

ShortForm: An R Package to Select Scale Short Forms With the Ant Colony Optimization Algorithm

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Anthony W. Raborn¹ and Walter L. Leite¹ 

Keywords

short form development, item selection, ant colony optimization algorithm, latent variable model, validity, structural equation modeling, data mining

Description

The ShortForm package aims to facilitate the development of short forms of scales by selecting items that maximize validity criteria set by the developer, such as fit to a latent variable model and relationship to a predictor or outcome. The method implemented has the advantage over item selection based on largest factor loadings or maximum information of optimizing with respect to multiple scale characteristics and validity criteria. The current version of ShortForm works in combination with either the lavaan R package or Mplus to fit latent variable models for short form selection.

The ShortForm package implements the method to select items for short forms of scales proposed by Leite, Huang, and Marcoulides (2008), which is an application of the ant colony optimization (ACO) algorithm (Dorigo & Stützle, 2004). This method is able to produce short forms that are optimized with respect to characteristics selected by the developer, such as model fit and validity evidence with respect to internal structure and relationships with other variables (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 2014). The method works by sampling items for sets of short forms with probabilities that are updated based on the quality of the best short form from the set. The ShortForm package is helpful to researchers aiming to develop a short form of a scale, either by using the ACO algorithm as the only item selection method or for comparison with other methods. Leite et al. (2008) developed a 22-item short form of the D39 diabetes quality of life scale that maximized a predicted relationship with a clinically relevant blood sugar threshold while maintaining adequate fit to the underlying latent variable model. They also demonstrated through a Monte Carlo simulation study that the ACO algorithm outperformed item selection based on largest factor loadings and maximal test information.

With the ShortForm package, users can stay fully within R using the “lavaan” package to define, estimate, and optimize their models, or if they have access to Mplus, they can use it to

¹University of Florida, Gainesville, USA

Corresponding Author:

Walter L. Leite, Research and Evaluation Methodology Program, School of Human Development and Organizational Studies in Education, College of Education, University of Florida, 1215 Norman Hall, Gainesville, FL 32611, USA.
Email: walter.leite@coe.ufl.edu

do the same. Currently, the package is designed to work with latent trait models with one or more latent factors and a predictor or outcome variable. The `antcolony.lavaan` and `antcolony.m-plus` functions search for the short form with a prespecified number of items on each factor that matches the user's goals for fit criteria and prediction. In addition, users can define the number of ants to run per iteration, the evaporation rate, and the number of iterations a specific model must be selected for the algorithm to stop (Leite et al., 2008). The algorithm saves each step into a summary file, which allows for debugging and keeps a log of the changing pheromone levels assigned to each item, and a feedback file, which keeps track of where the algorithm is while it searches for a solution. The results present the final model's fit indices and included variables as well as the mean of the regression coefficients of each variable and a ranking of the variables by pheromone. Included in the package is a simulated 56-item unidimensional achievement test data set with an auxiliary outcome variable and true ability score.

ShortForm is available on the Comprehensive R Archive Network (CRAN) at <http://www.cran.r-project.org> for free, or it can be installed through R (R Development Core Team, 2017) or RStudio (RStudio Team, 2017) with `install.packages("ShortForm")`. More details on the functions and example uses can be found in the package manual on CRAN. Windows, Mac, and Linux users can access the package by downloading an appropriate version of R and/or RStudio, although currently the `antcolony.m-plus` function only works on Windows computers. The documentation for this package is also available on CRAN and follows the requirements for all R packages.


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ORCID iD

Walter L. Leite  <https://orcid.org/0000-0001-7655-5668>

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