

MY455 Week 7

Homework 3

Exploratory Factor Analysis and Confirmatory Factor Analysis

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1. Exercise 1

```
> model.varimax.1 <- fa(values, nfactors = 1, residuals=TRUE,  
+                        rotate = "varimax")  
> model.varimax.1
```

Factor Analysis using method = minres

Call: fa(r = values, nfactors = 1, rotate = "varimax", residuals = TRUE)

Standardized loadings (pattern matrix) based upon correlation matrix

	MR1	h2	u2	com
equal	0.42	0.18	0.82	1
understand	0.52	0.27	0.73	1
nature	0.46	0.21	0.79	1
care	0.63	0.39	0.61	1
loyal	0.62	0.38	0.62	1

	MR1
SS loadings	1.43
Proportion Var	0.29

Mean item complexity = 1

Test of the hypothesis that 1 factor is sufficient.

The degrees of freedom for the null model are 10 and the objective function value is 10.000
The degrees of freedom for the model are 5 and the objective function value is 5.000

The root mean square of the residuals (RMSR) is 0.05
The df corrected root mean square of the residuals is 0.09

The harmonic number of observations is 2243 with the empirical chi square = 89.63
The total number of observations was 2243 with MLE Chi Square = 89.63

Tucker Lewis Index of factoring reliability = 0.88
RMSEA index = 0.087 and the 90 % confidence intervals are 0.072 0.103
BIC = 51.05
Fit based upon off diagonal values = 0.97
Measures of factor score adequacy

	MR1
Correlation of scores with factors	0.82
Multiple R square of scores with factors	0.68
Minimum correlation of possible factor scores	0.36

	equal	understand	nature	care	loyal
equal	0.82	0.10	-0.01	-0.03	-0.04
understand	0.10	0.73	0.01	0.00	-0.06
nature	-0.01	0.01	0.79	-0.04	0.04
care	-0.03	0.00	-0.04	0.61	0.04
loyal	-0.04	-0.06	0.04	0.04	0.62

(a) First question

```

> model.varimax.2 <- fa(values, nfactors = 2, residuals=TRUE,
+                        rotate = "varimax")
> model.varimax.2

Factor Analysis using method = minres
Call: fa(r = values, nfactors = 2, rotate = "varimax", residuals = TRUE)
Standardized loadings (pattern matrix) based upon correlation matrix
      MR1  MR2  h2  u2 com
equal    0.17 0.44 0.22 0.78 1.3
understand 0.18 0.66 0.47 0.53 1.1
nature    0.33 0.29 0.19 0.81 2.0
care      0.43 0.38 0.33 0.67 2.0
loyal     0.83 0.17 0.73 0.27 1.1


      MR1  MR2
SS loadings      1.05 0.89
Proportion Var    0.21 0.18
Cumulative Var    0.21 0.39
Proportion Explained 0.54 0.46
Cumulative Proportion 0.54 1.00


Mean item complexity = 1.5
Test of the hypothesis that 2 factors are sufficient.

The degrees of freedom for the null model are 10 and the objective function value is 1.00
The degrees of freedom for the model are 1 and the objective function value is 0.00

The root mean square of the residuals (RMSR) is 0
The df corrected root mean square of the residuals is 0.01

The harmonic number of observations is 2243 with the empirical chi square value of 0.27
The total number of observations was 2243 with MLE Chi Square = 0.27

Tucker Lewis Index of factoring reliability = 1.005
RMSEA index = 0 and the 90 % confidence intervals are NA 0.045
BIC = -7.45
Fit based upon off diagonal values = 1
Measures of factor score adequacy
      MR1
Correlation of scores with factors 0.84
Multiple R square of scores with factors 0.71

```

Minimum correlation of possible factor scores	0.42
	MR2
Correlation of scores with factors	0.73
Multiple R square of scores with factors	0.53
Minimum correlation of possible factor scores	0.07

	equal	understand	nature	care	loyal
equal	0.78	0.00	0.01	-0.00	0.00
understand	0.00	0.53	-0.00	0.00	-0.00
nature	0.01	-0.00	0.81	0.00	-0.00
care	-0.00	0.00	0.00	0.67	0.00
loyal	0.00	-0.00	-0.00	0.00	0.27

(b) Second question

```

> model.oblimin.2 <- fa(values, nfactors = 2, residuals=TRUE,
+                        rotate = "oblimin")
> model.oblimin.2

Factor Analysis using method = minres
Call: fa(r = values, nfactors = 2, rotate = "oblimin", residuals = TRUE)
Standardized loadings (pattern matrix) based upon correlation matrix
      MR1   MR2   h2   u2 com
equal      0.04  0.45 0.22 0.78  1
understand -0.03  0.70 0.47 0.53  1
nature      0.26  0.24 0.19 0.81  2
care        0.35  0.31 0.33 0.67  2
loyal       0.86 -0.02 0.73 0.27  1

      MR1   MR2
SS loadings      1.01 0.93
Proportion Var    0.20 0.19
Cumulative Var    0.20 0.39
Proportion Explained 0.52 0.48
Cumulative Proportion 0.52 1.00

With factor correlations of
      MR1   MR2
MR1 1.00 0.49
MR2 0.49 1.00

Mean item complexity = 1.4
Test of the hypothesis that 2 factors are sufficient.

The degrees of freedom for the null model are 10 and the objective function value is 1.44
The degrees of freedom for the model are 1 and the objective function value is 0.01

The root mean square of the residuals (RMSR) is 0
The df corrected root mean square of the residuals is 0.01

The harmonic number of observations is 2243 with the empirical chi square = 0.27
The total number of observations was 2243 with MLE Chi Square = 0.27

Tucker Lewis Index of factoring reliability = 1.005
RMSEA index = 0 and the 90 % confidence intervals are NA 0.045
BIC = -7.45

```

Fit based upon off diagonal values = 1

Measures of factor score adequacy

	MR1
Correlation of scores with factors	0.87
Multiple R square of scores with factors	0.76
Minimum correlation of possible factor scores	0.52
	MR2
Correlation of scores with factors	0.79
Multiple R square of scores with factors	0.63
Minimum correlation of possible factor scores	0.25

	equal	understand	nature	care	loyal
equal	0.78	0.00	0.01	-0.00	0.00
understand	0.00	0.53	-0.00	0.00	-0.00
nature	0.01	-0.00	0.81	0.00	-0.00
care	-0.00	0.00	0.00	0.67	0.00
loyal	0.00	-0.00	-0.00	0.00	0.27

(c) Third question

2. Exercise 2

```
> ESS6.model <- 'universalism =~ equal + understand + nature
+               benevolence =~ care + loyal'
> ESS6.model.fit <- cfa(ESS6.model, data = values)
> summary(ESS6.model.fit)
```

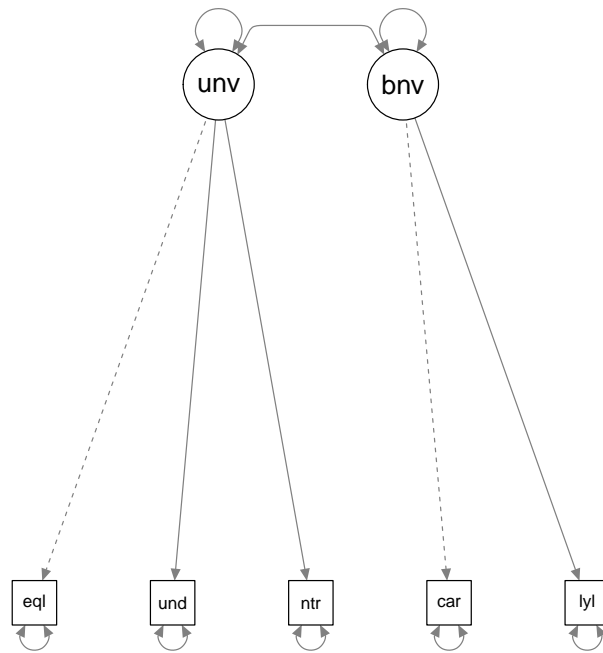
lavaan (0.5-16) converged normally after 29 iterations

Number of observations	2243
Estimator	ML
Minimum Function Test Statistic	54.320
Degrees of freedom	4
P-value (Chi-square)	0.000

Parameter estimates:

	Estimate	Std.err	Z-value	P(> z)
Information				Expected
Standard Errors				Standard
Latent variables:				
universalism =~				
equal	1.000			
understand	1.223	0.087	14.039	0.000
nature	1.071	0.082	13.051	0.000
benevolence =~				
care	1.000			
loyal	0.901	0.054	16.839	0.000
Covariances:				
universalism ~~				
benevolence	0.232	0.018	13.214	0.000
Variances:				
equal	0.807	0.029		
understand	0.657	0.029		
nature	0.881	0.032		
care	0.460	0.025		
loyal	0.427	0.021		
universalism	0.223	0.025		

benevolence 0.367 0.029



(a) First question


```
> ESS6.model.varfix.fit <- cfa(ESS6.model, data = values, std.lv = TRUE)
> summary(ESS6.model.varfix.fit)
```

lavaan (0.5-16) converged normally after 17 iterations

Number of observations	2243
Estimator	ML
Minimum Function Test Statistic	54.320
Degrees of freedom	4
P-value (Chi-square)	0.000

Parameter estimates:

	Estimate	Std.err	Z-value	P(> z)
Information				Expected
Standard Errors				Standard
Latent variables:				
universalism =~				
equal	0.472	0.026	17.882	0.000
understand	0.578	0.026	21.806	0.000
nature	0.506	0.028	18.225	0.000
benevolence =~				
care	0.605	0.024	25.278	0.000
loyal	0.546	0.022	24.652	0.000
Covariances:				
universalism ~~				
benevolence	0.810	0.030	26.775	0.000
Variances:				
equal	0.807	0.029		
understand	0.657	0.029		
nature	0.881	0.032		
care	0.460	0.025		
loyal	0.427	0.021		
universalism	1.000			
benevolence	1.000			

(b) Second question

```
> ESS6.model.meacon <- 'universalism =~ v1*equal + understand + v1*nature
+                           benevolence =~ care + loyal'
> ESS6.model.meacon.fit <- cfa(ESS6.model.meacon, data = values, std.lv = TRUE)
> summary(ESS6.model.meacon.fit)
```

lavaan (0.5-16) converged normally after 18 iterations

Number of observations	2243
Estimator	ML
Minimum Function Test Statistic	55.040
Degrees of freedom	5
P-value (Chi-square)	0.000

Parameter estimates:

	Estimate	Std.err	Z-value	P(> z)
Information				Expected
Standard Errors				Standard
Latent variables:				
universalism =~				
equal (v1)	0.488	0.020	24.981	0.000
undrstnd	0.581	0.027	21.917	0.000
nature (v1)	0.488	0.020	24.981	0.000
benevolence =~				
care	0.607	0.024	25.261	0.000
loyal	0.544	0.022	24.552	0.000

Covariances:

universalism ~~				
benevolence	0.805	0.030	26.628	0.000

Variances:

equal	0.799	0.028
understand	0.652	0.029
nature	0.890	0.030
care	0.458	0.025
loyal	0.429	0.021
universalism	1.000	
benevolence	1.000	

(c) Third question