appending table y to table x based on order
- Make sure rows align!
- bind_cols(table x, table y)

Produce a dataframe

Two step procedure

1. Create vectors.
2. Combine vectors using: df <- data.frame(vector1, vector2)

OR

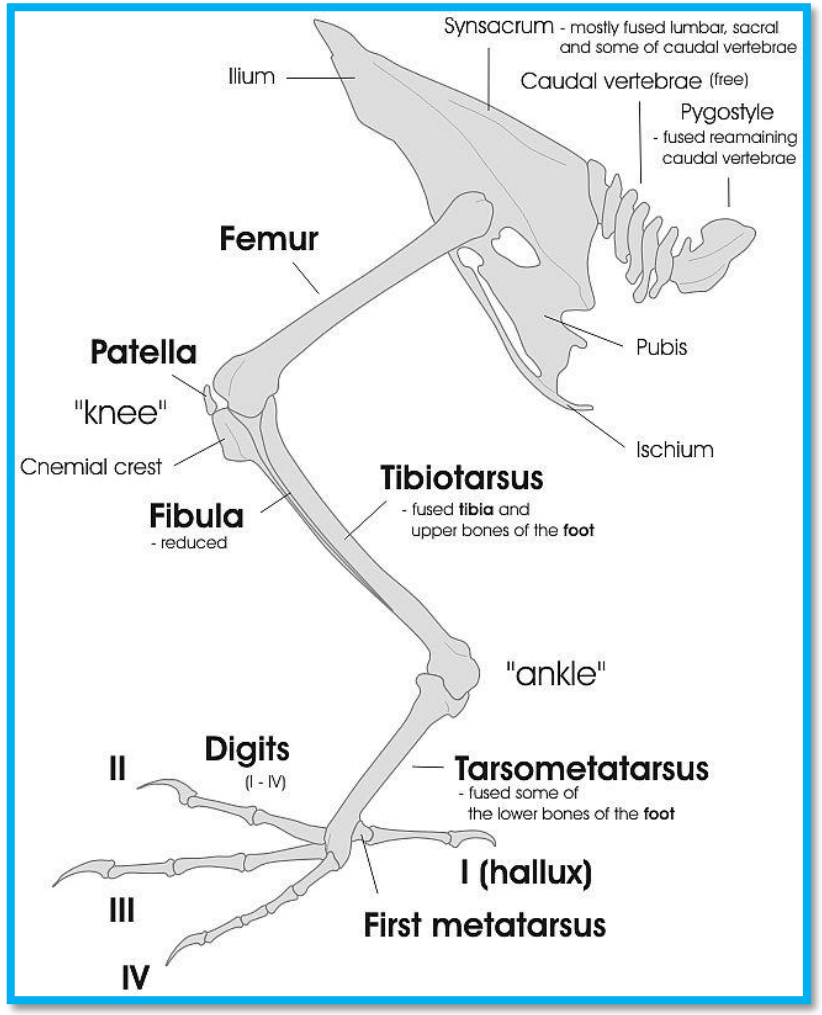
One step procedure

df <- data.frame(vector1=c(“value1”, “value2”, …), vector2=c(“value1”, “value2”, …))

Remember: the use of quotations differs between numeric and character type

Exercise

Bird Leg



Create an R object called *Tarsometatarsus_data* with the following data:

Sample	Tarsometatarsus
AIK001	6.3
AIK002	4.9
AIK003	3.4
AIK004	5.8
AIK005	3.1
AIK006	3.2
AIK007	5.0
AIK008	6.8
AIK009	7.4
AIK010	10.6

Answer

In coding, there are usually multiple ways to get the same result!

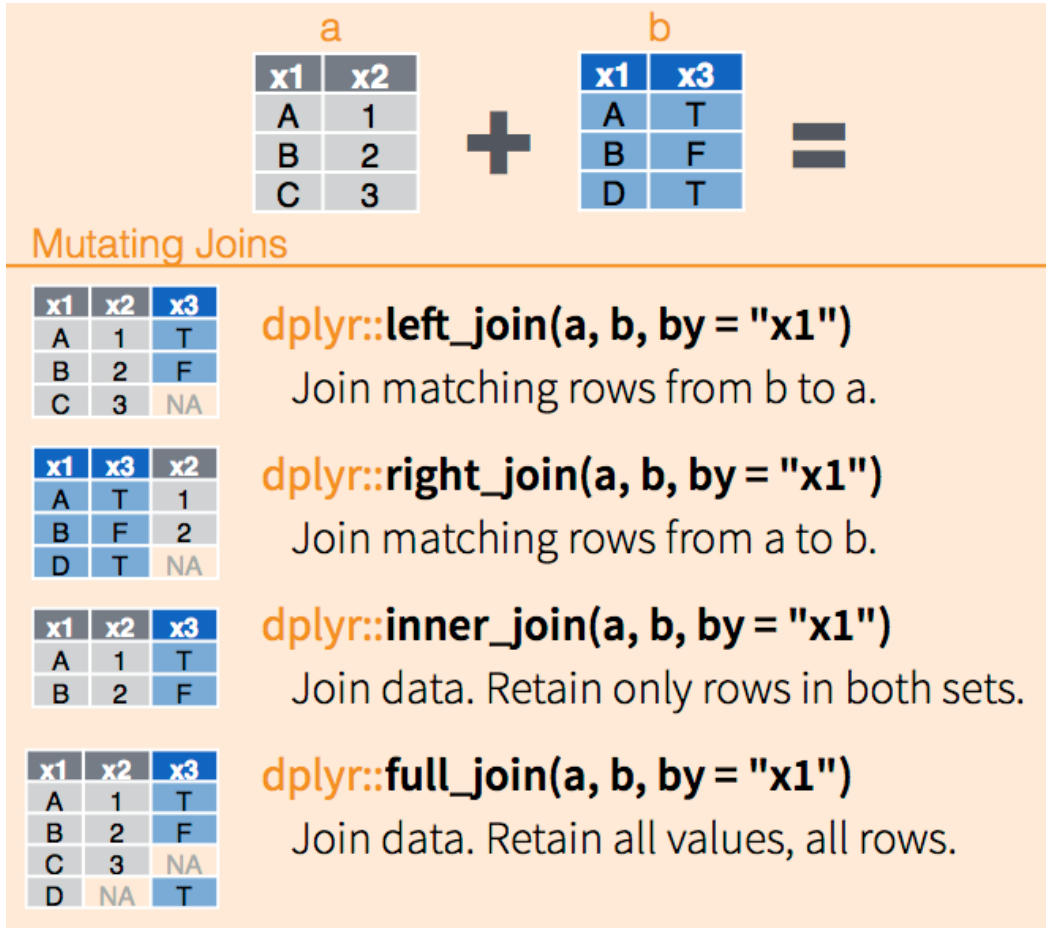
- Option 1: create individual vectors and combine to produce dataframe.
- Option 2: produce dataframe with vectors inside function.
- Option 3: select column 1 from *test* dataframe and combine it with a vector of tarsometatarsus data (can use bind(cols))

My Answer

```
test3 <- select(test,Sample)
Tarsometatarsus <- c(6.3,4.9,3.4,5.8,3.1,3.2,5.0,6.8,7.4,10.6)
df <- data.frame(test3,Tarsometatarsus)
```

Combining Datasets

- Use mutating joins if you want to combine two tables by matching rows with a column present in both datasets
- I highly recommend using this



Exercise

- Combine the tarsometarsus data with the *test* data in one object called *all_data.*
- Produce a new variable *TotalLength* in the *all_data* object (call the new object *all_data2*) that is the summation of femur + tibiotarsus + tarsometatarsus length
- Produce a new R object called *simple_data* that contains the following variables: Sample, Sex, Age, TotalLength in that order
- View *simple_data*

My Answer

```
all_data <- left_join(test,df,by="Sample")
```

where test = test data and df is the tarsometatarsus data

```
all_data2 <- mutate(all_data,
TotalLength=Femur+Tibiotarsus+Tarsometatarsus)

simple_data <- select(all_data2, Sample, Sex, Age, TotalLength)

View(simple_data)
```

Combining functions with a pipe operator

- The pipe operator (%>%) allows you to combine dplyr functions in the same line.
- object_name <- data %>% function(argument1) %>% function(argument 2)

Exercise:

Produce an R object *female_data* from *test* that contains only female data and excludes the sex column.

Answer

female_data <- test %>% filter(Sex==“F”) %>% select(-Sex)

References

- grunwaldlab.github
- https://bookdown.org/kdonovan125/ibis_data_analysis_r4/documenting-your-results-with-r-markdown.html