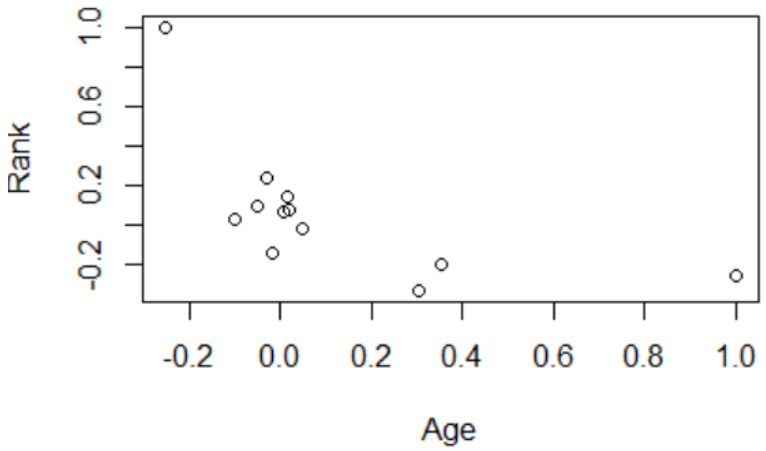
Factor Analysis

```
> head(AustralianOpen_Finalists_allstats)
     PlayerName Year total_matchs winpercentage      MatchID         Round Av
gMinsPerGame
1: Andre Agassi 2000           7             1 m_2000_A_114     4th Round
3.84
2: Andre Agassi 2000           7             1 m_2000_A_122 Quarterfinals
3.32
3: Andre Agassi 2000           7             1  m_2000_A_73     2nd Round
3.44
4: Andre Agassi 2000           7             1 m_2000_A_124    Semifinals
3.50
5: Andre Agassi 2000           7             1  m_2000_A_44     1st Round
3.48
6: Andre Agassi 2000           7             1  m_2000_A_97     3rd Round
3.39
```

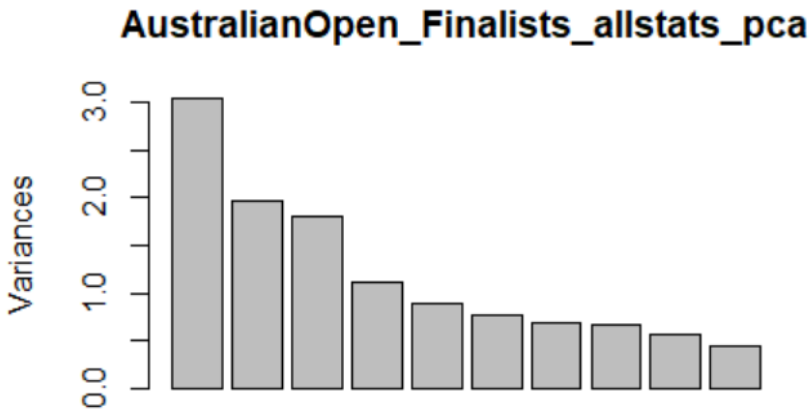
```
> str(AustralianOpen_Finalists_allstats)
Classes ‘data.table’ and 'data.frame':277 obs. of  27 variables:
 $ PlayerName           : chr  "Andre Agassi" "Andre Agassi" "Andre Agassi" "
Andre Agassi" ...
 $ Year                 : num  2000 2000 2000 2000 2000 ...
 $ total_matchs         : int  7 7 7 7 7 7 7 7 7 7 ...
 $ winpercentage        : num  1 1 1 1 1 1 1 1 1 1 ...
 $ MatchID              : chr  "m_2000_A_114" "m_2000_A_122" "m_2000_A_73" "m
_2000_A_124" ...
 $ Round                : chr  "4th Round" "Quarterfinals" "2nd Round" "Semif
inals" ...
 $ AvgMinsPerGame       : num  3.84 3.32 3.44 3.5 3.48 3.39 3.86 3.81 4 3.75
...
 $ AvgSecsPerPoint      : num  37.9 35.1 37.2 34.5 37.3 37 35 38.3 32.6 33.3
...
 $ AvgMinsPerSet        : num  41.3 31 31 35 29 31.7 34.8 39.3 68 33.8 ...
 $ Tournament           : chr  "Australian Open" "Australian Open" "Australia
n Open" "Australian Open" ...
 $ TotalMatchMins       : num  165 93 93 175 87 95 139 118 68 135 ...
 $ Points               : num  0 0 0 0 0 0 0 0 0 0 ...
 $ Age                  : num  30 30 30 30 30 30 30 31 31 31 ...
 $ Rank                 : num  1 1 1 1 1 1 1 6 6 6 ...
 $ Winner               : logi  TRUE TRUE TRUE TRUE TRUE TRUE ...
 $ TotalSets            : num  3 3 3 3 3 3 3 3 1 3 ...
 $ avgOdds              : num  0 0 0 0 0 0 0 0 0 0 ...
 $ maxOdds              : num  0 0 0 0 0 0 0 0 0 0 ...
 $ SP_Percent           : num  0.709 0.574 0.581 0.69 0.551 ...
 $ RP_Percent           : num  0.291 0.426 0.419 0.31 0.449 ...
 $ BP_Win_Percentage    : num  0.778 0.5 0 0.889 1 ...
 $ Aces                 : num  8 6 8 13 6 8 9 6 8 5 ...
 $ firstServeReturnsWon : num  11 13 12 19 18 14 23 30 19 33 ...
 $ SecondServeReturnsWon: num  28 27 27 29 22 25 27 18 16 32 ...
 $ FirstServesIn        : num  96 45 50 101 40 35 77 55 40 77 ...
 $ DoubleFaults         : num  4 1 1 3 1 3 5 0 2 2 ...
 $ FirstServePercentage : num  0.691 0.662 0.658 0.682 0.656 ...
 - attr(*, ".internal.selfref")=<externalptr>
 - attr(*, "sorted")= chr  "PlayerName" "Year"
```

```
> summary(AustralianOpen_Finalists_allstats)
  PlayerName             Year       total_matchs   winpercentage      MatchID
 Length:277         Min.   :2000   Min.   :6.000   Min.   :0.8333   Length:27
7
 Class :character   1st Qu.:2005   1st Qu.:7.000   1st Qu.:0.8571   Class :ch
aracter
 Mode  :character   Median :2009   Median :7.000   Median :0.8571   Mode  :ch
aracter
                    Mean   :2009   Mean   :6.935   Mean   :0.9278
                    3rd Qu.:2014   3rd Qu.:7.000   3rd Qu.:1.0000
                    Max.   :2019   Max.   :7.000   Max.   :1.0000
    Round           AvgMinsPerGame  AvgSecsPerPoint AvgMinsPerSet    Tourname
nt
 Length:277         Min.   :2.930   Min.   :30.20   Min.   : 0.00   Length:27
7
 Class :character   1st Qu.:3.860   1st Qu.:37.60   1st Qu.:34.70   Class :ch
aracter
 Mode  :character   Median :4.280   Median :40.70   Median :40.60   Mode  :ch
aracter
                    Mean   :4.361   Mean   :41.25   Mean   :41.29
                    3rd Qu.:4.700   3rd Qu.:44.30   3rd Qu.:47.30
                    Max.   :9.030   Max.   :75.00   Max.   :93.30
cor_tennis<-cor(AustralianOpen_Finalists_allstats_Numeric)
> plot(cor_tennis)
```




```
> AustralianOpen_Finalists_allstats_pca <- prcomp(AustralianOpen_Finalists_al
lstats_Numeric, scale=TRUE)
> plot(AustralianOpen_Finalists_allstats_pca)
> summary(AustralianOpen_Finalists_allstats_pca)
Importance of components:
                          PC1    PC2    PC3     PC4     PC5     PC6     PC7
PC8     PC9
Standard deviation     1.7420 1.4031 1.3450 1.06024 0.94928 0.87265 0.82817 0
.81273 0.75323
Proportion of Variance 0.2529 0.1641 0.1507 0.09368 0.07509 0.06346 0.05715 0
.05504 0.04728
Cumulative Proportion  0.2529 0.4169 0.5677 0.66136 0.73645 0.79991 0.85707 0
.91211 0.95939
                          PC10    PC11      PC12
Standard deviation     0.66214 0.22105 8.502e-16
Proportion of Variance 0.03654 0.00407 0.000e+00
```

```
Cumulative Proportion  0.99593 1.00000 1.000e+00
```




```
> eigen_AO_Finalists
         PC1          PC2          PC3          PC4          PC5          PC6
PC7
3.034501e+00 1.968804e+00 1.808901e+00 1.124111e+00 9.011337e-01 7.615134e-01
6.858578e-01
         PC8          PC9         PC10         PC11         PC12
6.605265e-01 5.673569e-01 4.384332e-01 4.886229e-02 7.227796e-31

> sumlambdas<-sum(eigen_AO_Finalists)
> sumlambdas
[1] 12

> propvar<-eigen_AO_Finalists/sumlambdas
> propvar
         PC1          PC2          PC3          PC4          PC5          PC6
PC7
2.528751e-01 1.640670e-01 1.507418e-01 9.367588e-02 7.509447e-02 6.345945e-02
5.715482e-02
         PC8          PC9         PC10         PC11         PC12
5.504387e-02 4.727975e-02 3.653610e-02 4.071857e-03 6.023163e-32

> cumvar_AO_Finalists<-cumsum(propvar)
> cumvar_AO_Finalists
      PC1       PC2       PC3       PC4       PC5       PC6       PC7       P
C8       PC9
0.2528751 0.4169420 0.5676838 0.6613597 0.7364542 0.7999136 0.8570684 0.91211
23 0.9593920
     PC10      PC11      PC12
0.9959281 1.0000000 1.0000000

> matlambdas<-rbind(eigen_AO_Finalists,propvar,cumvar_AO_Finalists)
> rownames(matlambdas)<-c("Eigenvalues","Prop.variance","Cum.propvariance")
> matlambdas
                     PC1      PC2       PC3        PC4         PC5         PC
6         PC7
Eigenvalues      3.0345008 1.968804 1.8089011 1.12411062 0.90113368 0.7615133
6 0.68585783
Prop.variance    0.2528751 0.164067 0.1507418 0.09367588 0.07509447 0.0634594
5 0.05715482
Cum.propvariance 0.2528751 0.416942 0.5676838 0.66135968 0.73645416 0.7999136
0 0.85706842
                       PC8         PC9       PC10         PC11          PC12
Eigenvalues      0.66052646 0.56735695 0.4384332 0.048862288 7.227796e-31
```

```
Prop.variance    0.05504387 0.04727975 0.0365361 0.004071857 6.023163e-32
Cum.propvariance 0.91211229 0.95939204 0.9959281 1.000000000 1.000000e+00

> print(AustralianOpen_Finalists_allstats_pca)
Standard deviations (1, .., p=12):
 [1] 1.741982e+00 1.403141e+00 1.344954e+00 1.060241e+00 9.492806e-01 8.72647
3e-01
 [7] 8.281653e-01 8.127278e-01 7.532310e-01 6.621429e-01 2.210482e-01 8.50164
4e-16

Rotation (n x k) = (12 x 12):
                             PC1         PC2          PC3          PC4
PC5
Age                   -0.00415178  0.42830942 -0.232554474  0.314609668 -0.04
632629
Rank                   0.13630501 -0.38197446  0.243595669  0.155808021  0.34
813788
avgOdds                0.11807701  0.34188696 -0.274509489  0.476805302 -0.14
611186
SP_Percent             0.48391843  0.19453812  0.308779847 -0.007946174 -0.03
292276
RP_Percent            -0.48391843 -0.19453812 -0.308779847  0.007946174  0.03
292276
BP_Win_Percentage      0.26061584  0.18226722 -0.006836468 -0.395263686  0.11
221296
Aces                   0.31732681 -0.19283950 -0.016447010  0.370417984  0.37
960882
firstServeReturnsWon   0.11056995 -0.24004315 -0.506991061  0.241247978  0.26
234179
SecondServeReturnsWon  0.13556848 -0.30358565 -0.404359859 -0.397499499 -0.08
812446
FirstServesIn          0.46875952 -0.01812074 -0.326892184 -0.188532278  0.10
380643
DoubleFaults           0.27786436 -0.21598416 -0.157093786  0.054974387 -0.70
441043
FirstServePercentage  -0.05423925  0.45923720 -0.261023158 -0.317897990  0.33
598190

# Multiplying each column of the eigenvector's matrix by the square-root of t
he corresponding eigenvalue in order to get the factor loadings
> unrot.fact.AO_Finalist <- sweep(pcafactors.AO_Finalists,MARGIN=2,Australian
Open_Finalists_allstats_pca$sdev[1:5],`*`)
> unrot.fact.AO_Finalist
                              PC1         PC2          PC3          PC4
PC5
Age                   -0.007232325  0.60097835 -0.312775054  0.333562015 -0.0
4397665
Rank                   0.237440856 -0.53596388  0.327624953  0.165194025  0.3
3048054
avgOdds                0.205688019  0.47971549 -0.369202617  0.505528449 -0.1
3870116
SP_Percent             0.842977134  0.27296435  0.415294670 -0.008424858 -0.0
3125294
RP_Percent            -0.842977134 -0.27296435 -0.415294670  0.008424858  0.0
3125294
BP_Win_Percentage      0.453988059  0.25574654 -0.009194735 -0.419074698  0.1
0652159
Aces                   0.552777545 -0.27058094 -0.022120471  0.392732271  0.3
6035529
firstServeReturnsWon   0.192610853 -0.33681431 -0.681879621  0.255780956  0.2
4903598
SecondServeReturnsWon  0.236157833 -0.42597337 -0.543845384 -0.421445198 -0.0
8365484
```

```
FirstServesIn          0.816570577 -0.02542595 -0.439654929 -0.199889618  0.0
9854144
DoubleFaults           0.484034681 -0.30305615 -0.211283905  0.058286089 -0.6
6868316
FirstServePercentage  -0.094483797  0.64437439 -0.351064123 -0.337048429  0.3
1894110
```

```
> # Performing the varimax rotation. The default in the varimax function is n
orm=TRUE thus, Kaiser normalization is carried out
> rot.fact.AO_Finalist<-varimax(unrot.fact.AO_Finalist)
> View(unrot.fact.AO_Finalist)
```

	PC1	PC2	PC3	PC4	PC5
Age	-0.007232325	0.60097835	-0.312775054	0.333562015	-0.04397665
Rank	0.237440856	-0.53596388	0.327624953	0.165194025	0.33048054
avgOdds	0.205688019	0.47971549	-0.369202617	0.505528449	-0.13870116
SP_Percent	0.842977134	0.27296435	0.415294670	-0.008424858	-0.03125294
RP_Percent	-0.842977134	-0.27296435	-0.415294670	0.008424858	0.03125294
BP_Win_Percentage	0.453988059	0.25574654	-0.009194735	-0.419074698	0.10652159
Aces	0.552777545	-0.27058094	-0.022120471	0.392732271	0.36035529
firstServeReturnsWon	0.192610853	-0.33681431	-0.681879621	0.255780956	0.24903598
SecondServeReturnsWon	0.236157833	-0.42597337	-0.543845384	-0.421445198	-0.08365484

```
> fact.load.AO_Finalist <- rot.fact.AO_Finalist$loadings[1:12,1:5]
> fact.load.AO_Finalist
                              PC1         PC2         PC3         PC4
PC5
Age                    0.01417243  0.72814415  0.11457330  0.06957223  0.1545
67083
Rank                   0.07246725 -0.41564789 -0.62758870  0.06356468 -0.1075
04872
avgOdds                0.08176690  0.81725989 -0.05724614 -0.02261173 -0.0717
92323
SP_Percent             0.94441580  0.06781892 -0.18709674  0.09197388 -0.1365
73701
RP_Percent            -0.94441580 -0.06781892  0.18709674 -0.09197388  0.1365
73701
BP_Win_Percentage      0.56347814 -0.04306566  0.13352199 -0.26351016  0.2279
00105
Aces                   0.23943920  0.08421228 -0.75317506 -0.16083968 -0.0761
31758
firstServeReturnsWon  -0.28675406  0.25351564 -0.46588950 -0.61594245 -0.0030
41345
SecondServeReturnsWon -0.05632020 -0.21434218  0.05986868 -0.80670947 -0.1188
56493
FirstServesIn          0.54306186  0.15813837 -0.21544506 -0.73753524 -0.0098
98431
DoubleFaults           0.20507606  0.09311755  0.05949905 -0.40314063 -0.7775
07787
FirstServePercentage   0.10563288  0.32105809  0.35105743 -0.18175837  0.7015
71521
```

```
> scale.AO_Finalist <- scale(AustralianOpen_Finalists_allstats_Numeric)
> scale.AO_Finalist
               Age        Rank    avgOdds   SP_Percent   RP_Percent BP_Win_Pe
rcentage
  [1,]  0.86020070 -0.49690020 -0.6817896  1.846062706 -1.846062706        0.
62668822
  [2,]  0.86020070 -0.49690020 -0.6817896 -0.339407071  0.339407071       -0.
24428066
  [3,]  0.86020070 -0.49690020 -0.6817896 -0.239027116  0.239027116       -1.
81202464
  [4,]  0.86020070 -0.49690020 -0.6817896  1.543274808 -1.543274808        0.
97507578
  [5,]  0.86020070 -0.49690020 -0.6817896 -0.727893792  0.727893792        1.
32346333
  [6,]  0.86020070 -0.49690020 -0.6817896 -0.313099754  0.313099754       -1.
81202464
  [7,]  0.86020070 -0.49690020 -0.6817896  0.075496756 -0.075496756       -0.
02031723
  [8,]  1.12913478 -0.19715857 -0.6817896 -0.714242303  0.714242303        0.
27830067

fit.pc
Principal Components Analysis
Call: principal(r = AustralianOpen_Finalists_allstats_Numeric, nfactors = 5,
    rotate = "varimax")
Standardized loadings (pattern matrix) based upon correlation matrix
                       RC1   RC4   RC2   RC3   RC5   h2    u2 com
Age                   0.01 -0.07  0.73 -0.11 -0.15 0.57 0.428 1.2
Rank                  0.07 -0.06 -0.42  0.63  0.11 0.59 0.413 1.9
avgOdds               0.08  0.02  0.82  0.06  0.07 0.68 0.316 1.0
SP_Percent            0.94 -0.09  0.07  0.19  0.14 0.96 0.041 1.2
RP_Percent           -0.94  0.09 -0.07 -0.19 -0.14 0.96 0.041 1.2
BP_Win_Percentage     0.56  0.26 -0.04 -0.13 -0.23 0.46 0.541 1.9
Aces                  0.24  0.16  0.08  0.75  0.08 0.66 0.337 1.4
firstServeReturnsWon -0.29  0.62  0.25  0.47  0.00 0.74 0.257 2.7
SecondServeReturnsWon -0.06  0.81 -0.21 -0.06  0.12 0.72 0.282 1.2
FirstServesIn         0.54  0.74  0.16  0.22  0.01 0.91 0.090 2.1
DoubleFaults          0.21  0.40  0.09 -0.06  0.78 0.82 0.179 1.7
FirstServePercentage  0.11  0.18  0.32 -0.35 -0.70 0.76 0.237 2.2

                       RC1  RC4  RC2  RC3  RC5
SS loadings           2.60 1.89 1.64 1.46 1.25
Proportion Var        0.22 0.16 0.14 0.12 0.10
Cumulative Var        0.22 0.37 0.51 0.63 0.74
Proportion Explained  0.29 0.21 0.19 0.17 0.14
Cumulative Proportion 0.29 0.51 0.69 0.86 1.00

Mean item complexity =  1.6
Test of the hypothesis that 5 components are sufficient.

The root mean square of the residuals (RMSR) is  0.08
 with the empirical chi square  248.7  with prob <  9.6e-44

Fit based upon off diagonal values = 0.89


> round(fit.pc$values, 3)
 [1] 3.035 1.969 1.809 1.124 0.901 0.762 0.686 0.661 0.567 0.438 0.049 0.000

> fit.pc$loadings

Loadings:
                      RC1    RC4    RC2    RC3    RC5
Age                                0.728 -0.115 -0.155
```

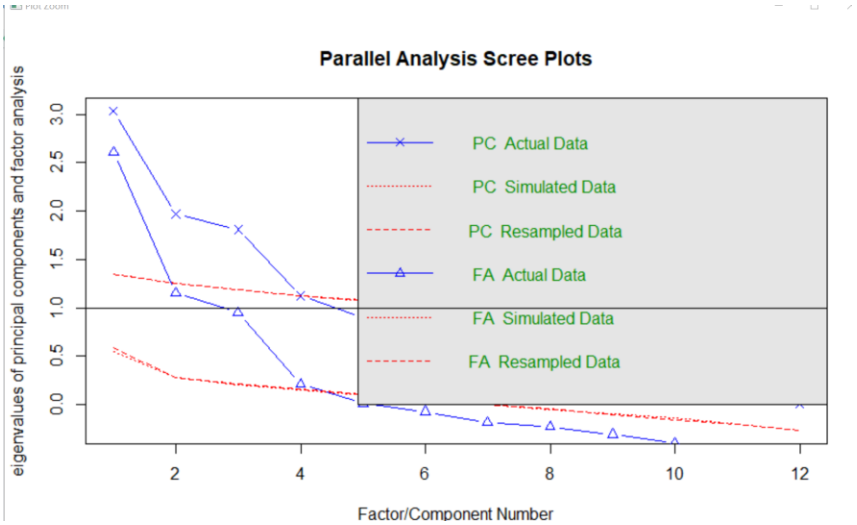
```
Rank                                -0.416  0.628  0.108
avgOdds                              0.817
SP_Percent             0.944                 0.187  0.137
RP_Percent            -0.944                -0.187 -0.137
BP_Win_Percentage      0.563  0.264         -0.134 -0.228
Aces                   0.239  0.161          0.753
firstServeReturnsWon  -0.287  0.616  0.254  0.466
SecondServeReturnsWon         0.807 -0.214         0.119
FirstServesIn          0.543  0.738  0.158  0.215
DoubleFaults           0.205  0.403                0.778
FirstServePercentage   0.106  0.182  0.321 -0.351 -0.702

                 RC1   RC4   RC2   RC3   RC5
SS loadings    2.604 1.891 1.636 1.459 1.247
Proportion Var 0.217 0.158 0.136 0.122 0.104
Cumulative Var 0.217 0.375 0.511 0.633 0.736
```

```
> for (i in c(1,3,2,4,5)) { print(fit.pc$loadings[[1,i]])}
[1] 0.01417243
[1] 0.7281442
[1] -0.06957223
[1] -0.1145733
[1] -0.1545671
```

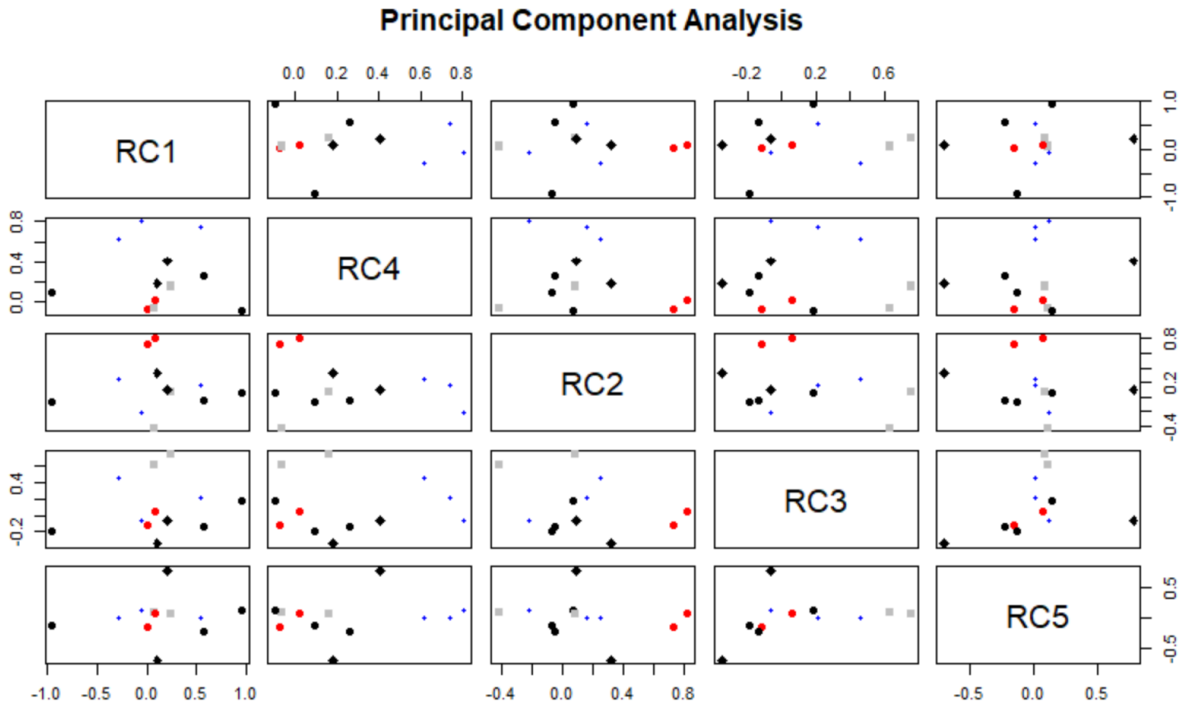
```
> fit.pc$communality
                 Age                 Rank               avgOdds
SP_Percent
           0.5722531            0.5874800            0.6835421
0.9586374
          RP_Percent     BP_Win_Percentage                 Aces  firstServe
ReturnsWon
           0.9586374            0.4585664            0.6633609
0.7429455
SecondServeReturnsWon         FirstServesIn          DoubleFaults  FirstServe
Percentage
           0.7176058            0.9103967            0.8213079
0.7627166
```

```
> fit.pc$scores
                RC1           RC4          RC2           RC3          RC5
  [1,]  5.177146171  0.912893568  0.55582435 -0.844971235  0.222439605
  [2,] -1.209413101 -1.309093868 -0.27211345 -1.947875711 -1.186757152
  [3,] -1.661026519 -1.609687230 -0.17625175 -1.425147783 -0.735841174
  [4,]  4.702099770  1.914816483  0.77426101  0.292659498 -0.178578817
  [5,] -1.348665943 -1.113806609 -0.14219933 -1.966954902 -1.670455839
  [6,] -2.199329966 -2.030564070 -0.62733517 -0.910022167  1.237189439
```

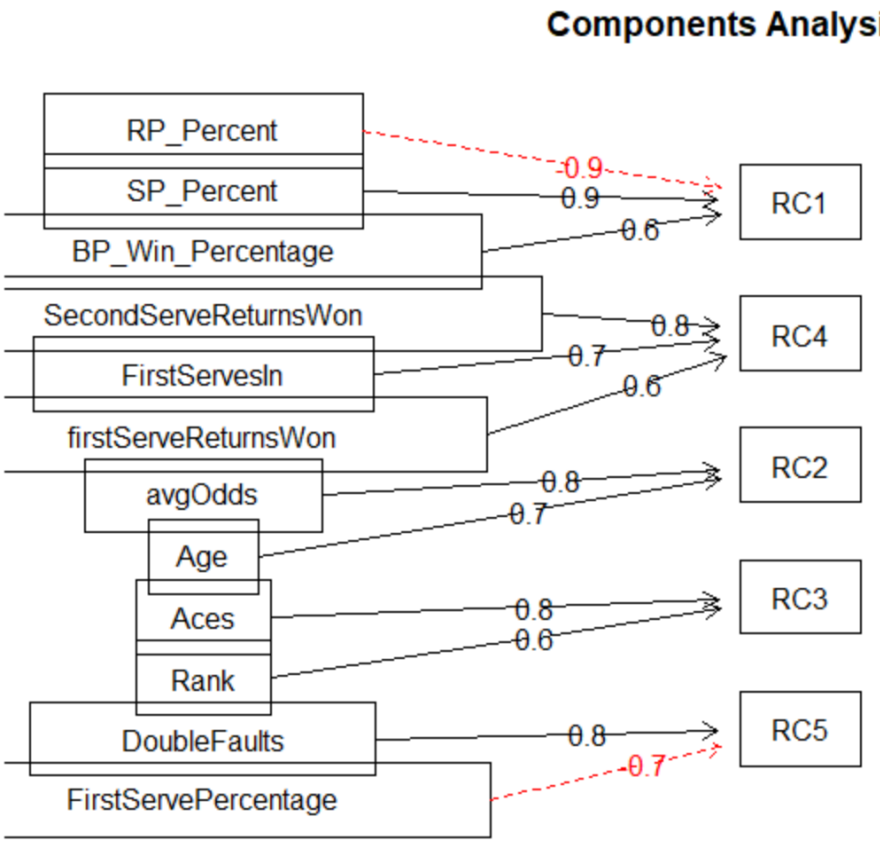
```
fa.parallel(AustralianOpen_Finalists_allstats_Numeric) #factor recommendation
```



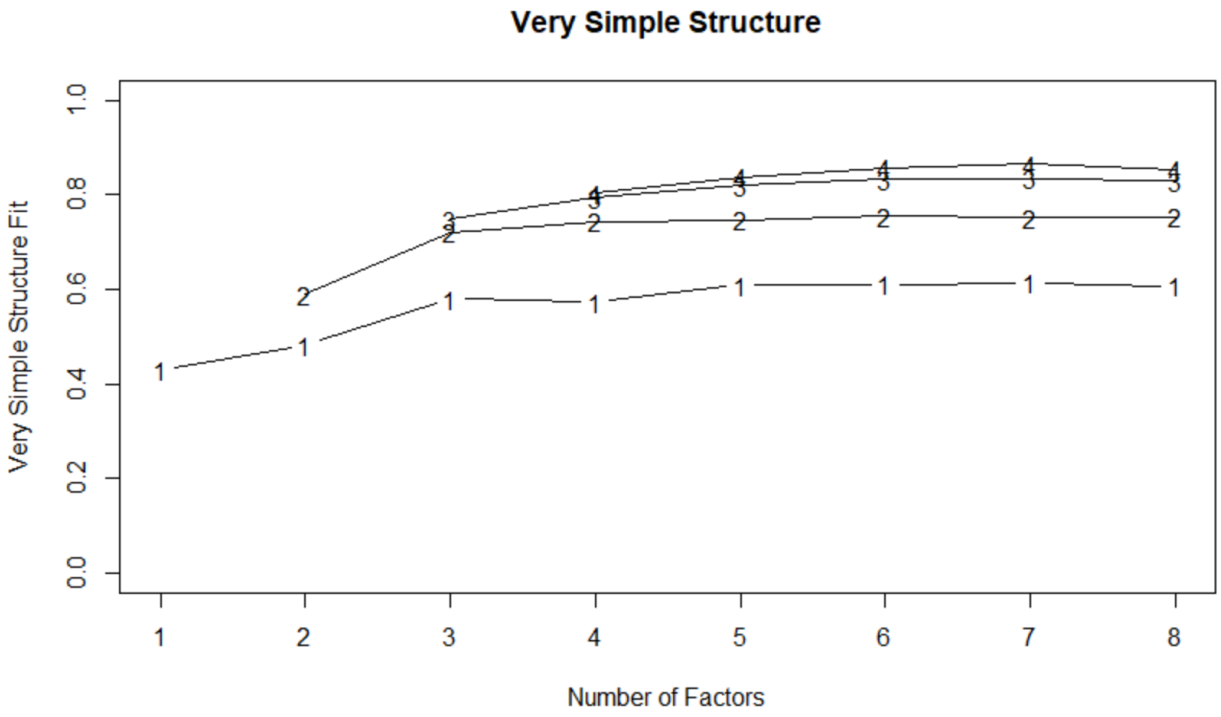

```
fa.plot(fit.pc) #see correlations within factors
```




```
> fa.diagram(fit.pc)#Visualize the realtionship
```




```
vss(AustralianOpen_Finalists_allstats_Numeric)
```



Renaming the 5 factor groups:
RC1 as TotalPoints
RC2 as OddsVsAge
RC3 as RankVsAces,
RC4 as ReturnPointVsFirstServe
RC5 as ServeStats