

Introduction to R for Biologists

Day 1 – Intro to R and the Tidyverse Ecosystem

Developed by Rachael Cox

Welcome to Class!!



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Teaching Assistant
Ph.D. Candidate

Course Summary

Day 1: Introduction to R syntax and the Rstudio Interface

Day 2: Making plot in the Tidyverse (ggplot)

Day 3: Manipulating data in the Tidyverse (dplyr)

Day 4: Statistical Applications of R

Course Format

Concept Slides and Code Along Activities

- **Lecture -> Coding -> Lecture -> Coding**
- Check email for link to my Github
 - <https://github.com/philipjsweet/R4Biology>

Course Format

The screenshot shows a GitHub repository page for the user `philipjsweet` named `R4Biology`. The repository is public. The main navigation bar includes links for Product, Solutions, Open Source, Pricing, and a search bar. Below the navigation is a header with the repository name and a public status badge. The main content area shows a file tree with a folder `Day_1` containing an Excel file `Student_Accounts.xlsx`. A tooltip on the right side of the screen provides options for cloning the repository via HTTPS or GitHub CLI, opening it with GitHub Desktop, or downloading it as a ZIP file. The URL `https://github.com/philipjsweet/R4Biology` is also displayed.

github.com/philipjsweet/R4Biology

Function referenc... Binary classificati... Keitz Chamber Morpheus UT Account Infor... Grep Learn to purrr Bike Rides in Texa

Product Solutions Open Source Pricing Search

philipjsweet / R4Biology Public

Code Issues Pull requests Actions Projects Security Insights

main 1 branch 0 tags Go to file Code

philipjsweet Add accounts

Day_1 Create Day_1 Worksheet

Student_Accounts.xlsx Add accounts

Local Codespaces

Clone

HTTPS GitHub CLI

<https://github.com/philipjsweet/R4Biology>

Use Git or checkout with SVN using the web URL.

Open with GitHub Desktop

Download ZIP

Course Format

The screenshot shows a GitHub repository page for the user `philipjsweet` named `R4Biology`. The repository is public. The main navigation bar includes links for Product, Solutions, Open Source, Pricing, and a search bar. Below the navigation is a header with the repository name and a public status badge. The main content area shows a file tree with a file named `Day_1` and an Excel file named `Student_Accounts.xlsx`. On the right side, there is a detailed cloning interface with tabs for Local and Codespaces, options for HTTPS or GitHub CLI, a URL field (`https://github.com/philipjsweet/R4Biology`), and links for opening with GitHub Desktop or downloading a ZIP file. A yellow dashed box highlights the `Download ZIP` button.

github.com/philipjsweet/R4Biology

Function referenc... Binary classificati... Keitz Chamber Morpheus UT Account Infor... Grep Learn to purrr Bike Rides in Texa

Product Solutions Open Source Pricing Search

philipjsweet / R4Biology Public

Code Issues Pull requests Actions Projects Security Insights

main 1 branch 0 tags Go to file Code

philipjsweet Add accounts

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Local Codespaces

Clone

HTTPS GitHub CLI

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Use Git or checkout with SVN using the web URL.

Open with GitHub Desktop

Download ZIP

Day 1 Outline

1. How to get set up using R
2. How and why to use RStudio & R Markdown (.Rmd)
3. Basics of programming
 - Data types
 - Functions
 - Troubleshooting
4. Intro to the Tidyverse
 - Tidy vs untidy data
 - Tidyverse-specific functions

R: The premier data analysis and visualization platform

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



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

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

Source Code for all Platforms

Windows and Mac users most likely want to download the precompiled binaries listed in the upper

R Studio: A nice user interface for R

<https://www.rstudio.com/products/rstudio/download/>



The screenshot shows the R Studio interface. On the left, the code editor displays an R Markdown file named 'class1.Rmd'. The code includes R global options, library imports, and a markdown section about R Markdown documents. The right side features the 'Environment' pane, which is currently empty. At the bottom, the 'Console' pane shows the standard R license notice. The 'Resources' sidebar on the far right provides links to various R-related resources.

class1.Rmd x

```
1 `r global_options, include=FALSE}
2 library(knitr)
3 opts_chunk$set(fig.align="center", fig.height=4, fig.width=4)
4 
5 ##In-class worksheet 1
6 
7 **Jan 17, 2017**
8 
9 
10 Much of the work in this class will be done via R Markdown
11 documents. R Markdown documents are documents that combine text, R
12 code, and R output, including figures. They are a great way to
13 produce self-contained and documented statistical analyses.
14 
15 Edit only below this line.
```

7:15 In-class worksheet 1 R Markdown

Console ~ /

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.

Environment History

Import Dataset

Global Environment

Environment is empty

Files Plots Packages Help Viewer

R Resources

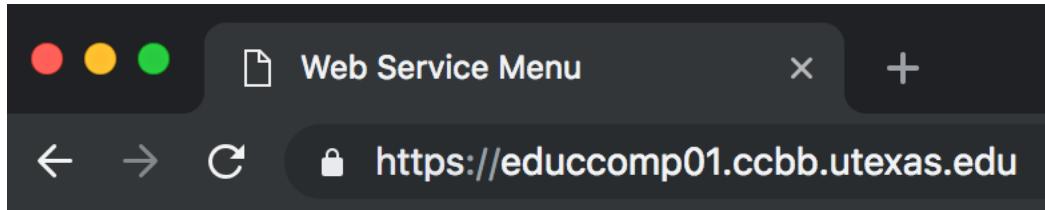
Learning R Online CRAN Task Views R on StackOverflow Getting Help with R

RStudio IDE Support RStudio Cheat Sheets RStudio Tip of the Day RStudio Packages RStudio Products

Access R Studio through your web browser

1. <https://gsafcomp01.ccbb.utexas.edu/>
2. <https://gsafcomp02.ccbb.utexas.edu/>

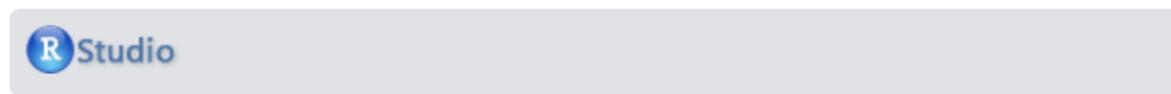
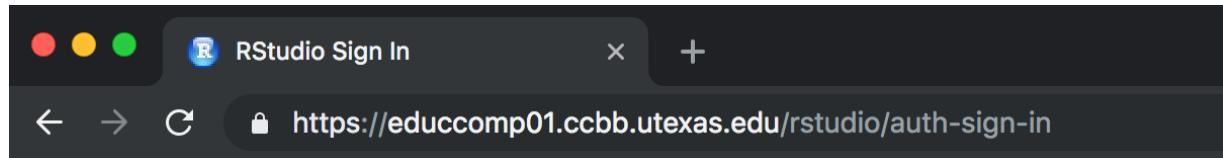
Select RStudio



Please choose one of the following applications:

- [RStudio](#) ←
- [Jupyterhub](#)

Sign in with your student# and password



Refer to class email for your individual username

Sign in to RStudio

Username:

Password:

Stay signed in

Sign In

The form consists of several input fields and a checkbox. The "Username:" field is highlighted with a red circle and arrow. The "Password:" field is below it, followed by a "Stay signed in" checkbox. At the bottom is a prominent blue "Sign In" button.

R Markdown

R Markdown: Open the markdown

The screenshot shows the RStudio interface running in a web browser at gsafcomp01.ccbb.utexas.edu/rstudio/. The browser's address bar and various tabs are visible at the top.

Console Pane:

```
R version 3.6.3 (2020-02-29) -- "Holding the Windsock"
Copyright (C) 2020 The R Foundation for Statistical Computing
Platform: x86_64-pc-linux-gnu (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.

> library(ggthemes)
Session restored from your saved work on 2023-May-25 21:29:05 UTC (3 hours ago)
> |
```

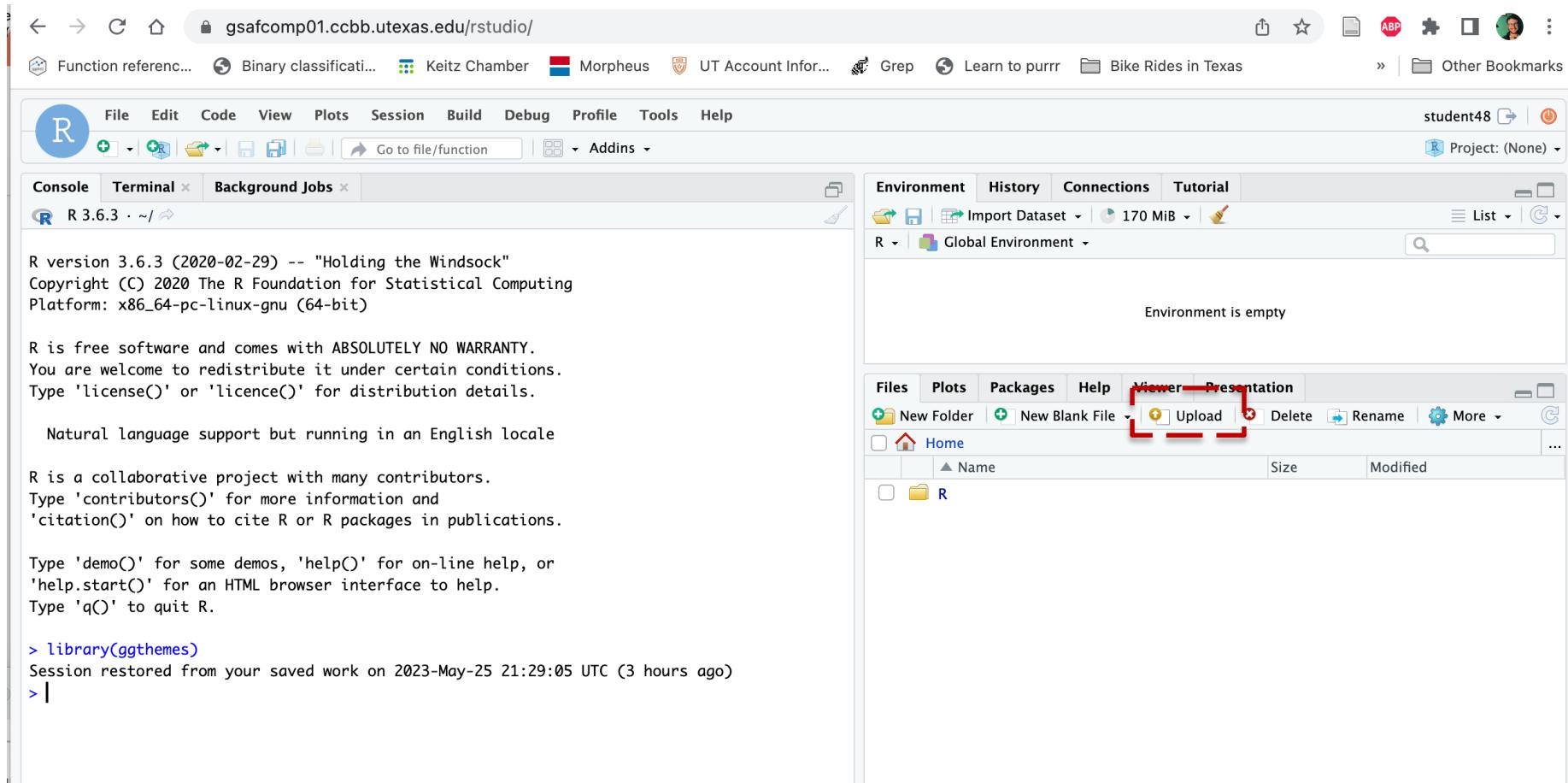
Environment Pane:

Environment is empty

Files Pane:

Name	Size	Modified
R		

R Markdown: Open the markdown



The screenshot shows the RStudio interface running in a web browser. The top navigation bar includes links for Function reference, Binary classification, Keitz Chamber, Morpheus, UT Account Information, Grep, Learn to purrr, Bike Rides in Texas, and Other Bookmarks. The user is signed in as student48.

The main window displays the R console output:

```
R version 3.6.3 (2020-02-29) -- "Holding the Windsock"
Copyright (C) 2020 The R Foundation for Statistical Computing
Platform: x86_64-pc-linux-gnu (64-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
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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.

> library(ggthemes)
Session restored from your saved work on 2023-May-25 21:29:05 UTC (3 hours ago)
> |
```

The RStudio interface includes the following panes:

- Environment**: Shows the Global Environment, which is currently empty.
- Files**: Shows a list of files including 'Home' and 'R'. The 'Upload' button is highlighted with a red box.

R Markdown: Open the markdown

The screenshot shows the RStudio interface running in a web browser. The title bar indicates the URL is `gsafcomp01.ccbb.utexas.edu/rstudio/`. The top menu bar includes File, Edit, Code, View, Plots, Session, Build, Debug, Profile, Tools, and Help. The sidebar on the left lists various packages and tools: Function reference..., Binary classificati..., Keitz Chamber, Morpheus, UT Account Infor..., Grep, Learn to purrr, Bike Rides in Texas, and Other Bookmarks. The main console window displays the R startup message and license information. A modal dialog box titled "Upload Files" is open in the center, prompting for a target directory (~) and a file to upload (Choose File). A tip at the bottom of the dialog suggests creating a zip file for multiple uploads. The environment pane shows an empty global environment. The bottom status bar shows the session was restored from work on 2023-May-25 21:29:05 UTC (3 hours ago).

```
R version 3.6.3 (2020-02-29) -- "Holding the Windsock"
Copyright (C) 2020 The R Foundation for Statistical Computing
Platform: x86_64-pc-linux-gnu (64-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
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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.

> library(ggthemes)
Session restored from your saved work on 2023-May-25 21:29:05 UTC (3 hours ago)
>
```

Upload Files

Target directory: ~

File to upload: No file chosen

TIP: To upload multiple files or a directory, create a zip file.
The zip file will be automatically expanded after upload.

OK Cancel

R Markdown: Open the markdown

The screenshot shows the RStudio interface running in a web browser window. The title bar indicates the URL is `gsafcomp01.ccbb.utexas.edu/rstudio/`. The top menu bar includes File, Edit, Code, View, Plots, Session, Build, Debug, Profile, Tools, and Help. The top toolbar has various icons for file operations like Open, Save, and Print. The left sidebar has tabs for Console, Terminal, and Background Jobs, with the Console tab active. The main workspace shows the R command-line interface (R 3.6.3) with standard startup messages. A modal dialog box titled "Upload Files" is centered over the workspace. It has fields for "Target directory:" (set to "~") and "File to upload:" (with a "Choose File" button). A tip message below says: "TIP: To upload multiple files or a directory, create a zip file. The zip file will be automatically expanded after upload." At the bottom of the dialog are "OK" and "Cancel" buttons. The right side of the interface shows the Environment pane, which is currently empty. The bottom navigation bar includes Pages, Help, Viewer, Presentation, and a file manager section with New Blank File, Upload, Delete, Rename, and More buttons.

```
R version 3.6.3 (2020-02-29) -- "Holding the Windsock"
Copyright (C) 2020 The R Foundation for Statistical Computing
Platform: x86_64-pc-linux-gnu (64-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
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Type 'contributors()' for more information and
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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.

> library(ggthemes)
Session restored from your saved work on 2023-May-25 21:29:05 UTC (3 hours ago)
>
```

R Markdown: Open the markdown

Demonstration Time!!

The screenshot shows the RStudio interface with the following details:

- Header Bar:** Shows the URL gsafcomp01.cccb.utexas.edu/rstudio/, a search bar, and various bookmarks.
- Toolbar:** Includes File, Edit, Code, View, Plots, Session, Build, Debug, Profile, Tools, Help, and Addins tabs.
- Console Tab:** Displays the R startup message for version 3.6.3 (2020-02-29) and the standard R welcome text.
- Environment Tab:** Shows the Global Environment with an empty list.
- File Menu:** Shows options like New Blank File, Upload, Delete, Rename, More, and a dropdown for Size and Modified.
- Central Area:** An "Upload Files" dialog box is open, prompting for a target directory and a file to upload. A red box highlights the "Choose File" button. Below it is a tip about uploading zip files.
- Bottom:** A command line prompt shows the user has run `> library(ggthemes)`.

R Markdown: Writing documents with embedded R code

The screenshot shows the RStudio interface with the file 'class1.Rmd' open. The code editor displays the following R Markdown document:

```
16 -----  
17 ## 1. Basic Markdown editing  
18 Try out basic R Markdown features, as described  
[here.](http://rmarkdown.rstudio.com/authoring\_basics.html) Write some text  
that is bold, and some that is in italics. Make a numbered list and a bulleted  
list. Make a nested list. Try the block-quote feature.  
19  
20 ## 2. Embedding R code  
21  
22 R code embedded in R chunks will be executed and the output will be shown.  
23 ```{r}  
24 # R code goes here  
25 x <- 5  
26 y <- 7  
27 z <- x * y  
28 z  
29  
30
```

R Markdown: Writing documents with embedded R code

1. Basic Markdown editing

Try out basic R Markdown features, as described [here](#). Write some text that is bold, and some that is italics. Make a numbered list and a bulleted list. Make a nested list. Try the block-quote feature.

2. Embedding R code

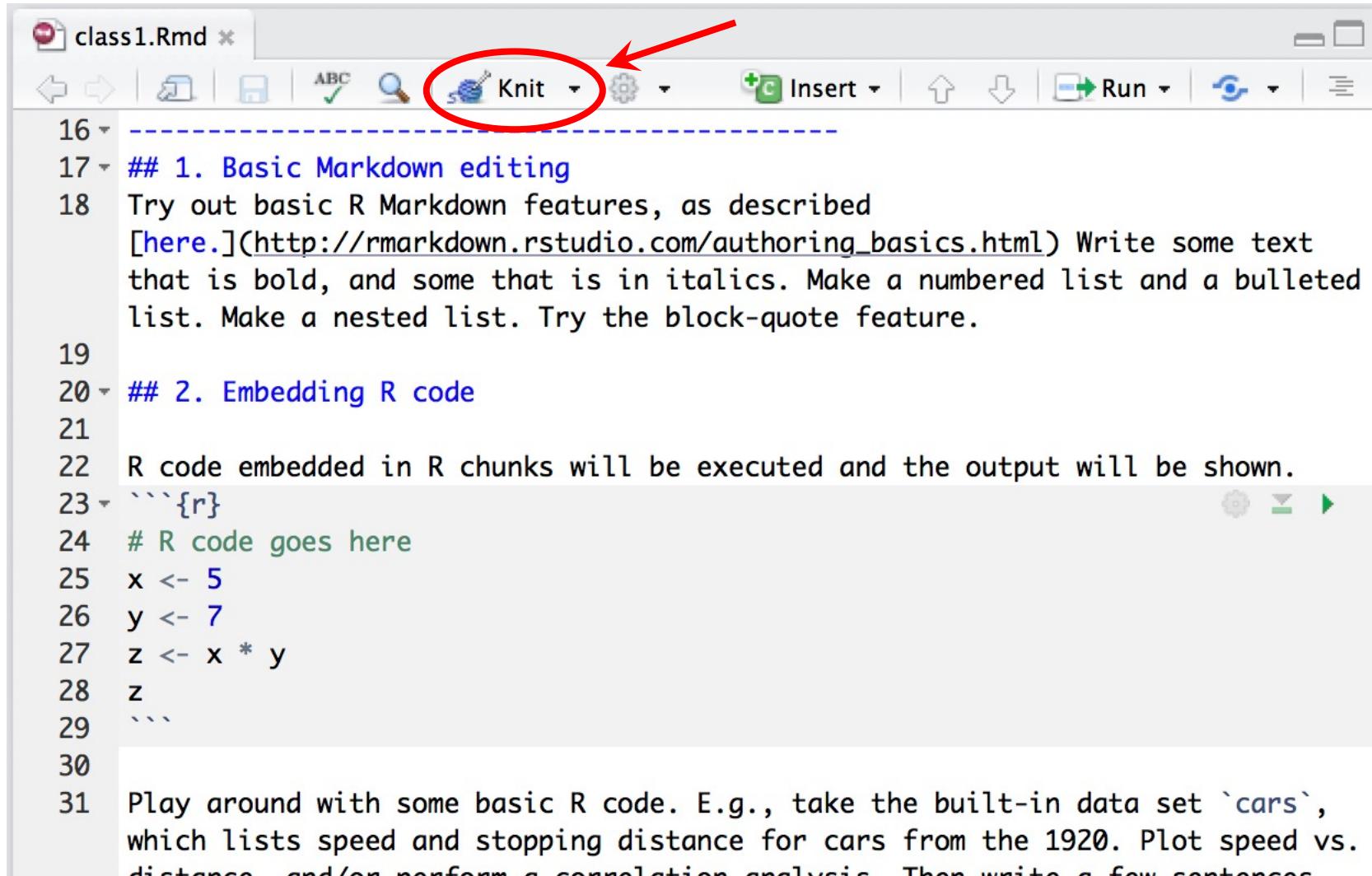
R code embedded in R chunks will be executed and the output will be shown.

```
# R code goes here
x <- 5
y <- 7
z <- x * y
z
```

```
## [1] 35
```

Play around with some basic R code. E.g., take the built-in data set `cars`, which lists speed and stopping distance for cars from the 1920. Plot speed vs. distance, and/or perform a correlation analysis. Then write a few sentences describing what you see.

We convert R Markdown to HTML by “knitting” the Markdown file



The screenshot shows the RStudio interface with a file named "class1.Rmd" open. The toolbar at the top has several icons: back, forward, file, ABC, magnifying glass, Knit (circled in red), settings, Insert, Run, and others. A red arrow points from the text above to the Knit icon. The main workspace displays R Markdown code:

```
16 -----  
17 ## 1. Basic Markdown editing  
18 Try out basic R Markdown features, as described  
[here.](http://rmarkdown.rstudio.com/authoring_basics.html) Write some text  
that is bold, and some that is in italics. Make a numbered list and a bulleted  
list. Make a nested list. Try the block-quote feature.  
19  
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22 R code embedded in R chunks will be executed and the output will be shown.  
23 ```{r}  
24 # R code goes here  
25 x <- 5  
26 y <- 7  
27 z <- x * y  
28 z  
29 ...  
30  
31 Play around with some basic R code. E.g., take the built-in data set `cars`,  
which lists speed and stopping distance for cars from the 1920. Plot speed vs.  
distance and/or perform a correlation analysis. Then write a few sentences
```

Markdown basics

http://rmarkdown.rstudio.com/authoring_basics.html

normal text

italics

bold

```
# Header 1  
## Header 2
```

List:

1. Item 1
2. Item 2
3. Item 3

normal text

italics

bold

Header 1

Header 2

List:

1. Item 1
2. Item 2
3. Item 3



Markdown basics

Embedded R code will be evaluated and printed

```
```{r}
head(cars)
plot(cars$speed, cars$dist)
```
```

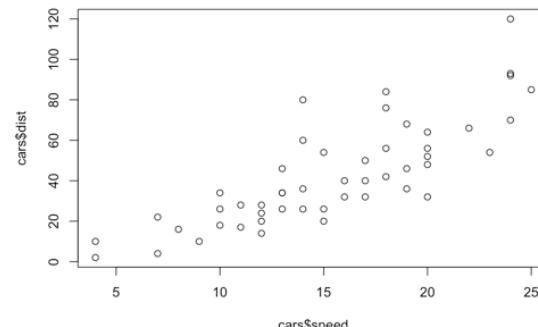


Embedded R code will be evaluated and printed

```
head(cars)
```

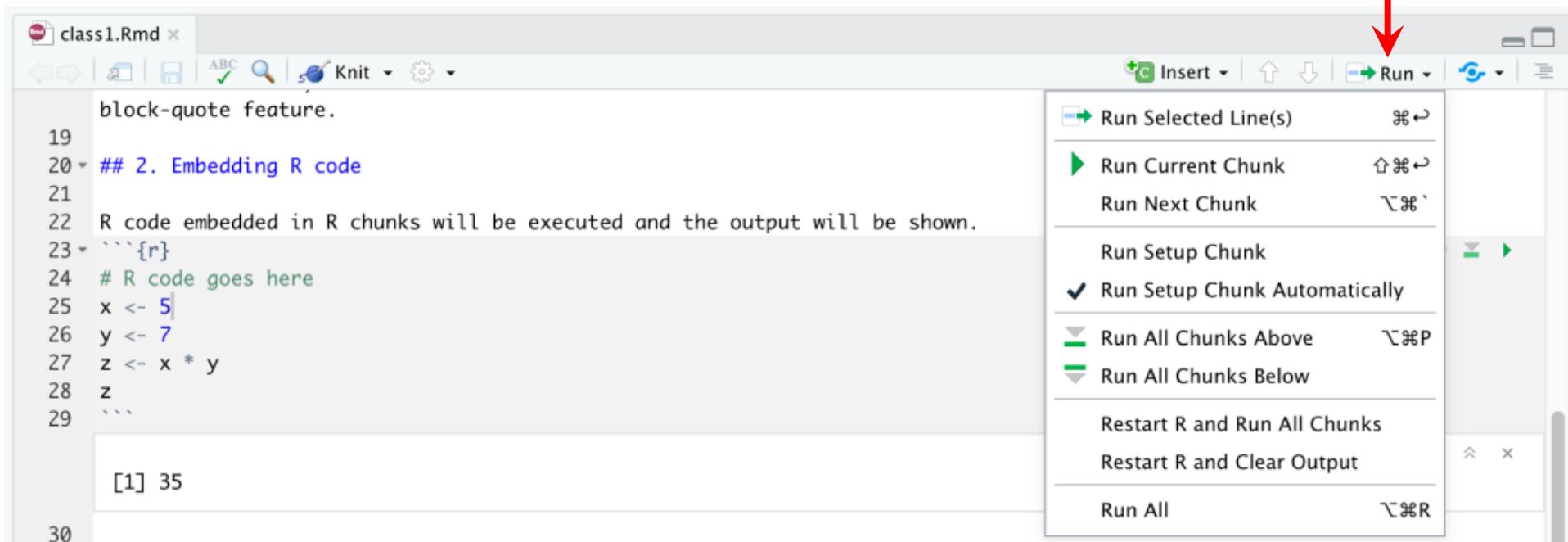
```
##   speed dist
## 1     4    2
## 2     4   10
## 3     7    4
## 4     7   22
## 5     8   16
## 6     9   10
```

```
plot(cars$speed, cars$dist)
```



Different ways to execute code in RStudio

Press the “Run” button



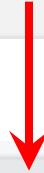
A screenshot of the RStudio interface showing an R Markdown file named "class1.Rmd". The code chunk at line 23 contains an R code block (indicated by `{{r}}`), which has been run and its output, "[1] 35", is displayed in the console area. The toolbar at the top includes icons for file operations, ABC, search, Knit, and a "Run" button. A red arrow points to the "Run" button. A context menu is open over the "Run" button, listing various execution options:

- Run Selected Line(s)
- Run Current Chunk
- Run Next Chunk
- Run Setup Chunk
- Run Setup Chunk Automatically
- Run All Chunks Above
- Run All Chunks Below
- Restart R and Run All Chunks
- Restart R and Clear Output
- Run All

Highlight code you want to execute and press ctrl+Enter (cmd+Enter on Macs)

R code embedded in R chunks will be executed and the output will be shown.

```
```{r}
R code goes here
x <- 5
y <- 7
z <- x * y
z
```



Console Terminal × Jobs ×

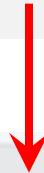
~/Desktop/projects/ ↵

```
> x <- 5
> y <- 7
> z <- x * y
> z
[1] 35
> |
```

Place pointer on line of code you want to execute,  
press ctrl+Enter (cmd+Enter on Macs)

R code embedded in R chunks will be executed and the output will be shown.

```
```{r}
# R code goes here
x <- 5
y <- 7
z <- x * y|
z
```



Console Terminal × Jobs ×

~/Desktop/projects/ ↵

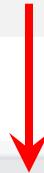
```
> z <- x * y
> |
```

Use **ctrl+Shift+Enter** (**cmd+Shift+Enter** on Macs) to execute an entire code chunk

R code embedded in R chunks will be executed and the output will be shown.

```
```{r}
R code goes here
x <- 5
y <- 7
z <- x * y
z
...```

```



Console Terminal × Jobs ×

~/Desktop/projects/ ↵

```
> x <- 5
> y <- 7
> z <- x * y
> z
[1] 35
> |
```

# Shortcuts for coding

- **Ctrl+Shift+M** (Cmd+Shift+M on Macs) produces a pipe operator `%>%` (will be used with the tidyverse)
- **Ctrl+Shift+C** (Cmd+Shift+C on Macs) will comment/uncomment a line or multiple lines
- **Tab** and **Shift+Tab** will indent and un-indent lines, respectively

# Your turn!

**Try Example #1 and #2**

**Stuck? Raise your hand and we'll come around**

# R Programming Basics

# Assignments, numbers, vectors

```
> x <- 5
```

Assign number 5 to variable x

```
> x
```

```
[1] 5
```

```
> 5*x^2+7
```

Calculate  $5 \cdot x^2 + 7$

```
[1] 132
```

```
> y <- c(1, 2, 3, 4, 5)
```

Create vector, assign  
to variable y

```
[1] 1 2 3 4 5
```

```
> x*y
```

Multiply each element

in y with the number in x

```
[1] 5 10 15 20 25
```

# Strings

A string contains text:

```
> name <- "Rachael Cox"
> name
[1] "Rachael Cox"
```

A vector of strings:

```
> animals <- c("cat", "mouse", "mouse",
"cat", "rabbit")
> animals
[1] "cat" "mouse" "mouse" "cat"
"rabbit"
```

# Factors

Factors keep track of distinct categories (levels) in a vector:

```
> animals
[1] "cat" "mouse" "mouse" "cat"
"rabbit"

> factor(animals)
[1] cat mouse mouse cat rabbit
Levels: cat mouse rabbit
```

# Data frames

We use data frames to store data sets with multiple variables:

```
> pets <- data.frame(
 family = c(1, 2, 3, 4, 5),
 pet = animals
)

> pets
family pet
1 1 cat
2 2 mouse
3 3 mouse
4 4 cat
5 5 rabbit
```

# Data frames

We access individual columns in a data frame with \$ + the column name:

```
> pets$family
[1] 1 2 3 4 5
```

```
> pets$pet
[1] cat mouse mouse cat rabbit
Levels: cat mouse rabbit
```

# Demonstration Time!

Work on Section #3

# Data frames

R has many built-in data frames:

> cars		> chickwts			
		speed	dist	weight	feed
1		4	2	1	179 horsebean
2		4	10	2	160 horsebean
3		7	4	3	136 horsebean
4		7	22	4	227 horsebean
5		8	16	...	...
6		9	10	11	309 linseed
7		10	18	12	229 linseed
8		10	26	13	181 linseed
9		10	34	14	141 linseed

# Data frames

Available built-in datasets can be accessed with `data()`

The screenshot shows the RStudio interface with the 'R data sets' browser panel open. The panel lists various built-in datasets from the 'datasets' package, each with a brief description. The 'Console' tab at the bottom shows the command `> data()` being run.

Data set	Description
AirPassengers	Monthly Airline Passenger Numbers 1949-1960
BJSales	Sales Data with Leading Indicator
BJSales.lead (BJSales)	Sales Data with Leading Indicator
BOD	Biochemical Oxygen Demand
CO2	Carbon Dioxide Uptake in Grass Plants
ChickWeight	Weight versus age of chicks on different diets
DNase	Elisa assay of DNase
EuStockMarkets	Daily Closing Prices of Major European Stock Indices, 1991-1998
Formaldehyde	Determination of Formaldehyde
HairEyeColor	Hair and Eye Color of Statistics Students
Harman23.cor	Harman Example 2.3
Harman74.cor	Harman Example 7.4
Indometh	Pharmacokinetics of Indomethacin
InsectSprays	Effectiveness of Insect Sprays
JohnsonJohnson	Quarterly Earnings per Johnson & Johnson Share
LakeHuron	Level of Lake Huron 1875-1972

```
> data()
```

# Data frames

Data set information can be accessed with `?dataset`

The screenshot shows the RStudio interface. On the left, the 'Environment' tab of the 'R data sets' pane is active, displaying a list of datasets. The 'cars' dataset is highlighted and circled in red. A red arrow points from the 'cars' entry in the environment pane to the 'Help' tab in the top navigation bar of the help window. The 'Help' tab is also circled in red. The main help window displays the documentation for the 'cars' dataset, which is titled 'Speed and Stopping Distances of Cars'. The documentation includes sections for 'Description', 'Usage', 'Format', and 'Source', along with a code example in the console pane at the bottom.

R data sets x

Quarterly Time Series of the Number of Australian Residents  
beaver1 (beavers)  
Body Temperature Series of Two Beavers  
beaver2 (beavers)  
Body Temperature Series of Two Beavers  
cars  
Speed and Stopping Distances of Cars  
chickwts  
Chicken Weights by Feed Type  
co2  
Mauna Loa Atmospheric CO2 Concentration  
crimtab

Environment History Connections

Files Plots Packages Help Viewer

R: Speed and Stopping Distances of Cars Find in Topic

cars {datasets}

## Speed and Stopping Distances of Cars

### Description

The data give the speed of cars and the distances taken to stop. Note that the data were recorded in the 1920s.

### Usage

cars

### Format

A data frame with 50 observations on 2 variables.

[,1] speed numeric Speed (mph)  
[,2] dist numeric Stopping distance (ft)

### Source

Ezekiel, M. (1930) *Methods of Correlation Analysis*. Wiley.

```
> data()
> ?data
> ?cars
> |
```

# Data frames

The `head( )` function shows the first few lines of a data frame:

```
> head(cars)
 speed dist
1 4 2
2 4 10
3 7 4
4 7 22
5 8 16
6 9 10
>
```

# Functions

Functions are called in the format **function(argument)**

```
> head(cars)
```

Function name

First argument

# Functions

Functions can have any number of required arguments or optional arguments

```
> head(cars, 8)
```

Function name      First argument  
(required)      Second argument  
(optional; default = 6)

# Functions

`head(cars, 8)` will show the first 8 lines of the data frame instead of the default 6:

```
> head(cars, 8)
```

	speed	dist
--	-------	------

1	4	2
---	---	---

2	4	10
---	---	----

3	7	4
---	---	---

4	7	22
---	---	----

5	8	16
---	---	----

6	9	10
---	---	----

7	10	18
---	----	----

8	10	26
---	----	----

# Functions

More information about what a function does and/or requires can be accessed with `?function`

The screenshot shows the RStudio interface. On the left, there's a data frame viewer showing the first 8 entries of the 'cars' dataset, with columns 'speed' and 'dist'. Below it is a console window where the command `?head` has been entered. A red circle highlights this command. A red arrow points from this circle to the title of the help page on the right. The help page for `head` is displayed in the main pane. It includes the title "Return the First or Last Part of an Object", a "Description" section stating it returns parts of various objects, and a "Usage" section showing the function signature and its methods for different classes.

R data sets × . × Environment History Connections

Files Plots Packages Help Viewer

R: Return the First or Last Part of an Object Find in Topic

head {utils}

## Return the First or Last Part of an Object

### Description

Returns the first or last parts of a vector, matrix, table, data frame or function. Since `head()` and `tail()` are generic functions, they can be used on objects of other classes. See `methods(head)` for more details.

### Usage

```
head(x, ...)
Default S3 method:
head(x, n = 6L, ...)
S3 method for class 'data.frame'
head(x, n = 6L, ...)
S3 method for class 'matrix'
head(x, n = 6L, ...)
S3 method for class 'ftable'
head(x, n = 6L, ...)
S3 method for class 'table'
head(x, n = 6L, ...)
S3 method for class 'function'
head(x, n = 6L, ...)
```

```
tail(x, ...)
Default S3 method:
```

# Functions

?function has argument information

The screenshot shows the RStudio interface with the 'Viewer' tab selected. The main area displays the help page for the 'tail' function. A red circle highlights the 'Arguments' section, which is bolded. Another red circle highlights the command '> ?head' in the console tab at the bottom left.

Environment History Connections

Files Plots Packages Help Viewer

R: Return the First or Last Part of an Object Find in Topic

```
S3 method for class 'ftable'
tail(x, n = 6L, addrownums = FALSE, ...)
S3 method for class 'table'
tail(x, n = 6L, addrownums = TRUE, ...)
S3 method for class 'function'
tail(x, n = 6L, ...)
```

**Arguments**

x an object

n a single integer. If positive, size for the resulting object: number of elements for a vector (including lists), rows for a matrix or data frame or lines for a function. If negative, all but the n last/first number of elements of x.

addrownums if there are no row names, create them from the row numbers.

... arguments to be passed to or from other methods.

Showing 1 to 8 of 50 entries

Console Terminal

> ?head  
>

# Functions

We can implicitly or explicitly pass arguments

```
> head(cars, 8)
 speed dist
```

1	4	2
2	4	10
3	7	4
4	7	22
5	8	16
6	9	10
7	10	18
8	10	26

```
>
```

```
> head(x=cars, n=8)
 speed dist
```

1	4	2
2	4	10
3	7	4
4	7	22
5	8	16
6	9	10
7	10	18
8	10	26

```
>
```

# Demonstration Time!

Work on Section #4

# Troubleshooting

# Ask RStudio for help

Type `?function` into console

The screenshot shows the RStudio interface with the 'Console' tab selected. In the console, the command `> ?t.test` is typed. To the right, the 'Viewer' panel displays the help documentation for the `t.test` function. A red arrow points from the console input to the title of the documentation.

**t.test {stats}** R Documentation

## Student's t-Test

### Description

Performs one and two sample t-tests on vectors of data.

### Usage

```
t.test(x, ...)
```

```
Default S3 method:
t.test(x, y = NULL,
 alternative = c("two.sided", "less", "greater"),
 mu = 0, paired = FALSE, var.equal = FALSE,
 conf.level = 0.95, ...)
```

```
S3 method for class 'formula'
t.test(formula, data, subset, na.action, ...)
```

# Ask Google for help

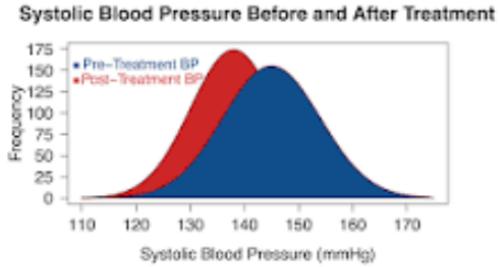
how do i run a t test in r

All Videos Images News Shopping More Settings Tools

About 2,780,000,000 results (0.64 seconds)

How to Perform T-tests in R. To conduct a one-sample t-test in R, we use the syntax `t.test(y, mu = 0)` where x is the name of our variable of interest and mu is set equal to the mean specified by the null hypothesis.

Aug 17, 2015

A line graph titled "Systolic Blood Pressure Before and After Treatment". The x-axis is labeled "Systolic Blood Pressure (mmHg)" and ranges from 110 to 170. The y-axis is labeled "Frequency" and ranges from 0 to 175. There are two bell-shaped curves: a blue curve for "Pre-Treatment BP" centered around 145 mmHg, and a red curve for "Post-Treatment BP" shifted to the right, centered around 140 mmHg, indicating a decrease in blood pressure after treatment.

[datascienceplus.com › t-tests ▾](http://datascienceplus.com/t-tests/)

[How to Perform T-tests in R | DataScience+](https://www.datascienceplus.com/how-to-perform-t-tests-in-r/)

 Error in `t.test.default(x, y)` : not enough 'x' observations

 Error in `t.test.default(x, y)` : not enough 'x' observations - Google Search

# Ask StackOverflow for help

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## Rotating and spacing axis labels in ggplot2

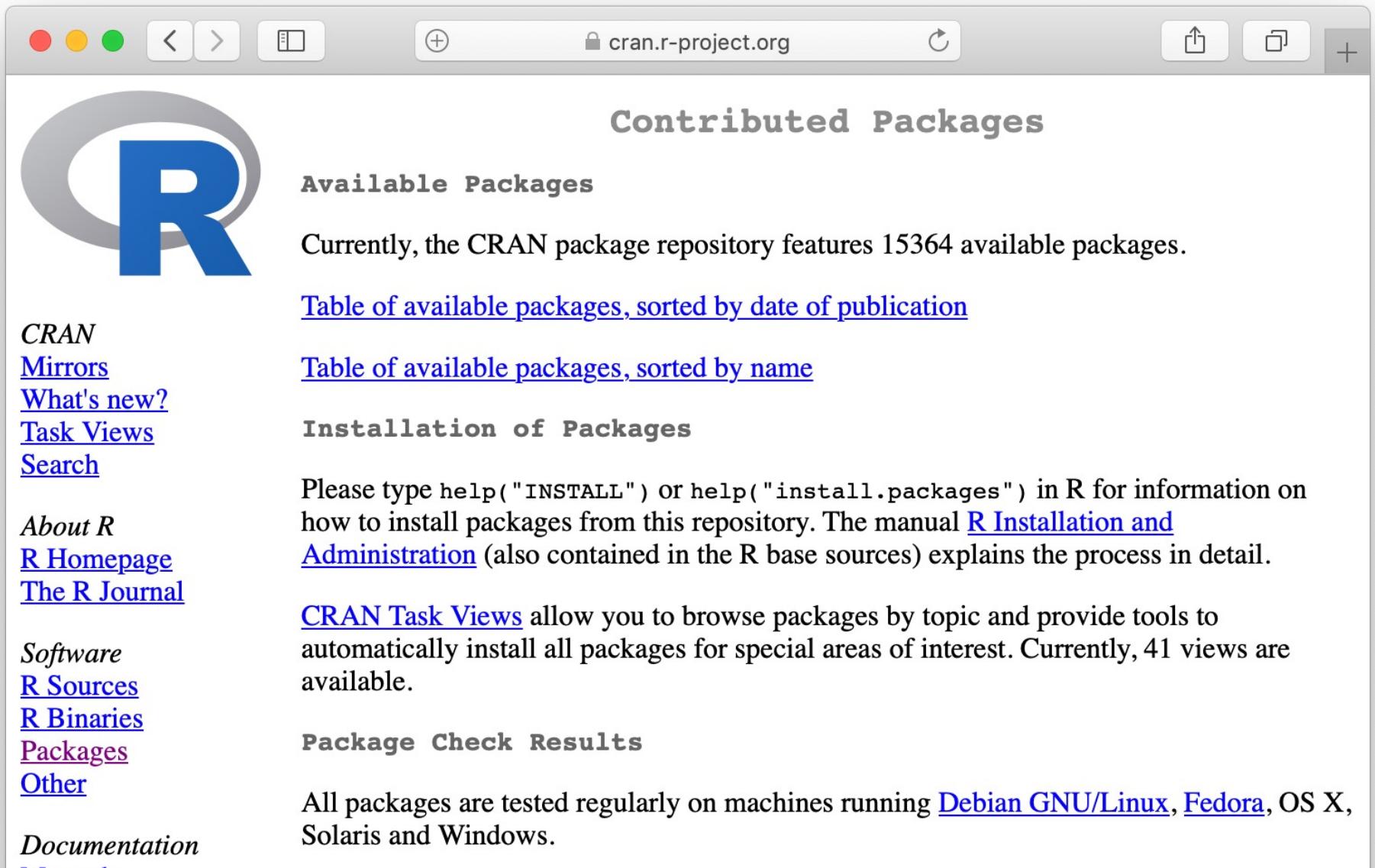
Asked 10 years, 10 months ago Active 18 days ago Viewed 768k times

 680 

I have a plot where the x-axis is a factor whose labels are long. While probably not an ideal visualization, for now I'd like to simply rotate these labels to be vertical. I've figured this part out with the code below, but as you can see, the labels aren't totally visible.

# Extending R through packages: There's a package for everything

# R packages are available on CRAN (Comprehensive R Archive Network)



The screenshot shows a web browser window with the URL `cran.r-project.org` in the address bar. The page title is "Contributed Packages". On the left, there is a large "R" logo. The main content area has several sections: "Available Packages" (with a note about 15364 packages), links to "Table of available packages, sorted by date of publication" and "Table of available packages, sorted by name", "Installation of Packages" (with instructions for R users), "CRAN Task Views" (described as allowing browsing by topic and automatic installation of packages for specific areas of interest), and "Package Check Results" (noted as being tested on Debian GNU/Linux, Fedora, OS X, Solaris, and Windows). On the far left, a sidebar lists various CRAN resources: CRAN Mirrors, What's new?, Task Views, Search, About R, R Homepage, The R Journal, Software, R Sources, R Binaries, Packages, Other, and Documentation.

## Contributed Packages



**Available Packages**

Currently, the CRAN package repository features 15364 available packages.

[Table of available packages, sorted by date of publication](#)

[Table of available packages, sorted by name](#)

**Installation of Packages**

Please type `help("INSTALL")` or `help("install.packages")` in R for information on how to install packages from this repository. The manual [R Installation and Administration](#) (also contained in the R base sources) explains the process in detail.

**CRAN Task Views** allow you to browse packages by topic and provide tools to automatically install all packages for special areas of interest. Currently, 41 views are available.

**Package Check Results**

All packages are tested regularly on machines running [Debian GNU/Linux](#), [Fedora](#), OS X, Solaris and Windows.

**CRAN**  
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# Bio-specific R packages are available on Bioconductor



Search:

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## About Bioconductor

*Bioconductor* provides tools for the analysis and comprehension of high-throughput genomic data.

*Bioconductor* uses the R statistical programming language, and is open source and open development. It has two releases each year, and an active user community. *Bioconductor* is also available as an [AMI](#) (Amazon Machine Image) and [Docker](#) images.

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- Core team **job opportunities** available, contact Martin.Morgan at RoswellPark.org
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