```
#use data set Cracker from Ecdat package
install.packages(Ecdat)
library(Ecdat)
data("Cracker")

#remove the Nabisco prices that equal zero
cracker <- Cracker
for (t in 1:3289) {
  if(cracker$price.nabisco[t] == 0){
    cracker <- cracker[-t,]
  }
}

#split the data in a train and test data set
set.seed(218)
sample <- sample.split(cracker, SplitRatio = 0.75)
train <- subset(cracker, sample == TRUE)
test <- subset(cracker, sample == FALSE)

#create matrices for train and test data with the marketing mix
variables (display, feature and log of price)
train_matrix <- sapply(train[,2:13], as.numeric)
test_matrix <- sapply(test[,2:13], as.numeric)
x_train <- as.matrix(train_matrix)
x_test <- as.matrix(test_matrix)
x_train_good <- cbind(x_train[,1:8],log(x_train[,9:12]))
x_test_good <- cbind(x_test[,1:8],log(x_test[,9:12]))


#create binary vectors containing the choice of the individuals for
training and test data
choice_train_sunshine <- ifelse(train$choice=="sunshine",1,0)
choice_train_kleebler <- ifelse(train$choice=="kleebler",1,0)
choice_train_nabisco <- ifelse(train$choice=="nabisco",1,0)
choice_train_private <- ifelse(train$choice=="private",1,0)
choice_sunshine_test <- ifelse(test$choice=="sunshine",1,0)
choice_kleebler_test <- ifelse(test$choice=="kleebler",1,0)
choice_nabisco_test <- ifelse(test$choice=="nabisco",1,0)
choice_private_test <- ifelse(test$choice=="private",1,0)

choice_all_train <- cbind(choice_train_sunshine,
choice_train_kleebler,choice_train_nabisco,choice_train_private)
choice_all_test <- cbind(choice_sunshine_test, choice_kleebler_test,
choice_nabisco_test, choice_private_test)

#make one matrix with all the variables
matrix_all <- cbind(x_train_good,choice_all_train)
matrix_all_test <- cbind(x_test_good,choice_all_test)

#create the parameters
parm <- rep(1,6)

#create log likelihood function for Multinomial Logit model
LL <- function(parm,matrix_all){
```

```
  # Computes the log likelihood for the Multinomial Logit model.
  #
  # Args:
  #   parm: A vector containing the parameters of the log likelihood
function (beta and gamma)
  #   matrix_all: A matrix containing all variables in the training
data set used for the log likelihood function (display,
  #   feature and log of price for the brands Sunshine, Kleebler,
Nabisco and Private for every observation)
  #
  # Returns:
  #   The log likelihood value for the Multinomial Logit model

  beta <- parm[1:3]
  gamma <- parm[4:6]
  x_train_good <- matrix_all[,1:12]
  choice_all_train <- matrix_all[,13:16]

  x_sunshine <- cbind(x_train_good[,1],x_train_good[,
5],x_train_good[,9])
  x_kleebler <- cbind(x_train_good[,2],x_train_good[,
6],x_train_good[,10])
  x_nabisco <- cbind(x_train_good[,3],x_train_good[,
7],x_train_good[,11])
  x_private <- cbind(x_train_good[,4],x_train_good[,
8],x_train_good[,12])
  n <- nrow(x_sunshine)
  output <- rep(1,n)

  #Log likelihood function
  for (i in 1:n) {
    q <- choice_all_train[i,1]%*%(beta[1]+gamma%*%x_sunshine[i,1:3]-
log(exp(beta[1]+gamma%*%x_sunshine[i,1:3])
+exp(beta[2]+gamma%*%x_kleebler[i,1:3])
+exp(beta[3]+gamma%*%x_nabisco[i,1:3])+exp(gamma%*%x_private[i,
1:3])))+choice_all_train[i,2]%*%(beta[2]+gamma%*%x_kleebler[i,1:3]-
log(exp(beta[1]+gamma%*%x_sunshine[i,1:3])
+exp(beta[2]+gamma%*%x_kleebler[i,1:3])
+exp(beta[3]+gamma%*%x_nabisco[i,1:3])+exp(gamma%*%x_private[i,
1:3])))+choice_all_train[i,3]%*%(beta[3]+gamma%*%x_nabisco[i,1:3]-
log(exp(beta[1]+gamma%*%x_sunshine[i,1:3])
+exp(beta[2]+gamma%*%x_kleebler[i,1:3])
+exp(beta[3]+gamma%*%x_nabisco[i,1:3])+exp(gamma%*%x_private[i,
1:3])))+choice_all_train[i,4]%*%(gamma%*%x_private[i,1:3]-
log(exp(beta[1]+gamma%*%x_sunshine[i,1:3])
+exp(beta[2]+gamma%*%x_kleebler[i,1:3])
+exp(beta[3]+gamma%*%x_nabisco[i,1:3])+exp(gamma%*%x_private[i,
1:3])))
    output[i] <- q
  }
  loglikelihood <- -sum(output)

}
```

```
#optimise the log likelihood of MNL using "BFGS"
MNL <- optim(par = parm, fn = LL, matrix_all = matrix_all, method =
"BFGS")
```