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On the Development of Web-GUI Interface for Analyzing Polytomous Responses(Draft)

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ABSTRACT

One type of measurement often done in education are measurement of the students' performance both for cognitive and affective aspects. These measures are extremely important therefore must use a good measuring tool and the results also easy to interpret. The measurement of students performance mostly use tests. Measurement test have evolved from traditional one to modern theories to apply more realistic models which are known as item response theory. However the use of modern test theory much rely on availability of the computer software. In this paper we report the development of a web-GUI interface that can be used to analyze polytomous responses, especially using partial credit and graded response models which will also contains theories and interpretations of the results. This web-GUI interface is expected to help teachers to understand and to do the analysis of polytomous responses more easily.

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INTRODUCTION

One type of measurement that is often done in the world of education is the measurement of learners. In measuring aspects of students at the level of cognitive and affective development is very important because it must have a good measuring tool. Because it is very influential on the development of students. Students' measurements mostly use measuring instruments in the form of tests, test-measuring theories evolving from traditional to modern tests more complex. With technological advances, test measurements can be found with a wide range of applications that can assist in testing tests on students. Judging from the current developments, the development of open-source item analysis R for items of more than two categories is still constrained on measuring tools and the application of theory. In the use of modern test theory can not

be separated from the application used. Researchers focus on developing test measurements in an online web-based application that comes with this tutorial, to facilitate users / educators to know and how to measure good items, especially polytomus type. Therefore, it is important to develop a web-based GUI interface by utilizing software Based on open source-R, which can be used to analyze polytomous responses, especially partial credit and graded response models.

Summary Theory Of Irt For Polytomous Rasch Polytomus Model and Clasic Test Theory.

The polytomus model is a generalization of the dichotomous Rasch model. It is a measurement model that has potential applications in a context where the objective is to measure the nature or ability through the process in which the response to an item. For example, this model applies to Likert scale usage, assessment scales, and educational assessment items.

Analysis of polytomous manifest variables is currently handled by ltm using the Graded Response Model (GRM). The GRM was first introduced by Samejima (1969), and postulates that the probability of the m th subject to endorse the k th response for the i th item is expressed

As

$$P(X_{im} = k | Z_m) = g(\beta_{ik}) - g(\beta_{i,k+1})$$

$$\beta_{ik} = a_i (Z_m - \beta_{ik}), k = 1, \dots, k_i,$$

where is the ordinal manifest variable with possible response categories, is the standing of the m th subject in the latent trait continuum, denotes the discrimination parameter, and 's are the extremity parameters with and . The interpretation of is essentially the same as in the models for dichotomous data. However, in GRM the 's represent the cut-off points in the cumulative probabilities scale and thus their interpretation is not direct. ltm fits the GRM under the logit link.

Graded Responses Model (GRM)

There are two types of approaches in IRT politomy model, first is indirect approach and second is direct approach. The type of direct approach is before entering the main equation to look at the category response functions (CRF), we must look at the operating characteristic functions (OCF) of each category first. The GRM and MGRM models are included in the indirect approach. So in this model we have to get OCF first for basic materials to make CRF. (Wahyu Widiarso, 2010).

OCF in GRM is manifested in the equation below. It means that in a point i with slope value in category j with location of then the individual probability n with trait level of θ is as follows.

$$P_{ix}^*(\theta) = \frac{\exp(a_i(\theta_n - \beta_{ij}))}{1 + \exp(a_i(\theta_n - \beta_{ij}))}$$

Information :

a_i = Slope parameters (slope)

β_{ij} = Threshold on item i in category j

θ = Trait level

The equation is similar to the 2PL model but more specific, ie in point i there are a number of j categories that each of them is estimated separately. The value of the slope () of all categories in a single item is equated.

Parcial Credit Model (PCM)

$$X_{ijh} = \begin{cases} t & \text{if person } j \text{ score in} \\ & \text{category } h \text{ on item } i \\ 0 & \text{if this is not the case} \end{cases}$$

For $h = 1, \dots, m_i$. So if the person scores in the zero category,

$$X_{ijh} = (0, 0, \dots, 0)$$

In the PCM, it is assumed that the probability of a person with parameter θ_j scoring in category h , $h = 1, \dots, m_i$, on an item with parameter δ_i , $\delta_i = (\delta_{i1}, \dots, \delta_{ih}, \dots, \delta_{imi}, \dots)$ is given by.

$$P(X_{ijh} = 1 | \theta_j, \delta_i) = \frac{\exp(h\theta_j - \sum_{g=1}^n \delta_{ig})}{1 + \sum_{k=1}^{m_i} \exp(k\theta_j - \sum_{g=1}^k \delta_{ig})}$$

$$d_{ijh} = \begin{cases} 1 & \text{if the conceptual item } h \text{ was} \\ & \text{administered to person } j \\ 0 & \text{if this is not the case} \end{cases}$$

For $h = 1, \dots, m_i$ furthermore, let y_{ij} be a response vector defined by

$$y_{ijh} = \begin{cases} 1 & \text{if } d_{ijh} = 1 \text{ and a correct response} \\ & \text{was given to conceptual item } h, \\ 0 & \text{if } d_{ijh} = 1 \text{ and an incorrect responses} \\ & \text{was given to conceptual item } h, \\ c & \text{if } d_{ijh} = 0 \end{cases}$$

For $h = 1, \dots, m_i$, where c is a constant. This constant is a dummy to simple mathematical formulation of the model;

$$P(y_{ijh} = 1 | d_{ijh} = 1; \theta_j, \beta_{ih}) = \frac{P_{i1}(\theta)}{P_{i0}(\theta) + P_{i1}(\theta)} = \frac{\exp(\theta_j - \beta_{ih})}{1 + \exp(\theta_j - \beta_{ih})}$$

With the difficulty parameter of conceptual item h with i let be the number of item steps taken within i , that i that is, Σ

In tabel 1, fore some item = 3, all possible responses () are enumerated together wiyh the associate probabilitas (| where (is a vector of item parameters

Tabel.1

y_{ij}	r_{ij}	$P(y_{ijn} \theta_j, \beta_i)$
0,c,c	0	$\frac{1}{1 + \exp(\theta_j - \beta_{i1})}$
1,0,c	1	$\frac{\exp(\theta_j - \beta_{i1})}{(1 + \exp(\theta_j - \beta_{i1}))(1 + \exp(\theta_j - \beta_{i1}))}$
1,1,0	2	$\frac{\exp(\theta_j - \beta_{i1}) \exp(\theta_j - \beta_{i2})}{1 + \exp(\theta_j - \beta_{i1}) (1 + \exp(\theta_j - \beta_{i2}))(1 + \exp(\theta_j - \beta_{i3}))}$

METHODS

Utilizing Program R especially for Linux.

For GUI development we use the shiny toolkit (shiny package)

GRM and GPCM ltm package

The development of dynamic Web GUI mainly utilize shiny toolkit in the shiny package. GRM, GPCM utilize ltm package . In addition to its computational features E-module type is also accompanied by related statistical formula. The mathematical notations are presented using MathJax.

RESULTS AND DISCUSSION

Data with polytomus response model.Data for analysis, many cases want to be displayed(= 20)

With science data optimus:

Comfort	Environment	Work	Future
1 strongly agree	strongly agree	strongly agree	agree
2 agree	strongly agree	agree	agree
3 agree	disagree	disagree	disagree
4 agree	agree	disagree	disagree
5 agree	strongly disagree	strongly agree	strongly agree
6 strongly agree	agree	strongly agree	agree
7 agree	disagree	disagree	agree
8 agree	disagree	disagree	agree
9 agree	agree	agree	strongly agree
10 strongly agree	agree	agree	agree
11 agree	agree	agree	strongly agree
12 agree	agree	strongly disagree	disagree
13 agree	disagree	agree	agree
14 agree	disagree	agree	agree
15 agree	strongly agree	agree	disagree
16 agree	strongly agree	agree	agree
17 agree	agree	strongly disagree	disagree
18 agree	agree	agree	agree
19 agree	disagree	disagree	agree
20 agree	agree	agree	agree

Technology Industry Benefit

- 1 strongly agree agree disagree
- 2 agree agree agree
- 3 strongly agree strongly agree agree
- 4 strongly agree strongly agree agree
- 5 disagree agree strongly disagree
- 6 agree strongly agree agree
- 7 strongly agree strongly agree strongly agree
- 8 agree strongly agree strongly agree
- 9 strongly agree strongly agree disagree
- 10 agree agree agree
- 11 disagree agree agree
- 12 disagree strongly agree agree
- 13 strongly agree agree agree
- 14 disagree disagree disagree
- 15 strongly agree agree disagree
- 16 strongly agree strongly agree agree
- 17 agree disagree disagree
- 18 disagree agree agree
- 19 agree agree disagree

An Example :

Call:

```
grm(data = dataset.grm() [, input$item2g], IRT.param = TRUE)
```

Coefficients:

	Extrmt1	Extrmt2	Extrmt3	Dscrmn
Comfort	-10.768	-5.645	3.097	0.411
Environment	-2.154	-0.790	0.627	1.570
Work	32.102	9.261	-24.402	-0.074
Future	-30.602	-11.806	10.455	0.108
Technology	-2.462	-0.885	0.642	1.650
Industry	-2.870	-1.529	0.286	1.642
Benefit	-21.232	-5.982	10.297	0.136

Log.Lik: -2998.129

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