Three-level saturated model for simulated data

Contents

## 1. Introduction

Using the same simulated data described previously, a "saturated model" using the dummy variables created previously is now fitted to the data. This model illustrates the use of the NFREE and DEVIANCE keywords to obtain a chi-square statistic for testing two nested models. A model of particular interest is the so-called saturated model, which is obtained by estimating the population means and the covariance matrices for both level-3 and level-2 at the six measurement occasions. The dummy variables created in the previous section, each corresponding to a specific measurement occasion, are used for this purpose.

2. Fitting the model

The model is fitted using the same sequence of dialog boxes shown in the previous Section. In order to compare the fit of the saturated model with the fit of the model described previously, the deviance statistic and number of estimated parameters from the first model are used. In the previous model, 11 parameters (4 fixed and 7 random) were estimated and a deviance statistic (-2 log(L)) of 23121.934 was obtained. Enter these values in the **Nfree** and **Deviance** fields of the **Title and Options** dialog box. Click **Next** to display the **Identification Variables** dialog box.
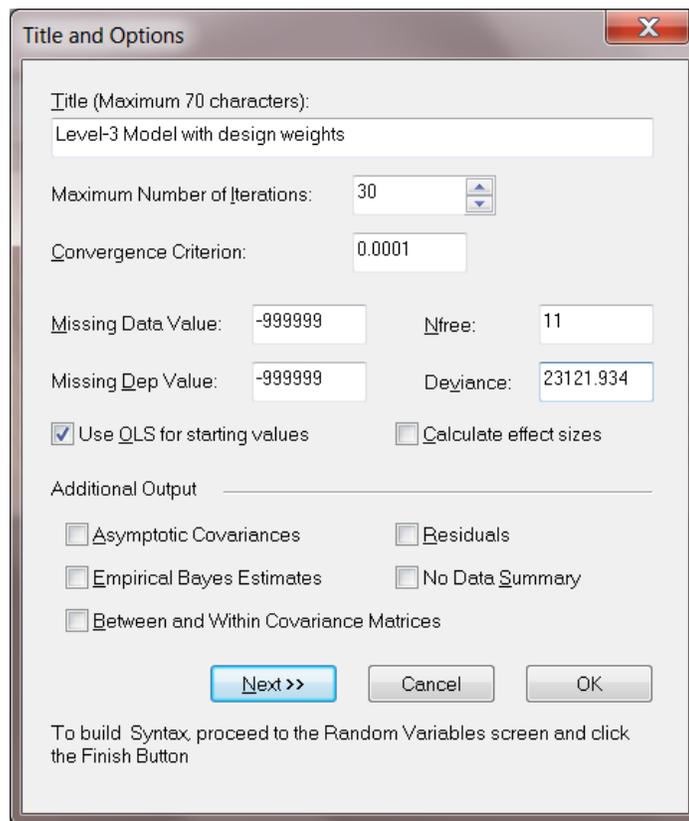
As no changes to the hierarchical structure or weight specification entered previously on the **Identification Variables** dialog box, click **Next** to load the **Response and Fixed Variables** dialog box.

Note that one cannot add an intercept term to the fixed part of the model when dummy1 to dummy6 are selected as predictors. If the intercept term is not unchecked, then the fixed parameter coefficients cannot be estimated, since the fixed-effect design matrix containing intcept, dummy1, …, dummy6 will not be of full rank. Click **Next** to proceed to the **Random Variables** dialog box.
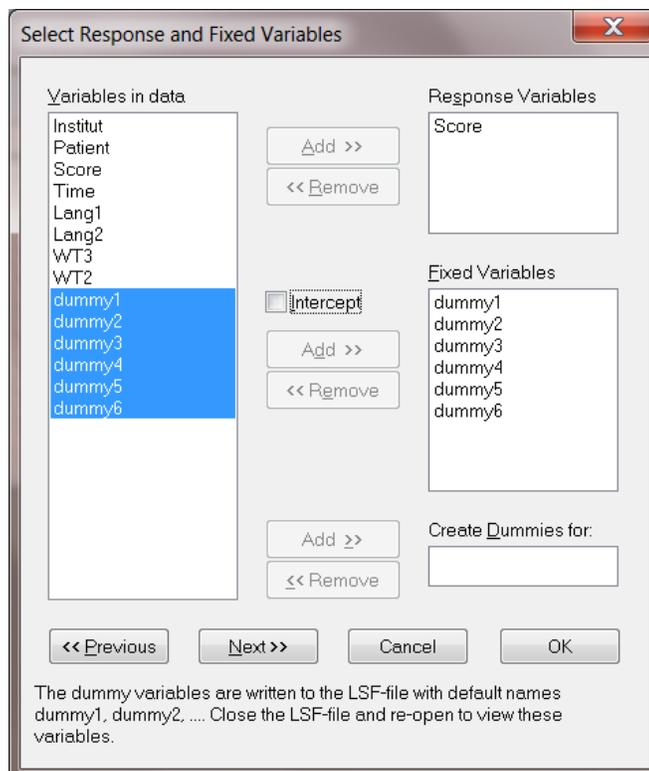
On the **Random Variables** dialog box, the intercept terms for the random effects are unchecked and dummy variables one to six are only added at levels 2 and 3.
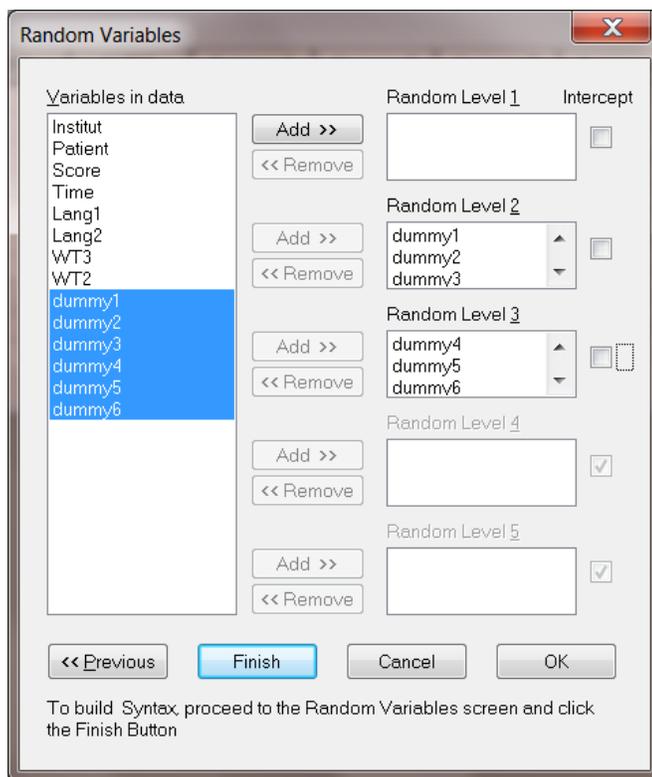
Click the **Finish** button to produce the PRELIS syntax file (which was subsequently saved as **surveyhlm2.prl**).


```
OPTIONS OLS=YES NFREE=11 DEVIANCE=23121.934 CONVERGE=0.000100 MAXITER=30 OUTPUT=STANDARD
TITLE=Level-3 Model with design weights;
SY='C:\LISREL9 Examples\MLEVELEX\surveyhlm.lsf';
ID3=Institut;
ID2=Patient;
WEIGHT3=WT3;
WEIGHT2=WT2;
RESPONSE=Score;
FIXED=dummy1 dummy2 dummy3 dummy4 dummy5 dummy6;
RANDOM2=dummy1 dummy2 dummy3 dummy4 dummy5 dummy6;
RANDOM3=dummy1 dummy2 dummy3 dummy4 dummy5 dummy6;
```

3. Discussion of results

The portions of the output below summarize the estimated parameter values for the fixed part of the model and the goodness of fit χ^2 statistic. The $\hat{\beta}$ values are estimates of the population mean scores at each of the six measurement occasions, after controlling for the within institution and within patient variation. Note that the difference in the -2 log(L) values is 2832.814. The χ^2 value of 1312.7329 was obtained by multiplying 2832.814 with the scale factor (0.46) obtained when design weights are included.

```
surveyhlm2.OUT                                                          ─ □ ✕

                        +----------------------+
                        | FIXED PART OF MODEL  |
                        +----------------------+
|

 -----------------------------------------------------------------------
  COEFFICIENTS              BETA-HAT        STD.ERR.       Z-VALUE      PR > |Z|
 -----------------------------------------------------------------------
  dummy1                    0.86268         0.11765        7.33286      0.00000
  dummy2                    1.47507         0.16289        9.05572      0.00000
  dummy3                    1.92424         0.19218       10.01261      0.00000
  dummy4                    2.43611         0.24712        9.85820      0.00000
  dummy5                    2.98651         0.29087       10.26742      0.00000
  dummy6                    3.40673         0.34567        9.85530      0.00000


                        +----------------------+
                        |  -2 LOG-LIKELIHOOD   |
                        +----------------------+

  DEVIANCE= -2*LOG(LIKELIHOOD) =      20289.1201028391
  NUMBER OF FREE PARAMETERS =             48

       |------------------------------------------------|
       | Chi-square Statistic for Testing the Fit of    |
       | the Current Model versus an Alternative Model   |
       |------------------------------------------------|

    -2Log(L)=       20289.1201 with      48  Free Parameters (Current Model)
    -2Log(L)=       23121.9340 with      11  Free Parameters (Alternative Model)
     Chi-Square=     1312.7329, df=       37, p-value=  0.00000
                              III
```

Results for the variance components (random part of the model) are shown below. The $\hat{\tau}$ values are estimates of the population variances/covariances at level-3 (institutions) and level-2 (patients). An inspection of the output shows that, in general, there is greater variation in scores at each time point within patients than is the case within institutions.

```
surveyhlm2.OUT                                                          ─ □ ✕
 -----------------------------------------------------------------------
  LEVEL 3                         TAU-HAT      STD.ERR.     Z-VALUE   PR > |Z|
 -----------------------------------------------------------------------
  dummy1   /dummy1               0.91628       0.16213      5.65142    0.00000
  dummy2   /dummy1               1.14733       0.21999      5.21535    0.00000
  dummy2   /dummy2               1.74251       0.39431      4.41920    0.00001
  dummy3   /dummy1               1.37995       0.24954      5.52995    0.00000
  dummy3   /dummy2               2.03690       0.43315      4.70253    0.00000
  dummy3   /dummy3               2.54612       0.49287      5.16596    0.00000
  dummy4   /dummy1               1.67425       0.32598      5.13604    0.00000
  dummy4   /dummy2               2.61631       0.55997      4.67225    0.00000
  dummy4   /dummy3               3.22516       0.62377      5.17039    0.00000
  dummy4   /dummy4               4.18454       0.81608      5.12759    0.00000
  dummy5   /dummy1               1.84738       0.33817      5.46284    0.00000
  dummy5   /dummy2               2.84893       0.61342      4.64437    0.00000
  dummy5   /dummy3               3.58711       0.68160      5.26281    0.00000
  dummy5   /dummy4               4.69860       0.89993      5.22107    0.00000
  dummy5   /dummy5               5.52001       1.03310      5.34316    0.00000
  dummy6   /dummy1               2.17376       0.40571      5.35786    0.00000
  dummy6   /dummy2               3.46369       0.77193      4.48704    0.00001
  dummy6   /dummy3               4.38163       0.85862      5.10311    0.00000
  dummy6   /dummy4               5.67540       1.11176      5.10487    0.00000
  dummy6   /dummy5               6.58911       1.27135      5.18275    0.00000
  dummy6   /dummy6               8.03923       1.59318      5.04602    0.00000
                              III
```

surveyhlm2.OUT

```
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  LEVEL 2                      TAU-HAT      STD.ERR.      Z-VALUE      PR > |Z|
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  dummy1   /dummy1              2.14267      0.25276       8.47722      0.00000
  dummy2   /dummy1              1.45763      0.22475       6.48547      0.00000
  dummy2   /dummy2              3.05585      0.43746       6.98541      0.00000
  dummy3   /dummy1              1.93046      0.29417       6.56248      0.00000
  dummy3   /dummy2              2.57313      0.40916       6.28886      0.00000
  dummy3   /dummy3              4.32406      0.58250       7.42334      0.00000
  dummy4   /dummy1              2.19516      0.31774       6.90869      0.00000
  dummy4   /dummy2              3.11563      0.50019       6.22893      0.00000
  dummy4   /dummy3              3.99632      0.57238       6.98198      0.00000
  dummy4   /dummy4              5.92608      0.83054       7.13521      0.00000
  dummy5   /dummy1              2.60166      0.38782       6.70850      0.00000
  dummy5   /dummy2              3.88162      0.59735       6.49803      0.00000
  dummy5   /dummy3              4.89266      0.68106       7.18386      0.00000
  dummy5   /dummy4              6.06821      0.84521       7.17954      0.00000
  dummy5   /dummy5              8.14698      1.05293       7.73741      0.00000
  dummy6   /dummy1              2.88799      0.41279       6.99622      0.00000
  dummy6   /dummy2              4.37310      0.74994       5.83124      0.00000
  dummy6   /dummy3              5.73908      0.83557       6.86847      0.00000
  dummy6   /dummy4              7.07375      0.99921       7.07933      0.00000
  dummy6   /dummy5              8.61156      1.16767       7.37497      0.00000
  dummy6   /dummy6             11.07436      1.57773       7.01916      0.00000
```