Numerical Data and Moodle

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The problem

The facts

Moodle in its standard version does not allow you to use advanced functions with randomly generated data to formulate questions for an exercise.

Exercise

Try calculating the variance of a set of randomly generated numbers in a question in the "Test" activity.

- How can we design this type of question, or more advanced ones?
- How can we generalize the production of questions with distinct data for ?
  - training exercises: identical exercises but with distinct numerical parameters (numbers, functions, etc.)
  - exam : different values for each student (to minimize the risk of cheating)

The process

1. Outsource the design :
   - random number generation
   - question design
   - calculation of answers
   - design of answer keys
2. Generate a file that can be imported by Cyberlearn (Question bank)
3. Cyberlearn : design a "Test" activity

Image from https://pixabay.com/

Requirements

- Moodle : building an activity "Test"
- Desirable knowledge:
  - R : basic notions of language
  - LaTeX : basic notions

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Work recognition

The solution is entirely based on the R package
exams: Automatic Generation of Exams in R

sources:

- *Grün and Zeileis 2009*
- *Zeileis, Umlauf, and Leisch 2014*
- *see also: Zeileis 2023*

Big thanks to the author: Zeileis, Achim for his work!

Required tools

Either

1. A LaTeX version installed on your laptop or via a browser
   - Windows : MiKTex or TeX Live
   - Linux : TeX Live
   - Mac : MacTeX
2. The software R

Or simply via

A browser

Posit Cloud (ex RStudio Cloud)

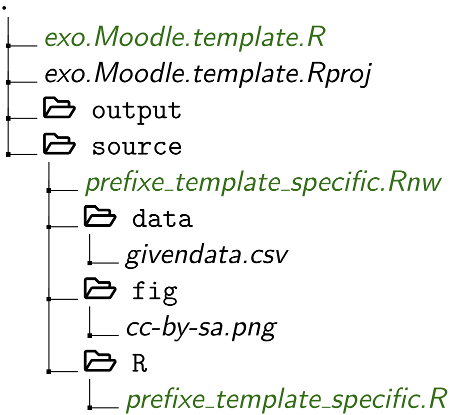
Exercice

Create an account on Posit Cloud if you don't have LaTeXand R.

The proposed solution

The template

The template, licensed under 🅭🅯🄎, contains the possible question options. The compressed file contains everything you need, according to the structure below.



```
.
├── exo.Moodle.template.R
├── exo.Moodle.template.Rproj
├── output
└── source
    ├── prefixe_template_specific.Rnw
    ├── data
    │   └── givendata.csv
    ├── fig
    │   └── cc-by-sa.png
    └── R
        └── prefixe_template_specific.R
```

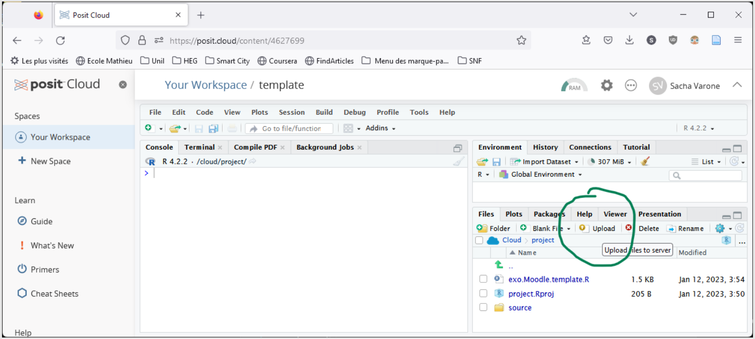
The files

- The statement : ./source/*.Rnw It contains the statement, questions, solutions and global feedback (= the answer key). ./source/ directory
- The script: ./source/R/*.R
  Allows you to generate random data or read a static file. It also contains all the calculations you wish to perform.
- Generated data: ./source/data/*.csv
  format The format *csv* is that of a tabular file. You can of course generate other file types (i.e. **.txt*, **.xlsx*, ...)
- Figures./source/fig/*.*}. You can generate several types of figures: **.png*, **.pdf*, ...

Posit Cloud: Import the zipped template

Exercise

1. From your Posit Cloud account, create a project which you name Template
2. From this project, "Upload" the zipped file.



```
R 4.2.2 · /cloud/project/
>
```

Name	Size	Modified
..		
exo.Moodle.template.R	1.5 KB	Jan 12, 2023, 3:54
project.Rproj	205 B	Jan 12, 2023, 3:50
source		

Running the template

Exercise

1. Click on "exo.Moodle.template.R".
2. Select lines 1 to 27 and execute the commands (CTRL-Enter or Run button).
3. On line 25, replace "n = 1" with "n = 2" and execute line 20. What happens to questions 3 and 4 and the solution/feedback?

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The orchestra conductor

The *exo.Moodle.template.R* file is the orchestra conductor. Its purpose is

- to indicate where the files are located
  - statements (i.e. *.Rnw)
  - data composition and calculations (i.e. *.R)
  - generated output (*.xml or *.pdf)
  - possible images
  - static data, if any
- initialize the seed of random numbers to be generated
- to generate the result (i.e. HTML, pdf or XML)

Explanation

exo.Moodle.template.R must be executed to produce the result.

Main : content

Loading libraries

```r
## load package
if(!require("knitr")) install.packages("knitr")
if(!require("tth")) install.packages("tth")
if(!require("base64enc")) install.packages("base64enc")
if(!require("exams")) install.packages("exams")
library("exams")
```

Explanation

If the libraries have not yet been downloaded once (part *if(...)*, then they will be. Next, the "exams" library is loaded into memory.

Directory specification

```r
currentdir.wd <- getwd()
script.path <- paste0(currentdir.wd, "/source/R/")
# for data export
data.path <- paste0(currentdir.wd, "/source/data/")
fig.path <- paste0(currentdir.wd, "/source/fig/")
```

Explanation

The files are in separate directories for greater clarity.
source/R for data composition and calculation files (*.R)
source/data for storage of generated or static data
source/fig for storing static figures

Main : content

Seed and statement

```r
# set  the seed
set.seed(2022)
# set the exercises
exo <- c("prefixe_template_specific.Rnw")
```

Explanation

set.seed() initializes the seed so that the result can be regenerated with the same data.
exo contains the list of question files.

Exporting to HTML

```r
# export as HTML for a quick check
exams2html(
file = exo,
encoding = "UTF-8",
edir = "./source",
template = "plain8",
n = 1
)
```

Explanation

Exporting to HTML allows you to quickly see a result close to what will be generated.
n=1 indicates that only one copy is generated.

Main : content

Export to XML

```r
# generate Moodle exo XML file
exams2moodle(
file = exo,
name = "2022.Template",
encoding = "UTF-8",
converter = "ttm",
dir = "output",
cloze = list(
cloze_mchoice_display = "MULTIRESPONSE",
shuffle = TRUE,
eval = list(
partial = TRUE,
negative = FALSE,
rule = "true"
)
),
edir = "source",
rule = "none",
n = 1
)
```

Explanation : XML export importable by Moodle

Produces the file that will be imported into the question database.
name = name of the directory in the question bank.
There is 1 sub-directory created per statement file, which will contain *n* versions of the statement.

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Exercise: nomenclature

Specific nomenclature for file consistency: words separated by ”_”.

- *prefix* = name of the course, for example *statIII*
- *name* = notion assessed, for example *TCL*
- *specific* = description of the exercise, for example *ticket*

Examples

Statement file	:	*statIII_TCL_ticket.Rnw*
Script R	:	*statIII_TCL_ticket.R*
Generated data	:	*ticket.csv*

Exercise: content

File *prefix_template_specific.Rnw*

Parameters

```
prefixe <- "prefixe"
name <- "template"
specific <- "specific"
scriptname <- paste0(prefixe,"_", name, "_", specific, ".R")
currentfile <- paste0(scriptname, "nw")
dataset.name <- paste0(specific, ".csv")
# precision
nbdecimal <- 3
precision <- 10^(-nbdecimal)
```

Explanation

The first lines are used to define a nomenclature common to all the files: statement, R script, generated data. *nbdecimal* indicates the desired precision for the numerical answers.

Availability of static files

```
include_supplement(file = "cc-by-sa.png", recursive = T
include_supplement(file = "givendata.csv", recursive =
```

Explanation

The aim is to make the static files used in the statement ”readable”.

Exercise: content

Running the script

```
source(paste0(script.path, scriptname))
```

Explanation

he commands contained in the R script are executed.

Loading libraries

```
# install package if needed
if(!require("ggplot2")) install.packages("ggplot2")
# package loading
library(ggplot2)
```

Explanation

This space is used to load the libraries you use in the statement file into memory.

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Questions: principles

- In a statement file, several questions can be asked.
- Questions are of one of the following types: "schoice", "mchoice", "num" or "string". In the case of a "schoice" or "mchoice" type, the answer is coded as a string of characters 0 and 1.
- Following the question text in the "itemize" environment, the keyword *##ANSWER?##* must be placed to indicate that an answer is expected. The "*?*" indicates the question number.
- The following command should finally be placed just before the end of the "question" environment in a chunk.
  It generates spaces for the student to give his answer.

answerlist(unlist(question))

Question: schoice type

```r
question[[1]] <- paste("option",1:5)
solution <- mchoice2string(c(rep(F,4),T))
sol <- c(sol, solution)
reponse[[1]] <- question[[1]][string2mchoice(solution)]
type <- c(type,"schoice")
point <- c(point, 1L)
```

Explanation

question	contains "option1", ..., "option5"
solution	designates "option5" as the solution (T), the others being false (F), then encodes it as a string "00001"
sol	adds the coded solution
reponse	adds the decoded solution
type	indicates the type of question, i.e. "schoice"
point	gives the number of points for this solution, i.e. 1 pt

Question: mchoice type

```r
question[[2]] <- paste("option",1:5)
solution <- mchoice2string(c(T,F,T,F,T))
sol <- c(sol, solution)
reponse[[2]] <- question[[2]][string2mchoice(solution)]
type <- c(type, "mchoice")
point <- c(point, sum(string2mchoice(solution)))
```

Explanation

Similar to a question of the type ”schoice”.
The difference is that several options must be validated, i.e. ”option 1” ”option 3” ”option 5”.

Question: num type

```r
question[[3]] <- ""
solution <- round(mean(x), nbdecimal)
sol <- c(sol, solution)
reponse[[3]] <- solution
type <- c(type, "num")
point <- c(point, 3L)
```

Explanation

A numerical value is requested.

The number of points awarded for a correct answer is 3 pts.

Question: string type

```r
question[[4]] <- dat[2, selectedindex]
solution <- dat[1, selectedindex]
sol <- c(sol, solution)
reponse[[4]] <- solution
type <- c(type, "string")
point <- c(point, 1L)
```

Explanation

A character string is expected. The data has been generated in the *.R script (i.e. the "dat" matrix) as well as the line number (i.e. "selectedindex").

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Test activity: Steps

1. RStudio/Posit : export to XML with the command *exams2moodle()*, with
   - the desired name (name = ...)
   - the number of versions (n = ...)
2. Moodle: Import the resulting file into the question bank
3. Moodle: Insert a Test activity
   3.1 Add random "questions"/exercises

   3.2 If necessary, adjust the (total) number of points per exercise.
4. Moodle: Finalize settings (if graded evaluation)

Test activity: Step 2

Explanation: number of points

The number of points n_i per answer i has been specified. Changing the total number of points N for an exercise means assigning a number of points proportional to n_i.

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Open Educational Resources (OER)

Based on this principle, a database of initial questions for statists is made available under licence 🅭🅯🄎.

Request

Contribute to its expansion so that we can all benefit from it!

Bibliography

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