

## Chapter 506

# Item Response Analysis

---

## Introduction

This procedure performs item response analysis. Item response analysis is concerned with the analysis of questions on a test which can be scored as either right or wrong.

Item Response Analysis is not the same as item analysis. Item analysis studies the internal reliability of a particular instrument (test, survey, questionnaire, etc.). The Item Analysis program, discussed elsewhere, conducts this type of analysis.

---

## Discussion

Let  $A_j$  represent the  $j^{\text{th}}$  individual's ability to perform a certain task. This ability may represent intelligence, math aptitude, geography knowledge, etc. Define the *logistic item characteristic curve* (ICC) as follows:

$$P_i(A_j) = \frac{1}{1 + e^{-z_{ij}}}$$

where

$$z_{ij} = d_i A_j + a_i$$

Note that  $P_i(A_j)$  is the probability that individual  $j$  with ability  $A_j$  marks item  $i$  correctly.  $z_{ij}$  is called the logit. An item's difficulty may be calculated using:

$$b_i = \frac{-a_i}{d_i}$$

This model is similar to the usual logistic regression model. A new problem has arisen in that the ability values, the  $A_j$ , are unknown and must be estimated. The program uses the Bock-Aikin (1981) MMLE/EM algorithm as provided in Baker (1992).

## Data Structure

The data are entered in two or more columns. Only numeric values are allowed. Also, a column containing the correct answers must be entered. An optional column containing row labels may also be entered.

Note that the answers correspond to items by position number. Thus, the answer to the item contained in variable one is in row one, the answer to the item contained in variable two is in row two, and so on.

An example of data appropriate for this procedure is shown in the table below. These data are contained in the Item dataset. These data represent the responses of sixteen individuals to a four-item test.

### Item Dataset

Item1	Item2	Item3	Item4	Answer	Name
1	3	2	1	1	Eric
2	2	2	3	3	Charlotte
1	3	2	2	2	Janet
3	3	3	3	1	Julie
1	1	2	2		Katie
3	3	3	1		Ryan
2	2	1	2		Tyson
1	1	2	1		Jordan
1	3	1	2		Bob
1	1	2	2		Linda
5	3	2	2		Mike
1	1	2	1		Michell
1	3	2	2		Randy
1	3	3	1		Jerry
1	3	2	1		Chris
1	3	1	1		Holly

# Example 1 – Item Response Analysis

This section presents an example of how to run an analysis of the data contained in the Item dataset.

## Setup

To run this example, complete the following steps:

### 1 Open the Item example dataset

- From the File menu of the NCSS Data window, select **Open Example Data**.
- Select **Item** and click **OK**.

### 2 Specify the Item Response Analysis procedure options

- Find and open the **Item Response Analysis** procedure using the menus or the Procedure Navigator.
- The settings for this example are listed below and are stored in the **Example 1** settings file. To load these settings to the procedure window, click **Open Example Settings File** in the Help Center or File menu.

```
Variables Tab
-----
Item Variables.....Item1-Item4
Answer Variable.....Answers
Label Variable.....Name
```

### 3 Run the procedure

- Click the **Run** button to perform the calculations and generate the output.

## Count Distribution Section

Count Distribution Section				
Variable	1	2	3	5
Item1	11	2	2	1
Item2	4	2	10	0
Item3	3	10	3	0
Item4	7	7	2	0
Total	25	21	17	1

This report shows the number of times each response was chosen for each item.

## Percentage Distribution Section

### Percentage Distribution Section

Variable	1	2	3	5
Item1	68.75	12.50	12.50	6.25
Item2	25.00	12.50	62.50	0.00
Item3	18.75	62.50	18.75	0.00
Item4	43.75	43.75	12.50	0.00
Total	39.06	32.81	26.56	1.56

This report shows the percentages of each of the possible responses for each item.

## Item Detail Section

### Item Detail Section for Item1

Value	Count	Individual Percent	Cumulative Percent	Percent Bar Chart
1 (Correct)	11	68.75	68.75	
2	2	12.50	81.25	
3	2	12.50	93.75	
5	1	6.25	100.00	
Total	16			

### Item Detail Section for Item2

Value	Count	Individual Percent	Cumulative Percent	Percent Bar Chart
1	4	25.00	25.00	
2	2	12.50	37.50	
3 (Correct)	10	62.50	100.00	
5	0	0.00	100.00	
Total	16			

### Item Detail Section for Item3

Value	Count	Individual Percent	Cumulative Percent	Percent Bar Chart
1	3	18.75	18.75	
2 (Correct)	10	62.50	81.25	
3	3	18.75	100.00	
5	0	0.00	100.00	
Total	16			

Item Response Analysis

**Item Detail Section for Item4**

Value	Count	Individual Percent	Cumulative Percent	Percent Bar Chart
1 (Correct)	7	43.75	43.75	
2	7	43.75	87.50	
3	2	12.50	100.00	
5	0	0.00	100.00	
Total	16			

This report provides an individual breakdown of the responses to each item.

**Item Response Estimation Section**

**Item Response Estimation Section**

Variable	Intercept	Discrimination Parameter (Slope)	Ability at which P(Correct)=0.5 (Difficulty)
Item1	5.977607	12.677396	-0.471517
Item2	0.510955	-0.025970	19.675165
Item3	0.577043	0.775644	-0.743954
Item4	-0.296144	0.878906	0.336946

This report gives the results of the IRT estimation for each item. The columns of the report are defined as follows.

**Variable**

The name of the item (question).

**Intercept**

The estimated intercept in the logistic ICC model. This is the value of  $a_i$ .

**Discrimination Parameter (Slope)**

The estimated slope in the logistic ICC model. This is the value of  $d_i$ . This value is sometimes referred to as the *Discrimination Parameter* of the item.

**Ability at which P(Correct)=0.5 (Difficulty)**

The estimated value of  $b_i$ . It is the ability level at which 50% of those responding are able to get this question right. It is sometimes called the *Difficulty* of the item.

## Estimated Abilities Section

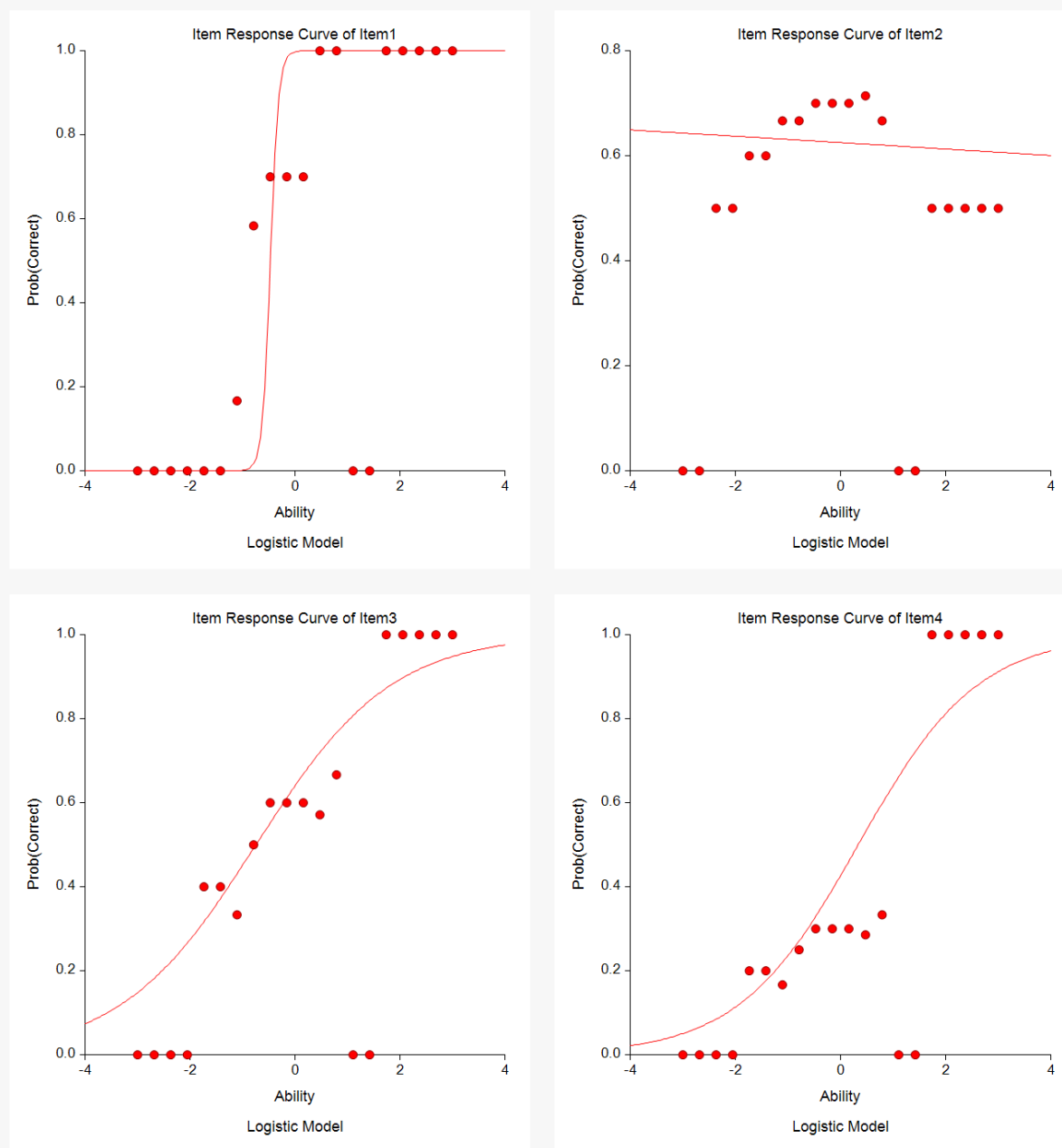
### Estimated Abilities Section

Row	Name	Number Correct	Percent Correct	Ability
1	Eric	4	100.00	2.500000
2	Charlotte	1	25.00	-0.800205
3	Janet	3	75.00	-0.077078
4	Julie	1	25.00	-1.552304
5	Katie	2	50.00	-0.053399
6	Ryan	2	50.00	-0.777427
7	Tyson	0	0.00	-1.536428
8	Jordan	3	75.00	2.500000
9	Bob	2	50.00	-0.260121
10	Linda	2	50.00	-0.053399
11	Mike	2	50.00	-0.809005
12	Michelle	3	75.00	2.500000
13	Randy	3	75.00	-0.077078
14	Jerry	3	75.00	0.040460
15	Chris	4	100.00	2.500000
16	Holly	3	75.00	0.040460

This report gives each individual's score and estimated ability. Remember that the test score may not correlate exactly with ability since the ability rating depends not only on how many questions are answered correctly, but also on which questions are answered correctly.

## IRC Plots Section

### Plot Section



These plots show the logistic item characteristic curve for each question as a solid line. The plotted points show the proportion of individuals with ability in a small neighborhood of the plotted ability that got the question right.

Note that the vertical axis gives the probability that an individual answers the question correctly and the horizontal axis gives their ability.

In most cases, the plots will show the familiar S-curve shape that is exhibited here. In some cases, however, the plots may look different.