gTheoryShiny: An online application for interactive g-theory inference

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Abstract

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Keywords: keyword1, keyword2

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Background

Generalizability theory (g-theory) is a framework used to access the reliability, or dependability of measurements. The roots of g-theory can be found in classical test theory and analysis of variances (ANOVA). The core concepts of the generalizability theory are G studies (universes of admissible observations) and D studies (universes of generalization). G theory has been widely used in (1) reliability analysis, (2) optimal experimental or measurement design, (3) identification of measurement error sources. Multiple programs for generalizability theory are available, such as *EduG* (Cardinet et al., 2011), *G_string*, *GENOVA*, *urGENOVA* and *mGENOVA*. In addition, G-theories analysis can also been performed in R language, using *gtheory* package and *lme4* package. However, none of those software is easily implemented using a interactive interface for users. Thus, to fill the gap, *gTheoryShiny* aims to provide a user-friendly program for data transformation, missing data imputation, inferences of univariate and multivariate generalizability theory, and visualizations.

Implementation

Overview of gTheoryShiny

gTheoryShiny was developed with following R packages:

- *tidyverse* for data transformation and visualization;
- *lme4* for univriate generalizability theory model estimation;
- *glmmTMB* for multivariate generalizability theory (MGT) model estimation;
- *gtheory* for results compilation and print;
- *sjmisc* for facets' relationships detection;

This program was wrapped by R/Shiny, a framework to build interactive web applications by R. By using these packages, *gTheoryShiny* could construct the g-studies and d-studies by the uploaded item responses from Excel file (.csv) or build-in R object,

perform bootstrapped standard error, customize levels of facet for d-studies, and visualize reliability of d-studies. A flow chart of the proposed *gTheoryShiny* is shown in Fig. 1. *gTheoryShiny* is compatible with three major operating systems and popular browsers.

Data input

gTheoryShiny currently supports two types of input:

- csv file with wide-format or long-format table for gtheory inferences. The wide-format data is an $(N + K) \times M$ matrix with discrete or continuous item scores, where N is the number of observables, K is the number of types of facets (e.g., items or raters), and M is the number of levels for combinations of facets.

g-theory model construction

Outcome inference

Results

Simulation data application

Conclusion

Reference

Cardinet, J., Johnson, S., & Pini, G. (2011). *Applying Generalizability Theory Using EduG*. Taylor & Francis.