PSC205A Assignment 01: Matrix Algebra

```
library(lavaan)
```

```
This is lavaan 0.6-16
lavaan is FREE software! Please report any bugs.
```

```
library(lavaanPlot)
library(dplyr)
```

```
Attaching package: 'dplyr'

The following objects are masked from 'package:stats':

    filter, lag

The following objects are masked from 'package:base':

    intersect, setdiff, setequal, union
```

```
dat <- read.table("mhs_latent.dat", na.string='.')
names(dat) <- c("id", "female", "age",
                "pc1", "app1", "gw1", "pw1", "par1", "teach1", "mate1", "fri1", "mot1", "a
                "pc2", "app2", "gw2", "pw2", "par2", "teach2", "mate2", "fri2", "mot2", "a
                "pc3", "app3", "gw3", "pw3", "par3", "teach3", "mate3", "fri3", "mot3", 'a
                "pc4", "app4", "gw4", "pw4", "par4", "teach4", "mate4", "fri4", "mot4", "a
```

1. SEM analysis

```
mod1 <- "
#factor loadings
pc =~ pc1 + pc2 + pc3 + pc4
app =~ app1 + app2 + app3 + app4
gw =~ gw1 + gw2 + gw3 + gw4
pw =~ pw1 + pw2 + pw3
par =~ par1 + par2 + par3 + par4
teach =~ teach1 + teach2 + teach3 + teach4
mate =~ mate1 + mate2 + mate3 + mate4
fri =~ fri1 + fri2 + fri3 + fri4
mot =~ mot1 + mot2 + mot3 + mot4
aff =~ aff1 + aff2 + aff3 + aff4
aut =~ aut1 + aut2 + aut3 + aut4

# structural relations
gw ~ app + pc + teach + par + mate + fri
pw ~ app +pc + teach + par + mate + fri

aff ~ pw
mot ~ pw + aff

# covariances
app ~~ 0*pc
app ~~ 0*teach
app ~~ 0*par
app ~~ 0*mate
app ~~ 0*fri
app ~~ 0*aff
app ~~ 0*mot

pc ~~ 0*teach
pc ~~ 0*par
pc ~~ 0*mate
pc ~~ 0*fri
pc ~~ 0*aff
pc ~~ 0*mot

gw ~~ 0*pw
gw ~~ 0*aff
gw ~~ 0*mot
```

```
  teach ~~ 0*par
  teach ~~ 0*mate
  teach ~~ 0*fri
  teach ~~ 0*aff
  teach ~~ 0*mot

  par ~~ 0*mate
  par ~~ 0*fri
  par ~~ 0*aff
  par ~~ 0*mot

  mate ~~ 0*fri
  mate ~~ 0*aff
  mate ~~ 0*mot

  fri ~~ 0*aff
  fri ~~ 0*mot
  "
```

```
  fit1 <- cfa(mod1, data = dat, fixed.x=FALSE, missing="fiml")
```

```
Warning in lav_data_full(data = data, group = group, cluster = cluster, : lavaan WARNING: so
  161 163
```

```
  res1 <- summary(fit1, fit.measures=T, standardized=TRUE)
```

2. Additional models

```
  mod_ind_m1 <- modindices(fit1)
  head(arrange(mod_ind_m1, desc(mi)))
```

```
    lhs op  rhs      mi   epc sepc.lv sepc.all sepc.nox
1  mate  ~   gw 141.273 1.003   0.928    0.928    0.928
2   app  ~   gw 138.258 3.161   2.063    2.063    2.063
3  mate  ~  fri 121.350 0.753   0.834    0.834    0.834
4  mate ~~  fri 121.350 0.176   0.834    0.834    0.834
5   fri  ~ mate 121.350 0.923   0.834    0.834    0.834
6 teach  ~   gw 113.457 0.815   0.834    0.834    0.834
```

The modification indices tell us that the model might be improved by allowing the variables friend support and classmate support to correlate. We can start by freeing this relation.

2.1. Model 2: mate ~~ fri

```
mod2 <- "
#factor loadings
pc =~ pc1 + pc2 + pc3 + pc4
app =~ app1 + app2 + app3 + app4
gw =~ gw1 + gw2 + gw3 + gw4
pw =~ pw1 + pw2 + pw3
par =~ par1 + par2 + par3 + par4
teach =~ teach1 + teach2 + teach3 + teach4
mate =~ mate1 + mate2 + mate3 + mate4
fri =~ fri1 + fri2 + fri3 + fri4
mot =~ mot1 + mot2 + mot3 + mot4
aff =~ aff1 + aff2 + aff3 + aff4
aut =~ aut1 + aut2 + aut3 + aut4

# structural relations
gw ~ app + pc + teach + par + mate + fri
pw ~ app +pc + teach + par + mate + fri

pw ~ aff
pw ~ mot

pc ~ mate

# covariances
app ~~ 0*pc
app ~~ 0*teach
app ~~ 0*par
app ~~ 0*mate
app ~~ 0*fri
app ~~ 0*aff
app ~~ 0*mot

pc ~~ 0*teach
pc ~~ 0*par
pc ~~ 0*mate
pc ~~ 0*fri
```

```
  pc ~~ 0*aff
  pc ~~ 0*mot

  gw ~~ 0*pw
  gw ~~ 0*aff
  gw ~~ 0*mot

  teach ~~ 0*par
  teach ~~ 0*mate
  teach ~~ 0*fri
  teach ~~ 0*aff
  teach ~~ 0*mot

  par ~~ 0*mate
  par ~~ 0*fri
  par ~~ 0*aff
  par ~~ 0*mot

  mate ~~ fri
  mate ~~ 0*aff
  mate ~~ 0*mot

  fri ~~ 0*aff
  fri ~~ 0*mot
  "
```

```
  fit2 <- cfa(mod2, data = dat, fixed.x=FALSE, missing="fiml")
```

```
Warning in lav_data_full(data = data, group = group, cluster = cluster, : lavaan WARNING: so
  161 163
```

```
  res2 <- summary(fit2, fit.measures=T, standardized=TRUE)

  mod_ind_m2 <- modindices(fit2)
  head(arrange(mod_ind_m2, desc(mi)))
```

```
    lhs op   rhs      mi   epc sepc.lv sepc.all sepc.nox
1 teach  ~    gw 106.810 0.764   0.803    0.803    0.803
2   app  ~    gw 100.605 2.293   1.536    1.536    1.536
3    pc  ~   aff  96.734 0.625   0.658    0.658    0.658
```

```
4   app  ~    pw  93.800 1.294   1.017    1.017    1.017
5 teach  ~  mate  90.270 0.654   0.699    0.699    0.699
6   par ~~ teach  89.125 0.152   0.700    0.700    0.700
```

The new modification indices suggest the model can be further improved by allowing parent support and teacher support to correlate.

2.2. Model 3: pc ~ mate + aff

```
mod3 <- "
#factor loadings
pc =~ pc1 + pc2 + pc3 + pc4
app =~ app1 + app2 + app3 + app4
gw =~ gw1 + gw2 + gw3 + gw4
pw =~ pw1 + pw2 + pw3
par =~ par1 + par2 + par3 + par4
teach =~ teach1 + teach2 + teach3 + teach4
mate =~ mate1 + mate2 + mate3 + mate4
fri =~ fri1 + fri2 + fri3 + fri4
mot =~ mot1 + mot2 + mot3 + mot4
aff =~ aff1 + aff2 + aff3 + aff4
aut =~ aut1 + aut2 + aut3 + aut4

# structural relations
gw ~ app + pc + teach + par + mate + fri
pw ~ app +pc + teach + par + mate + fri

pw ~ aff
pw ~ mot

pc ~ mate + aff

# covariances
app ~~ 0*pc
app ~~ 0*teach
app ~~ 0*par
app ~~ 0*mate
app ~~ 0*fri
app ~~ 0*aff
app ~~ 0*mot
```

```
pc ~~ 0*teach
pc ~~ 0*par
pc ~~ 0*mate
pc ~~ 0*fri
pc ~~ 0*aff
pc ~~ 0*mot

gw ~~ 0*pw
gw ~~ 0*aff
gw ~~ 0*mot

teach ~~ par
teach ~~ 0*mate
teach ~~ 0*fri
teach ~~ 0*aff
teach ~~ 0*mot

par ~~ 0*mate
par ~~ 0*fri
par ~~ 0*aff
par ~~ 0*mot

mate ~~ fri
mate ~~ 0*aff
mate ~~ 0*mot

fri ~~ 0*aff
fri ~~ 0*mot
"
```

```
fit3 <- cfa(mod3, data = dat, fixed.x=FALSE, missing="fiml")
```

```
Warning in lav_data_full(data = data, group = group, cluster = cluster, : lavaan WARNING: so
  161 163
```

```
res3 <- summary(fit3, fit.measures=T, standardized=TRUE)

mod_ind_m3 <- modindices(fit3)
head(arrange(mod_ind_m3, desc(mi)))
```

```
  lhs op  rhs      mi   epc sepc.lv sepc.all sepc.nox
```

```
1   app  ~   gw 114.572 2.649   1.755    1.755    1.755
2   app  ~   pw  86.117 1.210   0.966    0.966    0.966
3   app  ~   pc  80.682 0.591   0.625    0.625    0.625
4  mate  ~   pw  80.415 0.402   0.475    0.475    0.475
5 mate4 ~~ fri4  63.840 0.121   0.121    0.648    0.648
6  mate  ~   gw  60.005 0.453   0.443    0.443    0.443
```

Now the modification indices suggest an improvement in fit by regressing Physical appearance on Perceived competence.

2.3. Model 4: app ~ pc

```
mod4 <- "
#factor loadings
pc =~ pc1 + pc2 + pc3 + pc4
app =~ app1 + app2 + app3 + app4
gw =~ gw1 + gw2 + gw3 + gw4
pw =~ pw1 + pw2 + pw3
par =~ par1 + par2 + par3 + par4
teach =~ teach1 + teach2 + teach3 + teach4
mate =~ mate1 + mate2 + mate3 + mate4
fri =~ fri1 + fri2 + fri3 + fri4
mot =~ mot1 + mot2 + mot3 + mot4
aff =~ aff1 + aff2 + aff3 + aff4
aut =~ aut1 + aut2 + aut3 + aut4

# structural relations
gw ~ pc + teach + par + mate + fri
pw ~ app +pc + teach + par + mate + fri

pw ~ aff
pw ~ mot

pc ~ mate + aff
app ~ pc

# covariances
app ~~ gw
app ~~ 0*pc
app ~~ 0*teach
app ~~ 0*par
```

```
app ~~ 0*mate
app ~~ 0*fri
app ~~ 0*aff
app ~~ 0*mot

pc ~~ 0*teach
pc ~~ 0*par
pc ~~ 0*mate
pc ~~ 0*fri
pc ~~ 0*aff
pc ~~ 0*mot

gw ~~ 0*pw
gw ~~ 0*aff
gw ~~ 0*mot

teach ~~ 0*par
teach ~~ 0*mate
teach ~~ 0*fri
teach ~~ 0*aff
teach ~~ 0*mot

par ~~ 0*mate
par ~~ 0*fri
par ~~ 0*aff
par ~~ 0*mot

mate ~~ 0*fri
mate ~~ 0*aff
mate ~~ 0*mot

fri ~~ 0*aff
fri ~~ 0*mot

"
```

```
fit4 <- cfa(mod4, data = dat, fixed.x=FALSE, missing="fiml")
```

```
Warning in lav_data_full(data = data, group = group, cluster = cluster, : lavaan WARNING: so
  161 163
```

```r
res4 <- summary(fit4, fit.measures=T, standardized=TRUE)

mod_ind_m4 <- modindices(fit4)
head(arrange(mod_ind_m4, desc(mi)))
```

```
    lhs op   rhs      mi   epc sepc.lv sepc.all sepc.nox
1   fri  ~  mate 119.700 0.916   0.827    0.827    0.827
2  mate  ~   fri 119.700 0.747   0.827    0.827    0.827
3  mate ~~   fri 119.700 0.176   0.827    0.827    0.827
4  mate  ~    gw 117.259 0.956   0.934    0.934    0.934
5 teach  ~    gw  95.771 0.692   0.751    0.751    0.751
6   par  ~ teach  89.209 0.972   0.700    0.700    0.700
```

Model comparison

```r
anova(fit1, fit2, fit3, fit4)
```

```
Warning in lavTestLRT(object = object, ..., model.names = NAMES): lavaan WARNING:
    Some restricted models fit better than less restricted models;
    either these models are not nested, or the less restricted model
    failed to reach a global optimum. Smallest difference =
    -60.9682400409038

Warning in lavTestLRT(object = object, ..., model.names = NAMES): lavaan
WARNING: some models have the same degrees of freedom


Chi-Squared Difference Test

      Df   AIC   BIC  Chisq Chisq diff   RMSEA Df diff Pr(>Chisq)
fit3 834 12617 13170 2774.9
fit2 836 12872 13417 3033.1    258.178 0.70054       2  < 2.2e-16 ***
fit4 836 12811 13356 2972.1    -60.968 0.00000       0
fit1 839 12953 13487 3120.0    147.920 0.43021       3  < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

3. Results summary