

## ENTERING / CLEANING DATA 1

## R SCRIPTS

# R SCRIPTS

If you are writing code you think you will use later, write it in an R script file rather than using the console.

- Open a new script file in RStudio: `File -> New File -> R Script`.
- To run code from an R script file in RStudio, you can use the `Run` button (or `Command-R`). It will run whatever's on your cursor line or whatever's highlighted.
- To run the whole script, use `source`.
- Save scripts using the extension `.R`

## GETTING DATA INTO R

# BASICS OF GETTING DATA INTO R

Basic approach:

- Download data to your computer
- Make sure R is working in the directory with your data (`getwd`, `setwd`)
- Read data into R (`read.csv`, `read.table`)
- Check to make sure the data came in correctly (`dim`, `head`, `tail`, `str`)

## DIRECTORIES

# DIRECTORIES

Anytime you work in R, R will run from within a directory somewhere on your computer.

Let's review directories:

# DIRECTORIES

You can check your working directory anytime using `getwd()`:

```
getwd()
```

```
## [1] "/Users/brookeanderson/RProgrammingForResearch/slides"
```



# DIRECTORIES

You can use `setwd()` to change your directory.

To get to your home directory (for example, mine is “/Users/brookeanderson”), you can use the abbreviation `~`.

For example, if you want to change into your home directory and print its name, you could run:

```
setwd("~/")  
getwd()
```

```
## [1] "/Users/brookeanderson"
```

# DIRECTORIES

The most straightforward way to read in data is often to put it in your working directory and then read it in using the file name. If you're working in the directory with the file you want, you should see the file if you list files in the working directory:

```
list.files()
```

```
## [1] "CourseNotes_Week1.pdf" "CourseNotes_Week1.Rmd" "CourseNo  
## [4] "CourseNotes_Week2.Rmd" "CourseOverview.pdf" "CourseOv
```

# GETTING AROUND DIRECTORIES

There are a few abbreviations you can use to represent certain relative or absolute locations when you're using `setwd()`:

Command	Directory
<code>setwd("~/")</code>	Your home directory
<code>setwd("../")</code>	One directory up from your current directory
<code>setwd("../..")</code>	Two directories up from your current directory

# TAKING ADVANTAGE OF PASTE0

You can create an object with your directory name using `paste0`, and then use that to set your directory. We'll take a lot of advantage of this for reading in files.

The convention for `paste0` is:

```
[object name] <- paste0("[first thing you want to paste]",  
                          "[what you want to add to that]",  
                          "[more you want to add]")
```

# TAKING ADVANTAGE OF PASTE0

Here's an example:

```
my_dir <- paste0("~/Desktop/RCourseFall2015/",  
                "Week2_Aug31")
```

```
my_dir
```

```
## [1] "~/Desktop/RCourseFall2015/Week2_Aug31"
```

```
setwd(my_dir)
```

# RELATIVE VERSUS ABSOLUTE PATHNAMES

When you want to reference a directory or file, you can use one of two types of pathnames:

- *Relative*: How to get there from your current working directory
- *Absolute*: The full pathname

## RELATIVE VERSUS ABSOLUTE PATHNAMES

Say your current working directory was  
/Users/brookeanderson/Desktop/RCourseFall2015 and you wanted  
to get into the subdirectory Week2\_Aug31. Here are examples using the  
two types of pathnames:

Absolute:

```
setwd("/Users/brookeanderson/Desktop/RCourseFall2015/Week2_Aug31")
```

Relative:

```
setwd("Week2_Aug31")
```

## RELATIVE VERSUS ABSOLUTE PATHNAMES

Here are some other examples of relative pathnames:

If Week2\_Aug31 is a subdirectory of your current parent directory:

```
setwd("../Week2_Aug31")
```

If Week2\_Aug31 is a subdirectory of your home (root) directory:

```
setwd("~/Week2_Aug31")
```

If Week2\_Aug31 is a subdirectory of the subdirectory Ex of your current working directory:

```
setwd("Ex/Week2_Aug31")
```



## READING DATA INTO R

# WHAT KIND OF DATA CAN YOU GET INTO R?

The sky is the limit. . .

- Flat files
- Files from other statistical packages (SAS, Excel, Stata, SPSS)
- Tables on webpages (e.g., the table near the end of this page)
- Data in a database (e.g., SQL)
- Really crazy data formats used in other disciplines (e.g., netCDF files from climate folks, MRI data stored in Analyze, NIFTI, and DICOM formats)
- Data through APIs (e.g., GoogleMaps, Twitter)
- Incredibly messy data using `scan` and `readLines`

# TYPES OF FLAT FILES

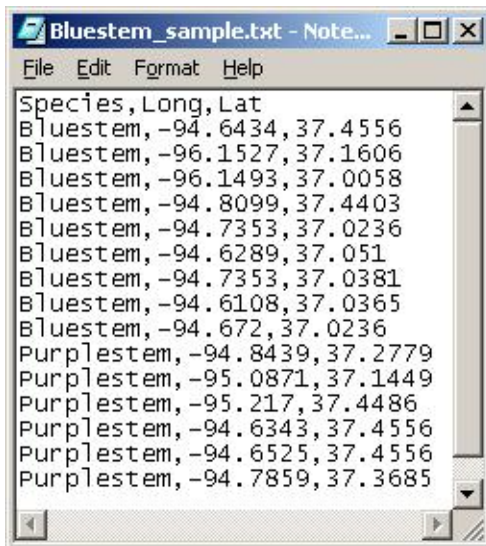
R can read in data from *a lot* of different formats. The only catch: you need to tell R how to do it.

To start, we'll look at flat files:

- ① Fixed width files
- ② Delimited files
  - “.csv”: Comma-separated values
  - “.tab”, “.tsv”: Tab-separated values
  - Other possible delimiters: colon, semicolon, pipe (“|”)

See if you can identify what types of files the following files are...

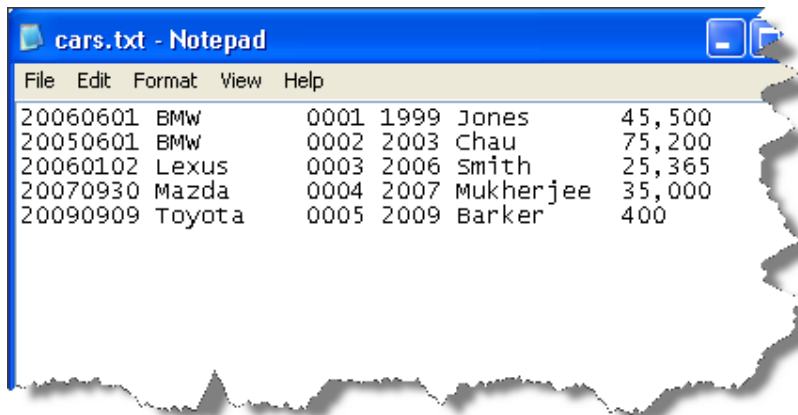
# WHAT TYPE OF FILE?



```
Bluestem_sample.txt - Note...
File Edit Format Help
Species, Long, Lat
Bluestem, -94.6434, 37.4556
Bluestem, -96.1527, 37.1606
Bluestem, -96.1493, 37.0058
Bluestem, -94.8099, 37.4403
Bluestem, -94.7353, 37.0236
Bluestem, -94.6289, 37.051
Bluestem, -94.7353, 37.0381
Bluestem, -94.6108, 37.0365
Bluestem, -94.672, 37.0236
Purplestem, -94.8439, 37.2779
Purplestem, -95.0871, 37.1449
Purplestem, -95.217, 37.4486
Purplestem, -94.6343, 37.4556
Purplestem, -94.6525, 37.4556
Purplestem, -94.7859, 37.3685
```

FIGURE 1: file example

# WHAT TYPE OF FILE?



20060601	BMW	0001	1999	Jones	45,500
20050601	BMW	0002	2003	Chau	75,200
20060102	Lexus	0003	2006	Smith	25,365
20070930	Mazda	0004	2007	Mukherjee	35,000
20090909	Toyota	0005	2009	Barker	400

FIGURE 2: file example

# WHAT TYPE OF FILE?

```
H|20110606|pizza.txt|
D|10|Chicken Pesto|20|23|30|5.5|7.4|9.9|
D|10|Meatball|10|53|60|6.5|8.4|10.9|
D|10|Fire Cracker|3|13|60|5.8|7.9|11.9|
D|10|Spinach|1|2|5|5.5|7.0|8.8|
D|10|BBQ Chicken|35|102|95|6.5|7.9|10.9|
D|10|Vegetarian|5|13|28|4.5|7.9|9.5|
D|10|Mexican|11|33|36|5.5|7.4|9.9|
D|10|The Monaco|22|53|7|5.5|7.5|8.9|
D|10|Chilli Prawn|5|5|6|5.5|7.4|9.9|
D|10|Chefs Special|8|18|40|5.8|7.8|9.8|
D|10|Marinara|3|17|41|5.5|7.4|9.0|
D|10|Supreme|50|52|58|5.5|7.4|9.2|
D|10|Margherita|9|19|87|5.0|7.0|8.0|
D|10|Napoli|60|85|66|5.2|7.2|9.2|
D|10|Caprice|31|32|38|5.5|7.4|9.3|
D|10|Ham and Pineapple|18|39|28|5.8|7.0|9.0|
T|16|
```

FIGURE 3: file example

# WHAT TYPE OF FILE?

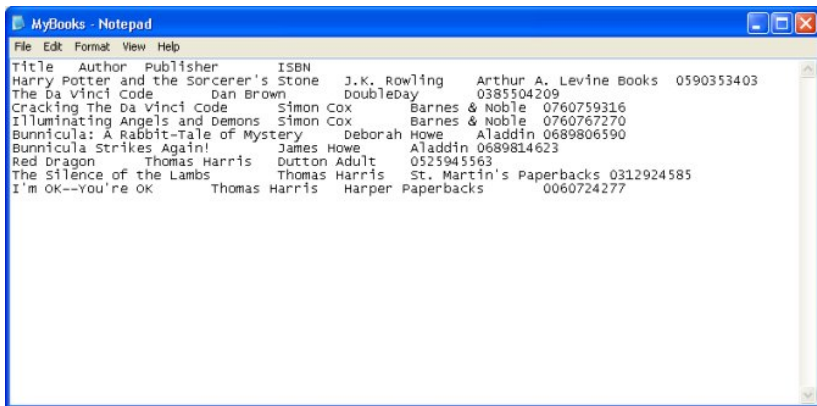
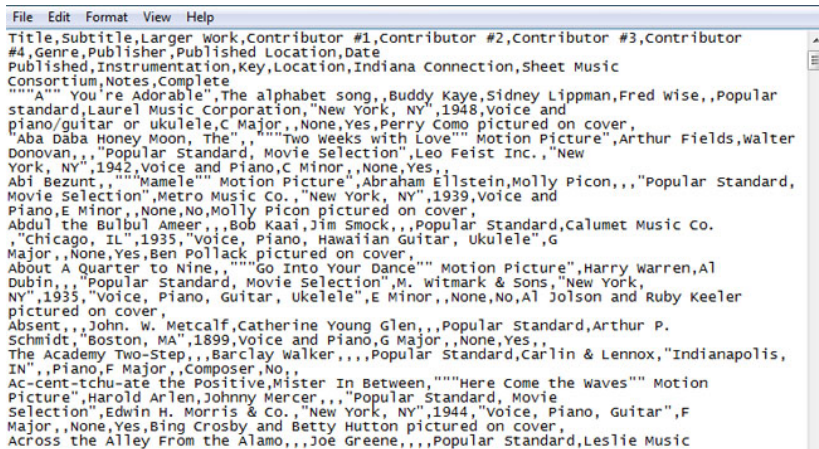


FIGURE 4: file example

# WHAT TYPE OF FILE?



```

File Edit Format View Help
Title,Subtitle,Larger Work,Contributor #1,Contributor #2,Contributor #3,Contributor
#4,Genre,Publisher,Published Location,Date
Published,Instrumentation,Key,Location,Indiana Connection,Sheet Music
Consortium,Notes,Complete
""""A"" You're Adorable",The alphabet song,,Buddy Kaye,Sidney Lippman,Fred Wise,,Popular
standard,Laurel Music Corporation,"New York, NY",1948,Voice and
piano/guitar or ukulele,C Major,,None,Yes,Perry Como pictured on cover,
"Aba Daba Honey Moon, The",,"""Two weeks with Love"" Motion Picture",Arthur Fields,walter
Donovan,,,,"Popular Standard, Movie Selection",Leo Feist Inc.,,"New
York, NY",1942,Voice and Piano,C Minor,,None,Yes,,
Abi Bezunt,,,"""Mamele"" Motion Picture",Abraham Ellstein,Molly Picon,,,"Popular Standard,
Movie Selection",Metro Music Co.,,"New York, NY",1939,Voice and
Piano,E Minor,,None,No,Molly Picon pictured on cover,
Abdul the Bulbul Ameer,,,"Bob Kaai,Jim Smock,,,,"Popular Standard,Calumet Music Co.
,"chicago, IL",1935,"Voice, Piano, Hawaiian Guitar, Ukulele",G
Major,,None,Yes,Ben Pollack pictured on cover,
About A Quarter to Nine,,,"""Go Into Your Dance"" Motion Picture",Harry warren,Al
Dubin,,,,"Popular Standard, Movie Selection",M. Witmark & Sons,"New York,
NY",1935,"voice, Piano, Guitar, Ukelele",E Minor,,None,No,Al Jolson and Ruby Keeler
pictured on cover,
Absent,,,John. W. Metcalf,Catherine Young Glen,,,,"Popular Standard,Arthur P.
Schmidt,"Boston, MA",1899,Voice and Piano,G Major,,None,Yes,,
The Academy Two-Step,,,Barclay Walker,,,,"Popular Standard,Carlin & Lennox,"Indianapolis,
IN",,"Piano,F Major,,Composer,No,,
AC-cent-tchu-ate the Positive,Mister In Between,,"""Here Come the waves"" Motion
Picture",Harold Arlen,Johnny Mercer,,,,"Popular Standard, Movie
Selection",Edwin H. Morris & Co.,,"New York, NY",1944,"Voice, Piano, Guitar",F
Major,,None,Yes,Bing Crosby and Betty Hutton pictured on cover,
Across the Alley From the Alamo,,,Joe Greene,,,,"Popular Standard,Leslie Music

```

FIGURE 5: file example



# WHAT TYPE OF FILE?

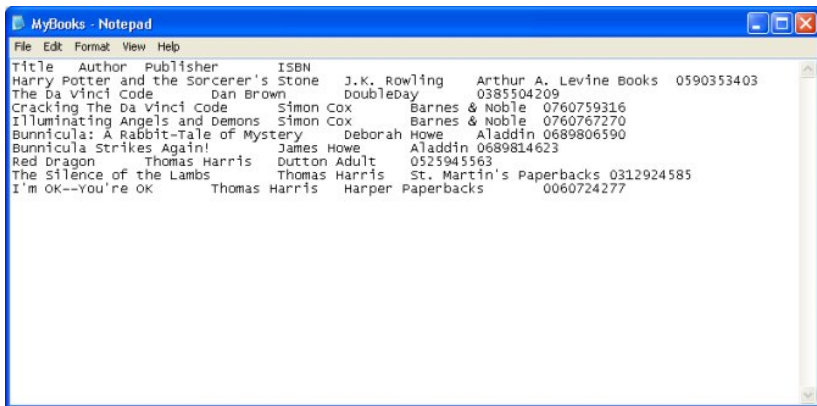


FIGURE 6: file example

# WHAT TYPE OF FILE?

1000233	Miralda	John
1000234	Faley	Nick
1000235	Baylog	Cathy
1000236	Gallardo	Mike
1000237	Christian	Daniel
1000238	Baufield	Daniel
1000239	Frazier	Robert
1000240	Garrido	Edward
1000241	Williams	Zachary
1000242	Morel	David
	Padilla	Damian
1000244	Rosenberg	Wayne
1000245	Blanchard	Phong S
1000246	Wiggins	David
1000247	Miller	Jeffrey
1000248	Coon	Terry
1000249	Chretien	Walter
1000250	Myers	Timothy
1000233	Miralda	John
1000234	Faley	Nick
1000235	Baylog	Cathy

# READING IN FLAT FILES

R can read any of these types of files using one of the `read.table` and `read.fwf` functions. Find out more about those functions with:

```
?read.table  
?read.fwf
```

## READ.TABLE FAMILY OF FUNCTIONS

Some of the interesting options with the `read.table` family of functions are:

Option	Description
<code>sep</code>	What is the delimiter in the data?
<code>skip</code>	How many lines of the start of the file should you skip?
<code>header</code>	Does the first line you read give column names?
<code>as.is</code>	Should you bring in strings as characters, not factors?
<code>nrows</code>	How many rows do you want to read in?
<code>na.strings</code>	How are missing values coded?

## READ.TABLE FAMILY OF FUNCTIONS

All members of the `read.table` family are doing the same basic thing. The only difference is what defaults they have for the separator (`sep`) and the decimal point (`dec`).

Members of the `read.table` family:

Function	Separator	Decimal point
<code>read.csv</code>	comma	period
<code>read.csv2</code>	semi-colon	comma
<code>read.delim</code>	tab	period
<code>read.delim2</code>	tab	comma

## READING IN ONLINE FLAT FILES

If you're reading in data from a non-secure webpage (i.e., one that starts with `http`), if the data is in a "flat-file" format, you can just read it in using the web address as the file name:

```
url <- paste0("http://www2.unil.ch/comparativegenometrics",  
              "/docs/NC_006368.txt")  
ld_genetics <- read.delim(url, header = TRUE)  
ld_genetics[1:5, 1:4]
```

```
##      pos  nA  nC  nG  
## 1   500 307 153 192  
## 2  1500 310 169 207  
## 3  2500 319 167 177  
## 4  3500 373 164 168  
## 5  4500 330 175 224
```

# READING IN ONLINE FLAT FILES

If you want to read in data from a secure webpage (e.g., one that starts with `https`), then you'll need to do something different.

First, you'll need to install then load the package `repmis`:

```
# install.packages("repmis")  
library(repmis)
```

## READING IN ONLINE FLAT FILES

Now you can use the `source.data` function to read in data from places like GitHub and Dropbox public folders:

```
url <- paste0("https://raw.githubusercontent.com/cmriivers/",  
              "ebola/master/country_timeseries.csv")  
ebola <- source_data(url)
```

```
## Downloading data from: https://raw.githubusercontent.com/cmri
```

```
## SHA-1 hash of the downloaded data file is:
```

```
## 6da83b3d2017245217d35989960184234a6c4e7f
```

```
ebola[1, 1:3]
```

```
##           Date Day Cases_Guinea
```

```
## 1 1/5/2015 289           2776
```



## SAVING DATA AS R OBJECTS

# SAVING R OBJECTS

You can save an R object you've created as an `.RData` file using `save()`:

```
save(ebola, file = "Ebola.RData")  
list.files()
```

```
## [1] "CourseNotes_Week1.pdf" "CourseNotes_Week1.Rmd" "CourseNo  
## [4] "CourseNotes_Week2.Rmd" "CourseOverview.pdf"      "CourseOv  
## [7] "Ebola.RData"
```

This saves to your current working directory (unless you specify a different location).

# LOADING R OBJECTS

Then you can re-load the object later using `load()`:

```
rm(ebola)
ls()
```

```
## [1] "current.wd" "ld_genetics" "my_dir" "url"
```

```
load("Ebola.RData")
ls()
```

```
## [1] "current.wd" "ebola" "ld_genetics" "my_dir" "
```

# SAVING R OBJECTS

One caveat for saving R objects: some people suggest you avoid this if possible, to make your research more reproducible.

Imagine someone wants to look at your data and code in 30 years. R might not work the same, so you might not be able to read an `.RData` file. However, you can open flat files (e.g., `.csv`, `.txt`) and R scripts (`.R`) in text editors— you should still be able to do this regardless of what happens to R.

Potential exceptions:

- You have an object that you need to save that has a structure that won't work well in a flat file
- Your starting dataset is really, really large, and it would take a long time for you to read in your data fresh every time

## CLEANING UP DATA IN R

# RENAMING COLUMNS

Often, you'll want to change the column names of a dataframe as soon as you bring in the data, especially if the original ones have things like spaces. We'll look at this in the `icd10` data.

```
library(readxl)
```

```
## DEFINEDNAME: 20 00 00 01 0b 00 00 00 01 00 00 00 00 00 00 06  
## DEFINEDNAME: 20 00 00 01 0b 00 00 00 01 00 00 00 00 00 00 06  
## DEFINEDNAME: 20 00 00 01 0b 00 00 00 01 00 00 00 00 00 00 06  
## DEFINEDNAME: 20 00 00 01 0b 00 00 00 01 00 00 00 00 00 00 06
```

```
icd10 <- read_excel("icd-10.xls")
```

# RENAMING COLUMNS

Take a look at the icd10 data we loaded in the exercise:

```
icd10[1:4, ]
```

##	Code	ICD Title
## 1	A00-B99	I. Certain infectious and parasitic diseases
## 2	A00-A09	Intestinal infectious diseases
## 3	A00	Cholera
## 4	A00.0	Cholera due to Vibrio cholerae 01, biovar cholerae

# RENAMING COLUMNS

You can use the `colnames()` function to find out what the current column names are:

```
colnames(icd10)
```

```
## [1] "Code"      "ICD Title"
```



```
colnames(icd10) <- c("code", "title")
icd10[1:2, ]
```

```
##          code                                     title
## 1 A00-B99 I. Certain infectious and parasitic diseases
## 2 A00-A09          Intestinal infectious diseases
```

## USING SUBSET()

You will often want to use only a portion of your data. You can use `subset()` to create a subset, using logical operators. For example, if you wanted to just pull out the rows of the `icd10` dataframe that start with the letter “A”, you could run:

```
icd10_a <- subset(icd10, substr(code, 1, 1) == "A")
```

## USING SUBSET()

Here are the ends of the original and the subsetted dataframes:

```
tail(icd10, 2)
```

```
##           code                               title
## 11089 Y89.9 Sequelae of unspecified external cause
## 11090  <NA>                               <NA>
```

```
tail(icd10_a, 2)
```

```
##           code                               title
## 458 A98.8 Other specified viral hemorrhagic fevers
## 459  A99           Unspecified viral hemorrhagic fever
```

# USING SUBSET()

The convention for `subset()` is:

```
subset([name of dataframe],  
       [logical statement describing which rows to keep],  
       select = [vector with the names of columns to keep])
```

# COMMON LOGICAL OPERATORS IN R

Operator	Meaning	Example
<code>==</code>	equals	<code>subset(df, city == "Los Angeles")</code>
<code>!=</code>	does not equal	<code>subset(df, city != "Los Angeles")</code>
<code>%in%</code>	is in	<code>subset(df, city %in% c("Los Angeles", "S"))</code>
<code>is.na()</code>	is NA	<code>subset(df, is.na(cases))</code>
<code>!is.na()</code>	is not NA	<code>subset(df, !is.na(cases))</code>
<code>&amp;</code>	and	<code>subset(df, city == "Los Angeles" &amp; !is.na(cases))</code>
<code> </code>	or	<code>subset(df, city == "Los Angeles"   !is.na(cases))</code>

## ADDING COLUMNS

In R, you can use the `$` operator after a dataframe to pull out one of it's columns. For example:

```
ca_measles <- read.delim("measles_data/02-09-2015.txt",  
                        header = FALSE,  
                        col.names = c("city", "count"))
```

```
head(ca_measles$count)
```

```
## [1] 6 20 2 4 2 34
```

## ADDING COLUMNS

You can take advantage of this to add new columns to an existing dataframe. For example, this data is from Feb. 9, 2015. We can add a column with the date to `ca_measles`:

```
ca_measles$date <- rep("02-09-2015", length = nrow(ca_measles))  
head(ca_measles, 3)
```

##	city	count	date
## 1	ALAMEDA	6	02-09-2015
## 2	LOS ANGELES	20	02-09-2015
## 3	City of Long Beach	2	02-09-2015

# ADDING COLUMNS

Two notes:

- The previous example uses the `rep()` function, which will repeat a value `length` number of times
- If the value you assign to the new column is not the right length (remember, all columns in a dataframe must be vectors of equal length), R will try to “recycle” it to fill up the dataframe. So, the following call would have been a simpler alternative:

```
ca_measles$date <- "02-09-2015"
ca_measles[1:2, ]
```

```
##           city count      date
## 1    ALAMEDA      6 02-09-2015
## 2 LOS ANGELES     20 02-09-2015
```



## DATE CLASS

One final common task in cleaning data is to change the class of some of the columns. This is especially common for dates, which will usually be read in as characters or factors.

# VECTOR CLASSES

Here are a few common vector classes in R:

Class	Example
character	"Chemistry", "Physics", "Mathematics"
numeric	10, 20, 30, 40
factor	Male [underlying number: 1], Female [2]
Date	"2010-01-01" [underlying number: 14,610]
logical	TRUE, FALSE

# VECTOR CLASSES

To find out the class of a vector, you can use `class()`:

```
class(ca_measles$date)
```

```
## [1] "character"
```

# VECTOR CLASSES

To find out the classes of all columns in a dataframe, you can use `str()`:

```
str(ca_measles)
```

```
## 'data.frame':    13 obs. of  3 variables:
## $ city : Factor w/ 13 levels "ALAMEDA","City of Long Beach",
## $ count: int  6 20 2 4 2 34 5 6 13 3 ...
## $ date : chr  "02-09-2015" "02-09-2015" "02-09-2015" "02-09-
```

## CONVERTING TO DATE CLASS

To convert a vector to the Date class, you can use `as.Date()`:

```
ca_measles$date <- as.Date(ca_measles$date,  
                           format = "%m-%d-%Y")  
head(ca_measles$date, 3)
```

```
## [1] "2015-02-09" "2015-02-09" "2015-02-09"
```

```
class(ca_measles$date)
```

```
## [1] "Date"
```

## CONVERTING TO DATE CLASS

Once you have an object in the Date class, you can do things like plot by date, calculate the range of dates, and calculate the total number of days the dataset covers:

```
range(ca_measles$date)
```

```
## [1] "2015-02-09" "2015-02-09"
```

```
diff(range(ca_measles$date))
```

```
## Time difference of 0 days
```

## CONVERTING TO DATE CLASS

The only tricky thing is learning the abbreviations for the format option. Here are some common ones:

Abbreviation	Meaning
%m	Month as a number (e.g., 1, 05)
%B	Full month name (e.g., August)
%b	Abbreviated month name (e.g., Aug)
%y	Two-digit year (e.g., 99)
%Y	Four-digit year (e.g., 1999)

# CONVERTING TO DATE CLASS

Here are some examples:

Your date	format =
10/23/2008	"%m/%d%Y"
08-10-23	"%y-%m-%d"
Oct. 23 2008	"%b. %d %Y"
October 23, 2008	"%B %d, %Y"



## VARIOUS AND SUNDRIES

# JOURNAL ASSIGNMENT

Two things I'd like to ask from you:

- Could you name your file using this convention: “[Your name] Journal [Week number]”?
- Please let me know at the top of each journal entry if you would **not** be alright with me using something from the entry for an example in a later class

# EXTRA CREDIT PROJECT

You have four different options for your extra credit project:

- Write up several functions to do tasks you do often in your research. Create a package from them, including a vignette to explain how to use them.
- Create an R Shiny web app as an interactive graphic to illustrate something interesting from your research.
- Choose a book from the “UseR” series, or a similar book that gives examples of how to use R for research within a specific discipline. Pick two or three chapters to study in depth. We will come up with some exercises for you to show you’ve mastered the material.
- Start an R Users group for Fort Collins. Figure out what you need to do to charter a local section, schedule the speakers for Spring 2016, etc.

# HELPFUL BOOKS FOR LEARNING R

There are two publishers that are leaders in good books for learning R:

- O'Reilly
- Springer

# HELPFUL BOOKS FOR LEARNING R

Some particular books you might want to check out:

- R for dummies
- R in a nutshell
- R cookbook
- R graphics cookbook
- A beginner's guide to R
- Roger Peng's Leanpub books