

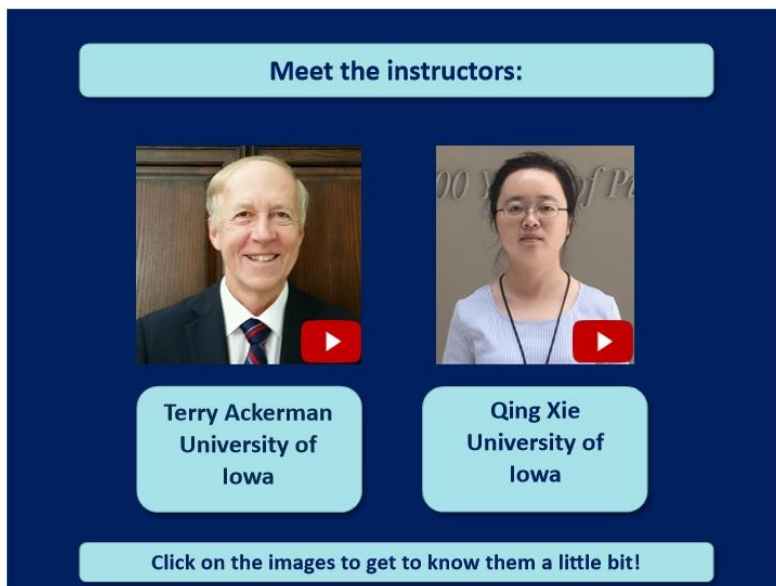
MIRT Graphics

1. Module Overview

1.1 Module Cover (START)





1.2 Instructors





1.3 Designers



Meet the instructional designers:



Jonathan Lehrfeld
ETS



Xi Lu
Florida State
University



André A. Rupp
Mindful
Measurement


Click on the images to get to know them a little bit!

1.4 Target Audience

Target Audience

Anyone who would like a gentle statistical introduction to this topic:

- graduate students and faculty in Master's, Ph.D., or certificate programs
- psychometricians and other measurement professionals
- data scientists / analysts
- research assistants or research scientists
- technical project directors
- assessment developers

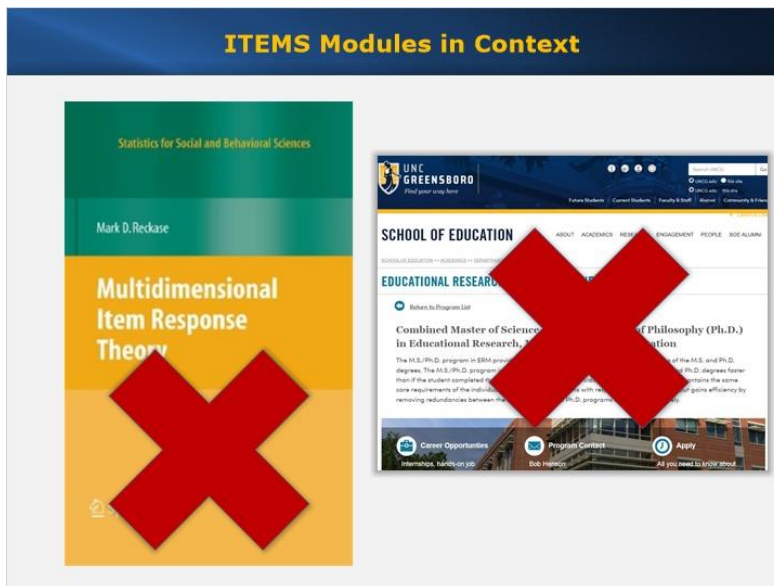


However, we hope that you find the information in this module useful no matter what your official title or role in an organization is!

1.5 Expectations (I)




1.6 Expectations (II)



1.7 Learning Objectives

Learning Objectives



1. Understand how to interpret evidence of dimensionality
2. Understand how the concepts and models change from UIRT to MIRT
3. Understand different ways to represent 2-D IRT item and test characteristics
4. Understand different ways to represent true score information and score scale consistency using centroids
5. Create MIRT graphics using an Rshiny app

1.8 Prerequisites


Prerequisites

To get the most out of this module, it is beneficial to:

- ✓ Be familiar with the underpinnings of classical test theory and its applications in assessment
- ✓ Understand the underlying theory, applications, and estimation of item response theory unidimensional models
- ✓ Have taken a graduate course in multivariate statistics, which includes factor analysis, principal components analysis, and multiple regression
- ✓ Have a working knowledge of running R

1.9 Resources

Resources



Reckase, M. D. (2009). *Multidimensional item response theory*. New York, NY: Springer.

Ackerman, T. A., Gierl, M. J., Walker, C. M. (2003). *Using multidimensional item response theory to evaluate educational and psychological tests*. Available in the ITEMS portal.

An NCME Instructional Module on
Using Multidimensional Item Response Theory to Evaluate Educational and Psychological Tests
Terry A. Ackerman, University of North Carolina-Greensboro
Mark J. Gierl, University of Alberta
Cindy M. Walker, University of Wisconsin-Madison


This instructional module provides an overview of multidimensional item response theory (MIRT) and its applications in educational and psychological testing. The module covers the theoretical foundations of MIRT, including the relationship between item response functions and latent variables, and the use of MIRT in evaluating educational and psychological tests. The module also discusses the practical applications of MIRT, such as the use of MIRT in item analysis and test evaluation. The module is designed to provide a comprehensive overview of MIRT for researchers and practitioners in the field of educational and psychological testing.

Keywords: Multidimensional item response theory, Educational and psychological tests, Test evaluation, Item analysis.

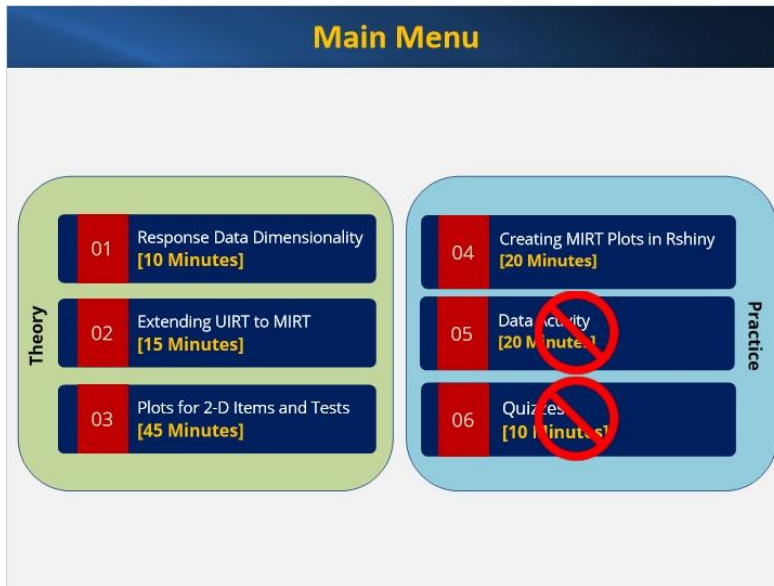
1.10 Module Citation

Module Citation

Ackerman, T., & Xie, Q. (2021). Multidimensional item response theory graphics (Digital ITEMS Module 23). *Educational Measurement: Issues and Practice*, 40(1), 105-106.



1.11 Main Menu





2. Response Data Dimensionality


2.1 Cover: Response Data Dimensionality



2.2 Learning Objectives: Response Data Dimensionality





Learning Objectives



1. Know what we mean when we say a test is multidimensional
2. Identify some of the features of items and examinees that can cause multidimensionality
3. Identify a common approach practitioners use to examine the dimensionality of their tests
4. Examine dimensionality of simulated unidimensional and two-dimensional data



2.3 Understanding Dimensionality



Understanding Dimensionality

- A single item is always unidimensional because it measures only one skill or one composite of multiple skills
- Two or more items can be multidimensional if each item measures a different skill or different skill composites
- It is important to understand which skills or skill composite are being measured in order to articulate the meaning of the score scale, draw subsequent interpretations, and model the data appropriately



2.4 Test Dimensionality (I)



Test Dimensionality

- Test data represents the interaction between examinees and items
- Tests produce multidimensional response data when:
 - Items are capable of measuring multiple skills
 - Examinees differ in levels of skill proficiencies
- If all the items on a test only measure one skill, the test will yield only unidimensional response data, regardless of whether examinees have varying levels of proficiency on multiple skills



2.5 Dimensionality (II)



Test Dimensionality

- If the items on a test measure multiple skills but the examinees vary in their levels of proficiency on only one of the skills, the test will yield only unidimensional response data
- It is very important for practitioners to not only understand the skills or skill composites needed to correctly respond to an item, but also understand the skills or skill composite of their examinees


2.6 Causes of Dimensionality (I)





Causes of Dimensionality

Some of the potential causes of dimensionality that may enable **items** to measure multiple skills:

- Items measure different content
- Items measure different levels of cognitive reasoning
- Phrasing and wording of items can resonate more meaning for one group of examinees than others




2.7 Causes of Dimensionality (II)





Causes of Dimensionality

Some of the potential causes of dimensionality that may cause **examinees** to vary in their levels of proficiency on a skill or skill composite:

- Different backgrounds or experiences due to socioeconomic status or educational opportunities
- Individual differences in interests or passions
- Different first languages
- Special needs requiring assistance for disabilities that may be physical, mental, or psychological





2.8 Assessing Dimensionality



Assessing Dimensionality

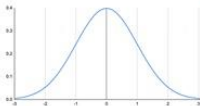
- There are many ways to assess the dimensionality of response data
- We will examine a scree plot of eigenvalues from a factor analysis of the inter-item tetrachoric correlation matrix
- The goals of this method are two-fold:
 - a) Identify the dimensionality of the data to determine which IRT model is most appropriate
 - b) Articulate what skills the scales represent

2.9 Example of Assessing Dimensionality



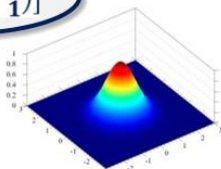
Example of Assessing Dimensionality

- To illustrate the distinction between scree plots for unidimensional and multidimensional data, we generated two 20-item tests for 1,000 examinees
- Dataset 1 used a unidimensional 2PL model for examinees from a $N(0,1)$ underlying ability distribution
- Dataset 2 used a two-dimensional compensatory model for examinees from an underlying bivariate normal distribution:



Dataset 1

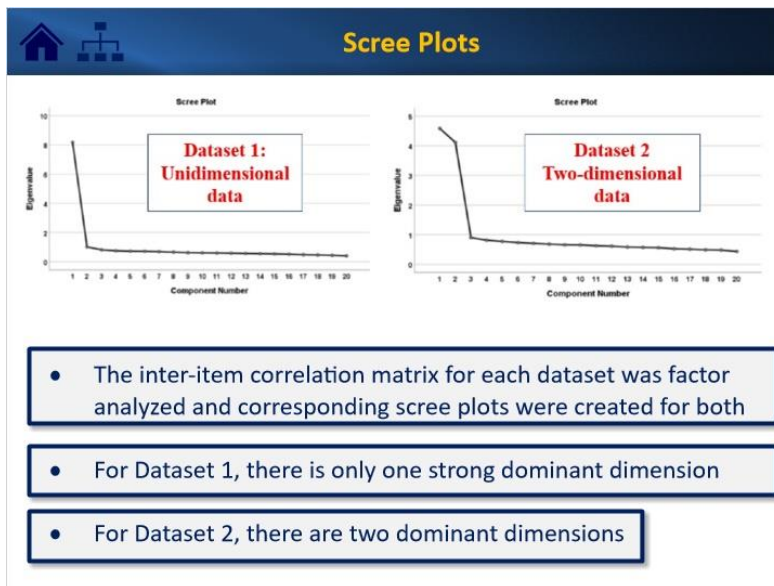
vs.



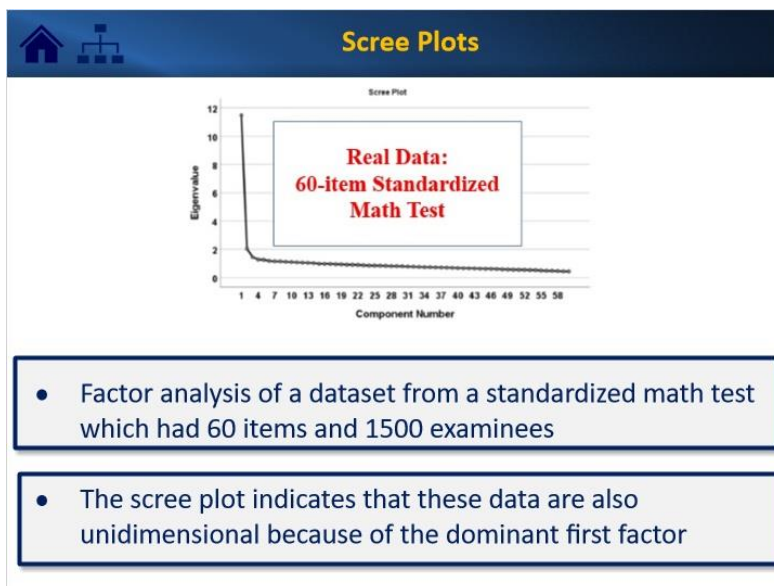
Dataset 2

$$\mathcal{N}\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}\right]$$



2.10 Scree Plots (I)



2.11 Scree Plots (II)



2.12 Summary of Assessing Dimensionality



Summary of Assessing Dimensionality

There have been many procedures developed to determine the dimensionality of test data. Here is a great article summarizing methods:

Educational Assessment, 19(33-37), 2014
Copyright © Taylor & Francis Group, LLC
ISSN: 1062-7197 print/1332-4977 online
DOI: 10.1080/10627197.2014.869430

A Framework for Dimensionality Assessment for Multidimensional Item Response Models

Dubravka Svetina
Indiana University



Roy Levy
Arizona State University

A framework is introduced for considering dimensionality assessment procedures for multidimensional item response models. The framework characterizes procedures in terms of their constructivist or exploratory approach, parametric or nonparametric assumptions, and applicability to dichotomous, polytomous, and missing data. Popular and emerging approaches are situated within the proposed framework and illustrated via analyses of item response data from the National Assessment of Educational Progress Science Assessment.

The analysis of the assumed dimensionality has long been recognized as an integral part of any application of unidimensional item response theory (IRT) models, in which a single latent variable is modeled as underlying observable item responses. Decades of research have shown that the use of a unidimensional model for multidimensional data structures (i.e., those in which

Click on the article to open its publisher's website.

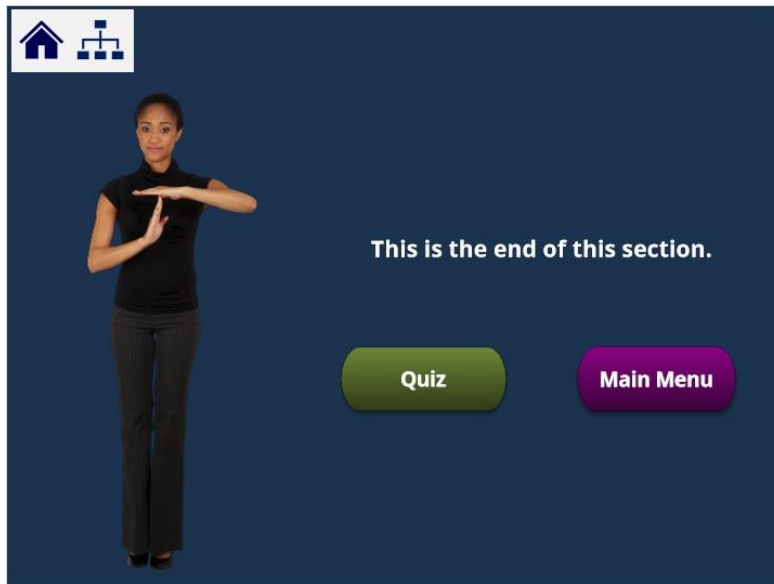
2.13 Summary: Response Data Dimensionality



Summary

- Test responses represent the interaction between examinees and items
- Data will be multidimensional if a items measure multiple skills AND examinees differ in proficiency level
- It is important for practitioners to assess dimensionality because they need to understand which models are most appropriate for their data
- It is also important to understand data dimensionality for validity purposes, so the claims about what the test is measuring and how the results are used are valid
- There are many procedures to determine dimensionality of data. One common approach is to examine the scree plot from a factor analysis of the inter-item tetrachoric correlation matrix.
- A dominant first factor suggests that the data are unidimensional

2.14 Bookend: Response Data Dimensionality





3. Extending UIRT to MIRT


3.1 Cover: Extending UIRT to MIRT



3.2 Learning Objectives: Extending UIRT to MIRT





Learning Objectives



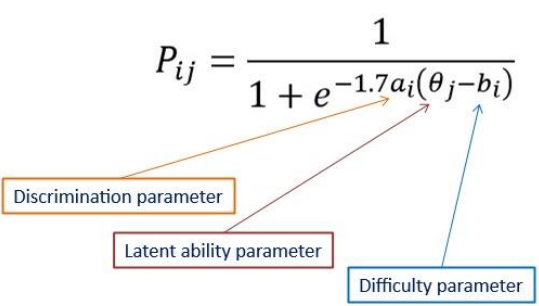
1. Understand how to extend UIRT models to 2-D IRT models
2. Understand how the UIRT ICC becomes a 2-D ICS
3. Explain why the M2PL model is known as a compensatory model
4. Examine how unidimensional polytomous models can be extended to their 2-D counterparts

3.3 The 2PL IRT Model



The 2-PL IRT Model

In the unidimensional 2PL model, the probability of examinee j responding correctly to item i can be expressed as:

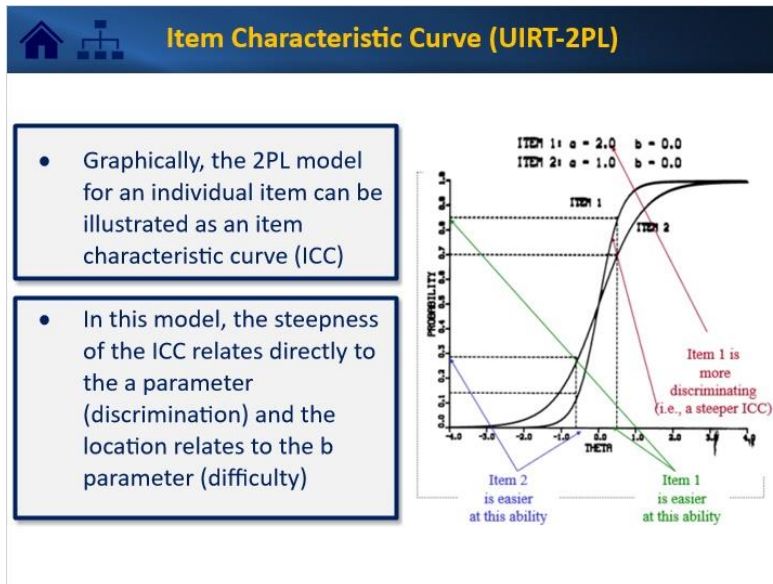
$$P_{ij} = \frac{1}{1 + e^{-1.7a_i(\theta_j - b_i)}}$$


Discrimination parameter

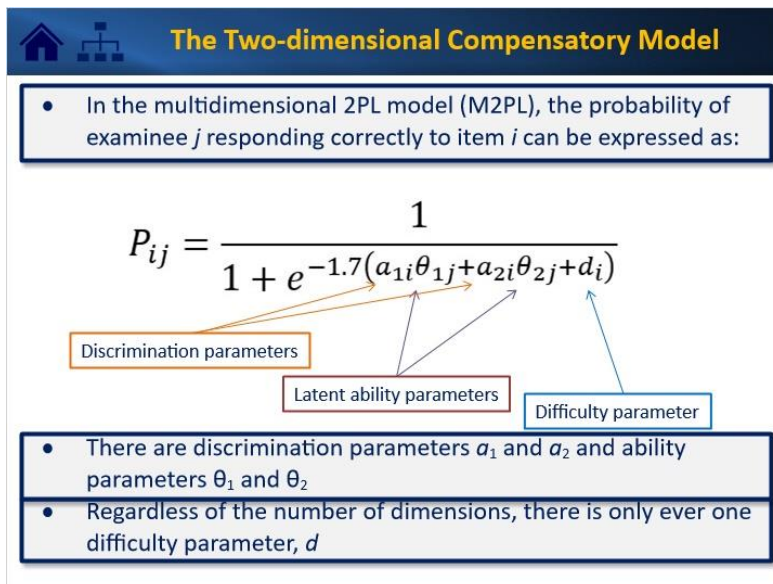
Latent ability parameter

Difficulty parameter

3.4 Item Characteristic Curves for UIRT 2PL



3.5 The 2-Dimensional Compensatory Model



3.6 2-D Compensatory Item Surface

2-D Compensatory Item Surface

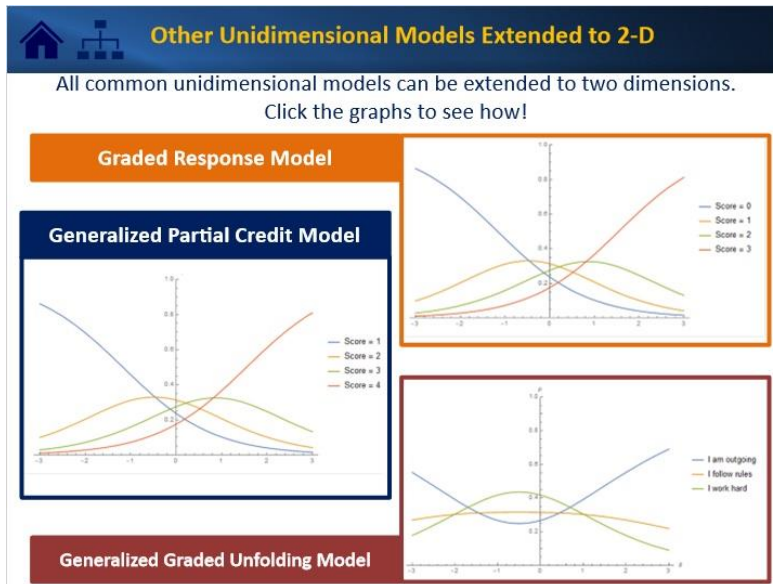
- Under the 2-D compensatory model, items can be illustrated with item characteristic surfaces (ICSs)
- The steepness of the ICS relates directly to the a parameters
- The relative sizes of the a s indicate which composite of θ_1 and θ_2 is being best measured. If $a_1 = a_2$, θ_1 and θ_2 are being measured equally well. If $a_1 > a_2$, θ_1 is being given greater emphasis, and if $a_1 < a_2$, θ_2 is being given greater emphasis.

3.7 Compensatory Surface Contour

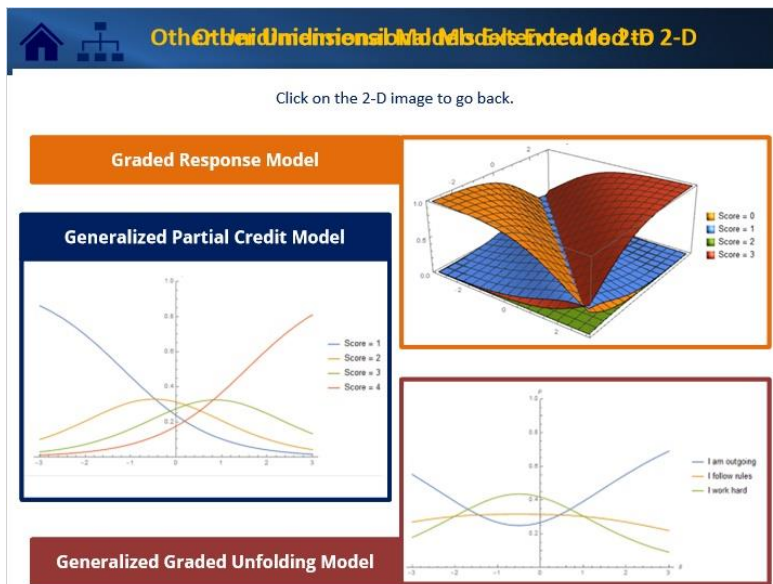
Compensatory Surface Contour

- Equiprobability contours are always parallel for the compensatory model
- Every (θ_1, θ_2) combination on the same contour has the same response probability
- When $a_1 = a_2$, compensation between abilities is optimal: examinees who are high on θ_1 but low on θ_2 have the same probability of answering correctly as an examinee with the opposite profile because being high on one ability compensates for being low on the other.

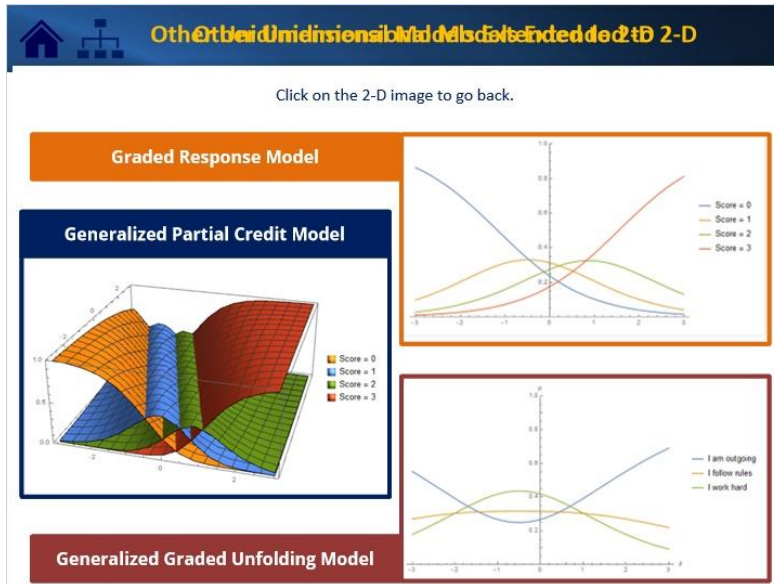
3.8 Other Unidimensional Models Extended to 2-D



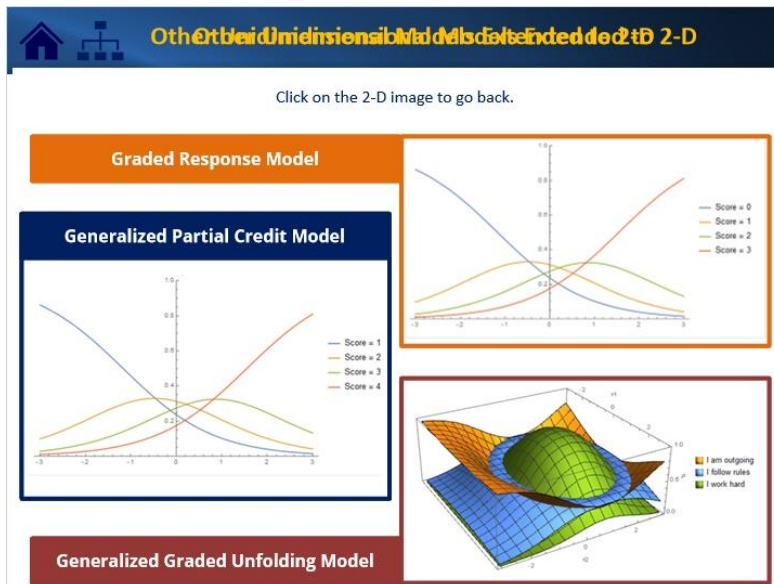
2DGRM (Slide Layer)





2DGPCM (Slide Layer)



2DGGUM (Slide Layer)






3.9 Summary: UIRT and MIRT Concepts

 **Summary**

- M2PL model requires a discrimination parameter and ability parameter for each dimension, but only one difficulty parameter
- Under the M2PL, the product of the discrimination and the ability parameters for each dimension are additive in the logit, so being high on one ability can compensate for being low on the other
- Compensation is optimal when $a_1 = a_2$ or when the model weights each ability equally
- Equiprobability contours of the compensatory model are always parallel. All examinees lying on the same equiprobability contour have the same response probability.
- Larger a values lead to steeper ICSSs, making the equiprobability contours closer together
- 2-D extensions are possible for other common IRT models as well

3.10 Bookend: Extending UIRT to MIRT





This is the end of this section.

[Quiz](#)

[Main Menu](#)

4. Plots for 2D Items and Tests


4.1 Cover: Plots for 2D Items and Tests



4.2 Learning Objectives: Plots for 2D Items and Tests

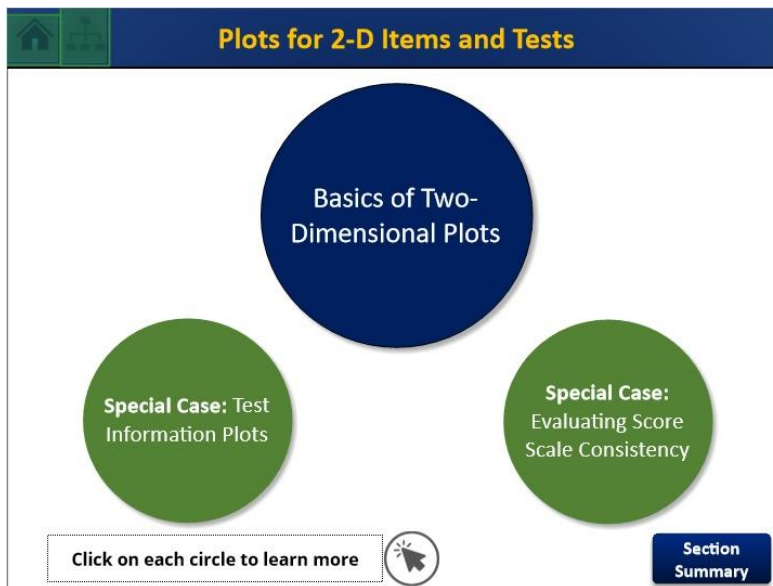
A slide titled "Learning Objectives" with a target icon. The slide contains four numbered learning objectives in rounded rectangular boxes. A horizontal line is at the bottom of the slide.

Learning Objectives



1. Understand how 2-D response surfaces are represented as item vectors and 1-D test characteristic curves generalize to 2-D test characteristic surfaces
2. Understand how item and test information in a 2-D latent space is calculated
3. Understand how test information is best captured using a clamshell plot and how a test information number plot profiles which composites are best measured
4. Understand score scale consistency and how to interpret a centroid plot when a scale is not consistent



4.3 Topic Selection



4.4 Bookmark: Basics of 2-D Plots



4.5 Item Vectors (I)





Item Vectors

- Plotting multiple ICSs can be very cumbersome
- Perhaps the best representation of 2-D tests is to represent each item as a vector in the latent ability plane

- Guidelines for process:
 - All vectors lie on lines that pass through the origin
 - Vectors can lie only in the first and third quadrants because parameters are constrained to be positive
 - Vectors representing easy items lie in the third quadrant; vectors representing difficult items lie in the first quadrant

- To create a vector, you need to know the length, the origin, and the angle with the θ_1 -axis

4.6 Item Vectors (II)



Item Vectors

- The length of the vector indicates how discriminating the item is. This value is called MDISC.

$$\text{MDISC} = \sqrt{(a_1^2 + a_2^2)}$$

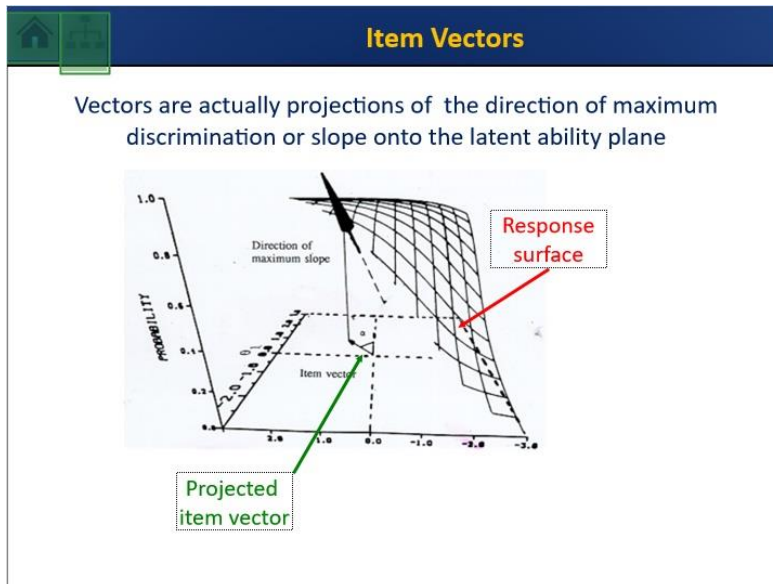
- The tail of the vector lies on the $p = .50$ equiprobability contour. The signed distance from the origin to this contour is denoted as MDIFF

$$\text{MDIFF} = \frac{-d}{\text{MDISC}}$$

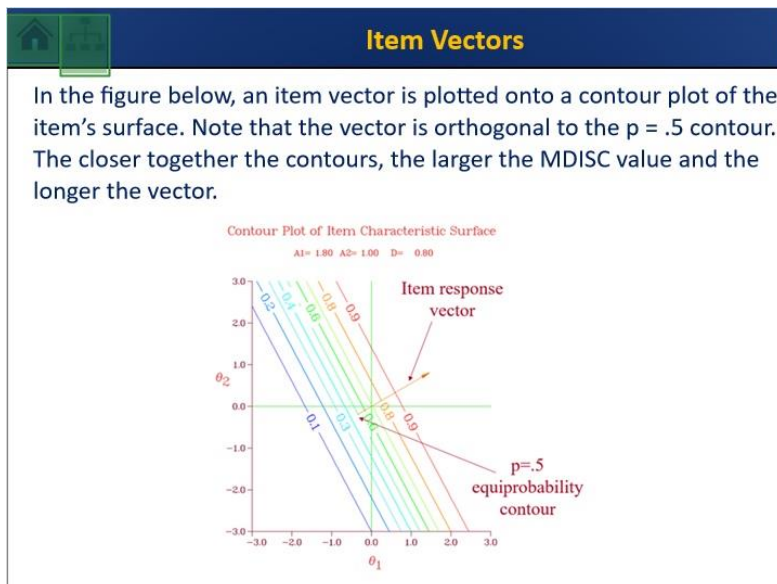
- The angular direction indicates the composite of ability that the item is best measuring

$$\alpha = \cos^{-1}\left(\frac{a_1}{\text{MDISC}}\right)$$



4.7 Item Vectors (III)



4.8 Item Vectors (III)

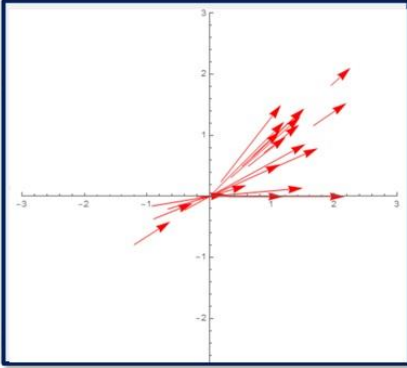


4.9 Item Vectors (IV)





Item Vectors

- Here is a vector plot of 2-D estimated parameters from a 20-item math quiz
- If a single score is reported then it is paramount that the vectors lie in a narrow sector (i.e., items are measuring similar composites)
- This is referred to as the Validity Sector



4.10 Item Vectors (V)

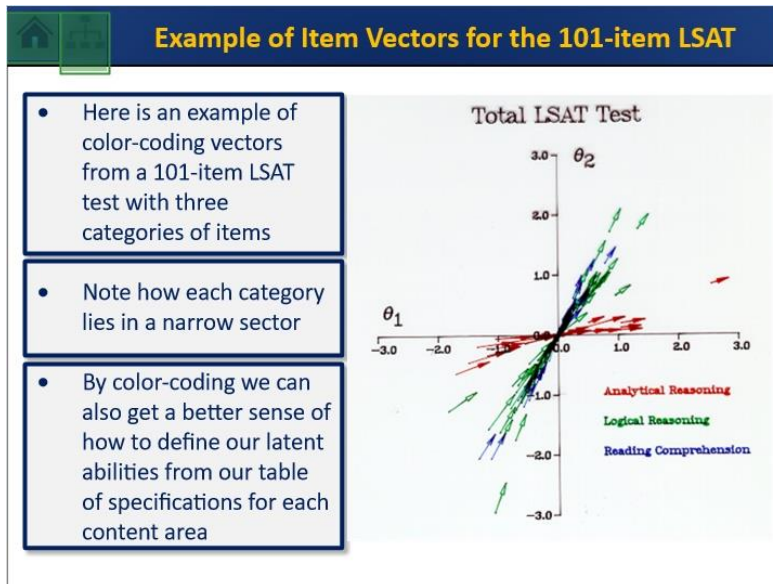


Item Vectors

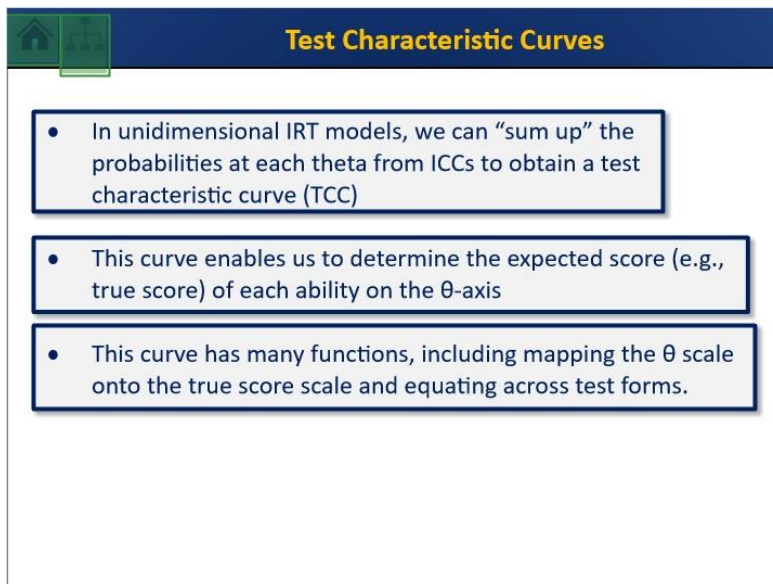
By color coding the vectors to match different content areas we can determine

- Are items from a certain content area more discriminating or more difficult?
- Do different items from different content areas measure different ability composites?
- How similar are the vector profiles for different yet “parallel” forms?

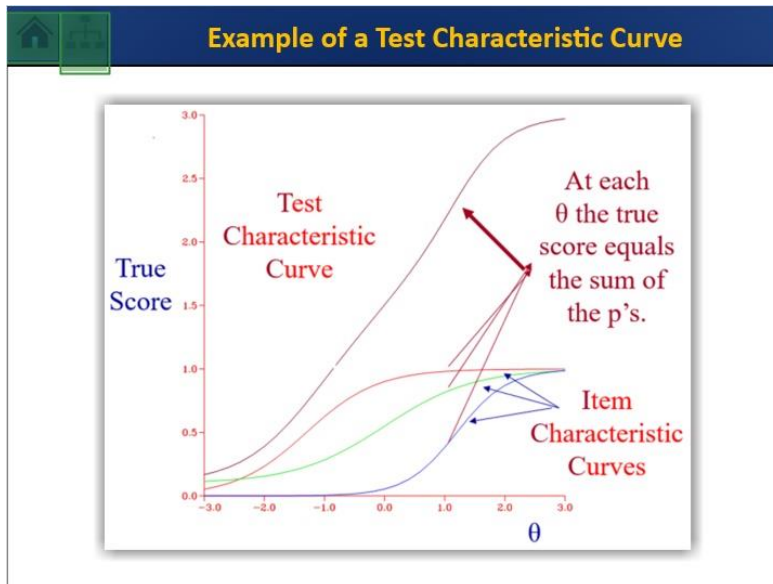
4.11 Example of Item Vectors for the 101-Item LSAT



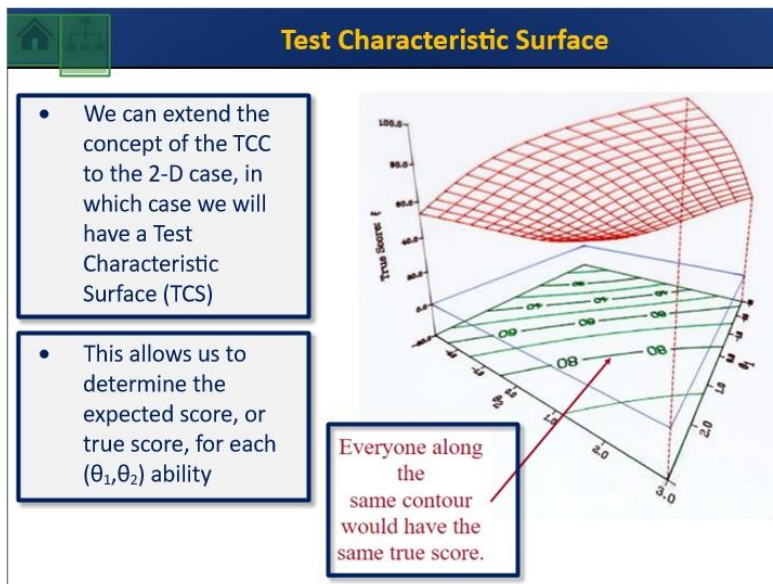
4.12 Test Characteristic Curves



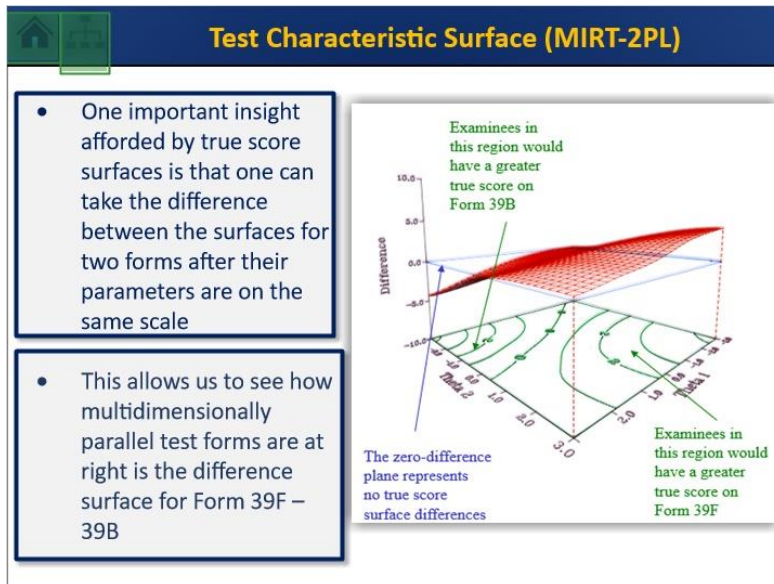
4.13 Example of a Test Characteristic Curve



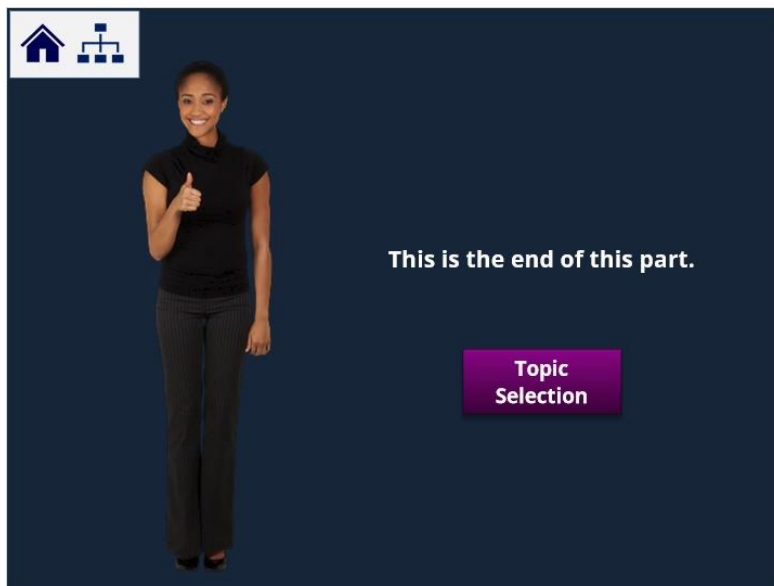
4.14 Test Characteristic Surface



4.15 Test Characteristic Surface (II)





4.16 Bookend: Basics of 2-D Plots



4.17 Bookmark: Test Information Plots



4.18 Test Information Plots (I)





Test Information Plots

- In unidimensional IRT models the formula for computing information for item i can be expressed as:

$$I_i(\theta) = 2.89P_iQ_i \quad \text{for the 1PL,}$$
$$I_i(\theta) = 2.89a_i^2P_iQ_i \quad \text{for the 2PL, and}$$
$$I_i(\theta) = 2.89a_i^2Q_i \frac{(P_i - c_i)^2}{(1 - c_i)^2P_i} \quad \text{for the 3PL}$$

- Note that when $c_i = 0$, the 3PL formula is the same as the 2PL, and when $a_i = 1$, the 2PL is the same as the 1PL

4.19 Test Information Plots (II)





Test Information Plots

- To compute the information for the 2-D M2PL model, one would have to use the following formula:

$$I_{\alpha}(\theta) = P(\theta)Q(\theta) \left(\sum_{v=1}^2 \alpha_v \cos \alpha_v \right)^2$$

- where $P(\theta)$ is the M2PL model, $Q(\theta)$ is $1 - P(\theta)$, and α is the composite direction for which you want to compute the information.

4.20 Test Information Plots (III)



Test Information Plots

- For example, assume $a_1 = 1$, $a_2 = 1$ and $d = 0$. To calculate the information in a 45° angle at the point (0,0), first calculate $P(0,0)$ and $Q(0,0)$.
- Under the M2PL, $P(0,0) = .5$ and $Q(0,0) = .5$, so:



$$I_{45}(1,1) = P(\theta)Q(\theta) \left(\sum_{v=1}^m \alpha_v \cos \alpha_v \right)^2$$

$$I_{45}(1,1) = (.5)(.5) [(1.0)(\cos 45) + (1.0)(\cos 45)]^2$$

$$I_{45}(1,1) = (.5)(.5) [(1.0)(.707) + (1.0)(.707)]^2$$

$$I_{45}(1,1) = .499$$
- Continuing to move away from the origin in the same direction, $P(1,1) = .967$ and $Q(1,1) = .033$, yielding $I_{45}(1,1) = .064$. If we move out further to (2,2), $I_{45}(2,2) = .002$. Information decreases because the ICS flattens out in this direction.

4.21 Test Information Plots (IV)



Test Information Plots

- Assume we are still working with the same item but now want to calculate $I_{30}(0,0)$:

$$I_{30}(0,0) = P(\theta)Q(\theta)(\sum_{v=1}^m \alpha_v \cos \alpha_v)^2$$

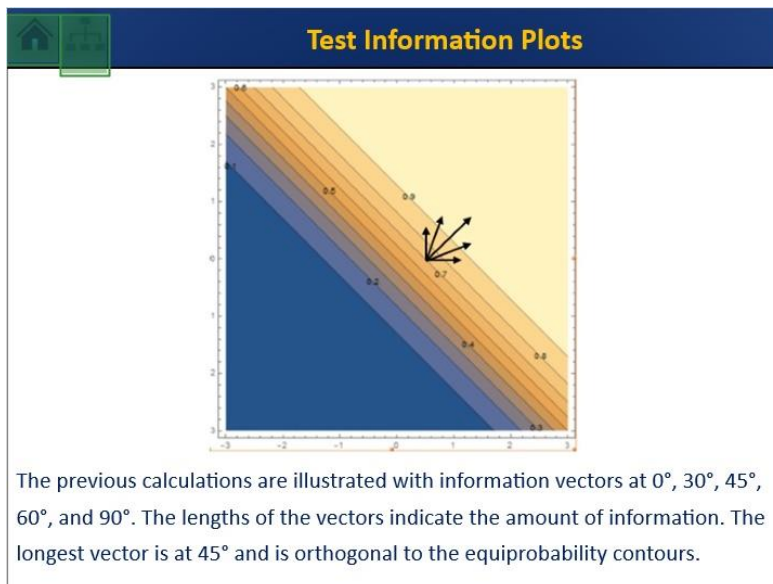
$$I_{30}(0,0) = (.5)(.5)((1.0)(\cos 30) + (1.0)(\cos 60))^2$$

$$I_{30}(0,0) = (.5)(.5)[(1.0)(.866) + (1.0)(.5)]^2$$



$$I_{30}(0,0) = .466$$

- Further, $I_0(0,0) = .25$. The angle of maximum information when $a_1 = a_2$ is at 45° , or orthogonal to the equiprobability contours. As we move away from this direction, the surface is not as steep, the item is not as discriminating, and the information decreases.

4.22 Test Information Plots



4.23 Clamshell Plots (I)





Clamshell Plots

Reckase and McKinley (1991) show a way to illustrate the amount of information for the M2PL model using a “clamshell” plot. To create this plot:

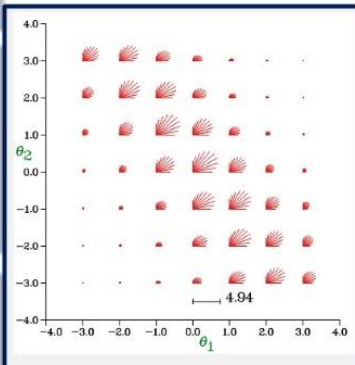
1. The amount of information is computed as 49 uniformly spaced points on a 7x7 grid on the (θ_1, θ_2) plane
2. At each point, the amount of information the test provides is computed for ten different directions (or ability composites) from 0 to 90 degrees in 10-degree increments
3. The resulting ten vectors at each ability point resemble a clamshell

4.24 Clamshell Plots (II)

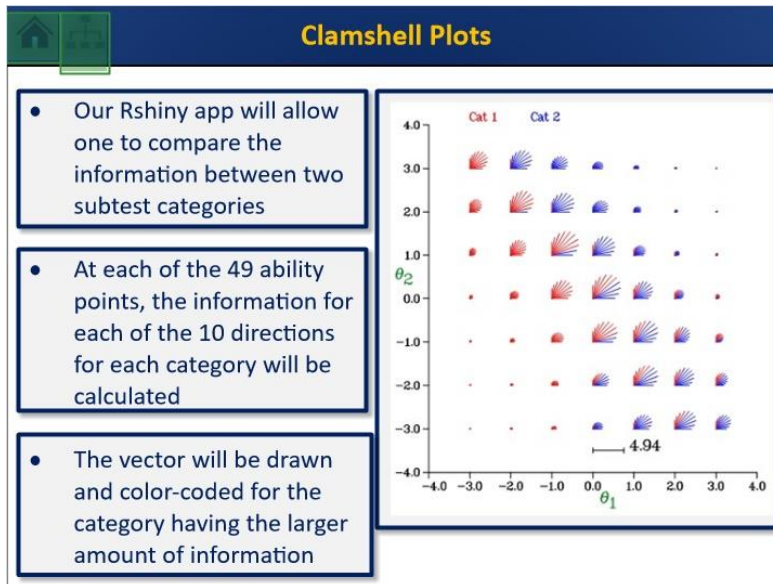


Clamshell Plots

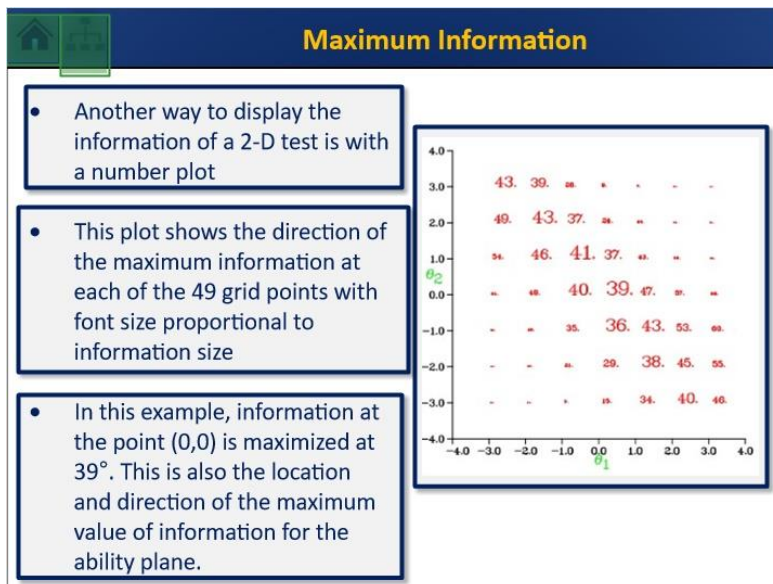
- Clamshell information plot for a standardized math test
- Like in the unidimensional case, the M2PL test information is the sum of the item information values at each (θ_1, θ_2) point at each of the 10 different degree directions
- If two forms were truly parallel, their clamshell plots would be similar after their parameters are put on the same scale



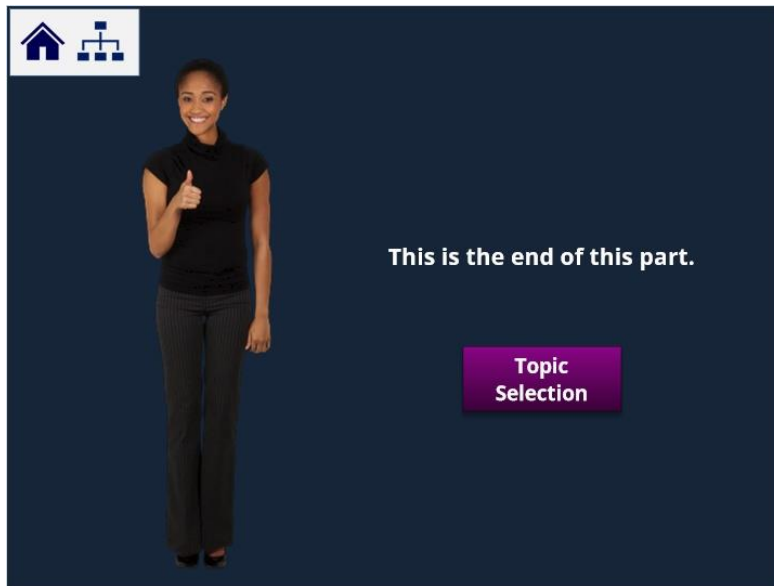
4.25 Clamshell Plots (III)



4.26 Maximum Information





4.27 Bookend: Examining Score Scale Consistency



4.28 Bookmark: Examining Score Scale Consistency





4.29 Score Scale Consistency (I)



Score Scale Consistency

- When a test is unidimensional, we automatically assume that all the items are measuring the same skill or the same composite of multiple skills
- When a test is two-dimensional, we assume that items are measuring different composite of the two latent skills
- It is important to ask whether there is any confounding of difficulty and dimensionality
 - Example: do easy items measure mainly θ_1 and difficult items measure mainly θ_2 ?
 - If so, low scores would represent different levels of θ_1 -ability and high scores different levels of θ_2 -ability.



4.30 Score Scale Consistency (II)



Score Scale Consistency

- Consider an algebra test with some story problems
- Easy items could be measuring θ_1 , algebraic reasoning
- Story problems, which always tend to be more difficult, require reading and understanding a real-life situation and then applying algebraic reasoning.
- These items could be measuring more reading ability, which would be θ_2



4.31 Conditional Estimation Using Centroids



Conditional Estimation Using Centroids

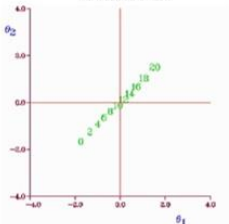
- To gain insight about score scale consistency, we create a centroid plot
- The purpose of this plot is to examine the means of the conditional distributions for each score category:
$$(\bar{\theta}_1, \bar{\theta}_2 | X = x)$$
- The number of the score scale will be printed at the $(\bar{\theta}_1, \bar{\theta}_2)$ of the distribution for all the people with that observed score
- For an interpretation of the score scale to be consistent, the centroid should form a linear pattern

4.32 Centroid Plots

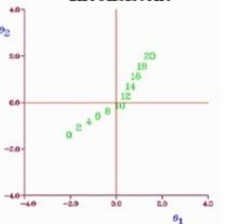


Centroid Plots

Consistent

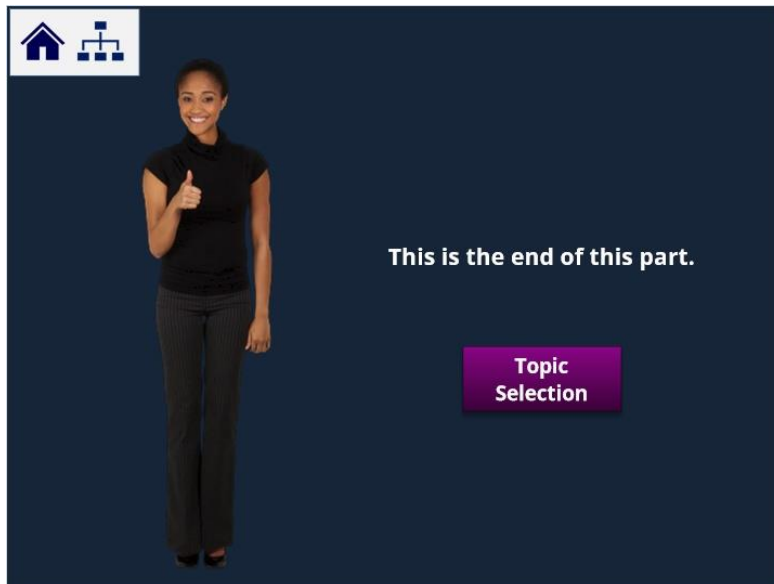


Inconsistent





- If the observed score scale is consistent, the centroids will be linear, as shown in the plot on the left
- If the score scale is inconsistent, the plot of the centroids will curve, as shown on the right. Here, differences between low scores tend to be a difference in θ_1 , and high scores tend to show differences primarily in θ_2 . This is a case of confounding difficulty and dimensionality.

4.33 Bookend: Test Information





4.34 Summary: Plots for 2D Items and Tests (I)



Summary

- With the M2PL, best to represent items as vectors
 - Length of vector = MDISC = discrimination
 - Location of tail in relation to origin = MDIFF = difficulty
 - Angle of vector with θ_1 axis = α = composite of (θ_1, θ_2) best measured
 - Tail of vectors lie on, and are orthogonal to, $P = .5$ probability contour
- Color-coding helps in understanding variation of composites
- The TCS helps determine the true score for all (θ_1, θ_2) combinations in the latent ability plane.
 - All examinees lying on the same true score contour will be expected to score the same on a test
- One form's TCS can be subtracted from another's to determine how parallel the two forms are
- The TCS for the M2PL model changes in slope/steepness depending on the direction one travels across the surface



4.35 Summary: Plots for 2D Items and Tests (II)




Summary

- To represent the amount of information across the 2-D latent ability plane we create a “clamshell” plot
- The clamshells tell us which composites are being best measured across the ability plane
- Practitioners need to be cautious about interpreting the two-dimensional test results if they just report a single observed or a single scaled score
- To examine whether the score scale is consistent in interpretation we construct a centroid plot
- Problems arise when there is a confounding and easy item measure primarily one ability and difficult items measure primarily the other ability

4.36 Bookend: Plots for 2D Items and Tests





This is the end of this section.

Quiz

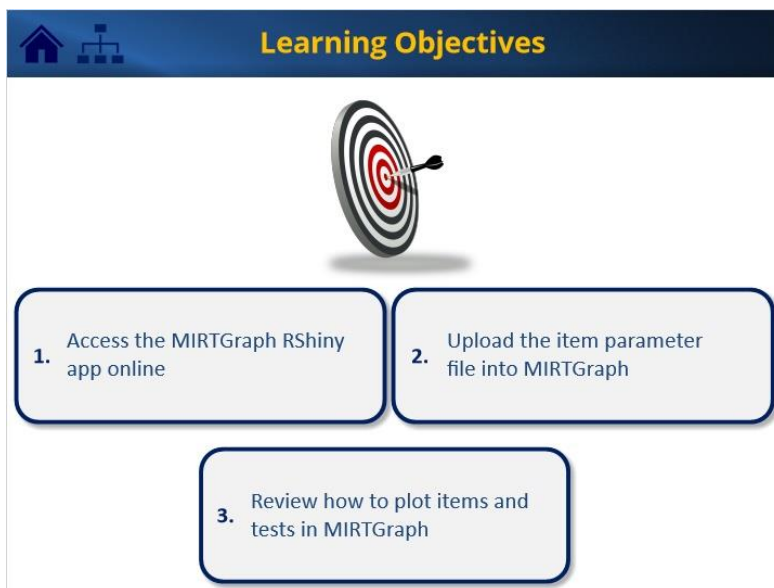
Main Menu

5. MIRT Plots in RShiny


5.1 Cover: MIRT Plots in Rshiny



5.2 Learning Objectives: MIRT Plots in RShiny



5.3 Access to RShiny





Access to Rshiny

The MIRTGraph Rshiny app can be accessed via the following link:

<https://qing-xie-uiowa.shinyapps.io/MIRTGraph/>



5.4 MIRTGraph RShiny App



MIRTGraph Rshiny App

MIRTGraph Rshiny App

Overview

Read data

Individual Test Items

Total Test

Test Information

Auto Test

MIRTGraph Rshiny APP

This app requires the user to input a file containing their estimated two-dimensional compensatory item parameters and/or content categories and then will give them the option to generate 5 different graphics.

Navigation of this app can be done through the 5 tabs at the left panel:

1. Overview: Brief explanation of the purpose and structure

2. Read in Dataset: Read in user specified item parameter dataset and provides descriptive summary statistics

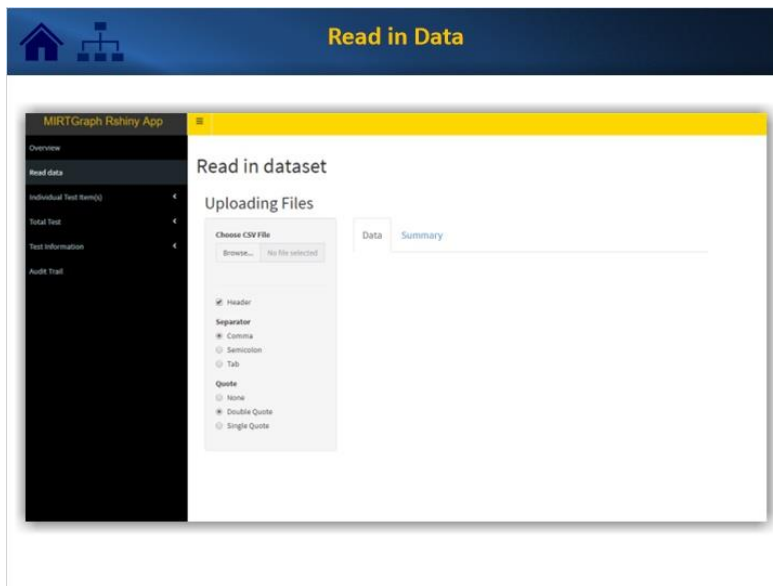
3. For Individual Test Items: Include item vector, item surface, and item contour

4. For Total Test: Include true score surface, true score contours, and conditional centroids

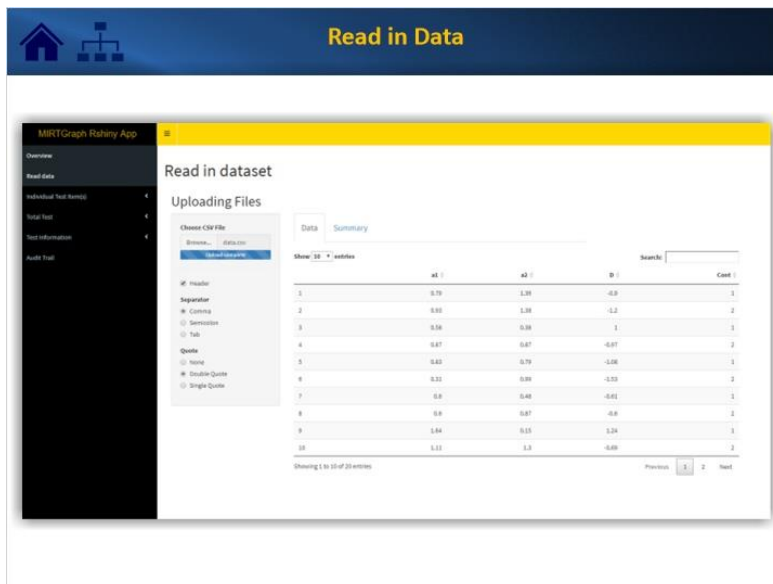
5. For Test Information: Include clamshell by test and content categories, and direction of maximum information

*This app requires to be opened in an internet browser

5.5 Read in Data (I)



5.6 Read in Data (II)



5.7 Read in Data (III)

Read in Data

Read in dataset

Uploading Files

Choose CSV File

Header

Separator

Quote

Summary

Par	Mean	Std	Median	Min	Max
a1	0.94	0.40	0.85	0.31	2.37
a2	0.79	0.48	0.78	0.00	1.76
D	-0.20	1.08	-0.60	-1.33	2.49

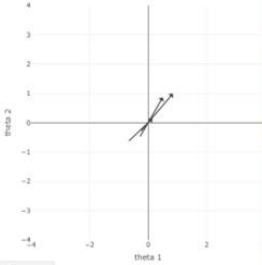
5.8 Item Vector Plots

Item Vector Plots

Item vector

Please enter Item ID that you want to plot:

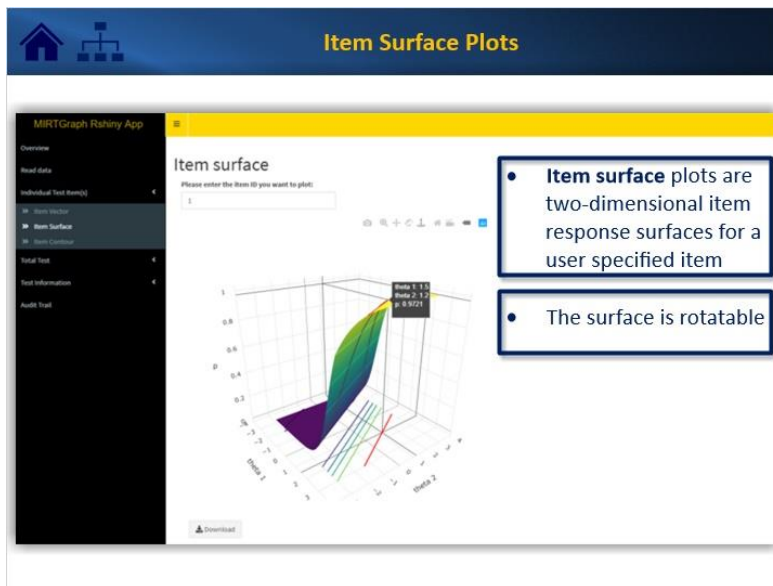
1,1,1



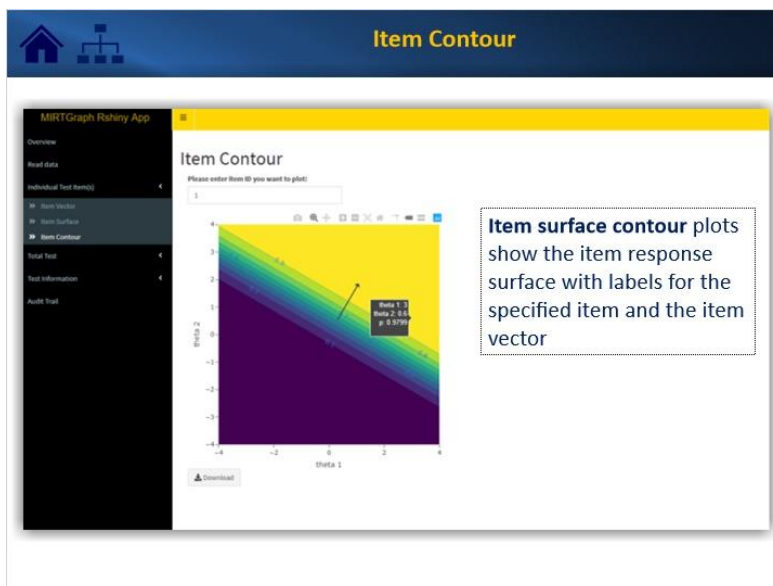
Download

- The tail of the vector lies on, as is orthogonal to, the $p = .5$ equiprobability contour
- The length of the vector is equal to MDISC
- The angle with the positive θ_1 axis is equal to the arccosine of $a1/\sqrt{MDISC}$

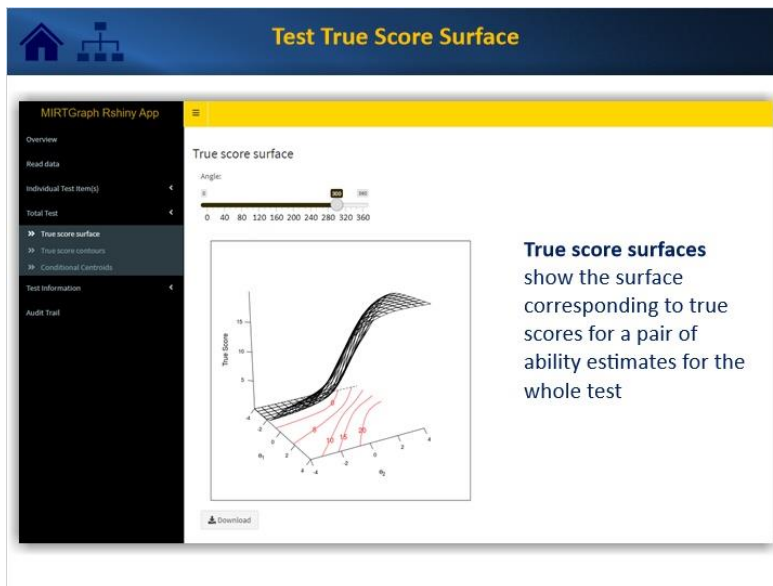
5.9 Item Surface Plots



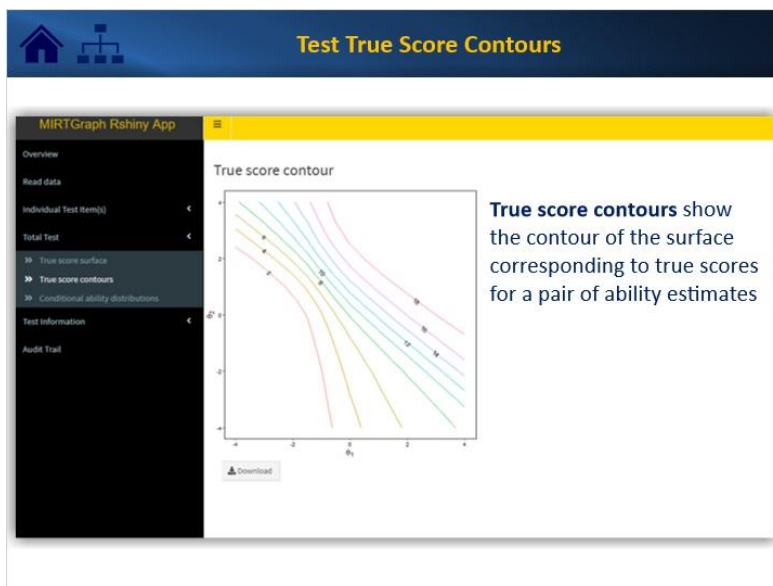
5.10 Item Contour Plots



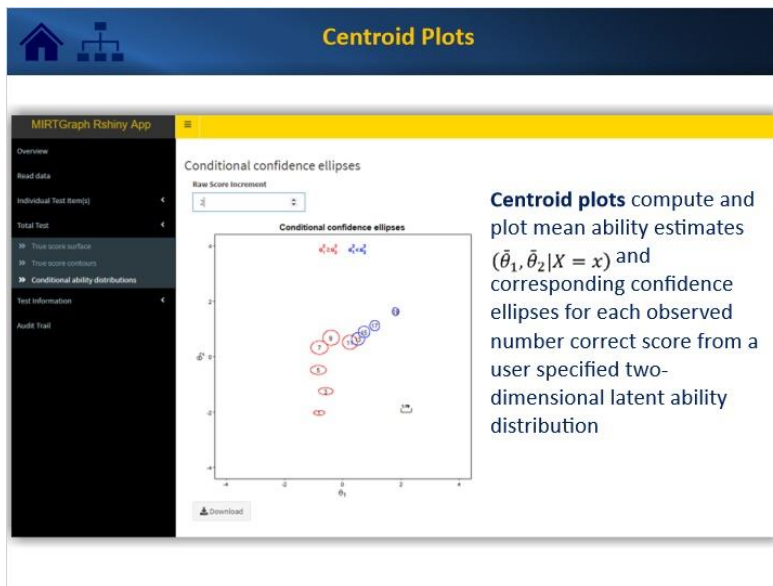
5.11 Test True Score Surfaces



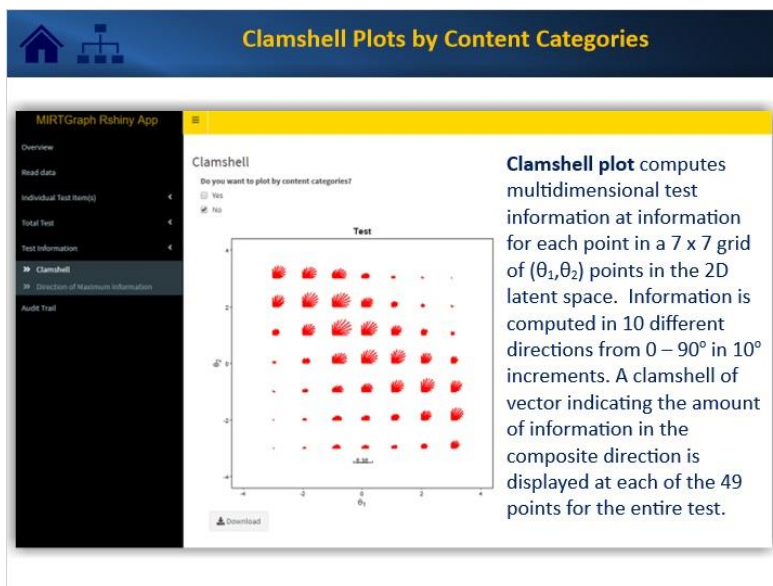
5.12 Test True Score Contours



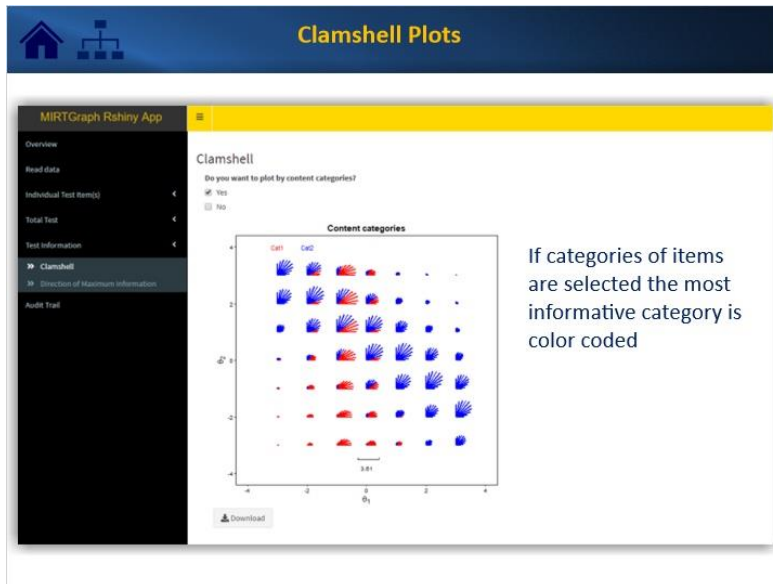
5.13 Centroid Plots



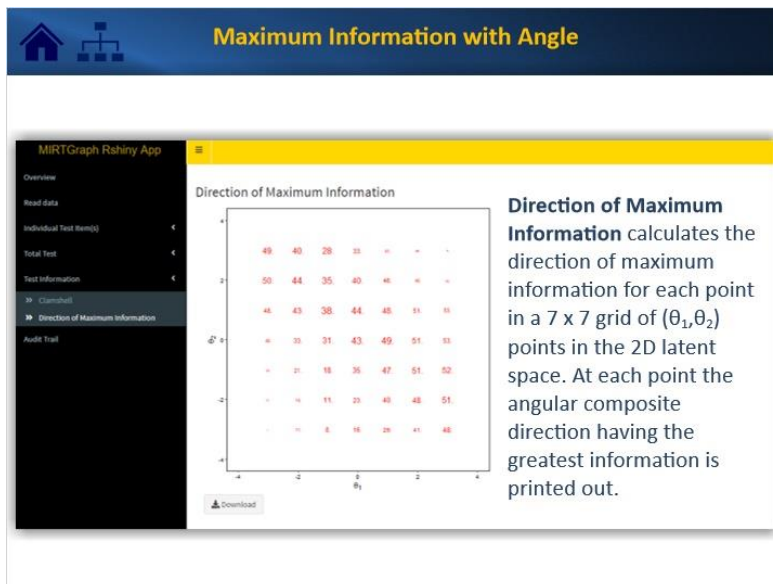
5.14 Clamshell Plots by Content Categories



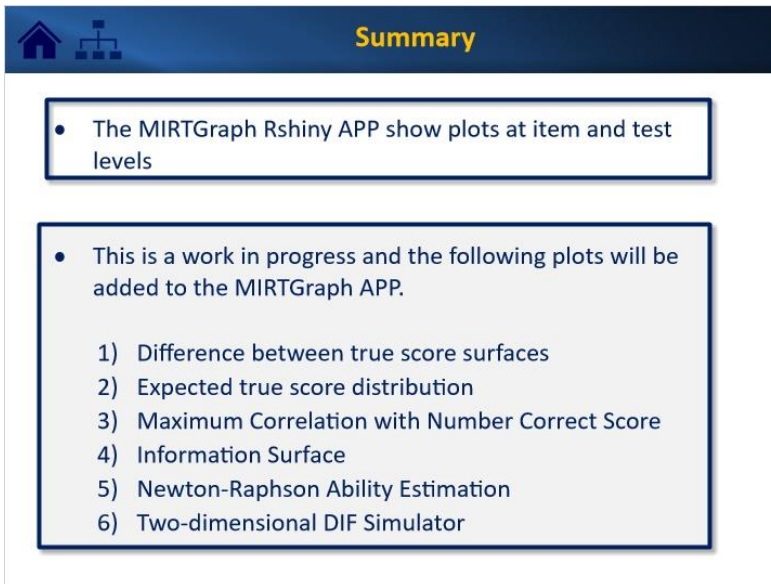
5.15 Clamshell Plots



5.16 Maximum Information with Angle



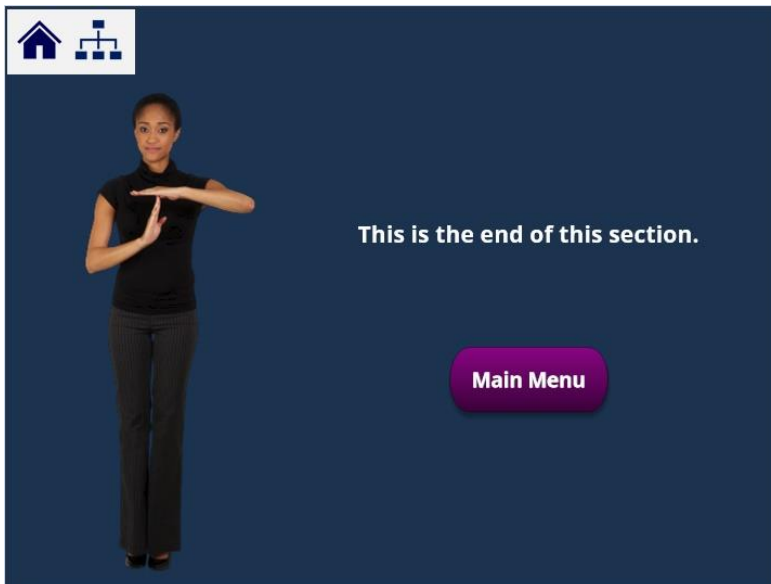
5.17 Summary



The screenshot shows the 'Summary' page of the MIRTGraph Rshiny APP. At the top, there is a dark blue header with a home icon and a tree diagram icon on the left, and the word 'Summary' in yellow on the right. Below the header, there are two white boxes with blue borders. The first box contains a single bullet point: 'The MIRTGraph Rshiny APP show plots at item and test levels'. The second box contains a bullet point: 'This is a work in progress and the following plots will be added to the MIRTGraph APP.' followed by a numbered list: 1) Difference between true score surfaces, 2) Expected true score distribution, 3) Maximum Correlation with Number Correct Score, 4) Information Surface, 5) Newton-Raphson Ability Estimation, and 6) Two-dimensional DIF Simulator.

- The MIRTGraph Rshiny APP show plots at item and test levels
- This is a work in progress and the following plots will be added to the MIRTGraph APP.
 - 1) Difference between true score surfaces
 - 2) Expected true score distribution
 - 3) Maximum Correlation with Number Correct Score
 - 4) Information Surface
 - 5) Newton-Raphson Ability Estimation
 - 6) Two-dimensional DIF Simulator

5.18 Bookend: Plots for 2D Items and Tests



The screenshot shows the 'Bookend' screen of the MIRTGraph Rshiny APP. It has a dark blue background. In the top left corner, there is a white box containing a home icon and a tree diagram icon. On the left side, there is a woman in a black top and dark pants, standing with her arms crossed. To her right, the text 'This is the end of this section.' is displayed in white. Below this text, there is a purple button with the text 'Main Menu' in white.

This is the end of this section.

Main Menu

5.19 Module Cover (END)

