

Question 1 – Item Response Functions and Person Estimates

```

> ## -----
> install.packages("irtoys")
Installing package into 'C:/Users/Dell/Documents/R/win-library/3.1'
(as 'lib' is unspecified)
trying URL 'http://cran.rstudio.com/bin/windows/contrib/3.1/irtoys_0.1.7.zip'
Content type 'application/zip' length 128877 bytes (125 kb)
opened URL
downloaded 125 kb

package 'irtoys' successfully unpacked and MD5 sums checked

The downloaded binary packages are in
  C:\Users\Dell\AppData\Local\Temp\Rtmpaw0sDW\downloaded_packages
> library("irtoys")
Loading required package: sm
Package 'sm', version 2.2-5.4: type help(sm) for summary information
Loading required package: ltm
Loading required package: MASS

Attaching package: 'MASS'

The following object is masked from 'package:sm':

  muscle

Loading required package: msm
Loading required package: polycor
Loading required package: mvtnorm
Loading required package: sfsmisc
> ## -----
> getwd()
[1] "C:/Users/Dell/Documents"
> ## -----
> # This actually runs the model
> rasch_model <- est(Scored, model="1PL", engine="ltm", rasch = TRUE)
> #
> # Estimated Parameters
> #
> est_params <- rasch_model$est
> colnames(est_params) <- c("Discrimination", "Difficulty", "Guessing")
> rownames(est_params) <- paste("Item", 1:18)
> est_params
  Discrimination Difficulty Guessing
Item 1          1 -1.40938612         0
Item 2          1 -0.35055656         0
Item 3          1 -0.90318970         0
Item 4          1 -0.97412011         0
Item 5          1 -1.62671110         0
Item 6          1  0.02533657         0
Item 7          1 -0.41418545         0
Item 8          1 -0.87993298         0
Item 9          1 -0.91498121         0
Item 10         1  0.52959427         0
Item 11         1 -1.17125435         0
Item 12         1 -0.04749604         0
Item 13         1  0.15008663         0
Item 14         1 -0.74253017         0
Item 15         1 -0.74245332         0
Item 16         1  0.36963876         0
Item 17         1 -0.84513136         0
Item 18         1 -1.45145349         0

```

a) Which item was the easiest item and which item was the hardest? (2 points)

Item 10 was the hardest with a difficulty score of 0.5295 and item 5 was the easiest with a difficulty score of -1.6267

```
> #
> # Standard Errors
> #
> est_se <- rasch_model$se
> colnames(est_se) <- c("Discrimination SE", "Difficulty SE", "Guessing SE")
> rownames(est_se) <- paste("Item", 1:18)
> est_se
```

	Discrimination SE	Difficulty SE	Guessing SE
Item 1	NA	0.1267448	0
Item 2	NA	0.1128011	0
Item 3	NA	0.1178581	0
Item 4	NA	0.1188426	0
Item 5	NA	0.1320051	0
Item 6	NA	0.1118476	0
Item 7	NA	0.1131572	0
Item 8	NA	0.1175527	0
Item 9	NA	0.1180162	0
Item 10	NA	0.1136598	0
Item 11	NA	0.1220123	0
Item 12	NA	0.1118797	0
Item 13	NA	0.1119630	0
Item 14	NA	0.1159197	0
Item 15	NA	0.1159189	0
Item 16	NA	0.1126941	0
Item 17	NA	0.1171115	0
Item 18	NA	0.1276902	0

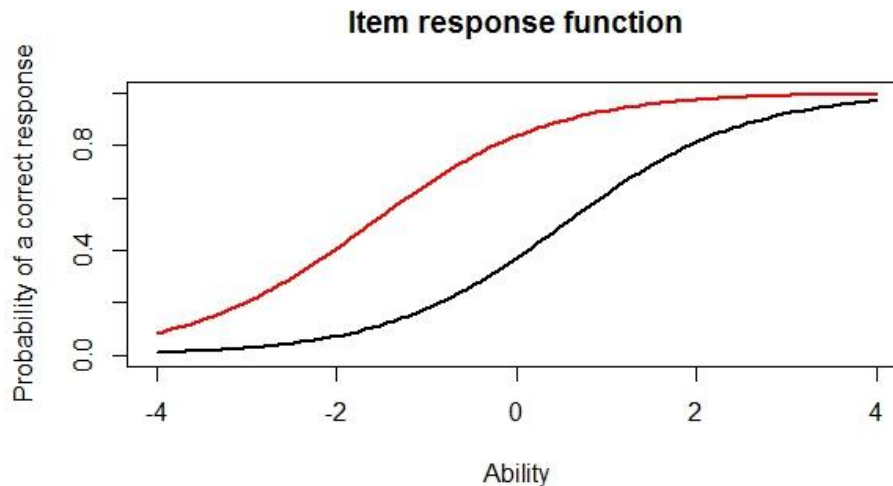
b) Provide a 95% confidence interval for the easiest item and interpret it. (2 points)

A confidence interval (CI) is calculated using the formula: $\text{Difficulty} \pm 1.96 \cdot \text{SE}$. A 95% CI for item 5 is [-1.885, -1.368]. Lower bound is -1.885 and the upper bound is -1.368. We can therefore be confident that there is a 95% probability that the difficulty for item 5 is between the upper and lower bound.

This assignment was done in cooperation with Sigrún Ósk Jakobsdóttir, Laufey Ásta Guðmundsdóttir, Helga Margrét Ólafsdóttir and Katrín Mjöll Halldórsdóttir

c) Provide a plot that contains both the easiest and the hardest item. (1 point)

```
> #
> plot(irf(est_params[c(10,5),]), co = NA)
```



d) What would we expect the probability of a correct response would be for someone who had an ability score of 0 for these two items? (2 points)

For item 5 and with an ability score of 0 the probability of a correct score would be around 0.4. For item 10 the probability of getting a correct score with the same ability score would be around 0.8.

```
> # Estimated abilities
> #
> est_abl <- as.data.frame(mlebm(Scored, ip = est_params))
> min(est_abl$est) # Prints the minimum score
[1] -3.999947
> max(est_abl$est) # Prints the maximum scores
[1] 3.999921
> which.min(est_abl$est) # Prints out the person minimum score
[1] 393
> which.max(est_abl$est) # Prints out the person with the maximum score
[1] 49
> # To find out score for person 399
> est_abl[393,]
      est      sem    n
393 -3.999947 1.225286 18
> # To find out score for person 49
> est_abl[49,]
      est      sem    n
49 3.999921 2.204373 18
```

e) What was the score of the person who did the best on the test? What was the score of the person who did the worst on the test? (2 points)

Person 49 did the best on the test and had a score of 3.999. Person 399 had the lowest score on the test and had a score of -3.99.

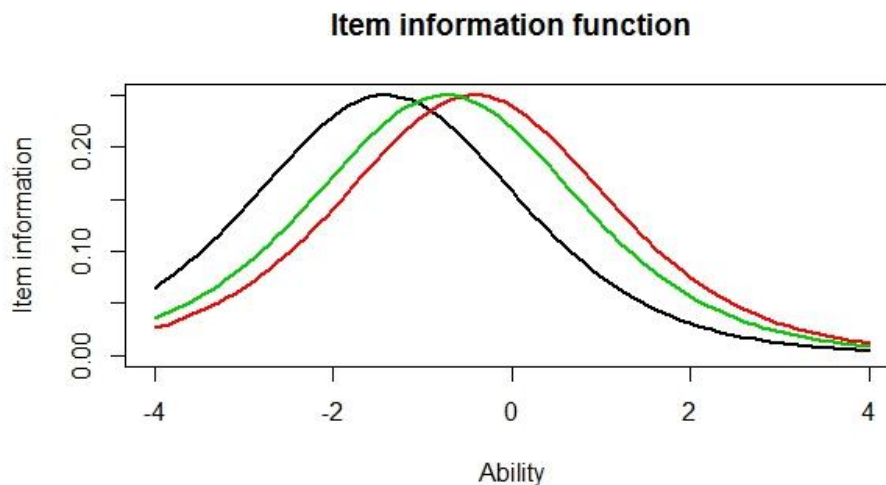
- f) **Provide a 95% confidence interval for the estimated ability for the student who did the best on the test and interpret it (2 points)**

The CI is calculated using the formula Ability score $\pm 1.96 \cdot \text{SEM}$. A 95% CI for person 49 is $[-0.321, 8.318]$. Lower bound is -0.321 and the upper bound is 8.318. We can therefore be certain that there is 95% probability that person 49 will have an ability score between the upper and lower bound. The CI is fairly large and therefore offers less information about ability than if the CI was smaller.

Question 2 – Information

```
> # Plot Item Information Function for items 1, 7, 15  
> #  
> plot(iif(est_params[c(1,7,15),]), co = NA)
```

- a) **Please state the three items you selected. (1 point)**
Items 1, 7 and 15 have been selected.
- b) **Provide a plot that contains these three items' information functions (1 point)**



- c) **What is the same about these items' information functions? What is different?**

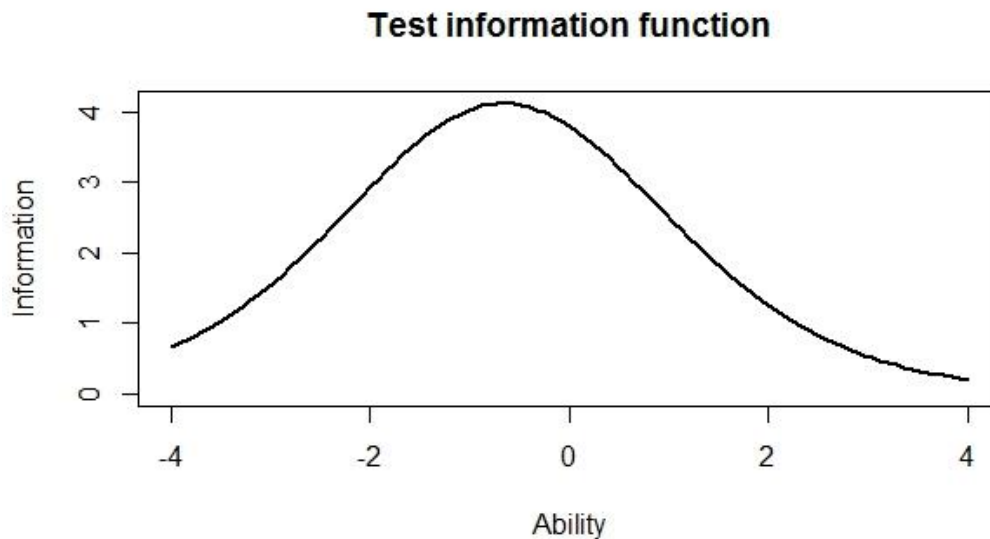
Hint: This can be a very short answer. (2 points)

All the items have the same shape and similar level of item information. The location for the items information functions is different.

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```
> # Plot Test Information Function
> #
> plot(tif(est_params))
```

d) Provide a plot of the test information function. (1 point)



e) Where is the majority of the information for this test located? (1 point)

The most information can be found between 0 and -1. At this interval you can best predict ability scores because of the amount of information.

Question 3 – Comparing the 2-PL

```
> # This actually runs the model
> twopl_model <- est(Scored, model="2PL", engine="ltm")
> #
> # Estimated Parameters
> #
> twopl_params <- twopl_model$est
> colnames(twopl_params) <- c("Discrimination", "Difficulty", "Guessing")
> rownames(twopl_params) <- paste("Item", 1:18)
> twopl_params
```

	Discrimination	Difficulty	Guessing
Item 1	0.6326689	-2.00058101	0
Item 2	1.5469622	-0.26815483	0
Item 3	1.2534918	-0.77297206	0
Item 4	0.9842598	-0.97706755	0
Item 5	1.6407242	-1.19389580	0
Item 6	1.4702029	0.01833431	0
Item 7	0.5632837	-0.65124651	0
Item 8	2.2881772	-0.56753253	0
Item 9	1.8004066	-0.64761748	0
Item 10	1.1142107	0.48542889	0
Item 11	1.0344119	-1.13363005	0
Item 12	0.3329130	-0.12951933	0
Item 13	0.3369968	0.36344671	0
Item 14	0.6608229	-1.01479867	0
Item 15	1.5980393	-0.55640285	0
Item 16	1.0362116	0.35459121	0
Item 17	1.8591845	-0.59017915	0
Item 18	1.2808752	-1.22177042	0

```
> #
> # Estimated abilities
```

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```
> #
> twopl_abl <- as.data.frame(mlebmme(Scored, ip = twopl_params))
> # Correlation between the ability estimates
> cor(twopl_abl$est, est_abl$est)
[1] 0.9709497
> # Plot Item Information Function for items 1, 7, 15
> #
> plot(iif(twopl_params[c(1,7,15),]), co = NA)
```

- a) Which item had the highest discrimination? Which one had the lowest discrimination? (2 points)

Item 12 had the lowest discrimination with a value of 0.3329. Item 8 had the highest discrimination with a value of 2.2882.

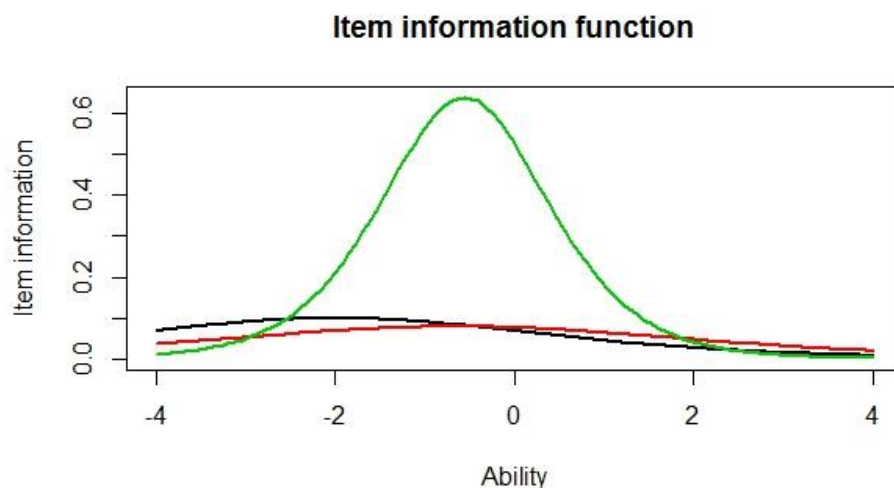
- b) Are the items that were the easiest and hardest in the Rasch model, also the easiest and hardest in the 2-PL? (1 point)

The items in the 2-PL are not the same ones as in the Rasch model since the easiest item in the Rasch model was item 10 and the hardest was item 5.

- c) What is the correlation between the ability estimates on the Rasch model and the 2-PL? If your interest was solely on estimating person abilities, do you think you would draw the same conclusions from both models? Why? (2 points)

The correlation between the Rasch model and the 2-PL model is 0.9709. You could draw the same conclusions from both models because the correlation between them is nearly perfect.

- d) Provide a plot of the item information function for the three items you selected in Question 2 but this time for the 2-PL model. (1 point)



- e) For the 2-PL model, how do the item information functions for these items differ? How does the 2-PL, item information functions from these items differ from their Rasch item information functions? (2 point)

One function is giving substantially more information than the other two. Only with the green item are you getting enough information to adequately predict ability scores. It offers the most information around -0,5. The green item also has the highest discrimination value. The black and the red items are not giving enough information to be able to discriminate or predict ability scores. The black seems to be giving most information around -3 and the red seems to be providing information around -1 and 0. With the Rasch items the all had similar discrimination but differed in their location but in the 2-PL they differ in their discrimination and their location.