University of Natural Resources
and Life Sciences, Vienna
Department of Water, Atmosphere
and Environment

eLearning exercises and tests

Daniel Wildt

SWARM project workshop WP 2.5
Theme-based training of teaching staff for acquiring new teaching and learning methods
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Home exams for Hydraulics and Hydromechanics

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Fig.: 78 different problems

Home exams for Hydraulics and Hydromechanics

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Fig.: approximately 200 participants à 10 home exams

Home exams for Hydraulics and Hydromechanics

Workflow

- ▶ submission
- ▶ ordering by problem
- ▶ evaluation and grading
- ▶ ordering by alphabet
- ▶ entering points into the system

Problems encounterd

- ▶ high overhead
- ▶ time gap between submission and feedback
- ▶ students only get final points
- ▶ learning from mistakes difficult

The R/exams package: Zeileis et al. (2014)

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- code problems in R
- dynamic creation of:
    - online tests
    - written exams
    - solution sheets
- formatting based on LaTeX and `html`

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Flexible Generation of E-Learning Exams in R: Moodle Quizzes, OLAT Assessments, and Beyond

Achim Zeileis   Nikolaus Umlauf   Friedrich Leisch
Universität Innsbruck   Universität Innsbruck   Universität für Bodenkultur Wien

Abstract

The capabilities of the package **exams** for automatic generation of (statistical) exams in R are extended by adding support for learning management systems. As in earlier versions of the package exam generation is still based on separate Sweave files for each exercise – but rather than just producing different types of PDF output files, the package can now render the *same* exercises into a wide variety of output formats. These include HTML (with various options for displaying mathematical content) and XML specifications for online exams in learning management systems such as **Moodle** or **OLAT**. This flexibility is accomplished by a new modular and extensible design of the package that allows for reading all weaved exercises into R and managing associated supplementary files (such as graphics or data files). The manuscript discusses the readily available user interfaces, the design of the underlying infrastructure, and new functionality can be built on top of the existing tools.

Keywords: exams, e-learning, multiple choice, arithmetic problems, Sweave, R, LaTeX, HTML, XML, IMS QTI, **Moodle**, **OLAT**.
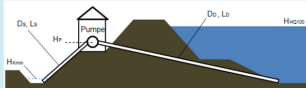
1. Introduction

The design for version 1 of the **exams** package was conceived eight years ago (in 2006) when the original authors (Grün and Zeileis 2009) were involved in a redesign of the introductory statistics lecture at WU Wirtschaftsuniversität Wien. Back then the main goal was to be able to produce exams along with associated self-study materials as PDF (portable document format) files. Thus, the main focus was still on printable materials for classic classroom exams. Although e-learning systems started to become available more easily back at that time, they

```
83  ## SOLUTION ================================
84
85  # Saugleitung
86  Q <-QS
87
88  vS <- 4*Q/(dS*dS*pi)
89  ReS <- vS*dS/nu
90  epsilonS <- kb/dS
91
92  lambdaS <- lambdafkt(ReS,epsilonS)
93
94  IrS <- vS *vS / (2 * g) * lambdaS / dS
95  hrS <- IrS * LS
96
97  # Druckleitung
98
99  vD <- 4*Q/(dD*dD*pi)
100 ReD <- vD*dD/nu
101 epsilonD <- kb/dD
102
103 lambdaD <- lambdafkt(ReD,epsilonD)
104
105 IrD <- vD *vD / (2 * g) * lambdaD / dD
106 hrD <- IrD * LD
107
108
109 # manometrische Foerderhoehe und Foerderstrom
110
111 HPumpe <- HHQ100 - HKmin + hrS + hrD
112
```

The R/exams package

- ▶ questions types
  - ▶ multiple / single choice
  - ▶ numeric
  - ▶ character string
- ▶ automated variation of values
- ▶ unlimited number of different assignments possible

Potential of the package

Disadvantages

- ► only final results count
- ► easy to copy correct values
- ► no possibility to make students draw sketches
- ► initially high effort for coding

Advantages

- ► learning through several attempts
- ► individual assignment for each student
- ► saved time for correcting
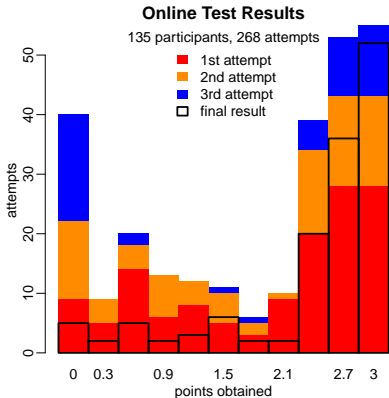- ► feedback straight after submission

Potential of the SWARM package

- ▶ new problem for each attempt
- ▶ learning curve visible
- ▶ essentially > 2 points for third attempt
- ▶ students use third attempt for "testing"

Online Test Results
135 participants, 268 attempts

Legend: 1st attempt, 2nd attempt, 3rd attempt, final result

points obtained / attempts

Potential of the package

Submission days
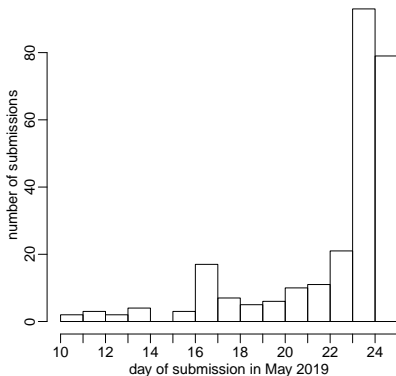
Fig.: Just in time!

Use of the package for offline tests

- use package as questions data base
- export tests in `pdf` format
- automatic evaluation of multiple choice questions
- manual evaluation of open questions

Fig.: source: *R/Exams* 2019
(`http://www.r-exams.org/`)

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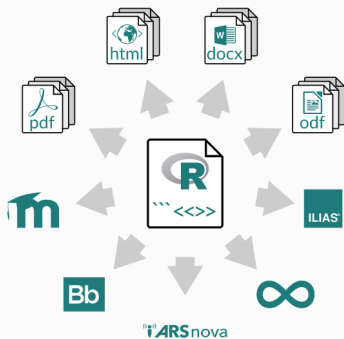**Department of Water, Atmosphere and Environment**
Institute of Hydraulic Engineering and River Research (IWA)

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/

University of Natural Resources
and Life Sciences, Vienna
Department of Water, Atmosphere
and Environment

References

R/Exams (2019). 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.