

data("USArrests")

View(USArrests)

	Murder	Assault	UrbanPop	Rape
Alabama	13.2	236	58	21.2
Alaska	10.0	263	48	44.5
Arizona	8.1	294	80	31.0
Arkansas	8.8	190	50	19.5
California	9.0	276	91	40.6
Colorado	7.9	204	78	38.7
Connecticut	3.3	110	77	11.1
Delaware	5.9	238	72	15.8
Florida	15.4	335	80	31.9
Georgia	17.4	211	60	25.8
Hawaii	5.3	46	83	20.2
Idaho	2.6	120	54	14.2
Illinois	10.4	249	83	24.0
Indiana	7.2	113	65	21.0
Iowa	2.2	56	57	11.3
Kansas	6.0	115	66	18.0
Kentucky	9.7	109	52	16.3
Louisiana	15.4	249	66	22.2
Maine	2.1	83	51	7.8
Maryland	11.3	300	67	27.8
Massachusetts	4.4	149	85	16.3
Michigan	12.1	255	74	35.1
Minnesota	2.7	72	66	14.9
Mississippi	16.1	259	44	17.1
Missouri	9.0	178	70	28.2
Montana	6.0	109	53	16.4

Showing 1 to 27 of 50 entries. 4 total columns

Data

USArrests50 obs. of 4 variables

df =USArrests

View(df)

	Murder	Assault	UrbanPop	Rape
Alabama	13.2	236	58	21.2
Alaska	10.0	263	48	44.5
Arizona	8.1	294	80	31.0
Arkansas	8.8	190	50	19.5
California	9.0	276	91	40.6
Colorado	7.9	204	78	38.7
Connecticut	3.3	110	77	11.1
Delaware	5.9	238	72	15.8
Florida	15.4	335	80	31.9
Georgia	17.4	211	60	25.8
Hawaii	5.3	46	83	20.2
Idaho	2.6	120	54	14.2
Illinois	10.4	249	83	24.0
Indiana	7.2	113	65	21.0
Iowa	2.2	56	57	11.3
Kansas	6.0	115	66	18.0
Kentucky	9.7	109	52	16.3
Louisiana	15.4	249	66	22.2
Maine	2.1	83	51	7.8
Maryland	11.3	300	67	27.8
Massachusetts	4.4	149	85	16.3
Michigan	12.1	255	74	35.1
Minnesota	2.7	72	66	14.9
Mississippi	16.1	259	44	17.1
Missouri	9.0	178	70	28.2
Montana	6.0	109	53	16.4

Showing 1 to 27 of 50 entries. 4 total columns

Console

Data

df50 obs. of 4 variables

```
min(df$Murder)
```

```
[1] 0.8
```

```
max(df$Murder)
```

```
[1] 17.4
```

```
max(df$Assault)
```

```
[1] 337
```

```
scaled_df=scale(df)
```

```
view(scaled_df)
```

	Murder	Assault	UrbanPop	Rape
Alabama	1.24256408	0.78283935	-0.52090661	-0.003416473
Alaska	0.50786248	1.10682252	-1.21176419	2.484202941
Arizona	0.07163341	1.47880321	0.99898006	1.042878388
Arkansas	0.23234938	0.23086801	-1.07359268	-0.184916602
California	0.27826823	1.26281442	1.75892340	2.067820292
Colorado	0.02571456	0.39885929	0.86080854	1.864967207
Connecticut	-1.03041900	-0.72908214	0.79172279	-1.081740768
Delaware	-0.43347395	0.80683810	0.44629400	-0.579946294
Florida	1.74767144	1.97077766	0.99898006	1.138966691
Georgia	2.20685994	0.48285493	-0.38273510	0.487701523
Hawaii	-0.57123050	-1.49704226	1.20623733	-0.110181255
Idaho	-1.19113497	-0.60908837	-0.79724965	-0.750769945
Illinois	0.59970018	0.93883125	1.20623733	0.295524916
Indiana	-0.13500142	-0.69308401	-0.03730631	-0.024769429
Iowa	-1.28297267	-1.37704849	-0.58999237	-1.060387812
Kansas	-0.41051452	-0.66908525	0.03177945	-0.345063775
Kentucky	0.43898421	-0.74108152	-0.93542116	-0.526563903
Louisiana	1.74767144	0.93883125	0.03177945	0.103348309
Maine	-1.30593210	-1.05306531	-1.00450692	-1.434064548
Maryland	0.80633501	1.55079947	0.10086521	0.701231086
Massachusetts	-0.77786532	-0.26110644	1.34440885	-0.526563903
Michigan	0.99001041	1.01082751	0.58446551	1.480613993
Minnesota	-1.16817555	-1.18505846	0.03177945	-0.676034598
Mississippi	1.90838741	1.05882502	-1.48810723	-0.441152078
Missouri	0.27826823	0.08687549	0.30812248	0.743936999
Montana	-0.41051452	-0.74108152	-0.86633540	-0.515887425

Showing 1 to 27 of 50 entries, 4 total columns

scaled_df	num [1:50, 1:4]	1.2426	0.5079	0.0716	0.2323	0.2783	...
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```
summary(scaled_df)
```

Murder		Assault		UrbanPop		Rape	
Min.	:-1.6044	Min.	:-1.5090	Min.	:-2.31714	Min.	:-1.4874
1st Qu.	:-0.8525	1st Qu.	:-0.7411	1st Qu.	:-0.76271	1st Qu.	:-0.6574
Median	:-0.1235	Median	:-0.1411	Median	: 0.03178	Median	:-0.1209
Mean	: 0.0000	Mean	: 0.0000	Mean	: 0.00000	Mean	: 0.0000
3rd Qu.	: 0.7949	3rd Qu.	: 0.9388	3rd Qu.	: 0.84354	3rd Qu.	: 0.5277
Max.	: 2.2069	Max.	: 1.9948	Max.	: 1.75892	Max.	: 2.6444

```
head(df)
```

	Murder	Assault	UrbanPop	Rape
Alabama	13.2	236	58	21.2
Alaska	10.0	263	48	44.5
Arizona	8.1	294	80	31.0
Arkansas	8.8	190	50	19.5
California	9.0	276	91	40.6
Colorado	7.9	204	78	38.7

	Murder	Assault	UrbanPop	Rape
Alabama	1.24256408	0.7828393	-0.5209066	-0.003416473
Alaska	0.50786248	1.1068225	-1.2117642	2.484202941
Arizona	0.07163341	1.4788032	0.9989801	1.042878388
Arkansas	0.23234938	2.2308680	-1.0735927	-0.184916602
California	0.27826823	1.2628144	1.7589234	2.067826692
Colorado	0.02571456	0.3988593	0.8608085	1.864967207

res.dist

Values														
res.dist	'dist' num [1:1225] 2.7 2.29 1.29 3.26 2.65 ...													
	Alabama	Alaska	Arizona	Arkansas	California	Colorado		Florida	Georgia	4.700701 3.0614170				
Alaska	2.7037541							Georgia	3.9738227 2.9838715 2.1812958					
Arizona	2.2935197 2.7006429							Hawaii	1.3843291 2.4748807 4.3596338	3.8105218				
Arkansas	1.2898102 2.8260386	2.7177583						Idaho	1.6354214 2.0382540 4.6998827	3.8005715 2.3658101				
California	2.6311004 3.0125415	1.3104842	2.7636409					Illinois	2.7400560 1.5584719 1.7711863	2.3135778 2.7329756 3.2728945				
Colorado	2.6510673 2.3265187	1.3650307 2.8310512	1.2876185					Indiana	1.6147898 1.6973340 3.6150778	2.6924143 1.5460727 1.4923351				
Connecticut	3.2152975 2.7399125	2.628575 2.6076395	4.0663898 3.3279920					Iowa	1.5470089 2.6068606 5.2682765	4.2517889 2.1564575 3.8049692				
Delaware	2.0192937 3.6213613	1.9083696 1.8003239	3.0737852 2.5547456					Kansas	1.2280424 1.5510884 3.8424558	5.0071474 1.4648766 1.2103118				
Florida	2.2981353 2.9967642	1.7493928 3.3721968	2.0250039 2.4458560					Kentucky	2.3346386 2.2514939 3.9474983	2.4408198 2.5203345 1.6565236				
Georgia	1.1343351 2.8194388	2.7871963 2.2117614	3.3780585 2.8649105					Louisiana	3.9329409 2.3266996 1.7529677	0.8592544 3.5687157 3.5283772				
Hawaii	3.3885300 4.5301340	2.3621208 2.9723097	3.6589083 2.8233524					Maine	1.8792141 2.6560808 5.3946798	4.3334217 2.7160558 0.8486112				
Idaho	2.9146623 2.0580555	3.5210071 1.7687255	4.4879436 2.467685					Maryland	3.4968269 1.9624834 1.4355204	1.8388691 3.6148670 3.4014584				
Illinois	1.8734993 2.7670626	1.0825512 2.4626424	1.9117469 1.7898322					Massachusetts	0.9468199 1.4382527 3.7753087	1.3276676 2.2201020				
Indiana	2.0761411 3.3655952	2.6407486 1.4450503	3.4061273 2.3655622				Alaska		Illinois	Indiana	Iowa	Kansas	Kentucky	Louisiana
Iowa	3.4878952 4.7251910	4.1157513 2.4252661	4.9708591 3.9406898				Arizona							
Kansas	2.2941096 3.6808173	2.7762838 1.5718411	3.6071725 2.6272281				Arkansas							
Kentucky	1.8475879 3.5440903	3.3567681 1.0598104	4.2463809 3.2274013				California							
Louisiana	3.7722224 2.9631431	2.2178519 2.0254276	3.0176625 2.6546743				Colorado							
Maine	4.4851115 4.8322605	4.2961903 3.3621893	5.2699843 4.2713441				Connecticut							
Maryland	1.2896460 2.2777590	1.2117356 2.0582244	2.3212581 1.9667562				Delaware							
Massachusetts	2.9874810 4.3729925	2.5162281 2.6881270	3.2156499 2.6522793				Florida							
	Connecticut	Delaware	Florida	Georgia	Hawaii	Idaho								
Alaska														
Arizona														
Arkansas														
California														

```
[ reached getOption("max.print") -- omitted 29 rows ]
```

	Alabama	Alaska	Arizona
Alabama	0.000000	2.703754	2.293520
Alaska	2.703754	0.000000	2.700643
Arizona	2.293520	2.700643	0.000000

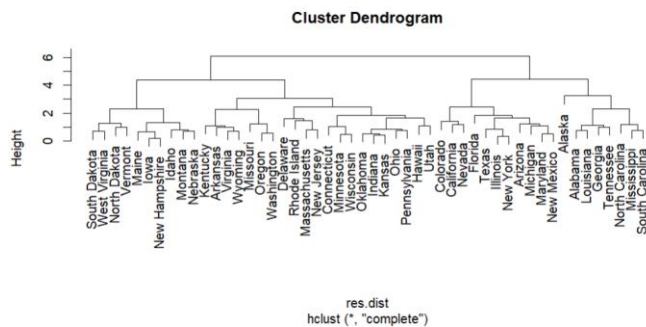
	Alabama	Alaska	Arizona
Alabama	0.000000	2.703754	2.293520
Alaska	2.703754	0.000000	2.700643
Arizona	2.293520	2.700643	0.000000

	Alabama	Alaska	Arizona
Alabama	0.000000	2.703754	2.293520
Alaska	2.703754	0.000000	2.700643
Arizona	2.293520	2.700643	0.000000

View(res.hc)

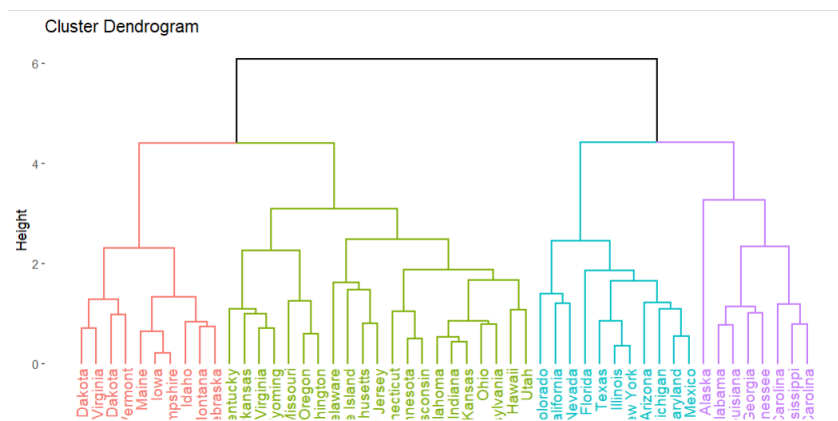
res.hc	list [7] (S3: hclust)	List of length 7
merge	integer [49 x 2]	-15 -13 -14 -23 -36 -20 -29 -32 -16 -49 3 -31 ...
height	double [49]	0.206 0.350 0.429 0.494 0.530 0.535 ...
order	integer [50]	41 48 34 45 19 15 ...
labels	character [50]	'Alabama' 'Alaska' 'Arizona' 'Arkansas' 'California' 'Col...
method	character [1]	'complete'
call	language	hclust(d = res.dist, method = "complete")
dist.method	character [1]	'euclidean'

plot(res.hc)



library("factoextra")

f viz_dend(res.hc, k=4)



grp=cutree(res.hc,k=4)

grp

Alabama	1	Alaska	1	Arizona	2	Arkansas	3	California	2
Colorado	2	Connecticut	3	Delaware	3	Florida	2	Georgia	1
Hawaii	3	Idaho	4	Illinois	2	Indiana	3	Iowa	4
Kansas	3	Kentucky	3	Louisiana	1	Maine	4	Maryland	2
Massachusetts	3	Michigan	2	Minnesota	3	Mississippi	1	Missouri	3
Montana	4	Nebraska	4	Nevada	2	New Hampshire	4	New Jersey	3
New Mexico	2	New York	2	North Carolina	1	North Dakota	4	Ohio	3
Oklahoma	3	Oregon	3	Pennsylvania	3	Rhode Island	3	South Carolina	1
South Dakota	4	Tennessee	1	Texas	2	Utah	3	Vermont	4
Virginia	3	Washington	3	West Virginia	4	Wisconsin	3	Wyoming	3

head(grp,n=4)

Alabama	Alaska	Arizona	Arkansas
1	1	2	3

```
head(grp,n=50)
```

Alabama	Alaska	Arizona	Arkansas	California
1	1	2	3	2
Colorado	Connecticut	Delaware	Florida	Georgia
2	3	3	2	1
Hawaii	Idaho	Illinois	Indiana	Iowa
3	4	2	3	4
Kansas	Kentucky	Louisiana	Maine	Maryland
3	3	1	4	2
Massachusetts	Michigan	Minnesota	Mississippi	Missouri
3	2	3	1	3
Montana	Nebraska	Nevada	New Hampshire	New Jersey
4	4	2	4	3
New Mexico	New York	North Carolina	North Dakota	Ohio
2	2	1	4	3
Oklahoma	Oregon	Pennsylvania	Rhode Island	South Carolina
3	3	3	3	1
South Dakota	Tennessee	Texas	Utah	Vermont
4	1	2	3	4
Virginia	Washington	West Virginia	Wisconsin	Wyoming
3	3	4	3	3

```
table(grp)
```

```
grp
 1  2  3  4
 8 11 21 10
.
```

```
> grp=cutree(res.hc,k=5)
> grp
```

Alabama	Alaska	Arizona	Arkansas	California
1	2	3	4	3
Colorado	Connecticut	Delaware	Florida	Georgia
3	4	4	3	1
Hawaii	Idaho	Illinois	Indiana	Iowa
4	5	3	4	5
Kansas	Kentucky	Louisiana	Maine	Maryland
4	4	1	5	3
Massachusetts	Michigan	Minnesota	Mississippi	Missouri
4	3	4	1	4
Montana	Nebraska	Nevada	New Hampshire	New Jersey
5	5	3	5	4
New Mexico	New York	North Carolina	North Dakota	Ohio
3	3	1	5	4
Oklahoma	Oregon	Pennsylvania	Rhode Island	South Carolina
4	4	4	4	1
South Dakota	Tennessee	Texas	Utah	Vermont
5	1	3	4	5
Virginia	Washington	West Virginia	Wisconsin	Wyoming
4	4	5	4	4

```
head(grp,n=50)
```

Alabama	Alaska	Arizona	Arkansas	California
1	2	3	4	3
Colorado	Connecticut	Delaware	Florida	Georgia
3	4	4	3	1
Hawaii	Idaho	Illinois	Indiana	Iowa
4	5	3	4	5
Kansas	Kentucky	Louisiana	Maine	Maryland
4	4	1	5	3
Massachusetts	Michigan	Minnesota	Mississippi	Missouri
4	3	4	1	4
Montana	Nebraska	Nevada	New Hampshire	New Jersey
5	5	3	5	4
New Mexico	New York	North Carolina	North Dakota	Ohio
3	3	1	5	4
Oklahoma	Oregon	Pennsylvania	Rhode Island	South Carolina
4	4	4	4	1
South Dakota	Tennessee	Texas	Utah	Vermont
5	1	3	4	5
Virginia	Washington	West Virginia	Wisconsin	Wyoming
4	4	5	4	4

```
table(grp)
```

```
grp
 1  2  3  4  5
 7  1 11 21 10
```