Assignment 5: Hierarchical Clustering

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Step 1: Data Preprocessing

Load the data

```
cereals_data <- read.csv("Cereals.csv")
head(cereals_data)
```

```
##                         name mfr type calories protein fat sodium fiber
carbo
## 1                  100%_Bran   N    C       70       4   1    130  10.0
5.0
## 2          100%_Natural_Bran   Q    C      120       3   5     15   2.0
8.0
## 3                   All-Bran   K    C       70       4   1    260   9.0
7.0
## 4 All-Bran_with_Extra_Fiber   K    C       50       4   0    140  14.0
8.0
## 5             Almond_Delight   R    C      110       2   2    200   1.0
14.0
## 6   Apple_Cinnamon_Cheerios   G    C      110       2   2    180   1.5
10.5
##   sugars potass vitamins shelf weight cups   rating
## 1      6    280       25     3      1 0.33 68.40297
## 2      8    135        0     3      1 1.00 33.98368
## 3      5    320       25     3      1 0.33 59.42551
## 4      0    330       25     3      1 0.50 93.70491
## 5      8     NA       25     3      1 0.75 34.38484
## 6     10     70       25     1      1 0.75 29.50954
```

Drop mfr & type columns

```
cereals_data <- cereals_data[-c(2,3)]
cereals_data
```

```
##                                     name calories protein fat sodium
fiber
## 1                              100%_Bran       70       4   1    130
10.0
## 2                      100%_Natural_Bran      120       3   5     15
2.0
```

```
## 3                             All-Bran       70        4   1    260
9.0
## 4                 All-Bran_with_Extra_Fiber       50        4   0    140
14.0
## 5                         Almond_Delight      110        2   2    200
1.0
## 6                   Apple_Cinnamon_Cheerios      110        2   2    180
1.5
## 7                              Apple_Jacks      110        2   0    125
1.0
## 8                                  Basic_4      130        3   2    210
2.0
## 9                                Bran_Chex       90        2   1    200
4.0
## 10                             Bran_Flakes       90        3   0    210
5.0
## 11                            Cap'n'Crunch      120        1   2    220
0.0
## 12                                Cheerios      110        6   2    290
2.0
## 13                   Cinnamon_Toast_Crunch      120        1   3    210
0.0
## 14                                Clusters      110        3   2    140
2.0
## 15                             Cocoa_Puffs      110        1   1    180
0.0
## 16                               Corn_Chex      110        2   0    280
0.0
## 17                             Corn_Flakes      100        2   0    290
1.0
## 18                               Corn_Pops      110        1   0     90
1.0
## 19                            Count_Chocula      110        1   1    180
0.0
## 20                       Cracklin'_Oat_Bran      110        3   3    140
4.0
## 21                  Cream_of_Wheat_(Quick)      100        3   0     80
1.0
## 22                                 Crispix      110        2   0    220
1.0
## 23                  Crispy_Wheat_&_Raisins      100        2   1    140
2.0
## 24                             Double_Chex      100        2   0    190
1.0
## 25                             Froot_Loops      110        2   1    125
1.0
## 26                           Frosted_Flakes      110        1   0    200
1.0
## 27                      Frosted_Mini-Wheats      100        3   0      0
3.0
```

```
## 28 Fruit_&_Fibre_Dates,_Walnuts,_and_Oats      120       3   2    160
5.0
## 29                          Fruitful_Bran      120       3   0    240
5.0
## 30                         Fruity_Pebbles      110       1   1    135
0.0
## 31                           Golden_Crisp      100       2   0     45
0.0
## 32                         Golden_Grahams      110       1   1    280
0.0
## 33                       Grape_Nuts_Flakes      100       3   1    140
3.0
## 34                              Grape-Nuts      110       3   0    170
3.0
## 35                      Great_Grains_Pecan      120       3   3     75
3.0
## 36                        Honey_Graham_Ohs      120       1   2    220
1.0
## 37                      Honey_Nut_Cheerios      110       3   1    250
1.5
## 38                              Honey-comb      110       1   0    180
0.0
## 39             Just_Right_Crunchy__Nuggets      110       2   1    170
1.0
## 40                  Just_Right_Fruit_&_Nut      140       3   1    170
2.0
## 41                                     Kix      110       2   1    260
0.0
## 42                                    Life      100       4   2    150
2.0
## 43                             Lucky_Charms      110       2   1    180
0.0
## 44                                   Maypo      100       4   1      0
0.0
## 45        Muesli_Raisins,_Dates,_&_Almonds      150       4   3     95
3.0
## 46      Muesli_Raisins,_Peaches,_&_Pecans      150       4   3    150
3.0
## 47                    Mueslix_Crispy_Blend      160       3   2    150
3.0
## 48                    Multi-Grain_Cheerios      100       2   1    220
2.0
## 49                        Nut&Honey_Crunch      120       2   1    190
0.0
## 50               Nutri-Grain_Almond-Raisin      140       3   2    220
3.0
## 51                      Nutri-grain_Wheat       90       3   0    170
3.0
## 52                    Oatmeal_Raisin_Crisp      130       3   2    170
1.5
```

```
## 53                  Post_Nat._Raisin_Bran      120       3   1    200
6.0
## 54                             Product_19      100       3   0    320
1.0
## 55                            Puffed_Rice       50       1   0      0
0.0
## 56                           Puffed_Wheat       50       2   0      0
1.0
## 57                      Quaker_Oat_Squares      100       4   1    135
2.0
## 58                          Quaker_Oatmeal      100       5   2      0
2.7
## 59                             Raisin_Bran      120       3   1    210
5.0
## 60                        Raisin_Nut_Bran      100       3   2    140
2.5
## 61                         Raisin_Squares       90       2   0      0
2.0
## 62                              Rice_Chex      110       1   0    240
0.0
## 63                          Rice_Krispies      110       2   0    290
0.0
## 64                         Shredded_Wheat       80       2   0      0
3.0
## 65                 Shredded_Wheat_'n'Bran       90       3   0      0
4.0
## 66               Shredded_Wheat_spoon_size       90       3   0      0
3.0
## 67                                 Smacks      110       2   1     70
1.0
## 68                              Special_K      110       6   0    230
1.0
## 69                  Strawberry_Fruit_Wheats       90       2   0     15
3.0
## 70                       Total_Corn_Flakes      110       2   1    200
0.0
## 71                       Total_Raisin_Bran      140       3   1    190
4.0
## 72                       Total_Whole_Grain      100       3   1    200
3.0
## 73                                 Triples      110       2   1    250
0.0
## 74                                    Trix      110       1   1    140
0.0
## 75                              Wheat_Chex      100       3   1    230
3.0
## 76                                 Wheaties      100       3   1    200
3.0
## 77                     Wheaties_Honey_Gold      110       2   1    200
1.0
```

```
##    carbo sugars potass vitamins shelf weight cups   rating
## 1    5.0      6    280       25     3   1.00 0.33 68.40297
## 2    8.0      8    135        0     3   1.00 1.00 33.98368
## 3    7.0      5    320       25     3   1.00 0.33 59.42551
## 4    8.0      0    330       25     3   1.00 0.50 93.70491
## 5   14.0      8     NA       25     3   1.00 0.75 34.38484
## 6   10.5     10     70       25     1   1.00 0.75 29.50954
## 7   11.0     14     30       25     2   1.00 1.00 33.17409
## 8   18.0      8    100       25     3   1.33 0.75 37.03856
## 9   15.0      6    125       25     1   1.00 0.67 49.12025
## 10  13.0      5    190       25     3   1.00 0.67 53.31381
## 11  12.0     12     35       25     2   1.00 0.75 18.04285
## 12  17.0      1    105       25     1   1.00 1.25 50.76500
## 13  13.0      9     45       25     2   1.00 0.75 19.82357
## 14  13.0      7    105       25     3   1.00 0.50 40.40021
## 15  12.0     13     55       25     2   1.00 1.00 22.73645
## 16  22.0      3     25       25     1   1.00 1.00 41.44502
## 17  21.0      2     35       25     1   1.00 1.00 45.86332
## 18  13.0     12     20       25     2   1.00 1.00 35.78279
## 19  12.0     13     65       25     2   1.00 1.00 22.39651
## 20  10.0      7    160       25     3   1.00 0.50 40.44877
## 21  21.0      0     NA        0     2   1.00 1.00 64.53382
## 22  21.0      3     30       25     3   1.00 1.00 46.89564
## 23  11.0     10    120       25     3   1.00 0.75 36.17620
## 24  18.0      5     80       25     3   1.00 0.75 44.33086
## 25  11.0     13     30       25     2   1.00 1.00 32.20758
## 26  14.0     11     25       25     1   1.00 0.75 31.43597
## 27  14.0      7    100       25     2   1.00 0.80 58.34514
## 28  12.0     10    200       25     3   1.25 0.67 40.91705
## 29  14.0     12    190       25     3   1.33 0.67 41.01549
## 30  13.0     12     25       25     2   1.00 0.75 28.02576
## 31  11.0     15     40       25     1   1.00 0.88 35.25244
## 32  15.0      9     45       25     2   1.00 0.75 23.80404
## 33  15.0      5     85       25     3   1.00 0.88 52.07690
## 34  17.0      3     90       25     3   1.00 0.25 53.37101
## 35  13.0      4    100       25     3   1.00 0.33 45.81172
## 36  12.0     11     45       25     2   1.00 1.00 21.87129
## 37  11.5     10     90       25     1   1.00 0.75 31.07222
## 38  14.0     11     35       25     1   1.00 1.33 28.74241
## 39  17.0      6     60      100     3   1.00 1.00 36.52368
## 40  20.0      9     95      100     3   1.30 0.75 36.47151
## 41  21.0      3     40       25     2   1.00 1.50 39.24111
## 42  12.0      6     95       25     2   1.00 0.67 45.32807
## 43  12.0     12     55       25     2   1.00 1.00 26.73451
## 44  16.0      3     95       25     2   1.00 1.00 54.85092
## 45  16.0     11    170       25     3   1.00 1.00 37.13686
## 46  16.0     11    170       25     3   1.00 1.00 34.13976
## 47  17.0     13    160       25     3   1.50 0.67 30.31335
## 48  15.0      6     90       25     1   1.00 1.00 40.10596
## 49  15.0      9     40       25     2   1.00 0.67 29.92429
```

```
## 50  21.0       7    130        25      3   1.33 0.67 40.69232
## 51  18.0       2     90        25      3   1.00 1.00 59.64284
## 52  13.5      10    120        25      3   1.25 0.50 30.45084
## 53  11.0      14    260        25      3   1.33 0.67 37.84059
## 54  20.0       3     45       100      3   1.00 1.00 41.50354
## 55  13.0       0     15         0      3   0.50 1.00 60.75611
## 56  10.0       0     50         0      3   0.50 1.00 63.00565
## 57  14.0       6    110        25      3   1.00 0.50 49.51187
## 58    NA      NA    110         0      1   1.00 0.67 50.82839
## 59  14.0      12    240        25      2   1.33 0.75 39.25920
## 60  10.5       8    140        25      3   1.00 0.50 39.70340
## 61  15.0       6    110        25      3   1.00 0.50 55.33314
## 62  23.0       2     30        25      1   1.00 1.13 41.99893
## 63  22.0       3     35        25      1   1.00 1.00 40.56016
## 64  16.0       0     95         0      1   0.83 1.00 68.23588
## 65  19.0       0    140         0      1   1.00 0.67 74.47295
## 66  20.0       0    120         0      1   1.00 0.67 72.80179
## 67   9.0      15     40        25      2   1.00 0.75 31.23005
## 68  16.0       3     55        25      1   1.00 1.00 53.13132
## 69  15.0       5     90        25      2   1.00 1.00 59.36399
## 70  21.0       3     35       100      3   1.00 1.00 38.83975
## 71  15.0      14    230       100      3   1.50 1.00 28.59278
## 72  16.0       3    110       100      3   1.00 1.00 46.65884
## 73  21.0       3     60        25      3   1.00 0.75 39.10617
## 74  13.0      12     25        25      2   1.00 1.00 27.75330
## 75  17.0       3    115        25      1   1.00 0.67 49.78744
## 76  17.0       3    110        25      1   1.00 1.00 51.59219
## 77  16.0       8     60        25      1   1.00 0.75 36.18756
```

Convert the names of breakfast cereals to row names

```
rownames(cereals_data) <- cereals_data$name
```

#Drop the name column

```
cereals_data <- cereals_data[-c(1)]
cereals_data
```

```
##                                     calories protein fat sodium fiber
carbo
## 100%_Bran                                 70       4   1    130  10.0
5.0
## 100%_Natural_Bran                        120       3   5     15   2.0
8.0
## All-Bran                                  70       4   1    260   9.0
7.0
## All-Bran_with_Extra_Fiber                 50       4   0    140  14.0
8.0
## Almond_Delight                           110       2   2    200   1.0
14.0
```

```
## Apple_Cinnamon_Cheerios                    110       2   2    180   1.5
10.5
## Apple_Jacks                                110       2   0    125   1.0
11.0
## Basic_4                                    130       3   2    210   2.0
18.0
## Bran_Chex                                   90       2   1    200   4.0
15.0
## Bran_Flakes                                 90       3   0    210   5.0
13.0
## Cap'n'Crunch                               120       1   2    220   0.0
12.0
## Cheerios                                   110       6   2    290   2.0
17.0
## Cinnamon_Toast_Crunch                      120       1   3    210   0.0
13.0
## Clusters                                   110       3   2    140   2.0
13.0
## Cocoa_Puffs                                110       1   1    180   0.0
12.0
## Corn_Chex                                  110       2   0    280   0.0
22.0
## Corn_Flakes                                100       2   0    290   1.0
21.0
## Corn_Pops                                  110       1   0     90   1.0
13.0
## Count_Chocula                              110       1   1    180   0.0
12.0
## Cracklin'_Oat_Bran                         110       3   3    140   4.0
10.0
## Cream_of_Wheat_(Quick)                     100       3   0     80   1.0
21.0
## Crispix                                    110       2   0    220   1.0
21.0
## Crispy_Wheat_&_Raisins                     100       2   1    140   2.0
11.0
## Double_Chex                                100       2   0    190   1.0
18.0
## Froot_Loops                                110       2   1    125   1.0
11.0
## Frosted_Flakes                             110       1   0    200   1.0
14.0
## Frosted_Mini-Wheats                        100       3   0      0   3.0
14.0
## Fruit_&_Fibre_Dates,_Walnuts,_and_Oats     120       3   2    160   5.0
12.0
## Fruitful_Bran                              120       3   0    240   5.0
14.0
## Fruity_Pebbles                             110       1   1    135   0.0
13.0
```

```
## Golden_Crisp                          100       2   0     45   0.0
11.0
## Golden_Grahams                        110       1   1    280   0.0
15.0
## Grape_Nuts_Flakes                     100       3   1    140   3.0
15.0
## Grape-Nuts                            110       3   0    170   3.0
17.0
## Great_Grains_Pecan                    120       3   3     75   3.0
13.0
## Honey_Graham_Ohs                      120       1   2    220   1.0
12.0
## Honey_Nut_Cheerios                    110       3   1    250   1.5
11.5
## Honey-comb                            110       1   0    180   0.0
14.0
## Just_Right_Crunchy__Nuggets           110       2   1    170   1.0
17.0
## Just_Right_Fruit_&_Nut                140       3   1    170   2.0
20.0
## Kix                                   110       2   1    260   0.0
21.0
## Life                                  100       4   2    150   2.0
12.0
## Lucky_Charms                          110       2   1    180   0.0
12.0
## Maypo                                 100       4   1      0   0.0
16.0
## Muesli_Raisins,_Dates,_&_Almonds      150       4   3     95   3.0
16.0
## Muesli_Raisins,_Peaches,_&_Pecans     150       4   3    150   3.0
16.0
## Mueslix_Crispy_Blend                  160       3   2    150   3.0
17.0
## Multi-Grain_Cheerios                  100       2   1    220   2.0
15.0
## Nut&Honey_Crunch                      120       2   1    190   0.0
15.0
## Nutri-Grain_Almond-Raisin             140       3   2    220   3.0
21.0
## Nutri-grain_Wheat                      90       3   0    170   3.0
18.0
## Oatmeal_Raisin_Crisp                  130       3   2    170   1.5
13.5
## Post_Nat._Raisin_Bran                 120       3   1    200   6.0
11.0
## Product_19                            100       3   0    320   1.0
20.0
## Puffed_Rice                            50       1   0      0   0.0
13.0
```

```
## Puffed_Wheat                              50       2   0      0   1.0
10.0
## Quaker_Oat_Squares                       100       4   1    135   2.0
14.0
## Quaker_Oatmeal                           100       5   2      0   2.7
NA
## Raisin_Bran                              120       3   1    210   5.0
14.0
## Raisin_Nut_Bran                          100       3   2    140   2.5
10.5
## Raisin_Squares                            90       2   0      0   2.0
15.0
## Rice_Chex                                110       1   0    240   0.0
23.0
## Rice_Krispies                            110       2   0    290   0.0
22.0
## Shredded_Wheat                            80       2   0      0   3.0
16.0
## Shredded_Wheat_'n'Bran                    90       3   0      0   4.0
19.0
## Shredded_Wheat_spoon_size                 90       3   0      0   3.0
20.0
## Smacks                                   110       2   1     70   1.0
9.0
## Special_K                                110       6   0    230   1.0
16.0
## Strawberry_Fruit_Wheats                   90       2   0     15   3.0
15.0
## Total_Corn_Flakes                        110       2   1    200   0.0
21.0
## Total_Raisin_Bran                        140       3   1    190   4.0
15.0
## Total_Whole_Grain                        100       3   1    200   3.0
16.0
## Triples                                  110       2   1    250   0.0
21.0
## Trix                                     110       1   1    140   0.0
13.0
## Wheat_Chex                               100       3   1    230   3.0
17.0
## Wheaties                                 100       3   1    200   3.0
17.0
## Wheaties_Honey_Gold                      110       2   1    200   1.0
16.0
##                                    sugars potass vitamins shelf weight
cups
## 100%_Bran                               6    280       25     3   1.00
0.33
## 100%_Natural_Bran                       8    135        0     3   1.00
1.00
```

```
## All-Bran                         5    320        25     3   1.00
0.33
## All-Bran_with_Extra_Fiber        0    330        25     3   1.00
0.50
## Almond_Delight                   8     NA        25     3   1.00
0.75
## Apple_Cinnamon_Cheerios         10     70        25     1   1.00
0.75
## Apple_Jacks                     14     30        25     2   1.00
1.00
## Basic_4                          8    100        25     3   1.33
0.75
## Bran_Chex                        6    125        25     1   1.00
0.67
## Bran_Flakes                      5    190        25     3   1.00
0.67
## Cap'n'Crunch                    12     35        25     2   1.00
0.75
## Cheerios                         1    105        25     1   1.00
1.25
## Cinnamon_Toast_Crunch            9     45        25     2   1.00
0.75
## Clusters                         7    105        25     3   1.00
0.50
## Cocoa_Puffs                     13     55        25     2   1.00
1.00
## Corn_Chex                        3     25        25     1   1.00
1.00
## Corn_Flakes                      2     35        25     1   1.00
1.00
## Corn_Pops                       12     20        25     2   1.00
1.00
## Count_Chocula                   13     65        25     2   1.00
1.00
## Cracklin'_Oat_Bran               7    160        25     3   1.00
0.50
## Cream_of_Wheat_(Quick)           0     NA         0     2   1.00
1.00
## Crispix                          3     30        25     3   1.00
1.00
## Crispy_Wheat_&_Raisins          10    120        25     3   1.00
0.75
## Double_Chex                      5     80        25     3   1.00
0.75
## Froot_Loops                     13     30        25     2   1.00
1.00
## Frosted_Flakes                  11     25        25     1   1.00
0.75
## Frosted_Mini-Wheats              7    100        25     2   1.00
0.80
```

```
## Fruit_&_Fibre_Dates,_Walnuts,_and_Oats     10    200        25      3   1.25
0.67
## Fruitful_Bran                              12    190        25      3   1.33
0.67
## Fruity_Pebbles                             12     25        25      2   1.00
0.75
## Golden_Crisp                               15     40        25      1   1.00
0.88
## Golden_Grahams                              9     45        25      2   1.00
0.75
## Grape_Nuts_Flakes                           5     85        25      3   1.00
0.88
## Grape-Nuts                                  3     90        25      3   1.00
0.25
## Great_Grains_Pecan                          4    100        25      3   1.00
0.33
## Honey_Graham_Ohs                           11     45        25      2   1.00
1.00
## Honey_Nut_Cheerios                         10     90        25      1   1.00
0.75
## Honey-comb                                 11     35        25      1   1.00
1.33
## Just_Right_Crunchy__Nuggets                 6     60       100      3   1.00
1.00
## Just_Right_Fruit_&_Nut                      9     95       100      3   1.30
0.75
## Kix                                         3     40        25      2   1.00
1.50
## Life                                        6     95        25      2   1.00
0.67
## Lucky_Charms                               12     55        25      2   1.00
1.00
## Maypo                                       3     95        25      2   1.00
1.00
## Muesli_Raisins,_Dates,_&_Almonds           11    170        25      3   1.00
1.00
## Muesli_Raisins,_Peaches,_&_Pecans          11    170        25      3   1.00
1.00
## Mueslix_Crispy_Blend                       13    160        25      3   1.50
0.67
## Multi-Grain_Cheerios                        6     90        25      1   1.00
1.00
## Nut&Honey_Crunch                            9     40        25      2   1.00
0.67
## Nutri-Grain_Almond-Raisin                   7    130        25      3   1.33
0.67
## Nutri-grain_Wheat                           2     90        25      3   1.00
1.00
## Oatmeal_Raisin_Crisp                       10    120        25      3   1.25
0.50
```

```
## Post_Nat._Raisin_Bran                14    260        25     3   1.33
0.67
## Product_19                            3     45       100     3   1.00
1.00
## Puffed_Rice                           0     15         0     3   0.50
1.00
## Puffed_Wheat                          0     50         0     3   0.50
1.00
## Quaker_Oat_Squares                    6    110        25     3   1.00
0.50
## Quaker_Oatmeal                       NA    110         0     1   1.00
0.67
## Raisin_Bran                          12    240        25     2   1.33
0.75
## Raisin_Nut_Bran                       8    140        25     3   1.00
0.50
## Raisin_Squares                        6    110        25     3   1.00
0.50
## Rice_Chex                             2     30        25     1   1.00
1.13
## Rice_Krispies                         3     35        25     1   1.00
1.00
## Shredded_Wheat                        0     95         0     1   0.83
1.00
## Shredded_Wheat_'n'Bran                0    140         0     1   1.00
0.67
## Shredded_Wheat_spoon_size             0    120         0     1   1.00
0.67
## Smacks                               15     40        25     2   1.00
0.75
## Special_K                             3     55        25     1   1.00
1.00
## Strawberry_Fruit_Wheats               5     90        25     2   1.00
1.00
## Total_Corn_Flakes                     3     35       100     3   1.00
1.00
## Total_Raisin_Bran                    14    230       100     3   1.50
1.00
## Total_Whole_Grain                     3    110       100     3   1.00
1.00
## Triples                               3     60        25     3   1.00
0.75
## Trix                                 12     25        25     2   1.00
1.00
## Wheat_Chex                            3    115        25     1   1.00
0.67
## Wheaties                              3    110        25     1   1.00
1.00
## Wheaties_Honey_Gold                   8     60        25     1   1.00
0.75
```

```
##                                          rating
## 100%_Bran                               68.40297
## 100%_Natural_Bran                       33.98368
## All-Bran                                59.42551
## All-Bran_with_Extra_Fiber               93.70491
## Almond_Delight                          34.38484
## Apple_Cinnamon_Cheerios                 29.50954
## Apple_Jacks                             33.17409
## Basic_4                                 37.03856
## Bran_Chex                               49.12025
## Bran_Flakes                             53.31381
## Cap'n'Crunch                            18.04285
## Cheerios                                50.76500
## Cinnamon_Toast_Crunch                   19.82357
## Clusters                                40.40021
## Cocoa_Puffs                             22.73645
## Corn_Chex                               41.44502
## Corn_Flakes                             45.86332
## Corn_Pops                               35.78279
## Count_Chocula                           22.39651
## Cracklin'_Oat_Bran                      40.44877
## Cream_of_Wheat_(Quick)                  64.53382
## Crispix                                 46.89564
## Crispy_Wheat_&_Raisins                  36.17620
## Double_Chex                             44.33086
## Froot_Loops                             32.20758
## Frosted_Flakes                          31.43597
## Frosted_Mini-Wheats                     58.34514
## Fruit_&_Fibre_Dates,_Walnuts,_and_Oats 40.91705
## Fruitful_Bran                           41.01549
## Fruity_Pebbles                          28.02576
## Golden_Crisp                            35.25244
## Golden_Grahams                          23.80404
## Grape_Nuts_Flakes                       52.07690
## Grape-Nuts                              53.37101
## Great_Grains_Pecan                      45.81172
## Honey_Graham_Ohs                        21.87129
## Honey_Nut_Cheerios                      31.07222
## Honey-comb                              28.74241
## Just_Right_Crunchy__Nuggets             36.52368
## Just_Right_Fruit_&_Nut                  36.47151
## Kix                                     39.24111
## Life                                    45.32807
## Lucky_Charms                            26.73451
## Maypo                                   54.85092
## Muesli_Raisins,_Dates,_&_Almonds        37.13686
## Muesli_Raisins,_Peaches,_&_Pecans       34.13976
## Mueslix_Crispy_Blend                    30.31335
## Multi-Grain_Cheerios                    40.10596
## Nut&Honey_Crunch                        29.92429
```

```
## Nutri-Grain_Almond-Raisin              40.69232
## Nutri-grain_Wheat                      59.64284
## Oatmeal_Raisin_Crisp                   30.45084
## Post_Nat._Raisin_Bran                  37.84059
## Product_19                             41.50354
## Puffed_Rice                            60.75611
## Puffed_Wheat                           63.00565
## Quaker_Oat_Squares                     49.51187
## Quaker_Oatmeal                         50.82839
## Raisin_Bran                            39.25920
## Raisin_Nut_Bran                        39.70340
## Raisin_Squares                         55.33314
## Rice_Chex                              41.99893
## Rice_Krispies                          40.56016
## Shredded_Wheat                         68.23588
## Shredded_Wheat_'n'Bran                 74.47295
## Shredded_Wheat_spoon_size              72.80179
## Smacks                                 31.23005
## Special_K                              53.13132
## Strawberry_Fruit_Wheats                59.36399
## Total_Corn_Flakes                      38.83975
## Total_Raisin_Bran                      28.59278
## Total_Whole_Grain                      46.65884
## Triples                                39.10617
## Trix                                   27.75330
## Wheat_Chex                             49.78744
## Wheaties                               51.59219
## Wheaties_Honey_Gold                    36.18756
```

Find the amount of missing values and then omit them

```
sum(is.na(cereals_data))
```

```
## [1] 4
```

```
cereals_data <- na.omit(cereals_data)
sum(is.na(cereals_data))
```

```
## [1] 0
```

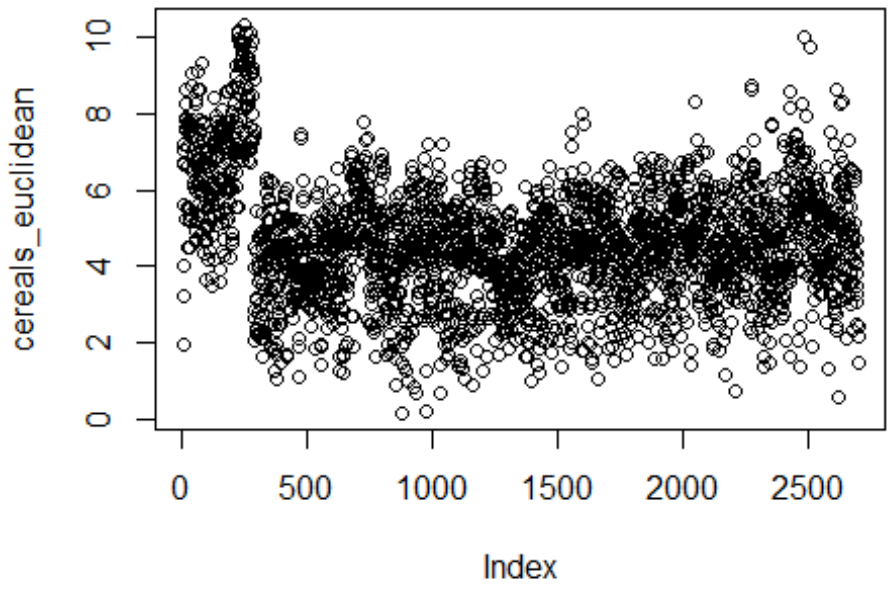
Step 2: Hierarchical Clustering

Normalize the data

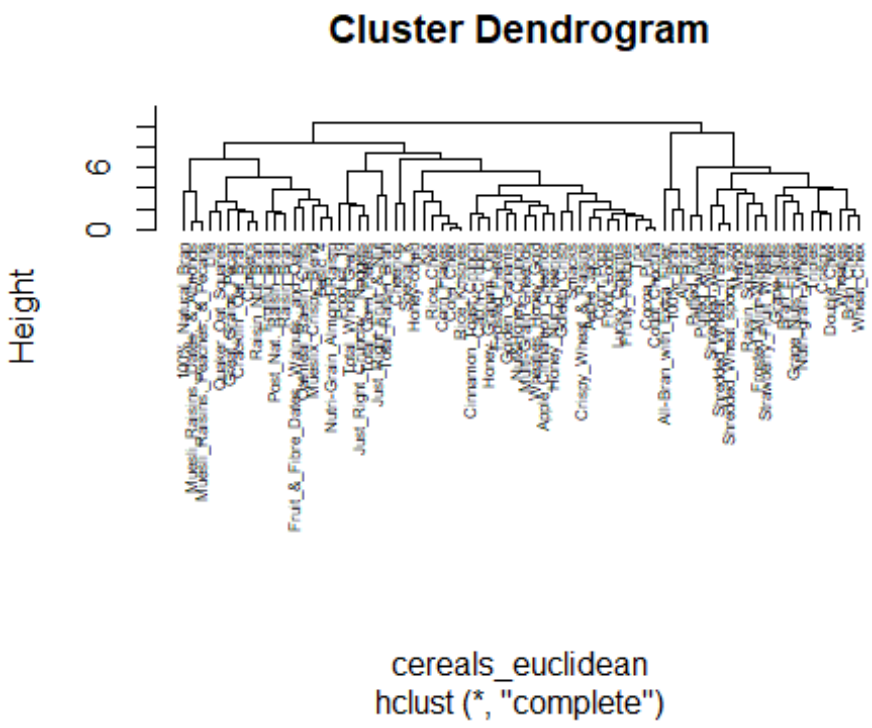
```
normalized_cereals <- scale(cereals_data[, -1])
```

Use the Euclidean distance measure

```
cereals_euclidean <- dist(normalized_cereals, method = "euclidean")
plot(cereals_euclidean)
```




```
CC1 <- hclust(cereals_euclidean)
plot(CC1, cex = 0.5, hang = -1)
```



Use Agnes

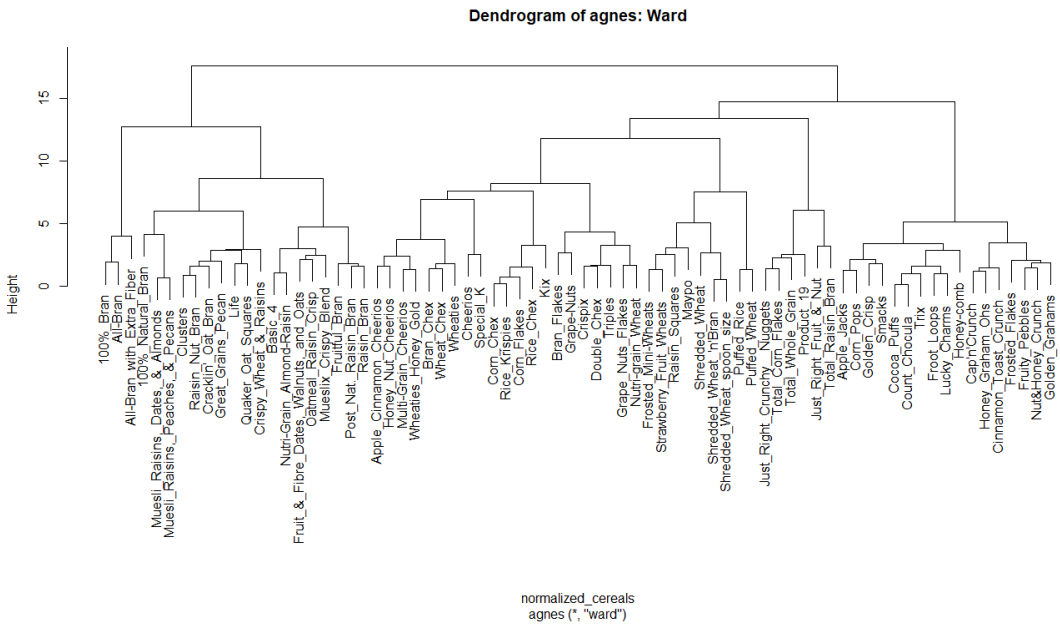
```
library(cluster)
library(stats)
Cereal_Single <- agnes(normalized_cereals, method = "single")
Cereal_Complete <- agnes(normalized_cereals, method = "complete")
Cereal_average <- agnes(normalized_cereals, method = "average")
Cereal_Ward <- agnes(normalized_cereals, method = "ward")

print(Cereal_Single$ac)

## [1] 0.5892187

print(Cereal_Complete$ac)

## [1] 0.8347316

print(Cereal_average$ac)

## [1] 0.7677452
```

Ward appears to be the best method

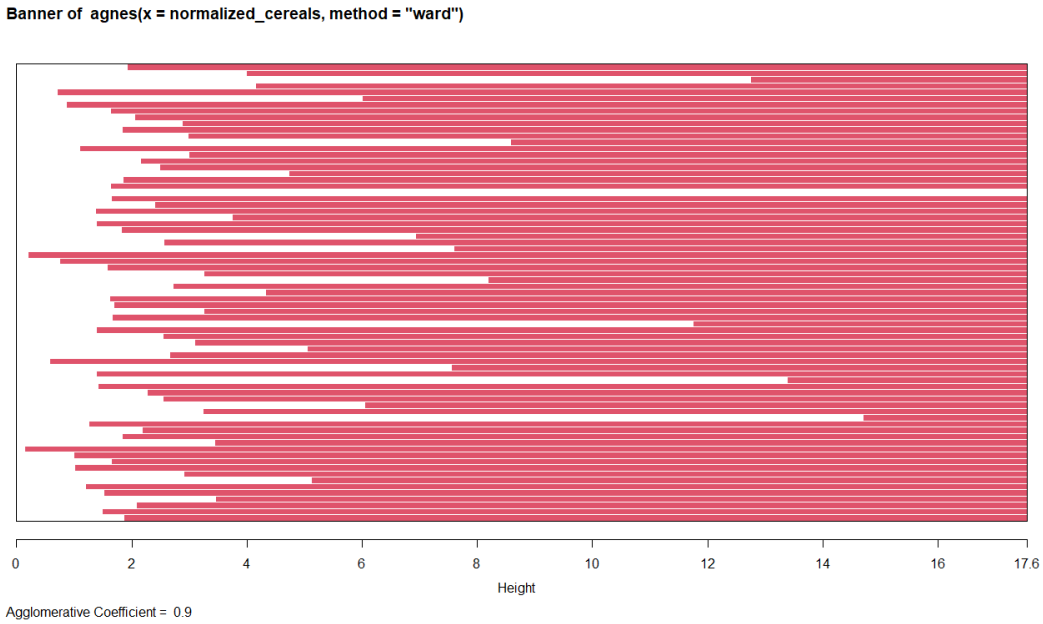
```
print(Cereal_Ward$ac)

## [1] 0.9021306
```

Apply hierarchical clustering with Ward's method & Visualize for Ward's method

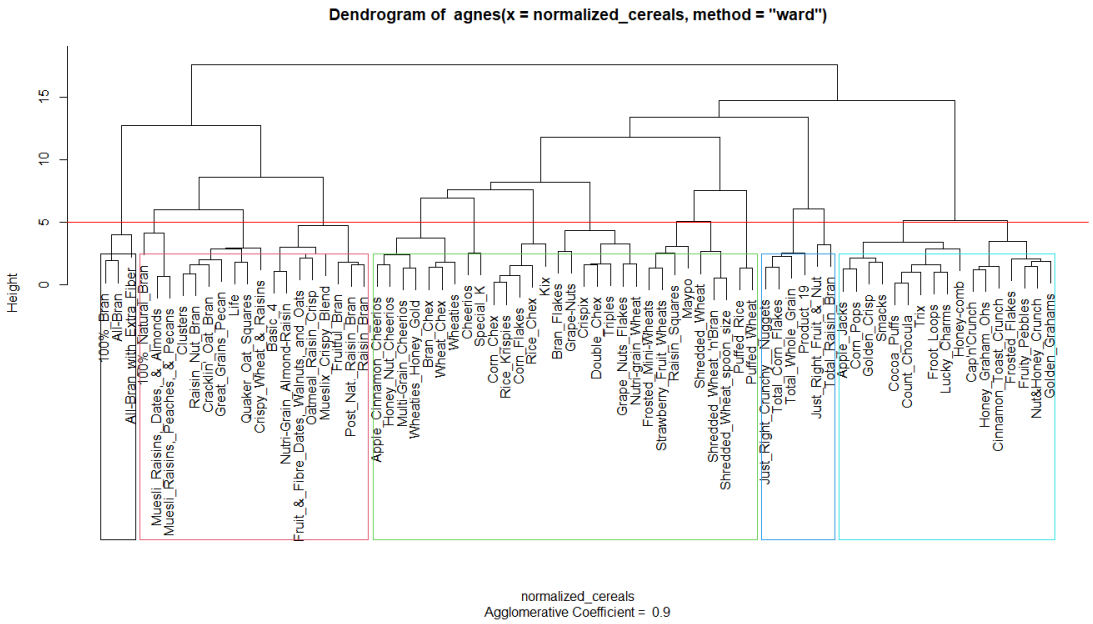
```
pltree(Cereal_Ward,main = "Dendrogram of agnes: Ward")
```




```
plot(Cereal_Ward)
```




```
rect.hclust(Cereal_Ward, k = 5, border = 1:5) # I would choose 5 clusters.
abline(h = 5, col = 'red')
```



Step 3: Cluster Stability and Healthy Cereals

Create cluster partitions A and B

```
set.seed(123)
partition_A <- sample(1:2, nrow(normalized_cereals), replace = TRUE)
partition_B <- 3 - partition_A
```

Fit cluster on partition A

```
cluster_A <- cutree(Cereal_Ward, k = 5)  # Assuming 4 clusters, adjust as needed
```

Calculate centroids of clusters in partition A

```
library(dplyr)

## Warning: package 'dplyr' was built under R version 4.3.2

##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

Combine partition_A, cluster_A, and normalized_cereals for easier processing

```
combined_data <- cbind(partition = partition_A, cluster = cluster_A)
combined_data_df <- as.data.frame(combined_data)
```

Calculate centroids of clusters in partition A

```
cluster_A_centroids <- combined_data_df %>%
  group_by(cluster) %>%
  summarise_all(mean) %>%
  select(-partition)
```

Calculate distances between partition B records and centroids from partition A

```
distances_to_centroids <- apply(normalized_cereals[partition_B, ], 1,
function(record) {
  apply(cluster_A_centroids, 1, function(centroid) {
    sqrt(sum((record - centroid)^2))
  })
})
```

Assign clusters to partition B based on minimum distances

```
cluster_B <- apply(distances_to_centroids, 2, which.min)
```

Assess cluster consistency

```
consistency <- sum(cluster_A == cluster_B) / length(cluster_B)
```

Identify healthy cereals cluster

Let’s assume ‘healthy’ cereals have low sugar and high fiber

```
healthy_cereals_cluster <- cluster_A[which(cereals_data$sugars < 5 &
cereals_data$fiber > 5)]
```

Print the results

```
cat("Cluster Consistency:", consistency, "\n")

## Cluster Consistency: 0.04054054

cat("Healthy Cereals Cluster:", healthy_cereals_cluster, "\n")
```

```
## Healthy Cereals Cluster: 1
```