Homework 2

Group 2
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Percentage of Effort Contributed by Student 1: 50%

Percentage of Effort Contributed by Student 2: 50%

Signature of Student 1: 

Signature of Student 2: 

Submission Date: 10/15/2019

Problem 1

```
library(psych)
data <-USJudgeRatings
fa.parallel(data)

## Warning in fa.stats(r = r, f = f, phi = phi, n.obs = n.obs, np.obs
## = np.obs, : The estimated weights for the factor scores are probably
## incorrect. Try a different factor extraction method.

## Warning in fac(r = r, nfactors = nfactors, n.obs = n.obs, rotate =
## rotate, : A loading greater than abs(1) was detected. Examine the loadings
## carefully.

## Warning in fa.stats(r = r, f = f, phi = phi, n.obs = n.obs, np.obs
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## incorrect. Try a different factor extraction method.

## Warning in fac(r = r, nfactors = nfactors, n.obs = n.obs, rotate =
## rotate, : An ultra-Heywood case was detected. Examine the results
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## incorrect. Try a different factor extraction method.

## Warning in fac(r = r, nfactors = nfactors, n.obs = n.obs, rotate =
## rotate, : An ultra-Heywood case was detected. Examine the results
carefully
```
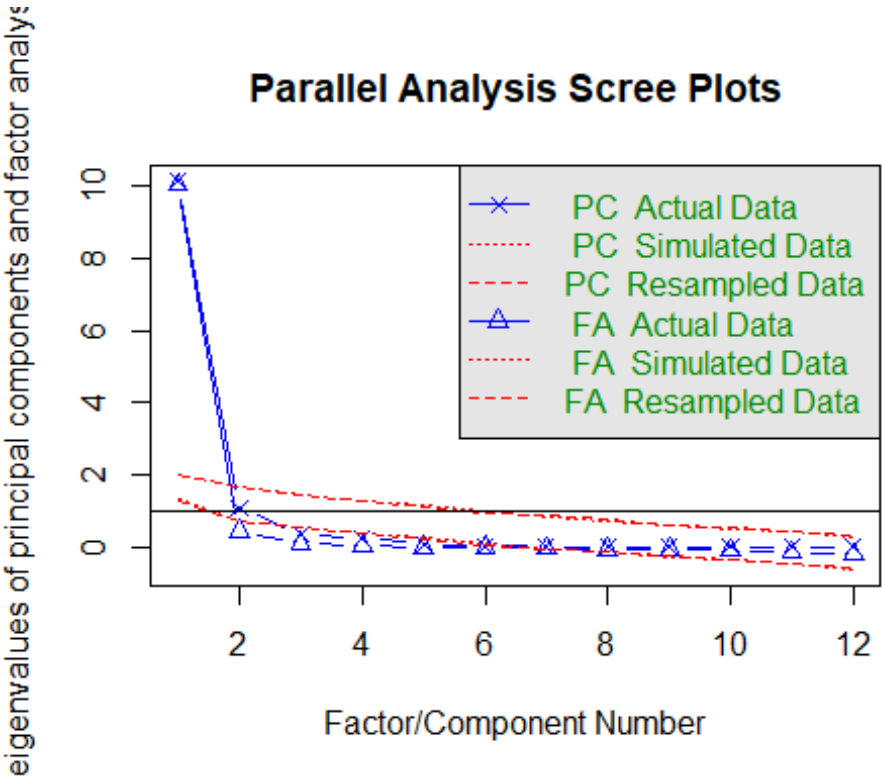




```
## Parallel analysis suggests that the number of factors =  1  and the number
of components =  1

pc<-principal(data[,-1],nfactors=1)
pc

## Principal Components Analysis
## Call: principal(r = data[, -1], nfactors = 1)
## Standardized loadings (pattern matrix) based upon correlation matrix
##       PC1   h2     u2 com
## INTG 0.92 0.84 0.1565   1
## DMNR 0.91 0.83 0.1663   1
## DILG 0.97 0.94 0.0613   1
## CFMG 0.96 0.93 0.0720   1
## DECI 0.96 0.92 0.0763   1
## PREP 0.98 0.97 0.0299   1
## FAMI 0.98 0.95 0.0469   1
## ORAL 1.00 0.99 0.0091   1
## WRIT 0.99 0.98 0.0196   1
## PHYS 0.89 0.80 0.2013   1
## RTEN 0.99 0.97 0.0275   1
##
##                  PC1
## SS loadings    10.13
## Proportion Var  0.92
##
## Mean item complexity =  1
```

```
## Test of the hypothesis that 1 component is sufficient.
##
## The root mean square of the residuals (RMSR) is  0.04
##  with the empirical chi square  6.21  with prob <  1
##
## Fit based upon off diagonal values = 1
```

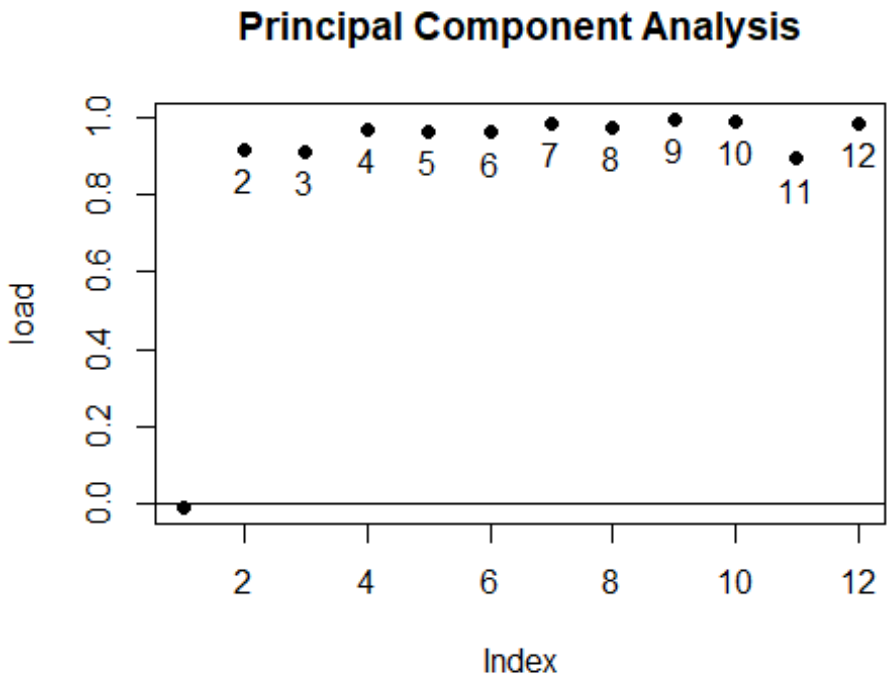
```
rc<- principal(data,nfactors=1,rotate = "varimax", scores = TRUE)
rc
```

```
## Principal Components Analysis
## Call: principal(r = data, nfactors = 1, rotate = "varimax", scores = TRUE)
## Standardized loadings (pattern matrix) based upon correlation matrix
##        PC1      h2     u2 com
## CONT -0.01 9.6e-05 0.9999   1
## INTG  0.92 8.4e-01 0.1563   1
## DMNR  0.91 8.3e-01 0.1660   1
## DILG  0.97 9.4e-01 0.0613   1
## CFMG  0.96 9.3e-01 0.0723   1
## DECI  0.96 9.2e-01 0.0764   1
## PREP  0.98 9.7e-01 0.0299   1
## FAMI  0.98 9.5e-01 0.0469   1
## ORAL  1.00 9.9e-01 0.0091   1
## WRIT  0.99 9.8e-01 0.0195   1
## PHYS  0.89 8.0e-01 0.2014   1
## RTEN  0.99 9.7e-01 0.0275   1
##
##                  PC1
## SS loadings    10.13
## Proportion Var  0.84
##
## Mean item complexity =  1
## Test of the hypothesis that 1 component is sufficient.
##
## The root mean square of the residuals (RMSR) is  0.05
##  with the empirical chi square  12.56  with prob <  1
##
## Fit based upon off diagonal values = 1
```

```
scores <- rc$scores
scores
```

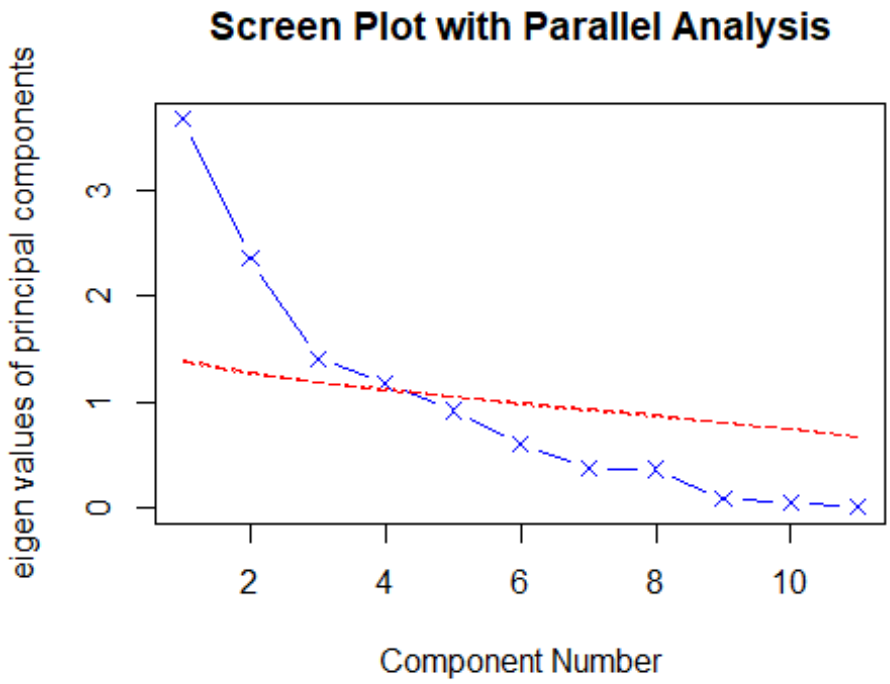
```
##                         PC1
## AARONSON,L.H.   -0.18400648
## ALEXANDER,J.M.   0.74765156
## ARMENTANO,A.J.   0.07072468
## BERDON,R.I.      1.13651889
## BRACKEN,J.J.    -2.15848207
## BURNS,E.B.       0.76821742
## CALLAHAN,R.J.    1.22243063
## COHEN,S.S.      -2.51260343
```

```
## DALY,J.J.         1.14963289
## DANNEHY,J.F.      0.32918115
## DEAN,H.H.        -0.10589377
## DEVITA,H.J.      -0.45257054
## DRISCOLL,P.J.    -0.21014722
## GRILLO,A.E.      -1.01338259
## HADDEN,W.L.JR.    0.42501399
## HAMILL,E.C.      -0.13973759
## HEALEY.A.H.      -0.91030943
## HULL,T.C.        -0.22553233
## LEVINE,I.         0.20145341
## LEVISTER,R.L.    -1.36839157
## MARTIN,L.F.      -0.57128247
## MCGRATH,J.F.     -0.97984173
## MIGNONE,A.F.     -1.99621925
## MISSAL,H.M.      -0.02581675
## MULVEY,H.M.       1.05284946
## NARUK,H.J.        1.42897516
## O'BRIEN,F.J.      0.47123628
## O'SULLIVAN,T.J.   1.09004545
## PASKEY,L.         0.59472217
## RUBINOW,J.E.      1.50120742
## SADEN.G.A.        0.34527687
## SATANIELLO,A.G.   0.17036943
## SHEA,D.M.         0.81143377
## SHEA,J.F.JR.      1.12983152
## SIDOR,W.J.       -2.15582532
## SPEZIALE,J.A.     0.63632965
## SPONZO,M.J.       0.37901740
## STAPLETON,J.F.    0.22614913
## TESTO,R.J.       -0.66166162
## TIERNEY,W.L.JR.   0.42466794
## WALL,R.A.        -0.81315467
## WRIGHT,D.B.       0.45956919
## ZARRILLI,K.J.    -0.28764663

factor.plot(rc)
```



Problem2

```
library(psych)
library(readxl)
data2<- read_excel("Glass Identification Data.xlsx")
fa.parallel(data2, n.iter = 100,fa="pc",show.legend = FALSE, main = "Screen
Plot with Parallel Analysis")

## Warning in fac(r = r, nfactors = nfactors, n.obs = n.obs, rotate =
## rotate, : A loading greater than abs(1) was detected. Examine the loadings
## carefully.

## Warning in fa.stats(r = r, f = f, phi = phi, n.obs = n.obs, np.obs
## = np.obs, : The estimated weights for the factor scores are probably
## incorrect. Try a different factor extraction method.

## Warning in fac(r = r, nfactors = nfactors, n.obs = n.obs, rotate =
## rotate, : An ultra-Heywood case was detected. Examine the results
carefully
```




```
## Parallel analysis suggests that the number of factors =  NA  and the
number of components =  3
```

```
library(GPArotation)
pc2 <- principal(data2, nfactors = 4, rotate = "none")
pc2
```

```
## Principal Components Analysis
## Call: principal(r = data2, nfactors = 4, rotate = "none")
## Standardized loadings (pattern matrix) based upon correlation matrix
##         PC1   PC2   PC3   PC4   h2    u2 com
## ID     0.84  0.20  0.02  0.10 0.76 0.244 1.1
## RI    -0.28  0.91  0.11 -0.16 0.95 0.051 1.3
## Na     0.55 -0.06 -0.42 -0.58 0.81 0.185 2.9
## Mg    -0.77 -0.43 -0.02 -0.31 0.87 0.126 1.9
## Al     0.73 -0.25  0.42  0.08 0.77 0.226 1.9
## Si     0.15 -0.39 -0.56  0.69 0.96 0.040 2.7
## K      0.05 -0.41  0.78  0.07 0.78 0.218 1.5
## CA    -0.11  0.92  0.00  0.28 0.94 0.060 1.2
## Ba     0.69  0.13  0.13 -0.25 0.57 0.429 1.4
## Fe    -0.22  0.18  0.32  0.29 0.27 0.731 3.4
## Class  0.95  0.11 -0.06  0.05 0.92 0.083 1.0
##
##                        PC1  PC2  PC3  PC4
## SS loadings           3.67 2.35 1.41 1.18
## Proportion Var        0.33 0.21 0.13 0.11
## Cumulative Var        0.33 0.55 0.68 0.78
```

```
## Proportion Explained  0.43 0.27 0.16 0.14
## Cumulative Proportion 0.43 0.70 0.86 1.00
##
## Mean item complexity =  1.9
## Test of the hypothesis that 4 components are sufficient.
##
## The root mean square of the residuals (RMSR) is  0.07
##  with the empirical chi square  116.03  with prob <  8.8e-17
##
## Fit based upon off diagonal values = 0.96
```

```
rc2 <- principal(data2,nfactors = 4,rotate = "Varimax", scores = TRUE)
rc2
```

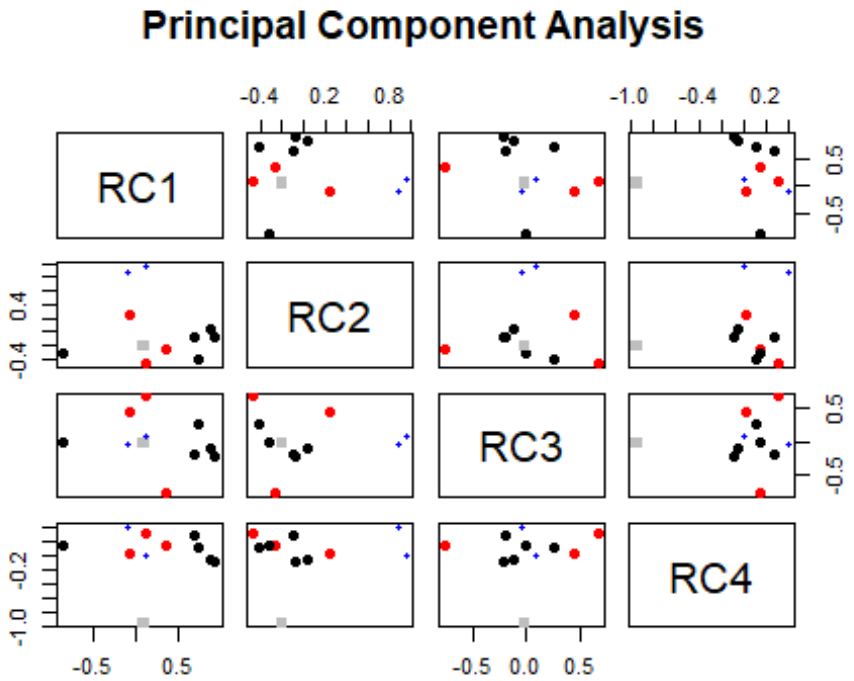
```
## Principal Components Analysis
## Call: principal(r = data2, nfactors = 4, rotate = "Varimax", scores =
TRUE)
## Standardized loadings (pattern matrix) based upon correlation matrix
##         RC1   RC2   RC3   RC4   h2    u2 com
## ID     0.86  0.03 -0.11 -0.04 0.76 0.244 1.0
## RI    -0.09  0.88 -0.05  0.41 0.95 0.051 1.4
## Na     0.36 -0.25 -0.77  0.16 0.81 0.185 1.8
## Mg    -0.87 -0.31 -0.01  0.15 0.87 0.126 1.3
## Al     0.73 -0.41  0.25  0.11 0.77 0.226 1.9
## Si     0.08 -0.20 -0.02 -0.96 0.96 0.040 1.1
## K      0.10 -0.46  0.68  0.32 0.78 0.218 2.3
## CA     0.11  0.96  0.10  0.00 0.94 0.060 1.1
## Ba     0.67 -0.09 -0.19  0.28 0.57 0.429 1.6
## Fe    -0.09  0.24  0.45  0.02 0.27 0.731 1.6
## Class  0.93 -0.08 -0.21 -0.08 0.92 0.083 1.1
##
##                        RC1  RC2  RC3  RC4
## SS loadings           3.51 2.35 1.43 1.32
## Proportion Var        0.32 0.21 0.13 0.12
## Cumulative Var        0.32 0.53 0.66 0.78
## Proportion Explained  0.41 0.27 0.17 0.15
## Cumulative Proportion 0.41 0.68 0.85 1.00
##
## Mean item complexity =  1.5
## Test of the hypothesis that 4 components are sufficient.
##
## The root mean square of the residuals (RMSR) is  0.07
##  with the empirical chi square  116.03  with prob <  8.8e-17
##
## Fit based upon off diagonal values = 0.96
```

```
scores <- rc2$scores
head(scores)
```

```
##             RC1         RC2        RC3        RC4
## [1,] -1.3228335  0.08736148 -1.0073056  1.1191533
```

```
## [2,] -0.9883907 -0.72368416 -0.6346247  0.1829914
## [3,] -0.9029532 -0.86545057 -0.3336277 -0.2575703
## [4,] -1.0162332 -0.50833752 -0.1292531  0.1499931
## [5,] -1.0134033 -0.56023328 -0.1825840 -0.3116792
## [6,] -0.7623038 -0.49304496  1.2814805 -0.4077912
```

```
factor.plot(rc2)
```



#Problem 3

```
data3 <- Harman23.cor
library(GPArotation)
library(psych)
options(digits = 2)
covariances <- Harman23.cor$cov
correlations <- cov2cor(covariances)
correlations
```

```
##                height arm.span forearm lower.leg weight bitro.diameter
## height           1.00     0.85    0.80      0.86   0.47           0.40
## arm.span         0.85     1.00    0.88      0.83   0.38           0.33
## forearm          0.80     0.88    1.00      0.80   0.38           0.32
## lower.leg        0.86     0.83    0.80      1.00   0.44           0.33
## weight           0.47     0.38    0.38      0.44   1.00           0.76
## bitro.diameter   0.40     0.33    0.32      0.33   0.76           1.00
## chest.girth      0.30     0.28    0.24      0.33   0.73           0.58
## chest.width      0.38     0.41    0.34      0.36   0.63           0.58
##                chest.girth chest.width
## height                0.30        0.38
```

```
## arm.span               0.28        0.41
## forearm                0.24        0.34
## lower.leg              0.33        0.36
## weight                 0.73        0.63
## bitro.diameter         0.58        0.58
## chest.girth            1.00        0.54
## chest.width            0.54        1.00
```

```
fa.parallel(correlations, n.obs = 112,fa="both", n.iter = 100, main = "Scree
plot with parallel analysis")
```

```
## Warning in fa.stats(r = r, f = f, phi = phi, n.obs = n.obs, np.obs
## = np.obs, : The estimated weights for the factor scores are probably
## incorrect. Try a different factor extraction method.

## Warning in fac(r = r, nfactors = nfactors, n.obs = n.obs, rotate =
## rotate, : A loading greater than abs(1) was detected. Examine the loadings
## carefully.

## Warning in fa.stats(r = r, f = f, phi = phi, n.obs = n.obs, np.obs
## = np.obs, : The estimated weights for the factor scores are probably
## incorrect. Try a different factor extraction method.

## Warning in fac(r = r, nfactors = nfactors, n.obs = n.obs, rotate =
## rotate, : An ultra-Heywood case was detected. Examine the results
carefully

## Warning in fac(r = r, nfactors = nfactors, n.obs = n.obs, rotate =
## rotate, : A loading greater than abs(1) was detected. Examine the loadings
## carefully.

## Warning in fa.stats(r = r, f = f, phi = phi, n.obs = n.obs, np.obs
## = np.obs, : The estimated weights for the factor scores are probably
## incorrect. Try a different factor extraction method.

## Warning in fac(r = r, nfactors = nfactors, n.obs = n.obs, rotate =
## rotate, : An ultra-Heywood case was detected. Examine the results
carefully

## Warning in fac(r = r, nfactors = nfactors, n.obs = n.obs, rotate =
## rotate, : A loading greater than abs(1) was detected. Examine the loadings
## carefully.

## Warning in fa.stats(r = r, f = f, phi = phi, n.obs = n.obs, np.obs
## = np.obs, : The estimated weights for the factor scores are probably
## incorrect. Try a different factor extraction method.

## Warning in fac(r = r, nfactors = nfactors, n.obs = n.obs, rotate =
## rotate, : An ultra-Heywood case was detected. Examine the results
carefully
```

```
## Warning in fac(r = r, nfactors = nfactors, n.obs = n.obs, rotate =
## rotate, : A loading greater than abs(1) was detected. Examine the loadings
## carefully.

## Warning in fa.stats(r = r, f = f, phi = phi, n.obs = n.obs, np.obs
## = np.obs, : The estimated weights for the factor scores are probably
## incorrect. Try a different factor extraction method.

## Warning in fac(r = r, nfactors = nfactors, n.obs = n.obs, rotate =
## rotate, : An ultra-Heywood case was detected. Examine the results
carefully

## Warning in fac(r = r, nfactors = nfactors, n.obs = n.obs, rotate =
## rotate, : A loading greater than abs(1) was detected. Examine the loadings
## carefully.

## Warning in fa.stats(r = r, f = f, phi = phi, n.obs = n.obs, np.obs
## = np.obs, : The estimated weights for the factor scores are probably
## incorrect. Try a different factor extraction method.

## Warning in fac(r = r, nfactors = nfactors, n.obs = n.obs, rotate =
## rotate, : An ultra-Heywood case was detected. Examine the results
carefully

## Warning in fa.stats(r = r, f = f, phi = phi, n.obs = n.obs, np.obs
## = np.obs, : The estimated weights for the factor scores are probably
## incorrect. Try a different factor extraction method.

## Warning in fa.stats(r = r, f = f, phi = phi, n.obs = n.obs, np.obs
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## incorrect. Try a different factor extraction method.

## Warning in fac(r = r, nfactors = nfactors, n.obs = n.obs, rotate =
## rotate, : A loading greater than abs(1) was detected. Examine the loadings
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## incorrect. Try a different factor extraction method.

## Warning in fac(r = r, nfactors = nfactors, n.obs = n.obs, rotate =
## rotate, : An ultra-Heywood case was detected. Examine the results
carefully

## Warning in fa.stats(r = r, f = f, phi = phi, n.obs = n.obs, np.obs
## = np.obs, : The estimated weights for the factor scores are probably
## incorrect. Try a different factor extraction method.

## Warning in fac(r = r, nfactors = nfactors, n.obs = n.obs, rotate =
## rotate, : A loading greater than abs(1) was detected. Examine the loadings
## carefully.
```

```
## Warning in fa.stats(r = r, f = f, phi = phi, n.obs = n.obs, np.obs
## = np.obs, : The estimated weights for the factor scores are probably
## incorrect. Try a different factor extraction method.

## Warning in fac(r = r, nfactors = nfactors, n.obs = n.obs, rotate =
## rotate, : An ultra-Heywood case was detected. Examine the results
carefully

## Warning in fac(r = r, nfactors = nfactors, n.obs = n.obs, rotate =
## rotate, : A loading greater than abs(1) was detected. Examine the loadings
## carefully.

## Warning in fa.stats(r = r, f = f, phi = phi, n.obs = n.obs, np.obs
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## incorrect. Try a different factor extraction method.

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## rotate, : An ultra-Heywood case was detected. Examine the results
carefully

## Warning in fa.stats(r = r, f = f, phi = phi, n.obs = n.obs, np.obs
## = np.obs, : The estimated weights for the factor scores are probably
## incorrect. Try a different factor extraction method.

## Warning in fac(r = r, nfactors = nfactors, n.obs = n.obs, rotate =
## rotate, : A loading greater than abs(1) was detected. Examine the loadings
## carefully.

## Warning in fa.stats(r = r, f = f, phi = phi, n.obs = n.obs, np.obs
## = np.obs, : The estimated weights for the factor scores are probably
## incorrect. Try a different factor extraction method.

## Warning in fac(r = r, nfactors = nfactors, n.obs = n.obs, rotate =
## rotate, : An ultra-Heywood case was detected. Examine the results
carefully

## Warning in fac(r = r, nfactors = nfactors, n.obs = n.obs, rotate =
## rotate, : A loading greater than abs(1) was detected. Examine the loadings
## carefully.

## Warning in fa.stats(r = r, f = f, phi = phi, n.obs = n.obs, np.obs
## = np.obs, : The estimated weights for the factor scores are probably
## incorrect. Try a different factor extraction method.

## Warning in fac(r = r, nfactors = nfactors, n.obs = n.obs, rotate =
## rotate, : An ultra-Heywood case was detected. Examine the results
carefully

## Warning in fac(r = r, nfactors = nfactors, n.obs = n.obs, rotate =
## rotate, : A loading greater than abs(1) was detected. Examine the loadings
## carefully.
```
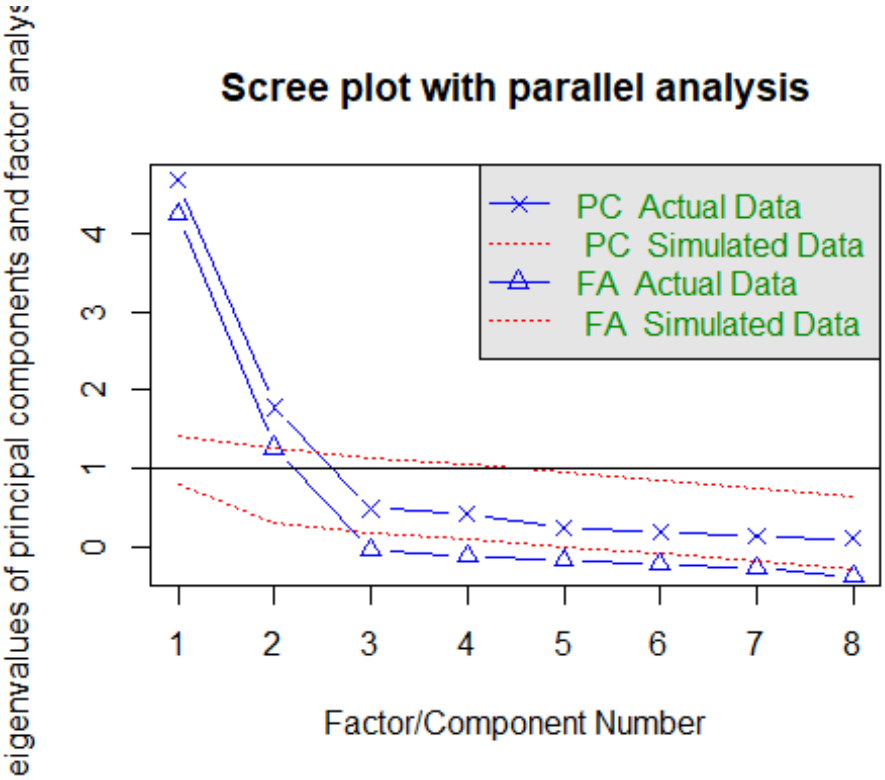

```
## Warning in fa.stats(r = r, f = f, phi = phi, n.obs = n.obs, np.obs
## = np.obs, : The estimated weights for the factor scores are probably
## incorrect. Try a different factor extraction method.

## Warning in fac(r = r, nfactors = nfactors, n.obs = n.obs, rotate =
## rotate, : An ultra-Heywood case was detected. Examine the results
carefully
```




```
## Parallel analysis suggests that the number of factors =  2  and the number
of components =  2
```

```
fa <- fa(correlations, nfactors = 2, rotate = "none", fm="pa")
fa
```

```
## Factor Analysis using method =  pa
## Call: fa(r = correlations, nfactors = 2, rotate = "none", fm = "pa")
## Standardized loadings (pattern matrix) based upon correlation matrix
##                  PA1   PA2   h2   u2 com
## height          0.86 -0.32 0.84 0.16 1.3
## arm.span        0.85 -0.41 0.89 0.11 1.4
## forearm         0.81 -0.41 0.82 0.18 1.5
## lower.leg       0.83 -0.34 0.81 0.19 1.3
## weight          0.75  0.57 0.89 0.11 1.9
## bitro.diameter 0.63  0.49 0.64 0.36 1.9
## chest.girth     0.57  0.51 0.58 0.42 2.0
## chest.width     0.61  0.35 0.49 0.51 1.6
##
```

```
##                        PA1  PA2
## SS loadings           4.45 1.51
## Proportion Var        0.56 0.19
## Cumulative Var        0.56 0.74
## Proportion Explained  0.75 0.25
## Cumulative Proportion 0.75 1.00
##
## Mean item complexity =  1.6
## Test of the hypothesis that 2 factors are sufficient.
##
## The degrees of freedom for the null model are  28  and the objective
function was  6.9
## The degrees of freedom for the model are 13  and the objective function
was  0.26
##
## The root mean square of the residuals (RMSR) is  0.02
## The df corrected root mean square of the residuals is  0.03
##
## Fit based upon off diagonal values = 1
## Measures of factor score adequacy
##                                                  PA1  PA2
## Correlation of (regression) scores with factors   0.98 0.94
## Multiple R square of scores with factors          0.96 0.89
## Minimum correlation of possible factor scores     0.93 0.77

fa.varimax <- fa(correlations,nfactors=2, rotate="varimax", fm="pa")
fa.varimax

## Factor Analysis using method =  pa
## Call: fa(r = correlations, nfactors = 2, rotate = "varimax", fm = "pa")
## Standardized loadings (pattern matrix) based upon correlation matrix
##                 PA1  PA2   h2   u2 com
## height         0.87 0.29 0.84 0.16 1.2
## arm.span       0.92 0.21 0.89 0.11 1.1
## forearm        0.89 0.19 0.82 0.18 1.1
## lower.leg      0.86 0.26 0.81 0.19 1.2
## weight         0.23 0.91 0.89 0.11 1.1
## bitro.diameter 0.18 0.78 0.64 0.36 1.1
## chest.girth    0.12 0.75 0.58 0.42 1.1
## chest.width    0.25 0.65 0.49 0.51 1.3
##
##                        PA1  PA2
## SS loadings           3.29 2.67
## Proportion Var        0.41 0.33
## Cumulative Var        0.41 0.74
## Proportion Explained  0.55 0.45
## Cumulative Proportion 0.55 1.00
##
## Mean item complexity =  1.1
## Test of the hypothesis that 2 factors are sufficient.
```

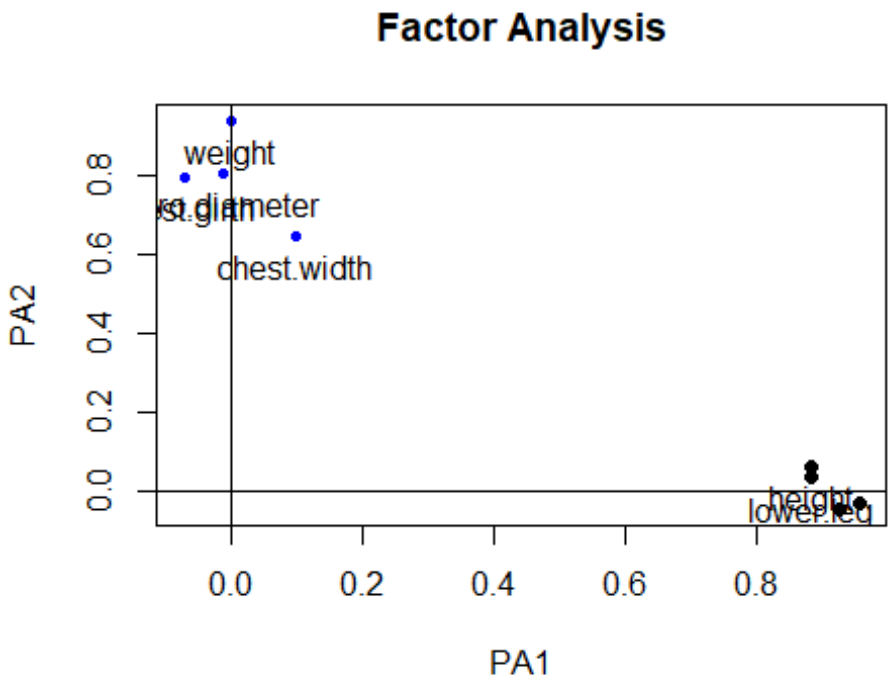
```
##
## The degrees of freedom for the null model are  28  and the objective
function was  6.9
## The degrees of freedom for the model are 13  and the objective function
was  0.26
##
## The root mean square of the residuals (RMSR) is  0.02
## The df corrected root mean square of the residuals is  0.03
##
## Fit based upon off diagonal values = 1
## Measures of factor score adequacy
##                                                  PA1  PA2
## Correlation of (regression) scores with factors   0.97 0.95
## Multiple R square of scores with factors          0.94 0.91
## Minimum correlation of possible factor scores     0.88 0.81
```

```
fa.promax <- fa(correlations,nfactors=2, rotate="promax", fm="pa")
fa.promax
```

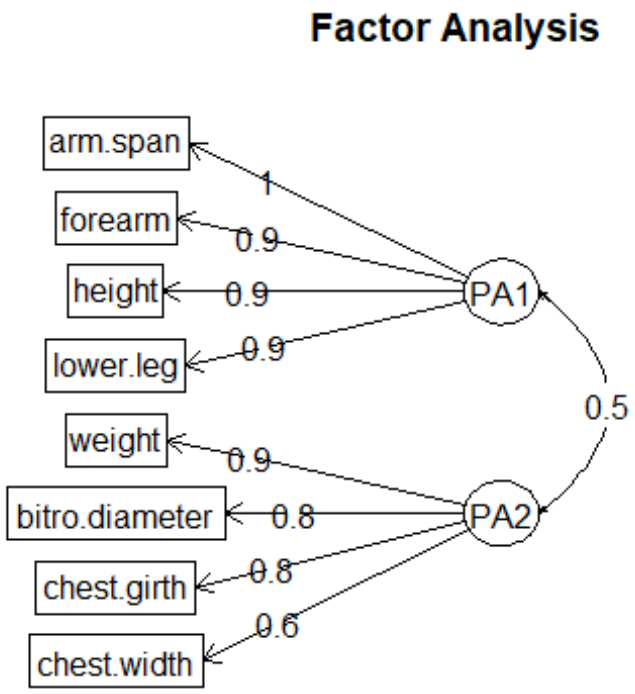
```
## Factor Analysis using method =  pa
## Call: fa(r = correlations, nfactors = 2, rotate = "promax", fm = "pa")
## Standardized loadings (pattern matrix) based upon correlation matrix
##                  PA1   PA2   h2   u2 com
## height          0.88  0.06 0.84 0.16   1
## arm.span        0.96 -0.03 0.89 0.11   1
## forearm         0.93 -0.05 0.82 0.18   1
## lower.leg       0.88  0.03 0.81 0.19   1
## weight          0.00  0.94 0.89 0.11   1
## bitro.diameter -0.01  0.81 0.64 0.36   1
## chest.girth    -0.07  0.80 0.58 0.42   1
## chest.width     0.10  0.65 0.49 0.51   1
##
##                        PA1  PA2
## SS loadings           3.36 2.60
## Proportion Var        0.42 0.32
## Cumulative Var        0.42 0.74
## Proportion Explained  0.56 0.44
## Cumulative Proportion 0.56 1.00
##
##  With factor correlations of
##      PA1  PA2
## PA1 1.00 0.48
## PA2 0.48 1.00
##
## Mean item complexity =  1
## Test of the hypothesis that 2 factors are sufficient.
##
## The degrees of freedom for the null model are  28  and the objective
function was  6.9
## The degrees of freedom for the model are 13  and the objective function
```

```
was  0.26
##
## The root mean square of the residuals (RMSR) is  0.02
## The df corrected root mean square of the residuals is  0.03
##
## Fit based upon off diagonal values = 1
## Measures of factor score adequacy
##                                                   PA1  PA2
## Correlation of (regression) scores with factors   0.98 0.96
## Multiple R square of scores with factors          0.96 0.93
## Minimum correlation of possible factor scores     0.91 0.85
```

```
factor.plot(fa.promax, labels = rownames(fa.promax$loadings))
```

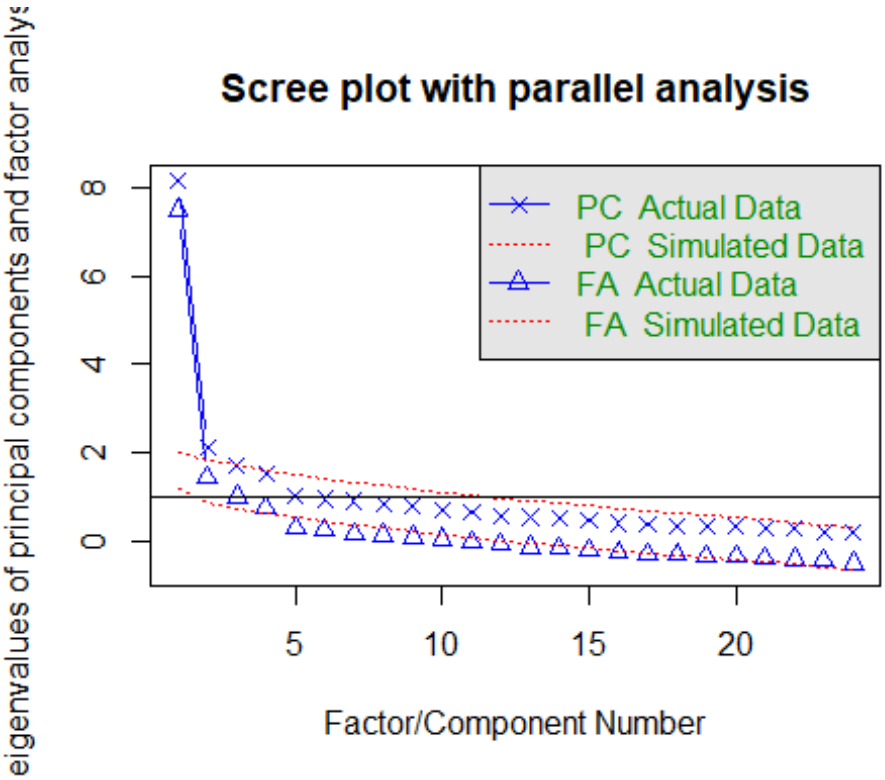



```
fa.diagram(fa.promax,simple = FALSE)
```



#Problem 4

```
data4 <- Harman74.cor
fa.parallel(data4$cov,fa="both", n.iter = 100, main = "Scree plot with
parallel analysis")

## Warning in fa.parallel(data4$cov, fa = "both", n.iter = 100, main = "Scree
## plot with parallel analysis"): It seems as if you are using a correlation
## matrix, but have not specified the number of cases. The number of subjects
## is arbitrarily set to be 100
```

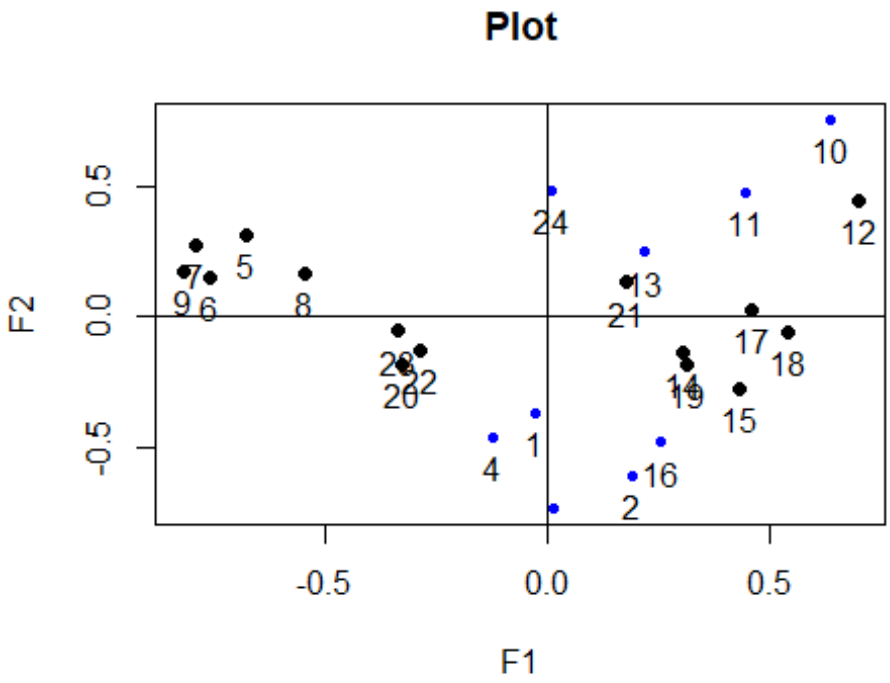



```
## Parallel analysis suggests that the number of factors =  4  and the number
of components =  2
```

```
Scaled <-dist(data4$cov, method = "euclidean", diag = FALSE, upper = FALSE, p
= 2)
Scaling <- cmdscale(Scaled,k=2)
Scaling
```

```
##                            [,1]   [,2]
## VisualPerception       -0.029 -0.367
## Cubes                   0.190 -0.608
## PaperFormBoard          0.016 -0.729
## Flags                  -0.121 -0.457
## GeneralInformation     -0.680  0.316
## PargraphComprehension  -0.763  0.153
## SentenceCompletion     -0.795  0.275
## WordClassification     -0.547  0.169
## WordMeaning            -0.823  0.175
## Addition                0.641  0.753
## Code                    0.449  0.474
## CountingDots            0.702  0.443
## StraightCurvedCapitals  0.219  0.248
## WordRecognition         0.305 -0.138
## NumberRecognition       0.436 -0.275
## FigureRecognition       0.253 -0.478
## ObjectNumber            0.460  0.029
## NumberFigure            0.543 -0.055
```

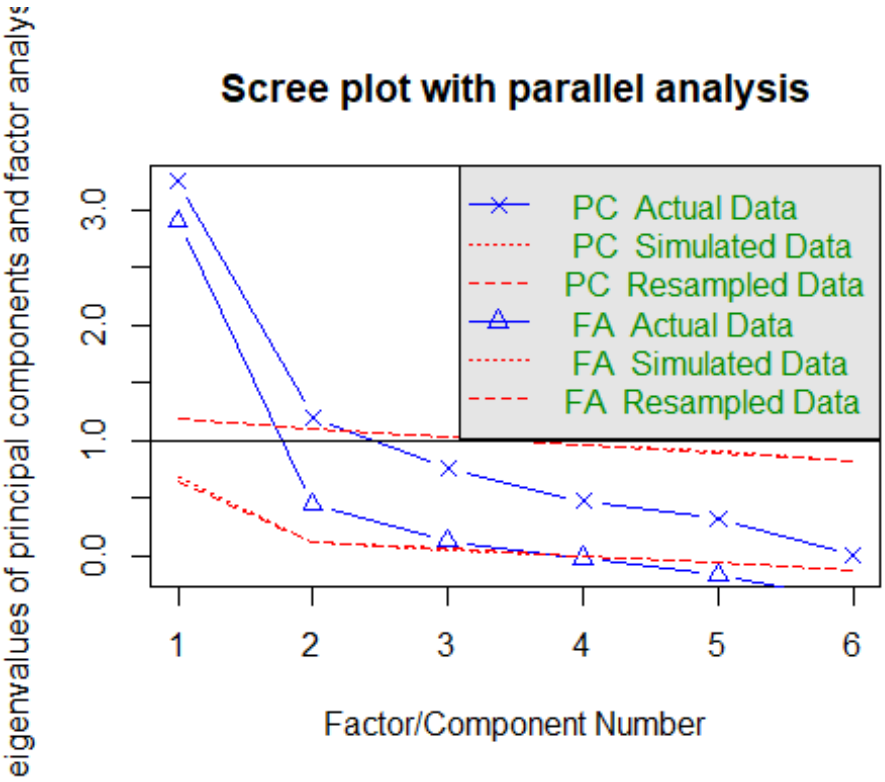
```
## FigureWord               0.313 -0.179
## Deduction               -0.330 -0.183
## NumericalPuzzles         0.177  0.132
## ProblemReasoning        -0.288 -0.128
## SeriesCompletion        -0.336 -0.054
## ArithmeticProblems       0.007  0.481

factor.plot(Scaling)
```



#Problem 5

```
library(readxl)
data5<- read_excel("Vertebral Column Data.xlsx")
str(data5)

## Classes 'tbl_df', 'tbl' and 'data.frame':    310 obs. of  7 variables:
##  $ X1   : num  63 39.1 68.8 69.3 49.7 ...
##  $ X2   : num  22.55 10.06 22.22 24.65 9.65 ...
##  $ X3   : num  39.6 25 50.1 44.3 28.3 ...
##  $ X4   : num  40.5 29 46.6 44.6 40.1 ...
##  $ X5   : num  98.7 114.4 106 101.9 108.2 ...
##  $ X6   : num  -0.25 4.56 -3.53 11.21 7.92 ...
##  $ Class: chr  "DH" "DH" "DH" "DH" ...

fa.parallel(data5[,-7],fa="both", n.iter = 100, main = "Scree plot with
parallel analysis")
```

```
## Warning in fac(r = r, nfactors = nfactors, n.obs = n.obs, rotate =
## rotate, : A loading greater than abs(1) was detected. Examine the loadings
## carefully.

## Warning in fa.stats(r = r, f = f, phi = phi, n.obs = n.obs, np.obs
## = np.obs, : The estimated weights for the factor scores are probably
## incorrect. Try a different factor extraction method.

## Warning in fac(r = r, nfactors = nfactors, n.obs = n.obs, rotate =
## rotate, : An ultra-Heywood case was detected. Examine the results
carefully

## Warning in fa.stats(r = r, f = f, phi = phi, n.obs = n.obs, np.obs
## = np.obs, : The estimated weights for the factor scores are probably
## incorrect. Try a different factor extraction method.
```




```
## Parallel analysis suggests that the number of factors =  3  and the number
of components =  2
```

```
Scaled2 <-dist(data5[,-7], method = "euclidean", diag = FALSE, upper = FALSE,
p = 2)
MultScale <- cmdscale(Scaled2,k=2)
MultScale
```

```
##          [,1]    [,2]
##   [1,] -25.21   13.20
##   [2,] -37.55  -18.95
##   [3,] -21.95   23.06
```

```
##   [4,] -10.85   13.92
##   [5,] -27.73   -7.59
##   [6,] -39.75  -22.96
##   [7,] -25.70   -4.49
##   [8,] -46.27   -5.18
##   [9,] -22.78  -14.08
##  [10,] -35.65    1.05
##  [11,] -40.76    0.51
##  [12,] -49.04  -32.71
##  [13,] -25.77   -8.43
##  [14,] -26.11   -5.24
##  [15,] -21.54    3.04
##  [16,] -31.17  -12.79
##  [17,] -20.76   18.25
##  [18,] -39.99  -23.90
##  [19,] -39.22  -18.33
##  [20,] -39.86  -12.47
##  [21,] -30.43  -16.49
##  [22,] -27.09   -1.77
##  [23,]  -7.40   10.16
##  [24,] -41.13   -7.98
##  [25,] -45.91  -19.50
##  [26,] -30.78   -6.05
##  [27,] -60.83  -32.46
##  [28,] -25.11   -5.66
##  [29,] -36.78  -14.64
##  [30,] -22.41   17.08
##  [31,] -20.96   -3.39
##  [32,] -29.52   -5.03
##  [33,] -33.53  -16.16
##  [34,] -35.42  -14.61
##  [35,] -24.99    3.86
##  [36,] -41.73  -24.93
##  [37,] -36.58  -24.84
##  [38,] -46.42  -31.87
##  [39,] -25.31    0.20
##  [40,] -30.53   -3.56
##  [41,] -49.18  -21.21
##  [42,] -34.42   -9.17
##  [43,] -27.74   -7.45
##  [44,] -22.59   12.15
##  [45,] -23.71   17.11
##  [46,] -32.02    1.72
##  [47,] -28.83  -10.37
##  [48,] -43.02  -11.04
##  [49,] -40.26  -14.29
##  [50,] -40.66  -21.55
##  [51,] -28.07   -3.19
##  [52,] -20.33    5.77
##  [53,] -29.54  -14.06
```

```
##  [54,] -33.76  -25.07
##  [55,] -46.82   -8.49
##  [56,] -27.77   -1.91
##  [57,] -33.00  -12.99
##  [58,] -32.52   -6.04
##  [59,] -40.01  -12.53
##  [60,] -27.35  -11.70
##  [61,]  39.13   -0.54
##  [62,]  79.96    1.74
##  [63,]  -5.79  -18.10
##  [64,]  13.24   20.97
##  [65,]   3.48   34.40
##  [66,]  13.61   19.56
##  [67,]  12.53   17.66
##  [68,]  49.62    5.18
##  [69,] -15.95   22.40
##  [70,]   2.59    7.39
##  [71,]  11.46    7.18
##  [72,]  75.94  -25.85
##  [73,]  55.51   -4.31
##  [74,]   1.66  -14.70
##  [75,]  43.32    8.19
##  [76,] 109.81  -56.59
##  [77,]  89.82  -21.23
##  [78,]  22.88   -3.90
##  [79,]  12.32    9.19
##  [80,] -14.18  -13.91
##  [81,]  51.50    0.34
##  [82,]  50.11  -10.57
##  [83,]  34.48    4.94
##  [84,]  50.75   -0.27
##  [85,]  28.02   -4.15
##  [86,] -15.91  -26.07
##  [87,]  -1.85    4.74
##  [88,]  -0.64  -24.41
##  [89,]  -7.27  -10.32
##  [90,]   3.38    1.88
##  [91,]  15.94   17.25
##  [92,]  14.07   11.58
##  [93,]  62.16    6.16
##  [94,]  28.20    3.32
##  [95,]  46.35   25.76
##  [96,] 101.54  -74.08
##  [97,]  63.28   31.65
##  [98,]  23.05   27.32
##  [99,]  51.41   17.16
## [100,]  -0.27   -7.45
## [101,]  15.02   27.98
## [102,]  24.38   17.44
## [103,]   8.31   19.92
```

```
## [104,]  -4.93   -2.76
## [105,]  69.35  -15.46
## [106,] -15.46   10.26
## [107,]  25.82    5.28
## [108,]  58.71   -7.32
## [109,]  20.18    5.79
## [110,]  19.17    5.38
## [111,]  18.45    3.33
## [112,]  60.05    9.70
## [113,]  -1.58    0.99
## [114,]  25.85    0.50
## [115,]  70.43   -5.42
## [116,] 375.72 -126.01
## [117,]  35.54    1.97
## [118,]  41.03   -4.82
## [119,]  -8.93   -1.99
## [120,]   2.46   -4.97
## [121,]   6.30  -15.92
## [122,]  69.28    8.85
## [123,]  43.61   -9.22
## [124,]  28.94   -1.71
## [125,]  11.59    0.99
## [126,]   2.39   -0.51
## [127,]   8.99   15.47
## [128,]  42.35   10.26
## [129,]  49.00   21.97
## [130,]  20.23    9.21
## [131,]  -9.80  -11.45
## [132,]  -0.10   15.94
## [133,]  29.44   -6.15
## [134,]  41.93   12.79
## [135,]  27.70  -13.01
## [136,]  63.77   -0.32
## [137,]  47.94   18.91
## [138,]  39.04   20.12
## [139,]  40.29   11.68
## [140,]  35.28   38.44
## [141,]  15.21   22.83
## [142,]  97.49  -23.07
## [143,]  56.33   33.61
## [144,]  71.44  -31.70
## [145,]   5.86    5.90
## [146,]  33.83   24.86
## [147,]  56.54   12.52
## [148,]   5.38    3.43
## [149,]  14.86    4.14
## [150,]  15.58    9.49
## [151,]  26.35   22.24
## [152,]   3.90  -10.04
## [153,]   5.65    0.71
```

```
## [154,]   5.71    2.79
## [155,] -10.31  -14.02
## [156,]  24.13   20.95
## [157,]  45.47    6.33
## [158,]   5.63  -17.51
## [159,]  21.78   -7.30
## [160,]  19.60   14.54
## [161,]  50.33   20.92
## [162,]  18.83    7.38
## [163,]  70.74   31.69
## [164,]  83.00   32.81
## [165,]  -6.62   -9.50
## [166,]  56.65    9.32
## [167,]  10.02    0.18
## [168,]  -2.00   36.93
## [169,]  58.98   44.89
## [170,] -12.78   -9.24
## [171,]   0.60   12.40
## [172,]   6.72   42.02
## [173,]  -7.88    3.82
## [174,]  -4.66   10.53
## [175,]  -7.58   -1.42
## [176,]  20.57   -6.23
## [177,]  15.38   16.18
## [178,]  29.92   22.60
## [179,]  35.16    6.22
## [180,]  30.48   -9.27
## [181,] -13.95  -46.54
## [182,]  12.37   19.00
## [183,]  43.14   18.67
## [184,]  49.15   -1.57
## [185,]  32.80   29.75
## [186,]  48.53   29.44
## [187,]  39.35   28.79
## [188,]   7.24    8.51
## [189,]  51.43   13.86
## [190,]  49.70   11.52
## [191,]   5.28   -9.68
## [192,]  40.49   13.14
## [193,]  94.81  -41.25
## [194,]  18.79   19.87
## [195,]  10.47   19.30
## [196,]  27.82   27.32
## [197,]  32.77    6.00
## [198,]  97.60  -17.31
## [199,]  17.30   16.58
## [200,]  15.37   15.03
## [201,]  15.35    0.41
## [202,]  68.37  -13.59
## [203,]  82.87  -12.03
```

```
## [204,]  12.31   25.16
## [205,]  -3.88   -0.73
## [206,]  82.59   -8.31
## [207,]  62.65    7.80
## [208,]  54.79   -1.99
## [209,]  70.41   19.46
## [210,]  -8.71  -12.03
## [211,] -32.89  -21.89
## [212,] -24.43    3.83
## [213,] -28.04   -7.42
## [214,] -31.50   -2.91
## [215,] -36.06   -5.33
## [216,] -45.52  -27.03
## [217,] -34.07   -3.23
## [218,] -28.98  -11.78
## [219,] -31.90   -7.66
## [220,] -18.77   15.25
## [221,] -37.99  -11.61
## [222,] -25.01    9.17
## [223,]   5.59    1.38
## [224,] -10.73   37.55
## [225,]   7.35   61.06
## [226,] -18.54   12.69
## [227,] -12.60   11.12
## [228,] -17.92   10.92
## [229,] -38.41  -21.38
## [230,] -39.18  -13.07
## [231,] -20.99   21.14
## [232,] -25.33   -1.08
## [233,] -34.61  -11.17
## [234,] -41.62  -18.66
## [235,] -25.80  -22.12
## [236,] -34.07   15.58
## [237,] -16.94   19.48
## [238,] -15.81   10.99
## [239,]  -7.55   15.06
## [240,] -29.82   -1.70
## [241,] -41.93   -6.10
## [242,] -20.48  -12.43
## [243,] -41.62  -19.60
## [244,] -41.94  -11.34
## [245,] -15.87    9.45
## [246,] -28.75    2.65
## [247,] -25.78   -9.88
## [248,] -34.04  -11.01
## [249,] -32.51   -6.43
## [250,] -30.85   -6.88
## [251,] -41.81  -17.53
## [252,] -32.36   -8.02
## [253,] -30.98    7.86
```

```
## [254,]  -6.40   15.44
## [255,] -12.58   29.37
## [256,]   5.43    8.38
## [257,] -19.24    2.24
## [258,] -36.81    3.83
## [259,] -36.89  -13.39
## [260,] -22.04   14.59
## [261,] -28.26    2.61
## [262,] -12.42   29.94
## [263,] -39.75  -19.88
## [264,] -45.49  -22.84
## [265,] -29.98   12.03
## [266,] -28.12  -10.42
## [267,] -32.90   -3.07
## [268,] -26.04    3.24
## [269,] -22.69    4.18
## [270,] -37.40  -27.70
## [271,] -27.32    8.24
## [272,] -28.50  -12.37
## [273,] -35.85  -11.27
## [274,] -38.50  -10.38
## [275,] -36.85  -14.86
## [276,] -15.58    9.50
## [277,] -31.74   -9.18
## [278,] -23.93   11.43
## [279,] -43.32   -7.85
## [280,] -20.60   -9.28
## [281,] -30.53   -6.25
## [282,] -17.62   10.42
## [283,] -26.60    2.46
## [284,] -28.22    1.07
## [285,] -23.42    5.36
## [286,] -17.18   11.67
## [287,] -20.95    8.73
## [288,] -37.61  -28.60
## [289,] -12.08   32.52
## [290,] -40.45  -13.30
## [291,] -44.91  -26.47
## [292,] -26.23   -5.60
## [293,] -42.48  -19.84
## [294,] -10.08   -7.73
## [295,] -38.83   -6.17
## [296,] -28.57   -3.51
## [297,] -43.04  -14.99
## [298,] -33.56  -11.23
## [299,] -24.96    1.86
## [300,]  -4.55   31.14
## [301,] -32.15   -1.10
## [302,]   2.32   42.93
## [303,] -34.37   -4.91
```

```
## [304,] -44.29  -17.43
## [305,] -41.27   -8.28
## [306,] -37.53   -3.27
## [307,] -33.66   -4.56
## [308,] -27.01    7.80
## [309,] -32.96   -3.69
## [310,] -40.72  -16.60
```

```
factor.plot(MultScale)
```