# Unsupervised Learning - Hierarchical Clustering

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## R Markdown

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When you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:

```r
# Hclust on mtcars dataset
set.seed(2835)

data(mtcars)
str(mtcars)
```

```
## 'data.frame':    32 obs. of  11 variables:
##  $ mpg : num  21 21 22.8 21.4 18.7 18.1 14.3 24.4 22.8 19.2 ...
##  $ cyl : num  6 6 4 6 8 6 8 4 4 6 ...
##  $ disp: num  160 160 108 258 360 ...
##  $ hp  : num  110 110 93 110 175 105 245 62 95 123 ...
##  $ drat: num  3.9 3.9 3.85 3.08 3.15 2.76 3.21 3.69 3.92 3.92 ...
##  $ wt  : num  2.62 2.88 2.32 3.21 3.44 ...
##  $ qsec: num  16.5 17 18.6 19.4 17 ...
##  $ vs  : num  0 0 1 1 0 1 0 1 1 1 ...
##  $ am  : num  1 1 1 0 0 0 0 0 0 0 ...
##  $ gear: num  4 4 4 3 3 3 3 4 4 4 ...
##  $ carb: num  4 4 1 1 2 1 4 2 2 4 ...
```

```r
dataset <- mtcars
```

```r
# Step 1: Find distance matrix
?dist
```

```
## starting httpd help server ... done
```

```r
d <- dist(dataset, method = 'euclidean')
d
```

```
##                      Mazda RX4 Mazda RX4 Wag  Datsun 710 Hornet 4 Drive
## Mazda RX4 Wag        0.6153251
## Datsun 710          54.9086059    54.8915169
```

```
## Hornet 4 Drive       98.1125212    98.0958939 150.9935191
## Hornet Sportabout   210.3374396   210.3358546 265.0831615    121.0297564
## Valiant              65.4717710    65.4392224 117.7547018     33.5508692
## Duster 360          241.4076490   241.4088680 294.4790230    169.4299647
## Merc 240D            50.1532711    50.1146059  49.6584796    121.2739722
## Merc 230             25.4683117    25.3284509  33.1803843    118.2433145
## Merc 280             15.3641921    15.2956865  66.9363534     91.4224033
## Merc 280C            15.6724727    15.5837744  67.0261397     91.4612914
## Merc 450SE          135.4307018   135.4254826 189.1954941     72.4964325
## Merc 450SL          135.4014424   135.3960351 189.1631745     72.4313532
## Merc 450SLC         135.4794674   135.4723157 189.2345426     72.5718466
## Cadillac Fleetwood  326.3395903   326.3355070 381.0926242    234.4403876
## Lincoln Continental 318.0469808   318.0429333 372.8012090    227.9726091
## Chrysler Imperial   304.7203408   304.7169175 359.3014906    218.1548299
## Fiat 128             93.2679950    93.2530993  40.9933763    184.9689734
## Honda Civic         102.8307567   102.8238713  52.7704607    191.5518700
## Toyota Corolla      100.6040368   100.5887588  47.6535017    192.6714187
## Toyota Corona        42.3075233    42.2659224  12.9654743    138.5304725
## Dodge Challenger    163.1150750   163.1134210 217.7795805     72.4403915
## AMC Javelin         149.6047203   149.6014522 204.3188913     61.3601899
## Camaro Z28          233.2228758   233.2248748 286.0049209    163.6632641
## Pontiac Firebird    248.6780270   248.6762035 303.3583889    156.2240346
## Fiat X1-9            92.5048389    92.4940020  39.8815148    184.4471198
## Porsche 914-2        44.4033659    44.4073589  13.1357109    139.1579524
## Lotus Europa         65.7328377    65.7362635  25.0948550    163.2367437
## Ford Pantera L      245.4247064   245.4293785 297.2940489    180.1140339
## Ferrari Dino         66.7661029    66.7764167  90.2415509    130.5523007
## Maserati Bora       265.6454248   265.6491465 309.7718171    229.3419352
## Volvo 142E           39.1894029    39.1626037  20.6939436    137.0363299
##                     Hornet Sportabout     Valiant  Duster 360   Merc 240D
## Mazda RX4 Wag
## Datsun 710
## Hornet 4 Drive
## Hornet Sportabout
## Valiant                   152.1241352
## Duster 360                 70.1767262 194.6094525
## Merc 240D                 241.5069657  89.5911056 281.2962502
## Merc 230                  233.4924012  85.0079649 265.8823313  33.6873047
## Merc 280                  199.3344960  60.2909811 227.8998521  64.7754228
## Merc 280C                 199.3406564  60.2655656 227.8813169  64.8898713
## Merc 450SE                 84.3888482  90.6970264 106.4084264 175.1620073
## Merc 450SL                 84.3683999  90.6769728 106.4320572 175.1189767
## Merc 450SLC                84.4332423  90.7092989 106.4010305 175.2118218
## Cadillac Fleetwood        116.2804201 266.6280942 119.0239068 355.6627498
## Lincoln Continental       108.0624299 259.6304391 104.5112999 348.9901277
## Chrysler Imperial          97.2049146 248.7713290  81.4297699 338.1959373
## Fiat 128                  302.0377212 152.1153263 333.9792070  68.6105903
## Honda Civic               310.0324645 158.9615769 344.0518316  72.0014488
## Toyota Corolla            309.5581776 159.8302995 341.0218232  76.2806458
## Toyota Corona             252.3331988 105.2876428 282.0508820  44.0850975
## Dodge Challenger           48.9838851 103.4310693 103.9023864 192.8617917
## AMC Javelin                61.4274240  91.0444349 110.3084921 180.5479760
## Camaro Z28                 70.9665308 187.8463771  10.0761203 273.8367985
## Pontiac Firebird           40.0052475 188.5272116  80.8057339 277.4606884
```

```
## Fiat X1-9                 301.5669483 151.4379425 333.4843231  67.9163981
## Porsche 914-2             254.1452553 106.0585767 285.1986201  39.4469276
## Lotus Europa              272.3582423 130.8248192 296.4572287  72.8971106
## Ford Pantera L             89.5934049 203.0177926  21.2655990 287.5238795
## Ferrari Dino              215.0673853 106.5694802 226.2036333 113.3023005
## Maserati Bora             170.7094473 242.4393015 107.7224977 313.8633093
## Volvo 142E                248.0063378 104.1863681 275.1353516  53.6823481
##                        Merc 230    Merc 280   Merc 280C  Merc 450SE  Merc 450SL
## Mazda RX4 Wag
## Datsun 710
## Hornet 4 Drive
## Hornet Sportabout
## Valiant
## Duster 360
## Merc 240D
## Merc 230
## Merc 280             39.2994160
## Merc 280C            39.3868519   1.5231546
## Merc 450SE          159.8179555 122.3642489 122.3461050
## Merc 450SL          159.7760899 122.3443771 122.3355492   0.9826495
## Merc 450SLC         159.8495837 122.3934970 122.3586862   1.3726252   2.1383405
## Cadillac Fleetwood  349.2832611 315.3904859 315.3557081 197.8842803 197.9154476
## Lincoln Continental 341.3154316 306.6760719 306.6406187 187.5997191 187.6330806
## Chrysler Imperial   328.4335161 292.7146896 292.6989332 171.6600758 171.6743028
## Fiat 128             69.3127910 106.5053149 106.6829794 228.3247948 228.2592340
## Honda Civic          78.5387212 116.7280991 116.8711475 238.0141824 237.9588183
## Toyota Corolla       76.7731674 113.6290721 113.8118009 235.5183809 235.4481971
## Toyota Corona        21.0962017  54.3641713  54.4258314 176.6020527 176.5727477
## Dodge Challenger    185.8331870 152.8929263 152.8722437  51.8008639  51.8242520
## AMC Javelin         172.5312555 139.1457974 139.1181977  41.2080044  41.2411618
## Camaro Z28          257.7469734 219.5520854 219.5276434  98.7203049  98.7566899
## Pontiac Firebird    271.3871978 238.1726099 238.1806292 124.3368538 124.3204160
## Fiat X1-9            68.5564864 105.7412910 105.8560373 227.7627676 227.7173075
## Porsche 914-2        22.1180967  57.6458160  57.8473863 179.5034108 179.4550855
## Lotus Europa         50.1094030  74.1443580  74.3824296 193.3074449 193.2407697
## Ford Pantera L      269.9772035 231.4081306 231.4024263 112.8181834 112.8296774
## Ferrari Dino         80.6550953  56.8365103  56.8987601 131.0272205 131.0077635
## Maserati Bora       288.8755628 250.5874125 250.5774357 157.1633256 157.1768956
## Volvo 142E           24.6913548  48.8053450  48.8884618 170.4500681 170.4225164
##                     Merc 450SLC Cadillac Fleetwood Lincoln Continental
## Mazda RX4 Wag
## Datsun 710
## Hornet 4 Drive
## Hornet Sportabout
## Valiant
## Duster 360
## Merc 240D
## Merc 230
## Merc 280
## Merc 280C
## Merc 450SE
## Merc 450SL
## Merc 450SLC
## Cadillac Fleetwood  197.8526242
```

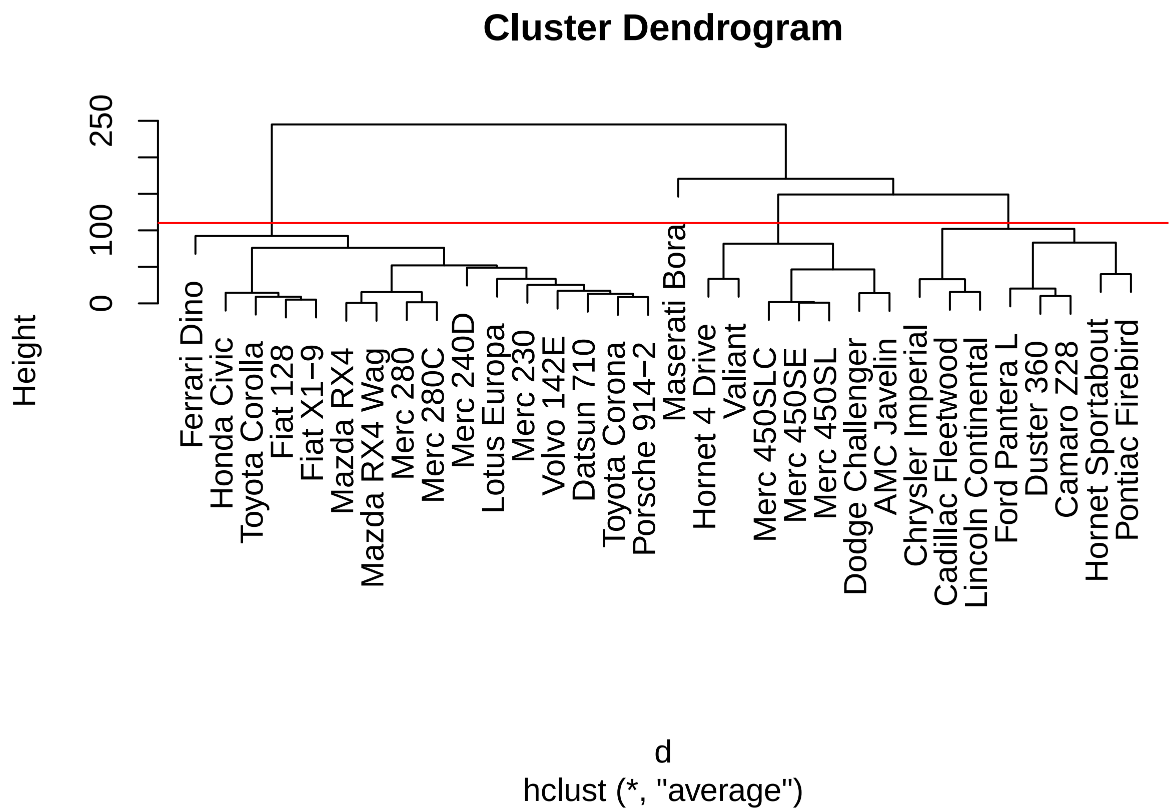
```
## Lincoln Continental 187.5671081         15.6224446
## Chrysler Imperial   171.6557637         40.8399636          25.3714237
## Fiat 128            228.4051825        417.7687579         410.0206984
## Honda Civic         238.0828999        425.3271621         417.9679574
## Toyota Corolla      235.6024098        425.3446517         417.5429986
## Toyota Corona       176.6305359        368.3195488         360.0267515
## Dodge Challenger     51.8012606        163.6314881         156.2805020
## AMC Javelin          41.1929050        176.8610896         169.0925457
## Camaro Z28           98.7035830        128.4587210         114.0932078
## Pontiac Firebird    124.3726128         78.5385347          72.6947903
## Fiat X1-9           227.8176554        417.2490481         409.4998363
## Porsche 914-2       179.5720446        370.0956775         362.0145494
## Lotus Europa        193.3969216        388.5350012         379.4716659
## Ford Pantera L      112.8332602        134.8119464         119.7236456
## Ferrari Dino        131.0704490        328.5441628         317.7063117
## Maserati Bora       157.1683970        214.9366858         199.3420611
## Volvo 142E          170.4843735        364.1000930         355.4009443
##                     Chrysler Imperial    Fiat 128 Honda Civic Toyota Corolla
## Mazda RX4 Wag
## Datsun 710
## Hornet 4 Drive
## Hornet Sportabout
## Valiant
## Duster 360
## Merc 240D
## Merc 230
## Merc 280
## Merc 280C
## Merc 450SE
## Merc 450SL
## Merc 450SLC
## Cadillac Fleetwood
## Lincoln Continental
## Chrysler Imperial
## Fiat 128                  397.2276375
## Honda Civic               405.8152201  14.5590942
## Toyota Corolla            404.6335386   7.8324789  14.3480626
## Toyota Corona             346.5724649  52.8798281  63.8985563     59.8451285
## Dodge Challenger          145.9194779 254.2367888 261.8498815    261.8345312
## AMC Javelin               157.8097554 241.1203621 248.9636504    248.6917065
## Camaro Z28                 91.2880886 325.6636235 335.8883188    332.6589699
## Pontiac Firebird           68.2030747 339.5857659 347.0655360    347.1667643
## Fiat X1-9                 396.7597522   5.1473415  14.7807070     10.3922856
## Porsche 914-2             348.8466861  49.0644372  59.4588768     56.3243031
## Lotus Europa              364.5994326  49.9112509  64.0495153     53.8846563
## Ford Pantera L             95.3805385 337.1639236 347.8337714    343.9920962
## Ferrari Dino              300.1640703 128.3950054 141.7044478    133.4707617
## Maserati Bora             174.2936864 349.5338830 362.1620777    355.2601619
## Volvo 142E                341.2896659  61.3301247  73.3766041     67.7189421
##                     Toyota Corona Dodge Challenger AMC Javelin  Camaro Z28
## Mazda RX4 Wag
## Datsun 710
## Hornet 4 Drive
## Hornet Sportabout
```

```
## Valiant
## Duster 360
## Merc 240D
## Merc 230
## Merc 280
## Merc 280C
## Merc 450SE
## Merc 450SL
## Merc 450SLC
## Cadillac Fleetwood
## Lincoln Continental
## Chrysler Imperial
## Fiat 128
## Honda Civic
## Toyota Corolla
## Toyota Corona
## Dodge Challenger      205.0347927
## AMC Javelin           191.5580526       14.0154995
## Camaro Z28            273.6316895      100.3046106 105.6062618
## Pontiac Firebird      290.6240706       85.8075196  99.2836114  86.2665759
## Fiat X1-9              51.8411748      253.6624046 240.5266823 325.1490914
## Porsche 914-2           8.6535903      206.6452569 193.3080584 276.8924414
## Lotus Europa           31.2536926      226.5004836 212.7568765 287.6179004
## Ford Pantera L        285.1287911      118.7516779 123.3832044  19.3589023
## Ferrari Dino           82.2355734      174.9280395 161.1060307 216.7489910
## Maserati Bora         299.1865216      185.9059273 185.1553411 102.5946154
## Volvo 142E             12.2505275      201.3682522 187.6978440 266.5277736
##                     Pontiac Firebird   Fiat X1-9 Porsche 914-2 Lotus Europa
## Mazda RX4 Wag
## Datsun 710
## Hornet 4 Drive
## Hornet Sportabout
## Valiant
## Duster 360
## Merc 240D
## Merc 230
## Merc 280
## Merc 280C
## Merc 450SE
## Merc 450SL
## Merc 450SLC
## Cadillac Fleetwood
## Lincoln Continental
## Chrysler Imperial
## Fiat 128
## Honda Civic
## Toyota Corolla
## Toyota Corona
## Dodge Challenger
## AMC Javelin
## Camaro Z28
## Pontiac Firebird
## Fiat X1-9                 339.1396182
## Porsche 914-2             292.1646488  48.3775209
```

```
## Lotus Europa             311.3862342  49.8406880    33.7678653
## Ford Pantera L           101.7389686 336.7018783   288.5852993  297.5376920
## Ferrari Dino             255.0570519 127.8210813    87.9105966   80.4553451
## Maserati Bora            188.3240020 349.1199576   303.9222549  303.2796468
## Volvo 142E               286.7497823  60.4120429    18.7555858   27.8104457
##                     Ford Pantera L Ferrari Dino Maserati Bora
## Mazda RX4 Wag
## Datsun 710
## Hornet 4 Drive
## Hornet Sportabout
## Valiant
## Duster 360
## Merc 240D
## Merc 230
## Merc 280
## Merc 280C
## Merc 450SE
## Merc 450SL
## Merc 450SLC
## Cadillac Fleetwood
## Lincoln Continental
## Chrysler Imperial
## Fiat 128
## Honda Civic
## Toyota Corolla
## Toyota Corona
## Dodge Challenger
## AMC Javelin
## Camaro Z28
## Pontiac Firebird
## Fiat X1-9
## Porsche 914-2
## Lotus Europa
## Ford Pantera L
## Ferrari Dino           224.4587490
## Maserati Bora           86.9383253  223.5342175
## Volvo 142E             277.4803312   70.4751034   289.1157363
```

```
# Step 2: Apply hierarchical clustering (hclust function of stat package)
?hclust
hc = hclust(d, method = "average")
```

```
# Step 3: Plot the dendogram
plot(hc)
# Step 4: Choosing Number of Cluster
# cut tree by height
abline (h =110, col ="red")
```




```
# cut tree by number of cluster
plot(hc)
fit <- cutree(hc, k=3)
fit
```

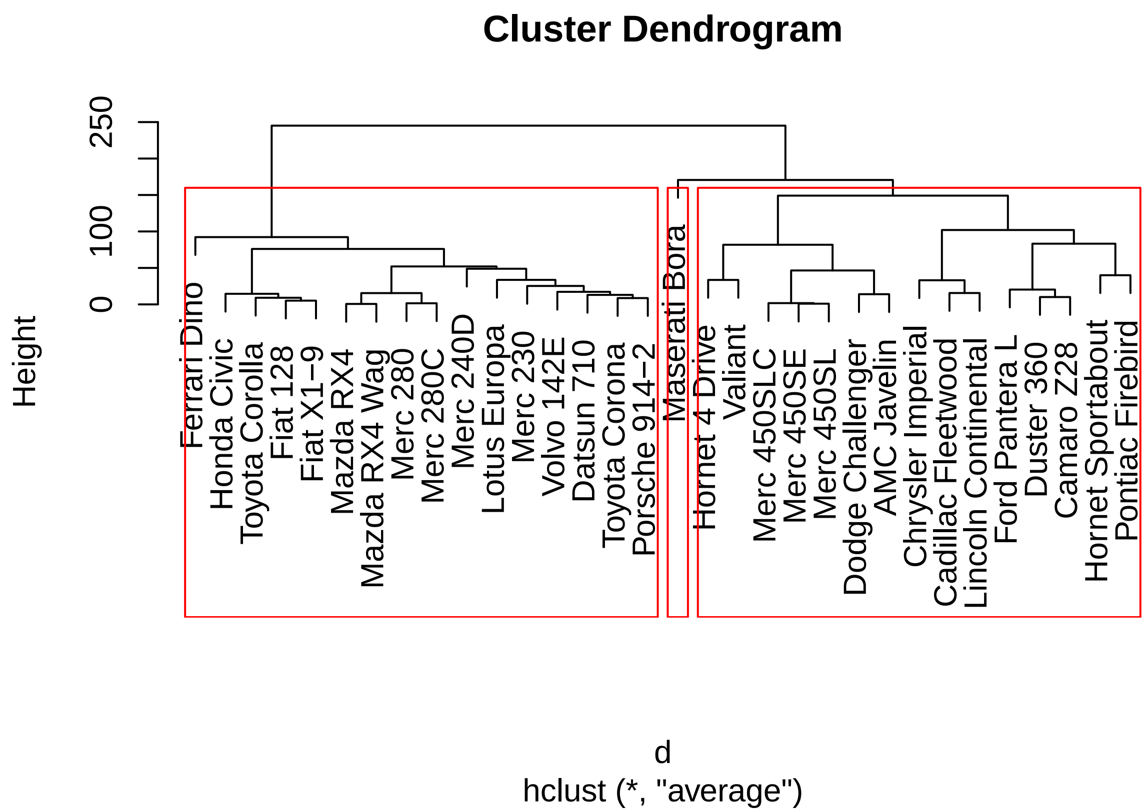
```
##           Mazda RX4       Mazda RX4 Wag          Datsun 710      Hornet 4 Drive
##                   1                   1                   1                   2
##   Hornet Sportabout             Valiant          Duster 360           Merc 240D
##                   2                   2                   2                   1
##            Merc 230            Merc 280           Merc 280C          Merc 450SE
##                   1                   1                   1                   2
##          Merc 450SL         Merc 450SLC  Cadillac Fleetwood Lincoln Continental
##                   2                   2                   2                   2
##   Chrysler Imperial            Fiat 128         Honda Civic      Toyota Corolla
##                   2                   1                   1                   1
##       Toyota Corona    Dodge Challenger         AMC Javelin          Camaro Z28
##                   1                   2                   2                   2
##    Pontiac Firebird           Fiat X1-9       Porsche 914-2        Lotus Europa
##                   2                   1                   1                   1
##      Ford Pantera L        Ferrari Dino       Maserati Bora          Volvo 142E
##                   2                   1                   3                   1
```

```
table(fit)
```

```
## fit
```

```
##  1  2  3
## 16 15  1
```

```
rect.hclust(hc, k=3, border="red")
```




# Example 2: iris dataset

```
# Hierarchical Clustering on iris dataset
str(iris)
```

```
## 'data.frame':    150 obs. of  5 variables:
##  $ Sepal.Length: num  5.1 4.9 4.7 4.6 5 5.4 4.6 5 4.4 4.9 ...
##  $ Sepal.Width : num  3.5 3 3.2 3.1 3.6 3.9 3.4 3.4 2.9 3.1 ...
##  $ Petal.Length: num  1.4 1.4 1.3 1.5 1.4 1.7 1.4 1.5 1.4 1.5 ...
##  $ Petal.Width : num  0.2 0.2 0.2 0.2 0.2 0.4 0.3 0.2 0.2 0.1 ...
##  $ Species     : Factor w/ 3 levels "setosa","versicolor",..: 1 1 1 1 1 1 1 1 1 1 ...
```

```
iris
```

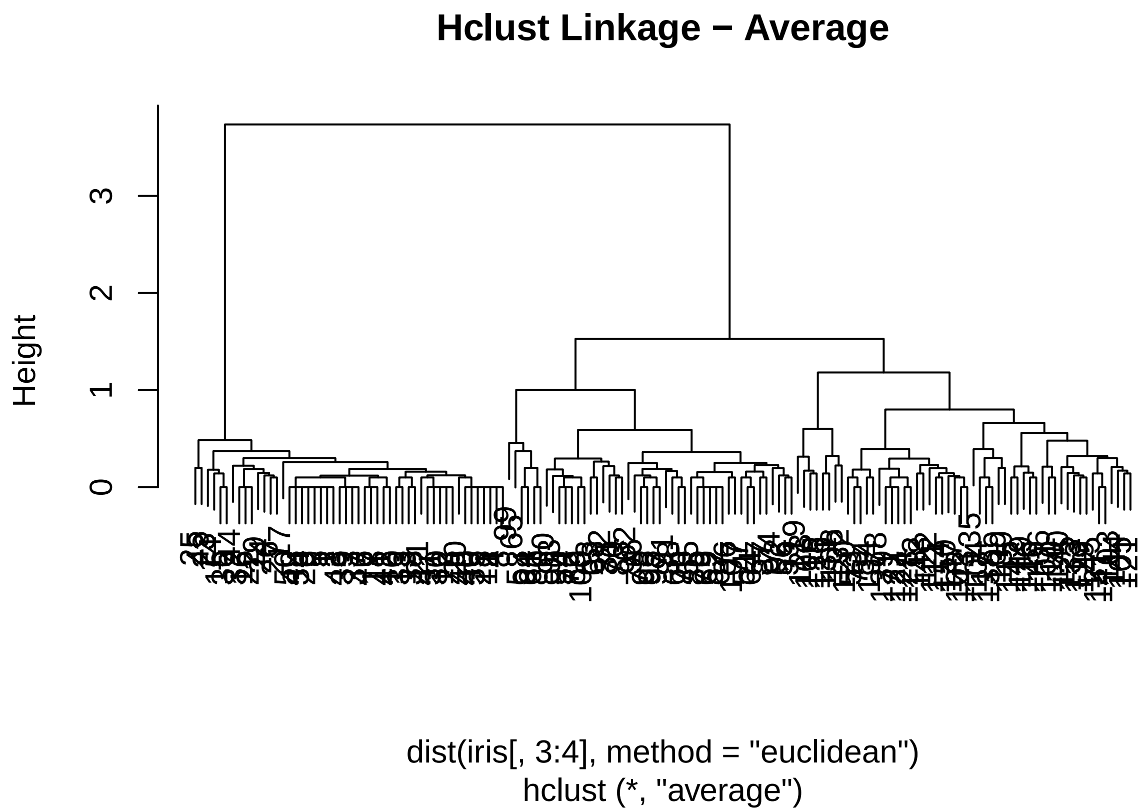
```
##     Sepal.Length Sepal.Width Petal.Length Petal.Width    Species
## 1            5.1         3.5          1.4         0.2     setosa
## 2            4.9         3.0          1.4         0.2     setosa
## 3            4.7         3.2          1.3         0.2     setosa
## 4            4.6         3.1          1.5         0.2     setosa
## 5            5.0         3.6          1.4         0.2     setosa
```

```
## 6            5.4         3.9          1.7         0.4     setosa
## 7            4.6         3.4          1.4         0.3     setosa
## 8            5.0         3.4          1.5         0.2     setosa
## 9            4.4         2.9          1.4         0.2     setosa
## 10           4.9         3.1          1.5         0.1     setosa
## 11           5.4         3.7          1.5         0.2     setosa
## 12           4.8         3.4          1.6         0.2     setosa
## 13           4.8         3.0          1.4         0.1     setosa
## 14           4.3         3.0          1.1         0.1     setosa
## 15           5.8         4.0          1.2         0.2     setosa
## 16           5.7         4.4          1.5         0.4     setosa
## 17           5.4         3.9          1.3         0.4     setosa
## 18           5.1         3.5          1.4         0.3     setosa
## 19           5.7         3.8          1.7         0.3     setosa
## 20           5.1         3.8          1.5         0.3     setosa
## 21           5.4         3.4          1.7         0.2     setosa
## 22           5.1         3.7          1.5         0.4     setosa
## 23           4.6         3.6          1.0         0.2     setosa
## 24           5.1         3.3          1.7         0.5     setosa
## 25           4.8         3.4          1.9         0.2     setosa
## 26           5.0         3.0          1.6         0.2     setosa
## 27           5.0         3.4          1.6         0.4     setosa
## 28           5.2         3.5          1.5         0.2     setosa
## 29           5.2         3.4          1.4         0.2     setosa
## 30           4.7         3.2          1.6         0.2     setosa
## 31           4.8         3.1          1.6         0.2     setosa
## 32           5.4         3.4          1.5         0.4     setosa
## 33           5.2         4.1          1.5         0.1     setosa
## 34           5.5         4.2          1.4         0.2     setosa
## 35           4.9         3.1          1.5         0.2     setosa
## 36           5.0         3.2          1.2         0.2     setosa
## 37           5.5         3.5          1.3         0.2     setosa
## 38           4.9         3.6          1.4         0.1     setosa
## 39           4.4         3.0          1.3         0.2     setosa
## 40           5.1         3.4          1.5         0.2     setosa
## 41           5.0         3.5          1.3         0.3     setosa
## 42           4.5         2.3          1.3         0.3     setosa
## 43           4.4         3.2          1.3         0.2     setosa
## 44           5.0         3.5          1.6         0.6     setosa
## 45           5.1         3.8          1.9         0.4     setosa
## 46           4.8         3.0          1.4         0.3     setosa
## 47           5.1         3.8          1.6         0.2     setosa
## 48           4.6         3.2          1.4         0.2     setosa
## 49           5.3         3.7          1.5         0.2     setosa
## 50           5.0         3.3          1.4         0.2     setosa
## 51           7.0         3.2          4.7         1.4 versicolor
## 52           6.4         3.2          4.5         1.5 versicolor
## 53           6.9         3.1          4.9         1.5 versicolor
## 54           5.5         2.3          4.0         1.3 versicolor
## 55           6.5         2.8          4.6         1.5 versicolor
## 56           5.7         2.8          4.5         1.3 versicolor
## 57           6.3         3.3          4.7         1.6 versicolor
## 58           4.9         2.4          3.3         1.0 versicolor
## 59           6.6         2.9          4.6         1.3 versicolor
```

```
## 60           5.2         2.7          3.9         1.4 versicolor
## 61           5.0         2.0          3.5         1.0 versicolor
## 62           5.9         3.0          4.2         1.5 versicolor
## 63           6.0         2.2          4.0         1.0 versicolor
## 64           6.1         2.9          4.7         1.4 versicolor
## 65           5.6         2.9          3.6         1.3 versicolor
## 66           6.7         3.1          4.4         1.4 versicolor
## 67           5.6         3.0          4.5         1.5 versicolor
## 68           5.8         2.7          4.1         1.0 versicolor
## 69           6.2         2.2          4.5         1.5 versicolor
## 70           5.6         2.5          3.9         1.1 versicolor
## 71           5.9         3.2          4.8         1.8 versicolor
## 72           6.1         2.8          4.0         1.3 versicolor
## 73           6.3         2.5          4.9         1.5 versicolor
## 74           6.1         2.8          4.7         1.2 versicolor
## 75           6.4         2.9          4.3         1.3 versicolor
## 76           6.6         3.0          4.4         1.4 versicolor
## 77           6.8         2.8          4.8         1.4 versicolor
## 78           6.7         3.0          5.0         1.7 versicolor
## 79           6.0         2.9          4.5         1.5 versicolor
## 80           5.7         2.6          3.5         1.0 versicolor
## 81           5.5         2.4          3.8         1.1 versicolor
## 82           5.5         2.4          3.7         1.0 versicolor
## 83           5.8         2.7          3.9         1.2 versicolor
## 84           6.0         2.7          5.1         1.6 versicolor
## 85           5.4         3.0          4.5         1.5 versicolor
## 86           6.0         3.4          4.5         1.6 versicolor
## 87           6.7         3.1          4.7         1.5 versicolor
## 88           6.3         2.3          4.4         1.3 versicolor
## 89           5.6         3.0          4.1         1.3 versicolor
## 90           5.5         2.5          4.0         1.3 versicolor
## 91           5.5         2.6          4.4         1.2 versicolor
## 92           6.1         3.0          4.6         1.4 versicolor
## 93           5.8         2.6          4.0         1.2 versicolor
## 94           5.0         2.3          3.3         1.0 versicolor
## 95           5.6         2.7          4.2         1.3 versicolor
## 96           5.7         3.0          4.2         1.2 versicolor
## 97           5.7         2.9          4.2         1.3 versicolor
## 98           6.2         2.9          4.3         1.3 versicolor
## 99           5.1         2.5          3.0         1.1 versicolor
## 100          5.7         2.8          4.1         1.3 versicolor
## 101          6.3         3.3          6.0         2.5  virginica
## 102          5.8         2.7          5.1         1.9  virginica
## 103          7.1         3.0          5.9         2.1  virginica
## 104          6.3         2.9          5.6         1.8  virginica
## 105          6.5         3.0          5.8         2.2  virginica
## 106          7.6         3.0          6.6         2.1  virginica
## 107          4.9         2.5          4.5         1.7  virginica
## 108          7.3         2.9          6.3         1.8  virginica
## 109          6.7         2.5          5.8         1.8  virginica
## 110          7.2         3.6          6.1         2.5  virginica
## 111          6.5         3.2          5.1         2.0  virginica
## 112          6.4         2.7          5.3         1.9  virginica
## 113          6.8         3.0          5.5         2.1  virginica
```

```
## 114          5.7         2.5          5.0         2.0  virginica
## 115          5.8         2.8          5.1         2.4  virginica
## 116          6.4         3.2          5.3         2.3  virginica
## 117          6.5         3.0          5.5         1.8  virginica
## 118          7.7         3.8          6.7         2.2  virginica
## 119          7.7         2.6          6.9         2.3  virginica
## 120          6.0         2.2          5.0         1.5  virginica
## 121          6.9         3.2          5.7         2.3  virginica
## 122          5.6         2.8          4.9         2.0  virginica
## 123          7.7         2.8          6.7         2.0  virginica
## 124          6.3         2.7          4.9         1.8  virginica
## 125          6.7         3.3          5.7         2.1  virginica
## 126          7.2         3.2          6.0         1.8  virginica
## 127          6.2         2.8          4.8         1.8  virginica
## 128          6.1         3.0          4.9         1.8  virginica
## 129          6.4         2.8          5.6         2.1  virginica
## 130          7.2         3.0          5.8         1.6  virginica
## 131          7.4         2.8          6.1         1.9  virginica
## 132          7.9         3.8          6.4         2.0  virginica
## 133          6.4         2.8          5.6         2.2  virginica
## 134          6.3         2.8          5.1         1.5  virginica
## 135          6.1         2.6          5.6         1.4  virginica
## 136          7.7         3.0          6.1         2.3  virginica
## 137          6.3         3.4          5.6         2.4  virginica
## 138          6.4         3.1          5.5         1.8  virginica
## 139          6.0         3.0          4.8         1.8  virginica
## 140          6.9         3.1          5.4         2.1  virginica
## 141          6.7         3.1          5.6         2.4  virginica
## 142          6.9         3.1          5.1         2.3  virginica
## 143          5.8         2.7          5.1         1.9  virginica
## 144          6.8         3.2          5.9         2.3  virginica
## 145          6.7         3.3          5.7         2.5  virginica
## 146          6.7         3.0          5.2         2.3  virginica
## 147          6.3         2.5          5.0         1.9  virginica
## 148          6.5         3.0          5.2         2.0  virginica
## 149          6.2         3.4          5.4         2.3  virginica
## 150          5.9         3.0          5.1         1.8  virginica
```

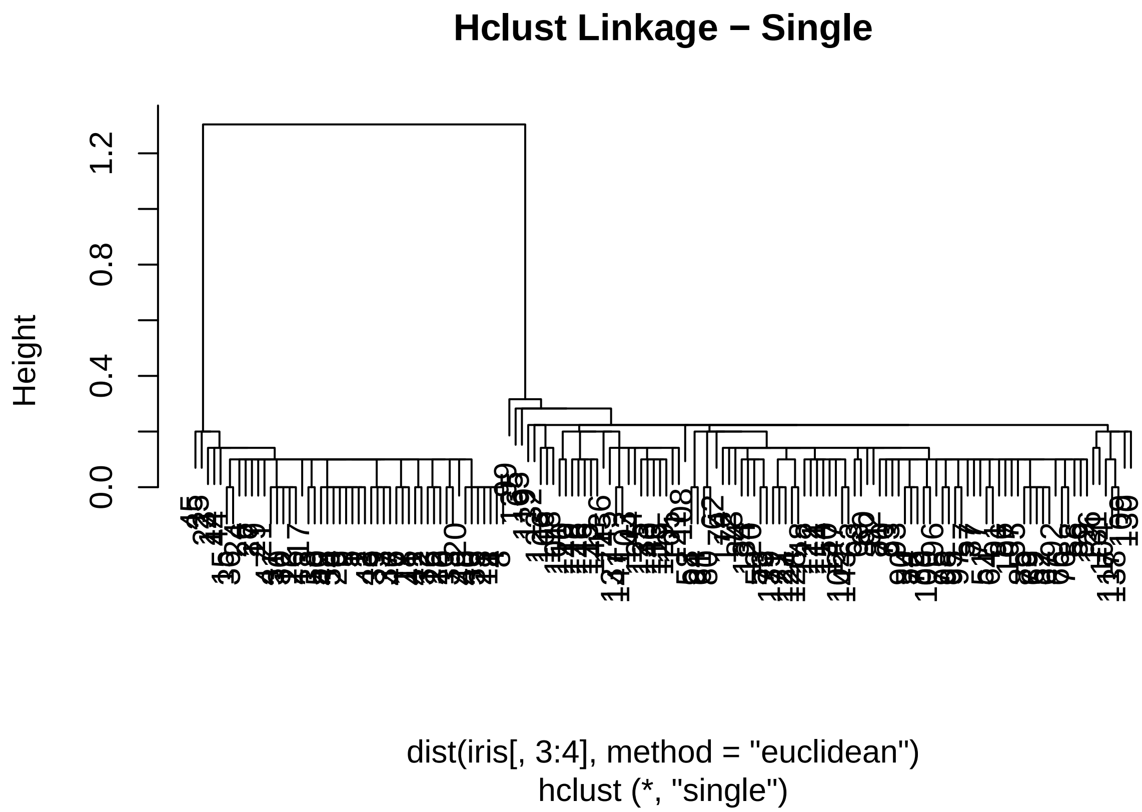
```r
hc.average <- hclust(dist(iris[, 3:4], method = 'euclidean'), method = 'average')
plot(hc.average, main = "Hclust Linkage - Average")
```




```r
clusterCut <- cutree(hc.average, 3)
table(clusterCut, iris$Species)
```

```
##
## clusterCut setosa versicolor virginica
##          1     50          0         0
##          2      0         45         1
##          3      0          5        49
```

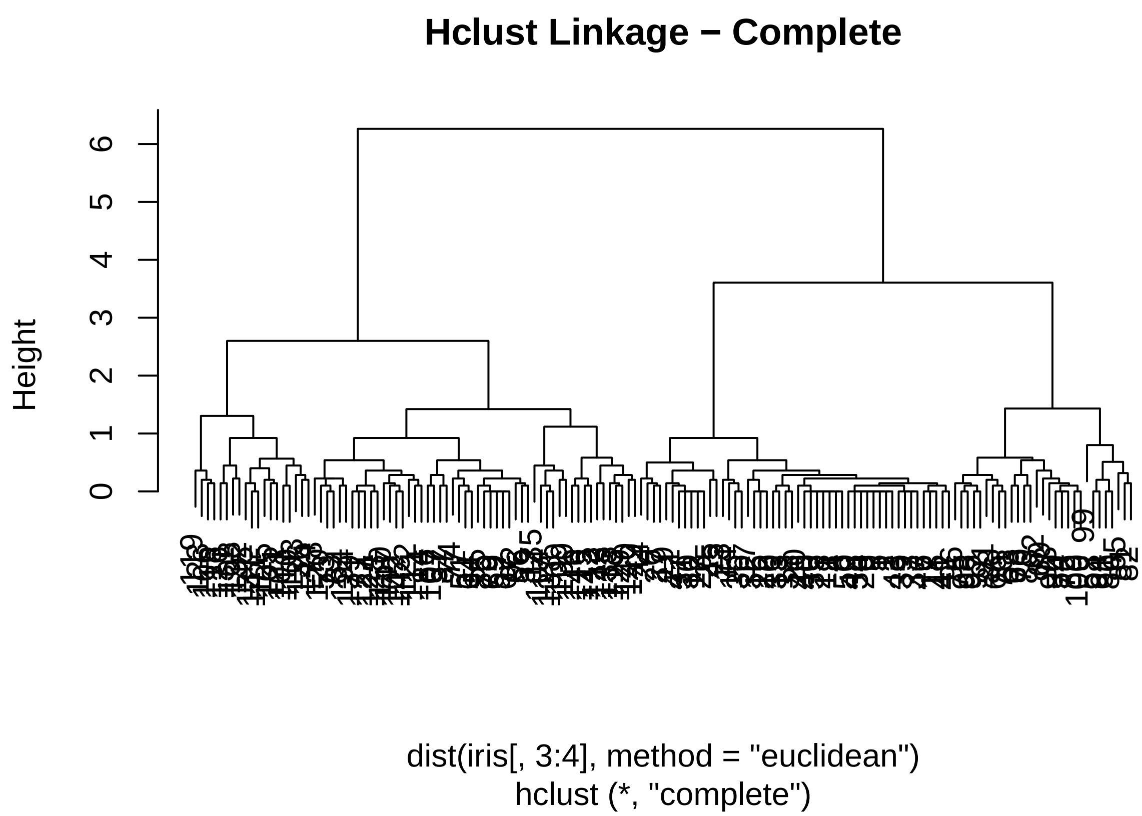
```r
hc.single <- hclust(dist(iris[, 3:4], method = 'euclidean'), method = 'single')
plot(hc.single, main = "Hclust Linkage - Single")
```




```
clusterCut <- cutree(hc.single, 3)
table(clusterCut, iris$Species)
```

```
##
## clusterCut setosa versicolor virginica
##          1     50          0         0
##          2      0         49        50
##          3      0          1         0
```

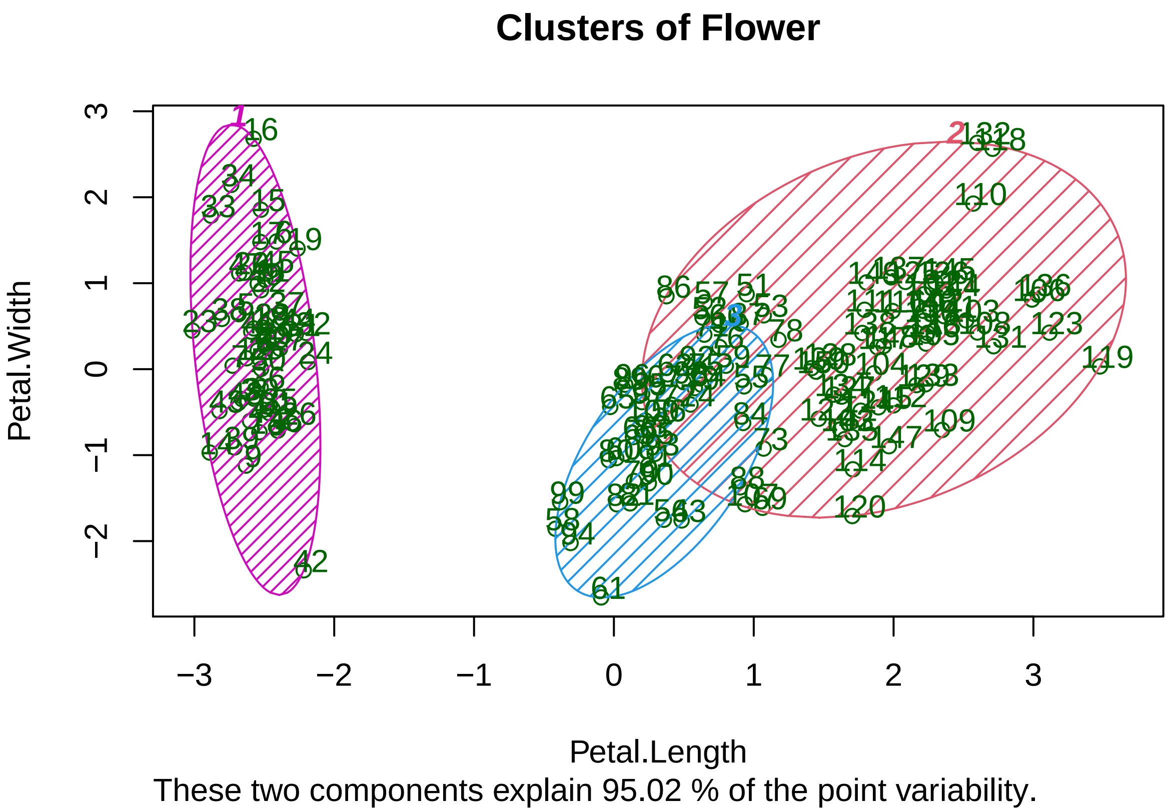
```
hc.complete <- hclust(dist(iris[, 3:4], method = 'euclidean'), method = 'complete')
plot(hc.complete, main = "Hclust Linkage - Complete")
```




```
clusterCut <- cutree(hc.complete, 3)
table(clusterCut, iris$Species)
```

```
##
## clusterCut setosa versicolor virginica
##          1     50          0         0
##          2      0         21        50
##          3      0         29         0
```

```
# Visualising the clusters
library(cluster)
clusplot(iris,
         clusterCut,
         lines = 0,
         shade = TRUE,
         color = TRUE,
         labels= 2,
         plotchar = FALSE,
         span = TRUE,
         main = paste('Clusters of Flower'),
         xlab = 'Petal.Length',
         ylab = 'Petal.Width')
```


Clusters of Flower
Petal.Width
Petal.Length
These two components explain 95.02 % of the point variability.