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Practice sheet 3 **Practice R, part 2** due on 2018-05-06

Preface

On this sheet, you will get to know some more functions for data analysis with R, especially those for time-related operations and graphic illustrations.

We continue working with the data sets `jikes.tsv`, `junit.tsv`, `zile.tsv` that you already know from the previous practice sheet.

Remember that the primary goal is not to deliver working R implementations, but to provide insights into the three projects the data comes from.

Task 3-1: Data manipulation

a) So far, the time stamp `tstamp` in your imported data sets (e.g., `junit`) is only available as a string. To enable date-related operations in R, it needs to be converted into a `POSIXct` object.[1] (Functions needed: `as.POSIXct`)

Add the converted variable as `tstamp2` to the data set (most easily done with `$`).

b) Now add the time stamp in the Unix format (i.e., number of seconds since 1970-01-01) as `tstamp3`. Quite often, this is more convenient when doing calculations involving dates and times. (Function needed: `as.numeric`)

c) Understand and explain the ways in which these two representations differ.

- Look at the elements of `tstamp2` and understand how the objects' representation on the screen is realized. Use `mode` and `class` to learn more about the objects.
- Calculate the difference between two time stamps from `tstamp2` and do the same calculation, but use the corresponding values (=same index) from `tstamp3` (e.g. using `diff` or just a simple `-`).
- Understand and explain the difference in how the two time differences are displayed. (Functions: `print.default`, `class` and `?difftime`)

d) Examine the time variations of the developers' activities during the course of the days and throughout the week.

- Extract the respective weekday from `tstamp2` and add it to your data frame as a factor named `wday`. Do the same for the hour add it your data frame as a factor named `hour`. (Functions: `as.POSIXlt` and `$` on its result, `factor`)
- Pre-define the `factors` levels (using the `levels` argument). This allows you to "count" zero occurrences (e.g., as are the hours 3 to 14, or *Tuesday* in the JUnit20 subset).

Now examine the sum of activities at each hour (0–23, disregarding the date) and on each weekday (Sunday–Saturday, disregarding the hour). Possible questions include: *Where are the minimum and maximum values (i.e., hours/weekdays of particularly high or low activity)? How much smaller or bigger are peak values compared to the average?* Investigate further questions. (Helpful functions: `summary`, `table`, indexing)

Characterize the three projects based on their activity "fingerprints". What conclusion can you draw about these projects based on this?

Since you now have written some functionality which enhances your data to make subsequent analyses easier, you should include the code for adding `tstamp2`, `tstamp3`, `wday`, and `hour` to your data frame in your existing `myread.cvsdata` function, and include the new implementation in your submission.

[1] For a better understanding you may use the following sources: `?DateTimeClasses` and the article on date-time classes by Brian D. Ripley and Kurt Hornik in the R-News Volume 1/2, June 2001 (http://cran.r-project.org/doc/Rnews/Rnews_2001-2.pdf#chapter*.12)

Task 3-2: Plotting data

a) Visualize the hourly and weekly activities calculated in Task **3-1 d)**. (Function: `plot`)

- `plot` is an object-oriented function (as is `print`, which is always implicitly applied to each command's result). There are separate versions of `plot` for many different types of objects.
  Get an overview with the help of `methods(plot)` and read up on the documentation of three `plot` functions you consider interesting. What did you learn?
- Try both `plot.table` and `plot.factor` to illustrate the weekday activities.
- Assign real short names to the weekdays by using the `labels` argument of `factor` (you may want to amend your `myread.cvsdata` function).
- Can you refine your project characterizations in terms their activity profile throughout the day and the week, respectively?

b) Get an overview of the distribution of the number of lines added or deleted per developer (variables `lines_add` and `lines_del`).

- Boxplots: Use `bwplot` with a formula like this one: `developer~log(lines_add+1, 2)`. Also use the arguments `varwidth` and `box.ratio` to improve the illustration. (Functions: `library(lattice)`, `bwplot`, `log`, `plot`, `table`, `?panel.bwplot`)
- Characterize the developers in each project. Possible questions include: *Are there developers who often add or delete particularly many lines?* or *Do the patch sizes vary particularly much or little?* Investigate other questions as well.
- Try at least one other formula for your boxplots (e.g., involving different variables), and discuss the results.

c) Get a more in-depth perspective on the same distributions (added and deleted lines) with the help of a density plot. It illustrates the frequency distribution with a curve.

- Here, the formula could be for instance `~log(lines_add+1,2)|developer`; also use the argument `width=1`. Read up on it and test its effect by trying different values. Explain what it is good for. (functions: `densityplot`, `log`)
- Try different formulas for your density plot and discuss the results. Alternatively: Compare the density plot to a histogram (function: `histogram`) and explain the differences.

d) Now, read at least the sections 1, 2.1, and 3.2.2 of the article *"Two Case Studies of Open Source Software Development: Apache and Mozilla"* by Mockus, Fielding, and Herbsleb (to be easily found on Google Scholar) to get an idea of its investigations.

- Understand the meaning of the values on the x-axis in Fig. 1 in section 3.2.2.
- Carry out an analysis with our data along the lines to the one in section 3.2.2 in Fig. 1. Compile corresponding images for our data sets.
- Use a linear scale on the x-axis.
- Each of your three images (one for each project) should contain three curves.
- Functions needed: `cumsum`, `length`, `lines`, `plot`, `sum`, `tapply`

Don't forget to interpret the results.

> Hint for **d)**: If you try it and don't succeed, you may skip this one, but only if you come up with (and execute) another idea for a non-trivial analysis on the same three data sets which involves in a (series of) plot(s). Don't forget to interpret your results.

Example outputs for `junit20.tsv`

Task 3-1

```
# Inspecting new variable tstamp2
junit20$tstamp2

##  [1] "2004-11-17 23:07:28 CET"  "2002-09-01 00:29:52 CEST"
##  [3] "2002-08-31 18:44:09 CEST" "2002-08-23 20:43:51 CEST"
##  [5] "2001-05-21 21:50:15 CEST" "2001-04-08 02:18:42 CEST"
##  [7] "2001-04-01 23:22:15 CEST" "2001-01-17 01:02:18 CET"
##  [9] "2001-01-10 00:39:50 CET"  "2000-12-03 15:36:14 CET"
## [11] "2000-12-03 15:36:14 CET"  "2004-11-17 23:47:23 CET"
## [13] "2004-11-13 01:33:00 CET"  "2002-08-31 18:44:09 CEST"
## [15] "2002-08-23 20:43:51 CEST" "2002-02-14 21:58:36 CET"
## [17] "2002-02-07 00:43:07 CET"  "2002-02-06 22:12:01 CET"
## [19] "2002-02-06 21:42:19 CET"  "2001-05-21 21:50:15 CEST"

# Inspecting new variable tstamp3
junit20$tstamp3

##  [1] 1100729248 1030832992 1030812249 1030128231  990474615  986689122
##  [7]  986160135  979689738  979083590  975854174  975854174 1100731643
## [13] 1100305980 1030812249 1030128231 1013720316 1013038987 1013029921
## [19] 1013028139  990474615

# Inspecting new variable wday
junit20$wday

##  [1] wed sun sat fri mon sun sun wed wed sun sun wed sat sat fri thu thu
## [18] wed wed mon
## Levels: sun mon tue wed thu fri sat

# Inspecting new variable hour
junit20$hour

##  [1] 23 0  18 20 21 2  23 1  0  15 15 23 1  18 20 21 0  22 21 21
## 24 Levels: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 ... 23
```

Raw hourly activity for `junit20`:

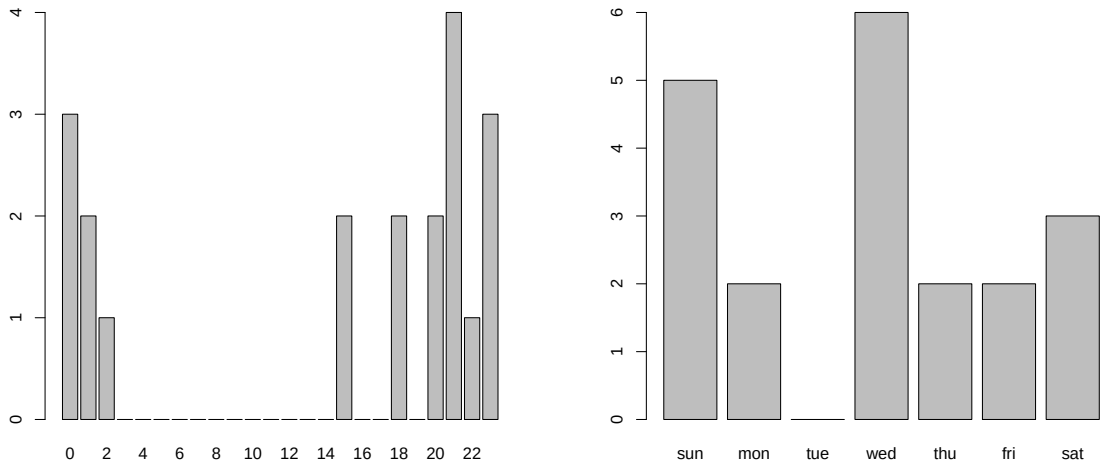
```
raw.hours(junit20)

##
##  0  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
##  3  2  1  0  0  0  0  0  0  0  0  0  0  0  2  0  0  2  0  2  4  1  3

max.hours(junit20)

## 21
##  4

min.hours(junit20)

##
##  3  4  5  6  7  8  9 10 11 12 13 14 16 17 19
##  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
```

Raw activity per day of week for `junit20`:

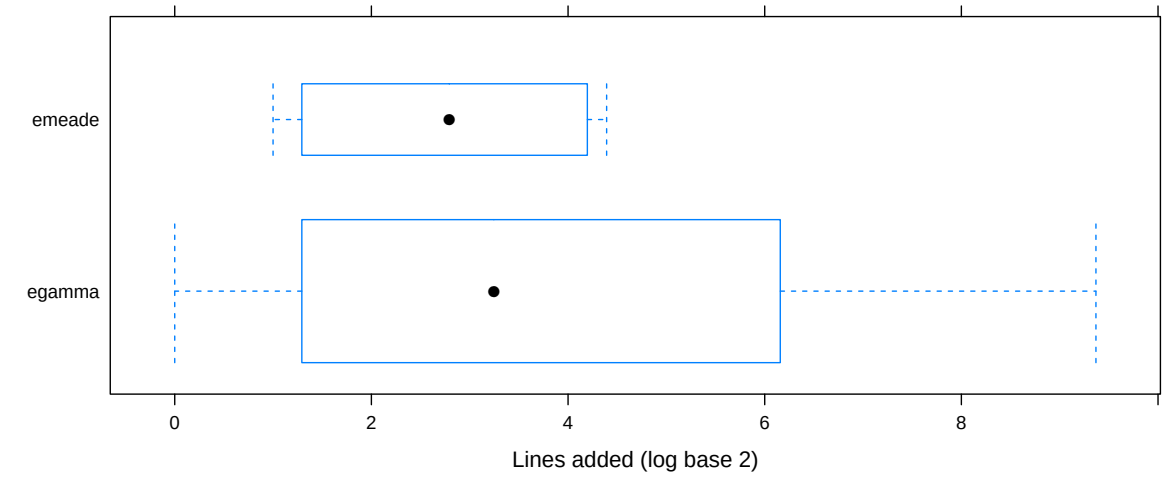
```
raw.weekdays(junit20)

##
## sun mon tue wed thu fri sat
##   5   2   0   6   2   2   3

max.weekdays(junit20)

## wed
##   6

min.weekdays(junit20)

## tue
##   0
```

Task 3-2

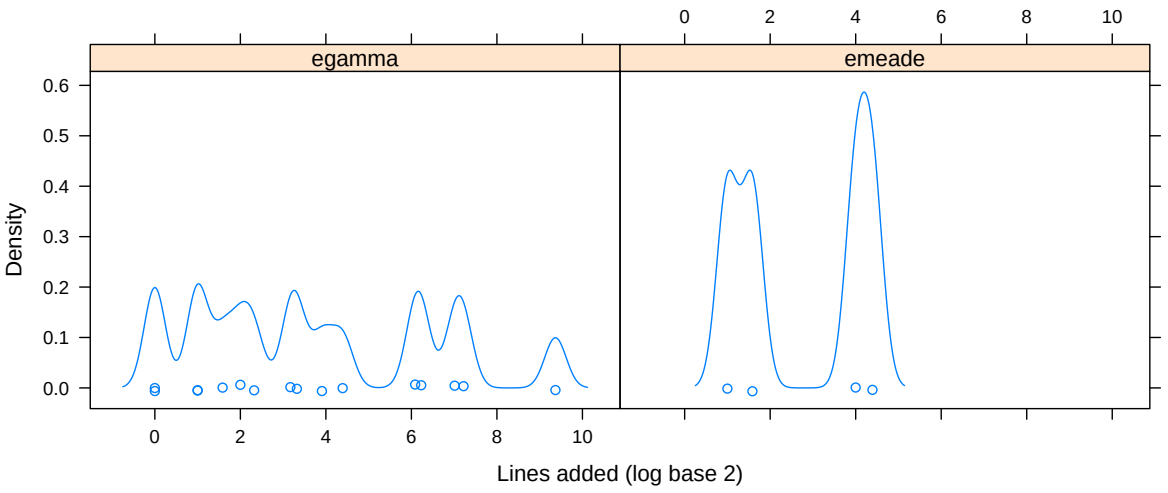
```
# Plots for junit20's hour and weekday distribution
myplot.hours.bars(junit20)
myplot.wdays.bars(junit20)
```



```
# Boxplot for lines_add per developer of junit20
myplot.lines_add.devs.boxplot(junit20)
```




```
# Density plot for lines_add per developer of junit20
myplot.lines_add.devs.densityplot(junit20)
```



```
# Plotting the developer participation for the junit20 subset
# (inspired by Mockus et al.)
myplot.participation(junit20)
```