Psychology 405: Psychometric Theory
Scale Construction: an example

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Outline

Scale construction: A 10 steps program

1. Personality scales are not created in a theoretical vacuum. Perhaps the most important step in developing a new scale is a consideration of what is the construct of interest. What is it, what are manifestations of it, what is it not, and what should it not relate to.
2. Then, what is the population of interest? Are they young old, highly literate, or somewhat challenged by literacy. Write items suitable for the population of interest.
3. Give the items to the participants. Make sure that they are engaged in the task.

Scale construction: A 10 steps program (continued)

4. To analyze the data, it is necessary to enter the data into a machine readable form.
    - This is a source of error. Double check for data entry errors.
    - Double entry (two different people enter the data and then the two files are automatically compared) is recommended.
    - Even better is automatic data entry (but then you need to check and double check the program).
    - my.data <- read.table(myfile)
    - my.data <- read.clipboard()
5. Run basic descriptive statistics to do one more check for errors. Graphically check as well.
    - describe()
    - pairs.panels()
6. Form the variance/covariance matrix from the items and examine the dimensionality of the resulting space.

Scale construction: A 10 steps program (continued)

7. Apply various data reduction techniques (factor analysis, principal components analysis, cluster analysis).
   - `fa`
   - `principal`
   - `iclust`
8. Form composite scales of the selected items. Check these scales for various measures of internal consistency.
   - `make.keys`
   - `score.items`
9. Discriminant validity requires that the scales not correlate with other, unrelated traits.
10. Convergent validity requires that the scale do correlate with other, alternative measures of the same trait.

Basic item development

As a demonstration of scale construction and validation, consider the following problem. N self report items are given to a number of people. This inventory has is composed of subsets of items that measure believed to measure different traits. In addition, each subject is rated by a friend on those same traits. There are several questions we can ask of these data:

1. Do the items form reliable scales?
2. What are the correlations of these scales?
3. Do the scales correlate with the peer ratings?
4. Can we empirically find a better structure of the items?
5. Do these revised scales show greater independence, reliability, and validity?

Item writing

To show the procedures, 14 students in a personality research course spent several weeks learning about each of four personality dimensions. Each student then wrote five items to assess each of four constructs.

1. Need for Achievement
2. Anxiety
3. Sociability
4. Impulsivity

As a group they examined all of the items and formed the best 84 items into one questionnaire with 21 items believed to measure each of the constructs. They administered this questionnaire to approximately ten friends each whom they also rated on these four constructs. Thus, we have a data set of about 140 participants assessed on 88 items (the 84 self report items and the 4 peer ratings). These four sets of items can be seen as samples from four domains.

Initial data reading

The data, item labels, and scoring keys are saved on a web server. They may be accessed by the read.table(file.name) command. We then use the dim command to find out the dimensions of the data file as well as the names command to find out what the names are.

```
prq.data.name <-  "http://personality-project.org/revelle/syllabi/301/prq.data"
prq.keys.name <- "http://personality-project.org/revelle/syllabi/301/prq.keys"
prq.labels.name <- "http://personality-project.org/revelle/syllabi/301/prq.labels"
prq.data <- read.table(prq.data.name,header=TRUE)
prq.keys <- read.table(prq.keys.name,header=TRUE)
prq.labels <-  read.table(prq.labels.name,header=TRUE)
dim(prq.data)
names(prq.data)
#only 75 subjects!
```

```
[1] 75 91
> names(prq.data)
 [1] "Exp"          "Subject"      "NeedAch"      "Anxiety"      "Sociability" "Impulsivity"
 [7] "Gender"       "q1"           "q2"           "q3"           "q4"          "q5"
[13] "q6"           "q7"           "q8"           "q9"           "q10"         "q11"
[19] "q12"          "q13"          "q14"          "q15"          "q16"         "q17"
[25] "q18"          "q19"          "q20"          "q21"          "q22"         "q23"
[31] "q24"          "q25"          "q26"          "q27"          "q28"         "q29"
[37] "q30"          "q31"          "q32"          "q33"          "q34"         "q35"
...
[85] "q78"          "q79"          "q80"          "q81"          "q82"         "q83"
[91] "q84"
```

Data checking

The first two variables are not particularly interesting, so we create a new data.frame without them. Then find the descriptive statistics of the data in order to make sure that the data were entered correctly.

```
> prq.items <- prq.data[,-c(1:2)]
> describe(prq.items)
```

```
             var  n mean   sd median trimmed  mad min max range  skew kurtosis   se
NeedAch        1 75 6.39 1.92      7    6.48 1.48   2  10     8 -0.40    -0.64 0.22
Anxiety        2 75 5.24 2.28      5    5.21 2.97   1  10     9  0.09    -1.18 0.26
Sociability    3 75 6.15 2.13      7    6.31 1.48   1   9     8 -0.69    -0.60 0.25
Impulsivity    4 75 5.16 2.35      5    5.20 2.97   1   9     8 -0.13    -1.32 0.27
Gender         5 74 1.51 0.50      2    1.52 0.00   1   2     1 -0.05    -2.02 0.06
q1             6 75 4.27 1.15      4    4.34 1.48   1   6     5 -0.52    -0.08 0.13
q2             7 75 3.37 1.39      3    3.33 1.48   1   6     5  0.21    -0.73 0.16
...
q82           87 75 3.84 1.46      4    3.92 1.48   1   6     5 -0.39    -0.74 0.17
q83           88 75 4.08 1.33      4    4.10 1.48   2   6     4 -0.35    -1.06 0.15
q84           89 75 3.89 1.33      4    3.92 1.48   1   6     5 -0.32    -0.80 0.15
```

Data checking

In doing this, we discovered (on the first pass through the data) that one of the variables had a range of 32 rather than the 6 that was appropriate. Correcting the data, we can start over again. Even with well meaning, careful data entry, mistakes will happen in data entry. It is recommended that data be entered twice and then compared using software that compares the two files line by line and entry by entry. In all cases, make sure to describe the data and check that the ranges are appropriate for the data.
Thus, the data were edited and the prior steps were done again until there were no incorrectly entered subjects. One error that makes data checking complicated is a blank field in Excel is read improperly. Using NA to specify not available is better. Note that the describe output shows that some variables do not have as many subjects as others.

Score the scales

1. Forming scale scores as linear sums (or averages) of the items is easy to do in R.
2. One technique (not recommended) is to do a series of recodings, creating new variables for each scale.
3. A simpler technique, using the `score.items` function from the *psych* package does this for all scales defined in a matrix of keys (the keys matrix).
4. This is essentially a matrix of -1, 0, and 1s where 0 means don't include the item in the scale, and a 1 means to include it. -1 means to reverse key the item.

A keys matrix

```
> prq.keys

   PNach PAnx PSoc PImp G Nach Anx Soc Imp
1      1    0    0    0 0    0   0   0   0
2      0    1    0    0 0    0   0   0   0
3      0    0    1    0 0    0   0   0   0
4      0    0    0    1 0    0   0   0   0
5      0    0    0    0 1    0   0   0   0
6      0    0    0    0 0    1   0   0   0
7      0    0    0    0 0    0   1   0   0
8      0    0    0    0 0    0   0   1   0
9      0    0    0    0 0    0   0   0  -1
...
84     0    0    0    0 0    0   0  -1   0
85     0    0    0    0 0    0   0   0   1
86     0    0    0    0 0    1   0   0   0
87     0    0    0    0 0    0   1   0   0
88     0    0    0    0 0    0   0   1   0
89     0    0    0    0 0    0   0   0   1
```

Making a keys matrix

Although it is possible to make up a keys matrix in Excel and copy it into R, it is easier to use the `make.keys` function.

```
> my.keys <- make.keys(nvars=89,keys.list =list(Pnach=1,PAnx=2,PSoc=3,PImp=4,G=5,
             Nach=c(6,10,14,18),Anx=c(7,11,15,19),Soc=c(8,12,-16,20),Imp=c(-9,13,-17,21)))
> my.keys

     Pnach PAnx PSoc PImp G Nach Anx Soc Imp
 [1,]     1    0    0    0 0    0   0   0   0
 [2,]     0    1    0    0 0    0   0   0   0
 [3,]     0    0    1    0 0    0   0   0   0
 [4,]     0    0    0    1 0    0   0   0   0
 [5,]     0    0    0    0 1    0   0   0   0
 [6,]     0    0    0    0 0    1   0   0   0
 [7,]     0    0    0    0 0    0   1   0   0
 [8,]     0    0    0    0 0    0   0   1   0
 [9,]     0    0    0    0 0    0   0   0  -1
[10,]     0    0    0    0 0    1   0   0   0
[11,]     0    0    0    0 0    0   1   0   0
[12,]     0    0    0    0 0    0   0   1   0
[13,]     0    0    0    0 0    0   0   0   1
[14,]     0    0    0    0 0    1   0   0   0
[15,]     0    0    0    0 0    0   1   0   0
[16,]     0    0    0    0 0    0   0  -1   0
[17,]     0    0    0    0 0    0   0   0  -1
[18,]     0    0    0    0 0    1   0   0   0
[19,]     0    0    0    0 0    0   1   0   0
[20,]     0    0    0    0 0    0   0   1   0
[21,]     0    0    0    0 0    0   0   0   1
...
```

Score the items

We use the `score.items` function.

We first do this just for the items. The item.scores is a list of multiple values:

1. scores – the actual scores for each subject
2. missing – where there any missing values for any subject?
3. alpha – coefficient alpha for each scale
4. av.r – the average r within each scale
5. n.items – how many items in each scale?
6. item.cor – the correlation of each item with each scale
7. cor – the correlation matrix of the scales
8. corrected – the raw correlations of the scales (below the diagonal), the alpha reliabilities (on the diagonal), and the intercorrelations corrected for unreliability (above the diagonal).

Using score.items

```
> tem.scores <- score.items(prq.keys[,6:9],prq.items)
> print(item.scores$corrected)
> round(item.scores$corrected,2)
```

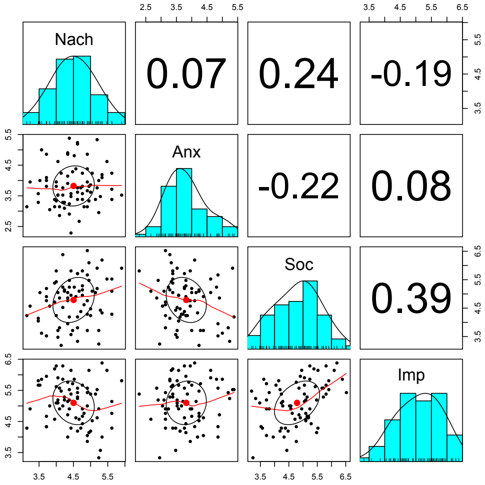
```
> print(item.scores$corrected)
            Nach         Anx        Soc         Imp
Nach  0.83928271  0.08193167  0.2755535 -0.22602236
Anx   0.06805717  0.82212135 -0.2545185  0.09498796
Soc   0.23857492 -0.21809815  0.8931604  0.44321814
Imp  -0.19259110  0.08010640  0.3895946  0.86509005


#rounding to 2 decimal places is nicer
      Nach   Anx   Soc   Imp
Nach  0.84  0.08  0.28 -0.23
Anx   0.07  0.82 -0.25  0.09
Soc   0.24 -0.22  0.89  0.44
Imp  -0.19  0.08  0.39  0.87
```

Show more of the output

```
> item.scores
Call: score.items(keys = prq.keys[, 6:9], items = prq.items)
(Unstandardized) Alpha:
      Nach  Anx  Soc  Imp
alpha 0.84 0.82 0.89 0.87
Average item correlation:
          Nach  Anx  Soc  Imp
average.r  0.2 0.18 0.28 0.23

 Guttman 6* reliability:
         Nach  Anx  Soc  Imp
Lambda.6 0.93 0.89 0.93 0.92

Scale intercorrelations corrected for attenuation
 raw correlations below the diagonal, alpha on the diagonal
 corrected correlations above the diagonal:
       Nach    Anx   Soc    Imp
Nach  0.839  0.082  0.28 -0.226
Anx   0.068  0.822 -0.25  0.095
Soc   0.239 -0.218  0.89  0.443
Imp  -0.193  0.080  0.39  0.865
 In order to see the item by scale loadings and frequency counts of the data
 print with the short option = FALSE
```

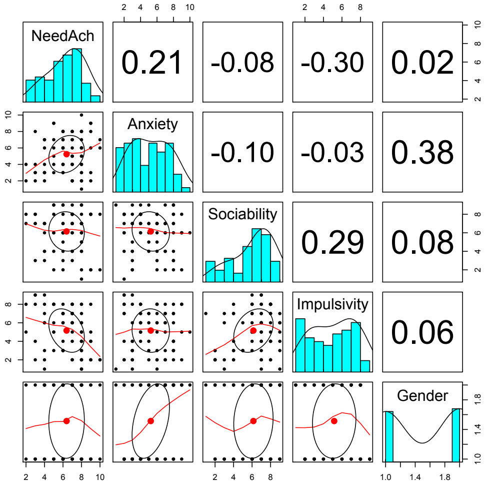
Display the four self report dimensions

pairs.panels(item.scores$scores) # note that scores are not shown in output



Show the peer rating structure

```
pairs.panels(prq.data[,3:7])
```

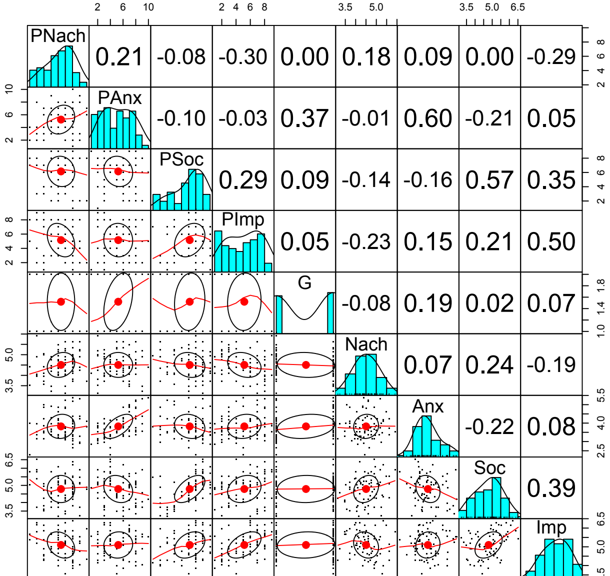


Score the peer ratings and the scales

```
mmtm <- score.items(prq.keys,prq.items)
```

```
> mmtm
Call: score.items(keys = prq.keys, items = prq.items)

(Unstandardized) Alpha:
      PNach PAnx PSoc PImp G Nach  Anx  Soc  Imp
alpha     1    1    1    1 1 0.84 0.82 0.89 0.87

Average item correlation:
          PNach PAnx PSoc PImp   G Nach  Anx  Soc  Imp
average.r   NaN  NaN  NaN  NaN NaN  0.2 0.18 0.28 0.23

 Guttman 6* reliability:
         PNach PAnx PSoc PImp G Nach  Anx  Soc  Imp
Lambda.6  0.27 0.19 0.22 0.18 4 0.93 0.89 0.93 0.92

Scale intercorrelations corrected for attenuation
 raw correlations below the diagonal, alpha on the diagonal
 corrected correlations above the diagonal:
        PNach   PAnx   PSoc   PImp       G    Nach    Anx     Soc    Imp
PNach  1.0000  0.207 -0.077 -0.304 -0.0011  0.1993  0.098 -0.0041 -0.311
PAnx   0.2068  1.000 -0.102 -0.030  0.3733 -0.0065  0.659 -0.2173  0.059
PSoc  -0.0767 -0.102  1.000  0.293  0.0919 -0.1555 -0.175  0.6014  0.372
PImp  -0.3041 -0.030  0.293  1.000  0.0545 -0.2502  0.161  0.2214  0.535
G     -0.0011  0.373  0.092  0.054  1.0000 -0.0865  0.210  0.0241  0.079
Nach   0.1826 -0.006 -0.142 -0.229 -0.0792  0.8393  0.082  0.2756 -0.226
Anx    0.0888  0.597 -0.159  0.146  0.1901  0.0681  0.822 -0.2545  0.095
Soc   -0.0039 -0.205  0.568  0.209  0.0228  0.2386 -0.218  0.8932  0.443
Imp   -0.2891  0.055  0.346  0.498  0.0736 -0.1926  0.080  0.3896  0.865

 In order to see the item by scale loadings and frequency counts of the data
 print with the short option = FALSE
```

Show the MMTM matrix graphically



Factor Analysis

The items analysed were meant to represent four constructs. Given the previous analysis, they probably do. But what if we did not know how many separate dimensions were in the data? Is it possible to find out? Three alternative procedure address this question.

1. Principal componenents analysis
2. Factor analysis
3. Cluster analysis

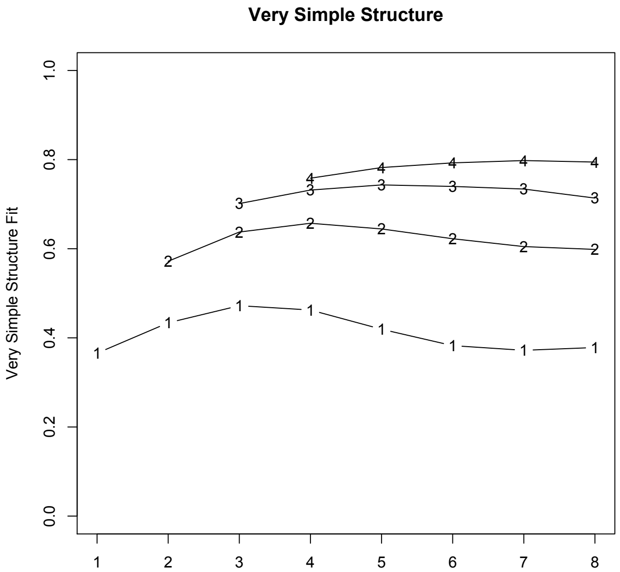
All three of these procedures are attempting to approximate the nvar * nvar correlation matrix R with a matrix of lesser rank, one that is nvar * nf. That is, can we find a Factor (Component or Cluster) such that

$$R \approx FF' + U^2 \qquad (1)$$

Factor analysis of PRQ

1. More items than people makes the matrix not invertible
2. Can be solved by the `fa` function using minres option
3. How many factors to extract?
   - VSS(prq.items)
   - Use VSS 3 (complexity 1) or 4 (complexity 2)
   - Use MAPS 8
4. Theory says 4

VSS of prq


Very Simple Structure
Very Simple Structure Fit
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7
8

Find a 4 factor as well as a 4 component solution

```
f4 <- fa(prq.items,4)
p4 <- principal(prq.items,4)
summary(f4)
```

```
> summary(f4)

Factor analysis with Call: fa(r = prq.items, nfactors = 4)

Test of the hypothesis that 4 factors are sufficient.
The degrees of freedom for the model is 3566  and the objective function was  523.91
The number of observations was  75  with Chi Square =  21393.03  with prob <  0

The root mean square of the residuals (RMSA) is  0.07
The df corrected root mean square of the residuals is  0.1

Tucker Lewis Index of factoring reliability =  NaN
RMSEA index =  0.365  and the 90 % confidence intervals are  0.255 0.262
BIC =  5996.86
 With factor correlations of
      MR1   MR2   MR4   MR3
MR1  1.00  0.12  0.17 -0.16
MR2  0.12  1.00 -0.03 -0.03
MR4  0.17 -0.03  1.00  0.02
MR3 -0.16 -0.03  0.02  1.00
```

Also try a cluster analysis

```
> ic <- ICLUST(prq.items,labels=strtrim(prq.labels[,2],20))
> summary(ic)

ICLUST (Item Cluster Analysis)Call: ICLUST(r.mat = prq.items, labels = strtrim(prq.labels[, 2], 20))
ICLUST

Purified Alpha:
 C83  C82  C85  C81
0.92 0.89 0.87 0.54

 Guttman Lambda6*
C83 C82 C85 C81
  1   1   1   1

Original Beta:
 C83  C82  C85  C81
0.58 0.47 0.48 0.40

Cluster size:
C83 C82 C85 C81
 40  25  20   4

Purified scale intercorrelations
 reliabilities on diagonal
 correlations corrected for attenuation above diagonal:
       C83     C82     C85  C81
C83  0.920 -0.0312  0.1818 0.11
C82 -0.028  0.8922 -0.0036 0.18
C85  0.162 -0.0032  0.8679 0.20
C81  0.074  0.1280  0.1386 0.54
```

Compare the solutions

```
> factor.congruence(list(f4,p4,ic))
```

	MR1	MR2	MR4	MR3	PC1	PC2	PC4	PC3	C83	C82	C85	C81
MR1	1.00	0.04	0.11	-0.11	0.99	0.14	0.22	-0.16	-0.84	0.22	-0.39	0.30
MR2	0.04	1.00	-0.05	0.00	0.08	0.99	-0.10	0.01	0.02	0.98	0.05	0.25
MR4	0.11	-0.05	1.00	0.02	0.18	-0.03	0.99	0.06	-0.63	-0.06	0.17	-0.54
MR3	-0.11	0.00	0.02	1.00	-0.19	-0.05	-0.01	1.00	0.19	-0.08	0.92	0.45
PC1	0.99	0.08	0.18	-0.19	1.00	0.17	0.28	-0.24	-0.87	0.25	-0.44	0.22
PC2	0.14	0.99	-0.03	-0.05	0.17	1.00	-0.07	-0.04	-0.07	0.99	-0.02	0.25
PC4	0.22	-0.10	0.99	-0.01	0.28	-0.07	1.00	0.02	-0.70	-0.08	0.10	-0.52
PC3	-0.16	0.01	0.06	1.00	-0.24	-0.04	0.02	1.00	0.21	-0.07	0.95	0.41
C83	-0.84	0.02	-0.63	0.19	-0.87	-0.07	-0.70	0.21	1.00	-0.13	0.32	0.13
C82	0.22	0.98	-0.06	-0.08	0.25	0.99	-0.08	-0.07	-0.13	1.00	-0.09	0.28
C85	-0.39	0.05	0.17	0.92	-0.44	-0.02	0.10	0.95	0.32	-0.09	1.00	0.19
C81	0.30	0.25	-0.54	0.45	0.22	0.25	-0.52	0.41	0.13	0.28	0.19	1.00

Combine the factor scores with the empirical scores

```
> scores.df <- data.frame(f4$scores,item.scores$scores)
> lowerCor(scores.df)
```

```
     X1    X2    X3    X4    Nach  Anx   Soc   Imp
X1    1.00
X2    0.37  1.00
X3    0.56 -0.05  1.00
X4   -0.56 -0.20 -0.10  1.00
Nach  0.33  0.95 -0.04 -0.13  1.00
Anx  -0.25  0.04  0.18  0.89  0.07  1.00
Soc   0.95  0.29  0.51 -0.50  0.24 -0.22  1.00
Imp   0.46 -0.24  0.96 -0.12 -0.19  0.08  0.39  1.00
```

Compare original, factors and clusters

```
> fkeys <- factor2cluster(f4)
> ckeys <- cluster2keys(ic)
> all.keys <- cbind(prq.keys,fkeys,ckeys)
> all.scores <- score.items(all.keys,prq.items)
> lowerMat(all.scores$cor)

      PNach PAnx  PSoc  PImp  G     Nach  Anx   Soc   Imp   MR1   MR2   MR4   MR3
PNach  1.00
PAnx   0.21  1.00
PSoc  -0.08 -0.10  1.00
PImp  -0.30 -0.03  0.29  1.00
G      0.00  0.37  0.09  0.05  1.00
Nach   0.18 -0.01 -0.14 -0.23 -0.08  1.00
Anx    0.09  0.60 -0.16  0.15  0.19  0.07  1.00
Soc    0.00 -0.21  0.57  0.21  0.02  0.24 -0.22  1.00
Imp   -0.29  0.05  0.35  0.50  0.07 -0.19  0.08  0.39  1.00
MR1   -0.03 -0.24  0.65  0.25 -0.01  0.23 -0.22  0.98  0.37  1.00
MR2    0.21 -0.02 -0.26 -0.33 -0.05  0.94  0.03  0.14 -0.30  0.12  1.00
MR4   -0.39  0.11  0.21  0.56  0.07 -0.09  0.22  0.30  0.94  0.27 -0.18  1.00
MR3    0.13  0.66 -0.18  0.07  0.21 -0.01  0.93 -0.30 -0.06 -0.28 -0.05  0.03  1.00
C83    0.26  0.14 -0.60 -0.49 -0.03 -0.04  0.07 -0.86 -0.77 -0.85  0.08 -0.71  0.19
C82    0.18 -0.04 -0.22 -0.28 -0.04  0.94  0.05  0.19 -0.24  0.16  0.99 -0.13 -0.04
C85    0.16  0.69 -0.19  0.08  0.23  0.02  0.97 -0.30  0.04 -0.31  0.00  0.17  0.94
C81    0.01  0.01  0.02  0.03 -0.10  0.24  0.22  0.05 -0.31  0.14  0.13 -0.28  0.36
    C83   C82   C85   C81
C83  1.00
C82  0.01  1.00
C85  0.17  0.00  1.00
C81  0.07  0.11  0.16  1.00
```

ICLUST output

```
> print(ic,sort=TRUE,labels=prq.labels)


ICLUST (Item Cluster Analysis)
Call: ICLUST(r.mat = prq.items, labels = strtrim(prq.labels[, 2], 20))

Purified Alpha:
 C83  C82  C85  C81
0.92 0.89 0.87 0.54

G6* reliability:
 C83  C82  C85  C81
0.84 0.97 0.96 1.00

Original Beta:
 C83  C82  C85  C81
0.58 0.47 0.48 0.40

Cluster size:
C83 C82 C85 C81
 40  25  20   4
```

Cluster 1

```
Item by Cluster Structure matrix: Sorted by loading
            item              content cluster   C83   C82   C85   C81
q35           40  I have a large soci       1 -0.71       -0.31
q83           88 I am a very sociable       1 -0.64  0.37
q67           72  I am always willing       1 -0.64
q23           28  I make friends easi       1 -0.63
q51           56  People are more lik       1  0.63
q11           16  I tend to avoid soc       1  0.63        0.32
q16           21  I tend to make deci       1 -0.61
q43           48  I am happier when I       1 -0.60  0.43
q39           44  Id rather spend tim       1 -0.58
q24           29  I often change my p       1 -0.58             -0.30
Sociability    3          Sociability       1 -0.57
q84           89 I am an impulsive pe       1 -0.56
q56           61  I often and activel       1 -0.55
q80           85  I often say the fir       1 -0.53
q59           64  I prefer large crow       1 -0.52
q44           49  I often regret deci       1 -0.52
q19           24  I am good at mainta       1 -0.52
q3             8  I like to meet new        1 -0.51
q31           36  I tend to talk a lo       1 -0.50       -0.34
q76           81  I sometimes look ba       1 -0.50
q8            13  I say things that I       1 -0.49
q47           52  I enjoy being alone       1  0.48
q52           57  I often get sidetra       1 -0.48             -0.34
q40           45  I act on sudden urg       1 -0.47
Impulsivity    4          Impulsivity       1 -0.47
q32           37  I indulge in my des       1 -0.46
q69           74  I tend to procrasti       1 -0.46 -0.31
q55           60  Ill spend time talk       1 -0.44
q68           73  I always think befo       1  0.44
q63           68  A good night for me       1  0.43        0.31
```

Cluster 2

NeedAch	1	NeedAch	1	
q81	86	I believe that if so	2	0.74
q17	22	I have high standar	2	0.72
q33	38	I find myself needi	2	0.69
q4	9	I am thoughtful and	2	0.63
q41	46	I always make sure	2	0.63
q25	30	If I fail, I keep t	2	0.62
q13	18	I like to go the ex	2	0.61
q1	6	I love to seek out	2	0.60
q77	82	I always see projec	2	0.60
q61	66	I experience great	2	0.60
q49	54	The joy of success	2	0.59
q60	65	I stay on task unti	2	0.58
q45	50	I prefer challengin	2	0.55
q73	78	I set long term and	2	0.51
q12	17	I weigh all the opt	2	0.50
q57	62	I always reach the	2	0.49
q78	83	I tend to back away	2	-0.47
q37	42	I get bored if a ta	2	0.46
q58	63	I prefer to work in	2	0.46
q27	32	I tend to enjoy sma	2	0.41
q5	10	Personal satisfacti	2	0.35
q21	26	I am a perfectionis	2	0.35
q65	70	I tend to have trou	2	-0.32
q75	80	I work better when	2	
q29	34	I seek the enjoymen	2	

Cluster 3

q42	47	Even trivial proble	3			0.71	
Anxiety	2	Anxiety	3			0.68	
q6	11	I dont handle stress	3			0.68	
q50	55	Even in non stressf	3			0.64	0.34
q2	7	I get nervous very e	3			0.62	
q18	23	I rarely feel tense	3			-0.61	
q34	39	I have a hard time f	3			0.59	
q10	15	I am easily bothered	3			0.57	
q26	31	I often feel anxious	3			0.56	
q22	27	I feel stressed when	3			0.55	
q30	35	I often feel tense,	3			0.54	
q62	67	A small unpleasant	3			0.54	
q66	71	I worry about what	3			0.52	
q70	75	I bounce back quick	3	-0.33	0.35	-0.47	
q74	79	I tend to dwell on	3			0.46	
q54	59	I feel tension in m	3			0.46	
q38	43	I often have unwant	3			0.45	
q14	19	Measures of skill or	3			0.42	
Gender	5	Gender	3			0.31	

Cluster 4

q72	77	I always stick to p	4		0.72
q64	69	I dislike changing	4		0.69
q82	87	I am more emotional	4		0.63
q9	14	I am a good multi t	4	0.31	0.55

Show the items for the factors

```
> rownames(f4$loadings) <- strtrim(prq.labels[,2],20)
> print(f4,sort=TRUE)
```

```
Factor Analysis using method =  minres
Call: fa(r = prq.items, nfactors = 4)
Standardized loadings (pattern matrix) based upon correlation matrix
                     item   MR1   MR2   MR4   MR3    h2   u2
 I have a large soci   40  0.79  0.02  0.06 -0.13 0.696 0.30
 I like to meet new     8  0.78  0.11 -0.16  0.15 0.607 0.39
 I tend to avoid soc   16 -0.77 -0.08  0.02  0.09 0.644 0.36
I am a very sociable   88  0.75  0.25  0.04 -0.13 0.725 0.28
 Id rather spend tim   44  0.74 -0.03 -0.01  0.14 0.531 0.47
 I make friends easi   28  0.70  0.14  0.10 -0.09 0.596 0.40
Sociability             3  0.64 -0.32  0.04 -0.04 0.482 0.52
 I am happier when I   48  0.62  0.32  0.15  0.08 0.575 0.42
 People are more lik   56 -0.61 -0.09 -0.15  0.13 0.487 0.51
 I often and activel   61  0.57  0.01  0.18  0.23 0.400 0.60
 I can easily start    12  0.55  0.10 -0.10  0.00 0.319 0.68
 I prefer large crow   64  0.55 -0.20  0.06 -0.10 0.352 0.65
 I am always willing   72  0.54  0.08  0.27 -0.08 0.455 0.54
 I am good at mainta   24  0.54  0.23  0.15 -0.12 0.454 0.55
 When given the choi   84 -0.50  0.35  0.10  0.01 0.327 0.67
 I enjoy being alone   52 -0.47  0.01 -0.13  0.09 0.278 0.72
 I dont understand h   76  0.43 -0.28  0.02 -0.13 0.272 0.73
 I tend to lead the    20  0.41 -0.06 -0.07 -0.25 0.256 0.74
 A good night for me   68 -0.39 -0.06 -0.06  0.27 0.283 0.72
 I am a good multi t   14  0.31  0.28 -0.22 -0.03 0.225 0.78
```

Factor 2

I believe that if so	86	0.12	0.75	0.14	0.03	0.619	0.38
I have high standar	22	0.13	0.67	-0.16	0.14	0.516	0.48
I find myself needi	38	0.17	0.65	0.08	0.07	0.487	0.51
I like to go the ex	18	0.12	0.65	-0.10	0.04	0.457	0.54
I stay on task unti	65	0.03	0.61	-0.07	0.07	0.390	0.61
I always make sure	46	0.10	0.61	-0.04	-0.03	0.403	0.60
I always see projec	82	0.07	0.61	-0.07	0.13	0.404	0.60
I am thoughtful and	9	0.03	0.60	-0.36	-0.11	0.517	0.48
The joy of success	54	0.20	0.57	0.06	0.06	0.393	0.61
I set long term and	78	-0.19	0.56	0.17	-0.02	0.336	0.66
I love to seek out	6	0.23	0.56	0.08	-0.14	0.436	0.56
If I fail, I keep t	30	0.27	0.56	-0.06	-0.04	0.424	0.58
I experience great	66	0.04	0.56	-0.07	-0.05	0.327	0.67
I tend to back away	83	0.20	-0.52	-0.03	0.39	0.427	0.57
I prefer challengin	50	0.09	0.48	0.00	-0.12	0.268	0.73
I tend to enjoy sma	32	-0.30	0.46	0.16	0.02	0.278	0.72
I prefer to work in	63	-0.03	0.46	0.22	0.09	0.255	0.74
I tend to procrasti	74	0.29	-0.45	0.27	0.13	0.372	0.63
I always reach the	62	0.24	0.44	-0.15	-0.04	0.293	0.71
Personal satisfacti	10	-0.10	0.43	0.16	0.21	0.252	0.75
I tend to have trou	70	0.11	-0.43	0.10	0.33	0.306	0.69
I weigh all the opt	17	-0.16	0.42	-0.21	0.05	0.253	0.75
I get bored if a ta	42	0.09	0.38	0.22	-0.15	0.239	0.76
I am a perfectionis	26	-0.10	0.35	-0.10	0.28	0.222	0.78
I only work as hard	58	0.12	-0.29	0.20	0.18	0.172	0.83
I seek the enjoymen	34	0.15	0.25	0.13	-0.14	0.140	0.86
I work better when	80	0.15	-0.23	0.05	-0.03	0.077	0.92
When working on a n	41	-0.12	0.23	-0.23	-0.02	0.129	0.87

Factor 3

```
I act on sudden urg   45 -0.03  0.07  0.72 -0.13 0.528 0.47
 I often change my p   29  0.12  0.05  0.72  0.00 0.559 0.44
 I often get sidetra   57  0.03 -0.14  0.69  0.12 0.521 0.48
 I say things that I   13  0.09 -0.16  0.61  0.08 0.426 0.57
 I often have unwant   43 -0.34  0.08  0.60  0.17 0.458 0.54
I am an impulsive pe   89  0.22  0.03  0.59 -0.08 0.452 0.55
 I dislike planning    33  0.02 -0.17  0.57  0.09 0.379 0.62
 I often regret deci   49  0.20 -0.14  0.54  0.28 0.457 0.54
 I indulge in my des   37  0.16  0.14  0.54  0.11 0.373 0.63
 I always stick to p   77  0.28  0.07 -0.53  0.24 0.352 0.65
 I always think befo   73 -0.10  0.26 -0.51  0.05 0.360 0.64
 I sometimes look ba   81  0.20  0.08  0.51  0.07 0.341 0.66
 I tend to act on my   53  0.04  0.27  0.48 -0.19 0.349 0.65
 I tend to make deci   21  0.33  0.14  0.48 -0.23 0.494 0.51
 I plan my activitie   25 -0.05  0.35 -0.45  0.18 0.368 0.63
 I often have diffic   51 -0.33  0.17  0.41 -0.01 0.239 0.76
Impulsivity             4  0.26 -0.31  0.39  0.14 0.355 0.65
 I often say the fir   85  0.30 -0.21  0.36 -0.09 0.307 0.69
 I feel tension in m   59 -0.26  0.21  0.33  0.24 0.252 0.75
NeedAch                 1 -0.04  0.23 -0.25  0.11 0.135 0.86
```

Factor 4

I dont handle stress	11	-0.12	-0.11	0.03	0.70	0.556	0.44
Even trivial proble	47	-0.15	0.01	0.04	0.67	0.506	0.49
Even in non stressf	55	0.01	0.01	-0.01	0.66	0.437	0.56
I worry about what	71	0.23	-0.09	-0.08	0.64	0.421	0.58
I get nervous very e	7	-0.16	-0.18	-0.01	0.62	0.490	0.51
I am easily bothered	15	0.05	-0.04	0.01	0.60	0.361	0.64
A small unpleasant	67	0.02	0.20	-0.04	0.60	0.396	0.60
I feel stressed when	27	0.00	0.25	-0.19	0.59	0.431	0.57
Anxiety	2	-0.21	0.07	0.21	0.57	0.436	0.56
I have a hard time f	39	-0.08	0.24	-0.03	0.55	0.371	0.63
I often feel anxious	31	-0.12	0.25	0.26	0.52	0.404	0.60
I am more emotional	87	0.34	-0.10	-0.10	0.49	0.303	0.70
I often feel tense,	35	-0.10	-0.01	0.25	0.47	0.304	0.70
I dislike changing	69	0.12	-0.03	-0.44	0.46	0.375	0.63
I rarely feel tense	23	0.25	-0.28	-0.29	-0.45	0.415	0.58
I tend to talk a lo	36	0.33	0.14	0.27	-0.45	0.485	0.52
I tend to dwell on	79	0.17	0.29	0.14	0.44	0.314	0.69
I bounce back quick	75	0.23	0.30	0.16	-0.43	0.418	0.58
Ill spend time talk	60	0.35	-0.15	0.29	0.38	0.363	0.64
Measures of skill or	19	-0.22	-0.04	0.13	0.29	0.162	0.84
Gender	5	-0.07	0.00	0.16	0.19	0.069	0.93