# Iterations and functionals

**Spring 2023**

April 28 2023

# Why repeat ourselves?

```
tinydata <- tribble(
  ~case, ~x, ~y, ~z,
  "a", 5, 3, -2,
  "b", 7, 1, -5,
  "c", 9, 12, -3
)
```

```
tinydata
# A tibble: 3 × 4
  case      x     y     z
  <chr> <dbl> <dbl> <dbl>
1 a         5     3    -2
2 b         7     1    -5
3 c         9    12    -3
```

## Find the mean of each columns

```
mean(tinydata$x)
[1] 7
```

```
mean(tinydata$y)
[1] 5.333333
```

```
mean(tinydata$z)
[1] -3.333333
```

# For loops

***What is a For loop?***

***A for loop is a way to iterate through a series of items stored as a data object in R.***

```
items <- c("grapes", "bananas", "chocolate", "bread")
for (i in items) {
  print(i)
}
[1] "grapes"
[1] "bananas"
[1] "chocolate"
[1] "bread"
```

# `for` loop components

the `for()` function is used to specify

- what object we're drawing from and
- what object we are writing to

```
for( i  in  items  )
     ^         ^
     |         |
     |         |___ object we are drawing from
     |
     |
obj. we write each item to
```

# `for` loop components

## The `brackets {}`

- Inside the brackets we house the code that is going to happen each iteration

```
for( i  in  items  ){
  |~~~~~~~~~~~~~~~~|
  |~~~~~~~~~~~~~~~~|
  |~~~~~~~~~~~~~~~~| code we need perform on each iteration.
  |~~~~~~~~~~~~~~~~|
  |~~~~~~~~~~~~~~~~|
  }
```

# for loops tinydata

```
tinydata
# A tibble: 3 × 4
  case      x     y     z
  <chr> <dbl> <dbl> <dbl>
1 a         5     3    -2
2 b         7     1    -5
3 c         9    12    -3
```

- Let's iterate calculation of column means:

```
my_means <- rep(NA, 3)   # initialize an empty vector
my_means
[1] NA NA NA
```

```
for (i in 1:3) {  # three columns to get the mean for
  my_means[i] <- mean(tinydata[[i+1]])  # mean of col. i+1 (skip col. 1)
}
my_means
[1]  7.000000  5.333333 -3.333333
```

## `for` loops: index vector

Use `seq_along(df)` or `1:ncol(df)` to create an index vector.

- Example: `seq_along(tinydata)`

```
seq_along(tinydata)
[1] 1 2 3 4
```

```
1:ncol(tinydata)
[1] 1 2 3 4
```

## Function for conditional evaluation

- if x is numeric then standardize, else just return x

```
standardize <- function(x, ...){   # ... used for arbitrary number of arguments
  if (is.numeric(x)){              # condition
    (x - mean(x, ...))/sd(x, ...)  # if TRUE, standardize
  } else{                          # else (FALSE)
    x                              # return x unchanged
  }
}
```

```
standardize(c(2,4,6,8, 10))
[1] -1.2649111 -0.6324555  0.0000000  0.6324555  1.2649111
```

```
standardize(c(2,4,6,8, "10"))
[1] "2"  "4"  "6"  "8"  "10"
```

```
standardize(c(2,4,6,8, NA), na.rm = TRUE)
[1] -1.1618950 -0.3872983  0.3872983  1.1618950         NA
```

# Standardizing tinydata

```
# allocate storage in a new data frame
scaled_tinydata <- tinydata %>%
  mutate(
    x = NA,
    y = NA,
    z = NA
  )
```

```
scaled_tinydata
# A tibble: 3 × 4
  case  x     y     z
  <chr> <lgl> <lgl> <lgl>
1 a     NA    NA    NA
2 b     NA    NA    NA
3 c     NA    NA    NA
```

```
for (i in seq_along(tinydata)){
    scaled_tinydata[, i] <- standardize(tinydata[[i]])
}
```

```
scaled_tinydata
# A tibble: 3 × 4
  case      x      y      z
  <chr> <dbl>  <dbl>  <dbl>
1 a        -1 -0.398  0.873
2 b         0 -0.740 -1.09
3 c         1  1.14   0.218
```

# Using `for` loops efficiently

### *For Loop with Break*

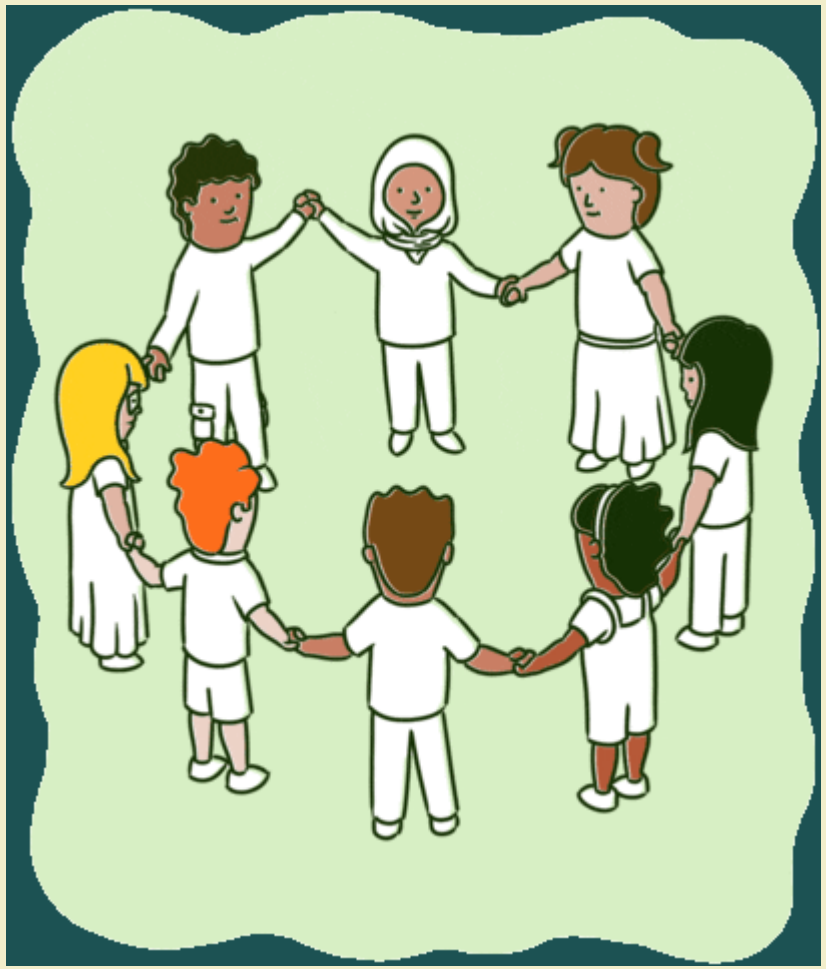
***For loops can be terminated early using the break statement. This can save processing time when the loop meets a specific condition.***

- ***e.g. Find the first even number in a vector:***

```
numbers <- c(5, 7, 15, 8, 20, 30)
for (num in numbers) {
  if (num %% 2 == 0) {
    print(paste("The first even number is", num))
    break
  }
}
[1] "The first even number is 8"
```

# GROUP ACTIVITY 1

05:00



- *Let's go over to maize server/ local Rstudio and our class moodle*
- *Get the class activity 15.Rmd file*
- *Work on activity 1*
- *Ask me questions*

# Functionals

*A **functional** function will apply the same operation (function) to each element of a vector, matrix, data frame or list.*

- *base-R: **apply** family of commands*
- ***purrr** package: **map** family of commands*

## `apply` family of commands

R has a family of commands that apply a function to different parts of a vector, matrix or data frame

***`lapply(X, FUN)`: applies FUN to each element in the vector/list X***

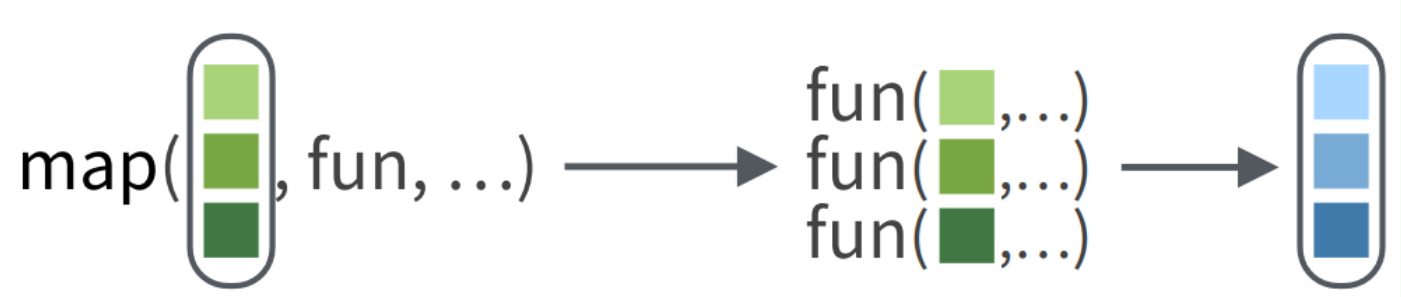
*Example: lapply(tinydata, FUN = mean)*

***`sapply(X, FUN)`:works like lapply, but returns a vector***

*Example: sapply(tinydata, FUN = mean)*

## `purrr` package

**powerful package for iteration with the same functionality as apply commands, but more readable**




- `map(.x, .f)` maps the function `.f` to elements in the vector/list `.x`

# lapply with tinydata

```
lapply(tinydata, FUN = mean)
$case
[1] NA

$x
[1] 7

$y
[1] 5.333333

$z
[1] -3.333333
```

- a 3x4 data frame is **summarized** in a list of length 4.

- R sees tinydata as a list whose elements are column vectors (variables)
- the FUN is applied to each list element
- a list is returned
- length is the number of variables in the data frame

## map

*In purrr, the map function is equivalent to lapply*

```
library(purrr)
map(tinydata, .f = mean)
$case
[1] NA

$x
[1] 7

$y
[1] 5.333333

$z
[1] -3.333333
```

## sapply with tinydata

***Output is an atomic vector (simplify)***

```
sapply(tinydata, FUN = mean)
     case          x          y          z
       NA   7.000000   5.333333 -3.333333
```

- a 3x4 data frame is **summarized** in a vector of length 4.

## map_dbl

***map_dbl is equivalent to sapply***

```
map_dbl(tinydata, .f = mean)
     case          x          y          z
       NA   7.000000   5.333333 -3.333333
```

## map_df

***map_df returns a data frame instead of a vector***

```
map_df(tinydata, .f = mean)
# A tibble: 1 × 4
   case     x     y     z
  <dbl> <dbl> <dbl> <dbl>
1    NA     7  5.33 -3.33
```

- No equivalency in base-R apply!

## Functionals: single function that mutates

`standardize` function gives us a list of standardized values

```
tinydata
# A tibble: 3 × 4
  case      x     y     z
  <chr> <dbl> <dbl> <dbl>
1 a         5     3    -2
2 b         7     1    -5
3 c         9    12    -3
```

```
lapply(tinydata, FUN = standardize)
$case
[1] "a" "b" "c"

$x
[1] -1  0  1

$y
[1] -0.3982161 -0.7395442  1.1377602

$z
[1]  0.8728716 -1.0910895  0.2182179
```

- a 3x4 data frame is **mutated** to a list of 4 vectors of length 3 each

## map_df

***In purrr, the map_df is equal to lapply + bind_cols:***

```
tinydata
# A tibble: 3 × 4
  case      x     y     z
  <chr> <dbl> <dbl> <dbl>
1 a         5     3    -2
2 b         7     1    -5
3 c         9    12    -3
```

```
map_df(tinydata, .f = standardize)
# A tibble: 3 × 4
  case      x      y      z
  <chr> <dbl>  <dbl>  <dbl>
1 a        -1 -0.398  0.873
2 b         0 -0.740 -1.09
3 c         1  1.14   0.218
```

- a 3x4 data frame is mutated to **standardized** 3x4 data frame

# applying multiple functions

- Let's get the 0.1 and 0.9 quantile for variables in `tinydata`

```
quantile(tinydata$x, probs = c(.1, .9))
10% 90%
5.4 8.6
```

```
quantile(tinydata$y, probs = c(.1, .9))
 10%  90%
 1.4 10.2
```

```
quantile(tinydata$z, probs = c(.1, .9))
 10%  90%
-4.6 -2.2
```

- the function output is a vector of length 2 (same lengths as probs)

## `map_df`: getting quantiles

```
tinydata %>%
  select_if(is.numeric) %>%   # only numeric columns
  map_df(
    .f = quantile,   # function to apply to cols
    probs = c(.1, .9)) # extra function arguments
# A tibble: 3 × 2
  `10%` `90%`
  <dbl> <dbl>
1   5.4   8.6
2   1.4  10.2
3  -4.6  -2.2
```

## `map_df`: getting quantiles

***Can use `.id` to record the variable names from `tinydata`:***

```
tinydata %>%
  select_if(is.numeric) %>%
  map_df(
    .f = quantile,
    probs = c(.1, .9),
    .id = "variable")
# A tibble: 3 × 3
  variable `10%` `90%`
  <chr>    <dbl> <dbl>
1 x          5.4   8.6
2 y          1.4  10.2
3 z         -4.6  -2.2
```

## `map_df` options

There are two types of `map_df`

- ***`map_dfr`: row binds the list created by map***
  - ***entries in the list are rows in the data frame***
- ***`map_dfc`: column binds the list created by map***
  - ***entries in the list are columns in the data frame***

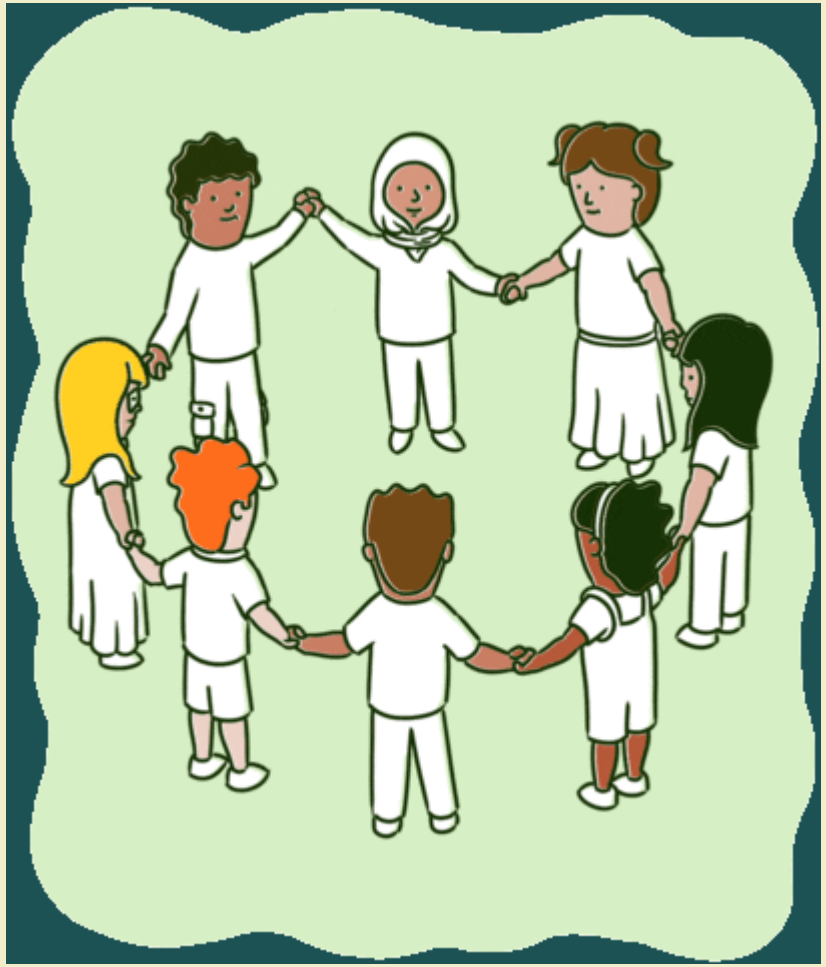
## Iterate or dplyr?!

**We need to manually add a percentile variable to help us ID the value in each row**

```
tinydata %>%
    summarize_if(is.numeric, .funs = quantile, probs = c(.1, .9)) %>%
    mutate(percentile = c(10,90))
# A tibble: 2 × 4
      x     y     z percentile
  <dbl> <dbl> <dbl>      <dbl>
1   5.4   1.4  -4.6         10
2   8.6  10.2  -2.2         90
```

# GROUP ACTIVITY 2

10:00



- Work on activity 2
- Ask me questions