For Laura

Paul Harmon and Sarah McKnight

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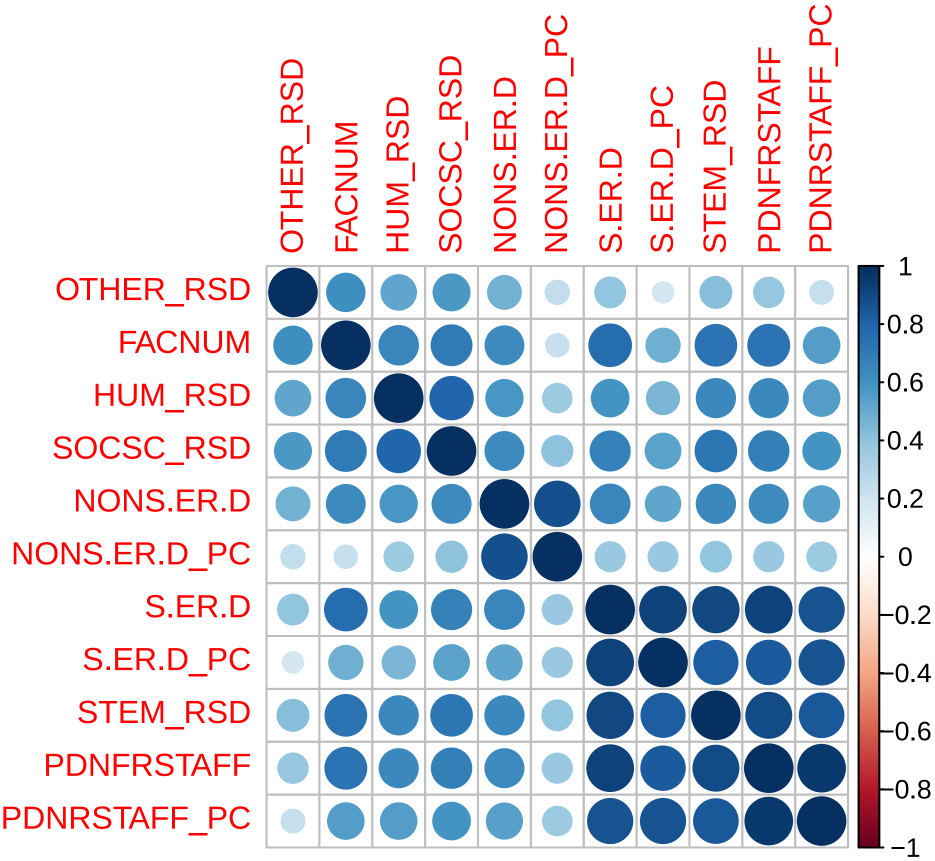
We generated a new SEM model for the Carnegie Data in order to get things to run efficiently. The code for generating the model and reading in the dataset is given below.

```r
#read in data
setwd("~/Carnegie-SEM/data")
cc2015 <- read.csv("CC2015data.csv",header = TRUE)

#######2015################
cc2015.full <- read.csv("CC2015data.csv", header = TRUE, as.is = TRUE)
#updated file
#cc2015.full <- read.csv("Updated2015.csv", header = TRUE)

cc2015 <- cc2015.full[(cc2015.full$BASIC2015>14&cc2015.full$BASIC2015<18),]
cc2015$BASIC2015 <- factor(cc2015$BASIC2015)



#function for ranking the data
minrank <- function(x){rank(x, ties.method = "min")}

#dataset that we want to use
cc2015Ps<-
  na.omit(cc2015[,c("NAME","BASIC2010","BASIC2015","FACNUM","HUM_RSD",
                    "OTHER_RSD","SOCSC_RSD","STEM_RSD","PDNFRSTAFF","S.ER.D","NONS.ER.D")])

#calculate the ranked data
cc2015.r <- data.frame(cc2015Ps[,1:3],sapply(cc2015Ps[,-c(1:3)],minrank))

cc2015percap <- cc2015Ps[,c("PDNFRSTAFF","S.ER.D","NONS.ER.D")]/cc2015Ps$FACNUM
colnames(cc2015percap) <- c("PDNRSTAFF_PC", "S.ER.D_PC", "NONS.ER.D_PC")
cc2015percap.r<-data.frame(sapply(cc2015percap,minrank))
cc2015_r <- cbind(cc2015.r, cc2015percap.r)

cc2015_matrix2 <- as.matrix(cc2015_r[-c(1:3)])
corrmatrix <- Hmisc::rcorr(cc2015_matrix2)
corrplot::corrplot(corrmatrix$r, order="hclust")
```



Based on the inability of the previous model to generate a positive-definite variance covariance matrix, we looked back at the model and determined that things are too highly correlated to get things to work. Rather than modeling the Aggregate and Per-Capita traits from the same set of variables, we decided to look at STEM vs. Non-STEM differences. This allowed us to have two correlated factors, but they did not depend on the same variables so we were able to get results that looked reasonable.

The model fit is below:

```
model4 <- '
HUMANITIES=~HUM_RSD+OTHER_RSD+SOCSC_RSD+NONS.ER.D+FACNUM
STEM=~STEM_RSD+PDNFRSTAFF+S.ER.D+FACNUM
Aggregate=~HUMANITIES+STEM'

lavaan_sem_new <- lavaan::sem(model4, data=cc2015_r, std.lv=TRUE,
                              orthogonal=FALSE, se="robust.huber.white")
lavaan::summary(lavaan_sem_new, standardized=TRUE, fit.measures=TRUE)
```

```
## lavaan (0.5-23.1097) converged normally after 128 iterations
##
##   Number of observations                           276
##
##   Estimator                                         ML
##   Minimum Function Test Statistic              110.024
##   Degrees of freedom                                17
##   P-value (Chi-square)                           0.000
##
## Model test baseline model:
```

```
##
##   Minimum Function Test Statistic            2223.162
##   Degrees of freedom                                28
##   P-value                                        0.000
##
## User model versus baseline model:
##
##   Comparative Fit Index (CFI)                    0.958
##   Tucker-Lewis Index (TLI)                       0.930
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)             -11847.548
##   Loglikelihood unrestricted model (H1)     -11792.536
##
##   Number of free parameters                         27
##   Akaike (AIC)                               23749.096
##   Bayesian (BIC)                             23846.847
##   Sample-size adjusted Bayesian (BIC)        23761.234
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                          0.141
##   90 Percent Confidence Interval          0.116  0.166
##   P-value RMSEA <= 0.05                          0.000
##
## Standardized Root Mean Square Residual:
##
##   SRMR                                           0.041
##
## Parameter Estimates:
##
##   Information                                 Observed
##   Standard Errors                   Robust.huber.white
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   HUMANITIES =~
##     HUM_RSD          38.108    9.787    3.894    0.000   81.310    0.847
##     OTHER_RSD        24.120    6.468    3.729    0.000   51.463    0.639
##     SOCSC_RSD        37.677    9.672    3.895    0.000   80.390    0.906
##     NONS.ER.D        27.306    6.978    3.913    0.000   58.262    0.729
##     FACNUM           18.010    6.675    2.698    0.007   38.427    0.482
##   STEM =~
##     STEM_RSD         33.562    8.626    3.891    0.000   77.096    0.939
##     PDNFRSTAFF       34.448    8.124    4.240    0.000   79.131    0.953
##     S.ER.D           33.529    8.408    3.988    0.000   77.021    0.967
##     FACNUM           13.886    5.838    2.379    0.017   31.897    0.400
##   Aggregate =~
##     HUMANITIES        1.885    0.615    3.065    0.002    0.883    0.883
##     STEM              2.068    0.634    3.260    0.001    0.900    0.900
##
## Intercepts:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .HUM_RSD         123.025    5.781   21.281    0.000  123.025    1.281
##    .OTHER_RSD       137.188    4.847   28.305    0.000  137.188    1.704
##    .SOCSC_RSD       130.529    5.338   24.451    0.000  130.529    1.472
##    .NONS.ER.D       138.344    4.811   28.759    0.000  138.344    1.731
##    .FACNUM          138.446    4.797   28.859    0.000  138.446    1.737
##    .STEM_RSD        136.554    4.942   27.632    0.000  136.554    1.663
##    .PDNFRSTAFF      136.101    4.997   27.238    0.000  136.101    1.640
##    .S.ER.D          138.500    4.796   28.879    0.000  138.500    1.738
##     HUMANITIES        0.000                               0.000    0.000
##     STEM              0.000                               0.000    0.000
##     Aggregate         0.000                               0.000    0.000
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .HUM_RSD        2612.532  366.089    7.136    0.000 2612.532    0.283
##    .OTHER_RSD      3835.029  334.063   11.480    0.000 3835.029    0.592
##    .SOCSC_RSD      1403.253  236.802    5.926    0.000 1403.253    0.178
##    .NONS.ER.D      2992.509  305.049    9.810    0.000 2992.509    0.469
##    .FACNUM         1908.187  223.671    8.531    0.000 1908.187    0.300
##    .STEM_RSD        796.821  117.031    6.809    0.000  796.821    0.118
##    .PDNFRSTAFF      629.148  162.047    3.883    0.000  629.148    0.091
##    .S.ER.D          415.725   88.612    4.692    0.000  415.725    0.065
##     HUMANITIES        1.000                               0.220    0.220
##     STEM              1.000                               0.190    0.190
##     Aggregate         1.000                               1.000    1.000
```

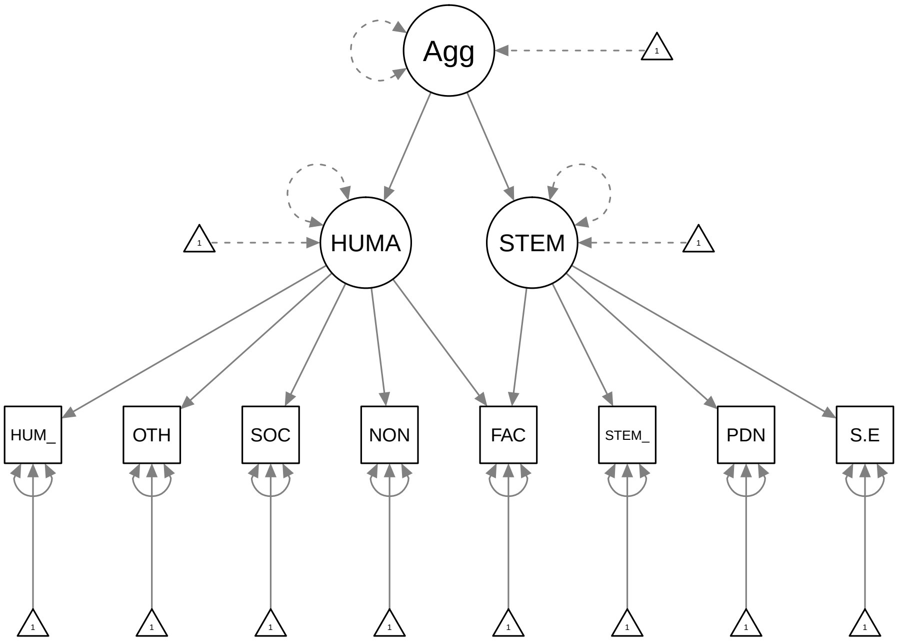
```r
CCScores <- as.data.frame(lavaan::predict(lavaan_sem_new))
rownames(CCScores) <- cc2015Ps$NAME
```

The model would look like the following, in a path diagram:

```r
library(semPlot)
```

```
## Warning: package 'semPlot' was built under R version 3.4.3
```

```r
semPaths(lavaan_sem_new)
```



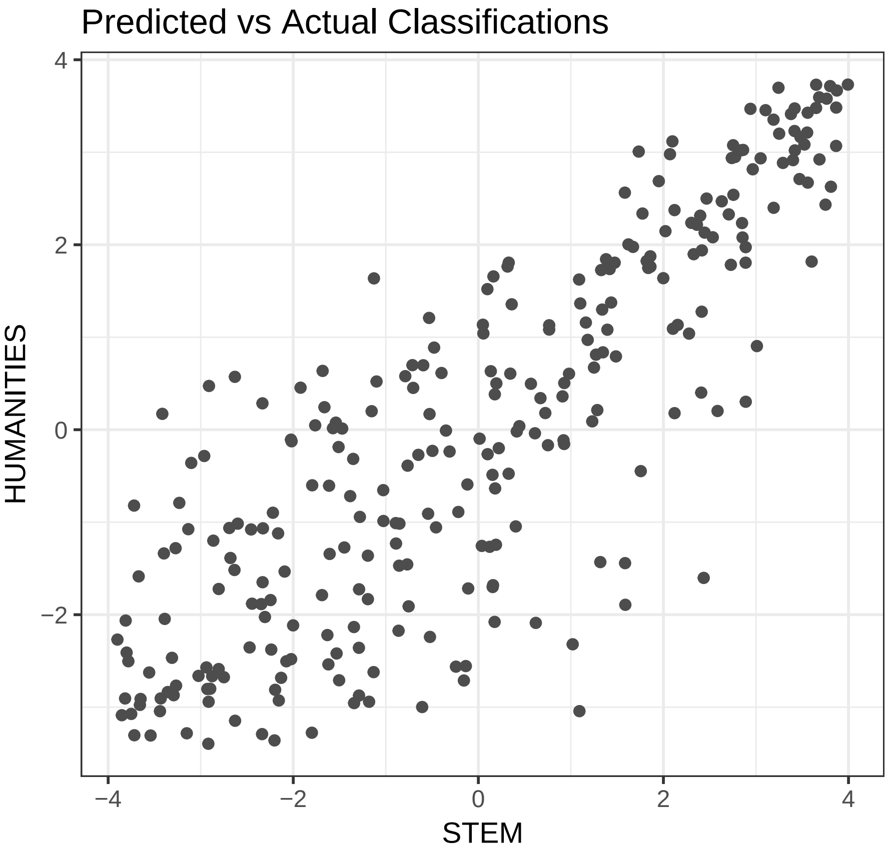
Finally, we can generate a plot of the factors plotted against each other:

```
library(ggplot2)
CCScores_r_cov_new <- as.data.frame(lavaan::predict(lavaan_sem_new))
names(CCScores_r_cov_new)
```

```
## [1] "HUMANITIES" "STEM"       "Aggregate"
```

```
    #creates a plot and colors by Carnegie Classification Colors
  ggplot(CCScores_r_cov_new) + geom_point(aes(x = STEM, y = HUMANITIES), color = "gray30", symbol = "gra
   ggtitle("Predicted vs Actual Classifications") + theme_bw() + coord_fixed(ratio = 1)
```

```
## Warning: Ignoring unknown parameters: symbol
```


Predicted vs Actual Classifications
HUMANITIES
4
2
0
−2
STEM
−4
−2
0
2
4