

Problem Set 3

Andreas Bender, Philipp Kopper, Philip Studener

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Resources

Read chapter 3 and 5 in The Art of R Programming. You can leave out the Extended Examples once again and Section 5.3.

Keyboard Shortcuts

Try incorporating the following shortcuts into your workflow for this weeks exercise sheet:

(On Mac you can replace CTRL with CMD but don't have to)

Shortcut	What does it do?
CTRL + Shift + N	opens new R-Script file
F1	Go to function help page (cursor over function)
F2	Get function code in new tab
CTRL + Shift + F	Search for keyword in all files in your directory

Exercise 1

Consider the `bundesliga` vector from the first exercise sheet.

```
bundesliga <- c(
  "FC Bayern"      = 55L,
  "BVB"            = 51L,
  "RB Leipzig"     = 50L,
  "Borussia MGB"   = 49L,
  "Bayer 04"       = 47L,
  "FC Schalke 04"  = 37L,
  "VfL Wolfsburg"  = 36L,
  "SC Freiburg"    = 36L,
  "TSG Hoffenheim" = 35L,
  "1. FC Köln"     = 32L,
  "Union Berlin"   = 30L,
  "Eintracht Frankfurt" = 28L,
  "Hertha Berlin"  = 28L,
  "FC Augsburg"    = 27L,
  "Mainz 05"       = 26L,
  "Fortuna Duesseldorf" = 22L,
  "Werder Bremen"  = 18L,
  "SC Paderborn"   = 16L)
```

- a. Convert the `bundesliga` vector to a matrix with one column and 18 rows. Store this matrix in an object called `bundesliga_mat` (*Hint: ARP, Section 3.1*). The resulting matrix is given below:

```
bundesliga_mat
```

```
##      [,1]
## [1,]  55
## [2,]  51
## [3,]  50
## [4,]  49
## [5,]  47
## [6,]  37
## [7,]  36
## [8,]  36
## [9,]  35
## [10,] 32
## [11,] 30
## [12,] 28
## [13,] 28
## [14,] 27
## [15,] 26
## [16,] 22
## [17,] 18
## [18,] 16
```

- b. What is the data type of `bundesliga_mat`. What is its class?
- c. Extract the points for the first 3 teams from this matrix. Then extract the last three teams. Store them in the objects `first3` and `last3` respectively (*Hint: ARP, Section 3.2. Also consider PS01, E2 and think about the equivalent of `length` for matrices (e.g. ARP, Section 3.5)*). The resulting output is given below:

```
first3
```

```
## [1] 55 51 50
```

```
last3
```

```
## [1] 22 18 16
```

- d. What is the data type of `first3` and `last3`. What is their class.
- e. Repeat c., but make sure, that the class of `first3` and `last3` remains a matrix (*Hint: See `?"["` and ARP, Section 3.6*).
- f. Currently, `bundesliga_mat` only contains the information about the points, but not the team that collected them. Create a copy of `bundesliga_mat` called `bundesliga_mat2`. Store the team names as row names in `bundesliga_mat2` (*Hint: ARP, Section 3.7*). The resulting output is given below:

```
bundesliga_mat2
```

```
##      [,1]
## FC Bayern      55
## BVB             51
## RB Leipzig     50
## Borussia MGB    49
## Bayer 04        47
## FC Schalke 04   37
## VfL Wolfsburg   36
## SC Freiburg     36
```

```
## TSG Hoffenheim      35
## 1. FC Köln          32
## Union Berlin        30
## Eintracht Frankfurt 28
## Hertha Berlin       28
## FC Augsburg         27
## Mainz 05            26
## Fortuna Duesseldorf 22
## Werder Bremen       18
## SC Paderborn        16
```

g. Is data type, class or dimension (`?dim`) of `bundesliga_mat` different then the one of `bundesliga_mat2`?

h. Create another copy of `bundesliga_mat` called `bundesliga_mat3`. Add a second column to this matrix that contains the teams rank (“Tabellenplatz”) names (*Hint*: ARP, Section 3.4.1). The resulting output is given below:

```
bundesliga_mat3
```

```
##      [,1] [,2]
## [1,]  55   1
## [2,]  51   2
## [3,]  50   3
## [4,]  49   4
## [5,]  47   5
## [6,]  37   6
## [7,]  36   7
## [8,]  36   8
## [9,]  35   9
## [10,] 32  10
## [11,] 30  11
## [12,] 28  12
## [13,] 28  13
## [14,] 27  14
## [15,] 26  15
## [16,] 22  16
## [17,] 18  17
## [18,] 16  18
```

i. What is the data type, class and dimension of `bundesliga_mat3`?

j. Add a third column to `bundesliga_mat3`, that indicates in which German federal state the team is located. The `states` vector and the resulting output are given below:

```
c("BAY", "NRW", "SXN", "NRW", "NRW", "NRW", "NSX", "BWB", "BWB", "NRW", "BER", "HES",
  "BER", "BAY", "RLP", "NRW", "BRE", "NRW")
```

```
bundesliga_mat3
```

```
##      [,1] [,2] [,3]
## [1,] "55" "1"  "BAY"
## [2,] "51" "2"  "NRW"
## [3,] "50" "3"  "SXN"
## [4,] "49" "4"  "NRW"
## [5,] "47" "5"  "NRW"
## [6,] "37" "6"  "NRW"
## [7,] "36" "7"  "NSX"
## [8,] "36" "8"  "BWB"
```

```
## [9,] "35" "9" "BWB"
## [10,] "32" "10" "NRW"
## [11,] "30" "11" "BER"
## [12,] "28" "12" "HES"
## [13,] "28" "13" "BER"
## [14,] "27" "14" "BAY"
## [15,] "26" "15" "RLP"
## [16,] "22" "16" "NRW"
## [17,] "18" "17" "BRE"
## [18,] "16" "18" "NRW"
```

k. What is the data type, class and dimension of `bundesliga_mat3`? What changed compared to `bundesliga_mat` and `bundesliga_mat2` and why? Discuss why this is not a desirable behaviour.

l. Currently, `bundesliga_mat3` doesn't have column names. Add column names "points", "rank" and "state" to the matrix. The resulting output is given below:

```
bundesliga_mat3
```

```
##      points rank state
## [1,] "55"    "1" "BAY"
## [2,] "51"    "2" "NRW"
## [3,] "50"    "3" "SXN"
## [4,] "49"    "4" "NRW"
## [5,] "47"    "5" "NRW"
## [6,] "37"    "6" "NRW"
## [7,] "36"    "7" "NSX"
## [8,] "36"    "8" "BWB"
## [9,] "35"    "9" "BWB"
## [10,] "32"   "10" "NRW"
## [11,] "30"   "11" "BER"
## [12,] "28"   "12" "HES"
## [13,] "28"   "13" "BER"
## [14,] "27"   "14" "BAY"
## [15,] "26"   "15" "RLP"
## [16,] "22"   "16" "NRW"
## [17,] "18"   "17" "BRE"
## [18,] "16"   "18" "NRW"
```

m. To overcome the problem in k., convert `bundesliga_mat3` to a `data.frame` by applying the function `as.data.frame` and store the result in object `bundesliga_df`.

```
bundesliga_df
```

```
##      points rank state
## 1         55     1   BAY
## 2         51     2  NRW
## 3         50     3  SXN
## 4         49     4  NRW
## 5         47     5  NRW
## 6         37     6  NRW
## 7         36     7  NSX
## 8         36     8  BWB
## 9         35     9  BWB
## 10        32    10  NRW
## 11        30    11  BER
## 12        28    12  HES
```

```
## 13      28   13   BER
## 14      27   14   BAY
## 15      26   15   RLP
## 16      22   16   NRW
## 17      18   17   BRE
## 18      16   18   NRW
```

n. What is the data type, class and dimension of `bundesliga_df`?

o. Use the `apply` function in order to extract the class of each column in `bundesliga_df` (*Hint*: ARP, Section 3.3.1 and 5.2.4). The resulting output is given below:

```
##      points      rank      state
## "character" "character" "character"
```

p. Internally, `data.frame` objects are stored as lists. Individual components of the list (columns in this case), can therefore be manipulated and overwritten the same way as list components (see ARP, Section 4.2.2). Use this knowledge to add two new columns to `bundesliga_df` that contain the points and rank as integer, rather than character. Call them `points_int` and `rank_int`. Delete the columns `points` and `rank`. The resulting output is shown below

```
bundesliga_df
```

```
##      state points_int rank_int
## 1      BAY          55         1
## 2      NRW          51         2
## 3      SXN          50         3
## 4      NRW          49         4
## 5      NRW          47         5
## 6      NRW          37         6
## 7      NSX          36         7
## 8      BWB          36         8
## 9      BWB          35         9
## 10     NRW          32        10
## 11     BER          30        11
## 12     HES          28        12
## 13     BER          28        13
## 14     BAY          27        14
## 15     RLP          26        15
## 16     NRW          22        16
## 17     BRE          18        17
## 18     NRW          16        18
```

```
str(bundesliga_df)
```

```
## 'data.frame':   18 obs. of  3 variables:
## $ state      : chr  "BAY" "NRW" "SXN" "NRW" ...
## $ points_int: int   55 51 50 49 47 37 36 36 35 32 ...
## $ rank_int   : int   1 2 3 4 5 6 7 8 9 10 ...
```

q. Repeat o. to check the class of the columns of `bundesliga_df`. Discuss with us during the live-sessions why this contradicts the output of `str(bundesliga_df)`.

Exercise 2

Create the following data frame (*Hint*: ARP, Section 5.1). Call the data frame `df`.

```
df
```

```
##      name age height weight gender
## 1   Alex  25   177    57      D
## 2   Lilly 31   163    69      F
## 3    Mark 23   190    83      M
## 4  Oliver 52   179    75      M
## 5  Martha 76   163    70      F
## 6   Lucas 49   183    83      M
## 7 Caroline 26   164    53      F
```

```
str(df)
```

```
## 'data.frame':  7 obs. of  5 variables:
## $ name   : chr  "Alex" "Lilly" "Mark" "Oliver" ...
## $ age    : num  25 31 23 52 76 49 26
## $ height: num  177 163 190 179 163 183 164
## $ weight: num   57 69 83 75 70 83 53
## $ gender: chr   "D" "F" "M" "M" ...
```

- The variable `gender` should be of class factor. Change the variable accordingly if necessary and change the levels to `female`, `male` and `diverse` instead of `F`, `M` and `D`.
- Create a data frame that contains the column `working`, that indicates whether the person has a job ("Yes") or not ("No"). Call the data frame `df2`. The expected output is given below:

```
df2
```

```
##    working
## 1     Yes
## 2     No
## 3     No
## 4     Yes
## 5     Yes
## 6     No
## 7     Yes
```

- Combine the two data frames `df` and `df2` columnwise. Store the result in object `df3`. The resulting output is given below:

```
##      name age height weight gender working
## 1   Alex  25   177    57      D     Yes
## 2   Lilly 31   163    69      F     No
## 3    Mark 23   190    83      M     No
## 4  Oliver 52   179    75      M     Yes
## 5  Martha 76   163    70      F     Yes
## 6   Lucas 49   183    83      M     No
## 7 Caroline 26   164    53      F     Yes
```

- Transform the `working` column to type `logical`, that contains `TRUE` if the person is working (Yes), and `FALSE` if the person is not working (No)).
- How many rows and columns does `df3` have?
- What data type and class is each column? *Hint*: Use `sapply`, ARP, Section 4.4.1 (remember, columns of data frames are equivalent to components of lists)

- g. Create a new column `bmi` for which you calculate the BMI for each person (see <https://de.wikipedia.org/wiki/Body-Mass-Index>).
- h. Create a subset of `df3` that only contains entries of males. Call it `males_df` (*Hint*: ARP, Section 5.2.1).
- i. Print out all the rows in `males_df` which have a `bmi` over 23.
- j. Print out a subset of `males_df` that only contains the columns `name` and `bmi`.

```
sessionInfo()
```

```
## R version 4.3.0 (2023-04-21)
## Platform: x86_64-apple-darwin20 (64-bit)
## Running under: macOS Big Sur 11.7.10
##
## Matrix products: default
## BLAS:   /Library/Frameworks/R.framework/Versions/4.3-x86_64/Resources/lib/libRblas.0.dylib
## LAPACK: /Library/Frameworks/R.framework/Versions/4.3-x86_64/Resources/lib/libRlapack.dylib; LAPACK
##
## locale:
## [1] en_US.UTF-8/en_US.UTF-8/en_US.UTF-8/C/en_US.UTF-8/en_US.UTF-8
##
## time zone: Europe/Berlin
## tzcode source: internal
##
## attached base packages:
## [1] stats      graphics  grDevices  utils      datasets  methods   base
##
## loaded via a namespace (and not attached):
## [1] compiler_4.3.0 fastmap_1.1.1 cli_3.6.1      tools_4.3.0
## [5] htmltools_0.5.5 rstudioapi_0.14 yaml_2.3.7     rmarkdown_2.21
## [9] knitr_1.43      xfun_0.39      digest_0.6.31  rlang_1.1.1
## [13] evaluate_0.21
```