Tutorial for Chapter 6: IASQ Instrumental Attitude towards Self-assessment Questionnaire

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# Preliminary steps before you can run the IASQ analysis

1. Create a folder called “IASQ\_analysis” on your desktop, for example. Download the data set ARMChapter6.csv and the R code Chapter\_6\_eRm.R from the website and save both in *that* folder. This folder will serve as your working directory containing all files you need to conduct the analysis and to store optional output (i.e., code, data, and figures). If the R code and the .csv files are not in the same folder, you will not be able to load the data using the code below.
2. Open the file Chapter\_6\_eRm.R in RStudio by clicking on the file. This will open the file in RStudio.
3. Go to “Session” “Set Working Directory” “To Source File Location”. This defines the folder you named above as your working directory in which you are currently working and where R expects all data sets to be.

You are now ready to run the analysis of the IASQ data used in ARM4 Chapter 6. Please use the following instructions and explanations of the R code.

# Rating Scale Model Analysis: Data Preparation

First, we will load the necessary packages we will need for this analysis. If you have not yet, you will need to install the packages using the install.packages() function below. This will only need to be done once. Then, we will load the packages into R using library(). This will need to be done each time you open R.

# Installing the required packages for this analysis.   
# This is only required once.   
# Uncomment the code below to run the install.packages function.  
# install.packages(c("eRm", "dplyr", "ggplot2", "pairwise", "TAM", "psych"))  
  
# Load the packages required for the analysis  
library(eRm)  
library(dplyr)  
library(TAM)  
library(psych)

Now we will load the dataset we need. The file is called ARMChapter6.csv. This time, it does have a header (header = TRUE), and a semi-colon is used as the field separator (sep = ";").

# Reading in the comma-seperated data set  
df <- read.csv("ARMChapter6.csv", header = TRUE, sep = ";")

Let’s remind ourselves about the Instrumental Attitude towards Self-assessment Questionnaire - the IASQ. The IASQ was developed to measure the instrumental attitude towards self-assessment of late elementary and middle school–aged children. It consists of 12 items, and this data set consists of responses from 462 school aged children in Hong Kong. It has 4 ordered-category response options. The 4 categories increase from “1. Strongly Disagree”, to “2. Disagree”, to “3. Agree”, and to “4. Strongly Agree”. A lower score on the scale or on the person measure means less positive attitude towards self-assessment. A higher score on the scale or on the person measure means a more positive attitude towards self-assessment.

We can be relieved that the IASQ authors have written ALL items in the same direction; higher scores ALWAYS means more positive attitude. Some authors often reverse the direction of some items. That technique is frequently used on attitude surveys with the idea of preventing respondents mindlessly choosing the same category for every item (response set). In that case, the scoring of those items should be reversed to accord with the other items. If items are reversed, it’s useful to include a reminder in the labels by using “R” for those items. Be aware that reverse scored items sometimes cause multidimensionality because people don’t always respond to negative items in the same way that they respond to positive items.

We will need to preprocess and format our data. We will create an object called iasq\_items containing the IASQ items we need for the analysis.

# Select the 12 columns of df where the IASQ items are at  
iasq\_items <- df[,2:13]  
# Looking at the first five rows of the IASQ dataframe  
head(iasq\_items)

## Appraisal Strengths Interest Work\_harder Independent Confidence Efficient  
## 1 4 3 4 4 4 4 4  
## 2 4 4 3 4 4 4 4  
## 3 4 3 3 4 4 4 4  
## 4 4 4 4 4 4 4 3  
## 5 4 4 4 3 4 4 4  
## 6 4 4 4 4 4 4 3  
## Scores Track\_progress How\_much Objectives Predict  
## 1 4 4 4 4 2  
## 2 4 4 3 4 3  
## 3 4 4 4 4 3  
## 4 3 4 4 4 3  
## 5 3 3 4 4 4  
## 6 3 4 4 4 3

# Look at the category distribution across the items  
sapply(iasq\_items, table)

## Appraisal Strengths Interest Work\_harder Independent Confidence Efficient  
## 1 43 21 56 40 47 48 49  
## 2 70 53 155 128 112 106 124  
## 3 237 212 193 189 203 204 200  
## 4 112 176 58 105 100 104 89  
## Scores Track\_progress How\_much Objectives Predict  
## 1 49 35 40 34 94  
## 2 141 103 85 94 166  
## 3 183 206 205 200 155  
## 4 89 118 132 134 47

We are now ready to run the actual Rating Scale analysis. In accordance with the corresponding Winsteps analysis, we will

* Fit a Rating Scale model for the IASQ
* Examine item parameters and fit
* Look at the Wright Map
* Remove misfitting items

# The IASQ Rating Scale Model

The IASQ data is not dichotomous (either a 0 or a 1); each item has 4 categories. Since it has multiple categories, this kind of data is called *polytomous* data. We cannot use a standard Rasch model or the RM function for polytomous data, but there are several other polytomous Rasch models that we can choose instead. In this tutorial, we will use the Rating Scale model (RSM). In the RSM, each item receives a location. A single set of threshold parameters is calculated for all the items. Each item’s individual thresholds are then determined by adding the item location to the threshold parameters.

One quirk about statistics programs is that they each use different optimization procedures (ways of fitting models) even when they are fitting the same kind of model. Different R packages use different methods - ARMsteps also uses its own method. Occasionally you’ll run into situations where your model won’t *converge* - for some reason the algorithm that fits the data to the model get stuck or encounters a problem. One way to get around this is to try another model fitting program. Because of this, it’s always good to know multiple R packages or statistical programs in your field!

Though the *eRm* package can fit rating scale models, it has trouble fitting the IASQ data, for a couple reasons we will not delve into. Instead for this tutorial, we are switching to another R package called *TAM*. You can learn more about the *TAM* package at the following link (<https://cran.r-project.org/web/packages/TAM/TAM.pdf>).

For pedagogical purposes, we will first try to fit a RSM with *eRm* using the RSM function so that you can see what happens.

# Fit the RSM using eRm. This will likely not work!  
erm\_rsm <- RSM(iasq\_items)

## Warning:   
## The following items have no 0-responses:  
## Appraisal Strengths Interest Work\_harder Independent Confidence Efficient Scores Track\_progress How\_much Objectives Predict  
## Responses are shifted such that lowest category is 0.

## Warning in sqrt(diag(solve(parest$hessian))): NaNs produced

## Warning in sqrt(diag(lres$W %\*% solve(parest$hessian) %\*% t(lres$W))): NaNs  
## produced

erm\_rsm

##   
## Results of RSM estimation:   
##   
## Call: RSM(X = iasq\_items)   
##   
## Conditional log-likelihood: 6433315   
## Number of iterations: 5   
## Number of parameters: 13   
##   
## Item (Category) Difficulty Parameters (eta):  
## Strengths Interest Work\_harder Independent Confidence Efficient  
## Estimate -479.7444 633.267060 226.4422 237.956116 207.252239 341.58124  
## Std.Err 2163.8854 5.871351 NaN 3.605264 1.503499 17.91626  
## Scores Track\_progress How\_much Objectives Predict Cat 2  
## Estimate 406.826581 42.220274 -42.21614 -61.40508 1009.388127 -3920.518  
## Std.Err 9.419394 1.680963 586.90084 366.39346 6.596575 21657.756  
## Cat 3  
## Estimate 2744.958784  
## Std.Err 5.919281

You may get a bunch of errors referring to *solve(parest$hessian)*, or you may just receive errors about *NaNs produced*. A Hessian matrix is used in optimization - fitting the model to the data. A problem with the Hessian matrix usually means the model fitting failed. “NaN” means “not a number” - also a bad sign. One way to tell that the model didn’t fit is because our item locations are extreme - “Strengths” has a location of -479. Our standard errors are also extreme. Some of the standard errors were not even estimated. If you ever encounter extreme parameters, it should signal to you that something may be very wrong with your data or how the model fit it.

In any case, let’s move on to the actual analysis. We will use the tam.mml function from *TAM* to fit the data. Unlike *eRm*, *TAM* requires that the lowest response category be 0. Since our categories run from 1 to 4, we will subtract 1 from the entire dataset to change the categories to 0 to 3. This will be the input in the resp (“responses”) argument. The model we are using is the rating scale model, so we will set the irtmodel argument equal to “RSM”. You will get a lot of output describing the optimization procedure; you don’t need to understand this for the purposes of this tutorial.

# Fit a Rating Scale model for the IASQ  
fit\_RSM <- tam.mml(resp = iasq\_items-1,   
 irtmodel = "RSM")

## ....................................................  
## Processing Data 2020-07-22 15:40:49   
## \* Response Data: 462 Persons and 12 Items   
## \* Numerical integration with 21 nodes  
## \* Created Design Matrices ( 2020-07-22 15:40:49 )  
## \* Calculated Sufficient Statistics ( 2020-07-22 15:40:49 )  
## ....................................................  
## Iteration 1 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |----  
## Deviance = 13568.6278  
## Maximum item intercept parameter change: 0.531258  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.488938  
## ....................................................  
## Iteration 2 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |----  
## Deviance = 12687.4328 | Absolute change: 881.1951 | Relative change: 0.06945417  
## Maximum item intercept parameter change: 0.14086  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.045432  
## ....................................................  
## Iteration 3 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |----  
## Deviance = 12610.1697 | Absolute change: 77.263 | Relative change: 0.00612704  
## Maximum item intercept parameter change: 0.063655  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.092406  
## ....................................................  
## Iteration 4 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |----  
## Deviance = 12587.8201 | Absolute change: 22.3496 | Relative change: 0.0017755  
## Maximum item intercept parameter change: 0.04956  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.075415  
## ....................................................  
## Iteration 5 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |----  
## Deviance = 12576.9431 | Absolute change: 10.877 | Relative change: 0.00086484  
## Maximum item intercept parameter change: 0.02924  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.06031  
## ....................................................  
## Iteration 6 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |----  
## Deviance = 12572.6041 | Absolute change: 4.339 | Relative change: 0.00034511  
## Maximum item intercept parameter change: 0.02689  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.038471  
## ....................................................  
## Iteration 7 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |----  
## Deviance = 12570.4459 | Absolute change: 2.1581 | Relative change: 0.00017168  
## Maximum item intercept parameter change: 0.019686  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.026514  
## ....................................................  
## Iteration 8 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |----  
## Deviance = 12569.3958 | Absolute change: 1.0501 | Relative change: 8.355e-05  
## Maximum item intercept parameter change: 0.012831  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.016523  
## ....................................................  
## Iteration 9 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |----  
## Deviance = 12568.9372 | Absolute change: 0.4586 | Relative change: 3.649e-05  
## Maximum item intercept parameter change: 0.008321  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.010402  
## ....................................................  
## Iteration 10 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |----  
## Deviance = 12568.7243 | Absolute change: 0.2129 | Relative change: 1.694e-05  
## Maximum item intercept parameter change: 0.007057  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.006528  
## ....................................................  
## Iteration 11 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |----  
## Deviance = 12568.6067 | Absolute change: 0.1176 | Relative change: 9.36e-06  
## Maximum item intercept parameter change: 0.003566  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.003607  
## ....................................................  
## Iteration 12 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |----  
## Deviance = 12568.5612 | Absolute change: 0.0455 | Relative change: 3.62e-06  
## Maximum item intercept parameter change: 0.002826  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.002579  
## ....................................................  
## Iteration 13 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |---  
## Deviance = 12568.5314 | Absolute change: 0.0298 | Relative change: 2.37e-06  
## Maximum item intercept parameter change: 0.00197  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.001909  
## ....................................................  
## Iteration 14 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |----  
## Deviance = 12568.512 | Absolute change: 0.0194 | Relative change: 1.55e-06  
## Maximum item intercept parameter change: 0.002009  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.000737  
## ....................................................  
## Iteration 15 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |---  
## Deviance = 12568.4977 | Absolute change: 0.0143 | Relative change: 1.14e-06  
## Maximum item intercept parameter change: 0.001389  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.000997  
## ....................................................  
## Iteration 16 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |----  
## Deviance = 12568.4879 | Absolute change: 0.0098 | Relative change: 7.8e-07  
## Maximum item intercept parameter change: 0.001459  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.000102  
## ....................................................  
## Iteration 17 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |--  
## Deviance = 12568.4804 | Absolute change: 0.0076 | Relative change: 6e-07  
## Maximum item intercept parameter change: 0.000984  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.000641  
## ....................................................  
## Iteration 18 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |---  
## Deviance = 12568.4754 | Absolute change: 0.005 | Relative change: 4e-07  
## Maximum item intercept parameter change: 0.001005  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.000152  
## ....................................................  
## Iteration 19 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |---  
## Deviance = 12568.4715 | Absolute change: 0.0039 | Relative change: 3.1e-07  
## Maximum item intercept parameter change: 0.000738  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 4e-04  
## ....................................................  
## Iteration 20 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |---  
## Deviance = 12568.4688 | Absolute change: 0.0027 | Relative change: 2.2e-07  
## Maximum item intercept parameter change: 0.000738  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 8e-06  
## ....................................................  
## Iteration 21 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |--  
## Deviance = 12568.4667 | Absolute change: 0.0021 | Relative change: 1.6e-07  
## Maximum item intercept parameter change: 0.000521  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.000289  
## ....................................................  
## Iteration 22 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |---  
## Deviance = 12568.4653 | Absolute change: 0.0014 | Relative change: 1.1e-07  
## Maximum item intercept parameter change: 0.000533  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 5.9e-05  
## ....................................................  
## Iteration 23 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |--  
## Deviance = 12568.4642 | Absolute change: 0.0011 | Relative change: 9e-08  
## Maximum item intercept parameter change: 0.000385  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.000198  
## ....................................................  
## Iteration 24 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |--  
## Deviance = 12568.4634 | Absolute change: 8e-04 | Relative change: 6e-08  
## Maximum item intercept parameter change: 0.000359  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 2e-06  
## ....................................................  
## Iteration 25 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |--  
## Deviance = 12568.4628 | Absolute change: 6e-04 | Relative change: 5e-08  
## Maximum item intercept parameter change: 0.000284  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.000134  
## ....................................................  
## Iteration 26 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |--  
## Deviance = 12568.4624 | Absolute change: 4e-04 | Relative change: 3e-08  
## Maximum item intercept parameter change: 0.000261  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 2.9e-05  
## ....................................................  
## Iteration 27 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |--  
## Deviance = 12568.4621 | Absolute change: 3e-04 | Relative change: 2e-08  
## Maximum item intercept parameter change: 0.000213  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 1e-04  
## ....................................................  
## Iteration 28 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |--  
## Deviance = 12568.4619 | Absolute change: 2e-04 | Relative change: 2e-08  
## Maximum item intercept parameter change: 0.000196  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0  
## ....................................................  
## Iteration 29 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |--  
## Deviance = 12568.4617 | Absolute change: 2e-04 | Relative change: 1e-08  
## Maximum item intercept parameter change: 0.000155  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 7.4e-05  
## ....................................................  
## Iteration 30 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |--  
## Deviance = 12568.4616 | Absolute change: 1e-04 | Relative change: 1e-08  
## Maximum item intercept parameter change: 0.000142  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 1.6e-05  
## ....................................................  
## Iteration 31 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |--  
## Deviance = 12568.4615 | Absolute change: 1e-04 | Relative change: 1e-08  
## Maximum item intercept parameter change: 0.000116  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 5.5e-05  
## ....................................................  
## Iteration 32 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |-  
## Deviance = 12568.4614 | Absolute change: 1e-04 | Relative change: 1e-08  
## Maximum item intercept parameter change: 9.6e-05  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0  
## ....................................................  
## Item Parameters  
## xsi.index xsi.label est  
## 1 1 Appraisal -0.6794  
## 2 2 Strengths -1.2425  
## 3 3 Interest -0.0213  
## 4 4 Work\_harder -0.4367  
## 5 5 Independent -0.4246  
## 6 6 Confidence -0.4569  
## 7 7 Efficient -0.3170  
## 8 8 Scores -0.2500  
## 9 9 Track\_progress -0.6333  
## 10 10 How\_much -0.7260  
## 11 11 Objectives -0.7473  
## 12 12 Predict 0.3522  
## 13 13 Cat1 -1.2609  
## 14 14 Cat2 -0.3162  
## ...................................  
## Regression Coefficients  
## [,1]  
## [1,] 0  
##   
## Variance:  
## [,1]  
## [1,] 0.8952  
##   
##   
## EAP Reliability:  
## [1] 0.845  
##   
## -----------------------------  
## Start: 2020-07-22 15:40:49  
## End: 2020-07-22 15:40:49   
## Time difference of 0.06012297 secs

Let’s first take a look at the item parameters for the IASQ. They are stored inside the fit\_RSM object.

# Extract IRT parameters from the fit\_RSM object.  
rsm\_par<-fit\_RSM[["item\_irt"]]   
rsm\_par

## item alpha beta tau.Cat1 tau.Cat2 tau.Cat3  
## 1 Appraisal 1 -0.67935424 -1.260889 -0.3161954 1.577084  
## 2 Strengths 1 -1.24241939 -1.260889 -0.3161954 1.577084  
## 3 Interest 1 -0.02116118 -1.260889 -0.3161954 1.577084  
## 4 Work\_harder 1 -0.43659369 -1.260889 -0.3161954 1.577084  
## 5 Independent 1 -0.42452207 -1.260889 -0.3161954 1.577084  
## 6 Confidence 1 -0.45676529 -1.260889 -0.3161954 1.577084  
## 7 Efficient 1 -0.31685833 -1.260889 -0.3161954 1.577084  
## 8 Scores 1 -0.24988318 -1.260889 -0.3161954 1.577084  
## 9 Track\_progress 1 -0.63324007 -1.260889 -0.3161954 1.577084  
## 10 How\_much 1 -0.72591428 -1.260889 -0.3161954 1.577084  
## 11 Objectives 1 -0.74723281 -1.260889 -0.3161954 1.577084  
## 12 Predict 1 0.35229709 -1.260889 -0.3161954 1.577084

We can see that we have 12 items. Each has the same alpha (slope of the logistic function) and it is set to 1, as is expected in a Rasch family model. The betas (item locations) are all different, but the tau’s are all the same. To find the actual locations of the thresholds that takes into account the item locations, we’ll have to use the tam.threshold function.

# See item thresholds  
item\_thresh<-tam.threshold(fit\_RSM)  
item\_thresh

## Cat1 Cat2 Cat3  
## Appraisal -2.210358 -0.8617859 1.0278625  
## Strengths -2.773407 -1.4248352 0.4648132  
## Interest -1.552277 -0.2035217 1.6859436  
## Work\_harder -1.967743 -0.6189880 1.2706604  
## Independent -1.955658 -0.6069031 1.2827454  
## Confidence -1.987885 -0.6391296 1.2503357  
## Efficient -1.847992 -0.4992371 1.3904114  
## Scores -1.780975 -0.4322205 1.4572449  
## Track\_progress -2.164398 -0.8156433 1.0740051  
## How\_much -2.257050 -0.9082947 0.9813538  
## Objectives -2.278290 -0.9297180 0.9599304  
## Predict -1.178741 0.1698303 2.0594788

We can also subtract the two columns from each other to check that the distances between thresholds is always the same.

# The distance between the thresholds is the same for all items  
item\_thresh[,2] - item\_thresh[,1]

## Appraisal Strengths Interest Work\_harder Independent   
## 1.348572 1.348572 1.348755 1.348755 1.348755   
## Confidence Efficient Scores Track\_progress How\_much   
## 1.348755 1.348755 1.348755 1.348755 1.348755   
## Objectives Predict   
## 1.348572 1.348572

Now let’s take a look at our item fit using the msq.itemfit function from *TAM*. The output is similar to what we’ve seem with *eRm*.

# Item fit  
msq.itemfit(fit\_RSM)

## $itemfit  
## item fitgroup Outfit Outfit\_t Outfit\_p Infit  
## 1 Appraisal 1 1.0136756 0.2364270 8.131014e-01 1.0135184  
## 2 Strengths 2 1.0425755 0.6456101 5.185319e-01 1.0874671  
## 3 Interest 3 0.8907619 -1.8592356 6.299375e-02 0.8657494  
## 4 Work\_harder 4 0.8948513 -1.7404914 8.177276e-02 0.9056193  
## 5 Independent 5 0.9516851 -0.7731908 4.394095e-01 0.9505830  
## 6 Confidence 6 0.9902723 -0.1366664 8.912945e-01 1.0035263  
## 7 Efficient 7 0.8608429 -2.3605917 1.824581e-02 0.8599179  
## 8 Scores 8 0.8750319 -2.1161823 3.432931e-02 0.8584728  
## 9 Track\_progress 9 0.9922700 -0.1021245 9.186579e-01 0.9937020  
## 10 How\_much 10 1.1455999 2.2113642 2.701063e-02 1.1537845  
## 11 Objectives 11 1.0387631 0.6228059 5.334121e-01 1.0403795  
## 12 Predict 12 1.4059439 6.0145406 1.803975e-09 1.3336369  
## Infit\_t Infit\_p  
## 1 0.23526488 8.140031e-01  
## 2 1.30952464 1.903567e-01  
## 3 -2.33812358 1.938084e-02  
## 4 -1.56456962 1.176839e-01  
## 5 -0.79717130 4.253516e-01  
## 6 0.07769739 9.380688e-01  
## 7 -2.39503266 1.661888e-02  
## 8 -2.43386130 1.493872e-02  
## 9 -0.08006533 9.361853e-01  
## 10 2.34506577 1.902372e-02  
## 11 0.65197038 5.144203e-01  
## 12 5.16156344 2.448959e-07  
##   
## $summary\_itemfit  
## fit M SD  
## Outfit Outfit 1.008523 0.1504780  
## Infit Infit 1.005530 0.1391984  
##   
## $time  
## [1] "2020-07-22 15:40:49 EDT" "2020-07-22 15:40:49 EDT"  
##   
## $CALL  
## msq.itemfit(object = fit\_RSM)  
##   
## attr(,"class")  
## [1] "msq.itemfit"

Our outfit and infit values generally range from 0.85 to 1.15, which is okay. Item 12 does have an outfit value of 1.4 and an infit of 1.3, both of which are unsatisfactory and correspond to a *p* value less than .001. You can read more about what happened to Item 12 in Chapter 6. Some of our other items (3, 7, 8, 10) also have significant p-values but more reasonable infit/outfit statistics.

TAM does not (yet) report classical part-whole corrected item-total correlations. Instead, we can use the *psych* package to get corrected item-total correlations. The column r.drop shows the correlation of the item responses with the scale composed of the remaining items. We want this to be positive. A positive correlation means that the higher you score on this item, the higher your score is on the rest of the test. You can see that item 12 (“Predict”) has a lower correlation than the other items, but it’s still positive.

# Use the "psych" package to get corrected item-total correlations:  
iasq\_rel <- psych::alpha(iasq\_items)   
# check column "r.drop" for the correlation of item responses with the scale composed of the remaining items.   
iasq\_rel[["item.stats"]]

## n raw.r std.r r.cor r.drop mean sd  
## Appraisal 462 0.6037451 0.6089317 0.5650486 0.5085584 2.904762 0.8710947  
## Strengths 462 0.5478593 0.5581196 0.5021039 0.4529561 3.175325 0.8050797  
## Interest 462 0.6331524 0.6352794 0.5897684 0.5438756 2.547619 0.8618856  
## Work\_harder 462 0.6821921 0.6815311 0.6621067 0.5979809 2.777056 0.8959257  
## Independent 462 0.6613972 0.6583701 0.6312106 0.5724688 2.770563 0.9027310  
## Confidence 462 0.6407562 0.6381161 0.5947487 0.5472748 2.787879 0.9093538  
## Efficient 462 0.7000422 0.6987109 0.6752176 0.6192823 2.712121 0.8967429  
## Scores 462 0.7064876 0.7039154 0.6783902 0.6262287 2.675325 0.9046742  
## Track\_progress 462 0.6212102 0.6203351 0.5813474 0.5281700 2.880952 0.8768564  
## How\_much 462 0.5702550 0.5691361 0.5145790 0.4660567 2.928571 0.9014845  
## Objectives 462 0.6212570 0.6217687 0.5713444 0.5270722 2.939394 0.8865138  
## Predict 462 0.4097858 0.4046553 0.3085874 0.2841717 2.335498 0.9138579

# Plots

## Wright Map

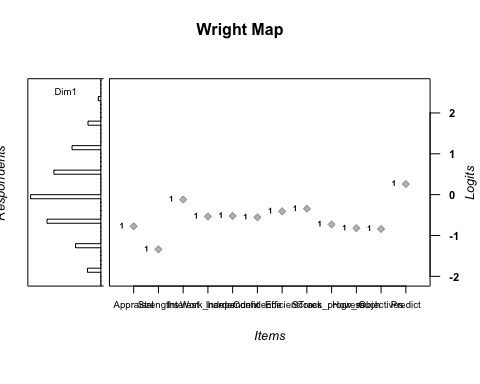
With the RSM, we can plot the Wright Map in two different ways. We can plot it with the item locations or with the item thresholds. Either way, you may notice that our item estimates are a little different from the ARMsteps tutorial - *TAM* defaults to center the scale on persons, rather than items. The only difference that our item locations are all shifted down about half a logit.

First let’s look at the Wright map with just the item locations. If you recall for the dichotomous Rasch model, the Wright map plots the difficulties of the items and the distribution of the person abilities. Our person ability distribution will be on the left. Persons at the top of the distribution are more positive towards self-assessment. You can see the logit scale running along the y-axis on the right side of the graph. In the center box, the locations of the items are plotted. Each dot is an item location. Items toward the top of the map are less likely to be endorsed by the students.

# Calculate item locations  
(item\_thresh <- IRT.threshold(fit\_RSM, type = "item"))

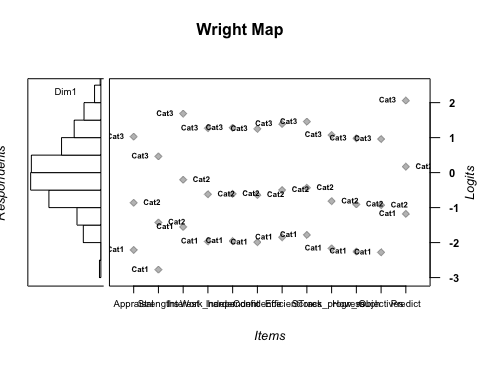
## [,1]  
## Appraisal -0.7748054  
## Strengths -1.3386978  
## Interest -0.1179332  
## Work\_harder -0.5329060  
## Independent -0.5203808  
## Confidence -0.5539229  
## Efficient -0.4102646  
## Scores -0.3430238  
## Track\_progress -0.7297308  
## How\_much -0.8204301  
## Objectives -0.8413794  
## Predict 0.2591513

# Plot the item locations Wright Map  
IRT.WrightMap(item\_thresh, type = "item")



From the above graph, we can see that “Predict” is the hardest item. “Strengths” is the easiest item. Most items fall around -1. Because this only plots the item location, we can’t see how well the items actually match up to the person distribution. In the next plot, each item will get 3 dots. Each dot represents the threshold location.

# Wright map with category thresholds  
IRT.WrightMap(fit\_RSM)



With this plot, you can see that the distances between categories 1 & 2 and 2 & 3 are the same for all items. The sets of thresholds are just shifted up and down on the logit scale depending on the item location. Because “Predict” is the hardest item, its thresholds are shifted higher than the other items.

Plotting the thresholds also gives you a better idea of the item difficulty spread and how it matches to the person parameters. We have a good match between persons and items; there are thresholds at both ends of the scale. In either plot, you can see that several items are very similar to each other. If you needed to reduce the scale, you could consider removing one of those.

Look at the first item, “Appraisal”. Using this plot, we can guess how a person would respond to this item. Remember that IASQ items have response options ranging from “1” (Strongly Disagree) to “4” (Strongly Agree). If a person had a ability score of -3, they are likely to respond “1” to “Appraisal” because the first threshold of this item is around -2; -2 is greater than -3. The second threshold of “Appraisal” is around -1. Therefore, if a person had an ability score between -2 and -1, they would be likely to respond “2” to this item. The third category is at +1. Therefore, if a person had an ability score between -1 and +1, they would be likely to respond “3” to this item. If their ability score was greater than 1, they would likely pick “4” when responding to “Appraisal.”

# Removing Misfitting Items

When you encounter poorly fitting items in a model, one option is to remove them from the scale. If you choose to remove an item, you should re-run the model without that item. The bad item may be influencing how the other good items fit the scale because the bad item is being used to construct our latent ability. You may find that the other items fit differently when the bad item is removed.

The code below shows you how to remove item 12 from the RSM. Does that affect fit statistics for other items? Are other indicators improved, or not? Check your findings against the commentary in ARM4. Chapter 6.

# Remove item 12 which is in the 12th column  
iasq\_items\_2 <- iasq\_items[,-12]  
  
# Look at the data  
head(iasq\_items\_2)

## Appraisal Strengths Interest Work\_harder Independent Confidence Efficient  
## 1 4 3 4 4 4 4 4  
## 2 4 4 3 4 4 4 4  
## 3 4 3 3 4 4 4 4  
## 4 4 4 4 4 4 4 3  
## 5 4 4 4 3 4 4 4  
## 6 4 4 4 4 4 4 3  
## Scores Track\_progress How\_much Objectives  
## 1 4 4 4 4  
## 2 4 4 3 4  
## 3 4 4 4 4  
## 4 3 4 4 4  
## 5 3 3 4 4  
## 6 3 4 4 4

# Fit the new model  
fit\_RSM\_no\_12 <- tam.mml(resp = iasq\_items\_2-1,   
 irtmodel = "RSM")

## ....................................................  
## Processing Data 2020-07-22 15:40:49   
## \* Response Data: 462 Persons and 11 Items   
## \* Numerical integration with 21 nodes  
## \* Created Design Matrices ( 2020-07-22 15:40:49 )  
## \* Calculated Sufficient Statistics ( 2020-07-22 15:40:49 )  
## ....................................................  
## Iteration 1 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |----  
## Deviance = 12286.3986  
## Maximum item intercept parameter change: 0.525164  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.429917  
## ....................................................  
## Iteration 2 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |----  
## Deviance = 11479.9796 | Absolute change: 806.419 | Relative change: 0.07024568  
## Maximum item intercept parameter change: 0.156577  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.062012  
## ....................................................  
## Iteration 3 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |----  
## Deviance = 11394.4752 | Absolute change: 85.5044 | Relative change: 0.00750402  
## Maximum item intercept parameter change: 0.074027  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.115985  
## ....................................................  
## Iteration 4 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |----  
## Deviance = 11365.9082 | Absolute change: 28.567 | Relative change: 0.0025134  
## Maximum item intercept parameter change: 0.057724  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.100559  
## ....................................................  
## Iteration 5 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |----  
## Deviance = 11351.6125 | Absolute change: 14.2957 | Relative change: 0.00125935  
## Maximum item intercept parameter change: 0.037384  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.082381  
## ....................................................  
## Iteration 6 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |----  
## Deviance = 11345.334 | Absolute change: 6.2785 | Relative change: 0.0005534  
## Maximum item intercept parameter change: 0.031595  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.054797  
## ....................................................  
## Iteration 7 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |----  
## Deviance = 11342.3009 | Absolute change: 3.0331 | Relative change: 0.00026742  
## Maximum item intercept parameter change: 0.027055  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.039441  
## ....................................................  
## Iteration 8 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |----  
## Deviance = 11340.5171 | Absolute change: 1.7837 | Relative change: 0.00015729  
## Maximum item intercept parameter change: 0.01807  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.025573  
## ....................................................  
## Iteration 9 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |----  
## Deviance = 11339.7001 | Absolute change: 0.817 | Relative change: 7.205e-05  
## Maximum item intercept parameter change: 0.012001  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.016509  
## ....................................................  
## Iteration 10 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |----  
## Deviance = 11339.3013 | Absolute change: 0.3988 | Relative change: 3.517e-05  
## Maximum item intercept parameter change: 0.006234  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.010637  
## ....................................................  
## Iteration 11 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |----  
## Deviance = 11339.1199 | Absolute change: 0.1814 | Relative change: 1.6e-05  
## Maximum item intercept parameter change: 0.005978  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.003531  
## ....................................................  
## Iteration 12 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |----  
## Deviance = 11339.0031 | Absolute change: 0.1169 | Relative change: 1.031e-05  
## Maximum item intercept parameter change: 0.004814  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.005155  
## ....................................................  
## Iteration 13 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |----  
## Deviance = 11338.9225 | Absolute change: 0.0806 | Relative change: 7.11e-06  
## Maximum item intercept parameter change: 0.003116  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.003975  
## ....................................................  
## Iteration 14 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |----  
## Deviance = 11338.875 | Absolute change: 0.0474 | Relative change: 4.18e-06  
## Maximum item intercept parameter change: 0.003422  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.001025  
## ....................................................  
## Iteration 15 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |---  
## Deviance = 11338.8397 | Absolute change: 0.0353 | Relative change: 3.11e-06  
## Maximum item intercept parameter change: 0.002237  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.002303  
## ....................................................  
## Iteration 16 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |----  
## Deviance = 11338.8169 | Absolute change: 0.0228 | Relative change: 2.01e-06  
## Maximum item intercept parameter change: 0.002365  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.000831  
## ....................................................  
## Iteration 17 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |---  
## Deviance = 11338.7993 | Absolute change: 0.0176 | Relative change: 1.55e-06  
## Maximum item intercept parameter change: 0.001625  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.001368  
## ....................................................  
## Iteration 18 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |----  
## Deviance = 11338.7874 | Absolute change: 0.012 | Relative change: 1.06e-06  
## Maximum item intercept parameter change: 0.001749  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.000117  
## ....................................................  
## Iteration 19 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |---  
## Deviance = 11338.7778 | Absolute change: 0.0096 | Relative change: 8.5e-07  
## Maximum item intercept parameter change: 0.001212  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.000916  
## ....................................................  
## Iteration 20 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |---  
## Deviance = 11338.7713 | Absolute change: 0.0064 | Relative change: 5.7e-07  
## Maximum item intercept parameter change: 0.001244  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.000105  
## ....................................................  
## Iteration 21 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |---  
## Deviance = 11338.7663 | Absolute change: 0.0051 | Relative change: 4.5e-07  
## Maximum item intercept parameter change: 0.000886  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.000623  
## ....................................................  
## Iteration 22 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |---  
## Deviance = 11338.7627 | Absolute change: 0.0035 | Relative change: 3.1e-07  
## Maximum item intercept parameter change: 0.000904  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 7.5e-05  
## ....................................................  
## Iteration 23 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |---  
## Deviance = 11338.7599 | Absolute change: 0.0028 | Relative change: 2.5e-07  
## Maximum item intercept parameter change: 0.000652  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.000448  
## ....................................................  
## Iteration 24 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |---  
## Deviance = 11338.758 | Absolute change: 0.0019 | Relative change: 1.7e-07  
## Maximum item intercept parameter change: 0.000676  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 5.1e-05  
## ....................................................  
## Iteration 25 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |--  
## Deviance = 11338.7565 | Absolute change: 0.0015 | Relative change: 1.4e-07  
## Maximum item intercept parameter change: 0.00048  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.000324  
## ....................................................  
## Iteration 26 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |--  
## Deviance = 11338.7554 | Absolute change: 0.0011 | Relative change: 9e-08  
## Maximum item intercept parameter change: 0.000456  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 3.9e-05  
## ....................................................  
## Iteration 27 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |--  
## Deviance = 11338.7546 | Absolute change: 8e-04 | Relative change: 7e-08  
## Maximum item intercept parameter change: 0.00037  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.000222  
## ....................................................  
## Iteration 28 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |--  
## Deviance = 11338.754 | Absolute change: 6e-04 | Relative change: 5e-08  
## Maximum item intercept parameter change: 0.000339  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 5.2e-05  
## ....................................................  
## Iteration 29 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |--  
## Deviance = 11338.7535 | Absolute change: 5e-04 | Relative change: 4e-08  
## Maximum item intercept parameter change: 0.000282  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 0.000117  
## ....................................................  
## Iteration 30 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |--  
## Deviance = 11338.7532 | Absolute change: 3e-04 | Relative change: 3e-08  
## Maximum item intercept parameter change: 0.000252  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 6.7e-05  
## ....................................................  
## Iteration 31 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |--  
## Deviance = 11338.7529 | Absolute change: 3e-04 | Relative change: 2e-08  
## Maximum item intercept parameter change: 0.000215  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 7.8e-05  
## ....................................................  
## Iteration 32 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |--  
## Deviance = 11338.7527 | Absolute change: 2e-04 | Relative change: 2e-08  
## Maximum item intercept parameter change: 0.000188  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 5.3e-05  
## ....................................................  
## Iteration 33 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |--  
## Deviance = 11338.7526 | Absolute change: 1e-04 | Relative change: 1e-08  
## Maximum item intercept parameter change: 0.000162  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 5.8e-05  
## ....................................................  
## Iteration 34 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |--  
## Deviance = 11338.7525 | Absolute change: 1e-04 | Relative change: 1e-08  
## Maximum item intercept parameter change: 0.000141  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 4.1e-05  
## ....................................................  
## Iteration 35 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |--  
## Deviance = 11338.7524 | Absolute change: 1e-04 | Relative change: 1e-08  
## Maximum item intercept parameter change: 0.000121  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 4.4e-05  
## ....................................................  
## Iteration 36 2020-07-22 15:40:49  
## E Step  
## M Step Intercepts |-  
## Deviance = 11338.7523 | Absolute change: 1e-04 | Relative change: 1e-08  
## Maximum item intercept parameter change: 9.7e-05  
## Maximum item slope parameter change: 0  
## Maximum regression parameter change: 0  
## Maximum variance parameter change: 3.5e-05  
## ....................................................  
## Item Parameters  
## xsi.index xsi.label est  
## 1 1 Appraisal -0.7122  
## 2 2 Strengths -1.3010  
## 3 3 Interest -0.0239  
## 4 4 Work\_harder -0.4583  
## 5 5 Independent -0.4457  
## 6 6 Confidence -0.4794  
## 7 7 Efficient -0.3331  
## 8 8 Scores -0.2630  
## 9 9 Track\_progress -0.6640  
## 10 10 How\_much -0.7609  
## 11 11 Objectives -0.7832  
## 12 12 Cat1 -1.3171  
## 13 13 Cat2 -0.3496  
## ...................................  
## Regression Coefficients  
## [,1]  
## [1,] 0  
##   
## Variance:  
## [,1]  
## [1,] 1.1  
##   
##   
## EAP Reliability:  
## [1] 0.852  
##   
## -----------------------------  
## Start: 2020-07-22 15:40:49  
## End: 2020-07-22 15:40:49   
## Time difference of 0.06643105 secs

# New thresholds  
item\_thresh\_2<-tam.threshold(fit\_RSM\_no\_12)  
item\_thresh\_2

## Cat1 Cat2 Cat3  
## Appraisal -2.294037 -0.9196472 1.0712585  
## Strengths -2.882721 -1.5085144 0.4823914  
## Interest -1.605560 -0.2313538 1.7595520  
## Work\_harder -2.040070 -0.6656799 1.3252258  
## Independent -2.027435 -0.6530457 1.3376770  
## Confidence -2.061127 -0.6869202 1.3039856  
## Efficient -1.914825 -0.5404358 1.4502869  
## Scores -1.844879 -0.4704895 1.5204163  
## Track\_progress -2.245697 -0.8714905 1.1194153  
## How\_much -2.342743 -0.9683533 1.0225525  
## Objectives -2.364899 -0.9906921 1.0002136

# Item fit  
msq.itemfit(fit\_RSM\_no\_12)

## $itemfit  
## item fitgroup Outfit Outfit\_t Outfit\_p Infit  
## 1 Appraisal 1 1.0424313 0.6746667 0.499887549 1.0353556  
## 2 Strengths 2 1.0636294 0.9290974 0.352838629 1.1125194  
## 3 Interest 3 0.9463656 -0.8745313 0.381828992 0.9019423  
## 4 Work\_harder 4 0.9360405 -1.0227720 0.306415650 0.9349244  
## 5 Independent 5 0.9896402 -0.1452673 0.884499800 0.9873572  
## 6 Confidence 6 1.0255431 0.4245899 0.671135654 1.0356345  
## 7 Efficient 7 0.8669384 -2.2262584 0.025996877 0.8670809  
## 8 Scores 8 0.9167841 -1.3657655 0.172012585 0.8948097  
## 9 Track\_progress 9 1.0213489 0.3537366 0.723536320 1.0172621  
## 10 How\_much 10 1.1834890 2.7141087 0.006645437 1.1932971  
## 11 Objectives 11 1.0950628 1.4509797 0.146785522 1.0891020  
## Infit\_t Infit\_p  
## 1 0.5718303 0.567436934  
## 2 1.6506955 0.098800769  
## 3 -1.6646415 0.095984307  
## 4 -1.0499655 0.293733977  
## 5 -0.1838078 0.854164214  
## 6 0.5864871 0.557548211  
## 7 -2.2430390 0.024894299  
## 8 -1.7622413 0.078028531  
## 9 0.2926140 0.769817208  
## 10 2.8779461 0.004002735  
## 11 1.3775074 0.168355423  
##   
## $summary\_itemfit  
## fit M SD  
## Outfit Outfit 1.007934 0.08981934  
## Infit Infit 1.006299 0.10153199  
##   
## $time  
## [1] "2020-07-22 15:40:49 EDT" "2020-07-22 15:40:49 EDT"  
##   
## $CALL  
## msq.itemfit(object = fit\_RSM\_no\_12)  
##   
## attr(,"class")  
## [1] "msq.itemfit"