VERSION 7.4
Mplus LANGUAGE ADDENDUM

In this addendum, changes introduced in Version 7.4 are described. They include corrections to minor problems that have been found since the release of Version 7.31 in May 2015 as well as the following new features:

- New IRT models: 3PL, 4PL, and Partial Credit Models
- Bootstrap extensions: Bootstrap standard errors for standardized coefficients, bootstrap confidence intervals for standardized coefficients, and bootstrap for internal and external Monte Carlo simulation studies
- R-square and standardized coefficients for models with latent variable interactions using XWITH (Muthén & Asparouhov, 2015)
- MODEL INDIRECT for Bayes using the IND option
- Standardized for MODEL INDIRECT for models that require numerical integration
- DIC for models with random loadings, three-level random slopes, and cross-classified random slopes
- Counterfactually-defined causal effects for ordinal mediators and ordinal outcomes
- New plots: Bootstrap distributions, moderation plots, and sensitivity plots (TYPE=SENSITIVITY PLOT2;)
- Saving of propensity scores
- Test of proportional odds for logistic regression with ordinal outcomes (Brant Wald Test)
- Random starts for weighted least squares estimators
- Option to generate an ID variable that corresponds to the record number (DEFINE: idvariable = _RECNUM;)

New IRT Models: 3PL, 4PL, and the Partial Credit Model

Three new models have been added for categorical dependent variables: the Three-parameter Logistic Regression Model with a guessing parameter (3PL), the Four-parameter Logistic Regression Model with lower (guessing) and upper asymptote parameters (4PL), and the Partial Credit Model (PCM). The 3PL and 4PL models are available for only binary variables. The PCM model is available for only ordered categorical (ordinal) variables. The PCM model with a binary variable is the same as the logistic regression model. Both observed and latent predictors are allowed. This means that the modeling includes IRT modeling with covariates. Translations to common IRT parameterizations are provided in the output. These models are available for TYPE=GENERAL, TYPE=COMPLEX, TYPE=MIXTURE, and TYPE=TWOLEVEL for the ML, MLF, and MLR estimators (Asparouhov & Muthén, 2015).

Convergence problems are common with the 3PL and 4PL models. Because of this, the normal prior distribution of MODEL PRIORS is available for the special parameters of these models. The use of priors in these models is described in Asparouhov and Muthén (2015).

The CATEGORICAL option of the VARIABLE command is used to specify the new models. The three settings are 3PL, 4PL, and PCM. The setting in parentheses follows the variable or set of variables for which that model will be estimated. A combination of 2PL, 3PL, 4PL, and PCM items can be analyzed.

Following is an example of how to specify that a 3PL model will be estimated:

CATEGORICAL = u1 (3pl) u4-u7 (3pl);

where u1, u4, u5, u6, and u7 are binary variables for which a Three-parameter Logistic Regression Model will be estimated. The guessing parameter cannot be referred to directly. Instead a parameter related to the guessing parameter is referred to (Asparouhov & Muthén, 2015). The parameter is referred to as the second threshold. The first threshold for a binary variable u1 is referred to as u1$1. The parameter related to guessing is referred to as u1$2.

Following is an example of how to specify that a 4PL model will be estimated:

CATEGORICAL = u1 (4pl) u4-u7 (4pl);

where u1, u4, u5, u6, and u7 are binary variables for which a Four-parameter Logistic Regression Model will be estimated. The lower (guessing) and upper asymptote parameters cannot be referred to directly. Instead a parameter which is related to the lower asymptote (guessing) parameter and a parameter which is related to the upper asymptote parameter are referred to (Asparouhov & Muthén, 2015). The parameter related to the lower asymptote (guessing) parameter is referred to as the second threshold. The parameter related to the upper asymptote parameter is referred to as the third threshold. The first threshold for a binary variable u1 is referred to as u1$1. The parameter related to the lower asymptote (guessing) parameter is referred to as u1$2. The parameter related to the lower asymptote parameter is referred to as u1$3.

Following is an example of how to specify that a PCM model will be estimated:

CATEGORICAL = u1 (pcm) u4-u7 (pcm);

where u1, u4, u5, u6, and u7 are ordered categorical (ordinal) variables for which a Partial Credit Model will be estimated. The Partial Credit Model has c-1 thresholds for an item with c categories and one slope parameter (Asparouhov & Muthén, 2015). Data for Monte Carlo simulation studies can be generated for the 3PL, 4PL, and PCM models using the GENERATE option of the MONTECARLO command. Following is an example of how to specify that data for a 3PL model will be generated:

GENERATE = u1-u4 (3pl);

Where u1, u2, u3, and u4 are variables for which data are generated using the 3PL model.

Following is an example of how to specify that data for a PCM model will be generated:

GENERATE = u1 (2 pcm) u4 (3 pcm);

where u1 and u4 are variables for which data are generated using a Partial Credit Model. The number 2 in parentheses following u1 is the number of thresholds for u1 indicating that it has three categories. The number 3 in parentheses following u4 is the number of thresholds for u4 indicating that it has four categories.

Saving of Propensity Scores

Propensity scores, that is, estimated probabilities can be saved for the second category of binary outcomes with TYPE=GENERAL, TYPE=COMPLEX, and TYPE=MIXTURE using the ML, MLF, MLR, WLS, WLSM, WLSMV, and ULSMV estimators. For ML, MLF, and MLR, both a logit and probit link are available. For the other estimators, only a probit link is available. The SAVE option

of the SAVEDATA command is used to save propensity scores for the second category of binary outcomes. Following is an example of how the option is specified:

```
SAVEDATA:
FILE is propensity.dat;
SAVE = PROPENSITY;
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REFERENCES

Asparouhov, T. & Muthén, B. (2015). IRT in Mplus. Technical appendix. Los Angeles: Muthén & Muthén.

Muthén, B. & Asparouhov, T. (2015). Latent variable interactions. Technical appendix. Los Angeles: Muthén & Muthén.