PSY 9555A (Nov 27): MONTECARLO in Mplus and Power
Example 1: Simulating a correlation between two variables

```
Title: monte carlo example;
MONTECARLO:
Names are x1 x2; !variables in the simulated population
NOBSERVATIONS = 80; !sample size of the data sets to be generated and analyzed
NREP = 1000; !the number of samples to be drawn from the population
SEED = 32346; !the seed to be used for the random draws
save = rep1.dat;!this saves the data of the first sample
MODEL POPULATION:!provides the population parameter values to be used in data generation
!the symbol @ represents parameters that are fixed followed by its population value
x1@1 x2@1;!the * represents free parameters followed by its population value
x1 with x2@0.30;
MODEL: !describes the analysis model and starting values
x1*1 x2*1;
x1 with x2*0.30;
OUTPUT:
tech9; !will list samples that did not converge
```

PSY 9555A (Oct 16): MONTECARLO in Mplus and Power
Example 1: Simulating 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	0.2982	0.1141	0.1150	0.0130	0.950	0.790
Means							
X1	0.000	-0.0039	0.1096	0.1106	0.0120	0.953	0.047
X2	0.000	0.0011	0.1106	0.1107	0.0122	0.949	0.051
Variances							
X1	1.000	0.9845	0.1578	0.1557	0.0251	0.921	1.000
X2	1.000	0.9867	0.1561	0.1560	0.0245	0.934	1.000

Bias $_{\text{x1 with x2}}$ = [(.300 - .2982)/.300] x 100 = 0.6%

Bias $_{\text{S.E. x1 with x2}}$ = [(.1141 - .1150)/.1141] x 100 = 0.79%

Coverage = 95% indicating that the 95% confidence intervals of 95% of replications include the population value of .30

% Sig Coeff = .790 = power

Criteria for Determining Appropriate Sample Size
Muthen & Muthen (2002)

- Bias of parameters and standard errors no larger than 10%
- For parameters of specific focus for power analysis, bias of standard errors should be no larger than 5%
- Coverage should range from .91 to .98
- Power should be at least .80 (Cohen)

Example 2: A similar example - covariance

```
Title: monte carlo example;
Montecarlo:
Names are x1 x2;
NOBSERVATIONS = 80;
NREP = 1000;
SEED = 552346;
save = rep2.dat;
MODEL POPULATION:
[x1*10 x2*15]; !means of 10 and 15
x1*4.0 x2*4.84; !standard deviations of 2.0 and 2.2
x1 with x2*1.32; !this works out to a correlation of .30 rxy = covxy/sx sy
MODEL:
[x1*10 x2*15];
x1*4.0 x2*4.84; !standard deviations of 2.0 and 2.2
x1 with x2*1.32;
OUTPUT:
tech9;
```

Example 2: A similar example - covariance

MODEL RESULTS

		ESTIMATES		S. E.	M. S. E.	95%	% Sig
	Population	Average	Std. Dev.	Average		Cover	Coeff
X1 WITH							
X2	1.320	1.2925	0.5251	0.5059	0.2762	0.939	0.766
Means							
X1	10.000	9.9869	0.2295	0.2210	0.0528	0.939	1.000
X2	15.000	15.0021	0.2489	0.2439	0.0619	0.937	1.000
Variances							
X1	4.000	3.9288	0.6004	0.6212	0.3652	0.933	1.000
X2	4.840	4.7907	0.7791	0.7575	0.6088	0.932	1.000

Example 3: A CFA (small sample size)

```
TITLE: CFA TWO-FACTOR, Normal data, no missing
MONTECARLO:
    NAMES ARE x1-x6;
    NOBSERVATIONS = 50;
    NREPS = 1000;
    SEED = 53566;
MODEL POPULATION:
    ESTEEM BY x1*.65 x2*.70 x3*.72;
    DEPRESS BY x4*.60 x5*.70 x6*.65;
    ESTEEM@1; DEPRESS@1;
    x1*.5775; x2*.51; x3*.4816; x4*.64; x5*.51; x6*.5775;
    ESTEEM WITH DEPRESS*.35;
MODEL:
    ESTEEM BY x1*.65 x2*.70 x3*.72;
    DEPRESS BY x4*.60 x5*.70 x6*.65;
    ESTEEM@1; DEPRESS@1;
    x1*.5775; x2*.51; x3*.4816; x4*.64; x5*.51; x6*.5775;
    ESTEEM WITH DEPRESS*.35;
ANALYSIS: ESTIMATOR = ML;
OUTPUT: TECH9;
```

Example 3: A CFA (small sample size)

Chi-Square Test of Model Fit

Degrees of freedom	8
Mean	8.613
Std Dev	4.101
Number of successful computations	988

Proportions		Percentiles	
Expected	Observed	Expected	Observed
0.990	0.992	1.646	1.658
0.980	0.985	2.032	2.241
0.950	0.965	2.733	2.989
0.900	0.920	3.490	3.785
0.800	0.836	4.594	5.060
0.700	0.765	5.527	6.115
0.500	0.572	7.344	8.074
0.300	0.367	9.524	10.354
0.200	0.257	11.030	11.822
0.100	0.118	13.362	13.758
0.050	0.062	15.507	15.822
0.020	0.020	18.168	18.127
0.010	0.012	20.090	20.940

RMSEA (Root Mean Square Error Of Approximation)

Mean	0.045
Std Dev	0.053
Number of successful computations	988

Proportions		Percentiles	
Expected	Observed	Expected	Observed
0.990	1.000	-0.078	0.000
0.980	1.000	-0.063	0.000
0.950	1.000	-0.042	0.000
0.900	1.000	-0.023	0.000
0.800	0.508	0.000	0.000
0.700	0.495	0.017	0.000
0.500	0.425	0.045	0.014
0.300	0.318	0.072	0.077
0.200	0.250	0.089	0.098
0.100	0.139	0.112	0.120
0.050	0.074	0.131	0.140
0.020	0.028	0.153	0.159
0.010	0.016	0.167	0.180

SRMR (Standardized Root Mean Square Residual)

Mean	0.058
Std Dev	0.017
Number of successful computations	988

Proportions		Percentiles	
Expected	Observed	Expected	Observed
0.990	0.999	0.019	0.024
0.980	0.993	0.024	0.028
0.950	0.969	0.031	0.033
0.900	0.919	0.037	0.038
0.800	0.794	0.044	0.044
0.700	0.684	0.050	0.049
0.500	0.460	0.058	0.057
0.300	0.276	0.067	0.065
0.200	0.192	0.073	0.072
0.100	0.108	0.080	0.081
0.050	0.065	0.086	0.089
0.020	0.031	0.093	0.098
0.010	0.023	0.098	0.103

Example 3: A CFA (small sample size)

MODEL RESULTS

		ESTIMATES		S. E.	M. S. E.	95%	% Sig
	Population	Average	Std. Dev.	Average		Cover	Coeff
ESTEEM BY							
X1	0.650	0.6402	0.1829	0.1625	0.0335	0.938	0.960
X2	0.700	0.6919	0.2103	0.1894	0.0442	0.944	0.973
X3	0.720	0.7162	0.1778	0.1700	0.0316	0.941	0.975
DEPRESS BY							
X4	0.600	0.5895	0.2283	0.2285	0.0522	0.936	0.912
X5	0.700	0.6977	0.1985	0.1849	0.0394	0.924	0.959
X6	0.650	0.6482	0.2122	0.2033	0.0450	0.946	0.945
ESTEEM WITH							
DEPRESS	0.350	0.3380	0.1948	0.1809	0.0381	0.901	0.492
Intercepts							
X1	0.000	0.0087	0.1433	0.1391	0.0206	0.936	0.064
X2	0.000	0.0019	0.1432	0.1390	0.0205	0.938	0.062
X3	0.000	0.0043	0.1421	0.1393	0.0202	0.935	0.065
X4	0.000	0.0025	0.1421	0.1393	0.0202	0.934	0.066
X5	0.000	0.0007	0.1406	0.1389	0.0197	0.939	0.061
X6	0.000	0.0041	0.1397	0.1389	0.0195	0.947	0.053
Variances							
ESTEEM	1.000	1.0000	0.0000	0.0000	0.0000	1.000	0.000
DEPRESS	1.000	1.0000	0.0000	0.0000	0.0000	1.000	0.000
Residual Variances							
X1	0.577	0.5342	0.2669	0.1937	0.0730	0.937	0.912
X2	0.510	0.4536	0.7152	0.4525	0.5142	0.955	0.825
X3	0.482	0.4354	0.2424	0.2144	0.0608	0.952	0.761
X4	0.640	0.5816	0.8065	0.7754	0.6531	0.947	0.902
X5	0.510	0.4492	0.2577	0.2378	0.0700	0.950	0.706
X6	0.577	0.5101	0.4944	0.4192	0.2487	0.950	0.828

Example 4: A CFA (large sample size = 500)

Chi-Square Test of Model Fit

Degrees of freedom 8

Mean	7.953
Std Dev	3.922
Number of successful computations	1000

Proportions		Percentiles	
Expected	Observed	Expected	Observed
0.990	0.997	1.646	1.884
0.980	0.984	2.032	2.075
0.950	0.952	2.733	2.782
0.900	0.903	3.490	3.519
0.800	0.806	4.594	4.645
0.700	0.707	5.527	5.585
0.500	0.492	7.344	7.250
0.300	0.289	9.524	9.438
0.200	0.192	11.030	10.919
0.100	0.100	13.362	13.221
0.050	0.050	15.507	15.473
0.020	0.019	18.168	18.066
0.010	0.008	20.090	19.646

RMSEA (Root Mean Square Error Of Approximation)

Mean	0.011
Std Dev	0.016
Number of successful computations	1000

Proportions		Percentiles	
Expected	Observed	Expected	Observed
0.990	1.000	-0.025	0.000
0.980	1.000	-0.021	0.000
0.950	1.000	-0.014	0.000
0.900	1.000	-0.009	0.000
0.800	1.000	-0.002	0.000
0.700	0.427	0.003	0.000
0.500	0.376	0.011	0.000
0.300	0.286	0.020	0.019
0.200	0.229	0.025	0.027
0.100	0.143	0.032	0.036
0.050	0.094	0.037	0.043
0.020	0.049	0.044	0.050
0.010	0.031	0.048	0.054

SRMR (Standardized Root Mean Square Residual)

Mean	0.018
Std Dev	0.005
Number of successful computations	1000

Proportions		Percentiles	
Expected	Observed	Expected	Observed
0.990	1.000	0.006	0.008
0.980	0.996	0.008	0.009
0.950	0.969	0.010	0.010
0.900	0.919	0.012	0.012
0.800	0.786	0.014	0.014
0.700	0.678	0.015	0.015
0.500	0.461	0.018	0.018
0.300	0.280	0.021	0.020
0.200	0.194	0.022	0.022
0.100	0.115	0.025	0.025
0.050	0.066	0.026	0.027
0.020	0.030	0.028	0.029
0.010	0.017	0.030	0.031

Example 4: A CFA (large sample size = 500)

MODEL RESULTS

		ESTIMATES		S. E.	M. S. E.	95%	% Sig
	Population	Average	Std. Dev.	Average		Cover	Coeff
ESTEEM BY							
X1	0.650	0.6512	0.0485	0.0479	0.0023	0.941	1.000
X2	0.700	0.6980	0.0486	0.0482	0.0024	0.952	1.000
X3	0.720	0.7192	0.0476	0.0484	0.0023	0.955	1.000
DEPRESS BY							
X4	0.600	0.5977	0.0505	0.0508	0.0026	0.947	1.000
X5	0.700	0.6978	0.0516	0.0523	0.0027	0.957	1.000
X6	0.650	0.6494	0.0508	0.0516	0.0026	0.953	1.000
ESTEEM WITH							
DEPRESS	0.350	0.3484	0.0592	0.0577	0.0035	0.948	1.000
Intercepts							
X1	0.000	0.0004	0.0433	0.0447	0.0019	0.963	0.037
X2	0.000	0.0004	0.0448	0.0446	0.0020	0.942	0.058
X3	0.000	0.0012	0.0449	0.0447	0.0020	0.939	0.061
X4	0.000	0.0025	0.0454	0.0446	0.0021	0.940	0.060
X5	0.000	-0.0008	0.0441	0.0446	0.0019	0.955	0.045
X6	0.000	0.0006	0.0456	0.0447	0.0021	0.950	0.050
Variances							
ESTEEM	1.000	1.0000	0.0000	0.0000	0.0000	1.000	0.000
DEPRESS	1.000	1.0000	0.0000	0.0000	0.0000	1.000	0.000
Residual Variances							
X1	0.577	0.5716	0.0494	0.0505	0.0025	0.948	1.000
X2	0.510	0.5076	0.0506	0.0514	0.0026	0.948	1.000
X3	0.482	0.4792	0.0532	0.0521	0.0028	0.945	1.000
X4	0.640	0.6379	0.0547	0.0548	0.0030	0.948	1.000
X5	0.510	0.5054	0.0583	0.0588	0.0034	0.961	1.000
X6	0.577	0.5745	0.0548	0.0563	0.0030	0.954	1.000

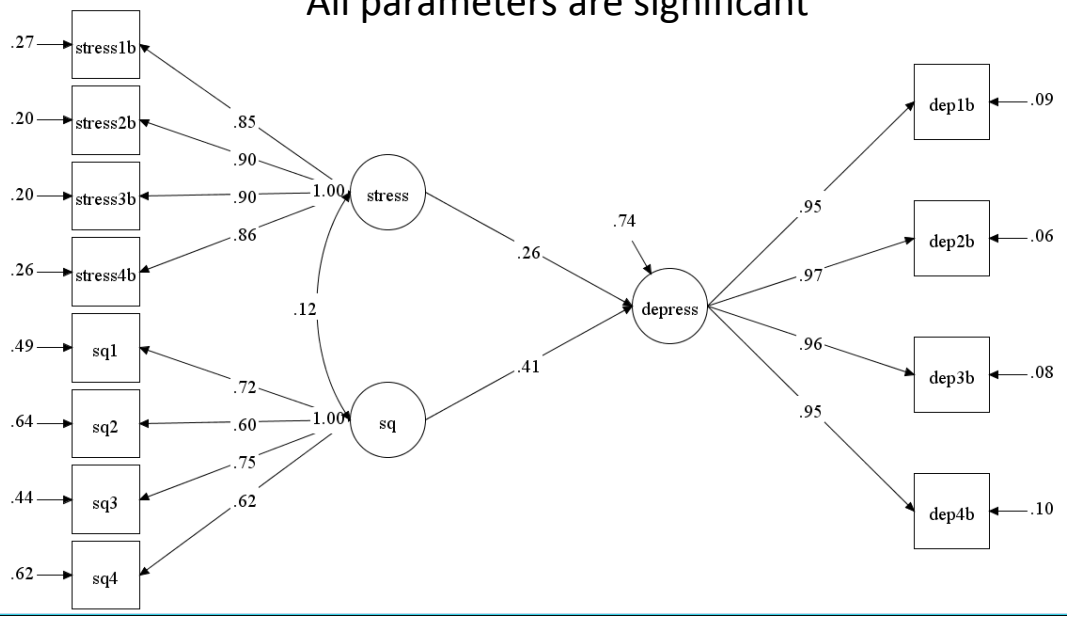
Example 5: Using Real Data

```
Title: PSY9555 Simulation with real data;
!note that two outliers of 0 were removed in grade;
data: file is sem_mplus2.dat;
    Format is 1F4, 1F1, 1F2, 23F8.2, 1F11.3, 72F8.2;
listwise = ON;
variable: names are studid gender age
bppa bpv bpa bph bptot
sq1 sq2 sq3 sq4 sq5 sq6 sq7 sq8 sq9 sq10 sq11 sq12 sq13 sq14 sq15
es es_pt es_fin grade
drink1 drink2 drink3 drink4 epis1 epis2 epis3 epis4
stress1 stress2 stress3 stress4 pleased1 pleased2 pleased3 pleased4
enjoyc1 enjoyc2 enjoyc3 enjoyc4 enjoyu1 enjoyu2 enjoyu3 enjoyu4
effort1 effort2 effort3 effort4 harm1 harm2 harm3 harm4 dep1 dep2 dep3 dep4
drink1b drink2b drink3b drink4b epis1b epis2b epis3b epis4b
stress1b stress2b stress3b stress4b please1b please2b please3b please4b
enjoyc1b enjoyc2b enjoyc3b enjoyc4b enjoyu1b enjoyu2b enjoyu3b enjoyu4b
effort1b effort2b effort3b effort4b harm1b harm2b harm3b harm4b
dep1b dep2b dep3b dep4b;
missing = blank;
usevariables are dep1b dep2b dep3b dep4b stress1b stress2b stress3b stress4b
sq1 sq2 sq3 sq4;
model: stress by stress1b stress2b stress3b stress4b;
depress by dep1b dep2b dep3b dep4b;
sq by sq1 sq2 sq3 sq4;
depress on stress sq;
output: sampstat stdyx tech1;
savedata: estimates = example2.dat;
```

```
Chi-Square Test of Model Fit

          Value                             97.231
          Degrees of Freedom                    51
          P-Value                           0.0001

RMSEA (Root Mean Square Error Of Approximation)

          Estimate                           0.048
          90 Percent C.I.                    0.033  0.063
          Probability RMSEA <= .05           0.560

CFI/TLI

          CFI                                0.989
          TLI                                0.986
```

N = 390

All parameters are significant



Example 5: Using Real Data

```
Title: PSY9555 Simulation with real data;
montecarlo:
names are dep1b dep2b dep3b dep4b stress1b stress2b
stress3b stress4b sq1 sq2 sq3 sq4;
nobservations = 50;
nreps = 1000;
seed = 45335;
population = example2.dat;
coverage = example2.dat;
model population:
stress by stress1b stress2b stress3b stress4b;
depress by dep1b dep2b dep3b dep4b;
sq by sq1 sq2 sq3 sq4;
depress on stress sq;
model:
stress by stress1b stress2b stress3b stress4b;
depress by dep1b dep2b dep3b dep4b;
sq by sq1 sq2 sq3 sq4;
depress on stress sq;
output: tech9;
```

Chi-Square Test of Model Fit

Degrees of freedom	51
Mean	58.813
Std Dev	11.492
Number of successful computations	1000

Proportions		Percentiles	
Expected	Observed	Expected	Observed
0.990	0.998	30.475	36.243
0.980	0.998	32.459	37.947
0.950	0.992	35.600	40.962
0.900	0.976	38.560	44.786
0.800	0.936	42.365	49.028
0.700	0.891	45.261	52.313
0.500	0.764	50.335	57.985
0.300	0.579	55.775	63.844
0.200	0.458	59.248	67.677
0.100	0.287	64.295	73.797
0.050	0.176	68.669	78.759
0.020	0.100	73.818	85.897
0.010	0.062	77.386	89.791

RMSEA (Root Mean Square Error Of Approximation)

Mean	0.048
Std Dev	0.036
Number of successful computations	1000

Proportions		Percentiles	
Expected	Observed	Expected	Observed
0.990	1.000	-0.036	0.000
0.980	1.000	-0.026	0.000
0.950	1.000	-0.012	0.000
0.900	0.738	0.002	0.000
0.800	0.715	0.018	0.000
0.700	0.674	0.029	0.023
0.500	0.544	0.048	0.052
0.300	0.348	0.067	0.071
0.200	0.226	0.079	0.081
0.100	0.099	0.095	0.095
0.050	0.038	0.108	0.104
0.020	0.012	0.123	0.117
0.010	0.003	0.133	0.123

Example 5: Using Real Data

MODEL RESULTS

		ESTIMATES		S. E.	M. S. E.	95%	% Sig
	Population	Average	Std. Dev.	Average		Cover	Coeff
STRESS BY							
STRESS1B	1.000	1.0000	0.0000	0.0000	0.0000	1.000	0.000
STRESS2B	1.047	1.0582	0.1336	0.1273	0.0180	0.940	1.000
STRESS3B	1.089	1.0983	0.1352	0.1324	0.0184	0.953	1.000
STRESS4B	1.012	1.0165	0.1376	0.1321	0.0189	0.929	1.000
DEPRESS BY							
DEP1B	1.000	1.0000	0.0000	0.0000	0.0000	1.000	0.000
DEP2B	0.974	0.9783	0.0608	0.0573	0.0037	0.929	1.000
DEP3B	1.027	1.0283	0.0688	0.0656	0.0047	0.941	1.000
DEP4B	0.980	0.9799	0.0684	0.0656	0.0047	0.934	1.000
SQ BY							
SQ1	1.000	1.0000	0.0000	0.0000	0.0000	1.000	0.000
SQ2	0.923	0.9675	0.3096	0.2909	0.0977	0.945	0.969
SQ3	1.217	1.2817	0.3725	0.3405	0.1428	0.938	0.988
SQ4	0.885	0.9318	0.2913	0.2732	0.0869	0.936	0.973
DEPRESS ON							
STRESS	1.037	1.0389	0.5734	0.5510	0.3285	0.954	0.486
SQ	3.119	3.3590	1.4735	1.3691	2.2266	0.947	0.753
SQ WITH							
STRESS	0.132	0.1356	0.1867	0.1783	0.0348	0.948	0.084

Example 6: Mediation – small sample = 50

```
TITLE: psy9555a simulation mediation small sample;
MONTECARLO:
    NAMES ARE ef1 ef2 ef3 pr1 pr2 pr3 goalset;
    NOBSERVATIONS = 50;
    NREPS = 1000;
    SEED = 53567;
MODEL POPULATION:
effort by ef1*.65 ef2*.70 ef3*.70;
perform by pr1*.80 pr2*.80 pr3*.85;
ef1*.5775 ef2*.51 ef3*.51;
pr1*.36 pr2*.36 pr3*.2775;
perform on effort*.70;
effort on goalset*.40;
perform on goalset*.20;
goalset*1;
effort@.84;
perform@.358;
MODEL:
effort by ef1*.65 ef2*.70 ef3*.70;
perform by pr1*.80 pr2*.80 pr3*.85;
ef1*.5775 ef2*.51 ef3*.51;
pr1*.36 pr2*.36 pr3*.2775;
perform on effort*.70;
effort on goalset*.40;
perform on goalset*.20;
goalset*1;
effort@.84;
perform@.358;
Model indirect:
perform IND goalset;
OUTPUT: tech9
```

Example 6: Mediation – small sample = 50

MODEL RESULTS

	Population	ESTIMATES Average	Std. Dev.	S. E. Average	M. S. E.	95% Cover	% Sig Coeff
EFFORT BY							
EF1	0.650	0.6359	0.1539	0.1428	0.0239	0.923	0.992
EF2	0.700	0.6802	0.1453	0.1420	0.0215	0.930	0.998
EF3	0.700	0.6849	0.1507	0.1423	0.0229	0.934	0.998
PERFORM BY							
PR1	0.800	0.7490	0.1910	0.1974	0.0390	0.965	0.918
PR2	0.800	0.7478	0.1923	0.1977	0.0397	0.965	0.917
PR3	0.850	0.7929	0.1983	0.2045	0.0425	0.966	0.919
PERFORM ON							
EFFORT	0.700	0.8139	0.4368	0.4898	0.2035	0.951	0.843
PERFORM ON							
GOALSET	0.200	0.2078	0.1848	0.1854	0.0342	0.973	0.310
EFFORT ON							
GOALSET	0.400	0.4186	0.2007	0.1770	0.0406	0.936	0.683
Means							
GOALSET	0.000	-0.0041	0.1384	0.1394	0.0191	0.945	0.055

TOTAL, TOTAL INDIRECT, SPECIFIC INDIRECT, AND DIRECT EFFECTS

	Population	ESTIMATES Average	Std. Dev.	S. E. Average	M. S. E.	95% Cover	% Sig Coeff
Effects from GOALSET to PERFORM							
Total	0.480	0.5482	0.2525	0.2724	0.0683	0.965	0.788
Tot indirect	0.280	0.3404	0.2522	0.2557	0.0672	0.919	0.239
Specific indirect							
PERFORM							
EFFORT							
GOALSET	0.280	0.3404	0.2522	0.2557	0.0672	0.919	0.239
Direct							
PERFORM							
GOALSET	0.200	0.2078	0.1848	0.1854	0.0342	0.973	0.310

Example 6: Mediation – sample size = 100

MODEL RESULTS

	Population	ESTIMATES Average	Std. Dev.	S. E. Average	M. S. E.	95% Cover	% Sig Coeff
EFFORT BY							
EF1	0.650	0.6406	0.1052	0.1015	0.0111	0.940	1.000
EF2	0.700	0.6885	0.1044	0.1012	0.0110	0.946	1.000
EF3	0.700	0.6913	0.1036	0.1016	0.0108	0.936	1.000
PERFORM BY							
PR1	0.800	0.7702	0.1397	0.1339	0.0204	0.951	0.986
PR2	0.800	0.7672	0.1363	0.1335	0.0196	0.960	0.986
PR3	0.850	0.8152	0.1444	0.1380	0.0220	0.956	0.986
PERFORM ON							
EFFORT	0.700	0.7592	0.2461	0.2248	0.0640	0.956	0.982
PERFORM ON							
GOALSET	0.200	0.1990	0.1130	0.1074	0.0128	0.975	0.536
EFFORT ON							
GOALSET	0.400	0.4116	0.1288	0.1218	0.0167	0.944	0.940
Means							
GOALSET	0.000	-0.0023	0.1005	0.0992	0.0101	0.935	0.065

TOTAL, TOTAL INDIRECT, SPECIFIC INDIRECT, AND DIRECT EFFECTS

	Population	ESTIMATES Average	Std. Dev.	S. E. Average	M. S. E.	95% Cover	% Sig Coeff
Effects from GOALSET to PERFORM							
Total	0.480	0.5126	0.1513	0.1443	0.0239	0.965	0.978
Tot indirect	0.280	0.3135	0.1529	0.1368	0.0245	0.947	0.851
Specific indirect							
PERFORM							
EFFORT							
GOALSET	0.280	0.3135	0.1529	0.1368	0.0245	0.947	0.851
Direct							
PERFORM							
GOALSET	0.200	0.1990	0.1130	0.1074	0.0128	0.975	0.536

Example 6: Mediation – sample size = 100

MODEL RESULTS

	Population	ESTIMATES Average	Std. Dev.	S. E. Average	M. S. E.	95% Cover	% Sig Coeff
EFFORT BY							
EF1	0.650	0.6406	0.1052	0.1015	0.0111	0.940	1.000
EF2	0.700	0.6885	0.1044	0.1012	0.0110	0.946	1.000
EF3	0.700	0.6913	0.1036	0.1016	0.0108	0.936	1.000
PERFORM BY							
PR1	0.800	0.7702	0.1397	0.1339	0.0204	0.951	0.986
PR2	0.800	0.7672	0.1363	0.1335	0.0196	0.960	0.986
PR3	0.850	0.8152	0.1444	0.1380	0.0220	0.956	0.986
PERFORM ON							
EFFORT	0.700	0.7592	0.2461	0.2248	0.0640	0.956	0.982
PERFORM ON							
GOALSET	0.200	0.1990	0.1130	0.1074	0.0128	0.975	0.536
EFFORT ON							
GOALSET	0.400	0.4116	0.1288	0.1218	0.0167	0.944	0.940
Means							
GOALSET	0.000	-0.0023	0.1005	0.0992	0.0101	0.935	0.065

TOTAL, TOTAL INDIRECT, SPECIFIC INDIRECT, AND DIRECT EFFECTS

	Population	ESTIMATES Average	Std. Dev.	S. E. Average	M. S. E.	95% Cover	% Sig Coeff
Effects from GOALSET to PERFORM							
Total	0.480	0.5126	0.1513	0.1443	0.0239	0.965	0.978
Tot indirect	0.280	0.3135	0.1529	0.1368	0.0245	0.947	0.851
Specific indirect							
PERFORM							
EFFORT							
GOALSET	0.280	0.3135	0.1529	0.1368	0.0245	0.947	0.851
Direct							
PERFORM							
GOALSET	0.200	0.1990	0.1130	0.1074	0.0128	0.975	0.536

Example 7: Latent Growth Modeling

```
TITLE: growth1.inp normal, no covariate, no missing
MONTECARLO:
NAMES ARE y1-y4;
NOBSERVATIONS = 40;
NREPS = 1000;
SEED = 53487;
SAVE = growth1.sav;
ANALYSIS:
MODEL POPULATION:
i BY y1-y4@1;
s BY y1@0 y2@1 y3@2 y4@3;
[y1-y4@0];
[i*0 s*.2];
i*.5;
s*.1;
i WITH s*0;
y1-y4*.5;
MODEL:
i BY y1-y4@1;
s BY y1@0 y2@1 y3@2 y4@3;
[y1-y4@0];
[i*0 s*.2];
i*.5;
s*.1;
i WITH s*0;
y1-y4*.5;
OUTPUT: TECH9;
```

Example 7: Latent Growth Modeling

MODEL RESULTS

		ESTIMATES		S. E.	M. S. E.	95%	% Sig
	Population	Average	Std. Dev.	Average		Cover	Coeff
I BY							
Y1	1.000	1.0000	0.0000	0.0000	0.0000	1.000	0.000
Y2	1.000	1.0000	0.0000	0.0000	0.0000	1.000	0.000
Y3	1.000	1.0000	0.0000	0.0000	0.0000	1.000	0.000
Y4	1.000	1.0000	0.0000	0.0000	0.0000	1.000	0.000
S BY							
Y1	0.000	0.0000	0.0000	0.0000	0.0000	1.000	0.000
Y2	1.000	1.0000	0.0000	0.0000	0.0000	1.000	0.000
Y3	2.000	2.0000	0.0000	0.0000	0.0000	1.000	0.000
Y4	3.000	3.0000	0.0000	0.0000	0.0000	1.000	0.000
I WITH							
S	0.000	0.0008	0.0868	0.0832	0.0075	0.941	0.059
Means							
I	0.000	0.0020	0.1417	0.1436	0.0201	0.944	0.056
S	0.200	0.2022	0.0722	0.0700	0.0052	0.944	0.810
Intercepts							
Y1	0.000	0.0000	0.0000	0.0000	0.0000	1.000	0.000
Y2	0.000	0.0000	0.0000	0.0000	0.0000	1.000	0.000
Y3	0.000	0.0000	0.0000	0.0000	0.0000	1.000	0.000
Y4	0.000	0.0000	0.0000	0.0000	0.0000	1.000	0.000
Variances							
I	0.500	0.4862	0.2267	0.2137	0.0515	0.919	0.658
S	0.100	0.0975	0.0561	0.0541	0.0032	0.927	0.417
Residual Variances							
Y1	0.500	0.5081	0.2172	0.2034	0.0472	0.937	0.767
Y2	0.500	0.4868	0.1397	0.1393	0.0197	0.908	1.000
Y3	0.500	0.5047	0.1585	0.1576	0.0251	0.926	0.993
Y4	0.500	0.5073	0.2600	0.2518	0.0676	0.934	0.526

Example 7: Latent Growth Modeling (adding two time-points)

MODEL RESULTS

		ESTIMATES		S. E.	M. S. E.	95%	% Sig
	Population	Average	Std. Dev.	Average		Cover	Coeff
I BY							
Y1	1.000	1.0000	0.0000	0.0000	0.0000	1.000	0.000
Y2	1.000	1.0000	0.0000	0.0000	0.0000	1.000	0.000
Y3	1.000	1.0000	0.0000	0.0000	0.0000	1.000	0.000
Y4	1.000	1.0000	0.0000	0.0000	0.0000	1.000	0.000
Y5	1.000	1.0000	0.0000	0.0000	0.0000	1.000	0.000
Y6	1.000	1.0000	0.0000	0.0000	0.0000	1.000	0.000
S BY							
Y1	0.000	0.0000	0.0000	0.0000	0.0000	1.000	0.000
Y2	1.000	1.0000	0.0000	0.0000	0.0000	1.000	0.000
Y3	2.000	2.0000	0.0000	0.0000	0.0000	1.000	0.000
Y4	3.000	3.0000	0.0000	0.0000	0.0000	1.000	0.000
Y5	4.000	4.0000	0.0000	0.0000	0.0000	1.000	0.000
Y6	5.000	5.0000	0.0000	0.0000	0.0000	1.000	0.000
I WITH							
S	0.000	-0.0003	0.0519	0.0519	0.0027	0.950	0.050
Means							
I	0.000	0.0029	0.1369	0.1357	0.0187	0.942	0.058
S	0.200	0.2009	0.0555	0.0559	0.0031	0.946	0.949
Intercepts							
Y1	0.000	0.0000	0.0000	0.0000	0.0000	1.000	0.000
Y2	0.000	0.0000	0.0000	0.0000	0.0000	1.000	0.000
Y3	0.000	0.0000	0.0000	0.0000	0.0000	1.000	0.000
Y4	0.000	0.0000	0.0000	0.0000	0.0000	1.000	0.000
Y5	0.000	0.0000	0.0000	0.0000	0.0000	1.000	0.000
Y6	0.000	0.0000	0.0000	0.0000	0.0000	1.000	0.000
Variances							
I	0.500	0.4826	0.1852	0.1748	0.0346	0.909	0.892
S	0.100	0.0981	0.0290	0.0289	0.0008	0.928	0.996

For Further Information:

STRUCTURAL EQUATION MODELING, 9(4), 599–620

TEACHER'S CORNER

How to Use a Monte Carlo Study to Decide on Sample Size and Determine Power

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