

ShinyItemAnalysis for psychometric training and research Patrícia Martinková^{1,2}, Adéla Drabinová^{1,2,3}



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IMPS 2018, Columbia University, New York City

Motivation

In some regions or scientific areas, understanding and use of psychometric concepts may be underdeveloped. Freely available and user friendly software may support dissemination of psychometric methods.

Many R packages cover general psychometric concepts or specific psychometric topics, however, for those new to R it may be hard to overcome the initial burden of R code-based environment.

Teaching psychometrics with ShinyItemAnalysis

ShinyItemAnalysis has some helpful features for teaching:

- Broad range of CTT as well as IRT methods, toy data examples
- Model equations, parameter estimates, and interactive interpretation of results
- Selected R code, ready to be copy-pasted and run in R
- Interactive training section including deploying item characteristic and item information curves for selected parameters and automatically graded exercises

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r and intricicials Select parameters a (discrimination), b (difficulty), c (guessing) and d (inalterition). By constraining $a = 1$, $c = 0$, $d = 1$ you get Rasch model. With option $c = 0$ and $d = 1$ you get 2PL model and with option $d = 1$ 3PL model. When different curve parameters describe properties of the same item but for different groups of respondents, this phenomenon is called Differential litem functioning (UP). See further section for more information.	Parameters Select number of responses and difficulty for cummulative probabilities b and common discrimination parameter a. Cummulative probability $P(Y \ge 0)$ is always equal to 1 and it is not displayed, corresponding category probability $P(Y = 0)$ is displayed with black color.	Exercise 1
a-distribution b-difficulty c-gravity d-instantion d-inst	Highest score 4	Consider the holiowing 2PL items with parameters Item 1: $a = 25, b = -0.5$ Item 2: $a = 1.5, b = 0$ For these therefind the following exercises with an accuracy of up to 0.05. Then click on Submit answers button. If you need a hint, click on blue button with question mark.
a - discrimination b - difficulty c - guessing d - inaltention	8 0 8 6 6 6 2 2 4 5 -	• Sketch item characteristic and information curves 2 × • Calculate probability of correct answer for latent abilities $\theta = -2, -1, 0, 1, 2$ 2 Item 1: $\theta = -2$ \checkmark $\theta = -1$ \times $\theta = 0$ \times $\theta = 1$ \times $\theta = 2$ \times
Select also the value of latent ability θ to see the integretation of the item characteristic curves.		0 0.3 0.4 0.9 0.9 Item 2: $\theta = -2$ \checkmark $\theta = -1$ \checkmark $\theta = 0$ \checkmark $\theta = 1$ \checkmark $\theta = 2$ \times 0 0.2 0.5 0.8 0.9

ShinyItemAnalysis

ShinyItemAnalysis (Martinková et al, 2018) İS an package and an online shiny application for R psychometric analysis of educational tests and their items. It was developed with the aim to

- Support teaching of psychometric concepts
- Present psychometric research
- Empower routine analysis of educational tests

ShinyItemAnalysis is available **online** at

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

It is also possible to install the package from **CRAN**

install.packages('ShinyItemAnalysis')

or **GitHub** (with devtools package)

install_github('patriciamar/ShinyItemAnalysis')

and run it locally:

library(ShinyItemAnalysis) startShinyItemAnalysis()

Example use scenarios



Presenting psychometric research

ShinyItemAnalysis is used to present our current results in psychometric research in an interactive way:

- DIF detection method based on nonlinear regression (Drabinová and Martinková, 2017) is included between offered methods
- Generalized ULI index (Martinková, Štěpánek et al., 2017) is available
- Simulated GMAT dataset is included to demonstrate the theoretical possibility of exactly equal distribution of total scores in groups, while DIF/DDF is still present (Martinková, Drabinová et al., 2017)



Automatic report generation

- Instructor for introductory measurement class uses the software for an in-class exercise
- A graduate student wants IRT to study independently and uses the program for self-study
- Lecturer checks properties of final exam multiple-choice test using data of their students
- Institution performs quick analysis of their admission tests shortly after administration

Covered topics are organized in sections

- Summary statistics
- Classical Test Theory (CTT), traditional item analysis (reliability, validity, distractor analysis, item difficulty and discrimination)
- Logistic, nonlinear and multinomial models
- Item Response Theory (IRT) models
- Differential Item Functioning (DIF)

Initial page gives some introductory information.

Description

To support routine usage of psychometric methods in test development, ShinyItemAnalysis offers possibility to upload data for analysis as csv files, and to generate PDF or HTML reports.

Below, report example is presented with HCI dataset (McFarland et al., 2017).



Discussion and conclusion

ShinyItemAnalysis is user-friendly and easily extendable tool for teaching psychometric concepts and for routine psychometric analysis of educational tests.

ShinyItemAnalysis seems to be a promising tool with over

6,000 online visits (not accounting for mirror pages)

 Item analysis by logistic models on Regression page · Item analysis by item response theory models on IRT models page. Differential item functioning (DIF) and differential distractor functioning (DDF) methods on DIF/Fairness page

es analysis of educational tests (such as admission tests) and their items includ

This application is based on the free statistical software R and its shiny package

· Exploration of total and standard scores on Summary page. · Correlation structure and predictive validity analysis on Validity page

For all graphical outputs a download button is provided. Moreover, on Reports page HTML or PDF report can be created. Additionaly, all application outputs are complemented by selected R code hence the modified in R

Data

For demonstration purposes, by default, 20-item dataset GMAT from R difNLR package is used. Other four datasets are available: GMAT2 and MSAT-B from difNLR package and Medical 100 and HCI from ShinyItemAnalys package. You can change the dataset (and try your own one) on page Data.

Availability

Application can be downloaded as R package from CRAN. It is also available online at Czech Academy of Sciences band shinyapps

Version

Current version of ShinyItemAnalysis available on CRAN is 1.2.7. Version available online is 1.2.7. The newest development version available on GitHub is 1.2.7. See also older versions: 0.1.0, 0.2.0, 1.0.0, 1.1.0, 1.2.3, 1.2.6.

Authors and contributors



8,000 downloads from CRAN from all over the world.

Use of ShinyItemAnalysis in measurement and psychometric courses allowed for validating functionality of the application. Next planned step is further content validation by higher number of psychometric experts and adding more psychometric methods and references.

ShinyItemAnalysis seems to fulfill its goal to make psychometric methodology available to researchers from various fields and regions.

Please provide your feedback at http://www.ShinyItemAnalysis.org

References

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This research was supported by Czech Science Foundation grant GJ15-15856Y "Estimation of psychometric measures as part of admission test development" and by Charles University grant PRIMUS/17/HUM/11 "Center for Educational Measurement and Psychometrics (CEMP)'

