

Structural equation modeling with R cookbook

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Preface

This is a Quarto book.

To learn more about Quarto books visit <https://quarto.org/docs/books>.

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1 Introduction

This is a book created from markdown and executable code.

See Knuth (1984) for additional discussion of literate programming.

```
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```

```
[1] 2
```

Part I

Part I: Measurement model

2 Single factor model

```
library(psychTools)
library(lavaan)
library(flexplavaan)

mod1 <- '
Agreeableness =~ A1 + A2 + A3 + A4 + A5
'

fit.mod1 <- cfa(mod1, data = bfi)
summary(fit.mod1, standardized = TRUE, fit.measures = TRUE)
```

lavaan 0.6-19 ended normally after 33 iterations

Estimator	ML
Optimization method	NLMINB
Number of model parameters	10
	Used Total
Number of observations	2709 2800

Model Test User Model:

Test statistic	86.696
Degrees of freedom	5
P-value (Chi-square)	0.000

Model Test Baseline Model:

Test statistic	2533.636
Degrees of freedom	10
P-value	0.000

User Model versus Baseline Model:

Comparative Fit Index (CFI)	0.968
Tucker-Lewis Index (TLI)	0.935

Loglikelihood and Information Criteria:

Loglikelihood user model (H0)	-21777.580
Loglikelihood unrestricted model (H1)	-21734.232
Akaike (AIC)	43575.160
Bayesian (BIC)	43634.203
Sample-size adjusted Bayesian (SABIC)	43602.430

Root Mean Square Error of Approximation:

RMSEA	0.078
90 Percent confidence interval - lower	0.064
90 Percent confidence interval - upper	0.092
P-value H_0: RMSEA <= 0.050	0.001
P-value H_0: RMSEA >= 0.080	0.415

Standardized Root Mean Square Residual:

SRMR	0.032
------	-------

Parameter Estimates:

Standard errors	Standard
Information	Expected
Information saturated (h1) model	Structured

Latent Variables:

	Estimate	Std.Err	z-value	P(> z)	Std.lv	Std.all
Agreeableness =~						
A1	1.000				0.528	0.376
A2	-1.465	0.090	-16.310	0.000	-0.774	-0.658
A3	-1.880	0.113	-16.696	0.000	-0.994	-0.762
A4	-1.358	0.093	-14.626	0.000	-0.717	-0.483
A5	-1.497	0.093	-16.098	0.000	-0.791	-0.627

Variances:

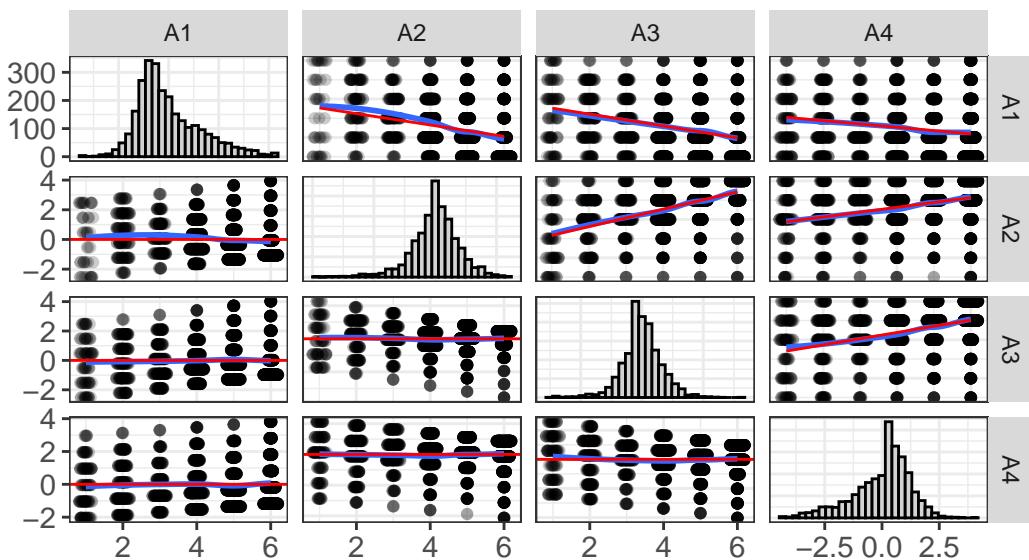
	Estimate	Std.Err	z-value	P(> z)	Std.lv	Std.all
.A1	1.693	0.048	34.915	0.000	1.693	0.858

.A2	0.784	0.029	27.443	0.000	0.784	0.567
.A3	0.714	0.035	20.314	0.000	0.714	0.420
.A4	1.694	0.051	33.277	0.000	1.694	0.767
.A5	0.965	0.033	28.977	0.000	0.965	0.607
Agreeableness	0.279	0.031	8.870	0.000	1.000	1.000

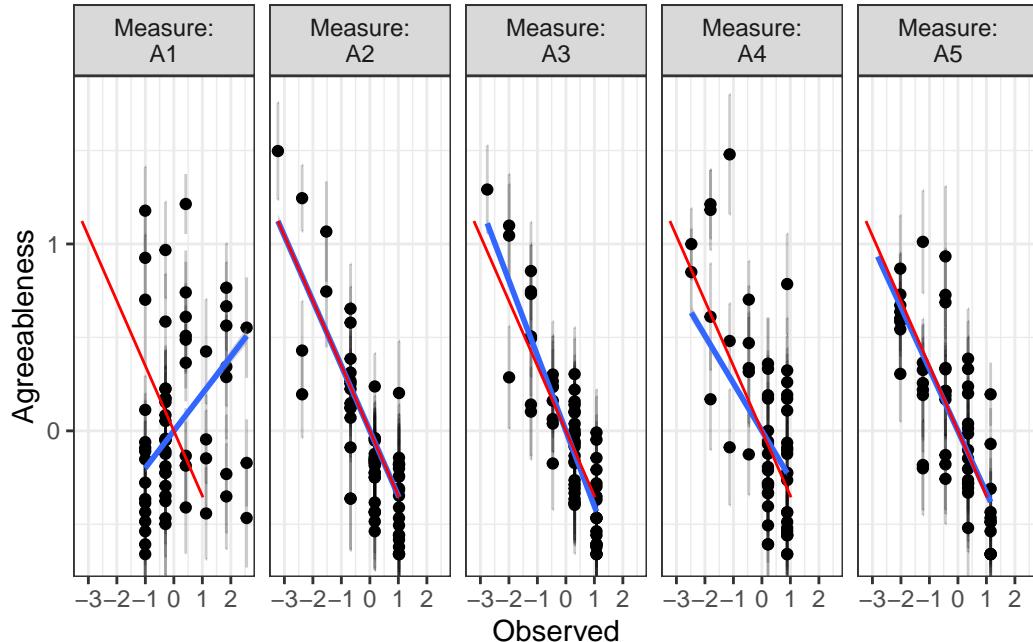
```
visualize(fit.mod1)
```

Trail/DDP Plots

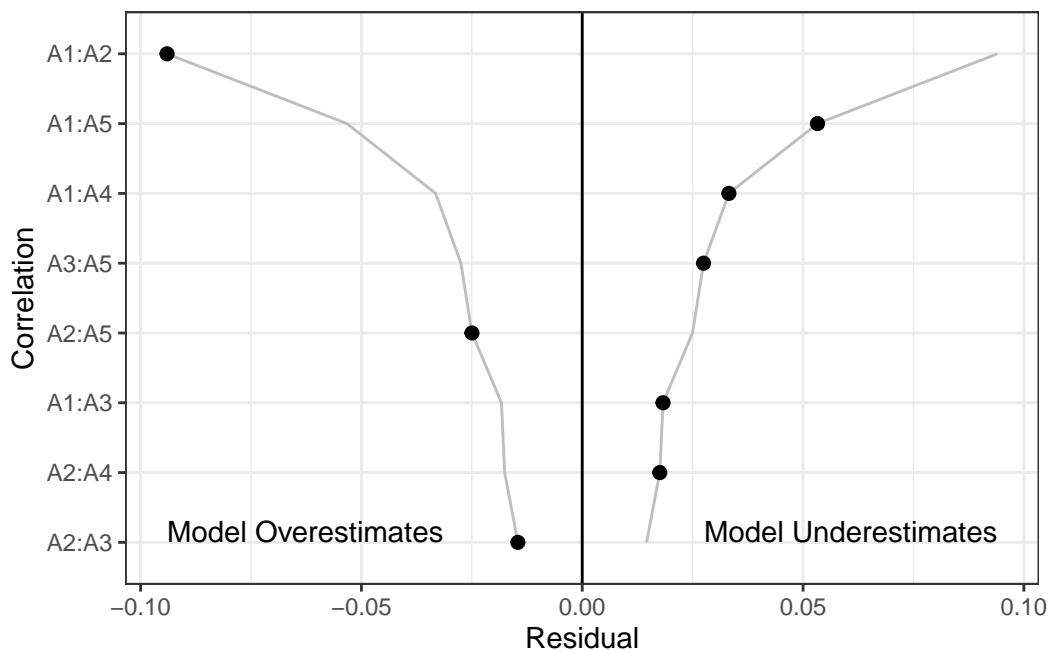
Red=Implied, Blue=Observed



```
measurement_plot(fit.mod1, sample = 300)
```



```
residual_plots(fit.mod1)
```



```

GWS2020 <- read.csv("C:/Users/deondb/Downloads/GWS2020.csv")

modgws <- '
  Stress =~ Item1 + Item2 + Item3 + Item4 + Item5 + Item6 + Item7 + Item8 + Item9
'

fit.modgws <- cfa(modgws, data = GWS2020)
summary(fit.modgws, standardized = TRUE, fit.measures = TRUE)

```

lavaan 0.6-19 ended normally after 22 iterations

Estimator	ML
Optimization method	NLMINB
Number of model parameters	18
Number of observations	1377

Model Test User Model:

Test statistic	808.572
Degrees of freedom	27
P-value (Chi-square)	0.000

Model Test Baseline Model:

Test statistic	6506.495
Degrees of freedom	36
P-value	0.000

User Model versus Baseline Model:

Comparative Fit Index (CFI)	0.879
Tucker-Lewis Index (TLI)	0.839

Loglikelihood and Information Criteria:

Loglikelihood user model (H0)	-14826.170
Loglikelihood unrestricted model (H1)	-14421.884
Akaike (AIC)	29688.341
Bayesian (BIC)	29782.439
Sample-size adjusted Bayesian (SABIC)	29725.260

Root Mean Square Error of Approximation:

RMSEA	0.145
90 Percent confidence interval - lower	0.136
90 Percent confidence interval - upper	0.154
P-value H_0: RMSEA <= 0.050	0.000
P-value H_0: RMSEA >= 0.080	1.000

Standardized Root Mean Square Residual:

SRMR	0.057
------	-------

Parameter Estimates:

Standard errors	Standard
Information	Expected
Information saturated (h1) model	Structured

Latent Variables:

	Estimate	Std.Err	z-value	P(> z)	Std.lv	Std.all
Stress =~						
Item1	1.000				0.810	0.762
Item2	1.114	0.036	31.162	0.000	0.902	0.814
Item3	0.963	0.035	27.841	0.000	0.780	0.737
Item4	0.895	0.036	24.948	0.000	0.725	0.668
Item5	0.763	0.031	24.824	0.000	0.618	0.665
Item6	0.831	0.029	28.328	0.000	0.673	0.748
Item7	0.813	0.035	23.238	0.000	0.659	0.627
Item8	0.837	0.031	27.235	0.000	0.678	0.723
Item9	0.771	0.032	24.225	0.000	0.624	0.651

Variances:

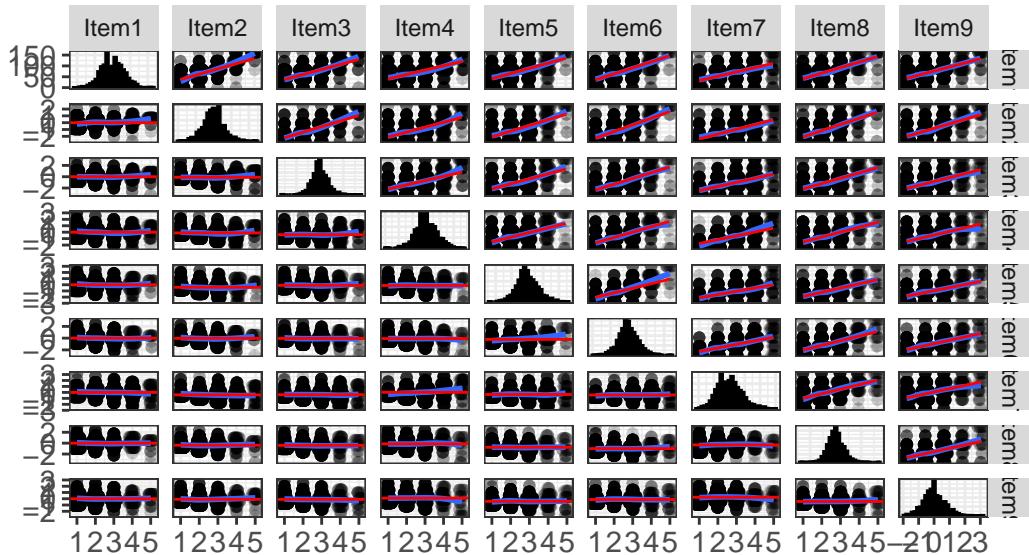
	Estimate	Std.Err	z-value	P(> z)	Std.lv	Std.all
.Item1	0.474	0.021	22.527	0.000	0.474	0.419
.Item2	0.414	0.020	20.962	0.000	0.414	0.337
.Item3	0.511	0.022	23.054	0.000	0.511	0.457
.Item4	0.651	0.027	24.084	0.000	0.651	0.553
.Item5	0.481	0.020	24.118	0.000	0.481	0.557
.Item6	0.356	0.016	22.826	0.000	0.356	0.440
.Item7	0.671	0.027	24.515	0.000	0.671	0.607
.Item8	0.420	0.018	23.311	0.000	0.420	0.478
.Item9	0.530	0.022	24.278	0.000	0.530	0.576

```
Stress          0.656    0.041   16.177    0.000    1.000    1.000
```

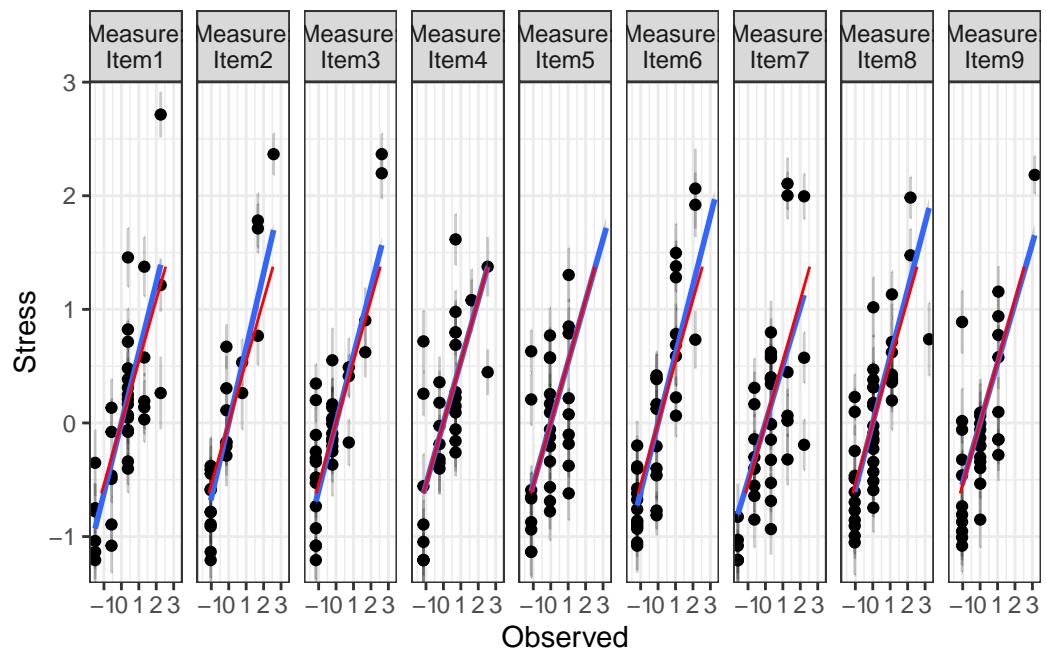
```
visualize(fit.modgws, subset = 1:9)
```

Trail/DDP Plots

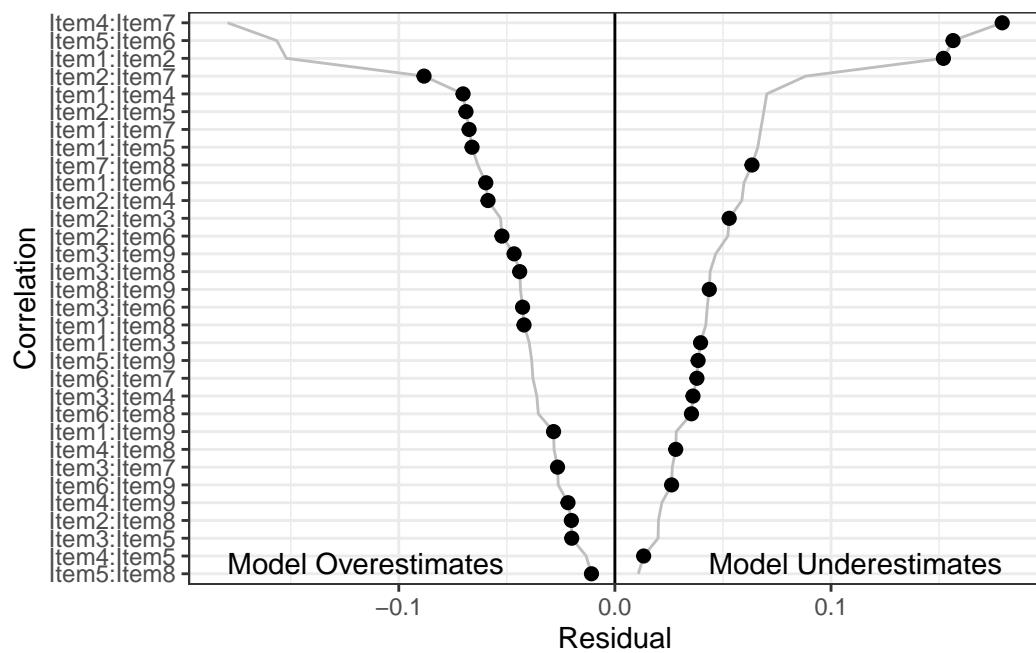
Red=Implied, Blue=Observed



```
measurement_plot(fit.modgws, sample = 300)
```



```
residual_plots(fit.modgws)
```



3 Multiple factors

```
library(lavaan)
library(flexlavaan)
library(psychTools)

mod3 <- '
Neuroticism    =~ N1 + N2 + N3 + N4 + N5
Agreeableness =~ A1 + A2 + A3 + A4 + A5

N1 ~~ N2
'

fit.mod3 <- cfa(model = mod3,
                  data  = bfi)

summary(fit.mod3,
        standardized = TRUE,
        fit.measures = TRUE)
```

lavaan 0.6-19 ended normally after 39 iterations

Estimator	ML
Optimization method	NLMINB
Number of model parameters	22
Number of observations	Used 2618 Total 2800

Model Test User Model:

Test statistic	394.745
Degrees of freedom	33
P-value (Chi-square)	0.000

Model Test Baseline Model:

Test statistic	7465.706
Degrees of freedom	45
P-value	0.000

User Model versus Baseline Model:

Comparative Fit Index (CFI)	0.951
Tucker-Lewis Index (TLI)	0.934

Loglikelihood and Information Criteria:

Loglikelihood user model (H0)	-43229.863
Loglikelihood unrestricted model (H1)	-43032.491
Akaike (AIC)	86503.726
Bayesian (BIC)	86632.870
Sample-size adjusted Bayesian (SABIC)	86562.969

Root Mean Square Error of Approximation:

RMSEA	0.065
90 Percent confidence interval - lower	0.059
90 Percent confidence interval - upper	0.071
P-value H_0: RMSEA <= 0.050	0.000
P-value H_0: RMSEA >= 0.080	0.000

Standardized Root Mean Square Residual:

SRMR	0.048
------	-------

Parameter Estimates:

Standard errors	Standard
Information	Expected
Information saturated (h1) model	Structured

Latent Variables:

	Estimate	Std.Err	z-value	P(> z)	Std.lv	Std.all
Neuroticism =~						
N1	1.000				1.069	0.681

N2	0.940	0.024	38.841	0.000	1.005	0.658
N3	1.206	0.041	29.617	0.000	1.289	0.807
N4	0.944	0.035	26.800	0.000	1.009	0.643
N5	0.833	0.035	23.538	0.000	0.890	0.549
Agreeableness =~						
A1	1.000				0.542	0.387
A2	-1.413	0.086	-16.450	0.000	-0.765	-0.651
A3	-1.838	0.109	-16.933	0.000	-0.996	-0.761
A4	-1.343	0.091	-14.789	0.000	-0.728	-0.488
A5	-1.487	0.091	-16.357	0.000	-0.806	-0.638
Covariances:						
	Estimate	Std.Err	z-value	P(> z)	Std.lv	Std.all
.N1 ~~						
.N2	0.621	0.040	15.696	0.000	0.621	0.471
Neuroticism ~~						
Agreeableness	0.117	0.016	7.304	0.000	0.203	0.203

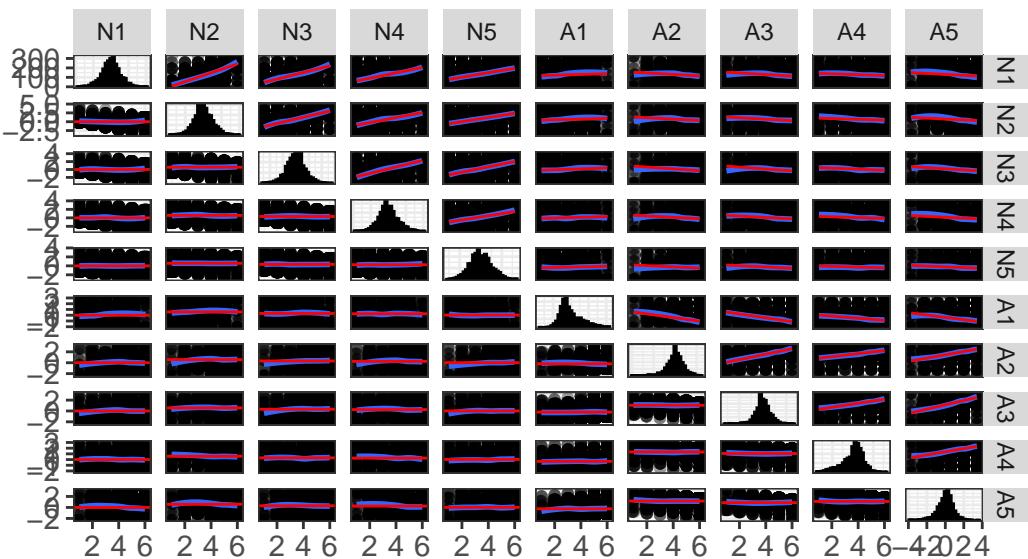
Variances:

	Estimate	Std.Err	z-value	P(> z)	Std.lv	Std.all
.N1	1.319	0.048	27.230	0.000	1.319	0.536
.N2	1.319	0.047	28.112	0.000	1.319	0.567
.N3	0.890	0.048	18.678	0.000	0.890	0.349
.N4	1.447	0.049	29.606	0.000	1.447	0.587
.N5	1.836	0.057	32.264	0.000	1.836	0.699
.A1	1.668	0.049	34.239	0.000	1.668	0.850
.A2	0.795	0.029	27.568	0.000	0.795	0.576
.A3	0.719	0.035	20.374	0.000	0.719	0.420
.A4	1.692	0.052	32.681	0.000	1.692	0.762
.A5	0.943	0.033	28.181	0.000	0.943	0.592
Neuroticism	1.142	0.066	17.384	0.000	1.000	1.000
Agreeableness	0.293	0.033	9.006	0.000	1.000	1.000

```
visualize(fit.mod3,
           subset = 1:10)
```

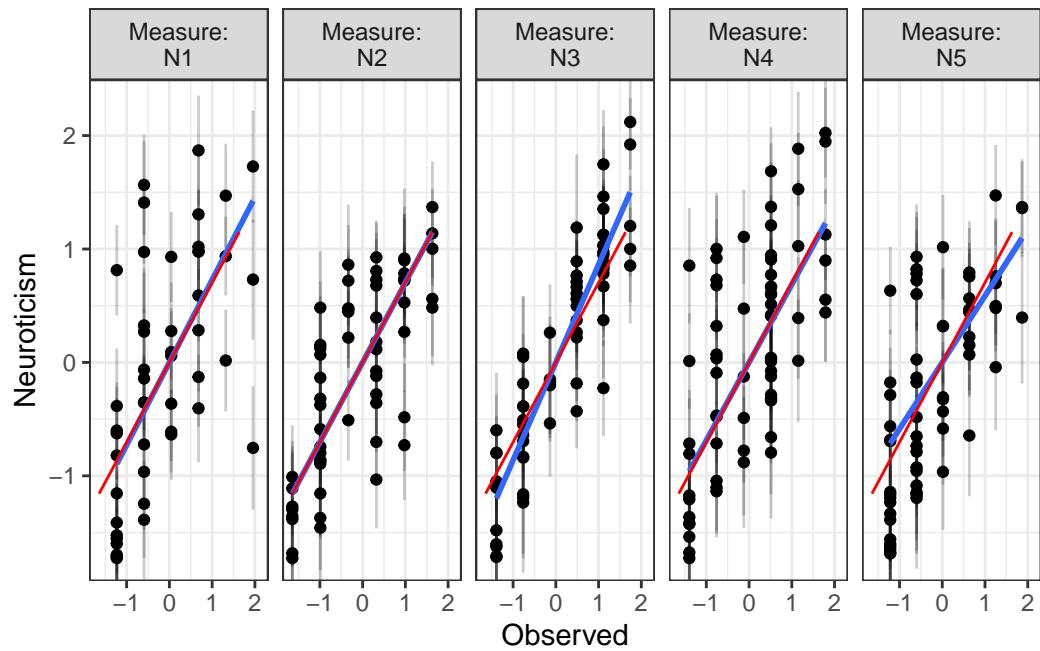
Trail/DDP Plots

Red=Implied, Blue=Observed

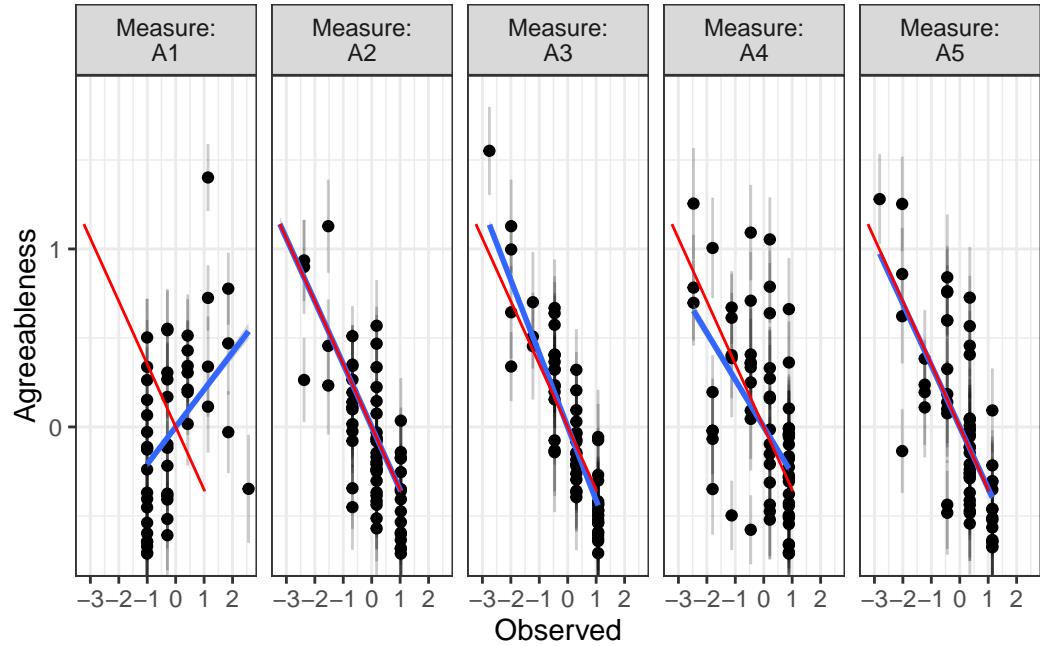


```
measurement_plot(fit.mod3,  
                  sample = 300)
```

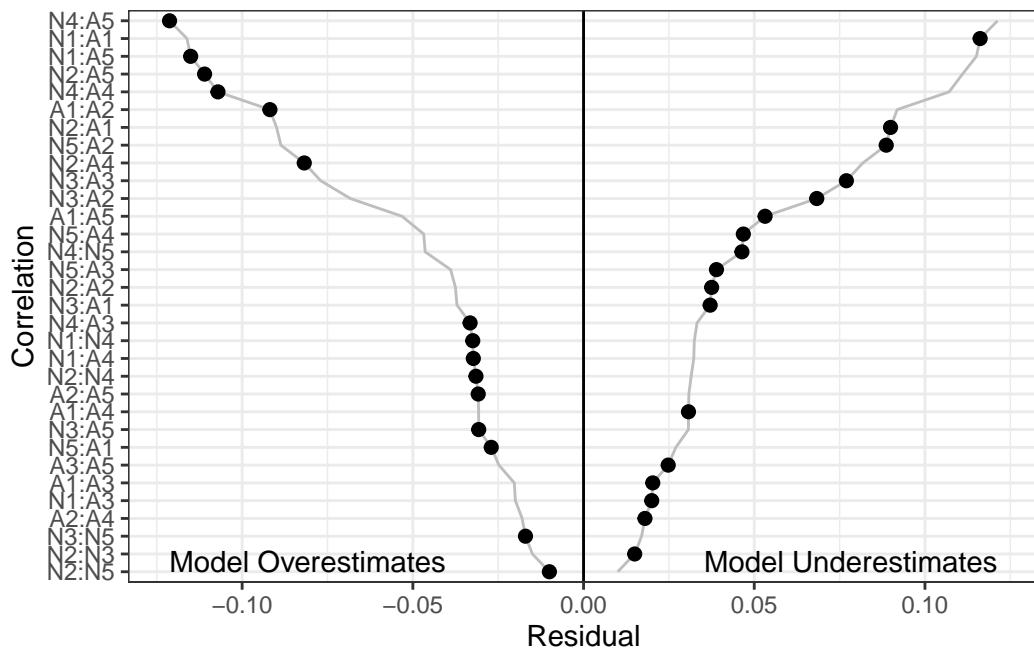
\$Neuroticism



\$Agreeableness



```
residual_plots(fit.mod3)
```



Part II

Part II: Diagnosing and improving the measurement model

4 Modification Indices

```
library(lavaan)
```

```
This is lavaan 0.6-19  
lavaan is FREE software! Please report any bugs.
```

```
library(psychTools)  
mod3 <- '  
Neuroticism =~ N1 + N2 + N3 + N4 + N5  
Agreeableness =~ A1 + A2 + A3 + A4 + A5  
'  
  
fit.mod3 <- cfa(model = mod3,  
                   data = bfi)  
  
summary(fit.mod3,  
        standardized = TRUE,  
        fit.measures = TRUE)
```

```
lavaan 0.6-19 ended normally after 36 iterations
```

Estimator	ML
Optimization method	NLMINB
Number of model parameters	21
Number of observations	Used 2618 Total 2800

Model Test User Model:

Test statistic	694.620
Degrees of freedom	34
P-value (Chi-square)	0.000

Model Test Baseline Model:

Test statistic	7465.706
Degrees of freedom	45
P-value	0.000

User Model versus Baseline Model:

Comparative Fit Index (CFI)	0.911
Tucker-Lewis Index (TLI)	0.882

Loglikelihood and Information Criteria:

Loglikelihood user model (H0)	-43379.800
Loglikelihood unrestricted model (H1)	-43032.491
Akaike (AIC)	86801.601
Bayesian (BIC)	86924.874
Sample-size adjusted Bayesian (SABIC)	86858.151

Root Mean Square Error of Approximation:

RMSEA	0.086
90 Percent confidence interval - lower	0.081
90 Percent confidence interval - upper	0.092
P-value H_0: RMSEA <= 0.050	0.000
P-value H_0: RMSEA >= 0.080	0.966

Standardized Root Mean Square Residual:

SRMR	0.054
------	-------

Parameter Estimates:

Standard errors	Standard
Information	Expected
Information saturated (h1) model	Structured

Latent Variables:

	Estimate	Std.Err	z-value	P(> z)	Std.lv	Std.all
Neuroticism =~						
N1	1.000				1.292	0.823

N2	0.949	0.023	40.791	0.000	1.226	0.803
N3	0.884	0.024	36.571	0.000	1.141	0.714
N4	0.680	0.024	27.853	0.000	0.878	0.559
N5	0.626	0.025	24.591	0.000	0.809	0.499
Agreeableness =~						
A1	1.000				0.545	0.389
A2	-1.404	0.085	-16.527	0.000	-0.765	-0.651
A3	-1.822	0.107	-17.018	0.000	-0.992	-0.759
A4	-1.338	0.090	-14.855	0.000	-0.729	-0.489
A5	-1.483	0.090	-16.448	0.000	-0.808	-0.640
Covariances:						
	Estimate	Std.Err	z-value	P(> z)	Std.lv	Std.all
Neuroticism ~~ Agreeableness						
Agreeableness	0.155	0.019	8.049	0.000	0.220	0.220
Variances:						
	Estimate	Std.Err	z-value	P(> z)	Std.lv	Std.all
.N1	0.793	0.036	22.094	0.000	0.793	0.322
.N2	0.826	0.035	23.877	0.000	0.826	0.355
.N3	1.249	0.043	29.352	0.000	1.249	0.490
.N4	1.694	0.051	33.284	0.000	1.694	0.687
.N5	1.974	0.058	34.081	0.000	1.974	0.751
.A1	1.665	0.049	34.211	0.000	1.665	0.849
.A2	0.796	0.029	27.597	0.000	0.796	0.576
.A3	0.725	0.035	20.614	0.000	0.725	0.424
.A4	1.690	0.052	32.667	0.000	1.690	0.761
.A5	0.939	0.033	28.108	0.000	0.939	0.590
Neuroticism	1.668	0.070	23.696	0.000	1.000	1.000
Agreeableness	0.297	0.033	9.060	0.000	1.000	1.000

```
modificationindices(fit.mod3)
```

	lhs	op	rhs	mi	epc	sepc.lv	sepc.all	sepc.nox
24	Neuroticism	=~	A1	19.035	0.098	0.127	0.091	0.091
25	Neuroticism	=~	A2	20.795	0.079	0.102	0.087	0.087
26	Neuroticism	=~	A3	29.798	0.104	0.135	0.103	0.103
27	Neuroticism	=~	A4	5.262	-0.053	-0.069	-0.046	-0.046
28	Neuroticism	=~	A5	50.336	-0.132	-0.171	-0.135	-0.135
29	Agreeableness	=~	N1	0.630	0.038	0.021	0.013	0.013
30	Agreeableness	=~	N2	0.295	0.025	0.014	0.009	0.009
31	Agreeableness	=~	N3	10.202	-0.168	-0.091	-0.057	-0.057

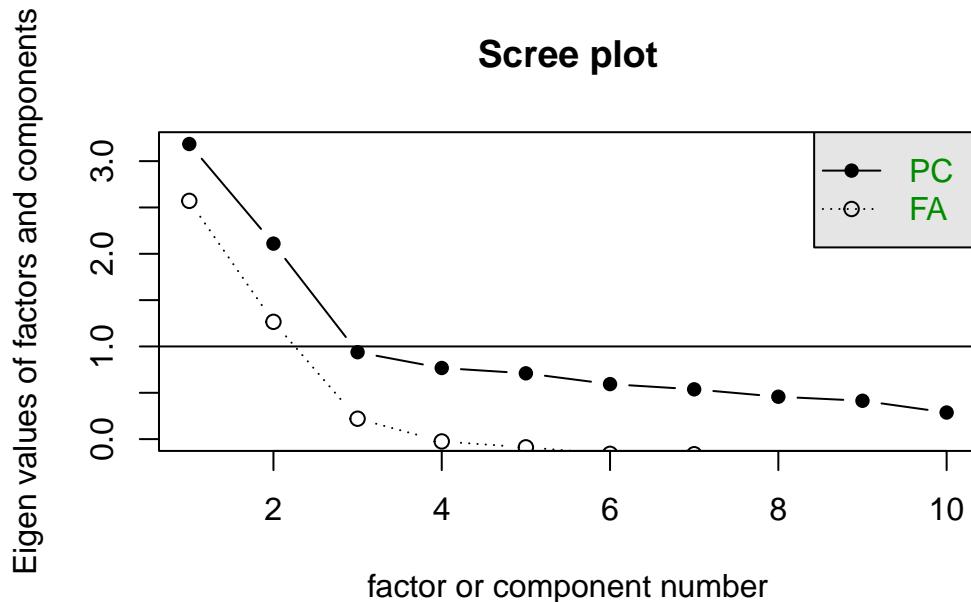
32	Agreeableness	=~	N4	25.954	0.293	0.160	0.102	0.102
33	Agreeableness	=~	N5	11.128	-0.205	-0.112	-0.069	-0.069
34		N1	~~	N2	345.707	0.775	0.775	0.958
35		N1	~~	N3	52.136	-0.272	-0.272	-0.274
36		N1	~~	N4	76.839	-0.291	-0.291	-0.251
37		N1	~~	N5	19.022	-0.149	-0.149	-0.119
38		N1	~~	A1	24.399	0.137	0.137	0.119
39		N1	~~	A2	4.495	-0.044	-0.044	-0.055
40		N1	~~	A3	13.106	0.079	0.079	0.104
41		N1	~~	A4	5.855	0.069	0.069	0.059
42		N1	~~	A5	5.301	-0.051	-0.051	-0.059
43		N2	~~	N3	37.647	-0.220	-0.220	-0.216
44		N2	~~	N4	68.849	-0.266	-0.266	-0.225
45		N2	~~	N5	42.497	-0.217	-0.217	-0.170
46		N2	~~	A1	3.438	0.051	0.051	0.043
47		N2	~~	A2	14.146	0.077	0.077	0.095
48		N2	~~	A3	0.861	0.020	0.020	0.026
49		N2	~~	A4	14.742	-0.108	-0.108	-0.091
50		N2	~~	A5	3.613	-0.042	-0.042	-0.048
51		N3	~~	N4	163.251	0.436	0.436	0.300
52		N3	~~	N5	47.254	0.247	0.247	0.157
53		N3	~~	A1	0.111	0.010	0.010	0.007
54		N3	~~	A2	0.254	0.012	0.012	0.012
55		N3	~~	A3	3.474	0.046	0.046	0.048
56		N3	~~	A4	0.614	0.025	0.025	0.017
57		N3	~~	A5	0.171	0.010	0.010	0.010
58		N4	~~	N5	86.112	0.360	0.360	0.197
59		N4	~~	A1	17.767	-0.146	-0.146	-0.087
60		N4	~~	A2	0.251	0.013	0.013	0.011
61		N4	~~	A3	3.030	-0.047	-0.047	-0.043
62		N4	~~	A4	20.479	-0.161	-0.161	-0.095
63		N4	~~	A5	10.813	-0.092	-0.092	-0.073
64		N5	~~	A1	8.114	-0.106	-0.106	-0.058
65		N5	~~	A2	7.324	0.075	0.075	0.060
66		N5	~~	A3	5.725	-0.069	-0.069	-0.058
67		N5	~~	A4	8.224	0.109	0.109	0.060
68		N5	~~	A5	0.301	0.016	0.016	0.012
69		A1	~~	A2	64.589	-0.219	-0.219	-0.190
70		A1	~~	A3	6.688	0.080	0.080	0.073
71		A1	~~	A4	4.991	0.080	0.080	0.048
72		A1	~~	A5	22.962	0.140	0.140	0.112
73		A2	~~	A3	0.654	-0.027	-0.027	-0.036
74		A2	~~	A4	3.109	0.051	0.051	0.044

75	A2	~~	A5	20.439	-0.124	-0.124	-0.143	-0.143
76	A3	~~	A4	0.417	-0.022	-0.022	-0.020	-0.020
77	A3	~~	A5	31.301	0.197	0.197	0.239	0.239
78	A4	~~	A5	0.192	-0.014	-0.014	-0.011	-0.011

5 Exploratory factor analysis

```
library(lavaan)
library(fexplavaan)
library(psychTools)
library(psych)

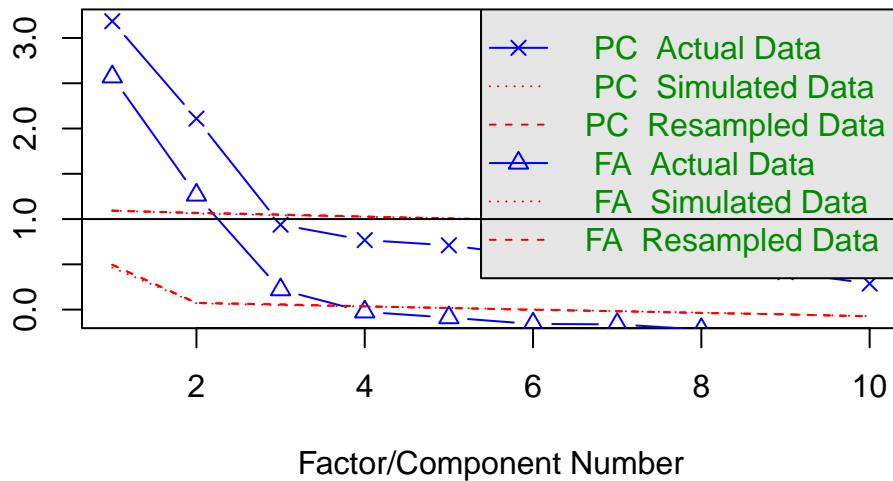
scree(bfi[c(1:5, 16:20)])
```



```
fa.parallel(bfi[c(1:5, 16:20)])
```

values of principal components and factor an

Parallel Analysis Scree Plots



Parallel analysis suggests that the number of factors = 3 and the number of components = 2

```
fa(bfi[c(1:5, 16:20)], nfactors = 2)
```

```
Factor Analysis using method = minres
Call: fa(r = bfi[c(1:5, 16:20)], nfactors = 2)
Standardized loadings (pattern matrix) based upon correlation matrix
      MR1    MR2     h2   u2 com
A1  0.07 -0.36  0.14  0.86 1.1
A2  0.05  0.69  0.47  0.53 1.0
A3  0.03  0.76  0.56  0.44 1.0
A4 -0.05  0.47  0.24  0.76 1.0
A5 -0.12  0.60  0.39  0.61 1.1
N1  0.78 -0.03  0.61  0.39 1.0
N2  0.76 -0.02  0.58  0.42 1.0
N3  0.77  0.05  0.58  0.42 1.0
N4  0.58 -0.08  0.36  0.64 1.0
N5  0.54  0.08  0.29  0.71 1.0
```

	MR1	MR2
SS loadings	2.44	1.78
Proportion Var	0.24	0.18

```
Cumulative Var      0.24 0.42
Proportion Explained 0.58 0.42
Cumulative Proportion 0.58 1.00
```

With factor correlations of

	MR1	MR2
MR1	1.00	-0.19
MR2	-0.19	1.00

Mean item complexity = 1

Test of the hypothesis that 2 factors are sufficient.

df null model = 45 with the objective function = 2.82 with Chi Square = 7880.99
df of the model are 26 and the objective function was 0.23

The root mean square of the residuals (RMSR) is 0.04

The df corrected root mean square of the residuals is 0.05

The harmonic n.obs is 2759 with the empirical chi square 396.78 with prob < 5.7e-68
The total n.obs was 2800 with Likelihood Chi Square = 636.27 with prob < 1.6e-117

Tucker Lewis Index of factoring reliability = 0.865

RMSEA index = 0.092 and the 90 % confidence intervals are 0.085 0.098

BIC = 429.9

Fit based upon off diagonal values = 0.98

Measures of factor score adequacy

	MR1	MR2
Correlation of (regression) scores with factors	0.92	0.88
Multiple R square of scores with factors	0.84	0.77
Minimum correlation of possible factor scores	0.68	0.54

```
fa(bfi[c(1:5, 16:20)], nfactors = 3)
```

```
Factor Analysis using method = minres
Call: fa(r = bfi[c(1:5, 16:20)], nfactors = 3)
```

Standardized loadings (pattern matrix) based upon correlation matrix

	MR2	MR1	MR3	h2	u2	com
A1	-0.36	0.24	-0.17	0.17	0.83	2.2
A2	0.69	-0.04	0.09	0.47	0.53	1.0
A3	0.75	0.06	-0.05	0.57	0.43	1.0
A4	0.47	0.00	-0.07	0.24	0.76	1.0
A5	0.59	-0.05	-0.10	0.40	0.60	1.1

N1	-0.01	0.88	-0.02	0.76	0.24	1.0
N2	-0.01	0.77	0.05	0.65	0.35	1.0
N3	0.05	0.37	0.47	0.57	0.43	1.9
N4	-0.07	-0.02	0.75	0.57	0.43	1.0
N5	0.08	0.16	0.46	0.32	0.68	1.3

	MR2	MR1	MR3
SS loadings	1.77	1.74	1.19
Proportion Var	0.18	0.17	0.12
Cumulative Var	0.18	0.35	0.47
Proportion Explained	0.38	0.37	0.25
Cumulative Proportion	0.38	0.75	1.00

With factor correlations of

	MR2	MR1	MR3
MR2	1.00	-0.16	-0.15
MR1	-0.16	1.00	0.63
MR3	-0.15	0.63	1.00

Mean item complexity = 1.3

Test of the hypothesis that 3 factors are sufficient.

df null model = 45 with the objective function = 2.82 with Chi Square = 7880.99
 df of the model are 18 and the objective function was 0.06

The root mean square of the residuals (RMSR) is 0.02

The df corrected root mean square of the residuals is 0.04

The harmonic n.obs is 2759 with the empirical chi square 121.95 with prob < 1.8e-17
 The total n.obs was 2800 with Likelihood Chi Square = 176.12 with prob < 5.6e-28

Tucker Lewis Index of factoring reliability = 0.95

RMSEA index = 0.056 and the 90 % confidence intervals are 0.049 0.064

BIC = 33.25

Fit based upon off diagonal values = 0.99

Measures of factor score adequacy

	MR2	MR1	MR3
Correlation of (regression) scores with factors	0.88	0.92	0.86
Multiple R square of scores with factors	0.77	0.86	0.74
Minimum correlation of possible factor scores	0.54	0.71	0.48

6 Correlated residuals

```
library(psychTools)
library(lavaan)
library(flexplavaan)

mod4 <- '
Neuroticism    =~ N1 + N2 + N3 + N4 + N5
Agreeableness =~ A1 + A2 + A3 + A4 + A5

N1 ~~ N2
N3 ~~ N4
'

fit.mod4 <- cfa(mod4,
                  data = bfi)

summary(fit.mod4,
        standardized = TRUE,
        fit.measures = TRUE)
```

lavaan 0.6-19 ended normally after 42 iterations

Estimator	ML
Optimization method	NLMINB
Number of model parameters	23
Number of observations	Used 2618 Total 2800

Model Test User Model:

Test statistic	394.559
Degrees of freedom	32
P-value (Chi-square)	0.000

Model Test Baseline Model:

Test statistic	7465.706
Degrees of freedom	45
P-value	0.000

User Model versus Baseline Model:

Comparative Fit Index (CFI)	0.951
Tucker-Lewis Index (TLI)	0.931

Loglikelihood and Information Criteria:

Loglikelihood user model (H0)	-43229.770
Loglikelihood unrestricted model (H1)	-43032.491
Akaike (AIC)	86505.540
Bayesian (BIC)	86640.554
Sample-size adjusted Bayesian (SABIC)	86567.476

Root Mean Square Error of Approximation:

RMSEA	0.066
90 Percent confidence interval - lower	0.060
90 Percent confidence interval - upper	0.072
P-value H_0: RMSEA <= 0.050	0.000
P-value H_0: RMSEA >= 0.080	0.000

Standardized Root Mean Square Residual:

SRMR	0.048
------	-------

Parameter Estimates:

Standard errors	Standard
Information	Expected
Information saturated (h1) model	Structured

Latent Variables:

	Estimate	Std.Err	z-value	P(> z)	Std.lv	Std.all
Neuroticism =~						
N1	1.000				1.075	0.685

N2	0.940	0.024	38.858	0.000	1.010	0.662
N3	1.192	0.050	23.837	0.000	1.282	0.802
N4	0.930	0.045	20.736	0.000	1.000	0.637
N5	0.830	0.036	23.362	0.000	0.892	0.550
Agreeableness =~						
A1	1.000				0.542	0.387
A2	-1.413	0.086	-16.453	0.000	-0.765	-0.651
A3	-1.838	0.109	-16.936	0.000	-0.996	-0.761
A4	-1.343	0.091	-14.790	0.000	-0.728	-0.488
A5	-1.487	0.091	-16.359	0.000	-0.806	-0.639
Covariances:						
	Estimate	Std.Err	z-value	P(> z)	Std.lv	Std.all
.N1 ~~						
.N2	0.609	0.047	12.987	0.000	0.609	0.466
.N3 ~~						
.N4	0.023	0.051	0.449	0.653	0.023	0.020
Neuroticism ~~						
Agreeableness	0.119	0.016	7.262	0.000	0.204	0.204
Variances:						
	Estimate	Std.Err	z-value	P(> z)	Std.lv	Std.all
.N1	1.306	0.055	23.585	0.000	1.306	0.531
.N2	1.308	0.053	24.875	0.000	1.308	0.562
.N3	0.909	0.065	14.039	0.000	0.909	0.356
.N4	1.465	0.062	23.684	0.000	1.465	0.594
.N5	1.833	0.058	31.661	0.000	1.833	0.697
.A1	1.668	0.049	34.238	0.000	1.668	0.850
.A2	0.795	0.029	27.569	0.000	0.795	0.576
.A3	0.719	0.035	20.378	0.000	0.719	0.420
.A4	1.692	0.052	32.681	0.000	1.692	0.762
.A5	0.943	0.033	28.179	0.000	0.943	0.592
Neuroticism	1.155	0.071	16.195	0.000	1.000	1.000
Agreeableness	0.294	0.033	9.008	0.000	1.000	1.000

Part III

Part III: Structural model

7 Summary

In summary, this book has no content whatsoever.

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References

- Knuth, Donald E. 1984. “Literate Programming.” *Comput. J.* 27 (2): 97–111. <https://doi.org/10.1093/comjnl/27.2.97>.