Group Search pt.2

This is a continuation of various methods that have been proposed in the last 10 years for searching for subgroups, either observed or unobserved, in the dataset. Most of these are in relation to measurement invariance of differential item functioning.

Strucchange

Easier to understand article:

http://journal.frontiersin.org/article/10.3389/fpsyg.2014.00438/abstract

More papers at Edgar Merkle's site:

http://semtools.r-forge.r-project.org/

estimation method depends on what type of covariate you have.

Need two new packages

```
library(psychotools)
library(OpenMx)
library(strucchange)
library(lavaan)
HS <- HolzingerSwineford1939
```

The One Factor Model from before

```
model1.lav <- '
F1 =~ x1 + x2 + x3 + x4 + x5 + x6 + x7 + x8 + x9
'
lav.fit <- cfa(model1.lav, HS,meanstructure=T)
#summary(lav.fit,fit=T)
```

Has problems with missing data, so can only use complete cases (BTW, no missing in HS, but for demo purposes)

```
comp <- complete.cases(HS)
HS.comp <- HS[comp,]
```

Test for continuous covariates: 1. "DM" 2. "CvM" 3. "maxLM"

Test for ordinal covariates: (note, takes much much longer – similar to semtree with ordinal) 1. "maxLMo" 2. "WDMo"

Lets run it – starting with no restrictions and searching

```
# can't run, not large enough sample size for 6 groups
#lav.fitGroup1 <- cfa(model1.lav, HS,meanstructure=T,group="ageyr",
#                      group.equal="loadings")


sctest(lav.fit, order.by = HS.comp$ageyr, parm = 1:8,
```

```r
         vcov = "info", functional = "maxLMo",plot=T)


sctest(lav.fit, order.by = HS.comp$ageyr,
                            parm = 1:8, vcov = "info",
                            functional = "WDMo",plot=T)
```

```r
lav.fitGroup2 <- cfa(model1.lav, HS.comp,meanstructure=T,group="school",
                    group.equal=c("loadings","intercepts"))

#summary(lav.fitGroup2,fit=T)
anova(lav.fit,lav.fitGroup2)
```

```
## Chi Square Difference Test
##
##                Df    AIC    BIC  Chisq Chisq diff Df diff Pr(>Chisq)
## lav.fit       27 7756.4 7856.5 312.26
## lav.fitGroup2 70 7723.4 7864.2 422.00     109.73      43  9.536e-08 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

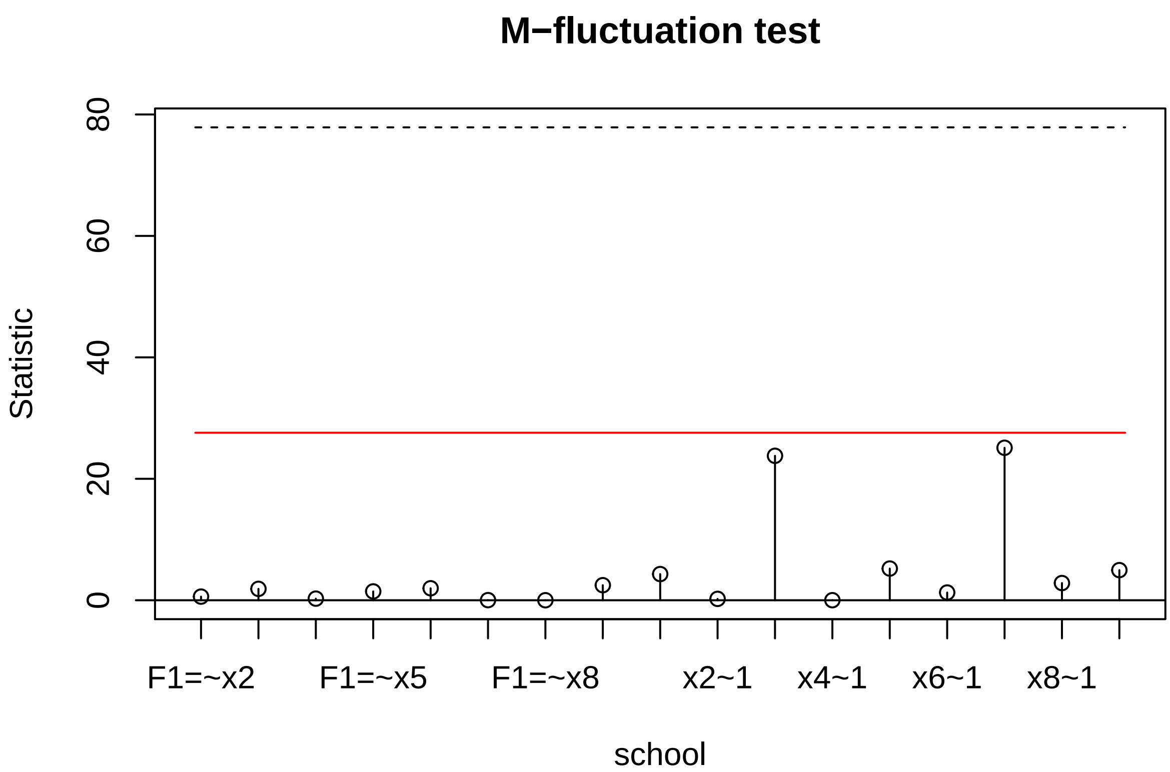
```r
# what are offending parameters
mod <- modindices(lav.fitGroup2)
mod[mod$op == "~1" & mod$mi > 10,]
```

```
##   lhs op rhs group     mi    epc sepc.lv sepc.all sepc.nox
## 1  x3 ~1         1 25.389  0.320   0.320    0.263    0.263
## 2  x7 ~1         1 24.437  0.306   0.306    0.275    0.275
## 3  x3 ~1         2 25.389 -0.320  -0.320   -0.311   -0.311
## 4  x7 ~1         2 24.437 -0.306  -0.306   -0.289   -0.289
```

2 Intercepts seem to be big problem

Do we get same answer with strucchange

```r
# get which parameters to fix:
# coef(lav.fitGroup2)
# intercepts 19:27
sctest(lav.fitGroup2, order.by = HS.comp$school,
                            parm = c(1:8,19:27), vcov = "info",
                            functional = "LMuo",plot=T)
```

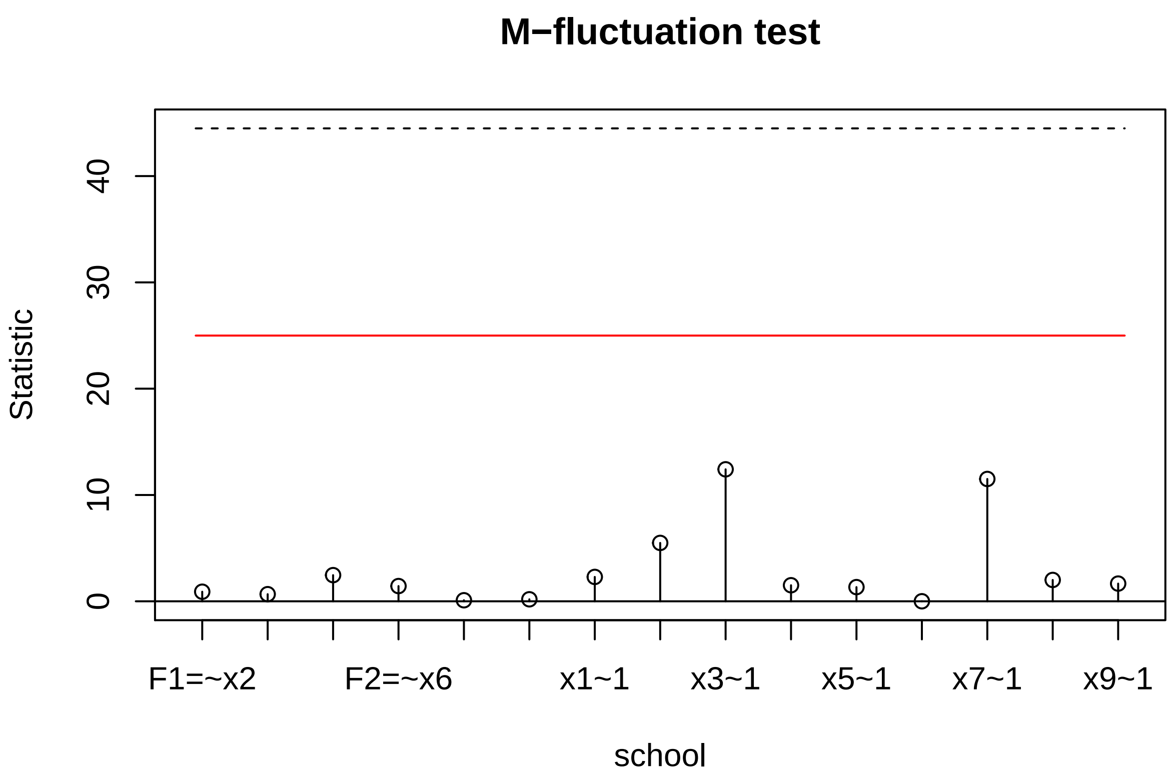



```
##
##  M-fluctuation test
##
## data:  lav.fitGroup2
## f(efp) = 77.877, p-value = 9.115e-10
```

```
# what if we change the model
model5.lav <- '
F1 =~ x1 + x2 + x3 # + x7 + x9
F2 =~ x4 + x5 + x6 # + x1
F3 =~ x7 + x8 + x9
'
lav.fitGroup5 <- cfa(model5.lav, HS,meanstructure=T,group="school",group.equal=c("loadings","intercepts
coef(lav.fitGroup5)
```

```
##     F1=~x2     F1=~x3     F2=~x5     F2=~x6     F3=~x8     F3=~x9     x1~~x1
##      0.576      0.798      1.120      0.932      1.130      1.009      0.555
##     x2~~x2     x3~~x3     x4~~x4     x5~~x5     x6~~x6     x7~~x7     x8~~x8
##      1.296      0.944      0.445      0.502      0.263      0.888      0.541
##     x9~~x9     F1~~F1     F2~~F2     F3~~F3     F1~~F2     F1~~F3     F2~~F3
##      0.654      0.796      0.879      0.322      0.410      0.178      0.180
##       x1~1       x2~1       x3~1       x4~1       x5~1       x6~1       x7~1
##      5.001      6.151      2.271      2.778      4.035      1.926      4.242
##       x8~1       x9~1 x1~~x1.g2 x2~~x2.g2 x3~~x3.g2 x4~~x4.g2 x5~~x5.g2
##      5.630      5.465      0.654      0.964      0.641      0.343      0.376
## x6~~x6.g2 x7~~x7.g2 x8~~x8.g2 x9~~x9.g2 F1~~F1.g2 F2~~F2.g2 F3~~F3.g2
##      0.437      0.625      0.434      0.522      0.708      0.870      0.505
## F1~~F2.g2 F1~~F3.g2 F2~~F3.g2    F1~1.g2    F2~1.g2    F3~1.g2
##      0.427      0.329      0.236     -0.148      0.576     -0.177
```

```r
sctest(lav.fitGroup5, order.by = HS.comp$school,
                              parm = c(1:6,22:30), vcov = "info",
                              functional = "LMuo",plot=T)
```




```
##
##  M-fluctuation test
##
## data:  lav.fitGroup5
## f(efp) = 44.4879, p-value = 9.22e-05
```

```r
#sctest(lav.fitGroup5, order.by = HS.comp$school,
#                              parm = c(1:9,25:33), vcov = "info",
#                              functional = "LMuo",plot=T)

lav.fitGroup55 <- cfa(model5.lav, HS,meanstructure=T,group="school",group.equal=c("loadings"))
lav.fitGroup555 <- cfa(model5.lav, HS,meanstructure=T,group="school")
lavTestLRT(lav.fitGroup555,lav.fitGroup55,lav.fitGroup5) # intercepts are prob
```

```
## Chi Square Difference Test
##
##                 Df    AIC    BIC  Chisq Chisq diff Df diff Pr(>Chisq)
## lav.fitGroup555 48 7484.4 7706.8 115.85
## lav.fitGroup55  54 7480.6 7680.8 124.04      8.192       6     0.2244
## lav.fitGroup5   60 7508.6 7686.6 164.10     40.059       6  4.435e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
mod2 <- modificationIndices(lav.fitGroup5)
mod2[mod2$op == "~1" & mod2$mi > 10,]
```

```
##   lhs op rhs group     mi    epc sepc.lv sepc.all sepc.nox
## 1  x3 ~1         1 17.717  0.248   0.248    0.206    0.206
## 2  x7 ~1         1 13.681  0.205   0.205    0.186    0.186
## 3  x3 ~1         2 17.717 -0.248  -0.248   -0.238   -0.238
## 4  x7 ~1         2 13.681 -0.205  -0.205   -0.193   -0.193
```

Rasch Trees

SEM Trees, but for binary variables (rasch model)
http://cran.r-project.org/web/packages/psychotree/vignettes/raschtree.pdf

http://link.springer.com/article/10.1007%2Fs11336-013-9388-3#page-1

You have to set up the dataset a certain way – its a little wonky

```r
library(psychotree)
```

```
## Loading required package: partykit
## Loading required package: grid
```

```r
library(colorspace)

HS.xs <- HS[,7:15]
for(i in 1:9){
HS.xs[,i] = ifelse(HS.xs[,i] < mean(HS.xs[,i]), 0, 1)
}
#summary(HS.xs)

mydata = data.frame(HS[,1:5])
mydata$scale <- as.matrix(HS.xs)
```

Run it

```r
RT_out <- raschtree(scale ~ sex + ageyr + school, data = mydata)
RT_out
```

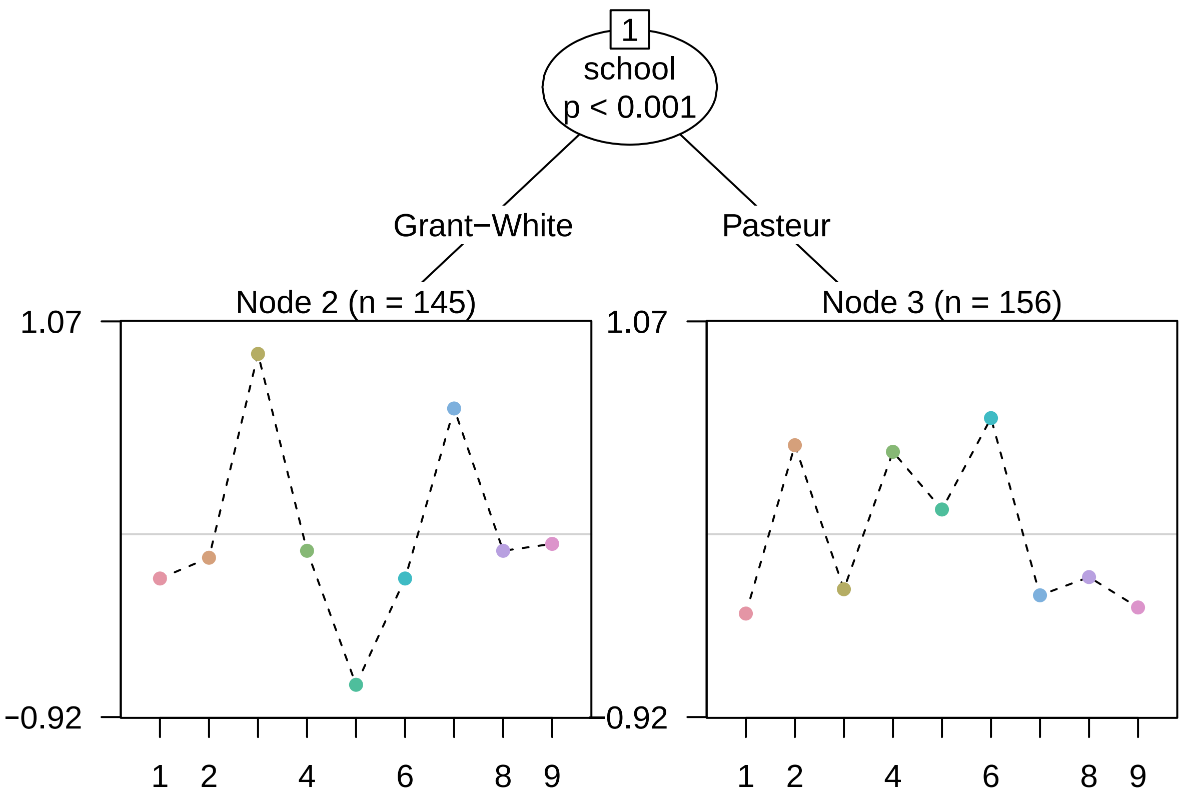
```
## Rasch tree
##
## Model formula:
## scale ~ sex + ageyr + school
##
## Fitted party:
## [1] root
## |   [2] school in Grant-White: n = 145
## |            scalex2       scalex3       scalex4       scalex5       scalex6
## |       1.044759e-01  1.129595e+00  1.392938e-01 -5.345298e-01 -8.612114e-06
## |            scalex7       scalex8       scalex9
## |       8.550781e-01  1.392938e-01  1.740704e-01
```

```
## |    [3] school in Pasteur: n = 156
## |           scalex2    scalex3    scalex4    scalex5    scalex6    scalex7
## |        0.84676450 0.12235959 0.81343399 0.52340945 0.98301944 0.09179353
## |           scalex8    scalex9
## |        0.18349732 0.03062488
##
## Number of inner nodes:    1
## Number of terminal nodes: 2
## Number of parameters per node: 8
## Objective function (negative log-likelihood): 1060.886
```

```r
# summary(RT_out)
```

Plot it

```r
plot(RT_out,col = rainbow_hcl(9))
```



More output from raschtree

```r
itempar(RT_out,node=1) # what would it be if no split
```

```
##    scalex1    scalex2    scalex3    scalex4    scalex5    scalex6
## -0.3082635  0.1784891  0.2614789  0.1784891 -0.2759642  0.1950127
##    scalex7    scalex8    scalex9
##  0.1291150 -0.1469228 -0.2114342
```

```r
itempar(RT_out, node = 2)
```

```
##     scalex1     scalex2     scalex3     scalex4     scalex5     scalex6
## -0.22302987 -0.11855399  0.90656550 -0.08373608 -0.75755971 -0.22303849
##     scalex7     scalex8     scalex9
##  0.63204820 -0.08373608 -0.04895948
```

```r
itempar(RT_out, node=3)
```

```
##    scalex1    scalex2    scalex3    scalex4    scalex5    scalex6
## -0.3994336  0.4473309 -0.2770740  0.4140004  0.1239758  0.5835858
##    scalex7    scalex8    scalex9
## -0.3076401 -0.2159363 -0.3688088
```

```r
coef(RT_out, node = 2)
```

```
##       scalex2       scalex3       scalex4       scalex5       scalex6
##  1.044759e-01  1.129595e+00  1.392938e-01 -5.345298e-01 -8.612114e-06
##       scalex7       scalex8       scalex9
##  8.550781e-01  1.392938e-01  1.740704e-01
```

Tutz DIFlasso

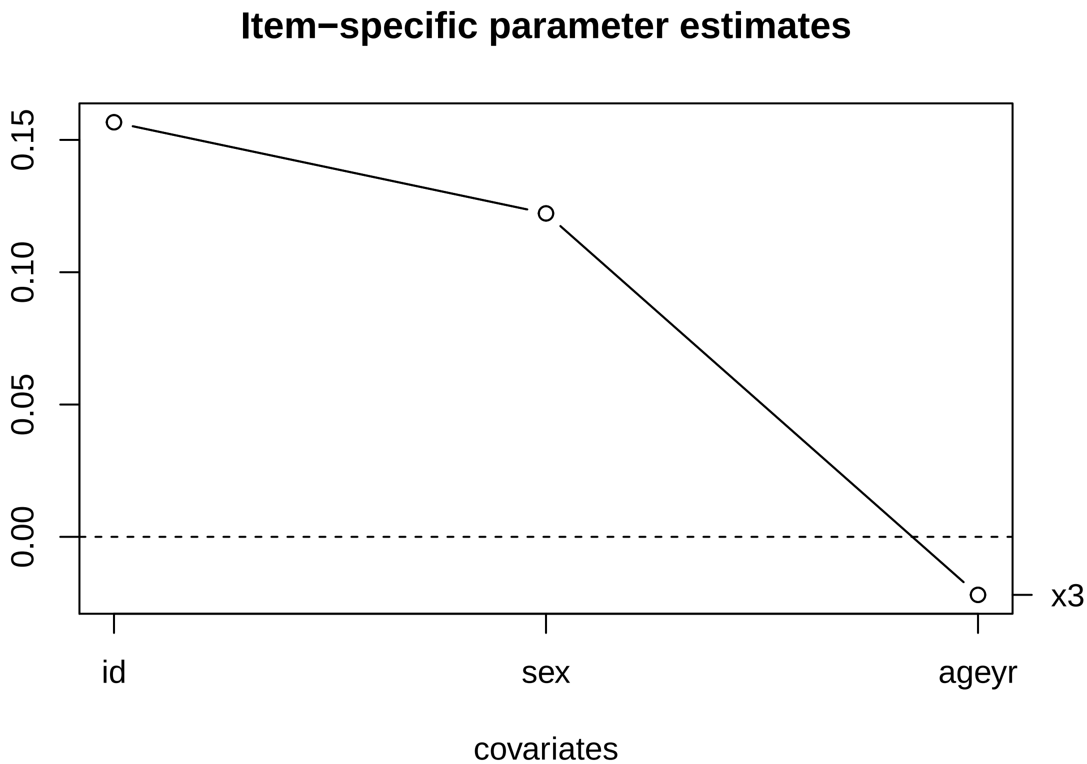
http://link.springer.com/article/10.1007%2Fs11336-013-9377-6

```r
library(DIFlasso)

Y <- data.frame(mydata$scale)
X <- sapply(HS[,1:3],as.numeric)
X.std <- data.frame(scale(X))
mlas1 <- DIFlasso(Y,X.std)
print(mlas1)
```

```
## Number of (valid) persons: P = 274
## Number of items: I = 9
## DIF Items: 3
##
## Matrix of estimated item-specific coefficients:
##       x1 x2          x3 x4 x5 x6 x7 x8 x9
## id     0  0  0.15666082  0  0  0  0  0  0
## sex    0  0  0.12222888  0  0  0  0  0  0
## ageyr  0  0 -0.02191697  0  0  0  0  0  0
```

```r
plot(mlas1)
```



Can re-fit (Code causes Tex problem)

```
mlas2 <- refitDIFlasso(mlas1)
mlas2
plot(mlas2)
```

Magis DIF Lasso

first load lassoDIF.R script and run functions

http://jeb.sagepub.com/content/early/2014/12/16/1076998614559747.abstract

Have to reformat dataset – kinda weird (this is common with some IRT packages – particularly using mixed models for IRT) * each row is one item response with columns corresponding to:
* item number
* id number
* values on covariates
First reshape data

```
HS$grade[is.na(HS$grade)] <- 7
library(reshape2)
# have to add ID variable that is a factor
hs.wide <- data.frame(HS[,1:4],HS.xs)
hs.wide$sum <- rowSums(HS.xs)
hs.wide$id <- as.factor(1:301)
HS$id <- as.factor(1:301)
xs <- c("x1","x2","x3","x4","x5","x6","x7","x8","x9")
hs.long <- melt(hs.wide, id.vars=c("id"),measure.vars =xs,variable.name="ITEM")
```

```r
hs.long$school <- NA
hs.long$ageyr <- NA
hs.long$grade <- NA
hs.long$sex <- NA
hs.long$SCORE <- NA
for(i in 1:301){
  hs.long[hs.long$id == i,]$school <- HS[HS$id == i,]$school
  hs.long[hs.long$id == i,]$ageyr <- HS[HS$id == i,]$ageyr
  hs.long[hs.long$id == i,]$grade <- HS[HS$id == i,]$grade
  hs.long[hs.long$id == i,]$sex <- HS[HS$id == i,]$sex
  hs.long[hs.long$id == i,]$SCORE <- hs.wide[hs.wide$id == i,]$sum
}
names(hs.long)[3] <- "Y"
```

Dataset is set up, now have to change variable names in lassoDIF.R

– right now, only can use one covariate at a time

Change lines 7 and 63 in lassoDIF.R to reflect covariate names

Important: Have to source() the lassoDIF.R code

```r
source("/Users/RJacobucci/Documents/Github/ATI_Labs/lassoDIF.R") # change path
```

```
## Loading required package: Matrix
##
## Attaching package: 'Matrix'
##
## The following object is masked from 'package:OpenMx':
##
##     expm
##
## Loaded glmnet 1.9-8
```

```r
out = lassoDIF(hs.long)
#lassoDIF.coef(out)
lassoDIF.ABWIC(out)
```

```
## $DIFitems
## [1] 3 4 7
##
## $DIFpars
##              [,1]
## Item1  0.0000000
## Item2  0.0000000
## Item3 -0.8685773
## Item4  0.3229705
## Item5  0.0000000
## Item6  0.0000000
## Item7  0.3584199
## Item8  0.0000000
```

```
## Item9  0.0000000
##
## $crit.value
##  [1] 2925.450 2923.210 2921.330 2919.765 2918.463 2917.385 2916.485
##  [8] 2915.736 2916.754 2917.343 2916.072 2915.015 2914.136 2913.405
## [15] 2912.803 2912.298 2911.878 2911.528 2911.238 2910.997 2910.797
## [22] 2910.630 2912.473 2912.321 2912.194 2912.088 2913.979 2919.852
## [29] 2919.733 2919.637 2921.549 2921.472 2921.408 2921.380 2921.094
##
## $crit.type
## [1] "AIC"
##
## $lambda
##  [1] 0.0100153500 0.0091256139 0.0083149195 0.0075762450 0.0069031922
##  [6] 0.0062899317 0.0057311515 0.0052220118 0.0047581026 0.0043354059
## [11] 0.0039502604 0.0035993302 0.0032795756 0.0029882271 0.0027227613
## [16] 0.0024808787 0.0022604842 0.0020596690 0.0018766937 0.0017099734
## [21] 0.0015580641 0.0014196500 0.0012935322 0.0011786184 0.0010739131
## [26] 0.0009785097 0.0008915816 0.0008123759 0.0007402067 0.0006744488
## [31] 0.0006145326 0.0005599392 0.0005101958 0.0004648714 0.0000000000
##
## $opt.lambda
## [1] 0.00141965
```

```
lassoDIF.CV(out,hs.long)
```

```
## $DIFitems
## [1] 3 4 7
##
## $DIFpars
##                     factor(data$ITEM)x1
##                               -2.2656246
##                     factor(data$ITEM)x2
##                               -2.8179508
##                     factor(data$ITEM)x3
##                               -2.5643464
##                     factor(data$ITEM)x4
##                               -2.9015793
##                     factor(data$ITEM)x5
##                               -2.3022572
##                     factor(data$ITEM)x6
##                               -2.8366645
##                     factor(data$ITEM)x7
##                               -2.8638504
##                     factor(data$ITEM)x8
##                               -2.4487127
##                     factor(data$ITEM)x9
##                               -2.3754795
##                              data$SCORE
##                                0.5832833
## factor(data$ITEM)x1:factor(data$sex)2
##                                0.0000000
## factor(data$ITEM)x2:factor(data$sex)2
##                                0.0000000
```

```
## factor(data$ITEM)x3:factor(data$sex)2
##                          -0.7074783
## factor(data$ITEM)x4:factor(data$sex)2
##                           0.1664686
## factor(data$ITEM)x5:factor(data$sex)2
##                           0.0000000
## factor(data$ITEM)x6:factor(data$sex)2
##                           0.0000000
## factor(data$ITEM)x7:factor(data$sex)2
##                           0.2025925
## factor(data$ITEM)x8:factor(data$sex)2
##                           0.0000000
## factor(data$ITEM)x9:factor(data$sex)2
##                           0.0000000
##
## $opt.lambda
## [1] 0.002986456
```

Mixture Rasch Models

http://www2.uaem.mx/r-mirror/web/packages/psychomix/vignettes/raschmix.pdf
http://epm.sagepub.com/content/early/2014/06/20/0013164414536183

```
library(psychomix)
```

```
## Loading required package: flexmix
## Loading required package: lattice
```

```
hs.mat <- as.matrix(HS.xs)
m1 <- raschmix(hs.mat,k=1); BIC(m1)
```

```
## 1 : * * *
```

```
## [1] 3607.675
```

```
m2 <- raschmix(hs.mat,k=2); BIC(m2) # best BIC
```

```
## 2 : * * *
```

```
## [1] 3558.929
```

```
m3 <- raschmix(hs.mat,k=3); BIC(m3)
```

```
## 3 : * * *
```

```
## [1] 3608.086
```

```r
m4 <- raschmix(hs.mat,k=4); BIC(m4)
```

```
## 4 : * * *
```

```
## [1] 3448.092
```

```r
# won't give class for people with all wrong or right
hs.mat2 <- data.frame(hs.mat)
hs.mat2$sum <- rowSums(hs.mat)
hs.mat3 <- HS[hs.mat2$sum != 0 & hs.mat2$sum != 9,]
```

How do our derived classes correspond to covariates

```r
library(psych)
```

```
##
## Attaching package: 'psych'
##
## The following object is masked from 'package:OpenMx':
##
##     tr
```

```r
cor(hs.mat3$ageyr,m2@cluster)
```

```
## [1] 0.1987088
```

```r
tetrachoric(data.frame(hs.mat3$sex,m2@cluster))
```

```
## Loading required package: mvtnorm
```

```
## Call: tetrachoric(x = data.frame(hs.mat3$sex, m2@cluster))
## tetrachoric correlation
##             hs.3. m2.cl
## hs.mat3.sex 1.00
## m2.cluster  0.01  1.00
##
##  with tau of
## hs.mat3.sex  m2.cluster
##      -0.037       0.073
```

```r
cor(hs.mat3$grade[1:273],m2@cluster[1:273])
```

```
## [1] -0.05036862
```

```r
tetrachoric(data.frame(as.numeric(hs.mat3$school),m2@cluster)) # highest
```

```
## Call: tetrachoric(x = data.frame(as.numeric(hs.mat3$school), m2@cluster))
## tetrachoric correlation
##                              a...3 m2.cl
## as.numeric.hs.mat3.school. 1.00
## m2.cluster                 0.35  1.00
##
##  with tau of
## as.numeric.hs.mat3.school.                m2.cluster
##                     -0.055                     0.073
```

Do we get similar results using the original dataset (back to CFA model)?

Factor Mixture Models in OpenMx

– only package to do it in R (I think?)

```
resVars <-  mxPath(from=c("x1","x2","x3","x4","x5","x6","x7","x8","x9"),
                        arrows=2,
                        free=TRUE,
                        values=c(1.1,1.3,1.2,.4,.5,.35,1.1,1,.9),
                        labels=c("e1","e2","e3","e4","e5","e6","e7","e8","e9"))

latVars <- mxPath(from="F1",
                        arrows=2,
                        free=TRUE,
                        values=0.26,
                        labels ="varF1")

manMeans <- mxPath(from="one",
                        to=c("x1","x2","x3","x4","x5","x6","x7","x8","x9"),
                        arrows=1,
                        free=c(TRUE,TRUE,TRUE,TRUE,T,T,T,T,T),
                        values=c(4.93,6,2.2,3,4.3,2.1,4.1,5.5,5.3),
                        labels =c("meanx1","meanx2","meanx3","meanx4","meanx5",
                                  "meanx6","meanx7","meanx8","meanx9"))

loadings <- mxPath(from="F1",
                        to=c("x1","x2","x3","x4","x5","x6","x7","x8","x9"),
                        arrows=1,
                        free=c(FALSE,T,T,T,T,T,T,T,T),
                        values=c(1,0.5,0.5,1.9,2.1,1.8,0.4,0.4,0.6),
                        labels =c("l1","l2","l3","l4","l5","l6","l7","l8","l9"))

latMeans <- mxPath(from="one", to="F1", arrows=1,
                    free=TRUE, values=0, labels="meanF1")

funML <- mxFitFunctionML(vector=TRUE)


class1 <- mxModel("Class1", type="RAM",
                  manifestVars=c("x1","x2","x3","x4","x5","x6","x7","x8","x9"),
                  latentVars="F1",resVars,loadings,manMeans,latMeans,latVars,funML)
```

```r
latVars2 <- mxPath(from="F1",
                        arrows=2,
                        free=TRUE,
                        values=2,
                        labels ="varF2")
# latent means
latMeans2 <- mxPath(from="one", to="F1", arrows=1,
                    free=TRUE, values=2, labels="meanF12")

class2 <- mxModel(class1, name="Class2", latVars2, latMeans2)

classP <- mxMatrix(type="Full", nrow=2, ncol=1,
                  free=c(TRUE, FALSE), values=1, lbound=0.001,
                  labels = c("p1","p2"), name="Props")

classS <- mxAlgebra( Props %x% (1/sum(Props)), name="classProbs" )

algFit <- mxAlgebra(-2*sum(log(classProbs[1,1] %x% Class1.fitfunction
                    + classProbs[2,1] %x% Class2.fitfunction)),
                    name="mixtureObj")

fit <- mxFitFunctionAlgebra("mixtureObj")
data <- mxData(observed=HS,type="raw")
fmm <- mxModel("Factor Mixture Model",
                data, class1, class2, classP, classS, algFit, fit)
fmmFit <- mxRun(fmm, suppressWarnings=TRUE)
```

```
## Running Factor Mixture Model

## Warning in runHelper(model, frontendStart, intervals, silent,
## suppressWarnings, : Data[1] 'id' must be an ordered factor. Please use
## mxFactor()

## Warning in runHelper(model, frontendStart, intervals, silent,
## suppressWarnings, : Data[5] 'school' must be an ordered factor. Please use
## mxFactor()
```

```r
# summary(fmmFit)
fmmFit$classProbs
```

```
## mxAlgebra 'classProbs'
## $formula:  Props %x% (1/sum(Props))
## $result:
##            [,1]
## [1,] 0.06223022
## [2,] 0.93776978
## dimnames: NULL
```

```r
#str(fmmFit)

fmmFit$submodels$Class2$fitfunction$likelihoods
```

```
## NULL
```

```r
comp <- fmmFit$output$algebras$Class1.fitfunction > fmmFit$output$algebras$Class2.fitfunction
sum(comp)/301
```

```
## [1] 0.1594684
```

```r
# http://openmx.psyc.virginia.edu/thread/717
indClassProbs <- function(model, classProbs, round=NA){
  # this function takes a mixture model in OpenMx
  # and returns the posterior class probabilities
    # using Bayes rule, individual person-class likelihoods
    # and the model class probability matrix, as described in
    # Ramaswamy, Desarbo, Reibstein, and Robinson, 1993
    cp <- mxEval(classProbs, model)
    cp2 <- as.vector(cp)
    cps <- diag(length(cp2))
    diag(cps) <- cp2
    subs <- model@submodels
    if(min(dim(cp))!=1)stop("Class probabilities matrix must be a row or column vector.")
    if(max(dim(cp))==1)stop("Class probabilities matrix must contain two or more classes.")
    of <- function(num){
        return(mxEval(objective, subs[[num]]))
        }
    rl <- sapply(1:length(names(subs)), of)
    raw <- (rl%*%cps)
    tot <- 1/apply(raw, 1, sum)
    div <- matrix(rep(tot, length(cp2)), ncol=length(cp2))
    icp <- raw * div
    if (is.numeric(round)){icp <- round(icp, round)}
    return(icp)
    }

#indClassProbs(fmmFit,fmmFit$classProbs)


prbs <- indClassProbs(fmmFit,fmmFit$classProbs)[,1]

HS$prbs <- prbs
lmm = lm(prbs ~ sex + ageyr + school + grade, data=HS)
summary(lmm)
```

```
##
## Call:
## lm(formula = prbs ~ sex + ageyr + school + grade, data = HS)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.14913 -0.07936 -0.04227 -0.00244  0.81070
##
## Coefficients:
##                Estimate Std. Error t value Pr(>|t|)
## (Intercept)   -0.15832    0.15328  -1.033  0.30251
```

```
## sex            0.02034    0.01876   1.084  0.27909
## ageyr         -0.02107    0.01077  -1.957  0.05124 .
## schoolPasteur -0.04529    0.01916  -2.364  0.01875 *
## grade          0.06516    0.02159   3.018  0.00277 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1597 on 296 degrees of freedom
## Multiple R-squared:  0.06175,    Adjusted R-squared:  0.04907
## F-statistic: 4.871 on 4 and 296 DF,  p-value: 0.0008108
```

```
cor(prbs,HS$sex)
```

```
## [1] 0.07661222
```

```
cor(prbs,HS$ageyr)
```

```
## [1] -0.07827931
```

```
cor(prbs,as.numeric(HS$school))
```

```
## [1] -0.1605882
```

```
cor(prbs[1:300],HS$grade[1:300])
```

```
## [1] 0.1214811
```

```
# compare 2 derived classes from both mixture models
cor(m2@cluster,prbs[hs.mat2$sum != 0 & hs.mat2$sum != 9])
```

```
## [1] -0.3488794
```

The answer is no.

Moderation Try with OpenMx - how you specify the use of a covariate in OpenMx

```
resVars <-  mxPath(from=c("x1","x2","x3","x4","x5","x6","x7","x8","x9"),
                        arrows=2,
                        free=TRUE,
                        values=c(1.1,1.3,1.2,.4,.5,.35,1.1,1,.9),
                        labels=c("e1","e2","e3","e4","e5","e6","e7","e8","e9"))

latVars <- mxPath(from="F1",
                        arrows=2,
                        free=TRUE,
                        values=0.26,
                        labels ="varF1")

manMeans <- mxPath(from="one",
                        to=c("x1","x2","x3","x4","x5","x6","x7","x8","x9"),
```

```
                        arrows=1,
                        free=c(TRUE,TRUE,TRUE,TRUE,T,T,T,T,T),
                        values=c(4.93,6,2.2,3,4.3,2.1,4.1,5.5,5.3),
                        labels =c("meanx1","meanx2","meanx3","meanx4","meanx5",
                                  "meanx6","meanx7","meanx8","meanx9"))

loadings <- mxPath(from="F1",
                        to=c("x1","x2","x3","x4","x5","x6","x7","x8","x9"),
                        arrows=1,
                        free=c(FALSE,T,T,T,T,T,T,T,T),
                        values=c(1,0.5,0.5,1.9,2.1,1.8,0.4,0.4,0.6),
                        labels =c("l1","l2","l3","l4","l5","l6","l7","l8","l9"))

latMeans <- mxPath(from="one", to="F1", arrows=1,
                    free=TRUE, values=0, labels="meanF1")

defValues    <- mxPath( from="one", to="DefDummy", arrows=1,
                        free=FALSE, values=1, labels="data.sex" )

# beta weights
betaWeights  <- mxPath( from="DefDummy", to=c("F1"), arrows=1,
                        free=TRUE, values=1, labels=c("beta_1") )

#LoadsDef           <- mxAlgebra(expression= l2 + beta*ageyr, name="l22" )


funML <- mxFitFunctionML()

HS.def <- HS[,c(2,7:15)]
HS.def$sex <- mxFactor(HS.def$sex,levels=c(1,2))

data <- mxData(observed=HS.def,type="raw")

Onefac <- mxModel("One fac mod",type="RAM",
                manifestVars=c("x1","x2","x3","x4","x5","x6","x7","x8","x9"),data,
                  latentVars=c("F1","DefDummy"),resVars,loadings,manMeans,latMeans,latVars,funML,
                betaWeights,defValues)
MxOut <- mxTryHard(Onefac)
summary(MxOut)
```