Multivariate Analysis for the Behavioral Sciences, Second Edition (Chapman and Hall/CRC, 2019)
Examples of Chapter 13: Principal Components Analysis

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Contents

Examples

Table 13.1: Correlations of Blood Chemistry Variables and Their Standard Deviations

```r
blood_chem <- c(1.000, 0.290, 0.202,-0.055,-0.105,-0.252,-0.229, 0.058,
                0.290, 1.000, 0.415, 0.285,-0.376,-0.349,-0.164,-0.129,
                0.202, 0.415, 1.000, 0.419,-0.521,-0.441,-0.145,-0.076,
               -0.055, 0.285, 0.419, 1.000,-0.877,-0.076, 0.023,-0.131,
               -0.105,-0.376,-0.521,-0.877, 1.000, 0.206, 0.034, 0.151,
               -0.252,-0.349,-0.441,-0.076, 0.206, 1.000, 0.192, 0.077,
               -0.229,-0.164,-0.145, 0.023, 0.034, 0.192, 1.000, 0.423,
                0.058,-0.129,-0.076,-0.131, 0.151, 0.077, 0.423, 1.000)
blood_corr <- matrix(blood_chem, ncol = 8)
sds <- c(0.371, 41.253, 1.935, 0.077, 0.071, 4.037, 2.732, 0.297)
names <- c("rBlood", "Plate", "wBlood", "Neut.", "Lymph", "Bilir.", "Sodium", "Potass.")
dimnames(blood_corr) <- list(names, names)

blood_corr
```

```
        rBlood  Plate wBlood  Neut.  Lymph Bilir. Sodium Potass.
rBlood   1.000  0.290  0.202 -0.055 -0.105 -0.252 -0.229   0.058
Plate    0.290  1.000  0.415  0.285 -0.376 -0.349 -0.164  -0.129
wBlood   0.202  0.415  1.000  0.419 -0.521 -0.441 -0.145  -0.076
Neut.   -0.055  0.285  0.419  1.000 -0.877 -0.076  0.023  -0.131
Lymph   -0.105 -0.376 -0.521 -0.877  1.000  0.206  0.034   0.151
Bilir.  -0.252 -0.349 -0.441 -0.076  0.206  1.000  0.192   0.077
Sodium  -0.229 -0.164 -0.145  0.023  0.034  0.192  1.000   0.423
Potass.  0.058 -0.129 -0.076 -0.131  0.151  0.077  0.423   1.000
```

```r
sds
```

```
[1]  0.371 41.253  1.935  0.077  0.071  4.037  2.732  0.297
```

Table 13.2

```r
# Calculate the covariance matrix:
blood_cov <- diag(sds) %*% blood_corr %*% diag(sds)
dimnames(blood_cov) <-list(names, names)
blood_pcacov <- princomp(covmat = blood_cov)

summary(blood_pcacov, loadings = TRUE)
```

```
## Importance of components:
##                            Comp.1      Comp.2     Comp.3      Comp.4
## Standard deviation     41.2877486 3.880212624 2.64197339 1.624583979
## Proportion of Variance  0.9856182 0.008705172 0.00403574 0.001525986
## Cumulative Proportion   0.9856182 0.994323381 0.99835912 0.999885108
##                             Comp.5       Comp.6       Comp.7       Comp.8
## Standard deviation     0.353951757 2.561722e-01 8.510631e-02 2.372715e-02
## Proportion of Variance 0.000072436 3.794288e-05 4.187837e-06 3.255049e-07
## Cumulative Proportion  0.999957544 9.999955e-01 9.999997e-01 1.000000e+00
##
## Loadings:
##         Comp.1 Comp.2 Comp.3 Comp.4 Comp.5 Comp.6 Comp.7 Comp.8
## rBlood                               0.943  0.329
## Plate   -0.999
## wBlood         -0.192        -0.981
## Neut.                                              0.758  0.650
## Lymph                                             -0.649  0.760
## Bilir.          0.961  0.195 -0.191
## Sodium          0.193 -0.979
## Potass.                              0.329 -0.942
```

Table 13.3

```r
blood_pcacor <- princomp(covmat = blood_corr)
summary(blood_pcacor, loadings = TRUE)
```

```
## Importance of components:
##                           Comp.1    Comp.2    Comp.3     Comp.4     Comp.5
## Standard deviation     1.6710100 1.2375848 1.1177138 0.88227419 0.78839505
## Proportion of Variance 0.3490343 0.1914520 0.1561605 0.09730097 0.07769584
## Cumulative Proportion  0.3490343 0.5404863 0.6966468 0.79394778 0.87164363
##                            Comp.6     Comp.7     Comp.8
## Standard deviation     0.69917350 0.66002394 0.31996216
## Proportion of Variance 0.06110545 0.05445395 0.01279697
## Cumulative Proportion  0.93274908 0.98720303 1.00000000
##
## Loadings:
##         Comp.1 Comp.2 Comp.3 Comp.4 Comp.5 Comp.6 Comp.7 Comp.8
## rBlood  -0.194  0.417  0.400  0.652  0.175 -0.363  0.176  0.102
## Plate   -0.400  0.154  0.168        -0.848  0.230 -0.110
## wBlood  -0.459         0.168 -0.274  0.251  0.403  0.677
## Neut.   -0.430 -0.472 -0.171  0.169  0.118        -0.237  0.678
## Lymph    0.494  0.360        -0.180 -0.139  0.136  0.157  0.724
## Bilir.   0.319 -0.320 -0.277  0.633 -0.162  0.384  0.377
## Sodium   0.177 -0.535  0.410 -0.163 -0.299 -0.513  0.367
## Potass.  0.171 -0.245  0.709         0.198  0.469 -0.376
```

Figure 13.1

```
par(mfrow = c(2,1))
plot(1:8, blood_pcacor$sdev^2,
     xlab = "Component number", ylab = "Component variance", type = "l")
title("Scree Diagram")

plot(1:8, log(blood_pcacor$sdev^2),
     xlab = "Component number", ylab = "log(component variance)", type = "l")
title("Log(Eigenvalue) Diagram")
```

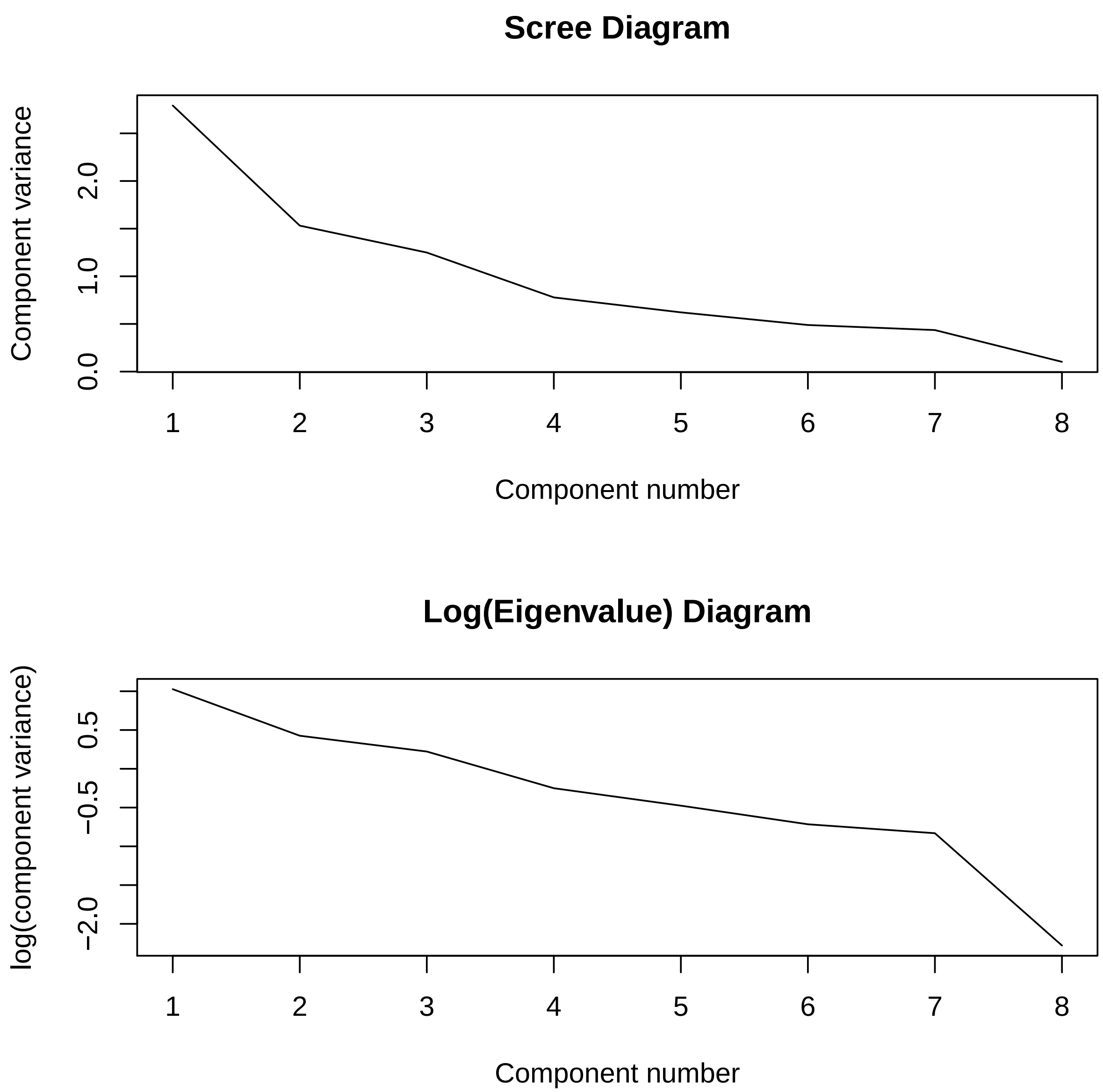

Table 13.4: Head Lengths (in Millimeters) of First and Second Sons of 25 Families

```
head_dat <- structure(
  c(191, 195, 181, 183, 176, 208, 189, 197, 188, 192, 179, 183,
    174, 190, 188, 163, 195, 186, 181, 175, 192, 174, 176, 197, 190,
    179, 201, 185, 188, 171, 192, 190, 189, 197, 187, 186, 174,
    185, 195, 187, 161, 183, 173, 182, 165, 185, 178, 176, 200, 187),
  .Dim = c(25L, 2L), .Dimnames = list(NULL, c("HLFS", "HLSS")))
head_dat
```

```
##       HLFS HLSS
##  [1,]  191  179
##  [2,]  195  201
##  [3,]  181  185
##  [4,]  183  188
##  [5,]  176  171
##  [6,]  208  192
##  [7,]  189  190
##  [8,]  197  189
##  [9,]  188  197
## [10,]  192  187
## [11,]  179  186
## [12,]  183  174
## [13,]  174  185
## [14,]  190  195
## [15,]  188  187
## [16,]  163  161
## [17,]  195  183
## [18,]  186  173
## [19,]  181  182
## [20,]  175  165
## [21,]  192  185
## [22,]  174  178
## [23,]  176  176
## [24,]  197  200
## [25,]  190  187
```

```
# get principal components
head_pc <- princomp(covmat = var(head_dat))
head_pc
```

```
## Call:
## princomp(covmat = var(head_dat))
##
## Standard deviations:
##    Comp.1    Comp.2
## 12.952459  5.322951
##
##  2  variables and  NA observations.
```

```
print(summary(head_pc), digits = 3, loadings = TRUE)
```

```
## Importance of components:
```

```
##                             Comp.1    Comp.2
## Standard deviation     12.9524588 5.3229513
## Proportion of Variance  0.8555135 0.1444865
## Cumulative Proportion   0.8555135 1.0000000
##
## Loadings:
##      Comp.1 Comp.2
## HLFS  0.693 -0.721
## HLSS  0.721  0.693
```

```r
# pc scores for first family
head_pc1 <- princomp(head_dat)
head_pc1$scores[1, ]
```

```
##     Comp.1     Comp.2
##  0.1695614 -7.1606738
```

```r
# check
0.693*(191-185.72)+0.721*(179-183.84)
```

```
## [1] 0.1694
```

```r
-0.721*(191-185.72)+0.693*(179-183.84)
```

```
## [1] -7.161
```

```r
y1 <- 12.9524588 * c(0.692986, 0.720951)
y2 <- 5.3229513 * c(-0.720951, 0.692986)
X <- cbind(y1, y2)
X %*% t(X)
```

```
##          [,1]      [,2]
## [1,] 95.29336  69.66166
## [2,] 69.66166 100.80662
```

Figure 13.2

```r
a1 <- 183.84-0.721*185.72/0.693
b1 <- 0.721/0.693
a2 <- 183.84-(-0.693*185.72/0.721)
b2 <- -0.693/0.721
plot(head_dat, xlab = "First Son's Head Length (mm)", ylab = "Second Son's Head Length")
abline(a1, b1)
abline(a2, b2, lty=2)
```

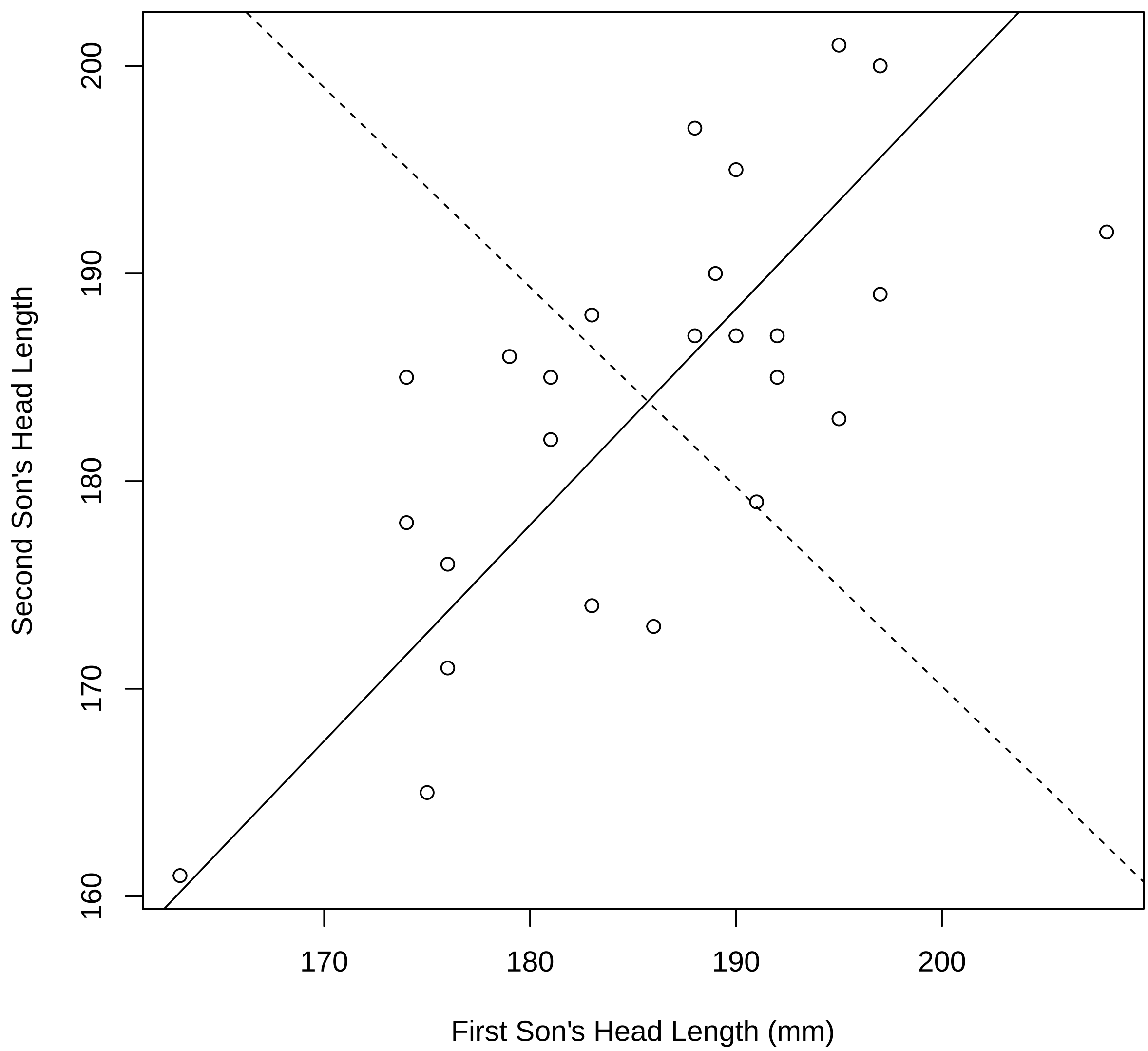

Figure 13.3

```
xlim <- range(head_pc1$scores[, 1])
plot(head_pc1$scores, xlim = xlim, ylim = xlim)
```

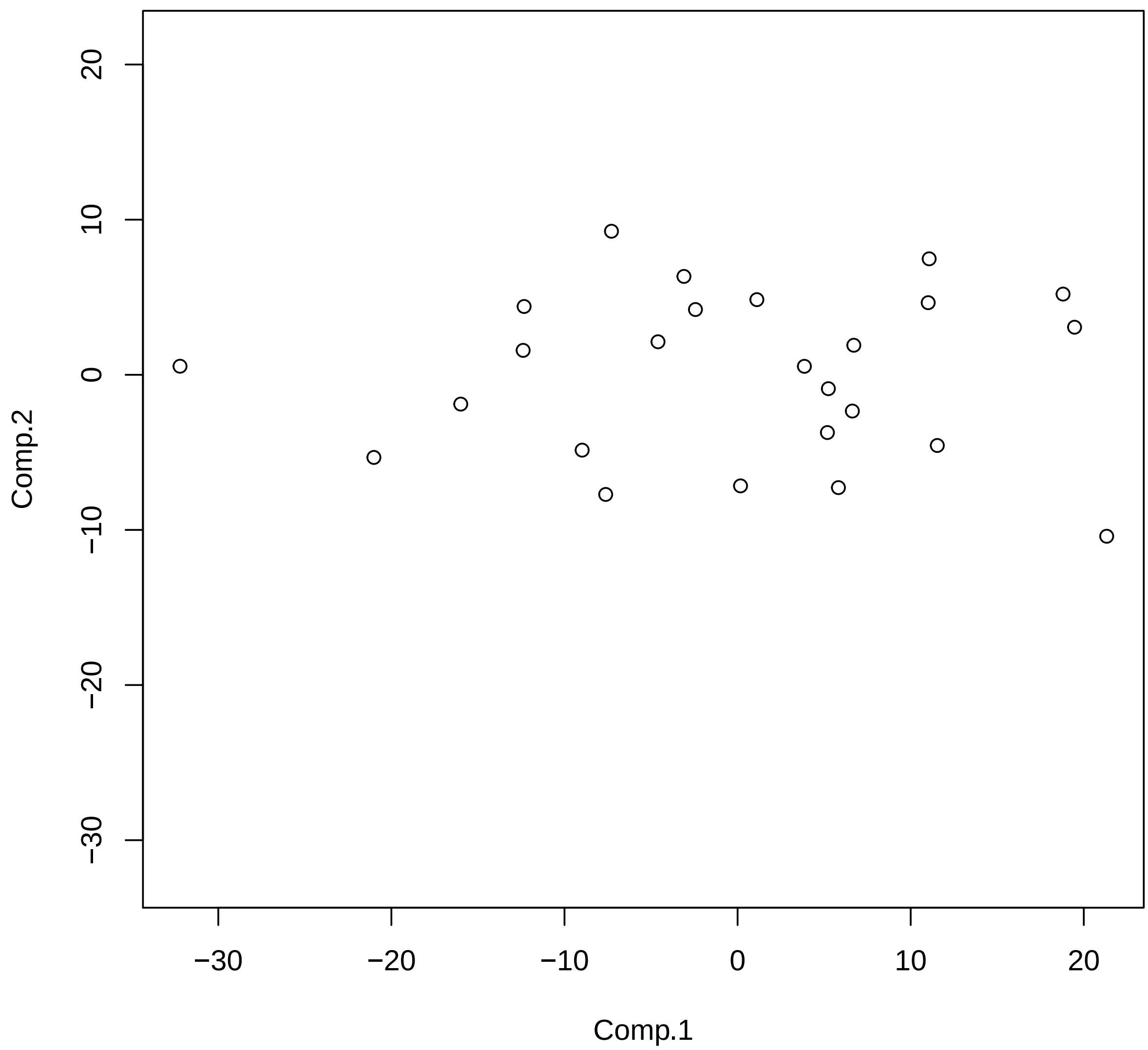

Table 13.5: Crime Rates in the United States

```r
crime <- read.table("data/crime.txt", sep = '\t')
str(crime)
```

```
## 'data.frame':    51 obs. of  7 variables:
##  $ Murder  : num  2 2.2 2 3.6 3.5 4.6 10.7 5.2 5.5 5.5 ...
##  $ Rape    : num  14.8 21.5 21.8 29.7 21.4 23.8 30.5 33.2 25.1 38.6 ...
##  $ Robbery : int  28 24 22 193 119 192 514 269 152 142 ...
##  $ Assault : int  102 92 103 331 192 205 431 265 176 235 ...
##  $ Burglary: int  803 755 949 1071 1294 1198 1221 1071 735 988 ...
##  $ Theft   : int  2347 2208 2697 2189 2568 2758 2924 2822 1654 2574 ...
##  $ Vehicle : int  164 228 181 906 705 447 637 776 354 376 ...
```

```r
crime
```

```
##    Murder Rape Robbery Assault Burglary Theft Vehicle
## ME    2.0 14.8      28     102      803  2347     164
## NH    2.2 21.5      24      92      755  2208     228
## VT    2.0 21.8      22     103      949  2697     181
## MA    3.6 29.7     193     331     1071  2189     906
## RI    3.5 21.4     119     192     1294  2568     705
## CT    4.6 23.8     192     205     1198  2758     447
## NY   10.7 30.5     514     431     1221  2924     637
## NJ    5.2 33.2     269     265     1071  2822     776
## PA    5.5 25.1     152     176      735  1654     354
## OH    5.5 38.6     142     235      988  2574     376
## IN    6.0 25.9      90     186      887  2333     328
## IL    8.9 32.4     325     434     1180  2938     628
## MI   11.3 67.4     301     424     1509  3378     800
## WI    3.1 20.1      73     162      783  2802     254
## MN    2.5 31.8     102     148     1004  2785     288
## IA    1.8 12.5      42     179      956  2801     158
## MO    9.2 29.2     170     370     1136  2500     439
## ND    1.0 11.6       7      32      385  2049     120
## SD    4.0 17.7      16      87      554  1939      99
## NE    3.1 24.6      51     184      748  2677     168
## KS    4.4 32.9      80     252     1188  3008     258
## DE    4.9 56.9     124     241     1042  3090     272
## MD    9.0 43.6     304     476     1296  2978     545
## DC   31.0 52.4     754     668     1728  4131     975
## VA    7.1 26.5     106     167      813  2522     219
## WV    5.9 18.9      41      99      625  1358     169
## NC    8.1 26.4      88     354     1225  2423     208
## SC    8.6 41.3      99     525     1340  2846     277
## GA   11.2 43.9     214     319     1453  2984     430
## FL   11.7 52.7     367     605     2221  4373     598
## KY    6.7 23.1      83     222      824  1740     193
## TN   10.4 47.0     208     274     1325  2126     544
## AL   10.1 28.4     112     408     1159  2304     267
## MS   11.2 25.8      65     172     1076  1845     150
## AR    8.1 28.9      80     278     1030  2305     195
## LA   12.8 40.1     224     482     1461  3417     442
## OK    8.1 36.4     107     285     1787  3142     649
```

```
## TX   13.5 51.6     240     354     2049  3987     714
## MT    2.9 17.3      20     118      783  3314     215
## ID    3.2 20.0      21     178     1003  2800     181
## WY    5.3 21.9      22     243      817  3078     169
## CO    7.0 42.3     145     329     1792  4231     486
## NM   11.5 46.9     130     538     1845  3712     343
## AZ    9.3 43.0     169     437     1908  4337     419
## UT    3.2 25.3      59     180      915  4074     223
## NV   12.6 64.9     287     354     1604  3489     478
## WA    5.0 53.4     135     244     1861  4267     315
## OR    6.6 51.1     206     286     1967  4163     402
## CA   11.3 44.9     343     521     1696  3384     762
## AK    8.6 72.7      88     401     1162  3910     604
## HI    4.8 31.0     106     103     1339  3759     328
```

Figure 13.4

```r
pairs(crime)
```

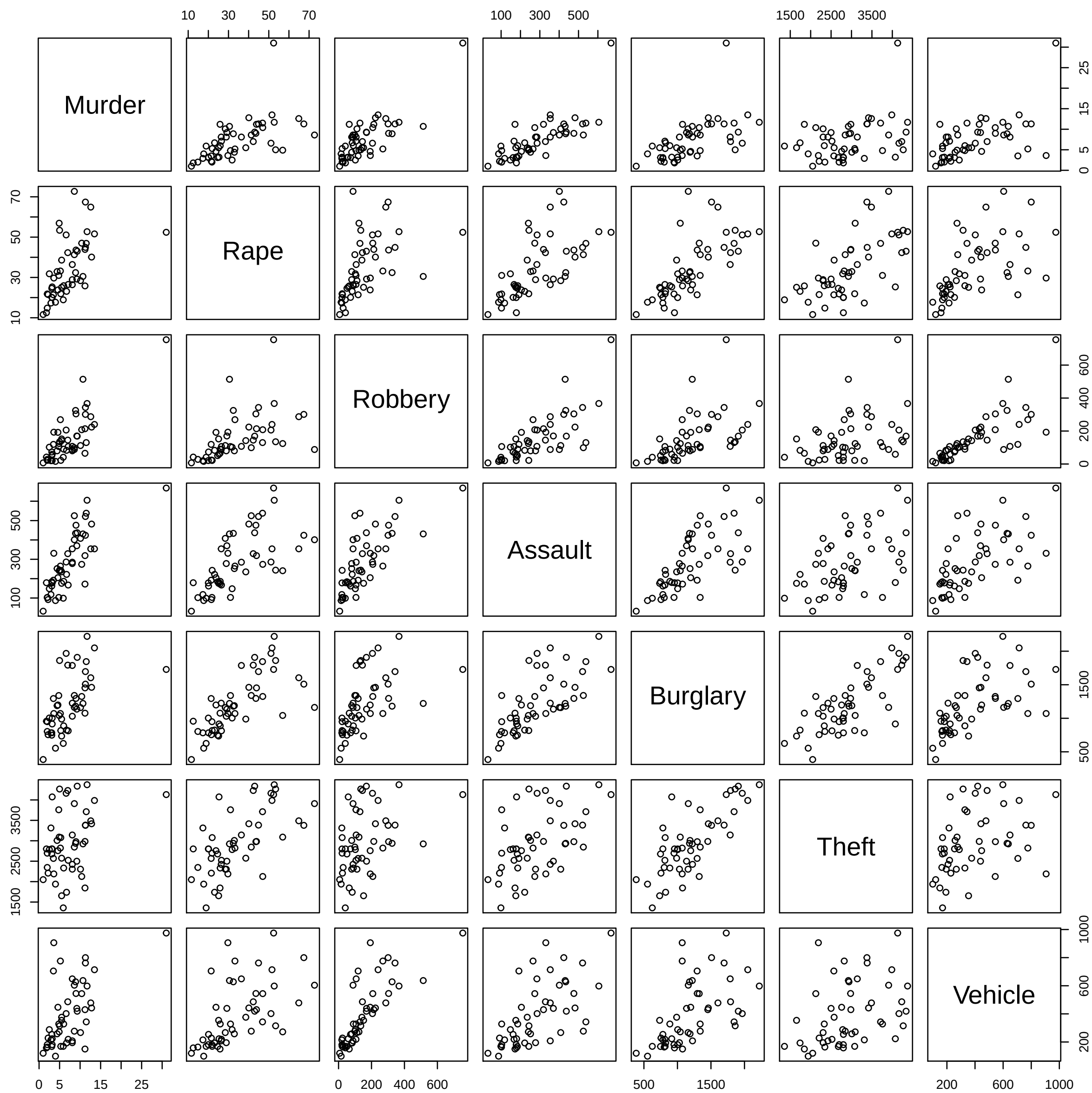

Table 13.6

```r
crime_pc <- princomp(crime, cor = TRUE)
summary(crime_pc, loadings = TRUE)
```

```
## Importance of components:
##                           Comp.1    Comp.2     Comp.3     Comp.4
## Standard deviation     2.1665871 0.9927836 0.68137811 0.58666059
## Proportion of Variance 0.6705856 0.1408028 0.06632516 0.04916724
## Cumulative Proportion  0.6705856 0.8113884 0.87771356 0.92688079
##                            Comp.5     Comp.6     Comp.7
## Standard deviation     0.48885815 0.42269922 0.30688358
## Proportion of Variance 0.03414033 0.02552495 0.01345393
## Cumulative Proportion  0.96102112 0.98654607 1.00000000
##
## Loadings:
##          Comp.1 Comp.2 Comp.3 Comp.4 Comp.5 Comp.6 Comp.7
## Murder   -0.381 -0.350 -0.538        -0.274  0.370  0.480
## Rape     -0.377  0.279        -0.830 -0.250        -0.151
## Robbery  -0.391 -0.420  0.131  0.275 -0.387        -0.651
## Assault  -0.410 -0.124 -0.335         0.564 -0.620
## Burglary -0.394  0.367         0.162  0.466  0.622 -0.283
## Theft    -0.321  0.628         0.449 -0.388 -0.282  0.256
## Vehicle  -0.366 -0.282  0.758         0.163         0.422
```

Figure 13.5

```
plot(1:7, crime_pc$sdev^2, type = "l", xlab = "Component Number", ylab = "Variance")
```

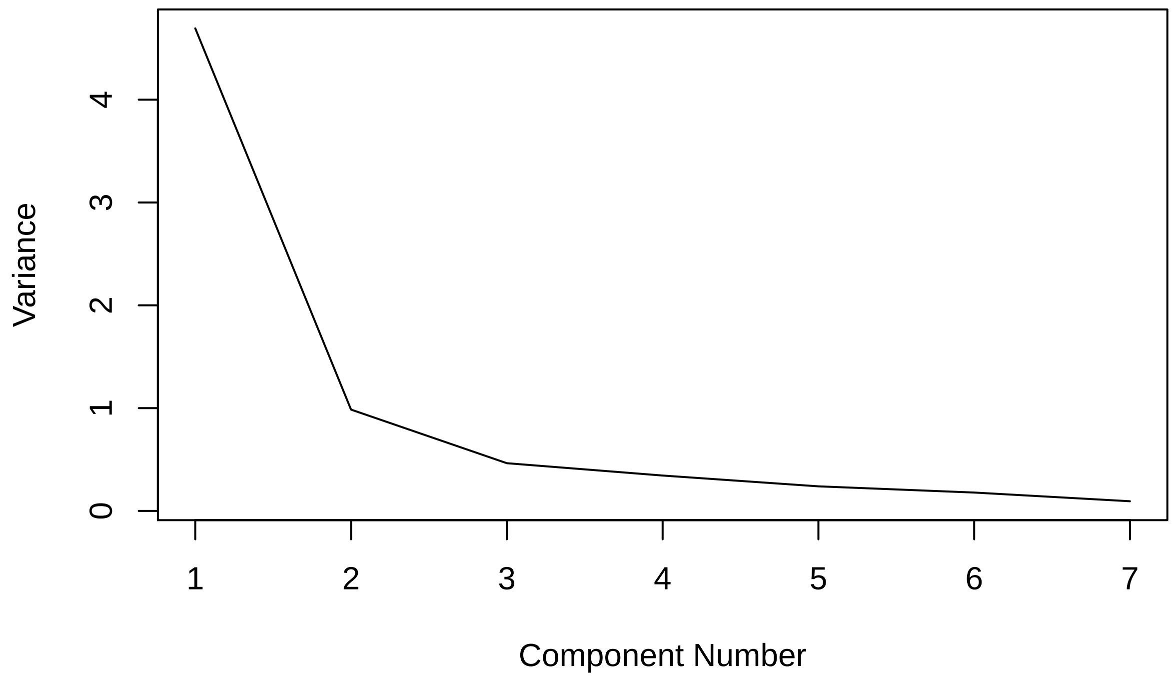

Figure 13.6

```r
xlim <- range(crime_pc$scores[, 1])
plot(crime_pc$scores[, 1], crime_pc$scores[, 2],
     xlab = "First PC score", ylab = "Second PC score", xlim = xlim, ylim = xlim, type = "n")
text(crime_pc$scores[, 1], crime_pc$scores[, 2], row.names(crime), cex=1.0)
```

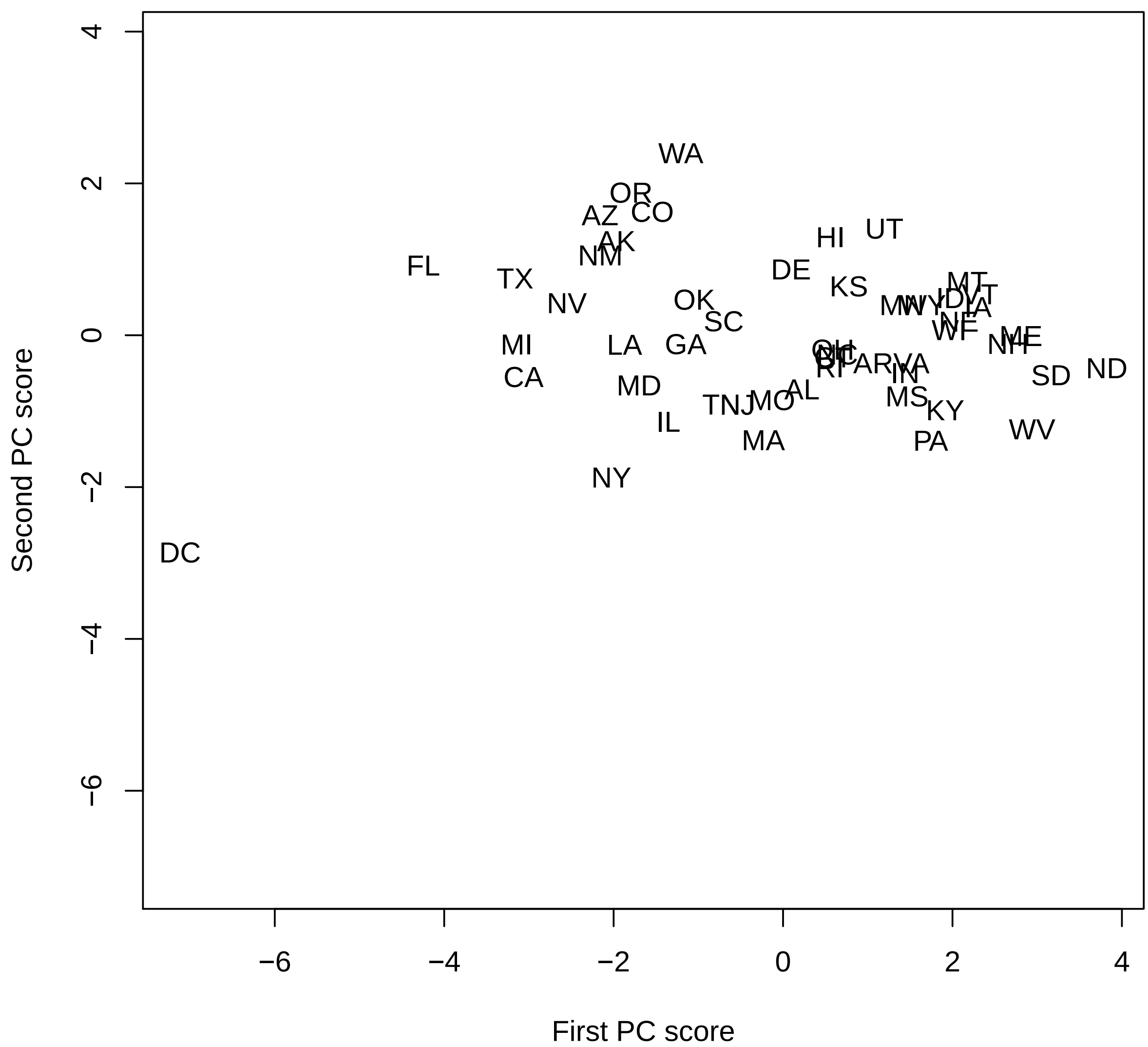

Table 13.7

```r
options(digits=3)
# use all pcas to get original correlation matrix
lambda <- crime_pc$sdev^2
Astar <- crime_pc$loadings[1:7, 1:7]
R <- Astar %*% diag(lambda) %*% t(Astar)
R
```

```
##          Murder  Rape Robbery Assault Burglary Theft Vehicle
## Murder    1.000 0.578   0.804   0.781    0.581 0.361   0.573
## Rape      0.578 1.000   0.530   0.659    0.721 0.635   0.569
## Robbery   0.804 0.530   1.000   0.740    0.551 0.400   0.786
## Assault   0.781 0.659   0.740   1.000    0.710 0.512   0.638
## Burglary  0.581 0.721   0.551   0.710    1.000 0.764   0.579
## Theft     0.361 0.635   0.400   0.512    0.764 1.000   0.386
## Vehicle   0.573 0.569   0.786   0.638    0.579 0.386   1.000
```

```r
# predicted correlation matrix based on first two components
lambda2 <- lambda[1:2]
Astar2 <- Astar[,1:2]
R2 <- Astar2 %*% diag(lambda2) %*% t(Astar2)
R2
```

```
##          Murder  Rape Robbery Assault Burglary Theft Vehicle
## Murder    0.801 0.578   0.843   0.775    0.578 0.357   0.752
## Rape      0.578 0.745   0.576   0.691    0.799 0.741   0.571
## Robbery   0.843 0.576   0.889   0.802    0.571 0.328   0.788
## Assault   0.775 0.691   0.802   0.803    0.713 0.540   0.739
## Burglary  0.578 0.799   0.571   0.713    0.862 0.821   0.576
## Theft     0.357 0.741   0.328   0.540    0.821 0.872   0.377
## Vehicle   0.752 0.571   0.788   0.739    0.576 0.377   0.708
```

Table 13.8: Correlation Matrix for Drug Usage Data

```r
drugs_corr <- structure(c(

 1,     0.447, 0.442, 0.435, 0.114, 0.203, 0.091, 0.082, 0.513, 0.304, 0.245, 0.101, 0.245,
 0.447, 1,     0.619, 0.604, 0.068, 0.146, 0.103, 0.063, 0.445, 0.318, 0.203, 0.088, 0.199,
 0.442, 0.619, 1,     0.583, 0.053, 0.139, 0.110, 0.066, 0.365, 0.240, 0.183, 0.074, 0.184,
 0.435, 0.605, 0.583, 1,     0.115, 0.258, 0.122, 0.097, 0.482, 0.368, 0.255, 0.139, 0.293,
 0.114, 0.068, 0.053, 0.115, 1,     0.349, 0.209, 0.321, 0.186, 0.303, 0.272, 0.279, 0.278,
 0.203, 0.146, 0.139, 0.258, 0.349, 1,     0.221, 0.355, 0.315, 0.377, 0.323, 0.367, 0.545,
 0.091, 0.103, 0.110, 0.122, 0.209, 0.221, 1,     0.201, 0.150, 0.163, 0.310, 0.232, 0.232,
 0.082, 0.063, 0.066, 0.097, 0.321, 0.355, 0.201, 1,     0.154, 0.219, 0.288, 0.320, 0.314,
 0.513, 0.445, 0.365, 0.482, 0.186, 0.315, 0.150, 0.154, 1,     0.534, 0.301, 0.204, 0.394,
 0.304, 0.318, 0.240, 0.368, 0.303, 0.377, 0.163, 0.219, 0.534, 1,     0.302, 0.368, 0.467,
 0.245, 0.203, 0.183, 0.255, 0.272, 0.323, 0.310, 0.288, 0.301, 0.302, 1,     0.304, 0.392,
 0.101, 0.088, 0.074, 0.139, 0.279, 0.367, 0.232, 0.320, 0.204, 0.368, 0.304, 1,     0.511,
 0.245, 0.199, 0.184, 0.293, 0.278, 0.545, 0.232, 0.314, 0.394, 0.467, 0.392, 0.511, 1

 ), .Dim = c(13L, 13L))

drugs <- c("Cigarettes", "Beer", "Wine", "Liquor", "Cocaine", "Tranquilizers", "Drugstore",
           "Heroin", "Marijuana", "Hashish", "Inhalants", "Hallucinogenics", "Amphetamine")
dimnames(drugs_corr) <- list(drugs, c(1:13))
drugs_corr
```

```
##                     1     2     3     4     5     6     7     8     9
## Cigarettes      1.000 0.447 0.442 0.435 0.114 0.203 0.091 0.082 0.513
## Beer            0.447 1.000 0.619 0.605 0.068 0.146 0.103 0.063 0.445
## Wine            0.442 0.619 1.000 0.583 0.053 0.139 0.110 0.066 0.365
## Liquor          0.435 0.604 0.583 1.000 0.115 0.258 0.122 0.097 0.482
## Cocaine         0.114 0.068 0.053 0.115 1.000 0.349 0.209 0.321 0.186
## Tranquilizers   0.203 0.146 0.139 0.258 0.349 1.000 0.221 0.355 0.315
## Drugstore       0.091 0.103 0.110 0.122 0.209 0.221 1.000 0.201 0.150
## Heroin          0.082 0.063 0.066 0.097 0.321 0.355 0.201 1.000 0.154
## Marijuana       0.513 0.445 0.365 0.482 0.186 0.315 0.150 0.154 1.000
## Hashish         0.304 0.318 0.240 0.368 0.303 0.377 0.163 0.219 0.534
## Inhalants       0.245 0.203 0.183 0.255 0.272 0.323 0.310 0.288 0.301
## Hallucinogenics 0.101 0.088 0.074 0.139 0.279 0.367 0.232 0.320 0.204
## Amphetamine     0.245 0.199 0.184 0.293 0.278 0.545 0.232 0.314 0.394
##                    10    11    12    13
## Cigarettes      0.304 0.245 0.101 0.245
## Beer            0.318 0.203 0.088 0.199
## Wine            0.240 0.183 0.074 0.184
## Liquor          0.368 0.255 0.139 0.293
## Cocaine         0.303 0.272 0.279 0.278
## Tranquilizers   0.377 0.323 0.367 0.545
## Drugstore       0.163 0.310 0.232 0.232
## Heroin          0.219 0.288 0.320 0.314
## Marijuana       0.534 0.301 0.204 0.394
## Hashish         1.000 0.302 0.368 0.467
## Inhalants       0.302 1.000 0.304 0.392
## Hallucinogenics 0.368 0.304 1.000 0.511
## Amphetamine     0.467 0.392 0.511 1.000
```

Table 13.9

```r
drugs_pc <- princomp(covmat = drugs_corr)
print(drugs_pc)
```

```
## Call:
## princomp(covmat = drugs_corr)
##
## Standard deviations:
##  Comp.1  Comp.2  Comp.3  Comp.4  Comp.5  Comp.6  Comp.7  Comp.8  Comp.9
##   2.093   1.430   0.977   0.902   0.875   0.831   0.793   0.787   0.757
## Comp.10 Comp.11 Comp.12 Comp.13
##   0.634   0.626   0.613   0.597
##
##  13  variables and  NA observations.
```

```r
summary(drugs_pc, loadings=TRUE)
```

```
## Importance of components:
##                           Comp.1 Comp.2 Comp.3 Comp.4 Comp.5 Comp.6 Comp.7
## Standard deviation         2.093  1.430 0.9773 0.9022 0.8745 0.8314 0.7933
## Proportion of Variance     0.337  0.157 0.0735 0.0626 0.0588 0.0532 0.0484
## Cumulative Proportion      0.337  0.494 0.5678 0.6304 0.6892 0.7424 0.7908
##                           Comp.8 Comp.9 Comp.10 Comp.11 Comp.12 Comp.13
## Standard deviation        0.7872 0.7572  0.6340  0.6261  0.6127  0.5975
## Proportion of Variance    0.0477 0.0441  0.0309  0.0302  0.0289  0.0275
## Cumulative Proportion     0.8385 0.8826  0.9135  0.9437  0.9725  1.0000
##
## Loadings:
##    Comp.1 Comp.2 Comp.3 Comp.4 Comp.5 Comp.6 Comp.7 Comp.8 Comp.9 Comp.10
## 1  -0.280 -0.283               -0.300 -0.387 -0.124  0.137  0.655 -0.139
## 2  -0.287 -0.394  0.120         0.187  0.161  0.114
## 3  -0.267 -0.393  0.207  0.139  0.309  0.141                0.107 -0.421
## 4  -0.318 -0.322                0.181  0.142        -0.164 -0.214  0.563
## 5  -0.208  0.290         0.582 -0.432  0.416  0.185 -0.244  0.204
## 6  -0.293  0.262 -0.165         0.122        -0.629 -0.399        -0.124
## 7  -0.176  0.190  0.723 -0.372 -0.178  0.277 -0.309  0.253
## 8  -0.201  0.317  0.153  0.534  0.327 -0.359         0.525 -0.169
## 9  -0.340 -0.160 -0.228 -0.112 -0.365 -0.129         0.285 -0.149  0.418
## 10 -0.329        -0.352 -0.125 -0.256  0.243  0.167  0.274 -0.400 -0.496
## 11 -0.274  0.163  0.330 -0.159 -0.152 -0.531  0.466 -0.417 -0.228
## 12 -0.245  0.327 -0.144 -0.272  0.379  0.210  0.413  0.162  0.440  0.179
## 13 -0.328  0.235 -0.235 -0.267  0.203        -0.132 -0.177
##    Comp.11 Comp.12 Comp.13
## 1   0.136   0.169   0.263
## 2          -0.695   0.410
## 3  -0.210   0.188  -0.564
## 4   0.181   0.519   0.210
## 5  -0.154
## 6   0.421  -0.170  -0.138
## 7
## 8
## 9  -0.154  -0.285  -0.502
## 10  0.187   0.240   0.152
```

```
## 11
## 12  0.308           -0.159
## 13 -0.733            0.269
```

Figure 13.7

```r
plot(1:13, drugs_pc$sdev^2, type = "l", xlab = "Component Number", ylab = "Variance")
```