

Exercises Basic CFAs

Additional exercise 1 (model parameter matrices)

- For the standardized-latent-variable identification approach, think about how the describe how the β , Λ , Ψ and Θ matrices will differ from that of the marker identification approach, and how they will be similar. Use function `inspect()` with argument `what = "est"` to check.
- For example 3.3 part III, write out the β , Λ , Ψ and Θ matrices. That is, write out the matrices for the two-factor model with correlated factors; the two-factor model in which one factor is regressed on the other; the one-factor model with correlated errors between two subtests.

Exercise 3.1

Umstattd-Meyer, Janke, and Beaujean (2013) measured poor psychosocial health as a single factor model using three items from a depression questionnaire and a measure of social activity. The covariance matrix (which contains four additional variables not used in the current exercise) is given below ($N = 6053$). (This matrix will be used for both Exercise 3.1 and 3.2):

```
Health.cov2 <- lav_matrix_lower2full(c(
  0.77,
  0.38, 0.65,
  0.39, 0.39, 0.62,
-0.25,-0.32,-0.27, 6.09,
  0.31, 0.29, 0.26,-0.36, 7.67,
  0.24, 0.25, 0.19,-0.18, 0.51, 1.69,
-3.16,-3.56,-2.63, 6.09,-3.12,-4.58,204.79,
-0.92,-0.88,-0.72, 0.88,-1.49,-1.41, 16.53, 7.24
))
rownames(Health.cov2) <- colnames(Health.cov2) <- c("Dep1", "Dep2", "Dep3", "SocAct",
  "Falls", "ChronCond", "PhysAct",
  "PersMob")
```

- Fit a single-factor model with the first four indicators. Use both the marker variable and standardized latent variable identification approaches. For the marker variable method, use `Dep1` as the marker variable. Check whether the resulting χ^2 and df are identical between the two methods.
- Looking at the standardized loadings, do you think it is a good idea to combine the three depression indicators and Social Activity as a measure of poor psychosocial health?

Exercise 3.2

The model for Exercise 3.1 was part of a larger SEM, shown in Figure 3.11 of the Beaujean book.

- Fit the SEM model in Figure 3.11 (see Beaujean book) to the data. Use the marker variable identification approach only. Evaluate and describe model fit. Make sure to add `fit.measures = TRUE` and `standardized = TRUE` to your call to `summary()` to obtain fit indices and standardized parameter estimates. Include both parameter estimates (e.g., significance and standardized values of loadings) as well as model fit indices (e.g., $\chi^2(df)$, RMSEA, CFI, SRMR) in your evaluation of model fit.

- b) Are both psychosocial and physical health predictive of personal mobility? Describe their effects.

Additional exercise 2 (reflective vs. formative latent variables)

Below, code to construct a covariance matrix is provided. The sample size was $N = 500$. The models to be fitted to these data consist of three latent variables:

- Variables $X1$, $X2$ and $X3$ are indicators of a latent variable Stress.
- Variables $Y1$, $Y2$ and $Y3$ are indicators of a reflective latent variable Satisfaction.
- Variables $Y4$, $Y5$ and $Y6$ are indicators of a reflective latent variable Optimism.
- Satisfaction and Optimism should be regressed on Stress.

- a) Fit a model to the data where Stress is a formative latent variable.
- b) Fit a model to the data where Stress is a reflective latent variable.
- c) Compare the values of the fit indices and the standardized loadings between the reflective and formative model. Based on these values, would you prefer the formative or reflective model?

```
## Input covariances:
cormat <- lav_matrix_lower2full(c(
  1.000,
  0.700, 1.000,
  0.713, 0.636, 1.000,
  0.079, 0.066, 0.076, 1.000,
  0.088, 0.058, 0.070, 0.681, 1.000,
  0.084, 0.056, 0.074, 0.712, 0.633, 1.000,
  0.279, 0.248, 0.240, 0.177, 0.155, 0.170, 1.000,
  0.250, 0.214, 0.222, 0.157, 0.143, 0.152, 0.373, 1.000,
  0.280, 0.236, 0.251, 0.173, 0.178, 0.171, 0.448, 0.344, 1.000
))

## Input standard deviations:
sds = c(2.5, 2.1, 3.0, 4.1, 3.9, 4.4, 1.2, 1.0, 1.2)

## Reconstruct covariance matrix from correlations and sds:
covmat <- diag(sds) %*% cormat %*% diag(sds)

## Assign row and column names:
rownames(covmat) <- colnames(covmat) <- c("Y1", "Y2", "Y3", "Y4", "Y5", "Y6",
                                           "X1", "X2", "X3")
```

Additional exercise 3 (ML vs. robust ML; model modifications)

Load the Holzinger and Swineford (1939) dataset, included in the lavaan package:

```
data(HolzingerSwineford1939)
```

This is a classic dataset with several scores on mental ability subtests, of 7th- and 8th-grade children. We use first six subtests ($x1 - x6$).

- a) Fit a single factor model using robust ML estimation. Use function `summary()` to inspect the fitted model. Make sure to add `standardized = TRUE` and `fit.measures = TRUE` in your call to `summary()`. Does the model fit well (evaluate parameter estimates as well as model fit indices, evaluate the latter using the Hu & Bentler (1999) criteria)?
- b) Compare the values of standard and robust chi-square values, CFI, RMSEA and SRMR.

- c) Inspect parameter estimates, modification indices and residuals to create a better fitting model.
- d) Does your new model fit well, according to the Hu & Bentler (1999) criteria?