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Fitting a Thurstonian IRT model to forced-choice data using Mplus

Anna Brown · Alberto Maydeu-Olivares

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Abstract To counter response distortions associated with the use of rating scales (a.k.a. Likert scales), items can be presented in a comparative fashion, so that respondents are asked to rank the items within blocks (forced-choice format). However, classical scoring procedures for these forced-choice designs lead to ipsative data, which presents psychometric challenges that are well described in the literature. Recently, Brown and Maydeu-Olivares (Educational and Psychological Measurement 71: 460–502, 2011a) introduced a model based on Thurstone's law of comparative judgment, which overcomes the problems of ipsative data. Here, we provide a step-by-step tutorial for coding forced-choice responses, specifying a Thurstonian item response theory model that is appropriate for the design used, assessing the model's fit, and scoring individuals on psychological attributes. Estimation and scoring is performed using Mplus, and a very straightforward Excel macro is provided that writes full Mplus input files for any forced-choice design. Armed with these tools, using a forced-choice design is now as easy as using ratings.

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Keywords Forced-choice format · Thurstonian IRT model · Ipsative data · Multidimensional IRT · Mplus

Typical questionnaire and survey items are presented to respondents one at a time (single-stimulus items), which often leads to indiscriminate endorsement of all desirable items by respondents, resulting in systematic score inflation. *Forced-choice* response formats were designed to reduce such biases by forcing people to choose between similarly attractive options. In forced-choice questionnaires, items are presented in blocks of two, three, four, or more items at a time, and respondents are asked to rank the items within each block according to some instruction (e.g., in terms of how well the items describe their behavior or attitudes). Sometimes, the respondents are asked to indicate only the top and the bottom ranks (e.g., to select one item that best describes them and one that least describes them).

One special case of forced-choice is the so-called *multidimensional forced-choice* (MFC), in which each item is assumed to measure only one psychological attribute, and all items within a block measure different attributes. MFC questionnaires are popular in the psychological assessment industry because it is believed that this format is more robust against response sets, halo effects, and impression management, and experimental evidence supports these ideas (e.g., Bartram, 2007; Cheung & Chan, 2002; Christiansen, Burns, & Montgomery, 2005; Jackson, Wroblewski, & Ashton, 2000).

The standard scoring used with forced-choice questionnaires involves adding the inverted rank orders of items within blocks to their respective scales. As a fixed number of points are allocated in every block, the total number of points on the test is the same for every individual (*ipsative* data). In other words, one scale score can be determined from the remaining scales. Ipsativity leads to some highly undesirable consequences, namely:

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Assessing Competencies for Social and Emotional Learning Jeremy Burrus,Samuel H. Rikoon,Meghan W. Brenneman,2022-07-12 Assessing Competencies for Social and Emotional Learning explores the conceptualization development and application of assessments of competencies and contextual factors related to social and emotional learning SEL As programs designed to teach students social and emotional competencies are being adopted at an ever increasing rate new measurements are needed to understand their impact on student attitudes behaviors and academic performance This book integrates standards of fairness reliability and validity and lessons learned from personality and attitude assessment to facilitate the principled development and use of SEL assessments Education professionals assessment developers and researchers will be better prepared to systematically develop and evaluate measures of social and emotional competencies

The Wiley Handbook of Psychometric Testing Paul Irwing,Tom Booth,David J. Hughes,2018-02-12 A must have resource for researchers practitioners and advanced students interested or involved in psychometric testing Over the past hundred years psychometric testing has proved to be a valuable tool for measuring personality mental ability attitudes and much more The word psychometrics can be translated as mental measurement however the implication that psychometrics as a field is confined to psychology is highly misleading Scientists and practitioners from virtually every conceivable discipline now use and analyze data collected from questionnaires scales and tests developed from psychometric principles and the field is vibrant with new and useful methods and approaches This handbook brings together contributions from leading psychometricians in a diverse array of fields around the globe Each provides accessible and practical information about their specialist area in a three step format covering historical and standard approaches innovative issues and techniques and practical guidance on how to apply the methods discussed Throughout real world examples help to illustrate and clarify key aspects of the topics covered The aim is to fill a gap for information about psychometric testing that is neither too basic nor too technical and specialized and will enable researchers practitioners and graduate students to expand their knowledge and skills in the area Provides comprehensive coverage of the field of psychometric testing from designing a test through writing items to constructing and evaluating scales Takes a practical approach addressing real issues faced by practitioners and researchers Provides basic and accessible mathematical and statistical foundations of all psychometric techniques discussed Provides example software code to help readers implement the analyses discussed **Advancing Methods for Psychological Assessment Across Borders** Kai Ruggeri,Gabriela Diana Roman,Agnieszka Walczak,Sam Norton,Pietro Cipresso,Rocio Del Pino,Kristina Egumenovska,2020-01-06 Decisions, Preferences, and Heuristics Pere Mir-Artigues,2023-08-14 This enlightening book comprehensively maps the current state of economic psychology and behavioural economics Exploring key concepts topics and models in the field it is also a launching pad for future research and provides useful insights on how good personal and professional decisions can be made advancing microeconomic

discourse Measuring Human Capabilities National Research Council,Division of Behavioral and Social Sciences and Education,Board on Behavioral, Cognitive, and Sensory Sciences,Committee on Measuring Human Capabilities: Performance Potential of Individuals and Collectives,2015-04-10 Every year the U S Army must select from an applicant pool in the hundreds of thousands to meet annual enlistment targets currently numbering in the tens of thousands of new soldiers A critical component of the selection process for enlisted service members is the formal assessments administered to applicants to determine their performance potential Attrition for the U S military is hugely expensive Every recruit that does not make it through basic training or beyond a first enlistment costs hundreds of thousands of dollars Academic and other professional settings suffer similar losses when the wrong individuals are accepted into the wrong schools and programs or jobs and companies Picking the right people from the start is becoming increasingly important in today s economy and in response to the growing numbers of applicants Beyond cognitive tests of ability what other attributes should selectors be considering to know whether an individual has the talent and the capability to perform as well as the mental and psychological drive to succeed Measuring Human Capabilities An Agenda for Basic Research on the Assessment of Individual and Group Performance Potential for Military Accession examines promising emerging theoretical technological and statistical advances that could provide scientifically valid new approaches and measurement capabilities to assess human capability This report considers the basic research necessary to maximize the efficiency accuracy and effective use of human capability measures in the military s selection and initial occupational assignment process The research recommendations of Measuring Human Capabilities will identify ways to supplement the Army s enlisted soldier accession system with additional predictors of individual and collective performance Although the primary audience for this report is the U S military this book will be of interest to researchers of psychometrics personnel selection and testing team dynamics cognitive ability and measurement methods and technologies Professionals interested in of the foundational science behind academic testing job selection and human resources management will also find this report of interest **Quantitative Psychology Research** L. Andries van der Ark,Daniel M. Bolt,Wen-Chung Wang,Jeffrey A. Douglas,Marie Wiberg,2016-08-04 The research articles in this volume cover timely quantitative psychology topics including new methods in item response theory computerized adaptive testing cognitive diagnostic modeling and psychological scaling Topics within general quantitative methodology include structural equation modeling factor analysis causal modeling mediation missing data methods and longitudinal data analysis These methods will appeal in particular to researchers in the social sciences The 80th annual meeting took place in Beijing China between the 12th and 16th of July 2015 Previous volumes to showcase work from the Psychometric Society s Meeting are New Developments in Quantitative Psychology Presentations from the 77th Annual Psychometric Society Meeting Springer 2013 Quantitative Psychology Research The 78th Annual Meeting of the Psychometric Society Springer 2015 and Quantitative Psychology Research The 79th Annual Meeting of the Psychometric Society Wisconsin USA 2014

Springer 2015 Handbook of Item Response Theory Modeling Steven P. Reise,Dennis A. Revicki,2014-11-20 Item response theory IRT has moved beyond the confines of educational measurement into assessment domains such as personality psychopathology and patient reported outcomes Classic and emerging IRT methods and applications that are revolutionizing psychological measurement particularly for health assessments used to demonstrate treatment effectiveness are reviewed in this new volume World renowned contributors present the latest research and methodologies about these models along with their applications and related challenges Examples using real data some from NIH PROMIS show how to apply these models in actual research situations Chapters review fundamental issues of IRT modern estimation methods testing assumptions evaluating fit item banking scoring in multidimensional models and advanced IRT methods New multidimensional models are provided along with suggestions for deciding among the family of IRT models available Each chapter provides an introduction describes state of the art research methods demonstrates an application and provides a summary The book addresses the most critical IRT conceptual and statistical issues confronting researchers and advanced students in psychology education and medicine today Although the chapters highlight health outcomes data the issues addressed are relevant to any content domain The book addresses IRT models applied to non educational data especially patient reported outcomes Differences between cognitive and non cognitive constructs and the challenges these bring to modeling The application of multidimensional IRT models designed to capture typical performance data Cutting edge methods for deriving a single latent dimension from multidimensional data A new model designed for the measurement of constructs that are defined on one end of a continuum such as substance abuse Scoring individuals under different multidimensional IRT models and item banking for patient reported health outcomes How to evaluate measurement invariance diagnose problems with response categories and assess growth and change Part 1 reviews fundamental topics such as assumption testing parameter estimation and the assessment of model and person fit New emerging and classic IRT models including modeling multidimensional data and the use of new IRT models in typical performance measurement contexts are examined in Part 2 Part 3 reviews the major applications of IRT models such as scoring item banking for patient reported health outcomes evaluating measurement invariance linking scales to a common metric and measuring growth and change The book concludes with a look at future IRT applications in health outcomes measurement The book summarizes the latest advances and critiques foundational topics such a multidimensionality assessment of fit handling non normality as well as applied topics such as differential item functioning and multidimensional linking Intended for researchers advanced students and practitioners in psychology education and medicine interested in applying IRT methods this book also serves as a text in advanced graduate courses on IRT or measurement Familiarity with factor analysis latent variables IRT and basic measurement theory is assumed **Advances in Thurstonian Forced-Choice Modeling** Markus Thomas Jansen,2023 *Fit of Item Response Theory Models* S. Sinharay,Shelby J. Haberman,Helena Jia,2011 Standard 3 9 of the Standards for

Educational and Psychological Testing American Educational Research Association American Psychological Association National Council for Measurement in Education 1999 demands evidence of model fit when an item response theory IRT model is used to make inferences from a data set We applied two recently suggested methods for assessing goodness of fit of IRT models generalized residual analysis Haberman 2009 and residual analysis for assessing item fit Bock Haberman 2009 to several operational data sets We assessed the practical significance of misfit whenever possible This report summarizes our findings Though evidence of misfit of the IRT model was found for all the data sets the misfit was not always practically significant Contains 3 tables 50 figures and 6 notes **The Effect of Fitting a Unidimensional IRT Model to Multidimensional Data in Content-balanced Computerized Adaptive Testing** Tian Song,2010 This study investigates the effect of fitting a unidimensional irt model to multidimensional data in content balanced computerized adaptive testing cat Unconstrained cat with the maximum information item selection method is chosen as the baseline and the performances of three content balancing procedures the constrained cat ccat the modified multinomial model mmm and the modified constrained cat mccat are evaluated in terms of measurement precision item pool utilization and item exposure control Three simulation factors are considered 1 multidimensional structure 2 ability distribution and 3 difficulty level of content areas Simulation results show that overall the content balancing methods are similar to or even better than the maximum information method in terms of measurement precision especially when the content areas have uneven difficulty levels However there is no significant difference in item pool usage and item exposure control Finally overall the three content balancing methods perform very similarly but mmm has the most efficient item pool usage The dissertation citations contained here are published with the permission of ProQuest llc Further reproduction is prohibited without permission Copies of dissertations may be obtained by Telephone 800 1 800 521 0600 Web page http www proquest com en US products dissertations individuals shtml **A Comparison of the Psychometric Properties of the Forced Choice and Likert Scale Versions of a Personality Instrument** Tina Joubert,Ilke Inceoglu,David Bartram,Kim Dowdeswell,Yin Lin,2015 The present research investigated if an item response theory IRT scored forced choice personality questionnaire has the same normative data structures as a similar version that uses a 5 point Likert scale instead The study was conducted using a sample of 349 training delegates who completed both an IRT scored forced choice and a normative single stimulus version of the questionnaire Results largely supported the scaling properties measurement precision and equivalence of the data structures of the two scoring methods *New Model-data Fit Indices for Item Response Theory (IRT): an Evaluation and Application* ,2015 **Handbook of Polytomous Item Response Theory Models** Michael Nering,Remo Ostini,2011-01-19 This comprehensive Handbook focuses on the most used polytomous item response theory IRT models These models help us understand the interaction between examinees and test questions where the questions have various response categories The book reviews all of the major models and includes discussions about how and where the models originated conceptually and

in practical terms Diverse perspectives on how these models can best be evaluated are also provided Practical applications provide a realistic account of the issues practitioners face using these models Disparate elements of the book are linked through editorial sidebars that connect common ideas across chapters compare and reconcile differences in terminology and explain variations in mathematical notation These sidebars help to demonstrate the commonalities that exist across the field By assembling this critical information the editors hope to inspire others to use polytomous IRT models in their own research so they too can achieve the type of improved measurement that such models can provide Part 1 examines the most commonly used polytomous IRT models major issues that cut across these models and a common notation for calculating functions for each model An introduction to IRT software is also provided Part 2 features distinct approaches to evaluating the effectiveness of polytomous IRT models in various measurement contexts These chapters appraise evaluation procedures and fit tests and demonstrate how to implement these procedures using IRT software The final section features groundbreaking applications Here the goal is to provide solutions to technical problems to allow for the most effective use of these models in measuring educational psychological and social science abilities and traits This section also addresses the major issues encountered when using polytomous IRT models in computerized adaptive testing Equating test scores across different testing contexts is the focus of the last chapter The various contexts include personality research motor performance health and quality of life indicators attitudes and educational achievement Featuring contributions from the leading authorities this handbook will appeal to measurement researchers practitioners and students who want to apply polytomous IRT models to their own research It will be of particular interest to education and psychology assessment specialists who develop and use tests and measures in their work especially researchers in clinical educational personality social and health psychology This book also serves as a supplementary text in graduate courses on educational measurement psychometrics or item response theory *IRT Model Fit from Different Perspectives* Muhammad Naveed Khalid,2009 *A Paradox Between IRT Invariance and Model-Data Fit When Utilizing the One-Parameter and Three-Parameter Models* Michael Custer,Sid Sharairi,Kenji Yamazaki,Diane Signatur,David Swift,Sharon Frey,2008 The present study compared item and ability invariance as well as model data fit between the one parameter 1PL and three parameter 3PL Item Response Theory IRT models utilizing real data across five grades second through sixth as well as simulated data at second fourth and sixth grade At each grade the 1PL and 3PL IRT models were run with each of three ability groups low middle and high utilizing PARSCALE Version 4 1 Results were compared in terms of item fit as well as Pearson and Spearman rank order correlations between estimated item and ability parameters At each grade the 3PL exhibited the best model data fit However the 1PL produced a greater degree of item and ability invariance across the three ability groups Contains 13 tables Item Response Theory for the Analysis and Construction of Multidimensional Forced-choice Tests Susanne Frick,2021 Exploring Item Response Modelling of Forced-choice Questionnaires James Vlahov,2014 **Multidimensional Item Response Theory in Clinical**

Measurement Arjan Berkeljon,2012 Bifactor item response theory IRT models are presented as a plausible structure for psychological measures with a primary scale and two or more subscales A bifactor graded response model appropriate for polytomous categorical data was fit to two university counseling center datasets N 4 679 and N 4 500 of Outcome Questionnaire 45 2 OQ psychotherapy intake data The bifactor model showed superior fit compared to a unidimensional IRT model IRT item parameters derived from the bifactor model show that items discriminate well on the primary scale Items on the OQ s subscales maintain some discrimination ability over and above the primary scale However reliability estimates for the subscales controlling for the primary scale suggest that clinical use should likely proceed with caution Item difficulty or severity parameters relfected item content well in that increased probability of endorsement was found at high levels of distress for items tapping severe symptomatology Increased probability of endorsement was found at lower levels of distress for items tapping milder symptomatology Analysis of measurement invariance showed that item parameters hold equally across gender for most OQ items A subset of items was found to have item parameters non invariant across gender Implications for research and practice are discussed and directions for future work given

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