



Latent Variable Modelling of Categorical Data

Tools of Analysis for Cross-National Surveys



Training workshop May 2012

Class 3 instructions: Latent trait and latent class models for multiple groups, with measurement invariance

The data for these exercises are taken from the latest (2008-9) wave of the European Values Survey:

EVS (2011): European Values Study 2008: Integrated Dataset (EVS 2008). GESIS Data Archive, Cologne. ZA4800 Data file Version 3.0.0, [doi:10.4232/1.11004](https://doi.org/10.4232/1.11004)
<http://info1.gesis.org/dbksearch/sdesc2.asp?no=4800&db=e&doi=10.4232/1.11004>

We will focus on a set of items asking respondents how much confidence they have in a range of institutions. We focus on a subset of the items for the analyses here, but include the full list of items in the data set, so that you may explore models using other items if you wish. The institutions are:

Variable name	Description
church	church
army	armed forces
educ	education system
press	the press
tu	trade unions
police	the police
parlt	parliament
civil	civil service
welfare	social security system
eu	European Union
nato	NATO
un	United Nations
health	health care system
justice	justice system
company	major companies
environ	environmental organisations
party	political parties
govt	government

In the data set they are provided in two forms. Variable names followed by a '4' (e.g. church4) are items with 4-point scales (with coding reversed from the original) so that:

- | | | |
|---|---|---------------|
| 1 | = | none at all |
| 2 | = | not very much |
| 3 | = | quite a lot |
| 4 | = | a great deal |

Variable names followed by a '2' (e.g. church2) are binary items recoded from the originals so that:

- | | | |
|---|---|------------------------------|
| 0 | = | none or not very much |
| 1 | = | quite a lot or a great deal. |

The models fitted in Class 3 and Class 4 are multiple-group models, where the groups are countries. The data file that you are using contains responses for the complete set of countries in the European Values Survey, but we will focus on those for Great Britain (country code 45), Northern Ireland (country code 46) and Greece (country code 19).

If you would like to try the analyses with different sets of countries you may wish to know the country codes:

1 Albania	25 Lithuania
2 Azerbaijan	26 Luxembourg
3 Austria	27 Malta
4 Armenia	28 Moldova
5 Belgium	29 Montenegro
6 Bosnia Herzegovina	30 Netherlands
7 Bulgaria	31 Norway
8 Belarus	32 Poland
9 Croatia	33 Portugal
10 Cyprus	34 Romania
11 Northern Cyprus	35 Russian Federation
12 Czech Republic	36 Serbia
13 Denmark	37 Slovak Republic
14 Estonia	38 Slovenia
15 Finland	39 Spain
16 France	40 Sweden
17 Georgia	41 Switzerland
18 Germany	42 Turkey
19 Greece	43 Ukraine
20 Hungary	44 Macedonia
21 Iceland	45 Great Britain
22 Ireland	46 Northern Ireland
23 Italy	47 Kosovo
24 Latvia	

1. 1 latent trait; 3 groups; 3 binary items: all parameters equal

- Mplus input file: **1trait_0_binary_gbnigr.inp**
- Model: 1 trait, 3 binary items (police2 part2 justice2), 3 groups = respondents from Great Britain ('gb'), Northern Ireland ('ni') and Greece (gr); trait means fixed to 0 and trait variances fixed to 1 for all three countries (groups)
- R command to read in the data and apply the LCAT function, defining a new object for the data set of three binary variables for the three countries:

```
bin3gbnigr<-lcat("1trait_0_binary_gbnigr.out",sessionpath)
```
- Viewing the results in two different formats:

```
print(bin3gbnigr,1)  
print(bin3gbnigr,1,alt=T)
```
- Plotting ICCs for the higher level of response (trust quite a lot or a great deal) for all 3 countries, for all 3 items:

```
plot(bin3gbnigr,1,groups=1:3,items=1:3,levels=2)
```

2. 1 latent trait; 3 groups; 3 binary items: trait means vary across groups

- Mplus input file: **1trait_1_binary_gbnigr.inp**.
- Model: 1 trait, 3 binary items (police2 part2 justice2), 3 groups = respondents from Great Britain ('gb'), Northern Ireland ('ni') and Greece (gr); trait variances fixed to 1 for all three countries (groups) but trait means allowed to vary between countries
- R command to read in the data and apply the LCAT function, and read the results in two different formats:

```
bin3gbnigr<-lcat("1trait_1_binary_gbnigr.out",sessionpath,addto=bin3gbnigr)  
print(bin3gbnigr,2)  
print(bin3gbnigr,2,alt=T)
```

3. 1 latent trait; 3 groups; 3 binary items: trait means and variances vary across groups

- Mplus input file: **1trait_2_binary_gbnigr.inp**
- Model: 1 trait, 3 binary items (police2 part2 justice2), 3 groups = respondents from Great Britain ('gb'), Northern Ireland ('ni') and Greece (gr); trait variances and trait means allowed to vary between countries
- R command to read in the data and apply the LCAT function, and read the results in two different formats:

```
bin3gbnigr<-lcat("1trait_2_binary_gbnigr.out",sessionpath,addto=bin3gbnigr)  
print(bin3gbnigr,3)  
print(bin3gbnigr,3,alt=T)
```

4. Relabel groups for presentation

- Since the multiple-group specification used for the trait models results in labelling like 'countryx1', assign group names. Please note that the input file for the workshop have been put together carefully so that the same order applies to both the (multiple group specification) trait models and the (covariate specification) latent class models that follow. There will be no error message to tell you if you relabel the groups incorrectly! So you need to be sure of what you are doing here.
- See the current way in which the groups are labelled for the models fitted in this session:
`bin3gbnigr`
- Now apply the group labels as follows:
`reorder(bin3gbnigr,groupnames=c("GB","GR","NI"))`
- And see the resulting presentation:
`bin3gbnigr`

5. 2 latent classes; 3 groups; 3 binary items: proportions in classes equal groups

- Mplus input file: **2class_0_binary_gbnigr.inp**
- Model: 2 classes, 3 binary items (police2 part2 justice2), 3 groups = respondents from Great Britain ('gb'), Northern Ireland ('ni') and Greece (gr); prior probabilities (i.e. proportions estimated to belong to each class) fixed to be the same for all countries
- R command to read in the data and apply the LCAT function, and read the results:
`bin3gbnigr<-lcat("2class_0_binary_gbnigr.out",sessionpath,addto=bin3gbnigr)
print(bin3gbnigr,4)`
- Plotting response probabilities for groups 1 to 3, for the higher response option ("quite a lot" or "a great deal") for items 1 to 3:
`plot(bin3gbnigr,4,groups=1:3,items=1:3,levels=2)`

6. 2 latent classes; 3 groups; 3 binary items: proportions in classes varies across groups

- Mplus input file **2class_1_binary_gbnigr.inp**
- Model: 2 classes, 3 binary items (police2 part2 justice2), 3 groups = respondents from Great Britain ('gb'), Northern Ireland ('ni') and Greece (gr); prior probabilities (i.e. proportions estimated to belong to each class) allowed to vary across countries
- R command to read in the data and apply the LCAT function, and read the results:
`bin3gbnigr<-lcat("2class_1_binary_gbnigr.out",sessionpath,addto=bin3gbnigr)
print(bin3gbnigr,5)`

7. 2 latent classes; 3 groups; 3 nominal items: proportions in classes varies across groups

- Mplus input file: **2class_1_categorical_gbnigr.inp**
- Model: 3 classes, 3 polytomous items (police4 parlt4 justice4) treated as nominal, 3 groups = respondents from Great Britain ('gb'), Northern Ireland ('ni') and Greece (gr); prior probabilities (i.e. proportions estimated to belong to each class) allowed to vary across countries
- R command to read in the data and apply the LCAT function, and read the results:

```
poly3gbnigr<-lcat("2class_1_categorical_gbnigr.out",sessionpath)  
print(poly3gbnigr,1)
```
- Plotting response probabilities for groups 1 to 3, for the higher response options ("quite a lot" or "a great deal") for items 1 to 3:

```
plot(poly3gbnigr,1,groups=1:3,items=1:3,levels=3,cumprob="high")
```

8. 3 latent classes; 3 groups; 3 nominal items: proportions in classes varies across groups

- Mplus input file: **3class_1_categorical_gbnigr.inp**
- Model: 3 classes, 3 binary items (police2 parlt2 justice2), 3 groups = respondents from Great Britain ('gb'), Northern Ireland ('ni') and Greece (gr); prior probabilities (i.e. proportions estimated to belong to each class) allowed to vary across countries
- R command to read in the data and apply the LCAT function, and read the results:

```
poly3gbnigr<-lcat("3class_1_categorical_gbnigr.out",sessionpath,addto=  
polygbnigr)  
print(poly3gbnigr,2)
```
- Plotting response probabilities for groups 1 to 3, for the higher response options ("quite a lot" or "a great deal") for items 1 to 3:

```
plot(poly3gbnigr,2,groups=1:3,items=1:3,levels=3,cumprob="high")
```

9. Relabel groups for presentation

- You may wish to apply this command again to give a substantive label to the country 'ref. group'.
- See the current way in which the groups are labelled for the models fitted in this session:

```
bin3gbnigr
```
- Now apply the group labels as follows:

```
reorder(bin3gbnigr,groupnames=c("GB","GR","NI"))
```
- And see the resulting presentation:

```
bin3gbnigr
```

10. Fit statistics

- Review fit statistic summaries for the models fitted in this session:
`bin3gbnigr`
- Now look more closely at any that interest you. For example,
`resid(bin3gbnigr, 2, item2way=T, over4=T, sort=T)`
`resid(bin3gbnigr, 6, item2way=T, over4=T, sort=T)`
- There are other details you can specify (see the LCAT manual for full information), e.g.
`item=c(1, 3)` would return just the residuals for items 1 and 3
`group=2` would return just the residuals for group number 2
`sumitem2way=T` gives sums of two-way residuals for pairs of items

Try for example:

```
resid(bin3gbnigr, 2, item2way=T, item=1)
resid(bin3gbnigr, 2, item2way=T, group=3)
resid(bin3gbnigr, 2, sumitem2way=T)
```

- Since we have only fitted latent class models for the polytomous items, just take a quick look at some fit statistics with the original group labels:
`poly3gbnigr`
`resid(poly3gbnigr, 1, item2way=T, over4=T, sort=T)`
`resid(poly3gbnigr, 2, item2way=T, over4=T, sort=T)`

11. Combinations of other groups

- If you have time, you may wish to repeat some of the models in this session but with different combinations of countries. Choose any that interest you and modify the Mplus input files accordingly (we suggest that you also save them with new names). The country codes are provided on Page 2 of these instructions.