

# A Short Introduction to Working With Data in R

## EXTRAS

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# Section 1

## Reading a csv file with base R

## Load a csv file using read.csv()

?read.csv

- If `read.csv()` encounters problems reading a file, it is more likely to trigger an **error** than `read_csv()`, which gives a warning more often.

```
DF_path <- file.path("../", "data", "data_example.csv")
try( read.csv(DF_path) )
```

```
# Error in read.table(file = file, header = header, sep = sep, quote = quote,
#   more columns than column names
```

## Check the file contents

- Let's take a peek at the first few lines and see if we can identify the problem (this is more often necessary with `read.csv()`):

```
readLines(DF_path, n = 4)
```

```
# [1] "Data from an experiment on the cold tolerance of the grass s  
# [2] "Modified from `data(CO2)`. See `?CO2`."  
# [3] "Type,Treatment,PlantNum,95,175,250,350,500,675,1000"  
# [4] "Quebec,nonchilled,1,16,30.4,34.8,37.2,35.3,39.2,39.7"
```

- The first **2** lines don't look like comma-separated values!
- They look like extra information that is not part of the data table *structure*.

## Load a csv file into R

- We can tell R to skip the lines with no data:

```
DF <- read.csv(DF_path, skip = 2)
DF_readr <- readr::read_csv(DF_path, skip = 2)
```

- Just because there were no Errors from R, doesn't mean there's nothing wrong with the data!

## readr vs base R functions

readr		base R	
<code>read_csv()</code>	comma separated values	<code>read.csv()</code>	
<code>read_csv2()</code>	';' as delimiter (allows ',' for decimals)	<code>read.csv2()</code>	',' for decimals, ';' as separator
<code>read_tsv()</code>	tab separated values	<code>read.delim()</code>	delimited files (tab is default)
<code>read_delim()</code>	(generic) files with any delimiter	<code>read.table()</code>	
<code>read_fwf()</code>	fixed width files	<code>read.fwf()</code>	

readr descriptions based on [#dsbox](#)

## Comparison of `read.csv()` and `read_csv()`

- In keeping with Tidyverse conventions, functions are names with words separated by “\_”
  - ▶ instead of “.” or camelCase, as in many base R functions
- The column names are different
  - ▶ `read.csv()` automatically applies `make.names()` to the column names to make ‘syntactically valid’ names to use in R.
  - ▶ convenient, but not always what we want.
  - ▶ there are other ‘cleaning’ functions available (e.g., `clean_names()` in the `janitor` package)
- `read_csv()` automatically replaced empty strings in the Treatment column with `NA`s.
- `read_csv()` left the ‘675’ column as numeric, but ignored the commas, resulting in larger numbers.
- `read_csv()` produces a “tbl\_df” (*tibble*) object, not a simple `data.frame`



# Tibble examples

- Tibbles have an enhanced `print()` method
- and they will *not* do partial matching on variable names, triggering a *warning* instead for columns that do not exist.

```
print(DF_readr, n=2)
```

```
# # A tibble: 13 x 10
#   Type      Treatment PlantNum `95` `175` `250` `350` `500`
#   <chr>    <chr>         <dbl> <dbl> <dbl> <dbl> <dbl> <chr>
# 1 Quebec nonchilled         1  16    30.4  34.8  37.2  35.3
# 2 Quebec <NA>              2 13.6   27.3  37.1  41.8  40.6
# # i 11 more rows
# # i 2 more variables: `675` <dbl>, `1000` <dbl>
```

```
is.null(DF$Treat)
```

```
# [1] FALSE
```

```
is.null(DF_readr$Treat)
```

```
# Warning: Unknown or uninitialised column: `Treat`.
```

```
# [1] TRUE
```

## Section 2

### Downloading Data From the Internet

# Downloading Data From the Internet

## Section 3

### File Encoding, Windows, & Microsoft Excel™

## Encoding non-English characters

- If you are running R in Windows, you may notice that some text values (character) look strange when read with `read.csv()`:  
“**QuÃ©bec**” instead of “Québec”
- There is nothing wrong with the file — this indicates a *mismatch* between the *encoding* used to write the file, and what R used to read it.
- Even though ‘.csv’ files are plain text, letters (especially non-english characters) can be *encoded* in different ways to represent them in the computer.
- “**UTF-8**” is a character encoding standard designed to handle many non-english characters.
  - ▶ The example data file was written in “UTF-8”
  - ▶ Most OSes and many programs use “UTF-8” encoding by default.
  - ▶ But *Windows* uses “latin1” by default, and so does R (< 4.2.0) when running in Windows.
  - ▶ Starting with v4.2.0, R uses “UTF-8” as the default encoding on Windows.

## Read a csv file with a different encoding

- You can specify the encoding used in the file with the 'encoding' argument of `read.csv()`

```
DF <- read.csv(DF_path, skip = 2, encoding = "UTF-8")
```

- If reading a file that was created on a Windows computer and encoded in "latin1", on a different system (mac, Unix, linux, etc.) — or a recent version of R ( $\geq 4.2$ ) on Windows — you can specify that, too:

```
read.csv(DF_path, skip = 2, encoding = "latin1")
```

# Encoding & Microsoft Excel™

- Excel can save a .csv file using UTF-8 encoding, but in doing so, it adds “**byte order mark**” (“BOM”) to the file.
  - ▶ This is a special character that Excel also uses to recognize that the file is encoded using UTF-8.
  - ▶ Thus a BOM can make the file “easier” to use with Excel, by allowing it to automatically recognize the UTF-8 encoding, but it can also **cause problems for other programs** (like R) that do not expect such a non-Unicode character.
- Without the BOM, Excel will assume the file is encoded in “latin1” if you double-click on the csv file to open it in Excel, even if it was actually encoded with UTF-8.
  - ▶ This can cause special characters to appear incorrectly.
  - ▶ You can still import a .csv file encoded in UTF-8 into Excel correctly, but it requires opening the file within Excel, or **importing it using commands in the “Data” ribbon / menu**

## Read a file with a BOM using `read.csv()` in R

- Reading a .csv file with a BOM using the usual method may cause the BOM to be included in the name of the first column (on Windows).

```
bom_bad <- read.csv("../data/data_example_bom.csv",  
                    encoding = "UTF-8")  
names(bom_bad)
```

- The solution with `read.csv()` is to use the argument `'fileEncoding = "UTF-8-BOM"'` (instead of the `'encoding'` argument)

```
bom <- read.csv("../data/data_example_bom.csv",  
                fileEncoding = "UTF-8-BOM")  
bom[4, 1:4]
```

```
#      Type Treatment PlantNum  X95  
# 4 Québec    chilled         1 14.2
```



## Read a file with a BOM using read\_csv()

- The readr package uses “UTF-8” encoding by default, and **automatically ignores a BOM**, if present.

```
bom_readr <- readr::read_csv("../data/data_example_bom.csv")  
bom_readr[4, 1:4] |> knitr::kable()
```

Type	Treatment	PlantNum	95
Québec	chilled	1	14.2

- write\_csv() (in the readr package) automatically encodes output files using “UTF-8”, for greater portability across systems.
  - ▶ *except* for older versions of base R (read.csv()) on Windows :(

!

Hopefully, these examples have demonstrated that the readr package makes it easy to work with “UTF-8” files by default, on any platform.

## Add a BOM to an output file

- It is possible to add a BOM to a csv file, but it must be done *manually* with base R:
  - ▶ code adapted from [this StackOverflow answer](#)

```
writeChar(  
  iconv("\ufeff", to = "UTF-8"),  
  "output.csv",  
  eos = NULL  
)  
write.csv(Data, "output.csv", append = TRUE, ... )
```

- The readr package can do this directly with a special `write_excel_csv` function:

```
write_excel_csv(Data, "output.csv", ... )
```

!

**R does not recommend doing this** (see `?file`), so use with caution.

## Using other encodings with readr

- You can control the encoding used by readr functions with the **locale** argument.

```
write_csv(Data, "data.csv",  
          locale = locale(encoding = "latin1")  
)  
  
read_csv(Data, "data.csv",  
         locale = locale(encoding = "latin1")  
)
```

- See `?readr::read_csv` and `?readr::locale` for details.

## Section 4

### Reading Data in Other Formats

# Reading Data in Other Formats

- Parquet files: an efficient columnar format, popular with Big Data and cloud computing
  - ▶ [Apache Arrow](#) (i.e., the 'arrow' package)
- The [Data Import Chapter of R for Data Science \(2e\)](#) describes these tidyverse packages for other types of data:
  - ▶ `haven` reads SPSS, Stata, and SAS files.
  - ▶ DBI, along with a database specific backend (e.g. RMySQL, RSQLite, RPostgreSQL, etc.) allows you to run SQL queries on a **database** and return a data frame.
- See the [Import Section of R for Data Science \(2nd edition\)](#) For more details on getting data into R from these and other sources.
- Other options are also described in the [R Data Import/Export](#) manual.

## Section 5

### Exporting to other formats

# Writing to Microsoft Excel™ files

Packages that can write to Excel files:

- **xlsx**: read, write, format Excel 2007 (.xlsx) and Excel 97/2000/XP/2003 (.xls) files.
  - ▶ Requires Java and the rJava package
- **XLConnect**: comprehensive and cross-platform R package for manipulating Microsoft Excel files (.xlsx & .xls) from within R.
  - ▶ Requires a Java Runtime Environment (JRE)
- **openxlsx**: simplified creation of Excel .xlsx files (**not** .xls).
  - ▶ *No dependency on Java*
- **writexl**: portable, light-weight data frame to **xlsx** exporter.
  - ▶ No Java or Excel required

!

I recommend *avoiding* exporting data to Excel files if possible. csv files are easier to read to & write from, and can be read by a wider variety of software (they are more portable).

Automated reports can be produced with R Markdown and output to a variety of more portable formats (pdf, HTML, etc.) instead.

# References (Extras)

CANSIM / CODR data:

- An ecosystem of R packages to access and process Canadian data
- Analyzing Canadian Demographic and Housing Data