R/exams: A One-for-All Exams Generator
Written Exams, Online Tests, and Live Quizzes with R

Achim Zeileis
http://www.R-exams.org/
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Using the product rule for \( f(x) = g(x) \cdot h(x) \), where \( g(x) = 2^x \) and \( h(x) = \log_2(x) \), we obtain

\[
\begin{align*}
  f'(x) &= (g(x) \cdot h(x))' = g'(x) \cdot h(x) + g(x) \cdot h'(x) \\
  &= 9x^8 - \frac{1}{x^2} + x^9 \cdot e^{2.7x} \cdot 2.7 \\
  &= e^{2.7x} \cdot 9x^8 + 2.7x^9 \\
  &= e^{2.7x} \cdot x^9 \cdot (9 + 2.7x).
\end{align*}
\]

Evaluated at \( x = 0.88 \), the answer is

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Motivation and challenges

**Motivation:**

- Many of us teach large lecture courses, also as support for other fields.
- For example, statistics, probability, or mathematics in curricula such as business and economics, social sciences, psychology, etc.
- At WU Wien and Universität Innsbruck: Some courses are attended by more than 1,000 students per semester.
- Several lecturers teach lectures and tutorials in parallel.

**Strategy:**

- Individualized organization of learning, feedback, and assessment.
- The same pool of exercises at the core of all parts of the course.
Motivation and challenges

<table>
<thead>
<tr>
<th></th>
<th>Learning</th>
<th>Feedback</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Synchronous</strong></td>
<td>Lecture</td>
<td>Live quiz</td>
<td>Written exam</td>
</tr>
<tr>
<td></td>
<td>Live stream</td>
<td>(+ Tutorial)</td>
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<tr>
<td><strong>Asynchronous</strong></td>
<td>Textbook</td>
<td>Self test</td>
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<td>Screencast</td>
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Motivation and challenges

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<td></td>
</tr>
</tbody>
</table>

**Learning:**

- **Standard:** Textbook along with presentation slides.
- **Streaming:** Videos streamed simultaneously or (pre-)recorded.
## Motivation and challenges

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<td></td>
<td>Screencast</td>
<td>(+ Forum)</td>
<td></td>
</tr>
</tbody>
</table>

**Feedback & assessment:**

- **Scalability**: Randomized dynamic exercises required.
- **Feedback**: Support for complete correct solutions.
- **Flexibility**: Automatic rendering into different assessment formats.
R package *exams*

**Exercises:**
- Each exercise is a single file (either `.Rmd` or `.Rnw`).
- Contains question and (optionally) the corresponding solution.
- Dynamic templates if R code is used for randomization.

**Answer types:**
- Single choice and multiple choice.
- Numeric values.
- Text strings (typically short).
- Combinations of the above (cloze).
R package exams

Output:

- PDF – fully customizable vs. standardized with automatic scanning/evaluation.
- HTML – fully customizable vs. embedded into exchange formats below.
- Moodle XML.
- QTI XML standard (version 1.2 or 2.1), e.g., for OLAT/OpenOLAT.
- ARSnova, TCExam, LOPS, …

Infrastructure: Standing on the shoulders of lots of open-source software…
## R package `exams`

<table>
<thead>
<tr>
<th>Type</th>
<th>Software</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistical computing</td>
<td>R</td>
<td>Random data generation, computations</td>
</tr>
<tr>
<td>Writing/reporting</td>
<td>\LaTeX, Markdown</td>
<td>Text formatting, mathematical notation</td>
</tr>
<tr>
<td>Reproducible research</td>
<td>knitr, rmarkdown, Sweave</td>
<td>Dynamically tie everything together</td>
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<td>Document conversion</td>
<td>TtH/TtM, pandoc</td>
<td>Conversion to HTML and beyond</td>
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<tr>
<td>Image manipulation</td>
<td>ImageMagick, magick, png</td>
<td>Embedding graphics</td>
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<tr>
<td>Web technologies</td>
<td>base64enc, RCurl, ...</td>
<td>Embedding supplementary files</td>
</tr>
<tr>
<td>Learning management</td>
<td>Moodle, OpenOLAT, ARSnova, ...</td>
<td>E-learning infrastructure</td>
</tr>
</tbody>
</table>
Exam 1

1. Question

What is the derivative of \( f(x) = x^3 \sqrt{7x} \), evaluated at \( x = 0.106 \)?

a. 44.03
b. 46.76
c. 35.63
d. 39.44
e. 30.24

Solution

Using the product rule for \( f(x) = g(x) \cdot h(x) \), where \( g(x) = x^3 \) and \( h(x) = \sqrt{7x} \), we obtain

\[
\frac{d}{dx}(f(x)) = \left[ g(x) \cdot h(x) \right] = g'(x) \cdot h(x) + g(x) \cdot h'(x)
\]

Evaluate \( g(x) = x^3 \), \( h(x) = \sqrt{7x} \):

\[
g(x) = x^3, \quad h(x) = \sqrt{7x} = (7x)^{1/2}
\]

Differentiate:

\[
g'(x) = 3x^2, \quad h'(x) = \frac{1}{2} \cdot 7x^{-1/2} = \frac{7}{2\sqrt{7x}}
\]

Combine:

\[
f'(x) = 3x^2 \cdot \sqrt{7x} + x^3 \cdot \frac{7}{2\sqrt{7x}}
\]

Evaluate at \( x = 0.106 \):

\[
f'(0.106) = 3(0.106)^2 \cdot \sqrt{7(0.106)} + (0.106)^3 \cdot \frac{7}{2\sqrt{7(0.106)}}
\]

Thus, rounded to two digits we have \( f'(0.106) = 44.03 \).

a. True
b. False
c. False

Dynamic Exercises
Dynamic exercises

Text file:
1. Random data generation (optional).
2. Question.

Examples:

- Multiple-choice knowledge quiz with shuffled answer alternatives.
  Which of these institutions already hosted a useR! or eRum conference?

- Dynamic numeric arithmetic exercise.
  What is the derivative of $f(x) = x^a e^{b \cdot x}$, evaluated at $x = c$?
Dynamic exercises: .Rmd

Example: Which of these institutions already hosted a useR! or eRum conference?
Dynamic exercises: .Rmd

Example: Which of these institutions already hosted a useR! or eRum conference?

Question
========
Which of these institutions already hosted a useR! or eRum conference?

Answerlist
----------
* Uniwersytet Ekonomiczny w Poznaniu
* Agrocampus Ouest
* Technische Universität Dortmund
* Universität Wien
* ETH Zürich
* Københavns Universitet
Dynamic exercises: .Rmd

**Example:** Which of these institutions already hosted a useR! or eRum conference?

**Solution**

The list of useR!/DSC and eRum hosts can be found at <https://www.R-project.org/conferences.html> and <https://erum.io/> respectively.

**Answerlist**

- True. eRum 2016 was hosted in Poznan.
- True. useR! 2009 was hosted at Agrocampus Ouest, Rennes.
- True. useR! 2008 was hosted at TU Dortmund.
- False. Universität Wien did not host an R conference yet (only TU Wien and WU Wien).
- False. ETH Zürich did not host an R conference yet.
- False. Københavns Universitet hosted DSC but not useR! or eRum.
Dynamic exercises: .Rmd

Example: Which of these institutions already hosted a useR! or eRum conference?

Solution

=======

The list of useR!/DSC and eRum hosts can be found at
<https://www.R-project.org/conferences.html> and <https://erum.io/>, respectively.

Answerlist

--------

* True. eRum 2016 was hosted in Poznan.
* True. useR! 2009 was hosted at Agrocampus Ouest, Rennes.
* True. useR! 2008 was hosted at TU Dortmund.
* False. Universität Wien did not host an R conference yet (only TU Wien and WU Wien).
* False. ETH Zürich did not host an R conference yet.
* False. Københavns Universitet hosted DSC but not useR! or eRum.

Meta-information

==============

exname: R conferences
extype: mchoice
exsolution: 111000
exshuffle: 5
Dynamic exercises: .Rnw

Example: What is the derivative of $f(x) = x^a e^{b \cdot x}$, evaluated at $x = c$?
Dynamic exercises: .Rnw

Example: What is the derivative of $f(x) = x^a e^{b \cdot x}$, evaluated at $x = c$?

```r
<<echo=FALSE, results=hide>>=
## parameters
a <- sample(2:9, 1)
b <- sample(seq(2, 4, 0.1), 1)
c <- sample(seq(0.5, 0.8, 0.01), 1)
## solution
res <- exp(b * c) * (a * c^(a-1) + b * c^a)
@
```
Example: What is the derivative of $f(x) = x^a e^{b \cdot x}$, evaluated at $x = c$?

```r
<<echo=FALSE, results=hide>>=
## parameters
a <- sample(2:9, 1)
b <- sample(seq(2, 4, 0.1), 1)
c <- sample(seq(0.5, 0.8, 0.01), 1)
## solution
res <- exp(b * c) * (a * c^(a-1) + b * c^a)
@

\begin{question}
What is the derivative of $f(x) = x^{\Sexpr{a}} e^{\Sexpr{b}x}$, evaluated at $x = \Sexpr{c}$?
\end{question}
```
Dynamic exercises: .Rnw

Example: What is the derivative of $f(x) = x^a e^{b \cdot x}$, evaluated at $x = c$?

\begin{solution}
Using the product rule for $f(x) = g(x) \cdot h(x)$, where $g(x) := x^{{a}}$ and $h(x) := e^{b \cdot x}$, we obtain
\begin{eqnarray*}
f'(x) & = & [g(x) \cdot h(x)]' = g'(x) \cdot h(x) + g(x) \cdot h'(x) \\
& = & {a} x^{a-1} \cdot e^{b \cdot x} + ...
\end{eqnarray*}
Evaluated at $x = {c}$, the answer is
\[ e^{b \cdot {c}} \cdot {c}^{a-1} \cdot (a + b \cdot {c}) = \text{fmt}(res, 6)}. \]
Thus, rounded to two digits we have $f'({c}) = \text{fmt}(res)$.\end{solution}

**Example:** What is the derivative of $f(x) = x^a e^{b \cdot x}$, evaluated at $x = c$?

\begin{solution}
Using the product rule for $f(x) = g(x) \cdot h(x)$, where $g(x) := x^\{\text{a}\}$ and $h(x) := e^{\{\text{b} \cdot x\}}$, we obtain
\begin{eqnarray*}
f'(x) & = & [g(x) \cdot h(x)]' = g'(x) \cdot h(x) + g(x) \cdot h'(x) \\\n& = & \text{a} \cdot x^{\{\text{a} - 1\}} \cdot e^{\{\text{b} \cdot x\}} + \\
& & \ldots
\end{eqnarray*}
Evaluated at $x = \text{c}$, the answer is
\[
\text{e}^{\{\text{b} \cdot \text{c}\}} \cdot \text{c}^{\{\text{a} - 1\}} \cdot (\text{a} + \text{b} \cdot \text{c}) = \text{fmt}(\text{res}, 6).
\]
Thus, rounded to two digits we have $f'(\text{c}) = \text{fmt}(\text{res})$.
\end{solution}

\extype{num}
\exsolution{\text{fmt}(\text{res})}
\exname{derivative exp}
\extol{0.01}
Dynamic exercises: Single choice

e xtype: schoice
exsolution: 010
Dynamic exercises: Single choice

Question
What is the seat of the federal authorities in Switzerland (i.e., the de facto capital)?

(a) Bern
(b) Lausanne
(c) Zurich
(d) St. Gallen
(e) Basel

Knowledge quiz: Shuffled distractors.
What is the derivative of \( f(x) = x^3 e^{3.3x} \), evaluated at \( x = 0.85 \)?

(a) 45.97  
(b) 35.82  
(c) 56.45  
(d) 69.32  
(e) 39.31

**Numeric exercises:** Distractors are random numbers and/or typical arithmetic mistakes.
Dynamic exercises: Multiple choice

extype: mchoice
exsolution: 011
Question
Which of these institutions already hosted a useR! or eRum conference?

(a) Agrocampus Ouest
(b) Universität Wien
(c) ETH Zürich
(d) Technische Universität Dortmund
(e) Uniwersytet Ekonomiczny w Poznaniu

Knowledge quiz: Shuffled true/false statements.
Question
In the following figure the distributions of a variable given by two samples (A and B) are represented by parallel boxplots. Which of the following statements are correct? (Comment: The statements are either about correct or clearly wrong.)

(a) The location of both distributions is about the same.
(b) Both distributions contain no outliers.

Interpretations: Statements that are approximately correct or clearly wrong.
Dynamic exercises: Numeric

extype: num
exsolution: 123.45
Dynamic exercises: Numeric

**Question**
Given the following information:

\[
\begin{align*}
\text{apple} + \text{pineapple} + \text{orange} &= 585 \\
\text{banana} + \text{orange} + \text{banana} &= 144 \\
\text{orange} + \text{banana} + \text{orange} &= 177
\end{align*}
\]

Compute:

\[
\begin{align*}
\text{banana} + \text{orange} + \text{pineapple} &= ?
\end{align*}
\]

**Numeric exercises**: Solving arithmetic problems.
Dynamic exercises: String

exetype: string
exsolution: ANSWER
Dynamic exercises: String

Question
What is the name of the R function for Poisson regression?

Knowledge quiz: Sample a word/phrase from a given vocabulary or list of question/answer pairs.

extype: string
exsolution: ANSWER
Dynamic exercises: Cloze

extype: cloze
exclozetype: mchoice|num
exsolution: 10|123.45
Question
Using the data provided in regression.csv estimate a linear regression of $y$ on $x$ and answer the following questions.

(a) $x$ and $y$ are not significantly correlated / $y$ increases significantly with $x$ / $y$ decreases significantly with $x$ 

(b) Estimated slope with respect to $x$:

Exercises with sub-tasks: Several questions based on same problem setting.
One-for-All
One-for-all

- The *same* exercise can be exported into different formats.
- Multiple standalone documents vs. combined exercise pool.
- Multiple-choice and single-choice supported in all output formats.
One-for-All

Idea: An exam is simply a list of exercise templates.

R> myexam <- list(
  +  "deriv2.Rnw",
  +  "fruit2.Rnw",
  +  c("ttest.Rnw", "boxplots.Rnw")
  +  )

Draw random exams:

- First randomly select one exercise from each list element.
- Generate random numbers/input for each selected exercise.
- Combine all exercises in output file(s) (PDF, HTML, …).
One-for-All

Written exam:

\begin{verbatim}
R> exams2nops(myexam, n = 3, dir = odir,
+    language = "hu", institution = "eRum 2018")
\end{verbatim}

Online test:

\begin{verbatim}
R> exams2moodle(myexam, n = 10, dir = odir)
\end{verbatim}

Live quiz:

\begin{verbatim}
R> exams2arsnova(myexam, n = 1, dir = odir)
\end{verbatim}

Other: exams2pdf(), exams2html(), exams2qti12(), exams2qti21(),...
| Written Exams |
Written Exams

**Flexible:** Roll your own.
- Combination with user-specified template in `exams2pdf()` and `exams2pandoc()`.
- Customizable but typically has to be evaluated “by hand”.

**Standardized:** “NOPS” format.
- `exams2nops()` intended for single- and multiple-choice questions.
- Can be scanned and evaluated automatically within R.
- Limited support for open-ended questions that have to be marked by a person.
1. What is the derivative of \( f(x) = x^7e^{3.7x} \), evaluated at \( x = 0.83 \)?
   (a) 49.35  
   (b) 87.17  
   (c) 71.00  
   (d) 72.46  
   (e) 55.20

2. Given the following information:
   \[ \begin{align*}
   + & + = 282 \\
   + & + = 137 \\
   + & + = 106 \\
   \end{align*} \]
   Compute:
   \( + + = ? \)
   (a) 106  
   (b) 313  
   (c) 161  
   (d) 232  
   (e) 454

3. The waiting time (in minutes) at the cashier of two supermarket chains with different cashier systems is compared. The following statistical test was performed:
   Two Sample t-test
   data: Waiting by Supermarket
   t = -3.3, df = 90, p-value = 1
   alternative hypothesis: true difference in means is greater than 0
   95 percent confidence interval:
   -3.227 Inf
   sample estimates:
   mean in group Sparag mean in group Consumo
   4.045 6.192
   Which of the following statements are correct? (Significance level 5%)
   (a) The absolute value of the test statistic is larger than 1.96.
   (b) A one-sided alternative was tested.
   (c) The p-value is larger than 0.05.
   (d) The test shows that the waiting time is longer at Sparag than at Consumo.
   (e) The test shows that the waiting time is shorter at Sparag than at Consumo.
Written exams

1. Create
   - As illustrated above.
   - Using \texttt{exams2nops()} , create (individual) PDF files for each examinee.
Written exams

1. Create
   - As illustrated above.
   - Using `exams2nops()` to create (individual) PDF files for each examinee.

2. Print
   - Print the PDF exams, e.g., on a standard printer.
   - …or for large exams at a print shop.
Written exams

3. Exam

- Conduct the exam as usual.
- Collect the completed exams sheets.
Written exams

4. Scan

- Scan exam sheets, e.g., on a photocopier.
- Using `nops_scan()`, process the scanned exam sheets to machine-readable content.
Written exams

4. Scan
- Scan exam sheets, e.g., on a photocopier.
- Using `nops_scan()`, process the scanned exam sheets to machine-readable content.

5. Evaluate
- Using `nops_eval()`, evaluate the exam to obtain marks, points, etc. and individual HTML reports for each examinee.
- Required files: Correct answers (1.), scans (4.), and a participant list in CSV format.
## Written exams

### A vizsga eredménye

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<tr>
<th>Név:</th>
<th>Jane Doe</th>
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<tbody>
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<td>1501090</td>
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### Értékelés

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<td>abc_e</td>
<td>abc___</td>
</tr>
<tr>
<td>3</td>
<td>0.000000</td>
<td>___</td>
<td>ab_d___</td>
</tr>
<tr>
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<td>c___</td>
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<tr>
<td>6</td>
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### Vizsgalap

R University
Exam 2015-07-29

### A vizsga eredménye

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<tr>
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<th>Ambi Dexter</th>
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<td>Regisztrációs szám:</td>
<td>9901071</td>
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<td>d___</td>
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<tr>
<td>2</td>
<td>0.0</td>
<td>a_cde</td>
<td>ab_d___</td>
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<td>0.0</td>
<td>b___</td>
<td>e___</td>
</tr>
<tr>
<td>4</td>
<td>0.0</td>
<td>___</td>
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<tr>
<td>6</td>
<td>1.5</td>
<td>abc___</td>
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### Vizsgalap

Universität Innsbruck
Klausur 2015-07-29

### Personal Data

- **Family Name:** DOE
- **Given Name:** JANE
- **Signature:** [Signature Image]

### Persönliche Daten

- **Nachname:** Dexter
- **Vorname:** Ambi
- **Unterschrift:** [Signature Image]
E-Learning
1. Goal

- Online tests with flexible exercise types.
- Possibly: Dynamic supplements and/or complete correct solution.
- Random variations of similar exercises to reduce the risk of cheating.
- Use university’s learning management system, e.g., Moodle, …
2. Create

- Draw random replications from exercise templates, e.g., via exams2moodle(), ...
- Automatically embed these into exchange file format (typically via HTML/XML).
E-Learning

2. Create

- Draw random replications from exercise templates, e.g., via exams2moodle(), …
- Automatically embed these into exchange file format (typically via HTML/XML).

3. Import

- Import in learning management system.
- From there handling “as usual” in the system.
Preview question: R01 Q1: deriv

What is the derivative of $f(x) = x^3 \cdot 3x^2$, evaluated at $x = 0.75$?

**Answer**: 51.83594

Check

Using the product rule for $f(x) = g(x) \cdot h(x)$, where $g(x) = x^3$ and $h(x) = 3x^2$, we obtain

$$f'(x) = [g(x) \cdot h(x)]' = g'(x) \cdot h(x) + g(x) \cdot h'(x)$$

$$= 3x^2 \cdot 3x^2 + x^3 \cdot 6x$$

$$= 9x^4 + 6x^4$$

$$= 15x^4$$

Evaluated at $x = 0.75$, the answer is

$$15 \cdot 0.75^4 = 15 \cdot 0.390625 = 5.859375$$

Thus, rounded to two digits we have $f'(0.75) = 5.86$.

The correct answer is: 5.86

Start again | Save | Fill in correct responses | Submit and finish | Close preview
E-Learning: Online test

Question 1 point

The waiting time (in minutes) at the cashier of two supermarket chains with different cashier systems is compared. The following statistical test was performed:

Two Sample t-test

data:  Waiting by Supermarket
  t = -0.90169, df = 139, p-value = 0.3704
  alternative hypothesis: true difference in means is less than 0
  95 percent confidence interval:
    Inf 0.8682572
  sample estimates:
  mean in group Sparag mean in group Consumo
    7.688248  7.862992

Which of the following statements are correct? (Significance level 5% )

- a. The absolute value of the test statistic is larger than 1.96.
- b. A one-sided alternative was tested.
- c. The p value is larger than 0.05 .
- d. The test shows that the waiting time is longer at Sparag than at Consumo.

Using the data provided in regression.csv estimate a linear regression of y on x and answer the following questions.

- a.1. x and y are not significantly correlated
- a.2. y increases significantly with x
- a.3. y decreases significantly with x

b. Estimated slope with respect to x: -0.98
E-Learning: Live quiz

1. Which of these institutions already hosted a useR! or eRum conference?
   - Universitäts Wien
   - ETH Zürich
   - Københavns Universitet

2. What is the derivative of $f(x) = x^9 e^{2x}$, evaluated at $x = 0.7$?
   - 2.43
   - 3.70
   - 2.10

3. Given the following information:

<table>
<thead>
<tr>
<th>Banana</th>
<th>Orange</th>
<th>Pear</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>470</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>502</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>2</td>
<td>166</td>
</tr>
</tbody>
</table>

   Compute:
   - $\text{Banana} + \text{Orange} + \text{Pear} = ?$
What else?

Under development:

- Many volunteers: Internationalization for “NOPS” exams.
- Nikolaus Umlauf: Exercise “stress tester”.
- Stefan Coors, Nikolaus Umlauf: Graphical exams manager based on shiny that can be used on a local machine or on a server.
- Achim Zeileis: Reports for lecturers based on IRT models.
- Niels Smits: Better management of exercise categories.
- Mirko Birbaumer, Andreas Melillo, Achim Zeileis: Ilias interface based on QTI 1.2.
Stress tester

R> s <- stresstest_exercise("deriv2.Rnw")
R> plot(s)
Stress tester

R> s <- stresstest_exercise("deriv2.Rnw")
R> plot(s)
Graphical exams manager
Graphical exams manager

Question
In the following figure the distributions of a variable given by two samples (A and B) are represented by parallel boxplots. Which of the following statements are correct? (Comment: The statements are either all correct or clearly wrong.)

Solution
a. The location of both distributions is about the same.
b. Both distributions contain no outliers.
c. The spread in sample A is clearly bigger than in B.
d. The skewness of both samples is similar.
e. Distribution B is left-skewed.
Examining exams

Report: Exercise difficulty, student performance, unidimensionality, fairness.

Methods: Psychometrics, especially item response theory.

Example: End-term exam from first-year mathematics course for business and economics students at Universität Innsbruck.
- 729 students (out of 941 registered).
- 13 single-choice exercises on the basics of analysis, linear algebra, financial mathematics.
- Two groups with partially different pools of exercise templates.

R> library("psychotools")
R> data("MathExam14W", package = "psychotools")
R> mex <- subset(MathExam14W, nsolved > 0 & nsolved < 13)
Examining exams

**Item difficulty**: Raw proportions vs. Rasch model.

R> plot(mex$solved, ...)
R> mr <- raschmodel(mex$solved)
R> plot(mr, ...)
Examining exams

Student performance: Points and person-item map.

R> hist(MathExam14W$points, ...)
R> piplot(mr)
Examining exams

Unidimensionality: Principal component analysis.

R> pr <- prcomp(mex$solved, scale = TRUE)
R> plot(pr, ...)
R> biplot(pr, ...)

[Graph and chart showing principal component analysis results with unidimensionality assessment]
Examining exams

**Fairness:** Differential item functioning.

```r
R> ma <- anchortest(solved ~ group, data = mex, adjust = "single-step")
R> plot(ma$final_tests, ...)
```

![Graph showing item difficulty parameters and family-wise 95% confidence intervals](image)
Recommendations

If you want to try 📚 R/exams:

• Start with simple exercises before moving to more complex tasks.
• Focus on content of exercises.
• Don’t worry about layout/formatting too much.
• Try to build a team (with lecturers, assistants, etc.).
• Use exercise types creatively.
• Don’t be afraid to try stuff, especially in formative assessments.
• Thorough quality control for dynamic exercises before summative assessments.
Resources

**Contributors:** Zeileis, Grün, Leisch, Umlauf, Smits, Birbaumer, Ernst, Keller, Krimm, Stauffer.

**Links:**
- **CRAN**  [https://CRAN.R-project.org/package=exams](https://CRAN.R-project.org/package=exams)
- **Forum**  [http://R-Forge.R-project.org/forum/?group_id=1337](http://R-Forge.R-project.org/forum/?group_id=1337)
- **StackOverflow**  [https://stackoverflow.com/questions/tagged/exams](https://stackoverflow.com/questions/tagged/exams)
- **Twitter**  @AchimZeileis

**References:**