

# MATH2411 T1B Tutorial 1

## A Brief Introduction to R and RSudio

HOU Zhen and LI Yixin

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# Arrangements of the Tutorials

- Teaching assistant: HOU Zhen(zhouah@connect.ust.hk)  
Substituter for the first two weeks: LI Yixin (yliqh@connect.ust.hk)
- Time and Venue: Thu 12:00 - 12:50, Room 4579
- Contents:
  - Week 1: Introduction to R
  - From Week 2 to the end:
    - Brief review: Preliminaries and Materials of the Lecture
    - Examples: with some tricks
    - Codes: More detailed than the lecture
    - Homework: After due days.
- Any questions or suggestions, feel free to contact!

## What is R?

*"R is a programming language created by statisticians for statisticians."*

## Why we use R?

- Advanced calculator
- Generate random variables
- Data visualization: R graph gallery [Link]
- ...

## What will be tested?

(Not sure)

- Correct some wrong codes
- Fill in the blanks

# How to learn a programming language (Important)

Based on my experience:

- ① Willing to explore
- ② Problem-based learning
- ③ Make your mind clear: What you have? What you want?
- ④ When you are unsure, just try!

When you have problems, what you can do:

- ① Google the problem directly: Ex: "R table"
- ② Learn from similar examples
- ③ Books and Documents
- ④ Quick check: Cheatsheets [[Link](#)]

# Contents of this tutorial

Assuming you don't know anything about R:

- Installation of R and RStudio
- A simple tutorial:
  - The one given by Professor YE: [Link]
  - Another one: [Link]
- The example in the lecture

# Introduction

- R is a programming language and free software environment for statistical computing and graphics supported by the R Foundation for Statistical Computing.
- RStudio is an integrated development environment (IDE) for R. It includes a console, syntax-highlighting editor that supports direct code execution, as well as tools for plotting, history, debugging and workspace management.

First time users often confuse the two. At its simplest, R is like a car's engine while RStudio is like a car's dashboard.

# Install R

R is available for Linux, MacOS, and Windows.

1. Open <https://cran.r-project.org/>. Click on the link for your operating system. For example, if you are using Windows, click on the link **Download R for Windows**.

The screenshot shows the 'Download and Install R' section of the CRAN website. The page title is 'The Comprehensive R Archive Network'. On the left, there's a sidebar with links like 'CRAN Mirrors', 'What's new?', 'Search', and 'CRAN Team'. The main content area has a heading 'Download and Install R' and a sub-section 'Precompiled binary distributions of the base system and contributed packages, Windows and Mac users most likely want one of these versions of R:'. It lists three download links: 'Download R for Linux (Debian/Fedora/Redhat/Ubuntu)', 'Download R for macOS', and 'Download R for Windows', with the Windows link being highlighted by a red rectangle. Below this, there's a note about Linux distributions and a section for 'Source Code for all Platforms' which lists various release types and their descriptions. At the bottom, there are sections for 'Questions About R' and 'Supporting CRAN'.

## 2. Then, click on the link **base**.

R for Windows

Subdirectories:

- [base](#) base
- [contrib](#)
- [old\\_contrib](#)
- [Tools](#)

Binaries for base distribution. This is what you want to [install R for the first time](#).  
Binaries of contributed CRAN packages (for R >= 3.4.x).  
Binaries of contributed CRAN packages for outdated versions of R (for R < 3.4.x).  
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.



CRAN  
Mirrors  
What's new?  
Search  
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About R  
R Homepage  
The R Journal  
  
Software  
R Sources  
R Binaries  
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Task Views  
Other  
  
Documentation  
Manuals  
FAQs  
Contributed  
  
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### 3. Click on the link **Download R 4.3.2 for Windows**.

R-4.3.2 for Windows

[Download R-4.3.2 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-snapshot 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: 2023-10-31



#### 4. Now, you will see that "R-4.3.2-win.exe" is downloading.

The screenshot shows a web browser displaying the CRAN R-4.3.2 for Windows page. The main content area shows the download link for "Download R-4.3.2 for Windows" (79 megabytes, 64 bit), the README file, and new features. A note about UCRT requirements is present. Below this, there's a frequently asked questions section with links to R running under Windows and updating packages. It also mentions the R FAQ and the R Windows FAQ. A note for webmasters about stable links is included. At the bottom, it shows the last change date as 2023-10-31. To the right of the main content, a download progress bar is visible in a separate window, showing the file "R-4.3.2-win.exe" at 99.2 KB/s - 4.5 MB/78.8 MB, with 13 minutes remaining.

R-4.3.2 for Windows

Download R-4.3.2 for Windows (79 megabytes, 64 bit)

README on the Windows binary distribution

New features in this version

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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

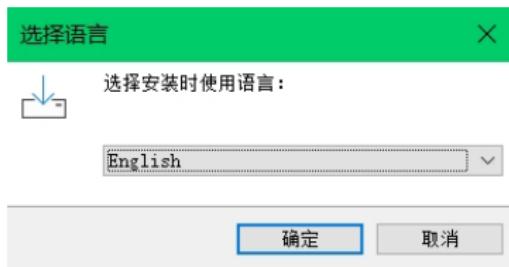
- Patches to this release are incorporated in the [patched snapshot build](#).
- A build of the development version (which will eventually become the next major release of R) is available in the [r-devel snapshot build](#).
- [Previous releases](#)

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

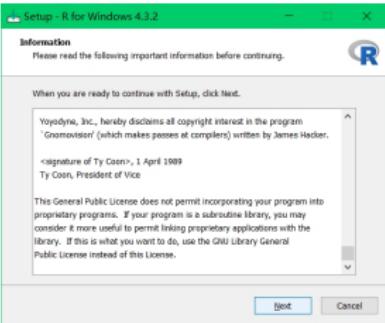
Last change: 2023-10-31

CRAN  
Mirrors  
What's new?  
Search  
CRAN Team  
  
About R  
R Homepage  
The R Journal  
  
Software  
R Sources  
R Binaries  
Packages  
Task Views  
Other  
  
Documentation  
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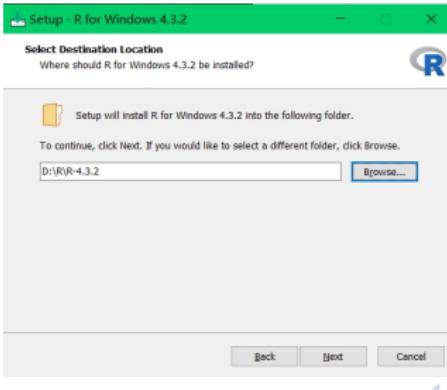
- After the download is complete, you are recommended to create a folder named "R" in your computer, and then move the downloaded file "R-4.3.2-win.exe" to the folder "R". Then, double click on the file "R-4.3.2-win.exe" to install R.
- Choose the language you want to use in R. Then, click on the button "OK".



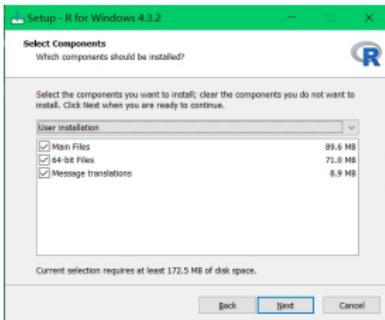
7. Click on the button "Next >".



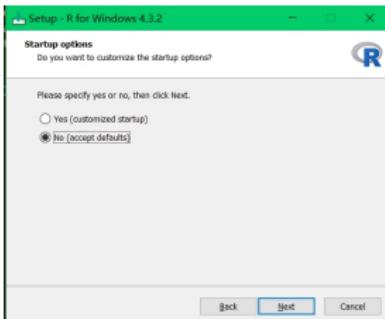
8. Click on the button "Browse..." to choose the folder where you want to install R. You can use the folder "R" created before. Then, click on the button "Next >".



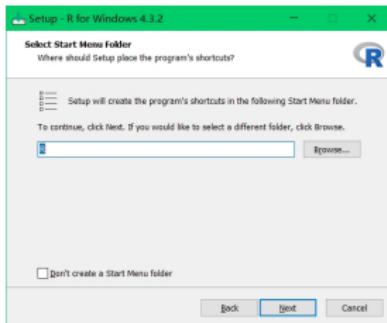
9. Click on the button "Next >".



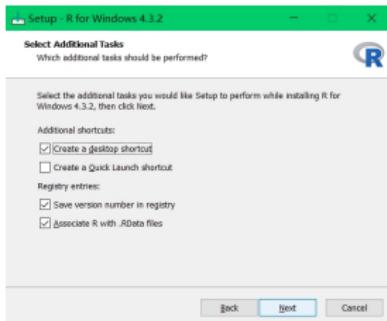
10. Click on the button "Next >".



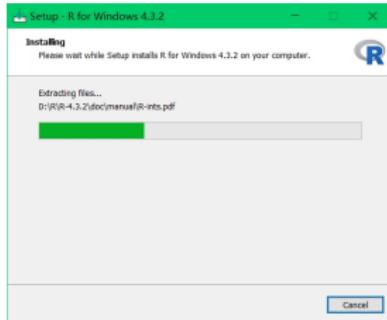
11. Click on the button "Next >".



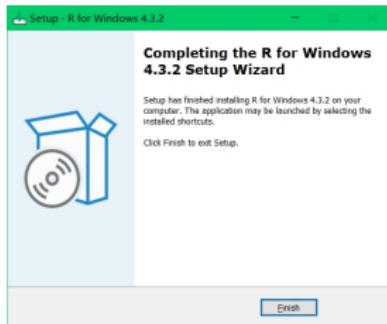
12. Click on the button "Next >".



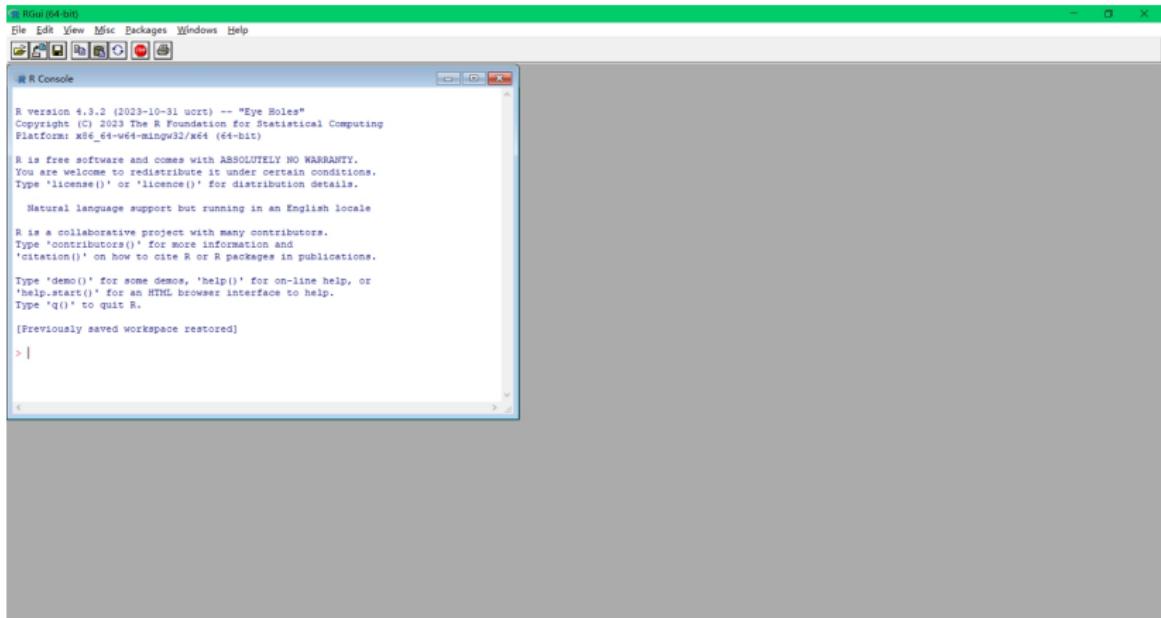
13. Then, you will see that R is installing.



14. Click on the button "Finish".



15. Now, you can find the icon of R on your desktop. Double click on the icon to open R.



Now, you have installed R successfully.

R is a command line driven program. The user enters commands at the prompt (> by default) and then press "Enter" in keyboard. Each command is executed one at a time.

Here are some examples for simple calculations in R:

```
> 4 + 5  
[1] 9  
> 6 / 2  
[1] 3  
> 4 * 7  
[1] 28
```

Before we introduce more about R, we will introduce RStudio first.

# Install RStudio

RStudio is a powerful and productive user interface for R. It's free and open source, and works great on Windows, Mac, and Linux.

1. Open <https://posit.co/download/rstudio-desktop/>. Click on the link **DOWNLOAD RSTUDIO DESKTOP FOR WINDOWS**.

The screenshot shows the Posit website with the URL <https://posit.co/download/rstudio-desktop/>. The page header includes the Posit logo, navigation links for PRODUCTS, SOLUTIONS, LEARN & SUPPORT, EXPLORE MORE, and PRICING, and a search icon. The main content area features a message about getting started with RStudio on Posit Cloud or by booking a call. Below this, there are two sections: '1: Install R' and '2: Install RStudio'. The '1: Install R' section contains a note about R version requirements and a 'DOWNLOAD AND INSTALL R' button. The '2: Install RStudio' section contains a large blue 'DOWNLOAD RSTUDIO DESKTOP FOR WINDOWS' button, file details (Size: 215.66 MB, SHA-256: D3C03C42, Version: 2023.12.1+402, Released: 2024-01-29), and a progress bar at the bottom.

1: Install R

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

DOWNLOAD AND INSTALL R

2: Install RStudio

DOWNLOAD RSTUDIO DESKTOP FOR WINDOWS

Size: 215.66 MB | [SHA-256: D3C03C42](#) | Version: 2023.12.1+402 | Released: 2024-01-29

Progress Bar: [███████████]

**Note:** If you are using other operating systems, you can find the corresponding link on the website. You can a list of the links for different operating systems and choose one you need.

The screenshot shows a table of download links for RStudio 2023.12.1-402. The columns are OS, Download, Size, and SHA-256. The OS column lists Windows 10/11, macOS 12+, Ubuntu 20/Debian 11, Ubuntu 22/Debian 12, Fedora 19/Red Hat 7, and OpenSUSE 15. The Download column contains links like RSTUDIO-2023.12.1-402.EXE, RSTUDIO-2023.12.1-402.DMG, RSTUDIO-2023.12.1-402-AMD64.DEB, RSTUDIO-2023.12.1-402-AMD64.DEB, RSTUDIO-2023.12.1-402-X86\_64.RPM, and RSTUDIO-2023.12.1-402-X86\_64.RPM. The Size column shows file sizes such as 215.66 MB, 382.66 MB, 149.27 MB, 149.96 MB, 166.36 MB, and 149.97 MB. The SHA-256 column shows unique hash values for each file.

OS	Download	Size	SHA-256
Windows 10/11	<a href="#">RSTUDIO-2023.12.1-402.EXE</a>	215.66 MB	<a href="#">D3C03C42</a>
macOS 12+	<a href="#">RSTUDIO-2023.12.1-402.DMG</a>	382.66 MB	<a href="#">C8D91850</a>
Ubuntu 20/Debian 11	<a href="#">RSTUDIO-2023.12.1-402-AMD64.DEB</a>	149.27 MB	<a href="#">81F221BE</a>
Ubuntu 22/Debian 12	<a href="#">RSTUDIO-2023.12.1-402-AMD64.DEB</a>	149.96 MB	<a href="#">75542CC2</a>
Fedora 19/Red Hat 7	<a href="#">RSTUDIO-2023.12.1-402-X86_64.RPM</a>	166.36 MB	<a href="#">FFBA2934</a>
OpenSUSE 15	<a href="#">RSTUDIO-2023.12.1-402-X86_64.RPM</a>	149.97 MB	<a href="#">8A2135AF</a>

## 2. Then, you will see that "RStudio-2023.12.1-402.exe" is downloading.

The screenshot shows a web page from posit.org with a list of RStudio download links for various operating systems. A file download progress bar for "RStudio-2023.12.1-402.exe" is overlaid on the page, indicating a download speed of 14.2 MB/s over 115 MB / 206 MB, estimated to finish in 4 seconds. The progress bar is nearly complete.

OS	Download Link	Size	Hash
Windows 10/11	<a href="#">RSTUDIO-2023.12.1-402.EXE</a>	215.66 MB	D3C03C42
macOS 12+	<a href="#">RSTUDIO-2023.12.1-402.DMG</a>	382.66 MB	C8D9185D
Ubuntu 20/Debian 11	<a href="#">RSTUDIO-2023.12.1-402-AMD64.DEB</a>	149.27 MB	B1F221BE
Ubuntu 22/Debian 12	<a href="#">RSTUDIO-2023.12.1-402-AMD64.DEB</a>	149.96 MB	75542CC2
Fedora 19/Red Hat 7	<a href="#">RSTUDIO-2023.12.1-402-X86_64.RPM</a>	166.36 MB	FFBA2934
OpenSUSE 15	<a href="#">RSTUDIO-2023.12.1-402-X86_64.RPM</a>	149.97 MB	8A2135AF

3. After the download is complete, you can move the downloaded file "RStudio-2023.12.1-402.exe" to the folder "R". Then, double click on the file "RStudio-2023.12.1-402.exe" to install RStudio.
4. Click on the button "Next >".



5. Click on the button "Browse..." to choose the folder where you want to install RStudio. You can use the folder "R". Then, click on the button "Next >".



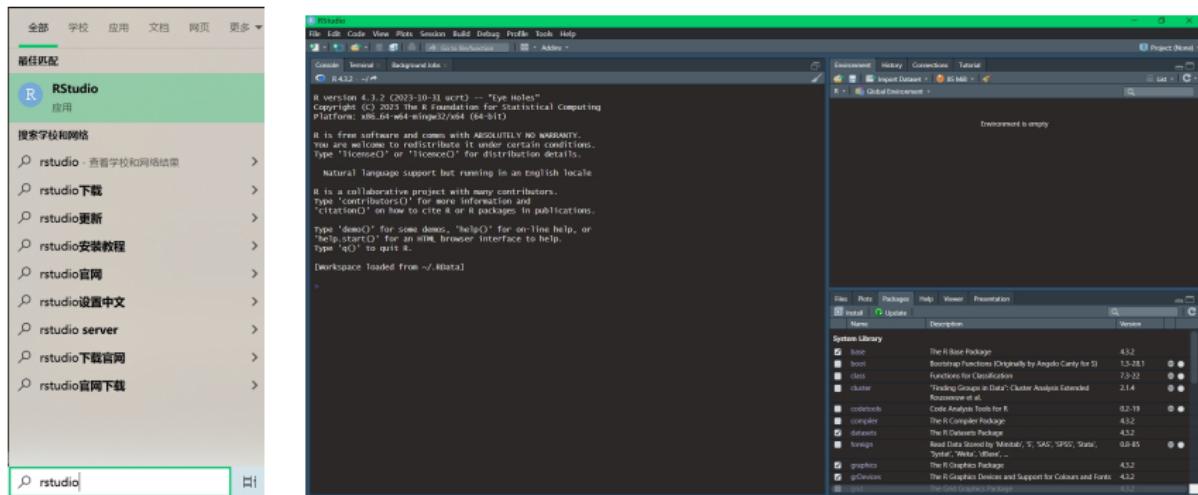
## 6. Click on the button "Install".



## 7. Then, you will see that RStudio is installing. After the installation is complete, click on the button "Finish".



8. Now, you can find the icon of RStudio on your desktop or search it in the start menu. Double click on the icon to open RStudio.



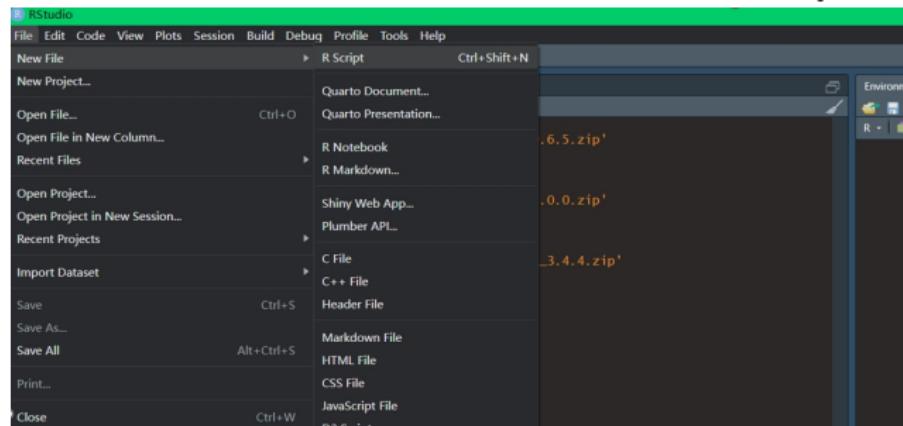
Now, you have installed RStudio successfully.

Note the three panes which are three panels dividing the screen: the console pane, the environment pane, and the files pane.

# R Scripts and Rmarkdown

- ① If we want to be able to reproduce and reuse our code for further needs, we should write it in a script file rather than directly in the console.

To create a new script file, click on the menu **File** and then click on the menu **New File** and then click on the menu **R Script**.



- ② Rmarkdown can show the codes and results in a HTML or PDF version.

Cheatsheet: [Link]

# R packages

R packages are collections of functions and data sets developed by the community. They increase the power of R by improving existing base R functionalities, or by adding new ones.

There are currently 16,000+ packages available in CRAN, and Bioconductor uses the same code format as CRAN.

To install a package, you can use the function **install.packages()**.

For example, to install the package **ggplot2**, you can type the following command in the console pane:

```
> install.packages("ggplot2")
also installing the dependencies 'colorspace', 'utf8', 'farver', 'labeling', 'munsell', 'R6', 'RColorBrewer', 'viridisLite', 'fansi', 'magrittr', 'pillar', 'pkgconfig', 'cli', 'glue', 'gttable', 'isoband', 'lifecycle', 'rlang', 'scales', 'tibble', 'vctrs', 'withr'
```

When the installation is complete, you can load the package **ggplot2** by using the function **library()**.

```
> library("ggplot2")
>
```