

# Session 1 - Introduction to R

## R for Stata Users

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The World Bank | [WB Github](#)

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# Sessions format

## Welcome!

We're glad you're joining us today!

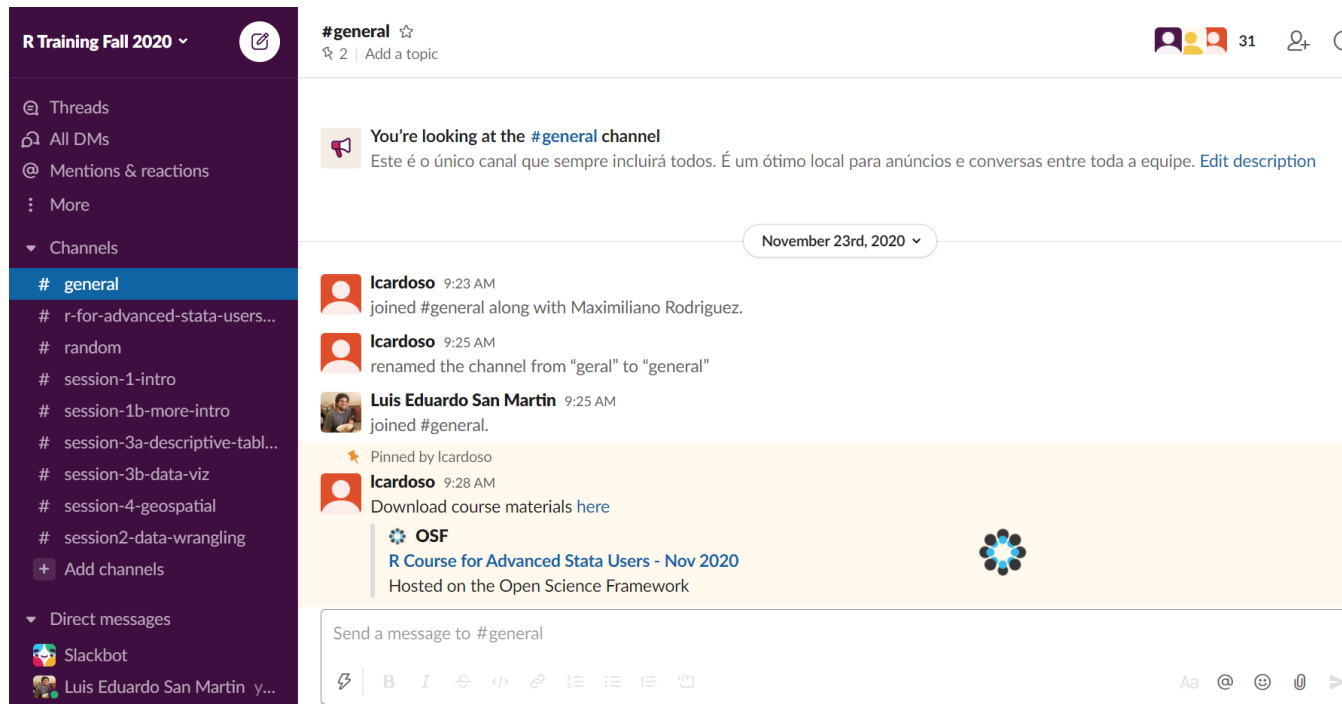
## Format

- These are hands-on sessions. You are strongly encouraged to **follow along in your computer** what the presenter is doing
- The sessions include exercises. You will be given 3-4 minutes to solve each exercise before we show the solution
- Every session has two TAs. For this session, our TAs are **Luiza Cardoso De Andrade** and **Rony Rodriguez-Ramirez**

# Sessions format

## Format

- The TAs will help you troubleshooting **particular issues** which make you unable to follow along the presentation. Send them a message over the chat whenever you need help
- You can also use our Slack workspace to troubleshoot. It is easier to follow direct conversations in Slack, and it also allows you to send screenshots (please send them if you can!)



# Sessions format

## Format

- You can join our Slack workspace using [this link](#)
- If you have a question feel free to unmute yourself or use the chat to ask it
- Please mute your microphone the rest of the time
- If your connection is good enough, please leave your video on
- The materials of each session will be shared in the OSF page of the course by the end of each session:  
<https://osf.io/86g3b/>

# Introduction

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# Introduction

## About this course

These training sessions will offer an introduction to R, its amazing features, and how Stata users can adapt from using Stata to using R.

We assume that you know how to do statistical programming in Stata or that you have a computer programming background.

## About this session

This first session will present the basic concepts you will need to use R.

# Introduction

## Sessions

1. Introduction to R
2. Introduction to R programming
3. Data processing
4. Data visualization
5. Descriptive analysis
6. Geospatial data

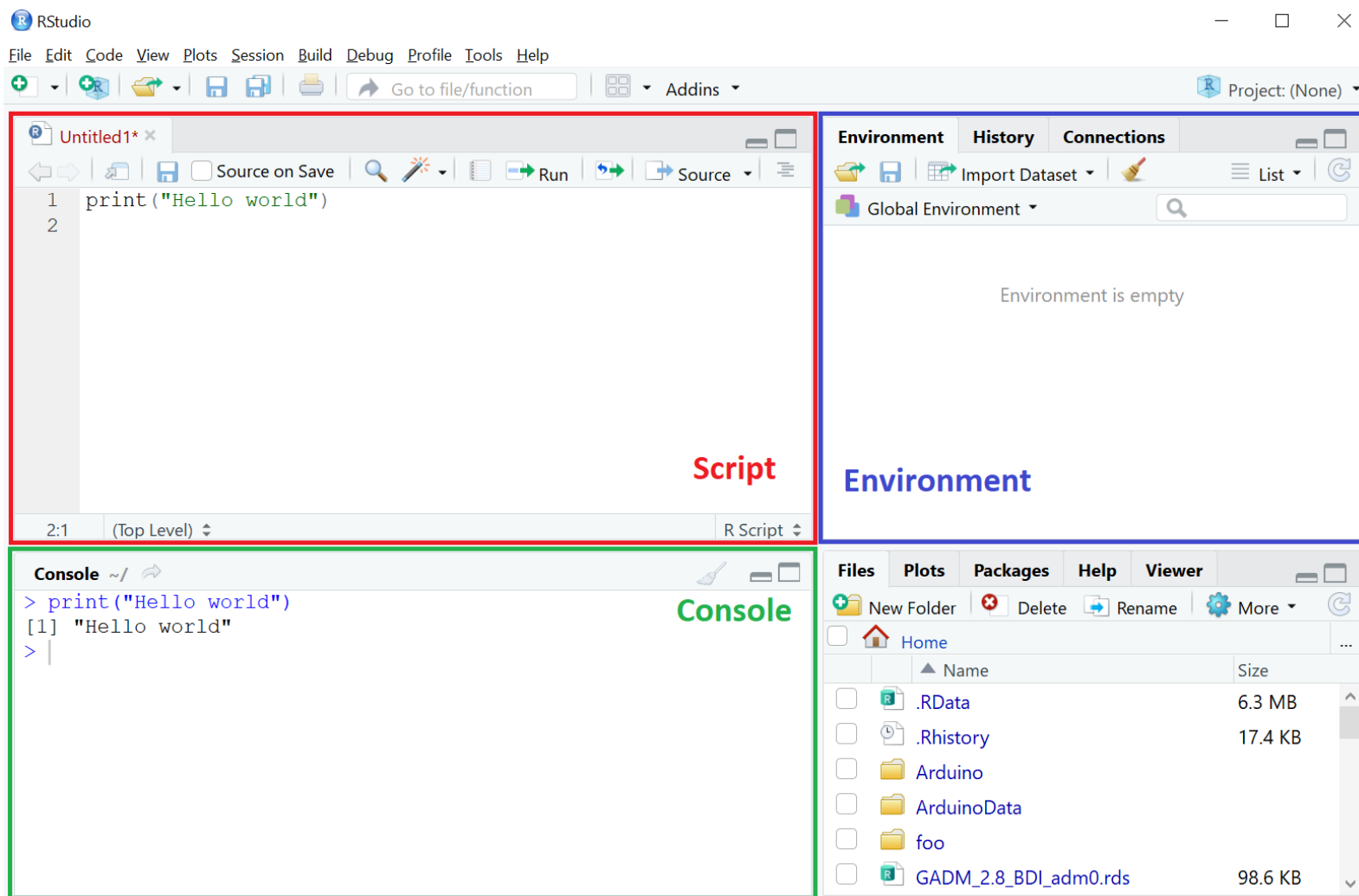
For the most recent versions of these trainings, visit the DIME-R-training GitHub repository at <https://github.com/worldbank/dime-r-training>



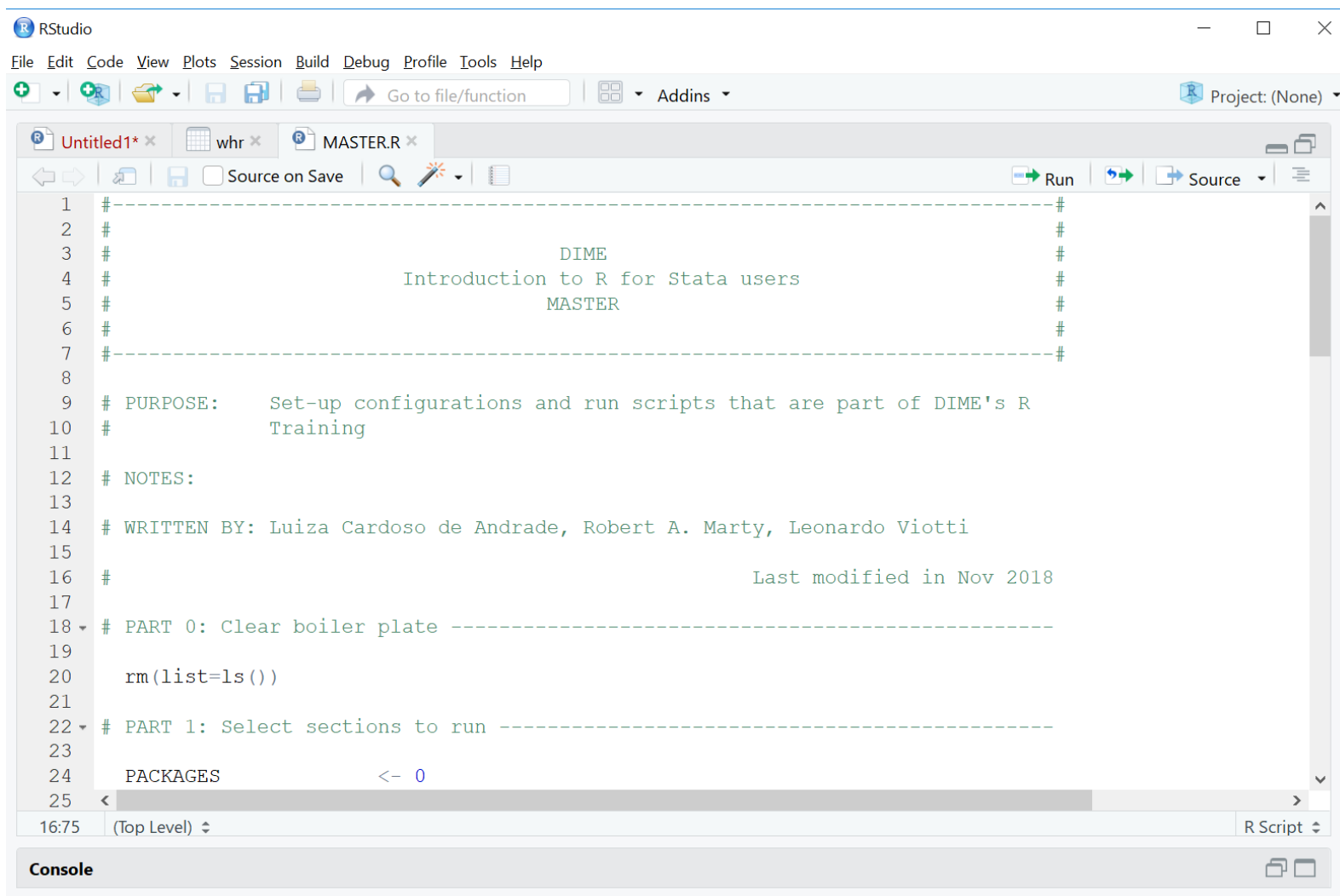
# Getting started

---

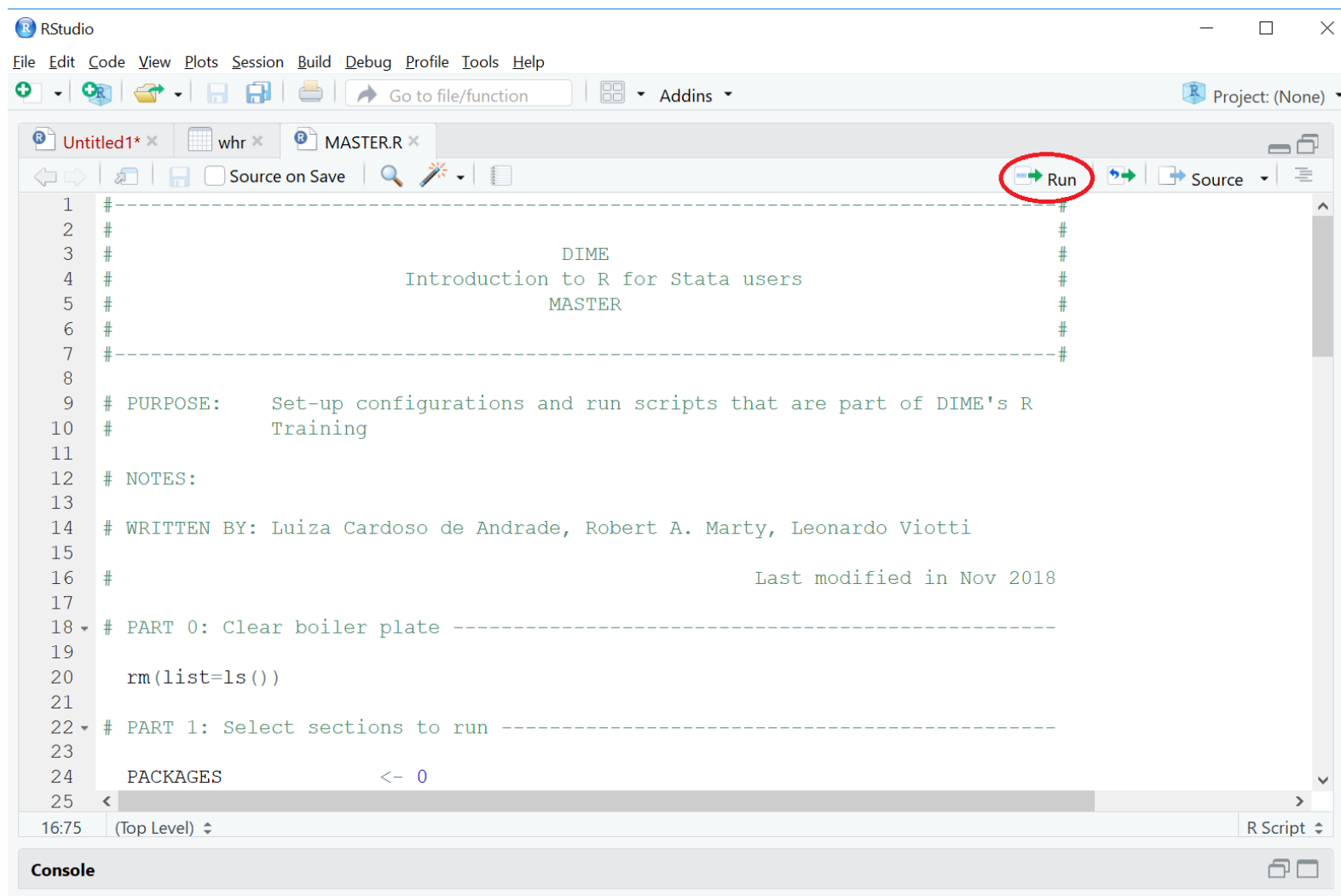
# Getting started - RStudio interface



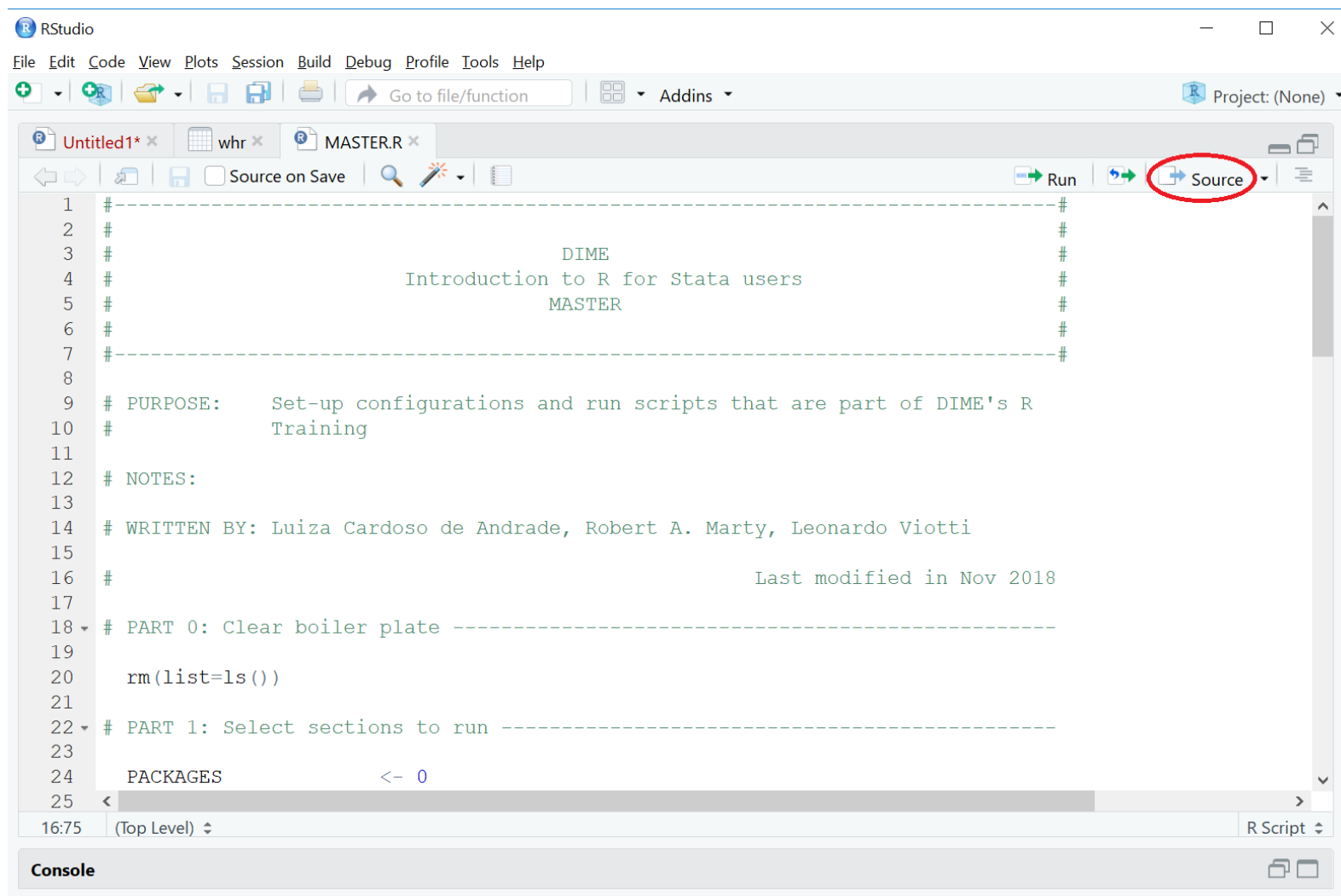
# Getting started - RStudio interface



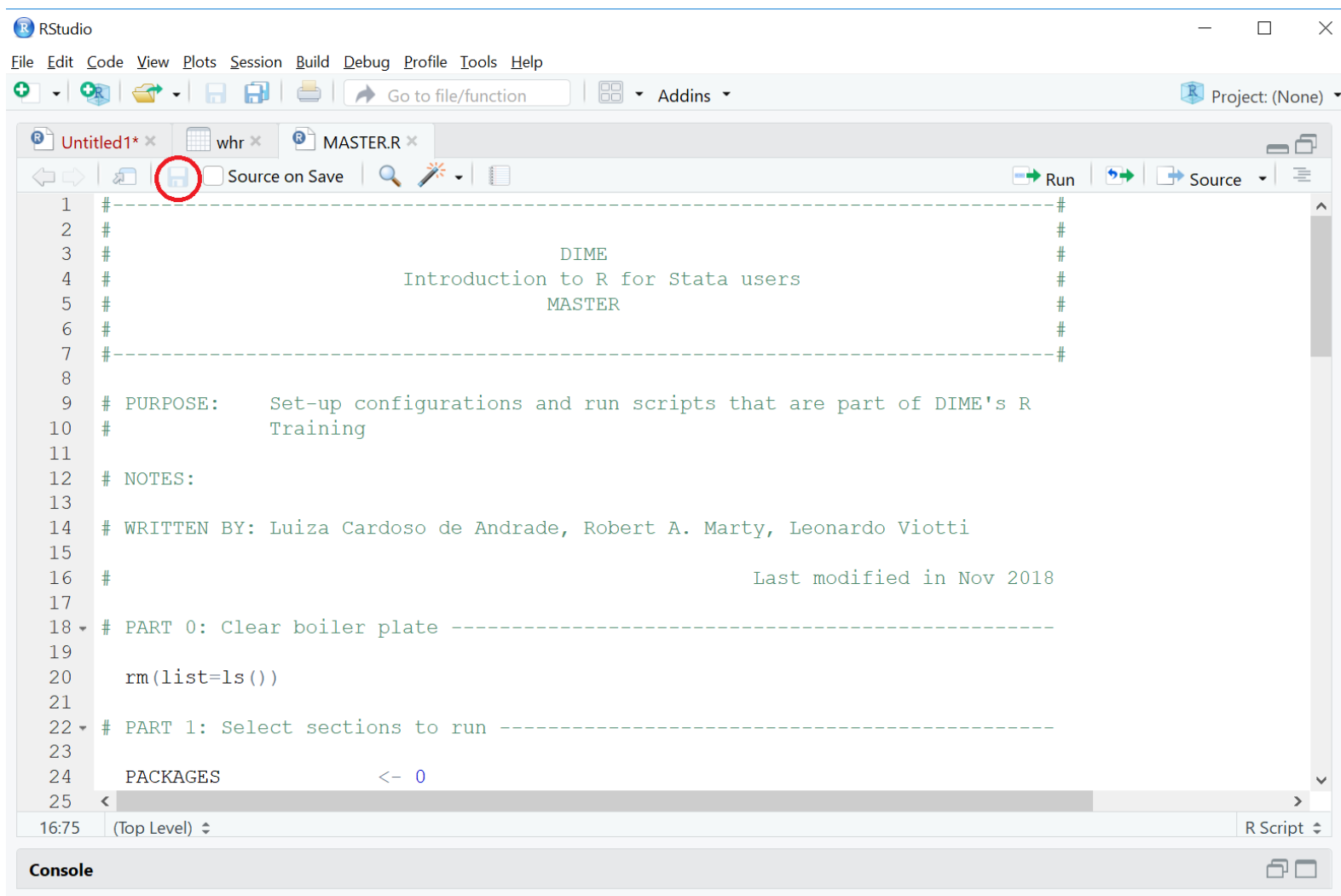
# Getting started - RStudio interface



# Getting started - RStudio interface



# Getting started - RStudio interface



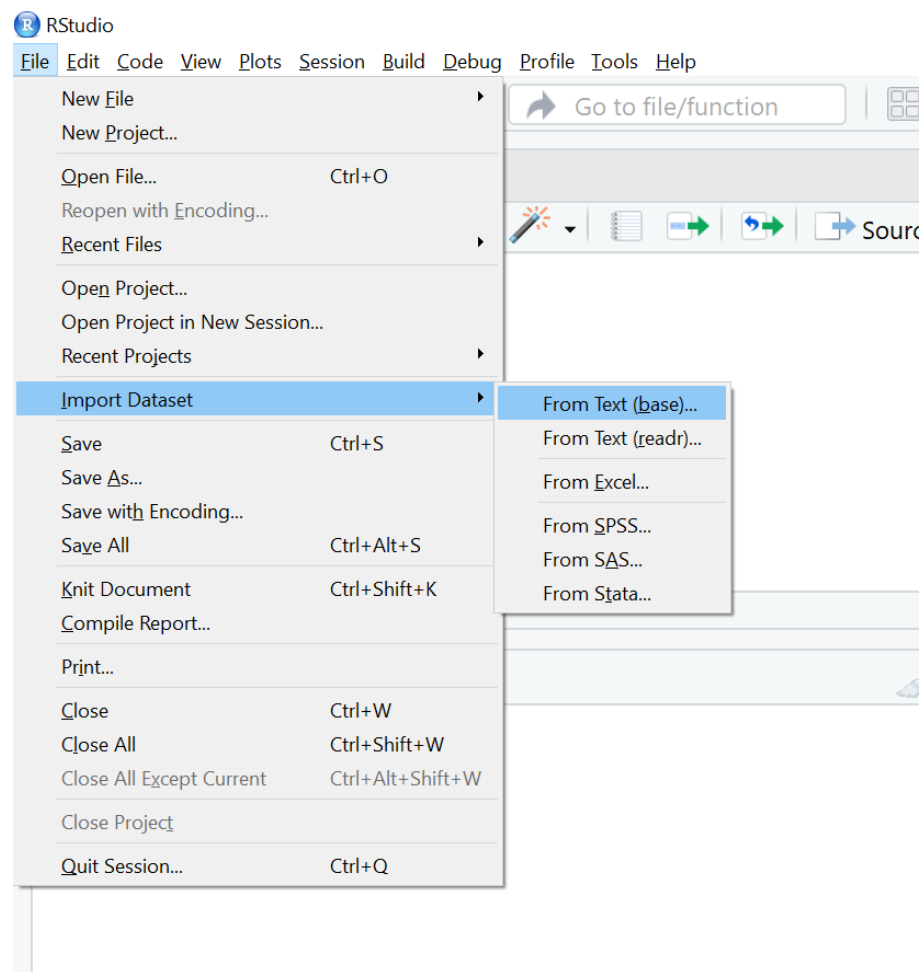
# Getting started - Importing data

Let's start by loading the data set we'll be using:

## Exercise 1: Import data

1. Go to the OSF page of the course (<https://osf.io/86g3b/>) and download the file located in `R for Stata Users - November 2021` > `Data` > `whr_panel.csv`
2. In RStudio, go to `File` > `Import Dataset` > `From Text (base)` and open the `whr_panel.csv` file.
  - Depending on your Rstudio version, it might be `File` > `Import Dataset` > `From CSV`
3. Assign the name `whr` to the dataset on the import window.

# Getting started - Importing data





# Getting started - Importing data

Import Dataset

Name  
whr

Encoding Automatic

Heading ☒ Yes ☐ No

Row names Automatic

Separator Comma

Decimal Period

Quote Double quote (")

Comment None

na.strings NA

☒ Strings as factors

Input File

"country","region","year","happy\_rank","happy\_score","gdp\_pc"  
"Norway","Western Europe",2017,1,7.53700017929077,1.616463184  
"Denmark","Western Europe",2017,2,7.52199983596802,1.48238301  
"Iceland","Western Europe",2017,3,7.50400018692017,1.48063302  
"Switzerland","Western Europe",2017,4,7.49399995803833,1.5649  
"Finland","Western Europe",2017,5,7.4689998626709,1.443571925  
"Netherlands","Western Europe",2017,6,7.3769998550415,1.50394  
"Canada","North America",2017,7,7.31599998474121,1.4792044162  
"New Zealand","Australia and New Zealand",2017,8,7.3140001296  
"Sweden","Western Europe",2017,9,7.28399991989136,1.494387266  
"Australia","Australia and New Zealand",2017,10,7.28399991989  
"Israel","Middle East and Northern Africa",2017,11,7.21299982  
"Costa Rica","Latin America and Caribbean",2017,12,7.07899999  
"Austria","Western Europe",2017,13,7.00600004196167,1.4870972  
"United States","North America",2017,14,6.99300003051758,1.54

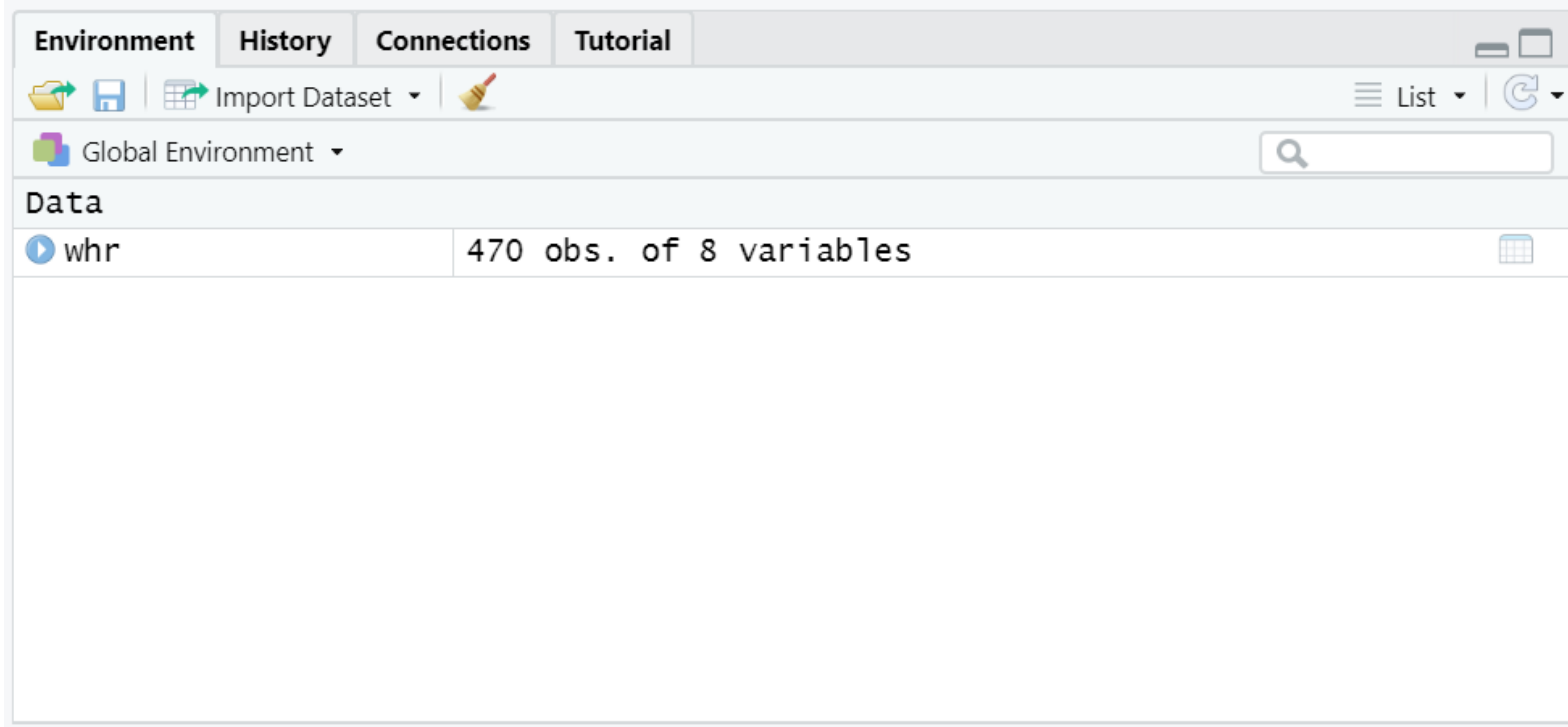
Data Frame

country	region	year	happy
Norway	Western Europe	2017	1
Denmark	Western Europe	2017	2
Iceland	Western Europe	2017	3
Switzerland	Western Europe	2017	4
Finland	Western Europe	2017	5
Netherlands	Western Europe	2017	6
Canada	North America	2017	7
New Zealand	Australia and New Zealand	2017	8
Sweden	Western Europe	2017	9
Australia	Australia and New Zealand	2017	10
Israel	Middle East and Northern Africa	2017	11
Costa Rica	Latin America and Caribbean	2017	12
Austria	Western Europe	2017	13
United States	North America	2017	14

Import

Cancel

# Getting started - RStudio interface



# Data in R

---

## In Stata:

- You can open **one dataset** and perform operations that can change that dataset.
- You can also have other things, such as matrices, macros and tempfiles, but they are secondary. **Most functions only use the main dataset.**
- If you wish to do any non-permanent changes to your data, **you'll need to preserve the original data to keep it intact.**

# Data in R

## In R:

**R** works in a completely different way:

- You can load **as many datasets as you wish** or your computer's memory allows
- Operations will have lasting effects **only if you store them**

# Data in R

## In R:

- Everything that exists in R's memory -- variables, datasets, functions -- **is an object**
- You could think of an object like a chunk of data with some properties that has a name by which you call it
- If you create an object, it's going to be stored in memory until you delete it or quit R
- Whenever you run anything you intend to use in the future, **you need to store it as an object.**

# Data in R

To better understand the idea, we're going to use the data we opened from the United Nations' World Happiness Report.

First, let's take a look at the data.


Type the following code **in the Console panel** and press Enter to explore the data:


```
# We can use the function View() to browse the whole data  
View(whr) # <--- Note that the first letter is uppercase
```

# Data in R

Alternatively we can print the first 6 obs. with `head()`:

Code

 Start Over

 Run Code

```
1  
2  
3
```



# Data in R

Now, let's try some simple manipulations. First, assume we're only interested in data of the year 2016.

## Exercise 2: Subset the data

- Subset the data set, keeping only observations where variable `year` equals `2016`.

```
# To do that we'll use the subset() function  
subset(wht, year == 2016)
```

- Then, look again at the first 6 observations


```
# Use the head() function again  
head(wht)
```


**Important:** It is a good practice to always write your code in the script window and run it from there

# Data in R

```
subset(whr, year == 2016)  
head(whr)
```

Code

 Start Over

 Run Code

1  
2  
3

# Data in R

We can see that nothing happened to the original data. This was because we didn't store the edit we made.

To store an object, we use the assignment operator (`<-`):


```
# Assign the Answer to the Ultimate Question of Life,  
# the Universe, and Everything  
x <- 42
```

# Data in R

```
# Assign the Answer to the Ultimate Question of Life,  
# the Universe, and Everything  
x <- 42
```

Code







 Start Over

 Run Code

```
1  
2  
3
```

# Data in R

From now on, `x` is associated with the stored value (until you replace it, delete it, or quit the R session).

Environment		History	Connections
   Import Dataset ▾ 			
 Global Environment ▾			
Data			
 whr	470 obs. of 8 variables		
Values			
x	42		

## Exercise 3: Create an object

Create a new dataset, called `whr2016`, that is a subset of the `whr` data set containing only data from the year 2016.

```
# Using the same function but now assigning it to an object
```

```
whr2016 <- subset(whr, year == 2016)
```

```
# Display the 6 first obs. of the new data
```

```
head(whr2016)
```

```
# Notice that we still have the original data set intact
```


```
head(whr)
```

# Data in R

```
whr2016 <- subset(whr, year == 2016)
head(whr2016)
head(whr)
```

Code

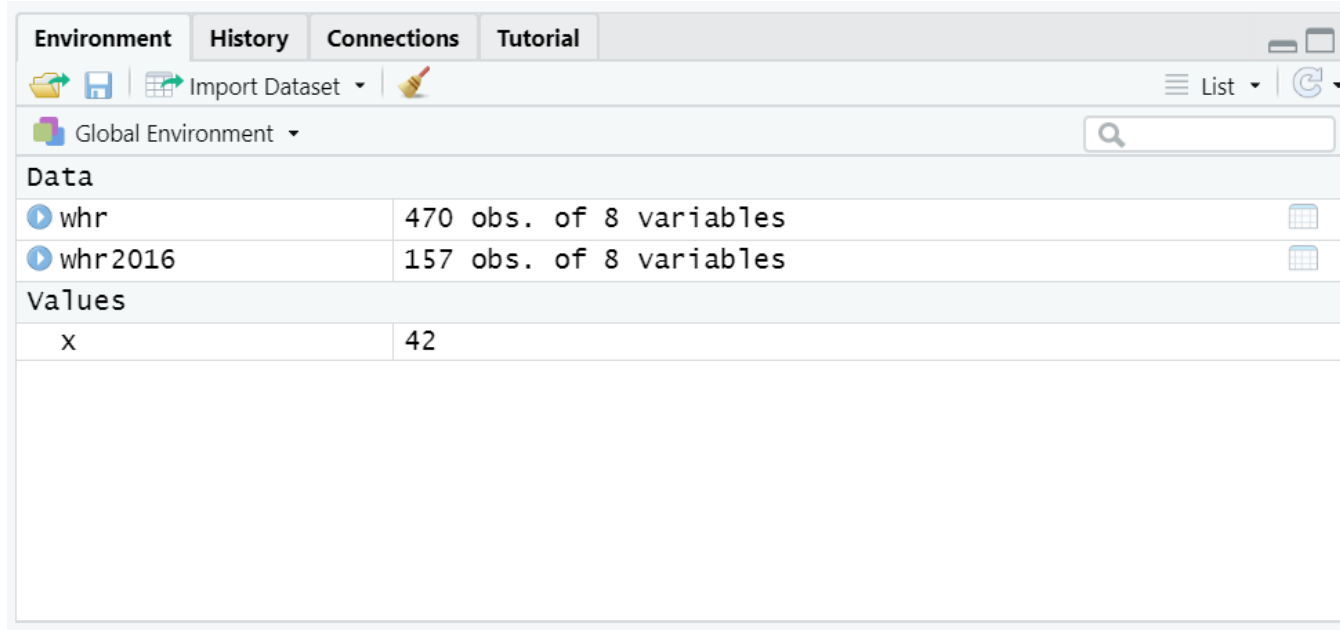
 Start Over

 Run Code

1  
2  
3

# Data in R

You can also see that your environment panel now has two **Data** objects:



The screenshot shows the RStudio Environment panel. At the top, there are tabs for 'Environment', 'History', 'Connections', and 'Tutorial'. Below the tabs is a toolbar with icons for file operations and a search bar. The main area of the panel is titled 'Global Environment' and contains a search bar. Below the search bar, there are two sections: 'Data' and 'Values'. The 'Data' section lists two objects: 'whr' and 'whr2016'. The 'Values' section lists one object: 'x'.

Data	
whr	470 obs. of 8 variables
whr2016	157 obs. of 8 variables

Values	
x	42



# Data in R

## Important concepts to take note:

- In R, if you want to change your data, you need to **store the result in an object** using the arrow operator `<-`
- It is also possible to simply replace the original data. This happens if you assign the new object to the same name as the original.

```
# This would have replaced "whr" instead of creating a new object:  
whr <- subset(whr, year == 2016)
```

**Important:** This will modify the original object -- `whr` in this case

## Printing a result vs storing a result

Print (display) is built into R. If you execute any action without storing it, R will simply **print the results of that action** but won't save anything in the memory.

```
# For instance, this will only print the observations that meet the specified condition:
```

```
subset(whr, year == 2016)
```

```
# To actually store the result, we would need to assign it to an object:
```

```
whr2016 <- subset(whr, year == 2016)
```

# Functions

---

# Functions

## Quick intro to functions

`head()`, `View()`, `subset()` and `read.csv()` are functions.

- Functions in R take named arguments (unlike in Stata that you have arguments and options)
- Arguments are always enclosed in parentheses
- Usually the first argument is the object you want to use the function on, e.g. `subset(whr, ...)`
- Functions usually return values that you can store in an object, print or use directly as an argument of another function.

We will explore these ideas in depth in a later session.

# R objects

---

# R objects

## R objects

Objects are the **building blocks of R programming**. This section will explore some of the most common classes, with a focus on data structures.

This will give you the foundation to explore your data and construct analytical outputs.

# R objects

## What is an object?

- An object is like a global or local in Stata, it's **something you can refer to later** in your code to get a value
- But while you can only put a number or a string in a global, **you can put anything into an object**: scalars, strings, datasets, vectors, plots, functions, etc.
- Objects also have attributes that can be used to manipulate them

# R objects

## Object classes

Here are the object classes we will cover in this first session:

- **Vectors:** an uni-dimensional object that **stores a sequence of values of the same class**
- **Data frames:** a combination of different vectors of the same length (the same as your dataset in Stata)
- **Lists:** a multidimensional object that can store several objects **of different classes and dimensions**



# R objects - Vectors

## Vectors

A vector is an uni-dimensional object composed by one or more elements of the same type.


Use the following code to create vectors in two different ways


```
# Creating a vector with the c() function  
v1 <- c(1,2,3,4,5)  
  
# Alternative way to create an evenly spaced vector  
v2 <- 1:5
```

# R objects - Vectors

```
v1 <- c(1,2,3,4,5) # Creating a vector with the c() function  
v2 <- 1:5          # Alternative way to create an evenly spaced vector
```

Code

 Start Over

 Run Code

1  
2  
3


# R objects - Vectors

You can use brackets for indexing vector elements

```
v2[4]    # Prints the 4th element of the vector  
v2[1:3]  # Prints from the 1st to the 3rd element
```

Code

 Start Over

 Run Code

```
1  
2  
3
```

# R objects - Vectors

## Vectors

To R, each of the columns of the object `whr` is a vector.

### Calling a vector from a `data.frame` column:

We use the `$` character to call vectors (variables) by their names in a `data.frame`

For example:

```
# Create a vector with the values of the "year" variable
year_vector <- whr$year


# See the 3 first elements of the year column
whr$year[1:3]
```


```
## [1] 2015 2015 2015
```

# R objects - Vectors

```
year_vector <- whr$year # creates a vector with the values of the "year" variable  
whr$year[1:3]           # see the 3 first elements of the year column
```

Code

 Start Over

 Run Code

```
1  
2  
3
```

# R objects - Data frames

## Data frames

The `whr` and `whr2016` objects are both data frames. You can also construct a new data frame from scratch by **combining vectors with the same number of elements**.

Now, type the following code to create a new data frame

```
# Dataframe created by biding vectors
df1 <- data.frame(v1,v2)
df1
```


```
##   v1 v2
## 1  1  1
## 2  2  2
## 3  3  3
## 4  4  4
## 5  5  5
```

# R objects - Data frames

```
df1 <- data.frame(v1,v2) #creates a df by binding to existing vectors  
df1
```

Code

 Start Over

 Run Code

1  
2  
3

# R objects - Data frames

## Data frames

Since a data frame has two dimensions, you can use indices for both. The first index indicates the row selection and the second indicates the column.

## Numeric indexing

```
# The first column of whr  
whr[,1]
```

```
# The 45th row of whr  
whr[45,]
```

```
# Or the 45th element of the first column  
whr[45,1]
```




# R objects - Data frames

```
whr[,1]    # The first column of whr  
whr[45,]   # The 45th row of whr  
whr[45,1]  # Or the 45th element of the first column
```

Code

 Start Over

 Run Code

```
1  
2  
3
```

# R objects - Data frames

## Data frames

Alternatively, you can use the column names for indexing, which is the same as using the `$` sign.

## Names indexing


```
# The 22th element of the country column  
whr[22, "country"] # The same as whr$country[22]
```


```
## # A tibble: 1 x 1  
##   country  
##   <chr>  
## 1 Oman
```

# R objects - Data frames

```
# The 22th element of the country column  
whr[22,"country"] # The same as whr$country[22]
```

Code

 Start Over

 Run Code

1  
2  
3

# R objects - Lists

## Lists

Lists are more complex objects that can contain many objects of **different classes and dimensions**.

The outputs of many functions, a regression for example, are similar to lists.

It would be beyond the scope of this introduction to go deep into them, but here's a quick example:

## Combine several objects of different types in a list

```
# Use the list() function  
lst <- list(v1, df1, 45)
```

Print the list yourself to see how it looks like.


# R objects - Lists

## Lists

```
lst <- list(v1, df1, 45) # definition of lst  
print(lst)              # checking the content of lst
```

Code

 Start Over

 Run Code

1  
2  
3

# Basic types of data

---

# Basic types of data

R has different kinds of data that can be recorded inside objects. They are very similar to what you have in Stata, and the main types are string, integer and numeric, factors, and boolean.

Let's start with the simpler ones:

## Strings

A sequence of characters that are usually represented between double quotes. They can contain single letters, words, phrases or even some longer text.

## Integer and numeric

As in Stata, there are two different ways to store numbers. They are different because they use memory differently. As default, R stores numbers in the numeric format (double).

# Basic types of data

## Strings

Now we'll use string data to practice some basic object manipulations in R.

### Exercise 4: Create a vector of strings

Create a string vector containing the names of commonly used statistical software:

```
# Creating string vector  
str_vec <- c("R", "Python", "SAS", "Excel", "Stata")
```


Now print them to check them out.




# Basic types of data - Strings

```
# Creating string vector  
str_vec <- c("R", "Python", "SAS", "Excel", "Stata")
```

Code

 Start Over

 Run Code

1  
2  
3

# Basic types of data

## Strings

### Exercise 5: Concatenate strings

1. Create a scalar (a vector of one element) containing the phrase "can be an option to" and call it `str_scalar`. Your code will be similar to this: `str_scalar <- "can be an option to"`
2. Use the function `paste()` with 3 arguments separated by commas:
  - The first argument as the 1st element of `str_vec`.
  - The second argument as the `str_scalar`.
  - The third argument as the 5th element of `str_vec`.
3. If you're not sure where to start, type:


```
help(paste)
```

# Basic types of data - Strings

```
str_scalar <- "can be an option to"      # creating str_scalar  
paste(str_vec[1], str_scalar, str_vec[5]) # using paste()
```

Code

 Start Over

 Run Code

1  
2  
3

# Advanced types of data

---

# Advanced types of data

R also has other more complex ways of storing data. These are the most used:

## Factors

Factors are **numeric categorical values with text labels**, equivalent to labeled variables in Stata. Turning strings into factors makes it easier to run different analyses on them and also uses less space in your memory.

## Booleans

Booleans are **logical binary variables**, accepting either `TRUE` or `FALSE` as values. They are automatically generated when performing logical operations.

# Advanced types of data

## Factors

We'll learn a more about factors in a later session, since they are important for the kind of analysis we usually do. For now, here are two important things to keep in mind when using them.

Unlike Stata, in R:

1. **You use the labels to refer to factors**
2. **You cannot choose the underlying values**

# Advanced types of data

## Booleans

Boolean data is the result of logical conditions. It can take two possible values: `TRUE` or `FALSE`.

- Stata doesn't have boolean types as such, but Whenever you're using an `if` statement, you're implicitly using boolean data.
- Another difference is that in R you can assign a boolean value to an object:

```
# Storing boolean values:
```

```
boolean_true  <- TRUE
```

```
boolean_false <- FALSE
```

```
# Printing:
```

```
boolean_true
```

```
## [1] TRUE
```


```
boolean_false
```


```
## [1] FALSE
```

# Advanced types of data - Booleans

```
boolean_true  <- TRUE  
boolean_false <- FALSE
```

Code

 Start Over

 Run Code

1  
2  
3



# Advanced types of data

## Booleans

### Exercise 6:

Create a boolean vector with the condition of annual income below average:

```
# Create vector  
inc_below_avg <- whr$economy_gdp_per_capita < mean(whr$economy_gdp_per_capita)  
  
# See the 6 first elements of the vector  
head(inc_below_avg)
```


```
## [1] FALSE FALSE FALSE FALSE FALSE FALSE
```

# Advanced types of data - Booleans

```
inc_below_avg <- whr$economy_gdp_per_capita < mean(whr$economy_gdp_per_capita) # Create vector  
head(inc_below_avg) # See the 6 first elements of the vector
```

Code

 Start Over

 Run Code

1  
2  
3

# Advanced types of data

## Booleans

We can use boolean vectors to index elements:

```
# Creating a vector with 5 elements:  
my_vector <- c("1st", "2nd", "3rd", "4th", "5th")  
my_vector
```

```
## [1] "1st" "2nd" "3rd" "4th" "5th"
```

```
# Selecting and printing the first and last elements only:  
boolean1 <- c(TRUE, FALSE, FALSE, FALSE, TRUE)  
my_vector[boolean1]
```

```
## [1] "1st" "5th"
```


```
# Selecting and printing every element but the first:  
boolean2 <- c(FALSE, TRUE, TRUE, TRUE, TRUE)  
my_vector[boolean2]
```

# Advanced types of data - Booleans

```
my_vector <- c("1st", "2nd", "3rd", "4th", "5th")  
boolean1 <- c(TRUE, FALSE, FALSE, FALSE, TRUE) # We'll use this to select the first and last elements only  
boolean2 <- c(FALSE, TRUE, TRUE, TRUE, TRUE)    # And this to select every element but the first
```

Code

 Start Over

 Run Code

1  
2  
3

# Advanced types of data

## Booleans

Now let's use the boolean vector `inc_below_avg` to add a dummy variable in the `whr` data set for the same condition.

### Exercise 7:

- Create a column in `whr` containing zeros and call it `rank_low`. You can do this by typing:

```
whr$rank_low <- 0
```

- Now use `inc_below_avg` to index the lines of the `rank_low` column and replace all observations that meet the condition with the value 1.

```
whr$rank_low[inc_below_avg] <- 1
```


**Important:** Notice that `whr$rank_low[inc_below_avg]` is subsetting the column `whr$rank_low` to the observations that have a value of `TRUE` in the boolean vector `inc_below_avg`

# Advanced types of data - Booleans

```
whr$rank_low <- 0 # this creates a vector of zeros  
whr$rank_low[inc_below_avg] <- 1  
# this ^ turns its values to 1, for the observations with a TRUE value in inc_below_avg
```

Code

 Start Over

 Run Code

```
1  
2  
3
```

# Advanced types of data

## Booleans

Instead of indexing the lines with the boolean vector `inc_below_avg`, we could also use the boolean condition itself:

```
# Replace with 1 those obs that meet the condition
whr$rank_low[inc_below_avg] <- 1
# is the same as
whr$rank_low[whr$happiness_score < mean(whr$economy_gdp_per_capita)] <- 1

# This in stata would be:
# gen      rank_low = 0
# replace rank_low = 1 if (...)
```

Thank you!



# Appendix

---

# Appendix - R and RStudio Installation

## Installation

This training requires that you have R and RStudio installed in your computer:

## Instructions

- To install R, visit (<https://cran.r-project.org>) and select a Comprehensive R Archive Network (CRAN) mirror close to you.
- To install RStudio, go to <https://www.rstudio.com/>. Note that you need to install R first.

# Appendix - R vs Stata

- R is object oriented while Stata is action oriented:
  - Classic example: Stata's `summarize` vs R's `summary()`
  - In Stata you declare what you want to do, while in R you usually declare the result you want to get
- R needs to load non-base commands (packages) at the beginning of each session
  - Imagine that in Stata you'd have to load a command installed with `ssc install` every time you'll use it in a new session
- R is less specialized, which means more flexibility and functionalities.
- R has a much broader network of users:
  - More resources online, which makes using Google a lot easier. You'll never want to see Statalist again in your life!
  - Development of new features and bug fixes happen faster.

# Appendix - R vs Stata

Some possible disadvantages of Stata:

- Higher cost of entry than Stata for learning how to use R.
- Stata is more specialized, which makes certain common tasks simpler. For example:
  - Running a regression with clustered standard errors
  - Analyzing survey data with weights
- Stata has wider adoption among micro-econometricians (though R adoption is steadily increasing).
  - Network externalities in your work environment.
  - Development of new specialized techniques and tools could happen faster (e.g. *ietoolkit*).

# Appendix - R vs Stata

Here are some advantages of R:

- R is a free and open source software!
- It allows you to have several datasets open simultaneously.
  - No need to use `keep`, `preserve`, `restore`
- It can run complex Geographic Information System (GIS) analyses.
- You can use it for web scrapping.
- You can run machine learning algorithms with it.
- You can create complex Markdown documents. This presentation, for example, is entirely done in R.
- You can create interactive dashboards and online applications with the Shiny package.

# Appendix - Help, Google and Stack Overflow

Help in R works very much like in Stata: the help files usually start with a brief description of the function, explain its syntax and arguments and list a few examples. There are two ways to access help files:

## Exercise 8: Use help

```
# You can use the help() function  
help(summary)  
  
# or its abbreviation  
?summary
```

# Appendix - Help, Google and Stack Overflow

- The biggest difference, however, is that **R has a much wider user community** and it has **a lot more online resources**.
- For instance, in 2014, Stata had 11 dedicated blogs written by users, while R had 550 (check <http://r4stats.com/articles/popularity/> for more details).
- The most powerful problem-solving tool in R, however, is Google. Searching the something yields tons of results.
- Often that means a Stack Overflow page where someone asked the same question and several people gave different answers. Here's a typical example: <https://stackoverflow.com/questions/1660124/how-to-sum-a-variable-by-group>

# Appendix - Useful resources

## Blogs, courses and resources:

- Surviving graduate econometrics with R: <https://thetarzan.wordpress.com/2011/05/24/surviving-graduate-econometrics-with-r-the-basics-1-of-8/>
- CRAN's manuals: <https://cran.r-project.org/manuals.html>
- R programming in Coursera: <https://www.coursera.org/learn/r-programming>
- R programming for dummies: <http://www.dummies.com/programming/r/>
- R bloggers: <https://www.r-bloggers.com/>
- R statistics blog: <https://www.r-statistics.com/>
- The R graph gallery: <https://www.r-graph-gallery.com/>
- R Econ visual library: (developed and maintained by DIME Analytics!) <https://worldbank.github.io/r-econ-visual-library/>



# Appendix - Useful resources

## Books:

- R for Stata Users - Robert A. Muenchen and Joseph Hilbe
- R Graphics Cookbook - Winston Chang <https://r-graphics.org/>
- R for Data Science - Hadley Wickham and Garrett Grolemund <https://r4ds.had.co.nz/>

# Appendix - Syntax

R's syntax is a bit heavier than Stata's:

- Parentheses to separate function names from its arguments.
- Commas to separate arguments.
- For comments we use the `#` sign.
- You can have line breaks inside function statements.
- In R, functions can be treated much like any other object. Therefore, they can be passed as arguments to other functions.

Similarly to Stata:

- Square brackets are used for indexing.
- Curly braces are used for loops and if statements.
- Largely ignores white spaces.

# Appendix - RStudio interface

## Script

Where you write your code. Just like a do file.

## Console

Where your results and messages will be displayed. But you can also type commands directly into the console, as in Stata.

## Environment

What's in R's memory.

## The 4th pane

Can display different things, including plots you create, packages loaded and help files.

# Appendix - Matrices

A matrix is a bi-dimensional object composed by one or more vectors of the same type.

Type the following code to test two different ways of creating matrices

```
# Matrix created by joining two vectors:
```

```
m1 <- cbind(v1,v1)
```

```
# Matrix using the
```

```
m2 <- matrix(c(1,1,2,3,5,8), ncol = 2)
```

# Appendix - Matrices

Now use the following code to check the elements of these matrices by indexing

```
# Matrix indexing: typing matrix[i,j] will give you  
# the element in the ith row and jth column of that matrix  
#m2[1,2]  
  
# Matrix indexing: typing matrix[i,] will give you the  
# ith row of that matrix  
m1[1,]  
  
# Matrix indexing: typing matrix[,j] will give you the  
# jth column of that matrix (as a vector)  
m1[,2]
```

# Appendix - Advanced types of data - Factors

## Factors

Create a factor vector using the following code

```
# Basic factor vector
num_vec <- c(1,2,2,3,1,2,3,3,1,2,3,3,1)
fac_vec <- factor(num_vec)

# A bit fancier factor vector
fac_vec <- factor(num_vec, labels=c("A", "B", "C"))

# Change labels
levels(fac_vec) = c('One', 'Two', 'Three')
```

# Appendix - Numbers and integers

Two scalars, one with a round number the other with a fractional part:

```
# a numeric scalar with an integer number  
int <- 13  
num <- 12.99
```

# Appendix - Numbers and integers

Now we can see the objects classes with the `class()` function and test it with the `is.integer()` and `is.numeric()` functions.

```
# you can see the number's format using the class function:
```

```
class(int)
```

```
## [1] "numeric"
```

```
class(num)
```

```
## [1] "numeric"
```

```
is.integer(int)
```

```
## [1] FALSE
```

```
is.numeric(int)
```

```
## [1] TRUE
```



# Appendix - Numbers and integers

## Numbers and integers

We can, however, coerce objects into different classes. We just need to be careful because the result might not be what we're expecting.

Use the `as.integer()` and `round()` functions on the `num` object to see the difference:

```
as.integer(num)
```

```
## [1] 12
```

```
# and
```

```
round(num)
```

```
## [1] 13
```