Overview

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Motivation

In IRT data analysis, person-item maps, response-characteristic curves and residual plots should be routinely inspected.

The graphical capabilities of IRT software packages are, unfortunately, quite poor.

Why Should IRT Data Be Visually Inspected?

To detect important features in the data

To compare expected and observed patterns

To check model assumptions
Three Graphs in IRT Data Analysis

- Person-item maps
  - Compare items and persons on the ability continuum
- Item characteristic curves (ICCs)
  - Fit expected item response functions to observations
- Residual plots
  - Screen item or person fits

Why R?

- R has excellent graphical capabilities.
- R is a well developed, simple and effective programming language.
- R is freely available.

Two Examples

- Euclidean Geometry: A Rasch model (Rasch, 1960) for dichotomous responses.
- Extramarital & premarital Sex: A Partial Credit model (Master, 1982) for polytomous responses.

Dichotomous Responses

- A sample of 150 individuals answered 9 items from a General Certificate of Education O-level mathematics paper.
- The Rasch model accounts for a student’s response to an item by the difference between the student’s ability and the difficulty level of the item.
- Item difficulty estimates and predicted person abilities are displayed on a single continuum (latent trait).
- BILOG-MG was used to extract model parameter estimates.

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- Fit the expected (cumulative) item characteristic functions to observed responses.
Residual Plots

- To verify whether or not an item (or a person) fit the model's expectation.

Polytomous Responses

- As part of the 1989 General Social Survey, subjects were asked to indicate their opinion on
  1. early teens (age 14-16) having sexual relations before marriage
  2. a man and a woman having sexual relations before marriage
  3. a married person having sexual relations with someone other than the marriage partner

  using a 4-point scale.
The Partial Credit Model

- The model extends the Rasch model to account for polytomous responses.
- The probability of a response to an item belonging to a particular category depends on the person’s ability and the thresholds of that item.
- Three thresholds (cut-points) are needed to transit from the first category to the last on a 4-point scale.
- WINSTEPS is used to extract parameter estimates of the model.

Person-Item Map

- Item step numbers are added next to the item difficulty estimates.

Item Characteristic Curves

- For each categorical response of an item, the item characteristic curves are displayed along with observed item response.
Residual Plots

- To verify whether or not an item (or a person) fits the model's expectation.
We implement in R three graphs: person-item maps, item characteristic curves, and residual plots using numerical output of common IRT packages.

The R scripts can readily be adapted for analysis with other IRT models.

A more complete IRT analysis can be accomplished with the help of other R packages, such as \textit{nlme}.

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