

Example of Second-Order Factor Model

This example tests a second-order factor model of the full 20-item CESD. Listwise deletion was used for convenience, and missing data estimation is probably preferable (although there were very few missing values overall).

```
title: Second Order Factor Model - Class Example;

data: file=c:\jason\mplus\semclass\cfa2nd.dat; format=20f1.0;
      listwise=on;

variable: names = rcesdel rcesdf1 rcesdg1 rcesdh1 rcesdl1 rcesdml rcesds1
                 rcesdc1 rcesdk1 rcesdn1 rcesdp1
                 rcesdal rcesdbl rcesddl rcesdil rcesdjl rcesdol rcesdrl
                 rcesdq1 rcesdt1 ;

      missing=blank;

analysis: type=general; estimator=mlm;

model: depaff by rcesdel-rcesds1;
       posaff by rcesdc1-rcesdp1;
       physical by rcesdal-rcesdrl;
       ipjudge by rcesdq1-rcesdt1;
       depress by depaff*1 posaff physical ipjudge;
       depress@1;

output: modindices (3.84) stdyx;
```

INPUT READING TERMINATED NORMALLY
Second Order Factor Model - Class Example;

SUMMARY OF ANALYSIS

Number of groups	1
Number of observations	294

DEPAFF	POSAFF	PHYSICAL	IPJUDGE	DEPRESS
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Estimator	MLM
Information matrix	EXPECTED
Maximum number of iterations	1000
Convergence criterion	0.500D-04
Maximum number of steepest descent iterations	20

Input data file(s)
c:\jason\mplus\semclass\cfa2nd.dat

Input data format
(20F1.0)

THE MODEL ESTIMATION TERMINATED NORMALLY

MODEL FIT INFORMATION

Number of Free Parameters	64
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Loglikelihood

H0 Value	-6396.520
H1 Value	-6225.553

Information Criteria

Akaike (AIC)	12921.040
Bayesian (BIC)	13156.790
Sample-Size Adjusted BIC	12953.828
(n* = (n + 2) / 24)	

Chi-Square Test of Model Fit

Value	280.889*
Degrees of Freedom	166
P-Value	0.0000
Scaling Correction Factor for MLM	1.2173

* The chi-square value for MLM, MLMV, MLR, ULSMV, WLSM and WLSMV cannot be used for chi-square difference testing in the regular way. MLM, MLR and WLSM chi-square difference testing is described on the Mplus website. MLMV, WLSMV, and ULSMV difference testing is done using the DIFFTEST option.

RMSEA (Root Mean Square Error Of Approximation)

Estimate	0.049
90 Percent C.I.	0.039 0.058
Probability RMSEA <= .05	0.587

CFI/TLI

CFI	0.903
TLI	0.890

Chi-Square Test of Model Fit for the Baseline Model

Value	1380.240
Degrees of Freedom	190
P-Value	0.0000

SRMR (Standardized Root Mean Square Residual)

Value	0.049
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WRMR (Weighted Root Mean Square Residual)

Value	1.042
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MODEL RESULTS

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
DEPAFF BY				
RCESDE1	1.000	0.000	999.000	999.000
RCESDF1	0.327	0.074	4.447	0.000
RCESDG1	0.867	0.079	10.963	0.000
RCESDH1	0.741	0.086	8.610	0.000
RCESDL1	0.858	0.081	10.623	0.000
RCESDM1	0.147	0.058	2.525	0.012
RCESDS1	0.880	0.075	11.809	0.000
POSAFF BY				
RCESDC1	1.000	0.000	999.000	999.000
RCESDK1	4.209	1.503	2.800	0.005
RCESDN1	4.489	1.569	2.862	0.004
RCESDP1	3.961	1.349	2.937	0.003
PHYSICAL BY				
RCESDA1	1.000	0.000	999.000	999.000
RCESDB1	1.398	0.181	7.742	0.000
RCESDD1	0.997	0.155	6.413	0.000
RCESDI1	0.802	0.125	6.406	0.000
RCESDJ1	0.941	0.169	5.576	0.000
RCESDO1	0.846	0.161	5.246	0.000
RCESDR1	0.953	0.153	6.217	0.000
IPJUDGE BY				
RCESDQ1	1.000	0.000	999.000	999.000
RCESDT1	2.883	2.080	1.386	0.166
DEPRESS BY				
DEPAFF	0.738	0.052	14.231	0.000
POSAFF	0.118	0.043	2.760	0.006

PHYSICAL	0.417	0.060	6.941	0.000
IPJUDGE	0.024	0.018	1.327	0.184
Variances				
DEPRESS	1.000	0.000	999.000	999.000

STANDARDIZED MODEL RESULTS

STDYX Standardization

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
DEPAFF BY				
RCEUDE1	0.766	0.029	26.231	0.000
RCEUDF1	0.323	0.065	4.960	0.000
RCEUDG1	0.614	0.046	13.483	0.000
RCEUDH1	0.610	0.049	12.406	0.000
RCEUDL1	0.768	0.032	24.110	0.000
RCEUDM1	0.252	0.083	3.042	0.002
RCEUDS1	0.785	0.033	23.449	0.000
POSAFF BY				
RCEUDC1	0.208	0.072	2.881	0.004
RCEUDK1	0.738	0.050	14.634	0.000
RCEUDN1	0.746	0.047	16.025	0.000
RCEUDP1	0.586	0.053	11.048	0.000
PHYSICAL BY				
RCEUDA1	0.554	0.056	9.904	0.000
RCEUDB1	0.674	0.037	18.147	0.000
RCEUDD1	0.484	0.054	8.914	0.000
RCEUDI1	0.546	0.067	8.137	0.000
RCEUDJ1	0.420	0.060	7.037	0.000
RCEUDO1	0.449	0.058	7.812	0.000
RCEUDR1	0.521	0.061	8.526	0.000
IPJUDGE BY				
RCEUDQ1	0.214	0.113	1.897	0.058
RCEUDT1	0.749	0.266	2.818	0.005
DEPRESS BY				
DEPAFF	0.957	0.039	24.409	0.000
POSAFF	0.782	0.051	15.489	0.000
PHYSICAL	0.806	0.049	16.614	0.000
IPJUDGE	0.332	0.135	2.459	0.014

Intercepts

RCEUDE1	1.233	0.058	21.114	0.000
RCEUDF1	0.544	0.038	14.160	0.000
RCEUDG1	1.071	0.054	19.871	0.000
RCEUDH1	0.658	0.041	16.054	0.000
RCEUDL1	0.501	0.034	14.874	0.000
RCEUDM1	0.250	0.035	7.177	0.000
RCEUDS1	0.791	0.042	18.688	0.000
RCEUDC1	0.373	0.035	10.750	0.000
RCEUDK1	0.606	0.037	16.481	0.000
RCEUDN1	0.668	0.041	16.148	0.000
RCEUDP1	0.702	0.039	17.765	0.000
RCEUDA1	0.641	0.040	16.009	0.000
RCEUDB1	0.864	0.046	18.764	0.000
RCEUDD1	0.919	0.048	19.263	0.000
RCEUDI1	0.483	0.035	13.887	0.000
RCEUDJ1	1.007	0.051	19.758	0.000
RCEUDO1	0.928	0.049	18.798	0.000
RCEUDR1	0.535	0.036	14.675	0.000
RCEUDQ1	0.198	0.029	6.788	0.000
RCEUDT1	0.253	0.034	7.435	0.000

Variances				
DEPRESS	1.000	0.000	999.000	999.000

R-SQUARE

Observed Variable	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
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RCESDE1	0.587	0.045	13.116	0.000
RCESDF1	0.104	0.042	2.480	0.013
RCESDG1	0.377	0.056	6.741	0.000
RCESDH1	0.372	0.060	6.203	0.000
RCESDL1	0.589	0.049	12.055	0.000
RCESDM1	0.064	0.042	1.521	0.128
RCESDS1	0.617	0.053	11.725	0.000
RCESDC1	0.043	0.030	1.440	0.150
RCESDK1	0.544	0.074	7.317	0.000
RCESDN1	0.556	0.069	8.013	0.000
RCESDP1	0.344	0.062	5.524	0.000
RCESDA1	0.307	0.062	4.952	0.000
RCESDB1	0.454	0.050	9.074	0.000
RCESDD1	0.235	0.053	4.457	0.000
RCESDI1	0.298	0.073	4.068	0.000
RCESDJ1	0.177	0.050	3.518	0.000
RCESDO1	0.202	0.052	3.906	0.000
RCESDR1	0.272	0.064	4.263	0.000
RCESDQ1	0.046	0.048	0.948	0.343
RCESDT1	0.561	0.398	1.409	0.159

Latent Variable	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
DEPAFF	0.916	0.075	12.205	0.000
POSAFF	0.612	0.079	7.744	0.000
PHYSICAL	0.650	0.078	8.307	0.000
IPJUDGE	0.110	0.090	1.229	0.219

Minimum M.I. value for printing the modification index 3.840

M.I. E.P.C. Std E.P.C. StdYX E.P.C.

BY Statements

DEPAFF BY RCESDI1	4.534	0.284	0.219	0.288
POSAFF BY RCESDG1	5.708	-1.979	-0.300	-0.275
POSAFF BY RCESDL1	5.341	1.372	0.208	0.241
POSAFF BY RCESDS1	4.971	1.316	0.199	0.230
IPJUDGE BY RCESDA1	4.421	2.131	0.156	0.167
DEPRESS BY RCESDG1	8.360	-1.832	-1.832	-1.682
DEPRESS BY RCESDL1	4.695	1.014	1.014	1.177
DEPRESS BY RCESDS1	4.136	0.952	0.952	1.102
DEPRESS BY RCESDI1	4.141	0.246	0.246	0.323

WITH Statements

RCESDG1 WITH RCESDE1	16.759	0.177	0.177	0.319
RCESDH1 WITH RCESDF1	6.102	-0.092	-0.092	-0.168
RCESDH1 WITH RCESDG1	7.830	0.127	0.127	0.199
RCESDL1 WITH RCESDE1	3.919	-0.063	-0.063	-0.177
RCESDL1 WITH RCESDG1	8.979	-0.111	-0.111	-0.234
RCESDM1 WITH RCESDE1	7.161	-0.054	-0.054	-0.194
RCESDM1 WITH RCESDG1	10.471	-0.082	-0.082	-0.219
RCESDM1 WITH RCESDL1	9.943	0.055	0.055	0.228
RCESDS1 WITH RCESDH1	14.044	-0.118	-0.118	-0.298
RCESDC1 WITH RCESDE1	5.376	-0.076	-0.076	-0.165
RCESDN1 WITH RCESDF1	3.958	-0.067	-0.067	-0.149
RCESDN1 WITH RCESDH1	12.384	-0.123	-0.123	-0.274
RCESDN1 WITH RCESDS1	3.861	0.054	0.054	0.167
RCESDN1 WITH RCESDK1	4.155	0.106	0.106	0.300
RCESDA1 WITH RCESDS1	4.947	-0.070	-0.070	-0.169
RCESDB1 WITH RCESDA1	4.902	0.112	0.112	0.181
RCESDI1 WITH RCESDH1	5.198	0.076	0.076	0.160
RCESDI1 WITH RCESDL1	3.992	0.053	0.053	0.149
RCESDI1 WITH RCESDP1	5.584	-0.089	-0.089	-0.169
RCESDI1 WITH RCESDB1	4.826	-0.090	-0.090	-0.178
RCESDO1 WITH RCESDH1	8.998	-0.133	-0.133	-0.206
RCESDO1 WITH RCESDS1	5.220	0.079	0.079	0.169
RCESDO1 WITH RCESDA1	6.761	-0.126	-0.126	-0.186
RCESDO1 WITH RCESDB1	12.028	0.185	0.185	0.268
RCESDR1 WITH RCESDI1	4.415	0.079	0.079	0.154
RCESDR1 WITH RCESDJ1	6.138	0.148	0.148	0.174
RCESDT1 WITH RCESDM1	4.253	0.016	0.016	0.194

lavaan

```
> d = read.fortran('c:/jason/mplus/semclass/cfa2nd.dat',
+               c("F1.0","F1.0","F1.0","F1.0","F1.0","F1.0","F1.0",
+               "F1.0","F1.0","F1.0","F1.0","F1.0","F1.0",
+               "F1.0","F1.0","F1.0","F1.0","F1.0","F1.0","F1.0",
+               "F1.0","F1.0"))
> names(d) = c("rcesde1", "rcesdf1", "rcesdgl", "rcesdh1", "rcesdl1", "rcesdm1", "rcesds1",
+             "rcesdc1", "rcesdk1", "rcesdn1", "rcesdp1",
+             "rcesda1", "rcesdb1", "rcesdd1", "rcesdi1", "rcesdj1", "rcesdo1", "rcesdr1",
+             "rcesdq1", "rcesdt1")
>
> model1 = '
+   depaff =~ rcesde1 + rcesdf1 + rcesdgl + rcesdh1 + rcesdl1 + rcesdm1 + rcesds1
+   posaff =~ rcesdc1 + rcesdk1 + rcesdn1 + rcesdp1
+   physical =~ rcesda1 + rcesdb1 + rcesdd1 + rcesdi1 + rcesdj1 + rcesdo1 + rcesdr1
+   ipjudge =~ rcesdq1 + rcesdt1
+   depress =~ NA*depaff + posaff + physical + ipjudge
+   depress~1*depress
+
+   fit = sem(model1, data = d, missing="listwise", mimic = "Mplus", estimator="mlm")
> summary(fit,fit.measures=TRUE, rsquare=TRUE, standardized=TRUE)
lavaan 0.6.15 ended normally after 91 iterations
```

Estimator	ML	
Optimization method	NLMINB	
Number of model parameters	64	
Number of observations	294	
Model Test User Model:		
Test Statistic	Standard	Scaled
Degrees of freedom	341.934	280.889
P-value (Chi-square)	166	166
Scaling correction factor	0.000	0.000
Satorra-Bentler correction (Mplus variant)		1.217
Model Test Baseline Model:		
Test statistic	1695.685	1380.240
Degrees of freedom	190	190
P-value	0.000	0.000
Scaling correction factor		1.229
User Model versus Baseline Model:		
Comparative Fit Index (CFI)	0.883	0.903
Tucker-Lewis Index (TLI)	0.866	0.890
Robust Comparative Fit Index (CFI)		0.904
Robust Tucker-Lewis Index (TLI)		0.891
Loglikelihood and Information Criteria:		
Loglikelihood user model (H0)	-6396.520	-6396.520
Loglikelihood unrestricted model (H1)	-6225.553	-6225.553
Akaike (AIC)	12921.040	12921.040
Bayesian (BIC)	13156.790	13156.790
Sample-size adjusted Bayesian (SABIC)	12953.828	12953.828
Root Mean Square Error of Approximation:		
RMSEA	0.060	0.049
90 Percent confidence interval - lower	0.051	0.040
90 Percent confidence interval - upper	0.069	0.057
P-value H_0: RMSEA <= 0.050	0.035	0.598
P-value H_0: RMSEA >= 0.080	0.000	0.000
Robust RMSEA		0.054
90 Percent confidence interval - lower		0.043
90 Percent confidence interval - upper		0.064
P-value H_0: Robust RMSEA <= 0.050		0.286
P-value H_0: Robust RMSEA >= 0.080		0.000
Standardized Root Mean Square Residual:		
SRMR	0.049	0.049
Parameter Estimates:		
Standard errors	Robust.sem	
Information	Expected	
Information saturated (h1) model	Structured	

Latent Variables:

	Estimate	Std.Err	z-value	P(> z)	Std.lv	Std.all
depaff =~						
rcesde1	1.000				0.771	0.766
rcesdf1	0.327	0.074	4.447	0.000	0.252	0.323
rcesdg1	0.867	0.079	10.963	0.000	0.669	0.614
rcesdh1	0.741	0.086	8.610	0.000	0.571	0.610
rcesdl1	0.858	0.081	10.623	0.000	0.661	0.768
rcesdm1	0.147	0.058	2.525	0.012	0.113	0.252
rcesds1	0.880	0.075	11.809	0.000	0.679	0.785
posaff =~						
rcesdc1	1.000				0.151	0.208
rcesdk1	4.209	1.503	2.800	0.005	0.637	0.738
rcesdn1	4.489	1.569	2.862	0.004	0.679	0.746
rcesdp1	3.961	1.349	2.937	0.003	0.599	0.586
physical =~						
rcesda1	1.000				0.518	0.554
rcesdb1	1.398	0.181	7.742	0.000	0.724	0.674
rcesdd1	0.997	0.155	6.413	0.000	0.516	0.484
rcesdi1	0.802	0.125	6.406	0.000	0.415	0.546
rcesdj1	0.941	0.169	5.576	0.000	0.487	0.420
rcesdo1	0.846	0.161	5.246	0.000	0.438	0.449
rcesdr1	0.953	0.153	6.217	0.000	0.493	0.521
ipjudge =~						
rcesdq1	1.000				0.073	0.214
rcesdt1	2.883	2.081	1.386	0.166	0.212	0.749
depress =~						
depaff	0.738	0.052	14.231	0.000	0.957	0.957
posaff	0.118	0.043	2.760	0.006	0.782	0.782
physical	0.417	0.060	6.941	0.000	0.806	0.806
ipjudge	0.024	0.018	1.327	0.184	0.332	0.332

Intercepts:

	Estimate	Std.Err	z-value	P(> z)	Std.lv	Std.all
.rcesde1	1.241	0.059	21.149	0.000	1.241	1.233
.rcesdf1	0.425	0.046	9.321	0.000	0.425	0.544
.rcesdg1	1.167	0.064	18.365	0.000	1.167	1.071
.rcesdh1	0.616	0.055	11.278	0.000	0.616	0.658
.rcesdl1	0.432	0.050	8.599	0.000	0.432	0.501
.rcesdm1	0.112	0.026	4.286	0.000	0.112	0.250
.rcesds1	0.684	0.050	13.564	0.000	0.684	0.791
.rcesdc1	0.272	0.043	6.400	0.000	0.272	0.373
.rcesdk1	0.524	0.050	10.398	0.000	0.524	0.606
.rcesdn1	0.609	0.053	11.459	0.000	0.609	0.668
.rcesdp1	0.718	0.060	12.031	0.000	0.718	0.702
.rcesda1	0.599	0.054	10.986	0.000	0.599	0.641
.rcesdb1	0.929	0.063	14.816	0.000	0.929	0.864
.rcesdd1	0.980	0.062	15.762	0.000	0.980	0.919
.rcesdi1	0.367	0.044	8.275	0.000	0.367	0.483
.rcesdj1	1.167	0.068	17.262	0.000	1.167	1.007
.rcesdo1	0.905	0.057	15.915	0.000	0.905	0.928
.rcesdr1	0.507	0.055	9.179	0.000	0.507	0.535
.rcesdq1	0.068	0.020	3.398	0.001	0.068	0.198
.rcesdt1	0.071	0.016	4.332	0.000	0.071	0.253
.depaff	0.000				0.000	0.000
.posaff	0.000				0.000	0.000
.physical	0.000				0.000	0.000
.ipjudge	0.000				0.000	0.000
.depress	0.000				0.000	0.000

Variances:

	Estimate	Std.Err	z-value	P(> z)	Std.lv	Std.all
depress	1.000				1.000	1.000
.rcesde1	0.418	0.043	9.677	0.000	0.418	0.413
.rcesdf1	0.548	0.053	10.422	0.000	0.548	0.896
.rcesdg1	0.739	0.059	12.478	0.000	0.739	0.623
.rcesdh1	0.550	0.047	11.721	0.000	0.550	0.628
.rcesdl1	0.305	0.038	8.108	0.000	0.305	0.411
.rcesdm1	0.189	0.040	4.690	0.000	0.189	0.936
.rcesds1	0.286	0.032	8.960	0.000	0.286	0.383
.rcesdc1	0.508	0.076	6.732	0.000	0.508	0.957
.rcesdk1	0.340	0.061	5.545	0.000	0.340	0.456
.rcesdn1	0.368	0.057	6.408	0.000	0.368	0.444
.rcesdp1	0.687	0.078	8.812	0.000	0.687	0.656
.rcesda1	0.605	0.055	10.945	0.000	0.605	0.693
.rcesdb1	0.631	0.056	11.217	0.000	0.631	0.546
.rcesdd1	0.869	0.065	13.415	0.000	0.869	0.765
.rcesdi1	0.407	0.052	7.851	0.000	0.407	0.702
.rcesdj1	1.106	0.081	13.719	0.000	1.106	0.823
.rcesdo1	0.758	0.048	15.773	0.000	0.758	0.798
.rcesdr1	0.653	0.077	8.508	0.000	0.653	0.728
.rcesdq1	0.112	0.043	2.633	0.008	0.112	0.954
.rcesdt1	0.035	0.033	1.057	0.291	0.035	0.439
.depaff	0.050	0.045	1.112	0.266	0.084	0.084

.posaff	0.009	0.006	1.402	0.161	0.388	0.388
.physical	0.094	0.030	3.117	0.002	0.350	0.350
.ipjudge	0.005	0.005	1.048	0.295	0.890	0.890

R-Square:

	Estimate
rcesde1	0.587
rcesdf1	0.104
rcesdg1	0.377
rcesdh1	0.372
rcesdl1	0.589
rcesdm1	0.064
rcesds1	0.617
rcesdc1	0.043
rcesdk1	0.544
rcesdn1	0.556
rcesdp1	0.344
rcesda1	0.307
rcesdb1	0.454
rcesdd1	0.235
rcesdi1	0.298
rcesdj1	0.177
rcesdo1	0.202
rcesdr1	0.272
rcesdq1	0.046
rcesdt1	0.561
depaff	0.916
posaff	0.612
physical	0.650
ipjudge	0.110