

# It's how you use the items that counts: An intelligent procedure for item selection in Item Response Theory

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## 1 Aim

## 2 Item Response Theory and Information Functions

- 2-Parameter Logistic Model
- Item and Test Information Functions

## 3 Item Selection Procedures

- Item Locating Algorithm – ILA
- Brute Force Procedure

## 4 Simulation Study

- Results

New Item Response Theory-based algorithm for the development of  
informative short test forms

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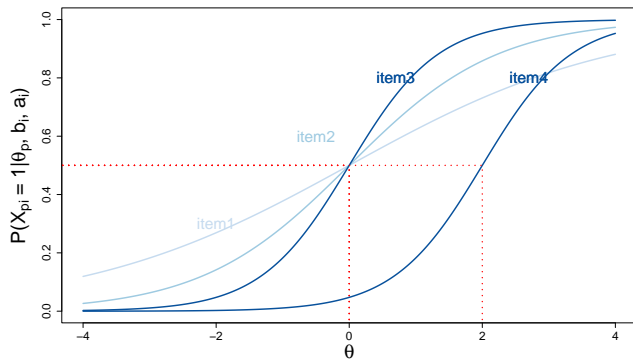
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$$P(x_{pi} = 1 | \theta_p, b_i, a_i) = \frac{\exp[a_i(\theta_p - b_i)]}{1 + \exp[a_i(\theta_p - b_i)]}$$



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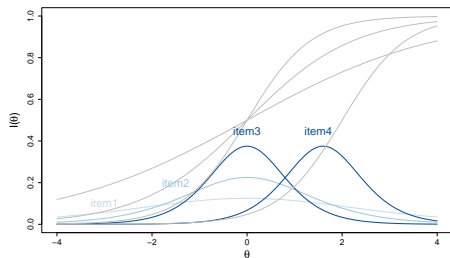
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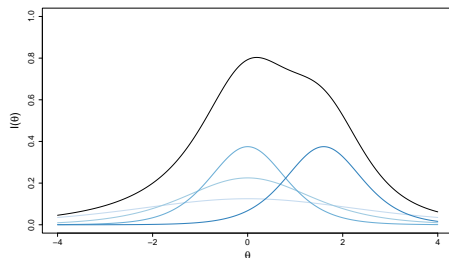
Item Information Function (IIF):

$$I_i(\theta) = a_i^2 P_i(\theta, b_i, a_i)[1 - P_i(\theta, b_i, a_i)]$$



Test Information Function (TIF):

$$I(\theta) = \sum_{i=1}^I I_i(\theta)$$





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$Q$ : vector of the item indexes selected for inclusion in the STF up to that iteration

$TIF^*$ : TIF target

$TIF_{TE} = \frac{\sum_{i \in Q} IIF_i}{||Q||}$ , where  $||Q||$  denotes the cardinality of  $Q$

Termination criterion:

The algorithm iterates the following steps until the termination criterion is reached:

①  $\Delta_{TIF} = |TIF^* - TIF_{TE}|.$

②  $\theta_{target} = \arg \max \Delta_{TIF}$

③  $\operatorname{argmin}_{i \in \{1, \dots, N\} \setminus Q} |\theta_{target} - b_i|$

④  $TIF_{TE} = \frac{\sum_{i \in Q} IIF_i}{||Q||}$

⑤ Repeat from Step 1 until the termination criterion is reached

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$N$ : Number of items in the item bank

$L = N - 1$ : Maximum length of the STFs that can developed from the item bank

$\binom{N}{l}$ : number of STFs resulting from the combination of the  $l = \{1, \dots, L\}$  items

The algorithm iterates the following steps until the termination criterion is reached:

①  $\overline{TIF}$  for each STF of length  $l$

②  $\Delta_{TIF} = TIF^* - \overline{TIF}$

③  $\overline{\Delta}_{TIF}$

The best STF is the one with the lowest value of  $\overline{\Delta}_{TIF}$ , that is the one that presents the lowest absolute distance from the TIF target.

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100 iterations:

- ① Generate an item bank of  $N = 6$  items:
  - Difficulty parameters:  $\mathcal{U}(-3, 3)$
  - Discrimination parameters:  $\mathcal{U}(.90, 2.0)$
- ② Generate  $TIF^*$  by randomly selecting items from the item bank (Mean number of items =  $3.34 \pm 1.13$ ). The parameters of the selected items are modified according to values drawn from uniform distributions  $\mathcal{U}(-0.20, 0.20)$ .
- ③ Considering the  $TIF^*$  at Step 2 and the item parameters at Step 1:
  - ILA  $\rightarrow$  Forwardly searches for the best item selection to recover the  $TIF^*$
  - BFP  $\rightarrow$  tries every possible item combination to find the STF best able to recover  $TIF^*$   $N = 6$  items,  $L = 5$  and  $\binom{6}{1} + \binom{6}{2} + \binom{6}{3} + \binom{6}{4} + \binom{6}{5} = 62$  STFs are developed and compared.

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