R Statistical Language: Introduction and Exercises

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WMO Verification Tutorial
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R-project

R-packages
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R-script

R-Project

▶ R is a language and environment for statistical computing and graphics

▶ R provides a wide variety of statistical techniques (linear and nonlinear modelling, classical statistical tests, time-series analysis, classification, clustering, . . .) and is highly extensible

▶ R provides a wide variety of graphical techniques to produce well-designed publication-quality plots

▶ R is available as Free Software and runs on most operating systems (Linux, Windows and MacOS)

▶ R is Open Source

https://www.r-project.org

The R Project for Statistical Computing

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

- R version 3.4.0 (You Stupid Darkness) has been released on Friday 2017-04-21.

- R version 3.3.3 (Another Canoe) has been released on Monday 2017-03-06.

- useR! 2017 (July 4 - 7 in Brussels) has opened registration and more at http://user2017.brussels/

- Tomas Kalibera has joined the R core team.

- The R Foundation welcomes five new ordinary members: Jennifer Bryan, Dianne Cook, Julie Josse, Tomas Kalibera, and Balasubramanian Narasimhan.

- The R Journal Volume 8/1 is available.

- The useR! 2017 conference will take place in Brussels, July 4 - 7, 2017.

- R version 3.2.5 (Very, Very Secure Dishes) has been released on 2016-04-14. This is a rebadging of the quick-fix release 3.2.4-revised.

- Notice XQuartz users (Mac OS X) A security issue has been detected with the Sparkle update mechanism used by XQuartz. Avoid updating over insecure channels.

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R Manuals

The R Manuals

edited by the R Development Core Team.

The following manuals for R were created on Debian Linux and may differ from the manuals for Mac or Windows on platform-specific pages, but most parts will be identical for all platforms. The correct version of the manuals for each platform are part of the respective R installations. The manuals change with R, hence we provide versions for the most recent released R version (R-release), a very current version for the patched release version (R-patched) and finally a version for the forthcoming R version that is still in development (R-devel).

Here they can be downloaded as PDF files, EPUB files, or directly browsed as HTML:

Manual	R-release	R-patched	R-devel
An Introduction to R is based on the former "Notes on R", gives an introduction to the language and how to use R for doing statistical analysis and graphics.	HTML | PDF | EPUB	HTML | PDF | EPUB	HTML | PDF | EPUB
R Data Import/Export describes the import and export facilities available either in R itself or via packages which are available from CRAN.	HTML | PDF | EPUB	HTML | PDF | EPUB	HTML | PDF | EPUB
R Installation and Administration	HTML | PDF | EPUB	HTML | PDF | EPUB	HTML | PDF | EPUB
Writing R Extensions covers how to create your own packages, write R help files, and the foreign language (C, C++, Fortran, ...) interfaces.	HTML | PDF | EPUB	HTML | PDF | EPUB	HTML | PDF | EPUB
A draft of **The R language definition** documents the language *per se*. That is, the objects that it works on, and the details of the expression evaluation process, which are useful to know when programming R functions.	HTML | PDF | EPUB	HTML | PDF | EPUB	HTML | PDF | EPUB
R Internals: a guide to the internal structures of R and coding standards for the core team working on R itself.	HTML | PDF | EPUB	HTML | PDF | EPUB	HTML | PDF | EPUB
The R Reference Index: contains all help files of the R standard and recommended packages in printable form. (9MB, approx. 3500 pages)	PDF	PDF	PDF

R Contributions

Contributed Documentation

English --- Other Languages

Manuals, tutorials, etc. provided by users of R. The R core team does not take any responsibility for contents, but we appreciate the effort very much and encourage everybody to contribute to this list! To submit, follow the submission instructions on the CRAN main page. All material below is available directly from CRAN, you may also want to look at the list of other R documentation available on the Internet.

Note: Please use the directory listing to sort by name, size or date (e.g., to see which documents have been updated lately).

English Documents

Documents with more than 100 pages:

- **"Visual Statistics. Use R!"** by Alexey Shipunov ([PDF](PDF), 2016-06-06, 301 pages). All book materials are accessible from Alexey Shipunov's English R page .
- **"Using R for Data Analysis and Graphics - Introduction, Examples and Commentary"** by John Maindonald ([PDF](PDF), data sets and scripts are available at JM's homepage).
- **"Practical Regression and Anova using R"** by Julian Faraway ([PDF](PDF), data sets and scripts are available at the book homepage).
- The Web Appendix to the book "An R Companion to Applied Regression" (second edition) by John Fox and Sanford Weisberg contains information about R to fit a variety of regression models.
- **"An Introduction to S and the Hmisc and Design Libraries"** by Carlos Alzola and Frank E. Harrell, especially of interest to SAS users, users of the Hmisc or Design packages, or R users interested in data manipulation, recoding, etc. ([PDF](PDF))
- **"Statistical Computing and Graphics Course Notes"** by Frank E. Harrell, includes material on S, LaTeX, reproducible research, making good graphs, brief overview of computer languaes, etc. ([PDF](PDF))
- **"An Introduction to R: Software for Statistical Modelling & Computing"** by Petra Kuhnert and Bill Venables ([ZIP 3.8MB](ZIP 3.8MB)): A 360 page PDF document of lecture notes in combination with the data sets and R scripts used in the manuscript.
- **"Introduction to the R Project for Statistical Computing for Use at the ITC"** by David Rossiter ([PDF](PDF), 2012-08-20, 141 pages).
- **"Analysis of Epidemiological Data Using R and Epicalc"** by Virasakdi Chongsuvivatwong ([PDF](PDF)).
- **"Statistics Using R with Biological Examples"** by Kim Seefeld and Ernst Linder ([PDF](PDF)).
- **"IcebreakeR"** by Andrew Robinson ([PDF](PDF), 2016-06-21, 161 pages).
- **"Applied Statistics for Bioinformatics Using R"** by Wim Krijnen ([PDF](PDF), 2009-11-17, 278 pages).
- **"An Introduction to R"** by Longhow Lam ([PDF](PDF), 2010-10-28, 212 pages).
- **"R and Data Mining: Examples and Case Studies"** by Yanchang Zhao ([PDF](PDF), 2013-04-26, 160 pages).
- **"A Student's Guide to R"** by Nicholas J. Horton, Randall Pruim, and Daniel T. Kaplan ([PDF](PDF), 2015-11-16, 119 pages).
- **"Is R Suitable Enough for Biostatisticians?"** by Adrian Olszewski ([PDF](PDF), 2015-06-28, 365 pages).

Documents with fewer than 100 pages:

CRAN
Mirrors
What's new?
Task Views
Search

About R
R Homepage
The R Journal

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R Sources
R Binaries
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R Packages

▶ R is a powerful high-level languages doing statistical analysis

▶ R has has built-in functions and contributed packages that can do most modern statistical methods

▶ Currently more than 10.000 contributed packages available

▶ R packages are open source, have manuals and references

▶ Contributions from people around the world

R Packages

Available CRAN Packages By Name

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

A3	Accurate, Adaptable, and Accessible Error Metrics for Predictive Models
abbyyR	Access to Abbyy Optical Character Recognition (OCR) API
abc	Tools for Approximate Bayesian Computation (ABC)
ABCanalysis	Computed ABC Analysis
abc.data	Data Only: Tools for Approximate Bayesian Computation (ABC)
abcdeFBA	ABCDE_FBA: A-Biologist-Can-Do-Everything of Flux Balance Analysis with this package
ABCoptim	Implementation of Artificial Bee Colony (ABC) Optimization
ABCp2	Approximate Bayesian Computational Model for Estimating P2
ABC.RAP	Array Based CpG Region Analysis Pipeline
abcrf	Approximate Bayesian Computation via Random Forests
abctools	Tools for ABC Analyses
abd	The Analysis of Biological Data
abf2	Load Gap-Free Axon ABF2 Files
ABHgenotypeR	Easy Visualization of ABH Genotypes
abind	Combine Multidimensional Arrays
abjutils	Useful Tools for Jurimetrical Analysis Used by the Brazilian Jurimetrics Association
abn	Modelling Multivariate Data with Additive Bayesian Networks
abodOutlier	Angle-Based Outlier Detection
AbsFilterGSEA	Improved False Positive Control of Gene-Permuting GSEA with Absolute Filtering
AbSim	Time Resolved Simulations of Antibody Repertoires
abundant	High-Dimensional Principal Fitted Components and Abundant Regression
ACA	Abrupt Change-Point or Aberration Detection in Point Series
acc	Exploring Accelerometer Data
accelerometry	Functions for Processing Minute-to-Minute Accelerometer Data
accelmissing	Missing Value Imputation for Accelerometer Data
AcceptanceSampling	Creation and Evaluation of Acceptance Sampling Plans
ACCLMA	ACC & LMA Graph Plotting
accrual	Bayesian Accrual Prediction
accrued	Data Quality Visualization Tools for Partially Accruing Data
ACD	Categorical data analysis with complete or missing responses
ACDm	Tools for Autoregressive Conditional Duration Models

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Sample of useful R Packages

- ▶ verification, SpatialVx

- ▶ fields, maps, mapdata, spatstat

- ▶ Packages must be installed to call:
  > install.packages("verification")

- ▶ Packages must be called to use:
  > library("verification")

- ▶ Citing Packages: > citation("verification")

- ▶ Citing R Project: > citation()

https://cran.r-project.org/package=verification

`verification: Weather Forecast Verification Utilities`

Utilities for verifying discrete, continuous and probabilistic forecasts, and forecasts expressed as parametric distributions are included.

Version:	1.42
Depends:	R (≥ 2.10), methods, fields, boot, CircStats, MASS, dtw
Imports:	graphics, stats
Published:	2015-07-15
Author:	NCAR - Research Applications Laboratory
Maintainer:	Eric Gilleland <ericg at ucar.edu>
License:	GPL-2	GPL-3 [expanded from: GPL (≥ 2)]
NeedsCompilation:	no
CRAN checks:	verification results

`Downloads:`

Reference manual:	verification.pdf
Package source:	verification_1.42.tar.gz
Windows binaries:	r-devel: verification_1.42.zip, r-release: verification_1.42.zip, r-oldrel: verification_1.42.zip
OS X El Capitan binaries:	r-release: verification_1.42.tgz
OS X Mavericks binaries:	r-oldrel: verification_1.42.tgz
Old sources:	verification archive

`Reverse dependencies:`

Reverse suggests: easyVerification, FRK, rattle, RODM, simpleNeural

`Linking:`

Please use the canonical form `https://CRAN.R-project.org/package=verification` to link to this page.

Getting help

▶ Manuals, Contributed documentations, Package manuals

▶ Help page within R (e.g. for function "verify"):

> ?verify

> help(verify)

  ▶ Arguments

  ▶ Values

  ▶ Examples

  ▶ References

▶ search engines, mailing lists, ...

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Writing R scripts

- ▶ R script files ending with ".r"

- ▶ R data files ending with ".rdata"(created by > save())

- ▶ Use a text editor to write R script files (e.g. Kate)

- ▶ Use hashtag # for comments

- ▶ Use console/terminal to execute scripts from R:
  > source("file.r")
  > load("data.Rdata")

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Working directory

▶ Create working directory, e.g. from terminal:
  home$: mkdir R-tutorial
  home$: cd R-tutorial

▶ Start R from working directory:
  home/R-tutorial$: R

▶ Save data files and R scripts in the working directory

Useful commands:

▶ get working directory: > getwd()

▶ change working directory: > setwd("path.to.directory")

▶ quit R: > q()

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Start with Excercises

▶ Download zip file: 2017-R-tutorial.zip

▶ Start R (from directory with zip file)

  ▶ Unzip file and create directory:
    ```
    > unzip("2017-R-tutorial.zip")
    ```

  ▶ Set working directory:
    ```
    > setwd("2017-R-tutorial")
    ```

  ▶ List of files in directory:
    ```
    > dir()
    ```

Use R as calculator

- arithmetic operations
  ```
  > 2 + 3
  > 2 ^ 2 + (5-1)*4 - 3/2
  ```

- assign operator '<-'
  ```
  > a <- 3/2
  > b <- a + a*2 - 3
  ```

To Do: Compute the difference between yy <- 2017 and the year
ystart you started at the university and divide this by the difference
between yy and the year you were born yborn. Multiply this with 100 to
get the percentage of your life you have spent at the university.

Use R as calculator

- arithmetic operations
  ```
  > 2 + 3
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- assign operator '<-'
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  > a <- 3/2
  > b <- a + a*2 - 3
  ```

To Do: Compute the difference between yy <- 2017 and the year ystart you started at the university and divide this by the difference between yy and the year you were born yborn. Multiply this with 100 to get the percentage of your life you have spent at the university.
```
> p <- 100*(yy-ystart)/(yy-yborn)
```

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Clean up your working space

▶ list of names of objects in working space:
  > ls()

▶ remove object 'x':
  > rm(x)

▶ clear working space (remove all objects):
  > rm(list=ls())

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Open example scripts in Editor

▶ example1.r (vectors, simple plot)

▶ example2.r (arrays, image plot)

▶ example3.r (time series)

Have you already installed the packages? Then call
```
> library("verification")
```

If package is not installed yet, type
```
> install.packages("verification")
```