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Item-Trait Pattern Recognition of Replenished Items in Multidimensional Computerized Adaptive Testing

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Abstract : Multidimensional computerized adaptive testing (MCAT) is a popular research topic in psychometrics. It is important for practitioners to clearly know the item-trait patterns of administered items when a test like MCAT is operated. Item-trait pattern recognition refers to detecting which latent traits in a psychological test are measured by each of the specified items. If the item-trait patterns of the replenished items in MCAT item pool are well detected, the interpretability of the items can be improved, which can further promote the abilities of the examinees who attending the MCAT to be accurately estimated. This research explores to solve the item-trait pattern recognition problem of the replenished items in MCAT item pool from the perspective of statistical variable selection. The popular multidimensional item response theory model, multidimensional two-parameter logistic model, is assumed to fit the response data of MCAT. The proposed method uses the least absolute shrinkage and selection operator (LASSO) to detect item-trait patterns of replenished items based on the essential information of item responses and ability estimates of examinees collected from a designed MCAT procedure. Several advantages of the proposed method are outlined. First, the proposed method does not strictly depend on the relative order between the replenished items and the selected operational items, so it allows the replenished items to be mixed into the operational items in reasonable order such as considering content constraints or other test requirements. Second, the LASSO used in this research improves the interpretability of the multidimensional replenished items in MCAT. Third, the proposed method can exert the advantage of shrinkage method idea for variable selection, so it can help to check item quality and key dimension features of replenished items and saves more costs of time and labors in response data collection than traditional factor analysis method. Moreover, the proposed method makes sure the dimensions of replenished items are recognized to be consistent with the dimensions of operational items in MCAT item pool. Simulation studies are conducted to investigate the performance of the proposed method under different conditions for varying dimensionality of item pool, latent trait correlation, item discrimination, test lengths and item selection criteria in MCAT. Results show that the proposed method can accurately detect the item-trait patterns of the replenished items in the two-dimensional and the three-dimensional item pool. Selecting enough operational items from the item pool consisting of high discriminating items by Bayesian A-optimality in MCAT can improve the recognition accuracy of item-trait patterns of replenished items for the proposed method. The pattern recognition accuracy for the conditions with correlated traits is better than those with independent traits especially for the item pool consisting of comparatively low discriminating items. To sum up, the proposed data-driven method based on the LASSO can accurately and efficiently detect the item-trait patterns of replenished items in MCAT.

Keywords : item-trait pattern recognition, least absolute shrinkage and selection operator, multidimensional computerized adaptive testing, variable selection
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