Rasch Measurement

Forskarutbildningskurs vid Karlstads universitet höstterminen 2014

- **Kursen anordnas av Centrum för forskning om barns och ungdomars psykiska hälsa och avdelningen för psykologi.**
- **Forskarutbildningsämne: Psykologi.**
- **Högskolepoäng: 7.5 ECTS.**
- **Undervisningsspråk: Svenska. Vissa moment på engelska kan förekomma.**
- **Kursen vänder sig i första hand till doktorander vid Karlstads universitet men är i mån av plats även öppen för doktorander från andra universitet och högskolor.**
- **Anmälan görs till Monica Eriksson,** monica.eriksson@kau.se**, senast den 1 september 2014.**

Lärare

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Kursinformation, sid 2-8

I. Description of the methodology – Rasch Measurement Theory

Composite measures including multiple items are used in health and social sciences to improve the reliability and validity of the instrument. The use of such measures is psychometrically justified only if the operating characteristics of the items work in the same way for all individuals and groups. This requirement of invariant measurement was first articulated in the 1920s by Thurstone. During the 1950s the Danish mathematician Georg Rasch formalised this requirement mathematically in a probabilistic response model, the Rasch model.

The Rasch model is built upon uni-dimensional scales which are intended to measure a single concept on a latent trait represented as a linear continuum. The response format is cumulative like frequency or Likert scales, reflecting more or less of a property. Since the Rasch model facilitates disclosure of measurement problems that may not be easily detected by traditional analyses, e.g. lack of invariance, the Rasch model can be used for rigorous examinations of instruments. The Rasch model also overcomes a common cause for concern in the construction of composite measures by justifying the summation of the raw scores across items and by providing a proper method for nonlinear transformation of ordinal raw scores to linear measures.
The Rasch model is, however, an efficient tool not just for post-hoc analysis of an instrument, but also for development of new instruments.

The Rasch model was originally mainly used in educational testing but is nowadays also increasingly applied in health sciences and social science research. The increasing use of Rasch analysis is also confirmed by an increasing number of published articles based on Rasch analysis. Since the millennium shift the number of Rasch matches in Web of Science has threefold. Historically, most Rasch papers have originated from USA which still dominates representing 60 percent of all Rasch matches in Web of Science. The increasing trend of published Rasch papers applies, however, not just to USA but also to Australia and many European countries.

A distinctive feature of the Rasch-model is that it's derived from theory which means that it is constructed a priori to the data. In Rasch analysis the data are compared with the model which is considered fixed representing required properties of the data. Therefore misfit between the data and the model should not be addressed by inclusion of additional parameters. This is opposite to traditional statistical modelling where the purpose is to describe or explain the data. Since the Rasch model has invariance as an integral property misfit between the data and the model implies that a check of fit of data to the model becomes a check of invariance. Hence, a measure that meets the requirements of the Rasch model can be used to make invariant comparisons across individuals and groups of individuals.

Although the Rasch model sometimes is described as a member of the class of Item Response Theory (IRT) models, the Rasch paradigm is contrasting the paradigm of other IRT models in a fundamental way. Instead of finding a model that best describes the data, the purpose of Rasch analysis is to disclose the anomalies in the data. In contrast, in the paradigm of other IRT-models misfit between the data and the model may lead to a model with more parameters, e.g. the 2-parameter model.

If the data fit the Rasch model the total score across items characterises a person totally. This implies that the total score is a sufficient statistic that in principle

captures the same information as a parameter estimate, enabling elimination of the person parameter in question. It follows that the item parameters can be estimated conditioning on the person total raw scores, and that there are no person parameters to be estimated simultaneously. Inversely, the sum of the item raw scores across all persons is a sufficient statistic for the item parameters. The sufficient statistic is the unique tool that enables separation of the person and item parameters in the estimation processes, which is a requirement for invariant measures.

There is no single measure to be used to examine the concordance between the data and the model, rather a variety of different tools. Also, not just formal statistical tests of fit should be used but also graphical representations e.g. Item Characteristic Curves.

II. Description of the course

The course is an introduction to Rasch measurement in social sciences and health sciences. The Rasch model is the only IRT-model that can be used to examine whether a scale or test meets the measurement requirements for invariant comparisons. If the data fit the Rasch model the total score across items characterizes a person totally enabling nonlinear transformation of ordinal raw scores to linear measures to be used with parametric statistical methods.

The course provides an overview of the theory underlying the Rasch model and its basic features. Advances in analysis of Differential Item Functioning (DIF) are covered extensively including methods to detect, quantify and resolve DIF using the Rasch model. A strong emphasis is on practical applications of Rasch analysis, including illustrative examples and hands on exercises.

III. Course outline

The target groups for the course are doctoral students in social sciences, health sciences and other fields who require knowledge about modern measurement methods.

The course starts with an introduction of the Rasch paradigm in social measurement and the theory underlying the Rasch model. The Rasch model of modern test theory is compared with traditional test theory as well as other IRT-models such as the 2-parameter model. In treating invariance, a special focus is on Differential Item Functioning (DIF) and methods to identify, quantify and resolve DIF. Other topics to be treated in the course include: targeting, tests of fit, reliability measures, multidimensionality, local dependency, categorisation of items. Each day of the course there is a mixture and integration of lectures and labs. The participants will have the opportunity to bring and analyse their own data.

Prerequisites

The course doesn’t require prior experiences of Rasch analysis, but familiarity with statistical methods such as regression analysis and analysis of variance is desirable.

The participants are supposed to bring their own computers and work on them.

Software

The program RUMM2030, which will expire at the end of 2014, will be made available to participants. (www.rummlab.com). RUMM2030 is a user friendly software specifically designed for Rasch analysis.

IV. Tentative syllabus for six day course

Day 1 **INTRODUCTION**
140918 History and philosophy of social measurement – the Rasch paradigm
CTT, IRT and latent trait models – the distinctive features of the Rasch model
Getting started with Rasch analysis using RUMM2030 software

Day 2 **THE FAMILY OF RASCH MODELS**
141002
a) The dichotomous Rasch model
b) The polytomous Rasch model
- constrained (rating) model
- -unconstrained (partial credit) model

EXAMINING THE DATA-MODEL FIT
- Graphical examinations
- Formal tests

Day 3 **DIFFERENTIAL ITEM FUNCTIONING (DIF)**
141009
- the meaning and consequences of DIF
- uniform and non uniform DIF
- real and artificial DIF
- detecting DIF
- quantifying DIF
- resolving DIF

Day 4 **VIOLATIONS OF THE RASCH MODEL – DIAGNOSTIC TOOLS**
141016
- Disordered thresholds
- Response dependence
- Trait dependence

Day 5 **APPLICATION OF THE RASCH ANALYSIS – STEP BY STEP**
141030

1. Targeting (item-person locations) and person separation.
2. Item fit
   a) General
   b) DIF
3. Polytomous Rasch Model: threshold ordering
4. Person fit
5. Response dependence and trait dependence
6. Resolving problems in accordance with the Rasch model
7. Using Rasch person estimates in analyses with standard statistical packages (e.g. SPSS)

Day 6 **EXAMINATION**
141113 **Paper presentations**

Readings (preliminary)

Andrich, D. (1988). Rasch Models for Measurement. Sage University Paper on Quantitative Applications in the social Sciences, Series 07-068. Sage Publications, Beverly Hills.

Andrich, D. (2004). Controversy and the Rasch model: a characteristic of incompatible paradigms? Medical Care, 42, 1–16.

Andrich, D. (2011). Rating scales and Rasch measurement. Expert Rev. Pharmacoeconomics Outcomes Res. 11(5), 571–585.

Andrich, D. (2013) The Legacies of R. A. Fisher and K. Pearson in the Application of the Polytomous Rasch Model for Assessing the Empirical Ordering of Categories. Educational and Psychological Measurement 73(4) 553–580.

Andrich, D. & Hagquist, C. (2012). Real and artificial differential item functioning. Journal of Educational and Behavioral Statistics, 37(3), 387-416.

Andrich, D. & Hagquist, C.
Real and Artificial Differential Item Functioning in Polytomous Items Educational and Psychological Measurement (accepted).

Hagquist, C., Andrich, D. (2004). Is the sense of coherence instrument applicable on adolescents? A latent trait analysis using Rasch-modelling. Personality and Individual Differences 36, 955–968.

Hagquist C, Bruce M, Gustavsson JP. (2009). Using the Rasch model in nursing research: An introduction and illustrative example. International Journal of Nursing Studies;46:380–93.

Marais, I., Andrich, D. (2008). Formalizing dimension and response violations of local independence in the unidimensional Rasch model. Journal of Applied Measurement 9, 200–215.

Rasch, G. (1960/80). Probabilistic models for some intelligence and attainment tests. (Copenhagen, Danish Institute for Educational Research). Expanded edition (1980) with foreword and afterword by B. D. Wright, (1980). (Chicago: The University of Chicago Press)

V. Background information about the instructor

Undergraduate
Bachelor of Science in Social Work, Socialhögskolan i Örebro, 1977

Graduate
Doctor of Philosophy in Social Work, Göteborg University, 1997.
Licentiate in Social Work, Göteborg University, 1992

Postgraduate
Visiting Scholar September 1998 - July1999, Telethon Institute for Child Health Research, Perth, Australia.
Visiting Scholar February - June 2001, Murdoch University and Telethon Institute for Child Health Research, Perth, Australia.

Docent
Associate Professor of Public Health, Karlstad University, 2003.

Current positions
Professor of Public Health, Karlstad University, 1 April 2011 –
Director, Centre for Research on Child and Adolescent Mental Health, Karlstad University, 2009-06-01 –

Previous positions
Project Manager, National Board of Health and Welfare, Centre for Epidemiology, 2001 – 2004.
Project manager, Health Committee, The Royal Swedish Academy of Sciences, 2006 – 2013, part time.

Supervision of doctoral students
Finished
Principal supervisor for

- Mona Sundh, PhD in Public Health, 2006.
- Daniel Bergh, PhD in Sociology, 2011.
- Linda Beckman, PhD in Public Health, 2013.

Ongoing
Principal supervisor for two doctoral students in Public Health and one in Social Work.

External research funding – ongoing
Swedish Research Council for Health, Working Life and Welfare (FORTE, previously FAS) : 6 million SEK in programme support 2013-2015, with an option of a three-year extension ("Impacts of changed living conditions on child and adolescent mental health"). The programme is in collaboration with the Department of Education and Special Education at the University of Gothenburg.

Other commitments
Member of the editorial board of Social Indicators Research, 2009 – .

Peer-reviewed articles on Rasch analysis

Andrich, D. & **Hagquist**, C.
Real and Artificial Differential Item Functioning in Polytomous Items
Educational and Psychological Measurement (accepted).

Andrich, D. & **Hagquist**, C. (2012). Real and artificial differential item functioning. *Journal of Educational and Behavioral Statistics*, 37(3), 387-416.

Hagquist, C. & Hellström, L. (2013) The psychometric properties of the Early Development Instrument – a Rasch analysis based on Swedish pilot data. *Social Indicators Research* (Published online 5 June)

Hagquist, C., Bruce, M., & Gustavsson, J. P. (2009). Using the rasch model in nursing research: An introduction and illustrative example. *International Journal of Nursing Studies, 46*(3), 380-393.

Hagquist, C. (2008). Psychometric properties of the PsychoSomatic problems scale: A Rasch analysis on adolescent data. *Social Indicators Research, 86*(3), 511-523.

Hagquist, C. (2007). The psychometric properties of the self-reported SDQ–An analysis of Swedish data based on the Rasch model. *Personality and Individual Differences, 43*(5), 1289-1301.

Hagquist, C., & Andrich, D. (2004). Is the sense of coherence-instrument applicable on adolescents? A latent trait analysis using Rasch-modelling. *Personality and Individual Differences, 36*(4), 955-968.

Hagquist, C., & Andrich, D. (2004). Measuring subjective health among adolescents in Sweden: A Rasch analysis of the HBSC-instrument. *Social Indicators Research, 68*(2), 201-220.

Hagquist, C. (2001). Evaluating composite health measures using Rasch modelling: An illustrative example. *Sozial-Und Präventivmedizin/Social and Preventive Medicine, 46*(6), 369-378.