# SIAmodules: **Modules for** ShinyItemAnalysis

Patrícia Martinková[1,2] & Jan Netík[1,2]

Psychoco, Zurich, June 8, 2023

[1] Institute of Computer Science, Czech Academy of Sciences
[2] Charles University

# Outline

1. Introduction
2. `ShinyItemAnalysis`
3. `SIAmodules`
4. `SIAtools`
5. Discussion

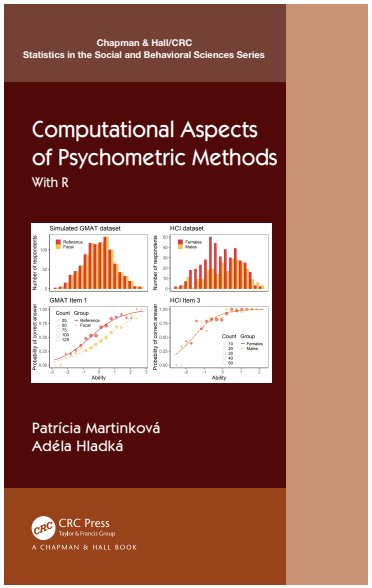
# Motivation: Dissemination of psychometric research

- 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/

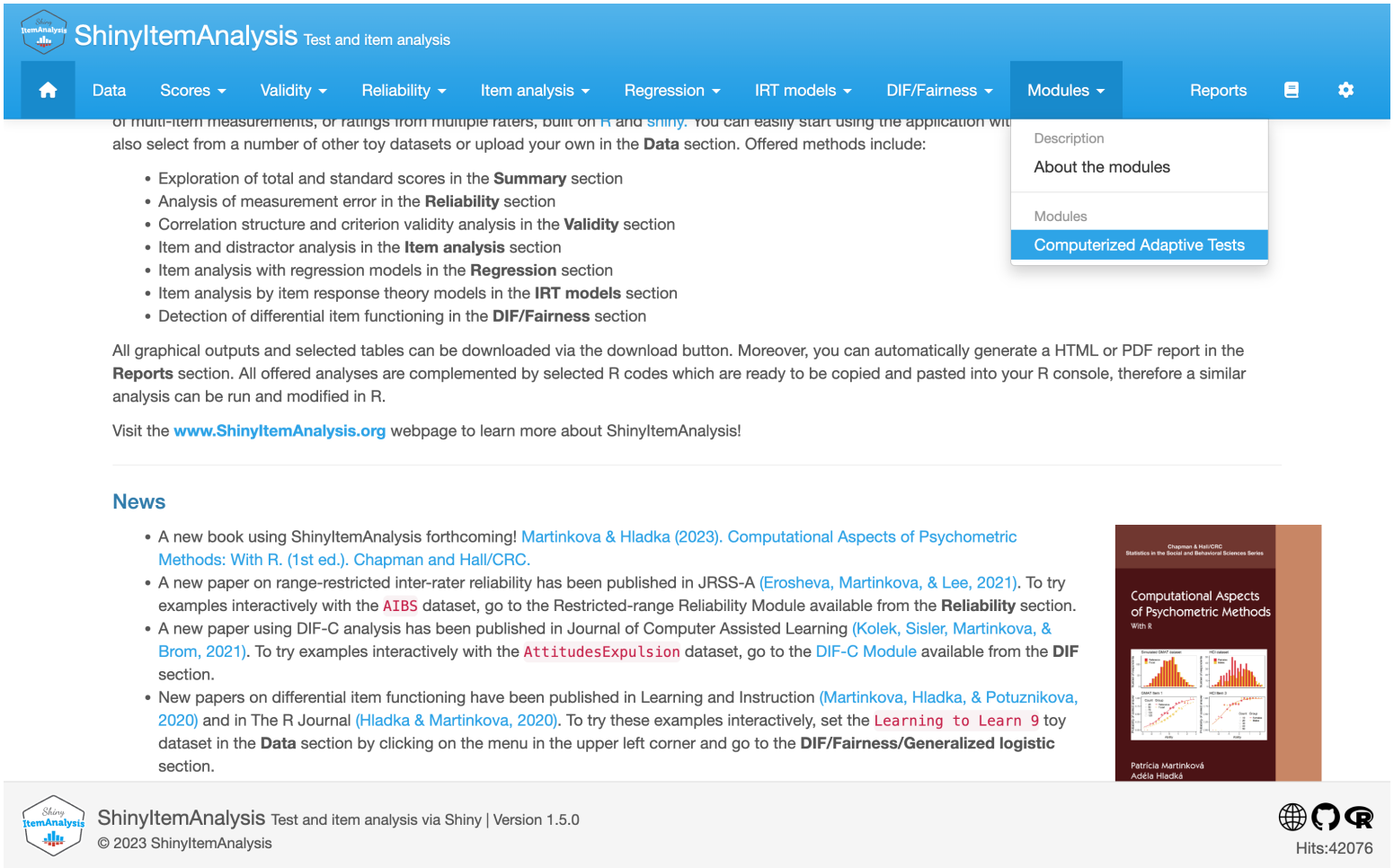
https://cemp.shinyapps.io/ShinyItemAnalysis/

---

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

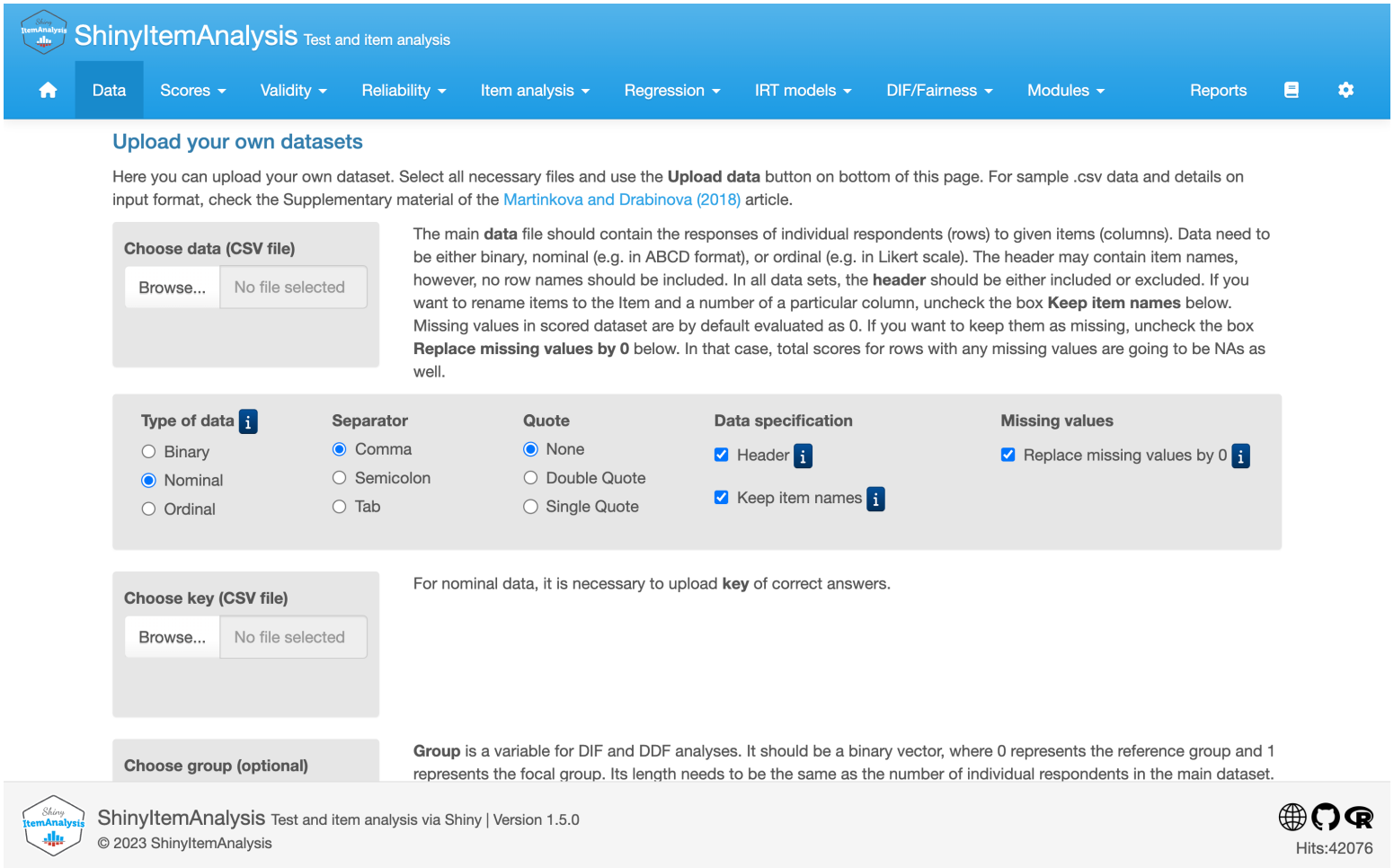
# ShinyItemAnalysis

- Psychometric topics organized in sections



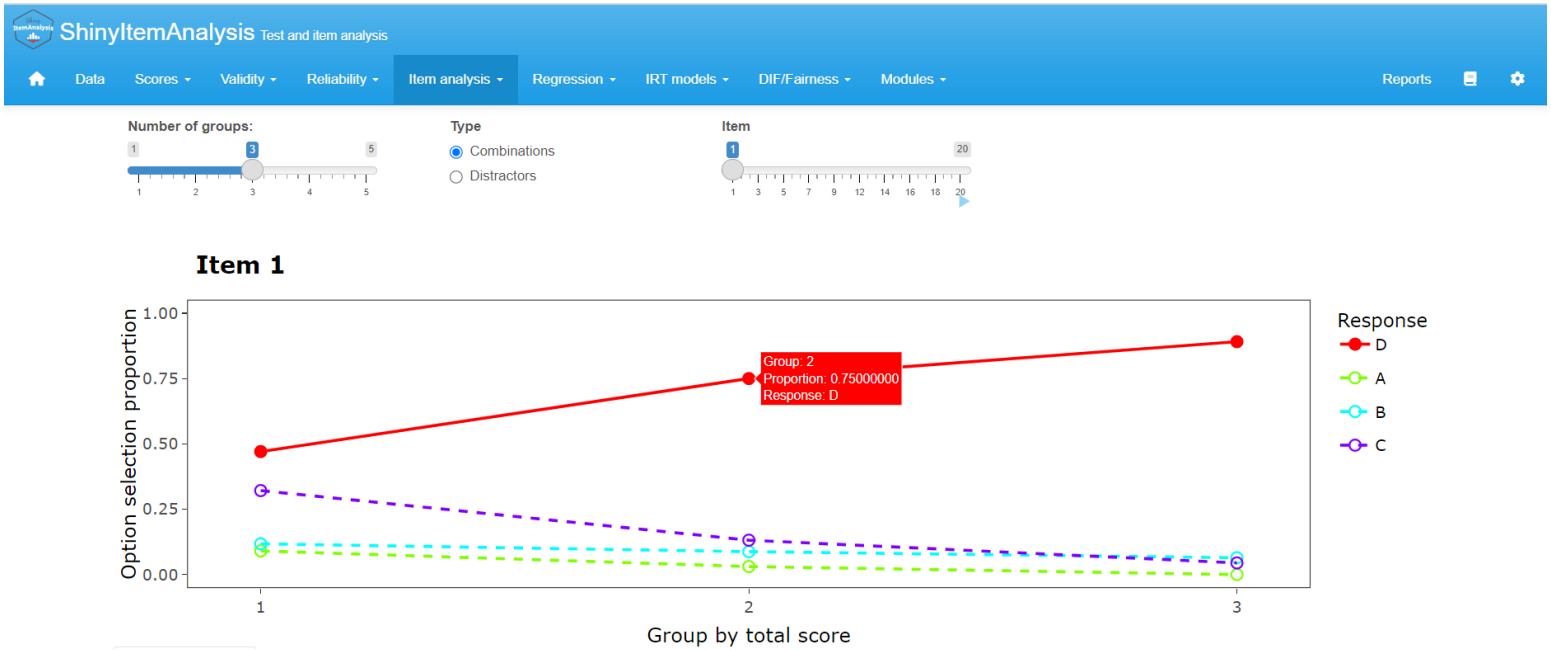
# Toy datasets

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



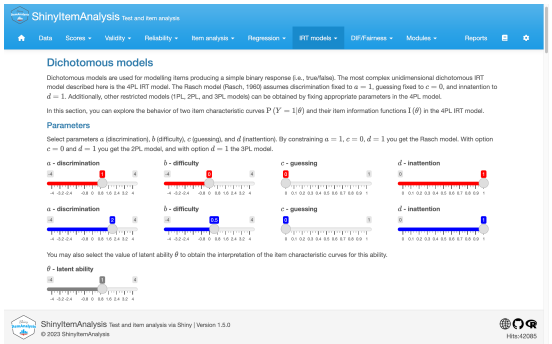
# Interactive presentations

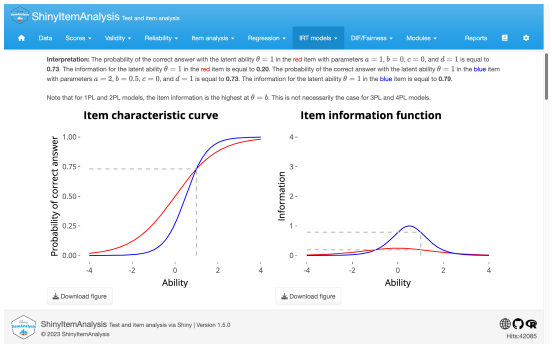
- Statistics and plots displayed interactively (`plotly`)

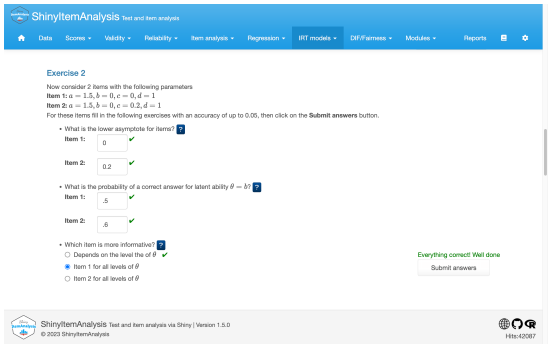


# Training sections

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

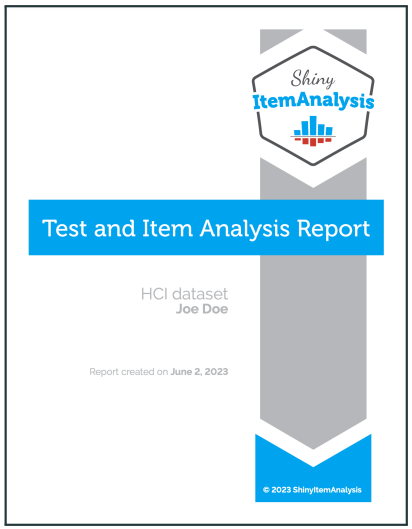


# Automatic report generation

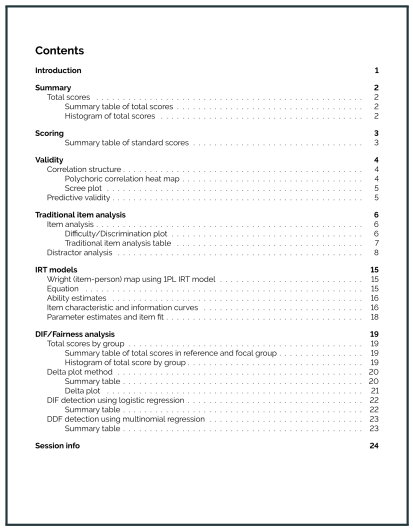
- Generating PDF/HTML reports for uploaded (or toy) data
- Generated using `rmarkdown`


Test and Item Analysis Report

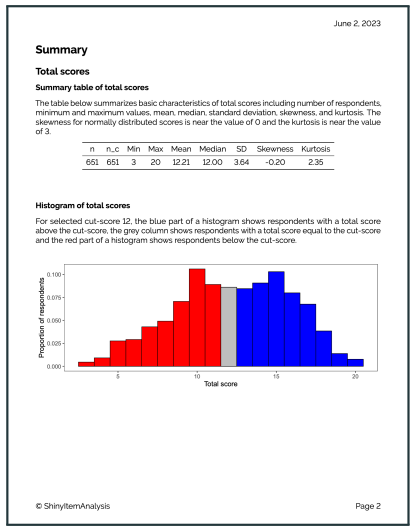
HCI dataset
Joe Doe

Report created on June 2, 2023

© 2023 ShinyItemAnalysis


Contents




June 2, 2023

Summary

Total scores

Summary table of total scores

The table below summarizes basic characteristics of total scores including number of respondents, minimum and maximum values, mean, median, standard deviation, skewness, and kurtosis. The skewness for normally distributed scores is near the value of 0 and the kurtosis is near the value of 3.

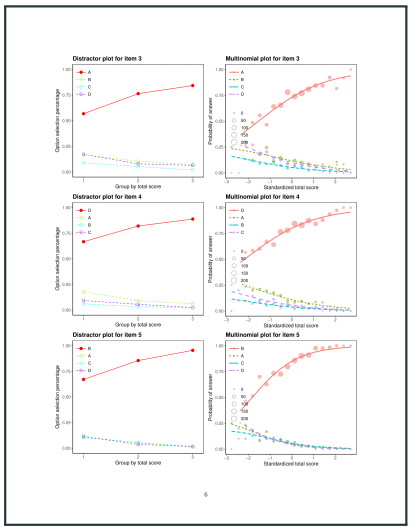
| n | n_c | Min | Max | Mean | Median | SD | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|
| 651 | 651 | 3 | 20 | 12.21 | 12.00 | 3.64 | -0.20 | 2.35 |

Histogram of total scores

For selected cut-score 12, the blue part of a histogram shows respondents with a total score above the cut-score, the grey column shows respondents with a total score equal to the cut-score and the red part of a histogram shows respondents below the cut-score.




© ShinyItemAnalysis Page 2



# 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:

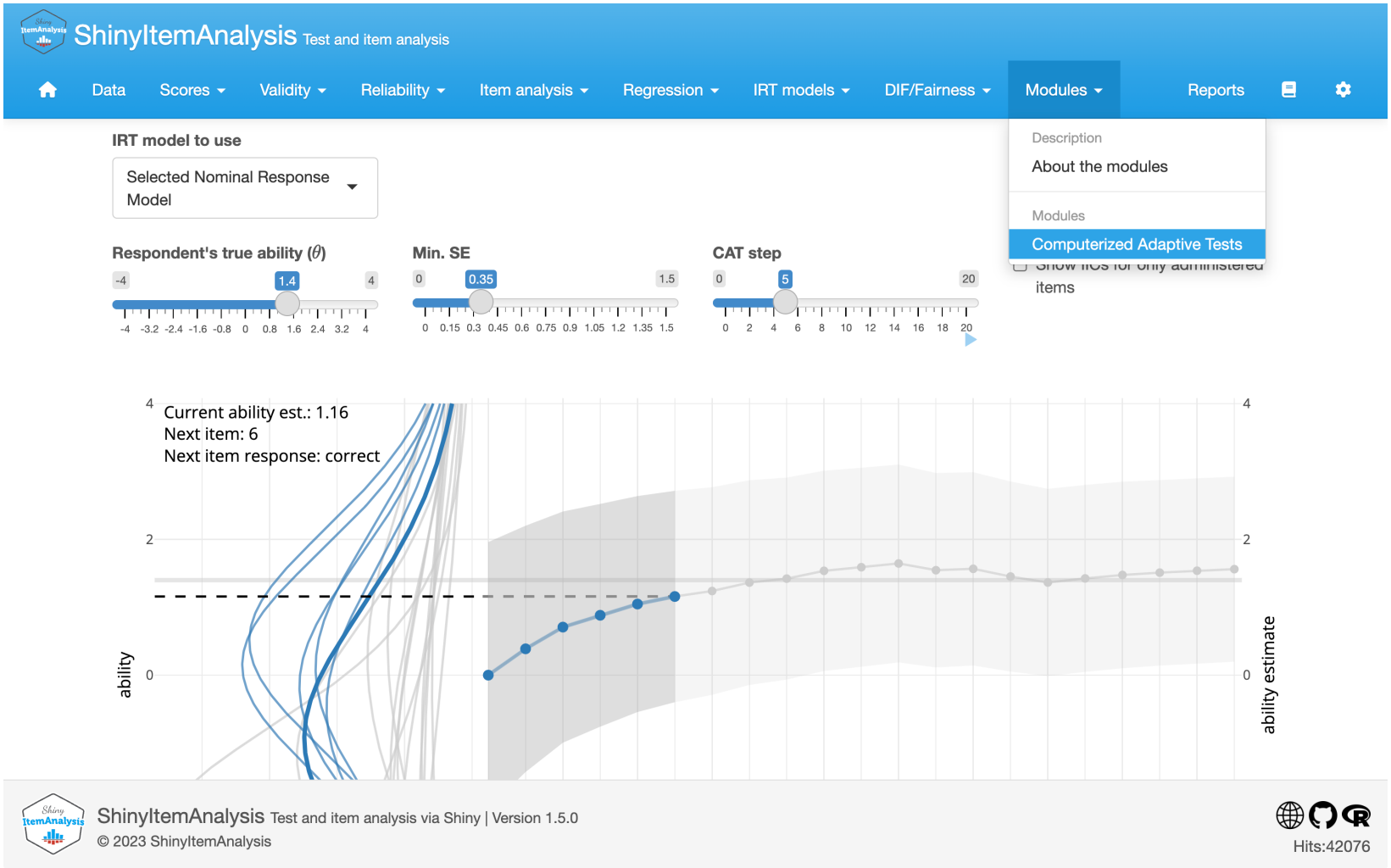
- Introduction to the topic
  - Description, citation, equations, etc.
- Interactive part
  - Interactive figure(s) (`plotly`, etc.)
  - Interactively updated statistics or other outputs
- Sample `R` code
- Full reference to the method if available
- Possibly Acknowledgements, author contributions

# Examples – SIAmodules package

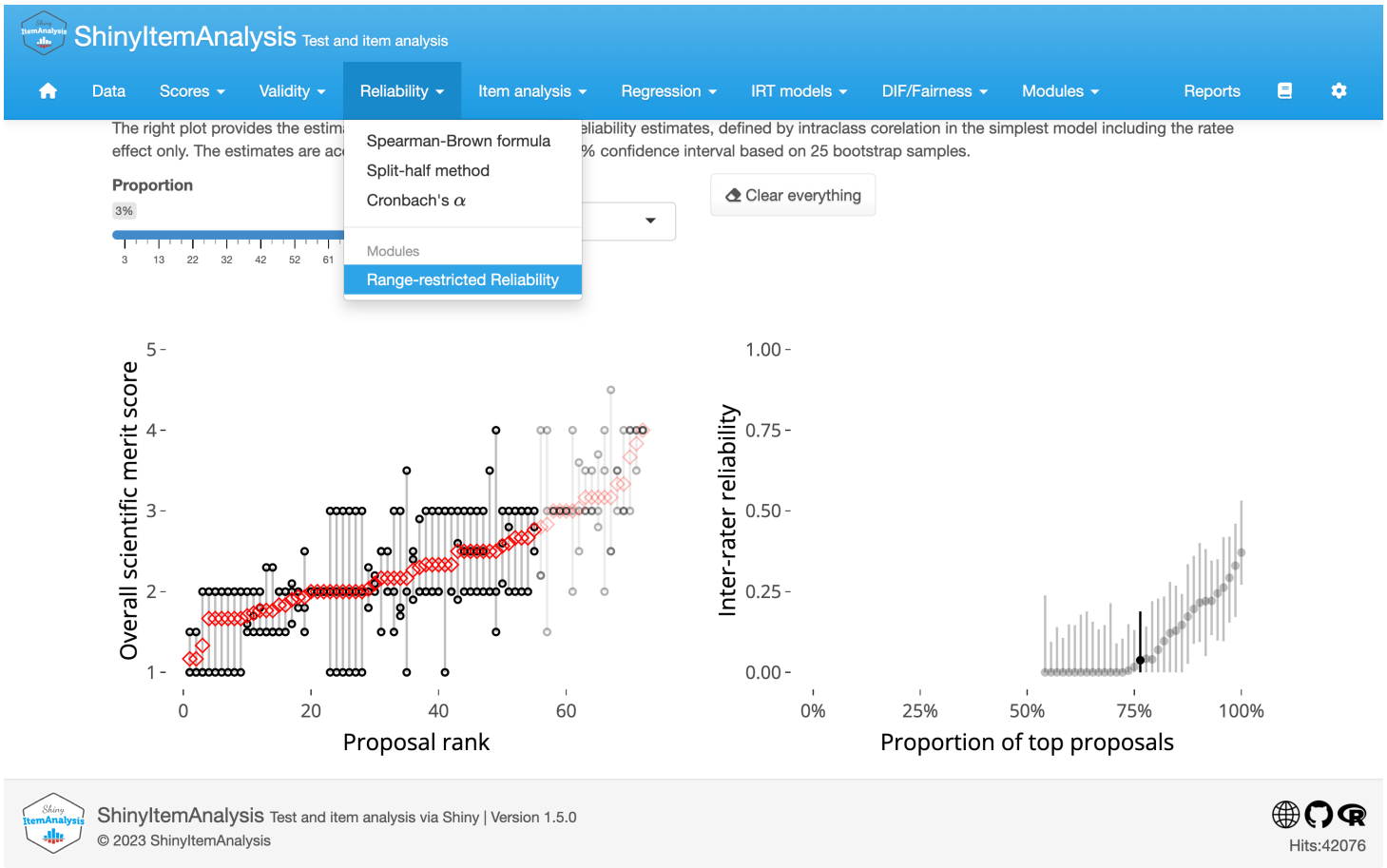
- SIAmodules package: A curated collection of extension modules for the ShinyItemAnalysis interactive app
- Three modules at the moment:
  - Computerized adaptive tests
  - Range-restricted reliability
  - Differential item functioning in change (DIF-C)

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

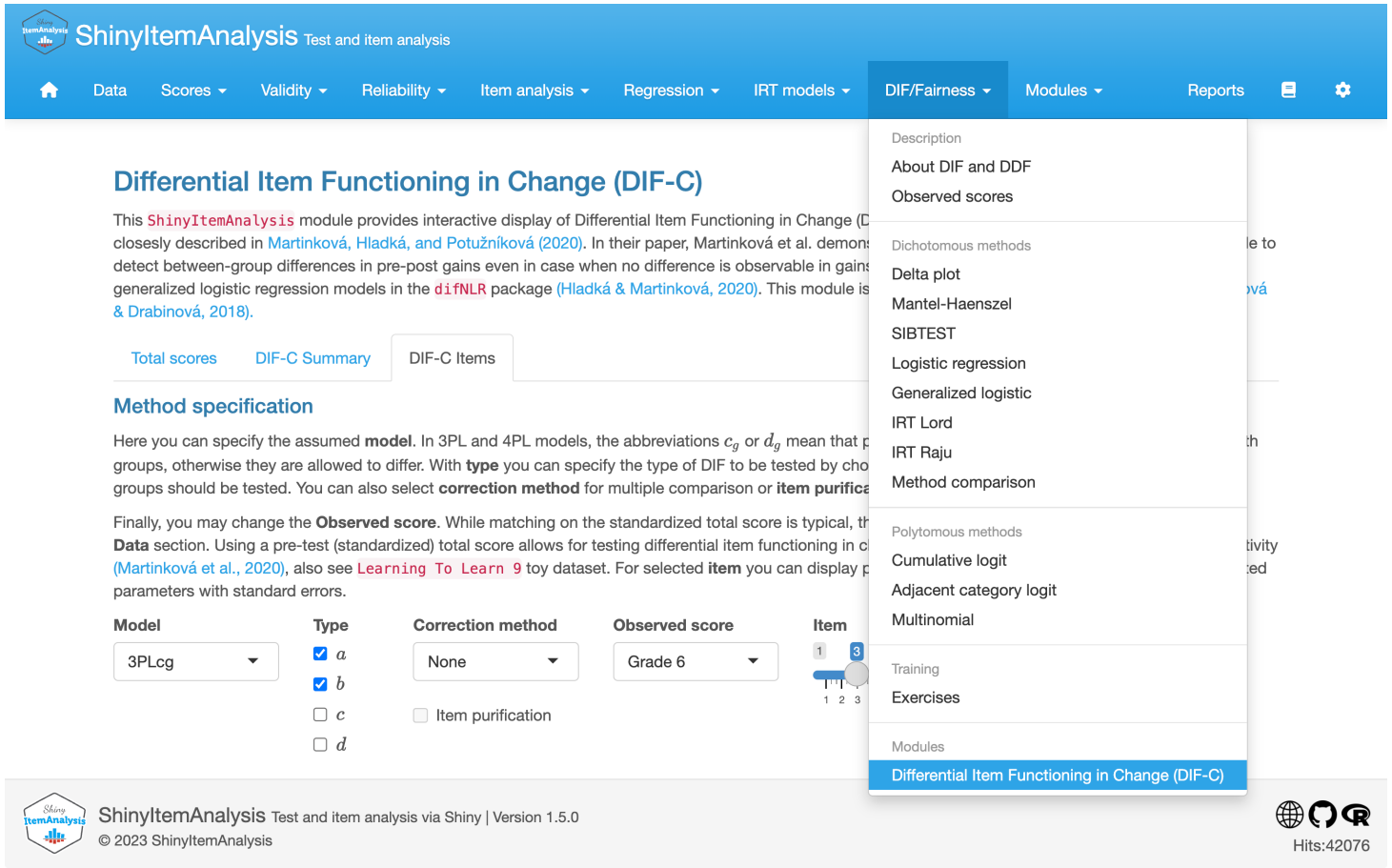


# Example 2: IRR in restricted range




Erosheva, 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




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 `SIAmodules` package
- SIA modules can be easily prepared with `SIAtools` package

- Collaboration is welcomed!

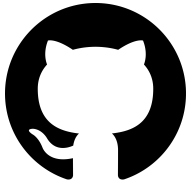
# Invitation

- 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

# References


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

Martinková, P., & Drabinová, A. (n.d.). ShinyItemAnalysis for teaching psychometrics and to enforce routine analysis of educational tests. , *10*(2), 503–515. doi: 10.32614/RJ-2018-074

Martinková, P., & Hladká, A. (n.d.). *Computational aspects of psychometric methods: With R*. Chapman and Hall/CRC. doi: 10.1201/9781003054313

Martinková, P., Hladká, A., & Potužnıková, E. (n.d.). Is academic tracking related to gains in learning competence? Using propensity score matching and differential item change functioning analysis for better understanding of tracking implications. , *66*, 101286. doi: 10.1016/j.learninstruc.2019.101286

Martinková, P., & Netík, J. (n.d.). *SIAmodules: Modules for 'ShinyItemAnalysis'.* Retrieved from `https://cran.r-project.org/package=SIAmodules` (R package version 0.1.1)