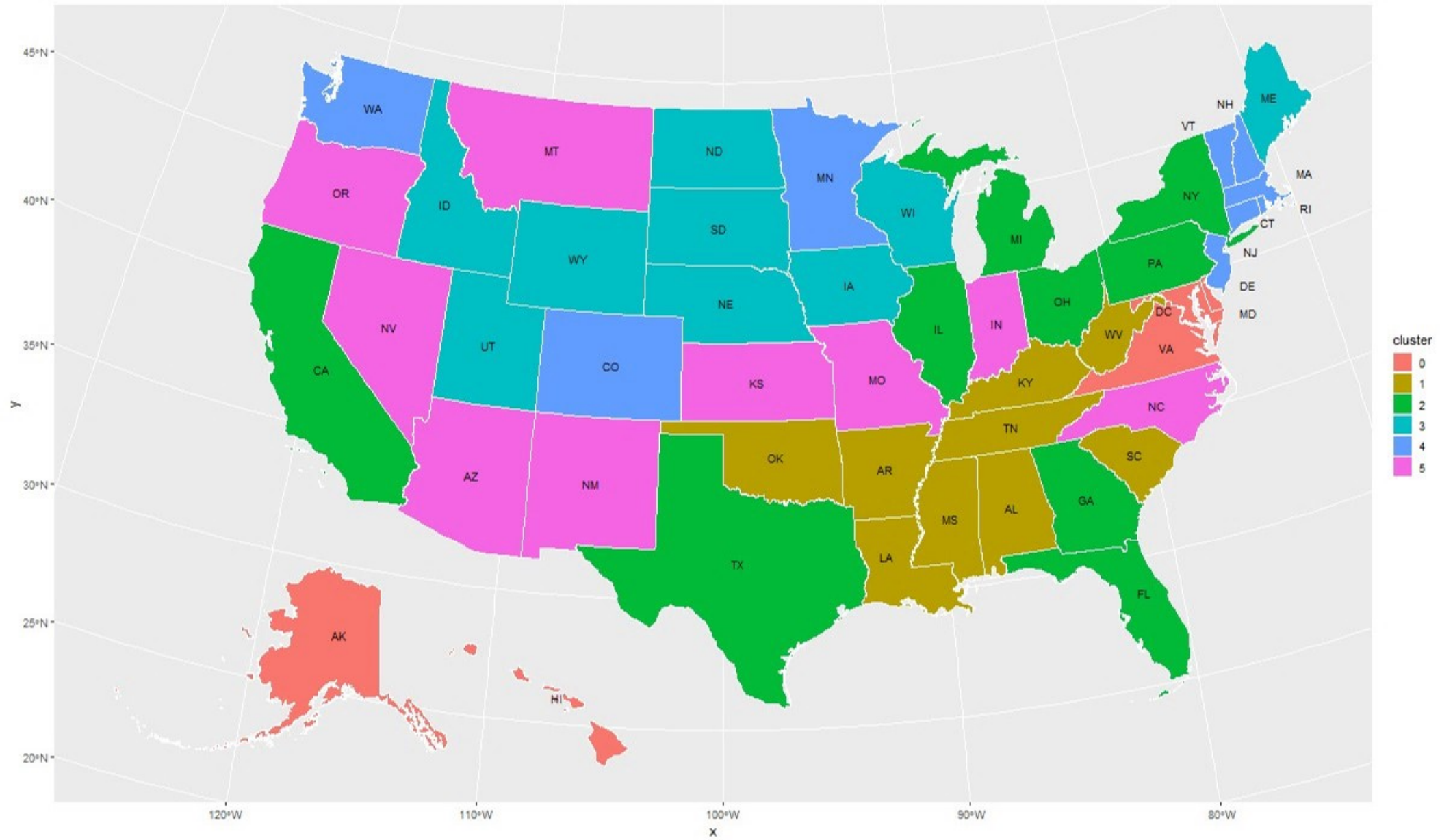
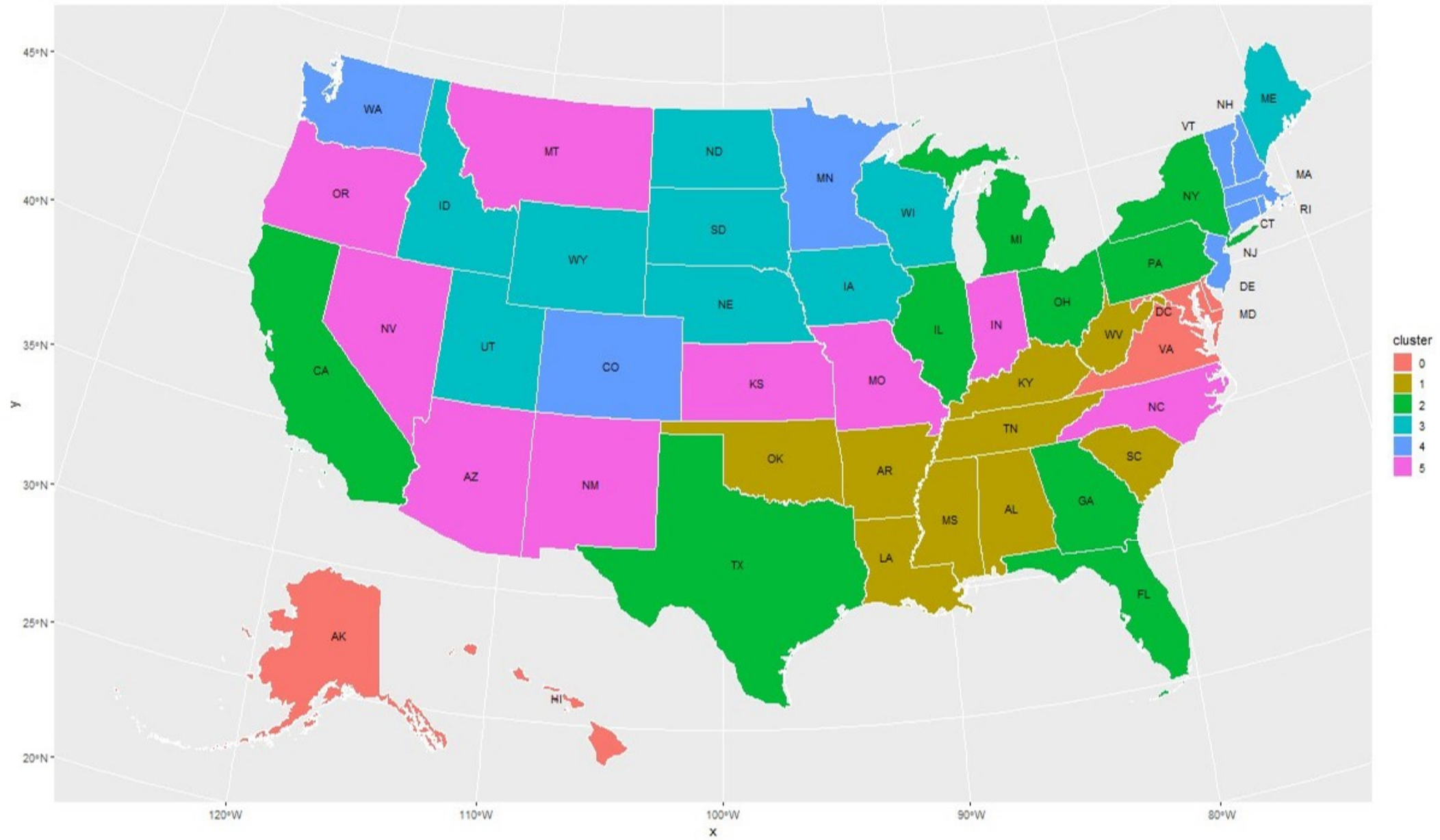
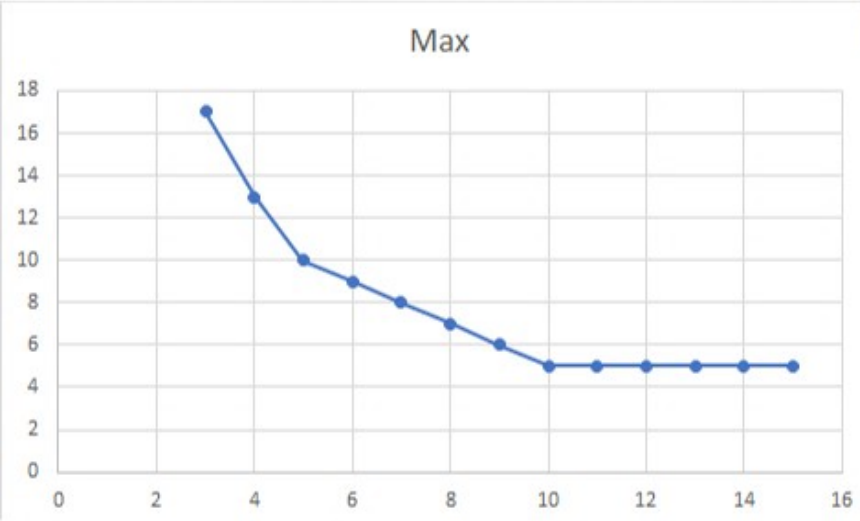

WA
OR
CA
ID
NV
MT
WY
UT
AZ
CO
NM
ND
SD
NE
KS
OK
TX
MN
IA
MO
AR
LA
WI
IL
MS
MI
IN
KY
TN
AL
OH
WV
GA
FL
SC
NC
VA
PA
NY
DC
MD
DE
NJ
CT
RI
MA
VT
NH
ME
AK
HI
45°N
40°N
35°N
30°N
25°N
20°N
120°W
110°W
100°W
90°W
80°W
x
y
cluster
0
1
2
3
4
5


WA
OR
CA
ID
NV
MT
WY
UT
AZ
CO
NM
ND
SD
NE
KS
OK
TX
MN
IA
MO
AR
LA
WI
IL
MS
MI
IN
KY
TN
AL
OH
WV
GA
FL
SC
NC
VA
PA
NY
DC
MD
DE
NJ
CT
RI
MA
VT
NH
ME
AK
HI
45°N
40°N
35°N
30°N
25°N
20°N
120°W
110°W
100°W
90°W
80°W
x
y
cluster
0
1
2
3
4
5

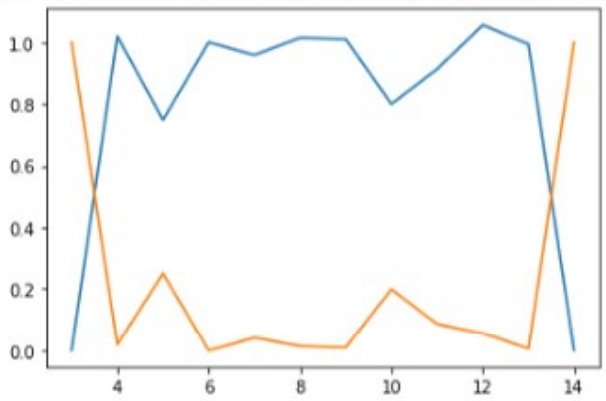


[9]:

```
bss_ = findknee(bss)
bss_ = bss_/np.max(bss_)

wss_ = findknee(np.array(pd.DataFrame(wss).mean(1)))
wss_ = wss_/np.max(wss_)

temp_df = pd.DataFrame(bss_/wss_).replace([np.inf, -np.i
temp_df.index = np.array(range(0,len(wss_)))+mink
plt.plot(temp_df)

set_ = np.abs(temp_df-1)
plt.plot(set_)
#plt.plot(set_)
optimal_k = np.nanargmin(set_)+mink

print(optimal_k)
```

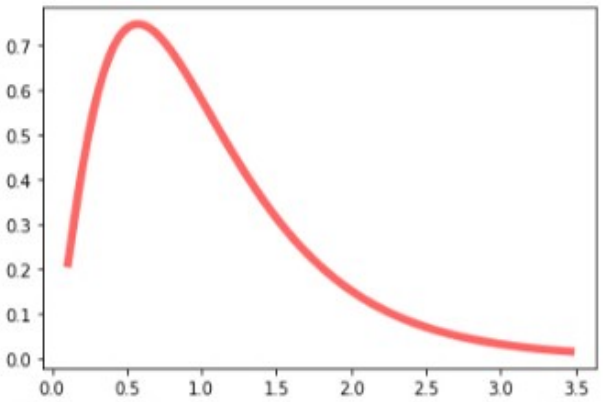
```
6
```

```
C:\Users\User\AppData\Local\Temp/ipykernel_10152/4072231
  temp_df = pd.DataFrame(bss_/wss_).replace([np.inf, -np
```



```
dfn = (optimal_k-1)
dfd = len(df)-(optimal_k)

F_scores = (BSS/dfn)/(within_ss/(dfd))

x = np.linspace(f.ppf(0.01, dfn, dfd),
                f.ppf(0.99, dfn, dfd), 100)
plt.plot(x, f.pdf(x, dfn, dfd),
       'r-', lw=5, alpha=0.6, label='f pdf')

print("F-Scores:", F_scores)

print("P-Scores:", 1-f.cdf(F_scores, dfn, dfd))
```

```
F-Scores: [ 78.52330489  66.43137145  60.12298189 152.1336309   81.82322516
  79.09952175]
P-Scores: [1.11022302e-16 1.11022302e-16 1.11022302e-16 1.11022302e-16
 1.11022302e-16 1.11022302e-16]
```

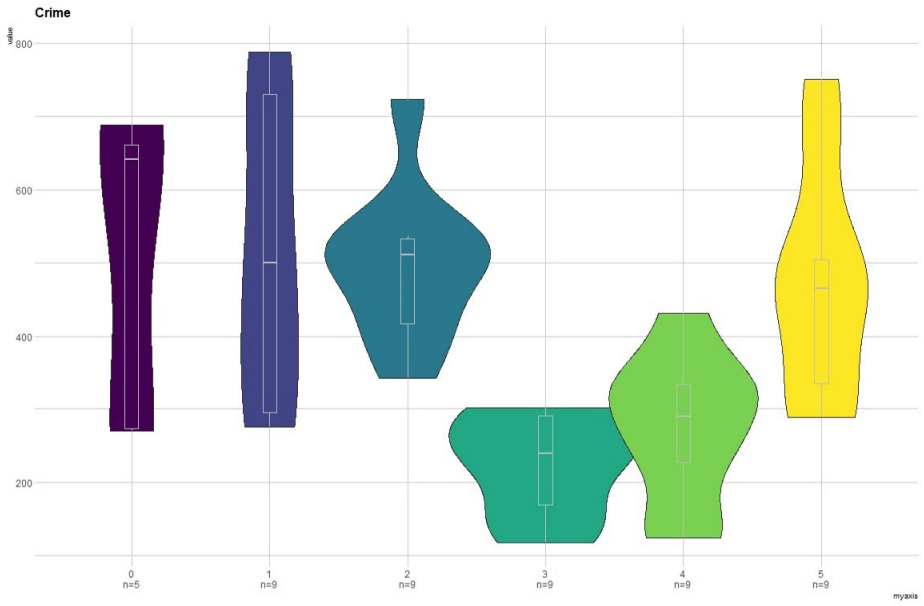


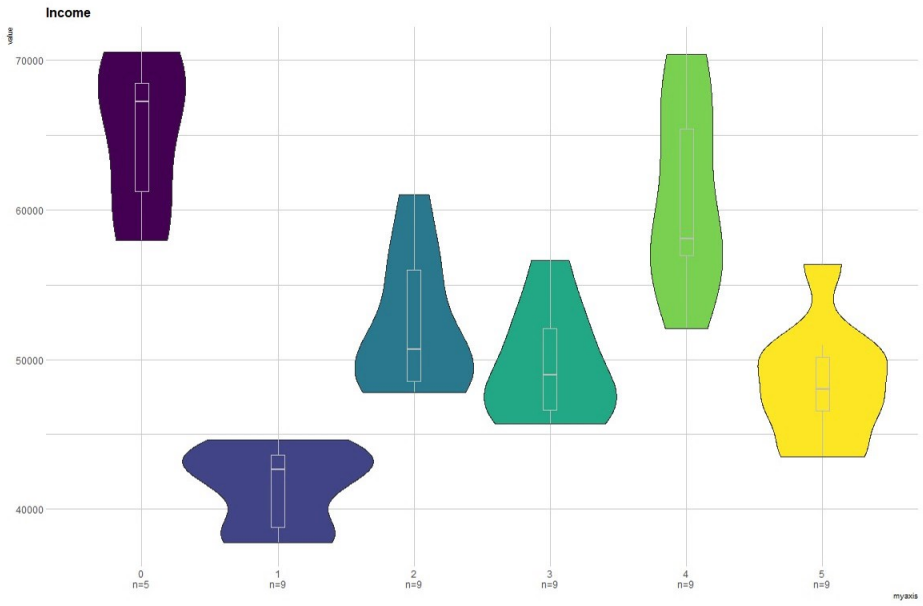
```
clf = KMeansConstrained(n_clusters=optimal_k, size_min=i
clf.fit_predict(X_pca)

labels = clf.labels_
clusters = clf.n_clusters
centers = clf.cluster_centers_

tot_ss, BSS, within_ss = deriveANOVA(clf, X_pca)
```

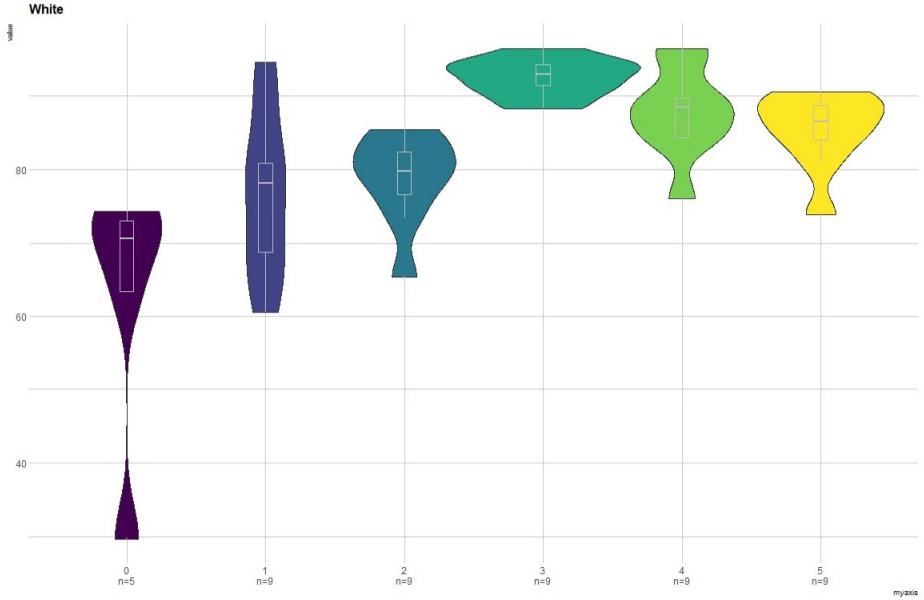
```
wss 200.1585375370103
tot_ss 500.00000000000006
bss 299.8414624629898
```

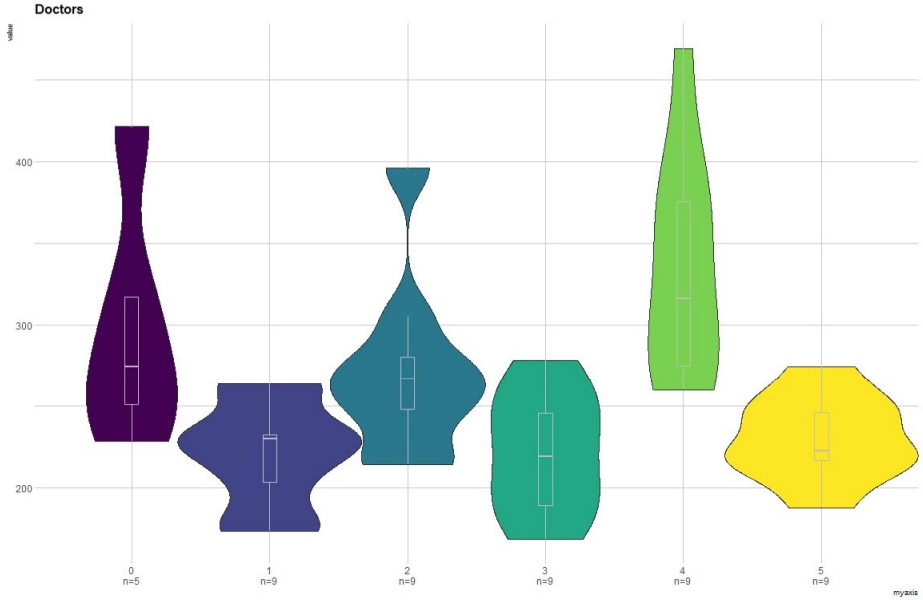
```
tss, bss, wss = findOptimalK_ANOVA(X_pca)
```

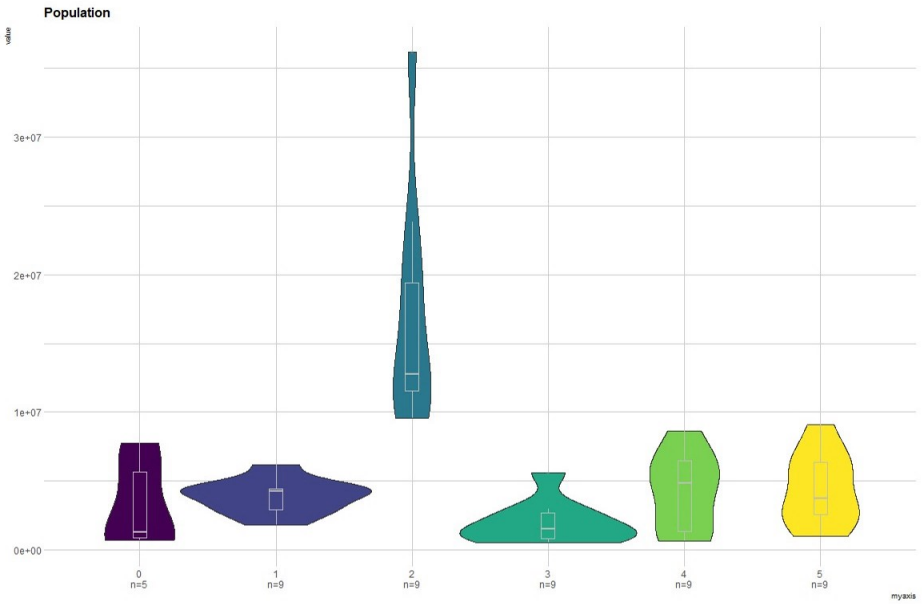
```
3
wss 295.33541317305645
tot_ss 500.00000000000006
bss 204.6645868269436
4
wss 245.29889619365105
tot_ss 500.00000000000006
bss 254.7011038063491
5
wss 231.80753075697675
tot_ss 500.00000000000006
bss 268.1924692430233
6
wss 200.15853753701026
tot_ss 500.00000000000006
bss 299.8414624629898
7
wss 186.7875232985095
tot_ss 500.00000000000006
bss 313.2124767014906
8
wss 171.9166763698156
tot_ss 500.00000000000006
bss 328.08332363018457
9
wss 161.1570544501567
tot_ss 500.00000000000006
bss 338.8429455498434
10
wss 158.4622626120873
tot_ss 500.00000000000006
bss 341.5377373879128
11
wss 143.324547683454
tot_ss 500.00000000000006
bss 356.67545231654606
12
wss 131.4983010746918
tot_ss 500.00000000000006
bss 368.50169892530835
13
wss 123.91356506793547
tot_ss 500.00000000000006
bss 376.0864349320646
14
wss 115.88086086487225
tot_ss 500.00000000000006
bss 384.11913913512785
```

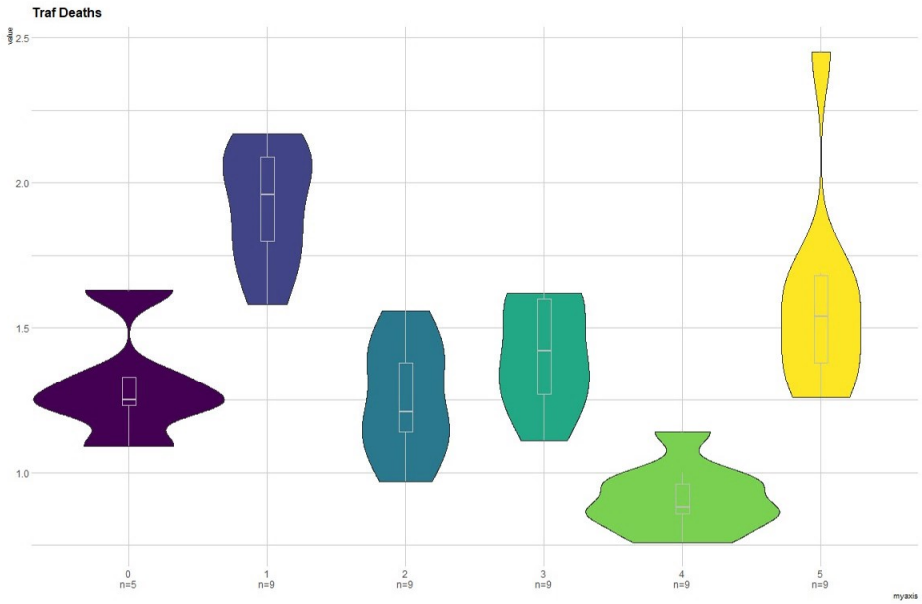

Crime
value
800
600
400
200
0
n=5
1
n=9
2
n=9
3
n=9
4
n=9
5
n=9
myaxis

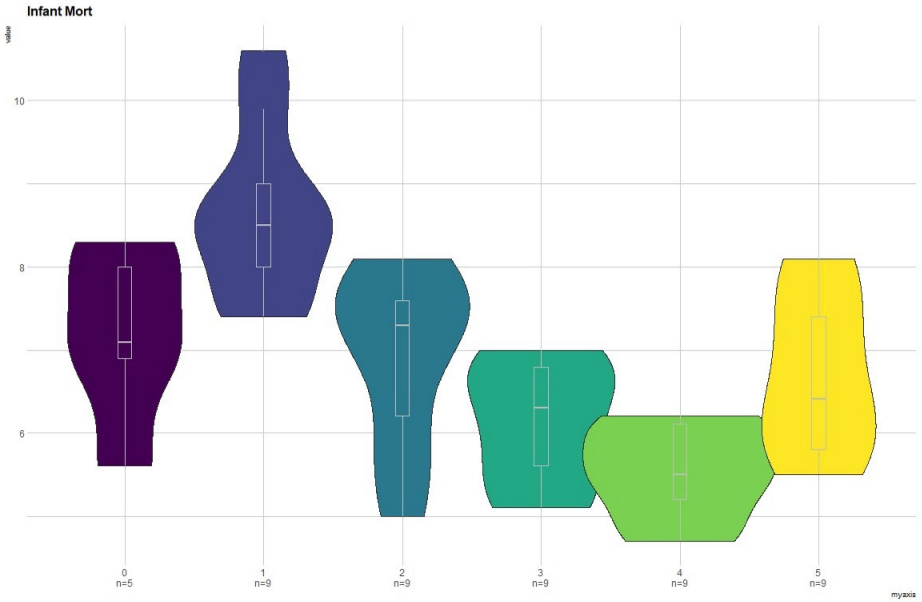

Income
value
70000
60000
50000
40000
0
n=5
1
n=9
2
n=9
3
n=9
4
n=9
5
n=9
myaxis

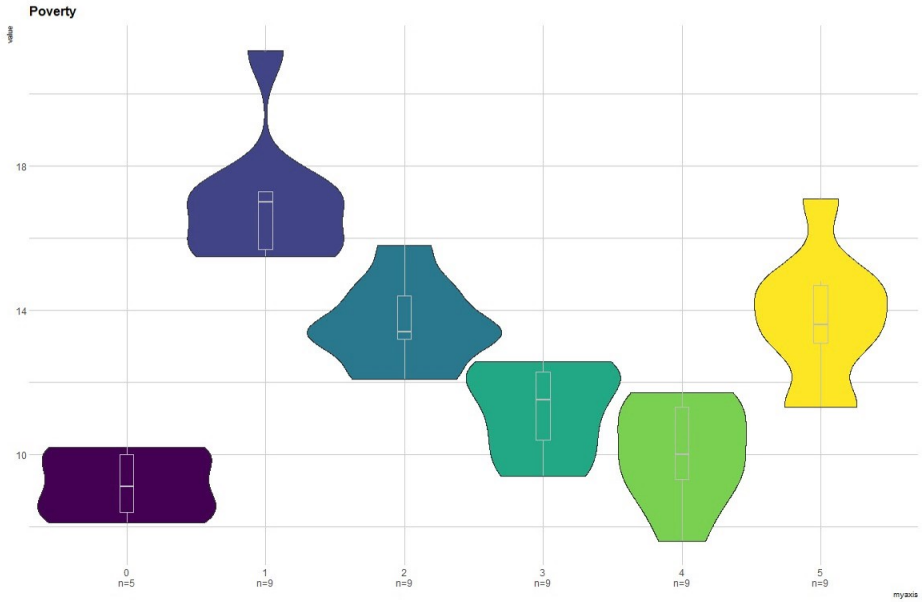

White
value
80
60
40
0
n=5
1
n=9
2
n=9
3
n=9
4
n=9
5
n=9
myaxis

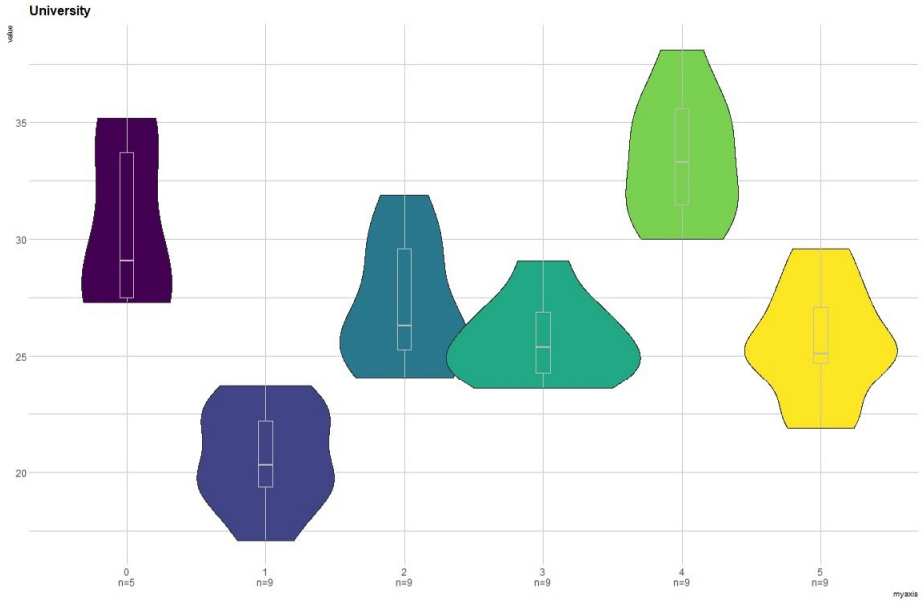

Doctors
value
400
300
200
0
n=5
1
n=9
2
n=9
3
n=9
4
n=9
5
n=9
myaxis

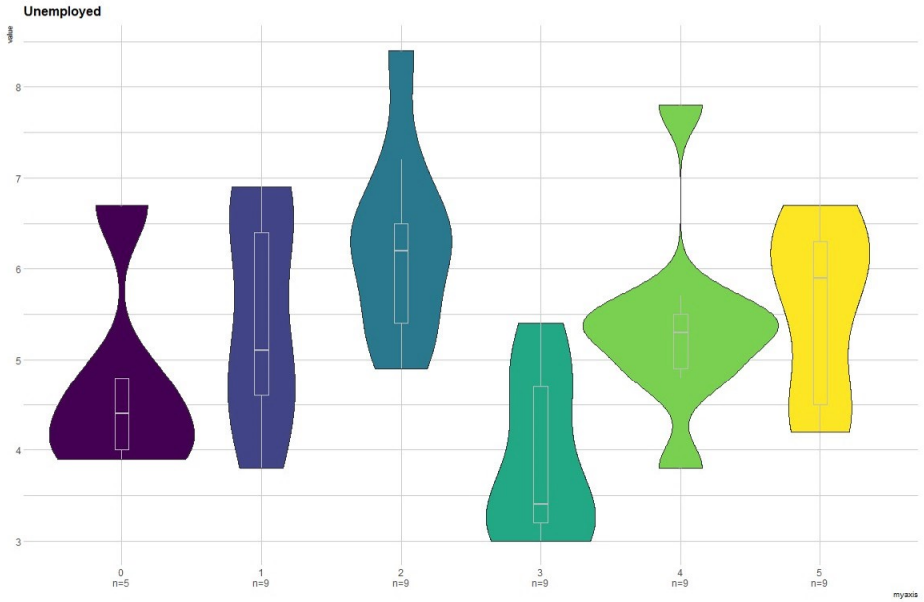

Population
value
3e+07
2e+07
1e+07
0e+00
0
n=5
1
n=9
2
n=9
3
n=9
4
n=9
5
n=9
myaxis

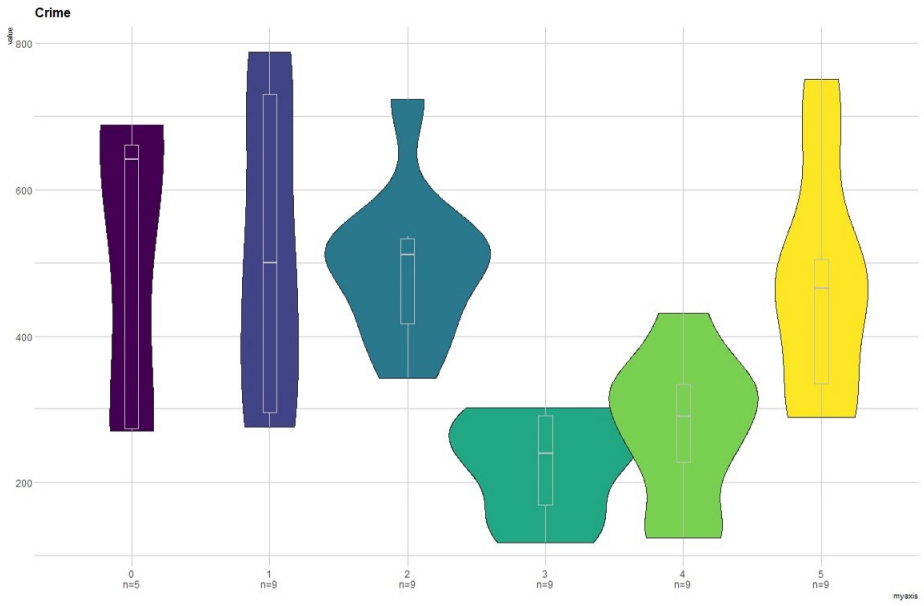

Traf Deaths
value
2.5
2.0
1.5
1.0
0
n=5
1
n=9
2
n=9
3
n=9
4
n=9
5
n=9
myaxis

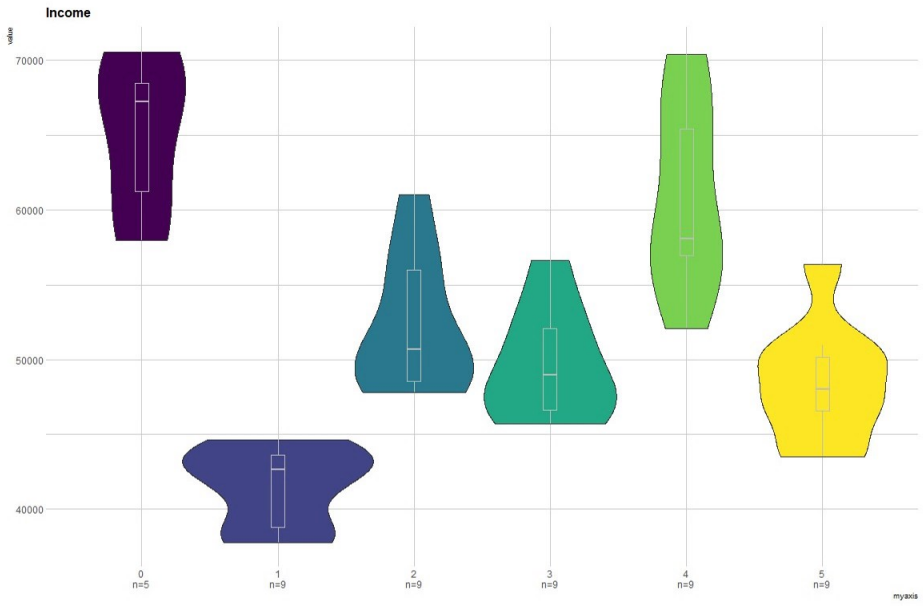

Infant Mort
value
10
8
6
0
n=5
1
n=9
2
n=9
3
n=9
4
n=9
5
n=9
myaxis

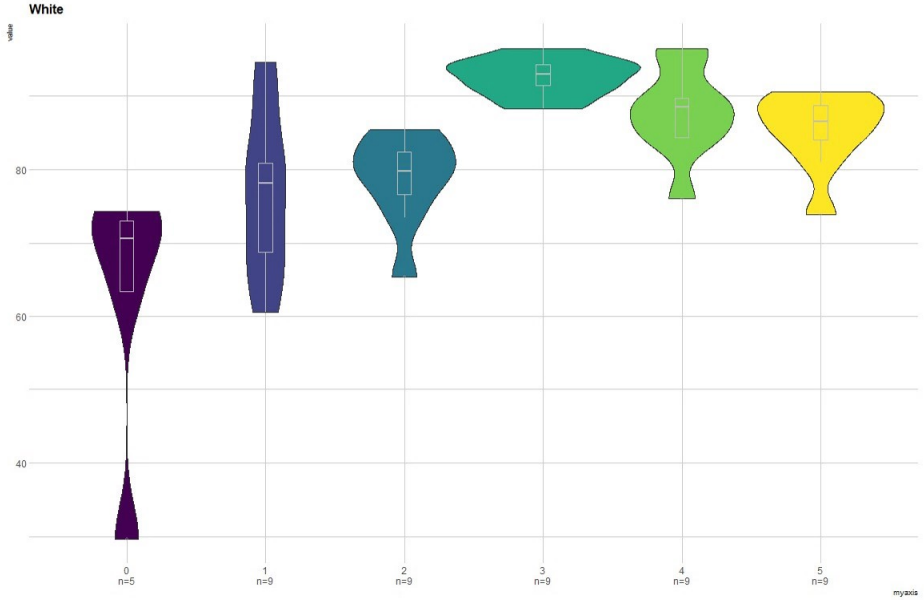

Poverty
value
18
14
10
0
n=5
1
n=9
2
n=9
3
n=9
4
n=9
5
n=9
myaxis

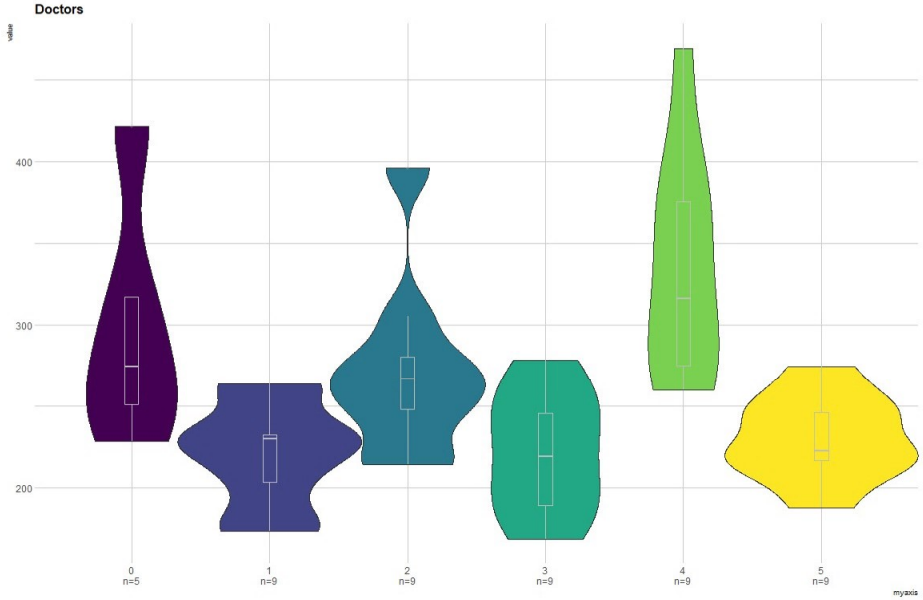

University
value
35
30
25
20
0
n=5
1
n=9
2
n=9
3
n=9
4
n=9
5
n=9
myaxis

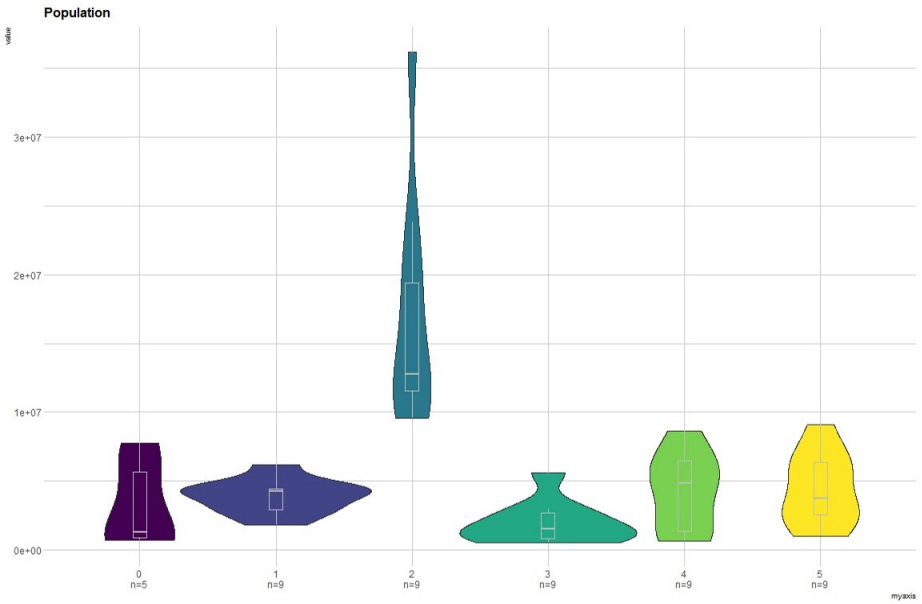

Unemployed
value
8
7
6
5
4
3
0
n=5
1
n=9
2
n=9
3
n=9
4
n=9
5
n=9
myaxis

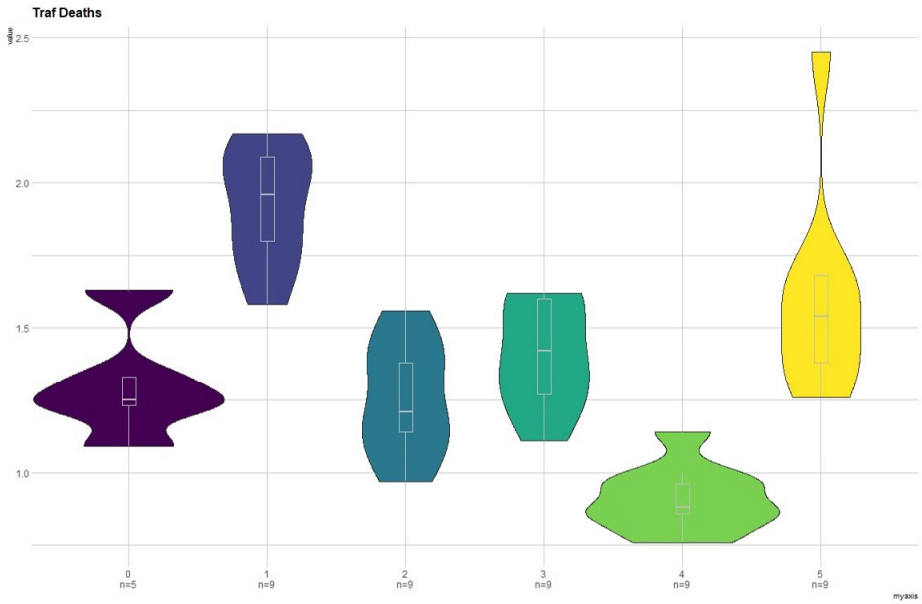

Crime
value
800
600
400
200
0
n=5
1
n=9
2
n=9
3
n=9
4
n=9
5
n=9
myaxis

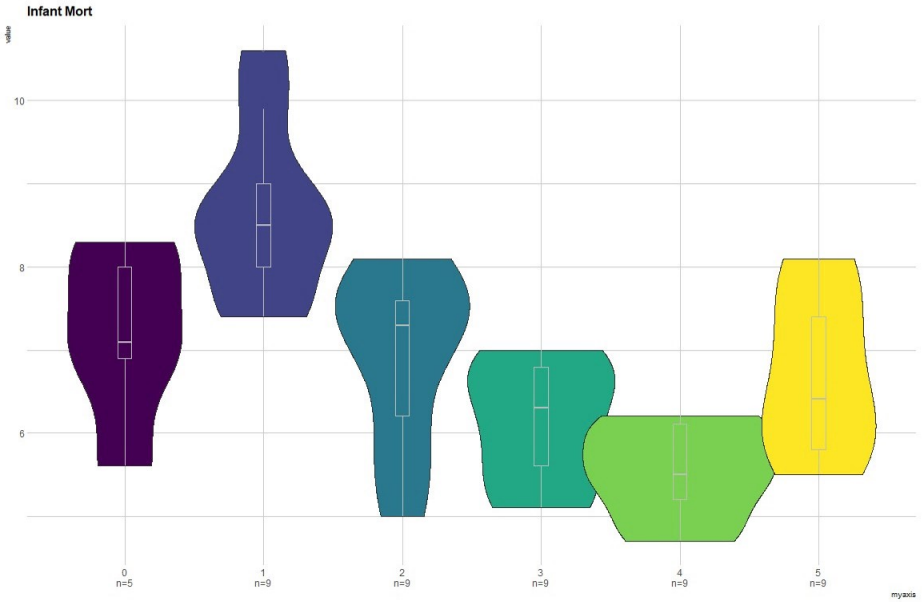

Income
value
70000
60000
50000
40000
0
n=5
1
n=9
2
n=9
3
n=9
4
n=9
5
n=9
myaxis

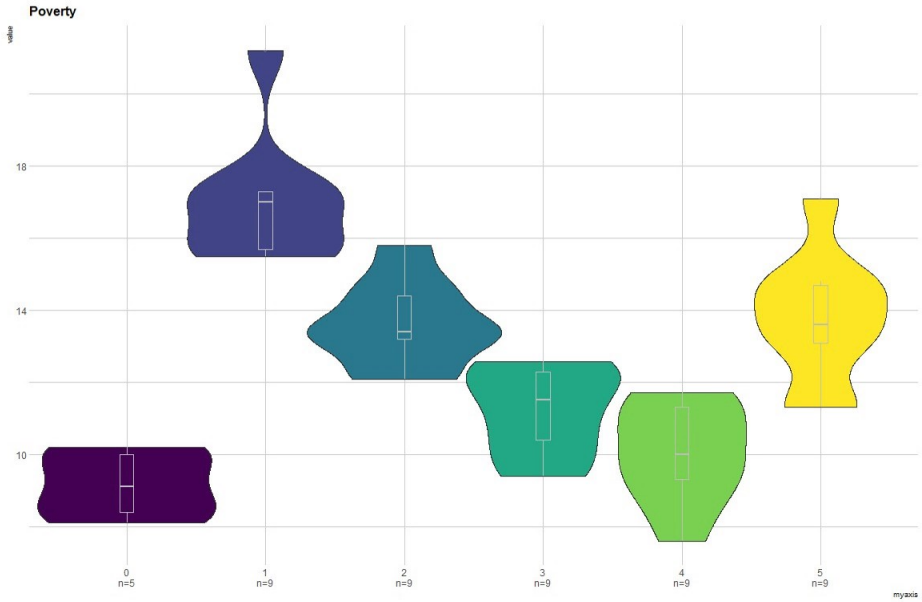

White
value
80
60
40
0
n=5
1
n=9
2
n=9
3
n=9
4
n=9
5
n=9
myaxis

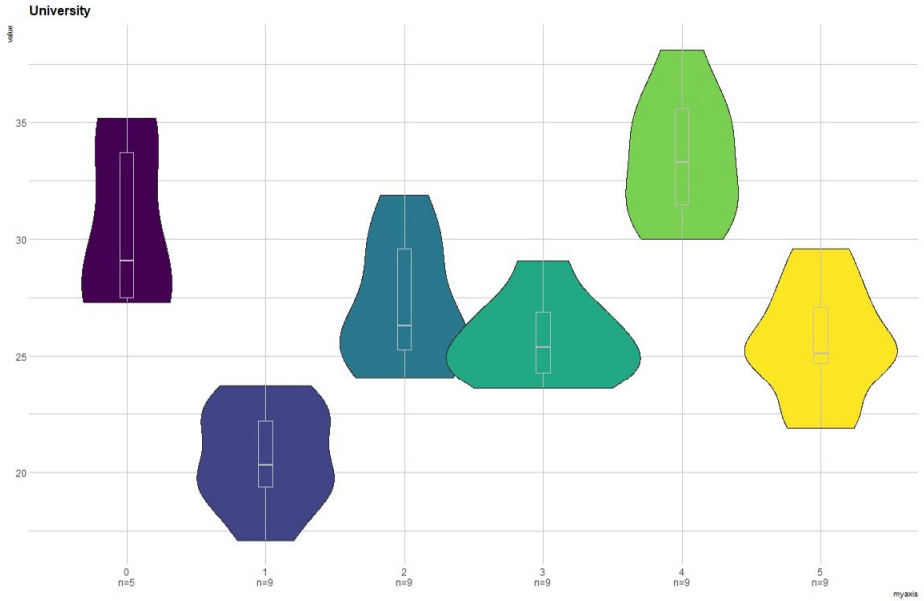

Doctors
value
400
300
200
0
n=5
1
n=9
2
n=9
3
n=9
4
n=9
5
n=9
myaxis

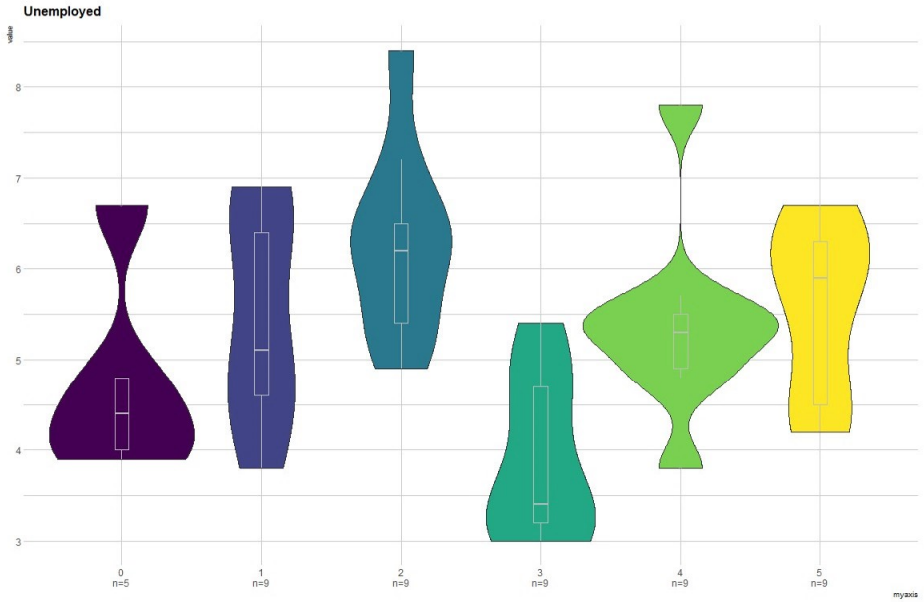

Population
value
3e+07
2e+07
1e+07
0e+00
0
n=5
1
n=9
2
n=9
3
n=9
4
n=9
5
n=9
myaxis


Traf Deaths
value
2.5
2.0
1.5
1.0
0
n=5
1
n=9
2
n=9
3
n=9
4
n=9
5
n=9
myaxis


Infant Mort
value
10
8
6
0
n=5
1
n=9
2
n=9
3
n=9
4
n=9
5
n=9
myaxis


Poverty
value
18
14
10
0
n=5
1
n=9
2
n=9
3
n=9
4
n=9
5
n=9
myaxis


University
value
35
30
25
20
0
n=5
1
n=9
2
n=9
3
n=9
4
n=9
5
n=9
myaxis


Unemployed
value
8
7
6
5
4
3
0
n=5
1
n=9
2
n=9
3
n=9
4
n=9
5
n=9
myaxis