Multivariate Data Analysis
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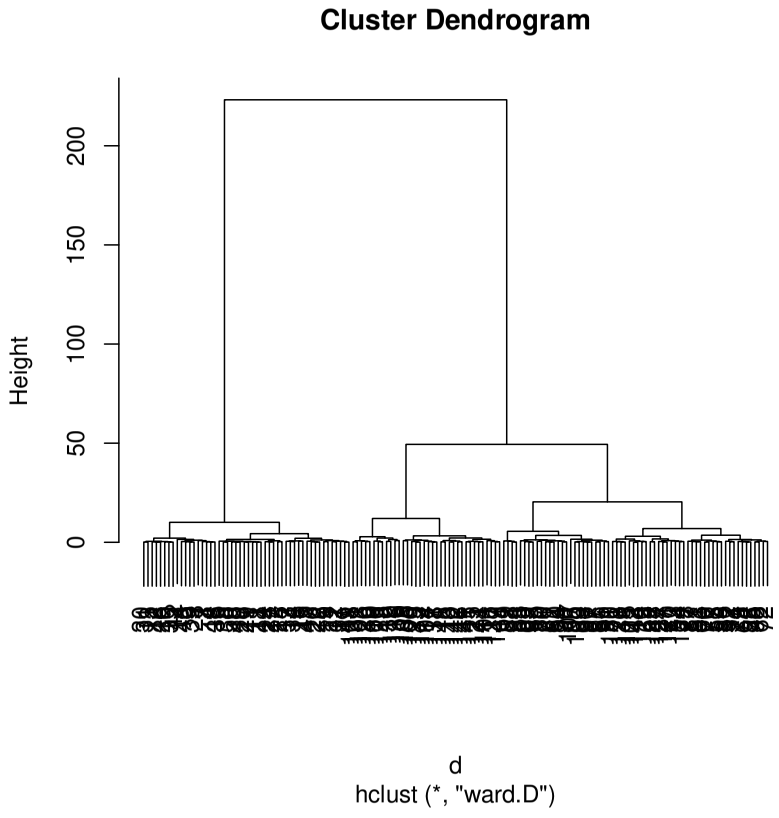
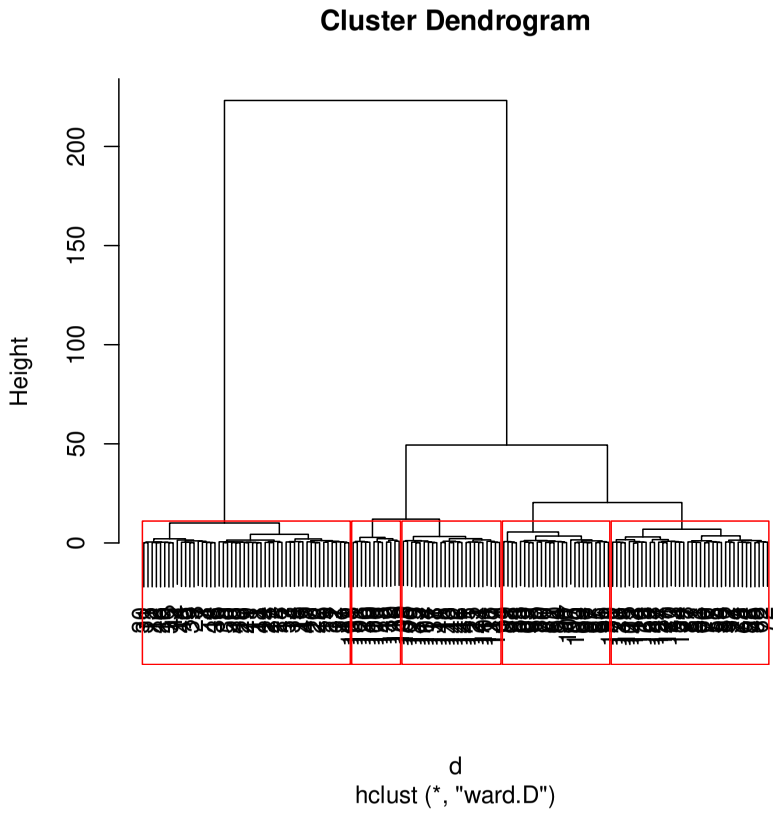
R Solution Exercise Sheet 3: Cluster Analysis

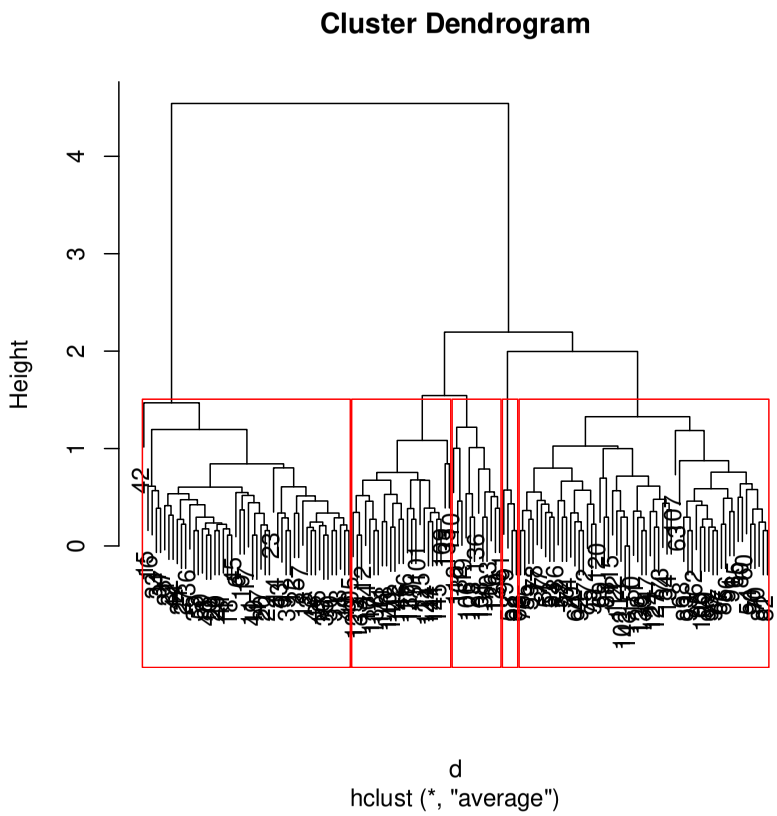
Computer Problems:

1. (a)
```
# Ward Hierarchical Clustering
d <- dist(iris, method = "euclidean") # distance matrix
fit <- hclust(d, method="ward")
plot(fit) # display dendogram
groups <- cutree(fit, k=5) # cut tree into 5 clusters
# draw dendogram with red borders around the 5 clusters
rect.hclust(fit, k=5, border="red")
```

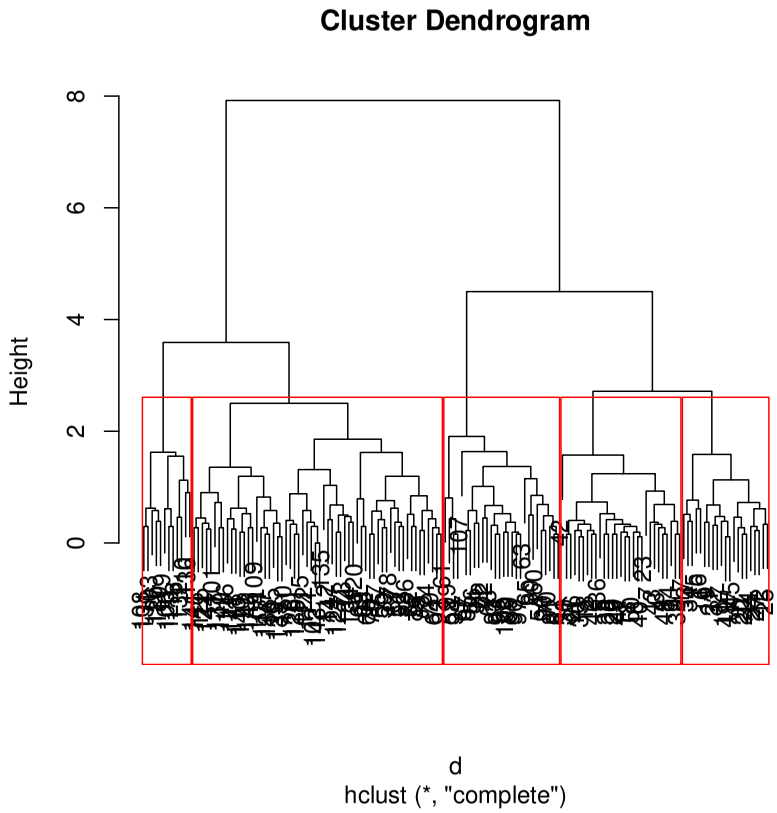




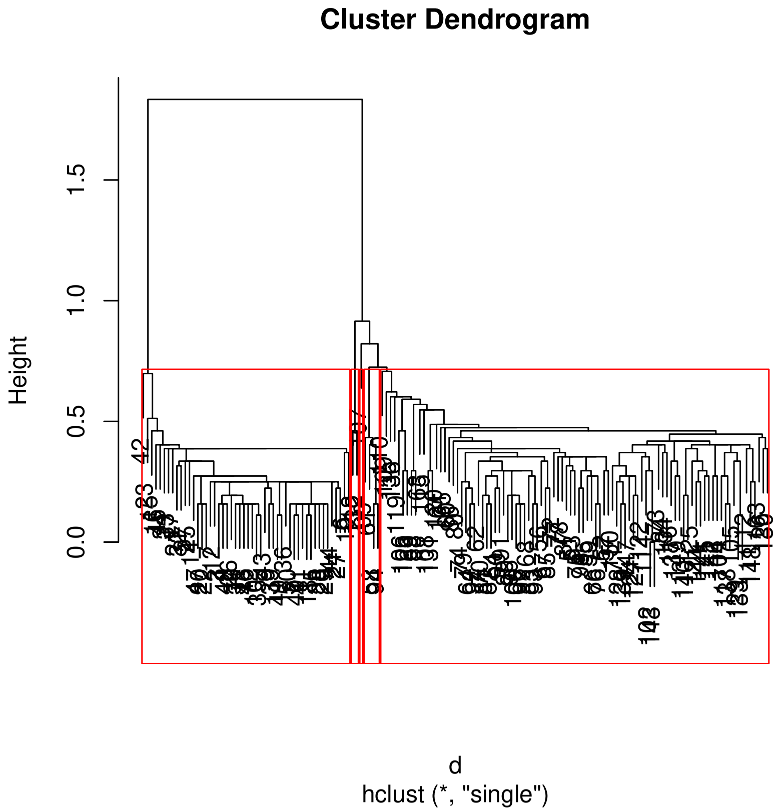
(b)
```
# Average Hierarchical Clustering
d <- dist(iris, method = "euclidean") # distance matrix
fit <- hclust(d, method="average")
plot(fit) # display dendogram
groups <- cutree(fit, k=5) # cut tree into 5 clusters
# draw dendogram with red borders around the 5 clusters
rect.hclust(fit, k=5, border="red")
```



(c)
```
# Complete Hierarchical Clustering
d <- dist(iris, method = "euclidean") # distance matrix
fit <- hclust(d, method="complete")
plot(fit) # display dendogram
groups <- cutree(fit, k=5) # cut tree into 5 clusters
# draw dendogram with red borders around the 5 clusters
rect.hclust(fit, k=5, border="red")
```



(d)
```
# Single Hierarchical Clustering
d <- dist(iris, method = "euclidean") # distance matrix
fit <- hclust(d, method="single")
plot(fit) # display dendogram
groups <- cutree(fit, k=5) # cut tree into 5 clusters
# draw dendogram with red borders around the 5 clusters
rect.hclust(fit, k=5, border="red")
```



2. (a)

```
# K-Means Clustering with 3 clusters
ir=iris[,1:4]
head(ir)

fit3 = kmeans(ir, 3)
fit3

ns clustering with 3 clusters of sizes 50, 62, 38

Cluster means:
  Sepal.Length Sepal.Width Petal.Length Petal.Width
1     5.006000    3.428000     1.462000    0.246000
2     5.901613    2.748387     4.393548    1.433871
3     6.850000    3.073684     5.742105    2.071053

Clustering vector:
  [1] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
 [39] 1 1 1 1 1 1 1 1 1 1 1 1 2 2 3 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
```

```
 [77] 2 3 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 3 2 3 3 3 3 2 3 3
[115] 2 3 3 3 3 2 3 2 3 2 3 3 2 2 3 3 3 3 3 2 3 3 3 3 2 3 3 3 2 3 3 3 2

Within cluster sum of squares by cluster:
[1] 15.15100 39.82097 23.87947
 (between_SS / total_SS =  88.4 %)

Available components:

[1] "cluster"      "centers"      "totss"        "withinss"     "tot.wi
[6] "betweenss"    "size"         "iter"         "ifault"
>

# K-Means Clustering with 2 clusters
fit2 = kmeans(ir, 2)
fit2

K-means clustering with 2 clusters of sizes 97, 53

Cluster means:
  Sepal.Length Sepal.Width Petal.Length Petal.Width
1     6.301031    2.886598     4.958763    1.695876
2     5.005660    3.369811     1.560377    0.290566

Clustering vector:
  [1] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
 [39] 2 2 2 2 2 2 2 2 2 2 2 2 1 1 1 1 1 1 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1
 [77] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 1 1 1 1 2 1 1 1 1 1 1 1 1 1 1
[115] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

Within cluster sum of squares by cluster:
[1] 123.79588  28.55208
 (between_SS / total_SS =  77.6 %)

Available components:

[1] "cluster"      "centers"      "totss"        "withinss"     "tot.wi
[6] "betweenss"    "size"         "iter"         "ifault"
```

(b)

```
library(cluster)
```

```
clusplot(ir, fit3$cluster, color=TRUE, shade=TRUE,
   labels=2, lines=0)
```