

# Lesson 03 - Getting data into R

*Robin Donatello*

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## Introduction

In this lesson we will introduce ways to get data into R, and how to use functions to exploring the data.

### Student Learning Objectives

After completing this lesson students will be able to

- Import data that is stored in an external Excel, CSV or tab-delimited text file into R.
- Use functions to examine data objects to ensure data was imported correctly.
- Identify missing data elements in a data table.
- Identify data types for each variable in a data frame.

### Preparation

Prior to this lesson students should

- Download the [03\_import\_notes.Rmd] R markdown file and save into your Math130 folder. This is a blank/outline version of these notes for you to follow along with during class and write your own notes.
- Install the `readxl` package by typing `install.packages("readxl")` into your console.

## Download data

In this lesson we are only going to explore reading files that exist on your computer into R from three most commonly used data sources: A tab-delimited text file, A CSV file and an Excel file. Let's start by downloading these files.

- From the Data page download the following data sets **into your MATH130 folder**: `NCBirths`, `email`, and `Police Shootings`.
- **DO NOT RENAME ANYTHING** If you download multiple copies of the data, do not keep the versions that have a (1) or some number in the name.

Ideally each row represents data on a single observation and each column contains data on a single variable, or characteristic, of the observation. This is called **tidy data**. We will start to learn some tools to look at the data, and for getting data from an external file into R for analysis.

The three different files we just downloaded have different file types, or extensions.

- `email.txt` is a `.txt` or "text" file.
- `NCBirths.csv` is a `.csv` or "comma separated values" file.
- `WashPost Police Shootings 2015.xlsx` is a `.xlsx` or Excel file.

Each of these file types differ in the type of *delimiter* used. The *delimiter* is a character or symbol that separates columns of data from each other when stored in an external file. Recall back to the Data Camp exercises on data frames and matrices. Each column in the matrix represented data on a specific variable. Something had to tell R how to distinguish which values went with which variable.

There are two main types of delimiters we will consider in this class; comma and tab. That does not mean that data can't be stored in other ways, these are just the two most common.

Each of these different data types requires a different function or mechanism to import the data into R. If you use the wrong mechanism, the data may not be read in correctly if at all.

## Importing data

To import data into R, we have to tell the program explicitly where to find the files you just downloaded. To do that we need to find the file's *path*.

The *path* is a programmatic way to direct your computer to the location of a file. It's like the file's address, or, where it lives on your computer.

In all the examples below, the path shown (**data/**) is the path on **MY** computer. You will have to update this path to **YOUR** path on **YOUR** machine that points to your MATH130 folder.

You can easily find the path of a file by navigating to the desired file in your finder or browser window, right click and copy the file to the clipboard, then right click and pasting into a R markdown file. This will show a path that looks something like this:

```
file:///C:/Box Sync/Data/Challenger.txt
```

You will need to remove the `file:///` part at the beginning before using this path. You will have three chances in this lab to practice this.

## Checking the import was successful

The first thing you should always do after importing a data file is look at the raw data and ask yourself the following things:

1. Were the variable names read in correctly?
2. Is there the expected number of rows and columns?
3. Are the data types for each variable as expected?

There are many ways this can be done, here are three

1. `str()` to show you the structure of the data frame.
2. `head()` to show you the top 6 rows
3. `data[1:x, 1:x]` - when the data frame is too large for the above two to work well, we can use matrix notation to view only the first X columns, and first X rows.

Next we will read in three different data sets, each with unique file types, and look at each one to make sure it was read in correctly.

## Text files

Text files are very simple files that have a `.txt` file extension. Common delimiters include a space, a comma (,) or a tab. Uncommon delimiters could include a % or even a semi-colon. By opening the file directly on your computer (not in R) you can see what delimiter is being used.

We will use the `read.table()` function that is in base R to read in any type of delimited file. A tab-delimited text file can be read in using `"\t"` as the delimiter character. In this class you **ALWAYS** want to include `header=TRUE` to signify that the data in the first row contains our column names.

```
email <- read.table("../data/email.txt", header=TRUE, sep="\t")
```

Here we call the `str()` or *structure* function to examine the data that was imported.

```
str(email)
```

```
## 'data.frame':    3921 obs. of  21 variables:
## $ spam          : int  0 0 0 0 0 0 0 0 0 0 ...
## $ to_multiple   : int  0 0 0 0 0 0 1 1 0 0 ...
## $ from          : int  1 1 1 1 1 1 1 1 1 1 ...
## $ cc           : int  0 0 0 0 0 0 0 1 0 0 ...
## $ sent_email    : int  0 0 0 0 0 0 1 1 0 0 ...
## $ time          : Factor w/ 3840 levels "2011-12-31 22:16:41",...: 1 2 6 3 4 5 7 10 14 8 ...
## $ image         : int  0 0 0 0 0 0 0 1 0 0 ...
## $ attach        : int  0 0 0 0 0 0 0 1 0 0 ...
## $ dollar        : int  0 0 4 0 0 0 0 0 0 0 ...
## $ winner        : Factor w/ 2 levels "no","yes": 1 1 1 1 1 1 1 1 1 1 ...
## $ inherit       : int  0 0 1 0 0 0 0 0 0 0 ...
## $ viagra        : int  0 0 0 0 0 0 0 0 0 0 ...
## $ password      : int  0 0 0 0 2 2 0 0 0 0 ...
## $ num_char      : num  11.37 10.5 7.77 13.26 1.23 ...
## $ line_breaks   : int  202 202 192 255 29 25 193 237 69 68 ...
## $ format        : int  1 1 1 1 0 0 1 1 0 1 ...
## $ re_subj       : int  0 0 0 0 0 0 0 0 0 0 ...
## $ exclaim_subj  : int  0 0 0 0 0 0 0 0 0 0 ...
## $ urgent_subj   : int  0 0 0 0 0 0 0 0 0 0 ...
## $ exclaim_mess  : int  0 1 6 48 1 1 1 18 1 0 ...
## $ number        : Factor w/ 3 levels "big","none","small": 1 3 3 3 2 2 1 3 3 3 ...
```

- The `email` data set has 3921 observations, and 21 variables.
- The variable names were read in correctly, as evidenced by the words in the far right corner after the `$`.
- Most variables are treated as numeric integers, except a few are factors. Including `time`. If we wanted to examine a time trend, we would need to convert the class into a `datetime`

What happens if you forget to include the arguments for `header` or `sep`? Try that now.

### Forgetting both arguments

```
email <- read.table("../data/email.txt")
head(email)
```

### Forgetting the header

```
email <- read.table("../data/email.txt", sep="\t")
head(email)
```

### Forgetting the separator

```
email <- read.table("../data/email.txt", header=TRUE)
head(email)
```

## CSV: Comma Separated Values

CSV is a fancy way of saying a text file with comma-separated values (i.e. CSV). This file type can also open in Excel, the icons even look similar. We could use `read.table()` to import this data file, but `read.csv()` is optimized to read in CSV files.

```
NCbirths <- read.csv("../data/NCbirths.csv", header=TRUE)
head(NCbirths)
```

```
##   fage mage      mature weeks   premie visits marital gained weight
## 1   NA   13 younger mom    39 full term    10 married    38   7.63
## 2   NA   14 younger mom    42 full term    15 married    20   7.88
## 3   19   15 younger mom    37 full term    11 married    38   6.63
## 4   21   15 younger mom    41 full term     6 married    34   8.00
## 5   NA   15 younger mom    39 full term     9 married    27   6.38
## 6   NA   15 younger mom    38 full term    19 married    22   5.38
##   lowbirthweight gender      habit whitemom
## 1           not low   male nonsmoker not white
## 2           not low   male nonsmoker not white
## 3           not low female nonsmoker    white
## 4           not low   male nonsmoker    white
## 5           not low female nonsmoker not white
## 6              low   male nonsmoker not white
```

- The NCbirths data set has 1000 rows and 13 columns.
- Variable names are read in OK.
- Most the data is begin read in as factors and integers.
- There are some NA values for the variable `fage` (fathers age).

## Excel files

The best method I have found so far to read in Excel files is from the `readxl` package by Hadley Wickham. This package need to be installed first, and then can be simply loaded using the `library()` function each time you start an R session where you will be reading in this type of data.

The `read_excel()` function is what we are going to use. Note the use of the underscore `_` instead of a period `.` between read and the file type.

```
library(readxl)
police <- read_excel("../data/WashPost Police Shootings 2015.xlsx", sheet=1, col_names=TRUE)
police[1:10,1:5]
```

```
## # A tibble: 10 x 5
##       id name                date                manner_of_death armed
##   <dbl> <chr>                <dtm>                <chr>          <chr>
## 1     3 Tim Elliot        2015-01-02 00:00:00 shot            gun
## 2     4 Lewis Lee Lembke    2015-01-02 00:00:00 shot            gun
## 3     5 John Paul Quintero 2015-01-03 00:00:00 shot and Tasered unarmed
## 4     8 Matthew Hoffman    2015-01-04 00:00:00 shot            toy weap~
## 5     9 Michael Rodriguez   2015-01-04 00:00:00 shot            nail gun
## 6    11 Kenneth Joe Brown  2015-01-04 00:00:00 shot            gun
## 7    13 Kenneth Arnold Bu~ 2015-01-05 00:00:00 shot            gun
## 8    15 Brock Nichols      2015-01-06 00:00:00 shot            gun
## 9    16 Autumn Steele      2015-01-06 00:00:00 shot            unarmed
## 10   17 Leslie Sapp III    2015-01-06 00:00:00 shot            toy weap~
```

- The variable `date` is a `dtm` or *date-time* variable. This means R recognizes it directly as a date, not some string of numbers.
- Categorical variables such as `manner_of_death` and `city` are read in as `character` instead of factor. We may or may not want to change that later.

- Numeric variables such as `age` are of type `dbl` (double). This is similar to `integer` or `numeric`, so we are fine.
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## Additional resources

- <https://www.datacamp.com/courses/importing-data-into-r>