

INTRODUCTION TO R

dr Maria Kubara, WNE UW

ABOUT ME

Researcher & lecturer at WNE UW

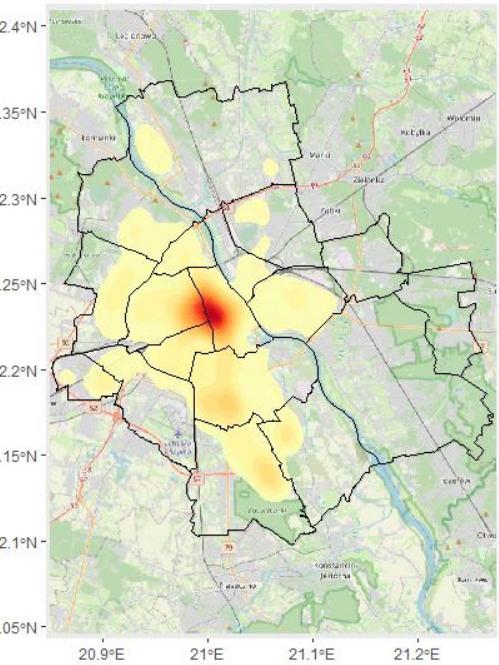
Working in R since 2017

PhD in Economics & Finance: *Urban Location and Startup Growth* (spatial machine learning, causal machine learning, all done in R)

Awarded for young researcher contributions
(EPAINOS, START2025)

Co-author and co-editor of textbooks about spatial data processing in R (Routledge, 2020 & forthcoming)

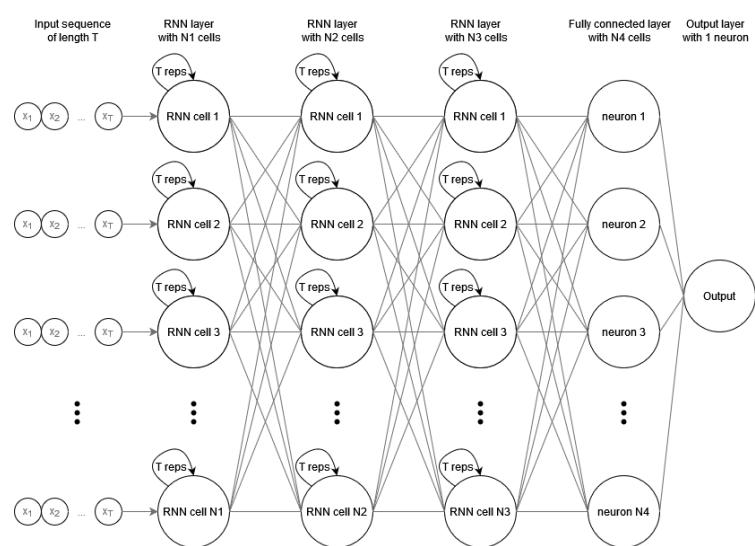




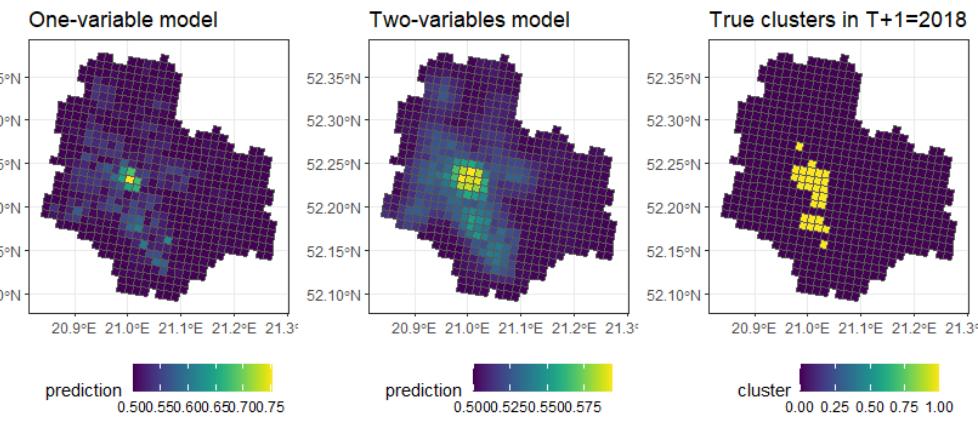
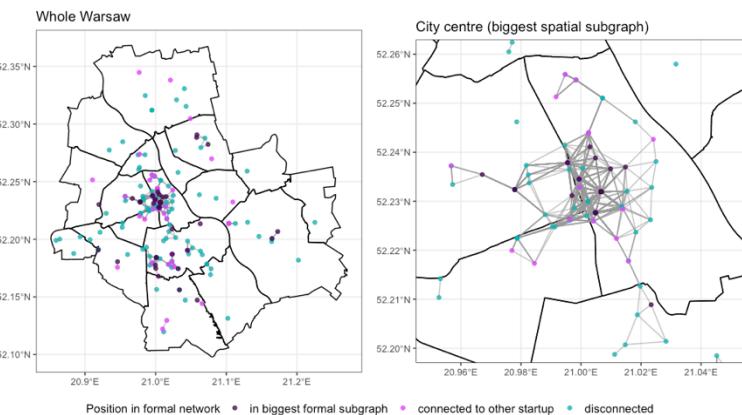
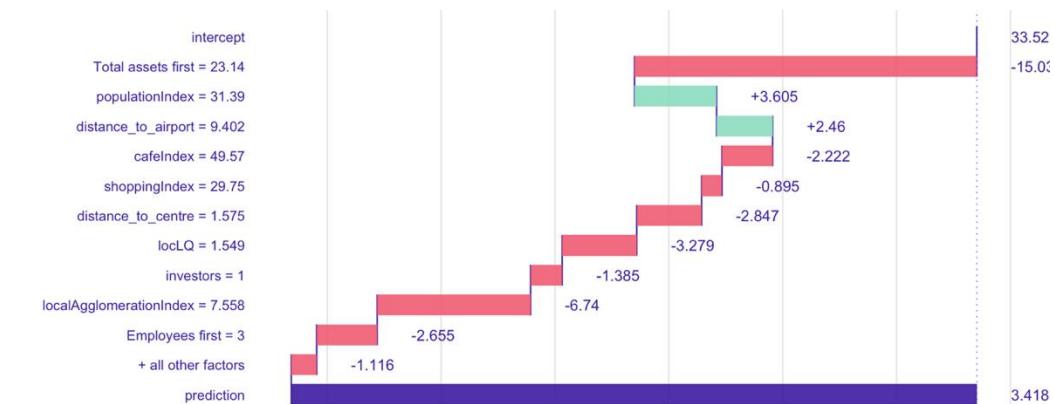
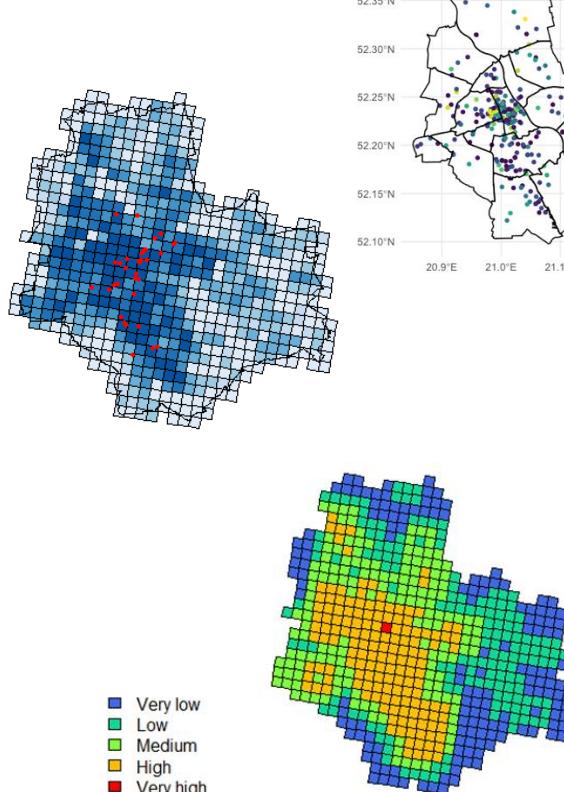
MY PHD PROJECT „URBAN LOCATION AND STARTUP GROWTH”

level
 300
 200
 100

- under 0
- 0 to 1
- 1 to 2
- 2 to 5
- 5 to 11
- 11 to 24
- 24 to 44
- over 44

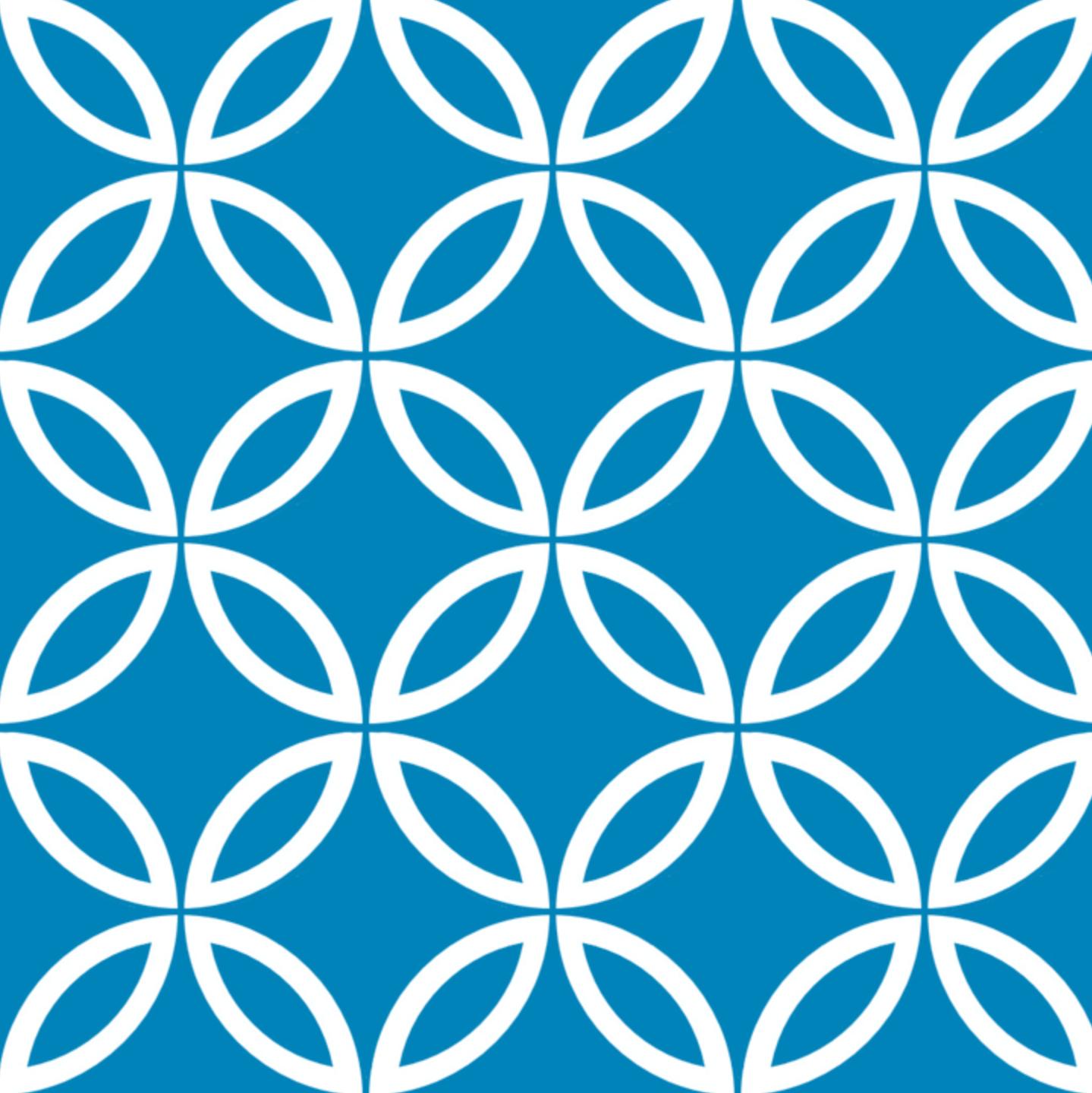


Very low
 Low
 Medium
 High
 Very high



PASSING RULES

- Quizzes/class work (max 30)
 - submitted within 48h of the class – 100%
 - submitted within a week after the class – max 80% points
 - abcd questions + some coding
- Exam (max 70) – ONSITE!!!
 - in the exam session
- Activity (bonus)
- Additional homework (without points – own exam practice)
 - around Christmas break
 - structured in the same way as the exam



COURSE MATERIAL (IN SHORT)

1. Intro to R and RStudio.
2. Learning datatypes and data structures in R.
3. The basis of statistical analysis and modelling in R.
4. Visualization in base R.
5. Loops and functions.
6. Tidyverse.
7. Rmarkdown.
8. Bonus class: how to prepare clean and reproducible code in R.

WHAT IS R?

- Programming language: designed for statistics, modelling, and visualization.
- Software environment: powerful IDEs (RStudio, Positron, Posit Workbench).
- Community-driven: CRAN has >20,000 packages.
- Cross-platform: works on Windows, MacOS, Linux.
- Open-source: all codes and packages are openly available and easy to add to

THE STORY OF R



R was created in the early 1990s by Ross Ihaka & Robert Gentleman in New Zealand.



Inspired by the S language (Bell Labs).



Goal: a free, open-source tool for statistical computing and graphics.



Quickly adopted in academia → became the global standard for statistical analysis.

THE STORY OF PYTHON IN STATISTICS

Python was created in 1991 by Guido van Rossum as a **general-purpose language**.

Initially focused on readability, simplicity, and software engineering.

In the 2000s: NumPy, SciPy, pandas, matplotlib emerged.

Later: scikit-learn (2010), TensorFlow (2015), PyTorch (2016).

Python became dominant in **machine learning & AI**, then spread into data analysis.

WHY LEARN R IN 2025?

- Tailor-made for data analysis and statistics.
- Rich ecosystem: tidyverse, caret, sf, Shiny, Quarto.
- Beautiful, customizable graphics (ggplot2).
- Reproducibility and transparency – publish-ready outputs.
- Academic and business relevance: used by researchers, governments, NGOs, and companies worldwide.
- **Examples:** epidemiologists modeling pandemics, financial analysts building risk models, ecologists studying biodiversity, NGOs analyzing survey data.

PROGRAMMING BILINGUALITY

Knowing **R** and **Python** makes you flexible and employable.

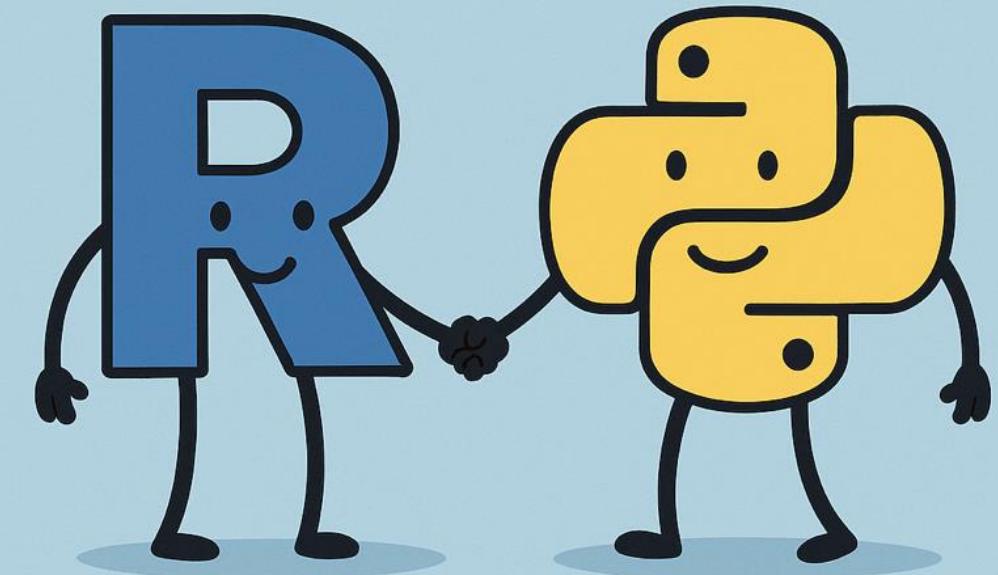
You can choose the best tool for the job: R for stats & visualization, Python for ML & deployment.

Learning two languages improves your understanding of **language structures**.

Easier to learn additional tools later (SQL, Julia, etc.).

Ability to compare solutions develops critical thinking in data science.

R COURSE FOR DATA SCIENTISTS



R VS PYTHON

R is better for:

Data wrangling (`dplyr`, `data.table`)

Statistical models & econometrics

Publication-ready plots (`ggplot2`, `lattice`)

Reproducible workflows (`RMarkdown`,
`Quarto`)

Python is better for:

Machine learning & AI frameworks
(`TensorFlow`, `PyTorch`)

Software engineering & deployment

Takeaway: A good data scientist
knows both. R gives you insights fast.

DEMO: DATA IN → ANALYSIS → VISUALIZATION → REPORT

R:

```
library(tidyverse)  
mtcars %>% ggplot(aes(hp, mpg)) + geom_point()
```

Python:

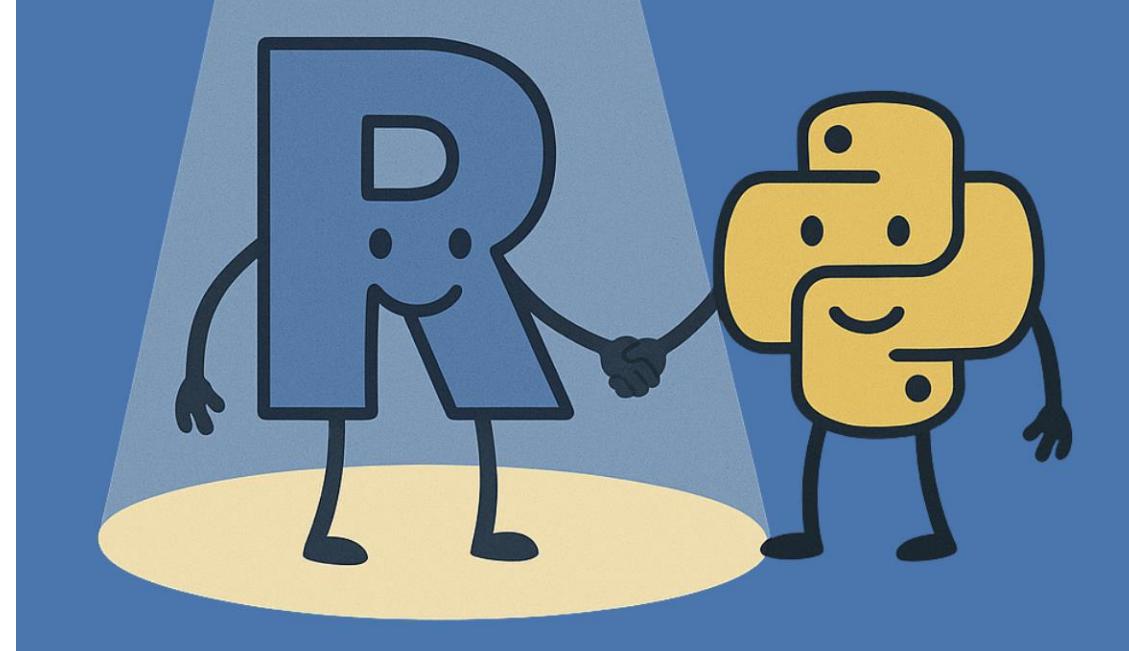
```
import pandas as pd  
import matplotlib.pyplot as plt
```

```
mtcars = pd.read_csv("mtcars.csv")  
plt.scatter(mtcars.hp, mtcars.mpg)  
plt.show()
```

- Python usually requires more setup & libraries for data analysis.
- R gives direct, elegant workflows for statistics.

WHAT MAKES R UNIQUE

- First language where **statistics came first, code second.**
- Designed by statisticians for real-world data.
- Academic heritage → cutting-edge methods often appear first in R.
- Flexible: from quick scripts to interactive dashboards + tons of packages
- **Research-driven:** best solutions in spatial analysis and quantitative finance usually arrive in R first, as it's easier to extend the ecosystem compared to Python.

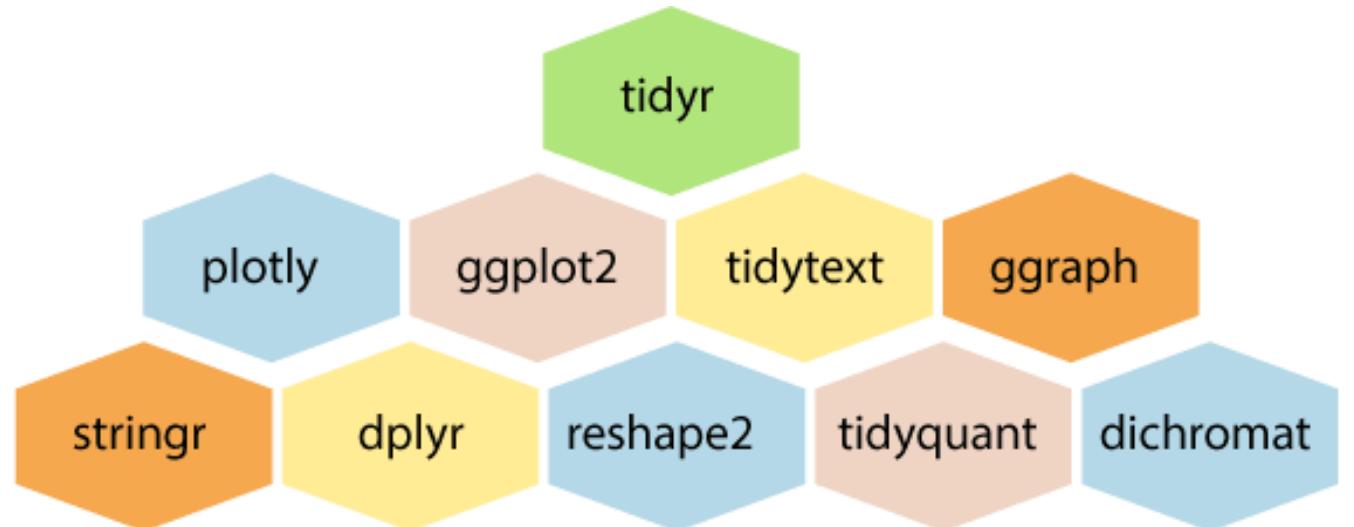


ADDITIONAL PACKAGES

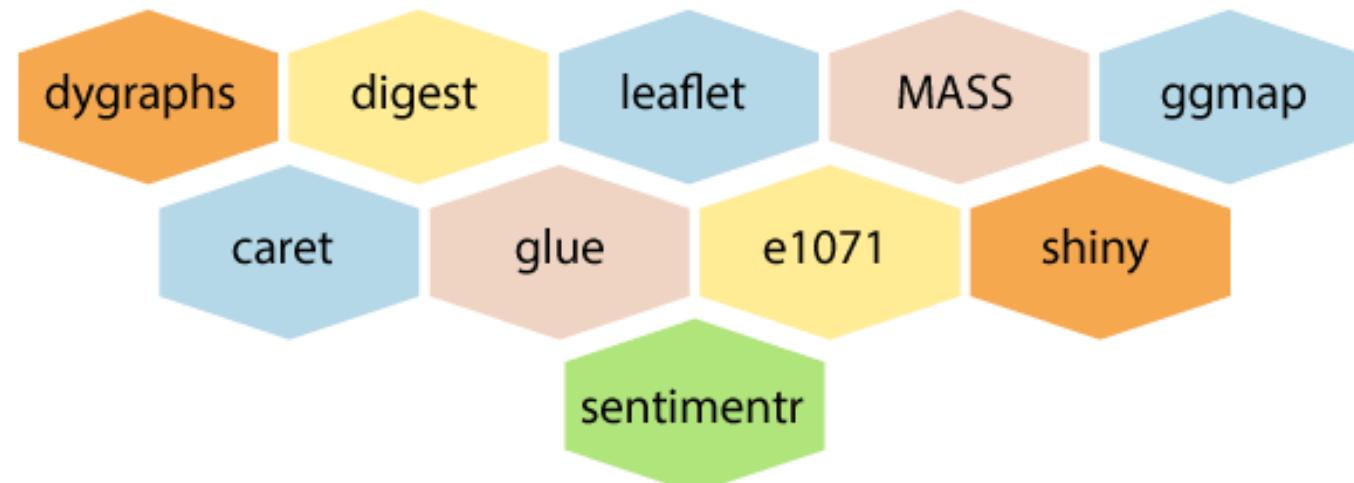
You can easily extend R possibilities with the usage of **packages**.

Packages are usually written by other R community members. They allow to use additional functions and methods.

Because R is a free software – adding new elements to it is legal and simple. Thanks to that, R potential can be enhanced fast with the help of its users.



list of Packages



Package 4

Package 3

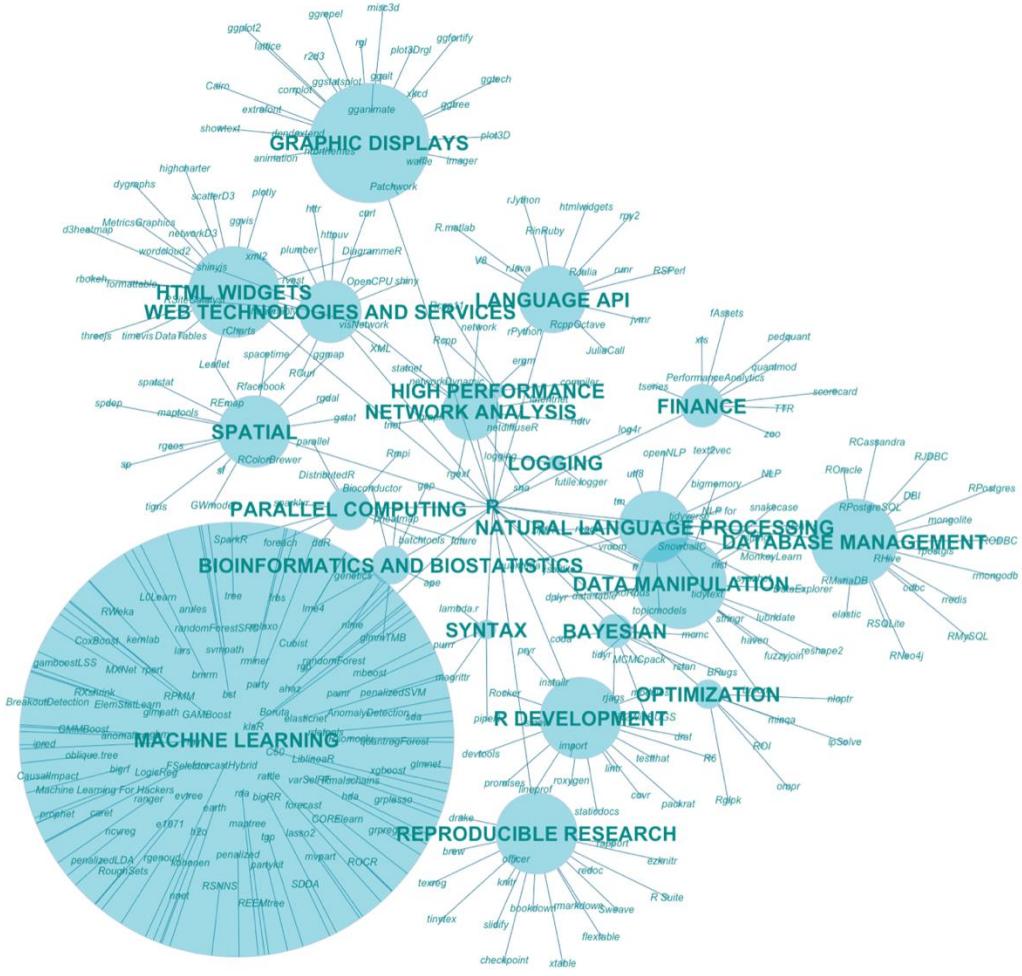
Package 2

Package 1

R language



CRAN Task Views
has 40 topics for
3,299 R packages



Awesome list of 324 R packages
in 20 catagories

Source: <https://awesomer.com>



Source: <https://cran.r-project.org>

TIDYVERSE PACKAGES

Import → Clean → Analyze → Visualize → Report

readr, dplyr, tidyr, ggplot2, stringr ...

One consistent grammar for data science.

Why it's a big deal: tidyverse unifies data manipulation, visualization, and reporting into one coherent framework.

Makes R code easier to read and share – closer to plain English.

Encourages reproducibility and collaboration.

Stands out from Python's ecosystem, where similar functions are spread across many libraries with less consistency.



WHAT YOU'LL GAIN

By the end of this course, you will:

- Understand R basics (objects, functions, tidyverse).
- Be able to analyze datasets in R.
- Create clear, reproducible visualizations & reports.
- Be equipped for advanced methods (ML, econometrics).

R COURSE FOR DATA SCIENTISTS



WHY CODE IF CHATGPT EXISTS?

AI is powerful, but **understanding code is critical**:

- You need to know what to ask and how to check results.
- Code literacy = ability to spot mistakes and bias.
- Employers value *skills*, not just AI prompts.

Coding builds problem-solving, logic, and independence.

ChatGPT can support your coding, but cannot replace your expertise.

In this course: we focus on building your own solid basics — don't rely on AI now, so you gain lasting skills for the future.

MOTIVATION

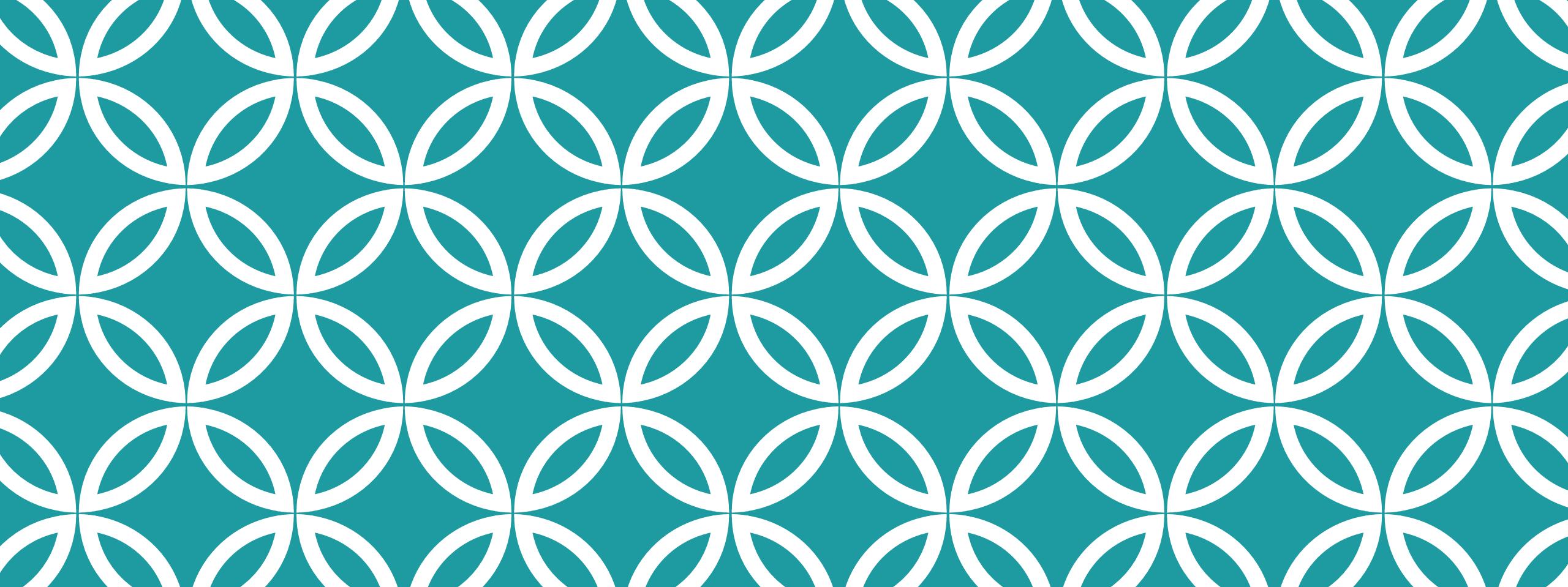
R is not just a language – it's a data scientist's toolbox.

Fast from raw data to publication-ready results.

Perfect for research, academia, and applied business analytics.

Once you learn R, you'll never fear messy data again.

*R opens the door to data-driven discovery.
Ready to start?*



R ENVIRONMENT

Packages and more

WHERE TO FIND INFORMATION ABOUT R?

<https://www.r-project.org/> - main website about R project, information about current versions, description of the language, reports from the recent changes and documentation

<https://cran.r-project.org/> - downloading the newest R version (Linux, MacOS, Windows)

<https://cran.r-project.org/web/views/> - Task Views – thematical catalog of the packages

<https://cran.r-project.org/web/packages/MASS/index.html> - websites regarding given packages (e.g. MASS package)

<https://rseek.org/> - search engine for packages and posts about R

<https://www.r-bloggers.com/> - blog of R community

<https://www.r-project.org/> - main website about R project, information about current versions, description of the language, reports from the recent changes and documentation

Detailed information about R



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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 **Information regarding recent R versions (new version available every 3-4 months)**

- [R version 4.1.1 \(Kick Things\) prerelease versions](#) will appear starting Saturday 2021-07-31.
Final release is scheduled for Tuesday 2021-08-10.
- [R version 4.1.0 \(Camp Pontanezen\)](#) has been released on 2021-05-18.
- [R version 4.0.5 \(Shake and Throw\)](#) was released on 2021-03-31.
- Thanks to the organisers of useR! 2020 for a successful online conference. Recorded tutorials and talks from the conference are available on the [R Consortium YouTube channel](#).
- You can support the R Foundation with a renewable subscription as a [supporting member](#)

News via Twitter

[News from the R Foundation](#)

Documentation and help pages



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The Comprehensive R Archive Network

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 \(Debian, Fedora/Redhat, Ubuntu\)](#) [Links for the newest R installation](#)
- [Download R for macOS](#)
- [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 (2021-05-18, Camp Pontanezen) [R-4.1.0.tar.gz](#), read [what's new](#) in the latest version.
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- Source code of older versions of R is [available here](#).
- Contributed extension [packages](#)

CRAN Task Views

CRAN task views aim to provide some guidance which packages on CRAN are relevant for tasks related to a certain topic. They give a brief overview of the included packages and can be automatically installed using the [ctv](#) package. The views are intended to have a sharp focus so that it is sufficiently clear which packages should be included (or excluded) - and they are *not* meant to endorse the "best" packages for a given task.

- To automatically install the views, the [ctv](#) package needs to be installed, e.g., via

```
install.packages("ctv")
```

and then the views can be installed via `install.views` or `update.views` (where the latter only installs those packages are not installed and up-to-date), e.g.,

```
ctv::install.views("Econometrics")
```

```
ctv::update.views("Econometrics")
```

- The task views are maintained by volunteers. You can help them by suggesting packages that should be included in their task views. The contact e-mail addresses are listed on the individual task view pages.
- For general concerns regarding task views contact the [ctv](#) package maintainer.

Topics [Thematic list of packages in R](#)

Bayesian	Bayesian Inference
ChemPhys	Chemometrics and Computational Physics
ClinicalTrials	Clinical Trial Design, Monitoring, and Analysis
Cluster	Cluster Analysis & Finite Mixture Models
Databases	Databases with R
DifferentialEquations	Differential Equations
Distributions	Probability Distributions
Econometrics	Econometrics
Environmetrics	Analysis of Ecological and Environmental Data
ExperimentalDesign	Design of Experiments (DoE) & Analysis of Experimental Data
ExtremeValue	Extreme Value Analysis
Finance	Empirical Finance
FunctionalData	Functional Data Analysis

Maintainer: Dirk Eddelbuettel

Contact: [Dirk.Eddelbuettel at R-project.org](mailto:Dirk.Eddelbuettel@R-project.org)

Version: 2021-08-05

URL: <https://CRAN.R-project.org/view=Finance>

This CRAN Task View contains a list of packages useful for empirical work in Finance, grouped by topic.

Description of the thematical group

Besides these packages, a very wide variety of functions suitable for empirical work in Finance is provided by both the basic R system (and its set of recommended core packages), and a number of other packages on the Comprehensive R Archive Network (CRAN). Consequently, several of the other CRAN Task Views may contain suitable packages, in particular the [Econometrics](#), [Multivariate](#), [Optimization](#), [Robust](#), [SocialSciences](#) and [TimeSeries](#) Task Views.

The `ctv` package supports these Task Views. Its functions `install.views` and `update.views` allow, respectively, installation or update of packages from a given Task View; the option `coreOnly` can restrict operations to packages labeled as *core* below.

Contributions are always welcome, and encouraged. Since the start of this CRAN task view in April 2005, most contributions have arrived as email suggestions. The source file for this particular task view file now also reside in a GitHub repository (see below) so that pull requests are also possible.

Standard regression models

Subcategories with listed packages, allowing for making certain calculations

- A detailed overview of the available regression methodologies is provided by the [Econometrics](#) task view. This is complemented by the [Robust](#) task view, which focuses on more robust and resistant methods.
- Linear models such as ordinary least squares (OLS) can be estimated by `lm()` (from the `stats` package contained in the basic R distribution). Maximum Likelihood (ML) estimation can be undertaken with the standard `optim()` function. Many other suitable methods are listed in the [Optimization](#) view. Non-linear least squares can be estimated with the `nls()` function, as well as with `nlme()` from the [nlme](#) package.
- For the linear model, a variety of regression diagnostic tests are provided by the [car](#), [lmtest](#), [strucchange](#), [urca](#), and [sandwich](#) packages. The [Rcmdr](#) package provide user interfaces that may be of interest as well.

Time series

Subcategories with listed packages, allowing for making certain calculations

- A detailed overview of tools for time series analysis can be found in the [TimeSeries](#) task view. Below a brief overview of the most important methods in finance is given.
- Classical time series functionality is provided by the `arima()` and `KalmanLike()` commands in the basic R distribution.
- The [dse](#) and [timsac](#) packages provide a variety of more advanced estimation methods; [fracdiff](#) can estimate fractionally integrated series; [longmemo](#) covers related material.
- For volatility modeling, the standard GARCH(1,1) model can be estimated with the `garch()` function in the [tseries](#) package. Rmetrics (see below) contains the [fGarch](#) package which has additional models. The [rugarch](#) Link forwarding to the package's website (with documentation) as ARFIMA, in-mean, external regressors and various other specifications; with methods for fit, forecast, simulation, inference and plotting are provided too. The [rmgarch](#) builds on it to provide the ability to estimate several multivariate GARCH models. The [betategarch](#) package can estimate and simulate the Beta-t-EGARCH model by Harvey. The [bayesGARCH](#)

MASS: Support Functions and Datasets for Venables and Ripley's MASS

Functions and datasets to support Venables and Ripley, "Modern Applied Statistics with S" (4th edition, 2002)

Name and short description of
the package

Version: 7.3-54

Priority: recommended

Depends: R (>= 3.3.0), grDevices, graphics, stats, utils

Imports: methods

Suggests: lattice, nlme, nnet, survival

Published: 2021-05-03

Author: Brian Ripley [aut, cre, cph], Bill Venables [ctb], Douglas M. Bates [ctb], Kurt Hornik [trl] (partial port ca 1998), Albrecht Gebhardt [trl] (partial port ca 1998), David Firth [ctb]

Maintainer: Brian Ripley <ripley at stats.ox.ac.uk>

Contact: <MASS@stats.ox.ac.uk>

License: [GPL-2](#) | [GPL-3](#)

URL: <http://www.stats.ox.ac.uk/pub/MASS4/>

NeedsCompilation: yes

Citation: [MASS citation info](#)

Materials: [NEWS](#)

In views: [Distributions](#), [Econometrics](#), [Environmetrics](#), [Multivariate](#), [NumericalMathematics](#), [Psychometrics](#), [Robust](#), [SocialSciences](#), [TeachingStatistics](#)

CRAN checks: [MASS results](#)

Dependencies and requirements of given package (including the R version)

TaskViews this package belongs to

Downloads:

Reference manual: [MASS.pdf](#) Documentation! Your greatest friend in programming and the most reliable source of knowledge!!!

Package source: [MASS_7.3-54.tar.gz](#)

Windows binaries: r-devel: [MASS_7.3-54.zip](#), r-release: [MASS_7.3-54.zip](#), r-oldrel: [MASS_7.3-54.zip](#)

macOS binaries: r-release (arm64): [MASS_7.3-54.tgz](#), r-release (x86_64): [MASS_7.3-54.tgz](#), r-oldrel: [MASS_7.3-54.tgz](#)

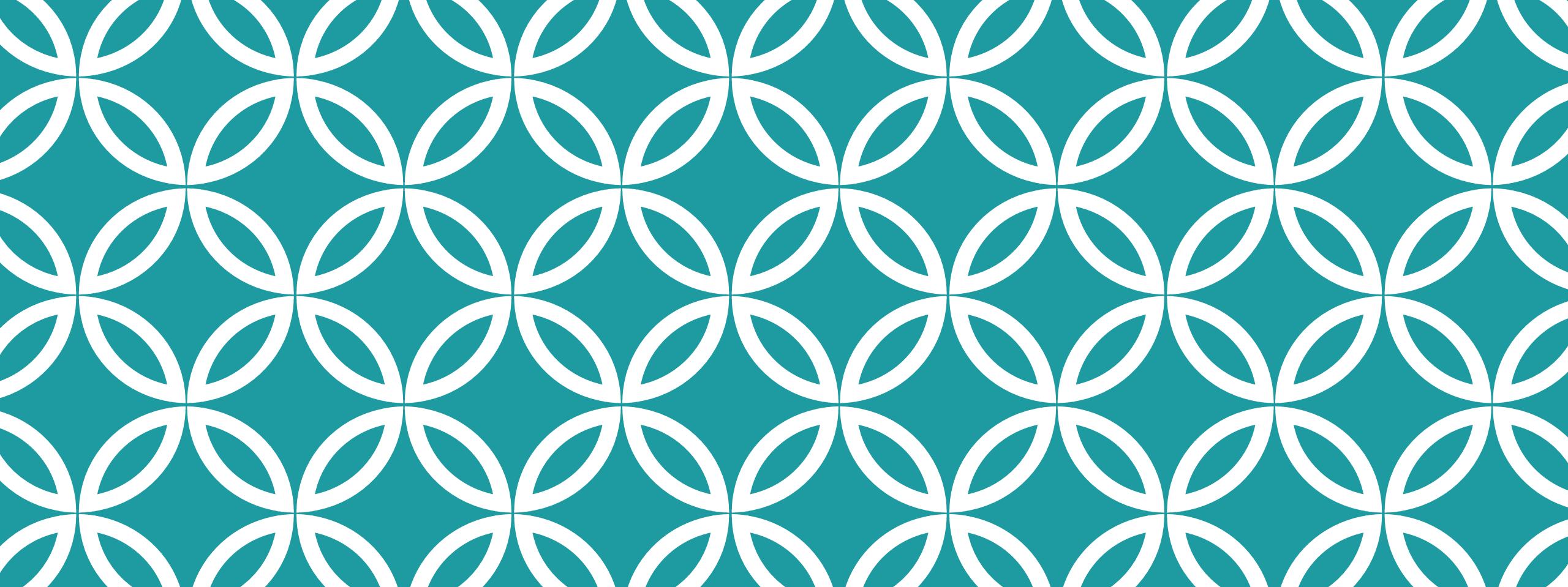
Old sources: [MASS archive](#)

Previous versions of the package

Reverse dependencies:

Reverse depends: [abc](#), [ABCp2](#), [acfMPPeriod](#), [AdaptFitOS](#), [addhaz](#), [anchors](#), [Aoptbdtvc](#), [arm](#), [aSPU](#), [ASSET](#), [BALLI](#), [bapred](#), [bayeslongitudinal](#), [bayespref](#), [bayess](#), [BayesVarSel](#), [bbemkr](#), [BCLustLonG](#), [BCSub](#), [bhm](#), [biclust](#), [bigReg](#), [BioMark](#), [biostat3](#), [biotools](#), [bivrP](#), [biwt](#), [Blendstat](#), [blmeco](#), [bmem](#), [BNPTSclust](#), [Boom](#), [bootspecdens](#), [bootStepAIC](#), [Boptbd](#), [BSGS](#), [bSims](#), [calibrate](#), [cap](#), [caper](#), [capushe](#), [CARBayes](#), [CARBayesST](#), [catdata](#), [CBPS](#), [ccda](#), [CEoptim](#), [CepLDA](#), [changePointsVar](#), [CircStats](#), [clickstream](#), [CLME](#), [clusterGeneration](#), [clusterSim](#), [cold](#), [coloredICA](#), [CompR](#), [convevol](#), [COSINE](#), [countgmifs](#), [CovSel](#), [cquad](#), [CRTgeeDR](#), [csurvey](#), [ctl](#), [CVEK](#), [cwm](#), [DCluster](#), [ddalpha](#), [Deducer](#), [deltaPlotR](#), [depmix](#), [depmixS4](#), [DepthProc](#), [designmatch](#), [Devore7](#), [dhglm](#), [distrMod](#), [dml](#), [dmm](#), [dmt](#), [DoubleCone](#), [Dowd](#), [dr](#), [drc](#), [DTRlearn2](#), [EDFIR](#), [EDISON](#),

Other packages which utilize the functions from this package



R INSTALLATION

Installing R for the first time on a given machine



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- [Download R for Windows](#)

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- Source code of older versions of R is [available here](#).
- Contributed extension [packages](#)

WINDOWS

R for Windows

Subdirectories:

[base](#)

Binaries for base distribution. This is what you want to [install R for the first time](#).

[contrib](#)

Binaries of contributed CRAN packages (for R $\geq 2.13.x$; managed by Uwe Ligges). There is also information on [third party software](#) available for CRAN Windows services and corresponding environment and make variables.

[old contrib](#)

Binaries of contributed CRAN packages for outdated versions of R (for R $< 2.13.x$; managed by Uwe Ligges).

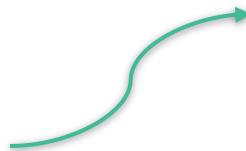
[Rtools](#)

Tools to build R and R packages. 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 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.



R-4.3.1 for Windows

[Download R-4.3.1 for Windows](#) (79 megabytes, 64 bit)

[README on the Windows binary distribution](#)

[New features in this version](#)

This build requires UCRT, which is part of Windows since Windows 10 and Windows Server 2016. On older systems, UCRT has to be installed manually from [here](#).

If you want to double-check that the package you have downloaded matches the package distributed by CRAN, you can compare the [md5sum](#) of the .exe to the [fingerprint](#) on the master server.

Frequently asked questions

- [Does R run under my version of Windows?](#)
- [How do I update packages in my previous version of 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 in the [r-devel snapshot build](#).
- [Previous releases](#)

Note to webmasters: A stable link which will redirect to the current Windows binary release is
<CRAN MIRROR>/bin/windows/base/release.html.

Last change: 2023-06-16

Download the file and go through the installation procedure (choose default options)

MAC OS

R for macOS

This directory contains binaries for the base distribution and of R and packages to run on macOS. R and package binaries for R versions older than 4.0.0 are only available from the [CRAN archive](#) so users of such versions should adjust the CRAN mirror setting (<https://cran-archive.r-project.org>) accordingly.

Note: Although we take precautions when assembling binaries, please use the normal precautions with downloaded executables.

R 4.4.1 "Race for Your Life" released on 2024/06/14

Please check the integrity of the downloaded package by checking the signature:

`pkgutil --check-signature R-4.4.1-arm64.pkg`

in the *Terminal* application. If Apple tools are not available you can check the SHA1 checksum of the downloaded image:
`openssl sha1 R-4.4.1-arm64.pkg`

Latest release:

Choose a version appropriate for your system

For Apple silicon (M1-3) Macs:

[R-4.4.1-arm64.pkg](#)

SHA1-

hash: 616560b17092bbdd8b814d9ed92d098e52204830
(ca. 94MB, notarized and signed)

For older Intel Macs:

[R-4.4.1-x86_64.pkg](#)

SHA1-

hash: e66eb09244121d7db7f8fb41d3c06a7579fc93b5
(ca. 96MB, notarized and signed)

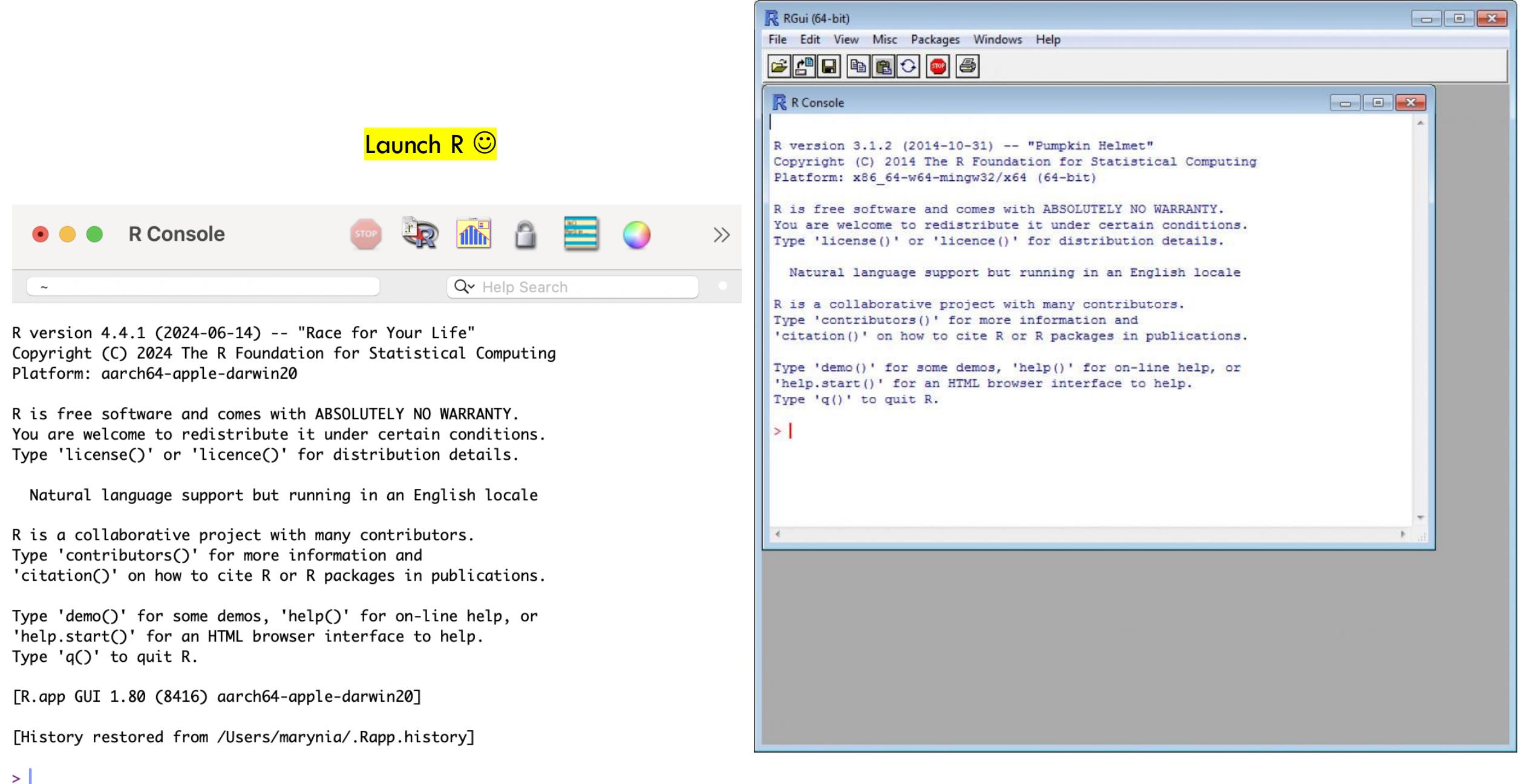
R 4.4.1 binary for macOS 11 (**Big Sur**) and higher, signed and notarized packages.

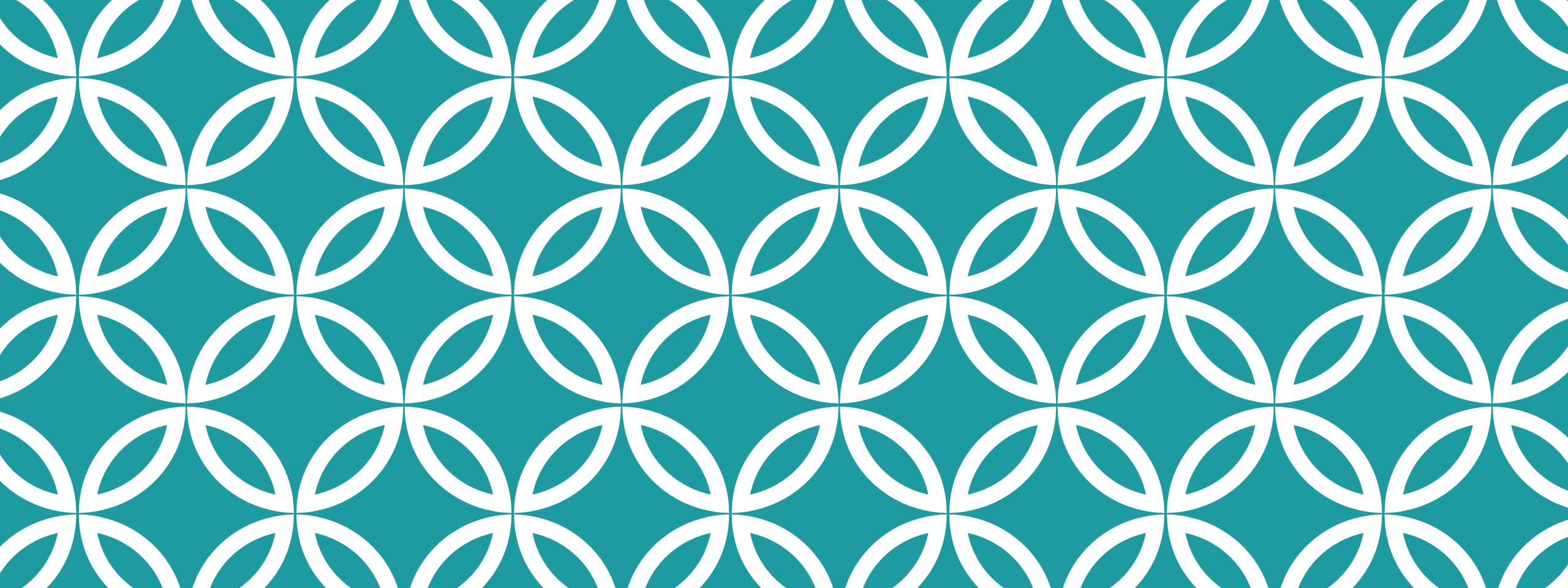
Contains R 4.4.1 framework, R.app GUI 1.80, Tcl/Tk 8.6.12 X11 libraries and Texinfo 6.8. The latter two components are optional and can be omitted when choosing "custom install", they are only needed if you want to use the `tcltk` R package or build package documentation from sources.

macOS Ventura users: there is a known bug in Ventura preventing installations from some locations without a prompt. If the installation fails, move the downloaded file away from the *Downloads* folder (e.g., to your home or Desktop).

Note: the use of X11 (including `tcltk`) requires [XQuartz](#) (version 2.8.5 or later). Always re-install XQuartz when upgrading your macOS to a new major version.

Download the file and go through the installation procedure





UPDATE R

Updating R on a machine
with previous version of R

R Console

R version 4.0.4 (2021-02-15) -- "Lost Library Book"

Copyright (C) 2021 The R Foundation for Statistical Computing

Platform: x86_64-w64-mingw32/x64 (64-bit)

R jest oprogramowaniem darmowym i dostarczany jest BEZ JAKIEJKOLWIEK GWARANCJI.

Możesz go rozpowszechniać pod pewnymi warunkami.

Wpisz 'license()' lub 'licence()' aby uzyskać szczegóły dystrybucji.

R jest projektem kolaboracyjnym z wieloma uczestnikami.

Wpisz 'contributors()' aby uzyskać więcej informacji oraz

'citation()' aby dowiedzieć się jak cytować R lub pakiety R w publikacjach.

Wpisz 'demo()' aby zobaczyć demo, 'help()' aby uzyskać pomoc on-line, lub

'help.start()' aby uzyskać pomoc w przeglądarce HTML.

Wpisz 'q()' aby wyjść z R.

> |

Open your current R version

R Console

```
R version 4.0.4 (2021-02-15) -- "Lost Library Book"
Copyright (C) 2021 The R Foundation for Statistical Computing
Platform: x86_64-w64-mingw32/x64 (64-bit)
```

```
R jest oprogramowaniem darmowym i dostarczany jest BEZ JAKIEJKOLWIEK GWARANCJI.
Możesz go rozpowszechniać pod pewnymi warunkami.
Wpisz 'license()' lub 'licence()' aby uzyskać szczegóły dystrybucji.
```

```
R jest projektem kolaboracyjnym z wieloma uczestnikami.
Wpisz 'contributors()' aby uzyskać więcej informacji oraz
'citation()' aby dowiedzieć się jak cytować R lub pakiety R w publikacjach
```

```
Wpisz 'demo()' aby zobaczyć demo, 'help()' aby uzyskać pomoc on-line, lub
'help.start()' aby uzyskać pomoc w przeglądarce HTML.
```

Wp:

Make sure that you have installed the package „installr”

```
> install.packages("installr")
Instalowanie pakietu w 'C:/Users/maria/Documents/R/win-library/4.0'
(ponieważ 'lib' nie jest określony)
--- Proszę wybrać serwer lustrzany CRAN do użycia w tej sesji ---
```

Secure CRAN mirrors

- 0-Cloud [https]
- Australia (Canberra) [https]
- Australia (Melbourne 1) [https]
- Australia (Melbourne 2) [https]
- Australia (Perth) [https]
- Austria [https]**
- Belgium (Brussels) [https]
- Brazil (BA) [https]
- Brazil (PR) [https]
- Brazil (RJ) [https]
- Brazil (SP 1) [https]
- Brazil (SP 2) [https]
- Bulgaria [https]
- Canada (MB) [https]
- Canada (ON 2) [https]
- Chile (Santiago) [https]
- China (Beijing 2) [https]
- China (Hefei) [https]
- China (Hong Kong) [https]
- China (Guangzhou) [https]
- China (Lanzhou) [https]
- China (Nanjing) [https]
- China (Shanghai 1) [https]
- China (Shanghai 2) [https]
- China (Shenzhen) [https]
- Costa Rica [https]
- Cyprus [https]
- Czech Republic [https]
- Denmark [https]
- East Asia [https]
- Ecuador (Cuenca) [https]
- Ecuador (Quito) [https]
- Estonia [https]
- France (Lyon) [https]
- France (Lyon 2) [https]
- France (Marseille) [https]
- France (Montpellier) [https]
- France (Paris 1) [https]

OK

Anuluj

**Choose server, from which you will
be downloading the package (any
server you'd like)**

```
R Console

próbowanie adresu URL 'https://cran.wu.ac.at/bin/windows/contrib/4.0/installr_0$ ^  
Content type 'application/zip' length 350806 bytes (342 KB)  
downloaded 342 KB

pakiet 'installr' został pomyślnie rozpakowany oraz sumy MD5 zostały sprawdzone  
Pobrane pakiety binarne są w  
    C:\Users\maria\AppData\Local\Temp\RtmpoL44JK\downloaded_packages  
> library(installr)

Welcome to installr version 0.23.2

More information is available on the installr project website:  
https://github.com/talgalili/installr/

Contact: <tal.galili@gmail.com>
Suggestions and bug-reports can be submitted at: https://github.com/talgalili/installr/issues

To suppress this message use:  
suppressPackageStartupMessages(library(installr))

Komunikat ostrzegawczy:  
pakiet 'installr' został zbudowany w wersji R 4.0.5
> updateR() Run updateR() command
```

Information X

i There is a newer version of R for you to download!

You are using R version: 4.0.4 (2021-02-15)
And the latest R version is: 4.1.0 (2021-05-18)

OK

Information

X



There is a newer version of R for you to download!
You are using R version: 4.0.4 (2021-02-15)
And the latest R version is: 4.1.0 (2021-05-18)

OK

C.compares the current R version installed on a given machine to the newest available version.
If your R is up-to-date the process ends here.

Question



Do you wish to see the NEWS regarding this new version of R?

YES NO

After clicking “Yes” there will be a website opened in your webbrowser informing you about the changes in R. Choose any.

Question



Do you wish to install the latest version of R?

YES NO

After clicking “Yes” the installation file will be downloading. After running it, the process of new R installation will begin.

49% downloaded

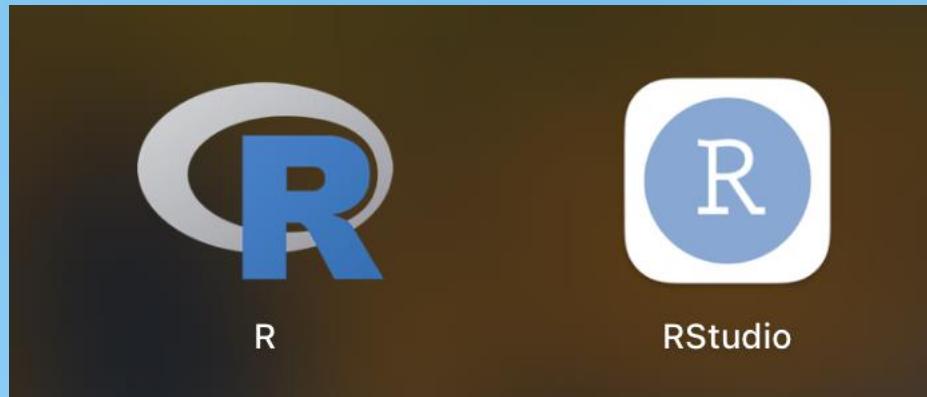
URL: <https://cran.rstudio.com/bin/windows/base/R-4.1.0-win.exe>



There is a newer version of R for you to download!

Compares the current R version installed on a

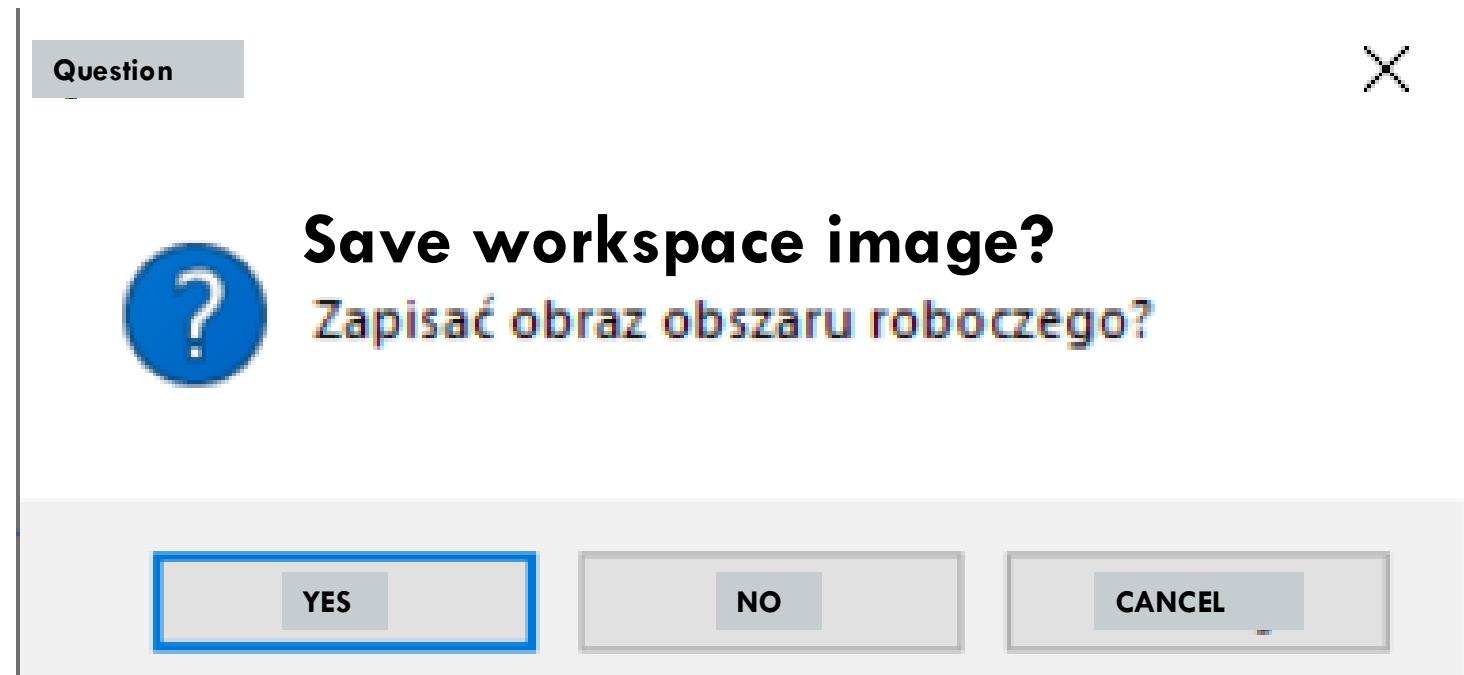
If this process fails on Mac, just go to <https://cloud.r-project.org/bin/macosx/> and download the pkg file with the newest version of R and go through the installation process once again. R in your Launchpad will be replaced with the newest version, and RStudio will use the newest R on your computer as well.

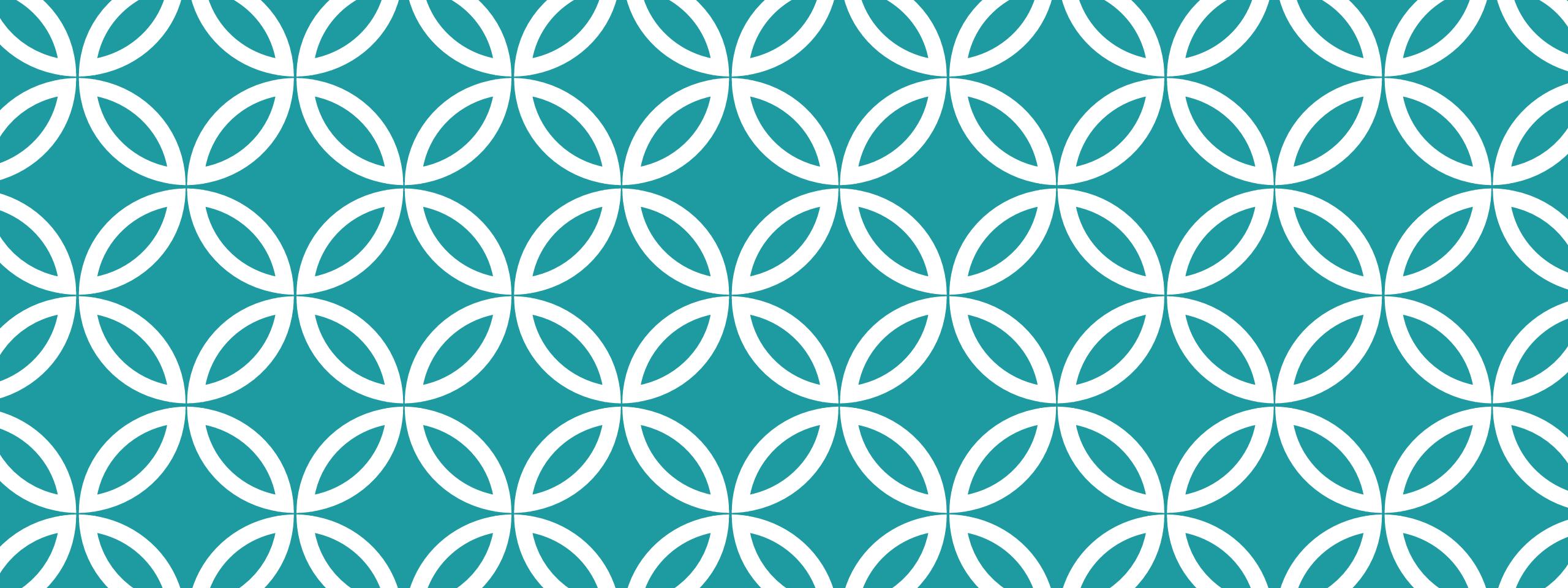
URL: <https://cran.rstudio.com/bin/windows/base/R-4.1.0-win.exe>

WORKSPACE IMAGE

The answer is always: NO.

Instead of saving the “workspace image” and creating unnecessary files, it’s better to save scripts with the used code and/or save given objects and datafiles after modifications with the usage of `save()` function. We will discuss it in the following classes.





R STUDIO

Helpful IDE for writing code and
creating bigger projects in R

RSTUDIO

<https://posit.co/downloads/> (before website rstudio.com, now after rebranding)

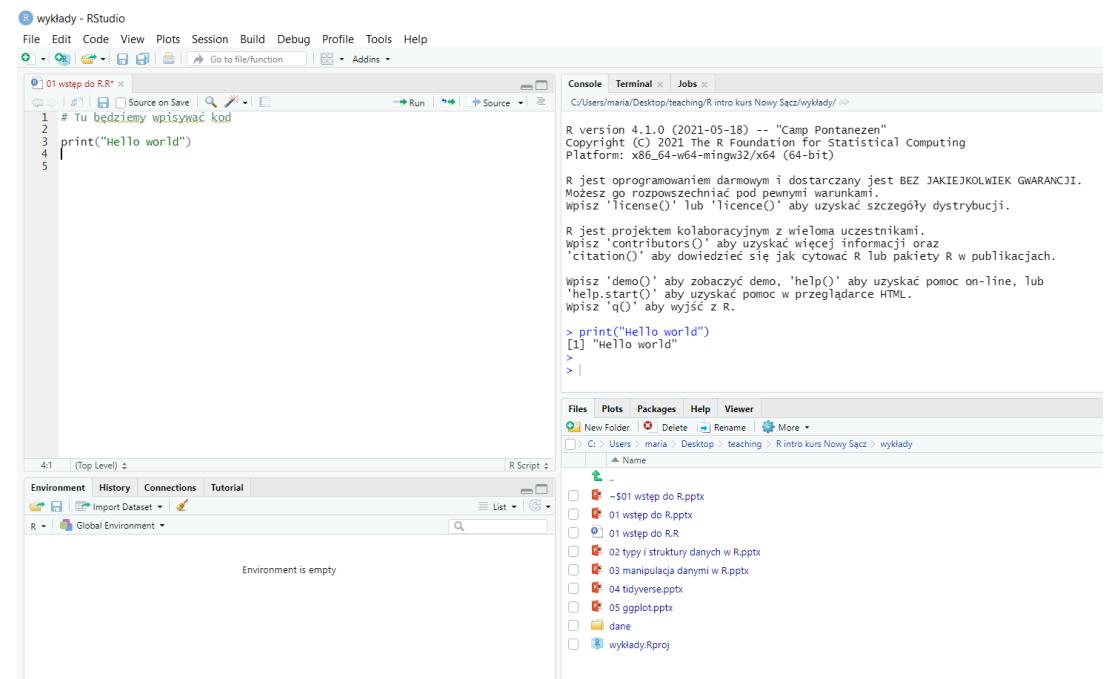
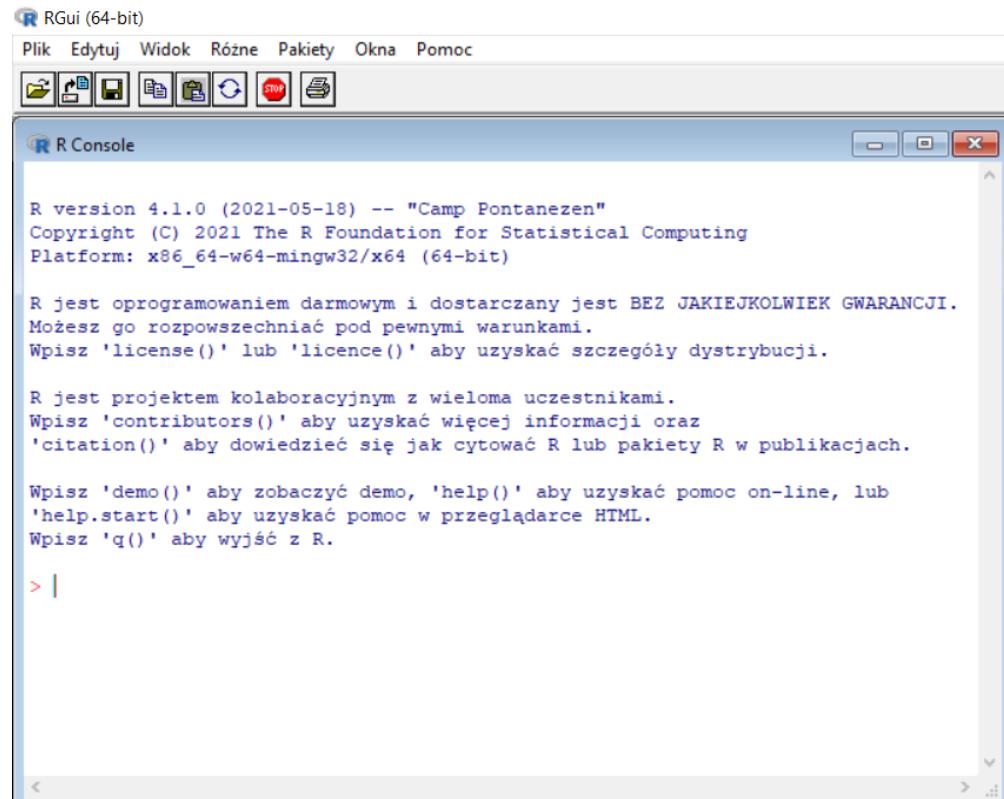
RStudio is an IDE (*integrated development environment*) – environment for writing code in R

It allows for better code management in R, e.g. creating code scripts or checking the syntax

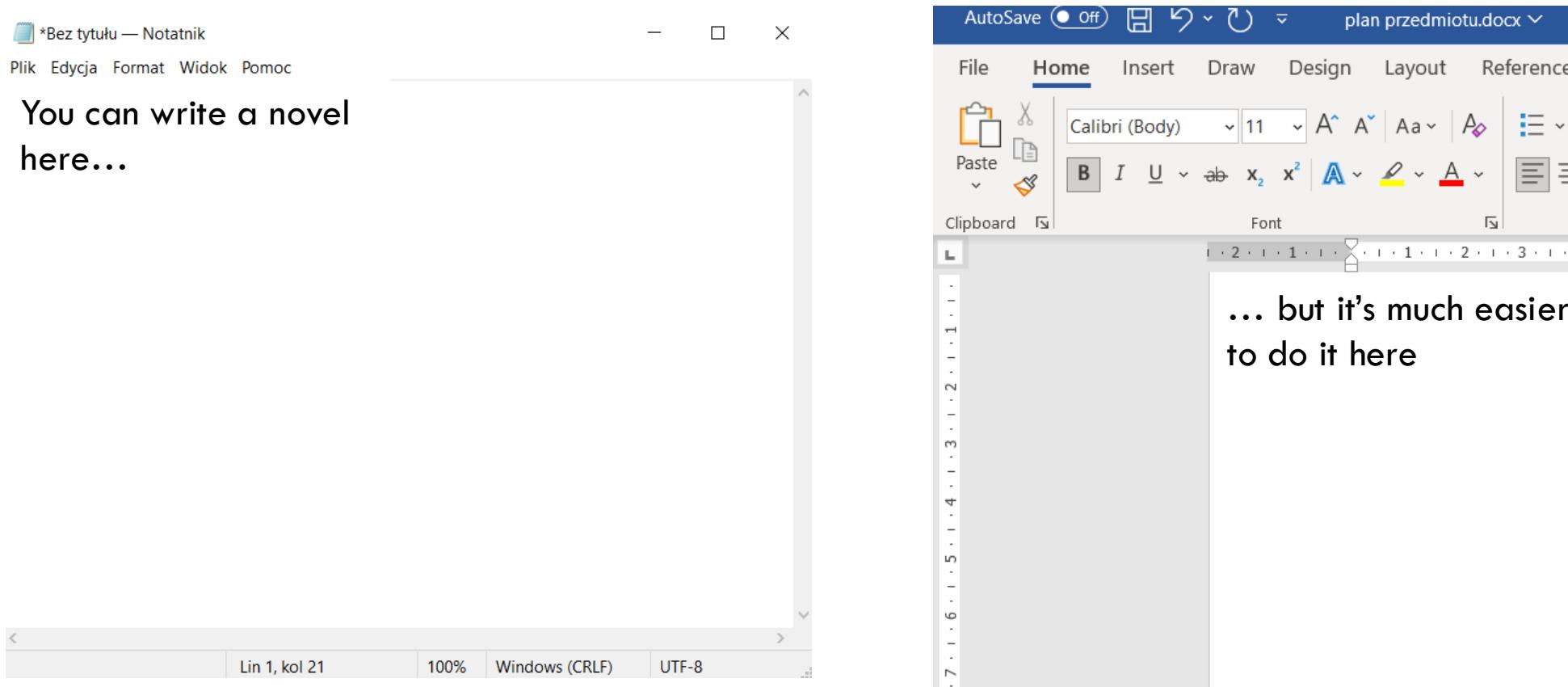
It allows for creating projects, which group individual code scripts and organize work on a bigger programming task

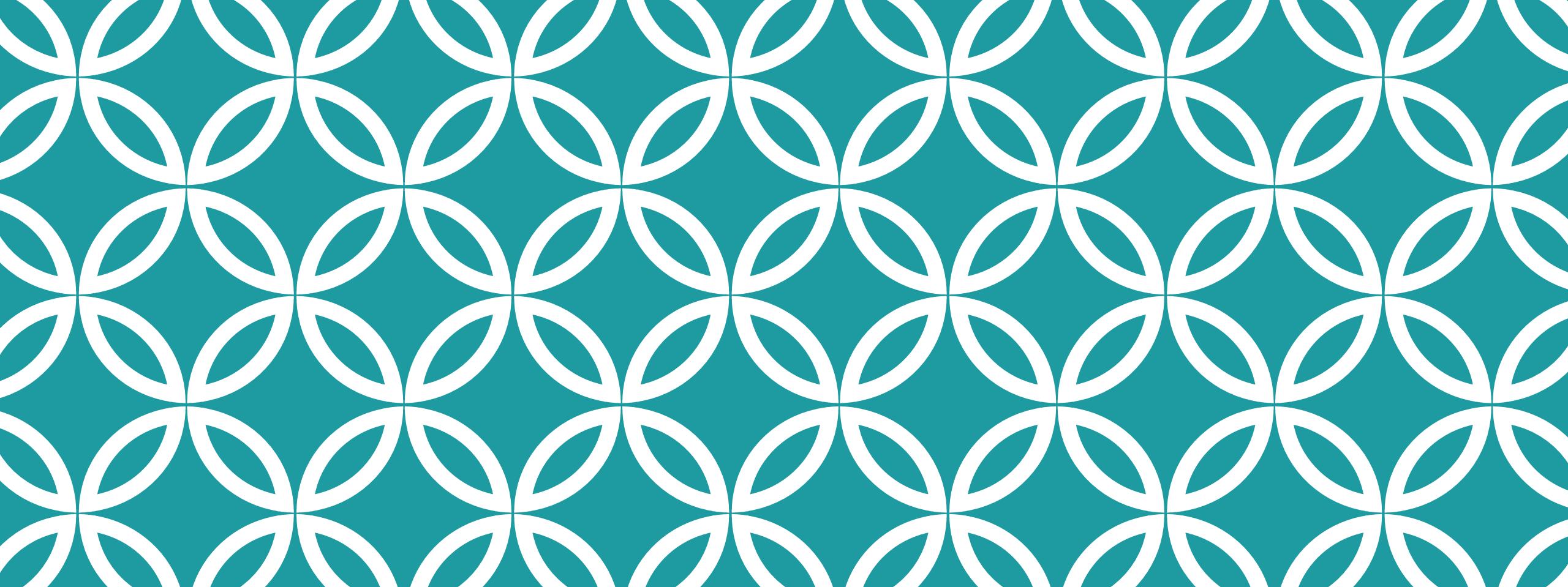
Free solutions available (open source), cross-platform, but commercial versions available as well

DIFFERENCE BETWEEN R AND RSTUDIO . . .



... IS MAINLY THE COMFORT





INSTALLING R STUDIO

To install RStudio you need to have an up-to-date R version **already** installed on your computer.



Open the website of RStudio provider- POSIT <https://posit.co/downloads/> and choose appropriate version

DOWNLOAD

RStudio IDE

The most popular coding environment for R, built with love by Posit.

Used by millions of people weekly, the RStudio integrated development environment (IDE) is a set of tools built to help you be more productive with R and Python. It includes a console, syntax-highlighting editor that supports direct code execution. It also features tools for plotting, viewing history, debugging and managing your workspace.

If you're a professional data scientist and want guidance on adopting open-source tools at your organization, don't hesitate to [book a call with us](#).

[DOWNLOAD RSTUDIO](#)

[DOWNLOAD RSTUDIO SERVER](#)

DOWNLOAD

RStudio Desktop

Used by millions of people weekly, the RStudio integrated development environment (IDE) is a set of tools built to help you be more productive with R and Python.

Don't want to download or install anything? Get started with RStudio on [Posit Cloud for free](#). If you're a professional data scientist looking to download RStudio and also need common enterprise features, don't hesitate to [book a call with us](#).

1: Install R

Make sure that your R is installed already

RStudio requires R 3.3.0+. Choose a version of R that matches your computer's operating system.

2: Install RStudio

Download the newest version of RStudio (the website usually detects a version suitable for your operating system)

[DOWNLOAD RSTUDIO DESKTOP FOR WINDOWS](#)

Size: 212.78 MB | [SHA-256: BCF6B866](#) | Version: 2023.06.2+561 | Released: 2023-08-30

[All Installers and Tarballs](#)

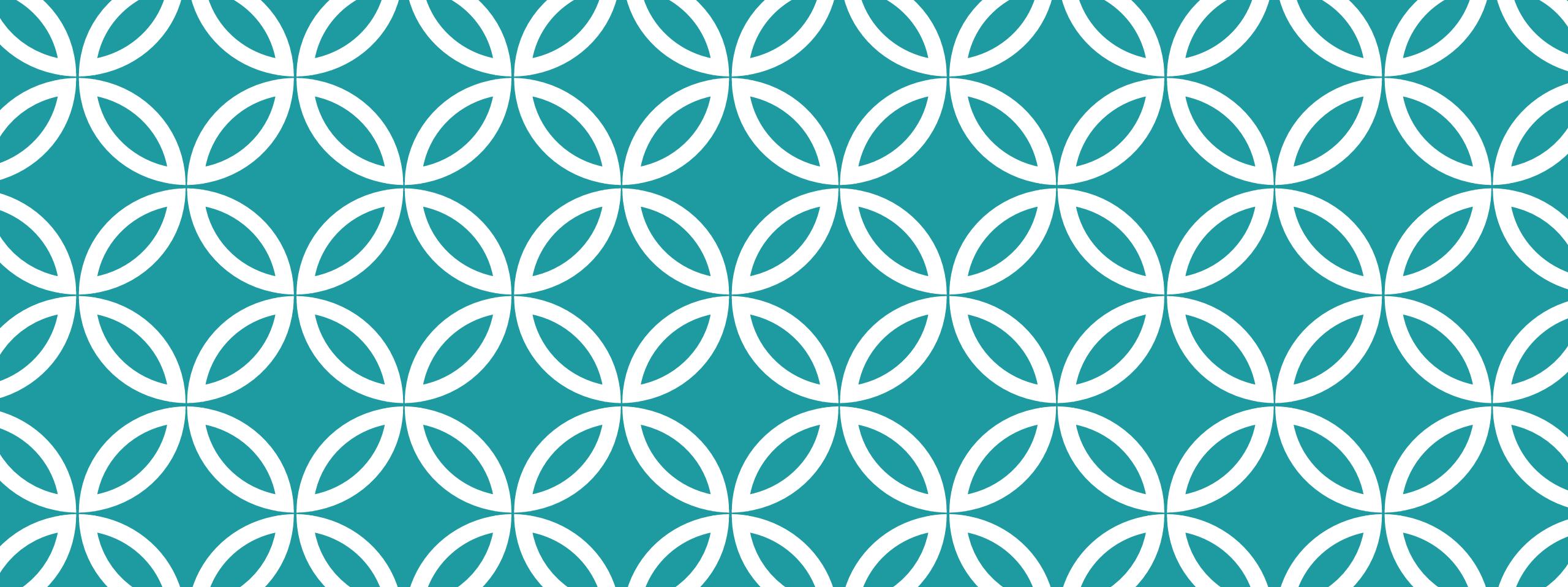
If needed, scroll down and choose suitable installer

OS	Download	Size	SHA-256
Windows 10/11	RSTUDIO-2023.06.2-561.EXE ↓	212.78 MB	BCF6B866
macOS 11+	RSTUDIO-2023.06.2-561.DMG ↓	375.50 MB	ED47CA60
Ubuntu 20/Debian 11	RSTUDIO-2023.06.2-561-AMD64.DEB ↓	146.05 MB	981FCBB3
Ubuntu 22	RSTUDIO-2023.06.2-561-AMD64.DEB ↓	146.60 MB	BB6B3C21
Fedora 19/Red Hat 7	RSTUDIO-2023.06.2-561-X86_64.RPM ↓	162.31 MB	7EAFA813

```
. Name it "profitPerStudent".  
a$students  
When using RStudio you may get a pop-up  
about a software update (regarding IDE). It is  
good to keep RStudio updated, to get the  
newest bugfixes and the most stable version of  
the environment.  
i RStudio 2023.06.2+561 is now available (you're using 2023.06.1+524)  
→ Quit and Download...  
→ Remind Later  
→ Ignore Update  
IMPORTANT! Updating R and updating  
RStudio are two different things. R is the  
heart of our operations. RStudio is just a  
layer on top of it, which makes our work  
a little bit more comfortable.
```

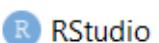
Copyright (C) 2023 The R Foundation for Statistical Computing
Platform: x86_64-w64-mingw32/x64 (64-bit)

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.
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 'help()' for on-line help and 'demo()' for examples.
Type 'help2dgrid()' for help on R packages in your browser interface to R.



WORK IN RSTUDIO

Creating scripts and projects



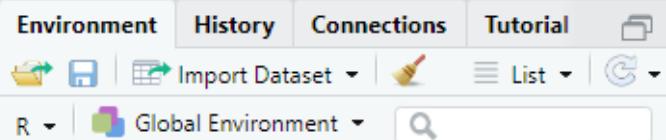
File Edit Code View Plots Session Build Debug Profile Tools Help



Go to file/function



Project: (None)



Environment is empty

Console Terminal x Jobs x

~/

R version 4.1.0 (2021-05-18) -- "Camp Pontanezen"
Copyright (C) 2021 The R Foundation for Statistical Computing
Platform: x86_64-w64-mingw32/x64 (64-bit)

R jest oprogramowaniem darmowym i dostarczany jest BEZ JAKIEJKOL
WIEK GWARANCJI. **Information about R will**
Możesz go rozoznaczać, instalować, itp. i.
Wpisz 'license()' w konsoli, aby uzyskać szczegółowe informacje o licencji. **display in a language chosen** szczegółów dystrybu
cji. **during the R installation**

R jest projektem kolaboracyjnym z wieloma uczestnikami.
Wpisz 'contributors()' aby uzyskać więcej informacji oraz
'citation()' aby dowiedzieć się jak cytować R lub pakiety R w pu
blikacjach.

Wpisz 'demo()' aby zobaczyć demo, 'help()' aby uzyskać pomoc on
line, lub
'help.start()' aby uzyskać pomoc w przeglądarce HTML.
Wpisz 'q()' aby wyjść z R.

> |

Files Plots Packages Help Viewer



Default view of RStudio

File Edit Code View Plots Session Build Debug Profile Tools Help



Hide Toolbar

Project: (None)

Panes

- Actual Size Ctrl+0
- Zoom In Ctrl++
- Zoom Out Ctrl+-
- Switch to Tab... Ctrl+Shift+.
- Next Tab Ctrl+Tab
- Previous Tab Ctrl+Shift+Tab
- First Tab Ctrl+Shift+F11
- Last Tab Ctrl+Shift+F12
- Move Focus to Source Ctrl+1
- Move Focus to Console Ctrl+2
- Move Focus to Terminal Alt+Shift+M
- Move Focus to Help Ctrl+3

- History Ctrl+4
- Show Files Ctrl+5
- Show Plots Ctrl+6
- Show Packages Ctrl+7
- Show Environment Ctrl+8
- Show Viewer Ctrl+9
- Show Connections Ctrl+F5
- Show Tutorial
- Show Jobs
- Show Other Panes

dins

- Show All Panes Ctrl+Alt+Shift+0
- Add Source Column Ctrl+F7
- Console on Left
- Console on Right
- Zoom Left / Center Column Ctrl+Alt+Shift+F12
- Zoom Right Column Ctrl+Alt+Shift+F11
- Zoom Source Ctrl+Shift+1
- Zoom Console Ctrl+Shift+2
- Zoom Help Ctrl+Shift+3
- Zoom History Ctrl+Shift+4
- Zoom Files Ctrl+Shift+5
- Zoom Plots Ctrl+Shift+6
- Zoom Packages Ctrl+Shift+7
- Zoom Environment Ctrl+Shift+8
- Zoom Viewer Ctrl+Shift+9
- Zoom Tutorial Ctrl+Shift+F6
- Zoom Connections Ctrl+Shift+F5
- Adjust Left Splitter
- Adjust Right Splitter
- Adjust Center Splitter
- Adjust Source Column Splitter
- Pane Layout...

Editing the view

(displaying/hiding the panels,

showing console on the right/left,

zoom itd.)

File Edit Code View Plots Session Build Debug Profile Tools Help

Go to file/function

Environment History Connections Tutorial

Import Dataset List

R Global Environment

Environment is empty

R version Copyright Platform:
R jest op WIEK GWARA
Możesz go Wpisz 'lic cji.
R jest pro Wpisz 'con 'citation(blikacjach

Wpisz 'demo()' aby zobaczyć demo, 'help()' aby uzyskać pomoc on-line lub start() aby uzyskać pomoc w przeglądarce HTML.
wpisz 'q()' aby wyjść z R.

Install Packages...
Check for Package Updates...
Version Control
Shell...
Terminal
Jobs
Addins
Keyboard Shortcuts Help Alt+Shift+K
Modify Keyboard Shortcuts...
Show Command Palette Ctrl+Shift+P
Project Options...
Global Options...

Project: (None)

Files Plots Packages Help Viewer

Example: changing the color scheme (dark mode)

The screenshot shows the RStudio interface with the 'Options' dialog box open. The 'Appearance' tab is selected in the left sidebar. In the 'Editor theme:' dropdown, the 'Gob' theme is highlighted. The main workspace displays a dark-themed code editor with the following R code:

```
# plotting of R objects
plot <- function (x, y, ...)
{
  if (is.function(x) &&
      is.null(attr(x, "class")))
  {
    if (missing(y))
      y <- NULL

    # check for ylab argument
    hasylab <- function(...)
      !all(is.na(
        pmatch(names(list(...)),
              "ylab")))

    if (hasylab(...))
      plot.function(x, y, ...)

    else
      plot.function(
        x, y,
        ylab = paste(
          deparse(substitute(x)),
          "(x)"),
        ...)

  }
  else
    UseMethod("plot")
}
```

File Edit Code View Plots Session Build Debug Profile Tools Help

New File

New Project...

Open File... Ctrl+O

Open File in New Column...

Recent Files

Open Project...

Open Project in New Session...

Recent Projects

Import Dataset

Save Ctrl+S

Save As...

Save All Ctrl+Alt+S

Publish...

Print...

Close Ctrl+W

Close All Ctrl+Shift+W

Close All Except Current Ctrl+Alt+Shift+W

Close Project

Quit Session... Ctrl+Q

R Script

Ctrl+Shift+N

Project: (None) ▾

R Notebook

Creating new script (file with the code)

R Markdown...

Shiny Web App...

Plumber API...

C File

C++ File

Header File

Markdown File

HTML File

CSS File

JavaScript File

D3 Script

Python Script

Shell Script

SQL Script

Stan File

Text File

R Sweave

R HTML

R Presentation

R Documentation...

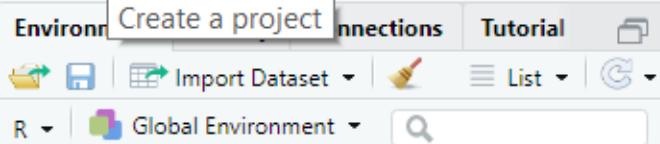


File Edit Code View Plots Session Build Debug Profile Tools Help



Addins

Project: (None)



Environment is empty

Creating new project

Console Terminal x Jobs x

~/

```
R version 4.1.0 (2021-05-18) -- "Camp Pontanezen"  
Copyright (C) 2021 The R Foundation for Statistical Computing  
Platform: x86_64-w64-mingw32/x64 (64-bit)
```

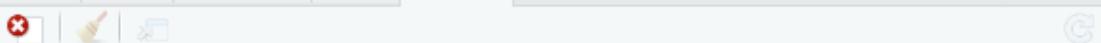
R jest oprogramowaniem darmowym i dostarczany jest BEZ JAKIEJKOL
WIEK GWARANCJI.
Możesz go rozpowszechniać pod pewnymi warunkami.
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cji.

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blikacjach.

Wpisz 'demo()' aby zobaczyć demo, 'help()' aby uzyskać pomoc on-
line, lub
'help.start()' aby uzyskać pomoc w przeglądarce HTML.
Wpisz 'q()' aby wyjść z R.

> |

Files Plots Packages Help Viewer





Go to file/function

Addins

Project: (None)

Environment History Connections Tutorial

Import Dataset List C

R Global Environment

Console Terminal x Jobs x

~/ ↗

R version 4.1.0 (2021-05-18) -- "Camp Pontanezen"
Copyright (C) 2021 The R Foundation for Statistical Computing

New Project Wizard

Create Project

Choosing new directory (folder)

- New Directory**
Start a project in a brand new working directory
- Existing Directory**
Associate a project with an existing working directory
- Version Control**
Checkout a project from a version control repository

Cancel

jest BEZ JAKIEJKOL
mi.
szczegóły dystrybu
estnikami.
ormacji oraz
lub pakiety R w pu
y uzyskać pomoc on-
ce HTML.

Environment

History

Connections

Tutorial



Import Dataset



List



Global Environment



Search

Console Terminal Jobs

~/



R version 4.1.0 (2021-05-18) -- "Camp Pontanezen"
Copyright (C) 2021 The R Foundation for Statistical Computing

Environment

New Project Wizard

Back

Project Type

New Project

Choosing "new project"

R Package

Create a new
project in an empty
directory

Shiny Web Application

R Package using Rcpp

R Package using RcppArmadillo

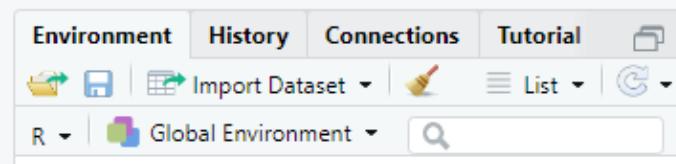
R Package using RcppEigen

R Package using devtools



Cancel

jest BEZ JAKIEJKOL
mi.
szczegóły dystrybu-
estnikami.
ormacji oraz
lub pakiety R w pu-
y uzyskać pomoc on-
ce HTML.



Console Terminal x Jobs x
~/ ↗

R version 4.1.0 (2021-05-18) -- "Camp Pontanezen"
Copyright (C) 2021 The R Foundation for Statistical Computing

New Project Wizard

Back Create New Project

Directory name:

Create project as subdirectory of:

Create a git repository

Use renv with this project

Choosing the project path and naming the folder which will be containing it

Open in new session

jest BEZ JAKIEJKOL
mi.
szczegóły dystrybu
estnikami.
ormacji oraz
lub pakiety R w pu
y uzyskać pomoc on-
ce HTML.

R nowy projekt - RStudio

File Edit Code View Plots Session Build Debug Profile Tools Help

Go to file/function Addins

Environment History Connections Tutorial Import Dataset List Global Environment

Environment is empty

Console Terminal Jobs

C:/Users/maria/Desktop/nowy projekt/ Wpisz 'contributors()' aby uzyskać więcej informacji oraz 'citation()' aby dowiedzieć się jak cytować R lub pakiety R w publikacjach.

Wpisz 'demo()' aby zobaczyć demo, 'help()' aby uzyskać pomoc on-line, lub 'help.start()' aby uzyskać pomoc w przeglądarce HTML.

Wpisz 'q()' aby wyjść z R.

Files Plots Packages Help Viewer

New Folder Delete Rename More

C: > Users > maria > Desktop > nowy projekt

	Name	Size	Modified
	..		
	nowy projekt.Rproj	218 B	Aug 6, 2021, 2:48 PM

After creating the project RStudio will automatically switch to the new project view

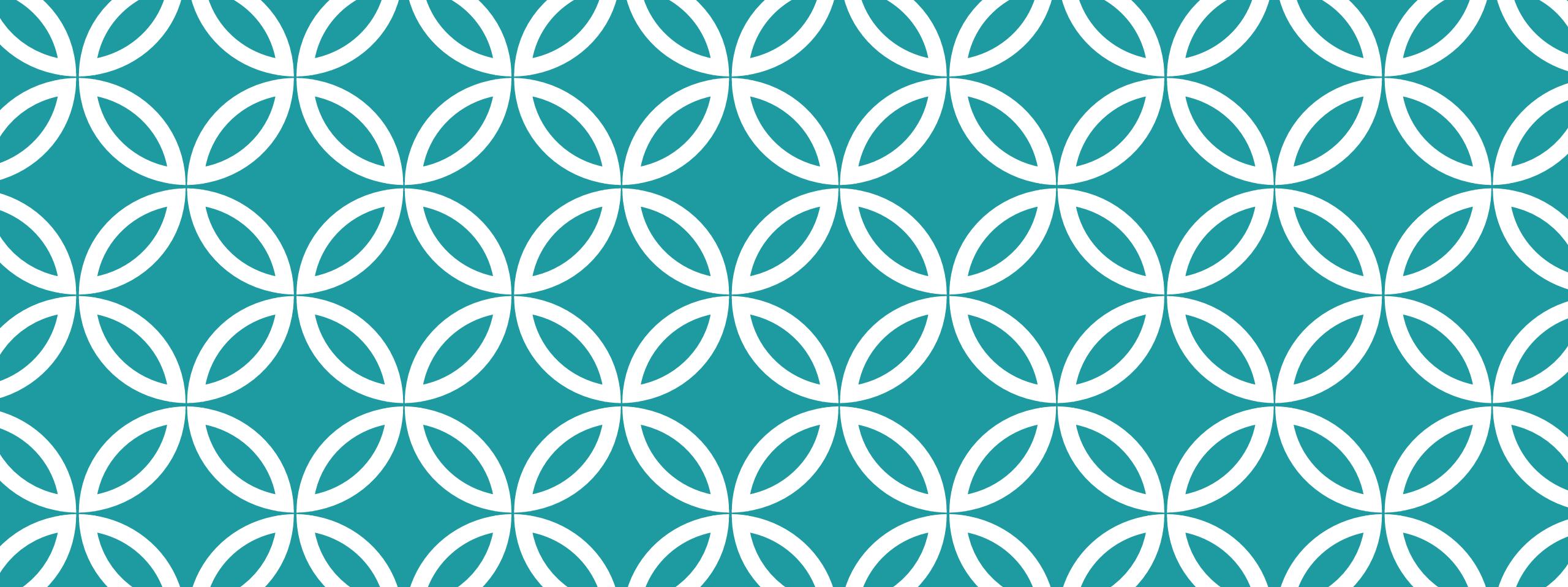
RStudio view while working on a project

The screenshot shows the RStudio interface with several key components highlighted:

- Code Editor:** Shows a script with comments and code. A yellow box highlights the text "Editing code and adding comments in a given script".
- Console:** Displays R session output. A yellow box highlights the text "Run code and check its results in the console".
- Environment:** Shows loaded variables `a` and `b`. A yellow box highlights the text "Loaded variables and datasets in the current session".
- File Browser:** Shows the project structure under "wykłady". A yellow box highlights the text "Looking through the files belonging to the project".

Below the main interface, there are two yellow boxes with descriptive text:

- Editing code and adding comments in a given script**
- Run code and check its results in the console**
- Loaded variables and datasets in the current session**
- Looking through the files belonging to the project**



BASIC OPERATIONS IN R

VARIABLE

Variable – used for storing data and results of the operations. Value of the variable can be a number, sequence of characters or other data structure. Variable must have a name, which will be used for calling its content in the code. Name is set freely by the user, but needs to comply with these conditions:

- Must start with a letter or an underscore _ symbol
- May contain only letters, numbers and underscore
- In names there is a difference between upper and lower-case
- You can use local letters in the names (like polish symbols qśćź, etc. – beware of the code sharing)

Assigning value to the variable:

a <- 12 or a = 12

FUNCTION

Function – sequence of instructions, making up for a block of code, which can be used multiple times in different places. Functions usually return certain values after finishing their work.

#example function call in R

```
function(argument1, argument2, argument3, ...)
```

#saving the function result to a variable

```
a <- function(argument1, argument2, argument3, ...)
```

BASIC OPERATIONS IN R

2+2

Simple mathematical operations

variable1 = 1

Assigning value to a variable

variable1 <- 1

Assigning value to a variable

vector1 <- c(1,2,3)

Creating a vector with values 1,2,3

vector2 <- c(1:10)

Vector with values from 1 to 10

help(c)

Opening documentation regarding given function

wekt <- rep(2, times=3)

Creating a vector with three repetitions of number 2

LOOK FOR HELP WITH YOUR CODE

how to do a vector 1 to 10 in R X |  

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Około 1370 000 000 wyników (1,11 s)

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[How do you create vectors with specific intervals in R? - Stack ...](#)

11 maj 2018 · 3 odpowiedzi

In R the equivalent function is seq and you can use it with the option by : seq(from = 5, to = 100, by = 5) # [1] 5 10 15 20 25 30 35 40 45 ...

[R numbers from 1 to 100 - Stack Overflow](#) 2 odpowiedzi 13 lip 2012

[R, generate number vector only contains 0 and 1 ...](#) 2 odpowiedzi 20 mar 2015

[Changing vector of 1-10 to vector of 1-3 using R ...](#) 2 odpowiedzi 15 mar 2015

[Counting the number of elements with the values ...](#) 19 odpowiedzi 7 lis 2011

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How do you create vectors with specific intervals in R?

Asked 8 years, 4 months ago Active 2 years, 9 months ago Viewed 154k times

I have a question about creating vectors. If I do `a <- 1:10`, "a" has the values 1,2,3,4,5,6,7,8,9,10.

46 My question is how do you create a vector with specific intervals between its elements. For example, I would like to create a vector that has the values from 1 to 100 but only count in intervals of 5 so that I get a vector that has the values 5,10,15,20,...,95,100

12 I think that in Matlab we can do `1:5:100`, how do we do this using R?

5 I could try doing `5*(1:20)` but is there a shorter way? (since in this case I would need to know the whole length (100) and then divide by the size of the interval (5) to get the 20)

[r](#) [vector](#) [intervals](#)

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edited Jun 19 '17 at 6:22



zx8754

42.7k ● 10 ● 97 ● 158

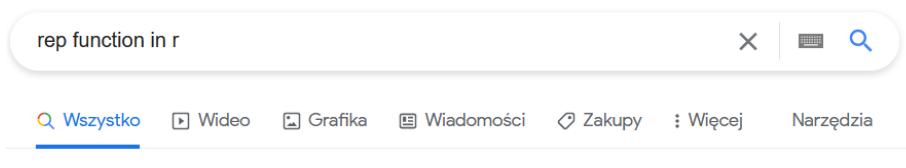
asked Mar 24 '13 at 17:24



Luli

513 ● 1 ● 4 ● 4

READ THE DOCUMENTATION



<https://www.rdocumentation.org> › rep › Tłumaczenie strony

rep function - RDocumentation

rep replicates the values in `x`. It is a generic **function**, and the (internal) default **method** is described here. `rep.int` and `rep_len` are faster simplified ...

Find the documentation in
the web or use these
commands within R:
`help(functionname)`
`?functionname`

RDocumentation

Search all packages and functions

base (version 3.6.2)

rep: Replicate Elements of Vectors and Lists

Description

`'rep'` replicates the values in `'x'`. It is a generic function, and the (internal) default method is described here.

`'rep.int'` and `'rep_len'` are faster simplified versions for two common cases. Internally, they are generic, so methods can be defined for them.

Usage

```
rep(x, ...)  
rep.int(x, times)  
rep_len(x, length.out)
```

Arguments

`x` a vector (of any mode including a `'list'`) or a factor or (for `'rep'` only) a `'POSIXct'` or `'POSIXlt'` or `'Date'` object; or an S4 object containing such an object.