Lab 9 Some Basic Item Response Theory (IRT) Analyses

The data set for this lab is the same as for the last lab, adaexam.sav (available on the data page: https://web.pdx.edu/~newsomj/data.htm).

SPSS

Plots for Item Characteristic Curves (ICC)

Menus

Conduct a Logistic Regression. The first step is the obtain results from a logistic regression with the scale score predicting one of the items. I will use item Question 2 (q2).

Analyze -> Regression -> Binary logistic
Move over item `q2` to the *Dependent* box. Then move over `mctotal` to the *Covariates* box.

Compute the probability using the logistic regression equation. Go to *Transform -> Compute Variable*. Then add a new variable such as (`px`) the Target Variable box. Under *Numeric Expression*, add `exp(.222*(mctotal - (-3.542)))/(1 + exp(.222*(mctotal - (-3.542))))` It is best to just copy this! Click on *OK*.

The equation is the same as the two parameter IRT equation:

$$P\left(X_{is}=1\right)=\frac{e^{\left(\alpha_i(\theta_s-\beta_i)\right)}}{1+e^{\left(\alpha_i(\theta_s-\beta_i)\right)}}$$

The -3.542 is the constant and .22 is the slope coefficient for `mctotal` from the logistic regression results.

Graphs -> Scatter/Dot…
Choose *Simple Scatter*
Move over the probability score (I called my `px`) to the Y axis box
Move over the `mctotal` score to the X axis box.
Click OK and a scatterplot will be generated

Add the line for the ICC. Double click on the scatterplot. This time choose *Elements -> Fit line at subgroups* choose *Cubic*, Click *Apply*, then exit chart.

Syntax

```
logistic regression vars=q1 with mctotal
     /print=summary ci(95) iter(1).

COMPUTE px = EXP(.222*(mctotal - (-3.542)))/(1 + EXP(.222*(mctotal - (-3.542)))).

GGRAPH
  /GRAPHDATASET NAME="graphdataset" VARIABLES=px mctotal
  /GRAPHSPEC SOURCE=INLINE.
BEGIN GPL
 SOURCE: s=userSource(id("graphdataset"))
  DATA: px=col(source(s), name("px"))
 DATA: mctotal=col(source(s), name("mctotal"))
    GUIDE: axis(dim(1), label("mctotal score"))
    GUIDE: axis(dim(2), label("Q2 Proportion Correct"))
  ELEMENT:  line(position(smooth.cubic(mctotal* px)))
END GPL.
```

Note: you can also generate a scatterplot with syntax and then follow the menu method described above by clicking on the graph in the output.

```
GRAPH
  /SCATTERPLOT(BIVAR)=px WITH mctotal.
```

ICCs by Group

Menus

Graphs -> Scatter/Dot…
Choose *Simple Scatter*
Move over the probability score (I called my `px` before) to the Y axis box
Move over the `mctotal` score to the X axis box.
This time add gender to the ***Set Markers by****:* box.
Click OK and a scatterplot will be generated

Double click on the scatterplot. This time choose *Elements -> **Fit line at subgroups*** choose *Cubic*, Click *Apply*, then exit chart.

R

This is code using the mirt package from R, which does full IRT analysis, including generating ICC plots.

IRT Parameters

```
library(lessR)
#you will need to change your location
d = Read("C:/Jason/SPSSWIN/pmclass/adaexam.sav", quiet=TRUE)

#variables need to be numeric, but they are factors in this data set
d$q1 <- as.numeric(d$q1)
d$q2 <- as.numeric(d$q2)
d$q3 <- as.numeric(d$q3)
d$q4 <- as.numeric(d$q4)
d$q5 <- as.numeric(d$q5)
d$q6 <- as.numeric(d$q6)
d$q7 <- as.numeric(d$q7)
d$q8 <- as.numeric(d$q8)
d$q9 <- as.numeric(d$q9)
d$q10 <- as.numeric(d$q10)

#create new data frame with just the 10 questions
d2 <- subset(d, select=c(q1,q2,q3,q4,q5,q6,q7,q8,q9,q10))

library(mirt)
irtmod <- mirt(data = d2, model = 1, itemtype = "2PL")
summary(irtmod)
print(irtmod)
coef(irtmod, IRTpars = TRUE)
```

ICC Plots

```
#item plots allowed one at a time using item number, trace is ICC and info is information
#the number 1 is for the first item
itemplot(irtmod,1,type="trace")

#you can print all plots at once with code like this, where 1:ncol(d) cycles through item 1 to item 10)
for(i in 1:ncol(d)) {
  print(itemplot(irtmod,i,type ="trace"))

}
```

By Group

Note that these analyses and plots were not possible for this data set because there were too few students and some items had all correct or all incorrect scores.

```
male <- d[.(gender==0), .(q1,q2,q3,q4,q5,q6,q7,q8,q9,q10)]

library(mirt)
mirtmod <- mirt(data = male, model = 1, itemtype = "2PL")
summary(mirtmod)
print(mirtmod)
coef(mirtmod, IRTpars = TRUE)
#produces plot for the expected score of the total scale
plot(mirtmod)
#item plots allowed one at a time using item number, trace is ICC and info is information
#the number 1 is for the first item
itemplot(mirtmod,1,type="trace")


female <- d[.(gender==1), .(q1:q10)]
library(mirt)
firtmod <- mirt(data = female, model = 1, itemtype = "2PL")
summary(firtmod)
print(firtmod)
coef(firtmod, IRTpars = TRUE)
#produces plot for the expected score of the total scale
plot(firtmod)
#item plots allowed one at a time using item number, trace is ICC and info is information
#the number 1 is for the first item
itemplot(firtmod,1,type="trace")
```

A more elegant way to do this is to create two formal groups. The plots will then overlay the ICCs for each group for each item. This too has problems and won't run for this data set because of some items with all correct or all incorrect items withing groups.

```
d <- d[order(d$gender),]
#note that the numbers 7 and 15 are the Ns for each group
group <- c(rep('D1', 7), rep('D2', 15))

#create new data frame with just the 10 questions
d2 <- subset(d, select=c(q1,q2,q3,q4,q5,q6,q7,q8,q9,q10))

library(mirt)
irtmod1 <- multipleGroup(d2, model = 1, group = group)
irtmod2 <- multipleGroup(d2, model = 1, group  = group, invariance = c('slopes'))
anova(irtmod1,irtmod2)
itemplot(irtmod1,1,type="trace")
```