

# 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 `read.table()` base function in R to read a text type of data file such as a *comma-separated value* or CSV file:

```
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 `read.csv()` base function in R to read a text type of data file such as a *comma-separated value* or CSV file:

```
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 a Microsoft Excel or .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 a Microsoft Excel or `.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
## 15	72	164

# Coding challenge

Check your email and look for the message from GitHub Classroom with a link to your next coding exercise.

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](#)