Exploratory Factor Analysis (EFA)

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Norwegian University of Science and Technology - A Course in `MplusAutomation`

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Change starting location to folder `03-efa`

```
source("rep_functions.R")

change_here(glue("{project_location}/03-efa"))

here()
```

```
## [1] "/EMPTY/YOU/FILL/IN/NTNU-start/03-efa"
```

DATA SOURCE: This lab exercise utilizes the NCES public-use dataset: Education Longitudinal Study of 2002 (Lauff & Ingels, 2014) See website: nces.ed.gov

Loading packages

```
library(MplusAutomation)
library(haven)
library(tidyverse)
library(here)
library(corrplot)
library(gt)
```

EXERCISE 1: READ IN DATA TO R ENVIRONMENT

```
lab_data <- read_spss("https://garberadamc.github.io/project-site/data/els_sub1_spss.sav")
```

EXERCISE 2: SUBSET

```r
# make a subset of all the student reported variables

by_student <- lab_data %>%
  select(22:145)

# make another subset (just the variables we will use for the EFA)

schl_safe <- lab_data %>%
  select(
    "BYS20A", "BYS20B", "BYS20C", "BYS20D", "BYS20E", "BYS20F", "BYS20G", # F1
    "BYS20H", "BYS20I", "BYS20J", "BYS20K", "BYS20L", "BYS20M", "BYS20N", # F2
    "BYS21A", "BYS21B", "BYS21C", "BYS21D", "BYS21E", # F3
    "BYSEX", "BYRACE", "BYSTLANG" # add some covariates or grouping variables
  )
```

EXERCISE 4: REVERSE CODE

Reverse indicators so scale has consistent meaning for factor interpretation

Expected factors based on item wording:

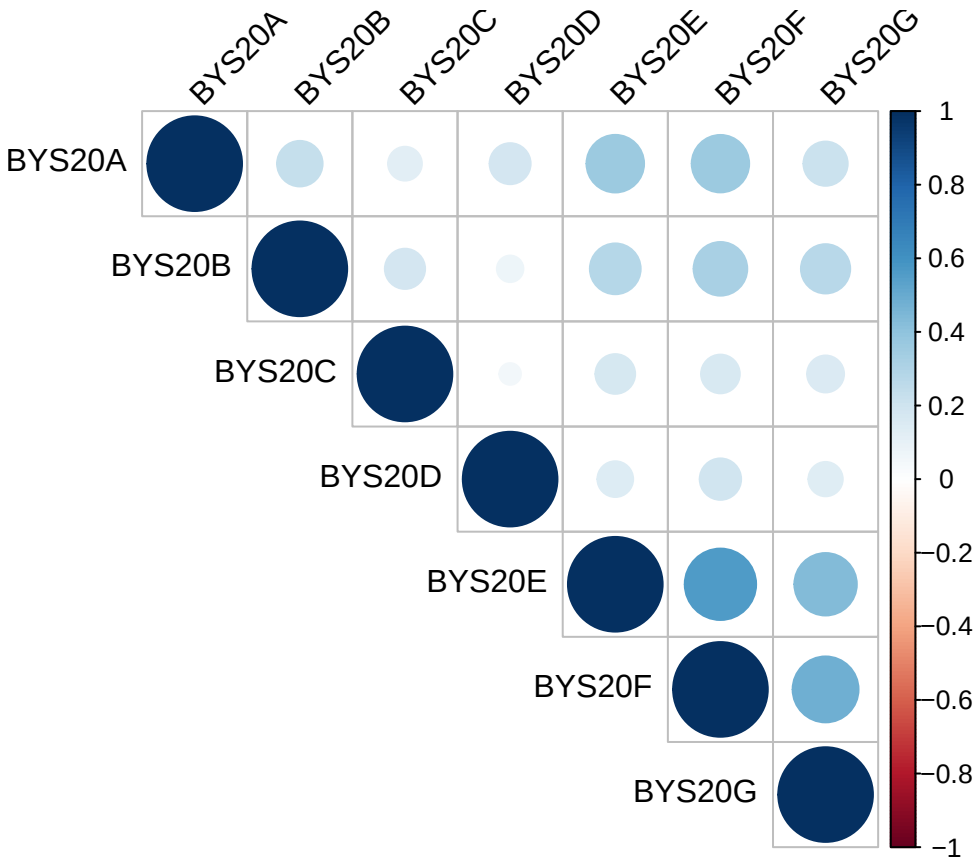
- Factor 1: "school climate", higher values indicate postive school climate
- Factor 2: "safety", higher values indicate safe school conditions
- Factor 3: "clear rules", higher values indicate clear communication of rules

```r
# Reverse code the following variables:

cols = c("BYS20A", "BYS20B", "BYS20C", # FACTOR 1: school climate
         "BYS20E", "BYS20F", "BYS20G",
         "BYS21A", "BYS21B", "BYS21C", "BYS21D", "BYS21E") # FACTOR 3: clear rules

# the number "5" will change: Use "number of categories" + 1 (e.g., 4 + 1)
schl_safe[ ,cols] <-  5 - schl_safe[ ,cols]
```

EXERCISE 5: CHECK CORRELATIONS

check correlations to see if coding was correct (all blue, no red)

```r
f1_cor <- cor(schl_safe[1:7], use = "pairwise.complete.obs")

corrplot(f1_cor,
         method = "circle",
         type = "upper",
         tl.col="black",
         tl.srt=45)
```



PRACTICE: CREATE SUB-FOLDERS

Folder `03-efa` is empty...

1. create folder named `data`
2. create folder named `efa_mplus`

EXERCISE 6: PREPARE DATASETS

Prepare dataset for `mplusObject()` by removing SPSS labels

```
# write a CSV datafile (preferable format for reading into R, without labels)
write_csv(schl_safe, here("data", "els_fa_ready_sub2.csv"))

# read the unlabeled data back into R
fa_data <- read_csv(here("data", "els_fa_ready_sub2.csv"))
```

EXERCISE 7: MPLUS AUTOMATION - GET DESCRIPTIVES

```
## TYPE = BASIC ANALYSIS (indicators: school climate, safety, clear rules )

m_basic  <- mplusObject(

  TITLE = "RUN TYPE = BASIC ANALYSIS - LAB 2 DEMO",

  VARIABLE =
 "! an mplusObject() will always need a 'usevar' statement
  ! ONLY specify variables to use in analysis
  ! lines of code in MPLUS ALWAYS end with a semicolon ';'

  usevar =
  BYS20A BYS20B BYS20C BYS20D BYS20E BYS20F BYS20G
  BYS20H BYS20I BYS20J BYS20K BYS20L BYS20M BYS20N
  BYS21A BYS21B BYS21C BYS21D BYS21E;",

  ANALYSIS =
    "type = basic" ,

  MODEL = "" ,

  PLOT = "",

  OUTPUT = "",

  usevariables = colnames(fa_data),   # tell MplusAutomation the column names to use
  rdata = fa_data)                    # this is the data object used (must be un-label)

m_basic_fit <- mplusModeler(m_basic,
               dataout=here("efa_mplus", "basic_els.dat"),
               modelout=here("efa_mplus", "basic_els.inp"),
               check=TRUE, run = TRUE, hashfilename = FALSE)

## END: TYPE = BASIC ANALYSIS
```

EXERCISE 8: EXPLORATORY FACTOR ANALYSIS (EFA)

```
## EXPLORATORY FACTOR ANALYSIS: (indicators: school climate, safety, clear rules)

m_efa_1  <- mplusObject(
  TITLE = "FACTOR ANALYSIS EFA - LAB 2 DEMO",
  VARIABLE =
 "usevar =
  BYS20A BYS20B BYS20C BYS20D BYS20E BYS20F BYS20G
  BYS20H BYS20I BYS20J BYS20K BYS20L BYS20M BYS20N
  BYS21A BYS21B BYS21C BYS21D BYS21E;",
```

```
  ANALYSIS =
 "type = efa 1 5;    ! run efa of 1 through 5 factor models
  estimator = MLR;   ! using the ROBUST ML Estimator
  parallel=50;       ! run the parallel analysis for viewing in elbow plot
  ",

  MODEL = "" ,

  PLOT = "type = plot3;",

  OUTPUT = "sampstat standardized residual modindices (3.84);",

  usevariables = colnames(fa_data),
  rdata = fa_data)

m_efa_1_fit <- mplusModeler(m_efa_1,
               dataout=here("efa_mplus", "efa_els.dat"),
               modelout=here("efa_mplus", "efa_els.inp"),
               check=TRUE, run = TRUE, hashfilename = FALSE)

## END: EXPLORATORY FACTOR ANALYSIS
```

EXERCISE 9: EFA REDUCED INDICATOR SET

Removed items: (loadings <.5 and/or cross-loadings)

How to make a tribble table?

```
lab_tools <- tribble(
  ~"Items", ~"Factor 1", ~"Factor 2",  ~"Factor 3",
 #----------/-------------/------------/-----------/,
  "BYS20C"  ,  " 0.149 "  ,  "0.168*"  ,  "0.120 "  ,
  "BYS20D"  ,  " 0.075 "  ,  "0.338*"  ,  "0.082 "  ,
  "BYS20H"  ,  " 0.345*"  ,  "0.307*"  ,  "0.061 "  ,
  "BYS20I"  ,  "-0.032 "  ,  "0.386*"  ,  "0.167 "  ,
  "BYS20L"  ,  " 0.004 "  ,  "0.400*"  ,  "0.377*"  ,
  "BYS21B"  ,  " 0.418*"  ,  "0.024 "  ,  "0.187*"  ,
)

lab_tools %>% gt()
```

Items	Factor 1	Factor 2	Factor 3
BYS20C	0.149	0.168*	0.120
BYS20D	0.075	0.338*	0.082
BYS20H	0.345*	0.307*	0.061
BYS20I	-0.032	0.386*	0.167
BYS20L	0.004	0.400*	0.377*
BYS21B	0.418*	0.024	0.187*

EXPLORATORY FACTOR ANALYSIS - REDUCED SET

```
m.step1  <- mplusObject(
  TITLE = "FACTOR ANALYSIS EFA - REDUCED SET - LAB 2 DEMO",
  VARIABLE =
    "usevar =
     BYS20A BYS20B BYS20E BYS20F BYS20G ! removed: BYS20C BYS20D
     BYS20J BYS20K BYS20M BYS20N        ! removed: BYS20H BYS20I BYS20L
     BYS21A BYS21C BYS21D BYS21E        ! removed: BYS21B
     ;",

  ANALYSIS =
    "type = efa 1 5;    ! run efa of 1 through 5 factor models
     estimator = MLR;   ! using the ROBUST ML Estimator
     parallel=50;       ! run the parallel analysis for viewing in elbow plot
    ",

  MODEL = "" ,

  PLOT = "type = plot3;",

  OUTPUT = "sampstat standardized residual modindices (3.84);",

  usevariables = colnames(fa_data),
  rdata = fa_data)

m.step1.fit <- mplusModeler(m.step1,
               dataout=here("efa_mplus", "efa_reduced.dat"),
               modelout=here("efa_mplus", "efa_reduced.inp"),
               check=TRUE, run = TRUE, hashfilename = FALSE)

## END: EXPLORATORY FACTOR ANALYSIS OF - REDUCED SET
```

References

Hallquist, M. N., & Wiley, J. F. (2018). MplusAutomation: An R Package for Facilitating Large-Scale Latent Variable Analyses in Mplus. Structural equation modeling: a multidisciplinary journal, 25(4), 621-638.

Horst, A. (2020). Course & Workshop Materials. GitHub Repositories, https://https://allisonhorst.github.io/

Muthén, L.K. and Muthén, B.O. (1998-2017). Mplus User's Guide. Eighth Edition. Los Angeles, CA: Muthén & Muthén

R Core Team (2017). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/

Wickham et al., (2019). Welcome to the tidyverse. Journal of Open Source Software, 4(43), 1686, https://doi.org/10.21105/joss.01686