Automatic generation of item analysis report in ShinyItemAnalysis using R Markdown

houdek@forsaga.net, adela.drabinova@gmail.com, lubomir.stepanek@lf1.cuni.cz, martinkova@cs.cas.cz

[1]Faculty of Informatics and Statistics, University of Economics, Prague,

[2]Department of Statistical Modelling, Institute of Computer Science, Czech Academy of Sciences
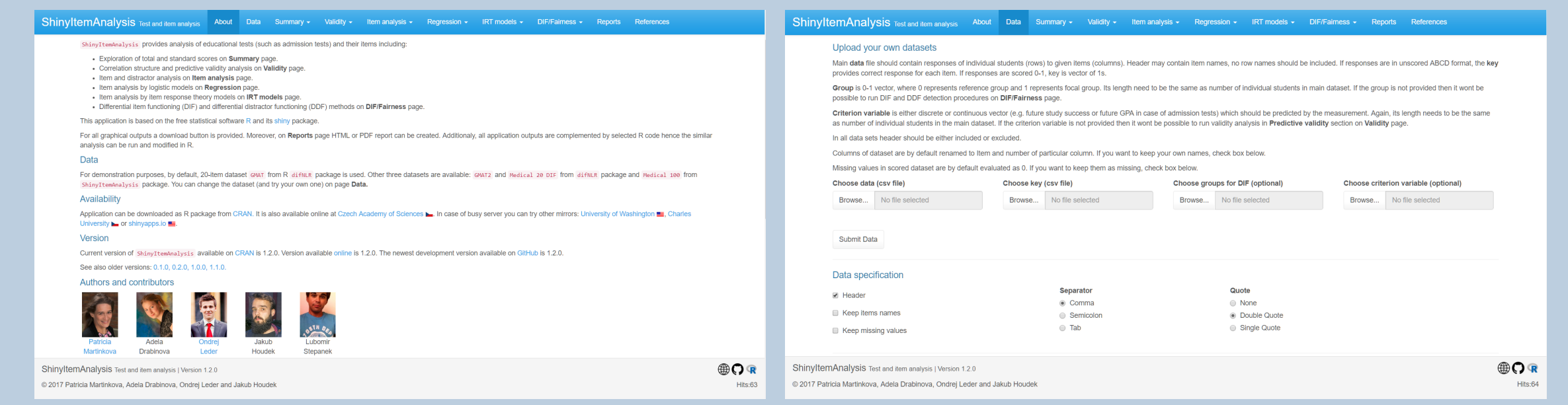
ShinyItemAnalysis

`ShinyItemAnalysis` is an R package and an online shiny application for psychometric analysis of educational tests and their items. It covers broad range of methods and it aims to be a simple tool for routine analysis of tests and for teaching psychometric concepts with R.

`ShinyItemAnalysis` is available online at

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

Reports

To support routine usage of advance methods in test development, `ShinyItemAnalysis` offers possibility to upload data for analysis, and to generate PDF/HTML reports.

Reports include:

- Summary statistics of given dataset
- Traditional item analysis with estimates of item difficulty and discrimination, distractor analysis
- Multinomial plots as application of regression models on item data
- IRT models: User can select between Rasch, 1PL, 2PL and 3PL models.
- Analysis of Differential Item Functioning (DIF) and Differential Distractor Functioning (DDF) offering delta plot, logistic regression and multinomial regression.

Download Options

Report generation section provides user with a variety of options for report generation:

- selection of format: HTML vs. PDF

  (for local use, PDF report needs installation of TEX)
- selection of available methods

  (reduces time when some analyses are not needed)
- customization of settings in selected methods
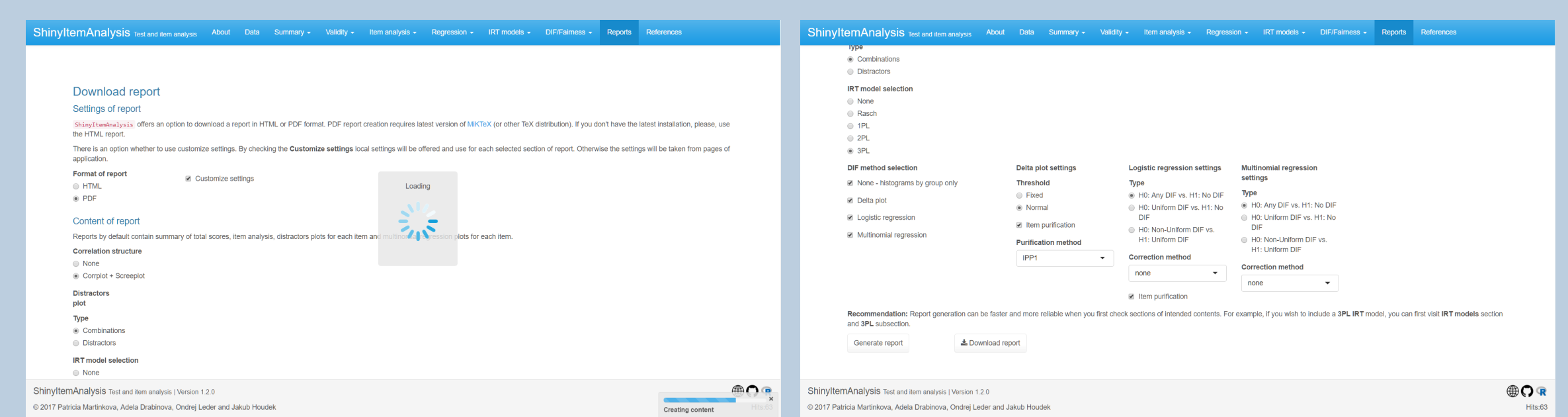
Learn more / Try it out!

Visit related talks:

- Drabinová A. difNLR: Detection of potentional gender/minority bias with extensions of logistic regression (Thursday 11:18AM, 4.01 Wild Gallery)

- Martinková P. Teaching psychometrics and analysing educational tests with ShinyItemAnalysis (Friday 11:00 AM, Plenary)
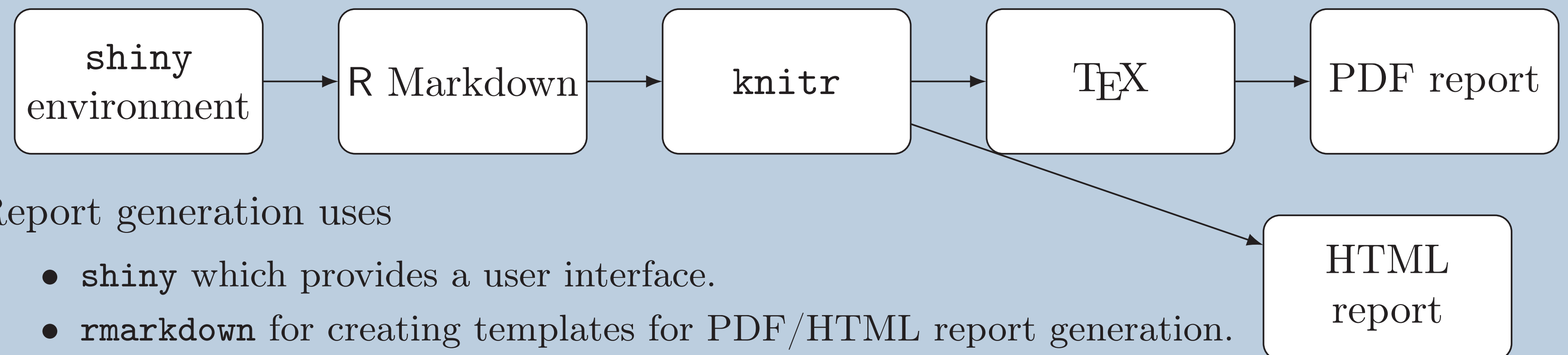

| ICS server | CRAN | GitHub | Article |

Report Generation

Report generation workflow may be described as follows:

Report generation uses

- `shiny` which provides a user interface.
- `rmarkdown` for creating templates for PDF/HTML report generation.
- `knitr` for compiling R markdown syntax into HTML/PDF
- TEX for creating PDF reports (latest distribution of TEX is needed).

Report Examples

Below, report example is presented with dataset GMAT (Martinková et al., 2017). This dataset was generated to demonstrate the theoretical possibility of exactly equal distribution of total scores in groups (7th page), while DIF is still present (8th page).
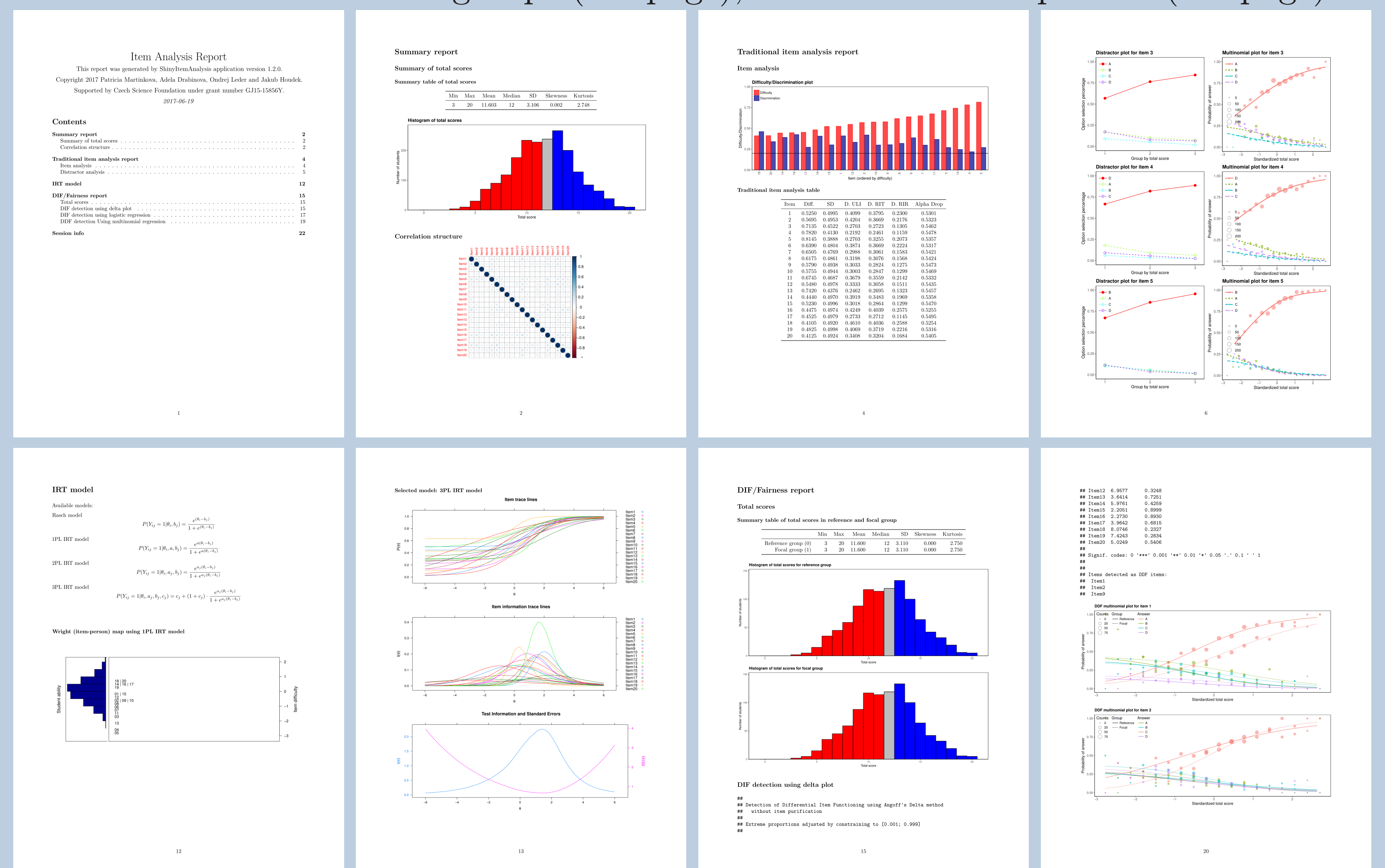
Dataset	# items	Local [s]	ICS [s]	shinyapps.io [s]
GMAT	20	60 + 44	46 + 31	35 + 29
GMAT2	20	51 + 33	27 + 31	20 + 26
Medical 20 DIF	20	137 + 37	91 + 39	64 + 28
Medical 100	100	800 + 139	725 + 46	480 + ∞

Discussion and Conclusion

We have met following issues and challenges during the development:

Issue	Our solution	Optimal solution
Inconsistency of graphical outputs of various plotting devices, such as `graphics`, `ggplot2` and specific plotting techniques of various packages used during analyses.	Usage of different plot saving functions such as `ggsave()` or generating plots in R Markdown template	Usage of universal plot saving function for all plotting packages
R Markdown cannot contain `shiny` objects.	Creation of additional `shiny` objects just for the needs of R Markdown and connecting it with the template via `render()` function	Adding a universal functionality for extracting objects from `shiny` environments
Report generation requires quite powerful hardware and a lot of processing time.	Splitting the process in `shiny` environment into generation and download	Implementation of multicore processing, for example
Server implementation is impractical	Taking care of server processing time via splitting report generation and download	Using a powerful server

Automatic report generation of uploaded datasets is a useful complement for `shiny` applications which may boost usage of advanced methods in routine analyses.

References

Allaire, J., Cheng, J., Xie, Y., McPherson, J., Chang, W., Allen, J., Wickham, H., Atkins, A., and Hyndman, R. (2016). *rmarkdown: Dynamic Documents for R*. R package version 1.3.

Chang, W., Cheng, J., Allaire, J., Xie, Y., and McPherson, J. (2017). *shiny: Web Application Framework for R*. R package version 1.0.3.

Martinkova, P., Drabinova, A., Leder, O., and Houdek, J. (2017). *ShinyItemAnalysis: Test and item analysis via shiny*. R package version 1.2.0.

Martinková, P., Drabinová, A., Liaw, Y.-L., Sanders, E. A., McFarland, J. L., and Price, R. M. (2017). Checking equity: Why differential item functioning analysis should be a routine part of developing conceptual assessments. *CBE-Life Sciences Education*, 16(2).