Analisis de componentes principales

```
x<-as.data.frame(state.x77);x
```

```
##                Population Income Illiteracy Life Exp Murder HS Grad Frost
## Alabama              3615   3624        2.1    69.05   15.1    41.3    20
## Alaska                365   6315        1.5    69.31   11.3    66.7   152
## Arizona              2212   4530        1.8    70.55    7.8    58.1    15
## Arkansas             2110   3378        1.9    70.66   10.1    39.9    65
## California          21198   5114        1.1    71.71   10.3    62.6    20
## Colorado             2541   4884        0.7    72.06    6.8    63.9   166
## Connecticut          3100   5348        1.1    72.48    3.1    56.0   139
## Delaware              579   4809        0.9    70.06    6.2    54.6   103
## Florida              8277   4815        1.3    70.66   10.7    52.6    11
## Georgia              4931   4091        2.0    68.54   13.9    40.6    60
## Hawaii                868   4963        1.9    73.60    6.2    61.9     0
## Idaho                 813   4119        0.6    71.87    5.3    59.5   126
## Illinois            11197   5107        0.9    70.14   10.3    52.6   127
## Indiana              5313   4458        0.7    70.88    7.1    52.9   122
## Iowa                 2861   4628        0.5    72.56    2.3    59.0   140
## Kansas               2280   4669        0.6    72.58    4.5    59.9   114
## Kentucky             3387   3712        1.6    70.10   10.6    38.5    95
## Louisiana            3806   3545        2.8    68.76   13.2    42.2    12
## Maine                1058   3694        0.7    70.39    2.7    54.7   161
## Maryland             4122   5299        0.9    70.22    8.5    52.3   101
## Massachusetts        5814   4755        1.1    71.83    3.3    58.5   103
## Michigan             9111   4751        0.9    70.63   11.1    52.8   125
## Minnesota            3921   4675        0.6    72.96    2.3    57.6   160
## Mississippi          2341   3098        2.4    68.09   12.5    41.0    50
## Missouri             4767   4254        0.8    70.69    9.3    48.8   108
## Montana               746   4347        0.6    70.56    5.0    59.2   155
## Nebraska             1544   4508        0.6    72.60    2.9    59.3   139
## Nevada                590   5149        0.5    69.03   11.5    65.2   188
## New Hampshire         812   4281        0.7    71.23    3.3    57.6   174
## New Jersey           7333   5237        1.1    70.93    5.2    52.5   115
## New Mexico           1144   3601        2.2    70.32    9.7    55.2   120
## New York            18076   4903        1.4    70.55   10.9    52.7    82
## North Carolina       5441   3875        1.8    69.21   11.1    38.5    80
## North Dakota          637   5087        0.8    72.78    1.4    50.3   186
## Ohio                10735   4561        0.8    70.82    7.4    53.2   124
## Oklahoma             2715   3983        1.1    71.42    6.4    51.6    82
## Oregon               2284   4660        0.6    72.13    4.2    60.0    44
## Pennsylvania        11860   4449        1.0    70.43    6.1    50.2   126
## Rhode Island          931   4558        1.3    71.90    2.4    46.4   127
## South Carolina       2816   3635        2.3    67.96   11.6    37.8    65
## South Dakota          681   4167        0.5    72.08    1.7    53.3   172
## Tennessee            4173   3821        1.7    70.11   11.0    41.8    70
## Texas               12237   4188        2.2    70.90   12.2    47.4    35
## Utah                 1203   4022        0.6    72.90    4.5    67.3   137
## Vermont               472   3907        0.6    71.64    5.5    57.1   168
## Virginia             4981   4701        1.4    70.08    9.5    47.8    85
## Washington           3559   4864        0.6    71.72    4.3    63.5    32
## West Virginia        1799   3617        1.4    69.48    6.7    41.6   100
## Wisconsin            4589   4468        0.7    72.48    3.0    54.5   149
## Wyoming               376   4566        0.6    70.29    6.9    62.9   173
##                 Area
```

```
## Alabama           50708
## Alaska           566432
## Arizona          113417
## Arkansas          51945
## California       156361
## Colorado         103766
## Connecticut        4862
## Delaware           1982
## Florida           54090
## Georgia           58073
## Hawaii             6425
## Idaho             82677
## Illinois          55748
## Indiana           36097
## Iowa              55941
## Kansas            81787
## Kentucky          39650
## Louisiana         44930
## Maine             30920
## Maryland           9891
## Massachusetts      7826
## Michigan          56817
## Minnesota         79289
## Mississippi       47296
## Missouri          68995
## Montana          145587
## Nebraska          76483
## Nevada           109889
## New Hampshire      9027
## New Jersey         7521
## New Mexico       121412
## New York          47831
## North Carolina    48798
## North Dakota      69273
## Ohio              40975
## Oklahoma          68782
## Oregon            96184
## Pennsylvania      44966
## Rhode Island       1049
## South Carolina    30225
## South Dakota      75955
## Tennessee         41328
## Texas            262134
## Utah              82096
## Vermont            9267
## Virginia          39780
## Washington        66570
## West Virginia     24070
## Wisconsin         54464
## Wyoming           97203
```

```
View(x)
```

```
colnames(x)
```

```
## [1] "Population" "Income"     "Illiteracy" "Life Exp"   "Murder"
## [6] "HS Grad"    "Frost"      "Area"
```

2.- Quitar los espacios de los nombres

```
colnames(x)[4]="Life.Exp"
colnames(x)[6]= "HS.Grad"
```

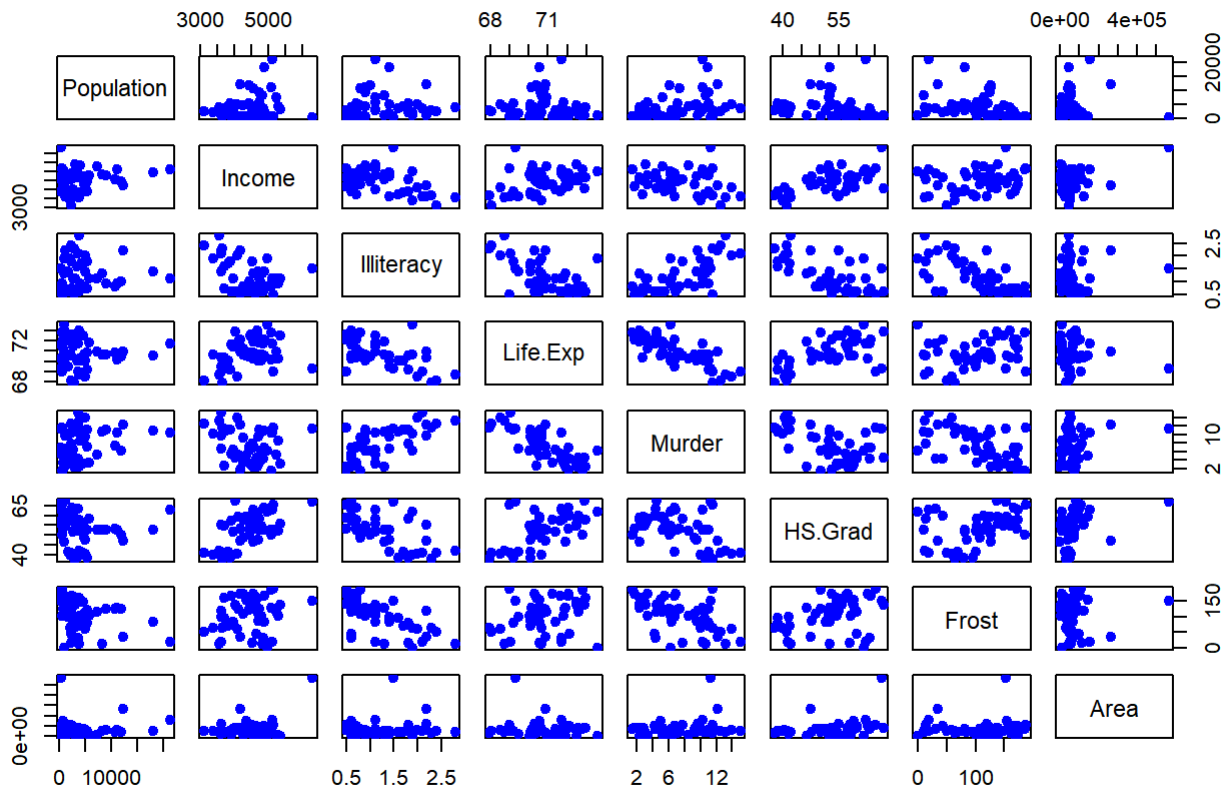## 3.- Se definen n (numero de estados) y p (variables)

```
dim(x)
```

```
## [1] 50  8
```

```
n<-dim(x)[1]
p<-dim(x)[2]
```

4.- Generaci?n de un scatterplot de las variables originales

```
pairs(x,col="blue", pch=19,
      main="Variables originales")
```

Variables originales

5.- Obtenci?n de los componentes principales con base en la matriz de covarianza muestral

```
mu<-colMeans(x);mu
```

```
## Population      Income Illiteracy    Life.Exp      Murder    HS.Grad       Frost
##   4246.4200   4435.8000     1.1700     70.8786      7.3780    53.1080    104.4600
##        Area
## 70735.8800
```

```
s<-cov(x);s
```

```
##                 Population      Income   Illiteracy      Life.Exp       Murder
## Population 19931683.7588   571229.7796  292.8679592 -4.078425e+02  5663.523714
## Income       571229.7796   377573.3061 -163.7020408  2.806632e+02  -521.894286
## Illiteracy      292.8680     -163.7020    0.3715306 -4.815122e-01     1.581776
## Life.Exp       -407.8425      280.6632   -0.4815122  1.802020e+00    -3.869480
## Murder         5663.5237     -521.8943    1.5817755 -3.869480e+00    13.627465
## HS.Grad       -3551.5096     3076.7690   -3.2354694  6.312685e+00   -14.549616
## Frost        -77081.9727     7227.6041  -21.2900000  1.828678e+01  -103.406000
## Area        8587916.9494 19049013.7510 4018.3371429 -1.229410e+04 71940.429959
##                  HS.Grad        Frost         Area
## Population  -3551.509551 -77081.97265  8.587917e+06
## Income       3076.768980  7227.60408  1.904901e+07
## Illiteracy     -3.235469    -21.29000  4.018337e+03
## Life.Exp        6.312685     18.28678 -1.229410e+04
## Murder        -14.549616   -103.40600  7.194043e+04
## HS.Grad        65.237894    153.99216  2.298732e+05
## Frost         153.992163   2702.00857  2.627039e+05
## Area       229873.192816 262703.89306  7.280748e+09
```

6.- Obtenci?n de los componentes principales con base a la matriz de covarianza muestral

```
es<-eigen(s);es
```

```
## eigen() decomposition
## $values
## [1] 7.280808e+09 1.993718e+07 3.126436e+05 2.153069e+03 3.651905e+01
## [6] 6.059100e+00 4.329810e-01 8.409484e-02
##
## $vectors
##                  [,1]          [,2]          [,3]          [,4]          [,5]
## [1,] -1.182966e-03  9.996005e-01  0.0278490777 -4.671254e-03  3.349393e-04
## [2,] -2.616550e-03  2.796866e-02 -0.9991766328  2.821732e-02 -7.792882e-03
## [3,] -5.518945e-07  1.420515e-05  0.0005844687  7.100747e-03 -4.054743e-02
## [4,]  1.688521e-06 -1.928393e-05 -0.0010367078 -3.875966e-03  1.193295e-01
## [5,] -9.881522e-06  2.787128e-04  0.0027764911  2.816092e-02 -2.386638e-01
## [6,] -3.157288e-05 -1.882545e-04 -0.0082661337 -2.784545e-02  9.622385e-01
## [7,] -3.607163e-05 -3.871630e-03 -0.0280421226 -9.987733e-01 -3.452920e-02
## [8,] -9.999959e-01 -1.255538e-03  0.0025827049 -3.168841e-05 -6.558672e-06
##                  [,6]          [,7]          [,8]
## [1,]  1.386661e-04 -5.183454e-05  2.191850e-05
## [2,] -1.119562e-04  3.850506e-05  6.290403e-05
## [3,] -3.091522e-02  2.550656e-02  9.983480e-01
## [4,]  2.855357e-01  9.508427e-01 -1.057617e-02
## [5,] -9.200852e-01  3.058552e-01 -4.620107e-02
## [6,] -2.656351e-01 -4.075556e-02  3.209925e-02
## [7,] -1.986814e-02  6.252701e-03  4.942864e-03
## [8,]  1.882356e-05 -4.090819e-07 -1.494594e-06
```

7.- Matriz de auto-valores(Lamdas)

```
eigen.val<-es$values;eigen.val
```

```
## [1] 7.280808e+09 1.993718e+07 3.126436e+05 2.153069e+03 3.651905e+01
## [6] 6.059100e+00 4.329810e-01 8.409484e-02
```

8.- Matriz de auto-vectores(a1)

```
eigen.vec<-es$vectors;eigen.vec
```

```
##                [,1]          [,2]          [,3]          [,4]          [,5]
## [1,] -1.182966e-03  9.996005e-01  0.0278490777 -4.671254e-03  3.349393e-04
## [2,] -2.616550e-03  2.796866e-02 -0.9991766328  2.821732e-02 -7.792882e-03
## [3,] -5.518945e-07  1.420515e-05  0.0005844687  7.100747e-03 -4.054743e-02
## [4,]  1.688521e-06 -1.928393e-05 -0.0010367078 -3.875966e-03  1.193295e-01
## [5,] -9.881522e-06  2.787128e-04  0.0027764911  2.816092e-02 -2.386638e-01
## [6,] -3.157288e-05 -1.882545e-04 -0.0082661337 -2.784545e-02  9.622385e-01
## [7,] -3.607163e-05 -3.871630e-03 -0.0280421226 -9.987733e-01 -3.452920e-02
## [8,] -9.999959e-01 -1.255538e-03  0.0025827049 -3.168841e-05 -6.558672e-06
##                [,6]          [,7]          [,8]
## [1,]  1.386661e-04 -5.183454e-05  2.191850e-05
## [2,] -1.119562e-04  3.850506e-05  6.290403e-05
## [3,] -3.091522e-02  2.550656e-02  9.983480e-01
## [4,]  2.855357e-01  9.508427e-01 -1.057617e-02
## [5,] -9.200852e-01  3.058552e-01 -4.620107e-02
## [6,] -2.656351e-01 -4.075556e-02  3.209925e-02
## [7,] -1.986814e-02  6.252701e-03  4.942864e-03
## [8,]  1.882356e-05 -4.090819e-07 -1.494594e-06
```

Proporci?n de variabilidad para cada vector

```
pro.var<-eigen.val/sum(eigen.val);pro.var
```

```
## [1] 9.972262e-01 2.730724e-03 4.282167e-05 2.948981e-07 5.001883e-09
## [6] 8.298931e-10 5.930385e-11 1.151817e-11
```

Proporci?n de variabilidad acumulada

```
pro.var.acum<-cumsum(eigen.val)/sum(eigen.val);pro.var.acum
```

```
## [1] 0.9972262 0.9999569 0.9999997 1.0000000 1.0000000 1.0000000 1.0000000
## [8] 1.0000000
```

Obtencion de los componentes principales con base en la matriz de correlaciones muestrales

```
R<-cor(x);R
```

```
##              Population      Income   Illiteracy    Life.Exp      Murder
## Population  1.00000000   0.2082276   0.10762237  -0.06805195   0.3436428
## Income      0.20822756   1.0000000  -0.43707519   0.34025534  -0.2300776
## Illiteracy  0.10762237  -0.4370752   1.00000000  -0.58847793   0.7029752
## Life.Exp   -0.06805195   0.3402553  -0.58847793   1.00000000  -0.7808458
## Murder      0.34364275  -0.2300776   0.70297520  -0.78084575   1.0000000
## HS.Grad    -0.09848975   0.6199323  -0.65718861   0.58221620  -0.4879710
## Frost      -0.33215245   0.2262822  -0.67194697   0.26206801  -0.5388834
## Area        0.02254384   0.3633154   0.07726113  -0.10733194   0.2283902
##                HS.Grad       Frost        Area
## Population  -0.09848975  -0.3321525   0.02254384
## Income       0.61993232   0.2262822   0.36331544
## Illiteracy  -0.65718861  -0.6719470   0.07726113
## Life.Exp     0.58221620   0.2620680  -0.10733194
## Murder      -0.48797102  -0.5388834   0.22839021
## HS.Grad      1.00000000   0.3667797   0.33354187
## Frost        0.36677970   1.0000000   0.05922910
## Area         0.33354187   0.0592291   1.00000000
```

```
eR<-eigen(R);eR
```

```
## eigen() decomposition
## $values
## [1] 3.5988956 1.6319192 1.1119412 0.7075042 0.3846417 0.3074617 0.1444488
## [8] 0.1131877
##
## $vectors
##               [,1]        [,2]        [,3]        [,4]         [,5]         [,6]
## [1,] -0.12642809  0.41087417  0.65632546  0.40938555 -0.405946365 -0.01065617
## [2,]  0.29882991  0.51897884  0.10035919  0.08844658  0.637586953  0.46177023
## [3,] -0.46766917  0.05296872 -0.07089849 -0.35282802 -0.003525994  0.38741578
## [4,]  0.41161037 -0.08165611  0.35993297 -0.44256334 -0.326599685  0.21908161
## [5,] -0.44425672  0.30694934 -0.10846751  0.16560017  0.128068739 -0.32519611
## [6,]  0.42468442  0.29876662 -0.04970850 -0.23157412  0.099264551 -0.64464647
## [7,]  0.35741244 -0.15358409 -0.38711447  0.61865119 -0.217363791  0.21268413
## [8,]  0.03338461  0.58762446 -0.51038499 -0.20112550 -0.498506338  0.14836054
##               [,7]        [,8]
## [1,] -0.062158658  0.21924645
## [2,]  0.009104712 -0.06029200
## [3,] -0.619800310  0.33868838
## [4,] -0.256213054 -0.52743331
## [5,] -0.295043151 -0.67825134
## [6,] -0.393019181  0.30724183
## [7,] -0.472013140 -0.02834442
## [8,]  0.286260213 -0.01320320
```

Obtenci?n de auto-valores

```
eigen.val<-eR$values
```

Obtenci?n de auto-vectores

```
eigen.vec<-eR$vectors
```

Proporcion de variablidad

```
pro.var<-eigen.val/sum(eigen.val)
```

Proporcion de variabilidad acumulada

```
pro.var.acum<-cumsum(eigen.val)/sum(eigen.val)
```

Media de los auto-valores

```
mean(eigen.val)
```

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

Obtencion de los coeficientes (nuevas variables)

1.- Centrar los datos con respecto a la media

```
ones<-matrix(rep(1,n),nrow=n, ncol=1)
```

2.- Construccion de la matriz centrada

```
X.cen<-as.matrix(x)-ones%*%mu
X.cen
```

```
##                Population   Income Illiteracy Life.Exp Murder HS.Grad     Frost
## Alabama          -631.42   -811.8       0.93  -1.8286  7.722 -11.808    -84.46
## Alaska          -3881.42   1879.2       0.33  -1.5686  3.922  13.592     47.54
## Arizona         -2034.42     94.2       0.63  -0.3286  0.422   4.992    -89.46
## Arkansas        -2136.42  -1057.8       0.73  -0.2186  2.722 -13.208    -39.46
## California      16951.58    678.2      -0.07   0.8314  2.922   9.492    -84.46
## Colorado        -1705.42    448.2      -0.47   1.1814 -0.578  10.792     61.54
## Connecticut     -1146.42    912.2      -0.07   1.6014 -4.278   2.892     34.54
## Delaware        -3667.42    373.2      -0.27  -0.8186 -1.178   1.492     -1.46
## Florida          4030.58    379.2       0.13  -0.2186  3.322  -0.508    -93.46
## Georgia           684.58   -344.8       0.83  -2.3386  6.522 -12.508    -44.46
## Hawaii          -3378.42    527.2       0.73   2.7214 -1.178   8.792   -104.46
## Idaho           -3433.42   -316.8      -0.57   0.9914 -2.078   6.392     21.54
## Illinois         6950.58    671.2      -0.27  -0.7386  2.922  -0.508     22.54
## Indiana          1066.58     22.2      -0.47   0.0014 -0.278  -0.208     17.54
## Iowa            -1385.42    192.2      -0.67   1.6814 -5.078   5.892     35.54
## Kansas          -1966.42    233.2      -0.57   1.7014 -2.878   6.792      9.54
## Kentucky         -859.42   -723.8       0.43  -0.7786  3.222 -14.608     -9.46
## Louisiana        -440.42   -890.8       1.63  -2.1186  5.822 -10.908    -92.46
## Maine           -3188.42   -741.8      -0.47  -0.4886 -4.678   1.592     56.54
## Maryland         -124.42    863.2      -0.27  -0.6586  1.122  -0.808     -3.46
## Massachusetts    1567.58    319.2      -0.07   0.9514 -4.078   5.392     -1.46
## Michigan         4864.58    315.2      -0.27  -0.2486  3.722  -0.308     20.54
## Minnesota        -325.42    239.2      -0.57   2.0814 -5.078   4.492     55.54
## Mississippi     -1905.42  -1337.8       1.23  -2.7886  5.122 -12.108    -54.46
## Missouri          520.58   -181.8      -0.37  -0.1886  1.922  -4.308      3.54
## Montana         -3500.42    -88.8      -0.57  -0.3186 -2.378   6.092     50.54
## Nebraska        -2702.42     72.2      -0.57   1.7214 -4.478   6.192     34.54
## Nevada          -3656.42    713.2      -0.67  -1.8486  4.122  12.092     83.54
## New Hampshire   -3434.42   -154.8      -0.47   0.3514 -4.078   4.492     69.54
## New Jersey       3086.58    801.2      -0.07   0.0514 -2.178  -0.608     10.54
## New Mexico      -3102.42   -834.8       1.03  -0.5586  2.322   2.092     15.54
## New York        13829.58    467.2       0.23  -0.3286  3.522  -0.408    -22.46
## North Carolina   1194.58   -560.8       0.63  -1.6686  3.722 -14.608    -24.46
## North Dakota    -3609.42    651.2      -0.37   1.9014 -5.978  -2.808     81.54
## Ohio             6488.58    125.2      -0.37  -0.0586  0.022   0.092     19.54
## Oklahoma        -1531.42   -452.8      -0.07   0.5414 -0.978  -1.508    -22.46
## Oregon          -1962.42    224.2      -0.57   1.2514 -3.178   6.892    -60.46
## Pennsylvania     7613.58     13.2      -0.17  -0.4486 -1.278  -2.908     21.54
## Rhode Island    -3315.42    122.2       0.13   1.0214 -4.978  -6.708     22.54
## South Carolina  -1430.42   -800.8       1.13  -2.9186  4.222 -15.308    -39.46
## South Dakota    -3565.42   -268.8      -0.67   1.2014 -5.678   0.192     67.54
## Tennessee         -73.42   -614.8       0.53  -0.7686  3.622 -11.308    -34.46
## Texas            7990.58   -247.8       1.03   0.0214  4.822  -5.708    -69.46
## Utah            -3043.42   -413.8      -0.57   2.0214 -2.878  14.192     32.54
## Vermont         -3774.42   -528.8      -0.57   0.7614 -1.878   3.992     63.54
## Virginia          734.58    265.2       0.23  -0.7986  2.122  -5.308    -19.46
## Washington       -687.42    428.2      -0.57   0.8414 -3.078  10.392    -72.46
## West Virginia   -2447.42   -818.8       0.23  -1.3986 -0.678 -11.508     -4.46
## Wisconsin         342.58     32.2      -0.47   1.6014 -4.378   1.392     44.54
## Wyoming         -3870.42    130.2      -0.57  -0.5886 -0.478   9.792     68.54
##                    Area
```

```
## Alabama         -20027.88
## Alaska          495696.12
## Arizona          42681.12
## Arkansas        -18790.88
## California        85625.12
## Colorado         33030.12
## Connecticut     -65873.88
## Delaware        -68753.88
## Florida         -16645.88
## Georgia         -12662.88
## Hawaii          -64310.88
## Idaho            11941.12
## Illinois        -14987.88
## Indiana         -34638.88
## Iowa            -14794.88
## Kansas           11051.12
## Kentucky        -31085.88
## Louisiana       -25805.88
## Maine           -39815.88
## Maryland        -60844.88
## Massachusetts   -62909.88
## Michigan        -13918.88
## Minnesota         8553.12
## Mississippi     -23439.88
## Missouri         -1740.88
## Montana          74851.12
## Nebraska          5747.12
## Nevada           39153.12
## New Hampshire   -61708.88
## New Jersey      -63214.88
## New Mexico       50676.12
## New York        -22904.88
## North Carolina  -21937.88
## North Dakota     -1462.88
## Ohio            -29760.88
## Oklahoma         -1953.88
## Oregon           25448.12
## Pennsylvania    -25769.88
## Rhode Island    -69686.88
## South Carolina  -40510.88
## South Dakota      5219.12
## Tennessee       -29407.88
## Texas           191398.12
## Utah             11360.12
## Vermont         -61468.88
## Virginia        -30955.88
## Washington       -4165.88
## West Virginia   -46665.88
## Wisconsin       -16271.88
## Wyoming          26467.12
```

3.- Construccion de la matriz diagonal de las varianzas

```
Dx<-diag(diag(s))
Dx
```

```
##           [,1]      [,2]       [,3]     [,4]      [,5]      [,6]      [,7]        [,8]
## [1,] 19931684      0.0 0.0000000 0.00000  0.00000  0.00000    0.000           0
## [2,]         0 377573.3 0.0000000 0.00000  0.00000  0.00000    0.000           0
## [3,]         0      0.0 0.3715306 0.00000  0.00000  0.00000    0.000           0
## [4,]         0      0.0 0.0000000 1.80202  0.00000  0.00000    0.000           0
## [5,]         0      0.0 0.0000000 0.00000 13.62747  0.00000    0.000           0
## [6,]         0      0.0 0.0000000 0.00000  0.00000 65.23789    0.000           0
## [7,]         0      0.0 0.0000000 0.00000  0.00000  0.00000 2702.009           0
## [8,]         0      0.0 0.0000000 0.00000  0.00000  0.00000    0.000 7280748061
```

4.- Construccion de la matriz centrada multiplicada

```
Dx^1/2
```

```
##           [,1]      [,2]       [,3]      [,4]     [,5]      [,6]      [,7]        [,8]
## [1,] 9965842      0.0 0.0000000 0.0000000 0.000000  0.00000    0.000           0
## [2,]        0 188786.7 0.0000000 0.0000000 0.000000  0.00000    0.000           0
## [3,]        0      0.0 0.1857653 0.0000000 0.000000  0.00000    0.000           0
## [4,]        0      0.0 0.0000000 0.9010102 0.000000  0.00000    0.000           0
## [5,]        0      0.0 0.0000000 0.0000000 6.813733  0.00000    0.000           0
## [6,]        0      0.0 0.0000000 0.0000000 0.000000 32.61895    0.000           0
## [7,]        0      0.0 0.0000000 0.0000000 0.000000  0.00000 1351.004           0
## [8,]        0      0.0 0.0000000 0.0000000 0.000000  0.00000    0.000 3640374030
```

Datos normalizados

```
Y<-X.cen%*%solve(Dx)^(1/2)
Y
```

```
##                         [,1]        [,2]      [,3]         [,4]         [,5]
## Alabama          -0.14143156 -1.32113867  1.525758 -1.362193670  2.091810096
## Alaska           -0.86939802  3.05824562  0.541398 -1.168509784  1.062429318
## Arizona          -0.45568908  0.15330286  1.033578 -0.244786635  0.114315444
## Arkansas         -0.47853603 -1.72148373  1.197638 -0.162843452  0.737361704
## California        3.79697895  1.10371551 -0.114842  0.619341473  0.791539640
## Colorado         -0.38199648  0.72940916 -0.771082  0.880069781 -0.156574234
## Connecticut      -0.25678625  1.48453153 -0.114842  1.192943751 -1.158866044
## Delaware         -0.82146423  0.60735274 -0.442962 -0.609806266 -0.319108041
## Florida           0.90280832  0.61711725  0.213278 -0.162843452  0.899895511
## Georgia           0.15333885 -0.56113404  1.361698 -1.742112063  1.766742482
## Hawaii           -0.75673121  0.85797525  1.197638  2.027274338 -0.319108041
## Idaho            -0.76905064 -0.51556631 -0.935142  0.738531557 -0.562908752
## Illinois          1.55685818  1.09232357 -0.442962 -0.550211224  0.791539640
## Indiana           0.23890291  0.03612870 -0.771082  0.001042913 -0.075307331
## Iowa             -0.31031978  0.31278991 -1.099202  1.252538793 -1.375577787
## Kansas           -0.44045778  0.37951409 -0.935142  1.267437554 -0.779620494
## Kentucky         -0.19250121 -1.17792581  0.705458 -0.580008745  0.872806544
## Louisiana        -0.09864953 -1.44970477  2.674178 -1.578225697  1.577119707
## Maine            -0.71417317 -1.20721935 -0.771082 -0.363976718 -1.267221915
## Maryland         -0.02786880  1.40478801 -0.442962 -0.490616183  0.303938219
## Massachusetts     0.35112174  0.51947212 -0.114842  0.708734036 -1.104688108
## Michigan          1.08961571  0.51296244 -0.442962 -0.185191593  1.008251383
## Minnesota        -0.07289072  0.38927860 -0.935142  1.550514003 -1.375577787
## Mississippi      -0.42679441 -2.17716102  2.017938 -2.077334173  1.387496932
## Missouri          0.11660455 -0.29586476 -0.607022 -0.140495311  0.520649962
## Montana          -0.78405795 -0.14451480 -0.935142 -0.237337254 -0.644175655
## Nebraska         -0.60531419  0.11749965 -0.935142  1.282336314 -1.213043980
## Nevada           -0.81900034  1.16067517 -1.099202 -1.377092431  1.116607254
## New Hampshire    -0.76927463 -0.25192445 -0.771082  0.261771222 -1.104688108
## New Jersey        0.69136206  1.30388803 -0.114842  0.038289814 -0.589997719
## New Mexico       -0.69491006 -1.35856931  1.689818 -0.416122380  0.629005833
## New York          3.09768318  0.76033012  0.377338 -0.244786635  0.954073447
## North Carolina    0.26757359 -0.91265653  1.033578 -1.243003587  1.008251383
## North Dakota     -0.80847282  1.05977520 -0.607022  1.416425159 -1.619378497
## Ohio              1.45337495  0.20375285 -0.607022 -0.043653368  0.005959573
## Oklahoma         -0.34302227 -0.73689528 -0.114842  0.403309446 -0.264930105
## Oregon           -0.43956182  0.36486732 -0.935142  0.932215443 -0.860887398
## Pennsylvania      1.70536334  0.02148193 -0.278902 -0.334179197 -0.346197009
## Rhode Island     -0.74261986  0.19887059  0.213278  0.760879698 -1.348488819
## South Carolina   -0.32039932 -1.30323706  1.853878 -2.174176116  1.143696222
## South Dakota     -0.79861728 -0.43745020 -1.099202  0.894968542 -1.538111594
## Tennessee        -0.01644532 -1.00053715  0.869518 -0.572559365  0.981162415
## Texas             1.78980744 -0.40327441  1.689818  0.015941674  1.306230029
## Utah             -0.68169467 -0.67342595 -0.935142  1.505817721 -0.779620494
## Vermont          -0.84543112 -0.86057912 -0.935142  0.567195811 -0.508730816
## Virginia          0.16453834  0.43159150  0.377338 -0.594907506  0.574827897
## Washington       -0.15397498  0.69686078 -0.935142  0.626790853 -0.833798430
## West Virginia    -0.54819682 -1.33253061  0.377338 -1.041870320 -0.183663202
## Wisconsin         0.07673438  0.05240289 -0.771082  1.192943751 -1.185955012
## Wyoming          -0.86693413  0.21188994 -0.935142 -0.438470521 -0.129485266
##                         [,6]        [,7]       [,8]
```

```
## Alabama        -1.46192933 -1.62482920 -0.23471832
## Alaska          1.68280347  0.91456761  5.80934967
## Arizona         0.61805142 -1.72101848  0.50020474
## Arkansas       -1.63526106 -0.75912574 -0.22022120
## California      1.17518912 -1.62482920  1.00349033
## Colorado        1.33614002  1.18389757  0.38709909
## Connecticut     0.35805383  0.66447550 -0.77201412
## Delaware        0.18472210 -0.02808727 -0.80576651
## Florida        -0.06289466 -1.79796989 -0.19508270
## Georgia        -1.54859519 -0.85531502 -0.14840362
## Hawaii          1.08852326 -2.00958630 -0.75369642
## Idaho           0.79138315  0.41438339  0.13994490
## Illinois       -0.06289466  0.43362124 -0.17565164
## Indiana        -0.02575214  0.33743197 -0.40595308
## Iowa            0.72947896  0.68371335 -0.17338976
## Kansas          0.84090650  0.18352913  0.12951447
## Kentucky       -1.80859279 -0.18199010 -0.36431342
## Louisiana      -1.35050179 -1.77873204 -0.30243404
## Maine           0.19710294  1.08770830 -0.46662534
## Maryland       -0.10003717 -0.06656298 -0.71307636
## Massachusetts   0.66757477 -0.02808727 -0.73727729
## Michigan       -0.03813298  0.39514553 -0.16312341
## Minnesota       0.55614723  1.06847045  0.10023896
## Mississippi    -1.49907184 -1.04769356 -0.27470552
## Missouri       -0.53336649  0.06810201 -0.02040238
## Montana         0.75424064  0.97228117  0.87722359
## Nebraska        0.76662148  0.66447550  0.06735382
## Nevada          1.49709091  1.60713038  0.45885807
## New Hampshire   0.55614723  1.33780041 -0.72320207
## New Jersey     -0.07527549  0.20276699 -0.74085176
## New Mexico      0.25900713  0.29895626  0.59390277
## New York       -0.05051382 -0.43208222 -0.26843554
## North Carolina -1.80859279 -0.47055792 -0.25710271
## North Dakota   -0.34765393  1.56865467 -0.01714434
## Ohio            0.01139037  0.37590768 -0.34878497
## Oklahoma       -0.18670303 -0.43208222 -0.02289865
## Oregon          0.85328734 -1.16312069  0.29824124
## Pennsylvania   -0.36003476  0.41438339 -0.30201214
## Rhode Island   -0.83050660  0.43362124 -0.81670087
## South Carolina -1.89525865 -0.75912574 -0.47477044
## South Dakota    0.02377121  1.29932470  0.06116589
## Tennessee      -1.40002514 -0.66293647 -0.34464796
## Texas          -0.70669822 -1.33626138  2.24310532
## Utah            1.75708850  0.62599979  0.13313582
## Vermont         0.49424305  1.22237328 -0.72038937
## Virginia       -0.65717487 -0.37436865 -0.36278987
## Washington      1.28661666 -1.39397495 -0.04882236
## West Virginia  -1.42478681 -0.08580083 -0.54690445
## Wisconsin       0.17234126  0.85685405 -0.19069958
## Wyoming         1.21233164  1.31856256  0.31018349
```

5.- Construccion de los coeficientes o scores eigen.vec matriz de autovectores

```
scores<-Y%*%eigen.vec
```

Nombramos las columnas PC1…PC8

```
colnames(scores)<-c("PC1","PC2","PC3","PC4","PC5",
                    "PC6", "PC7","PC8")
```

visualizamos

```
scores
```

```
##                      PC1         PC2          PC3          PC4          PC5
## Alabama        -3.78988728 -0.23477897 -0.229317426 -0.383268981  0.247550385
## Alaska          1.05313550  5.45617512 -4.240590401 -0.575673699 -0.109132365
## Arizona        -0.86742876  0.74506148 -0.077268654 -1.718843204  0.559754776
## Arkansas       -2.38177761 -1.28834366 -0.222792819 -0.623207350 -0.647476204
## California     -0.24138147  3.50952277  2.806440773  0.070375517 -0.968568143
## Colorado        2.06218136  0.50566387 -0.511384160  0.109922581 -0.002308581
## Connecticut     1.89943583 -0.24300645  0.662670280 -0.169730671  0.789097815
## Delaware        0.42478394 -0.50791950 -0.218723788  0.192652755  1.306688470
## Florida        -1.17212341  1.13474136  1.281840070 -0.488495802  0.676475545
## Georgia        -3.29417162  0.10995684 -0.387068686  0.455587595  0.476591353
## Hawaii          0.48704129  0.12526216  1.377335153 -2.950230930  1.067613830
## Idaho           1.42342916 -0.61114319 -0.434488061 -0.405610358 -0.407801993
## Illinois       -0.11896424  1.28238783  0.803855520  1.582992442  0.334149206
## Indiana         0.47120189 -0.24520088  0.301483896  0.656489461  0.045255535
## Iowa            2.32181208 -0.53685609  0.293246733 -0.204744921 -0.245734784
## Kansas          1.90151483 -0.07719072  0.177111056 -0.614073058 -0.110701112
## Kentucky       -2.12935981 -1.06425233 -0.251716929  0.348839068 -0.332521039
## Louisiana      -4.24100842 -0.34630079 -0.228892174 -0.879342117  0.227072460
## Maine           0.96019374 -1.70241922 -0.721478601  0.545261667 -0.504736683
## Maryland        0.20342599  0.38881112  0.339225021  0.661994566  1.467721016
## Massachusetts   1.19589376 -0.21865625  1.019629690 -0.290071067  0.256037722
## Michigan       -0.18186944  0.84711636  0.554194008  1.182753855  0.067545973
## Minnesota       2.43361605 -0.36533543  0.272388339 -0.067401738 -0.628490750
## Mississippi    -4.03208863 -1.05124066 -0.919582795 -0.175909614 -0.149968995
## Missouri       -0.31125449 -0.14830589 -0.006605131  0.553888853 -0.178846217
## Montana         1.37887297 -0.03353877 -1.339951830  0.244949880 -0.349313345
## Nebraska        2.18101665 -0.54774825 -0.055771873 -0.455863194 -0.352135895
## Nevada          1.12708455  1.13291366 -1.890646998  1.504838621  1.239670220
## New Hampshire   1.67128925 -1.31239813 -0.437881704  0.480357556  0.052346071
## New Jersey      0.64958222  0.28146986  0.973902564  0.616106237  0.780798216
## New Mexico     -1.32244692 -0.29357041 -1.361964694 -0.707016778 -0.708943056
## New York       -1.05034998  1.89371072  2.197830728  1.266966983 -0.349191317
## North Carolina -2.69433377 -0.51713890 -0.142734146  0.560640547 -0.108152312
## North Dakota    2.41766786 -0.78192203 -0.276975457  0.136309449 -0.030891850
## Ohio            0.26795708  0.41685336  1.032942807  1.147560168 -0.349627890
## Oklahoma       -0.07391320 -0.64658337  0.071187462 -0.606914285 -0.409030086
## Oregon          1.32472856  0.22767511  0.498963071 -1.350011371  0.188502796
## Pennsylvania   -0.07738173  0.26940938  1.070097480  1.289496583 -0.588055906
## Rhode Island    0.74084731 -1.46130325  0.227824040 -0.296882798  0.236743916
## South Carolina -3.71100631 -0.90984427 -0.748732017  0.315820402  0.362708720
## South Dakota    2.01253414 -1.31509491 -0.536546594  0.157426050 -0.750679525
## Tennessee      -2.21813394 -0.65102504  0.016767256 -0.002741771 -0.144730774
## Texas          -2.41364282  2.32744119  0.286040511 -0.804077700 -1.725463387
## Utah            2.26283736 -0.53433138 -0.219767287 -0.850616612 -0.769005564
## Vermont         1.36926611 -1.50938322 -0.445702144  0.359113201 -0.310115720
## Virginia       -0.99354796  0.18457034  0.210828404  0.324420224  0.671960034
## Washington      1.34001299  0.51154448  0.851811855 -1.237439671  0.653672381
## West Virginia  -1.50662213 -1.60198375 -0.492191330  0.342121310 -0.161788605
## Wisconsin       1.75754046 -0.63572738  0.425370544  0.112299153 -0.610595350
## Wyoming         1.48379101  0.04225606 -1.354211561  0.638982968  0.296051007
##                      PC6         PC7          PC8
```

```
## Alabama         -0.434103501  0.057251391 -0.53491642
## Alaska           1.001299389  0.302175087  0.11848462
## Arizona         -0.304979516  0.130724378  0.52455195
## Arkansas         0.258729249  0.033909974 -0.48772305
## California      -0.651287710  0.045319503  0.25738197
## Colorado        -0.266226332 -0.644119708 -0.37501659
## Connecticut      1.077936809 -0.538435562  0.07347167
## Delaware        -0.156822153  0.291529173  0.23950905
## Florida         -0.341142783  0.411065971 -0.25728695
## Georgia          0.104959039  0.036330946 -0.20039576
## Hawaii           0.175207752 -0.807723562 -0.26347852
## Idaho           -0.648579665  0.133008801 -0.23242852
## Illinois         0.044964532 -0.135084190 -0.15050737
## Indiana         -0.231733787  0.219988161 -0.17254551
## Iowa             0.093071203  0.129305163  0.02021091
## Kansas          -0.134983886  0.135676854 -0.32443271
## Kentucky         0.393670085  0.147513023 -0.56402840
## Louisiana       -0.043575107 -0.441696715  0.37369488
## Maine           -0.481174105  0.254004134  0.74240639
## Maryland         0.215590607  0.191707574 -0.20764691
## Massachusetts    0.160448119 -0.261738043  0.59785021
## Michigan        -0.230379908 -0.256762491 -0.54899334
## Minnesota        0.488866756 -0.097944969 -0.10171535
## Mississippi     -0.422545342 -0.116091507  0.44847365
## Missouri        -0.217837134  0.420311029 -0.60675094
## Montana         -0.412463576  0.373643716  0.27477538
## Nebraska         0.030949109  0.051988231 -0.09430245
## Nevada          -1.101174323 -0.449476252 -0.24448788
## New Hampshire   -0.171557565 -0.274758195  0.33906221
## New Jersey       0.732229595 -0.073859423  0.39494695
## New Mexico      -0.276267696 -1.168387600  0.35799143
## New York         0.001227133 -0.491315786  0.24339261
## North Carolina   0.403615700  0.214765541 -0.10343814
## North Dakota     1.654944533 -0.057683827 -0.24651631
## Ohio            -0.147211073  0.015420663  0.11720328
## Oklahoma        -0.181537513  0.331395743 -0.14751633
## Oregon          -0.458130108  0.924423599 -0.05168031
## Pennsylvania     0.198486677  0.114272267  0.57082896
## Rhode Island     1.294032650  0.006637358  0.15405471
## South Carolina   0.261472764  0.045910864  0.45271743
## South Dakota     0.347015906  0.346319001  0.01985115
## Tennessee        0.140907578  0.074689494 -0.41907867
## Texas            0.532238377 -0.001161419 -0.11418343
## Utah            -1.062374614 -0.487883426 -0.17066878
## Vermont         -0.626480055 -0.348350664 -0.27758795
## Virginia         0.316663847  0.073788811 -0.12476119
## Washington      -0.763524610  0.819264968  0.27789769
## West Virginia    0.187273618  0.553108696  0.33393641
## Wisconsin        0.414518844 -0.008885090 -0.04113368
## Wyoming         -0.764227810 -0.224091686  0.13052796
```

Generacion del grafico de los scores

```
pairs(scores, main="scores", col="blue", pch=19)
```

scores