Item Response Theory – ESM 677 – Thomas Young

Purpose: Item Response Theory (IRT) is a statistical framework used to analyze and interpret responses to tests and questionnaires.

Answers the Research Question: "What is the relationship between an individual's underlying ability or trait and their responses to a set of items on a test or questionnaire?"

Terms:

- Items: These are the values that describe the characteristics of the question asked in relation to the latent trait being measured
- Latent Trait: The underlying construct that is being measured by the test (ex: attitude)
- Response Model: Represents the probability / likelihood of correct answer

Variables:

- Person Parameter (Theta, θ): Represents the individual's level of the latent trait (e.g., ability, attitude)
- P(X = 1): Represents the probability of a correct response
- Item Parameters:
    - Item Discrimination (a): Indicates how well an item distinguishes between individuals with different levels of the latent trait
    - Item Difficulty (b): Represents the level of the latent trait required for a 50% chance of getting the item correct.
    - Guessing Parameter (c): Applies to multiple-choice items and represents the probability of getting the item correct by chance.

Assumptions:

1. Unidimensionality: Assumes that a set of items on a scale measure only one thing in common.
2. Monotonicity: phenomenon in which the probability of endorsing an item will continuously increase as an individual's trait level increases.
3. Item Invariance: phenomenon in which estimated item parameters are constant across different populations.
4. Local Independence: Given a person's level of the underlying trait, their responses to different items on a test are independent of each other.

Limitations:

- IRT relies on several assumptions that may not always hold in real-world data.
- IRT generally requires larger sample sizes than CTT for accurate parameter estimation.
- IRT models can be more complex than Classical Test Theory (CTT) methods, requiring specialized software and statistical expertise (steep learning curve).

Steps to Conduct (Example is using Bean 2019 article):

1. Administer Test
    a. ex: SCOFF Questionnaire: eating disorder screening instrument

2. Pick an appropriate model
    a. ex: 2-parameter logistic (2PL) model was most appropriate for dichotomous (yes / no answers) to clinical assessment items
3. Check Assumptions
    a. Unidimensionality – ex: Completed using full-information item factor analysis
    b. Monotonicity – ex: Completed using Mirt in R
    c. Item Invariance – ex: Completed using Mirt in R
    d. Local Independence – ex: computed a commonly used measure called Yen's Q3
4. Select Software
    a. ex: Analyses using R with the following packages: Itm & Mirt
5. Examine Results
    a. ex: Results suggested the SCOFF items varied in their relationship with eating disorder risk and operated differently for male and female students
6. Explain Results
    a. ex: SCOFF items are not equally weighted either overall or within male and female groups. Clinicians should first look at Item 2 to see if it was endorsed, next look at Item 1 to see if it was endorsed, and then proceed to examine the other items with item 3 being last (lowest correlated)

Resources:

- Bean, G. J. (2019). An item response theory analysis of the scoff questionnaire in a high school population. *Journal of Evidence-Based Social Work*, *16*(4), 404–422. https://doi.org/10.1080/26408066.2019.1617212
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