

# Dail Votes 2020

The 31st Dail Eireann (Irish Parliament) (March 11th, 2011 | February 6th, 2016) had 166 members who were affiliated with nine political parties or were independent.

In this report, Latent Class Analysis (LCA) is chosen to model clustering categorical data.

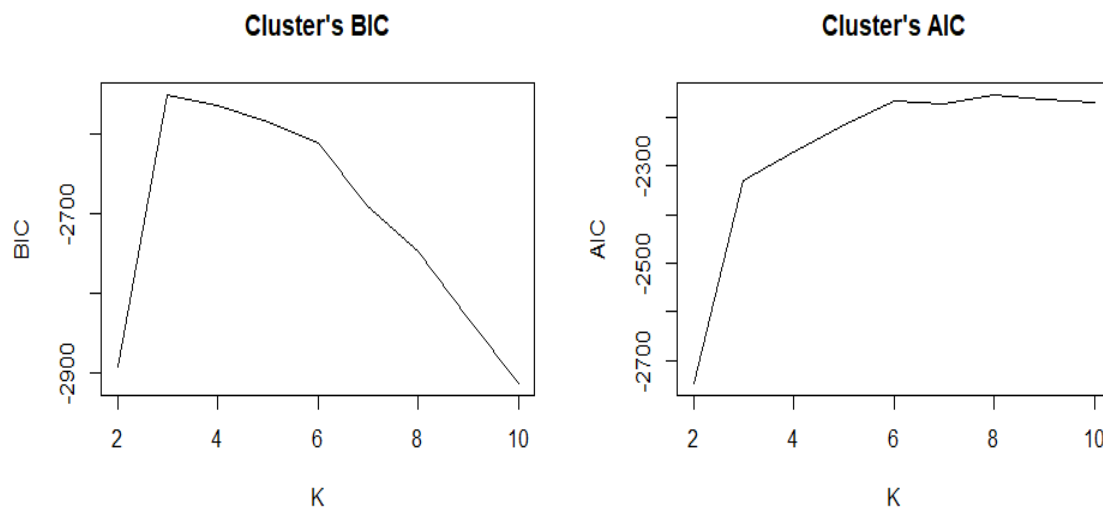
The data votes' first three columns give the name of the member and the subsequent columns give each vote for that member; there is an (y/n/a). The vote columns are transformed into a binary format.

```
str(votes)

## 'data.frame':    166 obs. of  26 variables:
## $ First.name: chr  "CaoimhghÃn" "Ãamon" "SeÃin" "AodhÃin" ...
## $ Last.name : chr  "Ã CaolÃin" "Ã CuÃv" "Ã FearghaÃl" "Ã RÃordÃin"
## ...
## $ Party      : chr  "Sinn Fein" "Fianna Fail" "Fianna Fail" "Labour" ...
## $ 1          : Factor w/ 3 levels "a","n","y": 2 1 2 1 2 2 2 1 1 3 ...
## $ 2          : Factor w/ 3 levels "a","n","y": 2 1 2 1 2 2 2 1 1 3 ...
## $ 3          : Factor w/ 3 levels "a","n","y": 3 3 3 1 1 1 3 1 1 2 ...
## $ 4          : Factor w/ 3 levels "a","n","y": 2 1 1 3 2 2 2 1 1 3 ...
## $ 5          : Factor w/ 3 levels "a","n","y": 2 1 1 3 2 2 1 1 1 3 ...
## $ 6          : Factor w/ 3 levels "a","n","y": 2 1 3 3 1 1 1 1 1 1 ...
## $ 7          : Factor w/ 3 levels "a","n","y": 3 1 1 1 1 1 3 1 1 1 ...
## $ 8          : Factor w/ 3 levels "a","n","y": 3 1 1 1 3 1 1 1 1 2 ...
## $ 9          : Factor w/ 3 levels "a","n","y": 3 1 1 1 3 1 1 1 1 2 ...
## $ 10         : Factor w/ 3 levels "a","n","y": 3 1 1 1 3 1 1 1 1 2 ...
## $ 11         : Factor w/ 3 levels "a","n","y": 3 1 1 1 3 1 1 1 1 2 ...
## $ 12         : Factor w/ 3 levels "a","n","y": 3 1 1 1 3 1 3 1 1 2 ...
## $ 13         : Factor w/ 3 levels "a","n","y": 3 1 3 1 3 1 3 1 1 2 ...
## $ 14         : Factor w/ 3 levels "a","n","y": 3 3 3 1 3 3 3 1 1 2 ...
## $ 15         : Factor w/ 3 levels "a","n","y": 2 1 3 1 2 1 3 1 1 3 ...
## $ 16         : Factor w/ 3 levels "a","n","y": 3 1 3 2 3 1 3 1 1 2 ...
## $ 17         : Factor w/ 3 levels "a","n","y": 2 1 3 1 2 1 3 1 1 3 ...
## $ 18         : Factor w/ 3 levels "a","n","y": 3 1 2 1 1 1 2 1 1 2 ...
## $ 19         : Factor w/ 3 levels "a","n","y": 3 1 1 1 3 1 2 1 1 2 ...
## $ 20         : Factor w/ 3 levels "a","n","y": 3 1 1 1 3 1 2 1 1 2 ...
## $ 21         : Factor w/ 3 levels "a","n","y": 2 1 2 3 2 1 2 1 1 3 ...
## $ 22         : Factor w/ 3 levels "a","n","y": 2 1 2 3 2 2 2 1 1 3 ...
## $ 23         : Factor w/ 3 levels "a","n","y": 1 1 3 1 1 1 1 1 1 2 ...

yes <- 1*(votes[, -(1:3)]=="y" )
```

In this section, we fit the model using `blca.em` function into the data for number of clusters of 2 until 10. Then, the AIC and BIC of each model are plotted to see the goodness of fit.



By looking at the plot, they both show the elbows while the number of clusters is three. The second option is six clusters. Here are the results of this clustering, size of each cluster and the characteristics of each cluster.

### 3 Clusters

```
summary(fit3)

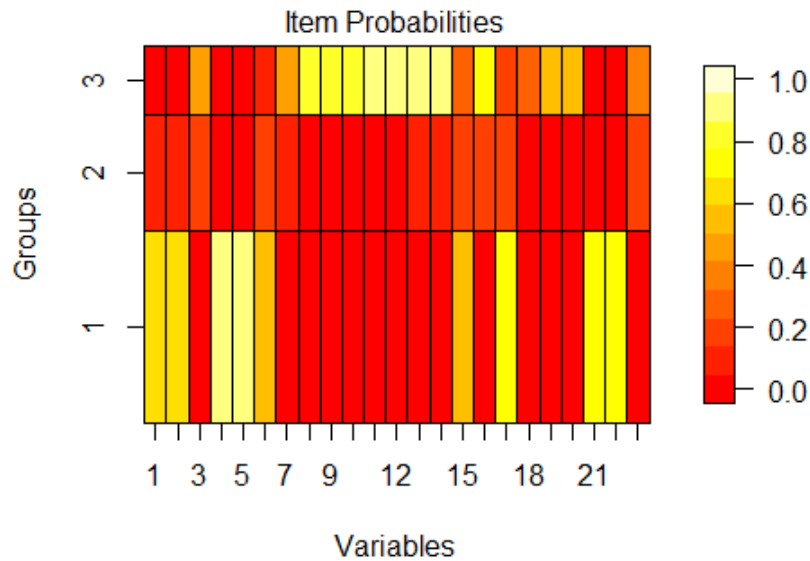
## Method: EM algorithm
## Number of iterations: 19
## Log-Posterior Increase at Convergence: 2.07989e-05
## Log-Posterior: -1094.929
## AIC: -2330.473
## BIC: -2551.424

fit3

## MAP Estimates:
## Item Probabilities:
##
##      1      2      3      4      5      6      7      8      9     10     11     12
## Group 1 0.635 0.611 0.000 0.954 0.954 0.586 0.000 0.000 0.000 0.00 0.000 0.000
## Group 2 0.100 0.100 0.196 0.000 0.019 0.201 0.079 0.020 0.020 0.02 0.000 0.020
## Group 3 0.000 0.000 0.500 0.000 0.000 0.134 0.433 0.833 0.833 0.80 0.866 0.932
##      13     14     15     16     17     18     19     20     21     22     23
## Group 1 0.000 0.000 0.585 0.000 0.705 0.00 0.000 0.000 0.754 0.742 0.000
## Group 2 0.059 0.117 0.182 0.156 0.140 0.02 0.039 0.020 0.000 0.000 0.176
## Group 3 0.933 0.900 0.300 0.733 0.167 0.30 0.533 0.533 0.000 0.000 0.401
##
## Membership Probabilities:
##
## Group 1 Group 2 Group 3
## 0.511 0.308 0.181
```

The membership of probabilities shows that 51.1% of 166 voters are in the Group 1, 30.8% in the Group 2 and 18.1% in the Group 3. Here is the heatmap for fitting the data into three clusters.

```
plot(fit3)
```



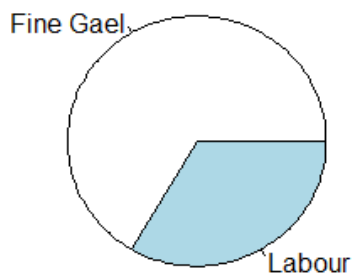
The members in each group have the same probabilities and behaves the same. In Group 2, the colors for 23 issues (variables) are relatively have the same shade. In Group 1, the darker shades are laying for variables 2-14 and 18-20.

### The Details for each Group

Group 1 consists of Fine Gael and Labour parties with total 84 politicians.

```
## Fine Gael    Labour
##          56         28
```

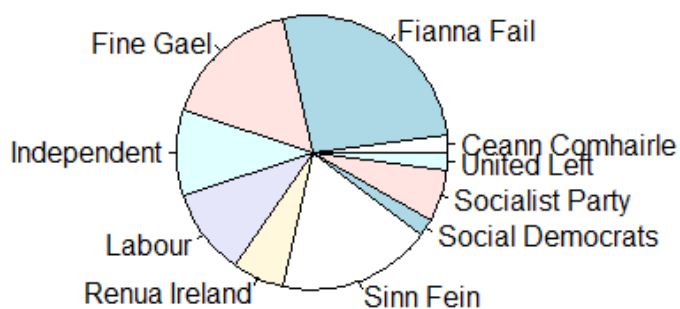
#### Group 1



Group 2 consists with more variety of parties with total 49 politicians.

##	Ceann Comhairle	Fianna Fail	Fine Gael	Independent
##	1	13	8	5
##	Labour	Renua Ireland	Sinn Fein	Social Democrats
##	5	3	9	1
##	Socialist Party	United Left		
##	3	1		

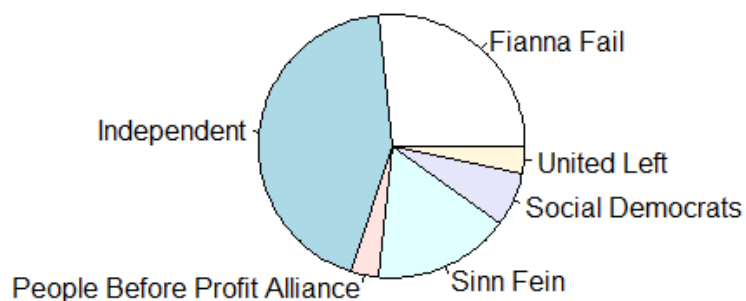
### Group 2



Group 3 consists of 30 members with variety of parties but Independent and Fianna Fail dominate the proportion with 13 and 8 members, respectively.

##	Fianna Fail	Independent
##	8	13
##	People Before Profit Alliance	Sinn Fein
##	1	5
##	Social Democrats	United Left
##	2	1

### Group 3



## 6 Clusters

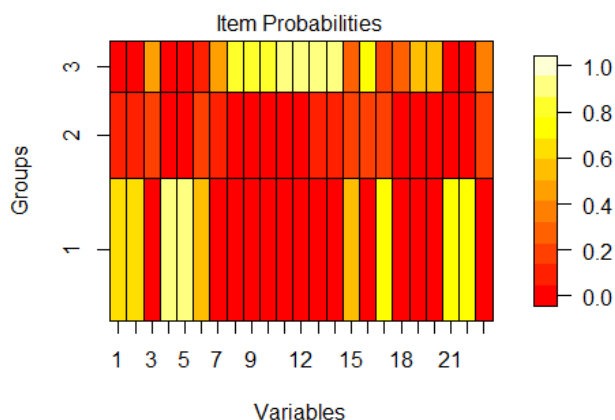
```
summary(fit6)
```

```
## Method: EM algorithm
## Number of iterations: 26
## Log-Posterior Increase at Convergence: 0.001797989
## Log-Posterior: -942.3195
## AIC: -2161.064
## BIC: -2606.078

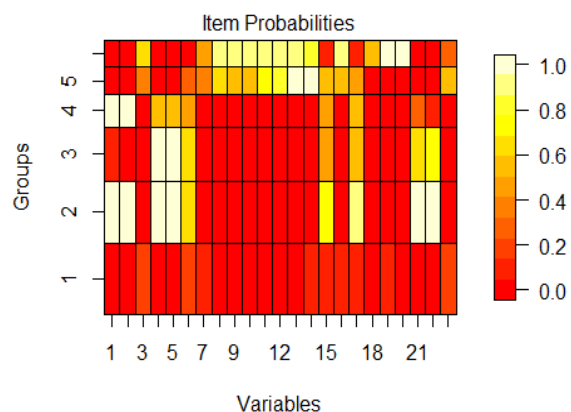
fit6
## MAP Estimates:
## Item Probabilities:
##           1      2      3      4      5      6      7      8      9     10     11     12
## Group 1 0.00 0.000 0.209 0.000 0.023 0.140 0.093 0.023 0.023 0.023 0.000 0.023
## Group 2 1.00 1.000 0.000 1.000 1.000 0.632 0.000 0.000 0.000 0.000 0.000 0.000
## Group 3 0.06 0.000 0.000 0.969 0.970 0.605 0.000 0.000 0.000 0.000 0.000 0.000
## Group 4 1.00 0.999 0.000 0.585 0.585 0.475 0.000 0.000 0.000 0.000 0.000 0.000
## Group 5 0.00 0.000 0.353 0.000 0.000 0.294 0.353 0.647 0.588 0.588 0.706 0.824
## Group 6 0.00 0.000 0.625 0.000 0.000 0.000 0.437 0.875 0.937 0.875 0.875 0.875
##           13     14     15     16     17     18     19     20     21     22     23
## Group 1 0.000 0.070 0.116 0.116 0.047 0.023 0.047 0.023 0.000 0.000 0.163
## Group 2 0.000 0.000 0.714 0.000 0.871 0.000 0.000 0.000 1.000 1.000 0.000
## Group 3 0.000 0.000 0.484 0.000 0.545 0.000 0.000 0.000 0.636 0.697 0.000
## Group 4 0.000 0.000 0.420 0.000 0.578 0.000 0.000 0.000 0.272 0.117 0.000
## Group 5 1.000 1.000 0.588 0.588 0.412 0.000 0.000 0.000 0.000 0.000 0.529
## Group 6 0.875 0.812 0.125 0.937 0.062 0.562 1.000 1.000 0.000 0.000 0.312
##
## Membership Probabilities:
## Group 1 Group 2 Group 3 Group 4 Group 5 Group 6
## 0.259 0.227 0.199 0.116 0.102 0.096
```

The membership of probabilities shows that 25.9% of 166 voters are in the Group 1, 22.7% in the Group 2, 19.9% in the Group 3, 11.6% in the Group 4, 10.2% in the Group 5, and 9.6% in the Group 6. Here is the heatmap for fitting the data into three and six clusters (respectively).

**Heatmap for 3 Clusters**



**Heatmap for 6 Clusters**



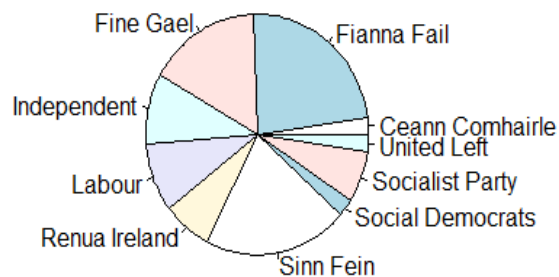
The members in each group have the same probabilities and behaves the same. In Group 1, the colors for 23 issues (variables) are relatively share the same shade (we may compare with Group 2 from the previous result, they look the same). In Group 2,3, and 4, the darker shades are laying for variables 2-14 and 18-20 just like Group 1 from the previous result. While Group 5 and 6 consist of more variety of item probabilities just like Group 3 from the previous result.

### The Details for each Group

Group 1 consists with the most variety of parties with total 43 politicians.

##	Ceann Comhairle	Fianna Fail	Fine Gael	Independent
##	1	10	7	4
##	Labour	Renua Ireland	Sinn Fein	Social Democrats
##	4	3	9	1
##	Socialist Party	United Left		
##	3	1		

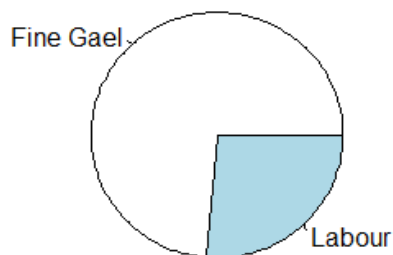
**Group 1**



Group 2 consists of Fine Gael and Labour parties with total 38 politicians.

##	Fine Gael	Labour
##	28	10

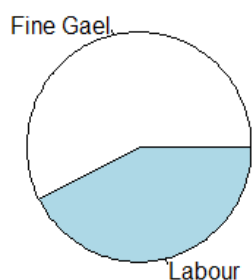
**Group 2**



Group 3 also consists of Fine Gael and Labour politicians with total 33 politicians.

##	Fine Gael	Labour
##	19	14

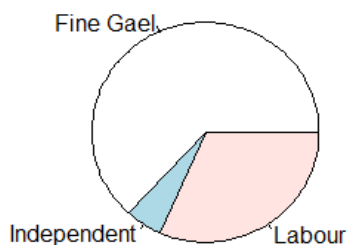
**Group 3**



Group 4 with total of 19 politicians also consists of Fine Gael and Labour politicians, but also there are Independent party politicians as members of this group.

##	Fine Gael	Independent	Labour
##	12	1	6

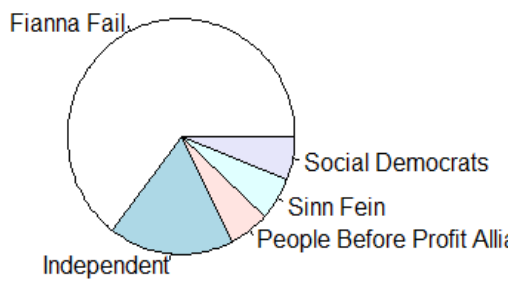
**Group 4**



Group 5 with total of 17 politicians is dominated by 11 politicians from Fianna Fail.

##	Fianna Fail	Independent
##	11	3
##	People Before Profit Alliance	Sinn Fein
##	1	1
##	Social Democrats	
##	1	

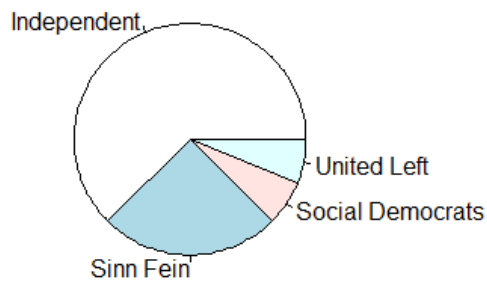
### Group 5



Group 6 with total of 16 politicians is dominated by 10 politicians from Independent party.

##	Independent	Sinn Fein	Social Democrats	United Left
##	10	4	1	1

### Group 6



While taking parsimonious model as a consideration, I suggest that three clusters is sufficient to model the data.



## APPENDICES

```
set.seed(1234)
fit2 <- blca.em(yes, 2, restarts=25)

## Restart number 1, logpost = -1326.62...
## Restart number 2, logpost = -1326.62...
## New maximum found... Restart number 3, logpost = -1326.62...
## Restart number 4, logpost = -1326.62...
## New maximum found... Restart number 5, logpost = -1326.62...
## Restart number 6, logpost = -1326.62...
## Restart number 7, logpost = -1326.62...
## Restart number 8, logpost = -1359.66...
## Restart number 9, logpost = -1326.62...
## Restart number 10, logpost = -1326.62...
## Restart number 11, logpost = -1326.62...
## Restart number 12, logpost = -1326.62...
## Restart number 13, logpost = -1326.62...
## Restart number 14, logpost = -1326.62...
## Restart number 15, logpost = -1326.62...
## Restart number 16, logpost = -1326.62...
## Restart number 17, logpost = -1326.62...
## Restart number 18, logpost = -1326.62...
## Restart number 19, logpost = -1326.62...
## Restart number 20, logpost = -1326.62...
## Restart number 21, logpost = -1359.66...
## Restart number 22, logpost = -1326.62...
## Restart number 23, logpost = -1326.62...
## Restart number 24, logpost = -1326.62...
## Restart number 25, logpost = -1326.62...

summary(fit2)

## _____
##
## Bayes-LCA
## Diagnostic Summary
## _____
##
## Hyper-Parameters:
##
## Item Probabilities:
##
## alpha:
##      1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
## Group 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
##
## beta:
##      1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
## Group 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
##
```

```

## Class Probabilities:
##
## delta:
## Group 1 Group 2
##      1      1
## _____
##
## Method: EM algorithm
##
## Number of iterations: 19
##
## Log-Posterior Increase at Convergence: 0
##
## Log-Posterior: -1326.625
##
## AIC: -2747.249
##
## BIC: -2893.513

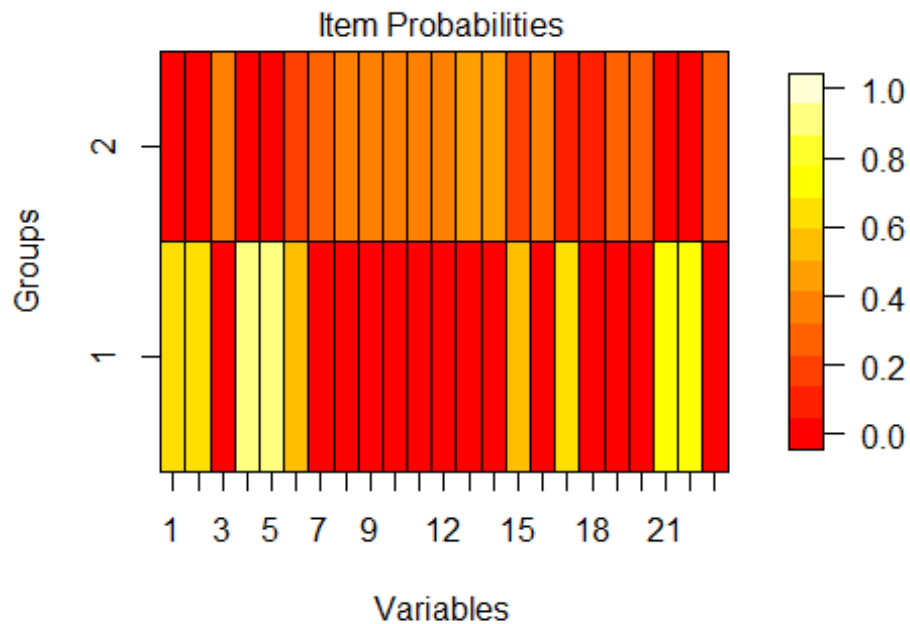
fit2

##
## MAP Estimates:
##
##
## Item Probabilities:
##
##      1      2      3      4      5      6      7      8      9      10      11      12
## Group 1 0.646 0.624 0.000 0.887 0.898 0.583 0.000 0.000 0.000 0.000 0.000 0.000
## Group 2 0.000 0.000 0.335 0.000 0.000 0.145 0.228 0.348 0.348 0.335 0.348 0.388
##      13      14      15      16      17      18      19      20      21      22      23
## Group 1 0.000 0.000 0.560 0.000 0.679 0.000 0.000 0.000 0.000 0.701 0.69 0.000
## Group 2 0.415 0.442 0.226 0.402 0.134 0.134 0.241 0.228 0.000 0.00 0.281
##
## Membership Probabilities:
##
## Group 1 Group 2
##      0.55      0.45

## Warning: Posterior standard deviations not returned.

plot(fit2)

```



```
fit3<- blca.em(yes, 3, restarts=25)

## Restart number 1, logpost = -1100.35...
## New maximum found... Restart number 2, logpost = -1100.32...
## New maximum found... Restart number 3, logpost = -1094.93...
## Restart number 4, logpost = -1098.48...
## Restart number 5, logpost = -1105.19...
## Restart number 6, logpost = -1106.42...
## Restart number 7, logpost = -1101.07...
## Restart number 8, logpost = -1097.5...
## Restart number 9, logpost = -1101.07...
## Restart number 10, logpost = -1116.14...
## Restart number 11, logpost = -1101.07...
## Restart number 12, logpost = -1102.59...
## Restart number 13, logpost = -1097.5...
## Restart number 14, logpost = -1102.59...
## Restart number 15, logpost = -1101.07...
## Restart number 16, logpost = -1106.42...
## Restart number 17, logpost = -1101.07...
## Restart number 18, logpost = -1106.42...
## Restart number 19, logpost = -1106.42...
## Restart number 20, logpost = -1101.07...
## Restart number 21, logpost = -1106.42...
## Restart number 22, logpost = -1105.94...
## Restart number 23, logpost = -1106.42...
## Restart number 24, logpost = -1094.93...
## Restart number 25, logpost = -1102.59...

summary(fit3)
```

```

## _____
##
## Bayes-LCA
## Diagnostic Summary
## _____
##
## Hyper-Parameters:
##
## Item Probabilities:
##
## alpha:
##      1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
## Group 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
##
## beta:
##      1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
## Group 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
##
## Class Probabilities:
##
## delta:
## Group 1 Group 2 Group 3
##      1      1      1
## _____
##
## Method: EM algorithm
##
## Number of iterations: 19
##
## Log-Posterior Increase at Convergence: 2.07989e-05
##
## Log-Posterior: -1094.929
##
## AIC: -2330.473
##
## BIC: -2551.424

fit3

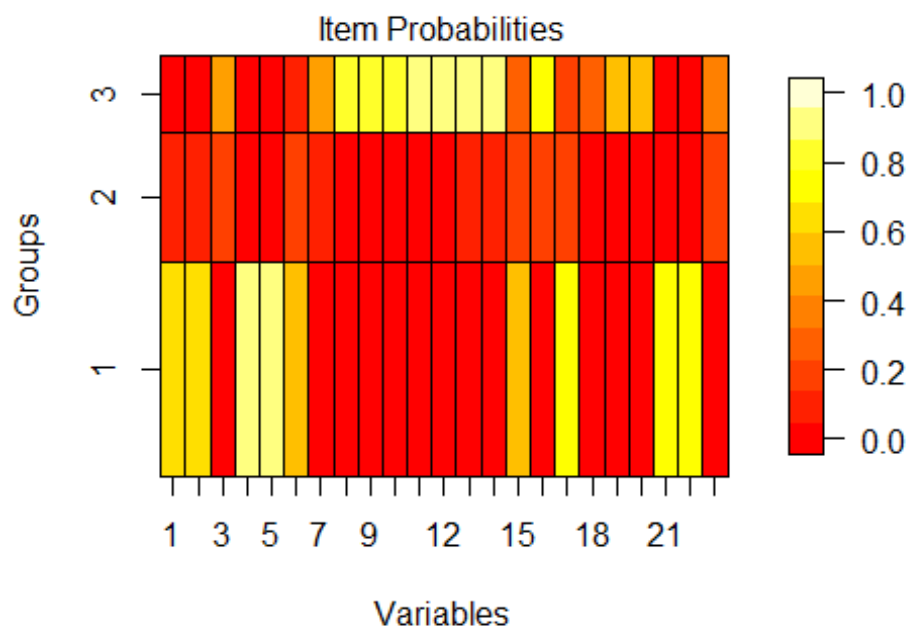
##
## MAP Estimates:
##
##
## Item Probabilities:
##
##      1      2      3      4      5      6      7      8      9      10      11      12
## Group 1 0.635 0.611 0.000 0.954 0.954 0.586 0.000 0.000 0.000 0.00 0.000 0.000
## Group 2 0.100 0.100 0.196 0.000 0.019 0.201 0.079 0.020 0.020 0.02 0.000 0.020
## Group 3 0.000 0.000 0.500 0.000 0.000 0.134 0.433 0.833 0.833 0.80 0.866 0.932
##      13      14      15      16      17      18      19      20      21      22      23
## Group 1 0.000 0.000 0.585 0.000 0.705 0.00 0.000 0.000 0.000 0.754 0.742 0.000

```

```
## Group 2 0.059 0.117 0.182 0.156 0.140 0.02 0.039 0.020 0.000 0.000 0.176
## Group 3 0.933 0.900 0.300 0.733 0.167 0.30 0.533 0.533 0.000 0.000 0.401
##
## Membership Probabilities:
##
## Group 1 Group 2 Group 3
## 0.511 0.308 0.181

## Warning: Posterior standard deviations not returned.

plot(fit3)
```



```
fit4<- blca.em(yes, 4, restarts=25)

## Restart number 1, logpost = -1047.98...
## Restart number 2, logpost = -1051.09...
## New maximum found... Restart number 3, logpost = -1045.45...
## New maximum found... Restart number 4, logpost = -1038.6...
## Restart number 5, logpost = -1049.99...
## Restart number 6, logpost = -1044.25...
## Restart number 7, logpost = -1041.49...
## Restart number 8, logpost = -1050.26...
## Restart number 9, logpost = -1039.46...
## Restart number 10, logpost = -1055.53...
## Restart number 11, logpost = -1059.69...
## Restart number 12, logpost = -1061.72...
## Restart number 13, logpost = -1065.26...
## Restart number 14, logpost = -1065.3...
## Restart number 15, logpost = -1054.79...
## Restart number 16, logpost = -1045.44...
```

```

## Restart number 17, logpost = -1060.98...
## Restart number 18, logpost = -1080.27...
## Restart number 19, logpost = -1057.68...
## Restart number 20, logpost = -1044.25...
## Restart number 21, logpost = -1044.25...
## Restart number 22, logpost = -1047.84...
## Restart number 23, logpost = -1065.23...
## Restart number 24, logpost = -1064.71...
## Restart number 25, logpost = -1052.61...

summary(fit4)

## _____
##
## Bayes-LCA
## Diagnostic Summary
## _____
##
## Hyper-Parameters:
##
## Item Probabilities:
##
## alpha:
##      1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
## Group 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
##
## beta:
##      1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
## Group 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
##
## Class Probabilities:
##
## delta:
## Group 1 Group 2 Group 3 Group 4
##      1      1      1      1
## _____
##
## Method: EM algorithm
##
## Number of iterations: 19
##
## Log-Posterior Increase at Convergence: 8.775644e-05
##
## Log-Posterior: -1038.605
##
## AIC: -2263.626
##
## BIC: -2559.265

```

```

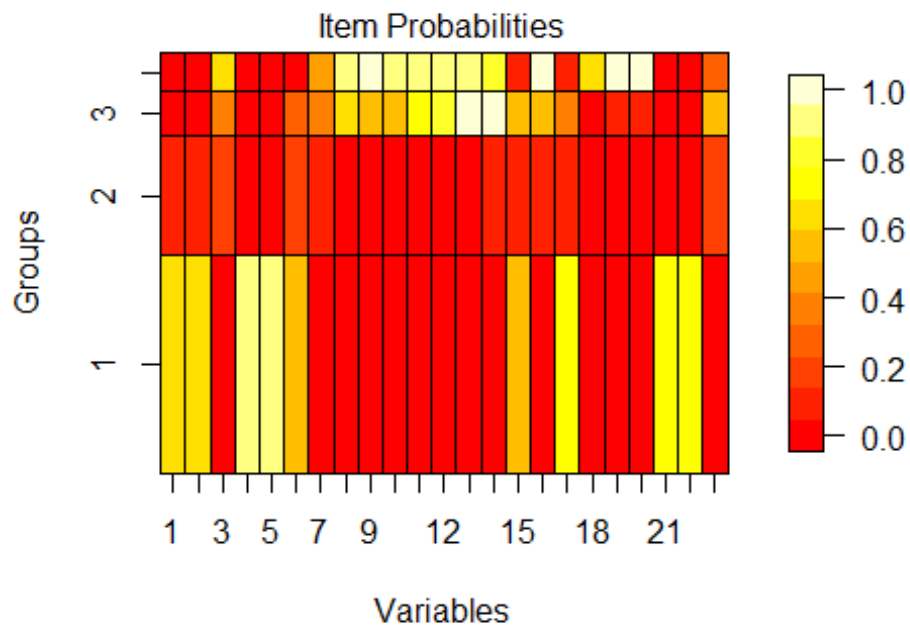
fit4

##
## MAP Estimates:
##
##
## Item Probabilities:
##
##      1      2      3      4      5      6      7      8      9     10     11     12
## Group 1 0.640 0.617 0.000 0.94 0.941 0.586 0.000 0.000 0.000 0.000 0.000 0.000
## Group 2 0.083 0.083 0.192 0.00 0.021 0.182 0.085 0.021 0.021 0.021 0.000 0.021
## Group 3 0.000 0.000 0.389 0.00 0.000 0.278 0.333 0.611 0.556 0.556 0.722 0.833
## Group 4 0.000 0.000 0.600 0.00 0.000 0.000 0.467 0.933 1.000 0.933 0.867 0.867
##      13     14     15     16     17     18     19     20     21     22     23
## Group 1 0.000 0.000 0.587 0.000 0.709 0.000 0.000 0.000 0.743 0.731 0.000
## Group 2 0.000 0.064 0.116 0.107 0.063 0.021 0.043 0.021 0.000 0.000 0.149
## Group 3 1.000 1.000 0.555 0.556 0.389 0.000 0.056 0.056 0.000 0.000 0.555
## Group 4 0.867 0.800 0.133 1.000 0.067 0.600 1.000 1.000 0.000 0.000 0.267
##
## Membership Probabilities:
##
## Group 1 Group 2 Group 3 Group 4
## 0.519 0.282 0.108 0.090

## Warning: Posterior standard deviations not returned.

plot(fit4)

```



```
fit5<- blca.em(yes, 5, restarts=25)
```

```

## Restart number 1, logpost = -1007.18...
## Restart number 2, logpost = -1015.82...
## New maximum found... Restart number 3, logpost = -1004.55...
## Restart number 4, logpost = -1008.89...
## Restart number 5, logpost = -1031.4...
## Restart number 6, logpost = -1029.01...
## New maximum found... Restart number 7, logpost = -998.05...
## New maximum found... Restart number 8, logpost = -994.81...
## Restart number 9, logpost = -1002.87...
## Restart number 10, logpost = -1020.4...
## Restart number 11, logpost = -1020.41...
## Restart number 12, logpost = -1022.35...
## Restart number 13, logpost = -1012.77...
## Restart number 14, logpost = -1019.63...
## Restart number 15, logpost = -1005.84...
## Restart number 16, logpost = -1001.73...
## Restart number 17, logpost = -1028.67...
## Restart number 18, logpost = -1015.86...
## Restart number 19, logpost = -1003.7...
## Restart number 20, logpost = -1001.59...
## Restart number 21, logpost = -1012.32...
## Restart number 22, logpost = -1008.49...
## New maximum found... Restart number 23, logpost = -987.95...
## Restart number 24, logpost = -1003.61...
## Restart number 25, logpost = -1015.86...

```

summary(fit5)

```

## _____
##
## Bayes-LCA
## Diagnostic Summary
## _____
##
## Hyper-Parameters:
##
## Item Probabilities:
##
## alpha:
##      1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
## Group 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
##
## beta:
##      1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
## Group 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
##
## Class Probabilities:

```



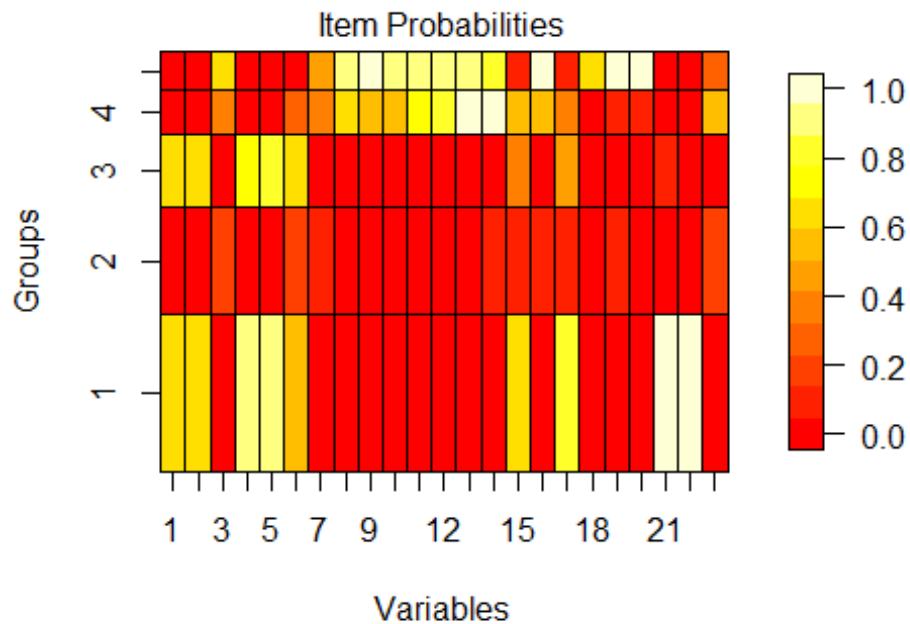
```
##
## delta:
## Group 1 Group 2 Group 3 Group 4 Group 5
##      1      1      1      1      1
## _____
##
## Method: EM algorithm
##
## Number of iterations: 22
##
## Log-Posterior Increase at Convergence: 0.001582789
##
## Log-Posterior: -987.9494
##
## AIC: -2207.543
##
## BIC: -2577.869

fit5

##
## MAP Estimates:
##
##
## Item Probabilities:
##
##      1      2      3      4      5      6      7      8      9      10     11     12
## Group 1 0.662 0.646 0.000 0.952 0.952 0.580 0.000 0.000 0.000 0.000 0.000 0.000
## Group 2 0.000 0.000 0.212 0.000 0.015 0.138 0.094 0.024 0.024 0.024 0.000 0.024
## Group 3 0.631 0.596 0.000 0.772 0.784 0.601 0.000 0.000 0.000 0.000 0.000 0.000
## Group 4 0.000 0.000 0.389 0.000 0.000 0.278 0.333 0.611 0.556 0.556 0.722 0.833
## Group 5 0.000 0.000 0.600 0.000 0.000 0.000 0.467 0.933 1.000 0.933 0.867 0.867
##      13     14     15     16     17     18     19     20     21     22     23
## Group 1 0.000 0.000 0.675 0.000 0.805 0.000 0.000 0.000 0.984 1.00 0.000
## Group 2 0.000 0.071 0.116 0.118 0.047 0.024 0.047 0.024 0.000 0.00 0.165
## Group 3 0.000 0.000 0.325 0.000 0.427 0.000 0.000 0.000 0.109 0.04 0.000
## Group 4 1.000 1.000 0.555 0.556 0.389 0.000 0.056 0.056 0.000 0.00 0.555
## Group 5 0.867 0.800 0.133 1.000 0.067 0.600 1.000 1.000 0.000 0.00 0.267
##
## Membership Probabilities:
##
## Group 1 Group 2 Group 3 Group 4 Group 5
## 0.373 0.256 0.172 0.108 0.090

## Warning: Posterior standard deviations not returned.

plot(fit5)
```



```
fit6<- blca.em(yes, 6, restarts=25)

## Restart number 1, logpost = -978.44...
## Restart number 2, logpost = -989.36...
## Restart number 3, logpost = -989.69...
## New maximum found... Restart number 4, logpost = -944.71...
## Restart number 5, logpost = -981.6...
## Restart number 6, logpost = -978.31...
## New maximum found... Restart number 7, logpost = -942.32...
## Restart number 8, logpost = -971.71...
## Restart number 9, logpost = -978...
## Restart number 10, logpost = -975.42...
## Restart number 11, logpost = -967.12...
## Restart number 12, logpost = -1016.29...
## Restart number 13, logpost = -991.84...
## Restart number 14, logpost = -977.13...
## Restart number 15, logpost = -954.89...
## Restart number 16, logpost = -988.85...
## Restart number 17, logpost = -969.17...
## Restart number 18, logpost = -944.35...
## Restart number 19, logpost = -993.52...
## Restart number 20, logpost = -975.72...
## Restart number 21, logpost = -968.01...
## Restart number 22, logpost = -956.24...
## Restart number 23, logpost = -964.76...
## Restart number 24, logpost = -957.18...
## Restart number 25, logpost = -986.73...

summary(fit6)
```

```

## _____
##
## Bayes-LCA
## Diagnostic Summary
## _____
##
## Hyper-Parameters:
##
## Item Probabilities:
##
## alpha:
##      1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
## Group 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 6 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
##
## beta:
##      1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
## Group 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 6 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
##
## Class Probabilities:
##
## delta:
## Group 1 Group 2 Group 3 Group 4 Group 5 Group 6
##      1      1      1      1      1      1
## _____
##
## Method: EM algorithm
##
## Number of iterations: 26
##
## Log-Posterior Increase at Convergence: 0.001797989
##
## Log-Posterior: -942.3195
##
## AIC: -2161.064
##
## BIC: -2606.078

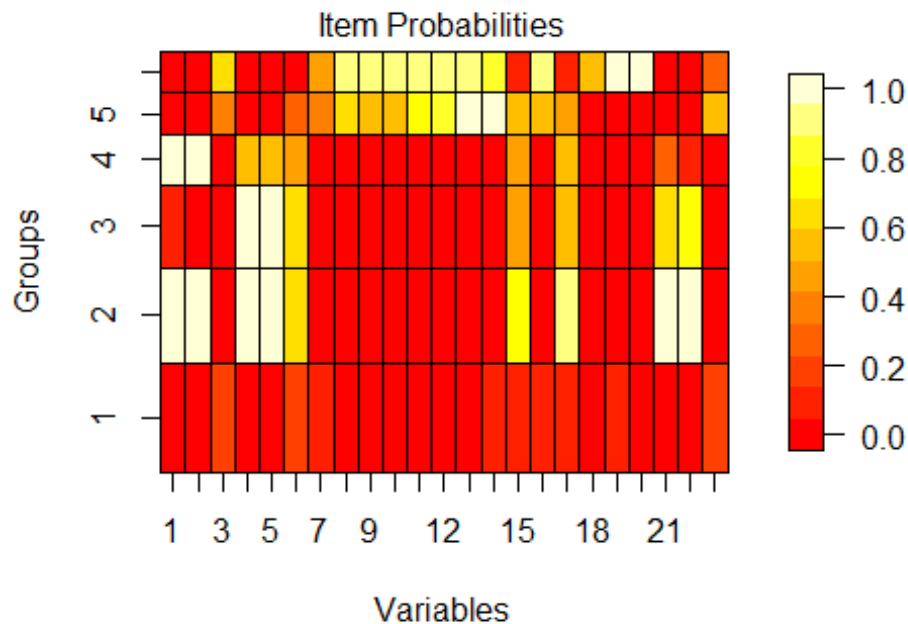
fit6

##
## MAP Estimates:
##
##
## Item Probabilities:
##

```

```
##           1      2      3      4      5      6      7      8      9     10     11     12
## Group 1 0.00 0.000 0.209 0.000 0.023 0.140 0.093 0.023 0.023 0.023 0.000 0.023
## Group 2 1.00 1.000 0.000 1.000 1.000 0.632 0.000 0.000 0.000 0.000 0.000 0.000
## Group 3 0.06 0.000 0.000 0.969 0.970 0.605 0.000 0.000 0.000 0.000 0.000 0.000
## Group 4 1.00 0.999 0.000 0.585 0.585 0.475 0.000 0.000 0.000 0.000 0.000 0.000
## Group 5 0.00 0.000 0.353 0.000 0.000 0.294 0.353 0.647 0.588 0.588 0.706 0.824
## Group 6 0.00 0.000 0.625 0.000 0.000 0.000 0.437 0.875 0.937 0.875 0.875 0.875
##           13     14     15     16     17     18     19     20     21     22     23
## Group 1 0.000 0.070 0.116 0.116 0.047 0.023 0.047 0.023 0.000 0.000 0.163
## Group 2 0.000 0.000 0.714 0.000 0.871 0.000 0.000 0.000 1.000 1.000 0.000
## Group 3 0.000 0.000 0.484 0.000 0.545 0.000 0.000 0.000 0.636 0.697 0.000
## Group 4 0.000 0.000 0.420 0.000 0.578 0.000 0.000 0.000 0.272 0.117 0.000
## Group 5 1.000 1.000 0.588 0.588 0.412 0.000 0.000 0.000 0.000 0.000 0.529
## Group 6 0.875 0.812 0.125 0.937 0.062 0.562 1.000 1.000 0.000 0.000 0.312
##
## Membership Probabilities:
##
## Group 1 Group 2 Group 3 Group 4 Group 5 Group 6
## 0.259 0.227 0.199 0.116 0.102 0.096

## Warning: Posterior standard deviations not returned.
plot(fit6)
```



```
fit7<- blca.em(yes, 7, restarts=25)

## Restart number 1, logpost = -955.63...
## New maximum found... Restart number 2, logpost = -936.16...
## Restart number 3, logpost = -963...
## Restart number 4, logpost = -980.94...
```

```

## Restart number 5, logpost = -936.18...
## Restart number 6, logpost = -959.85...
## Restart number 7, logpost = -962.08...
## Restart number 8, logpost = -950.12...
## Restart number 9, logpost = -964.99...
## Restart number 10, logpost = -964.87...
## Restart number 11, logpost = -944.09...
## New maximum found... Restart number 12, logpost = -928.46...
## Restart number 13, logpost = -955.53...
## Restart number 14, logpost = -972.92...
## Restart number 15, logpost = -950.32...
## Restart number 16, logpost = -943.7...
## Restart number 17, logpost = -972.52...
## Restart number 18, logpost = -946.6...
## Restart number 19, logpost = -942.09...
## Restart number 20, logpost = -968.77...
## Restart number 21, logpost = -967.7...
## Restart number 22, logpost = -954.71...
## Restart number 23, logpost = -953.63...
## Restart number 24, logpost = -941.75...
## Restart number 25, logpost = -975.28...

```

```
summary(fit7)
```

```

## _____
##
## Bayes-LCA
## Diagnostic Summary
## _____
##
## Hyper-Parameters:
##
## Item Probabilities:
##
##   alpha:
##       1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
## Group 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 6 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
##
##   beta:
##       1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
## Group 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 6 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
##
## Class Probabilities:

```

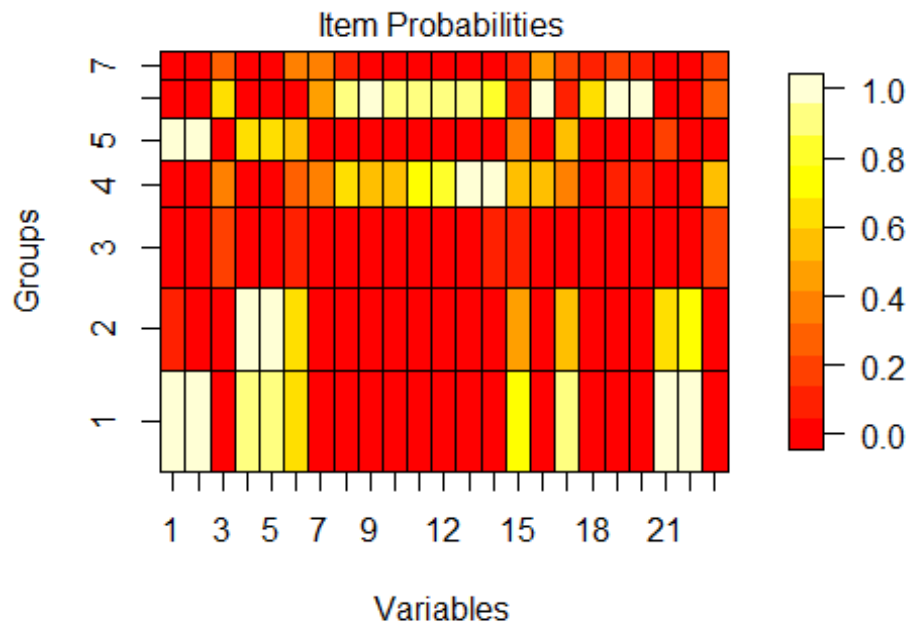
```
##
## delta:
## Group 1 Group 2 Group 3 Group 4 Group 5 Group 6 Group 7
##      1      1      1      1      1      1      1
## _____
##
## Method: EM algorithm
##
## Number of iterations: 23
##
## Log-Posterior Increase at Convergence: 0.001072085
##
## Log-Posterior: -928.4645
##
## AIC: -2177.771
##
## BIC: -2697.473

fit7

##
## MAP Estimates:
##
##
## Item Probabilities:
##
##      1      2      3      4      5      6      7      8      9      10     11     12
## Group 1 1.000 1.000 0.000 0.950 0.950 0.600 0.000 0.000 0.000 0.000 0.000 0.000
## Group 2 0.051 0.000 0.000 0.969 0.969 0.602 0.000 0.000 0.000 0.000 0.000 0.000
## Group 3 0.000 0.000 0.174 0.000 0.031 0.074 0.000 0.000 0.031 0.031 0.000 0.031
## Group 4 0.000 0.000 0.389 0.000 0.000 0.278 0.333 0.611 0.556 0.556 0.722 0.833
## Group 5 1.000 0.981 0.000 0.654 0.654 0.539 0.000 0.000 0.000 0.000 0.000 0.000
## Group 6 0.000 0.000 0.600 0.000 0.000 0.000 0.467 0.933 1.000 0.933 0.867 0.867
## Group 7 0.000 0.000 0.313 0.000 0.000 0.329 0.362 0.091 0.000 0.000 0.000 0.000
##      13     14     15     16     17     18     19     20     21     22     23
## Group 1 0.000 0.000 0.725 0.000 0.875 0.000 0.000 0.000 1.000 1.000 0.000
## Group 2 0.000 0.000 0.479 0.000 0.540 0.000 0.000 0.000 0.642 0.704 0.000
## Group 3 0.000 0.094 0.112 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.144
## Group 4 1.000 1.000 0.555 0.556 0.389 0.000 0.056 0.056 0.000 0.000 0.555
## Group 5 0.000 0.000 0.365 0.000 0.538 0.000 0.000 0.000 0.173 0.000 0.000
## Group 6 0.867 0.800 0.133 1.000 0.067 0.600 1.000 1.000 0.000 0.000 0.267
## Group 7 0.000 0.000 0.129 0.453 0.181 0.091 0.181 0.091 0.000 0.000 0.218
##
## Membership Probabilities:
##
## Group 1 Group 2 Group 3 Group 4 Group 5 Group 6 Group 7
## 0.241 0.197 0.192 0.108 0.104 0.090 0.067

## Warning: Posterior standard deviations not returned.

plot(fit7)
```



```
fit8<- blca.em(yes, 8, restarts=25)

## Restart number 1, logpost = -937.23...
## Restart number 2, logpost = -937.86...
## New maximum found... Restart number 3, logpost = -931.57...
## New maximum found... Restart number 4, logpost = -929.63...
## New maximum found... Restart number 5, logpost = -919.67...
## Restart number 6, logpost = -933.49...
## New maximum found... Restart number 7, logpost = -910.22...
## Restart number 8, logpost = -934.92...
## Restart number 9, logpost = -944.96...
## New maximum found... Restart number 10, logpost = -906.9...
## Restart number 11, logpost = -908.92...
## Restart number 12, logpost = -957.09...
## Restart number 13, logpost = -916.8...
## Restart number 14, logpost = -927.35...
## Restart number 15, logpost = -937.89...
## Restart number 16, logpost = -916.21...
## Restart number 17, logpost = -921.03...
## Restart number 18, logpost = -951.04...
## Restart number 19, logpost = -940.01...
## Restart number 20, logpost = -942.92...
## Restart number 21, logpost = -926.99...
## Restart number 22, logpost = -939.77...
## Restart number 23, logpost = -920.89...
## Restart number 24, logpost = -938.09...
## Restart number 25, logpost = -912.59...

summary(fit8)
```

```

## _____
##
## Bayes-LCA
## Diagnostic Summary
## _____
##
## Hyper-Parameters:
##
## Item Probabilities:
##
## alpha:
##      1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
## Group 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 6 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 8 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
##
## beta:
##      1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
## Group 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 6 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 8 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
##
## Class Probabilities:
##
## delta:
## Group 1 Group 2 Group 3 Group 4 Group 5 Group 6 Group 7 Group 8
##      1      1      1      1      1      1      1      1
## _____
##
## Method: EM algorithm
##
## Number of iterations: 24
##
## Log-Posterior Increase at Convergence: 0.001041747
##
## Log-Posterior: -906.8969
##
## AIC: -2178.743
##
## BIC: -2773.133
##
fit8
##
## MAP Estimates:

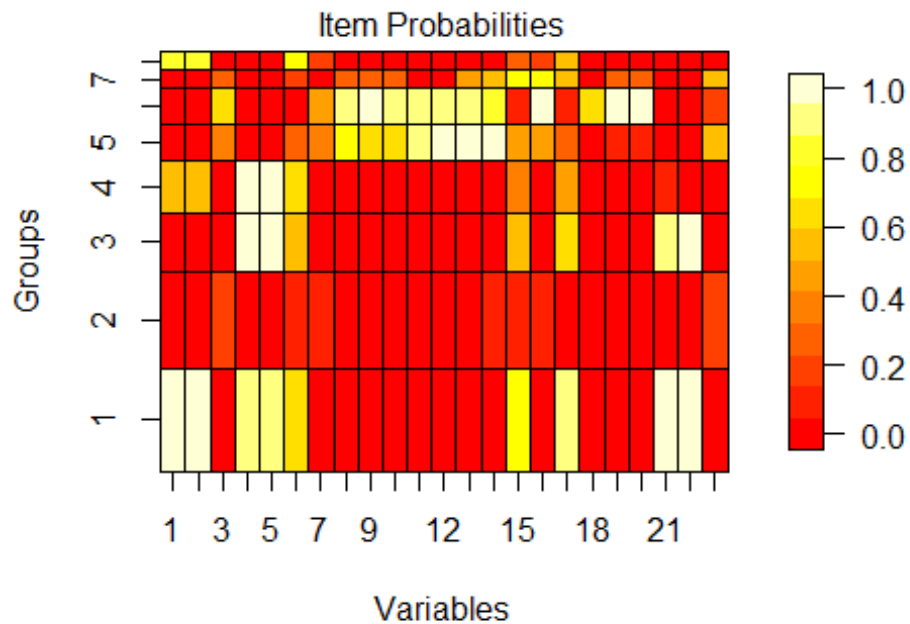
```



```
##
##
## Item Probabilities:
##
##      1      2      3      4      5      6      7      8      9     10     11     12
## Group 1 1.000 1.000 0.000 0.951 0.951 0.592 0.000 0.000 0.000 0.000 0.000 0.000
## Group 2 0.000 0.000 0.206 0.000 0.026 0.127 0.078 0.000 0.000 0.000 0.000 0.026
## Group 3 0.043 0.000 0.000 0.957 0.957 0.522 0.000 0.000 0.000 0.000 0.000 0.000
## Group 4 0.557 0.508 0.000 1.000 1.000 0.635 0.000 0.000 0.000 0.000 0.000 0.000
## Group 5 0.000 0.000 0.401 0.000 0.000 0.266 0.400 0.733 0.667 0.667 0.867 1.000
## Group 6 0.000 0.000 0.642 0.000 0.000 0.000 0.500 0.929 1.000 0.929 0.928 0.928
## Group 7 0.000 0.000 0.279 0.000 0.000 0.141 0.000 0.275 0.275 0.275 0.000 0.000
## Group 8 0.847 0.847 0.000 0.000 0.000 0.715 0.141 0.000 0.000 0.000 0.000 0.000
##      13     14     15     16     17     18     19     20     21     22     23
## Group 1 0.000 0.000 0.713 0.000 0.873 0.000 0.000 0.000 1.000 0.984 0.000
## Group 2 0.000 0.077 0.100 0.074 0.000 0.026 0.023 0.000 0.000 0.000 0.153
## Group 3 0.000 0.000 0.565 0.000 0.652 0.000 0.000 0.000 0.913 1.000 0.000
## Group 4 0.000 0.000 0.344 0.000 0.418 0.000 0.000 0.000 0.115 0.000 0.000
## Group 5 1.000 1.000 0.466 0.467 0.266 0.000 0.068 0.068 0.000 0.000 0.533
## Group 6 0.928 0.786 0.072 1.000 0.071 0.643 1.000 1.000 0.000 0.000 0.215
## Group 7 0.414 0.552 0.701 0.708 0.552 0.000 0.292 0.275 0.000 0.000 0.562
## Group 8 0.000 0.000 0.289 0.141 0.564 0.000 0.000 0.000 0.000 0.000 0.000
##
## Membership Probabilities:
##
## Group 1 Group 2 Group 3 Group 4 Group 5 Group 6 Group 7 Group 8
## 0.245 0.233 0.139 0.123 0.090 0.084 0.044 0.043

## Warning: Posterior standard deviations not returned.

plot(fit8)
```



```
fit9<- blca.em(yes, 9, restarts=25)

## Restart number 1, logpost = -916.45...
## Restart number 2, logpost = -931.12...
## New maximum found... Restart number 3, logpost = -898.49...
## Restart number 4, logpost = -932.81...
## Restart number 5, logpost = -909.51...
## Restart number 6, logpost = -899.86...
## Restart number 7, logpost = -915...
## Restart number 8, logpost = -903.98...
## Restart number 9, logpost = -916.75...
## New maximum found... Restart number 10, logpost = -886.35...
## Restart number 11, logpost = -903.57...
## Restart number 12, logpost = -888.48...
## Restart number 13, logpost = -914.07...
## Restart number 14, logpost = -919.76...
## Restart number 15, logpost = -912.67...
## Restart number 16, logpost = -901.81...
## Restart number 17, logpost = -902.33...
## New maximum found... Restart number 18, logpost = -881.14...
## Restart number 19, logpost = -891.37...
## Restart number 20, logpost = -894.98...
## Restart number 21, logpost = -922.89...
## Restart number 22, logpost = -913.74...
## Restart number 23, logpost = -907.8...
## Restart number 24, logpost = -934.89...
## Restart number 25, logpost = -918.74...

summary(fit9)
```

```

## _____
##
## Bayes-LCA
## Diagnostic Summary
## _____
##
## Hyper-Parameters:
##
## Item Probabilities:
##
## alpha:
##      1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
## Group 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 6 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 8 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 9 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
##
## beta:
##      1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
## Group 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 6 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 8 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 9 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
##
## Class Probabilities:
##
## delta:
## Group 1 Group 2 Group 3 Group 4 Group 5 Group 6 Group 7 Group 8 Group 9
##      1      1      1      1      1      1      1      1      1
## _____
##
## Method: EM algorithm
##
## Number of iterations: 24
##
## Log-Posterior Increase at Convergence: 0.001433895
##
## Log-Posterior: -881.1434
##
## AIC: -2171.078
##
## BIC: -2840.155

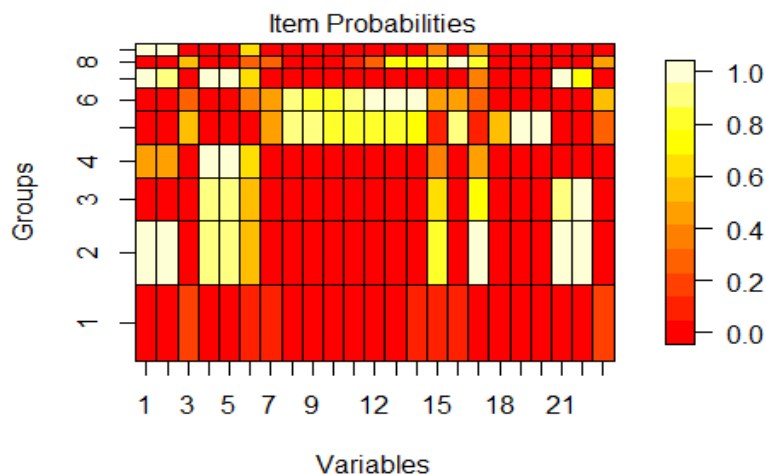
```

```
fit9
```

```
##
## MAP Estimates:
##
##
## Item Probabilities:
##
##      1      2      3      4      5      6      7      8      9      10     11     12
## Group 1 0.0 0.000 0.200 0.000 0.025 0.125 0.075 0.000 0.025 0.025 0.000 0.025
## Group 2 1.0 1.000 0.000 0.941 0.941 0.583 0.000 0.000 0.000 0.000 0.000 0.000
## Group 3 0.0 0.000 0.000 0.955 0.955 0.500 0.000 0.000 0.000 0.000 0.000 0.000
## Group 4 0.5 0.444 0.000 1.000 1.000 0.667 0.000 0.000 0.000 0.000 0.000 0.000
## Group 5 0.0 0.000 0.588 0.000 0.000 0.000 0.412 0.882 0.882 0.824 0.824 0.824
## Group 6 0.0 0.000 0.254 0.000 0.000 0.332 0.415 0.912 0.829 0.829 0.917 1.000
## Group 7 1.0 0.903 0.000 1.000 1.000 0.616 0.000 0.000 0.000 0.000 0.000 0.000
## Group 8 0.0 0.000 0.569 0.000 0.000 0.289 0.288 0.000 0.000 0.000 0.136 0.279
## Group 9 1.0 1.000 0.000 0.000 0.000 0.667 0.000 0.000 0.000 0.000 0.000 0.000
##      13     14     15     16     17     18     19 20     21     22     23
## Group 1 0.000 0.075 0.100 0.075 0.000 0.025 0.025 0 0.000 0.00 0.150
## Group 2 0.000 0.000 0.862 0.000 0.967 0.000 0.000 0 1.000 1.00 0.000
## Group 3 0.000 0.000 0.591 0.000 0.682 0.000 0.000 0 0.909 1.00 0.000
## Group 4 0.000 0.000 0.389 0.000 0.444 0.000 0.000 0 0.000 0.00 0.000
## Group 5 0.824 0.765 0.118 0.882 0.059 0.529 1.000 1 0.000 0.00 0.294
## Group 6 1.000 1.000 0.419 0.419 0.249 0.000 0.000 0 0.000 0.00 0.581
## Group 7 0.000 0.000 0.000 0.000 0.335 0.000 0.000 0 1.000 0.71 0.000
## Group 8 0.711 0.711 0.855 1.000 0.863 0.000 0.000 0 0.000 0.00 0.431
## Group 9 0.000 0.000 0.333 0.000 0.500 0.000 0.000 0 0.000 0.00 0.000
##
## Membership Probabilities:
##
## Group 1 Group 2 Group 3 Group 4 Group 5 Group 6 Group 7 Group 8 Group 9
## 0.241 0.203 0.133 0.108 0.102 0.073 0.062 0.042 0.036

## Warning: Posterior standard deviations not returned.

plot(fit9)
```



```

fit10<- blca.em(yes, 10, restarts=25)

## Restart number 1, logpost = -896.57...
## Restart number 2, logpost = -906.72...
## New maximum found... Restart number 3, logpost = -896.07...
## Restart number 4, logpost = -918.08...
## New maximum found... Restart number 5, logpost = -879.29...
## Restart number 6, logpost = -895.21...
## New maximum found... Restart number 7, logpost = -870.75...
## Restart number 8, logpost = -889.58...
## Restart number 9, logpost = -880.35...
## Restart number 10, logpost = -908.02...
## Restart number 11, logpost = -903.26...
## Restart number 12, logpost = -886.8...
## Restart number 13, logpost = -907.65...
## Restart number 14, logpost = -893.41...
## Restart number 15, logpost = -877.33...
## New maximum found... Restart number 16, logpost = -864.51...
## Restart number 17, logpost = -939.78...
## Restart number 18, logpost = -871.47...
## Restart number 19, logpost = -894.44...
## Restart number 20, logpost = -930.06...
## Restart number 21, logpost = -904.06...
## Restart number 22, logpost = -938.82...
## Restart number 23, logpost = -897.23...
## Restart number 24, logpost = -918.23...
## Restart number 25, logpost = -869.13...

summary(fit10)

## _____
##
## Bayes-LCA
## Diagnostic Summary
## _____
##
## Hyper-Parameters:
##
## Item Probabilities:
##
## alpha:
##      1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
## Group 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 6 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 8 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 9 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 10 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
##
## beta:
##      1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23

```

```

## Group 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 6 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 8 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 9 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## Group 10 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
##
## Class Probabilities:
##
## delta:
## Group 1 Group 2 Group 3 Group 4 Group 5 Group 6 Group 7 Group 8
##      1      1      1      1      1      1      1      1
## Group 9 Group 10
##      1      1
##
##
## Method: EM algorithm
##
## Number of iterations: 47
##
## Log-Posterior Increase at Convergence: 0.001133256
##
## Log-Posterior: -864.5137
##
## AIC: -2181.424
##
## BIC: -2925.189

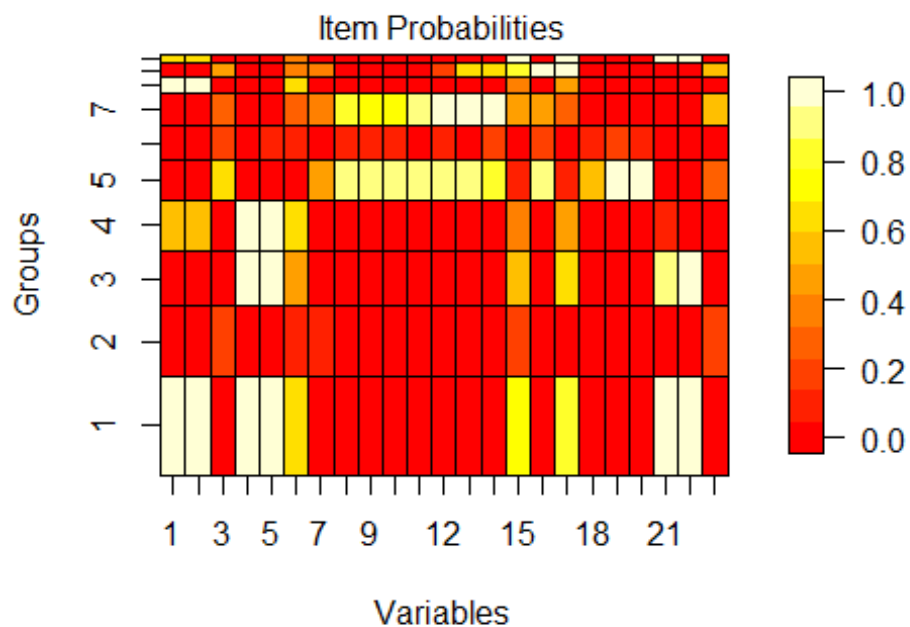
fit10

##
## MAP Estimates:
##
##
## Item Probabilities:
##
##      1      2      3 4      5      6      7      8      9      10      11      12
## Group 1 1.000 1.000 0.000 1 1.000 0.620 0.000 0.000 0.000 0.000 0.000 0.000
## Group 2 0.000 0.000 0.183 0 0.000 0.134 0.108 0.000 0.000 0.000 0.000 0.000
## Group 3 0.045 0.000 0.000 1 1.000 0.500 0.000 0.000 0.000 0.000 0.000 0.000
## Group 4 0.551 0.501 0.000 1 1.000 0.641 0.000 0.000 0.000 0.000 0.000 0.000
## Group 5 0.000 0.000 0.625 0 0.000 0.000 0.437 0.875 0.937 0.875 0.875 0.875
## Group 6 0.000 0.000 0.220 0 0.075 0.096 0.000 0.075 0.075 0.075 0.000 0.075
## Group 7 0.000 0.000 0.308 0 0.000 0.308 0.385 0.846 0.769 0.769 0.923 1.000
## Group 8 1.000 1.000 0.000 0 0.000 0.667 0.000 0.000 0.000 0.000 0.000 0.000
## Group 9 0.000 0.000 0.500 0 0.000 0.333 0.333 0.000 0.000 0.000 0.000 0.167
## Group 10 0.667 0.667 0.000 0 0.000 0.333 0.000 0.000 0.000 0.000 0.000 0.000
##      13      14      15      16      17      18      19      20      21      22      23
## Group 1 0.000 0.000 0.693 0.000 0.864 0.000 0.00 0.000 1.000 0.976 0.000
## Group 2 0.000 0.000 0.145 0.000 0.000 0.000 0.00 0.000 0.000 0.000 0.217
## Group 3 0.000 0.000 0.545 0.000 0.636 0.000 0.00 0.000 0.909 1.000 0.000

```

```
## Group 4 0.000 0.000 0.349 0.000 0.417 0.000 0.00 0.000 0.103 0.000 0.000
## Group 5 0.875 0.812 0.125 0.937 0.062 0.562 1.00 1.000 0.000 0.000 0.312
## Group 6 0.000 0.225 0.000 0.225 0.000 0.075 0.15 0.075 0.000 0.000 0.000
## Group 7 1.000 1.000 0.462 0.462 0.231 0.000 0.00 0.000 0.000 0.000 0.538
## Group 8 0.000 0.000 0.333 0.000 0.500 0.000 0.00 0.000 0.000 0.000 0.000
## Group 9 0.667 0.667 0.833 1.000 1.000 0.000 0.00 0.000 0.000 0.000 0.500
## Group 10 0.000 0.000 1.000 0.000 1.000 0.000 0.00 0.000 1.000 1.000 0.000
##
## Membership Probabilities:
##
## Group 1 Group 2 Group 3 Group 4 Group 5 Group 6 Group 7 Group 8
## 0.235 0.167 0.133 0.121 0.096 0.080 0.078 0.036
## Group 9 Group 10
## 0.036 0.018

## Warning: Posterior standard deviations not returned.
plot(fit10)
```

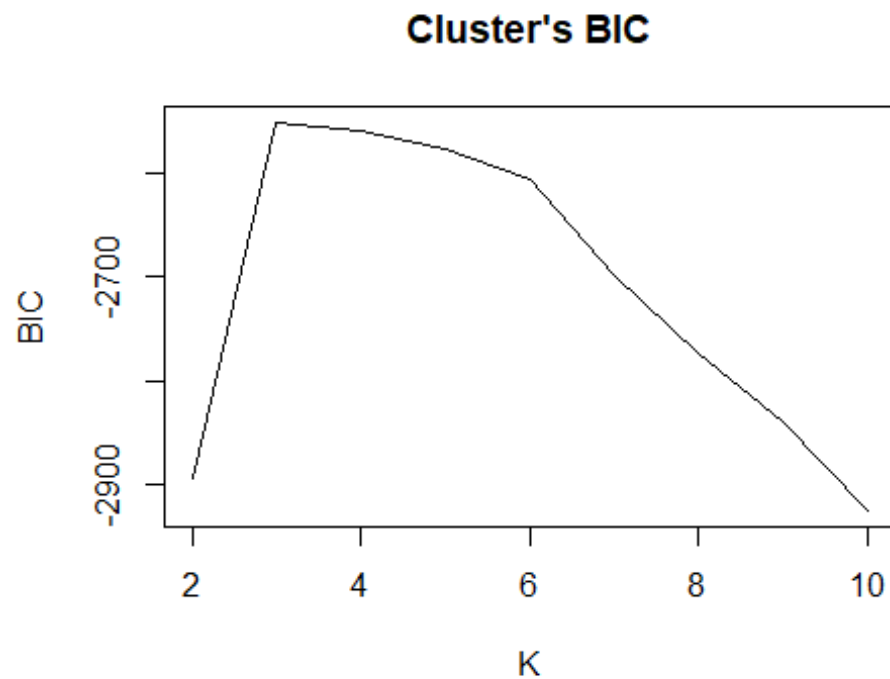


```
K<- seq(2,10,1)

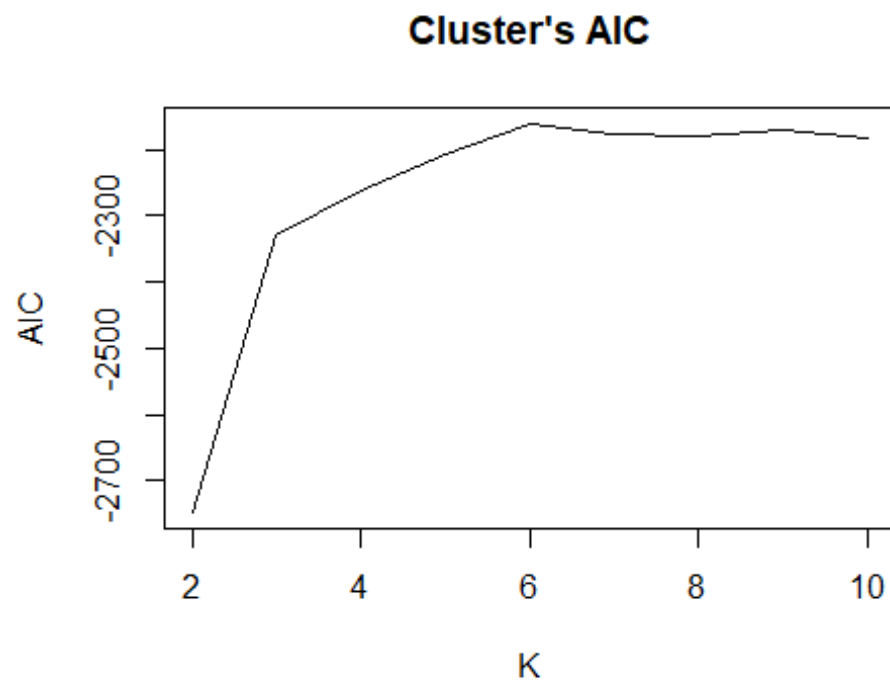
BIC<-
c(fit2$BIC,fit3$BIC,fit4$BIC,fit5$BIC,fit6$BIC,fit7$BIC,fit8$BIC,fit9$BIC,fit10$BIC)

AIC<-
c(fit2$AIC,fit3$AIC,fit4$AIC,fit5$AIC,fit6$AIC,fit7$AIC,fit8$AIC,fit9$AIC,fit10$AIC)

plot(K,BIC, main = "Cluster's BIC", type = "l")
```



```
plot(K,AIC, main = "Cluster's AIC", type = "l")
```



Then, after deciding on the number, you look at the results of this clustering, and describe the results - size of each cluster, characteristics of each cluster etc.



```

z<-fit3$Z
zr<-as.data.frame(round(z,1))
pol<-votes[,1:3]
library(dplyr)

##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##   filter, lag

## The following objects are masked from 'package:base':
##
##   intersect, setdiff, setequal, union

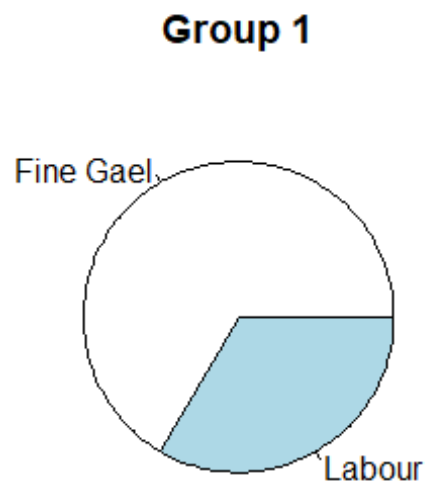
full<-bind_cols(pol,zr)
g1<-full[full$`Group 1`==1,]
g2<-full[full$`Group 2`==1,]
g3<-full[full$`Group 3`==1,]

x<-table(g1$Party)
x

##
## Fine Gael    Labour
##          56      28

pie(x,main = "Group 1")

```



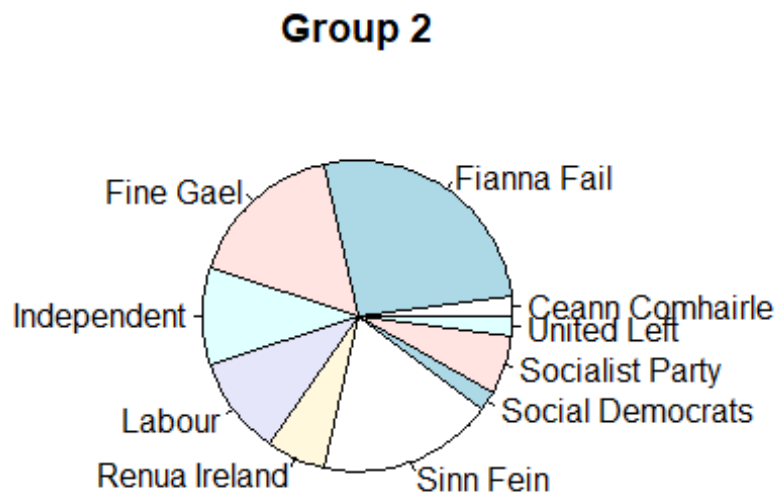
```

y<-table(g2$Party)
y

##
##   Ceann Comhairle      Fianna Fail      Fine Gael      Independent
##           1           13           8           5
##      Labour      Renua Ireland      Sinn Fein      Social Democrats
##           5           3           9           1
##   Socialist Party      United Left
##           3           1

pie(y,main = "Group 2")

```



```

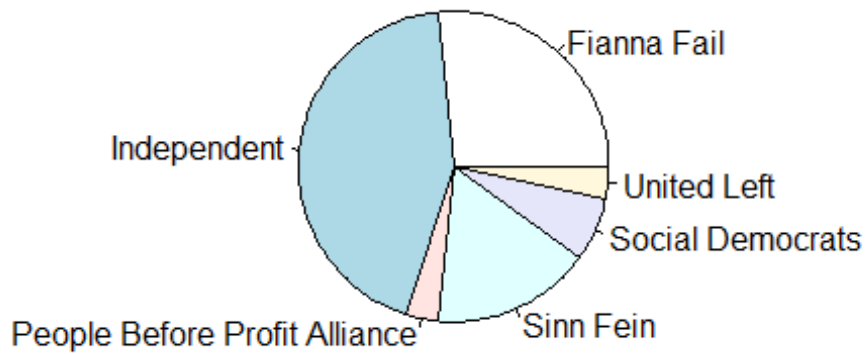
z<-table(g3$Party)
z

##
##           Fianna Fail      Independent
##           8           13
## People Before Profit Alliance      Sinn Fein
##           1           5
##           Social Democrats      United Left
##           2           1

pie(z,main = "Group 3")

```

### Group 3



```

z<-fit6$Z
zr<-as.data.frame(round(z,1))
pol<-votes[,1:3]
library(dplyr)
full<-bind_cols(pol,zr)
g1<-full[full$`Group 1`==1,]
g2<-full[full$`Group 2`==1,]
g3<-full[full$`Group 3`==1,]
g4<-full[full$`Group 4`==1,]
g5<-full[full$`Group 5`==1,]
g6<-full[full$`Group 6`==1,]

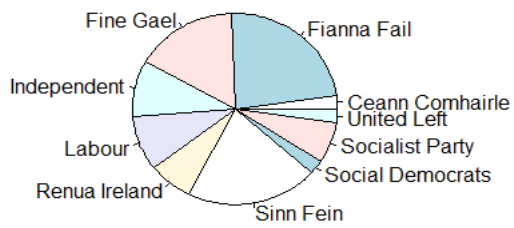
x<-table(g1$Party)
x

##
## Ceann Comhairle      Fianna Fail      Fine Gael      Independent
##           1           10           7           4
## Labour      Renua Ireland      Sinn Fein      Social Democrats
##           4           3           9           1
## Socialist Party      United Left
##           3           1

pie(x,main = "Group 1")

```

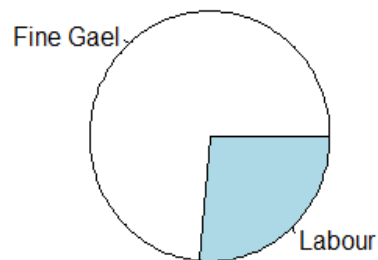
**Group 1**



```
y<-table(g2$Party)
y

##
## Fine Gael    Labour
##      28      10
pie(y,main = "Group 2")
```

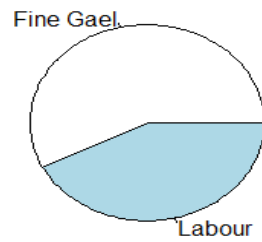
**Group 2**



```
z<-table(g3$Party)
z

##
## Fine Gael    Labour
##      19      14
pie(z,main = "Group 3")
```

**Group 3**

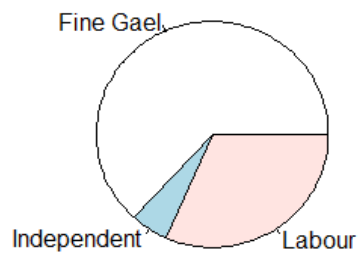


```
x1<-table(g4$Party)
x1

##
##   Fine Gael Independent   Labour
##         12           1         6

pie(x1,main = "Group 4")
```

**Group 4**

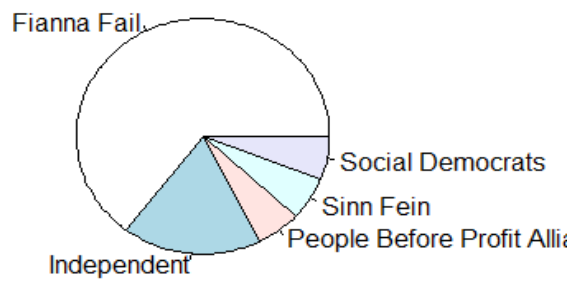


```
y1<-table(g5$Party)
y1

##
##           Fianna Fail           Independent
##                11                3
## People Before Profit Alliance       Sinn Fein
##                1                1
##           Social Democrats
##                1
```

```
pie(y1,main = "Group 5")
```

### Group 5



```
z1<-table(g6$Party)
```

```
z1
```

```
##
##      Independent      Sinn Fein Social Democrats      United Left
##              10              4              1              1
```

```
pie(z1,main = "Group 6")
```

### Group 6

