

# Creating and manipulating objects, and extending R using packages

## Learning the basics of R - Part 2

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# Outline

## 1. Base functions in R

- What is a function?
- Basic function syntax

## 2. Extending R using packages

- What are packages?
- How to install packages
- Loading packages to the environment

## 3. Accessing and reading data into R

# What is a function?

- A set of statements organized together to perform a specific task.
- R has a large number of in-built functions.
- In R, a function is an object so the R interpreter is able to pass control to the function, along with arguments that may be necessary for the function to accomplish the actions.
- The function in turn performs its task and returns control to the interpreter as well as any result which may be stored in other objects.

# Functions in R

## Base functions

- Term we use for built-in functions in R.
- These functions cover a wide range of purposes, use cases, and applications one of which is for statistical analysis (probably the most common built-in functions in R)
- Everything we do in R is almost always mediated/made possible by using functions

## Basic function syntax

```
function_name(argument1, argument2, ...)
```

# Using functions - accessing R builtin dataset

- First let us use some sample/toy data. R has built-in datasets for teaching/testing purposes. We will continue on the BMI theme from yesterday by accessing the women built-in dataset in R. This dataset is of average height (inches) and weight (lbs) of women age 30-39 years old.
- We access this data using the `data( )` function as follows:

```
data("women")
```

women

##	height	weight
## 1	58	115
## 2	59	117
## 3	60	120
## 4	61	123
## 5	62	126
## 6	63	129
## 7	64	132
## 8	65	135
## 9	66	139
## 10	67	142
## 11	68	146
## 12	69	150
## 13	70	154
## 14	71	159
## 15	72	164

# Using functions - exploring data structure

- Being able to understand the **data structure** of a dataset helps us make good decisions on how to work with data or how to analyse data.
- There are several R functions that gives us the characteristics and structure of a dataset such as:
  - The shape of the data
  - The number of records in the data
  - The variables of the data
  - The number of variables in the data
  - The values of variables in the data

# Using functions - describing the shape of the data

- We use the `class()` function to know the **class** attribute of an R object.
- Knowing the **class** of an R object give us information on what kind of object it is and how we can work with it in R

## Task:

- Using the women dataset that we just loaded, apply the `class()` function:

```
## Get class of women dataset  
class(women)
```

```
## [1] "data.frame"
```

# Using functions - number of records in the data

- We often need to know how many records are in the dataset that we are working on.
- This is useful for various statistical analysis that we perform on data.
- The function `nrow( )` gives us the number of rows of a `data.frame` R object

## Task:

- Using the `women` dataset, apply the `nrow( )` function to get the number of rows:

```
## Get number of rows of women dataset  
nrow(women)
```

```
## [1] 15
```



# Using functions - number of records in the data

## Bonus question:

- How many columns does the women dataset have?

```
ncol(women)
```

```
## [1] 2
```

# Using functions - variable names of a dataset

- We often need to know the variables of the dataset that we are working on.
- This is useful for various statistical analysis that we perform on data.
- The function `names( )` gives us the variable names of a `data.frame` R object

## Task:

- Using the `women` dataset, apply the `names( )` function to get the variable names:

```
## Get variable names of women dataset  
names(women)
```

```
## [1] "height" "weight"
```

# Using functions - variable names of a dataset

## Bonus questions:

- Can you describe the shape and structure of the output of `names(women)`?

```
## Get class of variable names of women dataset  
class(names(women))
```

```
## [1] "character"
```

- Can you get how *LONG* (how many variable names) the output of `names(women)` is?

```
## Get length of the variable names of women dataset  
length(names(women))
```

```
## [1] 2
```

# Using functions - describing the structure of a dataset

- Another approach to get a full description of the structure of a dataset object in R is by using the `str` function

```
str(women)
```

```
## 'data.frame':    15 obs. of  2 variables:
## $ height: num  58 59 60 61 62 63 64 65 66 67 ...
## $ weight: num  115 117 120 123 126 129 132 135 139 142 ...
```

- The output of using `str()` function is comprehensive.
  - It gives us the class of the object
  - It gives us the number of records/observations
  - It gives us the number of variables
  - It gives us the names of the variables
  - It gives us the class of each of the variables
  - It gives us a glimpse of the values of each of the variables

# Using functions - accessing the variables of a dataset

- When working with `data.frame` objects, we often need to use/access only a specific variable in that `data.frame` object
- Knowing how to access a specific variable in a `data.frame` object is one of the most important skill in R
- There are several ways to access a specific variable in a `data.frame` object

# Using functions - accessing the variables of a dataset

## Using the \$ operator

- Access the **height** variable using the **\$** operator

```
women$height
```

```
## [1] 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72
```

- Now try to access the **weight** variable using the **\$** operator

```
women$weight
```

```
## [1] 115 117 120 123 126 129 132 135 139 142 146 150 154 159 164
```

# Using functions - accessing the variables of a dataset

## Using the indexing method - [ ]

- Access the **height** variable using [ ]

```
women[ , "height"]
```

```
## [1] 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72
```

```
women[ , 1]
```

```
## [1] 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72
```

```
women[[1]]
```

```
## [1] 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72
```

# Using functions - accessing the variables of a dataset

## Using the indexing method - [ ]

- Now try to access the **weight** variable using [ ]

```
women[ , "weight"]
```

```
## [1] 115 117 120 123 126 129 132 135 139 142 146 150 154 159 164
```

```
women[ , 2]
```

```
## [1] 115 117 120 123 126 129 132 135 139 142 146 150 154 159 164
```

```
women[[2]]
```

```
## [1] 115 117 120 123 126 129 132 135 139 142 146 150 154 159 164
```



# Using functions - accessing other values of a dataset

## Bonus question:

- Access the **height** value for the **third** row/record of the dataset

```
women[3, "height"]
```

```
## [1] 60
```

```
women[, "height"][3]
```

```
## [1] 60
```

# Using functions - accessing other values of a dataset

## Bonus question:

- Access the **height** value for the **third** row/record of the dataset

```
women[3, ]["height"]
```

```
##    height  
## 3      60
```

```
women[3, ][["height"]]
```

```
## [1] 60
```

```
women$height[3]
```

```
## [1] 60
```

# Using functions - some basic statistical functions

Function	Description
mean()	Get the mean value of a set of numbers
median()	Get the median value of a set of numbers
var()	Get the estimated variance of the population from which you sampled
sd()	Get the standard deviation of the population from which you sampled
scale()	Get the z-scores for a set of numbers

# Using functions - application of some basic statistical functions

1. Get the mean height in the women dataset
2. Get the median weight in the women dataset

```
mean(women$height)
```

```
## [1] 65
```

```
median(women$weight)
```

```
## [1] 135
```

# Extending R using packages

- There are times that we need functions that are not built-in to R but are available through external **R packages**
- **R packages** are collections of functions and data sets developed by the community.
- **R packages** increase the power of R by improving existing base R functionalities, or by adding new ones.
- For this project, majority of the statistical tools/functions we need are already built-in to R.
- However, most of the tools we need for data access and loading, data manipulation, data processing, creating reports, reproducibility, and automation will require us to extend R using these additional **R packages**

# Extending R using packages

- We usually have our data in different files and these files can be in different file formats.
- Depending on the file format of your data, different functions are used to read these files into R.
- Base (built-in) functions in R have a limited types of data that it can read.
- We often need to install additional **R packages** to read other types of data e.g., .XLSX, .dta, .sav, etc.

# Extending R using packages

- Using base functions in R to read a text type of data file such as CSV

```
read.table(  
  file = "data/women.csv",  
  header = TRUE, sep = ",",  
)
```

##	height	weight
## 1	58	115
## 2	59	117
## 3	60	120
## 4	61	123
## 5	62	126
## 6	63	129
## 7	64	132
## 8	65	135
## 9	66	139
## 10	67	142
## 11	68	146
## 12	69	150
## 13	70	154
## 14	71	159
## 15	72	164

# Extending R using packages

- Using base functions in R to read a text type of data file such as CSV

```
read.csv(file = "data/women.csv")
```

##	height	weight
## 1	58	115
## 2	59	117
## 3	60	120
## 4	61	123
## 5	62	126
## 6	63	129
## 7	64	132
## 8	65	135
## 9	66	139
## 10	67	142
## 11	68	146
## 12	69	150
## 13	70	154
## 14	71	159
## 15	72	164



# Extending R using packages

- We should assign this data to an object. Let us call this object `women_csv`

```
women_csv <- read.csv("data/women.csv")
```

##	height	weight
## 1	58	115
## 2	59	117
## 3	60	120
## 4	61	123
## 5	62	126
## 6	63	129
## 7	64	132
## 8	65	135
## 9	66	139
## 10	67	142
## 11	68	146
## 12	69	150
## 13	70	154
## 14	71	159
## 15	72	164

# Extending R using packages

- Using the R package **openxlsx** to read .XLSX type of data file
- We first need to install the **openxlsx** package

```
install.packages("openxlsx")
```

- We then need to load the package into the current working environment. We use the `library()` function for this:

```
library("openxlsx")
```

# Extending R using packages

- Using the R package **openxlsx** to read .XLSX type of data file
- We are now ready to use the function `read.xlsx()` from the `openxlsx` package to read the `women.xlsx` file:

```
read.xlsx(  
  xlsxFile = "data/women.xlsx",  
  sheet = 1  
)
```

##	height	weight
## 1	58	115
## 2	59	117
## 3	60	120
## 4	61	123
## 5	62	126
## 6	63	129
## 7	64	132
## 8	65	135
## 9	66	139
## 10	67	142
## 11	68	146
## 12	69	150
## 13	70	154
## 14	71	159
## 15	72	164

# Extending R using packages

- We should assign this data to an object. Let us call this object `women_xlsx`

```
women_xlsx <- read.xlsx(  
  xlsxFile = "data/women.xlsx",  
  sheet = 1  
)
```

`women_xlsx`

##	height	weight
## 1	58	115
## 2	59	117
## 3	60	120
## 4	61	123
## 5	62	126
## 6	63	129
## 7	64	132
## 8	65	135
## 9	66	139
## 10	67	142
## 11	68	146
## 12	69	150
## 13	70	154
## 14	71	159
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# Coding challenge

Given what you have learned so far, I would like you to write an R script (add this to your script in `bmi.R`) that would:

- Calculate the BMI of each of the 15 records in the women dataset. For this, remember that the units of the weight in the women dataset is in lbs and the units of the height is in inches. So you need to do conversions. You can use the following:

1 inch = 0.0254 metres

1 lb = 0.453592 kgs

Compared to our exercise earlier, we are now working on 15 records. Think very well how you would apply the calculations!

- Determine which record has the highest BMI and which record has the lowest BMI using R code
- Determine how many records have a BMI higher than 23.
- Calculate the mean and median BMI of the 15 records

Questions?

# Thank you!

Slides can be viewed at <https://oxford-ihtm.io/open-reproducible-science/session3.html>

PDF version of slides can be downloaded at <https://oxford-ihtm.io/open-reproducible-science/pdf/session3-r-basics-part2.pdf>

R scripts for slides available [here](#)