cs539 hw5

Enbo Tian

2022-04-19

#KL Distance

a)

```
library(LaplacesDemon)
```

```
## Warning: ³Ì¼°ü'LaplacesDemon'ÊÇÓÃR°æ±¾4.1.3 À´½¨Ôìµ
```

```
p <- 1/3*dnorm(runif(10),-1,2)+2/3*dnorm(runif(10),1,1)

m <- 1:20/20*2-1 # set 100 m from -1 to 1
s <- 1:10/10+1  # set 100 s from 1 to 2

Dist <- rep(0,200)
count = 1
for(i in 1:20){
  for(j in 1:10){
    q <-  dnorm(runif(10),m[i],s[j])
    Dist[count] <- KLD(p,q)$intrinsic.discrepancy
    count = count+1
  }
}

Dist <- matrix(Dist,20,10)
Dist
```

```
##              [,1]        [,2]        [,3]        [,4]        [,5]        [,6]
##  [1,] 0.051528623 0.022053585 0.042376990 0.016014263 0.005805058 0.012867747
##  [2,] 0.035100657 0.032567618 0.018044372 0.013704384 0.007426326 0.001828294
##  [3,] 0.033580581 0.025357850 0.013825705 0.018812906 0.008763190 0.006440402
##  [4,] 0.026852949 0.017263826 0.015594883 0.012460643 0.012381518 0.010907768
##  [5,] 0.013405986 0.010532034 0.004584139 0.008320356 0.004405651 0.003696727
##  [6,] 0.016600708 0.008952167 0.012356357 0.009487572 0.004876103 0.005884748
##  [7,] 0.016982703 0.008865055 0.007115433 0.009168298 0.010552881 0.004981287
##  [8,] 0.008810145 0.015472934 0.005344224 0.008222800 0.006987781 0.005487008
##  [9,] 0.006936936 0.006315620 0.004504439 0.009157220 0.004039027 0.004918698
## [10,] 0.006459802 0.008105022 0.006658692 0.004488510 0.005825758 0.004553285
## [11,] 0.059511237 0.034696022 0.018080482 0.017287516 0.012094285 0.006346217
## [12,] 0.010295531 0.046245703 0.030441409 0.017901964 0.009722121 0.005715458
```

```
## [13,] 0.011629602 0.017360164 0.018026103 0.008903016 0.004927063 0.003106553
## [14,] 0.031161051 0.013504881 0.011938675 0.004447856 0.007883684 0.004186538
## [15,] 0.015176779 0.017958314 0.008498691 0.006311055 0.005701381 0.005304102
## [16,] 0.006807302 0.019047081 0.006270056 0.007672576 0.011320274 0.003649272
## [17,] 0.014339108 0.002963081 0.011141992 0.006944528 0.004843426 0.005625285
## [18,] 0.011784156 0.018572496 0.010191870 0.005101137 0.006899677 0.004193670
## [19,] 0.009363620 0.010105352 0.011647272 0.005256309 0.005385649 0.004355505
## [20,] 0.004713615 0.006797391 0.008019448 0.004960671 0.004355517 0.005265778
##              [,7]        [,8]        [,9]       [,10]
##  [1,] 0.004678833 0.004530489 0.007089941 0.008946457
##  [2,] 0.004788244 0.004580039 0.004995512 0.007577042
##  [3,] 0.006899846 0.005007089 0.004392229 0.010095136
##  [4,] 0.004770867 0.005522595 0.004050344 0.007538548
##  [5,] 0.004575291 0.005608202 0.005430594 0.008114883
##  [6,] 0.004701774 0.004776034 0.005040114 0.005665945
##  [7,] 0.004394910 0.004481142 0.003425548 0.008618815
##  [8,] 0.005184668 0.004073676 0.004625156 0.006486993
##  [9,] 0.005300653 0.004519078 0.005015232 0.006291955
## [10,] 0.004374450 0.004493330 0.005368770 0.005821111
## [11,] 0.005209637 0.006635037 0.006199658 0.011037575
## [12,] 0.006587271 0.003937939 0.005878040 0.005398171
## [13,] 0.005561030 0.003076802 0.006622955 0.001622373
## [14,] 0.004722771 0.004461688 0.004665626 0.004949039
## [15,] 0.005217446 0.005571407 0.007686618 0.006649446
## [16,] 0.005529562 0.004654158 0.005561296 0.004071864
## [17,] 0.004109749 0.004810760 0.004681222 0.003332179
## [18,] 0.004639370 0.004726640 0.005116235 0.002245801
## [19,] 0.004652093 0.004522612 0.006064131 0.004566409
## [20,] 0.004060277 0.004697400 0.005003160 0.005779801
```

```
min(Dist)
```

```
## [1] 0.001622373
```

```
which(Dist== min(Dist), arr.ind = TRUE)
```

```
##      row col
## [1,]  13  10
```

```
# row = 8, col= 3
8/20-1
```

```
## [1] -0.6
```

```
3/10+1
```

```
## [1] 1.3
```

Then $m_a = -0.6$, $\sigma_m^2 = 1.3$ have the minimum KL distance with p

b)

```
mean(p)
```

```
## [1] 0.273682
```

```
var(p)
```

```
## [1] 0.0007634665
```

```
q_p <- dnorm(runif(10),0.2809131,0.0009584375)

KLD(p,q)
```

```
## $KLD.px.py
##  [1] -0.008876449 -0.012898377 -0.001112540  0.010173742 -0.001888874
##  [6]  0.020081964 -0.011114162 -0.008946545  0.014821707  0.005586065
##
## $KLD.py.px
##  [1]  0.009839533  0.014883698  0.001125822 -0.009293137  0.001924473
##  [6] -0.016825488  0.012537601  0.009843754 -0.012954460 -0.005301996
##
## $mean.KLD
##  [1] 4.815422e-04 9.926603e-04 6.640670e-06 4.403026e-04 1.779981e-05
##  [6] 1.628238e-03 7.117196e-04 4.486043e-04 9.336235e-04 1.420344e-04
##
## $sum.KLD.px.py
## [1] 0.005826531
##
## $sum.KLD.py.px
## [1] 0.005779801
##
## $mean.sum.KLD
## [1] 0.005803166
##
## $intrinsic.discrepancy
## [1] 0.005779801
```

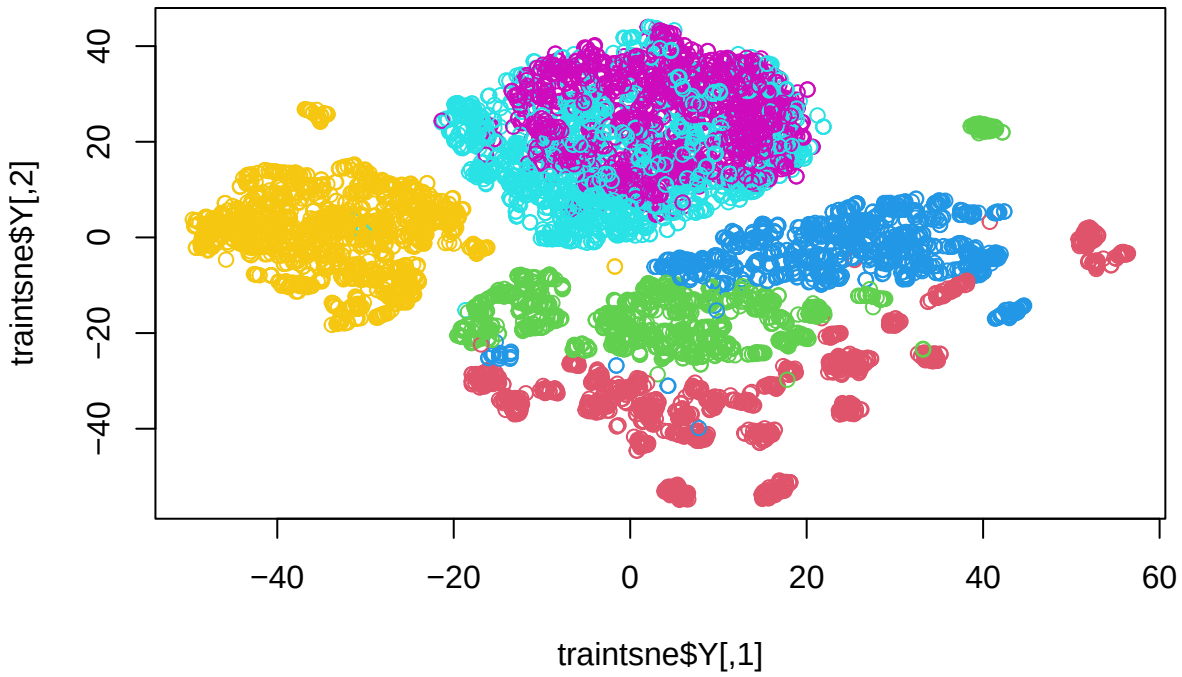
the KL distanced is 0.004042311, however, it is not the minimum KL distance.

TSNE

a)

```
library(Rtsne)
xtrain <- read.table("X_train.txt")
```

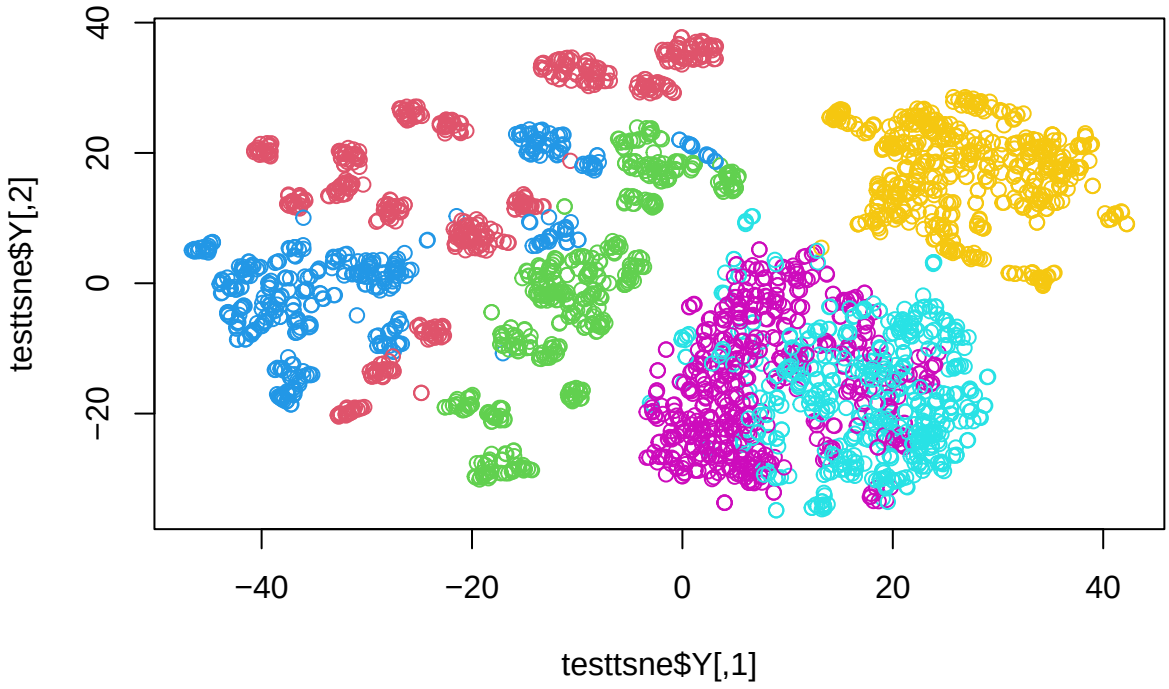
```
ytrain <- read.table("y_train.txt")

traintsne <- Rtsne(xtrain)
# Y
# 1   red WALKING
# 2   green WALKING_UPSTAIRS
# 3   blue WALKING_DOWNSTAIRS
# 4   light_blue SITTING
# 5   purple STANDING
# 6   yellow LAYING
plot(traintsne$Y,col= ytrain$V1+1)
```



The KL distance for Y=1 is the largest, Y = 7 is the smallest, Y = 4,5 are emed.

b)

```
xtest <- read.table("X_test.txt")
ytest <- read.table("y_test.txt")
testtsne <- Rtsne(xtest)
plot(testtsne$Y,col= ytest$V1+1)
```



The KL distance for red, green, blue(1, 2, 3) are large, 4,5,6 are small.

c)

The similarities part are the each part distribution of the color groups. both 4 and 5 are neighboring, 1 and 2 are dispersive.

Neural Networks

a)

```
library(neuralnet)
```

```
## Warning: ³Ì¼°ü'neuralnet'ÊÇÓÃR°æ±¾4.1.3 À´½¨Ôìµ
```

```
Y1 <- ytrain$V1
training <- data.frame(Y1,xtrain)
TrainNN <- neuralnet(Y1 ~ .,data = training)
summary(TrainNN)
```

```
##                     Length  Class      Mode
## call                     3 -none-     call
```

```
## response               7352 -none-     numeric
## covariate           4124472 -none-     numeric
## model.list                2 -none-     list
## err.fct                   1 -none-     function
## act.fct                   1 -none-     function
## linear.output             1 -none-     logical
## data                    562 data.frame list
## exclude                   0 -none-     NULL
## net.result                1 -none-     list
## weights                   1 -none-     list
## generalized.weights       1 -none-     list
## startweights              1 -none-     list
## result.matrix           567 -none-     numeric
```

```
plot(TrainNN,col.hidden = 'darkgreen',
col.hidden.synapse = 'darkgreen',
     show.weights = F,
     information = F,
     fill = 'lightblue')
```

```
Y2 <- ytest$V1
testing <- data.frame(Y2,xtest)
TestNN <- neuralnet(Y2 ~ .,data = testing)
summary(TestNN)
```

```
##                       Length  Class      Mode
## call                       3 -none-     call
## response                2947 -none-     numeric
## covariate            1653267 -none-     numeric
## model.list                 2 -none-     list
## err.fct                    1 -none-     function
## act.fct                    1 -none-     function
## linear.output              1 -none-     logical
## data                     562 data.frame list
## exclude                    0 -none-     NULL
## net.result                 1 -none-     list
## weights                    1 -none-     list
## generalized.weights        1 -none-     list
## startweights               1 -none-     list
## result.matrix            567 -none-     numeric
```

```
plot(TestNN,col.hidden = 'darkgreen',
col.hidden.synapse = 'darkgreen',
     show.weights = F,
     information = F,
     fill = 'lightblue')
```

b)

```
trainpartci<-read.table("subject_train.txt")
testpartci <- read.table("subject_test.txt")

Y3 <- trainpartci$V1
training <- data.frame(Y3,xtrain)
TrainNN <- neuralnet(Y3 ~ .,data = training)
plot(TrainNN,col.hidden = 'darkgreen',
col.hidden.synapse = 'darkgreen',
     show.weights = F,
     information = F,
     fill = 'lightblue')
```

```
Y4 <- testpartci$V1
testing <- data.frame(Y4,xtest)
TestNN <- neuralnet(Y4 ~ .,data = testing)
plot(TestNN,col.hidden = 'darkgreen',
col.hidden.synapse = 'darkgreen',
     show.weights = F,
     information = F,
     fill = 'lightblue')
```