Practical Machine Learning - Final Project

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Introduction

Background

Using devices such as Jawbone Up, Nike FuelBand, and Fitbit it is now possible to collect a large amount of data about personal activity relatively inexpensively. These type of devices are part of the quantified self movement – a group of enthusiasts who take measurements about themselves regularly to improve their health, to find patterns in their behavior, or because they are tech geeks. One thing that people regularly do is quantify how much of a particular activity they do, but they rarely quantify how well they do it. In this project, your goal will be to use data from accelerometers on the belt, forearm, arm, and dumbell of 6 participants. They were asked to perform barbell lifts correctly and incorrectly in 5 different ways. More information is available from the website here: http://groupware.les.inf.puc-rio.br/har (see the section on the Weight Lifting Exercise Dataset).

Data

The training data for this project are available here:

https://d396qusza40orc.cloudfront.net/predmachlearn/pml-training.csv

The test data are available here:

https://d396qusza40orc.cloudfront.net/predmachlearn/pml-testing.csv

The data for this project come from this source: http://groupware.les.inf.puc-rio.br/har. If you use the document you create for this class for any purpose please cite them as they have been very generous in allowing their data to be used for this kind of assignment.

Goal of the Project

The goal of your project is to predict the manner in which they did the exercise. This is the "classe" variable in the training set. You may use any of the other variables to predict with. You should create a report describing how you built your model, how you used cross validation, what you think the expected out of sample error is, and why you made the choices you did. You will also use your prediction model to predict 20 different test cases.

Loading All Needed Libraries

```
library(caret)
library(rpart)
library(rattle)
```

Getting The Data

```
trainingURL <- "https://d396qusza40orc.cloudfront.net/predmachlearn/pml-training.csv"
testingURL <- "https://d396qusza40orc.cloudfront.net/predmachlearn/pml-testing.csv"

originalTraining <- read.csv(url(trainingURL), na.strings=c("NA", "#DIV/0!", ""))
originalTesting <- read.csv(url(testingURL), na.strings=c("NA", "#DIV/0!", ""))
```

Cleaning The Data

The testing csv file contains more columns than the training one, so I need to remove some of them.

```
trainingColNames <- colnames(originalTraining)
testingColNames <- colnames(originalTesting)

commonColumns <- intersect(trainingColNames, testingColNames)

useFinalTesting <- originalTesting[commonColumns]
useTraining <- originalTraining[append(commonColumns, c("classe"))]

for (i in 1:length(useFinalTesting)) {
  class(useFinalTesting[i]) <- class(useTraining[i])
}
```

Preparing The Training Sets

```
set.seed(1)
inTrain <- createDataPartition(useTraining$classe, p=0.7, list=FALSE)
training <- useTraining[inTrain, ]
testing <- useTraining[-inTrain, ]
```

```
dim(training)
```

```
## [1] 13737   160
```

```
dim(testing)
```

```
## [1] 5885  160
```

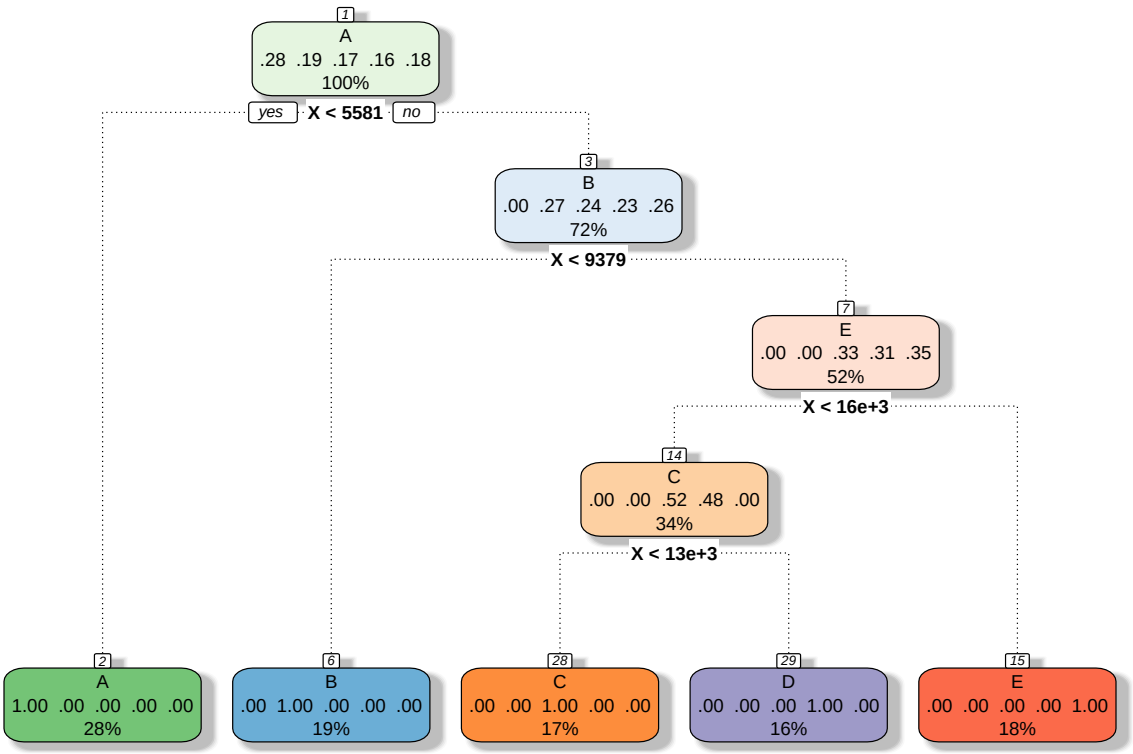
Training

For training I'm using decision tree method.

```
set.seed(1)
modelFit <- rpart(classe ~ ., data=training, method="class")
predictions <- predict(modelFit, testing, type="class")
```

The decision tree is:

```
fancyRpartPlot(modelFit)
```




```
(cm <- confusionMatrix(predictions, testing$classe))
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction    A    B    C    D    E
##          A 1674    0    0    0    0
##          B    0 1139    1    0    0
##          C    0    0 1025    0    0
##          D    0    0    0  963    0
##          E    0    0    0    1 1082
##
## Overall Statistics
##
##                Accuracy : 0.9997
##                  95% CI : (0.9988, 1)
```

```
##     No Information Rate : 0.2845
##     P-Value [Acc > NIR] : < 2.2e-16
##
##                   Kappa : 0.9996
##
##  Mcnemar's Test P-Value : NA
##
## Statistics by Class:
##
##                      Class: A Class: B Class: C Class: D Class: E
## Sensitivity            1.0000   1.0000   0.9990   0.9990   1.0000
## Specificity            1.0000   0.9998   1.0000   1.0000   0.9998
## Pos Pred Value         1.0000   0.9991   1.0000   1.0000   0.9991
## Neg Pred Value         1.0000   1.0000   0.9998   0.9998   1.0000
## Prevalence             0.2845   0.1935   0.1743   0.1638   0.1839
## Detection Rate         0.2845   0.1935   0.1742   0.1636   0.1839
## Detection Prevalence   0.2845   0.1937   0.1742   0.1636   0.1840
## Balanced Accuracy      1.0000   0.9999   0.9995   0.9995   0.9999
```

The decision tree algorithm gave 100% accuracy on the training set.

Predicting Final Results

```
summary(modelFit)
```

```
## Call:
## rpart(formula = classe ~ ., data = training, method = "class")
##   n= 13737
##
##          CP nsplit rel error       xerror         xstd
## 1 0.2703692      0 1.0000000 1.0000000000 0.0053780065
## 2 0.2568406      1 0.7296308 0.7297324789 0.0059550888
## 3 0.2437188      2 0.4727902 0.4728918726 0.0056411843
## 4 0.2290713      3 0.2290713 0.2291730241 0.0044145205
## 5 0.0100000      4 0.0000000 0.0003051572 0.0001761633
##
## Variable importance
##                     X       cvtd_timestamp            roll_belt
##                    41                   20                    4
##        pitch_forearm       pitch_dumbbell     accel_dumbbell_x
##                     4                    4                    4
## raw_timestamp_part_1        roll_dumbbell    magnet_dumbbell_y
##                     4                    3                    3
##         accel_belt_z        magnet_belt_y        magnet_belt_z
##                     3                    3                    3
##          accel_arm_x             yaw_arm           pitch_belt
##                     2                    2                    1
##
## Node number 1: 13737 observations,    complexity param=0.2703692
##   predicted class=A  expected loss=0.7156584  P(node) =1
##     class counts:  3906  2658  2396  2252  2525
```

```
##    probabilities: 0.284 0.193 0.174 0.164 0.184
##   left son=2 (3906 obs) right son=3 (9831 obs)
##   Primary splits:
##       X              < 5581       to the left,  improve=3496.8280, (0 missing)
##       cvtd_timestamp splits as  LLLRLLRRLLRLLRLLRLLR, improve=2083.4520, (0 missing)
##       roll_belt      < 130.5      to the left,  improve=1034.6270, (0 missing)
##       pitch_forearm  < -33.95     to the left,  improve= 782.3742, (0 missing)
##       accel_belt_z   < -186.5     to the right, improve= 616.9683, (0 missing)
##   Surrogate splits:
##       cvtd_timestamp       splits as  LLRRLRRRLRRLRRLRRLRR, agree=0.881, adj=0.583, (0 split)
##       pitch_forearm        < -26.45     to the left,  agree=0.799, adj=0.294, (0 split)
##       raw_timestamp_part_1 < 1322490000 to the left,  agree=0.759, adj=0.154, (0 split)
##       yaw_arm              < -115.5     to the left,  agree=0.755, adj=0.139, (0 split)
##       accel_arm_x          < -273.5     to the left,  agree=0.755, adj=0.139, (0 split)
##
## Node number 2: 3906 observations
##   predicted class=A  expected loss=0  P(node) =0.2843416
##     class counts:  3906     0     0     0     0
##    probabilities: 1.000 0.000 0.000 0.000 0.000
##
## Node number 3: 9831 observations,    complexity param=0.2568406
##   predicted class=B  expected loss=0.7296308  P(node) =0.7156584
##     class counts:     0  2658  2396  2252  2525
##    probabilities: 0.000 0.270 0.244 0.229 0.257
##   left son=6 (2658 obs) right son=7 (7173 obs)
##   Primary splits:
##       X                < 9379       to the left,  improve=2587.2170, (0 missing)
##       cvtd_timestamp   splits as  -LLR-LRR-LR-LR-LR-LR, improve=1696.3580, (0 missing)
##       roll_belt        < 128.5      to the left,  improve=1020.2460, (0 missing)
##       accel_belt_z     < -182.5     to the right, improve= 592.1390, (0 missing)
##       total_accel_belt < 20.5       to the left,  improve= 522.3411, (0 missing)
##   Surrogate splits:
##       cvtd_timestamp       splits as  -LRR-LRR-LR-LR-RR-RR, agree=0.845, adj=0.426, (0 split)
##       raw_timestamp_part_1 < 1322490000 to the left,  agree=0.772, adj=0.157, (0 split)
##       pitch_belt           < -42.85     to the left,  agree=0.768, adj=0.142, (0 split)
##       pitch_dumbbell       < 58.99232   to the right, agree=0.749, adj=0.073, (0 split)
##       accel_dumbbell_x     < 92.5       to the right, agree=0.747, adj=0.065, (0 split)
##
## Node number 6: 2658 observations
##   predicted class=B  expected loss=0  P(node) =0.193492
##     class counts:     0  2658     0     0     0
##    probabilities: 0.000 1.000 0.000 0.000 0.000
##
## Node number 7: 7173 observations,    complexity param=0.2437188
##   predicted class=E  expected loss=0.6479855  P(node) =0.5221664
##     class counts:     0     0  2396  2252  2525
##    probabilities: 0.000 0.000 0.334 0.314 0.352
##   left son=14 (4648 obs) right son=15 (2525 obs)
##   Primary splits:
##       X                < 16014.5    to the left,  improve=2455.0300, (0 missing)
##       cvtd_timestamp   splits as  --LR--LR-LR-LR-LR-LR, improve=1253.3590, (0 missing)
##       roll_belt        < 128.5      to the left,  improve= 919.2223, (0 missing)
##       accel_belt_z     < -178.5     to the right, improve= 573.6320, (0 missing)
##       total_accel_belt < 20.5       to the left,  improve= 473.4722, (0 missing)
```

```
##   Surrogate splits:
##       roll_belt      < 128.5      to the left,  agree=0.817, adj=0.481, (0 split)
##       cvtd_timestamp splits as  --LR--LR-LL-LL-LR-LR, agree=0.775, adj=0.360, (0 split)
##       accel_belt_z   < -178.5     to the right, agree=0.761, adj=0.322, (0 split)
##       magnet_belt_y  < 578.5      to the right, agree=0.753, adj=0.297, (0 split)
##       magnet_belt_z  < -379.5     to the right, agree=0.751, adj=0.292, (0 split)
##
## Node number 14: 4648 observations,    complexity param=0.2290713
##   predicted class=C  expected loss=0.4845095  P(node) =0.3383563
##     class counts:     0     0  2396  2252     0
##    probabilities: 0.000 0.000 0.515 0.485 0.000
##   left son=28 (2396 obs) right son=29 (2252 obs)
##   Primary splits:
##       X                 < 12799.5    to the left,  improve=2321.7690, (0 missing)
##       cvtd_timestamp    splits as  --LR--R--LR-LR-RR-LR, improve= 749.5025, (0 missing)
##       roll_dumbbell     < -65.07391  to the left,  improve= 396.2524, (0 missing)
##       magnet_dumbbell_y < 289.5      to the left,  improve= 336.8846, (0 missing)
##       pitch_dumbbell    < -1.223359  to the left,  improve= 311.7819, (0 missing)
##   Surrogate splits:
##       cvtd_timestamp    splits as  --LR--R--LR-LR-LR-LR, agree=0.780, adj=0.546, (0 split)
##       roll_dumbbell     < 57.58855   to the left,  agree=0.697, adj=0.374, (0 split)
##       magnet_dumbbell_y < 289.5      to the left,  agree=0.691, adj=0.362, (0 split)
##       pitch_dumbbell    < -1.223359  to the left,  agree=0.681, adj=0.341, (0 split)
##       accel_dumbbell_x  < -0.5       to the left,  agree=0.680, adj=0.340, (0 split)
##
## Node number 15: 2525 observations
##   predicted class=E  expected loss=0  P(node) =0.1838101
##     class counts:     0     0     0     0  2525
##    probabilities: 0.000 0.000 0.000 0.000 1.000
##
## Node number 28: 2396 observations
##   predicted class=C  expected loss=0  P(node) =0.1744195
##     class counts:     0     0  2396     0     0
##    probabilities: 0.000 0.000 1.000 0.000 0.000
##
## Node number 29: 2252 observations
##   predicted class=D  expected loss=0  P(node) =0.1639368
##     class counts:     0     0     0  2252     0
##    probabilities: 0.000 0.000 0.000 1.000 0.000
```

```
summary(testing)
```

```
##        X            user_name    raw_timestamp_part_1 raw_timestamp_part_2
##  Min.   :    2   adelmo  :1182   Min.   :1.322e+09    Min.   :   301
##  1st Qu.: 4926   carlitos: 931   1st Qu.:1.323e+09    1st Qu.:246658
##  Median : 9752   charles :1035   Median :1.323e+09    Median :496283
##  Mean   : 9799   eurico  : 919   Mean   :1.323e+09    Mean   :498029
##  3rd Qu.:14673   jeremy  :1006   3rd Qu.:1.323e+09    3rd Qu.:752290
##  Max.   :19622   pedro   : 812   Max.   :1.323e+09    Max.   :998750
##
##           cvtd_timestamp new_window   num_window      roll_belt
##  05/12/2011 11:24: 458   no :5763   Min.   :  1.0   Min.   :-28.80
##  28/11/2011 14:14: 452   yes: 122   1st Qu.:217.0   1st Qu.:  1.11
##  30/11/2011 17:11: 441              Median :422.0   Median :114.00
```

```
##  05/12/2011 14:23: 424              Mean   :427.8   Mean   : 64.84
##  02/12/2011 13:33: 423              3rd Qu.:640.0   3rd Qu.:123.00
##  05/12/2011 11:25: 411              Max.   :864.0   Max.   :162.00
##  (Other)         :3276
##    pitch_belt          yaw_belt       total_accel_belt kurtosis_roll_belt
##  Min.   :-55.8000   Min.   :-179.00   Min.   : 0.00    Min.   :-2.121
##  1st Qu.:  1.6600   1st Qu.: -88.30   1st Qu.: 3.00    1st Qu.:-1.400
##  Median :  5.2400   Median : -11.80   Median :17.00    Median :-0.997
##  Mean   :  0.2326   Mean   : -10.16   Mean   :11.38    Mean   :-0.479
##  3rd Qu.: 15.2000   3rd Qu.:  15.00   3rd Qu.:18.00    3rd Qu.:-0.355
##  Max.   : 60.0000   Max.   : 179.00   Max.   :28.00    Max.   :11.433
##                                                        NA's   :5768
##  kurtosis_picth_belt kurtosis_yaw_belt skewness_roll_belt
##  Min.   :-2.092      Mode:logical      Min.   :-3.032
##  1st Qu.:-1.031      NA's:5885         1st Qu.:-0.270
##  Median :-0.144                        Median : 0.008
##  Mean   : 3.706                        Mean   : 0.160
##  3rd Qu.: 2.422                        3rd Qu.: 0.594
##  Max.   :53.000                        Max.   : 3.595
##  NA's   :5777                          NA's   :5768
##  skewness_roll_belt.1 skewness_yaw_belt max_roll_belt     max_picth_belt
##  Min.   :-7.280       Mode:logical      Min.   :-94.300   Min.   : 3.0
##  1st Qu.:-1.177       NA's:5885         1st Qu.:-88.000   1st Qu.: 5.0
##  Median :-0.227                         Median : -5.100   Median :17.0
##  Mean   :-0.446                         Mean   : -5.281   Mean   :12.7
##  3rd Qu.: 0.624                         3rd Qu.: 18.125   3rd Qu.:18.0
##  Max.   : 6.782                         Max.   :180.000   Max.   :28.0
##  NA's   :5777                           NA's   :5763      NA's   :5763
##   max_yaw_belt    min_roll_belt      min_pitch_belt   min_yaw_belt
##  Min.   :-2.100   Min.   :-180.000   Min.   : 0.00   Min.   :-2.100
##  1st Qu.:-1.400   1st Qu.: -88.475   1st Qu.: 3.00   1st Qu.:-1.400
##  Median :-1.000   Median : -12.650   Median :16.00   Median :-1.000
##  Mean   :-0.482   Mean   : -10.181   Mean   :10.36   Mean   :-0.482
##  3rd Qu.:-0.400   3rd Qu.:   5.925   3rd Qu.:17.00   3rd Qu.:-0.400
##  Max.   :11.400   Max.   : 173.000   Max.   :20.00   Max.   :11.400
##  NA's   :5768     NA's   :5763       NA's   :5763    NA's   :5768
##  amplitude_roll_belt amplitude_pitch_belt amplitude_yaw_belt
##  Min.   :  0.000     Min.   : 0.000       Min.   :0
##  1st Qu.:  0.300     1st Qu.: 1.000       1st Qu.:0
##  Median :  1.000     Median : 1.000       Median :0
##  Mean   :  4.900     Mean   : 2.336       Mean   :0
##  3rd Qu.:  2.022     3rd Qu.: 2.000       3rd Qu.:0
##  Max.   :360.000     Max.   :12.000       Max.   :0
##  NA's   :5763        NA's   :5763         NA's   :5768
##  var_total_accel_belt avg_roll_belt    stddev_roll_belt var_roll_belt
##  Min.   : 0.000       Min.   :-20.90   Min.   : 0.000   Min.   :  0.00
##  1st Qu.: 0.100       1st Qu.:  1.10   1st Qu.: 0.131   1st Qu.:  0.00
##  Median : 0.200       Median :115.35   Median : 0.400   Median :  0.10
##  Mean   : 1.239       Mean   : 65.31   Mean   : 1.520   Mean   : 10.38
##  3rd Qu.: 0.300       3rd Qu.:122.42   3rd Qu.: 0.700   3rd Qu.:  0.50
##  Max.   :16.500       Max.   :151.15   Max.   :14.200   Max.   :200.70
##  NA's   :5763         NA's   :5763     NA's   :5763     NA's   :5763
##  avg_pitch_belt    stddev_pitch_belt var_pitch_belt   avg_yaw_belt
##  Min.   :-46.900   Min.   :0.000     Min.   :0.000   Min.   :-94.400
```

```
##  1st Qu.: -1.550   1st Qu.:0.200     1st Qu.:0.000   1st Qu.:-88.200
##  Median :  4.850   Median :0.300     Median :0.100   Median : -7.400
##  Mean   : -1.119   Mean   :0.538     Mean   :0.574   Mean   : -7.561
##  3rd Qu.: 14.300   3rd Qu.:0.600     3rd Qu.:0.400   3rd Qu.: 15.775
##  Max.   : 26.500   Max.   :2.600     Max.   :7.000   Max.   :173.500
##  NA's   :5763      NA's   :5763      NA's   :5763    NA's   :5763
##  stddev_yaw_belt    var_yaw_belt        gyros_belt_x
##  Min.   :  0.000   Min.   :    0.000   Min.   :-0.960000
##  1st Qu.:  0.100   1st Qu.:    0.010   1st Qu.:-0.050000
##  Median :  0.300   Median :    0.100   Median : 0.030000
##  Mean   :  2.066   Mean   :  256.671   Mean   :-0.008022
##  3rd Qu.:  0.700   3rd Qu.:    0.505   3rd Qu.: 0.110000
##  Max.   :176.600   Max.   :31183.240   Max.   : 2.220000
##  NA's   :5763      NA's   :5763
##   gyros_belt_y       gyros_belt_z      accel_belt_x      accel_belt_y
##  Min.   :-0.53000   Min.   :-1.4600   Min.   :-83.000   Min.   :-69.00
##  1st Qu.: 0.00000   1st Qu.:-0.2000   1st Qu.:-21.000   1st Qu.:  3.00
##  Median : 0.02000   Median :-0.1000   Median :-15.000   Median : 36.00
##  Mean   : 0.03927   Mean   :-0.1292   Mean   : -5.494   Mean   : 30.34
##  3rd Qu.: 0.11000   3rd Qu.:-0.0200   3rd Qu.: -5.000   3rd Qu.: 61.00
##  Max.   : 0.56000   Max.   : 1.6100   Max.   : 85.000   Max.   :149.00
##
##   accel_belt_z     magnet_belt_x   magnet_belt_y   magnet_belt_z
##  Min.   :-266.00   Min.   :-52.0   Min.   :354.0   Min.   :-615.0
##  1st Qu.:-162.00   1st Qu.:  9.0   1st Qu.:581.0   1st Qu.:-375.0
##  Median :-153.00   Median : 34.0   Median :601.0   Median :-319.0
##  Mean   : -73.23   Mean   : 56.1   Mean   :593.2   Mean   :-345.7
##  3rd Qu.:  27.00   3rd Qu.: 60.0   3rd Qu.:610.0   3rd Qu.:-306.0
##  Max.   : 105.00   Max.   :485.0   Max.   :669.0   Max.   : 284.0
##
##     roll_arm         pitch_arm          yaw_arm          total_accel_arm
##  Min.   :-180.00   Min.   :-87.800   Min.   :-180.0000   Min.   : 1.00
##  1st Qu.: -32.40   1st Qu.:-26.100   1st Qu.: -43.5000   1st Qu.:17.00
##  Median :   0.00   Median :  0.000   Median :   0.0000   Median :27.00
##  Mean   :  17.72   Mean   : -4.766   Mean   :  -0.9202   Mean   :25.42
##  3rd Qu.:  78.00   3rd Qu.: 11.200   3rd Qu.:  45.6000   3rd Qu.:33.00
##  Max.   : 179.00   Max.   : 88.500   Max.   : 180.0000   Max.   :65.00
##
##  var_accel_arm     avg_roll_arm      stddev_roll_arm   var_roll_arm
##  Min.   :  0.00   Min.   :-151.620   Min.   : 0.000   Min.   :   0.000
##  1st Qu.: 11.56   1st Qu.: -43.115   1st Qu.: 1.574   1st Qu.:   2.478
##  Median : 45.62   Median :   0.000   Median : 5.732   Median :  32.855
##  Mean   : 55.07   Mean   :   9.127   Mean   :10.918   Mean   : 292.028
##  3rd Qu.: 79.74   3rd Qu.:  75.564   3rd Qu.:17.049   3rd Qu.: 291.281
##  Max.   :253.01   Max.   : 163.333   Max.   :73.039   Max.   :5334.691
##  NA's   :5763     NA's   :5763       NA's   :5763     NA's   :5763
##  avg_pitch_arm     stddev_pitch_arm var_pitch_arm       avg_yaw_arm
##  Min.   :-77.019   Min.   : 0.000   Min.   :   0.000   Min.   :-173.44
##  1st Qu.:-24.667   1st Qu.: 1.872   1st Qu.:   3.541   1st Qu.: -37.12
##  Median : -0.393   Median : 7.979   Median :  63.668   Median :   0.00
##  Mean   : -4.761   Mean   :10.256   Mean   : 191.227   Mean   : -10.20
##  3rd Qu.:  8.783   3rd Qu.:15.768   3rd Qu.: 248.677   3rd Qu.:  22.77
##  Max.   : 75.659   Max.   :37.367   Max.   :1396.255   Max.   : 118.85
##  NA's   :5763      NA's   :5763     NA's   :5763       NA's   :5763
```

```
##  stddev_yaw_arm     var_yaw_arm         gyros_arm_x
##  Min.   :  0.000   Min.   :    0.000   Min.   :-6.37000
##  1st Qu.:  2.851   1st Qu.:    8.258   1st Qu.:-1.35000
##  Median : 16.267   Median :  264.646   Median : 0.06000
##  Mean   : 21.979   Mean   : 1024.494   Mean   : 0.03441
##  3rd Qu.: 36.040   3rd Qu.: 1298.895   3rd Qu.: 1.54000
##  Max.   :163.258   Max.   :26653.192   Max.   : 4.87000
##  NA's   :5763      NA's   :5763
##   gyros_arm_y       gyros_arm_z       accel_arm_x       accel_arm_y
##  Min.   :-3.2600   Min.   :-1.7700   Min.   :-342.00   Min.   :-286.0
##  1st Qu.:-0.8000   1st Qu.:-0.0700   1st Qu.:-238.00   1st Qu.: -55.0
##  Median :-0.2400   Median : 0.2500   Median : -39.00   Median :  13.0
##  Mean   :-0.2529   Mean   : 0.2753   Mean   : -57.18   Mean   :  31.2
##  3rd Qu.: 0.1600   3rd Qu.: 0.7200   3rd Qu.:  84.00   3rd Qu.: 137.0
##  Max.   : 2.7900   Max.   : 2.9500   Max.   : 435.00   Max.   : 296.0
##
##   accel_arm_z       magnet_arm_x     magnet_arm_y     magnet_arm_z
##  Min.   :-630.00   Min.   :-579.0   Min.   :-384.0   Min.   :-595
##  1st Qu.:-143.00   1st Qu.:-294.0   1st Qu.: -11.0   1st Qu.: 122
##  Median : -47.00   Median : 299.0   Median : 195.0   Median : 441
##  Mean   : -71.71   Mean   : 196.7   Mean   : 153.1   Mean   : 303
##  3rd Qu.:  23.00   3rd Qu.: 637.0   3rd Qu.: 319.0   3rd Qu.: 543
##  Max.   : 271.00   Max.   : 779.0   Max.   : 582.0   Max.   : 690
##
##  kurtosis_roll_arm kurtosis_picth_arm kurtosis_yaw_arm skewness_roll_arm
##  Min.   :-1.744    Min.   :-2.032     Min.   :-1.954   Min.   :-2.400
##  1st Qu.:-1.281    1st Qu.:-1.334     1st Qu.:-1.244   1st Qu.:-0.517
##  Median :-0.708    Median :-1.051     Median :-0.919   Median : 0.092
##  Mean   :-0.219    Mean   :-0.692     Mean   : 0.691   Mean   : 0.148
##  3rd Qu.: 0.035    3rd Qu.:-0.523     3rd Qu.:-0.152   3rd Qu.: 0.884
##  Max.   :21.456    Max.   : 9.166     Max.   :56.000   Max.   : 4.157
##  NA's   :5784      NA's   :5786       NA's   :5768     NA's   :5784
##  skewness_pitch_arm skewness_yaw_arm  max_roll_arm    max_picth_arm
##  Min.   :-1.699     Min.   :-6.557   Min.   :-71.90   Min.   :-164.00
##  1st Qu.:-0.588     1st Qu.:-0.647   1st Qu.:  0.00   1st Qu.: -17.88
##  Median : 0.073     Median :-0.045   Median :  5.10   Median :  16.25
##  Mean   : 0.030     Mean   :-0.192   Mean   : 11.78   Mean   :  22.93
##  3rd Qu.: 0.451     3rd Qu.: 0.360   3rd Qu.: 26.57   3rd Qu.:  82.50
##  Max.   : 3.043     Max.   : 7.483   Max.   : 85.50   Max.   : 179.00
##  NA's   :5786       NA's   :5768     NA's   :5763     NA's   :5763
##   max_yaw_arm     min_roll_arm    min_pitch_arm      min_yaw_arm
##  Min.   : 5.00   Min.   :-89.10   Min.   :-180.00   Min.   : 1.00
##  1st Qu.:30.00   1st Qu.:-41.85   1st Qu.: -83.67   1st Qu.: 8.00
##  Median :34.50   Median :-24.35   Median : -39.25   Median :13.00
##  Mean   :36.03   Mean   :-20.51   Mean   : -44.07   Mean   :15.01
##  3rd Qu.:42.00   3rd Qu.:  0.00   3rd Qu.:   0.00   3rd Qu.:20.00
##  Max.   :62.00   Max.   : 66.40   Max.   : 113.00   Max.   :38.00
##  NA's   :5763    NA's   :5763     NA's   :5763      NA's   :5763
##  amplitude_roll_arm amplitude_pitch_arm amplitude_yaw_arm
##  Min.   :  0.000    Min.   :  0.000     Min.   : 0.00
##  1st Qu.:  7.338    1st Qu.:  9.885     1st Qu.:13.00
##  Median : 27.810    Median : 53.050     Median :22.00
##  Mean   : 32.288    Mean   : 67.001     Mean   :21.02
##  3rd Qu.: 47.127    3rd Qu.:109.000     3rd Qu.:28.75
```

```
##  Max.   :110.300    Max.   :359.000     Max.   :50.00
##  NA's   :5763       NA's   :5763        NA's   :5763
##  roll_dumbbell     pitch_dumbbell     yaw_dumbbell
##  Min.   :-153.71   Min.   :-129.52   Min.   :-146.244
##  1st Qu.: -17.47   1st Qu.: -40.65   1st Qu.: -77.811
##  Median :  47.20   Median : -21.87   Median :  -3.375
##  Mean   :  23.21   Mean   : -11.11   Mean   :   1.616
##  3rd Qu.:  66.73   3rd Qu.:  17.57   3rd Qu.:  81.165
##  Max.   : 153.38   Max.   : 149.40   Max.   : 154.516
##
##  kurtosis_roll_dumbbell kurtosis_picth_dumbbell kurtosis_yaw_dumbbell
##  Min.   :-2.105         Min.   :-2.105          Mode:logical
##  1st Qu.:-0.612         1st Qu.:-0.462          NA's:5885
##  Median : 0.104         Median : 0.176
##  Mean   : 0.440         Mean   : 0.480
##  3rd Qu.: 1.098         3rd Qu.: 0.955
##  Max.   : 8.934         Max.   :11.950
##  NA's   :5763           NA's   :5763
##  skewness_roll_dumbbell skewness_pitch_dumbbell skewness_yaw_dumbbell
##  Min.   :-2.387         Min.   :-2.905          Mode:logical
##  1st Qu.:-0.646         1st Qu.:-0.727          NA's:5885
##  Median :-0.039         Median :-0.086
##  Mean   :-0.132         Mean   :-0.108
##  3rd Qu.: 0.421         3rd Qu.: 0.499
##  Max.   : 1.466         Max.   : 2.077
##  NA's   :5763           NA's   :5763
##  max_roll_dumbbell max_picth_dumbbell max_yaw_dumbbell min_roll_dumbbell
##  Min.   :-70.10    Min.   :-112.90    Min.   :-2.100   Min.   :-134.90
##  1st Qu.:-28.68    1st Qu.: -72.08    1st Qu.:-0.600   1st Qu.: -59.05
##  Median : 12.30    Median :  26.30    Median : 0.100   Median : -42.05
##  Mean   : 13.87    Mean   :  27.30    Mean   : 0.442   Mean   : -41.52
##  3rd Qu.: 58.00    3rd Qu.: 136.43    3rd Qu.: 1.100   3rd Qu.: -27.73
##  Max.   :137.00    Max.   : 152.80    Max.   : 8.900   Max.   :  73.20
##  NA's   :5763      NA's   :5763       NA's   :5763     NA's   :5763
##  min_pitch_dumbbell min_yaw_dumbbell amplitude_roll_dumbbell
##  Min.   :-146.20    Min.   :-2.100   Min.   :  0.00
##  1st Qu.: -96.58    1st Qu.:-0.600   1st Qu.: 11.57
##  Median : -76.10    Median : 0.100   Median : 32.09
##  Mean   : -38.71    Mean   : 0.442   Mean   : 55.39
##  3rd Qu.:  10.85    3rd Qu.: 1.100   3rd Qu.: 75.00
##  Max.   : 116.00    Max.   : 8.900   Max.   :256.48
##  NA's   :5763       NA's   :5763     NA's   :5763
##  amplitude_pitch_dumbbell amplitude_yaw_dumbbell total_accel_dumbbell
##  Min.   :  0.00           Min.   :0              Min.   : 0.00
##  1st Qu.: 16.01           1st Qu.:0              1st Qu.: 4.00
##  Median : 42.18           Median :0              Median :10.00
##  Mean   : 66.00           Mean   :0              Mean   :13.61
##  3rd Qu.: 95.81           3rd Qu.:0              3rd Qu.:19.00
##  Max.   :273.59           Max.   :0              Max.   :39.00
##  NA's   :5763             NA's   :5763
##  var_accel_dumbbell avg_roll_dumbbell stddev_roll_dumbbell
##  Min.   :  0.000    Min.   :-117.78   Min.   :  0.000
##  1st Qu.:  0.332    1st Qu.:  -1.61   1st Qu.:  4.385
##  Median :  0.752    Median :  46.62   Median : 11.911
```

```
##  Mean   :  5.461    Mean   :  26.01   Mean   : 20.315
##  3rd Qu.:  2.890    3rd Qu.:  59.74   3rd Qu.: 26.554
##  Max.   :230.428    Max.   : 117.80   Max.   :113.657
##  NA's   :5763       NA's   :5763      NA's   :5763
##  var_roll_dumbbell  avg_pitch_dumbbell stddev_pitch_dumbbell
##  Min.   :    0.00   Min.   :-70.73     Min.   : 0.000
##  1st Qu.:   19.24   1st Qu.:-38.22     1st Qu.: 2.562
##  Median :  141.92   Median :-18.80     Median : 7.887
##  Mean   : 1017.33   Mean   :-11.77     Mean   :13.259
##  3rd Qu.:  705.11   3rd Qu.: 16.07     3rd Qu.:16.589
##  Max.   :12917.90   Max.   : 93.93     Max.   :82.680
##  NA's   :5763       NA's   :5763       NA's   :5763
##  var_pitch_dumbbell avg_yaw_dumbbell   stddev_yaw_dumbbell
##  Min.   :   0.000   Min.   :-117.950   Min.   : 0.000
##  1st Qu.:   6.569   1st Qu.: -78.551   1st Qu.: 3.340
##  Median :  62.209   Median :  -9.488   Median : 9.355
##  Mean   : 416.162   Mean   :  -4.081   Mean   :16.140
##  3rd Qu.: 275.207   3rd Qu.:  71.076   3rd Qu.:23.187
##  Max.   :6836.023   Max.   : 134.905   Max.   :99.563
##  NA's   :5763       NA's   :5763       NA's   :5763
##  var_yaw_dumbbell  gyros_dumbbell_x  gyros_dumbbell_y   gyros_dumbbell_z
##  Min.   :   0.00   Min.   :-1.8500   Min.   :-2.06000   Min.   :-2.3000
##  1st Qu.:  11.16   1st Qu.:-0.0200   1st Qu.:-0.14000   1st Qu.:-0.3100
##  Median :  87.54   Median : 0.1400   Median : 0.03000   Median :-0.1300
##  Mean   : 567.08   Mean   : 0.1823   Mean   : 0.04064   Mean   :-0.1505
##  3rd Qu.: 537.66   3rd Qu.: 0.3700   3rd Qu.: 0.21000   3rd Qu.: 0.0300
##  Max.   :9912.85   Max.   : 2.1400   Max.   : 4.37000   Max.   : 1.8700
##  NA's   :5763
##  accel_dumbbell_x  accel_dumbbell_y accel_dumbbell_z  magnet_dumbbell_x
##  Min.   :-237.00   Min.   :-182.0   Min.   :-272.00   Min.   :-638.0
##  1st Qu.: -50.00   1st Qu.:  -8.0   1st Qu.:-141.00   1st Qu.:-536.0
##  Median :  -9.00   Median :  39.0   Median :  -1.00   Median :-481.0
##  Mean   : -29.37   Mean   :  51.1   Mean   : -38.54   Mean   :-328.1
##  3rd Qu.:  10.00   3rd Qu.: 107.0   3rd Qu.:  38.00   3rd Qu.:-309.0
##  Max.   : 224.00   Max.   : 315.0   Max.   : 318.00   Max.   : 583.0
##
##  magnet_dumbbell_y magnet_dumbbell_z  roll_forearm     pitch_forearm
##  Min.   :-741.0    Min.   :-250.00   Min.   :-180.00   Min.   :-72.50
##  1st Qu.: 230.0    1st Qu.: -46.00   1st Qu.:  -1.86   1st Qu.:  0.00
##  Median : 308.0    Median :  12.00   Median :  18.70   Median :  9.29
##  Mean   : 214.2    Mean   :  45.02   Mean   :  31.96   Mean   : 10.98
##  3rd Qu.: 389.0    3rd Qu.:  93.00   3rd Qu.: 139.00   3rd Qu.: 28.40
##  Max.   : 632.0    Max.   : 447.00   Max.   : 180.00   Max.   : 89.80
##
##   yaw_forearm      kurtosis_roll_forearm kurtosis_picth_forearm
##  Min.   :-180.00   Min.   :-1.768        Min.   :-2.093
##  1st Qu.: -68.40   1st Qu.:-1.393        1st Qu.:-1.156
##  Median :   0.00   Median :-1.081        Median :-0.672
##  Mean   :  18.48   Mean   :-0.704        Mean   : 0.475
##  3rd Qu.: 108.00   3rd Qu.:-0.522        3rd Qu.: 0.195
##  Max.   : 180.00   Max.   : 8.804        Max.   :28.565
##                    NA's   :5790          NA's   :5790
##  kurtosis_yaw_forearm skewness_roll_forearm skewness_pitch_forearm
##  Mode:logical         Min.   :-1.841        Min.   :-4.501
```

```
##  NA's:5885           1st Qu.:-0.326        1st Qu.:-0.925
##                      Median : 0.166        Median :-0.048
##                      Mean   : 0.094        Mean   :-0.220
##                      3rd Qu.: 0.392        3rd Qu.: 0.700
##                      Max.   : 2.658        Max.   : 2.422
##                      NA's   :5790          NA's   :5790
##  skewness_yaw_forearm max_roll_forearm max_picth_forearm max_yaw_forearm
##  Mode:logical         Min.   :-64.00   Min.   :-151.00   Min.   :-1.800
##  NA's:5885            1st Qu.:  0.00   1st Qu.:   0.00   1st Qu.:-1.400
##                       Median : 23.30   Median :  91.60   Median :-1.100
##                       Mean   : 21.15   Mean   :  69.39   Mean   :-0.704
##                       3rd Qu.: 45.20   3rd Qu.: 167.75   3rd Qu.:-0.550
##                       Max.   : 79.80   Max.   : 180.00   Max.   : 8.800
##                       NA's   :5763     NA's   :5763      NA's   :5790
##  min_roll_forearm  min_pitch_forearm min_yaw_forearm
##  Min.   :-65.800   Min.   :-180.00   Min.   :-1.800
##  1st Qu.: -3.275   1st Qu.:-173.25   1st Qu.:-1.400
##  Median :  0.000   Median : -35.25   Median :-1.100
##  Mean   : -0.358   Mean   : -47.57   Mean   :-0.704
##  3rd Qu.: 12.250   3rd Qu.:   0.00   3rd Qu.:-0.550
##  Max.   : 47.200   Max.   : 167.00   Max.   : 8.800
##  NA's   :5763      NA's   :5763      NA's   :5790
##  amplitude_roll_forearm amplitude_pitch_forearm amplitude_yaw_forearm
##  Min.   :  0.00         Min.   :  0.0           Min.   :0
##  1st Qu.:  0.45         1st Qu.:  1.0           1st Qu.:0
##  Median : 10.95         Median : 71.5           Median :0
##  Mean   : 21.50         Mean   :117.0           Mean   :0
##  3rd Qu.: 36.93         3rd Qu.:149.9           3rd Qu.:0
##  Max.   :100.00         Max.   :360.0           Max.   :0
##  NA's   :5763           NA's   :5763            NA's   :5790
##  total_accel_forearm var_accel_forearm avg_roll_forearm
##  Min.   : 1.00       Min.   :  0.000   Min.   :-177.11
##  1st Qu.:29.00       1st Qu.:  6.801   1st Qu.:   0.00
##  Median :36.00       Median : 21.165   Median :  14.11
##  Mean   :34.75       Mean   : 33.088   Mean   :  32.08
##  3rd Qu.:41.00       3rd Qu.: 48.695   3rd Qu.: 116.18
##  Max.   :78.00       Max.   :172.606   Max.   : 177.26
##                      NA's   :5763      NA's   :5763
##  stddev_roll_forearm var_roll_forearm    avg_pitch_forearm
##  Min.   :  0.000     Min.   :    0.000   Min.   :-64.955
##  1st Qu.:  0.218     1st Qu.:    0.048   1st Qu.:  0.000
##  Median :  5.514     Median :   30.407   Median : 11.752
##  Mean   : 34.674     Mean   : 4173.835   Mean   :  9.827
##  3rd Qu.: 38.825     3rd Qu.: 1511.218   3rd Qu.: 27.181
##  Max.   :174.240     Max.   :30359.613   Max.   : 51.638
##  NA's   :5763        NA's   :5763        NA's   :5763
##  stddev_pitch_forearm var_pitch_forearm  avg_yaw_forearm
##  Min.   : 0.000       Min.   :   0.000   Min.   :-151.45
##  1st Qu.: 0.144       1st Qu.:   0.026   1st Qu.: -30.28
##  Median : 3.362       Median :  11.337   Median :   0.00
##  Mean   : 7.124       Mean   : 121.883   Mean   :  15.16
##  3rd Qu.:12.246       3rd Qu.: 149.973   3rd Qu.:  90.18
##  Max.   :36.832       Max.   :1356.572   Max.   : 169.24
##  NA's   :5763         NA's   :5763       NA's   :5763
```

```
##  stddev_yaw_forearm var_yaw_forearm     gyros_forearm_x
##  Min.   :  0.000    Min.   :    0.000   Min.   :-3.360
##  1st Qu.:  0.502    1st Qu.:    0.252   1st Qu.:-0.220
##  Median : 21.228    Median :  450.776   Median : 0.050
##  Mean   : 35.219    Mean   : 3153.415   Mean   : 0.165
##  3rd Qu.: 46.482    3rd Qu.: 2161.971   3rd Qu.: 0.580
##  Max.   :150.586    Max.   :22676.196   Max.   : 3.520
##  NA's   :5763       NA's   :5763
##  gyros_forearm_y    gyros_forearm_z   accel_forearm_x   accel_forearm_y
##  Min.   :-7.02000   Min.   :-7.9400   Min.   :-487.00   Min.   :-632
##  1st Qu.:-1.48000   1st Qu.:-0.1800   1st Qu.:-175.00   1st Qu.:  60
##  Median : 0.05000   Median : 0.0800   Median : -56.00   Median : 202
##  Mean   : 0.06667   Mean   : 0.1419   Mean   : -60.39   Mean   : 166
##  3rd Qu.: 1.64000   3rd Qu.: 0.4900   3rd Qu.:  76.00   3rd Qu.: 313
##  Max.   : 6.13000   Max.   : 4.3100   Max.   : 389.00   Max.   : 583
##
##  accel_forearm_z   magnet_forearm_x  magnet_forearm_y magnet_forearm_z
##  Min.   :-391.00   Min.   :-1280.0   Min.   :-892.0   Min.   :-973.0
##  1st Qu.:-181.00   1st Qu.: -619.0   1st Qu.:  17.0   1st Qu.: 193.0
##  Median : -42.00   Median : -380.0   Median : 598.0   Median : 512.0
##  Mean   : -55.64   Mean   : -313.6   Mean   : 385.3   Mean   : 394.4
##  3rd Qu.:  26.00   3rd Qu.:  -72.0   3rd Qu.: 738.0   3rd Qu.: 654.0
##  Max.   : 287.00   Max.   :  661.0   Max.   :1460.0   Max.   :1040.0
##
##  classe
##  A:1674
##  B:1139
##  C:1026
##  D: 964
##  E:1082
##
##
```

```
summary(useFinalTesting)
```

```
##        X            user_name raw_timestamp_part_1 raw_timestamp_part_2
##  Min.   : 1.00   adelmo  :1   Min.   :1.322e+09    Min.   : 36553
##  1st Qu.: 5.75   carlitos:3   1st Qu.:1.323e+09    1st Qu.:268655
##  Median :10.50   charles :1   Median :1.323e+09    Median :530706
##  Mean   :10.50   eurico  :4   Mean   :1.323e+09    Mean   :512167
##  3rd Qu.:15.25   jeremy  :8   3rd Qu.:1.323e+09    3rd Qu.:787738
##  Max.   :20.00   pedro   :3   Max.   :1.323e+09    Max.   :920315
##
##           cvtd_timestamp new_window   num_window      roll_belt
##  30/11/2011 17:11:4      no:20      Min.   : 48.0   Min.   : -5.9200
##  05/12/2011 11:24:3                 1st Qu.:250.0   1st Qu.:  0.9075
##  30/11/2011 17:12:3                 Median :384.5   Median :  1.1100
##  05/12/2011 14:23:2                 Mean   :379.6   Mean   : 31.3055
##  28/11/2011 14:14:2                 3rd Qu.:467.0   3rd Qu.: 32.5050
##  02/12/2011 13:33:1                 Max.   :859.0   Max.   :129.0000
##  (Other)         :5
##    pitch_belt         yaw_belt      total_accel_belt kurtosis_roll_belt
##  Min.   :-41.600   Min.   :-93.70   Min.   : 2.00    Mode:logical
##  1st Qu.:  3.013   1st Qu.:-88.62   1st Qu.: 3.00    NA's:20
```

```
##  Median :  4.655   Median :-87.85   Median : 4.00
##  Mean   :  5.824   Mean   :-59.30   Mean   : 7.55
##  3rd Qu.:  6.135   3rd Qu.:-63.50   3rd Qu.: 8.00
##  Max.   : 27.800   Max.   :162.00   Max.   :21.00
##
##  kurtosis_picth_belt kurtosis_yaw_belt skewness_roll_belt
##  Mode:logical        Mode:logical      Mode:logical
##  NA's:20             NA:s:20           NA:s:20
##
##
##
##
##
##  skewness_roll_belt.1 skewness_yaw_belt max_roll_belt  max_picth_belt
##  Mode:logical         Mode:logical      Mode:logical   Mode:logical
##  NA's:20              NA:s:20           NA:s:20        NA:s:20
##
##
##
##
##
##  max_yaw_belt   min_roll_belt  min_pitch_belt min_yaw_belt
##  Mode:logical   Mode:logical   Mode:logical   Mode:logical
##  NA's:20        NA:s:20        NA:s:20        NA:s:20
##
##
##
##
##
##  amplitude_roll_belt amplitude_pitch_belt amplitude_yaw_belt
##  Mode:logical        Mode:logical         Mode:logical
##  NA's:20             NA:s:20              NA:s:20
##
##
##
##
##
##  var_total_accel_belt avg_roll_belt  stddev_roll_belt var_roll_belt
##  Mode:logical         Mode:logical   Mode:logical     Mode:logical
##  NA's:20              NA:s:20        NA:s:20          NA:s:20
##
##
##
##
##
##  avg_pitch_belt stddev_pitch_belt var_pitch_belt avg_yaw_belt
##  Mode:logical   Mode:logical      Mode:logical   Mode:logical
##  NA's:20        NA:s:20           NA:s:20        NA:s:20
##
##
##
##
##
##  stddev_yaw_belt var_yaw_belt    gyros_belt_x     gyros_belt_y
```

```
##  Mode:logical    Mode:logical   Min.   :-0.500   Min.   :-0.050
##  NA's:20         NA's:20        1st Qu.:-0.070   1st Qu.:-0.005
##                                 Median : 0.020   Median : 0.000
##                                 Mean   :-0.045   Mean   : 0.010
##                                 3rd Qu.: 0.070   3rd Qu.: 0.020
##                                 Max.   : 0.240   Max.   : 0.110
##
##   gyros_belt_z      accel_belt_x     accel_belt_y     accel_belt_z
##  Min.   :-0.4800   Min.   :-48.00   Min.   :-16.00   Min.   :-187.00
##  1st Qu.:-0.1375   1st Qu.:-19.00   1st Qu.:  2.00   1st Qu.: -24.00
##  Median :-0.0250   Median :-13.00   Median :  4.50   Median :  27.00
##  Mean   :-0.1005   Mean   :-13.50   Mean   : 18.35   Mean   : -17.60
##  3rd Qu.: 0.0000   3rd Qu.: -8.75   3rd Qu.: 25.50   3rd Qu.:  38.25
##  Max.   : 0.0500   Max.   : 46.00   Max.   : 72.00   Max.   :  49.00
##
##  magnet_belt_x    magnet_belt_y   magnet_belt_z       roll_arm
##  Min.   :-13.00   Min.   :566.0   Min.   :-426.0   Min.   :-137.00
##  1st Qu.:  5.50   1st Qu.:578.5   1st Qu.:-398.5   1st Qu.:   0.00
##  Median : 33.50   Median :600.5   Median :-313.5   Median :   0.00
##  Mean   : 35.15   Mean   :601.5   Mean   :-346.9   Mean   :  16.42
##  3rd Qu.: 46.25   3rd Qu.:631.2   3rd Qu.:-305.0   3rd Qu.:  71.53
##  Max.   :169.00   Max.   :638.0   Max.   :-291.0   Max.   : 152.00
##
##    pitch_arm          yaw_arm        total_accel_arm var_accel_arm
##  Min.   :-63.800   Min.   :-167.00   Min.   : 3.00   Mode:logical
##  1st Qu.: -9.188   1st Qu.: -60.15   1st Qu.:20.25   NA's:20
##  Median :  0.000   Median :   0.00   Median :29.50
##  Mean   : -3.950   Mean   :  -2.80   Mean   :26.40
##  3rd Qu.:  3.465   3rd Qu.:  25.50   3rd Qu.:33.25
##  Max.   : 55.000   Max.   : 178.00   Max.   :44.00
##
##  avg_roll_arm   stddev_roll_arm var_roll_arm   avg_pitch_arm
##  Mode:logical   Mode:logical    Mode:logical   Mode:logical
##  NA's:20        NA's:20         NA's:20        NA's:20
##
##
##
##
##
##  stddev_pitch_arm var_pitch_arm  avg_yaw_arm    stddev_yaw_arm
##  Mode:logical     Mode:logical   Mode:logical   Mode:logical
##  NA's:20          NA's:20        NA's:20        NA's:20
##
##
##
##
##
##  var_yaw_arm     gyros_arm_x      gyros_arm_y       gyros_arm_z
##  Mode:logical   Min.   :-3.710   Min.   :-2.0900   Min.   :-0.6900
##  NA's:20        1st Qu.:-0.645   1st Qu.:-0.6350   1st Qu.:-0.1800
##                 Median : 0.020   Median :-0.0400   Median :-0.0250
##                 Mean   : 0.077   Mean   :-0.1595   Mean   : 0.1205
##                 3rd Qu.: 1.248   3rd Qu.: 0.2175   3rd Qu.: 0.5650
##                 Max.   : 3.660   Max.   : 1.8500   Max.   : 1.1300
```

```
##
##   accel_arm_x      accel_arm_y      accel_arm_z       magnet_arm_x
##  Min.   :-341.0   Min.   :-65.00   Min.   :-404.00   Min.   :-428.00
##  1st Qu.:-277.0   1st Qu.: 52.25   1st Qu.:-128.50   1st Qu.:-373.75
##  Median :-194.5   Median :112.00   Median : -83.50   Median :-265.00
##  Mean   :-134.6   Mean   :103.10   Mean   : -87.85   Mean   : -38.95
##  3rd Qu.:   5.5   3rd Qu.:168.25   3rd Qu.: -27.25   3rd Qu.: 250.50
##  Max.   : 106.0   Max.   :245.00   Max.   :  93.00   Max.   : 750.00
##
##   magnet_arm_y     magnet_arm_z    kurtosis_roll_arm kurtosis_picth_arm
##  Min.   :-307.0   Min.   :-499.0   Mode:logical      Mode:logical
##  1st Qu.: 205.2   1st Qu.: 403.0   NA's:20           NA's:20
##  Median : 291.0   Median : 476.5
##  Mean   : 239.4   Mean   : 369.8
##  3rd Qu.: 358.8   3rd Qu.: 517.0
##  Max.   : 474.0   Max.   : 633.0
##
##  kurtosis_yaw_arm skewness_roll_arm skewness_pitch_arm skewness_yaw_arm
##  Mode:logical     Mode:logical      Mode:logical       Mode:logical
##  NA's:20          NA's:20           NA's:20            NA's:20
##
##
##
##
##
##  max_roll_arm   max_picth_arm  max_yaw_arm    min_roll_arm
##  Mode:logical   Mode:logical   Mode:logical   Mode:logical
##  NA's:20        NA's:20        NA's:20        NA's:20
##
##
##
##
##
##  min_pitch_arm  min_yaw_arm    amplitude_roll_arm amplitude_pitch_arm
##  Mode:logical   Mode:logical   Mode:logical       Mode:logical
##  NA's:20        NA's:20        NA's:20            NA's:20
##
##
##
##
##
##  amplitude_yaw_arm roll_dumbbell      pitch_dumbbell    yaw_dumbbell
##  Mode:logical      Min.   :-111.118   Min.   :-54.97   Min.   :-103.3200
##  NA's:20           1st Qu.:   7.494   1st Qu.:-51.89   1st Qu.: -75.2809
##                    Median :  50.403   Median :-40.81   Median :  -8.2863
##                    Mean   :  33.760   Mean   :-19.47   Mean   :  -0.9385
##                    3rd Qu.:  58.129   3rd Qu.: 16.12   3rd Qu.:  55.8335
##                    Max.   : 123.984   Max.   : 96.87   Max.   : 132.2337
##
##  kurtosis_roll_dumbbell kurtosis_picth_dumbbell kurtosis_yaw_dumbbell
##  Mode:logical           Mode:logical            Mode:logical
##  NA's:20                NA's:20                 NA's:20
##
##
```

```
##
##
##
##  skewness_roll_dumbbell skewness_pitch_dumbbell skewness_yaw_dumbbell
##  Mode:logical           Mode:logical            Mode:logical
##  NA's:20                NA's:20                 NA's:20
##
##
##
##
##
##  max_roll_dumbbell max_picth_dumbbell max_yaw_dumbbell min_roll_dumbbell
##  Mode:logical      Mode:logical       Mode:logical     Mode:logical
##  NA's:20           NA's:20            NA's:20          NA's:20
##
##
##
##
##
##  min_pitch_dumbbell min_yaw_dumbbell amplitude_roll_dumbbell
##  Mode:logical       Mode:logical     Mode:logical
##  NA's:20            NA's:20          NA's:20
##
##
##
##
##
##  amplitude_pitch_dumbbell amplitude_yaw_dumbbell total_accel_dumbbell
##  Mode:logical             Mode:logical           Min.   : 1.0
##  NA's:20                  NA's:20                1st Qu.: 7.0
##                                                  Median :15.5
##                                                  Mean   :17.2
##                                                  3rd Qu.:29.0
##                                                  Max.   :31.0
##
##  var_accel_dumbbell avg_roll_dumbbell stddev_roll_dumbbell
##  Mode:logical       Mode:logical      Mode:logical
##  NA's:20            NA's:20           NA's:20
##
##
##
##
##
##  var_roll_dumbbell avg_pitch_dumbbell stddev_pitch_dumbbell
##  Mode:logical      Mode:logical       Mode:logical
##  NA's:20           NA's:20            NA's:20
##
##
##
##
##
##  var_pitch_dumbbell avg_yaw_dumbbell stddev_yaw_dumbbell var_yaw_dumbbell
##  Mode:logical       Mode:logical     Mode:logical        Mode:logical
##  NA's:20            NA's:20          NA's:20             NA's:20
```

```
##
##
##
##
##
##  gyros_dumbbell_x  gyros_dumbbell_y  gyros_dumbbell_z accel_dumbbell_x
##  Min.   :-1.0300   Min.   :-1.1100   Min.   :-1.180   Min.   :-159.00
##  1st Qu.: 0.1600   1st Qu.:-0.2100   1st Qu.:-0.485   1st Qu.:-140.25
##  Median : 0.3600   Median : 0.0150   Median :-0.280   Median : -19.00
##  Mean   : 0.2690   Mean   : 0.0605   Mean   :-0.266   Mean   : -47.60
##  3rd Qu.: 0.4625   3rd Qu.: 0.1450   3rd Qu.:-0.165   3rd Qu.:  15.75
##  Max.   : 1.0600   Max.   : 1.9100   Max.   : 1.100   Max.   : 185.00
##
##  accel_dumbbell_y accel_dumbbell_z magnet_dumbbell_x magnet_dumbbell_y
##  Min.   :-30.00   Min.   :-221.0   Min.   :-576.0    Min.   :-558.0
##  1st Qu.:  5.75   1st Qu.:-192.2   1st Qu.:-528.0    1st Qu.: 259.5
##  Median : 71.50   Median :  -3.0   Median :-508.5    Median : 316.0
##  Mean   : 70.55   Mean   : -60.0   Mean   :-304.2    Mean   : 189.3
##  3rd Qu.:151.25   3rd Qu.:  76.5   3rd Qu.:-317.0    3rd Qu.: 348.2
##  Max.   :166.00   Max.   : 100.0   Max.   : 523.0    Max.   : 403.0
##
##  magnet_dumbbell_z  roll_forearm     pitch_forearm      yaw_forearm
##  Min.   :-164.00   Min.   :-176.00   Min.   :-63.500   Min.   :-168.000
##  1st Qu.: -33.00   1st Qu.: -40.25   1st Qu.:-11.457   1st Qu.: -93.375
##  Median :  49.50   Median :  94.20   Median :  8.830   Median : -19.250
##  Mean   :  71.40   Mean   :  38.66   Mean   :  7.099   Mean   :   2.195
##  3rd Qu.:  96.25   3rd Qu.: 143.25   3rd Qu.: 28.500   3rd Qu.: 104.500
##  Max.   : 368.00   Max.   : 176.00   Max.   : 59.300   Max.   : 159.000
##
##  kurtosis_roll_forearm kurtosis_picth_forearm kurtosis_yaw_forearm
##  Mode:logical          Mode:logical           Mode:logical
##  NA's:20               NA's:20                NA's:20
##
##
##
##
##
##  skewness_roll_forearm skewness_pitch_forearm skewness_yaw_forearm
##  Mode:logical          Mode:logical           Mode:logical
##  NA's:20               NA's:20                NA's:20
##
##
##
##
##
##  max_roll_forearm max_picth_forearm max_yaw_forearm min_roll_forearm
##  Mode:logical     Mode:logical      Mode:logical    Mode:logical
##  NA's:20          NA's:20           NA's:20         NA's:20
##
##
##
##
##
##  min_pitch_forearm min_yaw_forearm amplitude_roll_forearm
```

```
##  Mode:logical      Mode:logical    Mode:logical
##  NA's:20           NA's:20         NA's:20
##
##
##
##
##
##  amplitude_pitch_forearm amplitude_yaw_forearm total_accel_forearm
##  Mode:logical            Mode:logical          Min.   :21.00
##  NA's:20                 NA's:20               1st Qu.:24.00
##                                                Median :32.50
##                                                Mean   :32.05
##                                                3rd Qu.:36.75
##                                                Max.   :47.00
##
##  var_accel_forearm avg_roll_forearm stddev_roll_forearm var_roll_forearm
##  Mode:logical      Mode:logical     Mode:logical        Mode:logical
##  NA's:20           NA's:20          NA's:20             NA's:20
##
##
##
##
##
##  avg_pitch_forearm stddev_pitch_forearm var_pitch_forearm avg_yaw_forearm
##  Mode:logical      Mode:logical         Mode:logical      Mode:logical
##  NA's:20           NA's:20              NA's:20           NA's:20
##
##
##
##
##
##  stddev_yaw_forearm var_yaw_forearm gyros_forearm_x   gyros_forearm_y
##  Mode:logical       Mode:logical    Min.   :-1.0600   Min.   :-5.9700
##  NA's:20            NA's:20         1st Qu.:-0.5850   1st Qu.:-1.2875
##                                     Median : 0.0200   Median : 0.0350
##                                     Mean   :-0.0200   Mean   :-0.0415
##                                     3rd Qu.: 0.2925   3rd Qu.: 2.0475
##                                     Max.   : 1.3800   Max.   : 4.2600
##
##  gyros_forearm_z   accel_forearm_x  accel_forearm_y  accel_forearm_z
##  Min.   :-1.2600   Min.   :-212.0   Min.   :-331.0   Min.   :-282.0
##  1st Qu.:-0.0975   1st Qu.:-114.8   1st Qu.:   8.5   1st Qu.:-199.0
##  Median : 0.2300   Median :  86.0   Median : 138.0   Median :-148.5
##  Mean   : 0.2610   Mean   :  38.8   Mean   : 125.3   Mean   : -93.7
##  3rd Qu.: 0.7625   3rd Qu.: 166.2   3rd Qu.: 268.0   3rd Qu.: -31.0
##  Max.   : 1.8000   Max.   : 232.0   Max.   : 406.0   Max.   : 179.0
##
##  magnet_forearm_x magnet_forearm_y magnet_forearm_z
##  Min.   :-714.0   Min.   :-787.0   Min.   :-32.0
##  1st Qu.:-427.2   1st Qu.:-328.8   1st Qu.:275.2
##  Median :-189.5   Median : 487.0   Median :491.5
##  Mean   :-159.2   Mean   : 191.8   Mean   :460.2
##  3rd Qu.:  41.5   3rd Qu.: 720.8   3rd Qu.:661.5
##  Max.   : 532.0   Max.   : 800.0   Max.   :884.0
```

##

```
#(finalPrediction <- predict(modelFit, useFinalTesting, type="class"))
```