

# R – a statistical programming language

## Installation and Usage

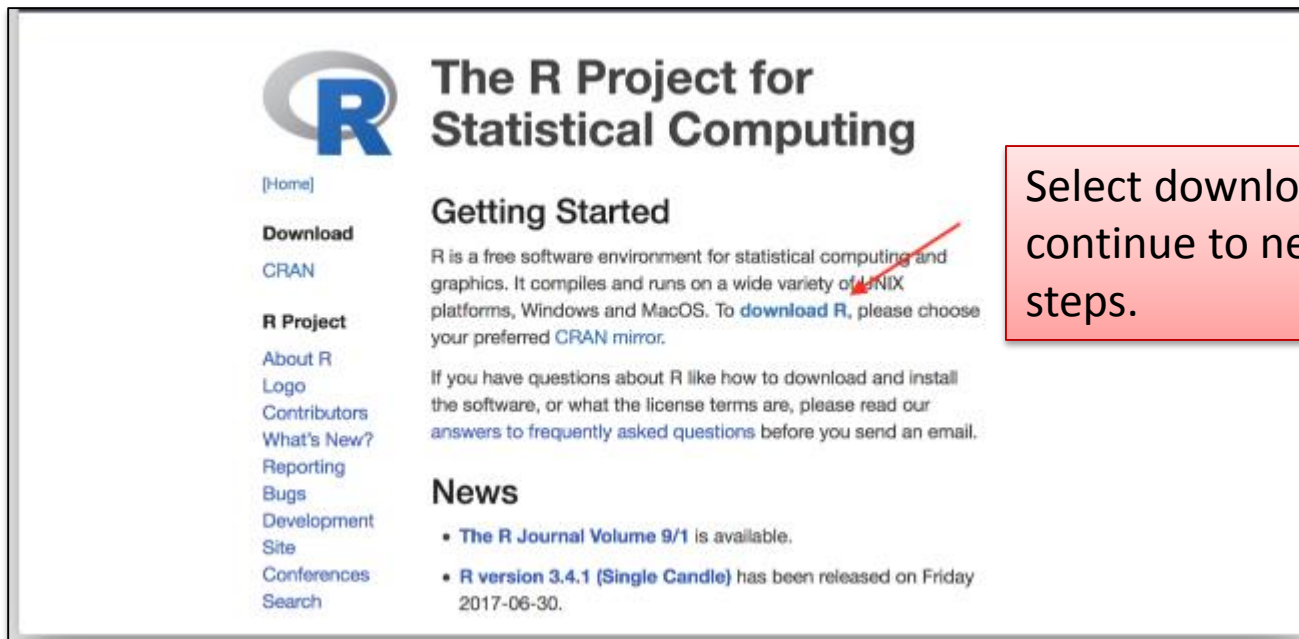
# Download and Install

# R and RStudio

- To work with R install 2 software packages:
  - **R environment**: provides the environment to execute R commands and scripts.
  - **RStudio**: An IDE (interface) to facilitate users working with R.

# Download and Install R(1)

- <https://www.r-project.org/>



The screenshot shows the R Project website homepage. The main heading is "The R Project for Statistical Computing". Below it, there is a "Getting Started" section with a red arrow pointing to the "download R" link in the text: "To download R, please choose your preferred CRAN mirror." A red callout box on the right contains the text: "Select download to continue to next steps." The left sidebar contains a navigation menu with links like [Home], Download, CRAN, R Project, About R, Logo, Contributors, What's New?, Reporting, Bugs, Development Site, Conferences, and Search.

**The R Project for Statistical Computing**

[Home]

**Download**  
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**Getting Started**

R is a free software environment for statistical computing and graphics. It compiles and runs on a wide variety of UNIX platforms, Windows and MacOS. To **download R**, please choose your preferred CRAN mirror.

If you have questions about R like how to download and install the software, or what the license terms are, please read our answers to frequently asked questions before you send an email.

**News**

- **The R Journal Volume 9/1** is available.
- **R version 3.4.1 (Single Candle)** has been released on Friday 2017-06-30.

Select download to continue to next steps.

# Download and Install R(2)

- Available mirrors

**CRAN Mirrors**

The Comprehensive R Archive Network is available at the following URLs, please choose a location close to you. Some statistics on the status of the mirrors can be found here: [main page](#), [windows release](#), [windows old release](#).

If you want to host a new mirror at your institution, please have a look at the [CRAN Mirror HOWTO](#).

0-Cloud	<a href="https://cloud.r-project.org/">https://cloud.r-project.org/</a>	Automatic redirection to servers worldwide, currently sponsored by Rstudio
	<a href="http://cloud.r-project.org/">http://cloud.r-project.org/</a>	Automatic redirection to servers worldwide, currently sponsored by Rstudio
Algeria	<a href="https://cran.usthb.dz/">https://cran.usthb.dz/</a>	University of Science and Technology Houari Boumediene
	<a href="http://cran.usthb.dz/">http://cran.usthb.dz/</a>	University of Science and Technology Houari Boumediene
Argentina	<a href="http://mirror.feaglp.unlp.edu.ar/CRAN/">http://mirror.feaglp.unlp.edu.ar/CRAN/</a>	Universidad Nacional de La Plata
Australia	<a href="https://cran.csiro.au/">https://cran.csiro.au/</a>	CSIRO
	<a href="http://cran.csiro.au/">http://cran.csiro.au/</a>	CSIRO
	<a href="https://mirror.aarnet.edu.au/pub/CRAN/">https://mirror.aarnet.edu.au/pub/CRAN/</a>	AARNET
	<a href="https://cran.ms.unimelb.edu.au/">https://cran.ms.unimelb.edu.au/</a>	School of Mathematics and Statistics, University of Melbourne

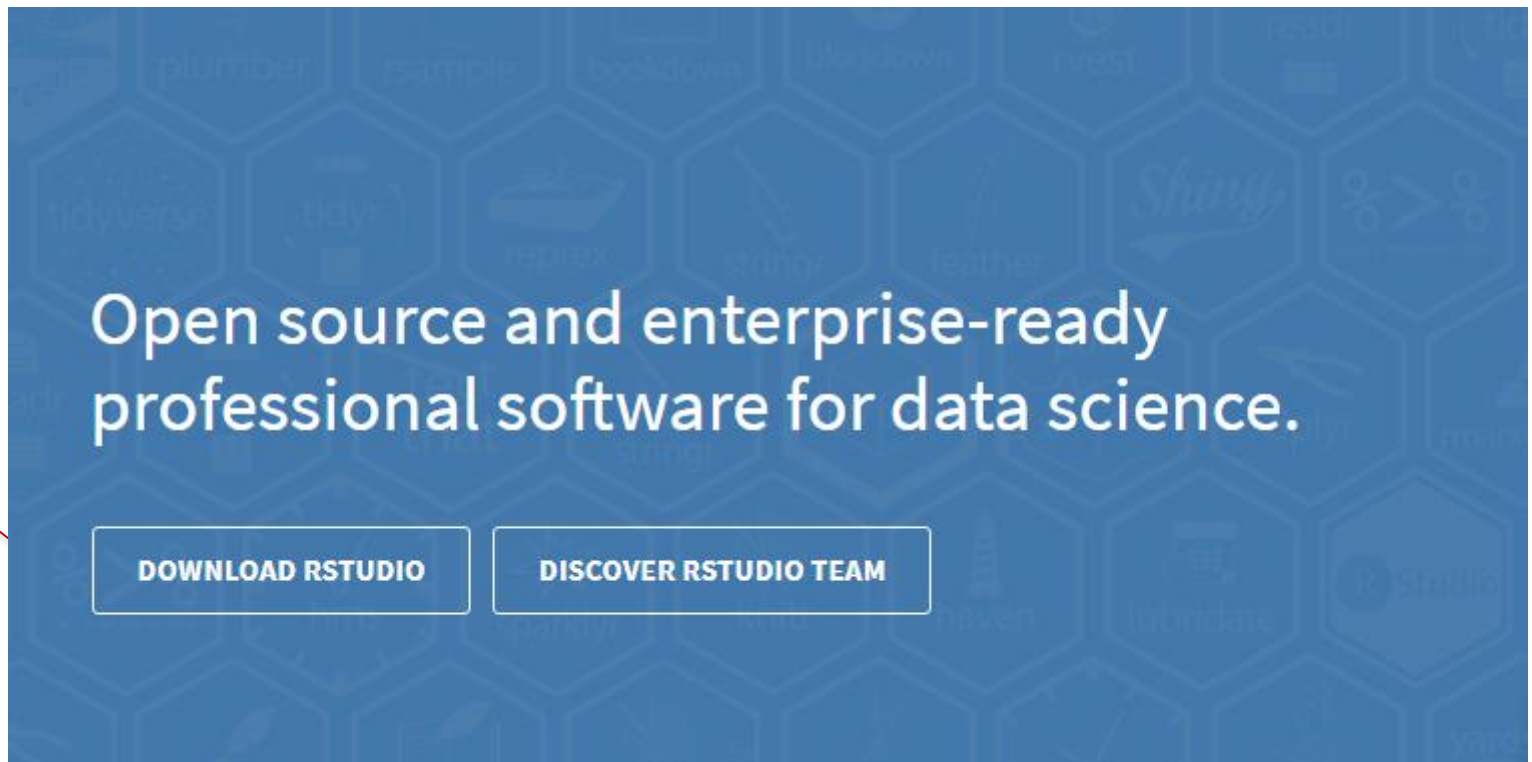
Select  
first  
mirror

# Download and Install R(3)

- Next, select Operating System (e.g. Windows).
- Select *Install R for the first time*.
- Select *Download R for Windows*.

# Download and Install RStudio(1)

- <https://www.rstudio.com/>



# Download and Install RStudio(2)

For 'RStudio Desktop - Open source license' version, scroll down and click the 'Download' button.

The screenshot shows the RStudio website's download page. The browser address bar indicates the URL is <https://www.rstudio.com/products/rstudio/download/>. The page features a navigation menu with links for 'Products', 'Resources', 'Pricing', 'About Us', and 'Blogs'. Below the navigation, there are four columns representing different RStudio products and their licenses:

	RStudio Desktop Open Source License	RStudio Desktop Commercial License	RStudio Server Open Source License	RStudio Server Pro Commercial License
Price	FREE	\$995 per year	FREE	\$9,995 per year
Integrated Tools for R	●	●	●	●
Priority Support		●		●
Access via Web Browser			●	●
Enterprise Security				●
Project				●

A red arrow points from the text box to the 'FREE' price for the RStudio Desktop Open Source License.



# Download and Install RStudio(3)

## Installers for Supported Platforms

Installers	Size	Date
<a href="#">RStudio 1.2.5001 - Ubuntu 18/Debian 10 (64-bit)</a>	105.43 MB	2019-09-19
<a href="#">RStudio 1.2.5001 - Debian 9 (64-bit)</a>	105.70 MB	2019-09-19
<a href="#">RStudio 1.2.5001 - Fedora 28/Red Hat 8 (64-bit)</a>	120.90 MB	2019-09-19
<a href="#">RStudio 1.2.5001 - macOS 10.12+ (64-bit)</a>	126.86 MB	2019-09-19
<a href="#">RStudio 1.2.5001 - SLES/OpenSUSE 12 (64-bit)</a>	99.04 MB	2019-09-19
<a href="#">RStudio 1.2.5001 - OpenSUSE 15 (64-bit)</a>	107.12 MB	2019-09-19
<a href="#">RStudio 1.2.5001 - Fedora 19/Red Hat 7 (64-bit)</a>	120.27 MB	2019-09-19
<a href="#">RStudio 1.2.5001 - Ubuntu 14/Debian 8 (64-bit)</a>	96.93 MB	2019-09-19
<a href="#">RStudio 1.2.5001 - Windows 10/8/7 (64-bit)</a>	149.83 MB	2019-09-19
<a href="#">RStudio 1.2.5001 - Ubuntu 16 (64-bit)</a>	104.88 MB	2019-09-19

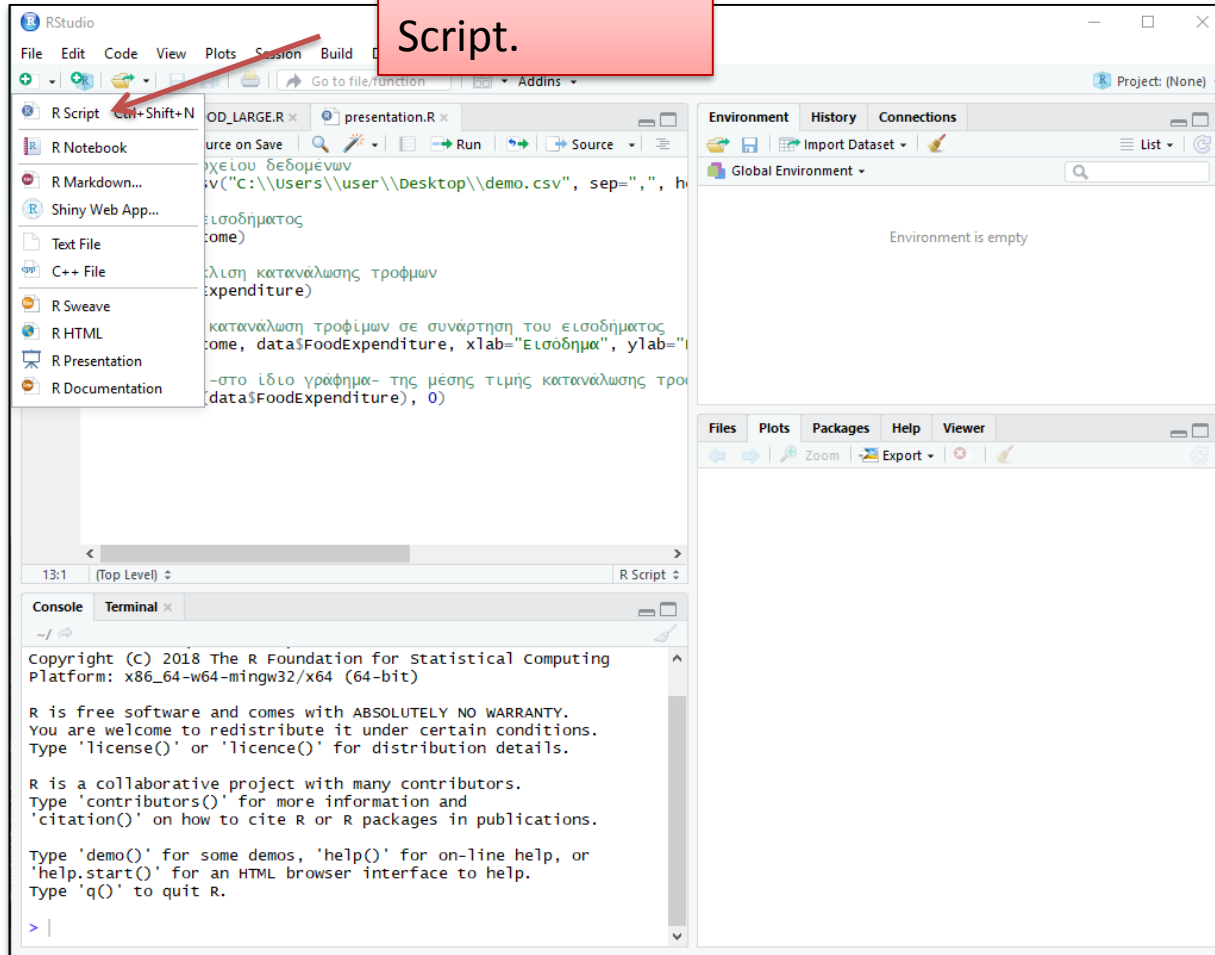
e.g. Installer  
for Windows



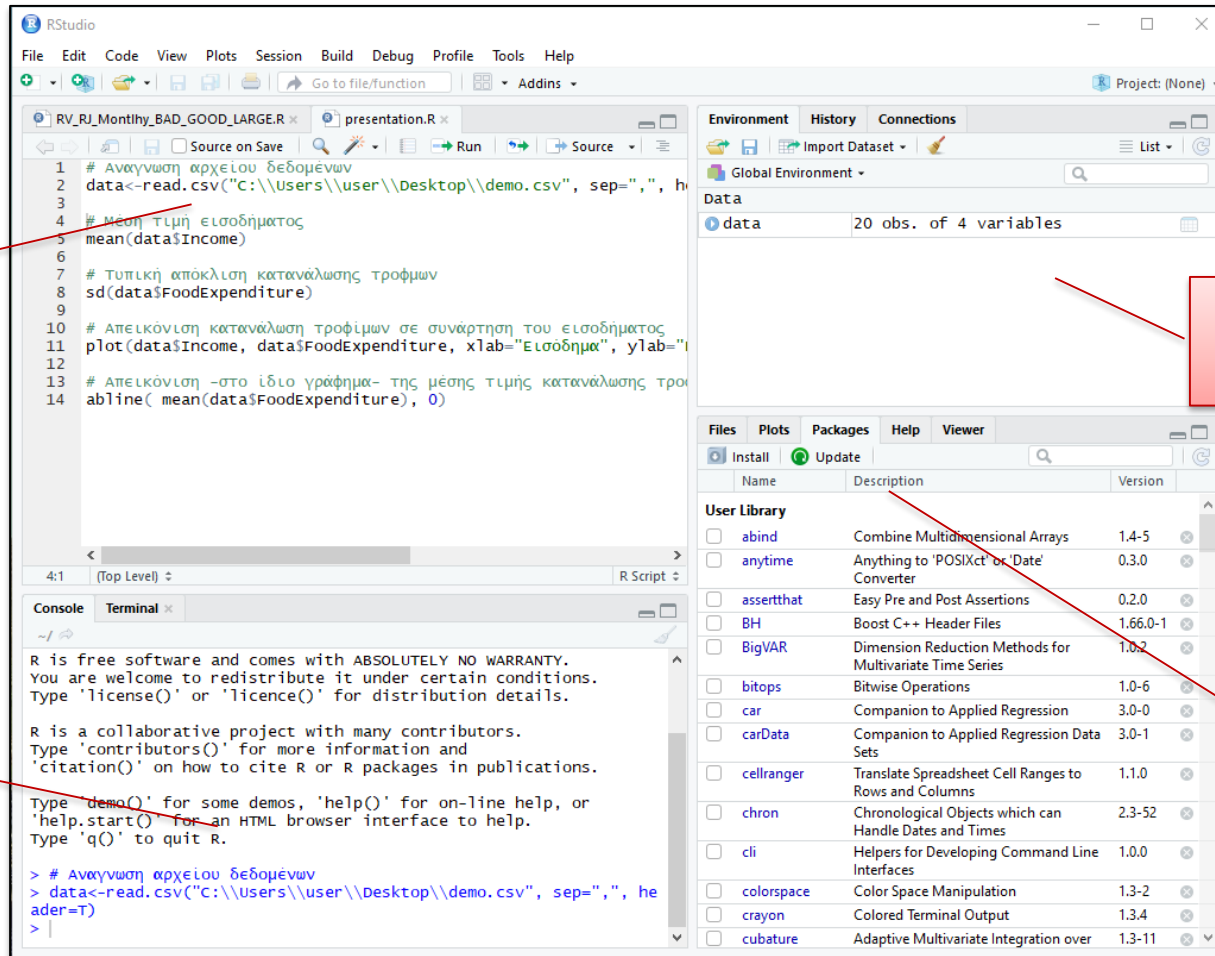
# RStudio Interface

# Rstudio Interface

Create a new R Script.



# Rstudio Panes



Editor

Environment

Console

Plots,  
Packages,  
Help

# R sessions in RStudio (Basic Examples)

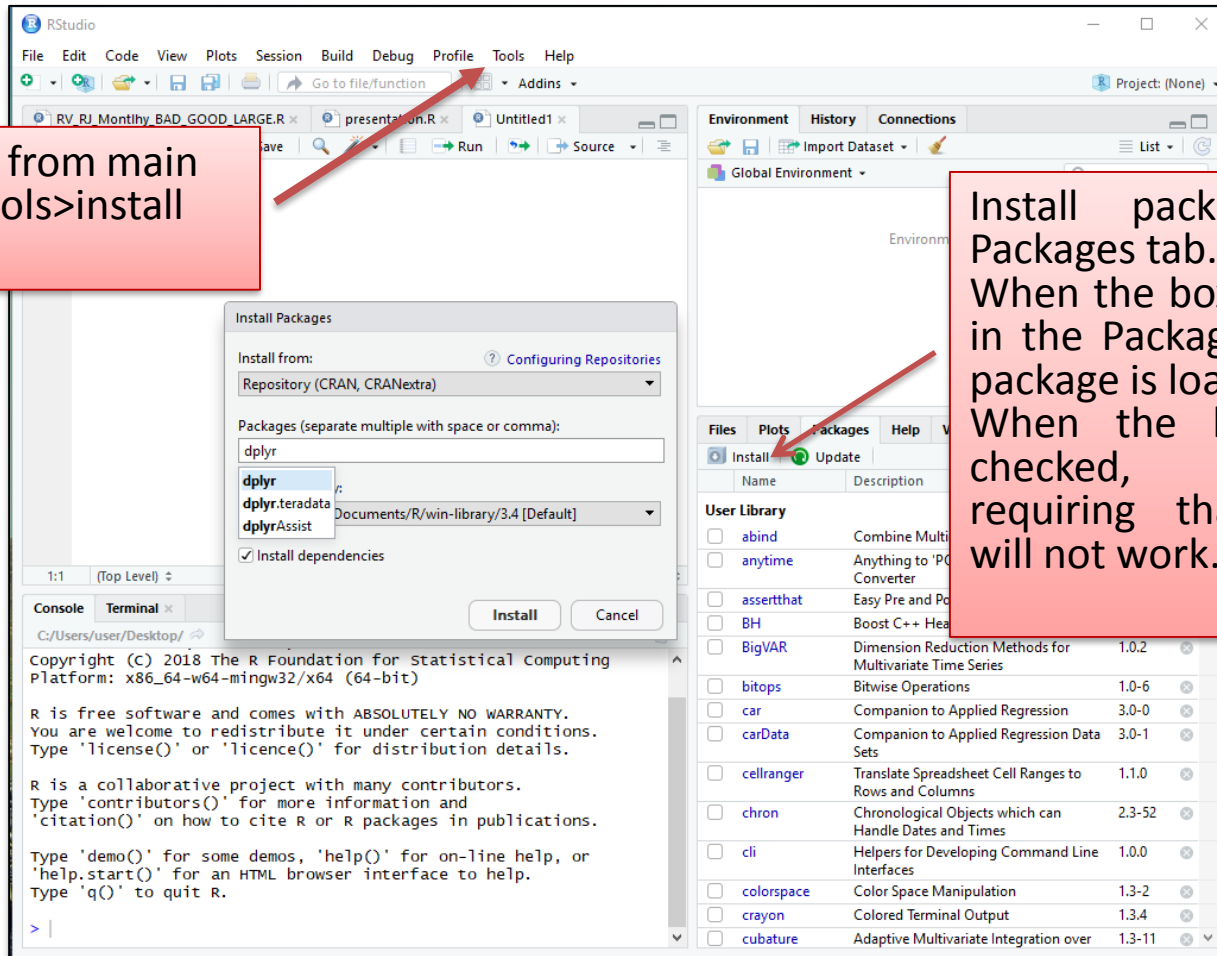
- An R session starts R and allows us to type command lines.
- Execute R code directly from the console or save commands as script files (plain text files that contain R code).
- A Package in R is a collection of functions, compiled code, data.
- Many packages are already installed.
- Install additional packages into Rstudio with two different methods.
- Packages allow us to perform specific functions.

# R libraries

# R libraries

- Make a package's contents available to use in the current R session.
- To use the package for a specific functionality we use the function `library()`.
- `library()` function loads the package into memory.
- We can load as many libraries as we need.
- `library(e1071)` → Naïve Bayes classifier.
- `library(stats)` → k-means clustering.
- `library(randomForest)` → Random Forest classification and regression.

# Install Packages - GUI method



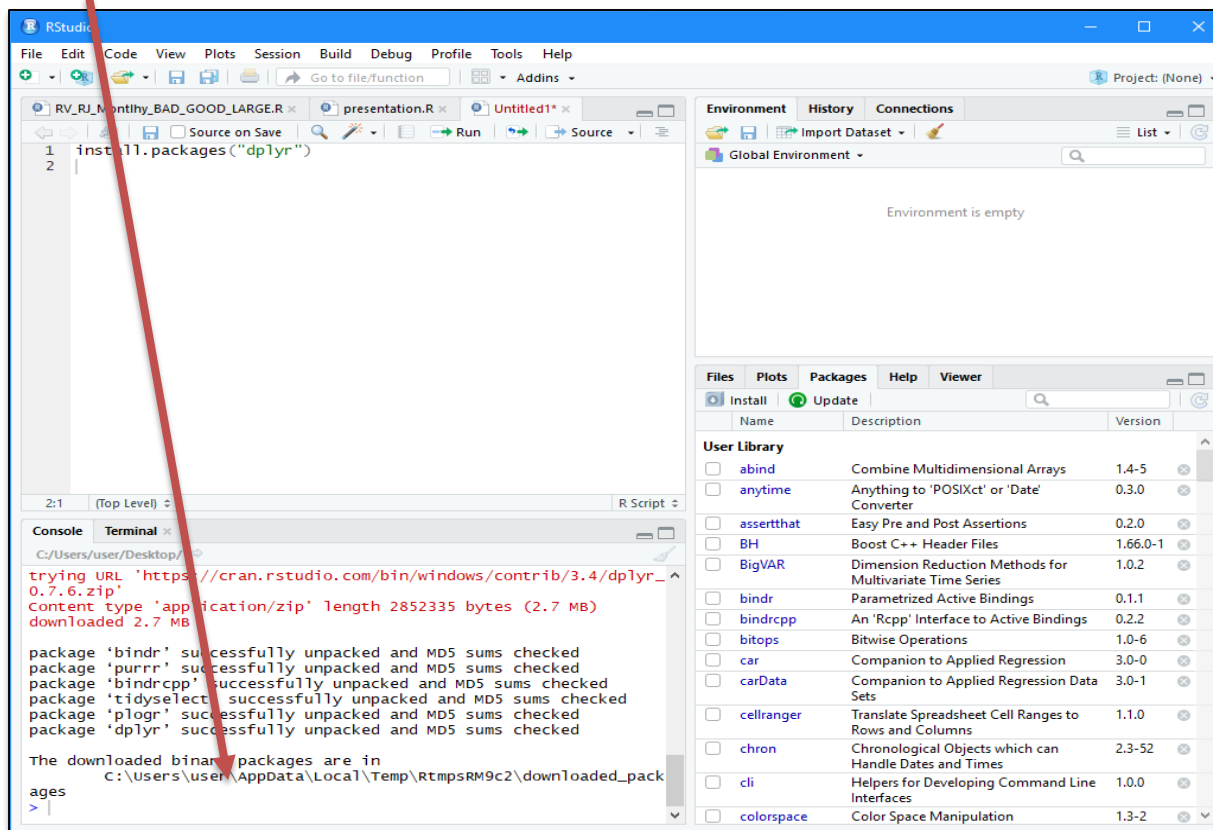
Install packages from main menu. Select Tools>install packages.

Install packages from Packages tab. When the box is checked in the Packages Tab, the package is loaded. When the box is not checked, commands requiring that package will not work.



# Install Packages - Console method

- The `install.packages()` function.



The screenshot shows the RStudio interface with the following components:

- Code Editor:** Contains the R script `install.packages("dplyr")`.
- Environment:** Shows "Global Environment" and "Environment is empty".
- Packages Panel:** Lists installed and available packages. The "User Library" section includes packages like `abind`, `anytime`, `assertthat`, `BH`, `BigVAR`, `bindr`, `bindrcpp`, `bitops`, `car`, `carData`, `cellranger`, `chron`, `cli`, and `colorspace`.
- Console:** Displays the output of the `install.packages()` function, showing the download of `dplyr` and the successful installation of several dependencies: `bindr`, `purrr`, `bindrcpp`, `tidyselect`, and `plyr`.

```
trying URL 'https://cran.rstudio.com/bin/windows/contrib/3.4/dplyr_0.7.6.zip'
Content type 'application/zip' length 2852335 bytes (2.7 MB)
downloaded 2.7 MB

package 'bindr' successfully unpacked and MD5 sums checked
package 'purrr' successfully unpacked and MD5 sums checked
package 'bindrcpp' successfully unpacked and MD5 sums checked
package 'tidyselect' successfully unpacked and MD5 sums checked
package 'plyr' successfully unpacked and MD5 sums checked
package 'dplyr' successfully unpacked and MD5 sums checked

The downloaded binary packages are in
  c:\users\user\AppData\Local\Temp\RTmpSRM9c2\downloaded_packages
```

# Manage/Use Packages

- `library()`

The screenshot shows the RStudio interface with the following components:

- Source Editor:** Contains three lines of R code:

```
1 install.packages("dplyr")
2 library(dplyr) # data manipulation
3
```
- Environment Panel:** Shows "Global Environment" and "Environment is empty".
- Packages Panel:** Displays a list of installed and available packages. The "User Library" section includes:

Name	Description	Version
<input type="checkbox"/> abind	Combine Multidimensional Arrays	1.4-5
<input type="checkbox"/> anytime	Anything to 'POSIXct' or 'Date' Converter	0.3.0
<input type="checkbox"/> assertthat	Easy Pre and Post Assertions	0.2.0
<input type="checkbox"/> BH	Boost C++ Header Files	1.66.0-1
<input type="checkbox"/> BigVAR	Dimension Reduction Methods for Multivariate Time Series	1.0.2
<input type="checkbox"/> bindr	Parametrized Active Bindings	0.1.1
<input type="checkbox"/> bindrcpp	An 'Rcpp' Interface to Active Bindings	0.2.2
<input type="checkbox"/> bitops	Bitwise Operations	1.0-6
<input type="checkbox"/> car	Companion to Applied Regression	3.0-0
<input type="checkbox"/> carData	Companion to Applied Regression Data Sets	3.0-1
<input type="checkbox"/> cellranger	Translate Spreadsheet Cell Ranges to Rows and Columns	1.1.0
<input type="checkbox"/> chron	Chronological Objects which can Handle Dates and Times	2.3-52
<input type="checkbox"/> cli	Helpers for Developing Command Line Interfaces	1.0.0
<input type="checkbox"/> colorspace	Color Space Manipulation	1.3-2
- Console:** Shows the output of the R script execution:

```
The downloaded binary packages are in
C:\Users\user\AppData\Local\Temp\RtmpsRM9c2\downloaded_packages
> library(dplyr) # data manipulation
Attaching package: 'dplyr'

The following objects are masked from 'package:stats':
  filter, lag

The following objects are masked from 'package:base':
  intersect, setdiff, setequal, union
> |
```

`library()` function to load an *installed* package.

# Using R

# Example Code

```
# Read data from file
data<-read.csv("demo.csv", sep=";", header=T)

# Compute arithmetic mean of Income
mean(data$Income)

# Compute the standard deviation of Food Expenditure
sd(data$FoodExpenditure)

# Plot showing the relation between Food Expenditure and Income
plot(data$Income, data$FoodExpenditure, xlab="Εισόδημα",
ylab="Κατανάλωση τροφίμων")

# Add line -in the same plot- of mean value of Food Expenditure
abline( mean(data$FoodExpenditure), 0)
```

# Run entire script or line by line

The screenshot displays the RStudio environment with a script editor, a console, and a plot window. A red box labeled "Run line-by-line." points to the "Run" button in the toolbar. Another red box labeled "Run entire script." points to the "Source" button. The script in the editor contains the following R code:

```
1 # Αναγνώση αρχείου δεδομένων
2 data<-read.csv("C:\\Users\\user\\Desktop\\demo.csv", sep=";", header=T)
3
4 # Μέση τιμή εισοδήματος
5 mean(data$Income)
6
7 # Τυπική απόκλιση κατανάλωσης τροφίμων
8 sd(data$FoodExpenditure)
9
10 # Απεικόνιση κατανάλωση τροφίμων σε συνάρτηση του εισοδήματος
11 plot(data$Income, data$FoodExpenditure, xlab="Εισόδημα", ylab="Κατανάλωση
12
13 # Απεικόνιση -στο ίδιο γράφημα- της μέσης τιμής κατανάλωσης τροφίμων
14 abline( mean(data$FoodExpenditure), 0)
15
16
17
```

The console shows the execution of the script, including the installation of the 'dplyr' package and the execution of the 'source()' function. The plot window displays a scatter plot of Food Expenditure (Κατανάλωση τροφίμων) on the y-axis (ranging from 5000 to 20000) versus Income (Εισόδημα) on the x-axis (ranging from 2e+04 to 1e+05). A horizontal line is drawn at the mean food expenditure, approximately 9000.

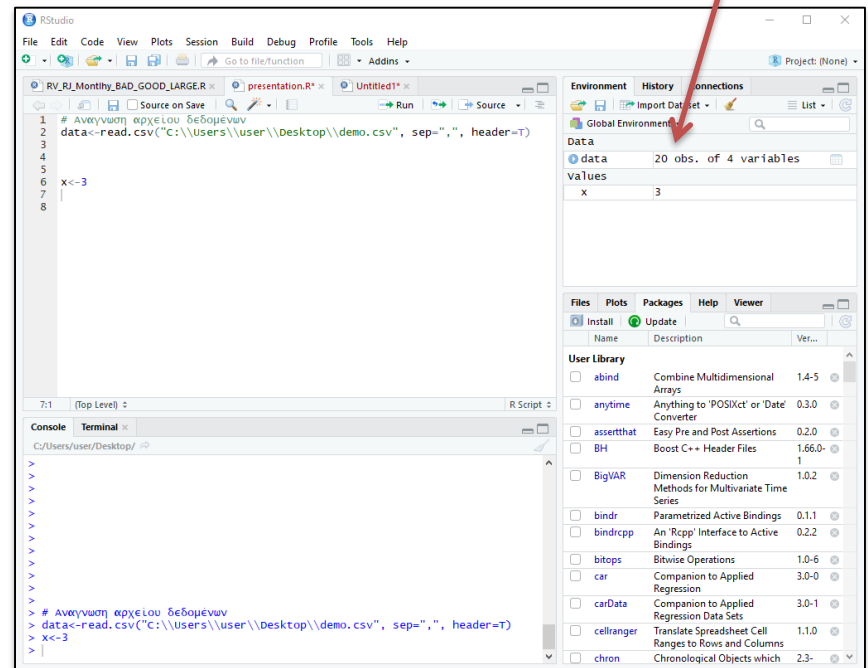
# Type commands in the console

- Execute R language commands by typing them line by line.
- Assign values to variables.
- Example → Declare 2 variables 'x' and 'y' to have values 3 and 2 respectively.
- `>x<-3`
- `>y<-2`
- Type commands directly in the console allows us to see the content of a variable or the structure of a created object.
- `>data[1,c(2,3)]`
- `>head(data, 10)`
- `>tail(data, 15)`

# Environment Pane

- List of every function or symbol that is defined in the Console.
- Datasets loaded into the Console.  
e.g. `data<-read.csv("demo.csv",sep="," ,header=T)`
- OR directly importing datasets to the Environment. The result is the same as if typing the command into the console.

Datasets and variables created.



# Export the graphics created (Plots Tab)

The screenshot displays the RStudio interface. The source editor on the left contains the following R code:

```
1 # Αναγνώση αρχείου δεδομένων
2 data<-read.csv("C:\\Users\\user\\Desktop\\demo.csv", sep=";", header=T)
3
4 # Μέση τιμή εισοδήματος
5 mean(data$Income)
6
7 # Τυπική απόκλιση κατανάλωσης τροφίμων
8 sd(data$FoodExpenditure)
9
10 # Απεικόνιση κατανάλωση τροφίμων σε συνάρτηση του εισοδήματος
11 plot(data$Income, data$FoodExpenditure, xlab="Εισόδημα", ylab="Κατανάλωση
12
13 # Απεικόνιση -στο ίδιο γράφημα- της μέσης τιμής κατανάλωσης τροφίμων
14 abline( mean(data$FoodExpenditure), 0)
15
16
17
```

The console on the bottom left shows the execution of the code, including the loading of the 'dplyr' package and the execution of the 'source()' function.

The Plots tab on the right shows a scatter plot with 'Εισόδημα' (Income) on the x-axis and 'Κατανάλωση τροφίμων' (Food Expenditure) on the y-axis. A horizontal reference line is drawn at the mean food expenditure. The plot is titled 'data' and contains 20 observations of 4 variables. An 'Export' menu is open over the plot, showing options: 'Save as Image...', 'Save as PDF...', and 'Copy to Clipboard...'. A red callout box with an arrow pointing to the 'Save as Image...' option contains the text: 'Save plots in the desired format.'



# Help Tab

- Get help on any function of R.

The screenshot displays the RStudio interface. The main editor window contains R code with the command `help(mean)` on line 17. A red callout box on the left points to this line with the text "Type help(function-name)". The right-hand pane is split into two sections. The top section, labeled "Viewer", shows a search for "mean" and lists "R: Arithmetic Mean" as the selected topic. A red callout box on the right points to this search result with the text "Type function name on Help tab." The bottom section of the right pane displays the help documentation for the "Arithmetic Mean" function, including its description, usage, and arguments.

```
1 # Ανάγνωση αρχείου δεδομένων
2 data<-read.csv("C:\\Users\\user\\Desktop\\demo.csv", sep=";", header=T)
3
4 # Μέση τιμή εισοδήματος
5 mean(data$Income)
6
7 # Απεικόνιση καταναλώσης τροφίμων
8 plot(data$Income, data$FoodExpenditure, xlab="Εισόδημα", ylab="Καταναλώση
9
10 # Απεικόνιση καταναλώσης τροφίμων σε συνάρτηση του εισοδήματος
11 plot(data$Income, data$FoodExpenditure, xlab="Εισόδημα", ylab="Καταναλώση
12
13 # Απεικόνιση -στο ίδιο γράφημα- της μέσης τιμής καταναλώσης τροφίμων
14 abline( mean(data$FoodExpenditure), 0)
15
16
17 help(mean)
18
```

Environment History Connections  
Global Environment  
Data  
data 20 obs. of 4 variables

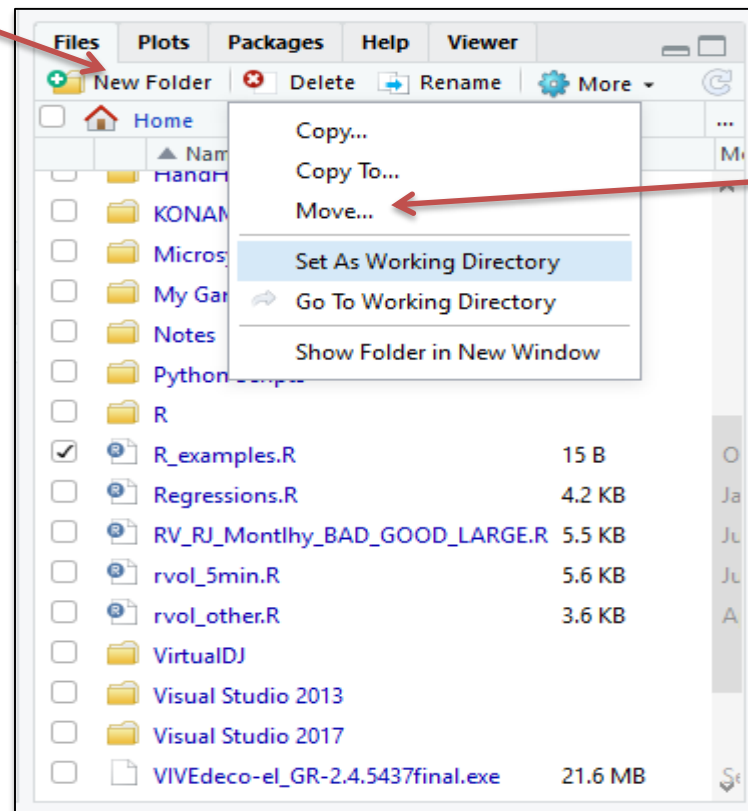
Files Plots Packages Help Viewer  
mean  
R: Arithmetic Mean - Find in Topic  
mean {base} R Documentation  
Arithmetic Mean  
Description  
Generic function for the (trimmed) arithmetic mean.  
Usage  
mean(x, ...)  
## Default S3 method:  
mean(x, trim = 0, na.rm = FALSE, ...)  
Arguments  
x An R object. Currently there are methods for numeric/logical vectors and [date](#), [date-time](#) and [time interval](#) objects. Complex vectors are allowed for `trim = 0` only.

# Save an R script

- Menu 'File > Save'
- Choose any directory.
- `getwd()` (To get the home directory for RStudio).
- Returns a path to the current working directory.

# View File in Files Tab

- Create a new directory inside of working directory to save the new file.



Move .R file to new directory.

# Quit an R Session

- Menu 'File > Quit session...'
- Save the workspace or not?
- Save → begin next session with variables and history loaded.
- Don't save → lose variables and history, files will be preserved.

# Useful links

- R for Beginners

[https://cran.r-project.org/doc/contrib/Paradis-rdebuts\\_en.pdf](https://cran.r-project.org/doc/contrib/Paradis-rdebuts_en.pdf)

- R

<https://www.r-project.org/>

- RStudio

<https://www.rstudio.com/>