Assignment 2

SEM 2: Structural Equation Modeling
Please hand in a .pdf file containing your report and a .R containing your codes or screenshots of every Jasp analysis. The deadline of this assignment is Wednesday May 24 11:00.

Assignment

Part 1

Last week you analyzed the following SEM model:

```
library("lavaan")

# Correlation matrix:
Cor <- getCov('
  1
  .16 1
  .61 .23 1
  -.46 -.16 -.06 1
  .34 .03 .50 .06 1
  -.17 -.14 .09 .49 .45 1
  .18 .08 .28 -.07 .37 .11 1')

# Standard deviations:
SD <- c(1.22, 1.74, 1.38, 1.42, 1.78, 1.93, 1.87)

# Covariances:
Cov <- cor2cov(Cor, SD)

# Names:
colnames(Cov) <- rownames(Cov) <- c("MC","MA","MS","WS","MSC","WSC","AA")

# Model:
Model <- '
AA ~ MSC + WSC
MSC ~ MS
WSC ~ WS
MS ~ MC + MA
WS ~ MC + MA
MS ~ MS

```

This model could be fitted in Lavaan using the following codes:
### Question 1 (4 points)

Think of an equivalent model and fit the model on the same dataset (tip: Lavaan automatically adds covariances between dependent variables which you might need to remove). Argue why you think the models should be equivalent. Compare the $\chi^2$ and degrees of freedom of both models, are they the same?

Given the following SEM analysis (original article on blackboard):

```r
library("semPlot")
library("lavaan")
suveg.r <- c(
  '1.00
-0.25 1.00
 0.11 -0.14 1.00
 0.25 -0.22 0.21 1.00
)```

```r
# Fit:
fit <- sem(Model, sample.cov = Cov, sample.nobs = 105, fixed.x = TRUE)
fit
```

```r
library("semPlot")
semPaths(fit, style = "RAM", layout = "tree2", rotation = 2)
```
suveg.r <- getCov(suveg.r, names = c("RMBI", "FES", "FEQN", "DERS", "SCL90ANX"))
sd.suveg <- c(0.33, 0.62, 1.00, 0.54, 0.47)
suveg <- cor2cov(R = suveg.r, sds = sd.suveg)

mod1 <- '

ENTER MODEL HERE

fit1 <- sem(mod1, sample.cov = suveg, sample.nobs = 676, fixed.x = FALSE)
semPaths(fit1, "mod", "std", layout = "tree2", rotation = 2,
          sizeMan = 10, curve = 2)

Question 2 (2 points) Fill in the model to replicate the above analysis

Question 3 (3 points) Given the above path diagram, which of these statements are true?

- FES ⊥⊥ SCL
- FES ⊥⊥ SCL | DER
- RMB ⊥⊥ FEQ | DER

We can obtain the implied variances and covariances using:

lavInspect(fit1, "sigma")

```r
# DERS  SCL90A  RMBI  FES  FEQN
# DERS  0.291
# SCL90ANX  0.134  0.221
# RMBI  0.044  0.021  0.109
# FES  -0.074  -0.034  -0.051  0.384
```
**Question 4 (2 points)** Using the Schur complement and the model implied variances and covariances, compute the partial correlation between FES and SCL given DER. Round your result to 4 digits.

**Question 5 (2 points)** Can the arrow DER $\rightarrow$ SCL be changed into DER $\leftarrow$ SCL? Why (not)?

Consider the following SEM diagram:

![SEM Diagram]

Let $\Lambda$, $\Psi$, and $\Theta$ be defined as:

$$
\Lambda = \begin{bmatrix} 1 & 0 & 0 \\ 2 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0.5 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 1 \end{bmatrix}, \quad \Psi = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0.5 & 0 \\ 0 & 0 & 0.5 \end{bmatrix}, \quad \Theta = \begin{bmatrix} 0 & 0 & 0 \\ 0.5 & 0 & 0 \\ 0 & 0.5 & 0 \end{bmatrix}
$$

And $\Theta$ is a diagonal matrix with 0.5 on all diagonal elements. We assume all variables are centered, meaning they have an expected value of 0:

$$
E(y_1) = E(y_2) = E(y_3) = E(y_4) = E(y_5) = E(y_6) = E(\eta_1) = E(\eta_2) = E(\eta_3) = 0
$$

This means that without knowing anything, our best prediction on a person’s score on any of these variables would be 0. This makes use of the fact that the expected values of all residuals are always zero as well:

$$
E(\epsilon_1) = E(\epsilon_2) = E(\epsilon_3) = E(\epsilon_4) = E(\epsilon_5) = E(\epsilon_6) = E(\zeta_1) = E(\zeta_2) = E(\zeta_3) = 0
$$

**Question 6 (4 points)** Compute the following expectations (tip: to compute these, derive structural equations in terms of exogenous variables and replace all unknown exogenous variables with their expectation):

- $E(y_1|\text{Do}(\eta_1 = 1))$
- $E(y_1|\text{Do}(\eta_2 = 1))$
- $E(y_1|\text{Do}(\eta_3 = 1))$
- $E(\eta_3|\text{Do}(\eta_1 = 1))$
- $E(\eta_1|\text{Do}(\eta_3 = 1))$

**Question 7 (4 points)** Are the following statements true or false (you do not have to compute these expectations)?

- $E(y_1|\text{Do}(\eta_2 = 1)) = E(y_1|\text{See}(\eta_2 = 1))$
- $E(\eta_3|\text{Do}(\eta_1 = 1)) = E(\eta_2|\text{See}(\eta_1 = 1))$
• $E(y_6| Do(\eta_1 = 3)) = E(y_6)$
• $E(\eta_2| Do(\eta_1 = -3)) > E(\eta_2)$

References
