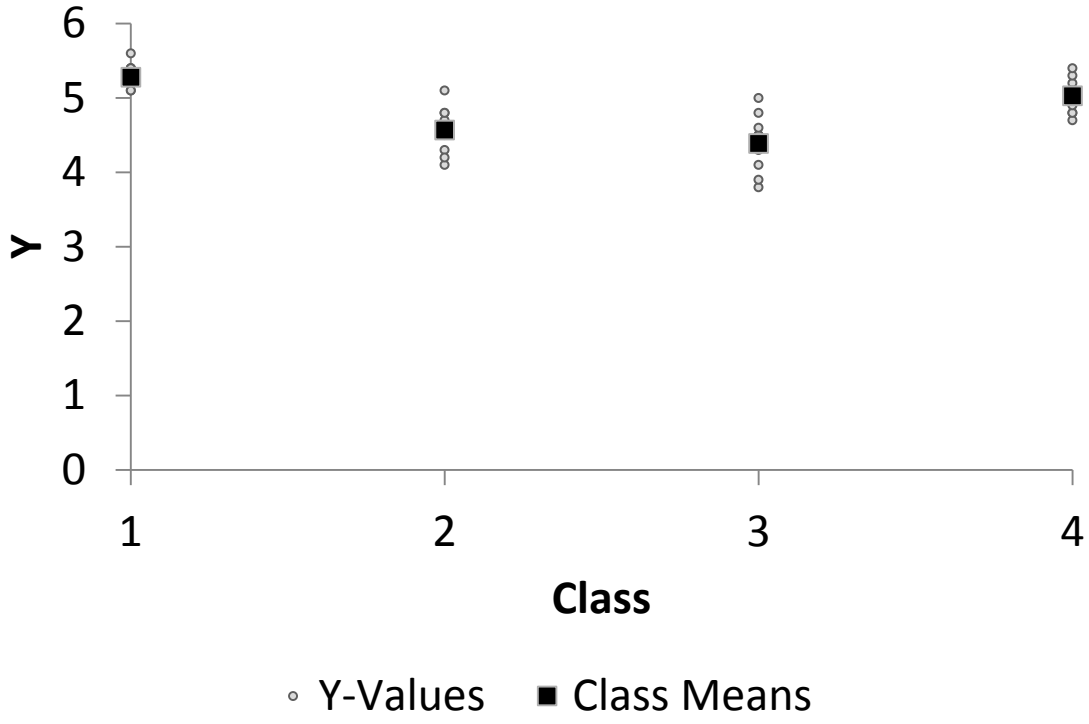
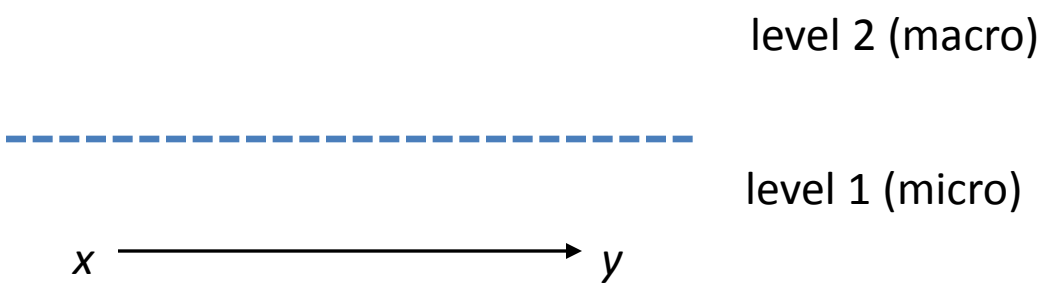
Multilevel Modeling: Introduction



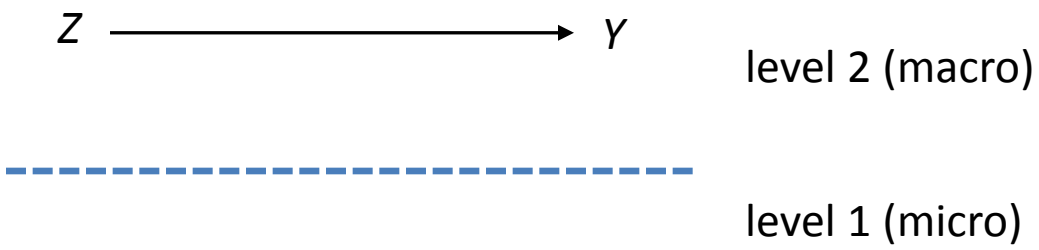
Macro-level, micro-level, and cross-level relations (Snijders & Bosker, 2012)

Micro-level propositions



Macro-level, micro-level, and cross-level relations (Snijders & Bosker, 2012)

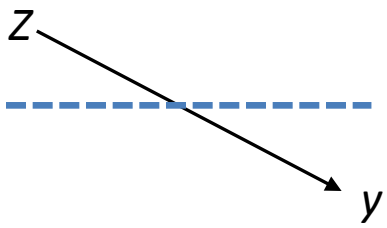
Macro-level propositions

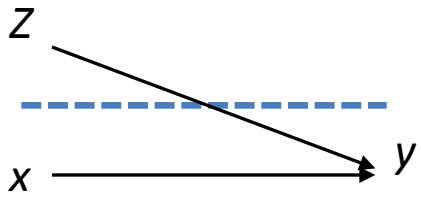


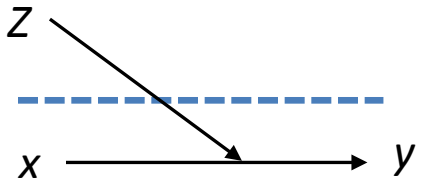
Macro-level, micro-level, and cross-level relations (Snijders & Bosker, 2012)

Macro-micro propositions

level 2 (macro)



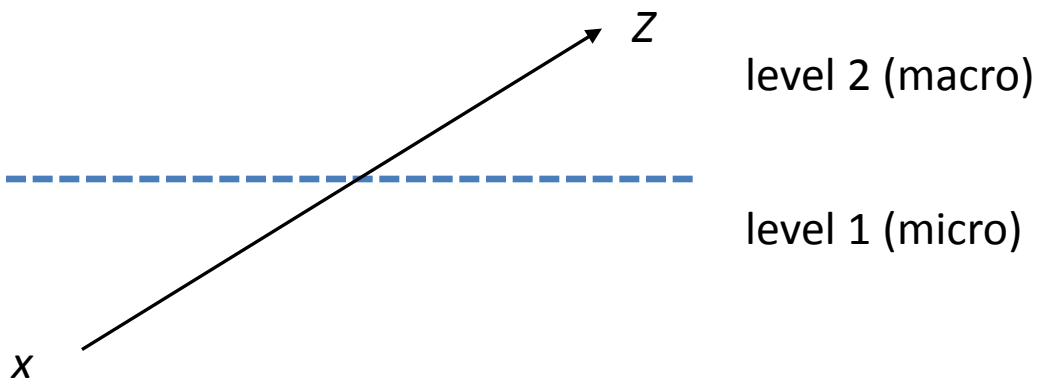




level 1 (micro)

Macro-level, micro-level, and cross-level relations (Snijders & Bosker, 2012)

Micro-macro propositions



Mplus Website

HLM Website

www.ssicentral.com/hlm/index.html

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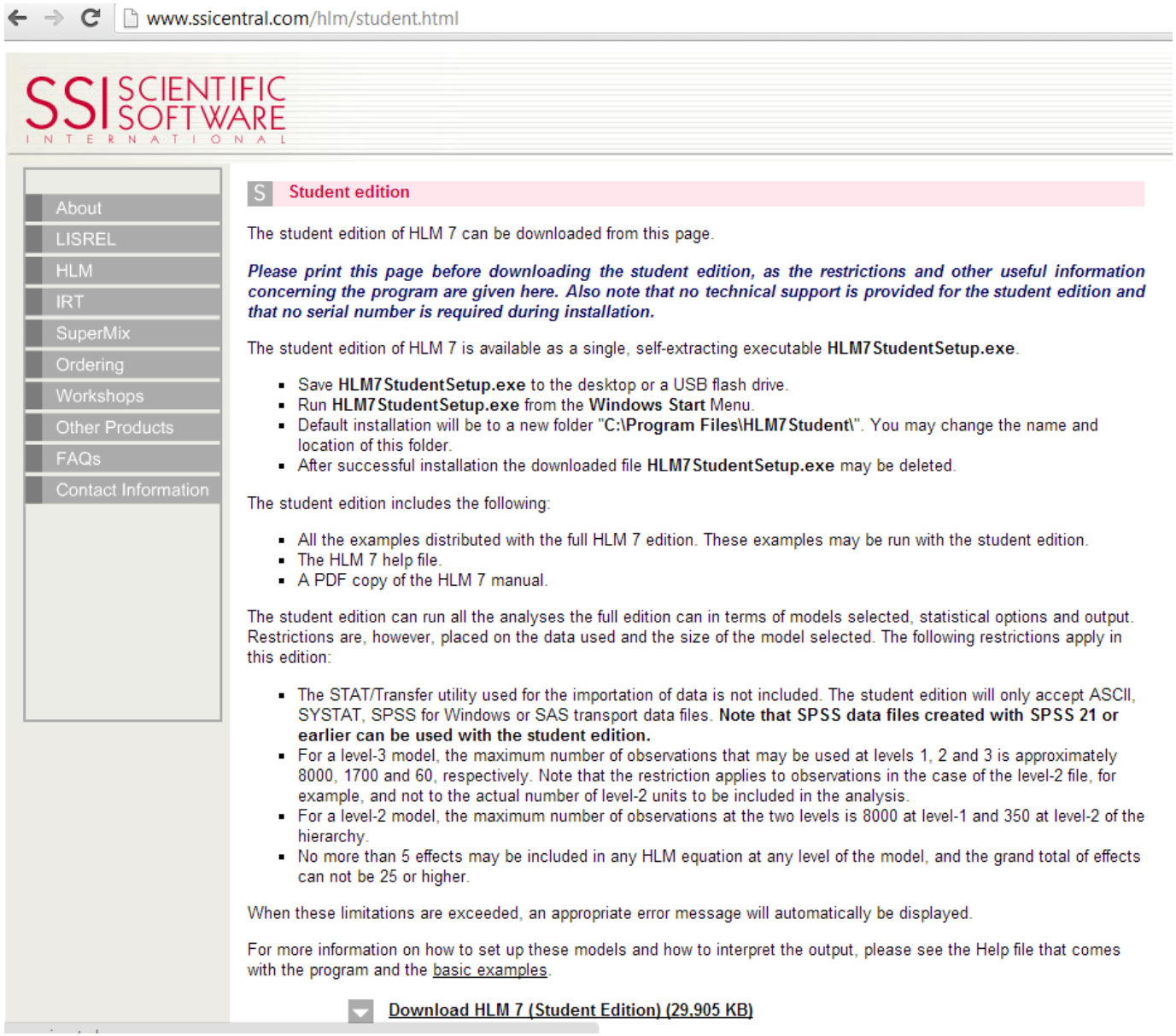
HLM - Hierarchical Linear and Nonlinear Modeling (HLM)

In social research and other fields, research data often have a hierarchical structure. That is, the individual subjects of study may be classified or arranged in groups which themselves have qualities that influence the study. In this case, the individuals can be seen as level-1 units of study, and the groups into which they are arranged are level-2 units. This may be extended further, with level-2 units organized into yet another set of units at a third level and with level-3 units organized into another set of units at a fourth level. Examples of this abound in areas such as education (students at level 1, teachers at level 2, schools at level 3, and school districts at level 4) and sociology (individuals at level 1, neighborhoods at level 2). It is clear that the analysis of such data requires specialized software. Hierarchical linear and nonlinear models (also called multilevel models) have been developed to allow for the study of relationships at any level in a single analysis, while not ignoring the variability associated with each level of the hierarchy.

The HLM program can fit models to outcome variables that generate a linear model with explanatory variables that account for variations at each level, utilizing variables specified at each level. HLM not only estimates model coefficients at each level, but it also predicts the random effects associated with each sampling unit at every level. While commonly used in education research due to the prevalence of hierarchical structures in data from this field, it is suitable for use with data from any research field that have a hierarchical structure. This includes longitudinal analysis, in which an individual's repeated measurements can be nested within the individuals being studied. In addition, although the examples above implies that members of this hierarchy at any of the levels are nested exclusively within a member at a higher level, HLM can also provide for a situation where membership is not necessarily "nested", but "crossed", as is the case when a student may have been a member of various classrooms during the duration of a study period.

The HLM program allows for continuous, count, ordinal, and nominal outcome variables and assumes a functional relationship between the expectation of the outcome and a linear combination of a set of explanatory variables. This relationship is defined by a suitable link function, for example, the identity link (continuous outcomes) or logit link (binary outcomes).

HLM Website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Student edition
The student edition of HLM 7 can be downloaded from this page.
Please print this page before downloading the student edition, as the restrictions and other useful information concerning the program are given here. Also note that no technical support is provided for the student edition and that no serial number is required during installation.
The student edition of HLM 7 is available as a single, self-extracting executable HLM7StudentSetup.exe.
Save HLM7StudentSetup.exe to the desktop or a USB flash drive.
Run HLM7StudentSetup.exe from the Windows Start Menu.
Default installation will be to a new folder "C:\Program Files\HLM7Student\". You may change the name and location of this folder.
After successful installation the downloaded file HLM7StudentSetup.exe may be deleted.
The student edition includes the following:
All the examples distributed with the full HLM 7 edition. These examples may be run with the student edition.
The HLM 7 help file.
A PDF copy of the HLM 7 manual.
The student edition can run all the analyses the full edition can in terms of models selected, statistical options and output. Restrictions are, however, placed on the data used and the size of the model selected. The following restrictions apply in this edition:
The STAT/Transfer utility used for the importation of data is not included. The student edition will only accept ASCII, SYSTAT, SPSS for Windows or SAS transport data files. Note that SPSS data files created with SPSS 21 or earlier can be used with the student edition.
For a level-3 model, the maximum number of observations that may be used at levels 1, 2 and 3 is approximately 8000, 1700 and 60, respectively. Note that the restriction applies to observations in the case of the level-2 file, for example, and not to the actual number of level-2 units to be included in the analysis.
For a level-2 model, the maximum number of observations at the two levels is 8000 at level-1 and 350 at level-2 of the hierarchy.
No more than 5 effects may be included in any HLM equation at any level of the model, and the grand total of effects can not be 25 or higher.
When these limitations are exceeded, an appropriate error message will automatically be displayed.
For more information on how to set up these models and how to interpret the output, please see the Help file that comes with the program and the basic examples.
Download HLM 7 (Student Edition) (29,905 KB)

Mplus Basic Syntax

Ten basic commands (with sub-commands)
Most common:

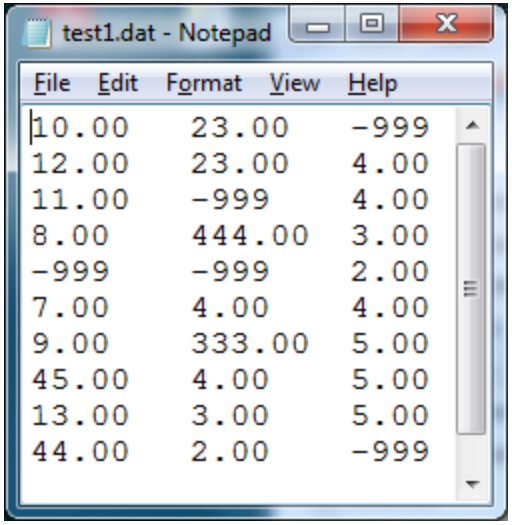
- TITLE:
- DATA:
- VARIABLE:
- MODEL:

Others:

- DEFINE:
- ANALYSIS:
- OUTPUT:
- SAVEDATA:
- PLOT:
- MONTECARLO:

Free Format Data File Specification in Mplus

```
DATA:
file is test1.dat;
VARIABLE:
names are v1 v2 v3;
missing all (-999);
```



Fixed Format Data File Specification in Mplus

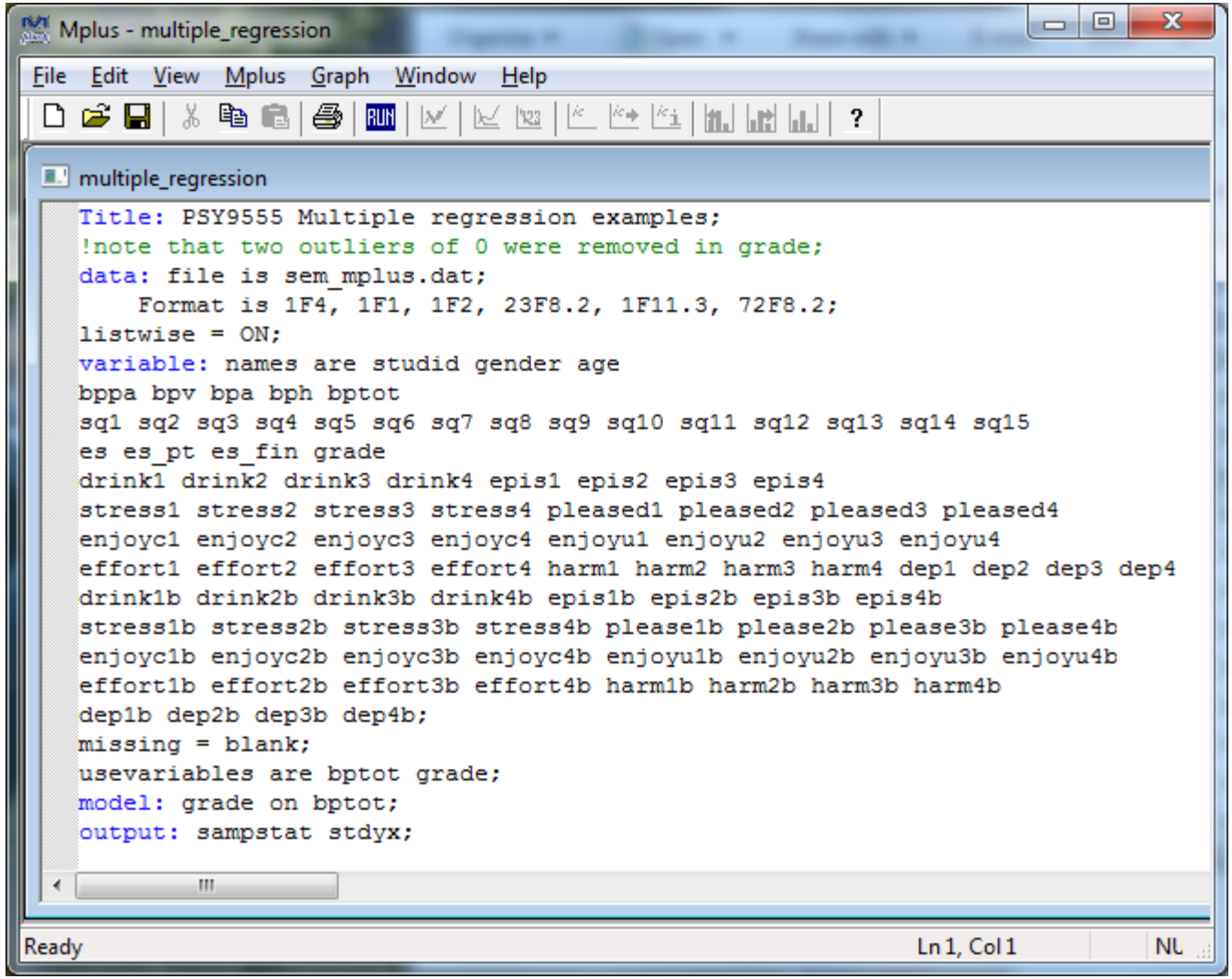
```
data: File is vignette.dat;
    Format is 21F8.2;
variable: names are clust gender age
everdr intox days12 daysse avgdr12 avgdrse smoke
bp_PA bp_V bp_A bp_H bp_tot AE_TR AE_LC AE_CB AE_RA
uni_num program2;
missing = blank;
```

vignette.dat - Notepad

File Edit Format View Help

```
    1.00      .00    18.00      .00                                          1.00    1
    1.00      .00    20.00      .00                                          1.00
    1.00      .00    28.00                                                          1
    1.00      .00    18.00      .00                                          1.00    1
    1.00      .00    22.00     1.00     1.00     5.00     5.00     8.00    10.00    2.00    3
    1.00      .00    18.00     1.00              2.50     5.00     3.00     4.00    3.00    2
    1.00      .00    26.00     1.00     1.00     2.50     5.00     6.00     6.00    3.00    1
    1.00      .00    18.00               1.00     2.50     2.50     4.00     4.00    1.00    2
    1.00      .00    24.00     1.00     1.00     5.00     2.50     3.00     3.00    3.00
    1.00      .00    18.00     1.00     1.00      .50     2.50     1.00     3.00    1.00    1
    1.00      .00    26.00     1.00     1.00     2.50     2.50     4.00     5.00    3.00    1
    1.00      .00    21.00     1.00     1.00     2.50     2.50     6.00     5.00    1.00
    1.00      .00    22.00     1.00     1.00      .50     1.00     4.00     2.00    1.00    1
    1.00      .00    30.00     1.00     1.00     1.00     1.00     8.00     4.00    3.00    1
    1.00      .00    20.00     1.00     1.00     1.00     1.00     6.00     7.00    1.00
    1.00      .00    25.00     1.00     1.00     2.50     1.00     4.00     4.00    1.00    3
    1.00      .00    19.00     1.00     1.00      .50     1.00     4.00     6.00    1.00    1
    1.00      .00    21.00     1.00     1.00     2.50     1.00     4.00     2.00    1.00    1
    1.00      .00    20.00     1.00     1.00     1.00     1.00     4.00     4.00    1.00
```

Mplus: Regression – One Predictor



Mplus: Regression – One Predictor

SAMPLE STATISTICS

SAMPLE STATISTICS

Means

	GRADE	BPTOT
1	74.698	59.829

Covariances

	GRADE	BPTOT
GRADE	94.201	
BPTOT	-23.893	304.857

Correlations

	GRADE	BPTOT
GRADE	1.000	
BPTOT	-0.141	1.000

MODEL RESULTS

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
GRADE ON				
BPTOT	-0.078	0.029	-2.672	0.008
Intercepts				
GRADE	79.387	1.828	43.425	0.000
Residual Variances				
GRADE	92.330	6.960	13.266	0.000

STANDARDIZED MODEL RESULTS

STDYX Standardization

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
GRADE ON				
BPTOT	-0.141	0.052	-2.699	0.007
Intercepts				
GRADE	8.179	0.329	24.831	0.000
Residual Variances				
GRADE	0.980	0.015	66.535	0.000

Mplus: Regression – One Predictor MLR (Maximum Likelihood Robust)

```
usevariables are bptot grade;
analysis:
estimator = mlr;
model: grade on bptot;
output: sampstat stdyx;
```

MODEL RESULTS

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
GRADE ON				
BPTOT	-0.078	0.032	-2.476	0.013
Intercepts				
GRADE	79.387	1.865	42.556	0.000
Residual Variances				
GRADE	92.330	9.062	10.189	0.000

STANDARDIZED MODEL RESULTS

STDYX Standardization

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
GRADE ON				
BPTOT	-0.141	0.056	-2.522	0.012
Intercepts				
GRADE	8.179	0.421	19.444	0.000
Residual Variances				
GRADE	0.980	0.016	62.179	0.000

Mplus: Logistic Regression

```
usevariables are grade bptot gender_d;
categorical is gender_d;
define:
if (gender eq 1) then gender_d = 1;
if (gender eq 2) then gender_d = 0;
analysis: estimator = ml; !if you don't specify this it does a probit regression analysis instead
model: gender_d on grade bptot;
output: sampstat standardized;
!plot: type=plot1;
```

MODEL RESULTS

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
GENDER_D ON				
GRADE	0.013	0.012	1.092	0.275
BPTOT	0.015	0.006	2.308	0.021
Thresholds				
GENDER_D$1	2.456	1.025	2.397	0.017

LOGISTIC REGRESSION ODDS RATIO RESULTS

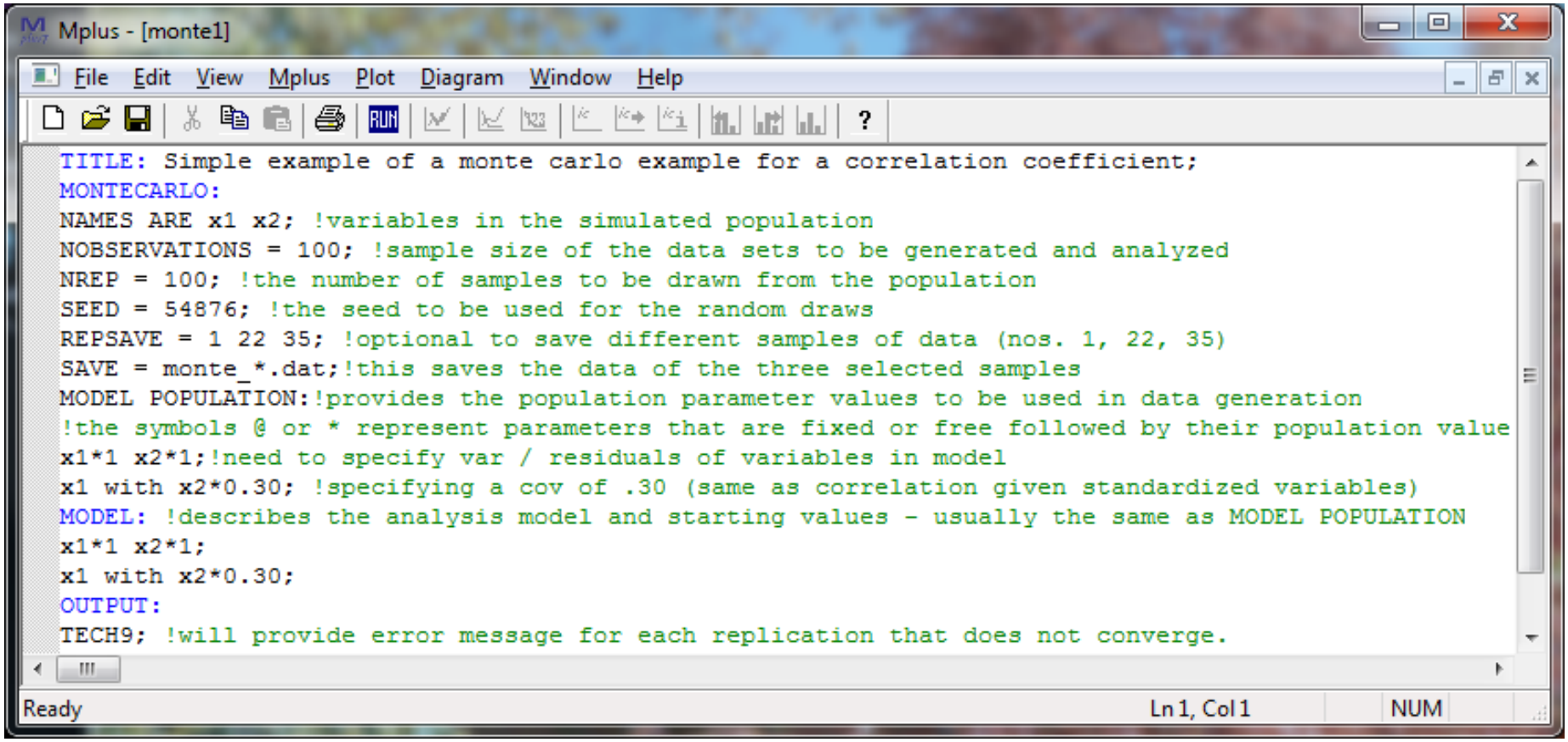
GENDER_D ON	
GRADE	1.013
BPTOT	1.015

STANDARDIZED MODEL RESULTS

STDYX Standardization

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
GENDER_D ON				
GRADE	0.068	0.062	1.096	0.273
BPTOT	0.141	0.060	2.346	0.019
Thresholds				
GENDER_D$1	1.339	0.550	2.437	0.015

MONTECARLO in Mplus and Power
Example : A Correlation between two variables



MONTECARLO in Mplus and Power
Example: A Correlation between two variables

MODEL RESULTS

		ESTIMATES		S. E.	M. S. E.	95%	% Sig
	Population	Average	Std. Dev.	Average		Cover	Coeff
X1 WITH							
X2	0.300	0.2850	0.1194	0.1143	0.0143	0.950	0.720
Means							
X1	0.000	0.0091	0.1133	0.1109	0.0128	0.920	0.080
X2	0.000	0.0271	0.1131	0.1101	0.0134	0.950	0.050
Variances							
X1	1.000	0.9903	0.1613	0.1566	0.0259	0.950	1.000
X2	1.000	0.9762	0.1578	0.1543	0.0252	0.910	1.000