

ADVANCES IN CD-CAT: THE GENERAL NONPARAMETRIC ITEM SELECTION METHOD

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Computerized adaptive testing (CAT) is characterized by its high estimation efficiency and accuracy, in contrast to the traditional paper-and-pencil format. CAT specifically for cognitive diagnosis (CD-CAT) carries the same advantages and has been seen as a tool for advancing the use of cognitive diagnosis (CD) assessment for educational practice. A powerful item selection method is the key to the success of a CD-CAT program, and to date, various parametric item selection methods have been proposed and well-researched. However, these parametric methods all require large samples, to secure high-precision calibration of the items in the item bank. Thus, at present, implementation of parametric methods in small-scale educational settings, such as classroom, remains challenging. In response to this issue, Chang, Chiu, and Tsai (*Appl Psychol Meas* 43:543–561, 2019) proposed the nonparametric item selection (NPS) method that does not require parameter calibration and outperforms the parametric methods for settings with only small or no calibration samples. Nevertheless, the NPS method is not without limitations; extra assumptions are required to guarantee a consistent estimator of the attribute profiles when data conform to complex models. To remedy this shortcoming, the general nonparametric item selection (GNPS) method that incorporates the newly developed general NPC (GNPC) method (Chiu et al. in *Psychometrika* 83:355–375, 2018) as the classification vehicle is proposed in this study. The inclusion of the GNPC method in the GNPS method relaxes the assumptions imposed on the NPS method. As a result, the GNPS method can be used with any model or multiple models without abandoning the advantage of being a small-sample technique. The legitimacy of using the GNPS method in the CD-CAT system is supported by Theorem 1 proposed in the study. The efficiency and effectiveness of the GNPS method are confirmed by the simulation study that shows the outperformance of the GNPS method over the compared parametric methods when the calibration samples are small.

Key words: Cognitive diagnosis, General nonparametric classification method, Computerized adaptive testing, CD-CAT, Nonparametric item selection.