

Data I/O

The R Bootcamp
www.therbootcamp.com
[@therbootcamp](https://twitter.com/therbootcamp)

July 2018

Data Input/Output

Raw data can come in many shapes and sizes, but **R's got you covered.**

Package	Description
readr	.csv, .txt, etc.
haven	.sav, .sas7bdat, .dta
readxl	.xls, .xlsx
R.matlab	.mat
jsonlite	.json
rvest	.html
XML, xml2	.xml



Raw (structured) Data

delim-separated data

```
id,sex,age,height,weight,income,education,confession,children
1,male,44,174.3,113.4,6300,SEK_III,catholic,2,5,7,610,40,6,4
2,male,65,180.3,75.2,10900,obligatory_school,confessionless,
3,female,31,168.3,55.5,5100,SEK_III,NA,2,7,6,720,14,3,6,102,
4,male,27,209,93.8,4200,SEK_III,catholic,2,7,8,680,39,6,0,11
5,male,24,176.7,NA,4e3,SEK_III,catholic,1,5,4,260,19,0,1,82,
6,male,63,186.6,67.4,11400,SEK_III,evangelical-reformed,0,7,
7,male,71,151.6,83.3,12e3,SEK_III,evangelical-reformed,2,8,5
8,female,41,155.7,67.8,7600,SEK_III,confessionless,1,7,2,135
9,male,43,176.1,69.3,8500,apprenticeship,catholic,2,7,5,150,
10,female,31,166.1,66.3,6100,SEK_II,catholic,1,6,7,700,0,0,3
11,female,42,157.8,51.9,8e3,obligatory_school,catholic,2,9,7
12,male,31,165.9,66,5900,apprenticeship,evangelical-reforme
13,female,38,162.5,73.4,6200,apprenticeship,confessionless,2
14,female,49,182.8,46.9,NA,SEK_III,evangelical-reformed,1,6,
15,female,39,160,NA,5600,SEK_III,other,2,7,4,540,35,7,4,122,
16,female,54,139.7,50.3,10900,SEK_III,evangelical-reformed,3
17,female,78,153.1,64.1,11e3,SEK_III,confessionless,2,7,2,95
18,female,62,174.6,63.8,11500,SEK_III,confessionless,2,9,7,1
19,male,88,191.4,99.8,14200,SEK_III,confessionless,2,7,3,121
20,male,74,183.8,78.1,12100,apprenticeship,catholic,2,5,7,11
```

markup data

```
<!doctype html>
<html lang="en" class="gr__therbootcamp_github_io">
  <head>...</head>
  <body data-gr-c-s-loaded="true">
    <script async src="https://www.google-analytics.com/analytics.js">
    <script type="text/javascript" async src="https://snap.licdn.com/li
    insight.min.js"></script>
    <script type="text/javascript">
      _linkedin_data_partner_id = "111419";
    </script>
    <script type="text/javascript">...</script>
  <div id="particles-js">
    <div class="content">
      <h1>
        <span class="site-title">TheRBootcamp</span>
        <span class="site-description">Learn Data Science in R</
      <a class="link" href="#upcoming" data-scroll>
        <font size="6" color="#FF3A2A">Basel July 21 22 28 29
      </a>
    </h1>
```

Delim-separated data

- 1 - Most typical file format.
- 2 - Requires **delimiter** to separate entries.



delim-separated data

```
id,sex,age,height,weight,income,education,confession,children
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3,female,31,168.3,55.5,5100,SEK_III,NA,2,7,6,720,14,3,6,102,
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6,male,63,186.6,67.4,11400,SEK_III,evangelical-reformed,0,7,
7,male,71,151.6,83.3,12e3,SEK_III,evangelical-reformed,2,8,5
8,female,41,155.7,67.8,7600,SEK_III,confessionless,1,7,2,135
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10,female,31,166.1,66.3,6100,SEK_II,catholic,1,6,7,700,0,0,3
11,female,42,157.8,51.9,8e3,obligatory_school,catholic,2,9,7
12,male,31,165.9,66,5900,apprenticeship,evangelical-reforme
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14,female,49,182.8,46.9,NA,SEK_III,evangelical-reformed,1,6,
15,female,39,160,NA,5600,SEK_III,other,2,7,4,540,35,7,4,122,
16,female,54,139.7,50.3,10900,SEK_III,evangelical-reformed,3
17,female,78,153.1,64.1,11e3,SEK_III,confessionless,2,7,2,97
18,female,62,174.6,63.8,11500,SEK_III,confessionless,2,9,7,1
19,male,88,191.4,99.8,14200,SEK_III,confessionless,2,7,3,121
20,male,74,183.8,78.1,12100,apprenticeship,catholic,2,5,7,11
```


readr

readr is a tidyverse package that provides convenient functions to **read in** (non-nested) data files into data frames (tibbles to be precise):



```
# Importing data from a file
```

```
data <- read_csv(file, ...)  # comma-delimited  
data <- read_csv2(file, ...) # semicolon-delimited  
data <- read_delim(file, ...) # arbitrary-delimited
```

```
# Writing a data frame to a file
```

```
write_csv(data_object, file, ...)  # comma-delimited  
write_delim(data_object, file, ...) # arbitrary-delimited
```

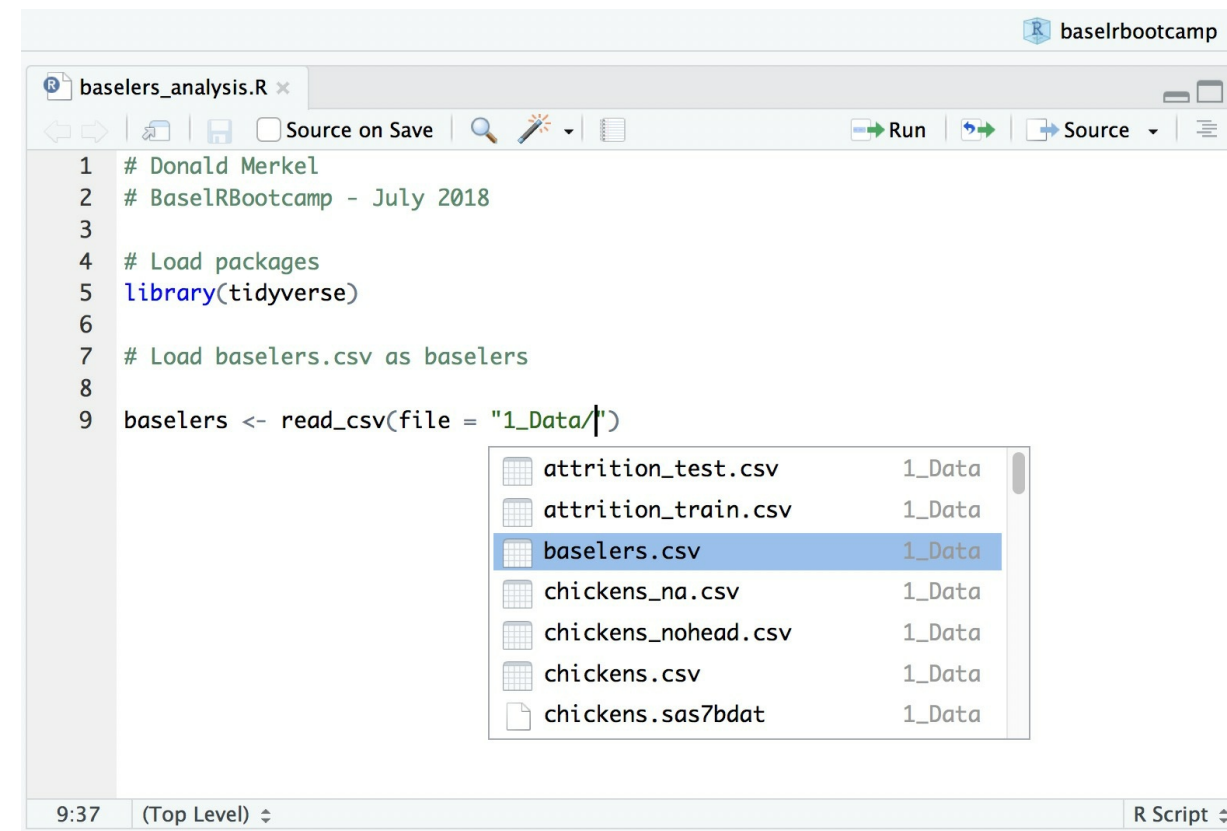
Finding the file path

1 - Identify the file path using the **auto-complete**.

2 - Initiate auto-complete and browse through the folder structure by placing the cursor between two quotation marks and using the **tab key**.



3 - Auto-complete begins with the project folder - **place your data inside your project folder!**

A screenshot of the RStudio IDE. The main editor window shows a script named 'baselers_analysis.R'. The script contains the following code:

```
1 # Donald Merkel
2 # BaselRBootcamp - July 2018
3
4 # Load packages
5 library(tidyverse)
6
7 # Load baselers.csv as baselers
8
9 baselers <- read_csv(file = "1_Data/|")
```

The cursor is at the end of the string "1_Data/|". An auto-complete dropdown menu is visible, listing several files in the '1_Data' directory: 'attrition_test.csv', 'attrition_train.csv', 'baselers.csv' (which is highlighted), 'chickens_na.csv', 'chickens_nohead.csv', 'chickens.csv', and 'chickens.sas7bdat'. The status bar at the bottom shows the time as 9:37, the location as (Top Level), and the file type as R Script.

Identifying the delimiter

- 1 - **Find the file** on your hard drive. Should be in your data folder inside your project.
- 2 - **Open the file** in RStudio (right-click on the file in the pane) a text viewer, e.g., `code::editor::openFile()` (Mac), `code::editor::openFile()` (Mac), `code::editor::openFile()` (Windows).



baselers.csv

```
id,sex,age,height,weight,income,education,confession,children
1,male,44,174.3,113.4,6300,SEK_III,catholic,2,5,7,610,40,6,4
2,male,65,180.3,75.2,10900,obligatory_school,confessionless,
3,female,31,168.3,55.5,5100,SEK_III,NA,2,7,6,720,14,3,6,102,
4,male,27,209,93.8,4200,SEK_III,catholic,2,7,8,680,39,6,0,11
5,male,24,176.7,NA,4e3,SEK_III,catholic,1,5,4,260,19,0,1,82,
6,male,63,186.6,67.4,11400,SEK_III,evangelical-reformed,0,7,
7,male,71,151.6,83.3,12e3,SEK_III,evangelical-reformed,2,8,5
8,female,41,155.7,67.8,7600,SEK_III,confessionless,1,7,2,135
9,male,43,176.1,69.3,8500,apprenticeship,catholic,2,7,5,150,
10,female,31,166.1,66.3,6100,SEK_II,catholic,1,6,7,700,0,0,3
11,female,42,157.8,51.9,8e3,obligatory_school,catholic,2,9,7
12,male,31,165.9,66,5900,apprenticeship,evangelical-reforme
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14,female,49,182.8,46.9,NA,SEK_III,evangelical-reformed,1,6,
15,female,39,160,NA,5600,SEK_III,other,2,7,4,540,35,7,4,122,
16,female,54,139.7,50.3,10900,SEK_III,evangelical-reformed,3
17,female,78,153.1,64.1,11e3,SEK_III,confessionless,2,7,2,97
18,female,62,174.6,63.8,11500,SEK_III,confessionless,2,9,7,1
19,male,88,191.4,99.8,14200,SEK_III,confessionless,2,7,3,121
20,male,74,183.8,78.1,12100,apprenticeship,catholic,2,5,7,11
```

Identifying the delimiter

- 1 - **Find the file** on your hard drive. Should be in your data folder inside your project.
- 2 - **Open the file** in RStudio (right-click on the file in the pane) a text viewer, e.g., `vim` (Mac), `notepad` (Mac), `notepad++` (Windows).

```
# Read with explicit column names
baselers <- read_delim(file = ".../baselers.csv",
                      delim = c(",",""))
```

baselers.csv

```
id,sex,age,height,weight,income,education,confession,children
1,male,44,174.3,113.4,6300,SEK_III,catholic,2,5,7,610,40,6,4
2,male,65,180.3,75.2,10900,obligatory_school,confessionless,
3,female,31,168.3,55.5,5100,SEK_III,NA,2,7,6,720,14,3,6,102,
4,male,27,209,93.8,4200,SEK_III,catholic,2,7,8,680,39,6,0,11
5,male,24,176.7,NA,4e3,SEK_III,catholic,1,5,4,260,19,0,1,82,
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20,male,74,183.8,78.1,12100,apprenticeship,catholic,2,5,7,11
```


Handling headers

1 - readr- functions typically expect the **column names** in the first line.

2 - If no column names are available, use the **col_names-argument** to provide them.

```
# Read with explicit column names
baselers <- read_csv(file = ".../baselers.csv",
                     col_names = c("id",
                                   "age",
                                   ...))
```

baselers.csv

```
id,sex,age,height,weight,income,education,confession,children
1,male,44,174.3,113.4,6300,SEK_III,catholic,2,5,7,610,40,6,4
2,male,65,180.3,75.2,10900,obligatory_school,confessionless,
3,female,31,168.3,55.5,5100,SEK_III,NA,2,7,6,720,14,3,6,102,
4,male,27,209,93.8,4200,SEK_III,catholic,2,7,8,680,39,6,0,11
5,male,24,176.7,NA,4e3,SEK_III,catholic,1,5,4,260,19,0,1,82,
6,male,63,186.6,67.4,11400,SEK_III,evangelical-reformed,0,7,
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20,male,74,183.8,78.1,12100,apprenticeship,catholic,2,5,7,11
```

Handling data types

Reading in data, **readr infers the type of data** for each column.

```
# Read baselers
read_csv(file = "1_Data/baselers.csv")

## Parsed with column specification:
## cols(
##   .default = col_integer(),
##   sex = col_character(),
##   height = col_double(),
##   weight = col_double(),
##   income = col_double(),
##   education = col_character(),
##   confession = col_character(),
##   food = col_double(),
##   fasnacht = col_character(),
##   eyecor = col_character()
## )

## See spec(...) for full column specifications.
```

baselers.csv

```
id,sex,age,height,weight,income,education,confession,children
1,male,44,174.3,113.4,6300,SEK_III,catholic,2,5,7,610,40,6,4
2,male,65,180.3,75.2,10900,obligatory_school,confessionless,
3,female,31,168.3,55.5,5100,SEK_III,NA,2,7,6,720,14,3,6,102,
4,male,27,209,93.8,4200,SEK_III,catholic,2,7,8,680,39,6,0,11
5,male,24,176.7,NA,4e3,SEK_III,catholic,1,5,4,260,19,0,1,82,
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8,female,41,155.7,67.8,7600,SEK_III,confessionless,1,7,2,135
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```


Handling data types

Incorrect data types can be fixed. Typically this involves:

- 1 - **removing character elements** from otherwise numeric variables.
- 2 - Setting **explicit NA strings** using the `na`-argument.
- 3 - Re-running `type_convert`.

```
# Read baselers
baseslers <- read_csv(file = ".../baselers.csv",
                      na = c('NA'))

# Try to fix incorrect data types
baselers <- type_convert(baseslers)
```

`baselers.csv`

```
id,sex,age,height,weight,income,education,confession,children
1,male,44,174.3,113.4,6300,SEK_III,catholic,2,5,7,610,40,6,4
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20,male,74,183.8,78.1,12100,apprenticeship,catholic,2,5,7,11
```

Other data

R provides **read and write functions** for practically all data file formats. See [rio](#).

readr



```
# read fixed width files (can be fast)
data <- read_fwf(file, ...)

# read Apache style log files
data <- read_log(file, ...)
```

haven



```
# read SAS's .sas7bat and sas7bcat files
data <- read_sas(file, ...)

# read SPSS's .sav files
data <- read_sav(file, ...)

# etc
```

readxl



```
# read Excel's .xls and .xlsx files
data <- read_excel(file, ...)
```

Other

```
# Read Matlab .mat files
data <- R.matlab::readMat(file, ...)

# Read and wrangle .xml and .html
data <- XML::xmlParseParse(file, ...)

# from package jsonlite: read .json files
data <- jsonlite::read_json(file, ...)
```


Websites

R provides **read and write functions** for practically all data file formats. See [rio](#).

```
# load package
library(rvest)
library(xml2)

# get html page (abbreviated)
url <- '.../R_(programming_language)'
page <- read_html(u)

# get xpath (abbreviated)
xpath <- '.../div/table[2]'

# get table using XPath
table <- page %>%
  html_node(
    xpath = xpath) %>%
  html_table()
```

```
## # A tibble: 15 x 3
##   Release Date      Description
##   <chr>      <chr>      <chr>
## 1 0.16      ""          This is the last alpha version
## 2 0.49      1997-04-23 This is the oldest source rele
## 3 0.60      1997-12-05 "R becomes an official part of "
## 4 0.65.1    1999-10-07 First versions of update.packa
## 5 1.0       2000-02-29 Considered by its developers s
## 6 1.4       2001-12-19 "S4 methods are introduced and "
## 7 2.0       2004-10-04 Introduced lazy loading, which
## 8 2.1       2005-04-18 Support for UTF-8 encoding, an
## 9 2.11      2010-04-22 Support for Windows 64 bit sys
## 10 2.13     2011-04-14 Adding a new compiler function
## 11 2.14     2011-10-31 Added mandatory namespaces for
## 12 2.15     2012-03-30 "New load balancing functions. "
## 13 3.0      2013-04-03 Support for numeric index valu
## 14 3.4      2017-04-21 Just-in-time compilation (JIT)
## 15 3.5      2018-04-23 Packages byte-compiled on inst
```

Remote databases

R provides **all necessary tools to pull data from or directly work with** remote databases such as, e.g., a SQL database. Find out more at:

db.rstudio.com

R's data formats

R's own formats provide the possibility to store **data as R objects** as well as substantial **compression**.

.RData

- 1 - Bundles **several R objects**.
- 2 - Loads objects **directly into workspace**.

```
# save data as .RData
save(baselers, zuerichers, ...,
     file = "my_data.RData")

# load data from .RData
load("my_data.RData")
```

.RDS

- 1 - Stores **single R objects**.
- 2 - Import is **assigned to object**.

```
# save data as .RDS
saveRDS(baselers,
        file = "baselers.rds")

# load data from .RDS
baselers <- readRDS("baselers.rds")
```

Practical

[Link to practical](#)