

# Introduction to R for Biologists

Day 1 – Intro to R and the Tidyverse Ecosystem

Developed by Rachel Cox

# Welcome to Class!!



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(he/him)  
Instructor  
Research Fellow



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(sher/her)  
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 the repository structure with files `Day_1` and `Student_Accounts.xlsx`. On the right, there is a detailed sidebar with options for cloning the repository via HTTPS or GitHub CLI, opening it with GitHub Desktop, or downloading 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 list of files and folders: `Day_1` (with a sub-item `Create Day_1 Worksheet`) and `Student_Accounts.xlsx`. To the right, 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.

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

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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

# 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 (knitr), and a code chunk setup. It also contains a header for an 'In-class worksheet' and a date ('\*\*Jan 17, 2017\*\*'). Below this, two paragraphs explain the use of R Markdown for statistical analyses and provide instructions for editing and knitting the document. The top navigation bar includes tabs for 'Environment' and 'History', and a 'Project: (None)' dropdown. The bottom navigation bar has tabs for 'Files', 'Plots', 'Packages', 'Help', and 'Viewer'. The 'Environment' pane on the right shows that the global environment is currently empty. At the bottom, the 'Console' pane displays the standard R license notice. To the right of the main workspace, there is a sidebar titled 'R Resources' containing links to various R-related resources like 'Learning R Online', 'CRAN Task Views', and 'RStudio Products'.

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 In this first worksheet, you will learn how to do some basic
16 markdown editing. After you have made a change to the document,
17 press "Knit HTML" in R Studio and see what kind of a result you
18 get.
19 
20 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

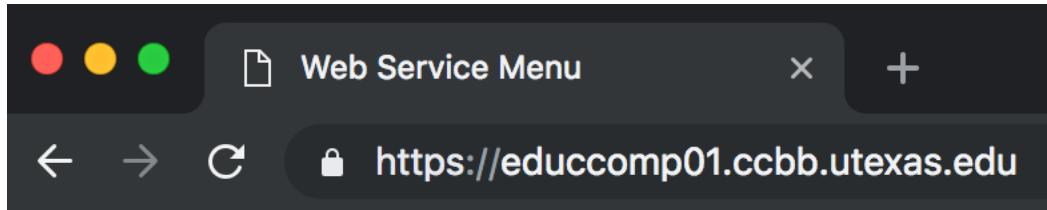
Learning R Online CRAN Task Views R on StackOverflow Getting Help with R

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/>

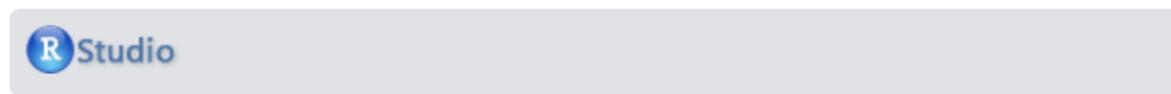
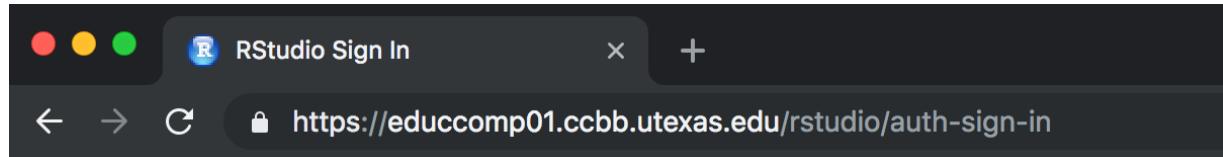
# Select RStudio



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 is a light gray rectangle with rounded corners. At the top center, it says "Sign in to RStudio". Below that is a "Username:" label with an associated text input field. Below that is a "Password:" label with an associated password input field. There is a "Stay signed in" checkbox followed by a "Sign In" button at the bottom.

# R Markdown

# R Markdown: Open the markdown

The screenshot shows the RStudio interface running in a web browser at [gsafcomp01.ccbb.utexas.edu/rstudio/](https://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:**

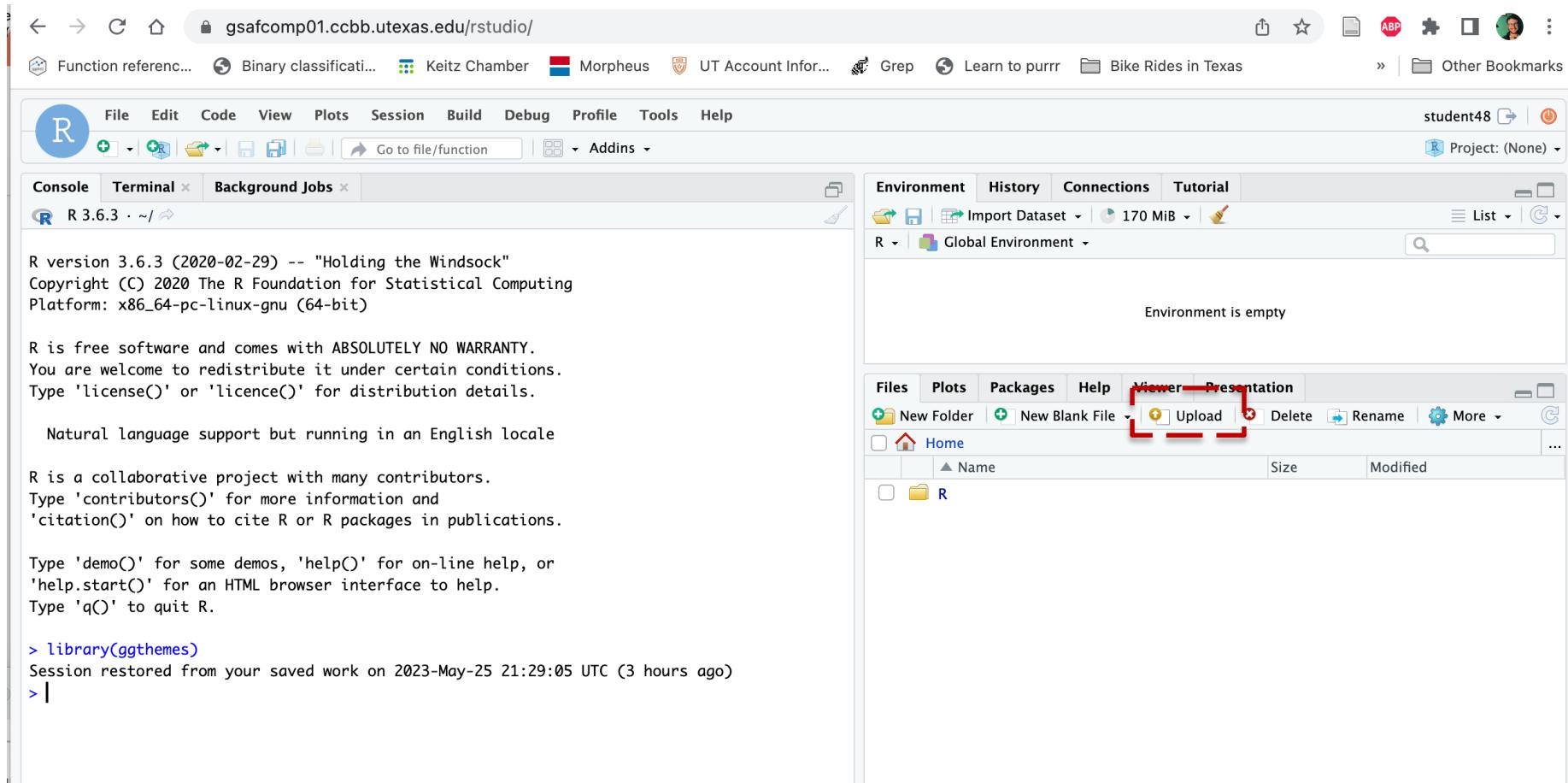
Environment is empty

**Plots pane:**

**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.
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'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 top right corner shows a user profile for "student48" and a "Project: (None)" dropdown. The main console area displays the standard R startup message for version 3.6.3. A modal dialog box titled "Upload Files" is centered over the console. It has fields for "Target directory:" (set to "~") and "File to upload:" (with a "Choose File" button and a message "No file chosen"). Below these is a tip: "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 background environment tab shows an "Import Dataset" operation with a progress of 170 MiB. The bottom right corner of the interface shows a sidebar with tabs for Pages, Help, Viewer, and Presentation, along with file management buttons like New Blank File, Upload, Delete, Rename, and More.

```
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)
>
```

# 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 a "Target directory:" input field containing "~" and a "Browse..." button. Below it is a "File to upload" section with a "Choose File" button and a message "No file chosen". A tip at the bottom 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 screen shows the Environment pane, which is currently empty. The bottom navigation bar includes Pages, Help, Viewer, Presentation, and a set of file management icons.

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)
>
```

# 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/](https://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 menus.
- 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 of objects.
- File Menu:** Shows options like New Blank File, Upload, Delete, Rename, More, and a dropdown for file sizes and modification dates.
- Central Area:** An "Upload Files" dialog box is open, prompting for a target directory and a file to upload. The "Choose File" button is highlighted with a red box.
- Bottom Left:** A command line history showing the execution of `library(ggthemes)` and a session restore message.

# R Markdown: Writing documents with embedded R code

The screenshot shows the RStudio interface with the following details:

- Title Bar:** The file name "class1.Rmd" is displayed in the title bar.
- Toolbar:** Standard RStudio toolbar icons for back, forward, file, search, and knit are visible.
- Text Editor:** The main pane contains R Markdown code. Lines 16-18 demonstrate basic editing features. Lines 19-21 introduce embedding R code. Lines 22-30 show an R chunk starting with ````{r}` and containing assignments for variables x, y, and z.
- Code Numbering:** Line numbers 16 through 30 are displayed on the left side of the editor.
- Run Buttons:** A "Run" button with a green arrow icon is located in the toolbar.

```
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

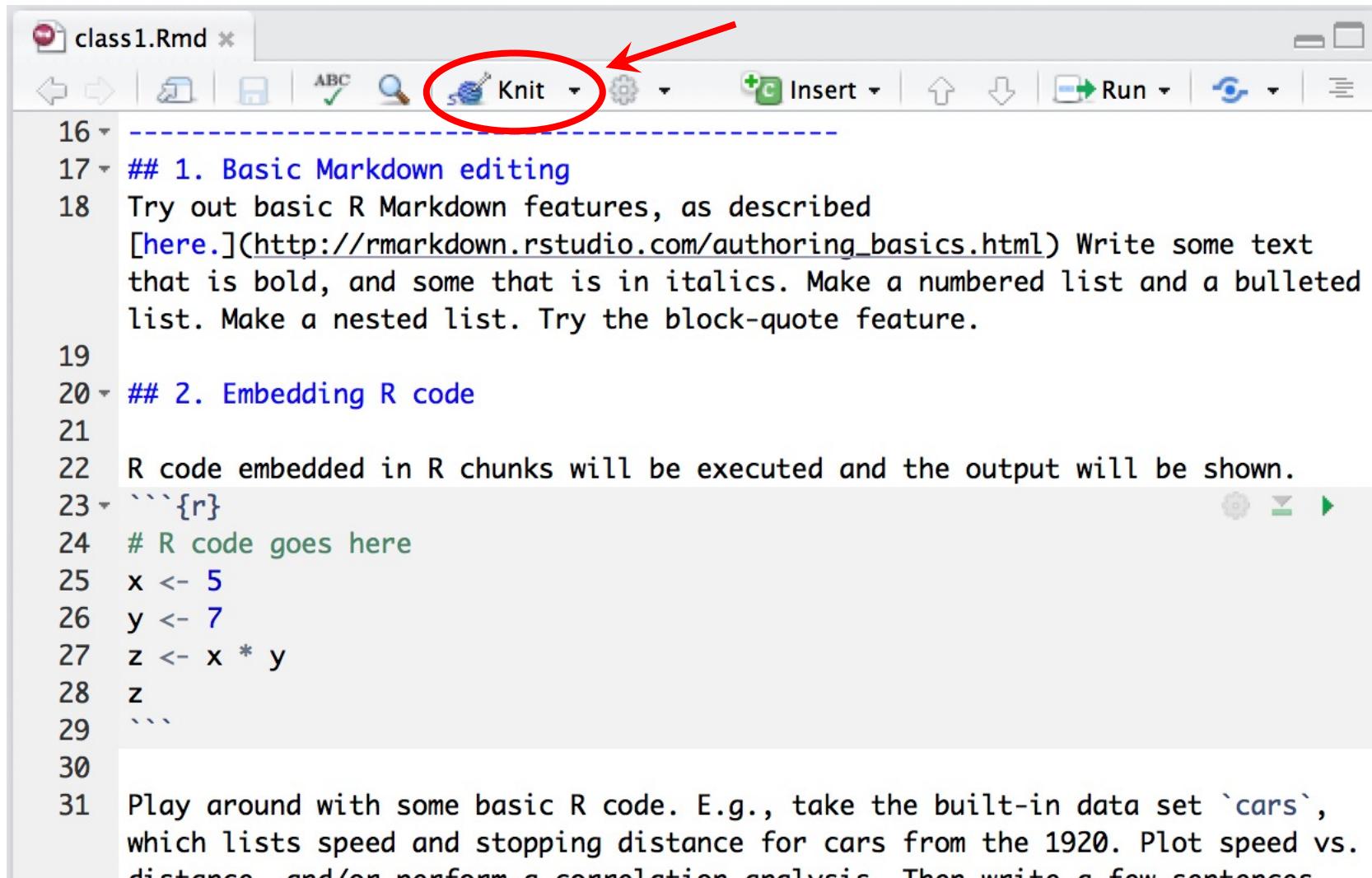
R code embedded in R chunks will be executed and the output will be shown.

```
# 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  
20 ## 2. Embedding R code  
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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](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)
```
```

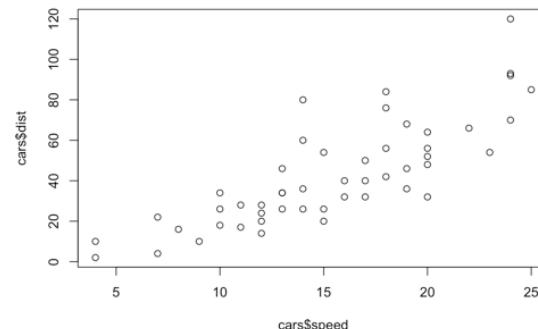


Embedded R code will be evaluated and printed

```
head(cars)
```

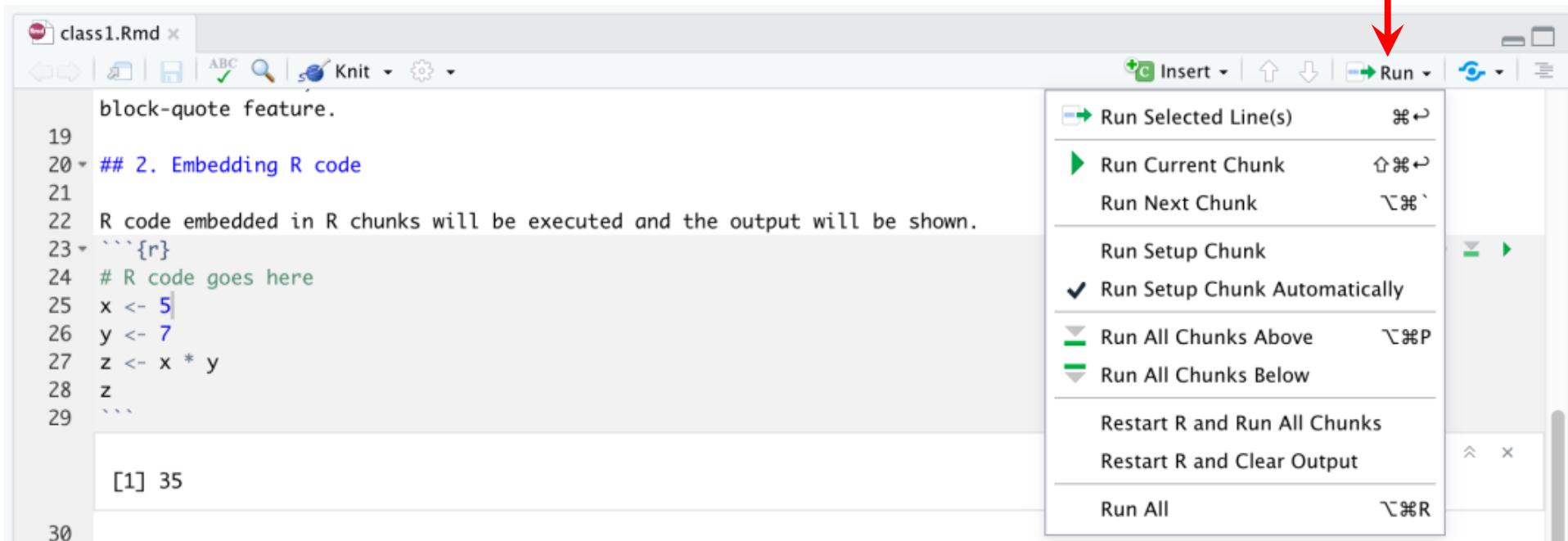
```
##   speed dist
## 1     4    2
## 2     4   10
## 3     7    4
## 4     7   22
## 5     8   16
## 6     9   10
```

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



# Different ways to execute code in RStudio

# Press the “Run” button



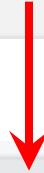
A screenshot of the RStudio interface showing an R Markdown file named "class1.Rmd". The code chunk at line 23 contains an R code block (indicated by `{{r}}`), which has been run and its output, "[1] 35", is displayed in the console area. The toolbar at the top includes icons for file operations, ABC, 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/ ↵

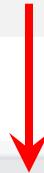
```
> z <- x * y
> |
```

# 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
...```

```



The screenshot shows an R console interface. At the top, there are tabs for "Console", "Terminal", and "Jobs". The "Console" tab is active. Below the tabs, the current working directory is listed as "~/Desktop/projects/". The main area displays the following R session:

```
> 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 sets in package 'datasets':	
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

Console Terminal × R Markdown ×

```
> 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 selected, 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 × . x Filter

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 have methods which are selected by the class of their argument.

### 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 function name in the help documentation title. The documentation includes sections for 'Description' and 'Usage', and shows the function's source code.

```
R: Student's t-Test - Find in Topic
```

**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



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Settings

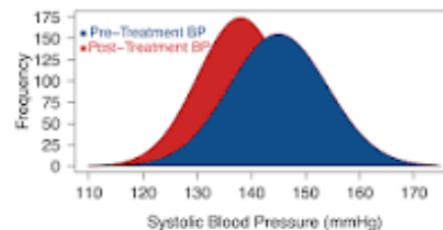
Tools

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

Systolic Blood Pressure Before and After Treatment



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

[How to Perform T-tests in R | DataScience+](http://datascienceplus.com/t-tests/)



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

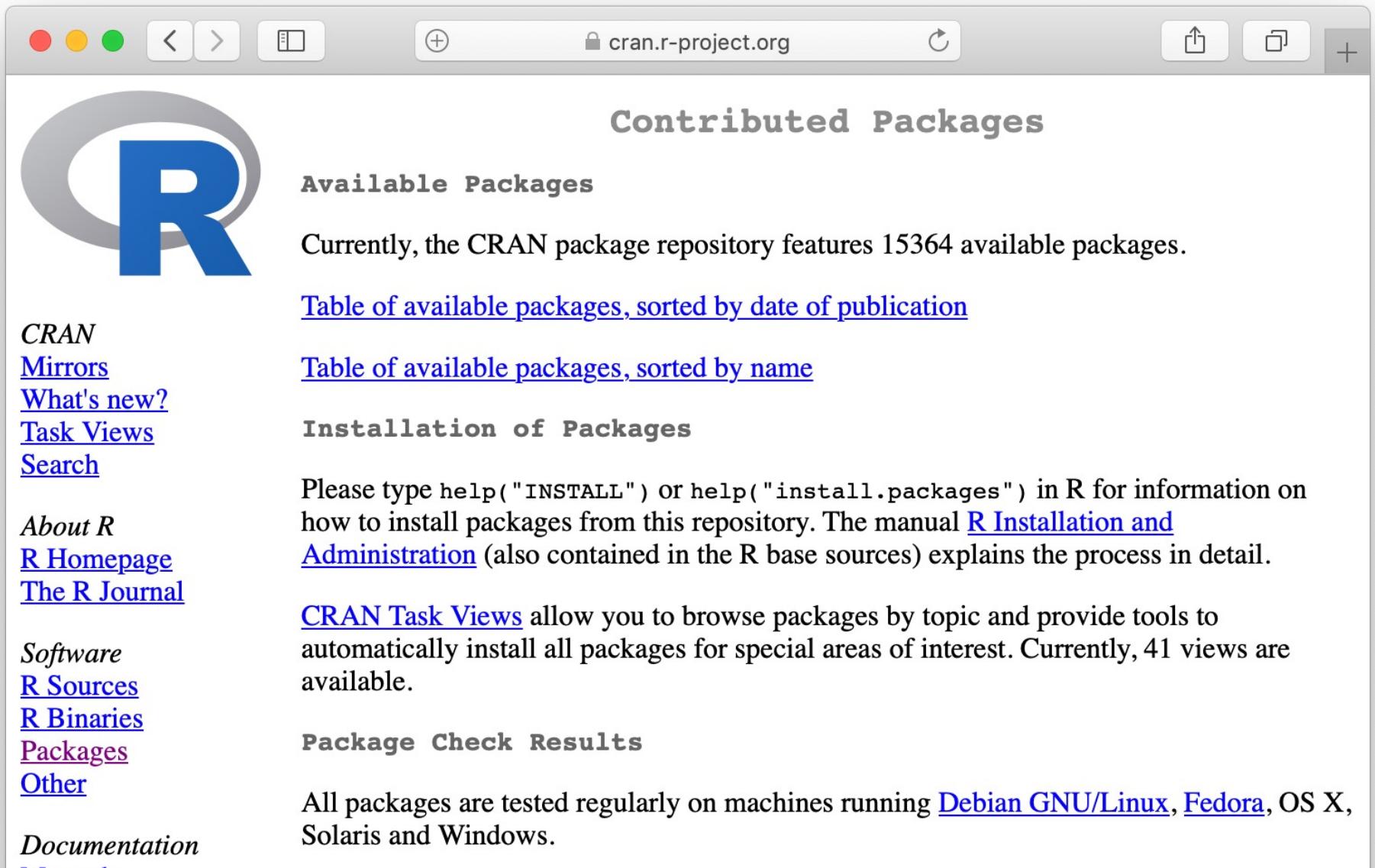
Asked 10 years, 10 months ago Active 18 days ago Viewed 768k times

 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" (noting regular testing on Debian GNU/Linux, Fedora, OS X, Solaris, and Windows). A sidebar on the left lists various CRAN resources like "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



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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
- *Bioconductor F1000 Research Channel* is

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