R Notebook

Code

This is an R Markdown (http://rmarkdown.rstudio.com) Notebook. When you execute code within the notebook, the results appear beneath the code.

Try executing this chunk by clicking the *Run* button within the chunk or by placing your cursor inside it and pressing *Ctrl+Shift+Enter*.

Hide

```
dat=read.csv("Credit_Clients.csv")
dat[,c(2,11:22)]=log(dat[,c(2,11:22)]+1)
```

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```
dat.pca
```

```
Standard deviations (1, .., p=21):
 [1] 2.7720676 1.8578138 1.1580548 1.1115245 1.0021180 0.9494930 0.9270709 0.8642698 0.8405703
0.7653064 0.7267367 0.7105132
[13] 0.6183060 0.5078439 0.4494011 0.4018901 0.3974625 0.2921424 0.2755125 0.2584773 0.2458398

Rotation (n x k) = (21 x 21):
                   PC1         PC2           PC3          PC4          PC5         PC6
PC7          PC8           PC9
LIMIT_BAL  0.001553808  0.30543825  0.0520988881 -0.177111768 -0.509651412  0.18960599 -0.27632
2256  0.162360017 -2.402044e-01
EDUCATION -0.061200712 -0.10078005 -0.1838530298 -0.558960100  0.332692223 -0.50834622  0.21111
2463  0.055732737  7.533320e-02
AGE        0.011635521  0.04520994 -0.0585830773 -0.749133149 -0.311482389  0.12601352 -0.10276
5868 -0.114983659  1.612284e-01
PAY_1     -0.171565480 -0.28468327  0.1063989905 -0.051379611 -0.170654415 -0.21164790 -0.09305
1577  0.009477202 -4.529314e-01
PAY_2     -0.217043278 -0.33147213 -0.0135614964  0.001165303 -0.118242664 -0.10944776  0.00362
5949  0.171227102 -3.424410e-01
PAY_3     -0.220358795 -0.32162552 -0.1573177074  0.084343143 -0.236576642 -0.10350000 -0.04641
8359 -0.134854364  5.824179e-02
PAY_4     -0.245720311 -0.28360325  0.0459918790 -0.061343930  0.004096059  0.28737951  0.05390
2392 -0.184924412  9.628973e-02
PAY_5     -0.246400272 -0.26224994  0.1042179969 -0.027832232 -0.089079775  0.31152386  0.13058
5004  0.112070557  3.112067e-01
PAY_6     -0.239015414 -0.23798893  0.1687858448 -0.029330473  0.099525363  0.14486388 -0.30762
5735  0.032699767  2.944541e-01
BILL_AMT1 -0.262455867  0.05937344 -0.3430135228  0.052779614  0.029301334  0.01970731  0.04772
3329  0.112370710 -2.125102e-01
BILL_AMT2 -0.275801217  0.06778032 -0.4515524388  0.051733933 -0.023316328  0.02434890  0.00155
7713 -0.056365762 -1.782712e-01
BILL_AMT3 -0.310360835  0.09361574 -0.0365479186 -0.053932979  0.159761245  0.18334267  0.07397
2046 -0.033589270 -1.699068e-01
BILL_AMT4 -0.316467128  0.08223277 -0.0008205108  0.028310748  0.066737772  0.03025060  0.11054
4466  0.207121883  7.937796e-02
BILL_AMT5 -0.308933050  0.08751558  0.1542232773  0.014386090  0.112659084 -0.11500432 -0.26096
6436 -0.091922619  9.516761e-02
BILL_AMT6 -0.287862286  0.11461874  0.2693504451  0.035440075 -0.108845831 -0.13771354  0.14367
9703 -0.248568954  7.850619e-02
PAY_AMT1  -0.122539902  0.25259621 -0.5577068610  0.101917885 -0.094941934  0.07536730 -0.07564
9724 -0.280424162  2.263029e-01
PAY_AMT2  -0.139109515  0.26054304  0.1725021482 -0.214062843  0.425633019  0.43900866  0.18187
3428 -0.036874108 -3.299062e-01
PAY_AMT3  -0.206182238  0.23958745 -0.0272926826  0.083337092 -0.043820374 -0.14812410  0.10258
4804  0.515704747  3.229469e-01
PAY_AMT4  -0.189033178  0.23071552  0.1562320100  0.016646922  0.229998513 -0.26516435 -0.58903
5751 -0.235047286 -1.742189e-02
PAY_AMT5  -0.164994160  0.23702738  0.2611505058  0.069910426 -0.300805532 -0.21642549  0.48791
6236 -0.412636309  4.797779e-03
PAY_AMT6  -0.182296509  0.22662258  0.1701685273 -0.029773345 -0.155626996 -0.12823863  0.00545
3769  0.400447820  8.357622e-06
                  PC10          PC11         PC12         PC13         PC14         PC15
PC16          PC17         PC18
LIMIT_BAL  0.225134108 -0.4944190903  0.312266399 -0.14413711  0.005715786 -0.01666038  0.01527
3234 -3.982786e-03  0.01916010
EDUCATION  0.296781073 -0.3132550619  0.113634041 -0.12127368 -0.005098754  0.02189153  0.02063
3830 -4.082177e-02  0.01420478
AGE       -0.335605240  0.3612665536 -0.071642683  0.13269576 -0.001652492 -0.03114833 -0.01866
```

```
6854  4.318606e-02 -0.02386550
PAY_1     -0.227140008 -0.1634514816 -0.552655935 -0.25182356 -0.301319824  0.05247406 -0.15145
0096 -1.282571e-01  0.01088383
PAY_2     -0.079377535  0.1560220633  0.194580723  0.04480097  0.427761841  0.27466544  0.10661
7829  2.295038e-01 -0.22000892
PAY_3      0.053239974 -0.1536998217  0.027338799  0.38568420  0.360858231 -0.16738802  0.02176
4144 -2.623176e-01 -0.17468339
PAY_4      0.237306904 -0.1255010887 -0.002782363  0.28113249 -0.143153447  0.17403110 -0.40668
7344  2.319788e-01  0.32635834
PAY_5      0.067313456 -0.0850347868  0.010063850 -0.11316707 -0.237070541  0.32709775  0.33058
2363 -2.036625e-01  0.11390616
PAY_6      0.096359479  0.0777529940  0.027687783 -0.50403869  0.296160745 -0.17404993 -0.16485
0558 -7.993732e-02 -0.05563915
BILL_AMT1  0.006309237  0.3742704695  0.451005670 -0.10918693 -0.329368744  0.09205700 -0.34412
0677 -3.654013e-01 -0.09258196
BILL_AMT2  0.022604230  0.1340345409 -0.050535596 -0.17840059  0.080647655 -0.04953946  0.38332
3130  3.566676e-01  0.51074647
BILL_AMT3 -0.091018631 -0.1277986856 -0.065816413  0.25176430  0.020236191 -0.56577709  0.09746
1235 -3.425721e-01  0.15830055
BILL_AMT4 -0.193967138 -0.2131874482  0.052737605  0.17952607 -0.230950945 -0.15032670 -0.19218
2789  5.454377e-01 -0.34704925
BILL_AMT5 -0.065318451 -0.0006731592  0.082583031  0.12705149 -0.312297867  0.12141371  0.53358
4383 -5.322248e-02 -0.28750304
BILL_AMT6  0.048047602  0.1496622616  0.086390968 -0.35546918 -0.006551215 -0.36503027 -0.04481
9381  1.980578e-01 -0.07006293
PAY_AMT1   0.116917283 -0.1334306008 -0.369367083 -0.13826542  0.071142829  0.18600803 -0.10576
9167 -2.813171e-02 -0.35491466
PAY_AMT2  -0.010268161 -0.0456962968 -0.139460519 -0.06526041  0.303454406  0.23932694  0.00207
1858 -6.271046e-02 -0.17957859
PAY_AMT3  -0.440789259 -0.1461727954 -0.071753645 -0.02855003  0.224883684  0.13375265 -0.13037
1285 -1.370680e-01  0.24925346
PAY_AMT4  -0.054299523  0.0028209000  0.065608873  0.18301238  0.078339932  0.24008031 -0.18551
9601 -6.475927e-05  0.25799219
PAY_AMT5  -0.042320391 -0.0171639567  0.089398102  0.00100407  0.105954206  0.23500433 -0.03310
0505 -1.240191e-01  0.08529441
PAY_AMT6   0.593214025  0.3733797423 -0.372623481  0.21745685  0.012208637 -0.01535741 -0.01218
4089 -1.726175e-02 -0.02381342
                  PC19         PC20          PC21
LIMIT_BAL -0.038045472 -0.019155578 -0.0187611193
EDUCATION -0.007056363  0.027061836 -0.0008775021
AGE        0.024888934 -0.008975658  0.0130242235
PAY_1      0.030735045 -0.081068512 -0.0050003447
PAY_2     -0.233758984  0.415969827  0.0349871517
PAY_3      0.306256978 -0.375385599 -0.2387922263
PAY_4     -0.417131250 -0.101316436 -0.1116438354
PAY_5      0.396496644  0.330404975 -0.0972184553
PAY_6     -0.043433954 -0.173637308  0.4321253829
BILL_AMT1  0.046906197 -0.100106351 -0.0264798272
BILL_AMT2  0.127150464 -0.241484800  0.0732072896
BILL_AMT3 -0.164098794  0.404079412  0.2027115242
BILL_AMT4  0.338048650 -0.024106690  0.2484703473
BILL_AMT5 -0.414269381 -0.282806000  0.0089395909
BILL_AMT6 -0.020096042  0.150616929 -0.5913824843
PAY_AMT1  -0.138811466  0.255914027 -0.0100289615
PAY_AMT2   0.118423063 -0.241203080 -0.1906990162
PAY_AMT3  -0.223786751 -0.096750037 -0.2008124148
PAY_AMT4   0.313118393  0.235761153 -0.0386242780
```

```
PAY_AMT5    0.022613585 -0.071604480   0.4380729194
PAY_AMT6    0.043406318 -0.010781205   0.0605269058
```

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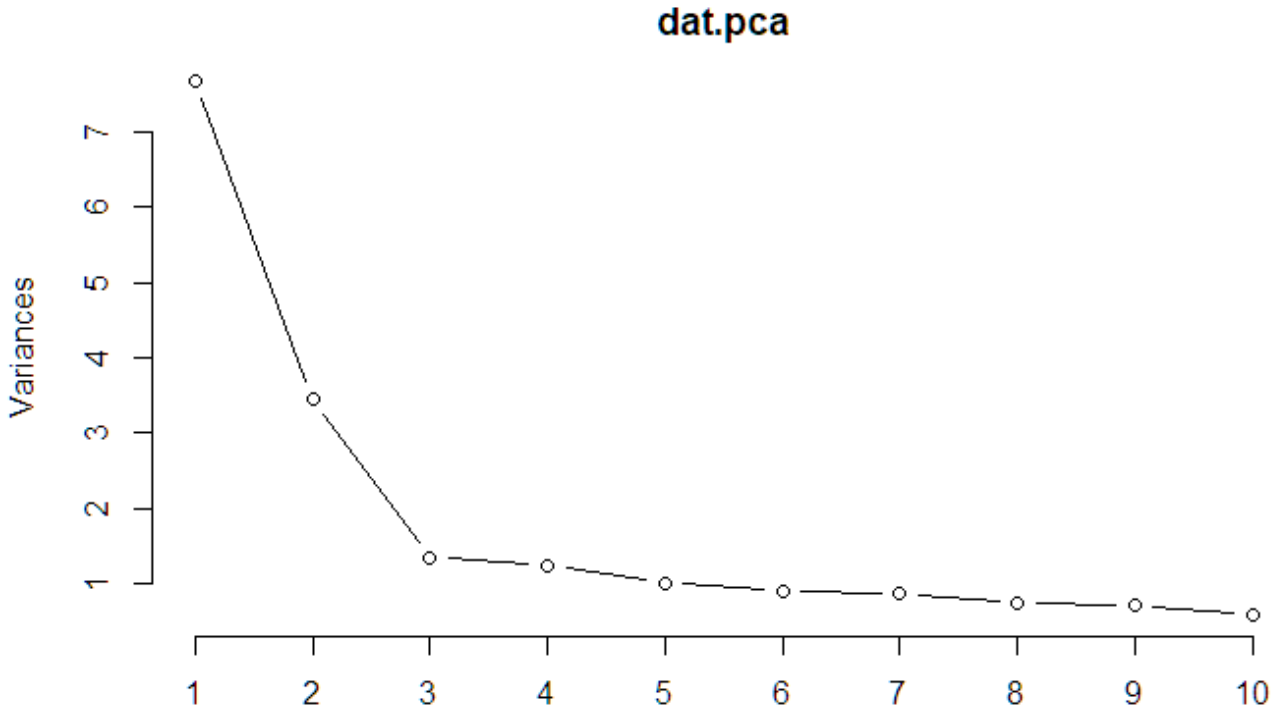
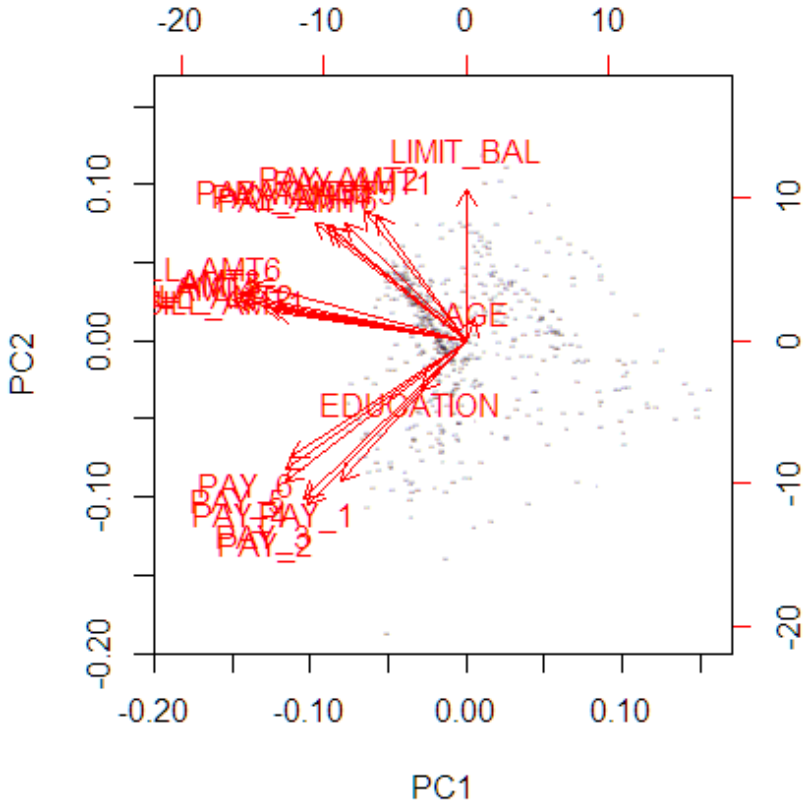
```
plot(dat.pca,type="l")
```





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```
dat.fa2=factanal(dat[,2:22],factors=2,scores="Bartlett")
dat.fa2
```

```
Call:
factanal(x = dat[, 2:22], factors = 2, scores = "Bartlett")

Uniquenesses:
LIMIT_BAL EDUCATION       AGE     PAY_1     PAY_2     PAY_3     PAY_4     PAY_5     PAY_6 BILL_
AMT1 BILL_AMT2 BILL_AMT3 BILL_AMT4
    0.799     0.960     0.997     0.584     0.339     0.296     0.246     0.298     0.412
0.508     0.463     0.235     0.196
BILL_AMT5 BILL_AMT6  PAY_AMT1  PAY_AMT2  PAY_AMT3  PAY_AMT4  PAY_AMT5  PAY_AMT6
    0.256     0.368     0.754     0.649     0.495     0.569     0.669     0.646

Loadings:
          Factor1 Factor2
LIMIT_BAL  0.285  -0.347
EDUCATION           0.198
AGE
PAY_1               0.643
PAY_2               0.810
PAY_3               0.836
PAY_4      0.174    0.851
PAY_5      0.206    0.812
PAY_6      0.224    0.733
BILL_AMT1  0.597    0.368
BILL_AMT2  0.623    0.386
BILL_AMT3  0.767    0.421
BILL_AMT4  0.780    0.443
BILL_AMT5  0.757    0.413
BILL_AMT6  0.716    0.345
PAY_AMT1   0.486
PAY_AMT2   0.585
PAY_AMT3   0.710
PAY_AMT4   0.656
PAY_AMT5   0.575
PAY_AMT6   0.594

               Factor1 Factor2
SS loadings      5.441   4.820
Proportion Var   0.259   0.230
Cumulative Var   0.259   0.489

Test of the hypothesis that 2 factors are sufficient.
The chi square statistic is 3223.74 on 169 degrees of freedom.
The p-value is 0
```

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```
dat.fa3=factanal(dat[,2:22],factors=3,scores="Bartlett")
dat.fa3
```

```
Call:
factanal(x = dat[, 2:22], factors = 3, scores = "Bartlett")

Uniquenesses:
LIMIT_BAL EDUCATION       AGE     PAY_1     PAY_2     PAY_3     PAY_4     PAY_5     PAY_6 BILL_
AMT1 BILL_AMT2 BILL_AMT3 BILL_AMT4
    0.799     0.956     0.997     0.578     0.306     0.286     0.251     0.280     0.377
0.368     0.005     0.250     0.221
BILL_AMT5 BILL_AMT6  PAY_AMT1  PAY_AMT2  PAY_AMT3  PAY_AMT4  PAY_AMT5  PAY_AMT6
    0.212     0.315     0.447     0.644     0.524     0.525     0.633     0.636

Loadings:
          Factor1 Factor2 Factor3
LIMIT_BAL  0.266  -0.354
EDUCATION           0.195
AGE
PAY_1               0.646
PAY_2               0.816   0.165
PAY_3               0.825   0.184
PAY_4      0.199    0.842
PAY_5      0.247    0.812
PAY_6      0.286    0.735
BILL_AMT1  0.431    0.342   0.574
BILL_AMT2  0.384    0.348   0.852
BILL_AMT3  0.694    0.397   0.333
BILL_AMT4  0.730    0.424   0.258
BILL_AMT5  0.779    0.398   0.153
BILL_AMT6  0.746    0.333   0.129
PAY_AMT1   0.282   -0.146   0.673
PAY_AMT2   0.577   -0.105   0.114
PAY_AMT3   0.657            0.210
PAY_AMT4   0.682            0.102
PAY_AMT5   0.604
PAY_AMT6   0.588            0.133

               Factor1 Factor2 Factor3
SS loadings      4.787   4.716   1.889
Proportion Var   0.228   0.225   0.090
Cumulative Var   0.228   0.452   0.542

Test of the hypothesis that 3 factors are sufficient.
The chi square statistic is 2570.58 on 150 degrees of freedom.
The p-value is 0
```

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```
dat.fa4=factanal(dat[,2:22],factors=4,scores="Bartlett")
dat.fa4
```

```
Call:
factanal(x = dat[, 2:22], factors = 4, scores = "Bartlett")

Uniquenesses:
LIMIT_BAL EDUCATION       AGE     PAY_1     PAY_2     PAY_3     PAY_4     PAY_5     PAY_6 BILL_
AMT1 BILL_AMT2 BILL_AMT3 BILL_AMT4
    0.804     0.953     0.997     0.578     0.308     0.274     0.259     0.279     0.285
0.364     0.020     0.269     0.255
BILL_AMT5 BILL_AMT6  PAY_AMT1  PAY_AMT2  PAY_AMT3  PAY_AMT4  PAY_AMT5  PAY_AMT6
    0.165     0.185     0.441     0.654     0.556     0.422     0.005     0.649

Loadings:
          Factor1 Factor2 Factor3 Factor4
LIMIT_BAL -0.354   0.234           0.101
EDUCATION  0.192
AGE
PAY_1      0.644
PAY_2      0.813           0.171
PAY_3      0.821           0.200   0.110
PAY_4      0.836   0.189
PAY_5      0.815   0.230
PAY_6      0.748   0.359          -0.157
BILL_AMT1  0.334   0.422   0.587
BILL_AMT2  0.340   0.380   0.847
BILL_AMT3  0.388   0.667   0.355
BILL_AMT4  0.417   0.689   0.285   0.123
BILL_AMT5  0.387   0.810   0.146
BILL_AMT6  0.332   0.682   0.136   0.470
PAY_AMT1  -0.153   0.266   0.679
PAY_AMT2  -0.113   0.561   0.121
PAY_AMT3           0.609   0.235   0.132
PAY_AMT4           0.755
PAY_AMT5           0.437           0.892
PAY_AMT6           0.553   0.145   0.156

               Factor1 Factor2 Factor3 Factor4
SS loadings      4.687   4.463   1.962   1.166
Proportion Var   0.223   0.213   0.093   0.056
Cumulative Var   0.223   0.436   0.529   0.585

Test of the hypothesis that 4 factors are sufficient.
The chi square statistic is 2175.45 on 132 degrees of freedom.
The p-value is 0
```

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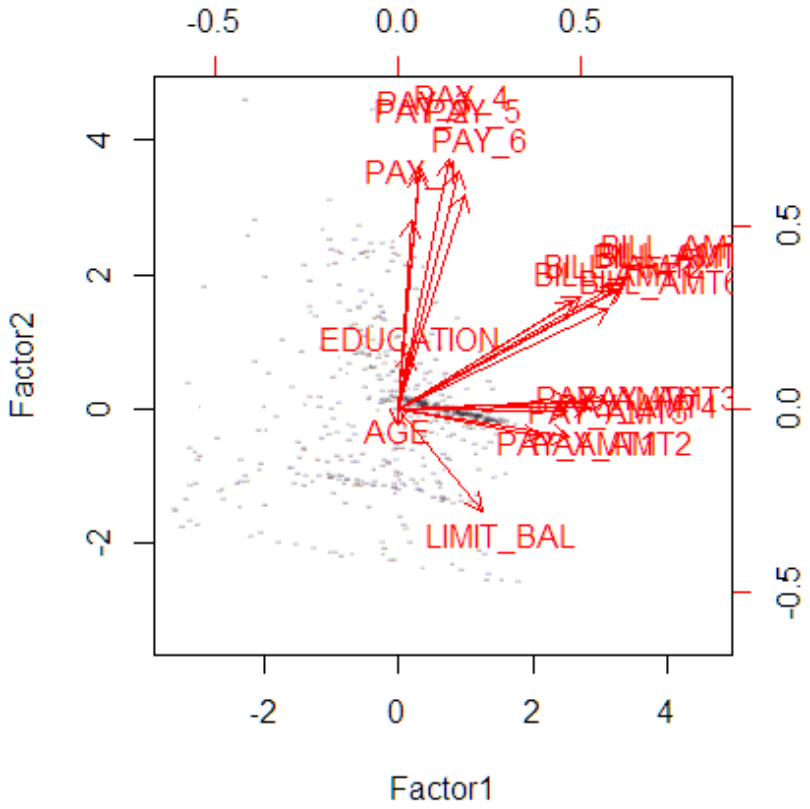
```
biplot.fa =  function (fa,...) {
  x = fa$scores[,1:2]
  y = fa$loadings[,1:2]
  biplot(x,y,...)
}
```



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```
library(GPArotation)
```

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```
dat.fa0 = factanal(dat[, 2:22], factors=3, rotation="oblimin", scores="regression")
dat.fa0
```

```
Call:
factanal(x = dat[, 2:22], factors = 3, scores = "regression",     rotation = "oblimin")

Uniquenesses:
LIMIT_BAL EDUCATION       AGE     PAY_1     PAY_2     PAY_3     PAY_4     PAY_5     PAY_6 BILL_
AMT1 BILL_AMT2 BILL_AMT3 BILL_AMT4
    0.799     0.956     0.997     0.578     0.306     0.286     0.251     0.280     0.377
0.368     0.005     0.250     0.221
BILL_AMT5 BILL_AMT6  PAY_AMT1  PAY_AMT2  PAY_AMT3  PAY_AMT4  PAY_AMT5  PAY_AMT6
    0.212     0.315     0.447     0.644     0.524     0.525     0.633     0.636

Loadings:
          Factor1 Factor2 Factor3
LIMIT_BAL  0.306  -0.429
EDUCATION           0.188
AGE
PAY_1               0.652
PAY_2     -0.117    0.812   0.159
PAY_3     -0.128    0.818   0.181
PAY_4      0.123    0.828
PAY_5      0.195    0.795
PAY_6      0.251    0.710  -0.101
BILL_AMT1  0.217    0.174   0.586
BILL_AMT2           0.143   0.917
BILL_AMT3  0.599    0.220   0.262
BILL_AMT4  0.665    0.254   0.168
BILL_AMT5  0.764    0.235
BILL_AMT6  0.744    0.178
PAY_AMT1           -0.319   0.741
PAY_AMT2   0.607   -0.240
PAY_AMT3   0.646   -0.148   0.138
PAY_AMT4   0.718   -0.160
PAY_AMT5   0.654   -0.147
PAY_AMT6   0.599   -0.118

               Factor1 Factor2 Factor3
SS loadings      4.322   4.290   1.943
Proportion Var   0.206   0.204   0.093
Cumulative Var   0.206   0.410   0.503

Factor Correlations:
        Factor1 Factor2 Factor3
Factor1   1.000  -0.288   0.504
Factor2  -0.288   1.000  -0.314
Factor3   0.504  -0.314   1.000

Test of the hypothesis that 3 factors are sufficient.
The chi square statistic is 2570.58 on 150 degrees of freedom.
The p-value is 0
```

Add a new chunk by clicking the *Insert Chunk* button on the toolbar or by pressing *Ctrl+Alt+I*.

When you save the notebook, an HTML file containing the code and output will be saved alongside it (click the *Preview* button or press *Ctrl+Shift+K* to preview the HTML file).

The preview shows you a rendered HTML copy of the contents of the editor. Consequently, unlike *Knit*, *Preview* does not run any R code chunks. Instead, the output of the chunk when it was last run in the editor is displayed.