

# Introduction I - R basics

## R for Advanced Stata Users

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DIME Analytics

The World Bank | [WB Github](#)

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# Installation

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## Installation

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

## Instructions

- Please visit (<https://cran.r-project.org>) and select a Comprehensive R Archive Network (CRAN) mirror close to you.
- If you're in the US, you can directly visit the mirror at Berkeley University at (<https://cran.cnr.berkeley.edu>).
- We also strongly suggest installing R studio. You can get it in (<https://www.rstudio.com/>), but you need to install R first.

# Introduction

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# Introduction



These training sessions will offer a quick introduction to R, its amazing features and why it is so much better than Stata.

# Introduction



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

The next sessions will include:

- **Introduction to R part II**
- **Data processing**
- **Data visualization**
- **Exploratory analysis**
- **Geospatial data and geospatial analysis in R**

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



## R vs Stata

Some advantages of R over Stata:

- It is less specialized:
  - More flexibility when programming.
  - Many more functionalities.
- 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.
- It is waaaay cooler in general.





Some possible disadvantages of R:

- Higher cost of entry than Stata for learning how to use it.
- Stata is more specialized:
  - Certain common tasks are simpler in Stata.
- 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*).



Here are some other advantages:

- R is a free and open source software!
- It allows you to have several datasets open simultaneously.
- 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 RStudio.
- You can create interactive dashboards and online applications with the Shiny package.



But Python is even more flexible and has more users than R, so why should I bother to learn R?

- Despite being super popular for data science, Python has fewer libraries developed for econometrics.
- Python is a bit harder to set up and get started.
- It can be a harder to find help only for statistics and econometrics in Python than in R, especially for beginners.

# Getting started

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

## Exercise 1: Import data

1. 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`
2. The file should be in `GitHub/dime-r-training/DataWork/DataSets/Final/whr_panel.csv`.
3. Assign the name `whr` to the dataset on the import window.

# Getting started



# Getting started



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",2017,9,7.28399991989136,1.494387269  
"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

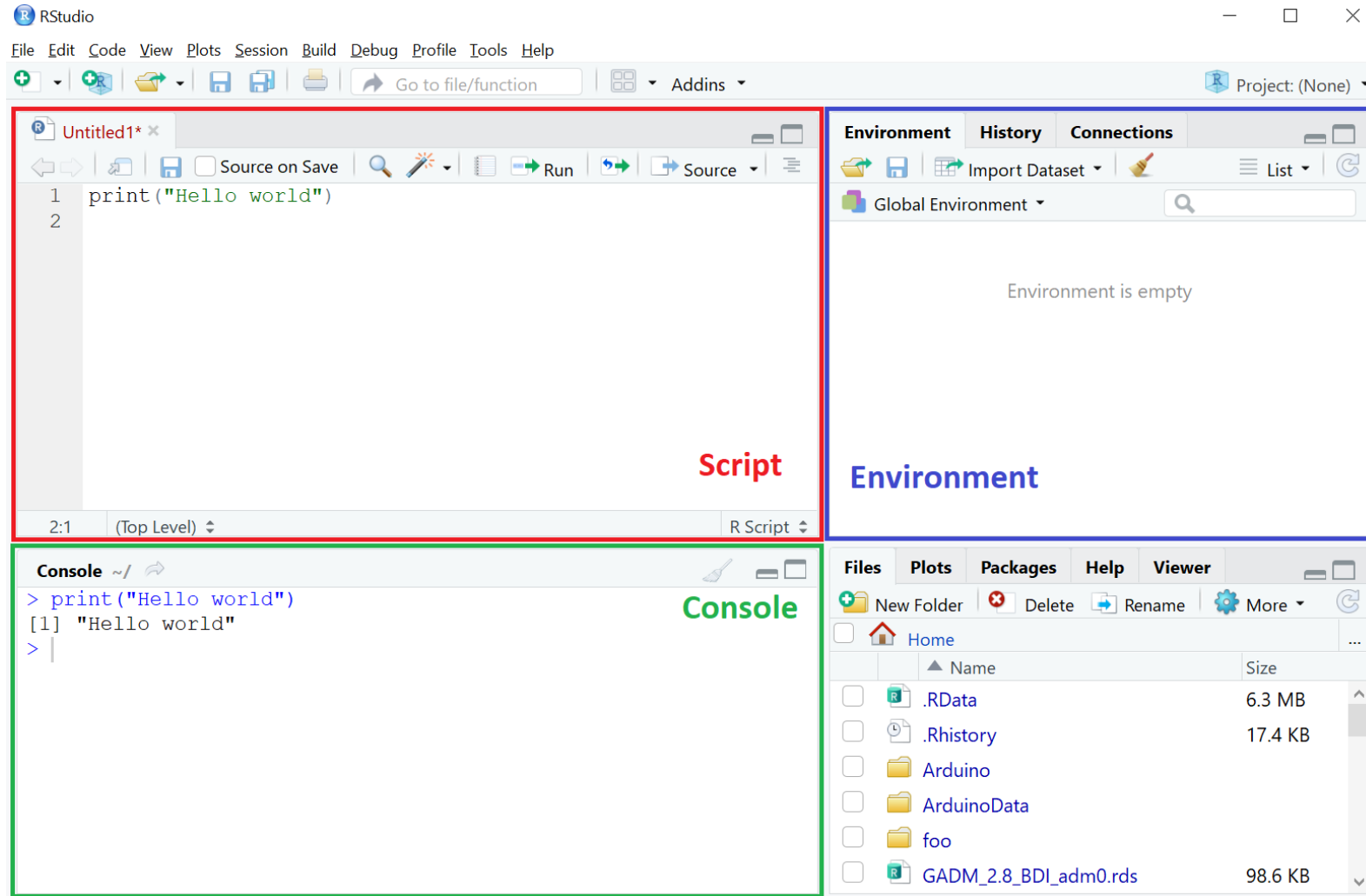
Import Cancel

# RStudio interface

---



# RStudio interface



# RStudio interface



RStudio

File Edit Code View Plots Session Build Debug Profile Tools Help

+ Addins Go to file/function Project: (None)

Untitled1\* x whr x

Filter

	country	region	year	happy_rank	happy_sc
1	Norway	Western Europe	2017	1	
2	Denmark	Western Europe	2017	2	
3	Iceland	Western Europe	2017	3	
4	Switzerland	Western Europe	2017	4	
5	Finland	Western Europe	2017	5	
6	Netherlands	Western Europe	2017	6	
7	Canada	North America	2017	7	

Showing 1 to 8 of 469 entries

Environment History Connections

Global Environment

Data

whr 469 obs. of 12 variables

Console ~/

```
> whr <- read.csv("~/GitHub/dime-r-training/DataWork/DataSets/Final/whr_panel.csv")
> View(whr)
> |
```

Files Plots Packages Help Viewer

New Folder Delete Rename More

Home

	Name	Size
<input type="checkbox"/>	.RData	6.3 MB
<input type="checkbox"/>	.Rhistory	17.4 KB
<input type="checkbox"/>	Arduino	
<input type="checkbox"/>	ArduinoData	
<input type="checkbox"/>	foo	
<input type="checkbox"/>	GADM_2.8_BDI_adm0.rds	98.6 KB

# RStudio interface

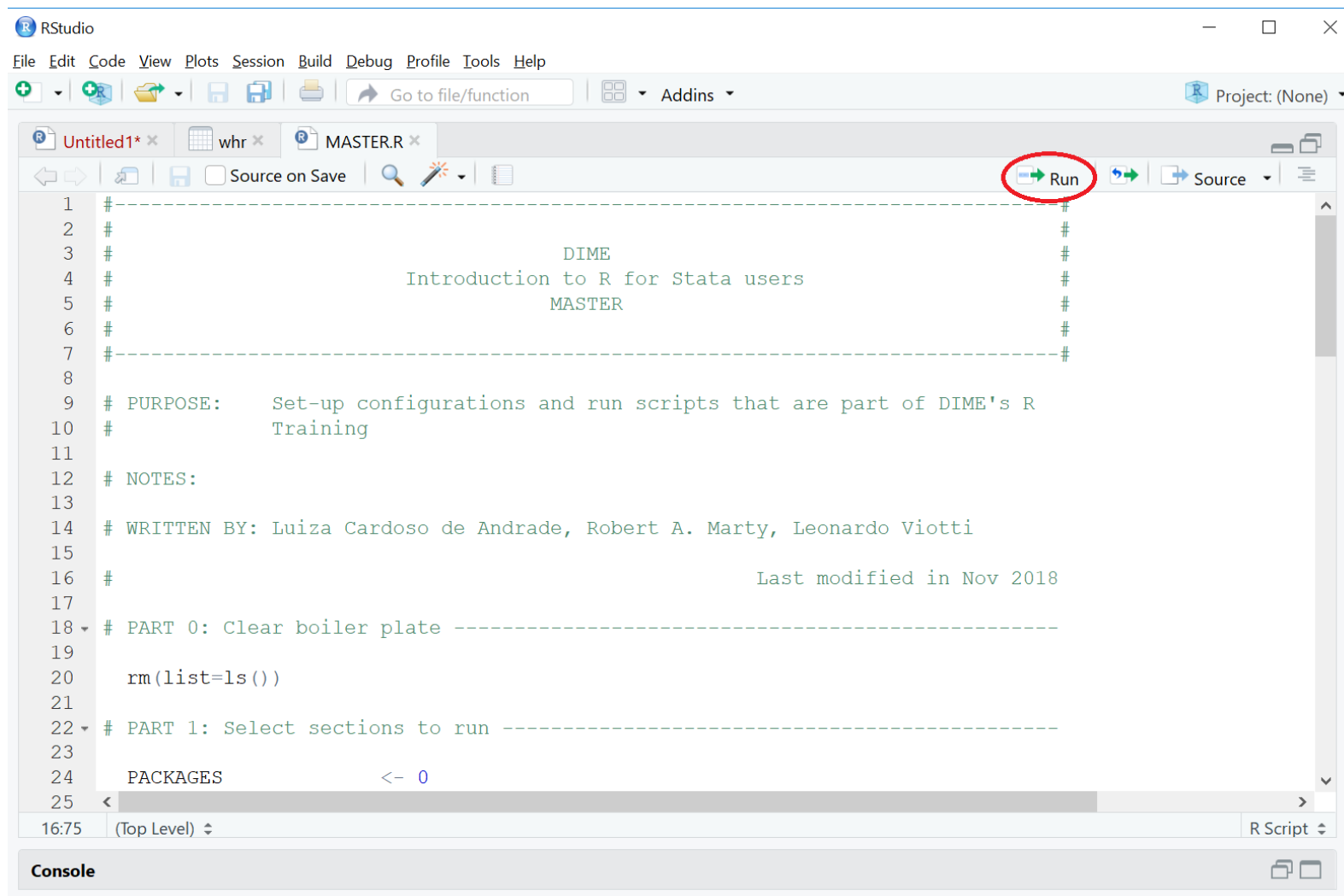


The screenshot displays the RStudio application window. At the top is a menu bar with options: File, Edit, Code, View, Plots, Session, Build, Debug, Profile, Tools, and Help. Below the menu is a toolbar with icons for file operations and a search bar labeled 'Go to file/function'. The main workspace shows three open files: 'Untitled1\*', 'whr', and 'MASTER.R'. The 'MASTER.R' file is active, showing R code with line numbers 1 through 25. The code includes a header section with dashed lines, a purpose statement, notes, and two parts of a script. The console at the bottom is currently empty and labeled 'Console'.

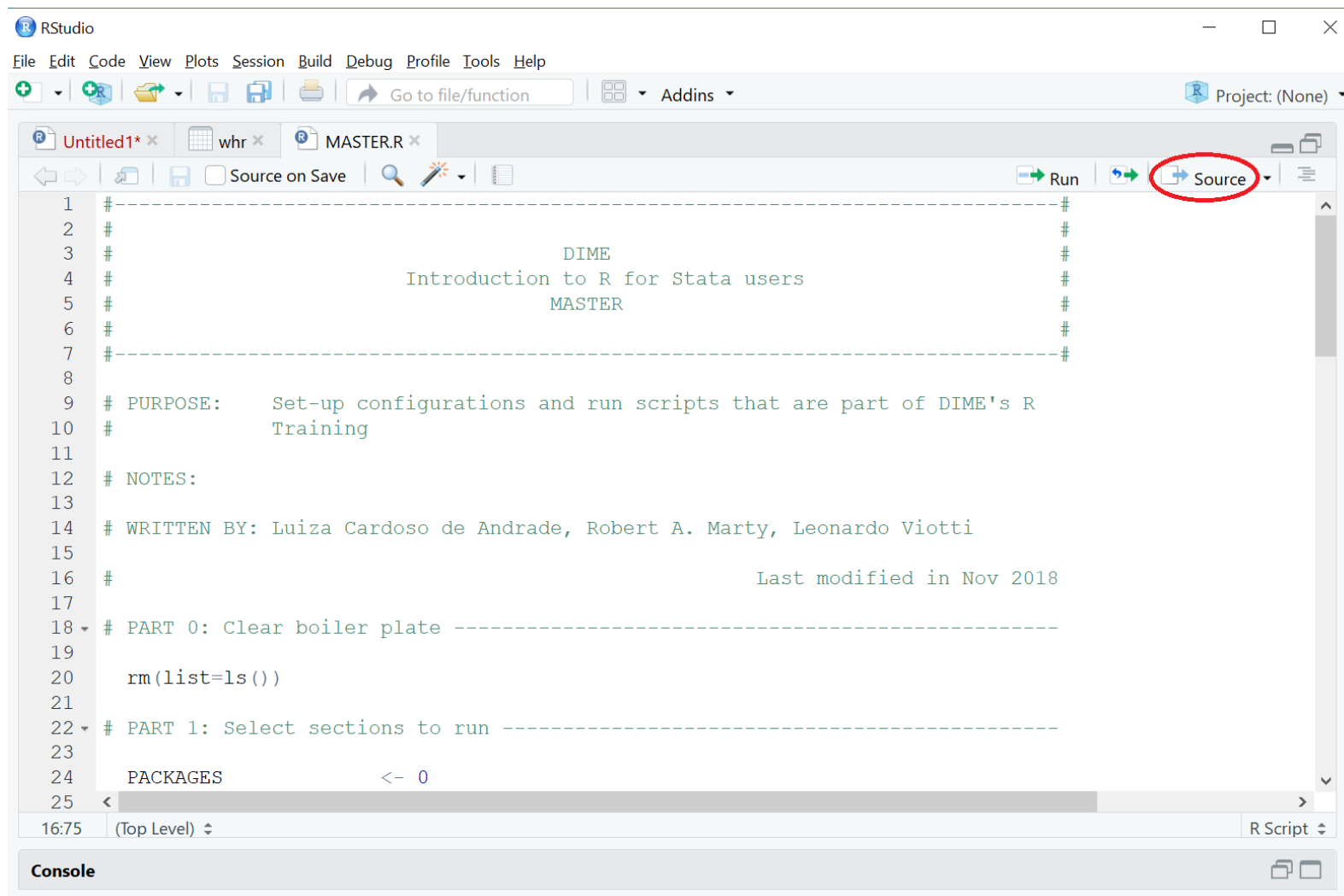
```
1 #-----#
2 #
3 #               DIME
4 #       Introduction to R for Stata users
5 #               MASTER
6 #-----#
7 #-----#
8
9 # PURPOSE:   Set-up configurations and run scripts that are part of DIME's R
10 #           Training
11
12 # NOTES:
13
14 # WRITTEN BY: Luiza Cardoso de Andrade, Robert A. Marty, Leonardo Viotti
15
16 #                               Last modified in Nov 2018
17
18 # PART 0: Clear boiler plate -----
19
20   rm(list=ls())
21
22 # PART 1: Select sections to run -----
23
24   PACKAGES           <- 0
25 <
```

16:75 (Top Level) R Script

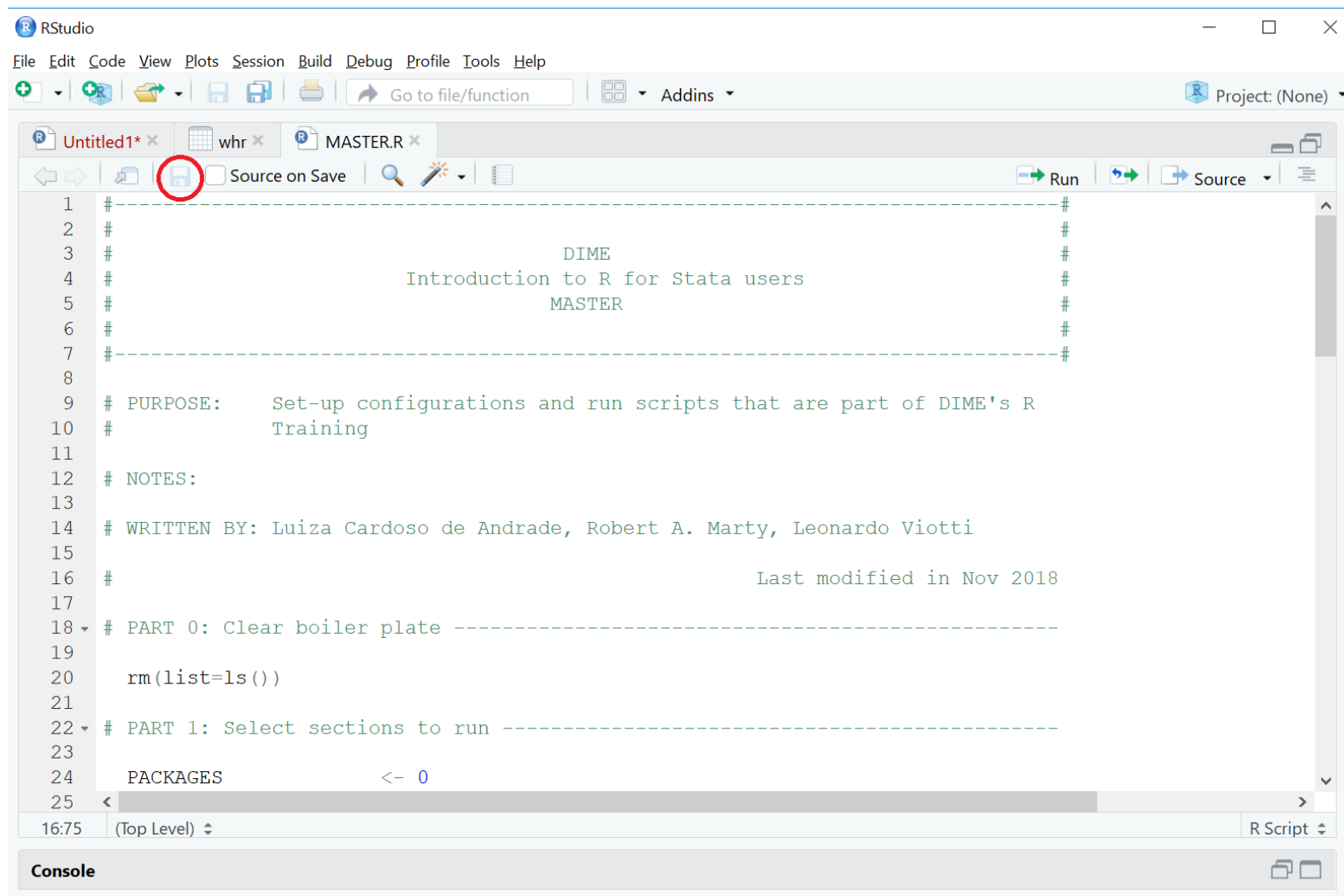
# RStudio interface



# RStudio interface



# 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.**





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

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



- 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**.



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 to explore the data:

```
# We can use the function View() to browse the whole data  
View(whr)  
  
# Alternatively we can print the first 6 obs. with head()  
head(whr)
```

# Data in R



RStudio

File Edit Code View Plots Session Build Debug Profile Tools Help

+ Addins Go to file/function Project: (None)

Untitled1\* whr MASTER.R

Filter

	country	region	year	happy_rank	happy_score	gdp_pc	family	health	freedom
1	Norway	Western Europe	2017	1	7.537	1.61646318	1.5335236	0.796666503	0.6354225
2	Denmark	Western Europe	2017	2	7.522	1.48238301	1.5511216	0.792565525	0.6260067
3	Iceland	Western Europe	2017	3	7.504	1.48063302	1.6105740	0.833552122	0.6271626
4	Switzerland	Western Europe	2017	4	7.494	1.56497955	1.5169117	0.858131289	0.6200705
5	Finland	Western Europe	2017	5	7.469	1.44357193	1.5402467	0.809157670	0.6179508
6	Netherlands	Western Europe	2017	6	7.377	1.50394464	1.4289392	0.810696125	0.5853844
7	Canada	North America	2017	7	7.316	1.47920442	1.4813490	0.834557652	0.6111009
8	New Zealand	Australia and New Zealand	2017	8	7.314	1.40570605	1.5481951	0.816759706	0.6140621
9	Sweden	Western Europe	2017	9	7.284	1.49438727	1.4781622	0.830875158	0.6129241
10	Australia	Australia and New Zealand	2017	10	7.284	1.48441494	1.5100420	0.843886793	0.6016073
11	Israel	Middle East and Northern Africa	2017	11	7.213	1.37538242	1.3762900	0.838404000	0.4059886
12	Costa Rica	Latin America and Caribbean	2017	12	7.079	1.10970628	1.4164037	0.759509265	0.5801316
13	Austria	Western Europe	2017	13	7.006	1.48709726	1.4599450	0.815328419	0.5677661
14	United States	North America	2017	14	6.993	1.54625928	1.4199206	0.774286628	0.5057405
15	Ireland	Western Europe	2017	15	6.977	1.53570664	1.5582211	0.809782624	0.5731103

Showing 1 to 16 of 469 entries

Console



```
head(whr)
```

```
##      country      region year happiness_rank happiness_score
## 1 Switzerland Western Europe 2015           1           7.587
## 2    Iceland Western Europe 2015           2           7.561
## 3    Denmark Western Europe 2015           3           7.527
## 4     Norway Western Europe 2015           4           7.522
## 5     Canada North America 2015           5           7.427
## 6     Finland Western Europe 2015           6           7.406
## economy_gdp_per_capita health_life_expectancy freedom
## 1           1.39651           0.94143 0.66557
## 2           1.30232           0.94784 0.62877
## 3           1.32548           0.87464 0.64938
## 4           1.45900           0.88521 0.66973
## 5           1.32629           0.90563 0.63297
## 6           1.29025           0.88911 0.64169
```



Now, let's try some simple manipulations. First, assume we're only interested in data of the year 2015.

## Exercise 2: Subset the data

1. Subset the data set, keeping only observations where variable `year` equals `2015`.

```
# To do that we'll use the subset() function  
subset(whr, year = 2015)
```

1. Then, look again at the first 6 observations

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



```
head(whr)
```

```
##      country      region year happiness_rank happiness_score
## 1 Switzerland Western Europe 2015           1           7.587
## 2   Iceland Western Europe 2015           2           7.561
## 3   Denmark Western Europe 2015           3           7.527
## 4    Norway Western Europe 2015           4           7.522
## 5    Canada North America 2015           5           7.427
## 6    Finland Western Europe 2015           6           7.406
## economy_gdp_per_capita health_life_expectancy freedom
## 1           1.39651           0.94143 0.66557
## 2           1.30232           0.94784 0.62877
## 3           1.32548           0.87464 0.64938
## 4           1.45900           0.88521 0.66973
## 5           1.32629           0.90563 0.63297
## 6           1.29025           0.88911 0.64169
```



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

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

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

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





## Exercise 3: Create an object

Create a new dataset, called `whr2015`, that is a subset of the `whr` data set containing only data from the year 2015.

```
# Using the same function but now assigning it to an object  
whr2015 ← subset(whr, year = 2015)  
  
# Display the 5 first obs. of the new data  
head(whr2015)  
  
# Notice that we still have the original data set intact  
head(whr)
```



```
head(whr2015)
```

```
##      country      region year happiness_rank happiness_score
## 1 Switzerland Western Europe 2015             1           7.587
## 2   Iceland Western Europe 2015             2           7.561
## 3   Denmark Western Europe 2015             3           7.527
## 4    Norway Western Europe 2015             4           7.522
## 5    Canada North America 2015             5           7.427
## 6    Finland Western Europe 2015             6           7.406
```



```
head(whr)
```

```
##      country      region year happiness_rank happiness_score
## 1 Switzerland Western Europe 2015             1           7.587
## 2    Iceland Western Europe 2015             2           7.561
## 3    Denmark Western Europe 2015             3           7.527
## 4     Norway Western Europe 2015             4           7.522
## 5     Canada North America 2015             5           7.427
## 6     Finland Western Europe 2015             6           7.406
```

# Data in R



You can also see that your environment pane now has two objects:

A screenshot of the RStudio Environment pane. The pane has tabs for 'Environment', 'History', and 'Connections'. Below the tabs is a toolbar with icons for file operations and a search bar. The main area shows the 'Global Environment' with a search bar and a table of objects. The table has two rows: 'whr' with 469 observations and 12 variables, and 'whr2015' with 157 observations and 12 variables. Each row has a play button icon on the left and a calendar icon on the right.

Data		
▶ whr	469 obs. of 12 variables	
▶ whr2015	157 obs. of 12 variables	



## Two important concepts to take note:

1. In R, if you want to change your data, you need to **store it in an object**.
2. It is possible to simply replace the original data. This happens if you assign the new object to the same name as the original.
3. 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.

# 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).
- 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 the next session.

# 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.



## What is an object?

- An object is like a global 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 it.



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**



## 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
```

You can use brackets for indexing

```
# Print the 4th element of the vector  
v2[4]
```

```
## [1] 4
```



## Vectors

To R, each of the columns of `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`

Type the following code:

```
# 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
```



## Data Frames

The `whr` and `whr2015` objects are both data frames. You can also construct a new data frame from scratch by **combining vectors with the same number of element**.

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
```



## 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 line of whr  
whr[45,]
```

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



## 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]
```

```
## [1] "Oman"
```





## 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.



## Lists

```
# Check the contents of lst  
print(lst)
```

```
## [[1]]  
## [1] 1 2 3 4 5  
##  
## [[2]]  
##   v1 v2  
## 1  1  1  
## 2  2  2  
## 3  3  3  
## 4  4  4  
## 5  5  5  
##  
## [[3]]  
## [1] 45
```

# 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, numeric, factor 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).



## 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 in order of importance:

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

Now print them to check them out.



## Strings

### Exercise 5: Concatenate strings

1. Create a scalar (a vector of one element) containing the phrase "is cooler than" and call it `str_scalar`.
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)
```



## Strings

```
### Using the paste function to combine strings
```

```
# Scalar
```

```
str_scalar ← "is cooler than"
```

```
# Using the paste() function
```

```
paste(str_vec[1], str_scalar, str_vec[5])
```

```
## [1] "R is cooler than Stata"
```

# 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

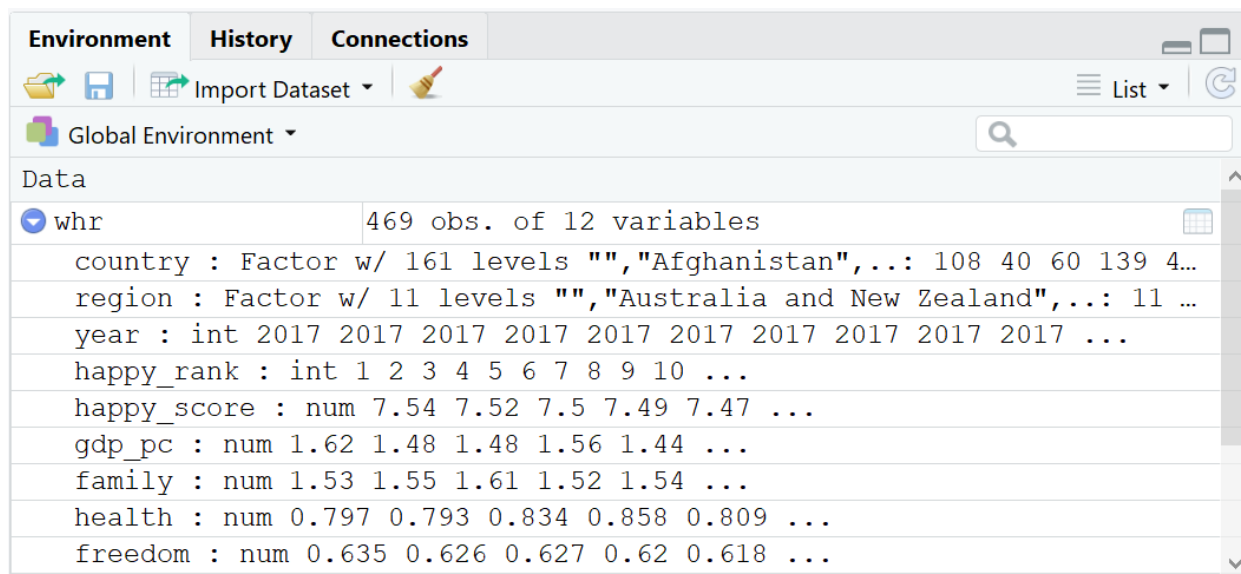
Booleans are **logical binary variables**, accepting either `TRUE` or `FALSE` as values. They are automatically generated when performing logical operations.

# Advanced types of data



## Factors

In `whr`, we can see that `country` and `region` are factor variables. In your environment panel you can see the information about the types of every variable in the `whr` dataframe, and for factors you can see the number of levels (unique values).



The screenshot shows the RStudio Environment panel with the 'whr' dataset selected. The panel displays the following information:

Environment	History	Connections
Global Environment		
Data		
whr	469 obs. of 12 variables	
country : Factor w/ 161 levels "", "Afghanistan", ...: 108 40 60 139 4...		
region : Factor w/ 11 levels "", "Australia and New Zealand", ...: 11 ...		
year : int 2017 2017 2017 2017 2017 2017 2017 2017 2017 2017 2017 ...		
happy_rank : int 1 2 3 4 5 6 7 8 9 10 ...		
happy_score : num 7.54 7.52 7.5 7.49 7.47 ...		
gdp_pc : num 1.62 1.48 1.48 1.56 1.44 ...		
family : num 1.53 1.55 1.61 1.52 1.54 ...		
health : num 0.797 0.793 0.834 0.858 0.809 ...		
freedom : num 0.635 0.626 0.627 0.62 0.618 ...		



## Factors

We'll learn how to deal with factors in detail on the next session, since they are very 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**



## Booleans

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

- Whenever you're using an `if` statement in Stata, you're implicitly using boolean data.
- The difference is that in R, this can be done in 2 steps.
- 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 the objects:
```

```
print(boolean_true)
```

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

```
print(boolean_false)
```

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



## Booleans

### Exercise 6:

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

```
# Create vector  
bool_vec ← whr$happy_rank < mean(whr$happy_rank)
```

```
## Warning in mean.default(whr$happy_rank): argument is not numeric or logical:  
## returning NA
```

```
# See the 6 first elements of the vector  
head(bool_vec)
```

```
## logical(0)
```



## Booleans

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

### Exercise 7:

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

```
whr$rank_low ← 0
```

1. Use `bool_vec` to index the lines of the `income_low` column and replace all observations that meet the condition with the value 1.

```
whr$rank_low[bool_vec] ← 1
```



## Booleans

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

```
# Replace with 1 those obs that meet the condition
whr$rank_low [bool_vec] ← 1
# is the same as
whr$rank_low [whr$happy_rank < mean(whr$happy_rank)] ← 1
```

```
## Warning in mean.default(whr$happy_rank): argument is not numeric or logical:
## returning NA
```

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

# 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
```

# 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>

# 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/>



## 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/>

Thank you!

# Appendix

---



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.





## 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)
```



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]
```



## 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
```

Did you notice anything strange? That happens because the default way R stores numbers is *numeric*, which is equivalent to *double* in Stata.



## 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
```