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

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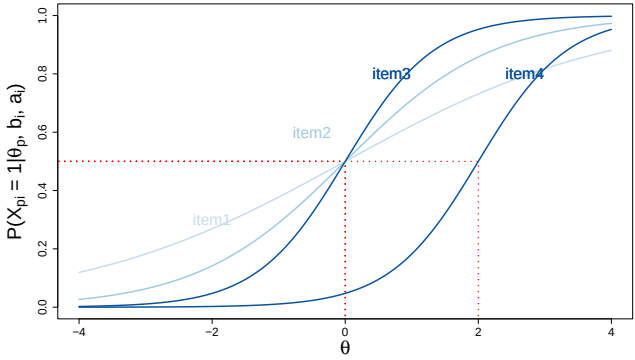
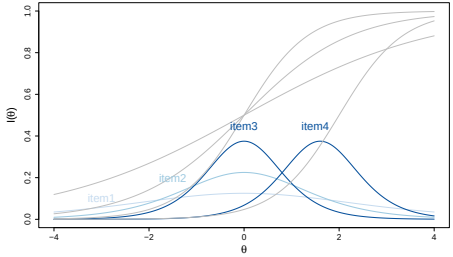
New Item Response Theory-based algorithm for the development of informative short test forms

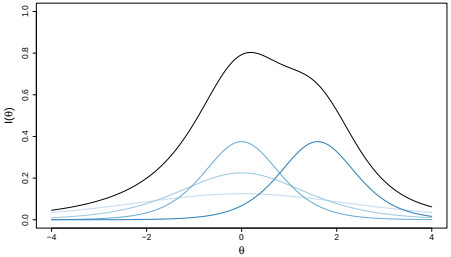
$$P(x_{pi} = 1|\theta_p, b_i, a_i) = \frac{\exp[a_i(\theta_p - b_i)]}{1+\exp[a_i(\theta_p - b_i)]}$$



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



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. $\Delta_{TIF} = |TIF^* - TIF_{\text{TE}}|$.
2. $\theta_{target} = \arg\max \Delta_{TIF}$
3. $\text{argmin}_{i \in \{1,\ldots,N\} \setminus Q} |\theta_{target} - b_i|$.
4. $TIF_{TE} = \frac{\sum_{i \in Q} IIF_i}{||Q||}$
5. Repeat from Step 1 until the termination criterion is reached

N: Number of items in the item bank
$L = N - 1$: Maximum length of the STFs that can developed from the item bank composed of N items
For each of the possible lengths $l = \{1, \dots L\}$ of the STF, a $\binom{N}{l}$ number of STFs is developed.
For each of the possible combinations of items of length l, the $\overline{TIF}$ is computed, and the absolute difference from the TIF target, $\Delta_{TIF} = TIF^* - \overline{TIF}$, and a mean of the absolute difference are obtained $\overline{\Delta}_{TIF}$. 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.