Bank_Data_Factor_Analysis.R

deepti

Thu Mar 28 21:52:18 2019

```r
bank <- read.csv("~/Spring 19 Sem/Multi Analysis/bank-full.csv", sep=";")
str(bank)

## 'data.frame':    45211 obs. of  17 variables:
##  $ age      : int  58 44 33 47 33 35 28 42 58 43 ...
##  $ job      : Factor w/ 12 levels "admin.","blue-collar",..: 5 10 3 2 12 5
5 3 6 10 ...
##  $ marital  : Factor w/ 3 levels "divorced","married",..: 2 3 2 2 3 2 3 1
2 3 ...
##  $ education: Factor w/ 4 levels "primary","secondary",..: 3 2 2 4 4 3 3 3
1 2 ...
##  $ default  : Factor w/ 2 levels "no","yes": 1 1 1 1 1 1 1 2 1 1 ...
##  $ balance  : int  2143 29 2 1506 1 231 447 2 121 593 ...
##  $ housing  : Factor w/ 2 levels "no","yes": 2 2 2 2 1 2 2 2 2 2 ...
##  $ loan     : Factor w/ 2 levels "no","yes": 1 1 2 1 1 1 2 1 1 1 ...
##  $ contact  : Factor w/ 3 levels "cellular","telephone",..: 3 3 3 3 3 3 3
3 3 3 ...
##  $ day      : int  5 5 5 5 5 5 5 5 5 5 ...
##  $ month    : Factor w/ 12 levels "apr","aug","dec",..: 9 9 9 9 9 9 9 9 9
9 ...
##  $ duration : int  261 151 76 92 198 139 217 380 50 55 ...
##  $ campaign : int  1 1 1 1 1 1 1 1 1 1 1 1 ...
##  $ pdays    : int  -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 ...
##  $ previous : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ poutcome : Factor w/ 4 levels "failure","other",..: 4 4 4 4 4 4 4 4 4 4
...
##  $ y        : Factor w/ 2 levels "no","yes": 1 1 1 1 1 1 1 1 1 1 ...

attach(bank)

library(ggplot2)
ggplot(bank, aes(y=age,x=education, fill=y)) + geom_boxplot()
```
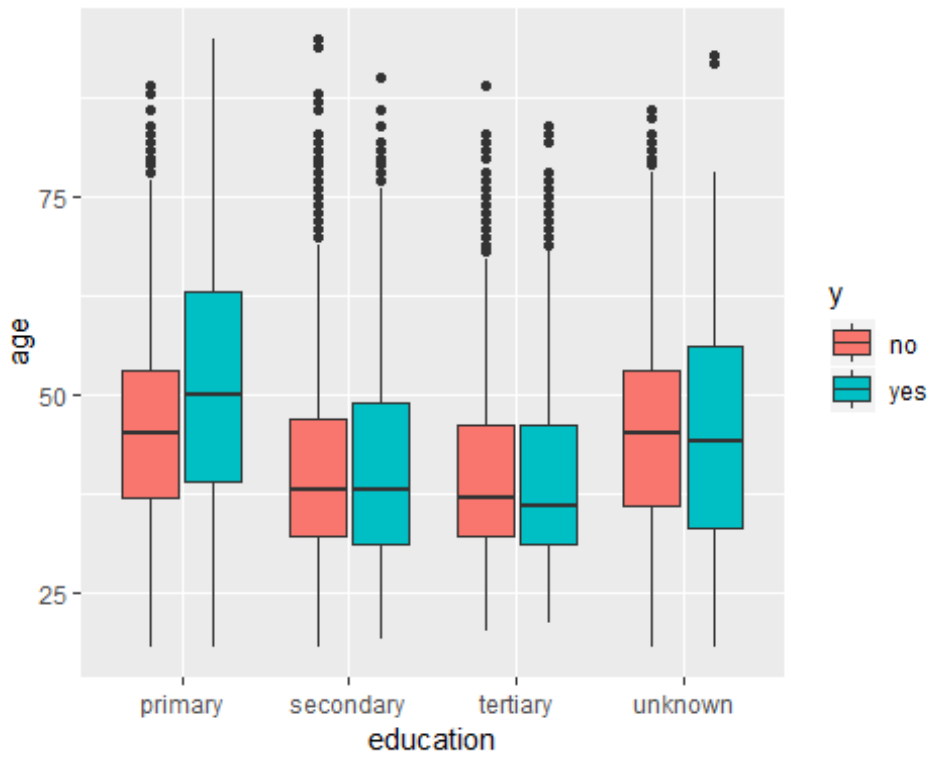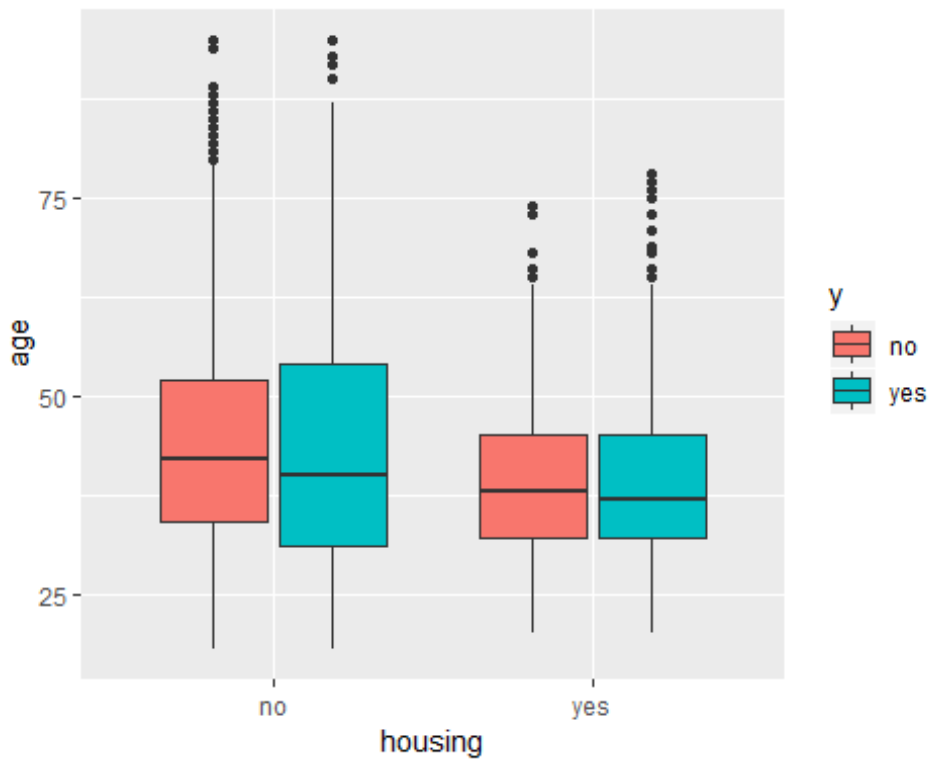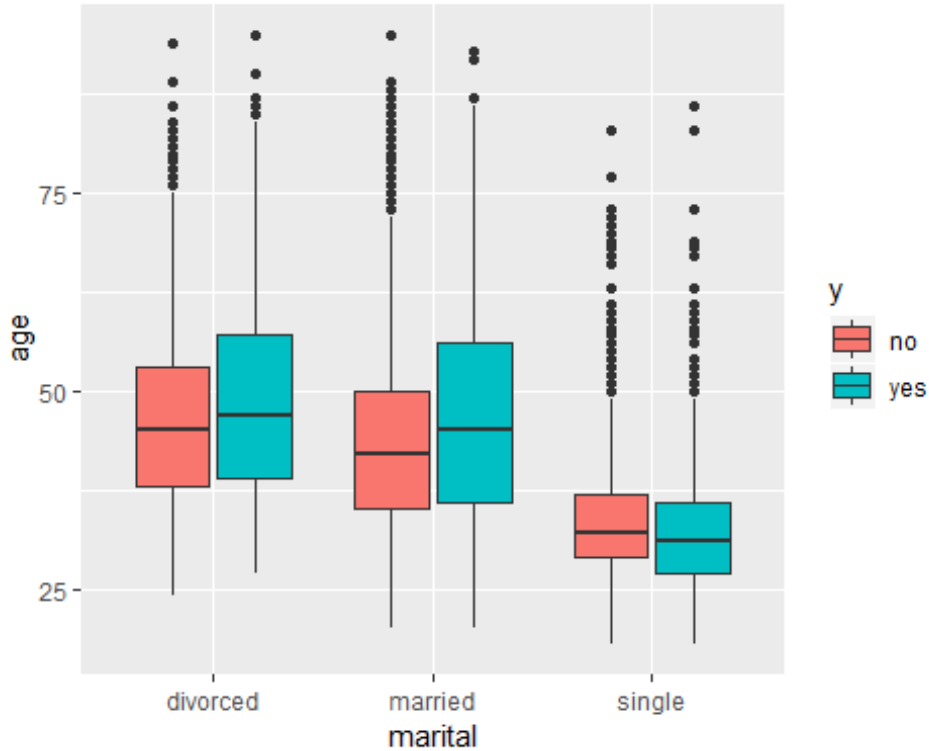
```
ggplot(bank, aes(y=age,x=housing, fill=y)) + geom_boxplot()
```

```
ggplot(bank, aes(y=age,x=marital, fill=y)) + geom_boxplot()
```



```
ggplot(bank, aes(y=balance,x=job, fill=y)) + geom_boxplot()
```

```r
boxplot(age ~ job)
```
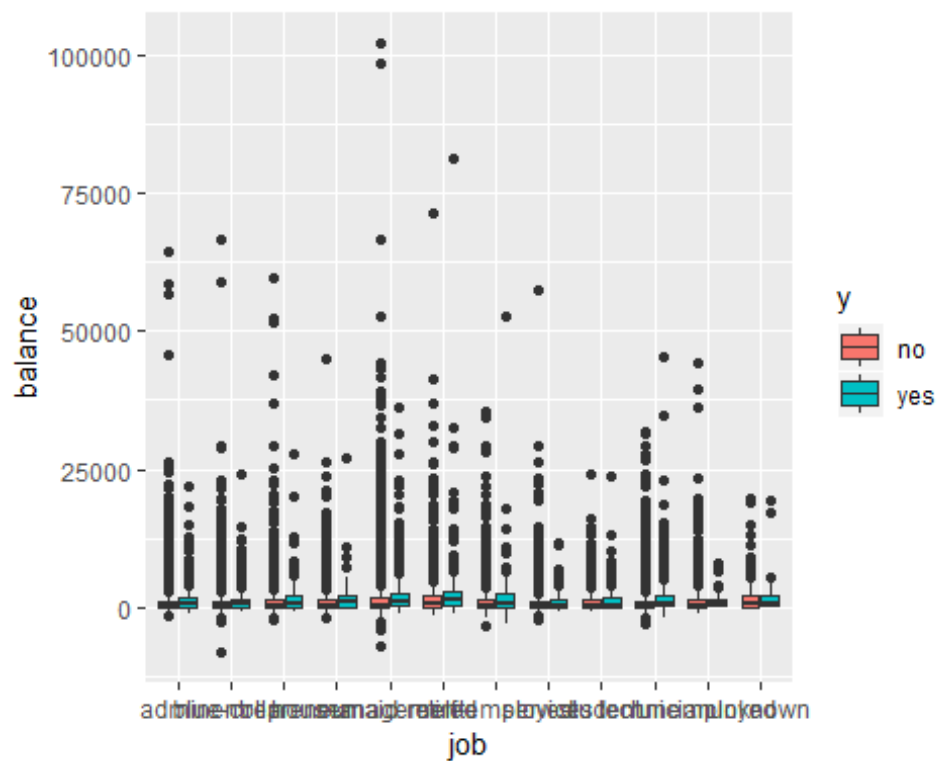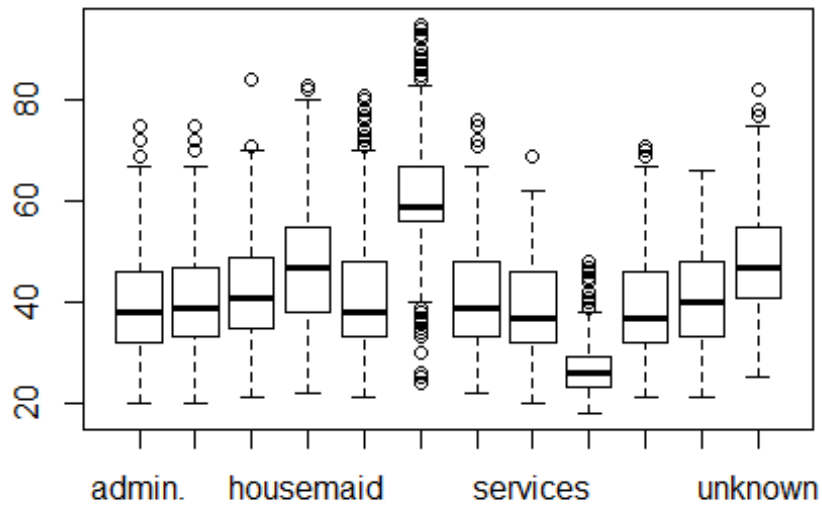


```r
unique(bank$default)
```

```
## [1] no  yes
## Levels: no yes
```

```r
default_dummy=ifelse(bank$default=='yes',1,0)
```

```r
unique(bank$housing)
```

```
## [1] yes no
## Levels: no yes
```

```r
housing_dummy=ifelse(bank$housing=='yes',1,0)
```

```r
unique(bank$loan)
```

```
## [1] no  yes
## Levels: no yes
```

```r
loan_dummy=ifelse(bank$loan=='yes',1,0)
```

```r
unique(bank$contact)
```

```
## [1] unknown   cellular  telephone
## Levels: cellular telephone unknown
```

```r
cell_dummy=ifelse(bank$contact=='cellular',1,0)

unique(bank$marital)

## [1] married  single   divorced
## Levels: divorced married single

married_dummy=ifelse(bank$marital=='married',1,0)
divorced_dummy=ifelse(bank$marital=='divorced',1,0)

admin_dummy=ifelse(bank$job== 'admin.',1,0)
bluecollar_dummy=ifelse(bank$job== 'blue-collar',1,0)
technician_dummy=ifelse(bank$job== 'technician',1,0)
services_dummy=ifelse(bank$job=='services',1,0)
management_dummy=ifelse(bank$job=='management',1,0)
retired_dummy=ifelse(bank$job=='retired',1,0)
entrepreneur_dummy=ifelse(bank$job=='entrepreneur',1,0)
selfemployed_dummy=ifelse(bank$job=='self-employed',1,0)
housemaid_dummy=ifelse(bank$job=='housemaid',1,0)
unemployed_dummy=ifelse(bank$job=='unemployed',1,0)
student_dummy=ifelse(bank$job=='student',1,0)

bank1=data.frame(age,balance,day,duration,campaign,pdays,previous,default_dum
my,housing_dummy,loan_dummy,cell_dummy,married_dummy,divorced_dummy,

admin_dummy,bluecollar_dummy,technician_dummy,services_dummy,management_dummy
,retired_dummy,

entrepreneur_dummy,selfemployed_dummy,housemaid_dummy,unemployed_dummy,studen
t_dummy)

# Computing Correlation Matrix
corrm.job <- cor(bank1)
corrm.job

##                             age        balance          day      duration
## age                1.0000000000  0.097782739 -0.009120046 -0.004648428
## balance            0.0977827394  1.000000000  0.004502585  0.021560380
## day               -0.0091200456  0.004502585  1.000000000 -0.030206341
## duration          -0.0046484285  0.021560380 -0.030206341  1.000000000
## campaign           0.0047603118 -0.014578279  0.162490216 -0.084569503
## pdays             -0.0237580141  0.003435322 -0.093044074 -0.001564770
## previous           0.0012883192  0.016673637 -0.051710497  0.001203057
## default_dummy     -0.0178793036 -0.066745057  0.009423899 -0.010021461
## housing_dummy     -0.1855130815 -0.068768316 -0.027981649  0.005075449
## loan_dummy        -0.0156552727 -0.084350246  0.011370158 -0.012411972
## cell_dummy        -0.0683752110  0.015879610  0.020185831  0.025542949
## married_dummy      0.2862568801  0.025708074  0.007102369 -0.022682929
## divorced_dummy     0.1646742841 -0.021731604 -0.000433111  0.006099890
## admin_dummy       -0.0557168481 -0.026725827 -0.010454887 -0.015721865
```

```
## bluecollar_dummy   -0.0440021457 -0.048756856 -0.022898115  0.009636854
## technician_dummy    -0.0686316215 -0.016183263  0.032517190 -0.009176081
## services_dummy      -0.0657801637 -0.038150675 -0.006531311  0.001427402
## management_dummy    -0.0235714033  0.067797227  0.019020516 -0.008322998
## retired_dummy        0.4473782669  0.046900051 -0.010122986  0.026032085
## entrepreneur_dummy   0.0217918185  0.009642377 -0.002311926 -0.001327465
## selfemployed_dummy  -0.0080927264  0.017850395  0.005061864  0.007382572
## housemaid_dummy      0.0866500450  0.001661416  0.003954916 -0.008045553
## unemployed_dummy     0.0004123369  0.009022792 -0.006382325  0.020322299
## student_dummy       -0.1973019012  0.001232856 -0.015894080 -0.006503553
##                          campaign        pdays      previous default_dummy
## age                   0.004760312 -0.023758014  0.001288319 -1.787930e-02
## balance              -0.014578279  0.003435322  0.016673637 -6.674506e-02
## day                   0.162490216 -0.093044074 -0.051710497  9.423899e-03
## duration             -0.084569503 -0.001564770  0.001203057 -1.002146e-02
## campaign              1.000000000 -0.088627668 -0.032855290  1.682153e-02
## pdays                -0.088627668  1.000000000  0.454819635 -2.997936e-02
## previous             -0.032855290  0.454819635  1.000000000 -1.832940e-02
## default_dummy         0.016821531 -0.029979361 -0.018329405  1.000000e+00
## housing_dummy        -0.023598707  0.124178400  0.037076150 -6.025218e-03
## loan_dummy            0.009979846 -0.022753639 -0.011043488  7.723424e-02
## cell_dummy           -0.032270965  0.225996328  0.131716708 -1.006107e-02
## married_dummy         0.031371290 -0.027600380 -0.012690602 -1.445963e-02
## divorced_dummy       -0.015483915  0.002896612 -0.004534419  1.777686e-02
## admin_dummy          -0.021868078  0.027496834  0.014245294 -1.003715e-02
## bluecollar_dummy      0.008986250  0.020063311 -0.017095359  1.034087e-02
## technician_dummy      0.020739365 -0.013477571 -0.001122739 -3.089271e-03
## services_dummy       -0.004671344  0.005709790 -0.010925770  6.765902e-05
## management_dummy      0.016686303 -0.007871366  0.019578719 -2.654893e-03
## retired_dummy        -0.030913063 -0.006314946  0.005818128 -1.129037e-02
## entrepreneur_dummy    0.002128448 -0.014203221 -0.008180632  2.628100e-02
## selfemployed_dummy    0.005479290 -0.010355532 -0.002370967  4.107473e-03
## housemaid_dummy       0.003096636 -0.031349724 -0.015204210 -3.592806e-04
## unemployed_dummy     -0.018447859 -0.010410966 -0.008503909  6.470248e-03
## student_dummy        -0.021813247  0.024485938  0.023555842 -1.622245e-02
##                      housing_dummy   loan_dummy    cell_dummy married_dummy
## age                   -0.185513082 -0.015655273 -0.0683752110   0.286256880
## balance               -0.068768316 -0.084350246  0.0158796096   0.025708074
## day                   -0.027981649  0.011370158  0.0201858307   0.007102369
## duration               0.005075449 -0.012411972  0.0255429485  -0.022682929
## campaign              -0.023598707  0.009979846 -0.0322709652   0.031371290
## pdays                  0.124178400 -0.022753639  0.2259963279  -0.027600380
## previous               0.037076150 -0.011043488  0.1317167080  -0.012690602
## default_dummy         -0.006025218  0.077234241 -0.0100610716  -0.014459629
## housing_dummy          1.000000000  0.041322866 -0.1560708266   0.017680694
## loan_dummy             0.041322866  1.000000000  0.0136038591   0.036905561
## cell_dummy            -0.156070827  0.013603859  1.0000000000  -0.043477419
## married_dummy          0.017680694  0.036905561 -0.0434774188   1.000000000
## divorced_dummy         0.001778034  0.016376783 -0.0067862807  -0.443647677
## admin_dummy            0.043046134  0.030781333  0.0006595637  -0.059572424
```

```
## bluecollar_dummy       0.177474869  0.018291405 -0.1293159114   0.122033433
## technician_dummy       -0.012822887  0.014798107  0.0569820979  -0.062949878
## services_dummy          0.070435297  0.035574867 -0.0308926754  -0.014615340
## management_dummy       -0.063382009 -0.038904191  0.1018532420  -0.032559955
## retired_dummy          -0.156632670 -0.014861001 -0.0204843406   0.076287703
## entrepreneur_dummy      0.010600051  0.039808166 -0.0023860562   0.044318525
## selfemployed_dummy     -0.027318952 -0.007881820  0.0154401257   0.010471978
## housemaid_dummy        -0.079380025 -0.017234414 -0.0156494875   0.045816483
## unemployed_dummy       -0.048228784 -0.035960853  0.0130066836  -0.014400748
## student_dummy          -0.085065505 -0.058503161  0.0290488286  -0.161871017
##                        divorced_dummy    admin_dummy bluecollar_dummy
## age                       0.164674284 -0.0557168481     -0.044002146
## balance                  -0.021731604 -0.0267258266     -0.048756856
## day                      -0.000433111 -0.0104548871     -0.022898115
## duration                  0.006099890 -0.0157218649      0.009636854
## campaign                 -0.015483915 -0.0218680777      0.008986250
## pdays                     0.002896612  0.0274968340      0.020063311
## previous                 -0.004534419  0.0142452936     -0.017095359
## default_dummy             0.017776857 -0.0100371471      0.010340865
## housing_dummy             0.001778034  0.0430461339      0.177474869
## loan_dummy                0.016376783  0.0307813332      0.018291405
## cell_dummy               -0.006786281  0.0006595637     -0.129315911
## married_dummy            -0.443647677 -0.0595724241      0.122033433
## divorced_dummy            1.000000000  0.0336242881     -0.062517892
## admin_dummy               0.033624288  1.0000000000     -0.188215593
## bluecollar_dummy         -0.062517892 -0.1882155926      1.000000000
## technician_dummy          0.009273970 -0.1615052103     -0.235375724
## services_dummy            0.016929695 -0.1143088549     -0.166592331
## management_dummy          0.003698621 -0.1848347587     -0.269375923
## retired_dummy             0.052180279 -0.0825110340     -0.120250575
## entrepreneur_dummy        0.003007167 -0.0662728696     -0.096585272
## selfemployed_dummy       -0.015796245 -0.0683642005     -0.099633152
## housemaid_dummy           0.017473252 -0.0603486981     -0.087951457
## unemployed_dummy          0.008668957 -0.0619071220     -0.090222684
## student_dummy            -0.049597256 -0.0523084894     -0.076233754
##                        technician_dummy services_dummy management_dummy
## age                        -0.068631622  -6.578016e-02     -0.023571403
## balance                    -0.016183263  -3.815068e-02      0.067797227
## day                         0.032517190  -6.531311e-03      0.019020516
## duration                   -0.009176081   1.427402e-03     -0.008322998
## campaign                    0.020739365  -4.671344e-03      0.016686303
## pdays                      -0.013477571   5.709790e-03     -0.007871366
## previous                   -0.001122739  -1.092577e-02      0.019578719
## default_dummy              -0.003089271   6.765902e-05     -0.002654893
## housing_dummy              -0.012822887   7.043530e-02     -0.063382009
## loan_dummy                  0.014798107   3.557487e-02     -0.038904191
## cell_dummy                  0.056982098  -3.089268e-02      0.101853242
## married_dummy              -0.062949878  -1.461534e-02     -0.032559955
## divorced_dummy              0.009273970   1.692970e-02      0.003698621
## admin_dummy                -0.161505210  -1.143089e-01     -0.184834759
```

```
## bluecollar_dummy         -0.235375724  -1.665923e-01      -0.269375923
## technician_dummy          1.000000000  -1.429506e-01      -0.231147773
## services_dummy           -0.142950587   1.000000e+00      -0.163599906
## management_dummy         -0.231147773  -1.635999e-01       1.000000000
## retired_dummy            -0.103185363  -7.303170e-02      -0.118090566
## entrepreneur_dummy       -0.082878493  -5.865907e-02      -0.094850353
## selfemployed_dummy       -0.085493837  -6.051014e-02      -0.097843485
## housemaid_dummy          -0.075469935  -5.341550e-02      -0.086371623
## unemployed_dummy         -0.077418844  -5.479489e-02      -0.088602054
## student_dummy            -0.065415136  -4.629900e-02      -0.074864401
##                        retired_dummy entrepreneur_dummy selfemployed_dummy
## age                      0.447378267        0.021791819       -0.008092726
## balance                  0.046900051        0.009642377        0.017850395
## day                     -0.010122986       -0.002311926        0.005061864
## duration                 0.026032085       -0.001327465        0.007382572
## campaign                -0.030913063        0.002128448        0.005479290
## pdays                   -0.006314946       -0.014203221       -0.010355532
## previous                 0.005818128       -0.008180632       -0.002370967
## default_dummy           -0.011290368        0.026280997        0.004107473
## housing_dummy           -0.156632670        0.010600051       -0.027318952
## loan_dummy              -0.014861001        0.039808166       -0.007881820
## cell_dummy              -0.020484341       -0.002386056        0.015440126
## married_dummy            0.076287703        0.044318525        0.010471978
## divorced_dummy           0.052180279        0.003007167       -0.015796245
## admin_dummy             -0.082511034       -0.066272870       -0.068364200
## bluecollar_dummy        -0.120250575       -0.096585272       -0.099633152
## technician_dummy        -0.103185363       -0.082878493       -0.085493837
## services_dummy          -0.073031704       -0.058659071       -0.060510138
## management_dummy        -0.118090566       -0.094850353       -0.097843485
## retired_dummy            1.000000000       -0.042341607       -0.043677754
## entrepreneur_dummy      -0.042341607        1.000000000       -0.035081976
## selfemployed_dummy      -0.043677754       -0.035081976        1.000000000
## housemaid_dummy         -0.038556665       -0.030968717       -0.031945977
## unemployed_dummy        -0.039552339       -0.031768442       -0.032770939
## student_dummy           -0.033419792       -0.026842780       -0.027689840
##                        housemaid_dummy unemployed_dummy student_dummy
## age                       0.0866500450     0.0004123369   -0.197301901
## balance                   0.0016614156     0.0090227918    0.001232856
## day                       0.0039549157    -0.0063823246   -0.015894080
## duration                 -0.0080455532     0.0203222992   -0.006503553
## campaign                  0.0030966362    -0.0184478589   -0.021813247
## pdays                    -0.0313497236    -0.0104109656    0.024485938
## previous                 -0.0152042099    -0.0085039090    0.023555842
## default_dummy            -0.0003592806     0.0064702478   -0.016222451
## housing_dummy            -0.0793800250    -0.0482287840   -0.085065505
## loan_dummy               -0.0172344136    -0.0359608525   -0.058503161
## cell_dummy               -0.0156494875     0.0130066836    0.029048829
## married_dummy             0.0458164829    -0.0144007479   -0.161871017
## divorced_dummy            0.0174732524     0.0086689569   -0.049597256
## admin_dummy              -0.0603486981    -0.0619071220   -0.052308489
```

```
## bluecollar_dummy      -0.0879514566    -0.0902226845   -0.076233754
## technician_dummy       -0.0754699347    -0.0774188442   -0.065415136
## services_dummy         -0.0534155016    -0.0547948850   -0.046298997
## management_dummy       -0.0863716232    -0.0886020541   -0.074864401
## retired_dummy          -0.0385566654    -0.0395523394   -0.033419792
## entrepreneur_dummy     -0.0309687170    -0.0317684424   -0.026842780
## selfemployed_dummy     -0.0319459771    -0.0327709389   -0.027689840
## housemaid_dummy         1.0000000000    -0.0289286423   -0.024443287
## unemployed_dummy       -0.0289286423     1.0000000000   -0.025074502
## student_dummy          -0.0244432874    -0.0250745024    1.000000000
```

```
plot(corrm.job)
```
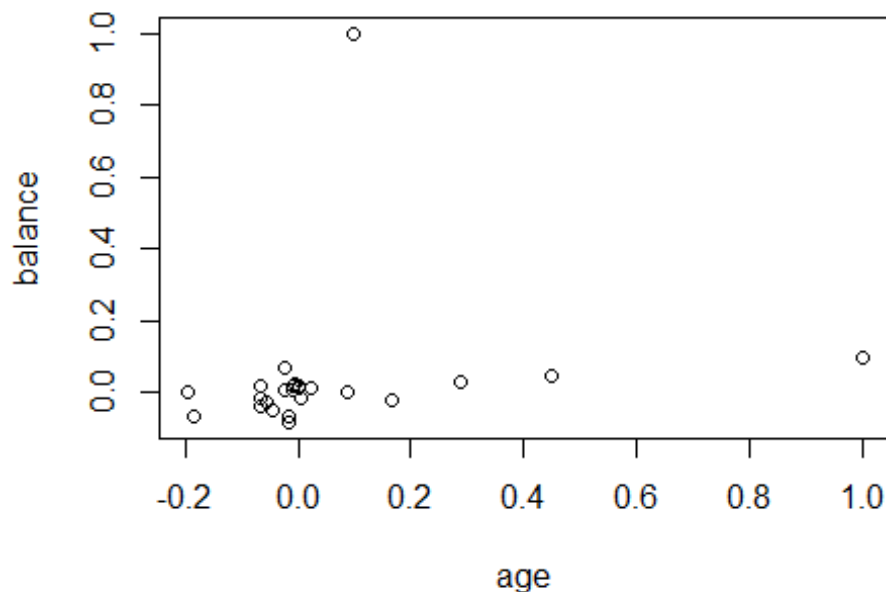


```
bank_pca <- prcomp(bank1, scale=TRUE)
bank_pca

## Standard deviations (1, .., p=24):
##  [1] 1.33844965 1.28503448 1.24822205 1.17257046 1.11445100 1.09587255
##  [7] 1.07326056 1.05901699 1.04666001 1.04300561 1.02140057 1.01735820
## [13] 1.01416721 1.01229356 0.98720911 0.95730835 0.94523110 0.91925677
## [19] 0.90856408 0.83749497 0.76847418 0.70991612 0.57851915 0.08595291
##
## Rotation (n x k) = (24 x 24):
##                              PC1         PC2          PC3          PC4
## age                  0.569318294 -0.20981495   0.11519363   0.220812369
## balance              0.136431648 -0.17156951   0.02405785  -0.163302019
## day                  0.059418593  0.07154041  -0.19566750  -0.195731497
```

```
## duration            -0.007808696 -0.05044539  0.03322156  0.077099400
## campaign             0.071690584  0.12991463 -0.14965979 -0.192439063
## pdays               -0.267207562 -0.32389991  0.48657173  0.075716057
## previous            -0.207016894 -0.33203403  0.43859732  0.031886666
## default_dummy       -0.011688999  0.07355946 -0.06880501  0.059004928
## housing_dummy       -0.256101191  0.31697015  0.22466536  0.206205407
## loan_dummy          -0.018056549  0.12223324  0.01063137  0.121024200
## cell_dummy          -0.155137611 -0.37743547  0.08347566 -0.248250473
## married_dummy        0.377325484  0.22379032  0.40990646 -0.292625174
## divorced_dummy      -0.059777795 -0.24896983 -0.31775550  0.525594559
## admin_dummy         -0.118692793 -0.02269682 -0.02667375  0.214602390
## bluecollar_dummy    -0.005484778  0.41751730  0.32228852  0.145468149
## technician_dummy    -0.097685059 -0.04674918 -0.16057401 -0.051013476
## services_dummy      -0.084735874  0.08390258 -0.02225662  0.143199790
## management_dummy    -0.014553299 -0.22637577 -0.10108961 -0.423658222
## retired_dummy        0.448368496 -0.25464810  0.06962613  0.248685264
## entrepreneur_dummy   0.046291161  0.02949425  0.01538236  0.008088858
## selfemployed_dummy   0.018603913 -0.01428582 -0.01226736 -0.074764293
## housemaid_dummy      0.135388675 -0.03314405 -0.04067568 -0.005552555
## unemployed_dummy     0.015204401 -0.05129622 -0.04771282 -0.004344841
## student_dummy       -0.212304260 -0.08086513 -0.11711951 -0.122560143
##                             PC5         PC6         PC7          PC8
## age                  0.05045844 -0.090007424  0.07343767  0.0029022871
## balance             -0.20316286  0.108831230  0.08869295  0.0369876194
## day                  0.23299774 -0.204016399  0.17551554  0.1838922279
## duration            -0.16835993  0.199240499 -0.05544368 -0.2600908646
## campaign             0.23357320 -0.259229849  0.22022006  0.2233641536
## pdays                0.10406098 -0.071142929  0.07473538  0.0280133584
## previous             0.13165009 -0.093079877  0.09362569  0.0569267720
## default_dummy        0.14524402 -0.199070450 -0.08027030 -0.1205427310
## housing_dummy       -0.03576172 -0.180480835  0.10334660 -0.0613144125
## loan_dummy           0.30823708 -0.282779230 -0.20115497 -0.1188024046
## cell_dummy           0.19185804 -0.030387100 -0.06894623 -0.0314369971
## married_dummy        0.13525628  0.001571138 -0.17662366 -0.0145079214
## divorced_dummy      -0.07128989 -0.210401979  0.25814558 -0.0265230546
## admin_dummy          0.03110704 -0.107824160 -0.44336056  0.6689262746
## bluecollar_dummy    -0.20852017  0.050528440  0.43721502  0.0917732995
## technician_dummy     0.61663938  0.341504993  0.31142644 -0.1607766706
## services_dummy       0.03130057 -0.110199160 -0.37625264 -0.5135887546
## management_dummy    -0.36771755 -0.508552464  0.12128887 -0.1541152341
## retired_dummy        0.02306536  0.075265038  0.03780626  0.0002201704
## entrepreneur_dummy   0.09763562 -0.078029069 -0.21313877 -0.0920294502
## selfemployed_dummy   0.01471725  0.105492017 -0.14845733  0.0418563401
## housemaid_dummy      0.01626816  0.080068700 -0.09485817  0.1016528877
## unemployed_dummy    -0.09127054  0.192415138 -0.08805854 -0.0423535915
## student_dummy       -0.18301211  0.390586165 -0.05655534  0.1316410580
##                             PC9        PC10         PC11          PC12
## age                 -0.02055961  0.01899410  0.003017453  0.0061180216
## balance             -0.06349185  0.28109715  0.186985066 -0.1570666075
## day                 -0.25370231 -0.05582818  0.187984088  0.0404964573
```

```
## duration             0.27380295  0.09689058  0.172574465  0.0702481546
## campaign            -0.33309209 -0.11620390  0.123069087  0.0084341860
## pdays               -0.10560222 -0.05965036  0.025312617  0.0327996841
## previous            -0.14273017 -0.09073198  0.031277498  0.0259227801
## default_dummy        0.26788782 -0.46161857 -0.000198242  0.0905748007
## housing_dummy       -0.01429705  0.26378799  0.089905643 -0.0221716052
## loan_dummy           0.24570045 -0.17099519 -0.044743674 -0.0592999846
## cell_dummy           0.10782075 -0.12818491  0.027332335  0.0805791579
## married_dummy        0.02930515  0.08186986 -0.049544742  0.0483345935
## divorced_dummy      -0.01103252 -0.04156962  0.101297102  0.0367078636
## admin_dummy          0.12267870  0.29063350 -0.043401009  0.0214157028
## bluecollar_dummy     0.05352306 -0.24481249  0.010733462  0.0154211106
## technician_dummy     0.17669076  0.31086242 -0.095081041 -0.0199198864
## services_dummy      -0.59822048  0.11051397 -0.048043636  0.0163644902
## management_dummy     0.18907075  0.11586201 -0.121895314  0.0008360632
## retired_dummy       -0.08515263 -0.07915230 -0.047755350 -0.2067772045
## entrepreneur_dummy   0.22329742 -0.20765619  0.137250169 -0.4563233943
## selfemployed_dummy  -0.07000420 -0.11898191  0.761619747 -0.0437733631
## housemaid_dummy     -0.13363741 -0.19801333 -0.354153598  0.4021783703
## unemployed_dummy     0.07287735 -0.12818443  0.251120230  0.6407257567
## student_dummy       -0.20214602 -0.40023847 -0.204254071 -0.3434643188
##                            PC13         PC14         PC15         PC16
## age                  0.00608206 -0.004366293  0.0337528061 -0.006569485
## balance              0.22759641 -0.105046637 -0.0520671815  0.371870157
## day                  0.08560075  0.152146462 -0.4412207944  0.058281117
## duration            -0.09912347  0.045680280 -0.7425113763  0.174578677
## campaign             0.11270968  0.081091964 -0.0904947294  0.062386121
## pdays                0.04785529 -0.019203409 -0.0006823068  0.043047490
## previous             0.06629664 -0.029377127  0.0032209294  0.122485125
## default_dummy       -0.13009310  0.078299387  0.1514064688  0.737797404
## housing_dummy        0.10524623 -0.078688089  0.0381481909  0.110299856
## loan_dummy          -0.16464085  0.062435569 -0.1247403804 -0.344748580
## cell_dummy          -0.08273178  0.075980512 -0.2120860907 -0.227977287
## married_dummy       -0.00770238  0.024366132  0.0173287855  0.012932230
## divorced_dummy       0.07179413 -0.132889375 -0.0155413006 -0.088530731
## admin_dummy         -0.04896376  0.123996856 -0.0869130468  0.127403587
## bluecollar_dummy    -0.06833214  0.046445448 -0.1374761952 -0.115721043
## technician_dummy    -0.01957358 -0.046238958  0.1130159712  0.092217511
## services_dummy      -0.01559822  0.099301632 -0.0567885916  0.070887107
## management_dummy    -0.09814717 -0.004809872  0.0920088209 -0.030629021
## retired_dummy       -0.14461331  0.276117409 -0.0039226996  0.011479493
## entrepreneur_dummy   0.68685598 -0.206269448 -0.0540121843 -0.085186116
## selfemployed_dummy  -0.38427914 -0.347563449  0.1809395855 -0.078377842
## housemaid_dummy      0.06064025 -0.692640876 -0.1893910616  0.035271397
## unemployed_dummy     0.42552982  0.377046144  0.1832868628 -0.110438590
## student_dummy       -0.04496363  0.156838269 -0.0209128774  0.025368516
##                            PC17         PC18         PC19         PC20
## age                 -0.037160967 -0.011395055  0.004270038 -0.002653752
## balance              0.709471260 -0.015272643 -0.057394328 -0.072379184
## day                 -0.009013789  0.128366794  0.624361632  0.106462164
```

```
## duration             -0.216033306 -0.232989994 -0.179382182  0.034209294
## campaign             -0.108187382 -0.287716654 -0.633312446 -0.171195787
## pdays                -0.022939603 -0.023669722  0.035965672 -0.081862029
## previous             -0.049672329 -0.252250229  0.027563398  0.414908550
## default_dummy         0.029351020  0.129669889  0.008551487 -0.050989400
## housing_dummy        -0.100569900 -0.197716946  0.244515968 -0.632498855
## loan_dummy            0.543946751 -0.420771568  0.052726883  0.022011974
## cell_dummy            0.119496681  0.505831845 -0.168427786 -0.439011235
## married_dummy        -0.053923228 -0.003352423  0.025539755 -0.028841388
## divorced_dummy        0.053592619  0.070698139 -0.036412103 -0.003909470
## admin_dummy          -0.008312730  0.069075030 -0.079474086  0.050373512
## bluecollar_dummy      0.190613253  0.284032462 -0.124411796  0.129833453
## technician_dummy     -0.023419725 -0.059094194  0.006253981  0.037674849
## services_dummy        0.078145011  0.170717871 -0.092914027  0.089732118
## management_dummy     -0.116261327 -0.159929886  0.076553883  0.014664990
## retired_dummy        -0.100774374 -0.095893822  0.117041096 -0.302847161
## entrepreneur_dummy   -0.172236441  0.094384520 -0.017606901  0.040395179
## selfemployed_dummy   -0.060090151 -0.058492199  0.051416395 -0.017525563
## housemaid_dummy       0.039720413 -0.102089975  0.076401366 -0.148963882
## unemployed_dummy      0.061637150 -0.174740024  0.061557886 -0.066020916
## student_dummy         0.039035968 -0.286235907  0.126297701 -0.167598278
##                              PC21         PC22         PC23         PC24
## age                  -0.451782216 -0.004216847  0.588238871 -4.830154e-03
## balance               0.043605841  0.005528825 -0.042296191 -4.965605e-05
## day                  -0.015452288 -0.056296283  0.009143914  1.183824e-03
## duration             -0.057922928 -0.033580808 -0.003434896  3.072494e-04
## campaign              0.024397810 -0.043478170 -0.003245432 -1.064625e-03
## pdays                -0.044950180 -0.723831081 -0.054510085 -4.102001e-04
## previous              0.084281044  0.564649925  0.006781896  3.270630e-04
## default_dummy        -0.027986450 -0.002612256  0.003942272  3.859072e-04
## housing_dummy        -0.065209293  0.232041590  0.127320981  6.805888e-03
## loan_dummy            0.020819921 -0.047439392  0.031579455  2.413718e-03
## cell_dummy           -0.063014058  0.276869517  0.068198534  3.527206e-03
## married_dummy        -0.406121507  0.068971605 -0.562689452  5.148771e-04
## divorced_dummy       -0.362858870  0.078914538 -0.499066462  2.035925e-03
## admin_dummy          -0.068071222  0.004166520  0.013590402 -3.464943e-01
## bluecollar_dummy      0.017171577  0.020748067  0.052998977 -4.470567e-01
## technician_dummy     -0.087987251 -0.021730367  0.007402561 -4.065986e-01
## services_dummy       -0.051923971  0.005764780  0.039950310 -3.147110e-01
## management_dummy     -0.041621190 -0.037921994  0.003559673 -4.416887e-01
## retired_dummy         0.515997779  0.045103915 -0.236810805 -2.341232e-01
## entrepreneur_dummy    0.062639086 -0.016504655  0.016138950 -1.940375e-01
## selfemployed_dummy   -0.016697782 -0.006007378  0.008764985 -1.995174e-01
## housemaid_dummy       0.129384326  0.007279696 -0.008482480 -1.766470e-01
## unemployed_dummy     -0.008035671  0.005774988  0.003961449 -1.816088e-01
## student_dummy        -0.412647180  0.049405350  0.018443658 -1.551608e-01
```

```r
summary(bank_pca)
```

```
## Importance of components:
##                             PC1     PC2     PC3     PC4     PC5     PC6
## Standard deviation       1.33845 1.2850 1.24822 1.17257 1.11445 1.09587
## Proportion of Variance   0.07464 0.0688 0.06492 0.05729 0.05175 0.05004
## Cumulative Proportion    0.07464 0.1434 0.20837 0.26566 0.31741 0.36744
##                             PC7     PC8     PC9    PC10    PC11    PC12
## Standard deviation       1.0733 1.05902 1.04666 1.04301 1.02140 1.01736
## Proportion of Variance   0.0480 0.04673 0.04565 0.04533 0.04347 0.04313
## Cumulative Proportion    0.4154 0.46217 0.50782 0.55314 0.59661 0.63974
##                            PC13    PC14    PC15    PC16    PC17    PC18
## Standard deviation       1.01417 1.0123 0.98721 0.95731 0.94523 0.91926
## Proportion of Variance   0.04286 0.0427 0.04061 0.03818 0.03723 0.03521
## Cumulative Proportion    0.68259 0.7253 0.76590 0.80408 0.84131 0.87652
##                            PC19    PC20    PC21   PC22    PC23    PC24
## Standard deviation       0.9086 0.83749 0.76847 0.7099 0.57852 0.08595
## Proportion of Variance   0.0344 0.02922 0.02461 0.0210 0.01395 0.00031
## Cumulative Proportion    0.9109 0.94014 0.96475 0.9858 0.99969 1.00000
```

```r
plot(bank_pca)
(eigen_bank <- bank_pca$sdev^2)
```

```
##  [1] 1.791447466 1.651313604 1.558058286 1.374921481 1.242001025
##  [6] 1.200936637 1.151888232 1.121516977 1.095497180 1.087860709
## [11] 1.043259127 1.035017703 1.028535131 1.024738242 0.974581823
## [16] 0.916439276 0.893461825 0.845033004 0.825488681 0.701397824
## [21] 0.590552567 0.503980892 0.334684406 0.007387903
```

```r
names(eigen_bank) <- paste("PC",1:24,sep="")
eigen_bank
```

```
##          PC1          PC2          PC3          PC4          PC5          PC6
## 1.791447466 1.651313604 1.558058286 1.374921481 1.242001025 1.200936637
##          PC7          PC8          PC9         PC10         PC11         PC12
## 1.151888232 1.121516977 1.095497180 1.087860709 1.043259127 1.035017703
##         PC13         PC14         PC15         PC16         PC17         PC18
## 1.028535131 1.024738242 0.974581823 0.916439276 0.893461825 0.845033004
##         PC19         PC20         PC21         PC22         PC23         PC24
## 0.825488681 0.701397824 0.590552567 0.503980892 0.334684406 0.007387903
```

```r
head(bank_pca$x)
```

```
##              PC1        PC2        PC3        PC4        PC5        PC6
## [1,]  1.29181970 0.09754913  0.4996106 -0.3536200 -1.6855612 -0.7630621
## [2,] -0.54648140 0.48919637 -0.7014667  0.9386638  0.7378376  1.3554017
## [3,]  0.10724104 1.80356047  0.5513918  0.6028371  0.7512374 -0.7288926
## [4,]  0.70107847 1.95630133  1.3861299  0.7967369 -1.1881234  0.5499114
## [5,] -0.36223921 0.18602263 -0.8376523  0.4469301 -0.9205231  0.9338749
## [6,] -0.02328569 0.68364065  0.2192581 -0.7658717 -1.5875162 -0.7308372
##              PC7        PC8       PC9       PC10       PC11       PC12
## [1,]  0.02445074 -0.69917008 0.7147376  1.18502447 -0.5740131 -0.1948376
## [2,]  0.78526608 -0.63903878 0.6168238  1.30272649 -0.6349214 -0.2779303
```

```
## [3,] -2.21260638 -1.00613898 2.0680727 -1.04227846  0.1106891 -2.8715414
## [4,]  0.73177730  0.06296081 0.2350184  0.16245768 -0.4037046 -0.1789498
## [5,] -0.34264621 -0.13645572 0.2448891 -0.06414585 -0.5349175 -0.1721052
## [6,] -0.16404386 -0.60546901 0.6694297  0.92146462 -0.7797231 -0.1427361
##             PC13       PC14      PC15        PC16        PC17       PC18
## [1,] -0.10201278 -0.4251133 1.2610833  0.35644573 -0.63547357 -1.0866594
## [2,] -0.02102612 -0.5275520 1.6105391  0.32786702 -0.65343429 -0.7195127
## [3,]  3.43844715 -1.3482848 0.8825167 -1.35714665 -0.08868156 -1.1063933
## [4,] -0.01583416 -0.3037606 1.1635790 -0.03536626  0.14597205  0.1655044
## [5,] -0.20697550 -0.2316946 1.0615040 -0.10550810 -0.39585073 -0.1941234
## [6,] -0.21115020 -0.3713310 1.5724255  0.05445035 -0.89816279 -0.9420118
##             PC19       PC20        PC21        PC22       PC23
## [1,]  0.16904841 -0.10576287 -0.986027847  0.03462465  0.6805872
## [2,]  0.05622714  0.05700325  0.300740977 -0.05509552  1.0964283
## [3,]  0.18502281  0.17725006  0.598859767 -0.06384403 -0.5042805
## [4,] -0.19656428  0.16951665 -0.345028865  0.20358858  0.2025300
## [5,] -0.48923760  1.23884612  1.124331478 -0.46578809  0.2107922
## [6,]  0.28082078 -0.07076961 -0.007420435  0.05619476 -0.5653373
##             PC24
## [1,] -0.0149767816
## [2,] -0.0112826192
## [3,]  0.0007625259
## [4,] -0.0119549921
## [5,]  1.0675303226
## [6,] -0.0046291489
```

```r
dim(bank_pca$x)
```

```
## [1] 45211    24
```

```r
# Identifying the scores by their fixed deposit status
jobtyp_pca <- data.frame((bank$y),bank_pca$x)
head(jobtyp_pca)
```

```
##   X.bank.y.         PC1        PC2        PC3        PC4        PC5
## 1        no  1.29181970 0.09754913  0.4996106 -0.3536200 -1.6855612
## 2        no -0.54648140 0.48919637 -0.7014667  0.9386638  0.7378376
## 3        no  0.10724104 1.80356047  0.5513918  0.6028371  0.7512374
## 4        no  0.70107847 1.95630133  1.3861299  0.7967369 -1.1881234
## 5        no -0.36223921 0.18602263 -0.8376523  0.4469301 -0.9205231
## 6        no -0.02328569 0.68364065  0.2192581 -0.7658717 -1.5875162
##         PC6        PC7         PC8       PC9       PC10       PC11
## 1 -0.7630621  0.02445074 -0.69917008 0.7147376  1.18502447 -0.5740131
## 2  1.3554017  0.78526608 -0.63903878 0.6168238  1.30272649 -0.6349214
## 3 -0.7288926 -2.21260638 -1.00613898 2.0680727 -1.04227846  0.1106891
## 4  0.5499114  0.73177730  0.06296081 0.2350184  0.16245768 -0.4037046
## 5  0.9338749 -0.34264621 -0.13645572 0.2448891 -0.06414585 -0.5349175
## 6 -0.7308372 -0.16404386 -0.60546901 0.6694297  0.92146462 -0.7797231
##         PC12        PC13       PC14      PC15        PC16        PC17
## 1 -0.1948376 -0.10201278 -0.4251133 1.2610833  0.35644573 -0.63547357
## 2 -0.2779303 -0.02102612 -0.5275520 1.6105391  0.32786702 -0.65343429
```

```
## 3 -2.8715414  3.43844715 -1.3482848 0.8825167 -1.35714665 -0.08868156
## 4 -0.1789498 -0.01583416 -0.3037606 1.1635790 -0.03536626  0.14597205
## 5 -0.1721052 -0.20697550 -0.2316946 1.0615040 -0.10550810 -0.39585073
## 6 -0.1427361 -0.21115020 -0.3713310 1.5724255  0.05445035 -0.89816279
##           PC18         PC19         PC20         PC21         PC22         PC23
## 1 -1.0866594  0.16904841 -0.10576287 -0.986027847  0.03462465  0.6805872
## 2 -0.7195127  0.05622714  0.05700325  0.300740977 -0.05509552  1.0964283
## 3 -1.1063933  0.18502281  0.17725006  0.598859767 -0.06384403 -0.5042805
## 4  0.1655044 -0.19656428  0.16951665 -0.345028865  0.20358858  0.2025300
## 5 -0.1941234 -0.48923760  1.23884612  1.124331478 -0.46578809  0.2107922
## 6 -0.9420118  0.28082078 -0.07076961 -0.007420435  0.05619476 -0.5653373
##           PC24
## 1 -0.0149767816
## 2 -0.0112826192
## 3  0.0007625259
## 4 -0.0119549921
## 5  1.0675303226
## 6 -0.0046291489

# Means of scores for all the PC's classified by Survival status
tabmeansPC <- aggregate(jobtyp_pca[,2:25],by=list(y=bank$y),mean)
tabmeansPC

##     y          PC1         PC2          PC3          PC4          PC5
## 1  no  0.008469446  0.1080954 -0.01877773  0.004302355  0.03554775
## 2 yes -0.063928385 -0.8159171  0.14173654 -0.032474683 -0.26831865
##            PC6          PC7          PC8          PC9          PC10         PC11
## 1 -0.05612354  0.01339727  0.02935573 -0.03583849  0.001314019 -0.01925154
## 2  0.42362713 -0.10112421 -0.22158050  0.27051317 -0.009918370  0.14531288
##            PC12         PC13         PC14         PC15         PC16         PC17
## 1 -0.003168746  0.02056883 -0.02240821  0.1043351 -0.02350089  0.02628173
## 2  0.023918072 -0.15525594  0.16913983 -0.7875340  0.17738753 -0.19837765
##            PC18         PC19         PC20         PC21         PC22
## 1  0.01537703  0.02477039 -0.01122966  0.000670917  0.007625051
## 2 -0.11606766 -0.18696982  0.08476284 -0.005064162 -0.057554790
##            PC23         PC24
## 1 -0.002090892  0.0001265467
## 2  0.015782304 -0.0009551897

tabmeansPC <- tabmeansPC[rev(order(tabmeansPC$y)),]
tabmeansPC

##     y          PC1         PC2          PC3          PC4          PC5
## 2 yes -0.063928385 -0.8159171  0.14173654 -0.032474683 -0.26831865
## 1  no  0.008469446  0.1080954 -0.01877773  0.004302355  0.03554775
##            PC6          PC7          PC8          PC9          PC10         PC11
## 2  0.42362713 -0.10112421 -0.22158050  0.27051317 -0.009918370  0.14531288
## 1 -0.05612354  0.01339727  0.02935573 -0.03583849  0.001314019 -0.01925154
##            PC12         PC13         PC14         PC15         PC16         PC17
## 2  0.023918072 -0.15525594  0.16913983 -0.7875340  0.17738753 -0.19837765
## 1 -0.003168746  0.02056883 -0.02240821  0.1043351 -0.02350089  0.02628173
```

```
##               PC18        PC19        PC20         PC21         PC22
## 2 -0.11606766 -0.18696982  0.08476284 -0.005064162 -0.057554790
## 1  0.01537703  0.02477039 -0.01122966  0.000670917  0.007625051
##               PC23         PC24
## 2  0.015782304 -0.0009551897
## 1 -0.002090892  0.0001265467

tabfmeans <- t(tabmeansPC[,-1])
tabfmeans

##                  2            1
## PC1   -0.0639283850  0.0084694461
## PC2   -0.8159171247  0.1080954279
## PC3    0.1417365351 -0.0187777299
## PC4   -0.0324746835  0.0043023546
## PC5   -0.2683186490  0.0355477515
## PC6    0.4236271341 -0.0561235387
## PC7   -0.1011242098  0.0133972733
## PC8   -0.2215805050  0.0293557259
## PC9    0.2705131742 -0.0358384895
## PC10  -0.0099183697  0.0013140188
## PC11   0.1453128776 -0.0192515357
## PC12   0.0239180724 -0.0031687462
## PC13  -0.1552559395  0.0205688258
## PC14   0.1691398279 -0.0224082097
## PC15  -0.7875340254  0.1043351400
## PC16   0.1773875282 -0.0235008927
## PC17  -0.1983776471  0.0262817338
## PC18  -0.1160676580  0.0153770313
## PC19  -0.1869698201  0.0247703867
## PC20   0.0847628374 -0.0112296640
## PC21  -0.0050641615  0.0006709170
## PC22  -0.0575547895  0.0076250509
## PC23   0.0157823037 -0.0020908924
## PC24  -0.0009551897  0.0001265467

colnames(tabfmeans) <- t(as.vector(tabmeansPC[1]))
tabfmeans

##                yes           no
## PC1   -0.0639283850  0.0084694461
## PC2   -0.8159171247  0.1080954279
## PC3    0.1417365351 -0.0187777299
## PC4   -0.0324746835  0.0043023546
## PC5   -0.2683186490  0.0355477515
## PC6    0.4236271341 -0.0561235387
## PC7   -0.1011242098  0.0133972733
## PC8   -0.2215805050  0.0293557259
## PC9    0.2705131742 -0.0358384895
## PC10  -0.0099183697  0.0013140188
## PC11   0.1453128776 -0.0192515357
```
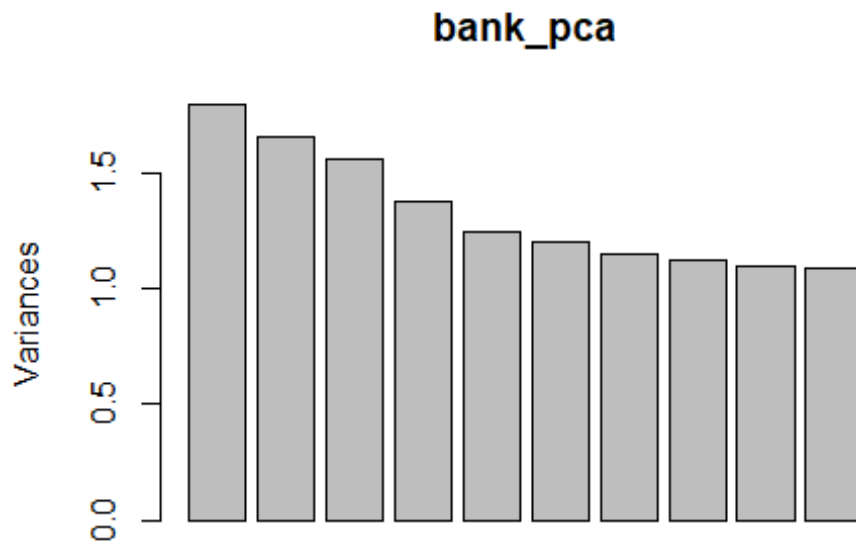
```
## PC12   0.0239180724 -0.0031687462
## PC13  -0.1552559395  0.0205688258
## PC14   0.1691398279 -0.0224082097
## PC15  -0.7875340254  0.1043351400
## PC16   0.1773875282 -0.0235008927
## PC17  -0.1983776471  0.0262817338
## PC18  -0.1160676580  0.0153770313
## PC19  -0.1869698201  0.0247703867
## PC20   0.0847628374 -0.0112296640
## PC21  -0.0050641615  0.0006709170
## PC22  -0.0575547895  0.0076250509
## PC23   0.0157823037 -0.0020908924
## PC24  -0.0009551897  0.0001265467
```

```r
# Standard deviations of scores for all the PC's classified by Survival
status
tabsdsPC <- aggregate(jobtyp_pca[,2:25],by=list(y=bank$y),sd)
tabfsds <- t(tabsdsPC[,-1])
colnames(tabfsds) <- t(as.vector(tabsdsPC[1]))
tabfsds
```

```
##                 no        yes
## PC1   1.28476771 1.68826923
## PC2   1.24695524 1.27492988
## PC3   1.23925152 1.30539417
## PC4   1.16170608 1.25117631
## PC5   1.11382274 1.08224584
## PC6   1.07066853 1.18748749
## PC7   1.08430963 0.98007798
## PC8   1.05207177 1.08480619
## PC9   1.04383899 1.02826924
## PC10 1.03278502 1.11719325
## PC11 1.01060916 1.08861504
## PC12 0.99931240 1.14424863
## PC13 1.01802624 0.97068137
## PC14 1.01090791 1.00682254
## PC15 0.88502357 1.31017633
## PC16 0.96805206 0.85135680
## PC17 0.93631498 0.98777708
## PC18 0.91774413 0.92244838
## PC19 0.91092635 0.86810144
## PC20 0.83709260 0.83575060
## PC21 0.75403431 0.86983129
## PC22 0.69194168 0.83099323
## PC23 0.57875666 0.57653320
## PC24 0.08586204 0.08663796
```

```r
plot(bank_pca)
```

bank_pca


```r
summary(bank_pca)
```

```
## Importance of components:
##                            PC1     PC2     PC3     PC4     PC5     PC6
## Standard deviation     1.33845  1.2850 1.24822 1.17257 1.11445 1.09587
## Proportion of Variance 0.07464  0.0688 0.06492 0.05729 0.05175 0.05004
## Cumulative Proportion  0.07464  0.1434 0.20837 0.26566 0.31741 0.36744
##                            PC7     PC8     PC9    PC10    PC11    PC12
## Standard deviation      1.0733 1.05902 1.04666 1.04301 1.02140 1.01736
## Proportion of Variance  0.0480 0.04673 0.04565 0.04533 0.04347 0.04313
## Cumulative Proportion   0.4154 0.46217 0.50782 0.55314 0.59661 0.63974
##                           PC13    PC14    PC15    PC16    PC17    PC18
## Standard deviation     1.01417  1.0123 0.98721 0.95731 0.94523 0.91926
## Proportion of Variance 0.04286  0.0427 0.04061 0.03818 0.03723 0.03521
## Cumulative Proportion  0.68259  0.7253 0.76590 0.80408 0.84131 0.87652
##                           PC19    PC20    PC21    PC22    PC23    PC24
## Standard deviation      0.9086 0.83749 0.76847  0.7099 0.57852 0.08595
## Proportion of Variance  0.0344 0.02922 0.02461  0.0210 0.01395 0.00031
## Cumulative Proportion   0.9109 0.94014 0.96475  0.9858 0.99969 1.00000
```

```r
plot(eigen_bank, xlab = "Component number", ylab = "Component variance", type
= "l", main = "Scree diagram")
```
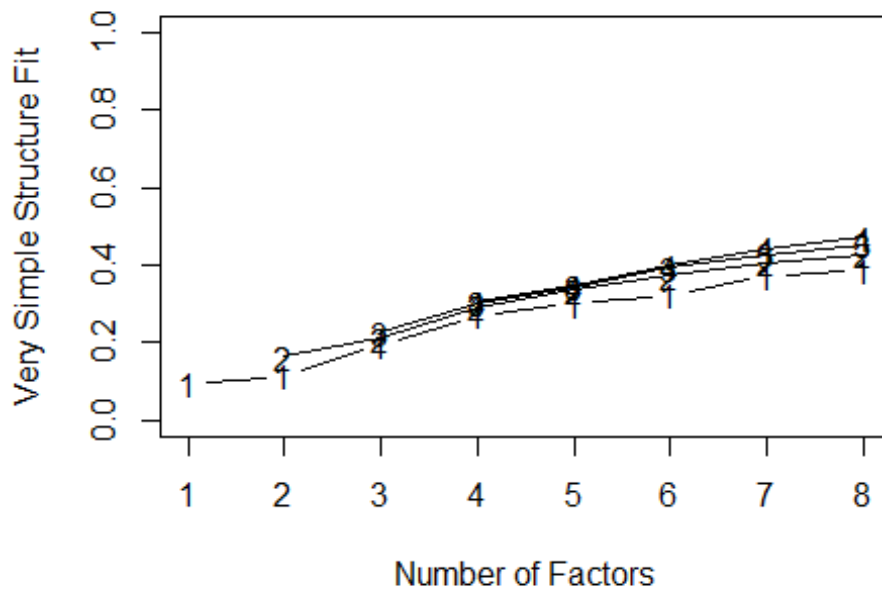
Scree diagram
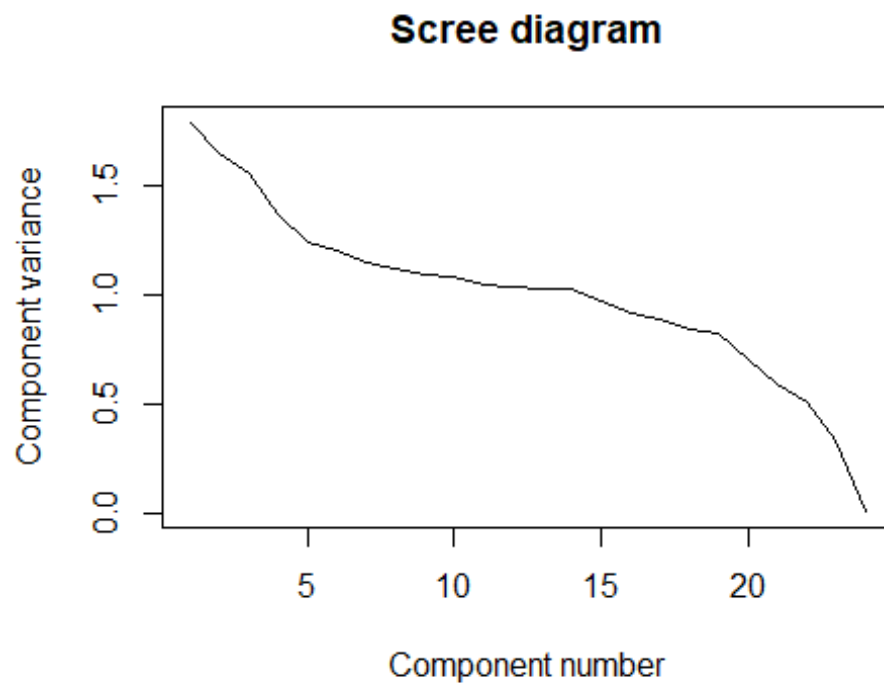

```r
#Can take till PC16 i.e. here 24 features reduced to 16
```

```r
library(psych)
```

```r
vss(bank1)
```

Very Simple Structure


```
## 
## Very Simple Structure
## Call: vss(x = bank1)
## VSS complexity 1 achieves a maximimum of 0.39   with   8   factors
## VSS complexity 2 achieves a maximimum of 0.43   with   8   factors
## 
## The Velicer MAP achieves a minimum of 0.01   with   1   factors
## BIC achieves a minimum of   127809   with   8   factors
## Sample Size adjusted BIC achieves a minimum of   128164.9   with   8   factors
## 
## Statistics by number of factors
##    vss1 vss2    map dof  chisq prob sqresid    fit RMSEA    BIC  SABIC
## 1 0.094 0.00 0.0088 252 222228    0      25 0.094  0.14 219527 220328
## 2 0.115 0.17 0.0111 229 210450    0      23 0.165  0.14 207995 208723
## 3 0.195 0.21 0.0130 207 195959    0      21 0.227  0.14 193740 194398
## 4 0.271 0.29 0.0151 186 181482    0      19 0.305  0.15 179488 180079
## 5 0.301 0.34 0.0189 166 176060    0      18 0.348  0.15 174281 174808
## 6 0.323 0.37 0.0238 147 159723    0      17 0.400  0.15 158147 158614
## 7 0.372 0.41 0.0302 129 148403    0      15 0.449  0.16 147020 147430
## 8 0.390 0.43 0.0372 112 129010    0      14 0.490  0.16 127809 128165
##   complex eChisq  SRMR eCRMS   eBIC
## 1     1.0 125527 0.071 0.074 122826
## 2     1.4 101991 0.064 0.070  99536
## 3     1.6  83571 0.058 0.067  81352
## 4     1.6  55607 0.047 0.058  53613
## 5     1.7  49688 0.045 0.058  47909
## 6     1.7  33856 0.037 0.050  32280
```

```
## 7      1.7  27018 0.033 0.048   25635
## 8      1.9  18021 0.027 0.042   16820
```

#therefore choosing 8 Factors

#Oblique rotation
fit.pc <- **fa**(bank1, nfactors=8, rotate="oblimin")

fit.pc

```
## Factor Analysis using method =  minres
## Call: fa(r = bank1, nfactors = 8, rotate = "oblimin")
## Standardized loadings (pattern matrix) based upon correlation matrix
##                     MR1    MR7    MR2    MR4    MR3    MR8    MR5    MR6     h2
## age                0.99   0.03   0.00   0.00   0.00   0.00   0.00  -0.01 0.9993
## balance            0.07   0.02  -0.10   0.02   0.01  -0.06  -0.06  -0.07 0.0224
## day               -0.01   0.02  -0.01  -0.11   0.03   0.04   0.00   0.00 0.0150
## duration           0.00  -0.03  -0.01   0.02  -0.03  -0.03  -0.03  -0.02 0.0024
## campaign          -0.01   0.04   0.03  -0.11   0.05   0.05   0.01   0.02 0.0160
## pdays              0.00   0.00   0.01   0.95   0.00   0.00   0.00   0.00 0.8968
## previous           0.01   0.01  -0.04   0.48   0.01  -0.01  -0.01  -0.02 0.2344
## default_dummy     -0.01  -0.02   0.03  -0.04   0.01   0.01   0.01   0.02 0.0027
## housing_dummy     -0.12   0.02   0.32   0.08   0.10   0.13   0.16   0.18 0.1361
## loan_dummy         0.01   0.03   0.08  -0.03   0.03   0.07   0.08   0.08 0.0133
## cell_dummy        -0.07   0.00  -0.19   0.24   0.02  -0.01  -0.06  -0.09 0.0984
## married_dummy      0.05   0.99   0.02   0.00   0.01   0.01   0.01   0.01 1.0005
## divorced_dummy     0.30  -0.52   0.08  -0.01   0.06   0.06   0.07   0.08 0.2901
## admin_dummy       -0.01   0.00  -0.03   0.00  -0.02  -0.02   0.99  -0.02 1.0042
## bluecollar_dummy  -0.01   0.00   0.97   0.00  -0.04  -0.04  -0.04  -0.04 1.0001
## technician_dummy  -0.01   0.00  -0.03   0.00  -0.03   0.99  -0.02  -0.02 1.0150
## services_dummy    -0.01   0.00  -0.03   0.00  -0.02  -0.02  -0.02   0.99 0.9985
## management_dummy  -0.01   0.00  -0.03   0.00   0.99  -0.03  -0.02  -0.02 1.0250
## retired_dummy      0.42  -0.02  -0.17   0.02  -0.17  -0.14  -0.12  -0.10 0.2444
## entrepreneur_dummy -0.02  0.04  -0.09  -0.01  -0.09  -0.08  -0.06  -0.05 0.0136
## selfemployed_dummy -0.05  0.03  -0.13  -0.01  -0.13  -0.12  -0.09  -0.09 0.0258
## housemaid_dummy    0.04   0.02  -0.11  -0.03  -0.10  -0.09  -0.07  -0.07 0.0234
## unemployed_dummy  -0.03  -0.01  -0.12  -0.01  -0.12  -0.11  -0.09  -0.08 0.0233
## student_dummy     -0.23  -0.09  -0.21   0.03  -0.20  -0.19  -0.17  -0.15 0.1155
##                        u2 com
## age                0.00071 1.0
## balance            0.97764 4.6
## day                0.98499 1.6
## duration           0.99758 5.3
## campaign           0.98402 2.4
## pdays              0.10319 1.0
## previous           0.76563 1.0
## default_dummy      0.99727 3.4
## housing_dummy      0.86390 3.4
## loan_dummy         0.98667 4.6
## cell_dummy         0.90163 2.6
```

```
## married_dummy        -0.00051 1.0
## divorced_dummy        0.70992 1.8
## admin_dummy          -0.00420 1.0
## bluecollar_dummy     -0.00012 1.0
## technician_dummy     -0.01503 1.0
## services_dummy        0.00147 1.0
## management_dummy     -0.02504 1.0
## retired_dummy         0.75563 2.4
## entrepreneur_dummy   0.98637 4.9
## selfemployed_dummy   0.97419 5.0
## housemaid_dummy       0.97659 5.2
## unemployed_dummy      0.97672 4.8
## student_dummy         0.88454 6.1
##
##                         MR1  MR7  MR2  MR4  MR3  MR8  MR5  MR6
## SS loadings           1.33 1.24 1.17 1.22 1.08 1.07 1.06 1.06
## Proportion Var        0.06 0.05 0.05 0.05 0.04 0.04 0.04 0.04
## Cumulative Var        0.06 0.11 0.16 0.21 0.25 0.30 0.34 0.38
## Proportion Explained  0.14 0.14 0.13 0.13 0.12 0.12 0.11 0.11
## Cumulative Proportion 0.14 0.28 0.41 0.54 0.65 0.77 0.89 1.00
##
##   With factor correlations of
##        MR1   MR7   MR2   MR4   MR3   MR8   MR5   MR6
## MR1  1.00  0.21 -0.06 -0.03 -0.03 -0.07 -0.06 -0.06
## MR7  0.21  1.00  0.12 -0.03 -0.02 -0.05 -0.05 -0.01
## MR2 -0.06  0.12  1.00  0.02 -0.21 -0.19 -0.15 -0.13
## MR4 -0.03 -0.03  0.02  1.00  0.00 -0.01  0.03  0.01
## MR3 -0.03 -0.02 -0.21  0.00  1.00 -0.18 -0.14 -0.13
## MR8 -0.07 -0.05 -0.19 -0.01 -0.18  1.00 -0.12 -0.11
## MR5 -0.06 -0.05 -0.15  0.03 -0.14 -0.12  1.00 -0.09
## MR6 -0.06 -0.01 -0.13  0.01 -0.13 -0.11 -0.09  1.00
##
## Mean item complexity =  2.8
## Test of the hypothesis that 8 factors are sufficient.
##
## The degrees of freedom for the null model are  276  and the objective
function was  5.35 with Chi Square of  241726.1
## The degrees of freedom for the model are 112  and the objective function
was  2.85
##
## The root mean square of the residuals (RMSR) is  0.03
## The df corrected root mean square of the residuals is  0.04
##
## The harmonic number of observations is  45211 with the empirical chi
square  18021.02  with prob <  0
## The total number of observations was  45211  with Likelihood Chi Square =
129009.6  with prob <  0
##
## Tucker Lewis Index of factoring reliability =  -0.316
## RMSEA index =  0.16  and the 90 % confidence intervals are  0.159 0.16
```

```
## BIC =   127809
## Fit based upon off diagonal values = 0.89

#what are factors for each variable , what is affectin and
#Fit based upon off diagonal values = 0.89 higher the better
#residual should be less
round(fit.pc$values, 3)

##  [1]  1.577  1.398  1.257  1.206  1.165  1.109  1.011  0.562  0.261  0.213
## [11]  0.138  0.122  0.080  0.054  0.042  0.005 -0.003 -0.033 -0.048 -0.065
## [21] -0.097 -0.147 -0.183 -0.408

fit.pc$loadings

##
## Loadings:
##                       MR1     MR7     MR2     MR4     MR3     MR8     MR5     MR6
## age                 0.992
## balance
## day                                          -0.108
## duration
## campaign                                     -0.108
## pdays                                         0.947
## previous                                      0.484
## default_dummy
## housing_dummy      -0.121           0.318                   0.127   0.163   0.181
## loan_dummy
## cell_dummy                         -0.193   0.236
## married_dummy               0.987
## divorced_dummy      0.301  -0.516
## admin_dummy                                                         0.988
## bluecollar_dummy                    0.971
## technician_dummy                                          0.990
## services_dummy                                                             0.987
## management_dummy                                  0.994
## retired_dummy       0.416          -0.169           -0.173 -0.143 -0.121 -0.103
## entrepreneur_dummy
## selfemployed_dummy                 -0.133           -0.127 -0.115
## housemaid_dummy                    -0.109           -0.103
## unemployed_dummy                   -0.124           -0.120 -0.111
## student_dummy      -0.227          -0.206           -0.197 -0.193 -0.167 -0.153
##
##                      MR1    MR7    MR2    MR4    MR3    MR8    MR5    MR6
## SS loadings        1.333  1.257  1.235  1.222  1.128  1.116  1.096  1.093
## Proportion Var     0.056  0.052  0.051  0.051  0.047  0.046  0.046  0.046
## Cumulative Var     0.056  0.108  0.159  0.210  0.257  0.304  0.349  0.395

#View(fit.pc)
# Loadings with more digits
for (i in c(1,2,3,4,5,6,7,8)) { print(fit.pc$loadings[[1,i]])}
```

```
## [1] 0.9919925
## [1] 0.03003172
## [1] -0.002983055
## [1] 0.002011022
## [1] 0.001468767
## [1] -0.002941017
## [1] -0.004388868
## [1] -0.006695473
```

Communalities
fit.pc$communality

```
##                age            balance                day
##        0.999288205        0.022361350        0.015006623
##           duration           campaign              pdays
##        0.002422461        0.015976188        0.896806997
##           previous      default_dummy      housing_dummy
##        0.234369348        0.002727426        0.136103920
##         loan_dummy         cell_dummy      married_dummy
##        0.013326636        0.098368395        1.000510588
##     divorced_dummy        admin_dummy   bluecollar_dummy
##        0.290078947        1.004202170        1.000119833
##   technician_dummy     services_dummy   management_dummy
##        1.015031575        0.998527223        1.025044500
##      retired_dummy entrepreneur_dummy selfemployed_dummy
##        0.244367140        0.013634905        0.025814261
##     housemaid_dummy   unemployed_dummy      student_dummy
##        0.023408655        0.023284051        0.115458229
```

Rotated factor scores, Notice the columns ordering: MR1, MR7, MR2, MR4,
MR3m
fit.pc$scores

```
##                  MR1        MR7           MR2          MR4           MR3
##     [1,]  1.566961e+00  0.7271740 -2.756735e-01 -0.389091132  2.074649e+00
##     [2,]  3.231035e-01 -1.2902486 -3.272992e-01 -0.387805588 -3.809572e-01
##     [3,] -8.012463e-01  0.7951218 -1.187477e-01 -0.418728529 -3.028731e-01
##     [4,]  5.194126e-01  0.7787244  2.024276e+00 -0.379349316 -3.675033e-01
##     [5,]  1.664591e+00 -1.5823885 -1.295277e+01 -1.636540506 -1.501140e+01
##     [6,] -6.133475e-01  0.8526226 -3.240004e-01 -0.386638504  1.978772e+00
##     [7,] -1.161345e+00 -1.2316997 -4.095467e-01 -0.381816152  1.870837e+00
##                  MR8        MR5           MR6
##     [1,] -2.821297e-01 -1.948512e-01 -0.1662269651
##     [2,]  2.280185e+00 -2.460201e-01 -0.2098633191
##     [3,] -2.050191e-01 -9.325430e-02 -0.0457333141
##     [4,] -3.276992e-01 -2.473323e-01 -0.2176696218
##     [5,] -1.286523e+01 -1.012301e+01 -8.6933086022
##     [6,] -3.522338e-01 -2.443516e-01 -0.2032879385
##     [7,] -4.408910e-01 -3.167783e-01 -0.2616576853
##     [8,] -1.702203e-01 -4.475210e-02  0.0056285943
```

```
##      [9,] -3.588582e-01 -2.514857e-01 -0.2063120899
```

```r
fa.parallel(bank1) # See factor recommendation
```

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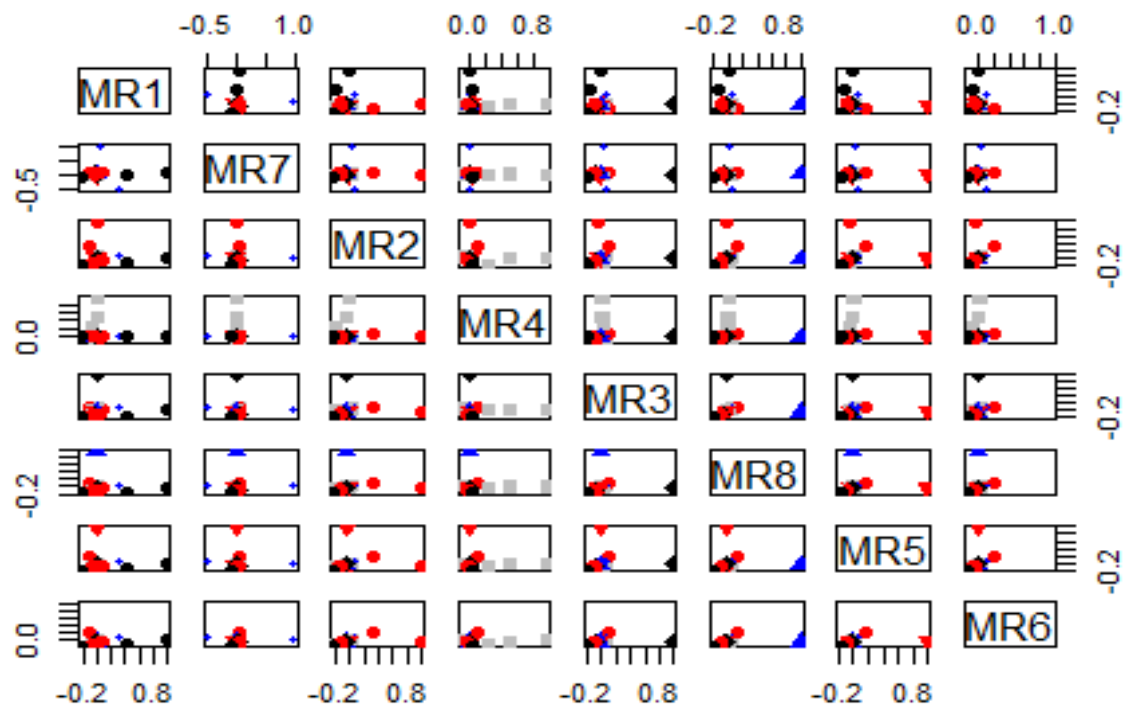
```
## Warning in fac(r = r, nfactors = nfactors, n.obs = n.obs, rotate =
## rotate, : An ultra-Heywood case was detected. Examine the results
## carefully
```


Parallel Analysis Scree Plots
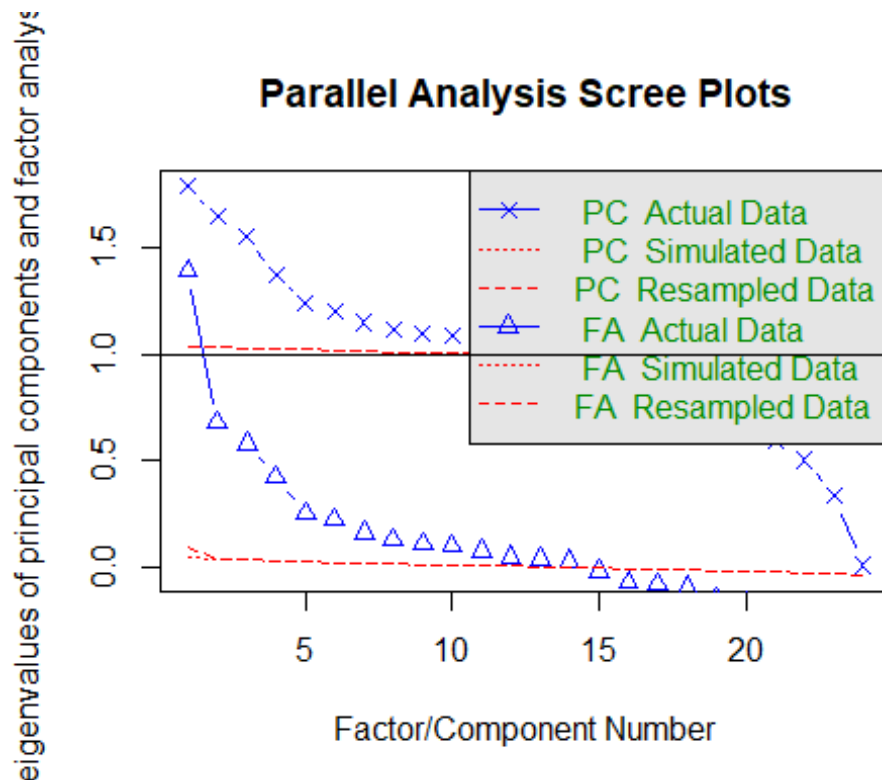
```
## Parallel analysis suggests that the number of factors =  14  and the
## number of components =  14
```

```r
fa.plot(fit.pc) # See Correlations within Factors
```

Factor Analysis

```
fa.diagram(fit.pc) # Visualize the relationship
```

Plot Zoom

Factor Analysis