Math 5365

Data Mining 1

Homework 18

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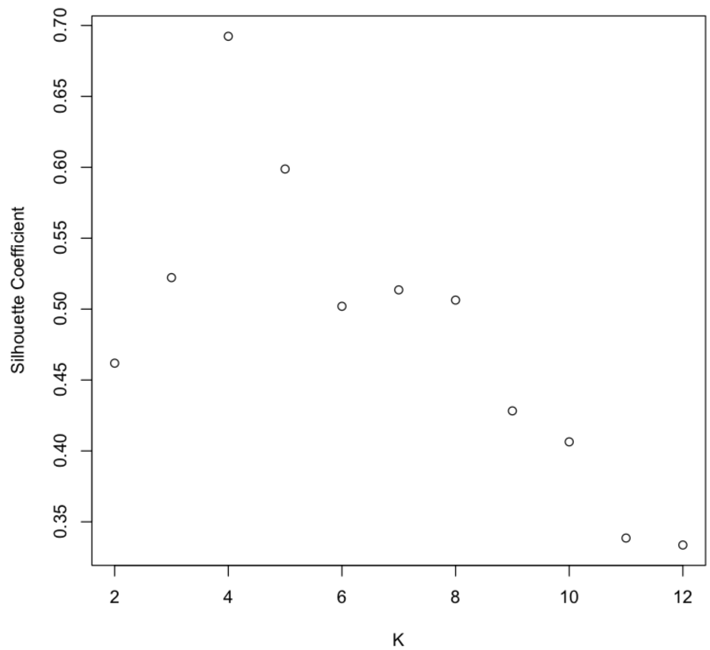
1. Consider the data from problem 1 on Homework 17

   (a) Find the number of clusters that maximizes the silhouette coefficient, and plot the silhouette coefficient, and plot the silhouette coefficient vs K.



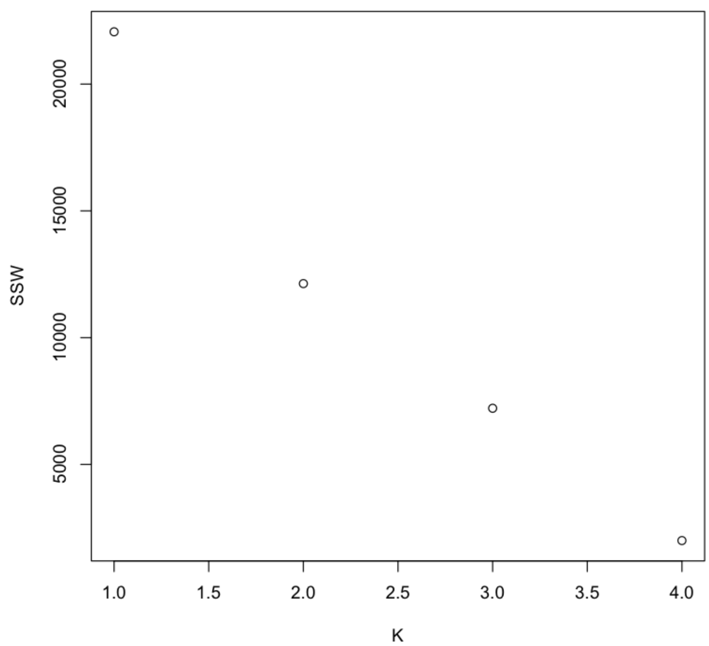
   The optimal number of clusters for the silhouette coefficient is 4.

   (b) What is the maximum possible value of the silhouette coefficient?

```
$max
[1] 0.6923732


$where
[1] 4
```

(c) Plot SSW vs K. Does the optimal value of K suggested by this plot agree with the one based on the silhouette coefficient?

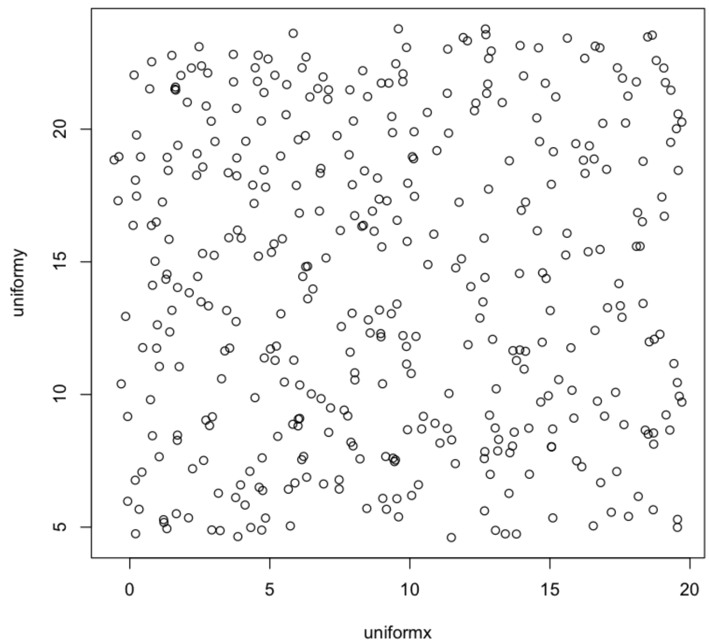


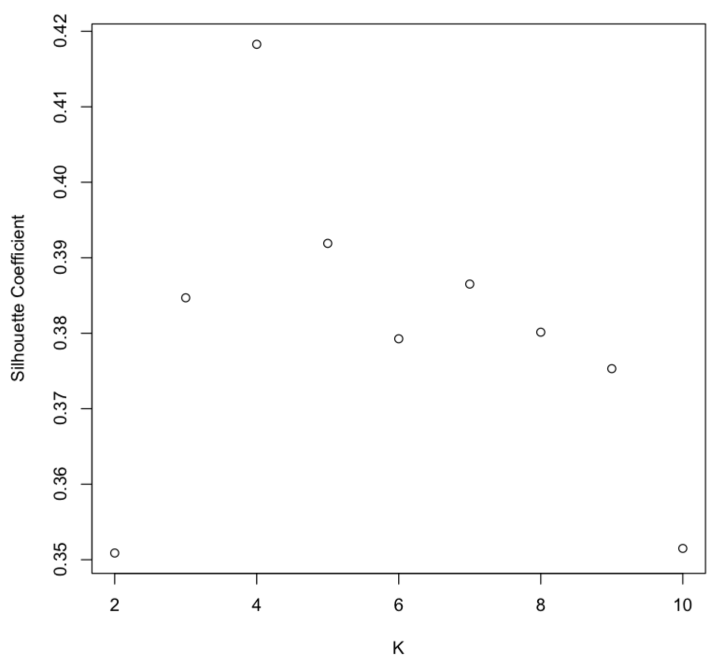
(d) Optional: Is the silhouette cofficient for this clustering statistically significant? (It may be a good idea to let R run while you're out of the office to do this problem.)

Running the same case with uniform data gave a silhouette coefficient maximized at k = 4 also.

```
$max
[1] 0.4182791


$where
[1] 4
```

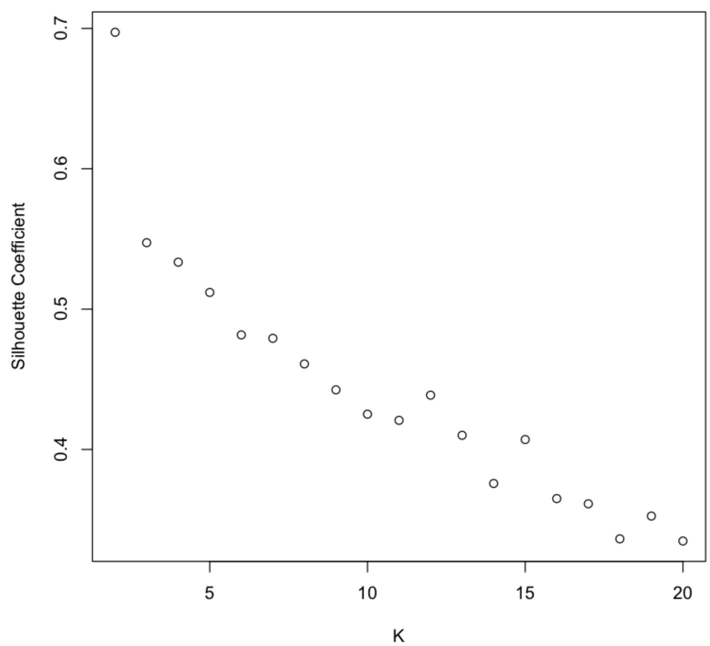


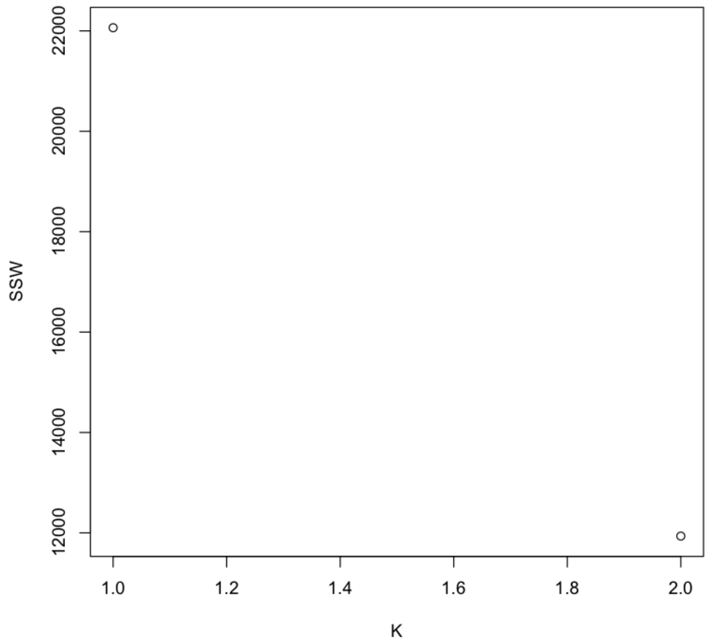


2. Repeat problem 1 for the wdbc data set. Also, find the weighted entropy and purity for the optimal clustering.

```
$max
[1] 0.6972646

$where
[1] 2
```





entropy = 0.5503462

purity = 0.8541301

```
#Data Mining hw 18
library(stats)
library(cluster)
library(fields)

wdbc <- read.csv(’˜/Dropbox/Tarleton/data_mining/dfiles/wdbc.data’,
                 header=F,sep=’,’)
wdbc <- wdbc[,-1]
source(’˜/Dropbox/Tarleton/data_mining/generic_functions/dataset_ops.R’)
source(’˜/Dropbox/Tarleton/data_mining/generic_functions/measures.R’)

x <- c(rnorm(100,  5, 1.5), rnorm(100, 15, 1.5),
       rnorm(100,  5, 1.5), rnorm(100, 15, 1.5))
y <- c(rnorm(100, 10, 1.5), rnorm(100, 10, 1.5),
       rnorm(100, 20, 1.5), rnorm(100, 20, 1.5))
plot(x, y)
points <- data.frame(x = x, y = y)
```

```
kmeans_reps <- function(data, centers, reps){
  w_ss = Inf
  for(i in 1:reps){
    k_cluster <- kmeans(x = data, centers = centers)
    if((k_cluster$tot.withinss) < w_ss){
      ssw = k_cluster$tot.withinss
      my_k_cluster <- k_cluster
    }
  }
  return(my_k_cluster)
}

min_rep <- function(K, eps){
  ceiling(log(eps) / log(1 - factorial(K)/K^K))
}

#   a. Find the number of clusters that maximizes the silhouette coefficient,
#      and plot the silhouette coefficient, and plot the silhouette
#      coefficient vs K.

mysil <- function(x, dmat){
  return(mean(silhouette(x = x, dmat = dmat)[,3]))
}

find_sil <- function(data, kmax, niter, eps){
  dmat <- rdist(data)
  sil_v <- 1:kmax
  for(K in 2:kmax){
          iter <- min(niter, min_rep(K, eps))
          kmeans_tmp <- kmeans_reps(data, K, iter)
          sil_v[K] <- mysil(kmeans_tmp$cluster, dmat)
  }
  sil_v <- sil_v[2:kmax]
  plot(2:kmax, sil_v, xlab='K', ylab='Silhouette Coefficient')
  return(list(max = max(sil_v), where = which.max(sil_v) + 1))
}
max_k <- find_sil(points, 12, 1000, 0.01)


#   b. What is the maximum possible value of the silhouette coefficient?
max_k$max

```

```
#   c. Plot SSW vs K. Does the optimal value of K suggested by this plot agree
#      with the one based on the silhouette coefficient?

plot_ssw <- function(data, kmax, niter, eps){
  ssw_v <- 1:kmax

  for(K in 1:kmax){
    iter <- min(niter, min_rep(K, eps))
    kmeans_tmp <- kmeans_reps(data, K, iter)
    ssw_v[K] <- kmeans_tmp$tot.withinss
  }
  plot(1:kmax, ssw_v, xlab='K',ylab='SSW')
}
plot_ssw(points, max_k$where, 1000, 0.01)

#   d. Optional: Is the silhouette cofficient for this clustering statistically
#      significant? (It may be a good idea to let R run while you're out of the
#      office to do this problem.)

rmat <- apply(points, 2, range)
uniformx <- runif(nrow(points), rmat[1,1], rmat[2,1])
uniformy <- runif(nrow(points), rmat[1,2], rmat[2,2])
upoints <- data.frame(uniformx, uniformy)

find_sil(upoints, 10, 1000, 0.01)

# 2. Repeat problem 1 for the wdbc data set. Also, find the weighted entropy
#    and purity for the optimal clustering.
#    a.
max_k <- find_sil(wdbc, 20, 1000, 0.01)

#    b.
max_k$max

#    c.
plot_ssw(points, max_k$where, 1000, 0.01)

table_ent <- function(table){
  col_sums <- apply(table, 2, sum)
  col_props <- col_sums / sum(col_sums)
  for(j in 1:ncol(table)){
          if(sum(table[,j] != 0)){
      table[,j] <- table[,j] / sum(table[,j])
          }
```

```
  }
  table_entropies <- apply(table, 2, entropy_eval)
  return(col_props %*% table_entropies)
}

best_wdbc <- kmeans_reps(wdbc[,2:ncol(wdbc)], 2, 1000)
predicted <- rep('',nrow(wdbc))
predicted[1 * (best_wdbc$cluster == 2) == 1] <- 'B'
predicted[1 * (best_wdbc$cluster == 1) == 1] <- 'M'
wdbc_tab <- table(wdbc$V2, predicted)
entropy <- table_ent(wdbc_tab)

purity <- sum(apply(wdbc_tab, 2, max)) / sum(wdbc_tab)
```