

آشنایی با نرم افزار R و کاربرد آن در آمار و طرح آزمایشات

دکتر پرویز مرادی

**PhD Medicinal Plant Metabolomics
University of Birmingham, UK**

عضو هیات علمی مرکز تحقیقات و آموزش کشاورزی و منابع طبیعی استان زنجان

parvizmoradi@gmail.com



سرفصل مطالب

- چرا R؟
 - دانلود و نصب نرم افزار R و Rstudio
 - آشنایی با محیط Rstudio
 - آشنایی با دستورات ساده R
 - کار کردن با داده‌ها و ایجاد فایل داده‌ای
 - یادآوری آمار مقدماتی
 - محاسبه آماره های توصیفی
 - انواع آزمون تی استیودنت
 - رگرسیون و همبستگی
 - کاربرد R در طرح آزمایشات
- جلسه اول و دوم
- جلسه سوم و چهارم

منابع مورد استفاده

An Introduction to R

Notes on R: A Programming Environment for Data Analysis and Graphics
Version 2.13.2 (2011-09-30)

W. N. Venables, D. M. Smith
and the R Development Core Team

R تجزیه آماری و برنامه نویسی در

محمدهادی پهلوانی
شهربانو و کیلی



انتشارات
جهاد دانشگاه
مشهد

انتشارات جهاد دانشگاهی
محمدهادی پهلوانی، شهربانو و کیلی



چرا R؟

زبان‌ها و نرم‌افزارهای زیادی برای محاسبات آماری، از جمله SAS، MatLab و SPSS و غیره وجود دارد.

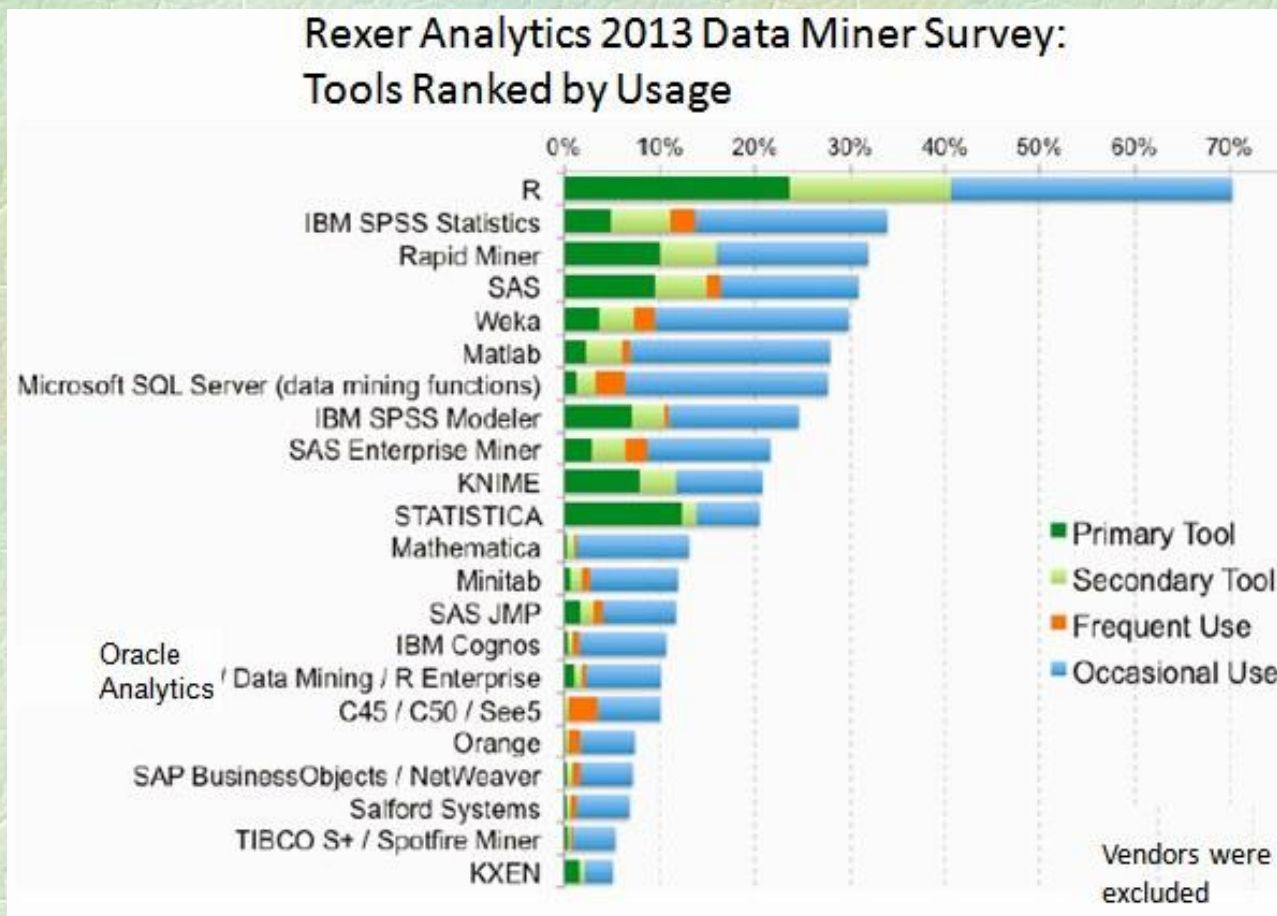
پس مزیت استفاده از زبان R چیست؟

- مهم‌ترین امتیاز رایگان و open-source بودن آن
- به روزرسانی دائمی
- ساده بودن زبان R
- وجود بسته‌های نرم‌افزاری فراوان برای تمام محاسبات آماری در همه زمینه‌های تحقیقاتی
- کاربران فراوانی در دنیا هستند که قبلاً بسته‌های آماری مورد نیاز را تهیه کرده‌اند و الان هم می‌توانند به کاربران جدید راهنمایی کنند.



R چیست؟

یک نرم افزار قدرتمند برای تجزیه های آماری است و اساسا جزئی از زبان S و S-Plus است. در ابتدا توسط دو برنامه نویس به نامهای Ross Ihaka and Robert Gentleman در گروه آمار دانشگاه اوکلند طراحی شد و به همین دلیل در سالهای اولیه به آن "R&R" هم می گفتند.





R

The screenshot shows the R GUI (64-bit) interface. The main window has a menu bar (File, Edit, View, Misc, Packages, Windows, Help) and a toolbar with icons for file operations. Two windows are open:

R Console

```
R version 3.1.1 (2014-07-10) -- "Sock it to Me"
Copyright (C) 2014 The R Foundation for Statistical Computing
Platform: x86_64-w64-mingw32/x64 (64-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

Natural language support but running in an English locale

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

[Previously saved workspace restored]

> demo()
> |
```

R demos

Demos in package 'base':

error.catching	More examples on catching and handling errors
is.things	Explore some properties of R objects and is.FOO() functions. Not for newbies!
recursion	Using recursion for adaptive integration
scoping	An illustration of lexical scoping.

Demos in package 'graphics':

Hershey	Tables of the characters in the Hershey vector fonts
Japanese	Tables of the Japanese characters in the Hershey vector fonts
graphics	A show of some of R's graphics capabilities
image	The image-like graphics builtins of R
persp	Extended persp() examples
plotmath	Examples of the use of mathematics annotation

Demos in package 'grDevices':

colors	A show of R's predefined colors()
hclColors	Exploration of hcl() space

Demos in package 'stats':

<

- RStudio is a **free** and **open source integrated development environment (IDE)** for R.
- Two editions:
 - **RStudio Desktop**, where the program is run locally as a regular desktop application;
 - **RStudio Server**, which allows accessing RStudio using a web browser while it is running on a remote Linux server.
- <http://www.rstudio.org/>



RStudio

File Edit Code View Plots Session Build Debug Tools Help

Project: (None)

```
1  
2  
3  
4  
5 #####  
6 #Data frames  
7 planets = c("Mercury", "Venus", "Earth", "Mars", "Jupiter", "Saturn", "Uranu  
8 type = c("Terrestrial planet", "Terrestrial planet", "Terrestrial planet", "  
9 diameter = c(0.382,0.949,1,0.532,11.209,9.449,4.007,3.883);  
10 rotation = c(58.64,-243.02,1,1.03,0.41,0.43,-0.72,0.67);  
11 rings= c(FALSE,FALSE,FALSE,FALSE,TRUE,TRUE,TRUE,TRUE);  
12 # Create the data frame:  
13 planets_df =data.frame(planets, type, diameter, rotation, rings)  
14  
15  
16 # Check the structure of planets_df  
17 str(planets_df)  
18 planets_df  
19 # with the help of square brackets? ]  
20 closest_planets_df = planets_df[1:3,]  
21 furthest_planets_df = planets_df[6:8,]  
22 # Have a look:  
23 <
```

Environment History

Global Environment

Environment is empty

Files Plots Packages Help Viewer

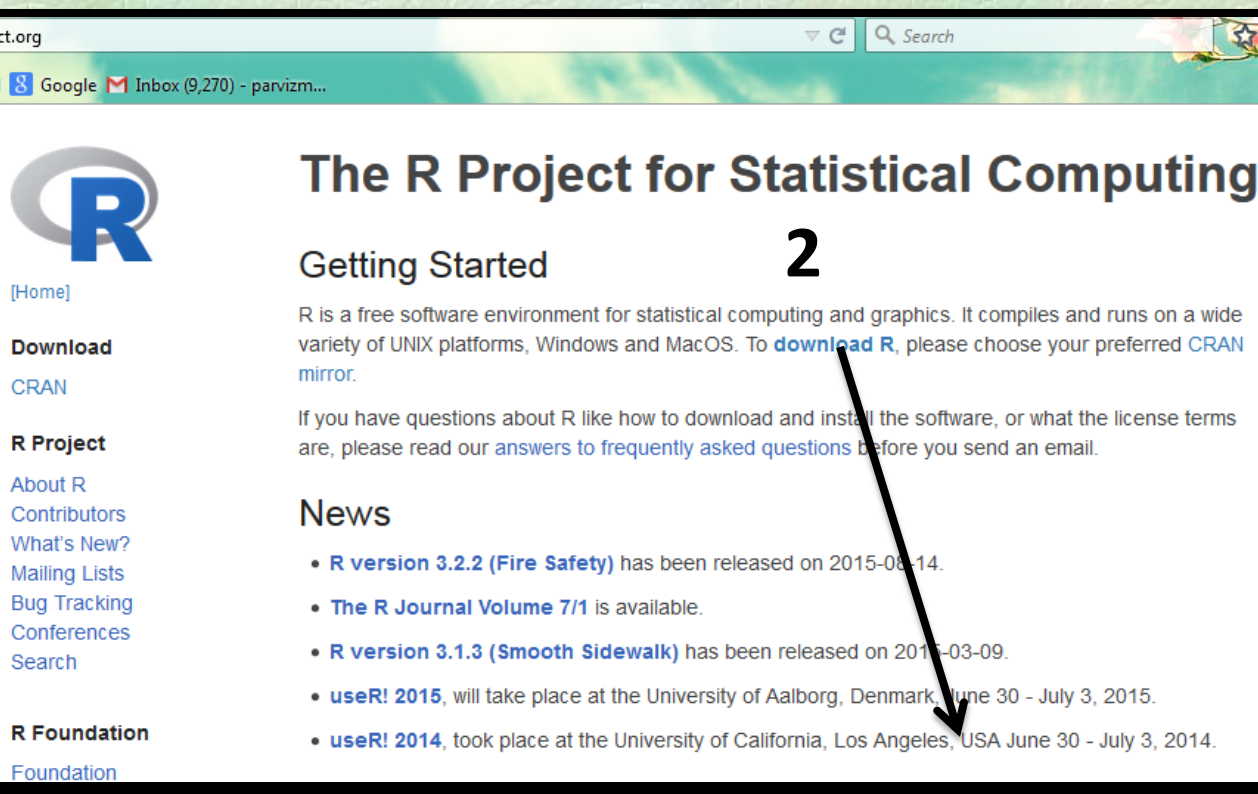
Name	Description	Version
User Library		
<input type="checkbox"/> manipulate	Interactive Plots for RStudio	0.98.1083
<input type="checkbox"/> rstudio	Tools and Utilities for RStudio	0.98.1083
System Library		
<input type="checkbox"/> boot	Bootstrap Functions (originally by Angelo Canty for S)	1.3-11
<input type="checkbox"/> class	Functions for Classification	7.3-10
<input type="checkbox"/> cluster	Cluster Analysis Extended Rousseeuw et al.	1.15.2
<input type="checkbox"/> codetools	Code Analysis Tools for R	0.2-8
<input type="checkbox"/> compiler	The R Compiler Package	3.1.1
<input type="checkbox"/> datasets	The R Datasets Package	3.1.1
<input type="checkbox"/> foreign	Read Data Stored by Minitab, S, SAS, SPSS, Stata, Systat, Weka, dBase, ...	0.8-61
<input type="checkbox"/> graphics	The R Graphics Package	3.1.1
<input type="checkbox"/> grDevices	The R Graphics Devices and Support for Colours and Fonts	3.1.1
<input type="checkbox"/> grid	The Grid Graphics Package	3.1.1
<input type="checkbox"/> KernSmooth	Functions for kernel smoothing for Wand & Jones (1995)	2.23-12

Console C:/GeorgeFiles/www/~jsyeh/1031/DM/PPT&PDF/cflin R/

> |

1

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



2

India

<http://ftp.iitm.ac.in/cran/>

Indian Institute of Technology Madras

Indonesia

<http://cran.repo.bppt.go.id/>

Agency for The Application and Assessment of Technology

Iran

<http://cran.um.ac.ir/>

Ferdowsi University of Mashhad

Ireland

<http://ftp.heanet.ie/mirrors/cran.r-project.org/>

HEAnet, Dublin

Italy

<http://cran.mirror.garr.it/mirrors/CRAN/>

Garr Mirror, Milano

3



Download and Install R

Precompiled binary distributions of the base system and contributed packages, **Windows and Mac** users most likely want one of these versions of R:

- [Download R for Linux](#)
- [Download R for \(Mac\) OS X](#)
- [Download R for Windows](#)

R is part of many Linux distributions, you should check with your Linux package management system in addition to the link above.

Source Code for all Platforms

Windows and Mac users most likely want to download the precompiled binaries listed in the upper box, not the source code. The sources have to be compiled before you can use them. If you do not know what this means, you probably do not want to do it!

- The latest release (2015-08-14, Fire Safety) [R-3.2.2.tar.gz](#), read [what's new](#) in the latest version.
- Sources of [R alpha and beta releases](#) (daily snapshots, created only in time periods before a planned release).
- Daily snapshots of current patched and development versions are [available here](#). Please read about [new features and bug fixes](#) before filing corresponding feature requests or bug reports.
- Source code of older versions of R is [available here](#).
- Contributed extension [packages](#)

Questions About R

- 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.

Subdirectories:

- [base](#) Binaries for base distribution (managed by Duncan Murdoch). This is what you want to [install R for the first time](#).
- [contrib](#) Binaries of contributed packages (managed by Uwe Ligges). There is also information on [third party software](#) available for CRAN Windows services and corresponding environment and make variables.
- [Rtools](#) Tools to build R and R packages (managed by Duncan Murdoch). This is what you want to build your own packages on Windows, or to build R itself.

Please do not submit binaries to CRAN. Package developers might want to contact Duncan Murdoch or Uwe Ligges directly in case of questions / suggestions related to Windows binaries.

You may also want to read the [R FAQ](#) and [R for Windows FAQ](#).

Note: CRAN does some checks on these binaries for viruses, but cannot give guarantees. Use the normal precautions with downloaded executables.



CRAN

[Mirrors](#)
[What's new?](#)
[Task Views](#)
[Search](#)

About R

[R Homepage](#)
[The R Journal](#)

Software



CRAN

[Mirrors](#)
[What's new?](#)
[Task Views](#)
[Search](#)

About R

[R Homepage](#)
[The R Journal](#)

Software

[R Sources](#)
[R Binaries](#)
[Packages](#)
[Other](#)

Documentation

[Manuals](#)
[FAQs](#)
[Contributed](#)

R-3.2.2 for Windows (32/64 bit)

[Download R 3.2.2 for Windows](#) (62 megabytes, 32/64 bit)

[Installation and other instructions](#)

[New features in this version](#)

If you want to double-check that the package you have downloaded exactly matches the package distributed by R, [fingerprint](#). You will need a version of md5sum for windows: both [graphical](#) and [command line versions](#) are available.

Frequently asked questions

- [Does R run under my version of Windows?](#)
- [How do I update packages in my previous version of R?](#)
- [Should I run 32-bit or 64-bit R?](#)

Please see the [R FAQ](#) for general information about R and the [R Windows FAQ](#) for Windows-specific information.

Other builds

- Patches to this release are incorporated in the [r-patched snapshot build](#).
- A build of the development version (which will eventually become the next major release of R) is available
- [Previous releases](#)

Note to webmasters: A stable link which will redirect to the current Windows binary release is [<CRAN MIRROR>/bin/windows/base/release.htm](#).

Welcome to RStudio - Open source and enterprise-ready professional software for R



www.rstudio.org

Download RStudio

Discover Shiny

shinyapps.io Login



Desktop

Run RStudio on your desktop

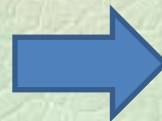
[RStudio Desktop >](#)



Server

Centralize access and computation

[RStudio Server >](#)



RStudio Desktop 0.99.489 — Release Notes

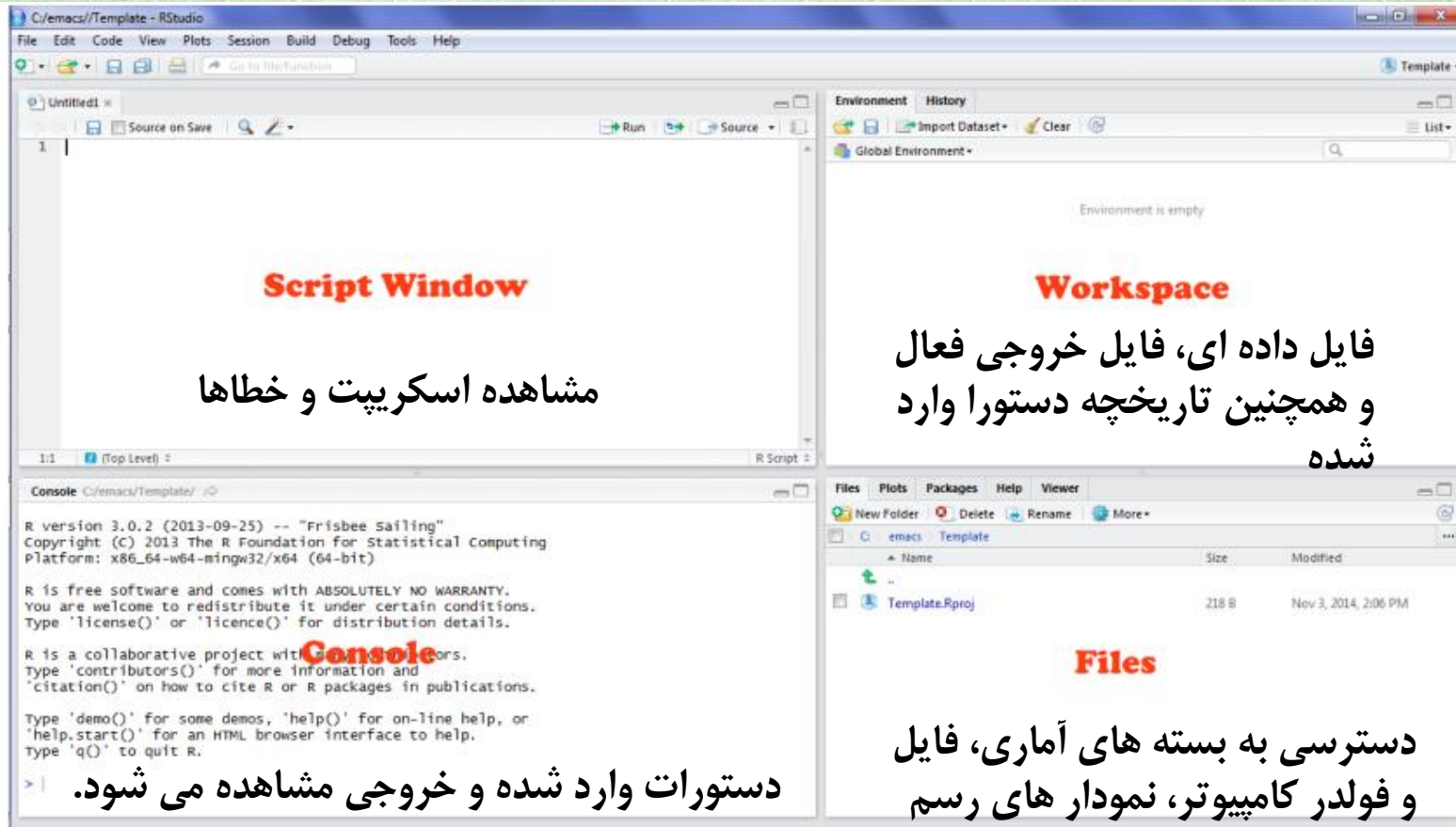
RStudio requires R 2.11.1 (or higher). If you don't already have R, you can download it [here](#).

Installers for Supported Platforms

Installers	Size	Date
RStudio 0.99.489 - Windows Vista/7/8/10	73.9 MB	2015-11-05
RStudio 0.99.489 - Mac OS X 10.6+ (64-bit)	56.2 MB	2015-11-05
RStudio 0.99.489 - Ubuntu 12.04+/Debian 8+ (32-bit)	77.4 MB	2015-11-05
RStudio 0.99.489 - Ubuntu 12.04+/Debian 8+ (64-bit)	83.9 MB	2015-11-05
RStudio 0.99.489 - Fedora 19+/RedHat 7+/openSUSE 13.1+ (32-bit)	76.8 MB	2015-11-05
RStudio 0.99.489 - Fedora 19+/RedHat 7+/openSUSE 13.1+ (64-bit)	77.7 MB	2015-11-05

بعد از این که دانلود RStudio به پایان رسید آن را نیز نصب کنید.

اجرای برنامه RStudio



R documentation and help

Manual, References,) برای آشنایی کلی با این نرم افزار (Material) :

- > `help.start()`

- اگر دستور را می دانید ولی جزئیات آنرا نمی دانید:

- > `?plot`

Tips and Reminders

- R is case-sensitive
- Comment your code so you remember what it does; comments are preceded with #
- R scripts are simply text files with a .R extension
- Use Ctrl + R to submit code
- Use the Tab key to let R/R Studio finish typing commands for you
- Use Shift + down arrow to highlight lines or blocks of code
- In R Studio: Ctrl + 1 and Ctrl + 2 switches between script and console
- Use up and down arrows to cycle through previous commands in console
- Don't be afraid of errors; you won't break R
- If you get stuck, Google is your friend

استفاده از R به عنوان ماشین حساب

- + add
- subtract
- * multiply
- / divide
- ^ raise to the power

- $1+3$
- 4

$$bmi = \frac{weight}{height^2}, \text{ units } \left[\frac{kg}{m^2} \right]$$

```
bmi = 75/1.75^2  
bmi  
[1] 24.48980
```

Underweight: BMI is less than 18.5
Normal weight: BMI is 18.5 to 24.9
Overweight: BMI is 25 to 29.9
Obese: BMI is 30 or more

log, exp, sin, tan, sqrt, etc.

```
sin(pi)
```

```
1.224606e-16
```


Category	BMI range – kg/m ²	BMI Prime
Very severely underweight	less than 15	less than 0.60
Severely underweight	from 15.0 to 16.0	from 0.60 to 0.64
Underweight	from 16.0 to 18.5	from 0.64 to 0.74
Normal (healthy weight)	from 18.5 to 25	from 0.74 to 1.0
Overweight	from 25 to 30	from 1.0 to 1.2
Obese Class I (Moderately obese)	from 30 to 35	from 1.2 to 1.4
Obese Class II (Severely obese)	from 35 to 40	from 1.4 to 1.6
Obese Class III (Very severely obese)	over 40	over 1.6

دستورات اختصاص داده ها به متغیر (عدد، بردار، ماتریس)

➤ `x=1`

➤ `x = 0:4`

➤ `x <- c(0,2,-1,pi,10)`

0.000000 2.000000 -1.000000 3.141593 10.000000

➤ `x=c(1:4,3:9)`

0 1 2 3 4

➤ `x <- seq(0,2,.25)`

0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00

➤ `rep(1:2,4)`

1 2 1 2 1 2 1 2

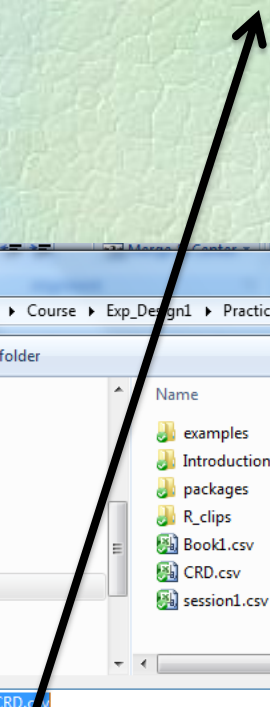
مثالی از کار با بردار

- `> x <- 1:10`
- `> x`
- `[1] 1 2 3 4 5 6 7 8 9 10`
- `> x2 <- x^2`
- `> x2`
- `[1] 1 4 9 16 25 36 49 64 81 100`
- `> sqrt(x2)`
- `[1] 1 2 3 4 5 6 7 8 9 10`

	A	B	C	D	E	F	G
1	rep	treat	yield				
2	1	1	30				
3	1	2	9				
4	1	3	16				
5	1	4	10				
6	1	5	30				
7	1	6	18				
8	1	7	17				
9	2	1	18				
10	2	2	9				
11	2	3	10				
12	2	4	4				
13	2	5	7				
14	2	6	24				
15	2	7	7				
16	3	1	32				
17	3	2	16				
18	3	3	18				
19	3	4	4				
20	3	5	21				
21	3	6	12				
22	3	7	16				
23	4	1	26				
24	4	2	4				
25	4	3	18				

ایجاد فایل داده ای به صورت ماتریس و فراخوان آن

Save as CRD.CSV
(Comma delimited)



تیمارها

A	B	C	D	E	F	G
۳۰	۹	۱۶	۱۰	۳۰	۱۸	۱۷
۱۸	۹	۱۰	۴	۷	۲۴	۷
۳۲	۱۶	۱۸	۴	۲۱	۱۲	۱۶
۲۶	۴	۱۸	۵	۹	۱۹	۱۷

Save As dialog box showing file name: CRD.csv and Save as type: CSV (Comma delimited) (*.csv)

۱- دایرکتوری حاوی داده ها را معرفی می کنیم.

The screenshot shows the RStudio interface with the Session menu open. The menu options are:

- Interrupt R
- Restart R Ctrl+Shift+F10
- Terminate R...
- Set Working Directory
 - To Source File Location
 - To Files Pane Location
 - Choose Directory... Ctrl+Shift+K
- Load Workspace...
- Save Workspace As...
- Clear Workspace...

The Environment pane on the right shows the Global Environment with the following data:

Environment	History
Global Environment	
Data	
data	28 obs. of 1 variables
Values	
datafile	"C:/Users/p.moradi/Dropbox/staff/Course/Exp_Design1..."
x	int [1:12] 0 1 2 3 4 5 10 11 12 13 ...

The Console shows the following output:

```

22 20
23 4
24 18
25 5
26 9
27 19
28 17
> summary(data)
  v1
Min.   : 4.00
1st Qu.: 9.00
Median :16.00
Mean   :15.21
3rd Qu.:18.25
Max.   :32.00
  
```

The R Documentation pane shows the following content:

Correlation, Variance and Covariance (Matrices)

Description

`var`, `cov` and `cor` compute the variance of `x` and the covariance or correlation of `x` and `y` if these are vectors. If `x` and `y` are matrices then the covariances (or correlations) between the columns of `x` and the columns of `y` are computed.

`cov2cor` scales a covariance matrix into the corresponding correlation matrix *efficiently*.

Usage

```

var(x, y = NULL, na.rm = FALSE, use)
cov(x, y = NULL, use = "everything",
    method = c("pearson", "kendall", "spearman"))
  
```

```
data=read.csv("CRD.csv", header=T)
```

۲- داده ها را فراخوان می کنیم

OR

```
data=read.table("CRD.txt", header=TRUE)
```

The screenshot shows the RStudio interface. The main window displays a data frame with 28 observations of 3 variables: rep, treat, and yield. The data is as follows:

	rep	treat	yield
1	1	1	30
2	1	2	9
3	1	3	16
4	1	4	10
5	1	5	30
6	1	6	18
7	1	7	17
8	2	1	18
9	2	2	9
10	2	3	10
11	2	4	4
12	2	5	7
13	2	6	24
14	2	7	7
15	3	1	32
16	3	2	16
17	3	3	18
18	3	4	4
19	3	5	21
20	3	6	12
21	3	7	16
22	4	1	26
23	4	2	4
24	4	3	18
25	4	4	5
26	4	5	9
27	4	6	19
28	4	7	17

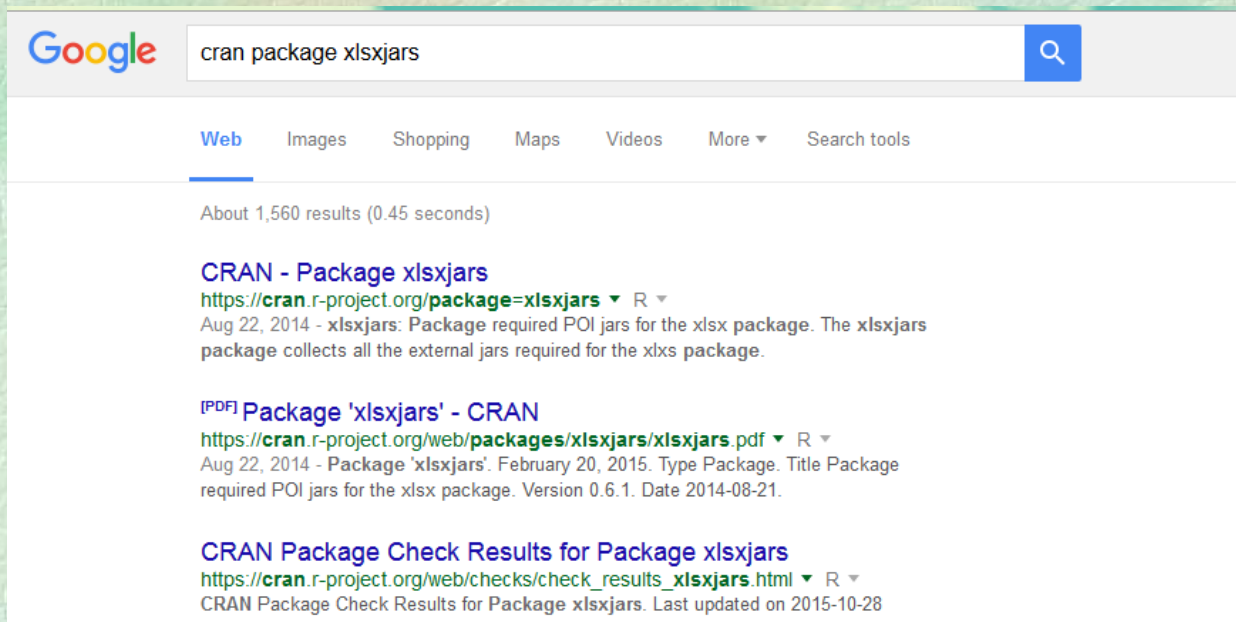
The Environment pane shows the 'data' object with 28 observations of 3 variables. The Packages pane shows a list of installed R packages, including agricolae, boot, class, cluster, codetools, compiler, datasets, foreign, graphics, qrDevices, grid, KernSmooth, lattice, manipulate, and MASS.

فراخوانی داده ها به طور مستقیم از اکسل



Google search results for "cran package rJava". The search bar contains "cran package rJava" and a magnifying glass icon. Below the search bar are tabs for "Web", "Images", "Shopping", "Maps", "Videos", "More", and "Search tools". The results show "About 16,400 results (0.26 seconds)". The first result is "CRAN - Package rJava" with the URL <https://cran.r-project.org/package=rJava> and a description: "Jul 29, 2015 - rJava: Low-Level R to Java Interface. Low-level interface to Java VM very much like .C/.Call and friends. Allows creation of objects, calling ...". The second result is "[PDF] Package 'rJava' - CRAN" with the URL <https://cran.r-project.org/web/packages/rJava/rJava.pdf> and a description: "by S Urbanek - 2012 - Cited by 5 - Related articles Package 'rJava'. July 29, 2015. Version 0.9-7. Title Low-Level R to Java Interface. Author Simon Urbanek <simon.urbanek@r-project.org>. Maintainer Simon ...".

۱- دانلود و نصب پکیج rJava



Google search results for "cran package xlsxjars". The search bar contains "cran package xlsxjars" and a magnifying glass icon. Below the search bar are tabs for "Web", "Images", "Shopping", "Maps", "Videos", "More", and "Search tools". The results show "About 1,560 results (0.45 seconds)". The first result is "CRAN - Package xlsxjars" with the URL <https://cran.r-project.org/package=xlsxjars> and a description: "Aug 22, 2014 - xlsxjars: Package required POI jars for the xlsx package. The xlsxjars package collects all the external jars required for the xlsx package.". The second result is "[PDF] Package 'xlsxjars' - CRAN" with the URL <https://cran.r-project.org/web/packages/xlsxjars/xlsxjars.pdf> and a description: "Aug 22, 2014 - Package 'xlsxjars'. February 20, 2015. Type Package. Title Package required POI jars for the xlsx package. Version 0.6.1. Date 2014-08-21.". The third result is "CRAN Package Check Results for Package xlsxjars" with the URL https://cran.r-project.org/web/checks/check_results_xlsxjars.html and a description: "CRAN Package Check Results for Package xlsxjars. Last updated on 2015-10-28".

۲- دانلود و نصب پکیج xlsxjars

About 21,000 results (0.42 seconds)

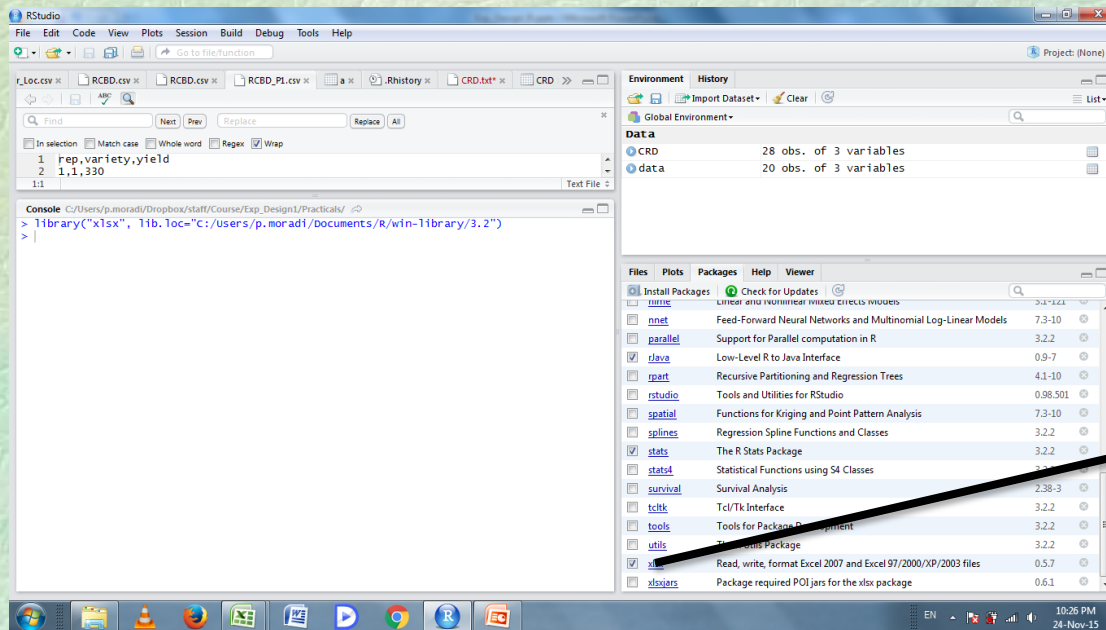
CRAN - Package xlsx

<https://cran.r-project.org/package=xlsx> R

Aug 2, 2014 - **xlsx**: Read, write, format Excel 2007 and Excel 97/2000/XP/2003 files.

Provide R functions to read/write/format Excel 2007 and Excel ...

۳- دانلود و نصب پکیج xlsx



۴- در لیست packages بسته xlsx را تیک می زنیم تا به این نحو این بسته لود می شود.

`data=read.xlsx("CRD.xlsx", 1, header=T)`