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:

This model could be fitted in Lavaan using the following codes:

```R
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
```
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
  0.18 -0.15 0.19 0.53 1.00'
)
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 <-'
```
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")

<table>
<thead>
<tr>
<th></th>
<th>DERS</th>
<th>SCL90A</th>
<th>RMBI</th>
<th>FES</th>
<th>FEQN</th>
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<tbody>
<tr>
<td>DERS</td>
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<tr>
<td>SCL90A</td>
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<td>0.221</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>RMBI</td>
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<td>0.021</td>
<td>0.109</td>
<td></td>
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</tr>
<tr>
<td>FES</td>
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<td>-0.034</td>
<td>-0.051</td>
<td>0.384</td>
<td></td>
</tr>
<tr>
<td>FEQN</td>
<td>0.113</td>
<td>0.052</td>
<td>0.036</td>
<td>-0.087</td>
<td>0.999</td>
</tr>
</tbody>
</table>

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:

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

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:

\[
E(y_1) = E(y_2) = E(y_3) = E(y_4) = E(y_5) = E(\eta_1) = E(\eta_2) = E(\eta_3) = 0
\]

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:

\[
E(\epsilon_1) = E(\epsilon_2) = E(\epsilon_3) = E(\epsilon_4) = E(\epsilon_5) = E(\zeta_1) = E(\zeta_2) = E(\zeta_3) = 0
\]

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):

- $E(y_1|\text{Do}(\eta_1 = 1))$
- $E(y_1|\text{Do}(y_2 = 1))$
- $E(\eta_1|\text{Do}(\eta_1 = 1))$
- $E(\eta_1|\text{Do}(\eta_3 = 1))$

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

- $E(y_1|\text{Do}(y_2 = 1)) = E(y_1|\text{See}(y_2 = 1))$
- $E(\eta_2|\text{Do}(\eta_1 = 1)) = E(\eta_2|\text{See}(\eta_1 = 1))$
- $E(y_6|\text{Do}(\eta_1 = 3)) = E(y_6)$
- $E(\eta_2|\text{Do}(\eta_1 = -3)) > E(\eta_2)$