EXPLORATORY FACTOR ANALYSIS

```
> cm <- matrix(c(1, 0.62, 0.54, 0.32, 0.284, 0.37,
+                0.62, 1, 0.51, 0.38, 0.351, 0.43,
+                0.54, 0.51, 1, 0.36, 0.336, 0.405,
+                0.32, 0.38, 0.36, 1, 0.686, 0.730,
+                0.284, 0.351, 0.336, 0.686, 1, 0.735,
+                0.37, 0.43, 0.405, 0.730, 0.735, 1),nrow = 6, ncol = 6)
> rownames(cm) <- c("m","p","c","e","h","f")
> colnames(cm) <- c("m","p","c","e","h","f")
> cm

      m     p     c     e     h     f
m 1.000 0.620 0.540 0.320 0.284 0.370
p 0.620 1.000 0.510 0.380 0.351 0.430
c 0.540 0.510 1.000 0.360 0.336 0.405
e 0.320 0.380 0.360 1.000 0.686 0.730
h 0.284 0.351 0.336 0.686 1.000 0.735
f 0.370 0.430 0.405 0.730 0.735 1.000

> eigen(cm)

$values
[1] 3.36709 1.19418 0.50701 0.37185 0.31316
[6] 0.24673

$vectors
         [,1]     [,2]       [,3]      [,4]
[1,] -0.36777 -0.50984  0.2669856  0.727680
[2,] -0.39135 -0.40921  0.4859166 -0.664645
[3,] -0.37195 -0.38258 -0.8316262 -0.152044
[4,] -0.43219  0.37482  0.0215319  0.065318
[5,] -0.42196  0.42146  0.0027301  0.011745
[6,] -0.45652  0.32882  0.0230327  0.034735
           [,5]      [,6]
[1,]  0.0475840 -0.041785
[2,] -0.0053920 -0.038728
[3,] -0.0033314 -0.023524
[4,] -0.7429703 -0.340567
[5,]  0.6651097 -0.449230
[6,]  0.0576177  0.823655

> library(psych)
> library(GPArotation)
> library(MASS)
> #fm="pa" gives principal factoring and by default SMC=FALSE such that initial communalities are 1
> #SMC=FALSE, max.iter=1 yields our princomp solution
> #SMC=TRUE, max.iter=100 yields our prinit solution
> faout <- fa(cm,nfactors=2, fm="pa", SMC=FALSE, max.iter=1,residuals = TRUE, rotate = "none")
> faout #h2 are communalities, u2 are specificities

Factor Analysis using method =  pa
Call: fa(r = cm, nfactors = 2, rotate = "none", residuals = TRUE, SMC = FALSE,
    max.iter = 1, fm = "pa")
```

```
Standardized loadings (pattern matrix) based upon correlation matrix
   PA1   PA2   h2   u2
m 0.67  0.56 0.77 0.23
p 0.72  0.45 0.72 0.28
c 0.68  0.42 0.64 0.36
e 0.79 -0.41 0.80 0.20
h 0.77 -0.46 0.81 0.19
f 0.84 -0.36 0.83 0.17

                       PA1  PA2
SS loadings           3.37 1.19
Proportion Var        0.56 0.20
Cumulative Var        0.56 0.76
Proportion Explained  0.74 0.26
Cumulative Proportion 0.74 1.00

Test of the hypothesis that 2 factors are sufficient.

The degrees of freedom for the null model are  15  and the objective function was  2.84
The degrees of freedom for the model are 4  and the objective function was  0.39

The root mean square of the residuals (RMSR) is  0.08
The df corrected root mean square of the residuals is  0.21

Fit based upon off diagonal values = 0.97
Measures of factor score adequacy
                                                 PA1
Correlation of scores with factors                 1
Multiple R square of scores with factors           1
Minimum correlation of possible factor scores      1
                                                 PA2
Correlation of scores with factors                 1
Multiple R square of scores with factors           1
Minimum correlation of possible factor scores      1
```

```
> faout$residual  #asks for the residual correlations with uniqueness on the diagonal

           m           p           c
m  0.2341798 -0.11374940 -1.5352e-01
p -0.1137494  0.28435560 -1.6707e-01
c -0.1535197 -0.16707420  3.5938e-01
e  0.0130286 -0.00632967 -1.0020e-02
h  0.0180897  0.00093934  9.8314e-05
f  0.0048839 -0.01087784 -1.6516e-02
           e           h          f
m  0.0130286  1.8090e-02  0.0048839
p -0.0063297  9.3934e-04 -0.0108778
c -0.0100198  9.8314e-05 -0.0165159
e  0.2033017 -1.1669e-01 -0.0815195
h -0.1166858  1.8838e-01 -0.0791067
f -0.0815195 -7.9107e-02  0.1691378

> faoutrot <- fa(cm,nfactors=2, fm="pa", SMC=FALSE, max.iter=1,residuals = TRUE, rotate = "varimax")
> faoutrot
```

```
Factor Analysis using method =  pa
Call: fa(r = cm, nfactors = 2, rotate = "varimax", residuals = TRUE,
    SMC = FALSE, max.iter = 1, fm = "pa")
Standardized loadings (pattern matrix) based upon correlation matrix
   PA1  PA2   h2   u2
m 0.15 0.86 0.77 0.23
p 0.25 0.81 0.72 0.28
c 0.24 0.76 0.64 0.36
e 0.87 0.21 0.80 0.20
h 0.89 0.16 0.81 0.19
f 0.87 0.28 0.83 0.17

                       PA1  PA2
SS loadings           2.44 2.12
Proportion Var        0.41 0.35
Cumulative Var        0.41 0.76
Proportion Explained  0.53 0.47
Cumulative Proportion 0.53 1.00

Test of the hypothesis that 2 factors are sufficient.

The degrees of freedom for the null model are  15  and the objective function was  2.84
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The root mean square of the residuals (RMSR) is  0.08
The df corrected root mean square of the residuals is  0.21

Fit based upon off diagonal values = 0.97
Measures of factor score adequacy
                                                PA1
Correlation of scores with factors                1
Multiple R square of scores with factors          1
Minimum correlation of possible factor scores     1
                                                PA2
Correlation of scores with factors                1
Multiple R square of scores with factors          1
Minimum correlation of possible factor scores     1
```

```
> princfa <-fa(cm,nfactors=2, fm="pa", SMC=TRUE, max.iter=100,residuals = TRUE, rotate = "none") #pr
> princfa
```

```
Factor Analysis using method =  pa
Call: fa(r = cm, nfactors = 2, rotate = "none", residuals = TRUE, SMC = TRUE,
    max.iter = 100, fm = "pa")
Standardized loadings (pattern matrix) based upon correlation matrix
   PA1   PA2   h2   u2
m 0.63  0.52 0.67 0.33
p 0.66  0.39 0.58 0.42
c 0.60  0.31 0.45 0.55
e 0.76 -0.31 0.68 0.32
h 0.75 -0.37 0.70 0.30
f 0.83 -0.30 0.79 0.21

                       PA1  PA2
```

```
SS loadings           3.03 0.84
Proportion Var        0.50 0.14
Cumulative Var        0.50 0.64
Proportion Explained  0.78 0.22
Cumulative Proportion 0.78 1.00

Test of the hypothesis that 2 factors are sufficient.

The degrees of freedom for the null model are  15  and the objective function was  2.84
The degrees of freedom for the model are 4  and the objective function was  0

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

Fit based upon off diagonal values = 1
Measures of factor score adequacy
                                                 PA1
Correlation of scores with factors              0.95
Multiple R square of scores with factors        0.91
Minimum correlation of possible factor scores   0.81
                                                 PA2
Correlation of scores with factors              0.84
Multiple R square of scores with factors        0.71
Minimum correlation of possible factor scores   0.42
```

```
> mlfa <-fa(cm,nfactors=2, residuals = TRUE,fm="ml") #maximum likelihood solution
> mlfa
```

```
Factor Analysis using method =  ml
Call: fa(r = cm, nfactors = 2, residuals = TRUE, fm = "ml")
Standardized loadings (pattern matrix) based upon correlation matrix
    ML1   ML2   h2   u2
m -0.07  0.86 0.68 0.32
p  0.08  0.72 0.58 0.42
c  0.11  0.60 0.45 0.55
e  0.82  0.01 0.68 0.32
h  0.86 -0.05 0.70 0.30
f  0.86  0.05 0.79 0.21

                       ML1  ML2
SS loadings           2.21 1.66
Proportion Var        0.37 0.28
Cumulative Var        0.37 0.65
Proportion Explained  0.57 0.43
Cumulative Proportion 0.57 1.00

 With factor correlations of
     ML1  ML2
ML1 1.00 0.52
ML2 0.52 1.00

Test of the hypothesis that 2 factors are sufficient.

The degrees of freedom for the null model are  15  and the objective function was  2.84
```

```
The degrees of freedom for the model are 4  and the objective function was  0

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

Fit based upon off diagonal values = 1
Measures of factor score adequacy
                                                ML1
Correlation of scores with factors             0.94
Multiple R square of scores with factors       0.89
Minimum correlation of possible factor scores  0.79
                                                ML2
Correlation of scores with factors             0.91
Multiple R square of scores with factors       0.82
Minimum correlation of possible factor scores  0.64
```