Assignment 2

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#Question 1

library("psych")  
library("mirt")

## Loading required package: stats4

## Loading required package: lattice

load("C:/Users/gtj24002/OneDrive - University of Connecticut/Desktop/IRT/Week1workspace.RData")

#Question 1a

# Define the response pattern (1 = correct, 0 = incorrect)  
# Define a range of theta values (ability levels)  
  
theta\_values <- seq(-3, 3, by = 0.05)  
response\_pattern <- c(1, 0, 1, 0, 1, 0)  
nitems<-length(response\_pattern)  
  
  
  
getloglike <- function(nitems,params,response) {  
   
 pq<-array(0,c(121,nitems))  
 theta<-seq(-3,3,.05)  
   
 for (j in 1:nitems) {  
   
   
 temp<- params[j,1]\*(theta - params[j,2])  
   
 p <- params[j,3] + (1-params[j,3])/(1 + exp(-temp))  
   
 pq[,j]<- response[j]\*p + (1-response[j])\*(1-p)  
   
 }  
   
 loglike<-apply(log(pq),1,sum)  
   
 loglike  
}  
  
  
  
item\_params<-matrix(c(1.2,2.5,1.2,2.0,1.8,1.5,-1.5,-1.0,0.0,0.5,1.0,1.8,0,0,0,0,0,0),ncol=3)  
  
getloglike(6,item\_params,response\_pattern)->logl  
  
  
which.max(logl)

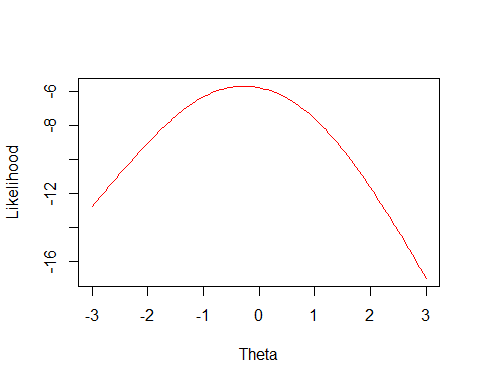
## [1] 55

seq(-3,3,.05)[which.max(logl)]

## [1] -0.3

#Question 1b

plot(seq(-3,3,.05),logl, type="l",col="red",ylab="Likelihood",xlab="Theta")

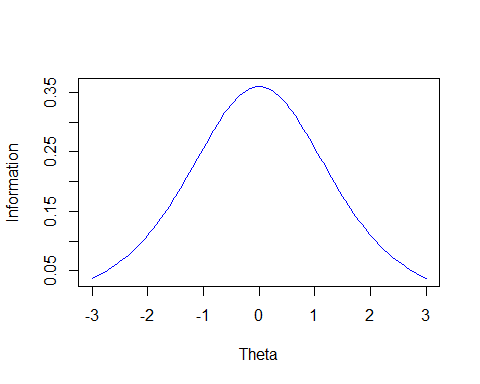
 The peak of the plot has an estimated likelihood value of -0.3 which is slightly below the average ability level compared to the test’s standard. Given the alternating response pattern [1,0,1,0,1,0], I think it makes sense because it signifies that the student has a moderate ability, not too good and not too bad. A value of -0.3 fits this pattern where the test taker is just slightly below the average ability.

#Question 1c

#Item Information Function  
item<-item\_params[3,]  
  
temp<- item[1]\*(seq(-3,3,.05) - item[2])  
  
info<-item[1]^2\*(1-item[3])/((item[3] + exp(temp))\*(1 + exp(-temp))\*(1 + exp(-temp)))  
  
info

## [1] 0.03728101 0.03945645 0.04175059 0.04416890 0.04671696 0.04940047  
## [7] 0.05222522 0.05519707 0.05832194 0.06160574 0.06505439 0.06867375  
## [13] 0.07246957 0.07644750 0.08061295 0.08497111 0.08952682 0.09428457  
## [19] 0.09924836 0.10442163 0.10980720 0.11540714 0.12122269 0.12725412  
## [25] 0.13350067 0.13996037 0.14662999 0.15350483 0.16057870 0.16784372  
## [31] 0.17529025 0.18290676 0.19067973 0.19859360 0.20663062 0.21477089  
## [37] 0.22299225 0.23127031 0.23957847 0.24788798 0.25616799 0.26438573  
## [43] 0.27250663 0.28049454 0.28831199 0.29592044 0.30328064 0.31035297  
## [49] 0.31709782 0.32347603 0.32944931 0.33498070 0.34003503 0.34457935  
## [55] 0.34858339 0.35201997 0.35486536 0.35709967 0.35870710 0.35967619  
## [61] 0.36000000 0.35967619 0.35870710 0.35709967 0.35486536 0.35201997  
## [67] 0.34858339 0.34457935 0.34003503 0.33498070 0.32944931 0.32347603  
## [73] 0.31709782 0.31035297 0.30328064 0.29592044 0.28831199 0.28049454  
## [79] 0.27250663 0.26438573 0.25616799 0.24788798 0.23957847 0.23127031  
## [85] 0.22299225 0.21477089 0.20663062 0.19859360 0.19067973 0.18290676  
## [91] 0.17529025 0.16784372 0.16057870 0.15350483 0.14662999 0.13996037  
## [97] 0.13350067 0.12725412 0.12122269 0.11540714 0.10980720 0.10442163  
## [103] 0.09924836 0.09428457 0.08952682 0.08497111 0.08061295 0.07644750  
## [109] 0.07246957 0.06867375 0.06505439 0.06160574 0.05832194 0.05519707  
## [115] 0.05222522 0.04940047 0.04671696 0.04416890 0.04175059 0.03945645  
## [121] 0.03728101

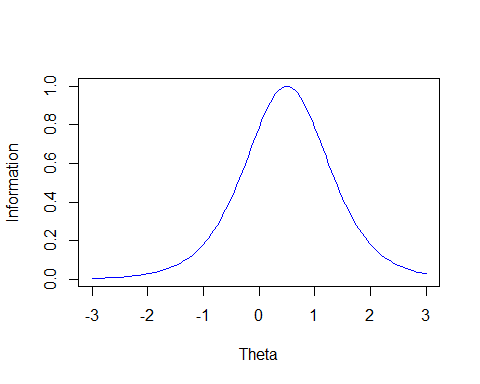
plot(seq(-3,3,.05),info, type="l",col="red",xlab="Theta",ylab="Information")  
  
points(seq(-3,3,.05),info, type="l",col="blue")



item<-item\_params[4,]  
  
temp<- item[1]\*(seq(-3,3,.05) - item[2])  
  
info<-item[1]^2\*(1-item[3])/((item[3] + exp(temp))\*(1 + exp(-temp))\*(1 + exp(-temp)))  
  
info

## [1] 0.003640885 0.004023029 0.004445193 0.004911549 0.005426697 0.005995715  
## [7] 0.006624198 0.007318317 0.008084874 0.008931362 0.009866037 0.010897989  
## [13] 0.012037222 0.013294745 0.014682665 0.016214287 0.017904227 0.019768530  
## [19] 0.021824798 0.024092321 0.026592227 0.029347626 0.032383774 0.035728236  
## [25] 0.039411054 0.043464919 0.047925344 0.052830833 0.058223039 0.064146912  
## [31] 0.070650825 0.077786672 0.085609924 0.094179633 0.103558374 0.113812096  
## [37] 0.125009871 0.137223519 0.150527076 0.164996078 0.180706639 0.197734276  
## [43] 0.216152459 0.236030850 0.257433197 0.280414866 0.305019996 0.331278268  
## [49] 0.359201316 0.388778819 0.419974342 0.452721037 0.486917361 0.522422988  
## [55] 0.559055168 0.596585808 0.634739590 0.673193450 0.711577763 0.749479518  
## [61] 0.786447733 0.822001229 0.855638786 0.886851493 0.915136962 0.940014849  
## [67] 0.961042983 0.977833247 0.990066291 0.997504161 1.000000000 0.997504161  
## [73] 0.990066291 0.977833247 0.961042983 0.940014849 0.915136962 0.886851493  
## [79] 0.855638786 0.822001229 0.786447733 0.749479518 0.711577763 0.673193450  
## [85] 0.634739590 0.596585808 0.559055168 0.522422988 0.486917361 0.452721037  
## [91] 0.419974342 0.388778819 0.359201316 0.331278268 0.305019996 0.280414866  
## [97] 0.257433197 0.236030850 0.216152459 0.197734276 0.180706639 0.164996078  
## [103] 0.150527076 0.137223519 0.125009871 0.113812096 0.103558374 0.094179633  
## [109] 0.085609924 0.077786672 0.070650825 0.064146912 0.058223039 0.052830833  
## [115] 0.047925344 0.043464919 0.039411054 0.035728236 0.032383774 0.029347626  
## [121] 0.026592227

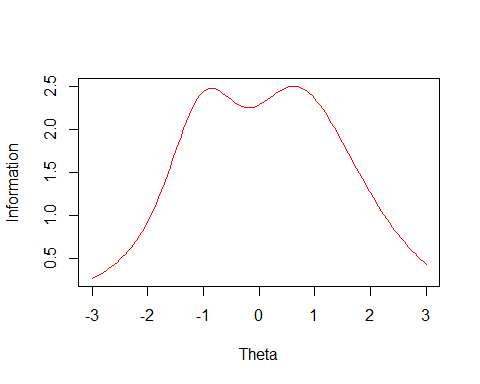
plot(seq(-3,3,.05),info, type="l",col="red",xlab="Theta",ylab="Information")  
  
points(seq(-3,3,.05),info, type="l",col="blue")

 Given the parameters for item 3 (a3=1.2, b3=0.0), the peak for the information function for Item 3 is around theta value of 0 which corresponds to the difficulty level (b3) of item 3 which is exactly where i would expect it to be.

Item 4 has a relatively higher discrimination (a4=2.0) and a relatively higher difficulty level (b4=0.5). Higher discrimination means more information is given around the item’s difficulty level. The peak information for this item (3) will be less than that of item 4. This is because Item 4 has higher discrimination level and a higher difficulty level (0.5) which is around the theta value or ability level of the Item 4 information function, making its peak more informative compared to that of item 3.

#Question 1d

infogrid <- function(nitems,item\_params) {  
   
 info<-array(0,c(121,nitems))  
   
 theta<-seq(-3,3,.05)  
   
 for (j in 1:nitems) {  
   
 temp<- item\_params[j,1]\*(theta - item\_params[j,2])  
   
 p <- item\_params[j,3] + (1-item\_params[j,3])/(1 + exp(-temp))  
   
 info[,j]<-item\_params[j,1]^2\*(1-item\_params[j,3])/((item\_params[j,3] + exp(temp))\*(1 + exp(-temp))\*(1 + exp(-temp)))  
   
 }  
   
 info  
}  
  
# construct the info grid for 6 item math test  
infogrid(6,item\_params)->testinfo  
  
# to plot the test info, sum the rows (ie sum for all the items)  
  
plot(seq(-3,3,.05),apply(testinfo,1,sum),type="l",col="red",xlab="Theta",ylab="Information")



# for response pattern (0,1,0,1,0,1) we had seen  
# that theta-hat was approx -0.3, which was  
# approximately slot 55 in the sequence  
# so let's find test information at slot 48  
  
apply(testinfo,1,sum)[55]

## [1] 2.267261

# the SE is 1/sqrt(testinformation)  
  
1/sqrt(apply(testinfo,1,sum)[55])

## [1] 0.6641241

The curve peaks around theta levels of -1 and 1. This means that the test is most effective or informative in estimating ability levels around these values therefore there is high precision around this region. The curve starts to fall off around extreme theta <-2 and extreme of theta > 2 which means the test provides less information around these two regions and its less precise in estimating ability levels around these values

#Question 1e Generating 6 new items that have item parameters exactly as these 6 will increase (double) the overall information of the test at each ability levels as test information is additive across items. Since the minimum standard error is the lowest at the peak of the ability levels, generating six new items with same item paramters will therefore reduce the minimum standard error, decreasing further.

#QUESTION 2

#a

## Model Fit  
library(mirt)  
mirt(astro,1,"Rasch") ->m1

## Iteration: 1, Log-Lik: -1915.038, Max-Change: 0.09593Iteration: 2, Log-Lik: -1914.886, Max-Change: 0.01964Iteration: 3, Log-Lik: -1914.866, Max-Change: 0.00910Iteration: 4, Log-Lik: -1914.861, Max-Change: 0.00415Iteration: 5, Log-Lik: -1914.860, Max-Change: 0.00194Iteration: 6, Log-Lik: -1914.859, Max-Change: 0.00088Iteration: 7, Log-Lik: -1914.859, Max-Change: 0.00057Iteration: 8, Log-Lik: -1914.859, Max-Change: 0.00041Iteration: 9, Log-Lik: -1914.859, Max-Change: 0.00028Iteration: 10, Log-Lik: -1914.859, Max-Change: 0.00015Iteration: 11, Log-Lik: -1914.859, Max-Change: 0.00009

mirt(astro,1,"2PL") ->m2

## Iteration: 1, Log-Lik: -1918.057, Max-Change: 1.73273Iteration: 2, Log-Lik: -1857.977, Max-Change: 1.06368Iteration: 3, Log-Lik: -1851.953, Max-Change: 0.51969Iteration: 4, Log-Lik: -1850.342, Max-Change: 0.39739Iteration: 5, Log-Lik: -1849.677, Max-Change: 0.36882Iteration: 6, Log-Lik: -1849.310, Max-Change: 0.28693Iteration: 7, Log-Lik: -1848.888, Max-Change: 0.02783Iteration: 8, Log-Lik: -1848.869, Max-Change: 0.03110Iteration: 9, Log-Lik: -1848.859, Max-Change: 0.02375Iteration: 10, Log-Lik: -1848.841, Max-Change: 0.00741Iteration: 11, Log-Lik: -1848.836, Max-Change: 0.00629Iteration: 12, Log-Lik: -1848.834, Max-Change: 0.00579Iteration: 13, Log-Lik: -1848.824, Max-Change: 0.00324Iteration: 14, Log-Lik: -1848.823, Max-Change: 0.00250Iteration: 15, Log-Lik: -1848.823, Max-Change: 0.00231Iteration: 16, Log-Lik: -1848.822, Max-Change: 0.00161Iteration: 17, Log-Lik: -1848.822, Max-Change: 0.00146Iteration: 18, Log-Lik: -1848.822, Max-Change: 0.00265Iteration: 19, Log-Lik: -1848.821, Max-Change: 0.00088Iteration: 20, Log-Lik: -1848.821, Max-Change: 0.00036Iteration: 21, Log-Lik: -1848.821, Max-Change: 0.00040Iteration: 22, Log-Lik: -1848.821, Max-Change: 0.00048Iteration: 23, Log-Lik: -1848.821, Max-Change: 0.00046Iteration: 24, Log-Lik: -1848.821, Max-Change: 0.00045Iteration: 25, Log-Lik: -1848.821, Max-Change: 0.00035Iteration: 26, Log-Lik: -1848.821, Max-Change: 0.00033Iteration: 27, Log-Lik: -1848.821, Max-Change: 0.00031Iteration: 28, Log-Lik: -1848.821, Max-Change: 0.00118Iteration: 29, Log-Lik: -1848.821, Max-Change: 0.00108Iteration: 30, Log-Lik: -1848.821, Max-Change: 0.00034Iteration: 31, Log-Lik: -1848.821, Max-Change: 0.00019Iteration: 32, Log-Lik: -1848.821, Max-Change: 0.00089Iteration: 33, Log-Lik: -1848.821, Max-Change: 0.00026Iteration: 34, Log-Lik: -1848.821, Max-Change: 0.00017Iteration: 35, Log-Lik: -1848.821, Max-Change: 0.00083Iteration: 36, Log-Lik: -1848.821, Max-Change: 0.00021Iteration: 37, Log-Lik: -1848.821, Max-Change: 0.00015Iteration: 38, Log-Lik: -1848.821, Max-Change: 0.00381Iteration: 39, Log-Lik: -1848.821, Max-Change: 0.00099Iteration: 40, Log-Lik: -1848.821, Max-Change: 0.00073Iteration: 41, Log-Lik: -1848.821, Max-Change: 0.00019Iteration: 42, Log-Lik: -1848.821, Max-Change: 0.00081Iteration: 43, Log-Lik: -1848.821, Max-Change: 0.00031Iteration: 44, Log-Lik: -1848.821, Max-Change: 0.00081Iteration: 45, Log-Lik: -1848.821, Max-Change: 0.00043Iteration: 46, Log-Lik: -1848.821, Max-Change: 0.00020Iteration: 47, Log-Lik: -1848.821, Max-Change: 0.00078Iteration: 48, Log-Lik: -1848.821, Max-Change: 0.00028Iteration: 49, Log-Lik: -1848.821, Max-Change: 0.00016Iteration: 50, Log-Lik: -1848.821, Max-Change: 0.00388Iteration: 51, Log-Lik: -1848.821, Max-Change: 0.00124Iteration: 52, Log-Lik: -1848.821, Max-Change: 0.00085Iteration: 53, Log-Lik: -1848.821, Max-Change: 0.00022Iteration: 54, Log-Lik: -1848.821, Max-Change: 0.00072Iteration: 55, Log-Lik: -1848.821, Max-Change: 0.00034Iteration: 56, Log-Lik: -1848.821, Max-Change: 0.00073Iteration: 57, Log-Lik: -1848.821, Max-Change: 0.00048Iteration: 58, Log-Lik: -1848.821, Max-Change: 0.00022Iteration: 59, Log-Lik: -1848.821, Max-Change: 0.00072Iteration: 60, Log-Lik: -1848.821, Max-Change: 0.00030Iteration: 61, Log-Lik: -1848.821, Max-Change: 0.00016Iteration: 62, Log-Lik: -1848.821, Max-Change: 0.00357Iteration: 63, Log-Lik: -1848.821, Max-Change: 0.00129Iteration: 64, Log-Lik: -1848.821, Max-Change: 0.00086Iteration: 65, Log-Lik: -1848.821, Max-Change: 0.00023Iteration: 66, Log-Lik: -1848.821, Max-Change: 0.00068Iteration: 67, Log-Lik: -1848.821, Max-Change: 0.00034Iteration: 68, Log-Lik: -1848.821, Max-Change: 0.00068Iteration: 69, Log-Lik: -1848.821, Max-Change: 0.00048Iteration: 70, Log-Lik: -1848.821, Max-Change: 0.00021Iteration: 71, Log-Lik: -1848.821, Max-Change: 0.00067Iteration: 72, Log-Lik: -1848.821, Max-Change: 0.00030Iteration: 73, Log-Lik: -1848.821, Max-Change: 0.00016Iteration: 74, Log-Lik: -1848.821, Max-Change: 0.00333Iteration: 75, Log-Lik: -1848.821, Max-Change: 0.00126Iteration: 76, Log-Lik: -1848.821, Max-Change: 0.00083Iteration: 77, Log-Lik: -1848.821, Max-Change: 0.00022Iteration: 78, Log-Lik: -1848.821, Max-Change: 0.00064Iteration: 79, Log-Lik: -1848.821, Max-Change: 0.00033Iteration: 80, Log-Lik: -1848.821, Max-Change: 0.00063Iteration: 81, Log-Lik: -1848.821, Max-Change: 0.00046Iteration: 82, Log-Lik: -1848.821, Max-Change: 0.00020Iteration: 83, Log-Lik: -1848.821, Max-Change: 0.00063Iteration: 84, Log-Lik: -1848.821, Max-Change: 0.00029Iteration: 85, Log-Lik: -1848.821, Max-Change: 0.00015Iteration: 86, Log-Lik: -1848.821, Max-Change: 0.00311Iteration: 87, Log-Lik: -1848.821, Max-Change: 0.00120Iteration: 88, Log-Lik: -1848.821, Max-Change: 0.00079Iteration: 89, Log-Lik: -1848.821, Max-Change: 0.00021Iteration: 90, Log-Lik: -1848.821, Max-Change: 0.00060Iteration: 91, Log-Lik: -1848.821, Max-Change: 0.00031Iteration: 92, Log-Lik: -1848.821, Max-Change: 0.00059Iteration: 93, Log-Lik: -1848.821, Max-Change: 0.00044Iteration: 94, Log-Lik: -1848.821, Max-Change: 0.00019Iteration: 95, Log-Lik: -1848.821, Max-Change: 0.00059Iteration: 96, Log-Lik: -1848.821, Max-Change: 0.00027Iteration: 97, Log-Lik: -1848.821, Max-Change: 0.00014Iteration: 98, Log-Lik: -1848.821, Max-Change: 0.00290Iteration: 99, Log-Lik: -1848.821, Max-Change: 0.00113Iteration: 100, Log-Lik: -1848.821, Max-Change: 0.00074Iteration: 101, Log-Lik: -1848.821, Max-Change: 0.00020Iteration: 102, Log-Lik: -1848.821, Max-Change: 0.00056Iteration: 103, Log-Lik: -1848.821, Max-Change: 0.00029Iteration: 104, Log-Lik: -1848.821, Max-Change: 0.00055Iteration: 105, Log-Lik: -1848.821, Max-Change: 0.00041Iteration: 106, Log-Lik: -1848.821, Max-Change: 0.00018Iteration: 107, Log-Lik: -1848.821, Max-Change: 0.00055Iteration: 108, Log-Lik: -1848.821, Max-Change: 0.00025Iteration: 109, Log-Lik: -1848.821, Max-Change: 0.00013Iteration: 110, Log-Lik: -1848.821, Max-Change: 0.00271Iteration: 111, Log-Lik: -1848.821, Max-Change: 0.00106Iteration: 112, Log-Lik: -1848.821, Max-Change: 0.00069Iteration: 113, Log-Lik: -1848.821, Max-Change: 0.00018Iteration: 114, Log-Lik: -1848.821, Max-Change: 0.00052Iteration: 115, Log-Lik: -1848.821, Max-Change: 0.00027Iteration: 116, Log-Lik: -1848.821, Max-Change: 0.00052Iteration: 117, Log-Lik: -1848.821, Max-Change: 0.00038Iteration: 118, Log-Lik: -1848.821, Max-Change: 0.00017Iteration: 119, Log-Lik: -1848.821, Max-Change: 0.00051Iteration: 120, Log-Lik: -1848.821, Max-Change: 0.00024Iteration: 121, Log-Lik: -1848.821, Max-Change: 0.00012Iteration: 122, Log-Lik: -1848.821, Max-Change: 0.00253Iteration: 123, Log-Lik: -1848.821, Max-Change: 0.00099Iteration: 124, Log-Lik: -1848.821, Max-Change: 0.00065Iteration: 125, Log-Lik: -1848.821, Max-Change: 0.00017Iteration: 126, Log-Lik: -1848.821, Max-Change: 0.00049Iteration: 127, Log-Lik: -1848.821, Max-Change: 0.00025Iteration: 128, Log-Lik: -1848.821, Max-Change: 0.00048Iteration: 129, Log-Lik: -1848.821, Max-Change: 0.00036Iteration: 130, Log-Lik: -1848.821, Max-Change: 0.00016Iteration: 131, Log-Lik: -1848.821, Max-Change: 0.00048Iteration: 132, Log-Lik: -1848.821, Max-Change: 0.00022Iteration: 133, Log-Lik: -1848.821, Max-Change: 0.00011Iteration: 134, Log-Lik: -1848.821, Max-Change: 0.00236Iteration: 135, Log-Lik: -1848.821, Max-Change: 0.00092Iteration: 136, Log-Lik: -1848.821, Max-Change: 0.00060Iteration: 137, Log-Lik: -1848.821, Max-Change: 0.00016Iteration: 138, Log-Lik: -1848.821, Max-Change: 0.00045Iteration: 139, Log-Lik: -1848.821, Max-Change: 0.00024Iteration: 140, Log-Lik: -1848.821, Max-Change: 0.00045Iteration: 141, Log-Lik: -1848.821, Max-Change: 0.00033Iteration: 142, Log-Lik: -1848.821, Max-Change: 0.00015Iteration: 143, Log-Lik: -1848.821, Max-Change: 0.00045Iteration: 144, Log-Lik: -1848.821, Max-Change: 0.00021Iteration: 145, Log-Lik: -1848.821, Max-Change: 0.00011Iteration: 146, Log-Lik: -1848.821, Max-Change: 0.00221Iteration: 147, Log-Lik: 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mirt(astro,1,"3PL") ->m3

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Max-Change: 0.00042Iteration: 292, Log-Lik: -1814.129, Max-Change: 0.00022Iteration: 293, Log-Lik: -1814.129, Max-Change: 0.00050Iteration: 294, Log-Lik: -1814.129, Max-Change: 0.00029Iteration: 295, Log-Lik: -1814.129, Max-Change: 0.00017Iteration: 296, Log-Lik: -1814.129, Max-Change: 0.00249Iteration: 297, Log-Lik: -1814.129, Max-Change: 0.00128Iteration: 298, Log-Lik: -1814.129, Max-Change: 0.00093Iteration: 299, Log-Lik: -1814.129, Max-Change: 0.00023Iteration: 300, Log-Lik: -1814.129, Max-Change: 0.00048Iteration: 301, Log-Lik: -1814.129, Max-Change: 0.00036Iteration: 302, Log-Lik: -1814.129, Max-Change: 0.00049Iteration: 303, Log-Lik: -1814.129, Max-Change: 0.00047Iteration: 304, Log-Lik: -1814.129, Max-Change: 0.00024Iteration: 305, Log-Lik: -1814.129, Max-Change: 0.00048Iteration: 306, Log-Lik: -1814.129, Max-Change: 0.00031Iteration: 307, Log-Lik: -1814.129, Max-Change: 0.00018Iteration: 308, Log-Lik: -1814.129, Max-Change: 0.00241Iteration: 309, Log-Lik: -1814.129, Max-Change: 0.00134Iteration: 310, Log-Lik: -1814.129, Max-Change: 0.00096Iteration: 311, Log-Lik: -1814.129, Max-Change: 0.00024Iteration: 312, Log-Lik: -1814.129, Max-Change: 0.00048Iteration: 313, Log-Lik: -1814.129, Max-Change: 0.00036Iteration: 314, Log-Lik: -1814.129, Max-Change: 0.00048Iteration: 315, Log-Lik: -1814.129, Max-Change: 0.00048Iteration: 316, Log-Lik: -1814.129, Max-Change: 0.00024Iteration: 317, Log-Lik: -1814.129, Max-Change: 0.00048Iteration: 318, Log-Lik: -1814.129, Max-Change: 0.00031Iteration: 319, Log-Lik: -1814.129, Max-Change: 0.00018Iteration: 320, Log-Lik: -1814.129, Max-Change: 0.00239Iteration: 321, Log-Lik: -1814.129, Max-Change: 0.00134Iteration: 322, Log-Lik: -1814.129, Max-Change: 0.00096Iteration: 323, Log-Lik: -1814.129, Max-Change: 0.00024Iteration: 324, Log-Lik: -1814.129, Max-Change: 0.00048Iteration: 325, Log-Lik: -1814.129, Max-Change: 0.00036Iteration: 326, Log-Lik: -1814.129, Max-Change: 0.00048Iteration: 327, Log-Lik: -1814.129, Max-Change: 0.00047Iteration: 328, Log-Lik: -1814.129, Max-Change: 0.00023Iteration: 329, Log-Lik: -1814.129, Max-Change: 0.00048Iteration: 330, Log-Lik: -1814.129, Max-Change: 0.00031Iteration: 331, Log-Lik: -1814.129, Max-Change: 0.00017Iteration: 332, Log-Lik: -1814.129, Max-Change: 0.00241Iteration: 333, Log-Lik: -1814.129, Max-Change: 0.00131Iteration: 334, Log-Lik: -1814.129, Max-Change: 0.00094Iteration: 335, Log-Lik: -1814.129, Max-Change: 0.00024Iteration: 336, Log-Lik: -1814.129, Max-Change: 0.00049Iteration: 337, Log-Lik: -1814.129, Max-Change: 0.00035Iteration: 338, Log-Lik: -1814.129, Max-Change: 0.00048Iteration: 339, Log-Lik: -1814.129, Max-Change: 0.00046Iteration: 340, Log-Lik: -1814.129, Max-Change: 0.00023Iteration: 341, Log-Lik: -1814.129, Max-Change: 0.00049Iteration: 342, Log-Lik: -1814.129, Max-Change: 0.00030Iteration: 343, Log-Lik: -1814.129, Max-Change: 0.00017Iteration: 344, Log-Lik: -1814.129, Max-Change: 0.00243Iteration: 345, Log-Lik: -1814.129, Max-Change: 0.00129Iteration: 346, Log-Lik: -1814.129, Max-Change: 0.00092Iteration: 347, Log-Lik: -1814.129, Max-Change: 0.00023Iteration: 348, Log-Lik: -1814.129, Max-Change: 0.00049Iteration: 349, Log-Lik: -1814.128, Max-Change: 0.00035Iteration: 350, Log-Lik: -1814.128, Max-Change: 0.00049Iteration: 351, Log-Lik: -1814.128, Max-Change: 0.00045Iteration: 352, Log-Lik: -1814.128, Max-Change: 0.00023Iteration: 353, Log-Lik: -1814.128, Max-Change: 0.00049Iteration: 354, Log-Lik: -1814.128, Max-Change: 0.00030Iteration: 355, Log-Lik: -1814.128, Max-Change: 0.00017Iteration: 356, Log-Lik: -1814.128, Max-Change: 0.00244Iteration: 357, Log-Lik: -1814.128, Max-Change: 0.00126Iteration: 358, Log-Lik: -1814.128, Max-Change: 0.00091Iteration: 359, Log-Lik: -1814.128, Max-Change: 0.00023Iteration: 360, Log-Lik: -1814.128, Max-Change: 0.00049Iteration: 361, Log-Lik: -1814.128, Max-Change: 0.00034Iteration: 362, Log-Lik: -1814.128, Max-Change: 0.00049Iteration: 363, Log-Lik: -1814.128, Max-Change: 0.00045Iteration: 364, Log-Lik: -1814.128, Max-Change: 0.00022Iteration: 365, Log-Lik: -1814.128, Max-Change: 0.00244Iteration: 366, Log-Lik: -1814.128, Max-Change: 0.00258Iteration: 367, Log-Lik: -1814.128, Max-Change: 0.00144Iteration: 368, Log-Lik: -1814.128, Max-Change: 0.00065Iteration: 369, Log-Lik: -1814.128, Max-Change: 0.00017Iteration: 370, Log-Lik: -1814.128, Max-Change: 0.00050Iteration: 371, Log-Lik: -1814.128, Max-Change: 0.00049Iteration: 372, Log-Lik: -1814.128, Max-Change: 0.00061Iteration: 373, Log-Lik: -1814.128, Max-Change: 0.00056Iteration: 374, Log-Lik: -1814.128, Max-Change: 0.00070Iteration: 375, Log-Lik: -1814.128, Max-Change: 0.00074Iteration: 376, Log-Lik: -1814.128, Max-Change: 0.00031Iteration: 377, Log-Lik: -1814.128, Max-Change: 0.00049Iteration: 378, Log-Lik: -1814.128, Max-Change: 0.00041Iteration: 379, Log-Lik: -1814.128, Max-Change: 0.00021Iteration: 380, Log-Lik: -1814.128, Max-Change: 0.00246Iteration: 381, Log-Lik: -1814.128, Max-Change: 0.00257Iteration: 382, Log-Lik: -1814.128, Max-Change: 0.00092Iteration: 383, Log-Lik: -1814.128, Max-Change: 0.00035Iteration: 384, Log-Lik: -1814.128, Max-Change: 0.00048Iteration: 385, Log-Lik: -1814.128, Max-Change: 0.00047Iteration: 386, Log-Lik: -1814.128, Max-Change: 0.00058Iteration: 387, Log-Lik: -1814.128, Max-Change: 0.00061Iteration: 388, Log-Lik: -1814.128, Max-Change: 0.00028Iteration: 389, Log-Lik: -1814.128, Max-Change: 0.00049Iteration: 390, Log-Lik: -1814.128, Max-Change: 0.00036Iteration: 391, Log-Lik: -1814.128, Max-Change: 0.00019Iteration: 392, Log-Lik: -1814.128, Max-Change: 0.00245Iteration: 393, Log-Lik: -1814.128, Max-Change: 0.00144Iteration: 394, Log-Lik: -1814.128, Max-Change: 0.00097Iteration: 395, Log-Lik: -1814.128, Max-Change: 0.00024Iteration: 396, Log-Lik: -1814.128, Max-Change: 0.00049Iteration: 397, Log-Lik: -1814.128, Max-Change: 0.00035Iteration: 398, Log-Lik: -1814.128, Max-Change: 0.00049Iteration: 399, Log-Lik: -1814.128, Max-Change: 0.00047Iteration: 400, Log-Lik: -1814.128, Max-Change: 0.00023Iteration: 401, Log-Lik: -1814.128, Max-Change: 0.00049Iteration: 402, Log-Lik: -1814.128, Max-Change: 0.00030Iteration: 403, Log-Lik: -1814.128, Max-Change: 0.00016Iteration: 404, Log-Lik: -1814.128, Max-Change: 0.00246Iteration: 405, Log-Lik: -1814.128, Max-Change: 0.00124Iteration: 406, Log-Lik: -1814.128, Max-Change: 0.00088Iteration: 407, Log-Lik: -1814.128, Max-Change: 0.00022Iteration: 408, Log-Lik: -1814.128, Max-Change: 0.00049Iteration: 409, Log-Lik: -1814.128, Max-Change: 0.00033Iteration: 410, Log-Lik: -1814.128, Max-Change: 0.00049Iteration: 411, Log-Lik: -1814.128, Max-Change: 0.00043Iteration: 412, Log-Lik: -1814.128, Max-Change: 0.00021Iteration: 413, Log-Lik: -1814.128, Max-Change: 0.00049Iteration: 414, Log-Lik: -1814.128, Max-Change: 0.00028Iteration: 415, Log-Lik: -1814.128, Max-Change: 0.00016Iteration: 416, Log-Lik: -1814.128, Max-Change: 0.00247Iteration: 417, Log-Lik: -1814.128, Max-Change: 0.00119Iteration: 418, Log-Lik: -1814.128, Max-Change: 0.00086Iteration: 419, Log-Lik: -1814.128, Max-Change: 0.00021Iteration: 420, Log-Lik: -1814.128, Max-Change: 0.00049Iteration: 421, Log-Lik: -1814.128, Max-Change: 0.00032Iteration: 422, Log-Lik: -1814.128, Max-Change: 0.00049Iteration: 423, Log-Lik: -1814.128, Max-Change: 0.00042Iteration: 424, Log-Lik: -1814.128, Max-Change: 0.00021Iteration: 425, Log-Lik: -1814.128, Max-Change: 0.00247Iteration: 426, Log-Lik: -1814.128, Max-Change: 0.00258Iteration: 427, Log-Lik: -1814.128, Max-Change: 0.00135Iteration: 428, Log-Lik: -1814.128, Max-Change: 0.00011

m1

##   
## Call:  
## mirt(data = astro, model = 1, itemtype = "Rasch")  
##   
## Full-information item factor analysis with 1 factor(s).  
## Converged within 1e-04 tolerance after 11 EM iterations.  
## mirt version: 1.42   
## M-step optimizer: nlminb   
## EM acceleration: Ramsay   
## Number of rectangular quadrature: 61  
## Latent density type: Gaussian   
##   
## Log-likelihood = -1914.859  
## Estimated parameters: 28   
## AIC = 3885.717  
## BIC = 3966.008; SABIC = 3877.45  
## G2 (134217699) = 2566.93, p = 1  
## RMSEA = 0, CFI = NaN, TLI = NaN

m2

##   
## Call:  
## mirt(data = astro, model = 1, itemtype = "2PL")  
##   
## Full-information item factor analysis with 1 factor(s).  
## Converged within 1e-04 tolerance after 157 EM iterations.  
## mirt version: 1.42   
## M-step optimizer: BFGS   
## EM acceleration: Ramsay   
## Number of rectangular quadrature: 61  
## Latent density type: Gaussian   
##   
## Log-likelihood = -1848.821  
## Estimated parameters: 54   
## AIC = 3805.642  
## BIC = 3960.489; SABIC = 3789.698  
## G2 (134217673) = 2434.86, p = 1  
## RMSEA = 0, CFI = NaN, TLI = NaN

m3

##   
## Call:  
## mirt(data = astro, model = 1, itemtype = "3PL")  
##   
## Full-information item factor analysis with 1 factor(s).  
## Converged within 1e-04 tolerance after 428 EM iterations.  
## mirt version: 1.42   
## M-step optimizer: BFGS   
## EM acceleration: Ramsay   
## Number of rectangular quadrature: 61  
## Latent density type: Gaussian   
##   
## Log-likelihood = -1814.128  
## Estimated parameters: 81   
## AIC = 3790.256  
## BIC = 4022.526; SABIC = 3766.341  
## G2 (134217646) = 2365.47, p = 1  
## RMSEA = 0, CFI = NaN, TLI = NaN

The 3PL has the highest log likelihood among the three item types indicating that it (3PL) fits the data better. Based on AIC, 3PL has the lowest among the three items indicating that it (3PL) provides the best tradeoff between fit and complexity. Based on BIC, 2PL has the lowest BIC. In conclusion, 3PL is the best choice based on Likelihood and AIC as it provides the best fit. However, considering the penalty for complexity in the 3PL, we would choose 2PL as it provides a balance between fit and simplicity.

#b

# get the item parameters (coefficients)  
coef(m2,IRTpars=T,simplify=T)

## $items  
## a b g u  
## V1 0.667 2.189 0 1  
## V2 1.045 0.413 0 1  
## V3 1.134 -0.835 0 1  
## V4 1.398 -1.126 0 1  
## V5 1.386 -0.554 0 1  
## V6 -1.280 -2.293 0 1  
## V7 0.957 0.016 0 1  
## V8 1.835 -0.923 0 1  
## V9 0.430 -0.006 0 1  
## V10 3.339 -0.799 0 1  
## V11 1.155 -1.492 0 1  
## V12 0.576 0.571 0 1  
## V13 1.626 -0.461 0 1  
## V14 1.118 -0.621 0 1  
## V15 0.309 0.405 0 1  
## V16 5.783 -1.355 0 1  
## V17 1.047 -0.533 0 1  
## V18 2.180 -0.676 0 1  
## V19 1.418 1.056 0 1  
## V20 1.750 -0.587 0 1  
## V21 1.405 -1.240 0 1  
## V22 1.585 -0.324 0 1  
## V23 1.730 -0.209 0 1  
## V24 0.660 1.714 0 1  
## V25 1.863 -0.285 0 1  
## V26 0.955 1.325 0 1  
## V27 0.391 2.340 0 1  
##   
## $means  
## F1   
## 0   
##   
## $cov  
## F1  
## F1 1

Assignment 1’s problem has manifested here because, item 6 has a negative discrimination value (-1.280) which is in contrast to the positive correlations of the other items. This could arise because the item may have been incorrectly scored or the wrong answer may have been incorrectly scored correct. Items 10 (3.339) and item 16 (5.783) are suspiciously large. Meaning these values are above 3. The possible reason could be that the said items may be too sensitive to changes in ability and might overfit.

#Question 2c

mirt(astro[,-c(6,16)],1,itemtype="Rasch")-> m1

## Iteration: 1, Log-Lik: -1837.767, Max-Change: 0.08883Iteration: 2, Log-Lik: -1837.393, Max-Change: 0.04176Iteration: 3, Log-Lik: -1837.312, Max-Change: 0.01989Iteration: 4, Log-Lik: -1837.294, Max-Change: 0.00920Iteration: 5, Log-Lik: -1837.290, Max-Change: 0.00430Iteration: 6, Log-Lik: -1837.288, Max-Change: 0.00202Iteration: 7, Log-Lik: -1837.287, Max-Change: 0.00109Iteration: 8, Log-Lik: -1837.287, Max-Change: 0.00067Iteration: 9, Log-Lik: -1837.287, Max-Change: 0.00051Iteration: 10, Log-Lik: -1837.286, Max-Change: 0.00036Iteration: 11, Log-Lik: -1837.286, Max-Change: 0.00013Iteration: 12, Log-Lik: -1837.286, Max-Change: 0.00011Iteration: 13, Log-Lik: -1837.286, Max-Change: 0.00003

mirt(astro[,-c(6,16)],1,itemtype="2PL")-> m2

## Iteration: 1, Log-Lik: -1841.782, Max-Change: 0.81459Iteration: 2, Log-Lik: -1804.793, Max-Change: 0.54013Iteration: 3, Log-Lik: -1799.662, Max-Change: 0.36547Iteration: 4, Log-Lik: -1798.209, Max-Change: 0.24377Iteration: 5, Log-Lik: -1797.591, Max-Change: 0.18069Iteration: 6, Log-Lik: -1797.305, Max-Change: 0.12827Iteration: 7, Log-Lik: -1797.047, Max-Change: 0.03154Iteration: 8, Log-Lik: -1797.029, Max-Change: 0.02802Iteration: 9, Log-Lik: -1797.019, Max-Change: 0.01280Iteration: 10, Log-Lik: -1797.011, Max-Change: 0.01023Iteration: 11, Log-Lik: -1797.007, Max-Change: 0.01547Iteration: 12, Log-Lik: -1797.004, Max-Change: 0.00624Iteration: 13, Log-Lik: -1797.003, Max-Change: 0.00389Iteration: 14, Log-Lik: -1797.001, Max-Change: 0.00327Iteration: 15, Log-Lik: -1797.000, Max-Change: 0.00293Iteration: 16, Log-Lik: -1796.996, Max-Change: 0.00116Iteration: 17, Log-Lik: -1796.996, Max-Change: 0.00102Iteration: 18, Log-Lik: -1796.996, Max-Change: 0.00090Iteration: 19, Log-Lik: -1796.995, Max-Change: 0.00017Iteration: 20, Log-Lik: -1796.995, Max-Change: 0.00019Iteration: 21, Log-Lik: -1796.995, Max-Change: 0.00017Iteration: 22, Log-Lik: -1796.995, Max-Change: 0.00009

mirt(astro[,-c(6,16)],1,itemtype="3PL")-> m3

## Iteration: 1, Log-Lik: -1861.182, Max-Change: 1.80379Iteration: 2, Log-Lik: -1794.362, Max-Change: 1.43715Iteration: 3, Log-Lik: -1780.589, Max-Change: 1.23293Iteration: 4, Log-Lik: -1774.488, Max-Change: 1.01193Iteration: 5, Log-Lik: -1771.268, Max-Change: 0.89155Iteration: 6, Log-Lik: -1769.373, Max-Change: 0.76781Iteration: 7, Log-Lik: -1767.718, Max-Change: 0.22077Iteration: 8, Log-Lik: -1765.966, Max-Change: 0.29253Iteration: 9, Log-Lik: -1765.858, Max-Change: 1.69911Iteration: 10, Log-Lik: -1765.679, Max-Change: 0.90137Iteration: 11, Log-Lik: -1765.607, Max-Change: 0.94702Iteration: 12, Log-Lik: -1765.550, Max-Change: 0.04104Iteration: 13, Log-Lik: -1765.548, Max-Change: 0.04120Iteration: 14, Log-Lik: -1765.524, Max-Change: 0.84638Iteration: 15, Log-Lik: -1765.481, Max-Change: 0.66973Iteration: 16, Log-Lik: -1765.378, Max-Change: 0.69882Iteration: 17, Log-Lik: -1765.350, Max-Change: 0.02140Iteration: 18, Log-Lik: -1765.341, Max-Change: 0.06670Iteration: 19, Log-Lik: -1765.329, Max-Change: 0.03697Iteration: 20, Log-Lik: -1765.322, Max-Change: 0.02904Iteration: 21, Log-Lik: -1765.317, Max-Change: 0.02402Iteration: 22, Log-Lik: -1765.309, Max-Change: 0.03069Iteration: 23, Log-Lik: -1765.304, Max-Change: 0.02149Iteration: 24, Log-Lik: -1765.301, Max-Change: 0.02960Iteration: 25, Log-Lik: -1765.295, Max-Change: 0.02654Iteration: 26, Log-Lik: -1765.292, Max-Change: 0.03099Iteration: 27, Log-Lik: -1765.289, Max-Change: 0.83301Iteration: 28, Log-Lik: -1765.276, Max-Change: 0.01991Iteration: 29, Log-Lik: -1765.274, Max-Change: 0.01331Iteration: 30, Log-Lik: -1765.272, Max-Change: 0.01618Iteration: 31, Log-Lik: -1765.268, Max-Change: 0.01168Iteration: 32, Log-Lik: -1765.266, Max-Change: 0.00466Iteration: 33, Log-Lik: -1765.266, Max-Change: 0.01592Iteration: 34, Log-Lik: -1765.265, Max-Change: 0.01561Iteration: 35, Log-Lik: -1765.264, Max-Change: 0.00645Iteration: 36, Log-Lik: -1765.263, Max-Change: 0.00856Iteration: 37, Log-Lik: -1765.262, Max-Change: 0.00423Iteration: 38, Log-Lik: -1765.261, Max-Change: 0.00500Iteration: 39, Log-Lik: -1765.261, Max-Change: 0.00124Iteration: 40, Log-Lik: -1765.261, Max-Change: 0.00592Iteration: 41, Log-Lik: -1765.261, Max-Change: 0.00121Iteration: 42, Log-Lik: -1765.260, Max-Change: 0.01041Iteration: 43, Log-Lik: -1765.260, Max-Change: 0.00128Iteration: 44, Log-Lik: -1765.260, Max-Change: 0.00257Iteration: 45, Log-Lik: -1765.260, Max-Change: 0.00350Iteration: 46, Log-Lik: -1765.260, Max-Change: 0.00246Iteration: 47, Log-Lik: -1765.259, Max-Change: 0.00411Iteration: 48, Log-Lik: -1765.259, Max-Change: 0.00039Iteration: 49, Log-Lik: -1765.259, Max-Change: 0.00034Iteration: 50, Log-Lik: -1765.259, Max-Change: 0.00176Iteration: 51, Log-Lik: -1765.259, Max-Change: 0.00037Iteration: 52, Log-Lik: -1765.259, Max-Change: 0.00185Iteration: 53, Log-Lik: -1765.259, Max-Change: 0.01074Iteration: 54, Log-Lik: -1765.259, Max-Change: 0.00091Iteration: 55, Log-Lik: -1765.259, Max-Change: 0.00084Iteration: 56, 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Max-Change: 0.00049Iteration: 382, Log-Lik: -1765.233, Max-Change: 0.00024Iteration: 383, Log-Lik: -1765.233, Max-Change: 0.00067Iteration: 384, Log-Lik: -1765.233, Max-Change: 0.00032Iteration: 385, Log-Lik: -1765.233, Max-Change: 0.00018Iteration: 386, Log-Lik: -1765.233, Max-Change: 0.00334Iteration: 387, Log-Lik: -1765.233, Max-Change: 0.00136Iteration: 388, Log-Lik: -1765.233, Max-Change: 0.00097Iteration: 389, Log-Lik: -1765.232, Max-Change: 0.00025Iteration: 390, Log-Lik: -1765.232, Max-Change: 0.00067Iteration: 391, Log-Lik: -1765.232, Max-Change: 0.00037Iteration: 392, Log-Lik: -1765.232, Max-Change: 0.00067Iteration: 393, Log-Lik: -1765.232, Max-Change: 0.00049Iteration: 394, Log-Lik: -1765.232, Max-Change: 0.00024Iteration: 395, Log-Lik: -1765.232, Max-Change: 0.00067Iteration: 396, Log-Lik: -1765.232, Max-Change: 0.00032Iteration: 397, Log-Lik: -1765.232, Max-Change: 0.00018Iteration: 398, Log-Lik: -1765.232, Max-Change: 0.00334Iteration: 399, Log-Lik: -1765.232, Max-Change: 0.00136Iteration: 400, Log-Lik: -1765.232, Max-Change: 0.00097Iteration: 401, Log-Lik: -1765.232, Max-Change: 0.00025Iteration: 402, Log-Lik: -1765.232, Max-Change: 0.00067Iteration: 403, Log-Lik: -1765.232, Max-Change: 0.00037Iteration: 404, Log-Lik: -1765.232, Max-Change: 0.00067Iteration: 405, Log-Lik: -1765.232, Max-Change: 0.00049Iteration: 406, Log-Lik: -1765.232, Max-Change: 0.00024Iteration: 407, Log-Lik: -1765.232, Max-Change: 0.00067Iteration: 408, Log-Lik: -1765.232, Max-Change: 0.00032Iteration: 409, Log-Lik: -1765.232, Max-Change: 0.00018Iteration: 410, Log-Lik: -1765.232, Max-Change: 0.00333Iteration: 411, Log-Lik: -1765.232, Max-Change: 0.00136Iteration: 412, Log-Lik: -1765.232, Max-Change: 0.00097Iteration: 413, Log-Lik: -1765.232, Max-Change: 0.00024Iteration: 414, Log-Lik: -1765.232, Max-Change: 0.00067Iteration: 415, Log-Lik: -1765.232, Max-Change: 0.00037Iteration: 416, Log-Lik: -1765.232, Max-Change: 0.00067Iteration: 417, Log-Lik: -1765.232, Max-Change: 0.00049Iteration: 418, Log-Lik: -1765.232, Max-Change: 0.00024Iteration: 419, Log-Lik: -1765.232, Max-Change: 0.00067Iteration: 420, Log-Lik: -1765.232, Max-Change: 0.00032Iteration: 421, Log-Lik: -1765.232, Max-Change: 0.00018Iteration: 422, Log-Lik: -1765.232, Max-Change: 0.00333Iteration: 423, Log-Lik: -1765.232, Max-Change: 0.00135Iteration: 424, Log-Lik: -1765.232, Max-Change: 0.00097Iteration: 425, Log-Lik: -1765.232, Max-Change: 0.00024Iteration: 426, Log-Lik: -1765.232, Max-Change: 0.00067Iteration: 427, Log-Lik: -1765.232, Max-Change: 0.00037Iteration: 428, Log-Lik: -1765.232, Max-Change: 0.00067Iteration: 429, Log-Lik: -1765.232, Max-Change: 0.00049Iteration: 430, Log-Lik: -1765.232, Max-Change: 0.00024Iteration: 431, Log-Lik: -1765.232, Max-Change: 0.00067Iteration: 432, Log-Lik: -1765.232, Max-Change: 0.00032Iteration: 433, Log-Lik: -1765.232, Max-Change: 0.00018Iteration: 434, Log-Lik: -1765.232, Max-Change: 0.00333Iteration: 435, Log-Lik: -1765.232, Max-Change: 0.00135Iteration: 436, Log-Lik: -1765.232, Max-Change: 0.00097Iteration: 437, Log-Lik: -1765.232, Max-Change: 0.00024Iteration: 438, Log-Lik: -1765.232, Max-Change: 0.00067Iteration: 439, Log-Lik: -1765.232, Max-Change: 0.00037Iteration: 440, Log-Lik: -1765.232, Max-Change: 0.00067Iteration: 441, Log-Lik: -1765.232, Max-Change: 0.00049Iteration: 442, Log-Lik: -1765.232, Max-Change: 0.00024Iteration: 443, Log-Lik: -1765.232, Max-Change: 0.00067Iteration: 444, Log-Lik: -1765.232, Max-Change: 0.00032Iteration: 445, Log-Lik: -1765.232, Max-Change: 0.00018Iteration: 446, Log-Lik: -1765.232, Max-Change: 0.00333Iteration: 447, Log-Lik: -1765.232, Max-Change: 0.00135Iteration: 448, Log-Lik: -1765.232, Max-Change: 0.00096Iteration: 449, Log-Lik: -1765.232, Max-Change: 0.00024Iteration: 450, Log-Lik: -1765.232, Max-Change: 0.00067Iteration: 451, Log-Lik: -1765.232, Max-Change: 0.00037Iteration: 452, Log-Lik: -1765.232, Max-Change: 0.00067Iteration: 453, Log-Lik: -1765.232, Max-Change: 0.00049Iteration: 454, Log-Lik: -1765.232, Max-Change: 0.00024Iteration: 455, Log-Lik: -1765.232, Max-Change: 0.00067Iteration: 456, Log-Lik: -1765.232, Max-Change: 0.00032Iteration: 457, Log-Lik: -1765.232, Max-Change: 0.00018Iteration: 458, Log-Lik: -1765.232, Max-Change: 0.00333Iteration: 459, Log-Lik: -1765.232, Max-Change: 0.00135Iteration: 460, Log-Lik: -1765.232, Max-Change: 0.00096Iteration: 461, Log-Lik: -1765.232, Max-Change: 0.00024Iteration: 462, Log-Lik: -1765.232, Max-Change: 0.00067Iteration: 463, Log-Lik: -1765.232, Max-Change: 0.00037Iteration: 464, Log-Lik: -1765.232, Max-Change: 0.00067Iteration: 465, Log-Lik: -1765.232, Max-Change: 0.00049Iteration: 466, Log-Lik: -1765.232, Max-Change: 0.00024Iteration: 467, Log-Lik: -1765.232, Max-Change: 0.00067Iteration: 468, Log-Lik: -1765.232, Max-Change: 0.00032Iteration: 469, Log-Lik: -1765.232, Max-Change: 0.00018Iteration: 470, Log-Lik: -1765.232, Max-Change: 0.00333Iteration: 471, Log-Lik: -1765.232, Max-Change: 0.00135Iteration: 472, Log-Lik: -1765.232, Max-Change: 0.00096Iteration: 473, Log-Lik: -1765.232, Max-Change: 0.00024Iteration: 474, Log-Lik: -1765.232, Max-Change: 0.00067Iteration: 475, Log-Lik: -1765.232, Max-Change: 0.00037Iteration: 476, Log-Lik: -1765.232, Max-Change: 0.00067Iteration: 477, Log-Lik: -1765.232, Max-Change: 0.00049Iteration: 478, Log-Lik: -1765.232, Max-Change: 0.00024Iteration: 479, Log-Lik: -1765.232, Max-Change: 0.00067Iteration: 480, Log-Lik: -1765.232, Max-Change: 0.00032Iteration: 481, Log-Lik: -1765.232, Max-Change: 0.00018Iteration: 482, Log-Lik: -1765.232, Max-Change: 0.00333Iteration: 483, Log-Lik: -1765.232, Max-Change: 0.00135Iteration: 484, Log-Lik: -1765.232, Max-Change: 0.00096Iteration: 485, Log-Lik: -1765.232, Max-Change: 0.00024Iteration: 486, Log-Lik: -1765.232, Max-Change: 0.00067Iteration: 487, Log-Lik: -1765.232, Max-Change: 0.00036Iteration: 488, Log-Lik: -1765.232, Max-Change: 0.00067Iteration: 489, Log-Lik: -1765.232, Max-Change: 0.00049Iteration: 490, Log-Lik: -1765.232, Max-Change: 0.00024Iteration: 491, Log-Lik: -1765.232, Max-Change: 0.00067Iteration: 492, Log-Lik: -1765.232, Max-Change: 0.00032Iteration: 493, Log-Lik: -1765.232, Max-Change: 0.00018Iteration: 494, Log-Lik: -1765.232, Max-Change: 0.00333Iteration: 495, Log-Lik: -1765.232, Max-Change: 0.00134Iteration: 496, Log-Lik: -1765.232, Max-Change: 0.00096Iteration: 497, Log-Lik: -1765.232, Max-Change: 0.00024Iteration: 498, Log-Lik: -1765.232, Max-Change: 0.00067Iteration: 499, Log-Lik: -1765.232, Max-Change: 0.00036Iteration: 500, Log-Lik: -1765.232, Max-Change: 0.00066

## Warning in EM.group(pars = pars, constrain = constrain, Ls = Ls, PrepList =  
## PrepList, : EM cycles terminated after 500 iterations.

m1

##   
## Call:  
## mirt(data = astro[, -c(6, 16)], model = 1, itemtype = "Rasch")  
##   
## Full-information item factor analysis with 1 factor(s).  
## Converged within 1e-04 tolerance after 13 EM iterations.  
## mirt version: 1.42   
## M-step optimizer: nlminb   
## EM acceleration: Ramsay   
## Number of rectangular quadrature: 61  
## Latent density type: Gaussian   
##   
## Log-likelihood = -1837.286  
## Estimated parameters: 26   
## AIC = 3726.573  
## BIC = 3801.129; SABIC = 3718.896  
## G2 (33554405) = 2411.79, p = 1  
## RMSEA = 0, CFI = NaN, TLI = NaN

m2

##   
## Call:  
## mirt(data = astro[, -c(6, 16)], model = 1, itemtype = "2PL")  
##   
## Full-information item factor analysis with 1 factor(s).  
## Converged within 1e-04 tolerance after 22 EM iterations.  
## mirt version: 1.42   
## M-step optimizer: BFGS   
## EM acceleration: Ramsay   
## Number of rectangular quadrature: 61  
## Latent density type: Gaussian   
##   
## Log-likelihood = -1796.995  
## Estimated parameters: 50   
## AIC = 3693.991  
## BIC = 3837.367; SABIC = 3679.228  
## G2 (33554381) = 2331.2, p = 1  
## RMSEA = 0, CFI = NaN, TLI = NaN

m3

##   
## Call:  
## mirt(data = astro[, -c(6, 16)], model = 1, itemtype = "3PL")  
##   
## Full-information item factor analysis with 1 factor(s).  
## FAILED TO CONVERGE within 1e-04 tolerance after 500 EM iterations.  
## mirt version: 1.42   
## M-step optimizer: BFGS   
## EM acceleration: Ramsay   
## Number of rectangular quadrature: 61  
## Latent density type: Gaussian   
##   
## Log-likelihood = -1765.232  
## Estimated parameters: 75   
## AIC = 3680.464  
## BIC = 3895.529; SABIC = 3658.32  
## G2 (33554356) = 2267.68, p = 1  
## RMSEA = 0, CFI = NaN, TLI = NaN

Rerunning part a and excluding the data for items 6 and 16, Rasch model (1PL) had the lowest BIC among the 3 logistic models. This means that the Rasch model is the preferred one interms of BIC.

#Question 2d

astromod1PL <- mirt(astro,1,"Rasch")

## Iteration: 1, Log-Lik: -1915.038, Max-Change: 0.09593Iteration: 2, Log-Lik: -1914.886, Max-Change: 0.01964Iteration: 3, Log-Lik: -1914.866, Max-Change: 0.00910Iteration: 4, Log-Lik: -1914.861, Max-Change: 0.00415Iteration: 5, Log-Lik: -1914.860, Max-Change: 0.00194Iteration: 6, Log-Lik: -1914.859, Max-Change: 0.00088Iteration: 7, Log-Lik: -1914.859, Max-Change: 0.00057Iteration: 8, Log-Lik: -1914.859, Max-Change: 0.00041Iteration: 9, Log-Lik: -1914.859, Max-Change: 0.00028Iteration: 10, Log-Lik: -1914.859, Max-Change: 0.00015Iteration: 11, Log-Lik: -1914.859, Max-Change: 0.00009

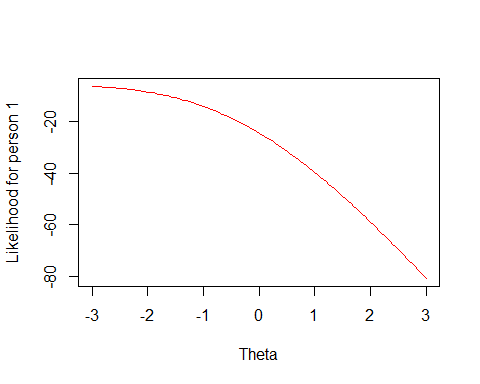
astrops<-coef(astromod1PL,simplify=T, IRTpars=T)$items[,1:3]  
  
head(fscores(astromod1PL, method="ML"))

## F1  
## [1,] -3.265955  
## [2,] -2.389276  
## [3,] -1.807100  
## [4,] -1.807100  
## [5,] -1.807100  
## [6,] -1.807100

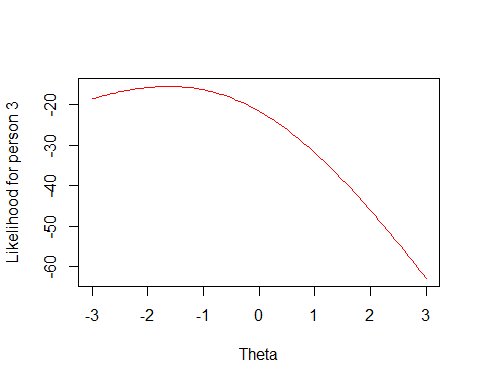
The theta estimate for the first person is estimatedly (-3.27) which means person 1 has a very low ability level compared to the others. The theta estimate for the third person is estimatedly (-1.81) which also signifies a low ability level but not as severe as person 1.

#Question 2e

itemparams<-coef(m1,simplify=T,IRTpars=T)$items[,1:3]  
  
resp\_vec1<-as.numeric(astro[1,-c(6,16)])  
resp\_vec3<-as.numeric(astro[3,-c(6,16)])  
  
getloglike(25,itemparams,resp\_vec1)->logl1  
getloglike(25,itemparams,resp\_vec3)->logl3  
  
  
plot(seq(-3,3,.05),logl1, type="l",col="red",ylab="Likelihood for person 1",xlab="Theta")

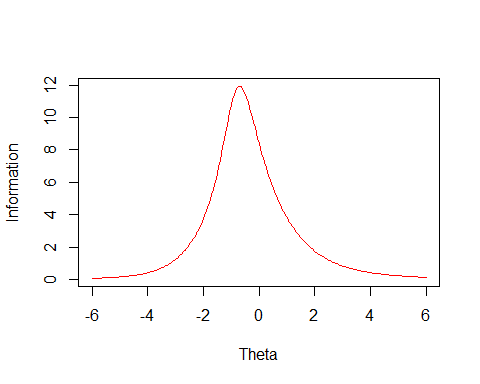


plot(seq(-3,3,.05),logl3, type="l",col="red",ylab="Likelihood for person 3",xlab="Theta")

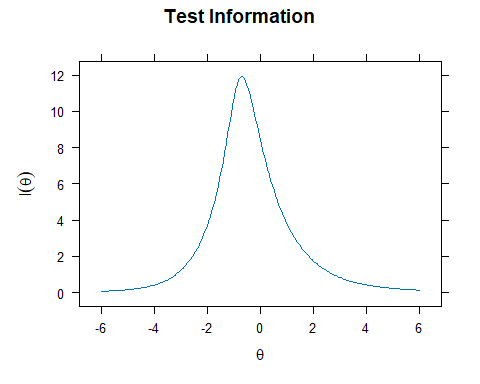
 From the plots, the peak for person one reflects the value/ability from d,which is around -3.3 and the peak for person 3 also reflects the value/ability from d which is -1.8 where the curve gets to the maximum and starts declining.

#Question 2f

infogrid <- function(nitems,params) {  
   
 info<-array(0,c(241,nitems))  
   
 theta<-seq(-6,6,.05)  
   
 for (j in 1:nitems) {  
   
 temp<- params[j,1]\*(theta - params[j,2])  
   
 p <- params[j,3] + (1-params[j,3])/(1 + exp(-temp))  
   
 info[,j]<-params[j,1]^2\*(1-params[j,3])/((params[j,3] + exp(temp))\*(1 + exp(-temp))\*(1 + exp(-temp)))  
   
 }  
   
 info  
}  
  
coef(m2,simplify=T,IRTpars=T)$items[,1:3] ->itemparams  
infogrid(25,itemparams)->testinfo  
  
plot(seq(-6,6,.05),apply(testinfo,1,sum),type="l",col="red",xlab="Theta",ylab="Information")



# Plot the test information using the built-in plot function  
plot(m2, type = "info")



The test information function for the 2PL without items 6 and 16 have the peak of the curve at the ability/theta level (around -1) simillar to that of the test information for the model (m2) signifying that that theta level provide the most information on the ability levels of the test takers. Both have peak heights around 16 as well.

Both tests also provide information across a wider range of ability levels (-6 to 6).They both show simillar patterns.