

R Basics for Paleoecologists

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APD Workshop Series: R Basics for Paleoecologists.

This is meant to be a simple guide to help otherwise busy paleoecologists make use of some helpful tools for conducting research and publishing. All the while, you will also be making your work reproducible.

Required Software and Download Instructions

For this workshop we will be using two separate, but related pieces of open-source software: R and R Studio.

R is a standalone open-source software for statistical analysis. It has an interesting history (you can find more here), but it is *both* a programming language and an environment within which you can use the language to execute commands. Thus, it is described as the “R Statistical Computing Environment”. R is an instantiation of a tiny universe with many rules, few (or none!) of which you know.

R Studio is a wrapper for R that allows us to see a bit more of what is going on inside of R and to control it through the window rather than exclusively through the “console”. R Studio knows the rules so you don’t have to. Much like a spell-checker in word processing, R Studio checks your code for you. More on this later.

Installing R Statistical Computing Environment First, you need to install R from cran.r-project.org. Click this link or the logo below, at the top of the page you will find a section titled “Download and Install R” and choose the appropriate download for your operating system (OS).



It should look something like this:

The screenshot shows the homepage of the CRAN (Comprehensive R Archive Network) website at cran.r-project.org. The page features the R logo in the top left corner. On the left sidebar, there are links for CRAN Mirrors, What's new?, Search, CRAN Team, About R, R Homepage, The R Journal, Software (with links for R Sources, R Binaries, Packages, Task Views, and Other), Documentation (with links for Manuals, FAQs, and Contributed), and a section for Submissions (with links for Submitting a package, CRAN Submissions, and CRAN Submissions by email). The main content area on the right includes sections for Download and Installation (with links for Precompiled binary distributions, Download R for Linux, Download R for Mac OS X, and Download R for Windows), Source Code for all platforms, and Questions About R. A large green arrow is overlaid on the page, pointing from the left sidebar towards the right margin.

R is ‘GNU S’, a freely available language and environment for statistical computing and graphics. It is similar to S and is available as free software under the [R project homepage](#) for further information.

CRAN is a network of ftp and web servers around the world.

To “submit” a package to CRAN, check that your submission is suitable.

If this fails, send an email to CRAN-submissions@R-project.org.

Note that we generally do not accept submissions of packages that:

For queries about this web site, please contact [the webmaster](#).

This server is hosted by the [Institute for Statistics and Mathematics](#).

Figure 1: **Figure 1**. cran.R-project website landing page.

The screenshot shows the CRAN homepage. At the top is the R logo. Below it are several navigation links: 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, Manuals, FAQs, and Contributed.

A large green arrow points from the CRAN logo area towards the right side of the page, where the following information is displayed:

Subdirectories:

- [base](#) Binaries for
- [contrib](#) Binaries of
- [old contrib](#) Binaries of
- [Rtools](#) Tools to bu

Please do not submit binaries to CRAN.
binaries.

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

Note: CRAN does some checks on these

Figure 2: **Figure 2.** cran.R-project windows download options, select 'base'.

Once you've selected the R version for your OS, you'll be given some download options. Select "base" and download the .exe file (Windows).

Double-click on this file and follow the instructions from your machine's prompts for installation. This differs slightly between each operating system and the version of the operating system you're using.

If you're using macOS, you will be directed to a slightly different looking page with multiple download options.

Here, you must choose a package based on the version of the macOS you're using as well as the kind of processor in your machine.

If you're using macOS 11 or greater (Apple names their updates, so this one is 'Big Sur') AND your machine uses an M1 chip, then select the top option (Fig 3:A). If you're using versions before this ('High Sierra') and have an Intel 64-bit chip, then download the second option (Fig 3:B).

Don't know what kind of chip is in your mac? You can quickly find out by clicking the apple icon at the top right of your screen, then selecting "about this mac". You should get a window listing the macOS version, kind of machine of you're using, and details about the processor and memory. Newer macs list the processor as the "Chip". You can get more detailed instructions for investigating your hardware from Apple's support page.

For windows users, R will install to your "program files" folder. For macOS users, you will need to move the R.app folder from the package (once opened) and drag it into your applications folder.

Introduction to R Syntax, Objects, and Functions Second, let's open up R to make sure that it works and to look at some important features that will help you later on. When you open R, you only get a text window called the console. This is where all of the action happens and as soon as you open R, you're given some basic, but important information.

Note the following: -the *working directory* is the folder where R looks when it goes to find or write things (Fig. 4:A). -the software version is at the top of the initialization text, this information is important for citations (Fig. 4:B). -the initialization text includes instructions for getting information about licensing, help, and for citing R (Fig. 4:C). -the *command line* is the line starting with ">", which is where you politely ask R to do things for you (Fig. 4:D).

We can actually try out a bit of coding at this point. Type the code below in your R console and hit "enter". You can also copy-paste from this document into the console as well.

```
citation()
```

This can also be written as:

```
citation("base")
```

Both these commands give us the same result.

```
##  
## To cite R in publications use:  
##  
##   R Core Team (2020). R: A language and environment for statistical  
##   computing. R Foundation for Statistical Computing, Vienna, Austria.
```

← → ⌂ cran.r-project.org

The screenshot shows the CRAN website at cran.r-project.org. The main content area displays the R logo and a message about binary distributions. To the left, there's a sidebar with links for CRAN mirrors, what's new, search, and the CRAN team. Below that are links for About R, R Homepage, and The R Journal. Further down are sections for Software (R Sources, R Binaries, Packages, Task Views, Other) and Documentation (Manuals, FAQs, Contributed). A large green arrow points upwards from the bottom section to the top section, labeled 'A.' above it. Another large green arrow points downwards from the top section to the bottom section, labeled 'B.' above it.

This directory contains binaries for a base distribution and pack...
Macs can be found in the [old](#) directory.

Note: Although we take precautions when assembling binaries,

Package binaries for R versions older than 3.2.0 are only available (<https://cran-archive.r-project.org>) accordingly.

R 4.2.2 "Innocent"

Please check the integrity of the downloaded package by checking `pkgutil --check-signature R-4.2.2.pkg` in the *Terminal* application. If Apple tools are not available you can use `openssl sha1 R-4.2.2.pkg`

A.

B.

[R-4.2.2-arm64.pkg](#) (notarized and signed)
SHA1-hash: c3bb657ca6912b9b98e254f63434a365da26848f
(ca. 86MB) for M1 and higher Macs only!

R 4.2.2 binary for arm64 package.
Contains R 4.2.2 f...
Important: this v...

macOS Ventura users file away from the ...

Note: the use of XQuartz when up...

This release uses XQuartz 2.8.0. It includes several packages which conflict with the X11 libraries and XQuartz. To avoid conflicts, please do not install the XQuartz package. Instead, use the X11 libraries and XQuartz when updating XQuartz. Note: the use of XQuartz when updating XQuartz when up...

[R-4.2.2.pkg](#) (notarized and signed)
SHA1-hash: 99b8d184f855e630ac950ca4e62cb7fc9a1f7b2e
(ca. 87MB) for Intel Macs

R 4.2.2 binary for intel package.
Contains R 4.2.2 f...
Texinfo 6.7. The 1...
install", they are c...
from sources.

Figure 3: **Figure 3.** cran.R-project macOS download options

The image shows a screenshot of the R Console window. At the top, there are three colored circles (red, yellow, green) and the text "R Console". A large orange arrow points from the top right towards the console area. In the top right corner of the console area, there is a white box containing the letter "A.". An orange circle highlights the command line prompt (~) at the top left of the console. Another large orange oval highlights the version information text: "R version 4.2.2 (2022-10-31) -- \"Innocent and Trusting\" Copyright (C) 2022 The R Foundation for Statistical Computing Platform: aarch64-apple-darwin20 (64-bit)". A third orange oval highlights the citation instructions: "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.", and "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.". A fourth orange oval highlights the command line text: "[R.app GUI 1.79 (8160) aarch64-apple-darwin20]", "[History restored from /Users/christopherkane/Library/Rapp.history]", and the prompt ">".

```
R version 4.2.2 (2022-10-31) -- "Innocent and Trusting"
Copyright (C) 2022 The R Foundation for Statistical Computing
Platform: aarch64-apple-darwin20 (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.

[R.app GUI 1.79 (8160) aarch64-apple-darwin20]

[History restored from /Users/christopherkane/Library/Rapp.history]
>
```

Figure 4: **Figure 4.** R Console with annotations for: A, working directory; B, version; C, citation instructions; and D, the command line.

```

## URL https://www.R-project.org/.
##
## A BibTeX entry for LaTeX users is
##
## @Manual{,
##   title = {R: A Language and Environment for Statistical Computing},
##   author = {{R Core Team}},
##   organization = {R Foundation for Statistical Computing},
##   address = {Vienna, Austria},
##   year = {2020},
##   url = {https://www.R-project.org/},
## }
##
## We have invested a lot of time and effort in creating R, please cite it
## when using it for data analysis. See also 'citation("pkgname")' for
## citing R packages.

```

Congratulations! If this is your first time using R, then you just ran your first *function*!

Note that “base” gives us the same output because the R Statistical Computing Environment comes with a lot of basic functions (hence “base”) that it can do. Later, we will explore how we can expand R with “packages” written and maintained by other users.

We have accumulated some vocabulary at this point and it is helpful to explain these terms and how they relate to each other here. R will do exactly what you tell it to, so it helps to know how it thinks. The R environment runs almost entirely by creating *objects* and applying *functions* to them. Like we experienced above, *functions* make things happen. In order for R to do things with an object, it has to know that it exists.

We could use “base” above because the citation() is already a part of R and knows where to find it (it’s always an object). Let’s learn how to create an object.

All coding languages run on *syntax* (rules for combining things for communication). Here’s some key symbols in R syntax.

| Syntax | Action |
|--------|--|
| = | equals sign is used to assign data to objects |
| <- | arrow-dash is the same as equals sign, assigns data to objects |
| # | hashes designate non-coding regions, used to annotate code |

You can copy-paste the entire section of code below and run it. Another nice thing about R is that you can submit a whole list of commands at once, as long as each of these commands and function are entered correctly. Because my annotations are preceded by a hash “#”, they’re not read as commands. As for whether one should use “=” or “<-”, there are trade-offs to either choice. I use “=” because it requires typing fewer characters.

```

# Here, we use "=" to create an object called "x" and assign it the value of 5.

x = 5

# We can also use "<-" to create another object called "y" and assign it the value of 6.

y <- 6

```

Once you run the above code, you may notice that basically nothing happened. R happily ran your commands and creates an object named “x” with a value of 5 and an object “y” with a value of 6. You didn’t tell R to give you any output, so none is given. Type “x” in the command line and then hit “enter”. Do the same for “y”. R should return the values each time after you hit “enter”. This is rudimentary, but you are *coding* now. Also, now that we’ve experienced what R is like, we can gain a better appreciation for what R Studio does for us.

Installing R Studio Third, you will need to download R Studio and install it. R Studio is available as a “free version” and a “professional” version. The links here go directly to the free version.



The webpage should detect what sort of OS you’re using and suggest the correct version of R Studio. If it does not, there are other download options below which correspond to various OS types and their individual versions. You will notice that the webpage also tells you to install R (which we’ve already done), so you can skip to “2” and download R Studio.

You’ll get either a .exe or a .pkg file when you download R Studio (depending on OS) and you can then run this file and follow the prompts from the installation wizard. Windows users will find R Studio in their program files while macOS users will have to move the R Studio app into the Applications folder. Make a shortcut to your desktop (Windows) or put the app in your taskbar (macOS) for easy access.

Now, let’s open R Studio and take a look at it. Double-click on the icon.

You should have three panes open in the window, as shown in Fig 6. above. The leftmost should look familiar. It is the R console! This is where you’ll enter commands to make R do things. It also shows you some of the same information, such as the location of the working directory (Fig 6:A) and command line (Fig 6:D). You may notice other tabs behind the console titled “Terminal” and “Background jobs”. Stick with the console for now, but this area of the window is dedicated to what R is *doing*.

On the right, the top pane also has tabs: “Environment” (Fig 6:E), “History” (Fig 6:F), “Connections” (Fig 6:G), and “Tutorial” (Fig 6:G). We will rely on “Environment” and “History” more than the others for this tutorial.

The “Environment” allows us to see inside R’s brain. Let’s take a quick look at how this works by entering the same commands from our first use of base R. You can type these commands manually or copy paste them.

```
x = 5  
y = 6
```

After you’ve run both commands (after hitting “enter”), you should see the environment update to include the new objects you’ve made. Base R didn’t show you anything, but we demonstrated that R remembered these objects and recalled their values. Here, we can see what R knows.

Now click on the “History” tab. Here is where you can find all of the past commands you have given R. This can be helpful for troubleshooting problems. It should look like Figure 8.

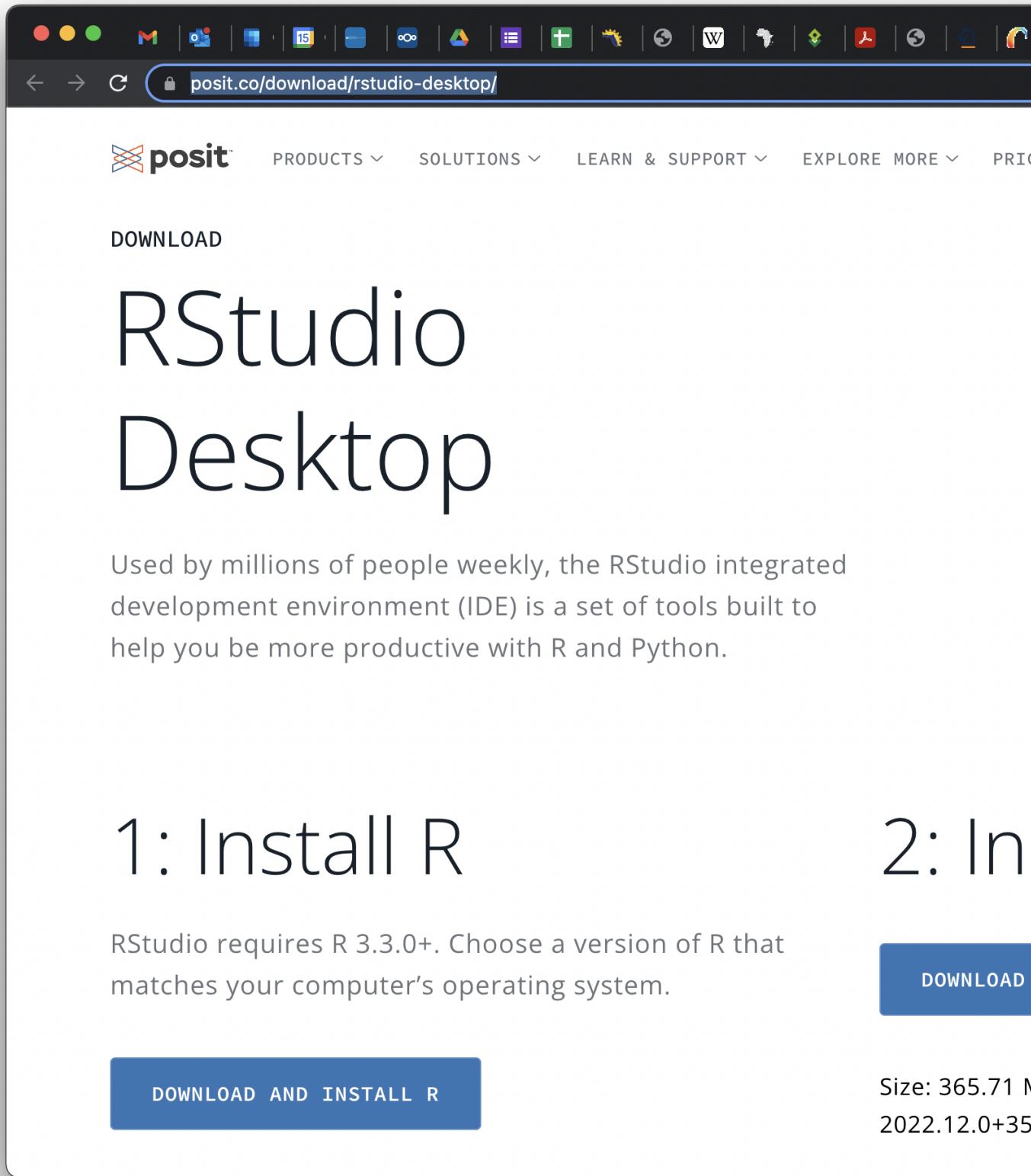


Figure 5: **Figure 5.** R Studio Download Page.
9

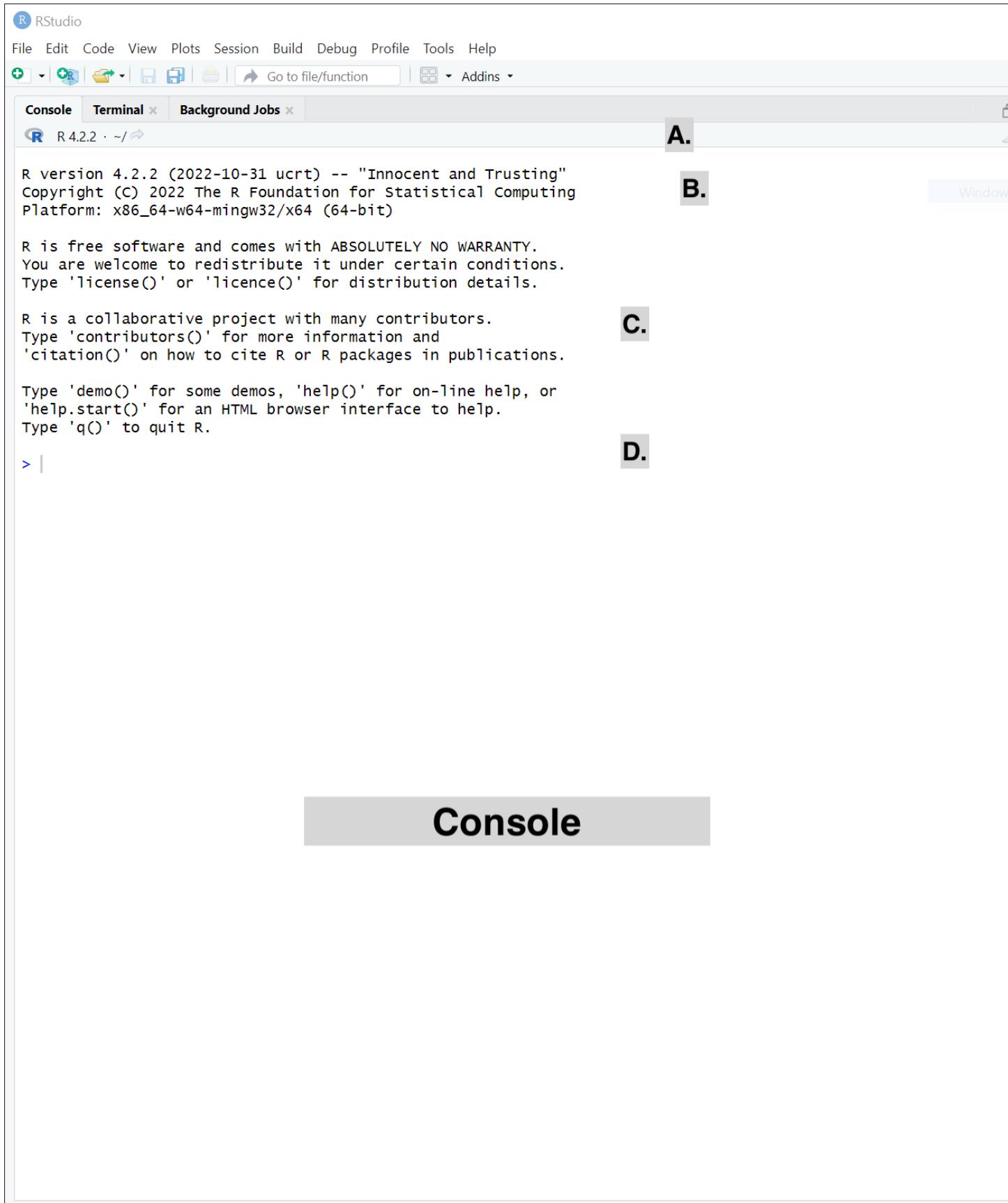
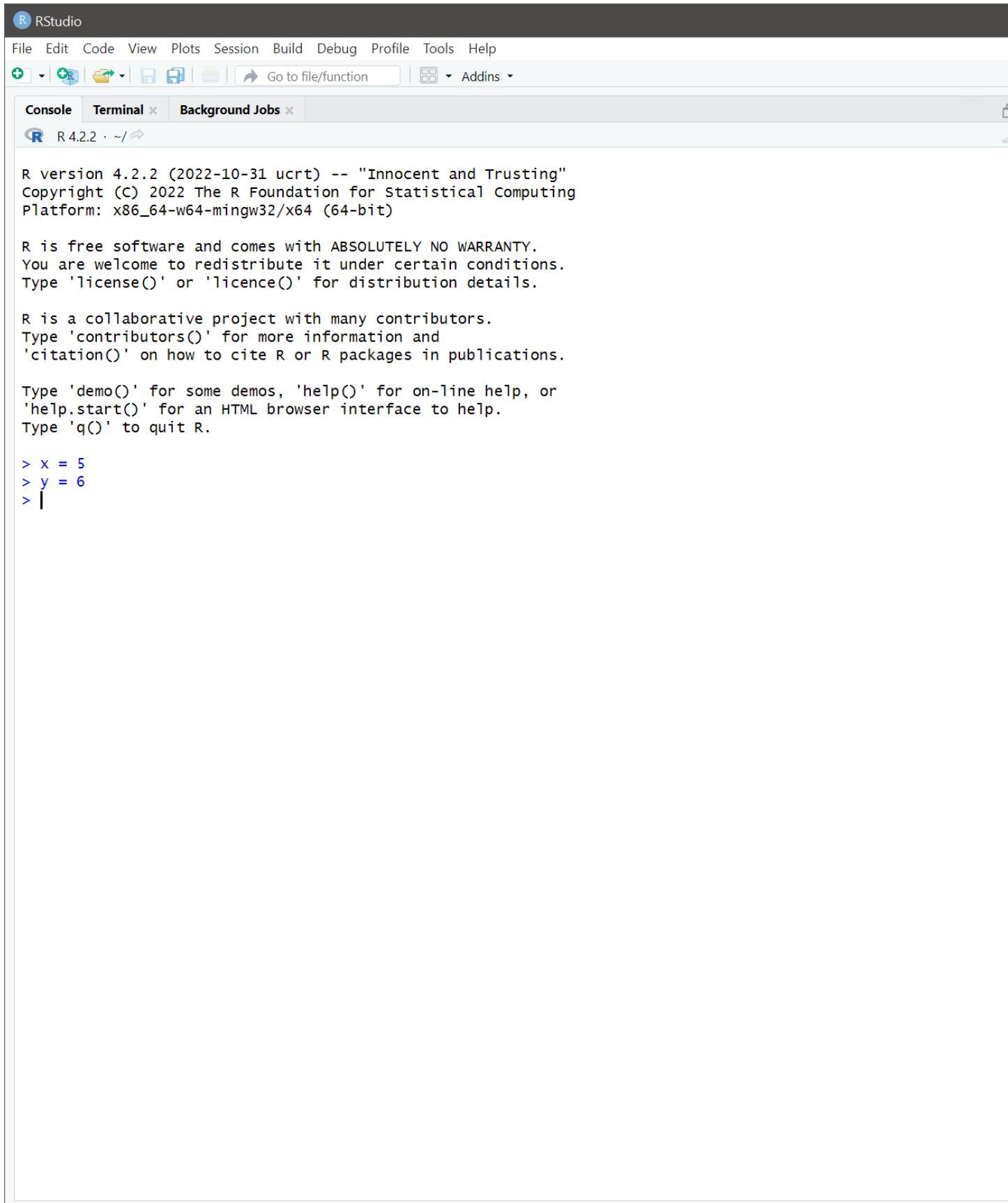


Figure 6: **Figure 6.** R Studio window with annotated console pane: A, working directory; B, R version; C, citation info; and D, the command line.



R version 4.2.2 (2022-10-31 ucrt) -- "Innocent and Trusting"
Copyright (C) 2022 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 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

```
> x = 5
> y = 6
> |
```

Figure 7: **Figure 7.** R Studio showing updated Environment pane after creating objects.
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The screenshot shows the RStudio interface with the following details:

- Header Bar:** Contains the RStudio logo, File, Edit, Code, View, Plots, Session, Build, Debug, Profile, Tools, Help menus, and various icons for file operations like Open, Save, and Print.
- Toolbar:** Includes icons for New Project, Open Project, Save, Print, and Go to file/function.
- Tab Bar:** Shows three tabs: Console (selected), Terminal, and Background Jobs.
- Console Area:** Displays the R startup message, license information, and a user input line starting with '>'.

```
R version 4.2.2 (2022-10-31 ucrt) -- "Innocent and Trusting"
Copyright (C) 2022 The R Foundation for Statistical Computing
Platform: x86_64-w64-mingw32/x64 (64-bit)

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'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.

> x = 5
> y = 6
> |
```

Figure 8: **Figure 8.** Screenshot of R studio window with history tab selected.
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The bottom-right pane has several file-navigation related tabs: “Files” (Fig 6:I), “Plots” (Fig 6:J), “Packages” (Fig 6:K), and “Help” (Fig 6:L). There’s other tabs here, but we will make the most use of “Files”, “Plots”, and “Help” during the workshop. “Files” shows you the contents of the working directory as well as the file path to the working directory (below the options - “New Folder”, “Delete”, “Rename”, “More”). This can be really helpful when troubleshooting your code. Remember, R has to be able to find your data. In order to help it do so, you have to know where R thinks it is. R always thinks it is in the working directory and this pane (plus the top of the Console) will help you figure out where R thinks that working directory is.

Another helpful pane in the bottom-right is the “Plots” pane. R Studio saves all of the plots that you make here. Because we’ve already defined two objects, let’s plot them and see what happens.

```
plot(x, y)
```

This should create a plot in this pane, looking something like this.

Excellent! You’ve already run your first function, defined objects, and then plotted them. This is basically all that R does, but we can create objects with multiple dimensions (vectors, matrices, arrays!) and run complicated functions to evaluate, synthesize, and plot this information.

Setting up R Markdown (Bonus)

At the end of the workshop, we will apply some of our R skills to make an R Markdown document. Markdown is *another* coding language, but it is native to R Studio and is helpful for presenting results. Let’s set up an R Markdown document and introduce the 4th pane in the R Studio window. At the top right of the R Studio window (not within the panes!) select the “new file” icon (plus sign over a piece of paper) and select the “R Markdown” option.

You will be prompted to download dependencies for R Markdown. Go ahead and select “yes”.

R Studio will automatically download and install packages necessary for using R Markdown.

R Markdown will prompt you to give your document a title and to list authors. You can enter any information you want here. Add your name and a provisional title. Make sure the default output is “html”. Outputting to .pdf requires some extra steps (installing LaTex) that can be addressed later. Html output is preferable because it doesn’t have page breaks and it can be printed directly from the web browser.

This should open an R markdown document as the fourth pane of the R Studio interface (above the Console). There are a range of document types that you can open, but the ones we will be using are R scripts and R Markdown.

R Markdown documents open with some information already entered for you. We will discuss more in the workshop on how to make use of these general features, but you can already use the “knit” command to convert this Markdown document to html.

The first time you do this, you’ll have to save the R Markdown (.Rmd) document somewhere. At this point, we are not worrying about file management, so feel free to save it to your “Documents” folder or wherever you prefer.

You should get output that looks like this. R markdown converts the document’s code into html and outputs the R commands as well as the markdown text. We will use this basic structure to build documents usable for publications and project management.

The screenshot shows the RStudio interface with the R console tab selected. The console window displays the standard R startup message, followed by user input and a blank line for further commands.

```
R version 4.2.2 (2022-10-31 ucrt) -- "Innocent and Trusting"
Copyright (C) 2022 The R Foundation for Statistical Computing
Platform: x86_64-w64-mingw32/x64 (64-bit)

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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.

> x = 5
> y = 6
> plot(x, y)
> |
```

Figure 9: **Figure 9.** R Studio window showing plot of values of x and y.
14

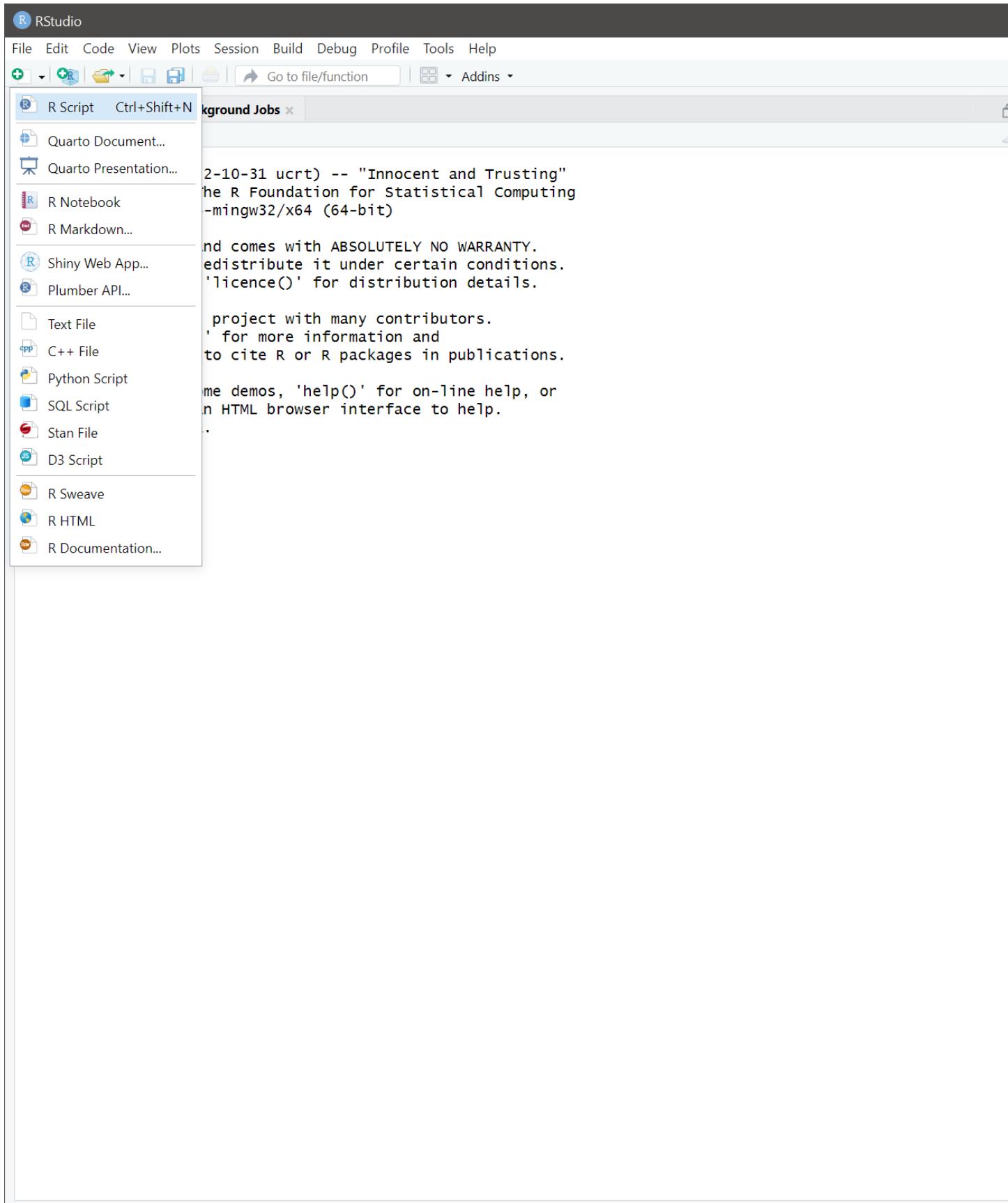


Figure 10: **Figure 10.** Screenshot of opening the 'new file' option and selecting R Markdown document

The screenshot shows the RStudio interface with the R console tab selected. The console window displays the standard R startup message, including the version (R 4.2.2), license information, and instructions for help and quitting. Below this, a few lines of R code are entered: `> x = 5`, `> y = 6`, and `> plot(x, y)`. A small vertical cursor is visible at the end of the third line.

A modal dialog box titled "Install Required Packages" is overlaid on the RStudio window. It contains an informational icon and text explaining that creating R Markdown documents requires specific packages. The package names listed are: base64enc, digest, evaluate, glue, highr, htmltools, rmarkdown, stringi, stringr, xfun, and yaml. At the bottom of the dialog, there is a question: "Do you want to install these packages now?" with a default "Yes" button.

Figure 11: **Figure 11.** Screenshot of installation prompt.
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The screenshot shows the RStudio interface with the 'Console' tab selected. The console window displays the output of an R session performing package installations. A progress bar at the top indicates the completion of an 'R Markdown Dependencies' task. Below this, the installation process for various packages is shown, including 'digest', 'evaluate', 'glue', 'xfun', and 'highr'. Each package's download and unpacking status is detailed, along with its final location in the local R library.

```
R Studio
File Edit Code View Plots Session Build Debug Profile Tools Help
+ - Go to file/function | Addins
Console Terminal x Background Jobs x
R Markdown Dependencies [ 0:00
=====
downloaded 190 KB
package 'digest' successfully unpacked and MD5 sums checked
The downloaded binary packages are in
  C:\Users\kiahtipes\AppData\Local\Temp\Rtmpaeq6D2\downloaded_packages

[3/26] Installing evaluate...
Installing package into 'C:/Users/kiahtipes/AppData/Local/R/win-library/4.2'
(as 'lib' is unspecified)
trying URL 'https://cran.rstudio.com/bin/windows/contrib/4.2/evaluate_0.20.zip'
Content type 'application/zip' length 80594 bytes (78 KB)
=====
downloaded 78 KB
package 'evaluate' successfully unpacked and MD5 sums checked
The downloaded binary packages are in
  C:\Users\kiahtipes\AppData\Local\Temp\Rtmpaeq6D2\downloaded_packages

[4/26] Installing glue...
Installing package into 'C:/Users/kiahtipes/AppData/Local/R/win-library/4.2'
(as 'lib' is unspecified)
trying URL 'https://cran.rstudio.com/bin/windows/contrib/4.2/glue_1.6.2.zip'
Content type 'application/zip' length 162457 bytes (158 KB)
=====
downloaded 158 KB
package 'glue' successfully unpacked and MD5 sums checked
The downloaded binary packages are in
  C:\Users\kiahtipes\AppData\Local\Temp\Rtmpaeq6D2\downloaded_packages

[5/26] Installing xfun...
Installing package into 'C:/Users/kiahtipes/AppData/Local/R/win-library/4.2'
(as 'lib' is unspecified)
trying URL 'https://cran.rstudio.com/bin/windows/contrib/4.2/xfun_0.37.zip'
Content type 'application/zip' length 412704 bytes (403 KB)
=====
downloaded 403 KB
package 'xfun' successfully unpacked and MD5 sums checked
The downloaded binary packages are in
  C:\Users\kiahtipes\AppData\Local\Temp\Rtmpaeq6D2\downloaded_packages

[6/26] Installing highr...
Installing package into 'C:/Users/kiahtipes/AppData/Local/R/win-library/4.2'
(as 'lib' is unspecified)
```

Figure 12: **Figure 12.** Screenshot of installation progress.

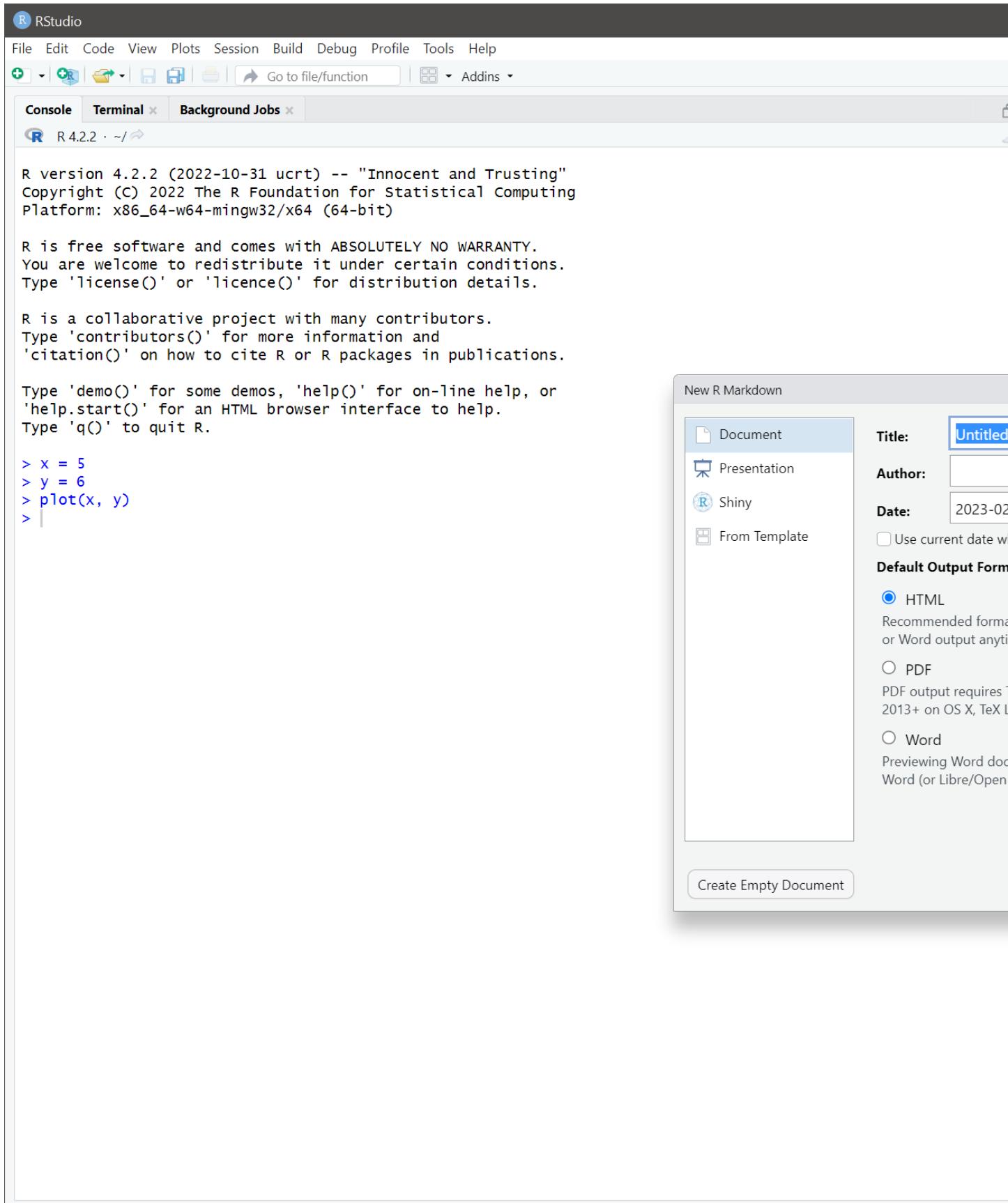


Figure 13: **Figure 13.** Screenshot of R Markdown initial screen.
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The screenshot shows the RStudio interface with the following details:

- Title Bar:** RStudio
- Menu Bar:** File, Edit, Code, View, Plots, Session, Build, Debug, Profile, Tools, Help
- Toolbar:** Includes icons for New, Open, Save, Print, Go to file/function, and Addins.
- Document Area:** Untitled1 (R Markdown)
- Source Tab:** Contains the R Markdown code:

```
1 ---  
2 title: "My Rmd Document"  
3 author: "Chris Kiatipes"  
4 date: "2023-02-17"  
5 output: html_document  
6 ---  
7  
8 ```{r setup, include=FALSE}  
9 knitr:::opts_chunk$set(echo = TRUE)  
10 ```  
11  
12 ## R Markdown  
13  
14 This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For more details on using R Markdown see <http://rmarkdown.rstudio.com>.  
15  
16 When you click the Knit button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:  
17  
18 ```{r cars}  
19 summary(cars)  
20 ```  
21  
22 ## Including Plots  
23  
24 You can also embed plots, for example:  
25  
26 ```{r pressure, echo=FALSE}  
27 plot(pressure)
```

- Status Bar:** # My Rmd Document
- Console Tab:** R 4.2.2 · ~/ ↵
- Console Output:**

```
R version 4.2.2 (2022-10-31 ucrt) -- "Innocent and Trusting"  
Copyright (C) 2022 The R Foundation for Statistical Computing  
Platform: x86_64-w64-mingw32/x64 (64-bit)

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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.

> x = 5
> y = 6
> plot(x, y)
>
```

Figure 14: **Figure 14.** Screenshot of initial R markdown document.

The screenshot shows the RStudio interface with the following details:

- File Menu:** File, Edit, Code, View, Plots, Session, Build, Debug, Profile, Tools, Help.
- Toolbar:** Includes icons for New, Open, Save, Print, Go to file/function, and Addins.
- Document Area:** Untitled1.Rmd (R Markdown). The code includes:

 - Front matter: `title: "Test"`, `author: "Chris"`, `date: "2023-01-01"`, `output: html`.
 - Code chunks: `## R Markdown`, `## Including Plots`.
 - Text: "This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For more details on using R Markdown see <<http://rmarkdown.rstudio.com>>." and "When you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:".
 - Plot embedding: `## Including Plots` followed by `plot(pressure)`.

- Knit Context Menu:** A context menu is open over the code, showing options: Knit to HTML (selected), Knit to PDF, Knit to Word, Knit with Parameters..., Knit Directory, and Clear Knitr Cache... .
- Console Tab:** Shows the R startup message for version 4.2.2.
- Console Output:**

```
R version 4.2.2 (2022-10-31 ucrt) -- "Innocent and Trusting"
Copyright (C) 2022 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 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.
```

Figure 15: ***Figure 15.*** Screenshot of save prompt for R markdown document.

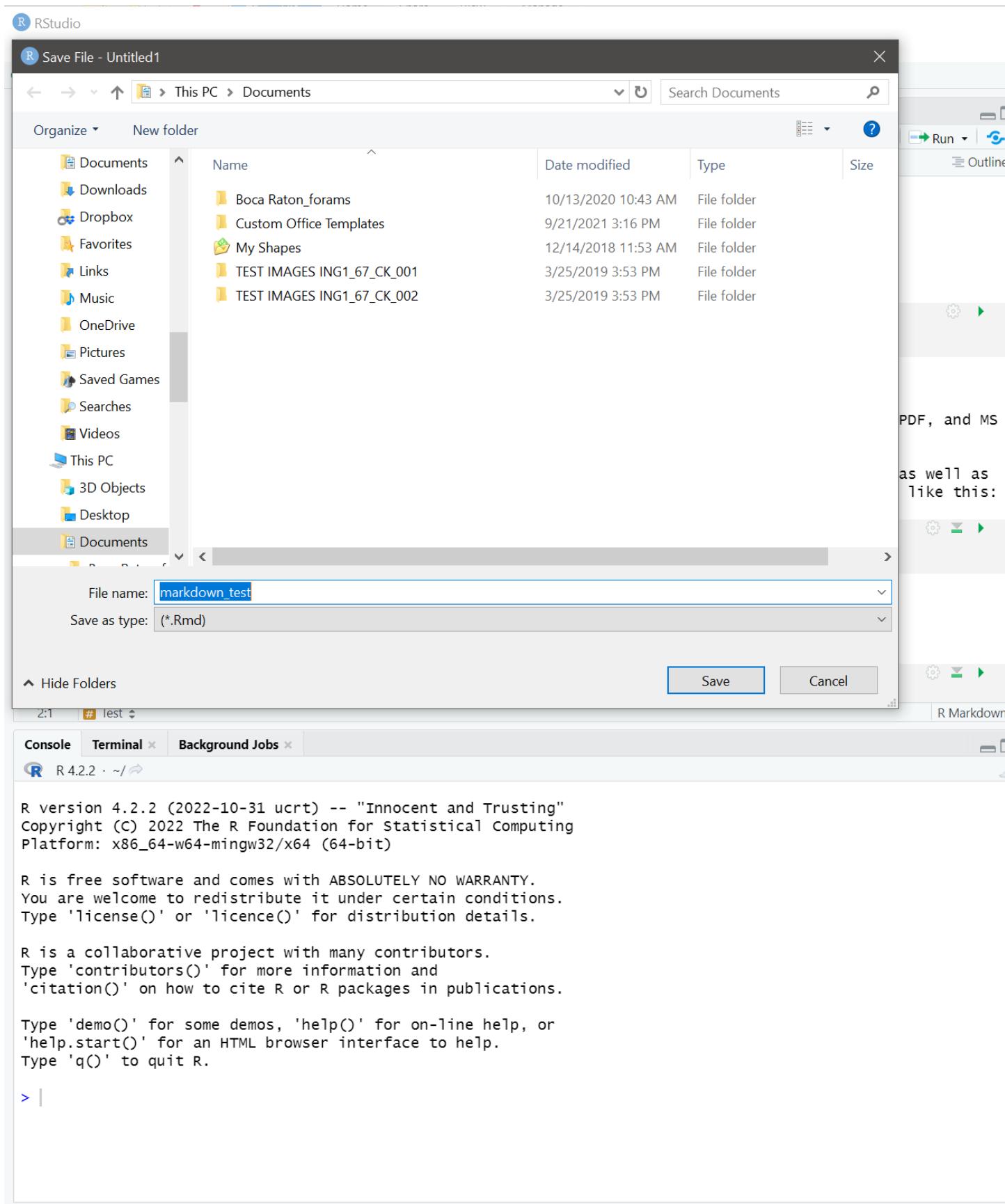


Figure 16: **Figure 16.** Screenshot of save option for R markdown document.

RStudio

File Edit Code View Plots Session Built-in Help

markdown_test.Rmd

Source Visual

```

1 ---  

2 title: "Test"  

3 author: "Chris Kiahtipes"  

4 date: "2023-02-17"  

5 output: html_document  

6 ---  

7  

8 ````{r setup, include=FALSE}  

9 knitr::opts_chunk$set(  

10 echo = TRUE,  

11 message = FALSE,  

12 warning = FALSE)  

13  

14 ## R Markdown  

15  

16 This is an R Markdown document. For more  

17 information about R Markdown see http://rmarkdown.rstudio.com.  

18 When you click the **Knit** button a document will be generated that includes both content as  

19 the output of any embedded R code chunks.  

20 ````  

21  

22 ## Including Plots  

23  

24 You can also embed plots  

25  

26 ````{r pressure, echo=FALSE}  

27 plot(pressure)
  
```

2:1 # Test

Console Terminal Render Background

R 4.2.2 · ~/

R version 4.2.2 (2022-10-31 uc Berkeley)
Copyright (C) 2022 The R Foundation for Statistical Computing
Platform: x86_64-w64-mingw32/x64 (64-bit)

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Type 'license()' or 'licence()' for more details.

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

Type 'demo()' for some demos, 'help.start()' for an HTML browser-based help system,
Type 'q()' to quit R.

> |

~ /markdown_test.html Open in Browser Find

Test

Chris Kiahtipes

2023-02-17

R Markdown

This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML documents. For more information about R Markdown see <http://rmarkdown.rstudio.com>.

When you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks. You can embed an R code chunk like this:

```
summary(cars)
```

```

##      speed         dist
## Min.   : 4.0   Min.   :  2.00
## 1st Qu.:12.0   1st Qu.: 26.00
## Median :15.0   Median : 36.00
## Mean    :15.4   Mean    : 42.98
## 3rd Qu.:19.0   3rd Qu.: 56.00
## Max.   :25.0   Max.   :120.00
  
```

Including Plots

You can also embed plots, for example:

Figure 17: **Figure 17.** Screenshot of html output from R markdown document.

At last, you have installed and initialized all of the basic tools we will use for the first APD workshop. There are a lot of open-access resources to help you get familiar with R Studio and R Markdown. Please check these out below.

Web Resources

R Studio provides resources for beginners that are free to use.

datacamp also provides some basic instructions for beginners that may be helpful.

James Scott's *Data Science in R: A Gentle Introduction* is another good resource that covers much of the same material.

Troubleshooting

Everyone encounters problems along the way and troubleshooting on the web can be helpful. Here's some suggestions for how to get better search results:

- Include software in search terms “R Studio, installation problems”.
- Include hardware in search terms “R Studio, installation problems, Windows 7”.
- Include names of key websites in search terms “R Studio, installation problems, Windows 7, stack overflow”.
- Include error messages in search terms “R Studio,”error: cannot compile“, Windows 7”.

If you are encountering a problem, it is likely that someone else has also had this issue. Google is useful, but you may find sites like stack overflow to be really useful.

Cheat Sheets

There's lots of cheat sheets that provide references for syntax, commands, and functions in R Studio and R Markdown. They're handy and strongly recommended for quick reference.

R Studio cheat sheets

R Markdown cheat sheet