Latent Class Model in Mplus

Below is a reanalysis of the latent class model of the sleep items (see the handout “Latent Class Analysis” for comparison to SAS and poLCA in R). Several settings were used that are optional, including starts = 100 10 to request random start values (two numbers are used—one for initial and one for paring down), stiterations=100 is for more starting value iterations, and lrtstarts = 200 60 100 75 for increasing the start values used for the bootstrapping for the p-value for the VLMR comparison to a one-class model. There is an error reported in the results indicating a parameter was set by the program, and so these results should not be trusted or reported without resolving the error. However, the results match the SAS results nearly perfectly and the error is likely a result of a poor item (for medication use) with a very low frequency. The error was not fixed with increased start values or user supplied start values, so a likely solution would be to remove this item from the model.

```
Mplus VERSION 8.5
MUTHEN & MUTHEN

INPUT INSTRUCTIONS


  title:  ICAR verbal ability items IRT model;

  data:  file=sleepitems.dat; format=free;

  variable:  names = trubslep trubstay wakenite liteslp refreshd medhelp
    problem stopb restlss drvsleep drvresul;

            categorical=trubslep trubstay wakenite liteslp refreshd medhelp
  problem stopb restlss drvsleep drvresul;

    classes = etac(2) ;

  analysis: type=mixture; starts = 100 10; stiterations=100;
      lrtstarts = 200 60 100 75 ;

  model:
       %overall%
       [etac#1*];

       %etac#1%

      %etac#2%

  output: tech11 tech14;



INPUT READING TERMINATED NORMALLY



ICAR verbal ability items IRT model;

SUMMARY OF ANALYSIS

Number of groups                                                 1
Number of observations                                         224

Number of dependent variables                                   11
Number of independent variables                                  0
Number of continuous latent variables                            0
Number of categorical latent variables                           1

Observed dependent variables

  Binary and ordered categorical (ordinal)
```

```
   TRUBSLEP    TRUBSTAY    WAKENITE    LITESLP     REFRESHD    MEDHELP
   PROBLEM     STOPB       RESTLSS     DRVSLEEP    DRVRESUL

Categorical latent variables
   ETAC


Estimator                                                       MLR
Information matrix                                         OBSERVED
Optimization Specifications for the Quasi-Newton Algorithm for
Continuous Outcomes
  Maximum number of iterations                                  100
  Convergence criterion                                   0.100D-05
Optimization Specifications for the EM Algorithm
  Maximum number of iterations                                  500
  Convergence criteria
    Loglikelihood change                                  0.100D-06
    Relative loglikelihood change                         0.100D-06
    Derivative                                            0.100D-05
Optimization Specifications for the M step of the EM Algorithm for
Categorical Latent variables
  Number of M step iterations                                     1
  M step convergence criterion                            0.100D-05
  Basis for M step termination                            ITERATION
Optimization Specifications for the M step of the EM Algorithm for
Censored, Binary or Ordered Categorical (Ordinal), Unordered
Categorical (Nominal) and Count Outcomes
  Number of M step iterations                                     1
  M step convergence criterion                            0.100D-05
  Basis for M step termination                            ITERATION
  Maximum value for logit thresholds                             15
  Minimum value for logit thresholds                            -15
  Minimum expected cell size for chi-square               0.100D-01
Optimization algorithm                                          EMA
Random Starts Specifications
  Number of initial stage random starts                         100
  Number of final stage optimizations                            10
  Number of initial stage iterations                            100
  Initial stage convergence criterion                     0.100D+01
  Random starts scale                                     0.500D+01
  Random seed for generating random starts                        0
Link                                                          LOGIT

Input data file(s)
  sleepitems.dat
Input data format  FREE


UNIVARIATE PROPORTIONS AND COUNTS FOR CATEGORICAL VARIABLES

    TRUBSLEP
      Category 1    0.594          133.000
      Category 2    0.406           91.000
    TRUBSTAY
      Category 1    0.562          126.000
      Category 2    0.438           98.000
    WAKENITE
      Category 1    0.192           43.000
      Category 2    0.808          181.000
    LITESLP
      Category 1    0.576          129.000
      Category 2    0.424           95.000
    REFRESHD
      Category 1    0.375           84.000
      Category 2    0.625          140.000
    MEDHELP
      Category 1    0.942          211.000
      Category 2    0.058           13.000
    PROBLEM
      Category 1    0.558          125.000
      Category 2    0.442           99.000
    STOPB
      Category 1    0.915          205.000
      Category 2    0.085           19.000
```

```
    RESTLSS
      Category 1    0.692          155.000
      Category 2    0.308           69.000
    DRVSLEEP
      Category 1    0.862          193.000
      Category 2    0.138           31.000
    DRVRESUL
      Category 1    0.897          201.000
      Category 2    0.103           23.000


RANDOM STARTS RESULTS RANKED FROM THE BEST TO THE WORST LOGLIKELIHOOD VALUES

Final stage loglikelihood values at local maxima, seeds, and initial stage start numbers:

           -1178.771  902278           21
           -1178.771  963053           43
           -1178.771  311214           64
           -1178.771  391179           78
           -1178.771  93468            3
           -1178.771  723775           97
           -1178.771  784664           75
           -1178.771  372176           23
           -1178.771  939021           8
           -1178.771  85462            51


     IN THE OPTIMIZATION, ONE OR MORE LOGIT THRESHOLDS APPROACHED EXTREME VALUES
     OF -15.000 AND 15.000 AND WERE FIXED TO STABILIZE MODEL ESTIMATION.  THESE
     VALUES IMPLY PROBABILITIES OF 0 AND 1.  IN THE MODEL RESULTS SECTION, THESE
     PARAMETERS HAVE 0 STANDARD ERRORS AND 999 IN THE Z-SCORE AND P-VALUE COLUMNS.

THE BEST LOGLIKELIHOOD VALUE HAS BEEN REPLICATED.  RERUN WITH AT LEAST TWICE THE
RANDOM STARTS TO CHECK THAT THE BEST LOGLIKELIHOOD IS STILL OBTAINED AND REPLICATED.



THE MODEL ESTIMATION TERMINATED NORMALLY



MODEL FIT INFORMATION

Number of Free Parameters                        23

Loglikelihood

          H0 Value                        -1178.771
          H0 Scaling Correction Factor      1.0873
            for MLR

Information Criteria

          Akaike (AIC)                     2403.543
          Bayesian (BIC)                   2482.011
          Sample-Size Adjusted BIC         2409.120
            (n* = (n + 2) / 24)

Chi-Square Test of Model Fit for the Binary and Ordered Categorical
(Ordinal) Outcomes**

          Pearson Chi-Square

          Value                             866.925
          Degrees of Freedom                   2018
          P-Value                           1.0000

          Likelihood Ratio Chi-Square

          Value                             338.123
          Degrees of Freedom                   2018
          P-Value                           1.0000
```

```
** Of the 2048 cells in the latent class indicator table, 6
   were deleted in the calculation of chi-square due to extreme values.



FINAL CLASS COUNTS AND PROPORTIONS FOR THE LATENT CLASSES
BASED ON THE ESTIMATED MODEL

    Latent
   Classes

       1        115.40114          0.51518
       2        108.59886          0.48482


FINAL CLASS COUNTS AND PROPORTIONS FOR THE LATENT CLASSES
BASED ON ESTIMATED POSTERIOR PROBABILITIES

    Latent
   Classes

       1        115.40114          0.51518
       2        108.59886          0.48482


FINAL CLASS COUNTS AND PROPORTIONS FOR THE LATENT CLASSES
BASED ON THEIR MOST LIKELY LATENT CLASS MEMBERSHIP

Class Counts and Proportions

    Latent
   Classes

       1              115          0.51339
       2              109          0.48661


CLASSIFICATION QUALITY

     Entropy                         0.766


Average Latent Class Probabilities for Most Likely Latent Class Membership (Row)
by Latent Class (Column)

           1        2

    1   0.938    0.062
    2   0.069    0.931


Classification Probabilities for the Most Likely Latent Class Membership (Column)
by Latent Class (Row)

           1        2

    1   0.935    0.065
    2   0.066    0.934


Logits for the Classification Probabilities for the Most Likely Latent Class Membership (Column)
by Latent Class (Row)

              1        2

    1      2.663    0.000
    2     -2.656    0.000



MODEL RESULTS

                                                    Two-Tailed
                    Estimate       S.E.  Est./S.E.    P-Value
```

Latent Class 1

Thresholds				
TRUBSLEP$1	-0.388	0.211	-1.840	0.066
TRUBSTAY$1	-1.222	0.367	-3.333	0.001
WAKENITE$1	-2.537	0.485	-5.231	0.000
LITESLP$1	-0.485	0.231	-2.101	0.036
REFRESHD$1	-1.291	0.349	-3.699	0.000
MEDHELP$1	2.064	0.314	6.582	0.000
PROBLEM$1	-1.248	0.418	-2.987	0.003
STOPB$1	2.540	0.387	6.566	0.000
RESTLSS$1	-0.089	0.215	-0.414	0.679
DRVSLEEP$1	1.365	0.268	5.093	0.000
DRVRESUL$1	1.915	0.333	5.755	0.000

Latent Class 2

Thresholds				
TRUBSLEP$1	1.356	0.325	4.168	0.000
TRUBSTAY$1	2.422	0.722	3.354	0.001
WAKENITE$1	-0.763	0.256	-2.978	0.003
LITESLP$1	1.282	0.358	3.585	0.000
REFRESHD$1	0.178	0.235	0.757	0.449
MEDHELP$1	15.000	0.000	999.000	999.000
PROBLEM$1	2.364	0.624	3.789	0.000
STOPB$1	2.228	0.357	6.239	0.000
RESTLSS$1	2.436	0.618	3.945	0.000
DRVSLEEP$1	2.598	0.437	5.947	0.000
DRVRESUL$1	2.507	0.458	5.478	0.000

Categorical Latent Variables

Means				
ETAC#1	0.061	0.245	0.248	0.804

RESULTS IN PROBABILITY SCALE

Latent Class 1

TRUBSLEP				
Category 1	0.404	0.051	7.965	0.000
Category 2	0.596	0.051	11.738	0.000
TRUBSTAY				
Category 1	0.228	0.064	3.530	0.000
Category 2	0.772	0.064	11.985	0.000
WAKENITE				
Category 1	0.073	0.033	2.226	0.026
Category 2	0.927	0.033	28.121	0.000
LITESLP				
Category 1	0.381	0.054	7.006	0.000
Category 2	0.619	0.054	11.373	0.000
REFRESHD				
Category 1	0.216	0.059	3.651	0.000
Category 2	0.784	0.059	13.283	0.000
MEDHELP				
Category 1	0.887	0.031	28.309	0.000
Category 2	0.113	0.031	3.594	0.000
PROBLEM				
Category 1	0.223	0.072	3.081	0.002
Category 2	0.777	0.072	10.732	0.000
STOPB				
Category 1	0.927	0.026	35.363	0.000
Category 2	0.073	0.026	2.789	0.005
RESTLSS				
Category 1	0.478	0.054	8.918	0.000
Category 2	0.522	0.054	9.747	0.000
DRVSLEEP				
Category 1	0.797	0.043	18.340	0.000
Category 2	0.203	0.043	4.684	0.000
DRVRESUL				
Category 1	0.872	0.037	23.406	0.000
Category 2	0.128	0.037	3.447	0.001

Latent Class 2

TRUBSLEP				
Category 1	0.795	0.053	15.002	0.000
Category 2	0.205	0.053	3.866	0.000
TRUBSTAY				
Category 1	0.918	0.054	16.988	0.000
Category 2	0.082	0.054	1.508	0.132
WAKENITE				
Category 1	0.318	0.056	5.724	0.000
Category 2	0.682	0.056	12.276	0.000
LITESLP				
Category 1	0.783	0.061	12.875	0.000
Category 2	0.217	0.061	3.572	0.000
REFRESHD				
Category 1	0.544	0.058	9.333	0.000
Category 2	0.456	0.058	7.812	0.000
MEDHELP				
Category 1	1.000	0.000	0.000	1.000
Category 2	0.000	0.000	0.000	1.000
PROBLEM				
Category 1	0.914	0.049	18.644	0.000
Category 2	0.086	0.049	1.754	0.079
STOPB				
Category 1	0.903	0.031	28.787	0.000
Category 2	0.097	0.031	3.102	0.002
RESTLSS				
Category 1	0.920	0.046	20.124	0.000
Category 2	0.080	0.046	1.761	0.078
DRVSLEEP				
Category 1	0.931	0.028	33.042	0.000
Category 2	0.069	0.028	2.460	0.014
DRVRESUL				
Category 1	0.925	0.032	28.988	0.000
Category 2	0.075	0.032	2.363	0.018

LATENT CLASS ODDS RATIO RESULTS

			95% C.I.	
	Estimate	S.E.	Lower 2.5%	Upper 2.5%
Latent Class 1 Compared to Latent Class 2				
TRUBSLEP				
Category > 1	5.719	2.232	2.662	12.290
TRUBSTAY				
Category > 1	38.242	29.256	8.538	171.292
WAKENITE				
Category > 1	5.892	3.365	1.924	18.045
LITESLP				
Category > 1	5.851	2.564	2.479	13.810
REFRESHD				
Category > 1	4.347	2.047	1.727	10.940
MEDHELP				
Category > 1	*********	0.000	*********	*********
PROBLEM				
Category > 1	37.030	27.673	8.560	160.201
STOPB				
Category > 1	0.732	0.415	0.241	2.225
RESTLSS				
Category > 1	12.490	7.858	3.639	42.866
DRVSLEEP				
Category > 1	3.431	1.905	1.155	10.189
DRVRESUL				
Category > 1	1.806	1.164	0.511	6.386

QUALITY OF NUMERICAL RESULTS

Condition Number for the Information Matrix 0.208E-01
(ratio of smallest to largest eigenvalue)

```
TECHNICAL 11 OUTPUT

     Random Starts Specifications for the k-1 Class Analysis Model
        Number of initial stage random starts                100
        Number of final stage optimizations                   10



     VUONG-LO-MENDELL-RUBIN LIKELIHOOD RATIO TEST FOR 1 (H0) VERSUS 2 CLASSES

          H0 Loglikelihood Value                       -1286.159
          2 Times the Loglikelihood Difference           214.775
          Difference in the Number of Parameters              12
          Mean                                            19.364
          Standard Deviation                              17.425
          P-Value                                         0.0000

     LO-MENDELL-RUBIN ADJUSTED LRT TEST

          Value                                          211.518
          P-Value                                         0.0000


TECHNICAL 14 OUTPUT

     Random Starts Specifications for the k-1 Class Analysis Model
        Number of initial stage random starts                100
        Number of final stage optimizations                   10

     Random Starts Specification for the k-1 Class Model for Generated Data
        Number of initial stage random starts                200
        Number of final stage optimizations                   60
     Random Starts Specification for the k Class Model for Generated Data
        Number of initial stage random starts                100
        Number of final stage optimizations                   75
     Number of bootstrap draws requested                  Varies


     PARAMETRIC BOOTSTRAPPED LIKELIHOOD RATIO TEST FOR 1 (H0) VERSUS 2 CLASSES

          H0 Loglikelihood Value                       -1286.159
          2 Times the Loglikelihood Difference           214.775
          Difference in the Number of Parameters              12
          Approximate P-Value                             0.0000
          Successful Bootstrap Draws                           5


DIAGRAM INFORMATION

  Mplus diagrams are currently not available for Mixture analysis.
  No diagram output was produced.


     Beginning Time:  11:36:20
        Ending Time:  11:36:25
       Elapsed Time:  00:00:05



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