R/exams installation and set-up

Daniel Wildt

SWARM
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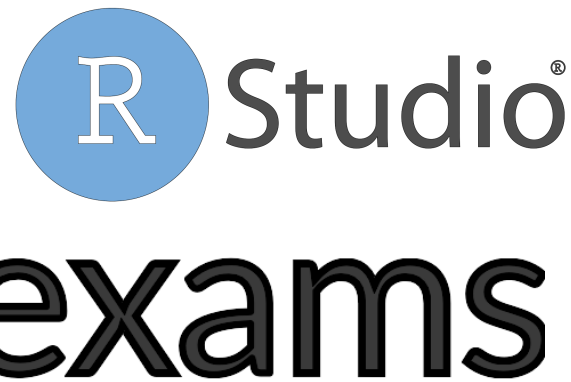
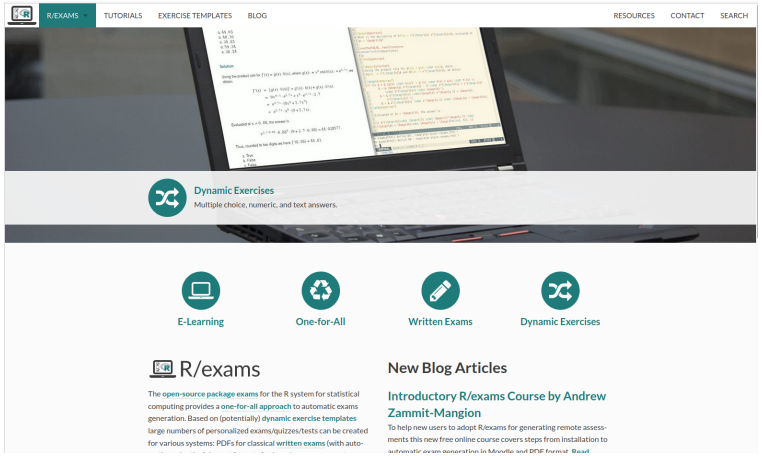
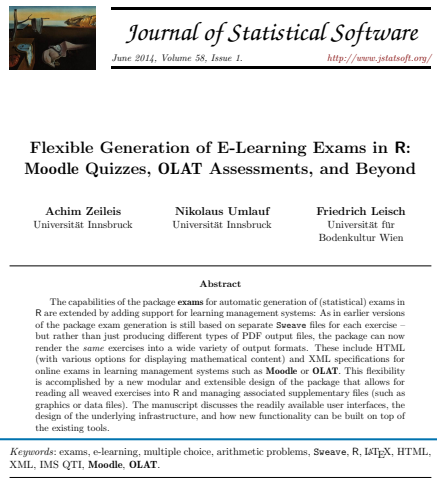
Outline I



Sources

- Homepage `www.r-exams.org` (*R/Exams* 2020)
  - installation notes
  - tutorials
  - exercise templates
- Publication:
  A. Zeileis et al. (2014). 'Flexible Generation of E-Learning Exams in R: Moodle Quizzes, OLAT Assessments, and Beyond'. *Journal of Statistical Software* 58 (1). DOI: 10.18637/jss.v058.i01

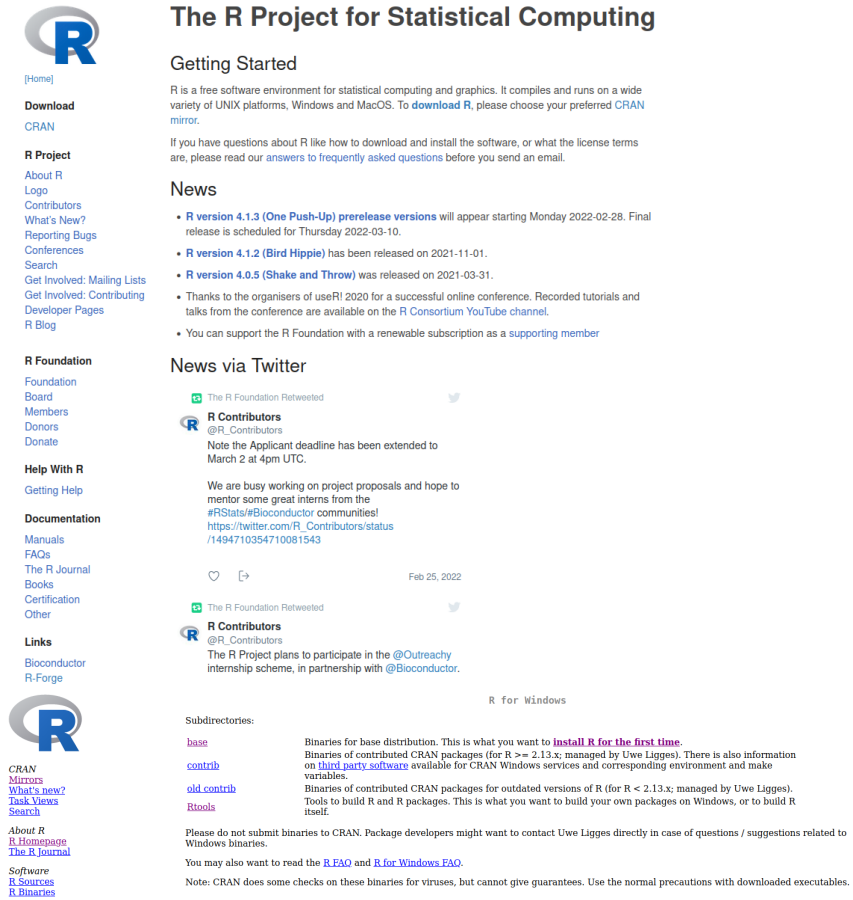




Installation: R

Installation notes can be found on: `http://www.r-exams.org/tutorials/installation/`

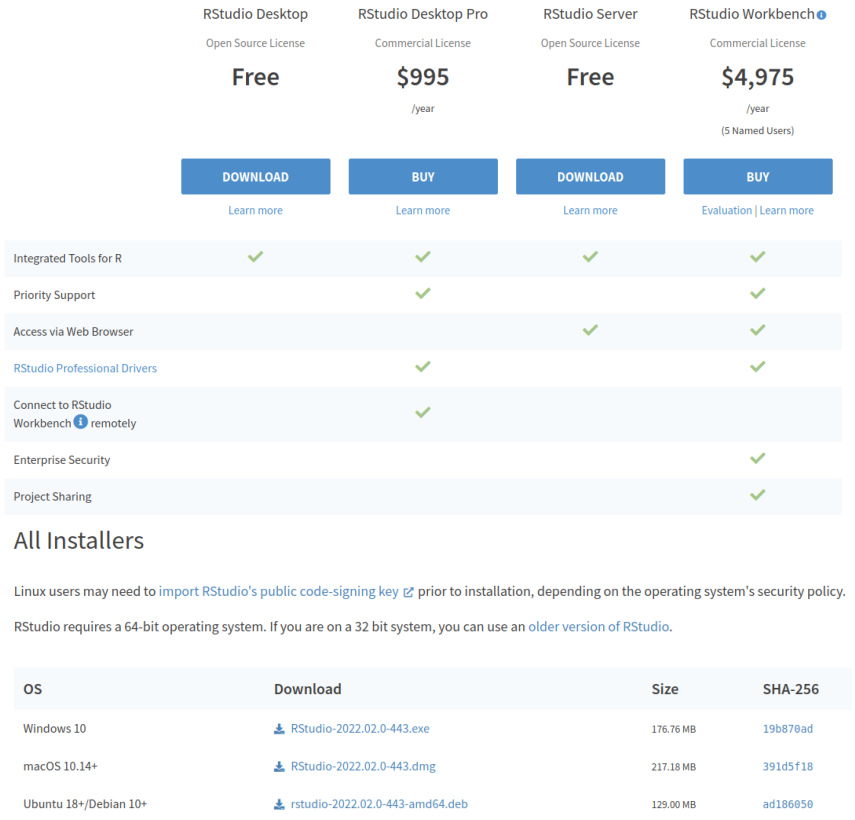
1. R can be downloaded from the Comprehensive R Archive Natwork (CRAN): `https://cran.r-project.org/`
2. Download R for your operating system
3. Choose subdirectories “base” and “Rtools”



Installation: RStudio

Integrated development environment for development of R-scripts:

1. Download and install RStudio Desktop for your operating system `https://rstudio.com/products/rstudio/download/#download`
2. Start RStudio (e. g. via Start menu on Windows)



	RStudio Desktop	RStudio Desktop Pro	RStudio Server	RStudio Workbench
	Open Source License	Commercial License	Open Source License	Commercial License
	Free	$995 /year	Free	$4,975 /year (5 Named Users)
	DOWNLOAD	BUY	DOWNLOAD	BUY
	Learn more	Learn more	Learn more	Evaluation | Learn more
Integrated Tools for R	✓	✓	✓	✓
Priority Support		✓		✓
Access via Web Browser			✓	✓
RStudio Professional Drivers		✓		✓
Connect to RStudio Workbench remotely		✓		
Enterprise Security				✓
Project Sharing				✓

All Installers

Linux users may need to import RStudio's public code-signing key prior to installation, depending on the operating system's security policy.

RStudio requires a 64-bit operating system. If you are on a 32 bit system, you can use an older version of RStudio.

OS	Download	Size	SHA-256
Windows 10	RStudio-2022.02.0-443.exe	176.76 MB	19b870ad
macOS 10.14+	RStudio-2022.02.0-443.dmg	217.18 MB	391d5f18
Ubuntu 18+/Debian 10+	rstudio-2022.02.0-443-amd64.deb	129.00 MB	ad186050

Installation: RStudio

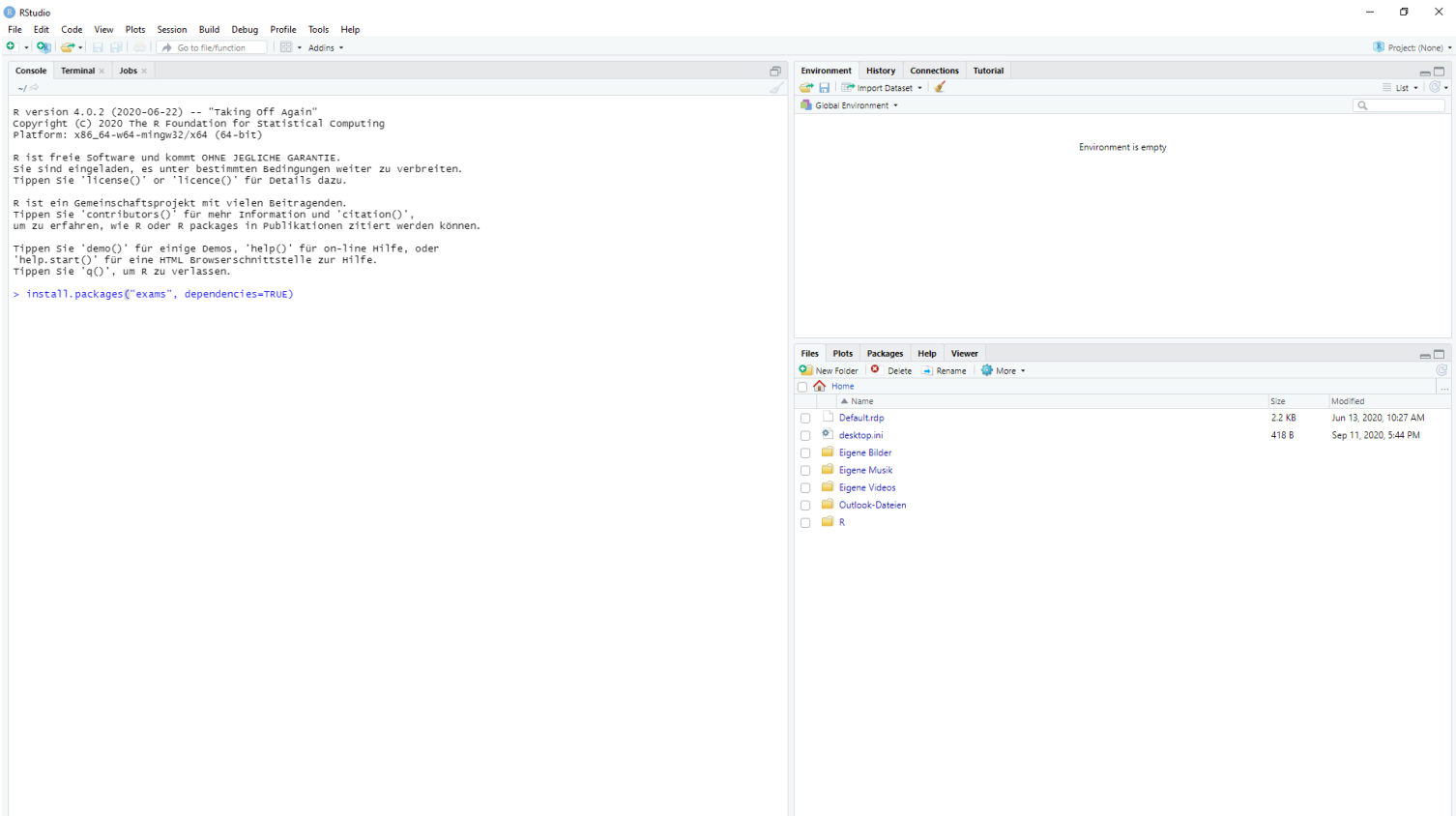


Fig.: View of RStudio after first start

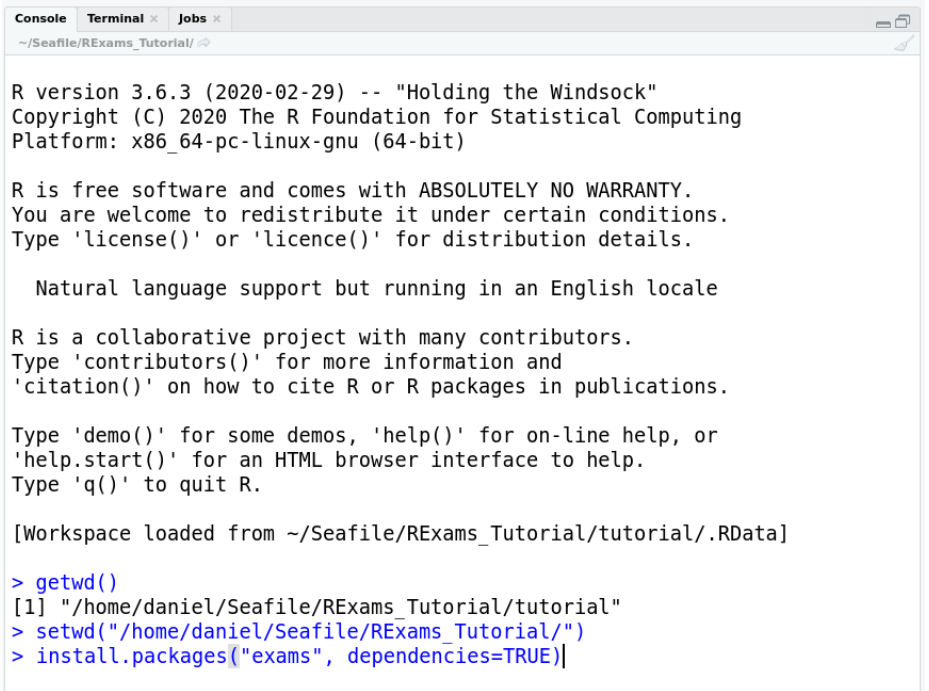
Installation: R/exams

Download and install R/exams package via command line in RStudio (only necessary before first use of R/exams):

```
> install.packages("exams",
    dependencies=TRUE)
```

Load R/exams package via command line in RStudio (necessary every time after RStudio is started):

```
> library(exams)
```

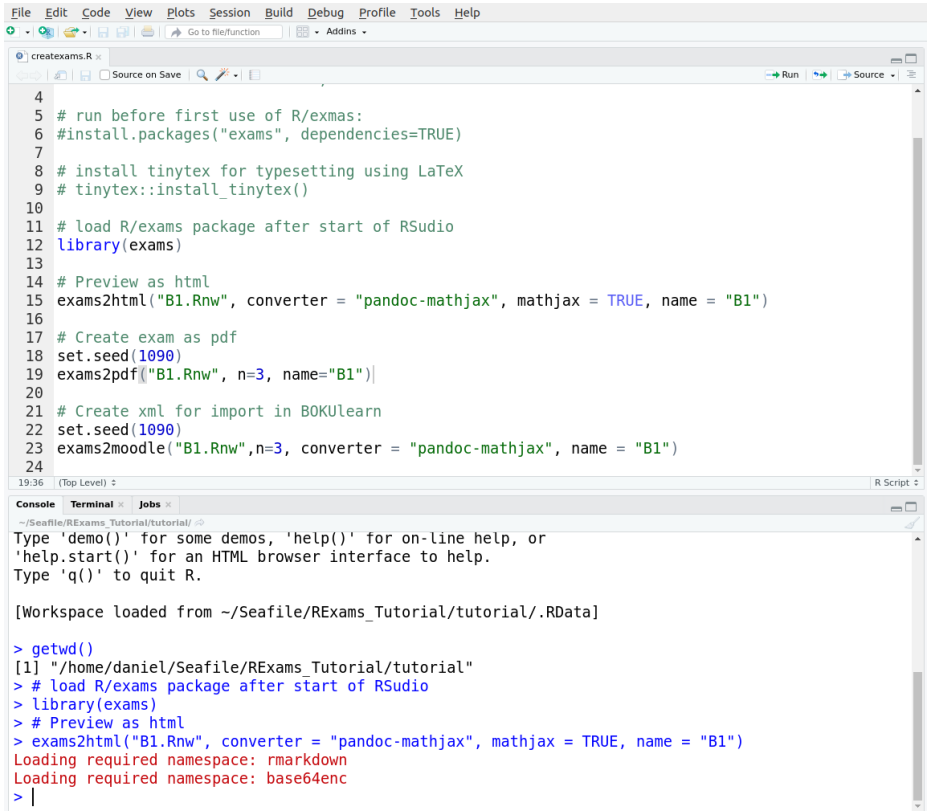


First example

When working with RStudio: Open project via `File > Open Project` Example is defined and created by two R-scripts:

1. `B1.Rnw` definition of the exercise
2. `createexams.R` script which runs commands of the R/exams API

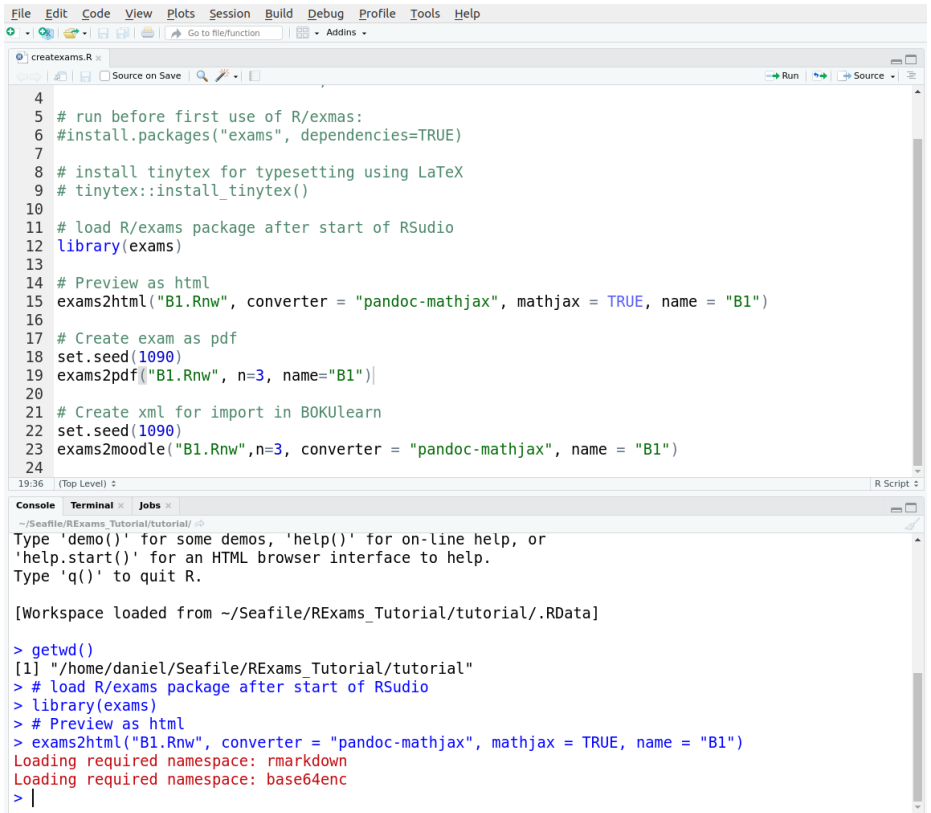
Open files via `File > Open File` Image files for figures to be included in the exercise are saved in the `figures` folder.



First example

Execute commands in `createexams.R` by pressing `Crtl + Enter` with the cursor in the respective line.

- `exmas2html()` create html of exercise, useful for testing and debugging
- `exmas2pdf()` create pdf of exercise, e. g. for test on paper
- `exmas2moodle()` create xml of exercise for import into Moodle



Set path:

`setwd("path/to/files")`

First example

2 components

1. LaTeX (default):
   - for text
   - comment: %
   - commands started with backslash (e. g. `\rho` for ρ)
2. R-code:

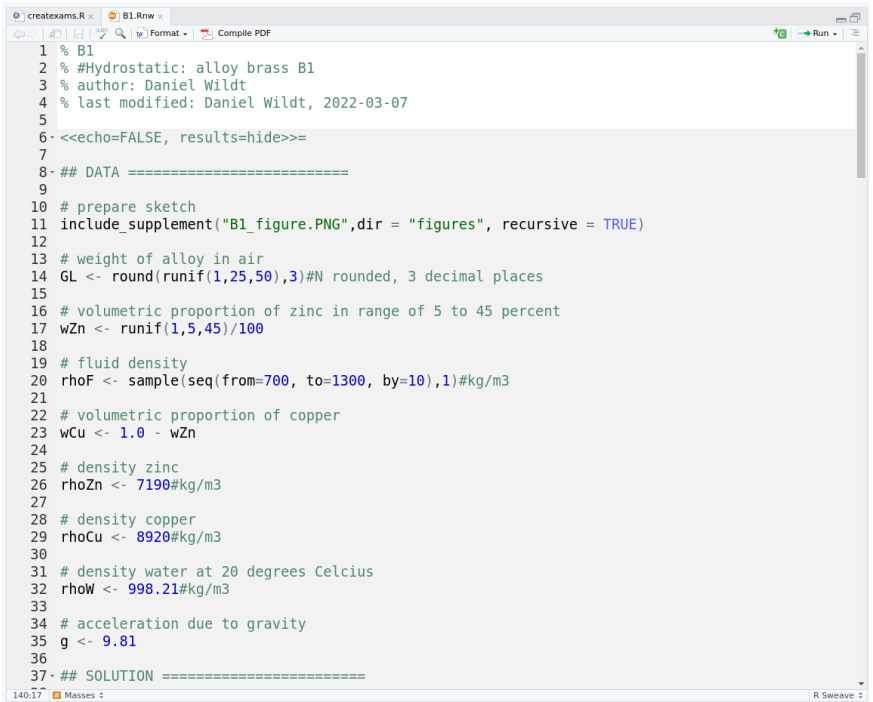
```
<<echo=FALSE, results=hide>>=
# R-code and calculations
@
```

   - comment: #
   - global variable definition by <-

First example

Create random numbers with R:

- `runif(n,low,high)` creates a vector with `n` elements from a uniform distribution with limits `low` and `high`
- `sample(d, n)` randomly choose `n` elements from a vector `d`
- e. g. vector of pipe diameters in m: `d<-c(50,65,80,100,125,150)/1000`
- `round(x, n)` round `x` to `n` decimal places



First example

- basic arithmetic `+`, `-`, `*`, `/`
- functions e. g. trigonometry: `cos()`, `sin()`, `tan()`
- mathematical constants: `pi`, `exp(1)`
- `if` – `then` – `else` statements
- `for`-loops, conditional loops

```
36
37 ## SOLUTION ========================
38
39 # mass and volume
40 m <- GL / g
41
42 mZn <- m * wZn
43 mCu <- m * wCu
44
45 VZn <- mZn / rhoZn
46 VCu <- mCu / rhoCu
47
48 V <- VZn + VCu
49
50 # weight under buoyancy
51 GA <- GL - V * rhoF * g
52
53 # density brass
54 rhoL <- m / V
```

First example

- `questions`: text for the question (defined later)
- `solutions`: correct answers
- `explanations`: additional explanations
- `tolerances`: +/− tolerances (for numeric questions)
- `type`: question type
- **`points`**: integers for weighting of sub-questions

createexams.R | B1.Rnw

Format | Compile PDF | Run

```
56
57 ## QUESTION ====================
58
59 questions <- solutions <- explanations <- tolerances <- rep(list(""), 6)
60 type <- rep(list("num"), 6)
61
62 questions[[1]] <- ""
63 solutions[[1]] <- explanations[[1]] <- mCu
64 tolerances[[1]] <- 0.01
65
66 questions[[2]] <- ""
67 solutions[[2]] <- explanations[[2]] <- mZn
68 tolerances[[2]] <- 0.01
69
70 questions[[3]] <- ""
71 solutions[[3]] <- explanations[[3]] <- wCu
72 tolerances[[3]] <- 0.002
73
74 questions[[4]] <- ""
75 solutions[[4]] <- explanations[[4]] <- wZn
76 tolerances[[4]] <- 0.002
77
78 questions[[5]] <- ""
79 solutions[[5]] <- explanations[[5]] <- rhoL
80 tolerances[[5]] <- 10
81
82 questions[[6]] <- c("weight would be higher", "weight would be lower")
83 type[[6]] <- "schoice"
84 solutions[[6]] <- explanations[[6]] <- c((rhoF > rhoW), (rhoF < rhoW))
85 tolerances[[6]] <- 0
86
87 if(any(explanations[c(1,2,3,4,5)] < 0)) explanations[c(1,2,3,4,5)] <- lapply(solutions[c(1,2
   ,3,4,5)], function(x) paste("$", x, "$", sep = ""))
88
89 explanations[6] <- lapply(solutions[6], function(x) ifelse(x, "True", "False"))
90 solutions[6] <- lapply(solutions[6], mchoice2string)
91 @
```

First example

Question types (Zeileis et al., 2014):

- `num`: for questions with a numeric answer
- `string`: for questions with a (short) text answer
- `schoice`: for single-choice questions where exactly one of the questions/statements is true and all others are false (drop-down menu)
- `mchoice`: for multiple-choice questions where each element of the question/statement can either be true or false
- `cloze`: combination of questions/statements with num, string, or mchoice answers. Thus, each element of the question has either a numeric, short text, or single/multiple-choice answer

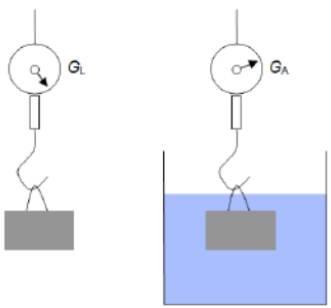
First example

Exam 1

1. **Question**

The weight of a piece of brass amounts to G_{L}. Its weight under buoyancy in a fluid with density ρ_F amounts to G_{A}. The density of the components of the alloy are given with ρ_{Cu} und ρ_{Zn} for copper and zinc respectively.

- $G_L = 35.648\,\mathrm{N}$
- $G_A = 31.712\,\mathrm{N}$
- $\rho_{\mathrm{Zn}} = 7190\,\mathrm{kg\,m^{-3}}$
- $\rho_{\mathrm{Cu}} = 8920\,\mathrm{kg\,m^{-3}}$
- $\rho_F = 950\,\mathrm{kg\,m^{-3}}$
- $\rho_{\mathrm{W}} = 998.21\,\mathrm{kg\,m^{-3}}$



What is the mass of copper in the alloy in kg?	. kg
What is the mass of zinc in the alloy in kg?	. kg
What is the mass proportion of copper in the alloy?	. 1
What is the mass proportion of zinc in the alloy?	. 1
What is the density of the brass in $\mathrm{kg\,m^{-3}}$?	. kgm-3
Would the weight of the brass under buoyancy in water at 20° C with density ρ_{W} weight would be higher. / weight would be higher or lower?	be lower.

- question text in LaTeX
- code for mathematical symbols between $$
- value from R-variable by `Sexpr`

```
92 solutions[6] <- lapply(solutions[6], mchoice2string)
93 @
94
95 \begin{question}
96
97 The weight of a piece of brass amounts to $G_\mathrm{L}$. Its weight under buoyancy in a fluid with density $\rho_F$
   amounts to $G_\mathrm{A}$. The density of the components of the alloy are given with $\rho_\mathrm{Cu}$ und $\rho_\mathrm
   {Zn}$ for copper and zinc respectively.
98
99 \begin{itemize}
100 \item $G_L = \Sexpr{format(round(GL,3),nsmall=3)}\,\mathrm{N}$
101 \item $G_A = \Sexpr{format(round(GA,3),nsmall=3)}\,\mathrm{N}$
102 \item $\rho_\mathrm{Zn} = \Sexpr{rhoZn}\,\mathrm{kg\,m^{-3}}$
103 \item $\rho_\mathrm{Cu} = \Sexpr{rhoCu}\,\mathrm{kg\,m^{-3}}$
104 \item $\rho_F = \Sexpr{rhoF}\,\mathrm{kg\,m^{-3}}$
105 \item $\rho_\mathrm{W} = \Sexpr{rhoW}\,\mathrm{kg\,m^{-3}}$
106 \end{itemize}
107
108 \begin{center}
109 \includegraphics[width=0.4\textwidth]{B1_figure.PNG}
110 \end{center}
111
112
113 \begin{tabular}{lr}
114 What is the mass of copper in the alloy in kg?
115 & ##ANSWER1## kg\\
116 What is the mass of zinc in the alloy in kg?
117 & ##ANSWER2## kg\\
118 What is the mass proportion of copper in the alloy?
119 & ##ANSWER3## 1\\
120 What is the mass proportion of zinc in the alloy?
121 & ##ANSWER4## 1\\
122 What is the density of the brass in $\mathrm{kg\,m^{-3}}$?
123 & ##ANSWER5## kgm-3\\
124 Would the weight of the brass under buoyancy in water at $20^\circ\,C with density $\rho_\mathrm{W}$ be higher or lower?
125 & ##ANSWER6## \\
126 \end{tabular}
```

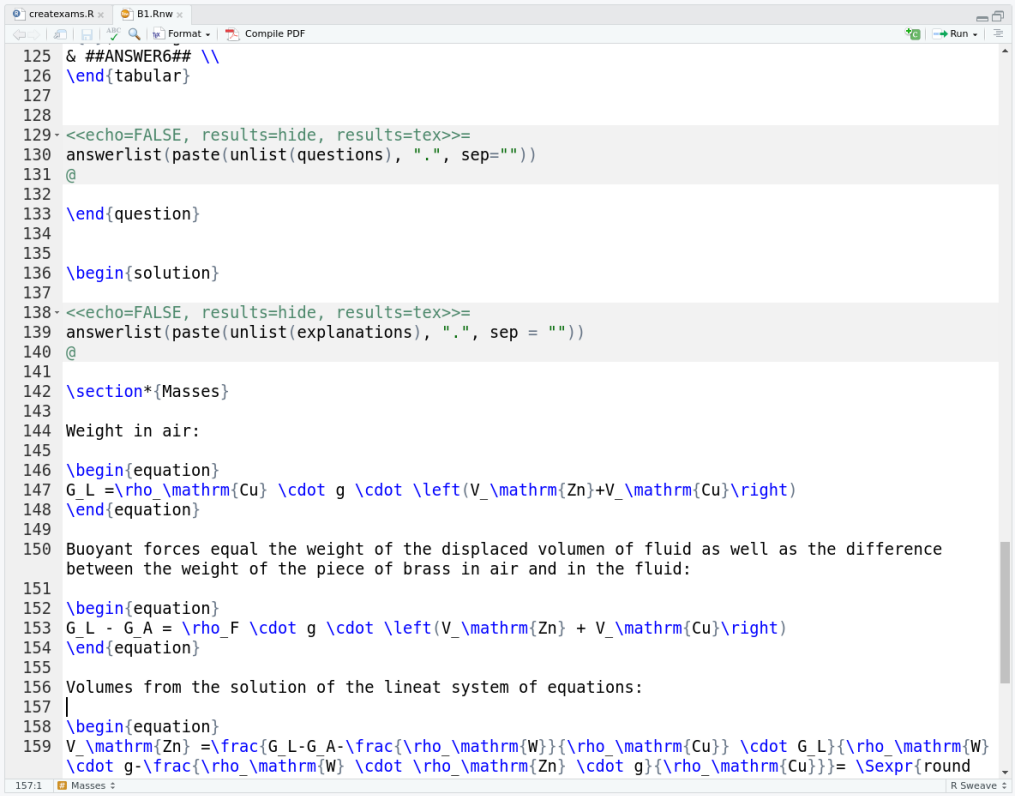
First example

Solutions:

- optional part
- either for students or for own reference

LaTeX references:

- mathematical symbols: `http://detexify.kirelabs.org/classify.html`
- numerous further resources for e. g. special characters online



First example

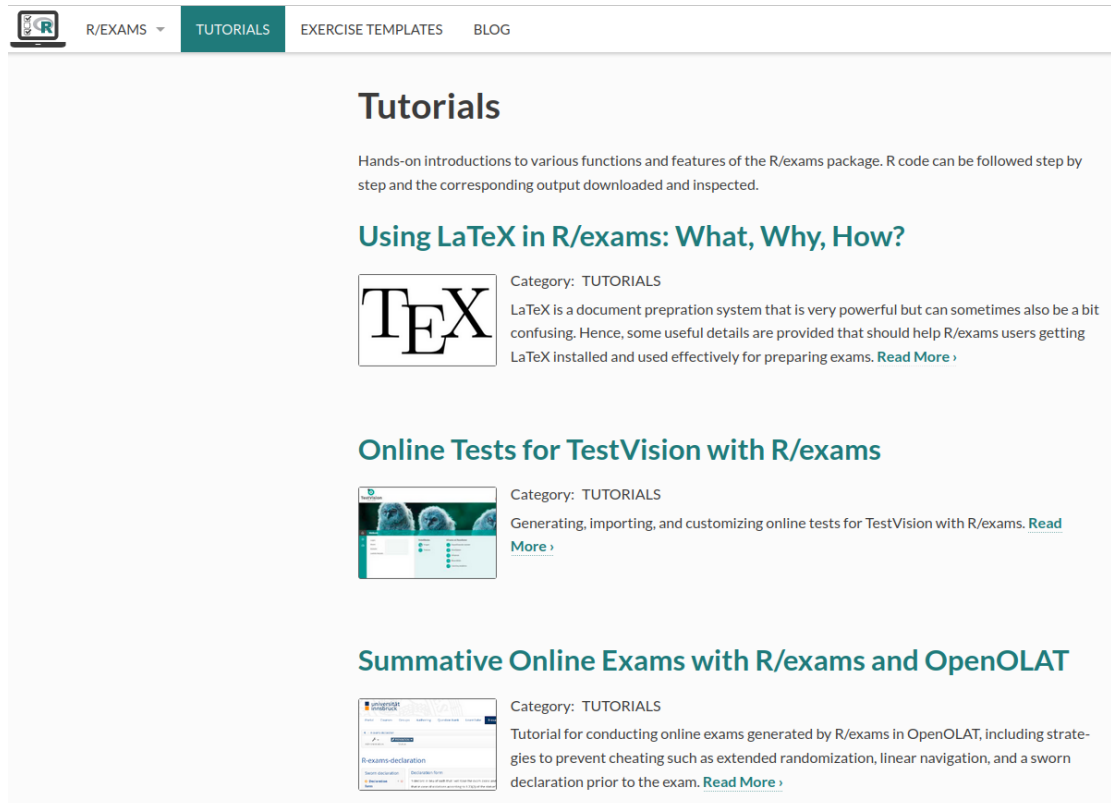
Meta-information defined at the end of the file:

- question type
- exam name, section, version
- concatenate solutions, points, tolerances

```
\begin{equation}
V_\mathrm{Zn} =\frac{G_L-G_A-\frac{\rho_\mathrm{W}}{\rho_\mathrm{Cu}} \cdot G_L}{\rho_\mathrm{W} \cdot g-\frac{\rho_\mathrm{W} \cdot \rho_\mathrm{Zn} \cdot g}{\rho_\mathrm{Cu}}}= \Sexpr{round(VZn*10^6,1)}\,\mathrm{cm^3}
\end{equation}

\begin{equation}
V_\mathrm{Cu} = \frac{G_L-\rho_\mathrm{Zn} \cdot g \cdot V_\mathrm{Zn}}{\rho_\mathrm{Cu} \cdot g}= \Sexpr{round(VCu*10^6,1)}\,\mathrm{cm^3}
\end{equation}

\dots

\end{solution}

%% META-INFORMATION
%% \extype{cloze}
%% \exsolution{\Sexpr{paste(solutions, collapse = "|")}}
%% \exclozetype{\Sexpr{paste(type, collapse = "|")}}
%% \exname{B}
%% \exsection{B1}
%% \extitle{Hydrostatik}
%% \extol{\Sexpr{paste(tolerances,collapse = "|")}}
%% \exversion{2020S}

157:1  Masses  R Sweave
```

Examples and tutorials

- wide range of example exercises and exams available on `http://www.r-exams.org/tutorials/`



University of Natural Resources and Life Sciences, Vienna
Department of Water, Atmosphere and Environment
Institute of Hydraulic Engineering and River Research (IWA)

Dipl.-Ing. Daniel Wildt, MSc

Muthgasse 107, A - 1190 Wien
Tel.: 01-47654-81935
daniel.wildt@boku.ac.at
http://www.wau.boku.ac.at/iwa/

References I

R/Exams (2020). URL: http://www.r-exams.org/.

Zeileis, A., N. Umlauf and F. Leisch (2014). 'Flexible Generation of E-Learning Exams in R: Moodle Quizzes, OLAT Assessments, and Beyond'. *Journal of Statistical Software* 58 (1). DOI: 10.18637/jss.v058.i01.