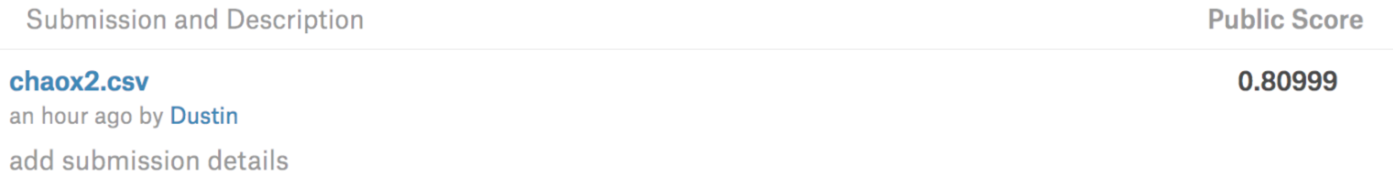
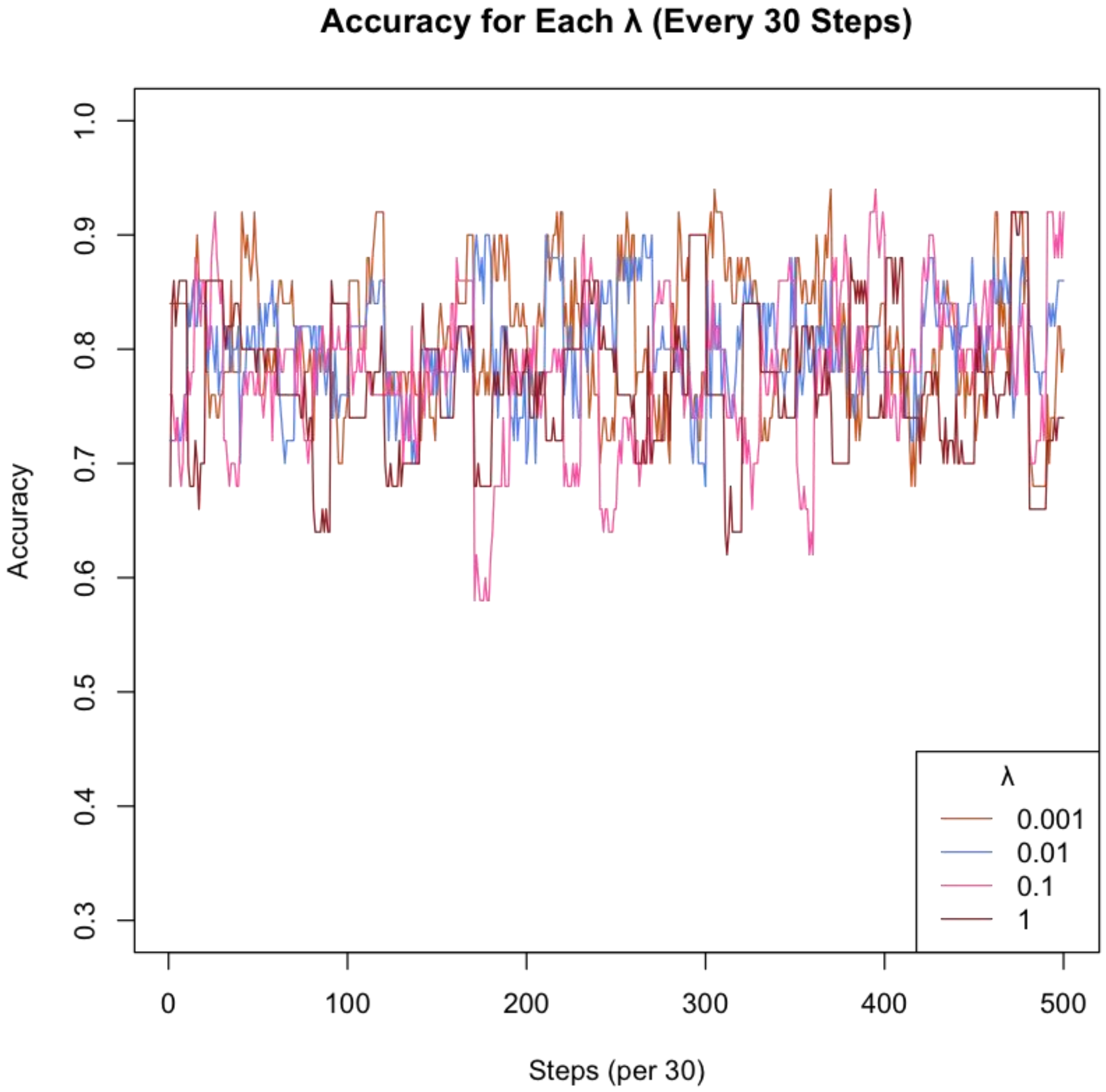
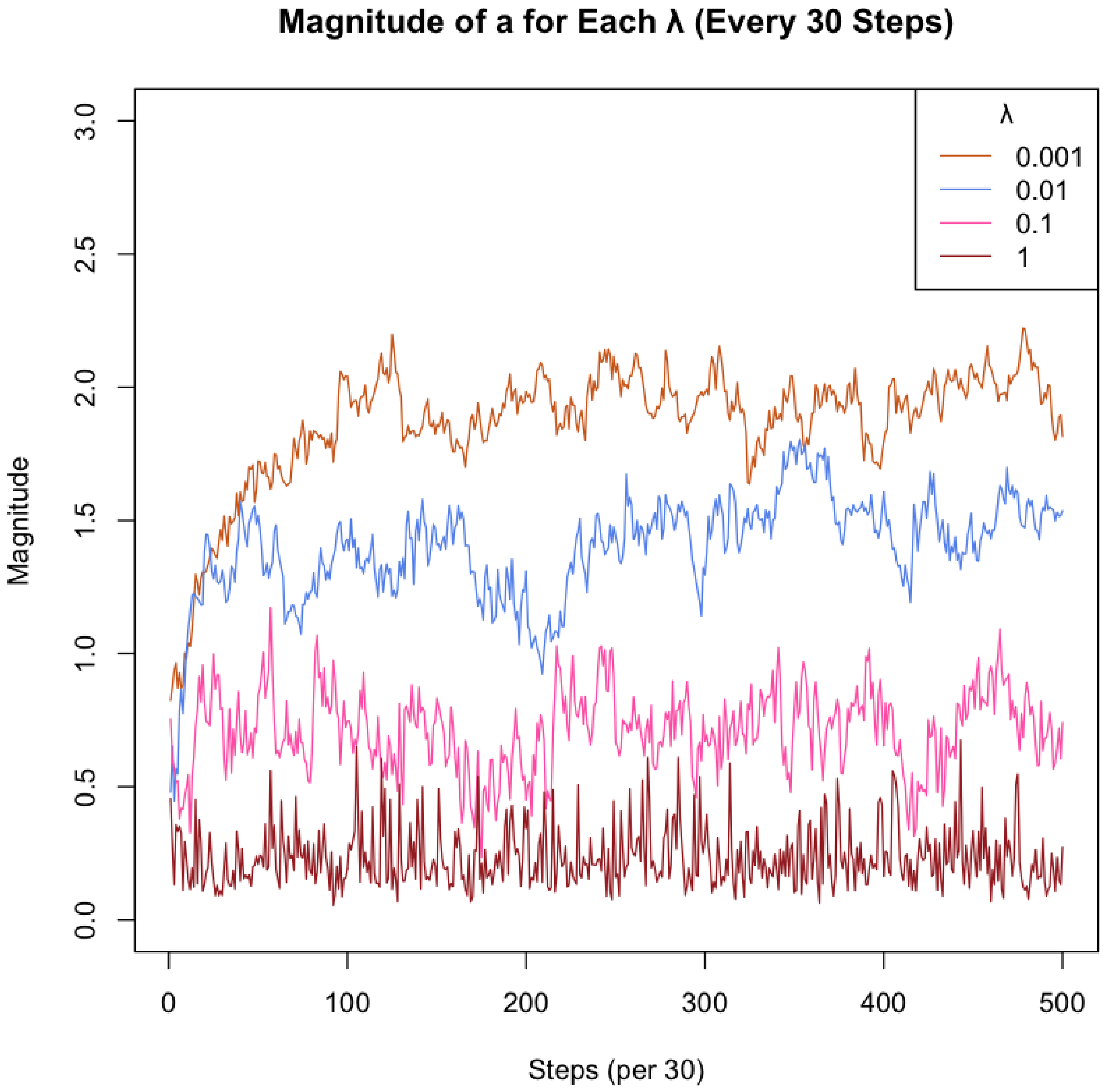


Submission and Description	Public Score
chaox2.csv an hour ago by Dustin add submission details	0.80999

best test dataset accuracy obtained on Kaggle: **0.80999**

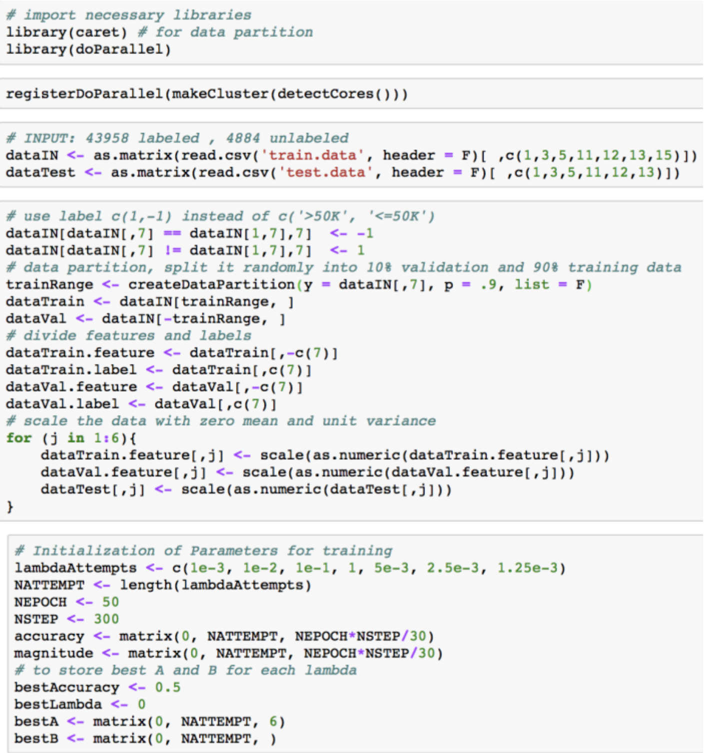

Accuracy for Each λ (Every 30 Steps)
Accuracy
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
0
100
200
300
400
500
Steps (per 30)
λ
0.001
0.01
0.1
1


Magnitude of a for Each λ (Every 30 Steps)
λ
0.001
0.01
0.1
1
Magnitude
0.0
0.5
1.0
1.5
2.0
2.5
3.0
0
100
200
300
400
500
Steps (per 30)

Requirement: Your estimate of the best value of the regularization constant, together with a brief description of why you believe that is a good value. What was your choice for the learning rate and why did you choose it?

My estimate of the best value of the regularization constant is between 0.001 and 0.0025.
If I must choose one, I will choose **0.00125**.
Primarily, I choose a learning rate as the textbook recommended. Based on this fixed learning rate, I apply **binary search** on the regularization constant, compare their final accuracy on the validation set. Then, I found the best regularization constant just wanders between 0.001 and 0.0025.

My choice for the learning rate is a random range: $\frac{\mathrm{runif}(1,1,10)}{(0.01 * \mathrm{epoch} + \mathrm{runif}(1,25,100))}$.
runif(1, x, y) will generate a random double number between x and y.
The basic reason is that I believe “randomization” is the best teacher. It will effectively speed up the process of parameter adjustment using a range rather than just some magic numbers. Besides, the ratio of $0.01 * \mathrm{epoch}$ and $\mathrm{runif}(1,25,100))$ should be appropriate, which means the epoch should not affect the stepsize too much or too little. If it is too little, the existence of epoch in the formula is meaningless. If it is too much, the training speed will slow down too fast.



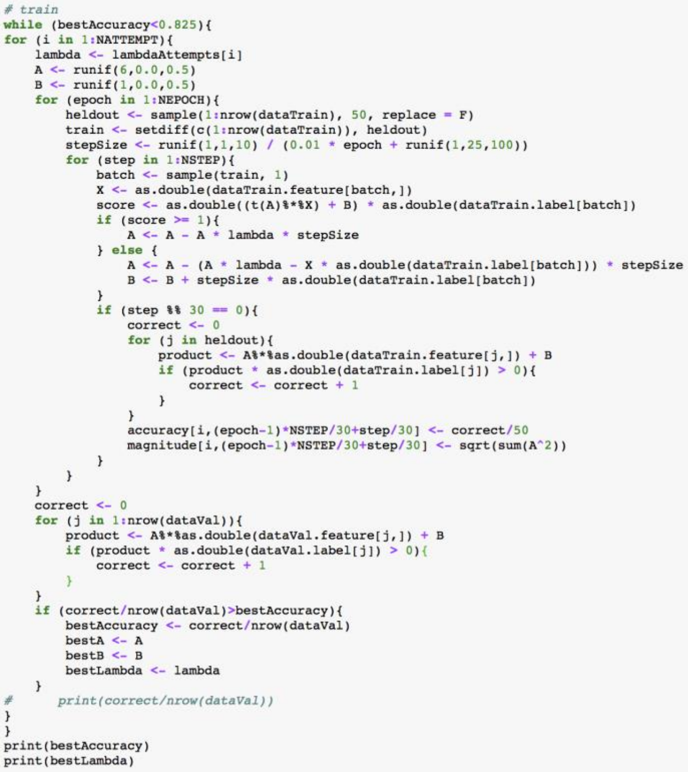
```
# import necessary libraries
library(caret) # for data partition
library(doParallel)
```

```
registerDoParallel(makeCluster(detectCores()))
```

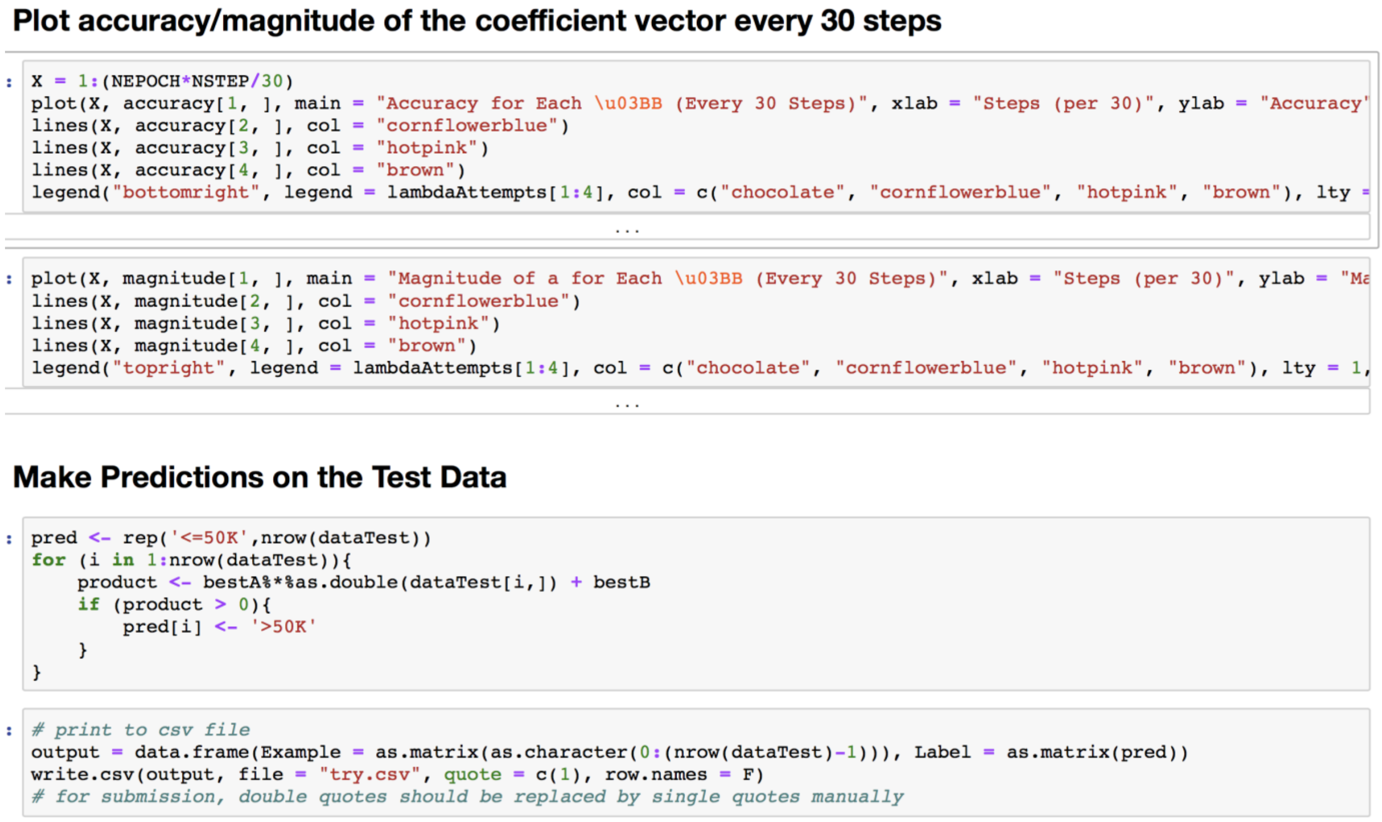
```
# INPUT: 43958 labeled , 4884 unlabeled
dataIN <- as.matrix(read.csv('train.data', header = F)[ ,c(1,3,5,11,12,13,15)])
dataTest <- as.matrix(read.csv('test.data', header = F)[ ,c(1,3,5,11,12,13)])
```

```
# use label c(1,-1) instead of c('>50K', '<=50K')
dataIN[dataIN[,7] == dataIN[1,7],7]  <- -1
dataIN[dataIN[,7] != dataIN[1,7],7]  <- 1
# data partition, split it randomly into 10% validation and 90% training data
trainRange <- createDataPartition(y = dataIN[,7], p = .9, list = F)
dataTrain <- dataIN[trainRange, ]
dataVal <- dataIN[-trainRange, ]
# divide features and labels
dataTrain.feature <- dataTrain[,-c(7)]
dataTrain.label <- dataTrain[,c(7)]
dataVal.feature <- dataVal[,-c(7)]
dataVal.label <- dataVal[,c(7)]
# scale the data with zero mean and unit variance
for (j in 1:6){
    dataTrain.feature[,j] <- scale(as.numeric(dataTrain.feature[,j]))
    dataVal.feature[,j] <- scale(as.numeric(dataVal.feature[,j]))
    dataTest[,j] <- scale(as.numeric(dataTest[,j]))
}
```

```
# Initialization of Parameters for training
lambdaAttempts <- c(1e-3, 1e-2, 1e-1, 1, 5e-3, 2.5e-3, 1.25e-3)
NATTEMPT <- length(lambdaAttempts)
NEPOCH <- 50
NSTEP <- 300
accuracy <- matrix(0, NATTEMPT, NEPOCH*NSTEP/30)
magnitude <- matrix(0, NATTEMPT, NEPOCH*NSTEP/30)
# to store best A and B for each lambda
bestAccuracy <- 0.5
bestLambda <- 0
bestA <- matrix(0, NATTEMPT, 6)
bestB <- matrix(0, NATTEMPT, )
```



```
# train
while (bestAccuracy<0.825){
for (i in 1:NATTEMPT){
    lambda <- lambdaAttempts[i]
    A <- runif(6,0.0,0.5)
    B <- runif(1,0.0,0.5)
    for (epoch in 1:NEPOCH){
        heldout <- sample(1:nrow(dataTrain), 50, replace = F)
        train <- setdiff(c(1:nrow(dataTrain)), heldout)
        stepSize <- runif(1,1,10) / (0.01 * epoch + runif(1,25,100))
        for (step in 1:NSTEP){
            batch <- sample(train, 1)
            X <- as.double(dataTrain.feature[batch,])
            score <- as.double((t(A)%*%X) + B) * as.double(dataTrain.label[batch])
            if (score >= 1){
                A <- A - A * lambda * stepSize
            } else {
                A <- A - (A * lambda - X * as.double(dataTrain.label[batch])) * stepSize
                B <- B + stepSize * as.double(dataTrain.label[batch])
            }
            if (step %% 30 == 0){
                correct <- 0
                for (j in heldout){
                    product <- A%*%as.double(dataTrain.feature[j,]) + B
                    if (product * as.double(dataTrain.label[j]) > 0){
                        correct <- correct + 1
                    }
                }
                accuracy[i,(epoch-1)*NSTEP/30+step/30] <- correct/50
                magnitude[i,(epoch-1)*NSTEP/30+step/30] <- sqrt(sum(A^2))
            }
        }
    }
    correct <- 0
    for (j in 1:nrow(dataVal)){
        product <- A%*%as.double(dataVal.feature[j,]) + B
        if (product * as.double(dataVal.label[j]) > 0){
            correct <- correct + 1
        }
    }
    if (correct/nrow(dataVal)>bestAccuracy){
        bestAccuracy <- correct/nrow(dataVal)
        bestA <- A
        bestB <- B
        bestLambda <- lambda
    }
#      print(correct/nrow(dataVal))
}
}
print(bestAccuracy)
print(bestLambda)
```



Plot accuracy/magnitude of the coefficient vector every 30 steps

```
: X = 1:(NEPOCH*NSTEP/30)
  plot(X, accuracy[1, ], main = "Accuracy for Each \u03BB (Every 30 Steps)", xlab = "Steps (per 30)", ylab = "Accuracy'
  lines(X, accuracy[2, ], col = "cornflowerblue")
  lines(X, accuracy[3, ], col = "hotpink")
  lines(X, accuracy[4, ], col = "brown")
  legend("bottomright", legend = lambdaAttempts[1:4], col = c("chocolate", "cornflowerblue", "hotpink", "brown"), lty =
                                                         ...
```

```
: plot(X, magnitude[1, ], main = "Magnitude of a for Each \u03BB (Every 30 Steps)", xlab = "Steps (per 30)", ylab = "Ma
  lines(X, magnitude[2, ], col = "cornflowerblue")
  lines(X, magnitude[3, ], col = "hotpink")
  lines(X, magnitude[4, ], col = "brown")
  legend("topright", legend = lambdaAttempts[1:4], col = c("chocolate", "cornflowerblue", "hotpink", "brown"), lty = 1,
                                                         ...
```

Make Predictions on the Test Data

```
: pred <- rep('<=50K',nrow(dataTest))
  for (i in 1:nrow(dataTest)){
      product <- bestA%*%as.double(dataTest[i,]) + bestB
      if (product > 0){
          pred[i] <- '>50K'
      }
  }
```

```
: # print to csv file
  output = data.frame(Example = as.matrix(as.character(0:(nrow(dataTest)-1))), Label = as.matrix(pred))
  write.csv(output, file = "try.csv", quote = c(1), row.names = F)
  # for submission, double quotes should be replaced by single quotes manually
```