Quantessentials
R advice – R and Excel

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Getting data into and out of Excel

Whether you're a fan or not, data will come to you in Excel spreadsheets and people will want the results from an analysis to be delivered in a similar form. In this edition of Quantessentials we compare the various libraries available to R users for both reading from and writing to Excel spreadsheets.

We find significant differences between the various libraries

Some packages have dependencies that might be problematic. Other packages are more capable of handling dates. A few packages even support writing formulae and formatting the output excel file (as opposed to just writing data).

The choice really depends on how much functionality is required

For reading in data, the *readr* or the *readxl* packages fulfil these needs easily and efficiently. For creating workbooks and formatting them, the dependency-free *openxlsx* is probably the best overall package.

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Reading and writing data from Excel

Microsoft Excel is ubiquitous throughout finance. Analysts build models in it, people download data into it and they generate their charts in it. Whether you love it or not as a user of R you will have to both load data in from spreadsheets and produce your output in Excel.

As is common in R there are a number of packages which offer functions to do this. In this note we will compare them[1] for both speed and convenience.

The list of packages we will investigate is

- dataframes2xls
- excel.link
- gdata
- openxlsx
- readxl
- WriteXLS
- XLConnect
- xlsx
- xlutils3

In many cases saving the data as a csv file (for either reading or writing) can be the simplest approach, and we will also look at *data.table*, *readr* as well as the base *read.csv* function.

We look at three operations: reading in data, writing data to a sheet (or csv file) and then creating formulae within our sheet.

As with any comparison of R packages (or any other software for that matter) one can only run a limited numer of tests. So our conclusions below are potentially dependent on our choice of the tests we ran. We didn't try the packages on linux and so for that OS one may find other conclusions hold.

Package dependencies

Although the packages are all on cran they have some dependencies which can be problematic. *xlsx* and *XLConnect* both use the *rJava* package which obviously needs java to be installed on your machine. *gdata* and *WriteXLS* need the perl programming language to be installed. This is standard on linux and Mac OS X machines, but would probably need installing on a Windows machine. *dataframes2xls* needs python to be installed which again may cause problems under Windows. These latter three packages are probably more of use for linux users than Windows ones. In this report we will not investigate them further given the problems most people have in installing software on work PCs.

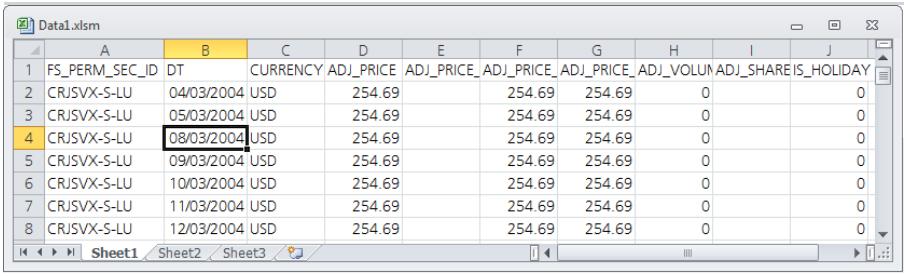
[1] We have attempted to find all the packages which offer this functionality, but it is quite possible that we missed some.

openxlsx, *readxl* and *xlutils3* are the only packages in the list which have no system dependencies.

Reading data

The first example is to read in a 10,000 line spreadsheet which contains 10 columns of data which we show in Figure 1.

Figure 1: Data to read from spreadsheet



Data1.xlsm

	A	B	C	D	E	F	G	H	I	J
1	FS_PERM_SEC_ID	DT	CURRENCY	ADJ_PRICE	ADJ_PRICE_	ADJ_PRICE_	ADJ_PRICE_	ADJ_VOLUN	ADJ_SHARE	IS_HOLIDAY
2	CRJSVX-S-LU	04/03/2004	USD	254.69		254.69	254.69	0		0
3	CRJSVX-S-LU	05/03/2004	USD	254.69		254.69	254.69	0		0
4	CRJSVX-S-LU	08/03/2004	USD	254.69		254.69	254.69	0		0
5	CRJSVX-S-LU	09/03/2004	USD	254.69		254.69	254.69	0		0
6	CRJSVX-S-LU	10/03/2004	USD	254.69		254.69	254.69	0		0
7	CRJSVX-S-LU	11/03/2004	USD	254.69		254.69	254.69	0		0
8	CRJSVX-S-LU	12/03/2004	USD	254.69		254.69	254.69	0		0

Sheet1 Sheet2 Sheet3

Source: UBS, Data taken from Factset

In Figure 2 below we show that the three functions to read csv files produce outputs which are all data.frames but in the case of *readr* and *fread* they also have other classes. Also, we see that the date column (here in DD/MM/YYYY format) causes a potential problem just using the simple commands to read CSV files.[2]

Figure 2: Reading data via a CSV file

```
require (microbenchmark)
require (data.table)
require (readr)

x1 <- read.csv ("Data1.csv")
x2 <- readr::read_csv ("Data1.csv")
x3 <- data.table::fread ("Data1.csv")

> class (x1)
[1] "data.frame"
> class (x2)
[1] "tbl_df"     "tbl"        "data.frame"
> class (x3)
[1] "data.table" "data.frame"

> class (x1$DT)
[1] "factor"
> class (x2$DT)
[1] "character"
> class (x3$DT)
[1] "character"
```

Source: UBS. Analysis run in the standard implementation of R.

All three functions have a way of specifying the type of a column of data, but you need a trick (which we show below) in order to get *read.csv* to be able to convert the date. *fread* says in its documentation that it reads dates as characters and "they can be converted afterwards using the excellent *fasttime* package or standard base functions". In this case we would have to use *as.Date*.

[2] We note that in some countries a CSV file uses a semicolon as a separator as a comma is used as the decimal point. There are equivalent functions to those shown here, e.g. *read.csv2,* which read this format.

Figure 3: Reading data via a CSV file (continued)

```
setAs("character","myDate", function(from) as.Date(from, format="%d/%m/%Y") )

microbenchmark (x1 <- read.csv ("Data1.csv", colClasses  = c (DT = "myDate")),
        x2 <- readr::read_csv ("Data1.csv", col_types = cols (DT = col_date ("%d/%m/%Y"))),
        x3 <- data.table::fread ("Data1.csv"))

Unit: milliseconds
             expr      min       lq     mean   median       uq      max neval cld
         read.csv    53.48    55.04    59.97    56.24    61.70   112.51   100   c
  readr::read_csv    17.75    19.04    21.34    20.02    21.10    64.65   100 a
data.table::fread    26.05    26.92    28.93    27.57    30.21    46.32   100  b
```

Source: UBS. Analysis run in the standard implementation of R.

So in this case using *read_csv* from *readr* is quicker, especially given the convenience of being able to specify the date column as a Date class.

The *readr* package is the fastest

Figure 4: Reading data from an XLSX file

```
require (xlsx)
require (XLConnect)
require (readxl)
require (openxlsx)

x4 <- openxlsx::read.xlsx ("Data1.xlsx", detectDates = TRUE)
x5 <- xlsx::read.xlsx2 ("Data1.xlsx", sheetIndex = 1, colClasses = c ("DT" = "Date"))
x6 <- readxl::read_excel ("Data1.xlsx", sheet = 1)

wb <- XLConnect::loadWorkbook ("Data1.xlsx")
x7 <- XLConnect::readWorksheet (wb, sheet = "Sheet1")

microbenchmark (openxlsx::read.xlsx ("Data1.xlsx", detectDates = TRUE),
        xlsx::read.xlsx2 ("Data1.xlsx", sheetIndex = 1, colClasses = c ("DT" = "Date")),
        readxl::read_excel ("Data1.xlsx", sheet = 1),
        XLConnect::readWorksheet (wb, sheet = "Sheet1") times= 10)

milliseconds
                   expr       min        lq     mean    median        uq        max neval cld
     openxlsx::read.xlsx    290.61    303.78   314.28    306.63    326.21     356.29    10  b
        xlsx::read.xlsx2    548.86    570.98   753.27    770.29    900.35    1024.01    10   c
      readxl::read_excel     68.01     71.33    75.68     74.44     77.19      92.72    10 a
XLConnect::loadWorkbook    192.14    215.67   488.13    347.79    624.40    1060.66    10
XLConnect::readWorksheet   239.49    244.90   250.86    245.99    248.87     296.17    10
```

Source: UBS

The *readxl* package is by far the quickest, with the *openxlsx* package the second. *XLConnect* could be quicker if reading multiple sheets from the same workbook. The *readxl* package has a small downside which is it converts the date to a *POSIXct* class (rather than a date). The *xlsx* package has two functions – *read.xlsx* and *read.xlsx2* – the latter of which is much quicker for large data sets. However, even the slowest reading of a CSV file is quicker than any of these approaches. But for the convenience of not having to duplicate files, hence having both a CSV and XLSX version of a data file sitting around, the *readxl* package seems a good option.

***readxl* is by far the quickest**

Writing to an Excel file

The second test we carried out was writing the same data.frame back to an XLSX or CSV file. As can be seen in Figure 5 below, the *fwrite* function from the *data.table* package is faster by an order of magnitude than the base *write.csv* function.

Figure 5: Writing to a CSV file

```
microbenchmark (data.table::fwrite (x4, "data.table.csv"),
        write.csv (x4, "base.csv"), times = 10)

Unit: milliseconds
               expr        min         lq       mean     median         uq       max neval cld
 data.table::fwrite       9.10       9.26       9.94       9.69       9.79     11.91    10  a
          write.csv     191.02     194.79     201.28     198.32     205.13    218.08    10   b
```

Source: UBS

Writing directly to an XLSX file is, again, much slower than writing to CSV, as can be seen in Figure 6 below. Note we had problems using the *microbenchmark* package with XLConnect, hence the *tictoc* call. Also we note that *xlsx* has two writing functions, write.xlsx and write.xlsx2 – the latter is supposedly much quicker for larger data sets.

Figure 6: Writing to an XLSX file

```
microbenchmark (xlsx::write.xlsx2 (x4, "xlsx.xlsx"),
        openxlsx::write.xlsx (x4, "openxlsx.xlsx"))

Unit: milliseconds
                 expr      min       lq      mean   median       uq      max neval cld
    xlsx::write.xlsx2   785.45   830.39   1003.08   879.10  1031.05  4210.25   100   a
 openxlsx::write.xlsx   868.71   918.58    973.12   963.67  1014.30  1208.40   100   a

require (tictoc)
tic()
wb <- XLConnect::loadWorkbook ("XLConnect.xlsx", create = TRUE)
XLConnect::createSheet(wb, name = "Sheet1")
XLConnect::writeWorksheet (wb, x4, sheet = "Sheet1")
XLConnect::saveWorkbook (wb)
toc ()

0.87 sec elapsed
```

Source: UBS

Perhaps surprisingly the time taken in every case here was very similar. We would argue that the *openxlsx* solution probably is the best given its lack of dependency on having other languages installed.

We would recommend openxlsx even though the times taken are similar.

Writing formulae and formatting

Our final test involves creating a worksheet which not only contains data but also formulae and formatting. Only the *XLConnect* and the *openxlsx* packages seem to be able to do both of these. *xlsx* can format cells but not create formulae.

We are going to create a very simple data frame which contains earnings and prices for a few years and then add a formula to create a P/E.

Figure 7: Creating a simple worksheet with formatting and formulae

```
df = data.frame (YEAR = 2007:2016, PRICE = rnorm (10, 50, 10), E = rnorm (10, 5, 2))

df
   YEAR    PRICE         E
1  2007 45.25492  4.953523
2  2008 41.57183  7.824527
3  2009 30.93758  7.388120
4  2010 44.38623  2.691964
5  2011 60.58362  8.479485
6  2012 60.25571  5.160644
7  2013 52.00801  2.158600
8  2014 60.03262  6.843576
9  2015 63.74208  5.923330
10 2016 59.28581 11.758603

##
## openxlsx example
##

wb <- openxlsx::createWorkbook ()
openxlsx::addWorksheet (wb, "PE")
headerStyle <- createStyle(textDecoration = "Bold", border = "Bottom")
openxlsx::writeData (wb, "PE", x = df, headerStyle = headerStyle)

## Write a single cell formula
formula <- "AVERAGE(B2:B11)"
openxlsx::writeFormula (wb, sheet = "PE", x = formula, startCol = 2, startRow = 12)

## Write a vector of formulae
formula <- paste0 ("B", 2:11, "/C", 2:11)
class (formula) <- c (class (formula), "formula")
openxlsx::writeData (wb, sheet = "PE", x = formula, startCol = 4, startRow = 2)

openxlsx::saveWorkbook (wb, "openxlsxFormula.xlsx", overwrite = TRUE)

##
## XLConnect example
##

wb <- XLConnect::loadWorkbook ("XLConnectFormula.xlsx", create = TRUE)
XLConnect::createSheet (wb, "PE")
XLConnect::writeWorksheet (wb, df, sheet = "PE")

## Write a single cell formula
formula <- "AVERAGE(B2:B11)"
XLConnect::setCellFormula (wb, sheet = "PE", row = 12, col = 2, formula = formula)

## Write a vector of formulae
formula <- paste0 ("B", 2:11, "/C", 2:11)
XLConnect::setCellFormula (wb, sheet = "PE", row = 2:11, col = 4, formula = formula)

cs <- createCellStyle(wb)
setBorder(cs, side = c("bottom"), type = XLC$"BORDER.THICK", color = XLC$"COLOR.BLACK")
setCellStyle (wb, sheet = "PE", row = 1, col = 1:3, cellstyle = cs)

XLConnect::saveWorkbook (wb)
```

Source: UBS

The syntax for both libraries are very similar and so in this case it is hard to really prefer one over the other.

Specialist packages

The *xlutils3* package uses *readxl* to create a list of lists for all the Excel files in a directory. The top list is for each workbook, each workbook contains a list of sheets and each sheet is returned as a dataframe.

Conclusion

The choice in this case really depends on how much functionality you require. If all you need to do is read in data then either the *readr* or the *readxl* packages fulfil these needs easily and efficiently.

***readr* and *readxl* are the winners for simple reading …**

For creating workbooks and formatting them the dependency free *openxlsx* is probably the best overall package.

… and *openxlsx* is best overall

Appendix

R environment

We used R version 3.3.1 for our tests. The files were written to and from our local hard drive in order to lessen any delays caused by our network. It is running on an Intel i7-6700 running at 3.4GHz.

We show below the version numbers of the packages we compared.

Figure 8: Package versions tested

Package	Version	Package	Version
data.table	1.10.1	readxl	0.1.1
openxlsx	3.0.0	XLConnect	0.2.12
readr	1.0.0	xlsx	0.5.7

Source: UBS

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