Questions and Sample Answers for Chapter 9

Section 1 – Questions

Question 1

Consider a modeling example with four dichotomous attributes (0 = non-mastery, 1 = mastery). Construct the latent class profiles for all resulting 16 classes using the process described in this chapter. Moreover, create the log-linear structural model expressions for a situation where the four attributes are assumed to be uncorrelated and show the *Mplus* code that is necessary to implement this model.

Question 2

What is the Q-matrix for a full LCDM that is specified with the following *Mplus* model syntax? Assume that the latent classes are constructed using the process described in this chapter.

```
MODEL:
%c#1%
[x1$1] (t1_1);
[x2$1] (t2_1);
[x3$1] (t3_1);

%c#2%
[x1$1] (t1_2);
[x2$1] (t2_2);
[x3$1] (t3_1);

%c#3%
[x1$1] (t1_1);
[x2$1] (t2_3);
[x3$1] (t3_2);

%c#4%
[x1$1] (t1_2);
[x2$1] (t2_4);
[x3$1] (t3_2);
```

Question 3

In order to estimate DCMs using *MPlus* software, it is important to understand the program's default settings in order to ensure appropriate modification of the syntax of the analytic code. Which of the following statements are correct descriptions of these settings?

a. *MPlus* interprets the highest value of categorical variables as the referent category, requiring a negative threshold parameterization in order for resulting estimates to be properly interpreted.

b. Outcome variables are assumed to be categorical in *Mplus*; if they are continuous the a separate command is necessary to identify them as such.

c. In order to facilitate estimation of parameters for the log-linear structural component of the model, *MPlus* sets the parameter for estimating class membership in the first latent class to zero, and model constraints must be specified accordingly.

d. In the calculation of the

Question 4

Which of the following is true of the estimation of core DCMs in *Mplus*?

a. The option `MIXTURE` should be used to estimate DCMs in *Mplus* as DCMs are constrained latent class models which can be subsumed into a larger class of models called finite mixture models.

b. By specifying model constraints within the `MODEL CONSTRAINTS` section, one can estimate core DCMs (i.e., DINA, DINO, NIDO, NIDA, C-RUM, and NC-RUM) in *Mplus*.

c. Getting stuck in a local minima or maxima is not a problem for estimating DCMs within *Mplus*.

d. One can estimate all structural model parameterization that were discussed in Chapter 8 with *Mplus*.

e. None of the above.

f. All of the above.

Section 2 – Sample Answers

Question 1

The latent class profiles are shown below along with the log-linear structural model kernels, which contain only main effects to capture the assumption that the attributes are uncorrelated.

Latent Class	Attribute Profile	Log-linear model kernel
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		

The following is the relevant code for the structural model specification in the `Model` and `Model Constraint` statements:

```
MODEL:

%OVERALL%
[C#1] (m1);
[C#2] (m2);
[C#3] (m3);
[C#4] (m4);
[C#5] (m5);
[C#6] (m6);
[C#7] (m7);
[C#8] (m8);
[C#9] (m9);
[C#10] (m10);
[C#11] (m11);
[C#12] (m12);
[C#13] (m13);
[C#14] (m14);
[C#15] (m15);
```

```
MODEL CONSTRAINT:          ! for structural model

NEW (g_0 g_11 g_12 g_13 g_14);
m1 = - (g_11 + g_12 + g_13 + g_14);
m2 = g_14 - (g_11 + g_12 + g_13 + g_14);
m3 = g_13 - (g_11 + g_12 + g_13 + g_14);
m4 = g_13 + g_14 - (g_11 + g_12 + g_13 + g_14);
m5 = g_12 - (g_11 + g_12 + g_13 + g_14);
m6 = g_12 + g_14 - (g_11 + g_12 + g_13 + g_14);
m7 = g_12 + g_13 - (g_11 + g_12 + g_13 + g_14);
m8 = g_12 + g_13 + g_14 - (g_11 + g_12 + g_13 + g_14);
m9 = g_11 - (g_11 + g_12 + g_13 + g_14);
m10 = g_11 + g_14 - (g_11 + g_12 + g_13 + g_14);
m11 = g_11 + g_13 - (g_11 + g_12 + g_13 + g_14);
m12 = g_11+ g_13 + g_14 - (g_11 + g_12 + g_13 + g_14);
m13 = g_11 + g_12 - (g_11 + g_12 + g_13 + g_14);
m14 = g_11 + g_12 + g_14 - (g_11 + g_12 + g_13 + g_14);
m15 = g_11 +g_12 + g_13 - (g_11 + g_12 + g_13 + g_14);
g_0 = - (g_11 + g_12 + g_13 + g_14);
```

Question 2

Using the process described in this chapter the attribute profiles for the four latent classes are $c_1 = [0,0];\ c_2 = [0,1];\ c_3 = [1,0];\ c_4 = [1,1]$.

Thus, the Q-matrix is $\begin{pmatrix} 0 & 1 \\ 1 & 1 \\ 1 & 0 \end{pmatrix}$.

The first item has the same thresholds for classes 1 and 3 as well as 2 and 4, indicating that attribute 1 is not measured by the item. Similarly, the last item has the same thresholds for latent classes 1 and 2 as well as 3 and 4, indicating that attribute 2 is not measured by this item. The second item has different thresholds for each latent class, indicating that both attributes are measured by this item.

Question 3

Correct answer: b

a. When specifying threshold parameters it is necessary to multiply the log-linear kernel by -1, but this is not because of how *Mplus* "reads in" or "recodes" data. For dichotomous items, the threshold parameterization in *Mplus* provides the probability of an incorrect rather than a correct response, which makes the negative parameterization necessary in order to for interpretations to be correct.

b. *Mplus* assumes that variables are continuous. Thus, it is necessary to specify that outcome variables are categorical, which is often the case when DCMs are applied to real data. This can be achieved using the `CATEGORICAL ARE` statement.

c. In order to facilitate estimation, *Mplus* sets the structural model parameter for the last latent class to zero, which is the class in which members have mastered all measured attributes.

d. If the number of possible response patterns is overwhelmingly large, and as a result there are a large number of empty cells in the joint cross-classification table, certain low-frequency patterns are omitted from computations so no additional adjustment to degrees of freedom is necessary.

Question 4

Correct answers: a & b

As for option (c), the estimation process for DCMs in Mplus is generally efficient (i.e., fast) but the estimation routines can still get "stuck" in local maxima or minima of the response surface because DCMs are highly parameterized multidimensional models.

As for option (d), one can estimate the log-linear structural parameterization for DCMs within Mplus, but there are currently no options for estimating either a tetrachoric structural model or a higher-order structural model.