

4.

```
##a
P <-matrix(c(10000,60,60,1),byrow=TRUE,nr=2)
A <- cov2cor(P)
A
```

```
##      [,1] [,2]
## [1,]  1.0  0.6
## [2,]  0.6  1.0
```

```
##b
P.prcomp <- prcomp(P)
print(P.prcomp)
```

```
## Standard deviations (1, ..., p=2):
## [1] 7.028765e+03 7.105302e-15
##
## Rotation (n x k) = (2 x 2):
##           PC1          PC2
## [1,] -0.999982385  0.005935509
## [2,] -0.005935509 -0.999982385
```

```
P.prcomp$sdev^2
```

```
## [1] 4.940354e+07 5.048532e-29
```

```
##c
A.prcomp <- prcomp(A)
print(A.prcomp)
```

```
## Standard deviations (1, ..., p=2):
## [1] 4.000000e-01 1.570092e-16
##
## Rotation (n x k) = (2 x 2):
##           PC1          PC2
## [1,] -0.7071068 -0.7071068
## [2,]  0.7071068 -0.7071068
```

```
A.prcomp$sdev^2
```

```
## [1] 1.600000e-01 2.46519e-32
```

```
summary(P.prcomp)
```

```
## Importance of components:
##                PC1      PC2
## Standard deviation  7029 7.105e-15
## Proportion of Variance  1 0.000e+00
## Cumulative Proportion  1 1.000e+00
```

```
summary(A.prcomp)
```

```
## Importance of components:
##                PC1      PC2
## Standard deviation  0.4 1.57e-16
## Proportion of Variance 1.0 0.00e+00
## Cumulative Proportion 1.0 1.00e+00
```

d.(b),(c)의 결과를 비교하고 그 차이를 설명하시오.

*b의 PC1의 표준편차는 7029인 반면 c의 PC1의 표준편차는 0.4이다.

*누적비율은 둘 다 100%이다.

미국 범죄통계

```
df <- read.csv(file = "C:/Users/Administrator/Desktop/crime-kr.csv",header=T)
x <- subset(df, select=-c(state,div,region,statekr,ndx))
cor(x)
```

```
##      murder      rape  robbery  assault  burglary  larceny
## murder  1.00000000 0.6012205 0.4837076 0.6485505 0.3858168 0.1019198
## rape    0.60122047 1.0000000 0.5918793 0.7402595 0.7121301 0.6139882
## robbery 0.48370757 0.5918793 1.0000000 0.5570782 0.6372420 0.4467399
## assault 0.64855048 0.7402595 0.5570782 1.0000000 0.6229085 0.4043633
## burglary 0.38581683 0.7121301 0.6372420 0.6229085 1.0000000 0.7921210
## larceny  0.10191983 0.6139882 0.4467399 0.4043633 0.7921210 1.0000000
## auto    0.06881448 0.3489015 0.5906795 0.2758426 0.5579533 0.4441799
##      auto
## murder  0.06881448
## rape    0.34890153
## robbery  0.59067951
## assault  0.27584265
## burglary 0.55795326
## larceny  0.44417992
## auto    1.00000000
```

```
cor.prcomp <- prcomp(x,center = TRUE,scale=TRUE)
print(cor.prcomp)
```

```
## Standard deviations (1, ..., p=7):
## [1] 2.0285363 1.1129788 0.8519487 0.5625229 0.5079119 0.4712106 0.3522159
##
## Rotation (n x k) = (7 x 7):
##
```

	PC1	PC2	PC3	PC4	PC5	PC6
murder	-0.3002792	-0.62917444	0.17824530	-0.23211411	0.53812286	0.25911677
rape	-0.4317594	-0.16943512	-0.24419758	0.06221567	0.18847069	-0.77327066
robbery	-0.3968755	0.04224698	0.49586087	-0.55798926	-0.51997683	-0.11438481
assault	-0.3966517	-0.34352815	-0.06950972	0.62980445	-0.50665138	0.17236294
burglary	-0.4401572	0.20334059	-0.20989509	-0.05755491	0.10103335	0.53598716
larceny	-0.3573595	0.40231912	-0.53923144	-0.23488987	0.03009857	0.03940645
auto	-0.2951768	0.50242093	0.56838373	0.41923832	0.36975317	-0.05729763

```
##
## PC7
## murder 0.267592768
## rape -0.296485476
## robbery -0.003902681
## assault 0.191744586
## burglary -0.648117080
## larceny 0.601690040
## auto 0.147046259
```

```
cor.prcomp$sdev^2
```

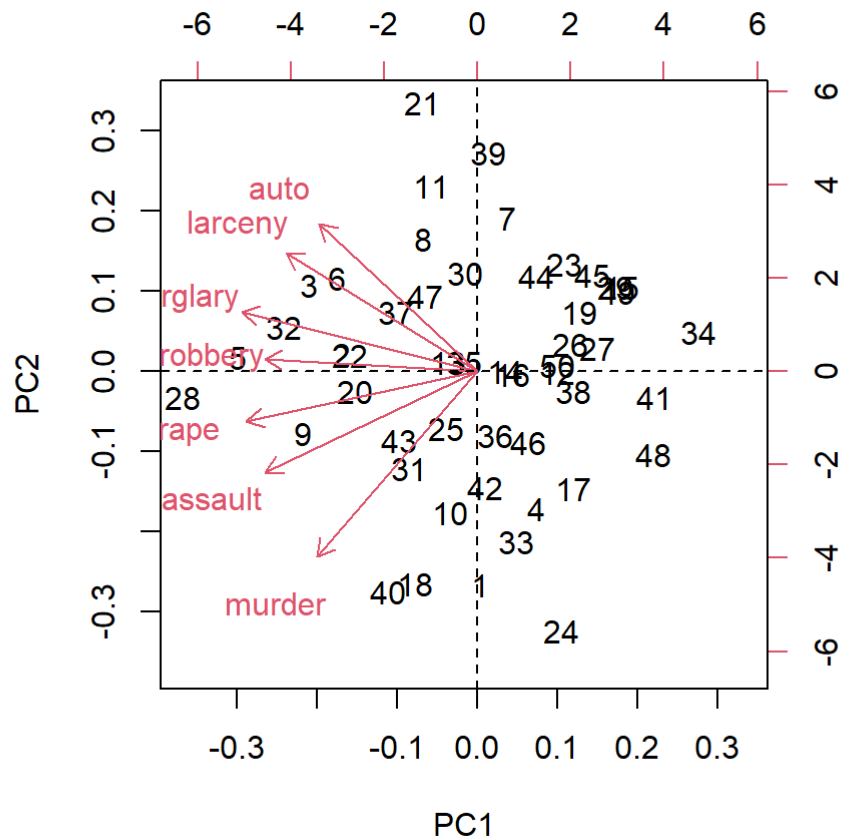
```
## [1] 4.1149595 1.2387218 0.7258166 0.3164320 0.2579745 0.2220395 0.1240561
```

```
summary(cor.prcomp)
```

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

	PC1	PC2	PC3	PC4	PC5	PC6	PC7
Standard deviation	2.0285	1.1130	0.8519	0.5625	0.50791	0.47121	0.35222
Proportion of Variance	0.5878	0.1770	0.1037	0.0452	0.03685	0.03172	0.01772
Cumulative Proportion	0.5878	0.7648	0.8685	0.9137	0.95056	0.98228	1.00000

```
biplot(cor.prcomp,cex=1)
abline(h=0,v=0,lty=2)
```



*주성분 개수: 2개, 근거: PC2에서 누적 기여율(Cumulative Proportion)이 70%가 넘으므로 주성분의 수로 정할 수 있다.

*주성분1(PC1)의 경우 변수별 전반적인 절대값 수치가 비슷하기 때문에, 전반적인 강력범죄 발생 관련 지수를 의미한다.

*주성분2(PC2)의 경우 murder(살인)과 Auto(차량절도)가 큰 것으로 보아, 이들에 관한 지수를 의미한다.

*주성분1의 최고점수를 받은 주: Nevada(네바다), 최저점수를 받은 주: Alabama(알라바마)

*주성분2의 최고점수를 받은 주: New Jersey(뉴저지), 최저점수를 받은 주: Minnesota(미네소타)

*행렬도(biplot)설명: auto와 murder는 직교하므로 상관관계가 없다. 한편 murder를 제외한 나머지 변수들은 서로 양의 상관관계를 가진다.

Olivetti 얼굴인식

```
Z <- read.csv(file = "C:/Users/Administrator/Desktop/olivetti_X.csv", header=T)
cov.prcomp <- prcomp(Z, center=TRUE, scale=FALSE)
cov.prcomp$sdev^2
```

```
## [1] 1.878398e+01 1.109833e+01 6.315377e+00 3.960547e+00 2.847376e+00
## [6] 2.501737e+00 1.914777e+00 1.593572e+00 1.552579e+00 1.326129e+00
## [11] 1.260519e+00 1.136067e+00 9.884733e-01 9.095434e-01 8.415869e-01
## [16] 7.753112e-01 7.282999e-01 6.460005e-01 5.978914e-01 5.922840e-01
## [21] 5.540455e-01 4.862385e-01 4.631170e-01 4.514658e-01 4.326584e-01
## [26] 4.212422e-01 4.062437e-01 3.932256e-01 3.630028e-01 3.490811e-01
## [31] 3.182458e-01 3.044471e-01 2.870702e-01 2.638733e-01 2.540721e-01
## [36] 2.505945e-01 2.418344e-01 2.361092e-01 2.234434e-01 2.167241e-01
## [41] 2.058712e-01 2.013827e-01 1.939666e-01 1.895856e-01 1.826423e-01
## [46] 1.794047e-01 1.761102e-01 1.746385e-01 1.655931e-01 1.617896e-01
## [51] 1.558056e-01 1.518157e-01 1.467073e-01 1.419202e-01 1.408618e-01
## [56] 1.366117e-01 1.317521e-01 1.302053e-01 1.283779e-01 1.255920e-01
## [61] 1.230814e-01 1.197189e-01 1.187623e-01 1.168342e-01 1.131119e-01
## [66] 1.108886e-01 1.086022e-01 1.058625e-01 1.035821e-01 1.018010e-01
## [71] 1.010717e-01 1.000968e-01 9.734431e-02 9.557158e-02 9.324042e-02
## [76] 9.057237e-02 9.046589e-02 8.738849e-02 8.678190e-02 8.615279e-02
## [81] 8.437729e-02 8.221398e-02 8.063210e-02 7.832010e-02 7.731965e-02
## [86] 7.642969e-02 7.581580e-02 7.371177e-02 7.216513e-02 7.204163e-02
## [91] 7.063518e-02 6.977652e-02 6.945054e-02 6.856835e-02 6.540176e-02
## [96] 6.392318e-02 6.316817e-02 6.275578e-02 6.228742e-02 6.121501e-02
## [101] 5.999700e-02 5.969789e-02 5.864477e-02 5.751113e-02 5.679721e-02
## [106] 5.631518e-02 5.553151e-02 5.439494e-02 5.329181e-02 5.297470e-02
## [111] 5.211418e-02 5.158746e-02 5.069520e-02 5.003769e-02 4.944972e-02
## [116] 4.919044e-02 4.845440e-02 4.701224e-02 4.675786e-02 4.597336e-02
## [121] 4.516841e-02 4.451534e-02 4.388493e-02 4.344767e-02 4.319215e-02
## [126] 4.296101e-02 4.234070e-02 4.195260e-02 4.138556e-02 4.091821e-02
## [131] 4.056634e-02 3.954086e-02 3.902752e-02 3.849025e-02 3.813318e-02
## [136] 3.776293e-02 3.732054e-02 3.696302e-02 3.667868e-02 3.617110e-02
## [141] 3.531993e-02 3.520505e-02 3.487970e-02 3.426927e-02 3.377439e-02
## [146] 3.351032e-02 3.329131e-02 3.300818e-02 3.252793e-02 3.222342e-02
## [151] 3.191291e-02 3.153651e-02 3.143261e-02 3.101386e-02 3.083508e-02
## [156] 3.055763e-02 2.999684e-02 2.963068e-02 2.948909e-02 2.920825e-02
## [161] 2.893904e-02 2.868683e-02 2.849177e-02 2.811671e-02 2.776016e-02
## [166] 2.738722e-02 2.721640e-02 2.669243e-02 2.656536e-02 2.620010e-02
## [171] 2.603191e-02 2.586610e-02 2.550234e-02 2.521519e-02 2.481458e-02
## [176] 2.472690e-02 2.464579e-02 2.422576e-02 2.400537e-02 2.377579e-02
## [181] 2.340362e-02 2.315865e-02 2.281586e-02 2.257282e-02 2.227033e-02
## [186] 2.189765e-02 2.170027e-02 2.163464e-02 2.137516e-02 2.127845e-02
## [191] 2.104771e-02 2.084439e-02 2.061884e-02 2.045894e-02 2.034332e-02
## [196] 1.996637e-02 1.979715e-02 1.971325e-02 1.954296e-02 1.901510e-02
## [201] 1.894303e-02 1.864288e-02 1.861616e-02 1.850128e-02 1.839389e-02
## [206] 1.807496e-02 1.793138e-02 1.785249e-02 1.775726e-02 1.743133e-02
## [211] 1.731454e-02 1.711768e-02 1.696307e-02 1.668693e-02 1.658990e-02
## [216] 1.651131e-02 1.609909e-02 1.606357e-02 1.575401e-02 1.558690e-02
## [221] 1.546533e-02 1.542985e-02 1.535976e-02 1.519008e-02 1.497258e-02
## [226] 1.487455e-02 1.469265e-02 1.465320e-02 1.455518e-02 1.442976e-02
## [231] 1.436680e-02 1.416687e-02 1.383847e-02 1.379375e-02 1.351345e-02
## [236] 1.347203e-02 1.325153e-02 1.319515e-02 1.311023e-02 1.296766e-02
## [241] 1.280051e-02 1.271080e-02 1.260978e-02 1.249349e-02 1.241380e-02
## [246] 1.215384e-02 1.213227e-02 1.209968e-02 1.190541e-02 1.175312e-02
## [251] 1.173346e-02 1.151834e-02 1.142586e-02 1.128106e-02 1.113868e-02
## [256] 1.105659e-02 1.096769e-02 1.094630e-02 1.087402e-02 1.071192e-02
## [261] 1.060017e-02 1.053599e-02 1.045108e-02 1.032851e-02 1.019082e-02
## [266] 1.008805e-02 1.005084e-02 9.998446e-03 9.845755e-03 9.773938e-03
## [271] 9.679094e-03 9.597494e-03 9.505197e-03 9.448516e-03 9.371568e-03
## [276] 9.259287e-03 9.140512e-03 9.068560e-03 8.989250e-03 8.941551e-03
## [281] 8.816415e-03 8.769417e-03 8.725088e-03 8.653942e-03 8.593693e-03
```

```
## [286] 8.515353e-03 8.460813e-03 8.436194e-03 8.200581e-03 8.182765e-03
## [291] 8.041994e-03 7.913388e-03 7.855443e-03 7.757104e-03 7.675080e-03
## [296] 7.639095e-03 7.596103e-03 7.467155e-03 7.400106e-03 7.370095e-03
## [301] 7.250234e-03 7.218957e-03 7.173032e-03 7.128846e-03 6.969322e-03
## [306] 6.864406e-03 6.808228e-03 6.733418e-03 6.666841e-03 6.637932e-03
## [311] 6.607298e-03 6.538632e-03 6.474376e-03 6.339613e-03 6.300320e-03
## [316] 6.271142e-03 6.207342e-03 6.137279e-03 6.123840e-03 6.025531e-03
## [321] 6.018647e-03 5.944204e-03 5.779255e-03 5.760491e-03 5.704674e-03
## [326] 5.633208e-03 5.593348e-03 5.549404e-03 5.483534e-03 5.464845e-03
## [331] 5.406854e-03 5.345015e-03 5.270949e-03 5.187930e-03 5.161347e-03
## [336] 5.100172e-03 5.027477e-03 4.954044e-03 4.896811e-03 4.847838e-03
## [341] 4.796383e-03 4.770889e-03 4.720929e-03 4.581513e-03 4.570723e-03
## [346] 4.510674e-03 4.497960e-03 4.436545e-03 4.339641e-03 4.232976e-03
## [351] 4.213763e-03 4.109179e-03 4.076824e-03 4.037157e-03 4.008566e-03
## [356] 3.950042e-03 3.916980e-03 3.855443e-03 3.797612e-03 3.762560e-03
## [361] 3.692094e-03 3.674342e-03 3.647797e-03 3.593465e-03 3.487289e-03
## [366] 3.426991e-03 3.357001e-03 3.315486e-03 3.283106e-03 3.251970e-03
## [371] 3.190998e-03 3.167969e-03 3.105085e-03 3.069185e-03 3.042452e-03
## [376] 3.004806e-03 2.944635e-03 2.869927e-03 2.835855e-03 2.729956e-03
## [381] 2.679620e-03 2.640722e-03 2.612534e-03 2.547897e-03 2.522012e-03
## [386] 2.471122e-03 2.413010e-03 2.327507e-03 2.225563e-03 2.148525e-03
## [391] 2.067733e-03 1.978462e-03 1.904053e-03 1.750284e-03 1.726318e-03
## [396] 1.700318e-03 1.595201e-03 1.301792e-03 3.548231e-30
```

```
summary(cov.prcomp)
```

Importance of components:

	PC1	PC2	PC3	PC4	PC5	PC6	PC7
## Standard deviation	4.3340	3.3314	2.51304	1.99011	1.6874	1.58169	1.38375
## Proportion of Variance	0.2375	0.1403	0.07984	0.05007	0.0360	0.03163	0.02421
## Cumulative Proportion	0.2375	0.3778	0.45762	0.50769	0.5437	0.57531	0.59952
	PC8	PC9	PC10	PC11	PC12	PC13	PC14
## Standard deviation	1.26237	1.24603	1.15158	1.12273	1.06586	0.9942	0.9537
## Proportion of Variance	0.02015	0.01963	0.01677	0.01594	0.01436	0.0125	0.0115
## Cumulative Proportion	0.61966	0.63929	0.65606	0.67199	0.68635	0.6988	0.7104
	PC15	PC16	PC17	PC18	PC19	PC20	PC21
## Standard deviation	0.91738	0.8805	0.85340	0.80374	0.77323	0.76960	0.7443
## Proportion of Variance	0.01064	0.0098	0.00921	0.00817	0.00756	0.00749	0.0070
## Cumulative Proportion	0.72099	0.7308	0.74000	0.74816	0.75572	0.76321	0.7702
	PC22	PC23	PC24	PC25	PC26	PC27	PC28
## Standard deviation	0.69731	0.68053	0.67191	0.65777	0.64903	0.63737	0.62708
## Proportion of Variance	0.00615	0.00585	0.00571	0.00547	0.00533	0.00514	0.00497
## Cumulative Proportion	0.77636	0.78222	0.78792	0.79339	0.79872	0.80386	0.80883
	PC29	PC30	PC31	PC32	PC33	PC34	PC35
## Standard deviation	0.60250	0.59083	0.56413	0.55177	0.53579	0.51369	0.50406
## Proportion of Variance	0.00459	0.00441	0.00402	0.00385	0.00363	0.00334	0.00321
## Cumulative Proportion	0.81342	0.81783	0.82185	0.82570	0.82933	0.83267	0.83588
	PC36	PC37	PC38	PC39	PC40	PC41	PC42
## Standard deviation	0.50059	0.49177	0.48591	0.47270	0.46554	0.4537	0.44876
## Proportion of Variance	0.00317	0.00306	0.00298	0.00282	0.00274	0.0026	0.00255
## Cumulative Proportion	0.83905	0.84210	0.84509	0.84791	0.85065	0.8533	0.85580
	PC43	PC44	PC45	PC46	PC47	PC48	PC49
## Standard deviation	0.44042	0.4354	0.42737	0.42356	0.41965	0.41790	0.40693
## Proportion of Variance	0.00245	0.0024	0.00231	0.00227	0.00223	0.00221	0.00209
## Cumulative Proportion	0.85825	0.8607	0.86296	0.86523	0.86745	0.86966	0.87175
	PC50	PC51	PC52	PC53	PC54	PC55	PC56
## Standard deviation	0.40223	0.39472	0.38964	0.38302	0.37672	0.37532	0.36961
## Proportion of Variance	0.00205	0.00197	0.00192	0.00185	0.00179	0.00178	0.00173
## Cumulative Proportion	0.87380	0.87577	0.87769	0.87954	0.88134	0.88312	0.88485
	PC57	PC58	PC59	PC60	PC61	PC62	PC63
## Standard deviation	0.36298	0.36084	0.35830	0.35439	0.35083	0.34600	0.3446
## Proportion of Variance	0.00167	0.00165	0.00162	0.00159	0.00156	0.00151	0.0015
## Cumulative Proportion	0.88651	0.88816	0.88978	0.89137	0.89292	0.89444	0.8959
	PC64	PC65	PC66	PC67	PC68	PC69	PC70
## Standard deviation	0.34181	0.33632	0.3330	0.32955	0.32537	0.32184	0.31906
## Proportion of Variance	0.00148	0.00143	0.0014	0.00137	0.00134	0.00131	0.00129
## Cumulative Proportion	0.89742	0.89885	0.9002	0.90162	0.90296	0.90427	0.90556
	PC71	PC72	PC73	PC74	PC75	PC76	PC77
## Standard deviation	0.31792	0.31638	0.31200	0.30915	0.30535	0.30095	0.30078
## Proportion of Variance	0.00128	0.00127	0.00123	0.00121	0.00118	0.00115	0.00114
## Cumulative Proportion	0.90683	0.90810	0.90933	0.91054	0.91172	0.91286	0.91401
	PC78	PC79	PC80	PC81	PC82	PC83	PC84
## Standard deviation	0.2956	0.2946	0.29352	0.29048	0.28673	0.28396	0.27986
## Proportion of Variance	0.0011	0.0011	0.00109	0.00107	0.00104	0.00102	0.00099
## Cumulative Proportion	0.9151	0.9162	0.91730	0.91836	0.91940	0.92042	0.92141
	PC85	PC86	PC87	PC88	PC89	PC90	PC91
## Standard deviation	0.27806	0.27646	0.27535	0.27150	0.26864	0.26841	0.26577
## Proportion of Variance	0.00098	0.00097	0.00096	0.00093	0.00091	0.00091	0.00089
## Cumulative Proportion	0.92239	0.92336	0.92431	0.92525	0.92616	0.92707	0.92796
	PC92	PC93	PC94	PC95	PC96	PC97	PC98
## Standard deviation	0.26415	0.26353	0.26186	0.25574	0.25283	0.2513	0.25051
## Proportion of Variance	0.00088	0.00088	0.00087	0.00083	0.00081	0.0008	0.00079
## Cumulative Proportion	0.92884	0.92972	0.93059	0.93142	0.93222	0.9330	0.93382

	PC99	PC100	PC101	PC102	PC103	PC104	PC105
##							
## Standard deviation	0.24957	0.24742	0.24494	0.24433	0.24217	0.23981	0.23832
## Proportion of Variance	0.00079	0.00077	0.00076	0.00075	0.00074	0.00073	0.00072
## Cumulative Proportion	0.93460	0.93538	0.93614	0.93689	0.93763	0.93836	0.93908
	PC106	PC107	PC108	PC109	PC110	PC111	PC112
##							
## Standard deviation	0.23731	0.2357	0.23323	0.23085	0.23016	0.22829	0.22713
## Proportion of Variance	0.00071	0.0007	0.00069	0.00067	0.00067	0.00066	0.00065
## Cumulative Proportion	0.93979	0.9405	0.94118	0.94185	0.94252	0.94318	0.94383
	PC113	PC114	PC115	PC116	PC117	PC118	PC119
##							
## Standard deviation	0.22516	0.22369	0.22237	0.22179	0.22012	0.21682	0.21624
## Proportion of Variance	0.00064	0.00063	0.00063	0.00062	0.00061	0.00059	0.00059
## Cumulative Proportion	0.94447	0.94511	0.94573	0.94635	0.94697	0.94756	0.94815
	PC120	PC121	PC122	PC123	PC124	PC125	PC126
##							
## Standard deviation	0.21441	0.21253	0.21099	0.20949	0.20844	0.20783	0.20727
## Proportion of Variance	0.00058	0.00057	0.00056	0.00055	0.00055	0.00055	0.00054
## Cumulative Proportion	0.94873	0.94930	0.94987	0.95042	0.95097	0.95152	0.95206
	PC127	PC128	PC129	PC130	PC131	PC132	PC133
##							
## Standard deviation	0.20577	0.20482	0.20343	0.20228	0.20141	0.1988	0.19755
## Proportion of Variance	0.00054	0.00053	0.00052	0.00052	0.00051	0.0005	0.00049
## Cumulative Proportion	0.95260	0.95313	0.95365	0.95417	0.95468	0.9552	0.95567
	PC134	PC135	PC136	PC137	PC138	PC139	PC140
##							
## Standard deviation	0.19619	0.19528	0.19433	0.19319	0.19226	0.19152	0.19019
## Proportion of Variance	0.00049	0.00048	0.00048	0.00047	0.00047	0.00046	0.00046
## Cumulative Proportion	0.95616	0.95664	0.95712	0.95759	0.95806	0.95852	0.95898
	PC141	PC142	PC143	PC144	PC145	PC146	PC147
##							
## Standard deviation	0.18794	0.18763	0.18676	0.18512	0.18378	0.18306	0.18246
## Proportion of Variance	0.00045	0.00045	0.00044	0.00043	0.00043	0.00042	0.00042
## Cumulative Proportion	0.95942	0.95987	0.96031	0.96074	0.96117	0.96159	0.96202
	PC148	PC149	PC150	PC151	PC152	PC153	PC154
##							
## Standard deviation	0.18168	0.18036	0.17951	0.1786	0.1776	0.1773	0.17611
## Proportion of Variance	0.00042	0.00041	0.00041	0.0004	0.0004	0.0004	0.00039
## Cumulative Proportion	0.96243	0.96284	0.96325	0.9637	0.9640	0.9645	0.96484
	PC155	PC156	PC157	PC158	PC159	PC160	PC161
##							
## Standard deviation	0.17560	0.17481	0.17320	0.17214	0.17172	0.17090	0.17011
## Proportion of Variance	0.00039	0.00039	0.00038	0.00037	0.00037	0.00037	0.00037
## Cumulative Proportion	0.96523	0.96562	0.96600	0.96637	0.96675	0.96712	0.96748
	PC162	PC163	PC164	PC165	PC166	PC167	PC168
##							
## Standard deviation	0.16937	0.16880	0.16768	0.16661	0.16549	0.16497	0.16338
## Proportion of Variance	0.00036	0.00036	0.00036	0.00035	0.00035	0.00034	0.00034
## Cumulative Proportion	0.96784	0.96820	0.96856	0.96891	0.96926	0.96960	0.96994
	PC169	PC170	PC171	PC172	PC173	PC174	PC175
##							
## Standard deviation	0.16299	0.16186	0.16134	0.16083	0.15969	0.15879	0.15753
## Proportion of Variance	0.00034	0.00033	0.00033	0.00033	0.00032	0.00032	0.00031
## Cumulative Proportion	0.97027	0.97061	0.97093	0.97126	0.97158	0.97190	0.97222
	PC176	PC177	PC178	PC179	PC180	PC181	PC182
##							
## Standard deviation	0.15725	0.15699	0.15565	0.1549	0.1542	0.1530	0.15218
## Proportion of Variance	0.00031	0.00031	0.00031	0.0003	0.0003	0.0003	0.00029
## Cumulative Proportion	0.97253	0.97284	0.97315	0.9735	0.9738	0.9740	0.97434
	PC183	PC184	PC185	PC186	PC187	PC188	PC189
##							
## Standard deviation	0.15105	0.15024	0.14923	0.14798	0.14731	0.14709	0.14620
## Proportion of Variance	0.00029	0.00029	0.00028	0.00028	0.00027	0.00027	0.00027
## Cumulative Proportion	0.97463	0.97491	0.97519	0.97547	0.97575	0.97602	0.97629
	PC190	PC191	PC192	PC193	PC194	PC195	PC196
##							
## Standard deviation	0.14587	0.14508	0.14438	0.14359	0.14303	0.14263	0.14130
## Proportion of Variance	0.00027	0.00027	0.00026	0.00026	0.00026	0.00026	0.00025
## Cumulative Proportion	0.97656	0.97682	0.97709	0.97735	0.97761	0.97786	0.97812
	PC197	PC198	PC199	PC200	PC201	PC202	PC203
##							
## Standard deviation	0.14070	0.14040	0.13980	0.13790	0.13763	0.13654	0.13644


```

## Proportion of Variance 0.00025 0.00025 0.00025 0.00024 0.00024 0.00024 0.00024
## Cumulative Proportion 0.97837 0.97862 0.97886 0.97910 0.97934 0.97958 0.97981
## PC204 PC205 PC206 PC207 PC208 PC209 PC210
## Standard deviation 0.13602 0.13562 0.13444 0.13391 0.13361 0.13326 0.13203
## Proportion of Variance 0.00023 0.00023 0.00023 0.00023 0.00023 0.00022 0.00022
## Cumulative Proportion 0.98005 0.98028 0.98051 0.98074 0.98096 0.98119 0.98141
## PC211 PC212 PC213 PC214 PC215 PC216 PC217
## Standard deviation 0.13158 0.13083 0.13024 0.12918 0.12880 0.12850 0.1269
## Proportion of Variance 0.00022 0.00022 0.00021 0.00021 0.00021 0.00021 0.0002
## Cumulative Proportion 0.98163 0.98184 0.98206 0.98227 0.98248 0.98269 0.9829
## PC218 PC219 PC220 PC221 PC222 PC223 PC224
## Standard deviation 0.1267 0.1255 0.1248 0.1244 0.1242 0.12393 0.12325
## Proportion of Variance 0.0002 0.0002 0.0002 0.0002 0.0002 0.00019 0.00019
## Cumulative Proportion 0.9831 0.9833 0.9835 0.9837 0.9839 0.98407 0.98427
## PC225 PC226 PC227 PC228 PC229 PC230 PC231
## Standard deviation 0.12236 0.12196 0.12121 0.12105 0.12064 0.12012 0.11986
## Proportion of Variance 0.00019 0.00019 0.00019 0.00019 0.00018 0.00018 0.00018
## Cumulative Proportion 0.98445 0.98464 0.98483 0.98501 0.98520 0.98538 0.98556
## PC232 PC233 PC234 PC235 PC236 PC237 PC238
## Standard deviation 0.11902 0.11764 0.11745 0.11625 0.11607 0.11512 0.11487
## Proportion of Variance 0.00018 0.00017 0.00017 0.00017 0.00017 0.00017 0.00017
## Cumulative Proportion 0.98574 0.98592 0.98609 0.98626 0.98643 0.98660 0.98677
## PC239 PC240 PC241 PC242 PC243 PC244 PC245
## Standard deviation 0.11450 0.11388 0.11314 0.11274 0.11229 0.11177 0.11142
## Proportion of Variance 0.00017 0.00016 0.00016 0.00016 0.00016 0.00016 0.00016
## Cumulative Proportion 0.98693 0.98710 0.98726 0.98742 0.98758 0.98774 0.98789
## PC246 PC247 PC248 PC249 PC250 PC251 PC252
## Standard deviation 0.11024 0.11015 0.11000 0.10911 0.10841 0.10832 0.10732
## Proportion of Variance 0.00015 0.00015 0.00015 0.00015 0.00015 0.00015 0.00015
## Cumulative Proportion 0.98805 0.98820 0.98835 0.98850 0.98865 0.98880 0.98895
## PC253 PC254 PC255 PC256 PC257 PC258 PC259
## Standard deviation 0.10689 0.10621 0.10554 0.10515 0.10473 0.10462 0.10428
## Proportion of Variance 0.00014 0.00014 0.00014 0.00014 0.00014 0.00014 0.00014
## Cumulative Proportion 0.98909 0.98923 0.98937 0.98951 0.98965 0.98979 0.98993
## PC260 PC261 PC262 PC263 PC264 PC265 PC266
## Standard deviation 0.10350 0.10296 0.10264 0.10223 0.10163 0.10095 0.10044
## Proportion of Variance 0.00014 0.00013 0.00013 0.00013 0.00013 0.00013 0.00013
## Cumulative Proportion 0.99006 0.99020 0.99033 0.99046 0.99059 0.99072 0.99085
## PC267 PC268 PC269 PC270 PC271 PC272 PC273
## Standard deviation 0.10025 0.09999 0.09923 0.09886 0.09838 0.09797 0.09749
## Proportion of Variance 0.00013 0.00013 0.00012 0.00012 0.00012 0.00012 0.00012
## Cumulative Proportion 0.99098 0.99110 0.99123 0.99135 0.99147 0.99159 0.99171
## PC274 PC275 PC276 PC277 PC278 PC279 PC280
## Standard deviation 0.09720 0.09681 0.09623 0.09561 0.09523 0.09481 0.09456
## Proportion of Variance 0.00012 0.00012 0.00012 0.00012 0.00011 0.00011 0.00011
## Cumulative Proportion 0.99183 0.99195 0.99207 0.99219 0.99230 0.99241 0.99253
## PC281 PC282 PC283 PC284 PC285 PC286 PC287
## Standard deviation 0.09390 0.09365 0.09341 0.09303 0.09270 0.09228 0.09198
## Proportion of Variance 0.00011 0.00011 0.00011 0.00011 0.00011 0.00011 0.00011
## Cumulative Proportion 0.99264 0.99275 0.99286 0.99297 0.99308 0.99318 0.99329
## PC288 PC289 PC290 PC291 PC292 PC293 PC294
## Standard deviation 0.09185 0.09056 0.09046 0.08968 0.08896 0.08863 0.08807
## Proportion of Variance 0.00011 0.00010 0.00010 0.00010 0.00010 0.00010 0.00010
## Cumulative Proportion 0.99340 0.99350 0.99361 0.99371 0.99381 0.99391 0.99400
## PC295 PC296 PC297 PC298 PC299 PC300 PC301
## Standard deviation 0.08761 0.0874 0.08716 0.08641 0.08602 0.08585 0.08515
## Proportion of Variance 0.00010 0.0001 0.00010 0.00009 0.00009 0.00009 0.00009
## Cumulative Proportion 0.99410 0.9942 0.99429 0.99439 0.99448 0.99458 0.99467

```

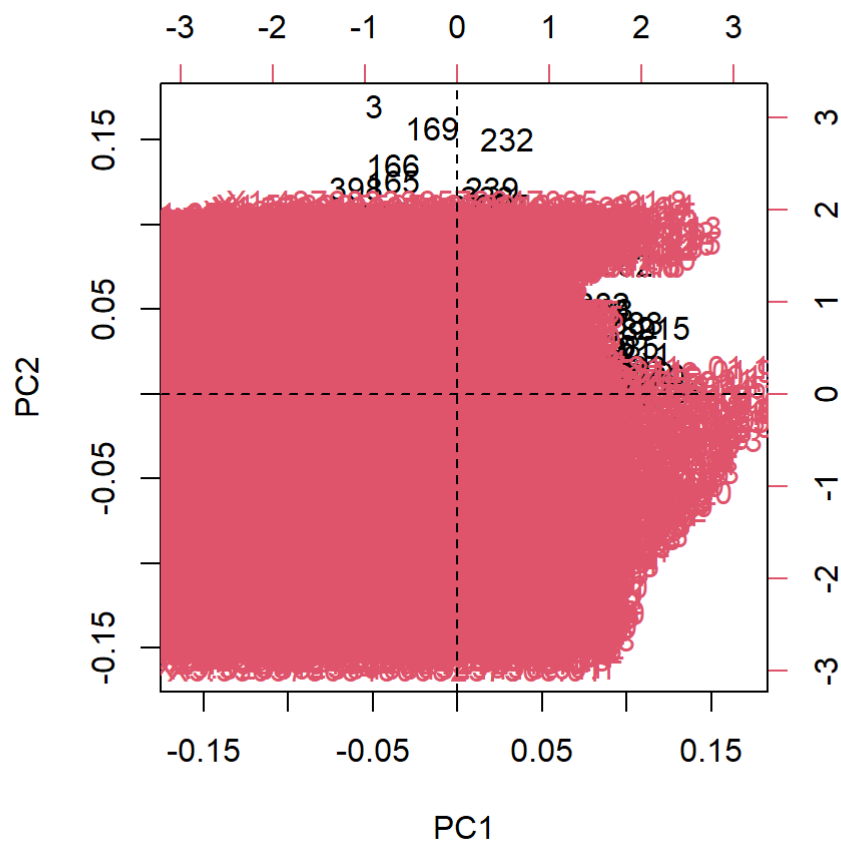
```

##          PC302  PC303  PC304  PC305  PC306  PC307  PC308
## Standard deviation  0.08496 0.08469 0.08443 0.08348 0.08285 0.08251 0.08206
## Proportion of Variance 0.00009 0.00009 0.00009 0.00009 0.00009 0.00009 0.00009
## Cumulative Proportion 0.99476 0.99485 0.99494 0.99503 0.99511 0.99520 0.99529
##          PC309  PC310  PC311  PC312  PC313  PC314  PC315
## Standard deviation  0.08165 0.08147 0.08129 0.08086 0.08046 0.07962 0.07937
## Proportion of Variance 0.00008 0.00008 0.00008 0.00008 0.00008 0.00008 0.00008
## Cumulative Proportion 0.99537 0.99545 0.99554 0.99562 0.99570 0.99578 0.99586
##          PC316  PC317  PC318  PC319  PC320  PC321  PC322
## Standard deviation  0.07919 0.07879 0.07834 0.07825 0.07762 0.07758 0.07710
## Proportion of Variance 0.00008 0.00008 0.00008 0.00008 0.00008 0.00008 0.00008
## Cumulative Proportion 0.99594 0.99602 0.99610 0.99617 0.99625 0.99633 0.99640
##          PC323  PC324  PC325  PC326  PC327  PC328  PC329
## Standard deviation  0.07602 0.07590 0.07553 0.07505 0.07479 0.07449 0.07405
## Proportion of Variance 0.00007 0.00007 0.00007 0.00007 0.00007 0.00007 0.00007
## Cumulative Proportion 0.99647 0.99655 0.99662 0.99669 0.99676 0.99683 0.99690
##          PC330  PC331  PC332  PC333  PC334  PC335  PC336
## Standard deviation  0.07392 0.07353 0.07311 0.07260 0.07203 0.07184 0.07142
## Proportion of Variance 0.00007 0.00007 0.00007 0.00007 0.00007 0.00007 0.00006
## Cumulative Proportion 0.99697 0.99704 0.99711 0.99717 0.99724 0.99730 0.99737
##          PC337  PC338  PC339  PC340  PC341  PC342  PC343
## Standard deviation  0.07090 0.07038 0.06998 0.06963 0.06926 0.06907 0.06871
## Proportion of Variance 0.00006 0.00006 0.00006 0.00006 0.00006 0.00006 0.00006
## Cumulative Proportion 0.99743 0.99749 0.99756 0.99762 0.99768 0.99774 0.99780
##          PC344  PC345  PC346  PC347  PC348  PC349  PC350
## Standard deviation  0.06769 0.06761 0.06716 0.06707 0.06661 0.06588 0.06506
## Proportion of Variance 0.00006 0.00006 0.00006 0.00006 0.00006 0.00005 0.00005
## Cumulative Proportion 0.99786 0.99791 0.99797 0.99803 0.99808 0.99814 0.99819
##          PC351  PC352  PC353  PC354  PC355  PC356  PC357
## Standard deviation  0.06491 0.06410 0.06385 0.06354 0.06331 0.06285 0.06259
## Proportion of Variance 0.00005 0.00005 0.00005 0.00005 0.00005 0.00005 0.00005
## Cumulative Proportion 0.99825 0.99830 0.99835 0.99840 0.99845 0.99850 0.99855
##          PC358  PC359  PC360  PC361  PC362  PC363  PC364
## Standard deviation  0.06209 0.06162 0.06134 0.06076 0.06062 0.06040 0.05995
## Proportion of Variance 0.00005 0.00005 0.00005 0.00005 0.00005 0.00005 0.00005
## Cumulative Proportion 0.99860 0.99865 0.99869 0.99874 0.99879 0.99883 0.99888
##          PC365  PC366  PC367  PC368  PC369  PC370  PC371
## Standard deviation  0.05905 0.05854 0.05794 0.05758 0.05730 0.05703 0.05649
## Proportion of Variance 0.00004 0.00004 0.00004 0.00004 0.00004 0.00004 0.00004
## Cumulative Proportion 0.99892 0.99897 0.99901 0.99905 0.99909 0.99913 0.99917
##          PC372  PC373  PC374  PC375  PC376  PC377  PC378
## Standard deviation  0.05628 0.05572 0.05540 0.05516 0.05482 0.05426 0.05357
## Proportion of Variance 0.00004 0.00004 0.00004 0.00004 0.00004 0.00004 0.00004
## Cumulative Proportion 0.99921 0.99925 0.99929 0.99933 0.99937 0.99941 0.99944
##          PC379  PC380  PC381  PC382  PC383  PC384  PC385
## Standard deviation  0.05325 0.05225 0.05177 0.05139 0.05111 0.05048 0.05022
## Proportion of Variance 0.00004 0.00003 0.00003 0.00003 0.00003 0.00003 0.00003
## Cumulative Proportion 0.99948 0.99951 0.99955 0.99958 0.99961 0.99964 0.99968
##          PC386  PC387  PC388  PC389  PC390  PC391  PC392
## Standard deviation  0.04971 0.04912 0.04824 0.04718 0.04635 0.04547 0.04448
## Proportion of Variance 0.00003 0.00003 0.00003 0.00003 0.00003 0.00003 0.00003
## Cumulative Proportion 0.99971 0.99974 0.99977 0.99980 0.99982 0.99985 0.99987
##          PC393  PC394  PC395  PC396  PC397  PC398
## Standard deviation  0.04364 0.04184 0.04155 0.04123 0.03994 0.03608
## Proportion of Variance 0.00002 0.00002 0.00002 0.00002 0.00002 0.00002
## Cumulative Proportion 0.99990 0.99992 0.99994 0.99996 0.99998 1.00000
##          PC399
## Standard deviation  1.884e-15

```

```
## Proportion of Variance 0.000e+00
## Cumulative Proportion 1.000e+00
```

```
biplot(cov.prcomp,cex=1)
abline(h=0,v=0,lty=2)
```



*주성분 개수: 14개, 근거: PC14에서 누적 기여율(Cumulative Proportion)이 70%가 넘으므로 주성분의 수로 정할 수 있다.