Assignment 1

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Importing data from flat files with utils

A comma-separated values (csv) file can be read and converted to a data frame by calling read.csv with the file path as parameter. The function call str(pools) prints out the structure of the data frame pools that we just created.

```r
# Import swimming_pools.csv:
pools <- read.csv("swimming_pools.csv")



# Print the structure of pools
str(pools)
```

```
## 'data.frame':    20 obs. of  4 variables:
##  $ Name     : Factor w/ 20 levels "Acacia Ridge Leisure Centre",..: 1 2 3 4 5 6 19 7 8 9 ...
##  $ Address  : Factor w/ 20 levels "1 Fairlead Crescent, Manly",..: 5 20 18 10 9 11 6 15 12 17 ...
##  $ Latitude : num  -27.6 -27.6 -27.6 -27.5 -27.4 ...
##  $ Longitude: num  153 153 153 153 153 ...
```

Since we do not want to import the data entries as factors, stringsAsFactors has to be specified as well.

```r
# Import swimming_pools.csv correctly: pools
pools <- read.csv("swimming_pools.csv", stringsAsFactors = FALSE)

# Check the structure of pools
str(pools)
```

```
## 'data.frame':    20 obs. of  4 variables:
##  $ Name     : chr  "Acacia Ridge Leisure Centre" "Bellbowrie Pool" "Carole Park" "Centenary Pool (inn
##  $ Address  : chr  "1391 Beaudesert Road, Acacia Ridge" "Sugarwood Street, Bellbowrie" "Cnr Boundary
##  $ Latitude : num  -27.6 -27.6 -27.6 -27.5 -27.4 ...
##  $ Longitude: num  153 153 153 153 153 ...
```

The function read.delim is similar to read.csv, but used for tab separated values instead of csv. The parameter header specifies if the first line in the input consists of a header or data. Summary prints summary statistics about all variables in the specified data frame.

```r
# Import hotdogs.txt:
hotdogs <- read.delim("hotdogs.txt", header = FALSE)
```

The function read.table has to be used for reading in data that is neither csv nor tab separated. Instead a separator can be specified with the parameter sep. The parameter col.names adds header information to the dataframe. head(hotdogs) prints out the first couple of observations of hotdogs data frame.

```r
# Import the hotdogs.txt file: hotdogs
hotdogs <- read.table("hotdogs.txt",
                      sep = "\t",
                      col.names = c("type", "calories", "sodium"))

# Call head() on hotdogs
head(hotdogs)
```

```
##   type calories sodium
## 1 Beef      186    495
## 2 Beef      181    477
## 3 Beef      176    425
## 4 Beef      149    322
## 5 Beef      184    482
## 6 Beef      190    587
```

In this exercise the read.delim function had to be completed, header is set to false, because hotdogs.txt does not contain header information and the header is instead provided with the col.names parameter. which.min and which.max return the index of the observation with the lowest and highest value in the given variable.

```
# Finish the read.delim() call
hotdogs <- read.delim("hotdogs.txt", header = FALSE, col.names = c("type", "calories", "sodium"))

# Select the hot dog with the least calories: lily
lily <- hotdogs[which.min(hotdogs$calories), ]

# Select the observation with the most sodium: tom
tom <- hotdogs[which.max(hotdogs$sodium), ]

# Print lily and tom
lily
```

```
##       type calories sodium
## 50 Poultry       86    358
```

```
tom
```

```
##    type calories sodium
## 15 Beef      190    645
```

The parameter colClasses can be used to explicitly set the classes of the columns. If a column class is set to NULL, then the column will not be imported.

```
hotdogs2 <- read.delim("hotdogs.txt", header = FALSE,
                       col.names = c("type", "calories", "sodium"),
                       colClasses = c("factor", "NULL", "numeric"))


# Display structure of hotdogs2
str(hotdogs2)
```

```
## 'data.frame':    54 obs. of  2 variables:
##  $ type  : Factor w/ 3 levels "Beef","Meat",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ sodium: num  495 477 425 322 482 587 370 322 479 375 ...
```

readr & data.table

Instead of using read.csv this exercise teaches us how to use read_csv, which is contained in the readr package. The important difference is that instead of a data frame we get a tibble, which is similar to a data frame, but with extended functionality.

```
# Load the readr package
library(readr)

# Import potatoes.csv with read_csv(): potatoes
potatoes <- read_csv('potatoes.csv')
```

```
##
## -- Column specification --------------------------------------------------------
## cols(
##   area = col_double(),
##   temp = col_double(),
##   size = col_double(),
##   storage = col_double(),
##   method = col_double(),
##   texture = col_double(),
##   flavor = col_double(),
##   moistness = col_double()
## )
```

The readr equivalent of read.delim is read_tsv.

```
# readr is already loaded

# Column names
properties <- c("area", "temp", "size", "storage", "method",
                "texture", "flavor", "moistness")

# Import potatoes.txt: potatoes
potatoes <- read_tsv('potatoes.txt', col_names=properties)
```

```
##
## -- Column specification --------------------------------------------------------
## cols(
##   area = col_double(),
##   temp = col_double(),
##   size = col_double(),
##   storage = col_double(),
##   method = col_double(),
##   texture = col_double(),
##   flavor = col_double(),
##   moistness = col_double()
## )
```

```
# Call head() on potatoes
head(potatoes)
```

```
## # A tibble: 6 x 8
##    area  temp  size storage method texture flavor moistness
##   <dbl> <dbl> <dbl>   <dbl>  <dbl>   <dbl>  <dbl>     <dbl>
## 1     1     1     1       1      1     2.9    3.2       3
## 2     1     1     1       1      2     2.3    2.5       2.6
## 3     1     1     1       1      3     2.5    2.8       2.8
## 4     1     1     1       1      4     2.1    2.9       2.4
## 5     1     1     1       1      5     1.9    2.8       2.2
## 6     1     1     1       2      1     1.8    3         1.7
```

Confusingly read_delim is the readr version of read.table and is used to read arbitrarily separated data. The parameter delim specifies the separator.

```
properties <- c("area", "temp", "size", "storage", "method",
                "texture", "flavor", "moistness")

# Import potatoes.txt using read_delim(): potatoes
potatoes <- read_delim('potatoes.txt', delim="\t", col_names = properties)
```

```
##
## -- Column specification --------------------------------------------------------
## cols(
##   area = col_double(),
##   temp = col_double(),
##   size = col_double(),
##   storage = col_double(),
##   method = col_double(),
##   texture = col_double(),
##   flavor = col_double(),
##   moistness = col_double()
## )
```

```
# Print out potatoes
potatoes
```

```
## # A tibble: 160 x 8
##     area  temp  size storage method texture flavor moistness
##    <dbl> <dbl> <dbl>   <dbl>  <dbl>   <dbl>  <dbl>     <dbl>
##  1     1     1     1       1      1     2.9    3.2       3
##  2     1     1     1       1      2     2.3    2.5       2.6
##  3     1     1     1       1      3     2.5    2.8       2.8
##  4     1     1     1       1      4     2.1    2.9       2.4
##  5     1     1     1       1      5     1.9    2.8       2.2
##  6     1     1     1       2      1     1.8    3         1.7
##  7     1     1     1       2      2     2.6    3.1       2.4
##  8     1     1     1       2      3     3      3         2.9
##  9     1     1     1       2      4     2.2    3.2       2.5
## 10     1     1     1       2      5     2      2.8       1.9
## # ... with 150 more rows
```

The parameter skip is used to specify the number of lines that are ignored before reading in data and n_max can be set to limit the number of observations that get imported. For example skip=2, n_max=4, then lines 3, 4, 5, 6 are imported.

```
# Column names
properties <- c("area", "temp", "size", "storage", "method",
                "texture", "flavor", "moistness")

# Import 5 observations from potatoes.txt: potatoes_fragment
potatoes_fragment <- read_tsv("potatoes.txt", skip = 6, n_max = 5, col_names = properties)
```

```
##
## -- Column specification --------------------------------------------------------
## cols(
##   area = col_double(),
##   temp = col_double(),
##   size = col_double(),
##   storage = col_double(),
##   method = col_double(),
##   texture = col_double(),
##   flavor = col_double(),
##   moistness = col_double()
## )
```

col_types is used to specify the types of the columns, c stands for character, d for double, i for integer l for logical and _ skips the column. In the example below all columns contain characters.

```
# Import all data, but force all columns to be character: potatoes_char
potatoes_char <- read_tsv("potatoes.txt", col_types = "cccccccc", col_names = properties)
```

This exercise teaches us to use collector function, which are also used to specify the column types. In the example below the first column is set to be of type factor with the levels Beef, Meat and Poultry. The remaining two columns contain integers.

```
fac <- col_factor(levels = c("Beef", "Meat", "Poultry"))
int <- col_integer()

# Edit the col_types argument to import the data correctly: hotdogs_factor
hotdogs_factor <- read_tsv("hotdogs.txt",
                           col_names = c("type", "calories", "sodium"),
                           col_types = list(fac,int,int))

# Display the summary of hotdogs_factor
summary(hotdogs_factor)
```

```
##       type       calories         sodium
##  Beef   :20   Min.   : 86.0   Min.   :144.0
##  Meat   :17   1st Qu.:132.0   1st Qu.:362.5
##  Poultry:17   Median :145.0   Median :405.0
##               Mean   :145.4   Mean   :424.8
##               3rd Qu.:172.8   3rd Qu.:503.5
##               Max.   :195.0   Max.   :645.0
```

The function fread from data.table is similar to the previously discussed functions to read in data, but with one big advantage: it is very fast and the best choice when importing large amounts of data.

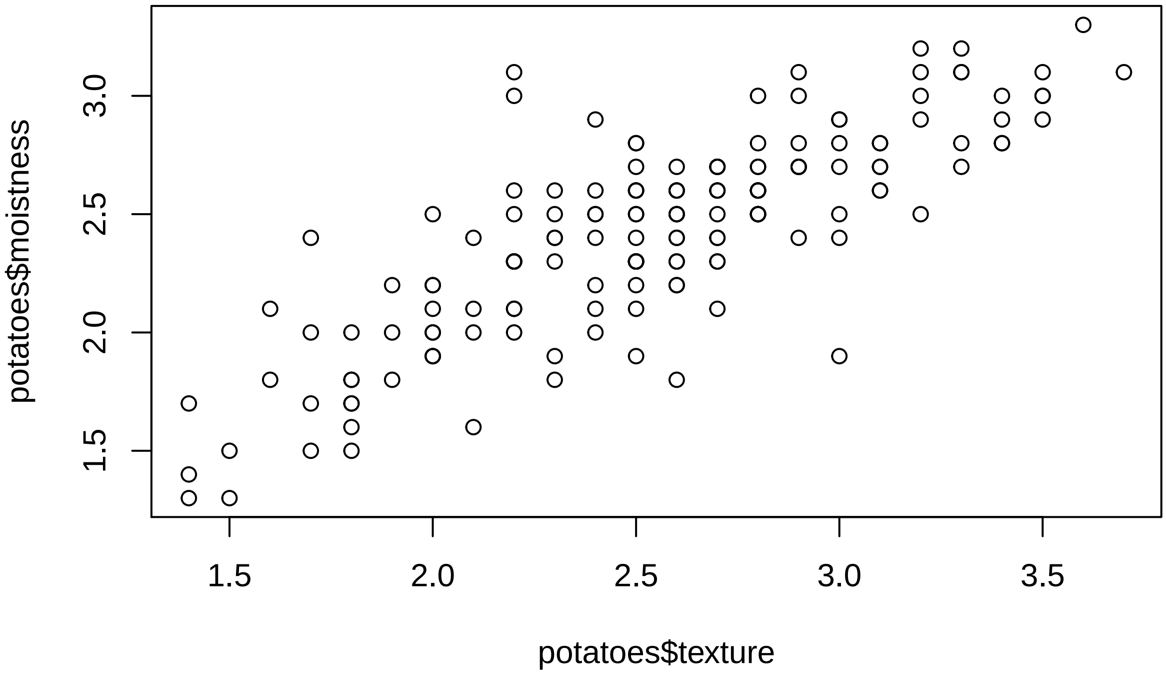
```
# load the data.table package
library(data.table)

# Import potatoes.csv with fread(): potatoes
potatoes <- fread("potatoes.csv")
```

The parameters drop and select can be used to drop or select variables from the data. The function plot is used to, you guessed it, create a scatter plot of moistness over texture.

```
potatoes <- fread("potatoes.csv",select= c(6,8))

# Plot texture (x) and moistness (y) of potatoes
plot( potatoes$texture,   potatoes$moistness)
```



The package readxl is used to load data from xlsx and xls files. The function excel_sheets lists all the sheets from the excel file specified.

```
# Load the readxl package
library(readxl)

# Print the names of all worksheets
excel_sheets("urbanpop.xlsx")
```

```
## [1] "1960-1966" "1967-1974" "1975-2011"
```

After figuring out which sheets we want to import, the next thing to do is to use read_excel to actually import the data. By setting the sheet parameter we can specify which sheets should be imported. In the example below three sheets are read and then combined to a list.

```
# Read the sheets, one by one
pop_1 <- read_excel("urbanpop.xlsx", sheet = 1)
pop_2 <- read_excel("urbanpop.xlsx", sheet = 2)
pop_3 <- read_excel("urbanpop.xlsx", sheet = 3)

# Put pop_1, pop_2 and pop_3 in a list: pop_list
pop_list <- list(pop_1,pop_2, pop_3)

# Display the structure of pop_list
str(pop_list)
```

```
## List of 3
##  $ : tibble [209 x 8] (S3: tbl_df/tbl/data.frame)
##   ..$ country: chr [1:209] "Afghanistan" "Albania" "Algeria" "American Samoa" ...
##   ..$ 1960   : num [1:209] 769308 494443 3293999 NA NA ...
##   ..$ 1961   : num [1:209] 814923 511803 3515148 13660 8724 ...
##   ..$ 1962   : num [1:209] 858522 529439 3739963 14166 9700 ...
##   ..$ 1963   : num [1:209] 903914 547377 3973289 14759 10748 ...
##   ..$ 1964   : num [1:209] 951226 565572 4220987 15396 11866 ...
##   ..$ 1965   : num [1:209] 1000582 583983 4488176 16045 13053 ...
##   ..$ 1966   : num [1:209] 1058743 602512 4649105 16693 14217 ...
##  $ : tibble [209 x 9] (S3: tbl_df/tbl/data.frame)
##   ..$ country: chr [1:209] "Afghanistan" "Albania" "Algeria" "American Samoa" ...
##   ..$ 1967   : num [1:209] 1119067 621180 4826104 17349 15440 ...
##   ..$ 1968   : num [1:209] 1182159 639964 5017299 17996 16727 ...
##   ..$ 1969   : num [1:209] 1248901 658853 5219332 18619 18088 ...
##   ..$ 1970   : num [1:209] 1319849 677839 5429743 19206 19529 ...
##   ..$ 1971   : num [1:209] 1409001 698932 5619042 19752 20929 ...
##   ..$ 1972   : num [1:209] 1502402 720207 5815734 20263 22406 ...
##   ..$ 1973   : num [1:209] 1598835 741681 6020647 20742 23937 ...
##   ..$ 1974   : num [1:209] 1696445 763385 6235114 21194 25482 ...
##  $ : tibble [209 x 38] (S3: tbl_df/tbl/data.frame)
##   ..$ country: chr [1:209] "Afghanistan" "Albania" "Algeria" "American Samoa" ...
##   ..$ 1975   : num [1:209] 1793266 785350 6460138 21632 27019 ...
##   ..$ 1976   : num [1:209] 1905033 807990 6774099 22047 28366 ...
##   ..$ 1977   : num [1:209] 2021308 830959 7102902 22452 29677 ...
##   ..$ 1978   : num [1:209] 2142248 854262 7447728 22899 31037 ...
##   ..$ 1979   : num [1:209] 2268015 877898 7810073 23457 32572 ...
##   ..$ 1980   : num [1:209] 2398775 901884 8190772 24177 34366 ...
##   ..$ 1981   : num [1:209] 2493265 927224 8637724 25173 36356 ...
##   ..$ 1982   : num [1:209] 2590846 952447 9105820 26342 38618 ...
##   ..$ 1983   : num [1:209] 2691612 978476 9591900 27655 40983 ...
##   ..$ 1984   : num [1:209] 2795656 1006613 10091289 29062 43207 ...
##   ..$ 1985   : num [1:209] 2903078 1037541 10600112 30524 45119 ...
##   ..$ 1986   : num [1:209] 3006983 1072365 11101757 32014 46254 ...
##   ..$ 1987   : num [1:209] 3113957 1109954 11609104 33548 47019 ...
##   ..$ 1988   : num [1:209] 3224082 1146633 12122941 35095 47669 ...
##   ..$ 1989   : num [1:209] 3337444 1177286 12645263 36618 48577 ...
##   ..$ 1990   : num [1:209] 3454129 1198293 13177079 38088 49982 ...
##   ..$ 1991   : num [1:209] 3617842 1215445 13708813 39600 51972 ...
##   ..$ 1992   : num [1:209] 3788685 1222544 14248297 41049 54469 ...
##   ..$ 1993   : num [1:209] 3966956 1222812 14789176 42443 57079 ...
##   ..$ 1994   : num [1:209] 4152960 1221364 15322651 43798 59243 ...
##   ..$ 1995   : num [1:209] 4347018 1222234 15842442 45129 60598 ...
##   ..$ 1996   : num [1:209] 4531285 1228760 16395553 46343 60927 ...
##   ..$ 1997   : num [1:209] 4722603 1238090 16935451 47527 60462 ...
##   ..$ 1998   : num [1:209] 4921227 1250366 17469200 48705 59685 ...
##   ..$ 1999   : num [1:209] 5127421 1265195 18007937 49906 59281 ...
##   ..$ 2000   : num [1:209] 5341456 1282223 18560597 51151 59719 ...
##   ..$ 2001   : num [1:209] 5564492 1315690 19198872 52341 61062 ...
##   ..$ 2002   : num [1:209] 5795940 1352278 19854835 53583 63212 ...
##   ..$ 2003   : num [1:209] 6036100 1391143 20529356 54864 65802 ...
##   ..$ 2004   : num [1:209] 6285281 1430918 21222198 56166 68301 ...
##   ..$ 2005   : num [1:209] 6543804 1470488 21932978 57474 70329 ...
##   ..$ 2006   : num [1:209] 6812538 1512255 22625052 58679 71726 ...
##   ..$ 2007   : num [1:209] 7091245 1553491 23335543 59894 72684 ...
##   ..$ 2008   : num [1:209] 7380272 1594351 24061749 61118 73335 ...
##   ..$ 2009   : num [1:209] 7679982 1635262 24799591 62357 73897 ...
##   ..$ 2010   : num [1:209] 7990746 1676545 25545622 63616 74525 ...
##   ..$ 2011   : num [1:209] 8316976 1716842 26216968 64817 75207 ...
```

Loading in every sheet one-by-one is exhausting. lapply automates that procedure and imports all sheets with one line of code.

```
pop_list <- lapply(excel_sheets("urbanpop.xlsx"), read_excel, path = "urbanpop.xlsx")
# Display the structure of pop_list
str(pop_list)
```

```
## List of 3
##  $ : tibble [209 x 8] (S3: tbl_df/tbl/data.frame)
##   ..$ country: chr [1:209] "Afghanistan" "Albania" "Algeria" "American Samoa" ...
##   ..$ 1960   : num [1:209] 769308 494443 3293999 NA NA ...
##   ..$ 1961   : num [1:209] 814923 511803 3515148 13660 8724 ...
##   ..$ 1962   : num [1:209] 858522 529439 3739963 14166 9700 ...
##   ..$ 1963   : num [1:209] 903914 547377 3973289 14759 10748 ...
##   ..$ 1964   : num [1:209] 951226 565572 4220987 15396 11866 ...
##   ..$ 1965   : num [1:209] 1000582 583983 4488176 16045 13053 ...
##   ..$ 1966   : num [1:209] 1058743 602512 4649105 16693 14217 ...
##  $ : tibble [209 x 9] (S3: tbl_df/tbl/data.frame)
##   ..$ country: chr [1:209] "Afghanistan" "Albania" "Algeria" "American Samoa" ...
##   ..$ 1967   : num [1:209] 1119067 621180 4826104 17349 15440 ...
##   ..$ 1968   : num [1:209] 1182159 639964 5017299 17996 16727 ...
##   ..$ 1969   : num [1:209] 1248901 658853 5219332 18619 18088 ...
##   ..$ 1970   : num [1:209] 1319849 677839 5429743 19206 19529 ...
##   ..$ 1971   : num [1:209] 1409001 698932 5619042 19752 20929 ...
##   ..$ 1972   : num [1:209] 1502402 720207 5815734 20263 22406 ...
##   ..$ 1973   : num [1:209] 1598835 741681 6020647 20742 23937 ...
##   ..$ 1974   : num [1:209] 1696445 763385 6235114 21194 25482 ...
##  $ : tibble [209 x 38] (S3: tbl_df/tbl/data.frame)
##   ..$ country: chr [1:209] "Afghanistan" "Albania" "Algeria" "American Samoa" ...
##   ..$ 1975   : num [1:209] 1793266 785350 6460138 21632 27019 ...
##   ..$ 1976   : num [1:209] 1905033 807990 6774099 22047 28366 ...
##   ..$ 1977   : num [1:209] 2021308 830959 7102902 22452 29677 ...
##   ..$ 1978   : num [1:209] 2142248 854262 7447728 22899 31037 ...
##   ..$ 1979   : num [1:209] 2268015 877898 7810073 23457 32572 ...
##   ..$ 1980   : num [1:209] 2398775 901884 8190772 24177 34366 ...
##   ..$ 1981   : num [1:209] 2493265 927224 8637724 25173 36356 ...
##   ..$ 1982   : num [1:209] 2590846 952447 9105820 26342 38618 ...
##   ..$ 1983   : num [1:209] 2691612 978476 9591900 27655 40983 ...
##   ..$ 1984   : num [1:209] 2795656 1006613 10091289 29062 43207 ...
##   ..$ 1985   : num [1:209] 2903078 1037541 10600112 30524 45119 ...
##   ..$ 1986   : num [1:209] 3006983 1072365 11101757 32014 46254 ...
##   ..$ 1987   : num [1:209] 3113957 1109954 11609104 33548 47019 ...
##   ..$ 1988   : num [1:209] 3224082 1146633 12122941 35095 47669 ...
##   ..$ 1989   : num [1:209] 3337444 1177286 12645263 36618 48577 ...
##   ..$ 1990   : num [1:209] 3454129 1198293 13177079 38088 49982 ...
##   ..$ 1991   : num [1:209] 3617842 1215445 13708813 39600 51972 ...
##   ..$ 1992   : num [1:209] 3788685 1222544 14248297 41049 54469 ...
##   ..$ 1993   : num [1:209] 3966956 1222812 14789176 42443 57079 ...
##   ..$ 1994   : num [1:209] 4152960 1221364 15322651 43798 59243 ...
##   ..$ 1995   : num [1:209] 4347018 1222234 15842442 45129 60598 ...
##   ..$ 1996   : num [1:209] 4531285 1228760 16395553 46343 60927 ...
##   ..$ 1997   : num [1:209] 4722603 1238090 16935451 47527 60462 ...
##   ..$ 1998   : num [1:209] 4921227 1250366 17469200 48705 59685 ...
##   ..$ 1999   : num [1:209] 5127421 1265195 18007937 49906 59281 ...
##   ..$ 2000   : num [1:209] 5341456 1282223 18560597 51151 59719 ...
##   ..$ 2001   : num [1:209] 5564492 1315690 19198872 52341 61062 ...
##   ..$ 2002   : num [1:209] 5795940 1352278 19854835 53583 63212 ...
##   ..$ 2003   : num [1:209] 6036100 1391143 20529356 54864 65802 ...
##   ..$ 2004   : num [1:209] 6285281 1430918 21222198 56166 68301 ...
##   ..$ 2005   : num [1:209] 6543804 1470488 21932978 57474 70329 ...
##   ..$ 2006   : num [1:209] 6812538 1512255 22625052 58679 71726 ...
##   ..$ 2007   : num [1:209] 7091245 1553491 23335543 59894 72684 ...
##   ..$ 2008   : num [1:209] 7380272 1594351 24061749 61118 73335 ...
##   ..$ 2009   : num [1:209] 7679982 1635262 24799591 62357 73897 ...
##   ..$ 2010   : num [1:209] 7990746 1676545 25545622 63616 74525 ...
##   ..$ 2011   : num [1:209] 8316976 1716842 26216968 64817 75207 ...
```

The parameter col_names is used to specify the header, i.e., the column names, for the data frame. It can also be set to TRUE which results in the first line being read as header information or FALSE, in which case read_excel comes up with column names on its own.

```
cols <- c("country", paste0("year_", 1960:1966))
pop_b <- read_excel("urbanpop_nonames.xlsx", col_names = cols)
```

Like with readr, the skip parameter can be specified to skip the first couple of lines of a certain sheet.

```
urbanpop_sel <- read_excel("urbanpop.xlsx",col_names = FALSE,sheet=2, skip = 21)
```

```
## New names:
## * `` -> ...1
## * `` -> ...2
## * `` -> ...3
## * `` -> ...4
## * `` -> ...5
## * ...
```

The gdata package extends R with many data manipulation functions. It is another option for reading in .xls files.

```
library(gdata)
```

```
## gdata: read.xls support for 'XLS' (Excel 97-2004) files ENABLED.

##

## gdata: read.xls support for 'XLSX' (Excel 2007+) files ENABLED.

##
## Attaching package: 'gdata'

## The following objects are masked from 'package:data.table':
##
##     first, last

## The following object is masked from 'package:stats':
##
##     nobs

## The following object is masked from 'package:utils':
##
##     object.size
## The following object is masked from 'package:base':
##
##     startsWith
```

```
# Import the second sheet of urbanpop.xls: urban_pop
urban_pop <- read.xls("urbanpop.xls", sheet=2)

# Print the first 11 observations using head()
head(urban_pop, n = 11)
```

```
##                country       X1967       X1968       X1969       X1970
## 1          Afghanistan  1119067.20  1182159.06  1248900.79  1319848.78
## 2              Albania   621179.85   639964.46   658853.12   677839.12
## 3              Algeria  4826104.22  5017298.60  5219331.87  5429743.08
## 4       American Samoa    17348.66    17995.51    18618.68    19206.39
## 5              Andorra    15439.62    16726.99    18088.32    19528.96
## 6               Angola   757496.32   798459.26   841261.96   886401.63
## 7  Antigua and Barbuda    22086.25    22149.39    22182.92    22180.87
## 8            Argentina 17753280.98 18124103.64 18510462.30 18918072.79
## 9              Armenia  1337032.09  1392892.13  1449641.49  1507619.77
## 10               Aruba    29414.72    29576.09    29737.87    29901.57
## 11           Australia  9934404.03 10153969.77 10412390.67 10664093.55
##          X1971       X1972       X1973       X1974
## 1   1409001.09  1502401.79  1598835.45  1696444.83
## 2    698932.25   720206.57   741681.04   763385.45
## 3   5619041.53  5815734.49  6020647.35  6235114.38
## 4     19752.02    20262.67    20741.97    21194.38
## 5     20928.73    22405.84    23937.05    25481.98
## 6    955010.09  1027397.35  1103829.78  1184486.23
## 7     22560.87    22907.76    23221.29    23502.92
## 8  19329718.16 19763078.00 20211424.85 20664728.90
## 9   1564367.60  1622103.53  1680497.75  1739063.02
## 10    30081.36    30279.76    30467.42    30602.87
## 11 11047706.39 11269945.50 11461120.68 11772934.25
```

Due to the underlying implementation of read.xls based on read.csv enables us to use all the previously discussed read.csv options for read.xls, like stringsAsFactors, col.names, skip and many more.

```
columns <- c("country", paste0("year_", 1967:1974))

# Finish the read.xls call
urban_pop <- read.xls("urbanpop.xls", sheet = 2,
                      skip = 50, header = FALSE, stringsAsFactors = FALSE,
                      col.names = columns)

# Print first 10 observation of urban_pop
head(urban_pop, n=10)
```

```
##               country  year_1967  year_1968  year_1969  year_1970
## 1              Cyprus  231929.74  237831.38  243983.34  250164.52
## 2      Czech Republic 6204409.91 6266304.50 6326368.97 6348794.89
## 3             Denmark 3777552.62 3826785.08 3874313.99 3930042.97
## 4            Djibouti   77788.04   84694.35   92045.77   99845.22
## 5            Dominica   27550.36   29527.32   31475.62   33328.25
## 6  Dominican Republic 1535485.43 1625455.76 1718315.40 1814060.00
## 7             Ecuador 2059355.12 2151395.14 2246890.79 2345864.41
## 8               Egypt 13798171.00 14248342.19 14703858.22 15162858.52
## 9         El Salvador  1345528.98  1387218.33  1429378.98  1472181.26
## 10  Equatorial Guinea    75364.50    77295.03    78445.74    78411.07
##      year_1971   year_1972   year_1973   year_1974
## 1    261213.21   272407.99   283774.90   295379.83
## 2   6437055.17  6572632.32  6718465.53  6873458.18
## 3   3981360.12  4028247.92  4076867.28  4120201.43
## 4    107799.69   116098.23   125391.58   136606.25
## 5     34761.52    36049.99    37260.05    38501.47
## 6   1915590.38  2020157.01  2127714.45  2238203.87
## 7   2453817.78  2565644.81  2681525.25  2801692.62
## 8  15603661.36 16047814.69 16498633.27 16960827.93
## 9   1527985.34  1584758.18  1642098.95  1699470.87
## 10    77055.29    74596.06    71438.96    68179.26
```

In this exercise cbind is used to combine the first three sheets of urbanpop.xls, omitting the first columns in sheet 2 and 3. Then na.omit is used to remove all observations that contain NA values. Then, a summary of the combined and cleaned data is printed with the function summary.

```r
path <- "urbanpop.xls"
urban_sheet1 <- read.xls(path, sheet = 1, stringsAsFactors = FALSE)
urban_sheet2 <- read.xls(path, sheet = 2, stringsAsFactors = FALSE)
urban_sheet3 <- read.xls(path, sheet = 3, stringsAsFactors = FALSE)

# Extend the cbind() call to include urban_sheet3: urban
urban <- cbind(urban_sheet1, urban_sheet2[-1], urban_sheet3[-1])

# Remove all rows with NAs from urban: urban_clean
urban_clean <- na.omit(urban)
```

Reproducible Excel work with XLConnect

XLConnect is used as bridge between an excel file and R. In contrast to the previously discussed approaches, the excel file is changed when the data is altered in R. In contrast to readxl and gdata, XLConnect establishes an interface to the file and edits your files from inside R.

```r
# urbanpop.xlsx is available in your working directory

# Load the XLConnect package
library("XLConnect")
```

```
## XLConnect 1.0.2 by Mirai Solutions GmbH [aut],
##   Martin Studer [cre],
##   The Apache Software Foundation [ctb, cph] (Apache POI),
##   Graph Builder [ctb, cph] (Curvesapi Java library)

## https://mirai-solutions.ch
## https://github.com/miraisolutions/xlconnect
```

```r
# Build connection to urbanpop.xlsx: my_book
my_book = loadWorkbook("urbanpop.xlsx")

# Print out the class of my_book
class(my_book)
```

```
## [1] "workbook"
## attr(,"package")
## [1] "XLConnect"
```

getSheets is used to list all sheets from the excel file, while the function readWorksheet can then be used to read in the specified sheet.

```
my_book <- loadWorkbook("urbanpop.xlsx")

# List the sheets in my_book
getSheets(my_book)
```

```
## [1] "1960-1966" "1967-1974" "1975-2011"
```

```
# Import the second sheet in my_book
sheet_2 = readWorksheet(my_book, sheet=2)
```

The parameters startCol and endCol can be set to specify which columns to import. Cbind is used in the example below to combine sheets.

```
# Build connection to urbanpop.xlsx
my_book <- loadWorkbook("urbanpop.xlsx")

# Import columns 3, 4, and 5 from second sheet in my_book: urbanpop_sel
urbanpop_sel <- readWorksheet(my_book, sheet = 2, startCol=3, endCol=5)

# Import first column from second sheet in my_book: countries
countries = readWorksheet(my_book, sheet=2, startCol=1, endCol=1)

# cbind() urbanpop_sel and countries together: selection
selection = cbind(countries, urbanpop_sel)
```

Using the function createSheet we can create new sheets in the excel file. This would not have been possible with the previous approaches.

```
# Build connection to urbanpop.xlsx
my_book <- loadWorkbook("urbanpop.xlsx")

# Add a worksheet to my_book, named "data_summary"
createSheet(my_book, "data_summary")

# Use getSheets() on my_book
getSheets(my_book)
```

```
## [1] "1960-1966"    "1967-1974"    "1975-2011"    "data_summary"
```

This exercise teaches us how to write to a sheet of a Worksheet object. Then we save the current Worksheet to a file called summary.xlsx.

```
# Create data frame: summ
sheets <- getSheets(my_book)[1:3]
dims <- sapply(sheets, function(x) dim(readWorksheet(my_book, sheet = x)), USE.NAMES = FALSE)
summ <- data.frame(sheets = sheets,
                   nrows = dims[1, ],
                   ncols = dims[2, ])

# Add data in summ to "data_summary" sheet
writeWorksheet(my_book, summ, "data_summary")
```

```
# Save workbook as summary.xlsx
saveWorkbook(my_book, "summary.xlsx")
```

The function renameSheet can be used to rename sheets. In the example below the sheet data_summary of my_book is renamed to summary.

```
renameSheet(my_book, "data_summary", "summary")
saveWorkbook(my_book, "renamed.xlsx")
```

The function removeSheet is used to remove a sheet from the specified workbook. The sheet can be either determined by giving an index or the name of the sheet, like below.

```
removeSheet(my_book, "summary")
saveWorkbook(my_book, "clean.xlsx")
```