

SIAModules: **Modules** for ShinyItemAnalysis

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Psychoco, Zurich, June 8, 2023

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1. Introduction
2. ShinyItemAnalysis
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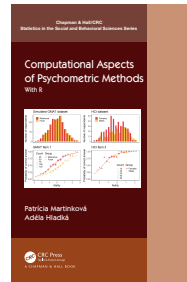
Motivation: Dissemination of psychometric research

- Psychometrics deals with the advancement of quantitative measurement practices in psychology, education, health, and many other fields
- Covers a number of statistical methods that are useful for the behavioral and social sciences:
 - Estimation of reliability to deal with the omnipresence of measurement error
 - Detailed description of item functioning encompassed in item response theory (IRT) models
 - New methods are being developed
- Many of those who use psychometric methods are new to R

Motivation: Teaching psychometrics with R

Goals

- Explain psychometric models and methods
 - In context of statistics and data science
 - Step-by-step development of models
- Illustrate important computational aspects
 - Real and simulated data from various fields
- Present toolbox of R functions and packages
 - Similarities/differences across different packages
- Make procedures and concepts better available
 - Interactive ShinyItemAnalysis application



Martinková & Hladká (n.d.)

ShinyItemAnalysis

Software for psychometric analysis of educational tests, psychological assessments, health-related and other types of multi-item measurements

- R package
 - Version 1.5.0 on [CRAN](#), newest version on [GitHub](#)
- Interactive shiny application
 - Accessible locally from R with `run_app()` function
 - Online at ICS server and shinyapps.io

<https://shiny.cs.cas.cz/ShinyItemAnalysis/>

<https://cemp.shinyapps.io/ShinyItemAnalysis/>

Martinková and Drabinová (n.d.). ShinyItemAnalysis for teaching psychometrics and to enforce routine analysis of educational tests. *The R Journal*. 10(2), 503–515.

<https://doi.org/10.32614/RJ-2018-074>

ShinyItemAnalysis

- Psychometric topics organized in sections

ShinyItemAnalysis Test and item analysis

Home Data Scores Validity Reliability Item analysis Regression IRT models DIF/Fairness Modules Reports

of multi-item measurements, or ratings from multiple raters, built on R and shiny. You can easily start using the application with also select from a number of other toy datasets or upload your own in the **Data** section. Offered methods include:

- Exploration of total and standard scores in the **Summary** section
- Analysis of measurement error in the **Reliability** section
- Correlation structure and criterion validity analysis in the **Validity** section
- Item and distractor analysis in the **Item analysis** section
- Item analysis with regression models in the **Regression** section
- Item analysis by item response theory models in the **IRT models** section
- Detection of differential item functioning in the **DIF/Fairness** section

All graphical outputs and selected tables can be downloaded via the download button. Moreover, you can automatically generate a HTML or PDF report in the **Reports** section. All offered analyses are complemented by selected R codes which are ready to be copied and pasted into your R console, therefore a similar analysis can be run and modified in R.

Visit the www.ShinyItemAnalysis.org webpage to learn more about ShinyItemAnalysis!

News


- A new book using ShinyItemAnalysis forthcoming! [Martinkova & Hladka \(2023\). Computational Aspects of Psychometric Methods: With R. \(1st ed.\)](#), Chapman and Hall/CRC.
- A new paper on range-restricted inter-rater reliability has been published in JRSS-A ([Eroshova, Martinkova, & Lee, 2021](#)). To try examples interactively with the **AIBS** dataset, go to the Restricted-range Reliability Module available from the **Reliability** section.
- A new paper using DIF-C analysis has been published in Journal of Computer Assisted Learning ([Kolek, Sisler, Martinkova, & Brom, 2021](#)). To try examples interactively with the **AttitudesExpulsion** dataset, go to the **DIF-C** Module available from the **DIF** section.
- New papers on differential item functioning have been published in Learning and Instruction ([Martinkova, Hladka, & Potuznikova, 2020](#)) and in The R Journal ([Hladka & Martinkova, 2020](#)). To try these examples interactively, set the **Learning to Learn 9** toy dataset in the **Data** section by clicking on the menu in the upper left corner and go to the **DIF/Fairness/Generalized logistic** section.



ShinyItemAnalysis Test and item analysis via Shiny | Version 1.5.0
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Hits:42076

Toy datasets

- Number of toy datasets, upload of one's own data is possible

 ShinyItemAnalysis Test and item analysis





[Home](#) [Data](#) [Scores](#) [Validity](#) [Reliability](#) [Item analysis](#) [Regression](#) [IRT models](#) [DIF/Fairness](#) [Modules](#) [Reports](#)  

Upload your own datasets

Here you can upload your own dataset. Select all necessary files and use the **Upload data** button on bottom of this page. For sample .csv data and details on input format, check the Supplementary material of the [Martinkova and Drabinova \(2018\)](#) article.

Choose data (CSV file)

The main **data** file should contain the responses of individual respondents (rows) to given items (columns). Data need to be either binary, nominal (e.g. in ABCD format), or ordinal (e.g. in Likert scale). The header may contain item names, however, no row names should be included. In all data sets, the **header** should be either included or excluded. If you want to rename items to the Item and a number of a particular column, uncheck the box **Keep item names** below. Missing values in scored data are by default evaluated as 0. If you want to keep them as missing, uncheck the box **Replace missing values by 0** below. In that case, total scores for rows with any missing values are going to be NAs as well.


Type of data 	Separator	Quote	Data specification	Missing values
<input type="radio"/> Binary	<input checked="" type="radio"/> Comma	<input checked="" type="radio"/> None	<input checked="" type="checkbox"/> Header 	<input checked="" type="checkbox"/> Replace missing values by 0 
<input checked="" type="radio"/> Nominal	<input type="radio"/> Semicolon	<input type="radio"/> Double Quote	<input type="checkbox"/> Keep item names 	
<input type="radio"/> Ordinal	<input type="radio"/> Tab	<input type="radio"/> Single Quote		




Choose key (CSV file)

For nominal data, it is necessary to upload **key** of correct answers.

Choose group (optional)

Group is a variable for DIF and DDF analyses. It should be a binary vector, where 0 represents the reference group and 1 represents the focal group. Its length needs to be the same as the number of individual respondents in the main dataset.

 ShinyItemAnalysis Test and item analysis via Shiny | Version 1.5.0
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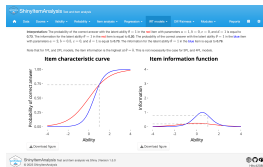
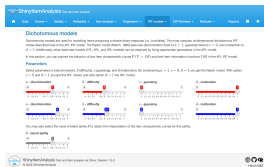
Interactive presentations

- Statistics and plots displayed interactively (plotly)



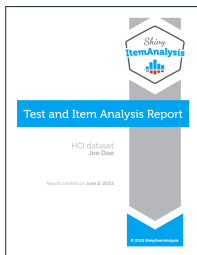
Training sections

- Interactive training sections
 - Currently for IRT models and DIF
 - Demonstrations of item characteristic and information curves
 - Exercise sections

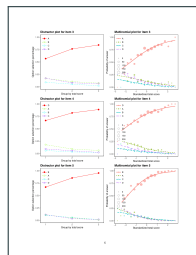
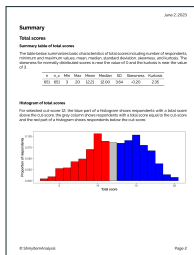


Automatic report generation

- Generating PDF/HTML reports for uploaded (or toy) data
- Generated using rmarkdown



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Some further notable features of ShinyItemAnalysis

- Interactive presentations - statistics, plots (plotly)
- Toy data, possibility to upload one's own data
- Training sections, quizzes
- Possibility to download PDF/HTML reports
- Possibility to download tables and figures
- Sample R code for each section
- `run_app()` function runs the app in the background by default in RStudio IDE, keeping the console available
- Starting from v1.5.0, additional modules can be easily incorporated

SIA modules

- Integrate with and build upon the `ShinyItemAnalysis` app
- A module consists of server logic and UI function pair; these are defined as regular functions in `R/` directory of a package
- `ShinyItemAnalysis` app automatically searches for SIA modules in installed R packages and incorporates them into the app's UI
 - A package needs to have
`Config/ShinyItemAnalysis/module: true`
line declared in its `DESCRIPTION` to be searched for modules
 - A modules' title, category and function bindings are obtained from `inst/sia/modules.yml` file located in a package
 - A package with SIA modules is loaded and attached, then modules' functions are called and added in respective sections (section `Modules` by default)

SIA modules

Recommended structure:

- Introduction to the topic
 - Description, citation, equations, etc.
- Interactive part
 - Interactive figure(s) (plotly, etc.)
 - Interactively updated statistics or other outputs
- Sample R code
- Full reference to the method if available
- Possibly Acknowledgements, author contributions

Examples – SIAModules package

- SIAModules package: A curated collection of extension modules for the ShinyItemAnalysis interactive app
- Three modules at the moment:
 - Computerized adaptive tests
 - Range-restricted reliability
 - Differential item functioning in change (DIF-C)

Martinková and Netík (n.d.). *SIAModules: Modules for 'ShinyItemAnalysis'*. R package version 0.1.0. <https://CRAN.R-project.org/package=SIAModules>

Example 1: CAT post-hoc simulation

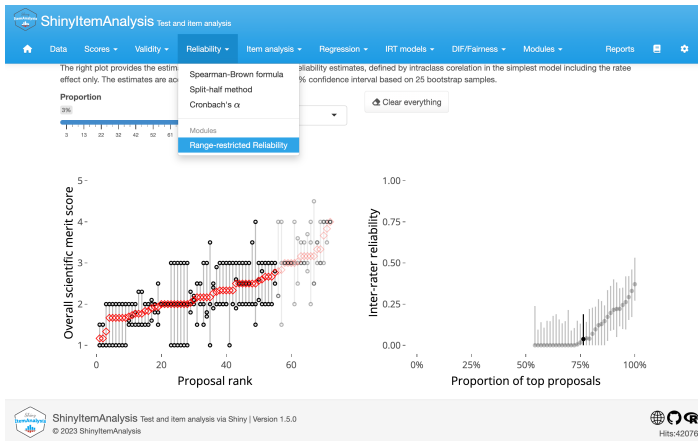
The screenshot displays the ShinyItemAnalysis web application interface. The top navigation bar includes a home icon, a menu with options like Data, Scores, Validity, Reliability, Item analysis, Regression, IRT models, DIF/Fairness, Modules, Reports, and a settings icon. The 'Modules' dropdown menu is open, showing options like Description, About the modules, Modules, and Computerized Adaptive Tests (which is highlighted).

The main content area shows the 'IRT model to use' set to 'Selected Nominal Response Model'. Below this are three sliders: 'Respondent's true ability (θ)' with a value of 1.4, 'Min. SE' with a value of 0.35, and 'CAT step' with a value of 5. The 'CAT step' slider has a blue arrow pointing to the right.

The central plot shows 'ability' on the y-axis (ranging from 0 to 4) and 'ability estimate' on the x-axis (ranging from 0 to 20). A dashed horizontal line is at approximately 1.16. The plot displays a series of blue lines representing individual ability estimates over time, with a shaded gray area indicating the confidence interval. Text on the plot reads: 'Current ability est.: 1.16', 'Next item: 6', and 'Next item response: correct'.

The footer contains the ShinyItemAnalysis logo, the text 'ShinyItemAnalysis Test and item analysis via Shiny | Version 1.5.0', '© 2023 ShinyItemAnalysis', and social media icons for GitHub, R, and Shiny, along with the text 'Hits:42076'.

Example 2: IRR in restricted range



Eroshva, Martinková, and Lee (n.d.). When zero may not be zero: A cautionary note on the use of inter-rater reliability in evaluating grant peer review. *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, 184(3), 904—919.

Example 3: DIF-C

The screenshot displays the ShinyItemAnalysis web application. The top navigation bar includes a home icon, 'Data', 'Scores', 'Validity', 'Reliability', 'Item analysis', 'Regression', 'IRT models', 'DIF/Fairness', 'Modules', 'Reports', and a settings icon. The main content area is titled 'Differential Item Functioning in Change (DIF-C)'. Below the title is a paragraph of text explaining the module's purpose and citing Martinková, Hladká, and Potužníková (2020). There are three tabs: 'Total scores', 'DIF-C Summary' (which is active), and 'DIF-C Items'. Under 'Method specification', there are several sections: 'Model' (3PLog), 'Type' (checkboxes for a, b, c, d), 'Correction method' (None), 'Observed score' (Grade 6), and 'Item' (a slider). A dropdown menu is open over the 'DIF/Fairness' tab, listing various methods and models such as 'Delta plot', 'Mantel-Haenszel', 'SIBTEST', 'Logistic regression', 'Generalized logistic', 'IRT Lord', 'IRT Raju', 'Method comparison', 'Cumulative logit', and 'Adjacent category logit'. The footer of the application shows the ShinyItemAnalysis logo, version information (1.5.0), and a 'Hits:42076' counter.

Martinková, Hladká, and Potužníková (n.d.). Is academic tracking related to gains in learning competence? Using propensity score matching and differential item change functioning analysis [...] *Learning and Instruction*, 66, 101286.

SIAtools for easy modules building

- SIAtools package provides a companion tool aiding with the creation and management of the modules
- Developers can create a standalone module in a new R package using the RStudio project wizard, or can add any number of modules to their existing packages
- SIAtools automatically create all necessary infrastructure and open the files you need to edit
- `preview_module` function is designed to preview any work-in-progress modules, mimicking the environment of the ShinyItemAnalysis app

Discussion

- Interactive presentations may help promote data science research and make it more available to wider range of users
- `ShinyItemAnalysis` for interactive presentation of psychometric topics and methods
- SIA modules to offer additional/new psychometric methods interactively and for wider use
- Sample modules in `SIAmModules` package
- SIA modules can be easily prepared with `SIAtools` package

- Collaboration is welcomed!

Invitation

- IMPS 2024 in Prague (mid July)





Thank you for your attention!

`www.cs.cas.cz/martinkova`



Acknowledgements:

- Czech Science Foundation grant 21-03658S
- Technology Agency of the Czech Republic grant TL05000008

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- Erosheva, E. A., Martinková, P., & Lee, C. J. (n.d.). When zero may not be zero: a cautionary note on the use of inter-rater reliability in evaluating grant peer review. , *184*(3), 904—919. doi: 10.1111/rssa.12681
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