National Chung Cheng University

Turning Output of Item Response Theory Data Analysis into Graphs with R

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Overview

- Motivation
- Importance of graphing data
- Graphical methods for item response theory
- Why R?
- Two examples
- Conclusions

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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.

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Why Should IRT Data Be Visually Inspected?

- To detect important features in the data
- To compare expected and observed patterns
- To check model assumptions

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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

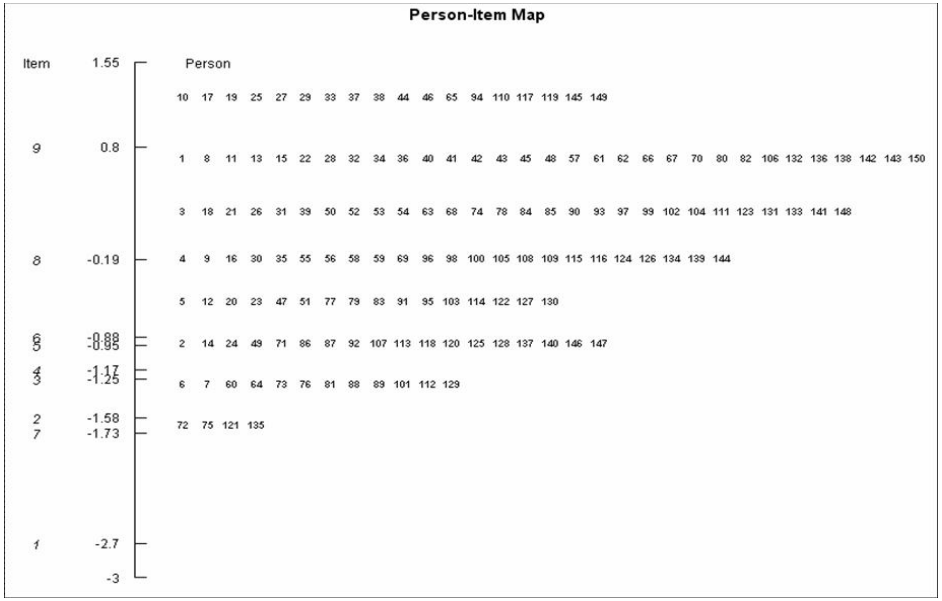
- Euclidean Geometry: A Rasch model (Rasch, 1960) for dichotomous responses.
- Extramarital & premarital Sex: A Partial Credit model (Master, 1982) for polytomous responses.

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.

Person-Item Map

- 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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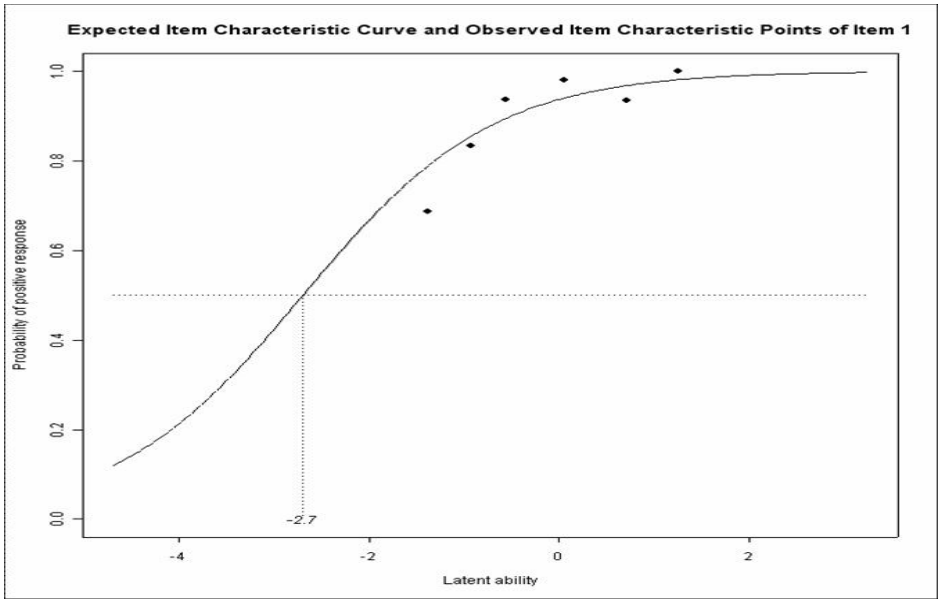
Item Characteristic Curves

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



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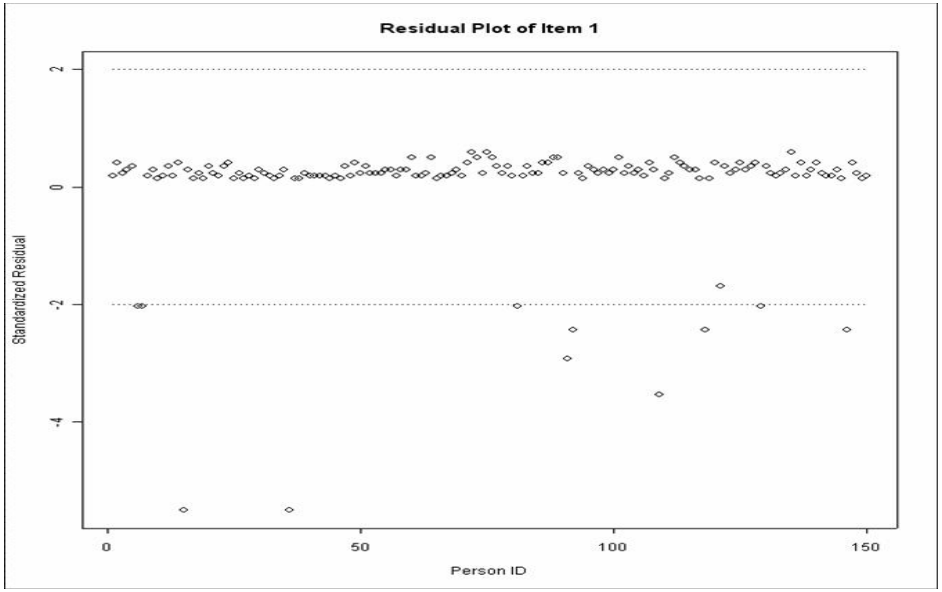
Residual Plots

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



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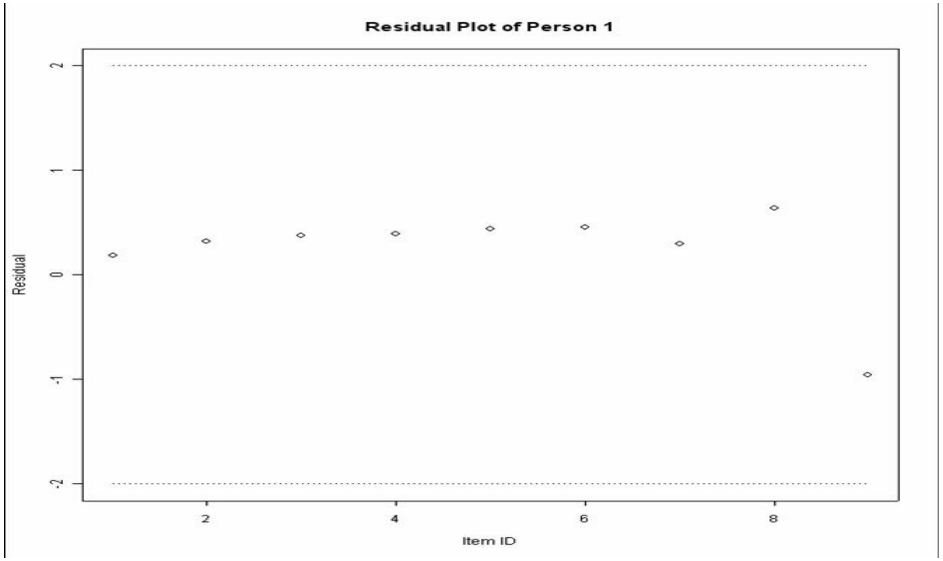

Polytomous Responses

- 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.

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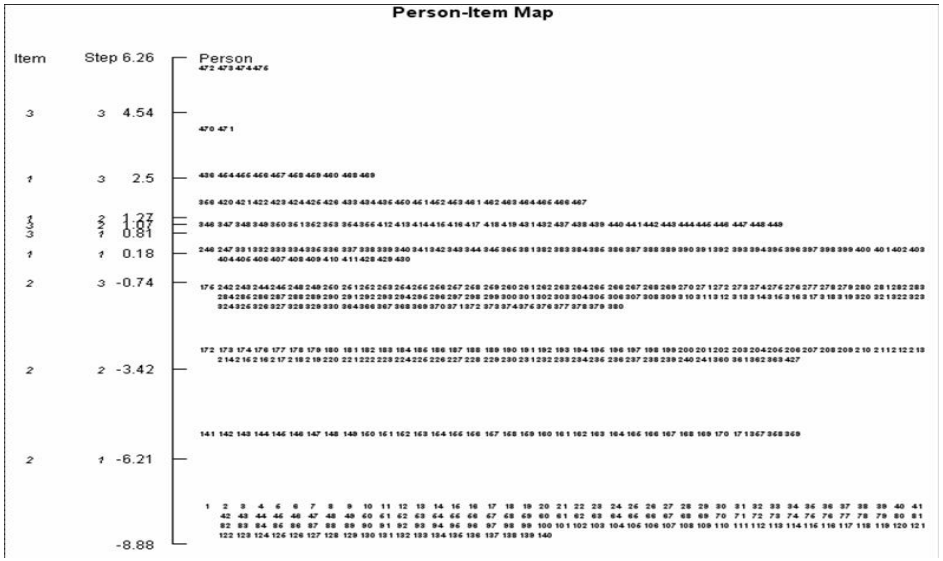
The Partial Credit Model

- 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.

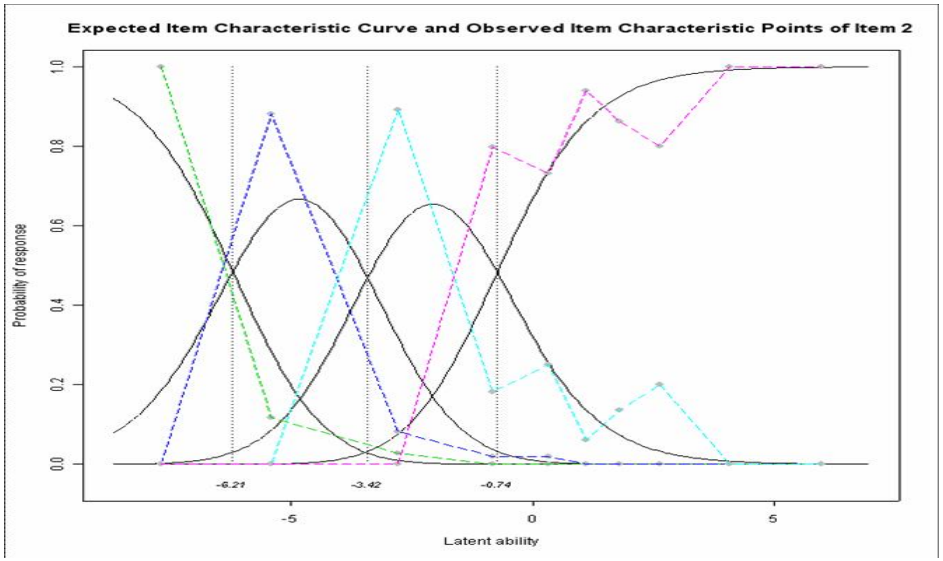
Person-Item Map

- 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.



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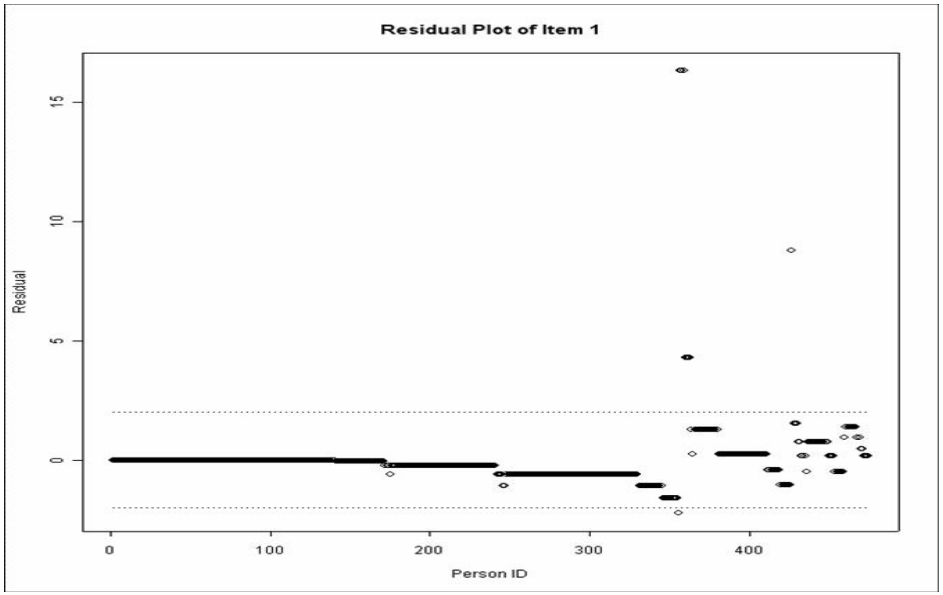

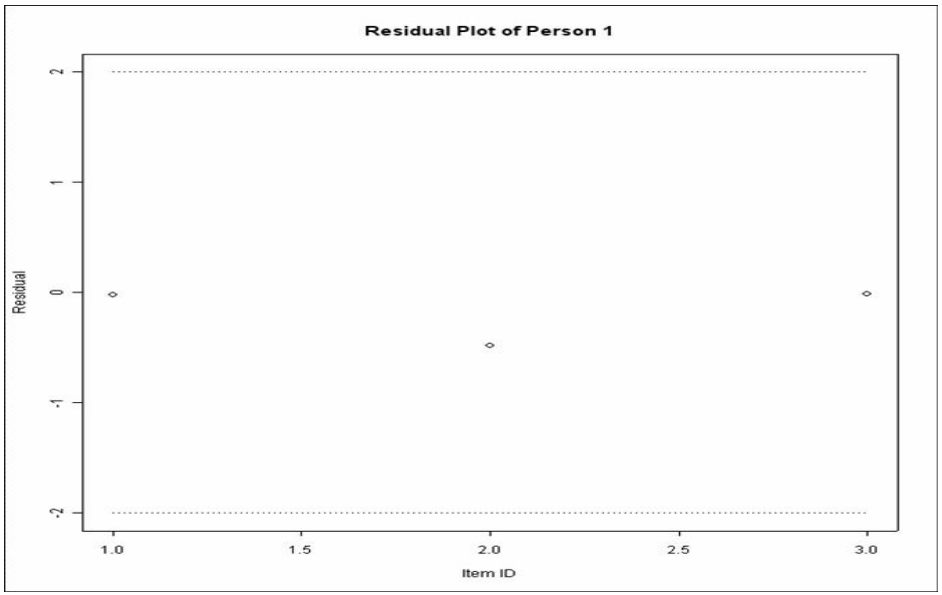

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Conclusions

- 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 *nlme*.

Thank you!

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